

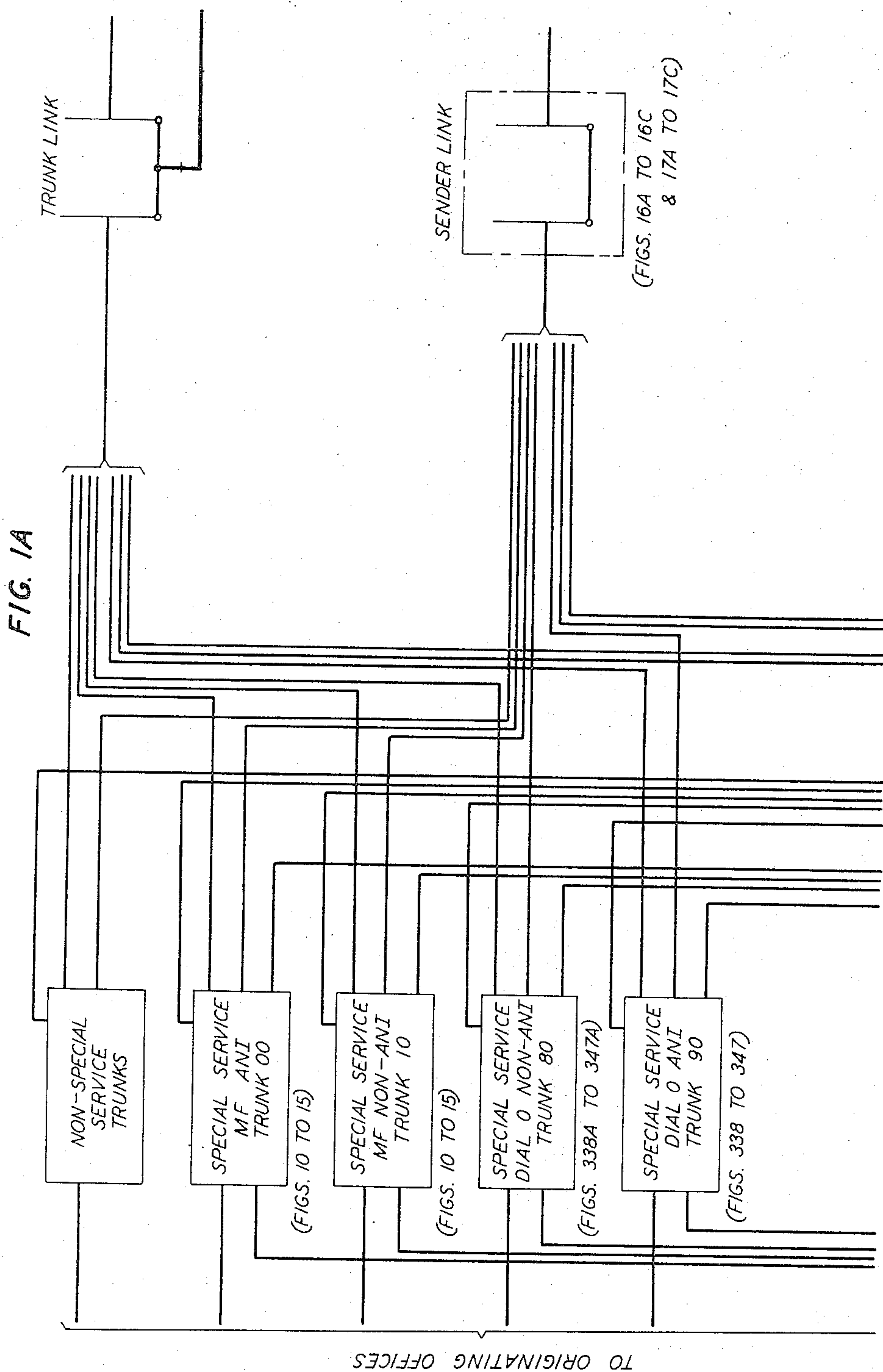
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R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
INTERMEDIATE SWITCHING CENTER

3,341,661

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INVENTOR  
R. B. CURTIS  
BY  
Donald M. Cluett  
ATTORNEY



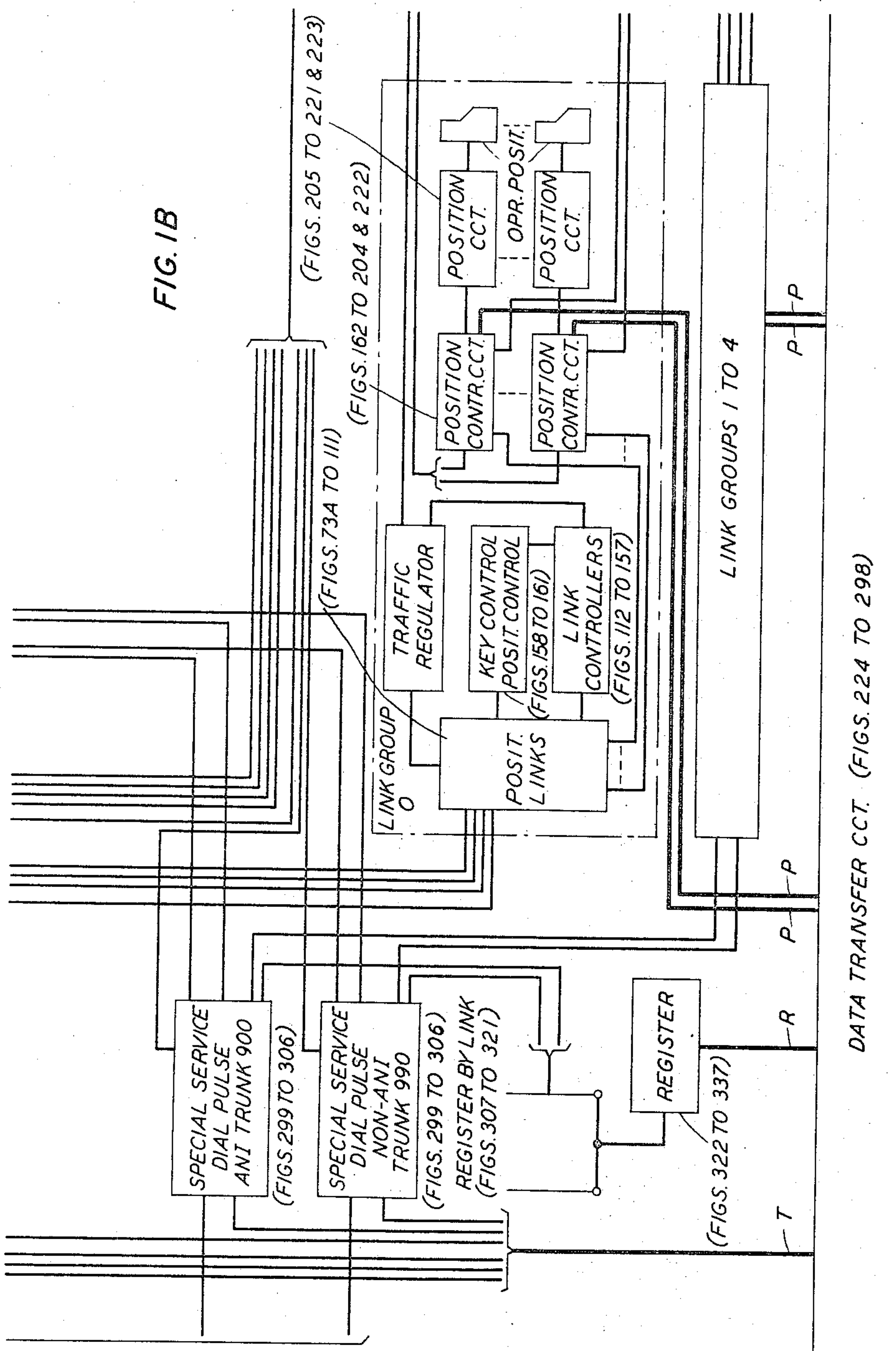
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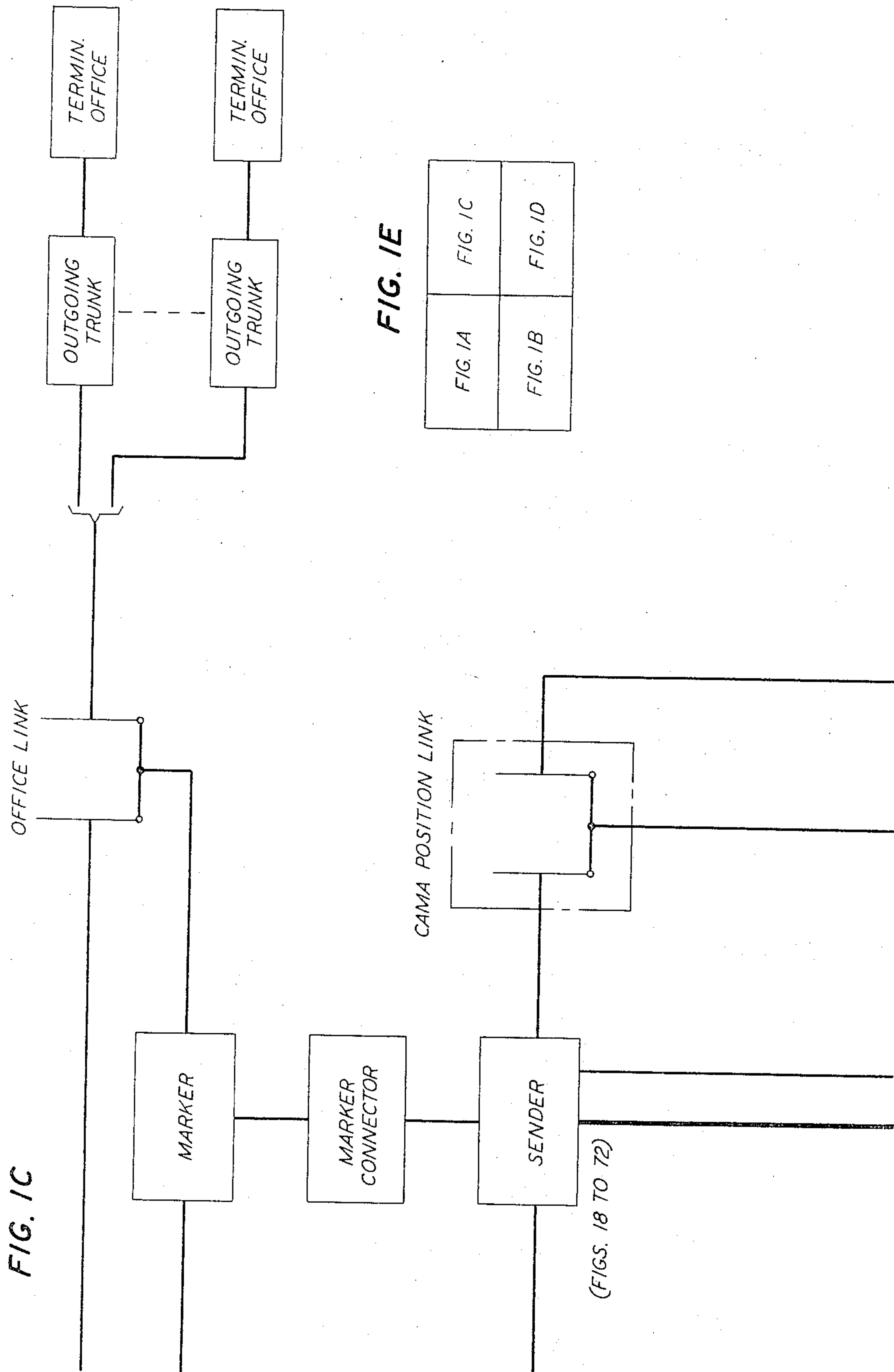
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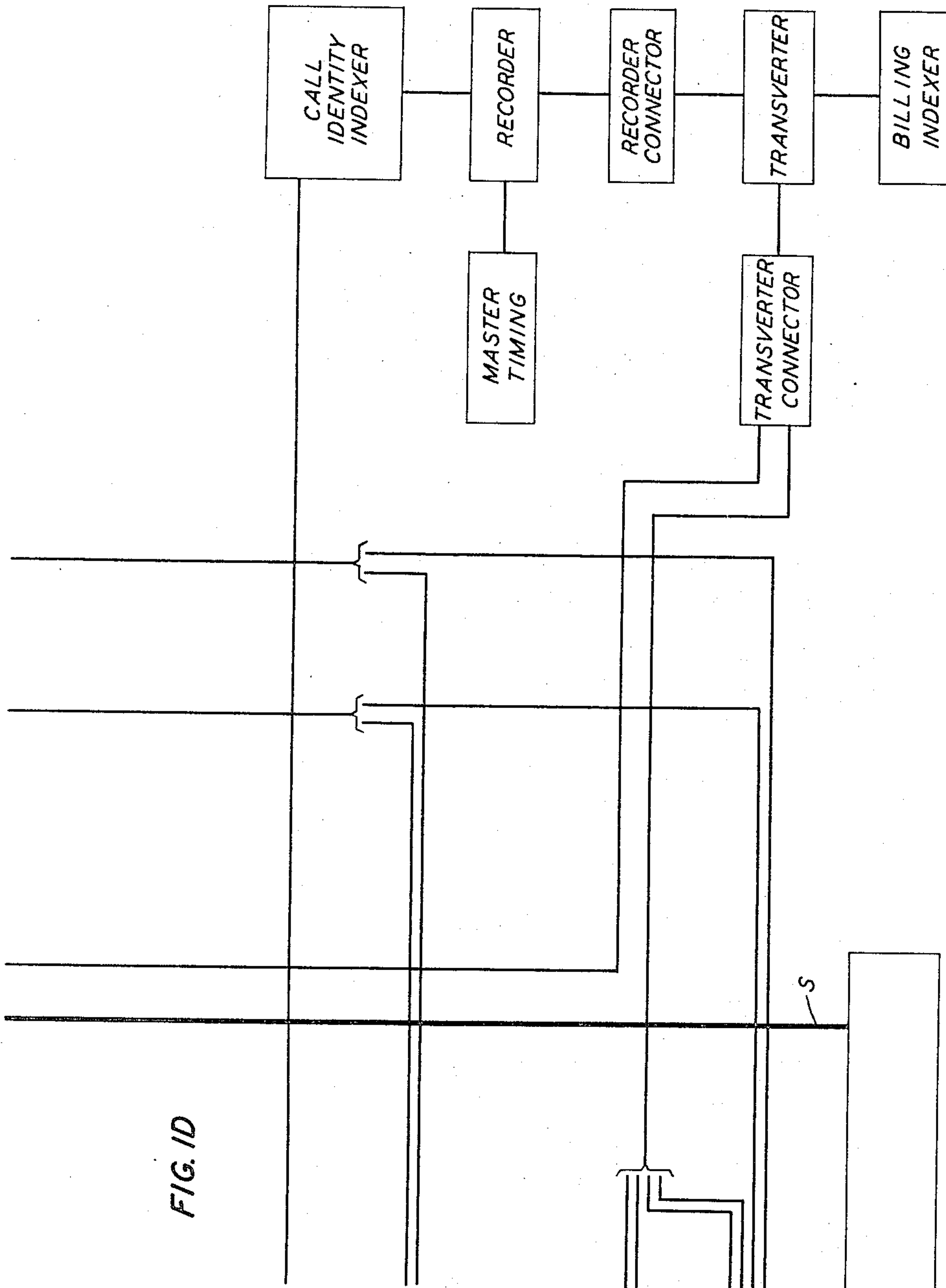
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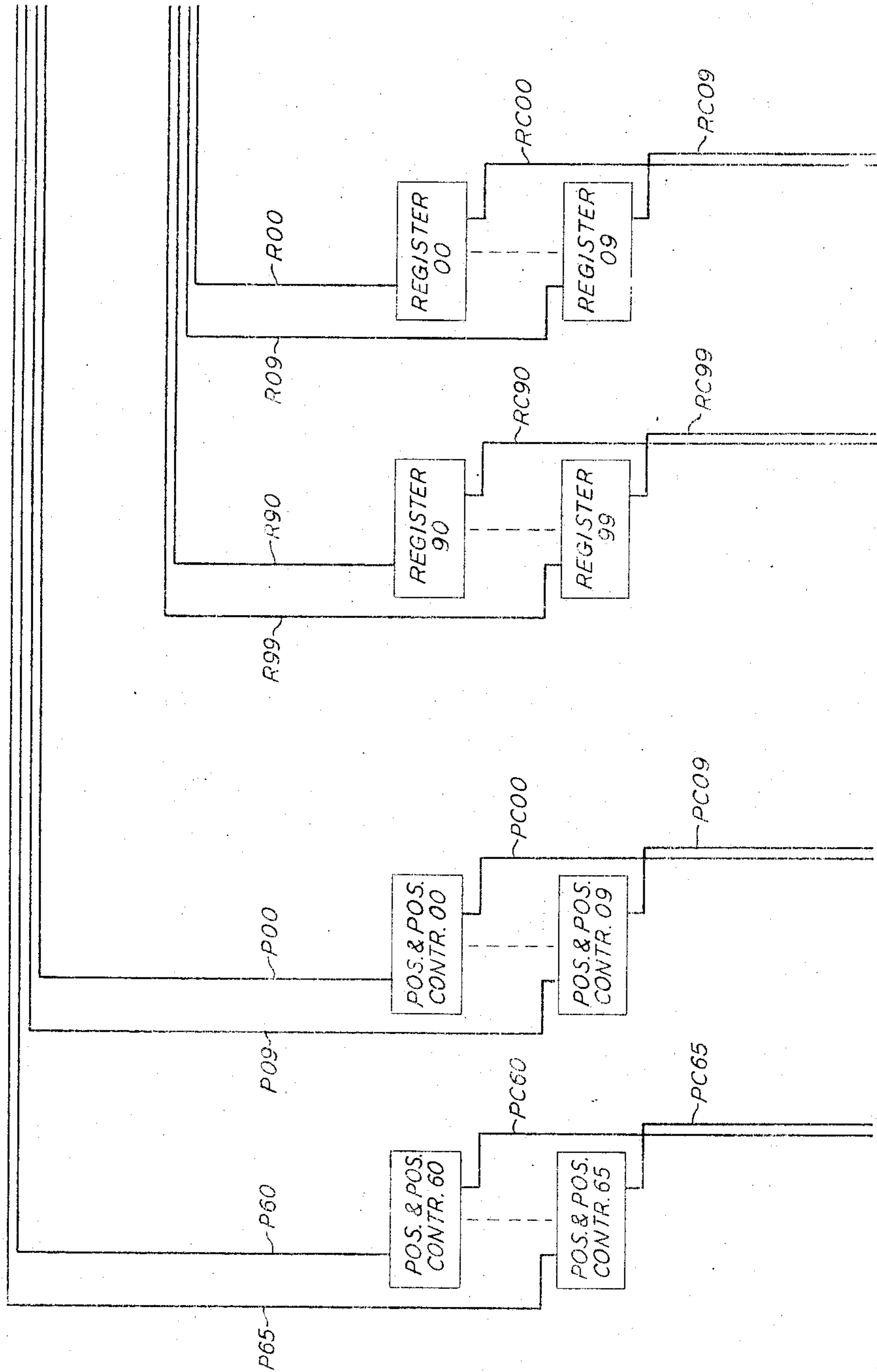
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FIG. 2A





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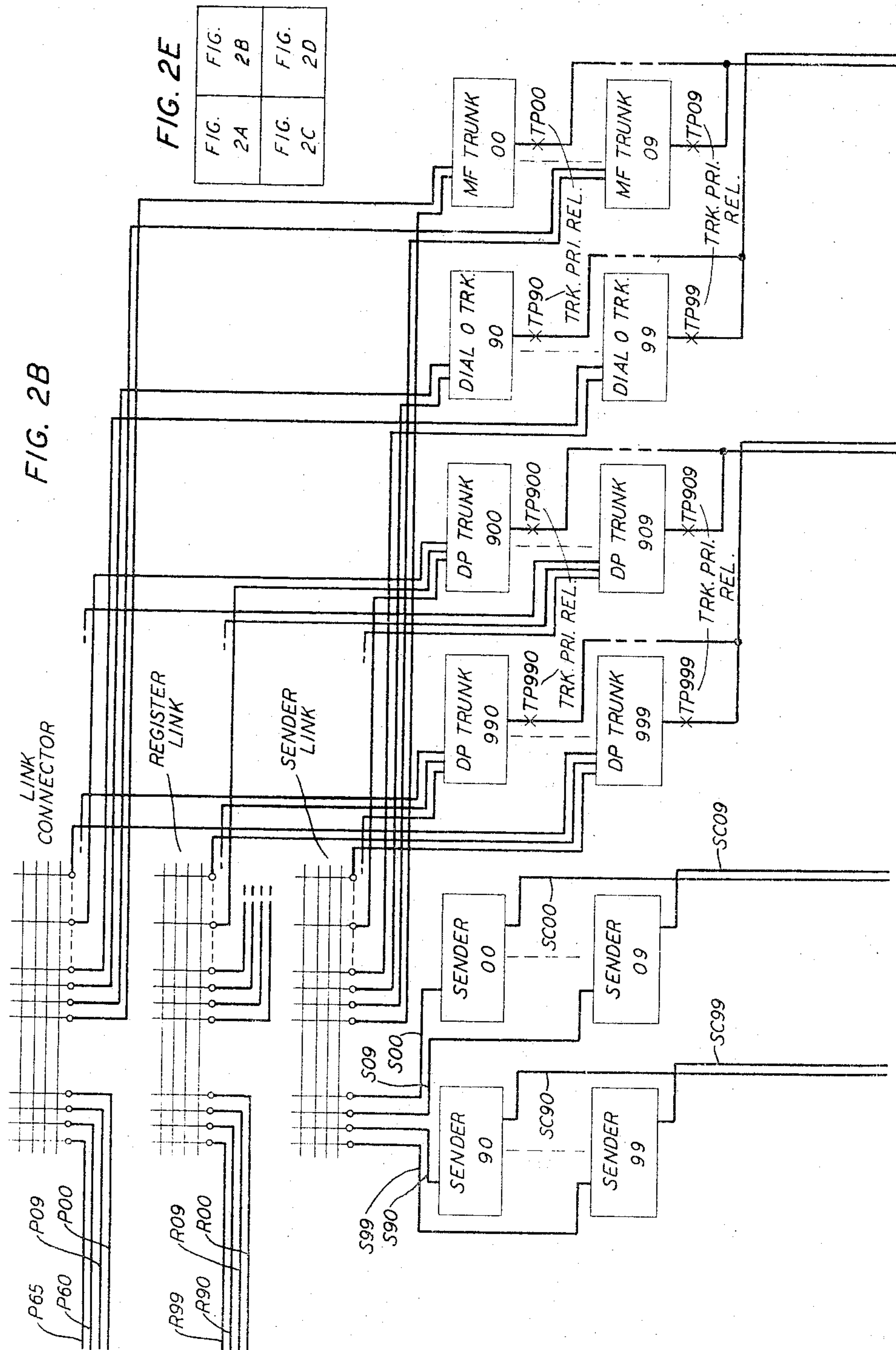
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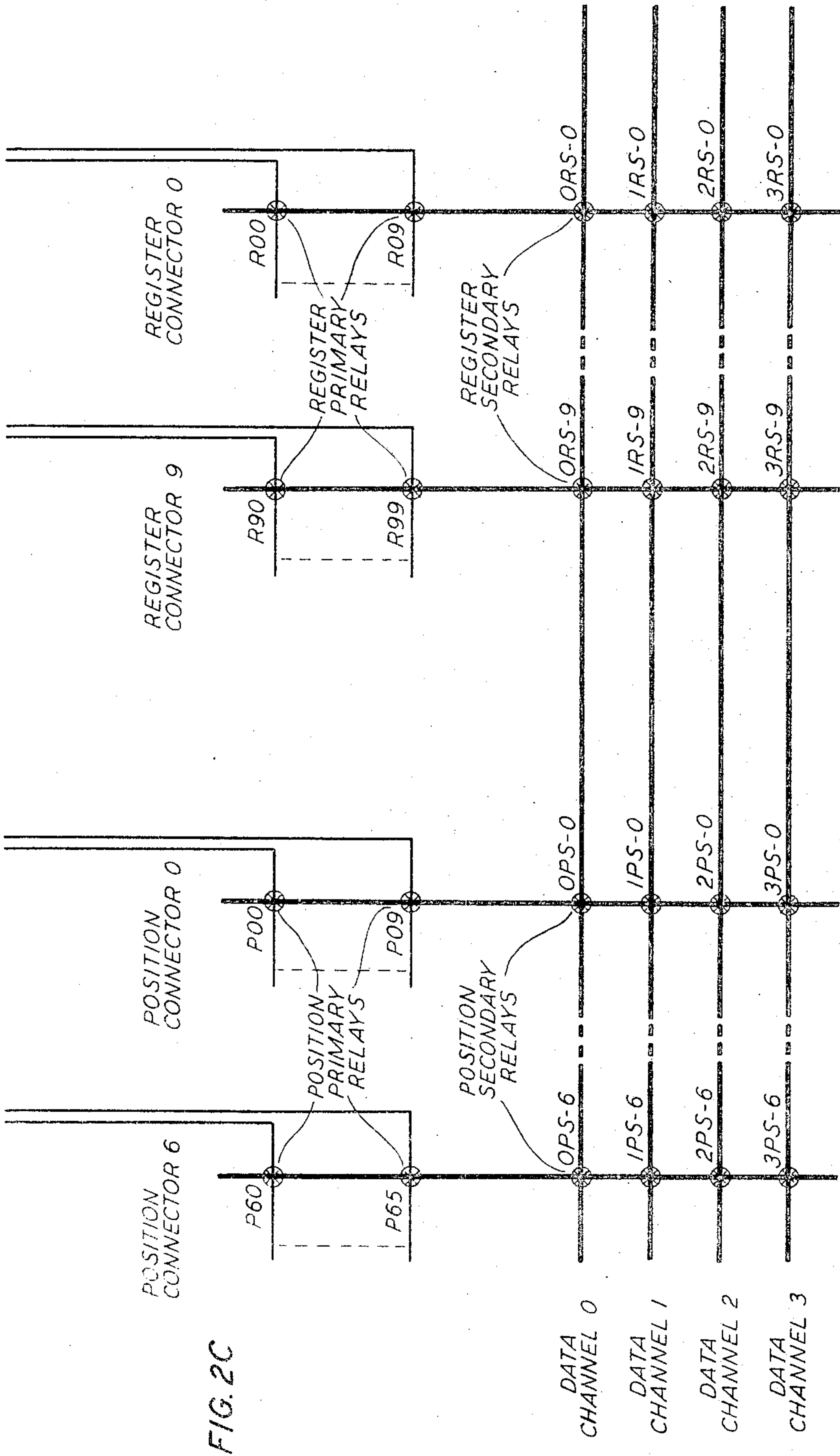
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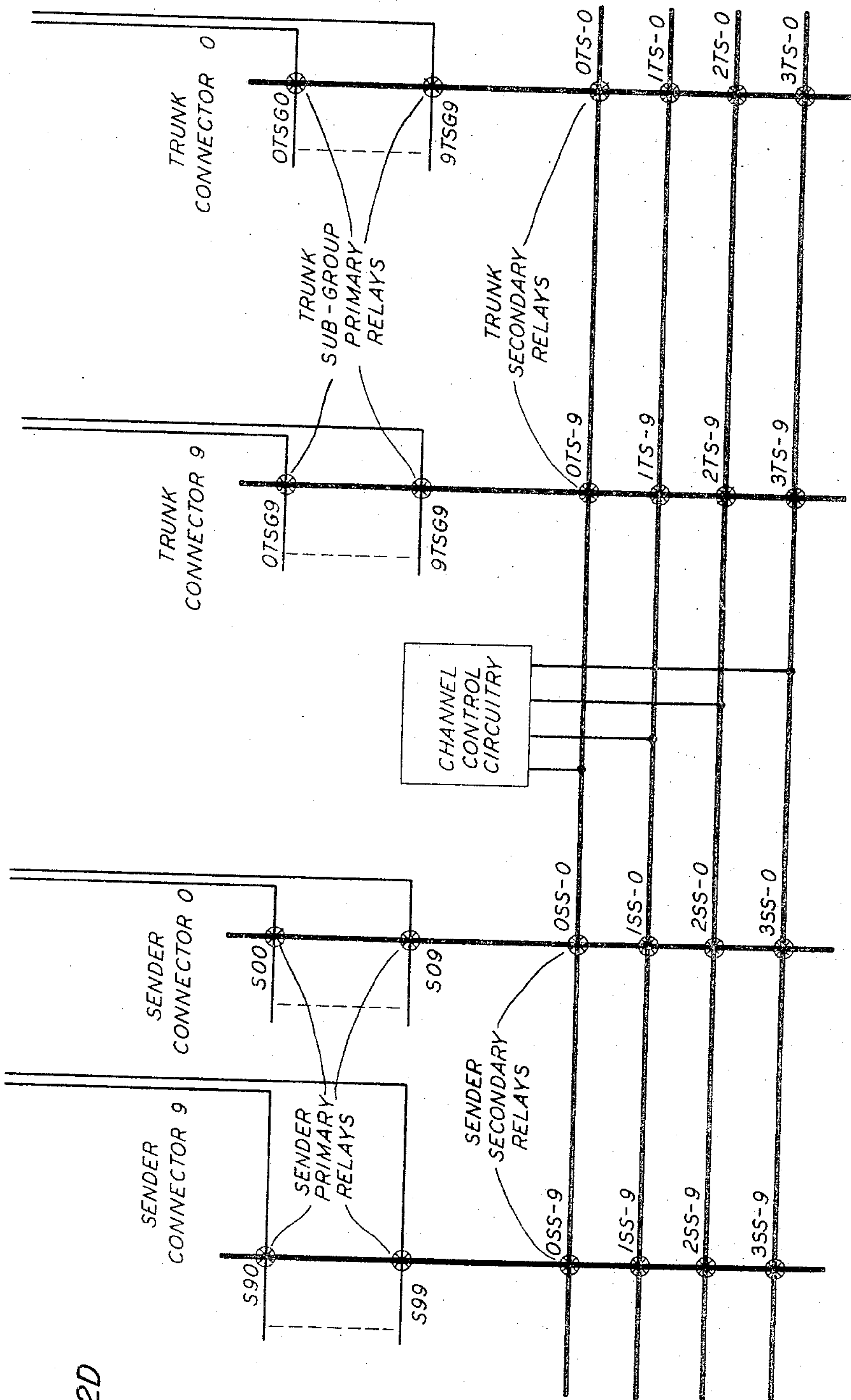
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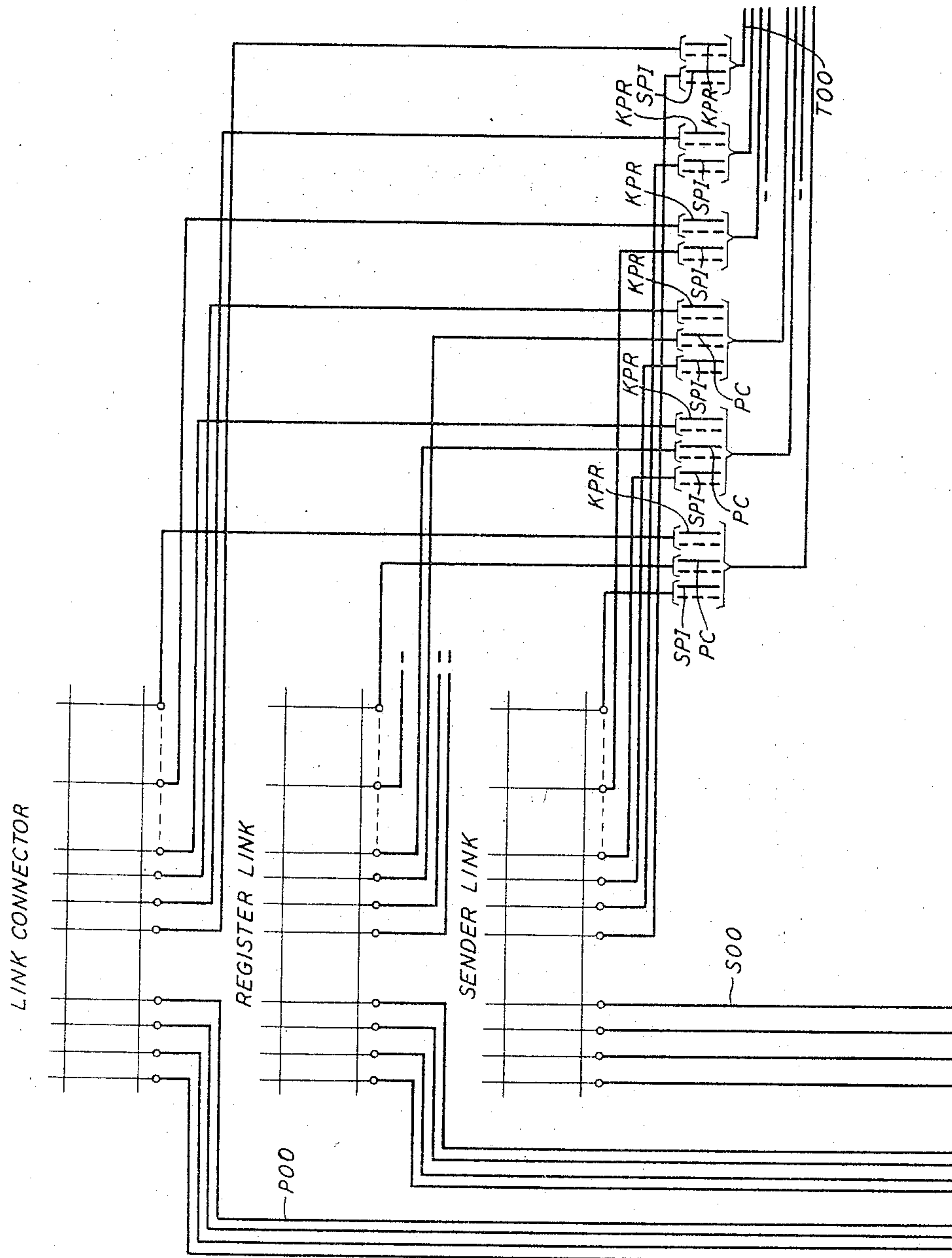


FIG. 3A



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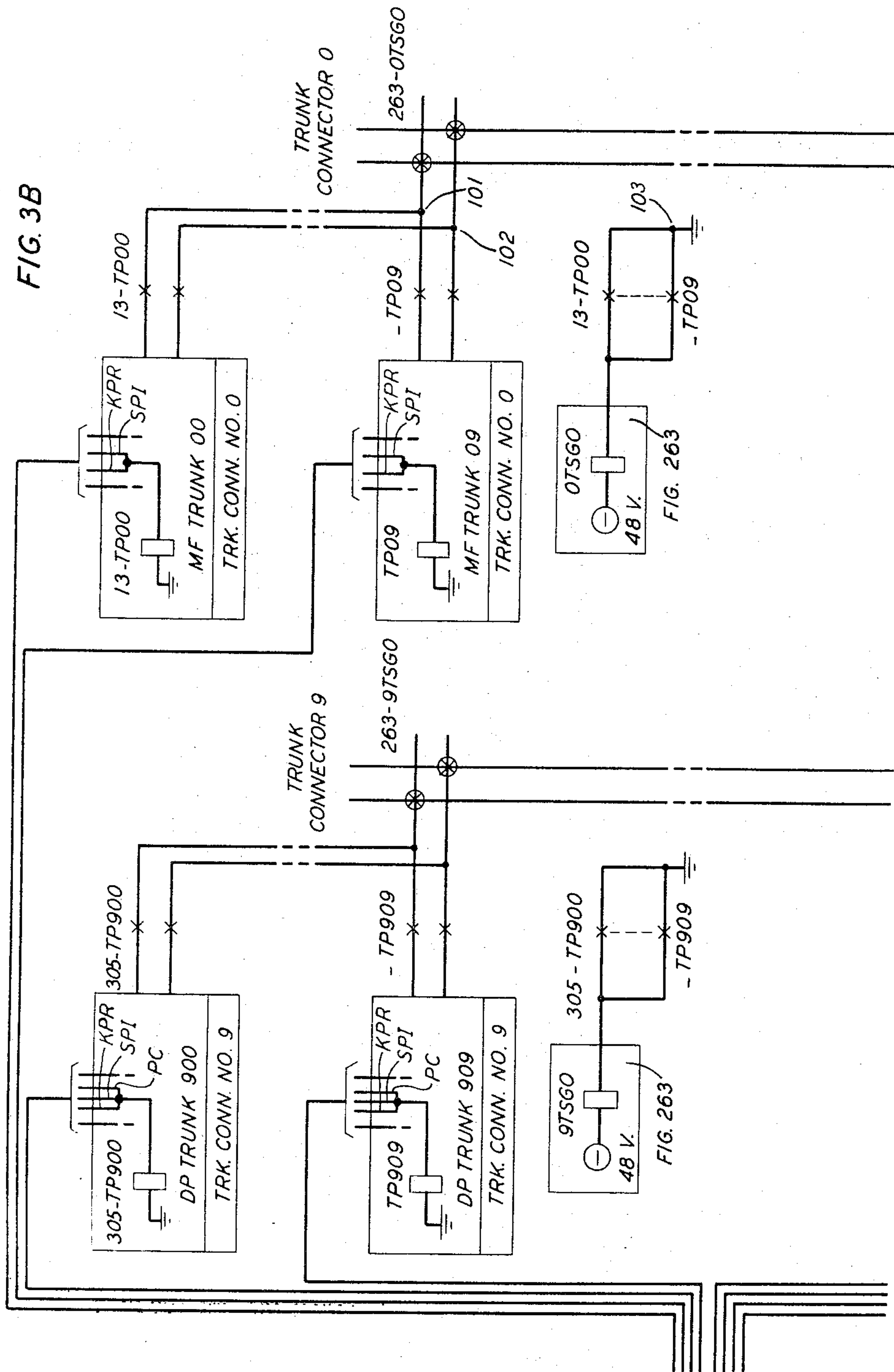
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FIG. 3C

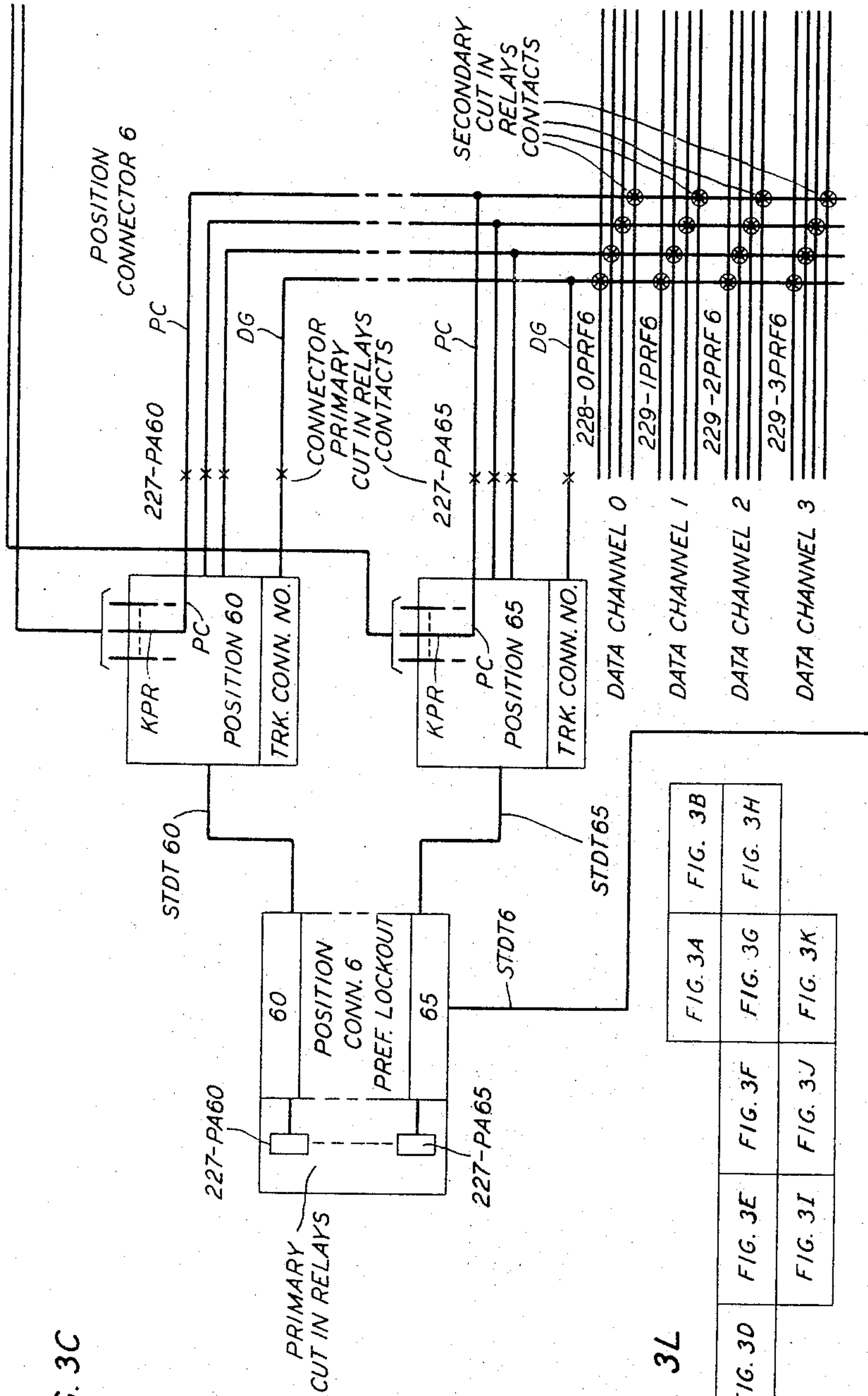


FIG. 3L

|         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|
| FIG. 3C | FIG. 3D | FIG. 3E | FIG. 3F | FIG. 3G | FIG. 3H |
|         |         | FIG. 3I | FIG. 3J | FIG. 3K |         |



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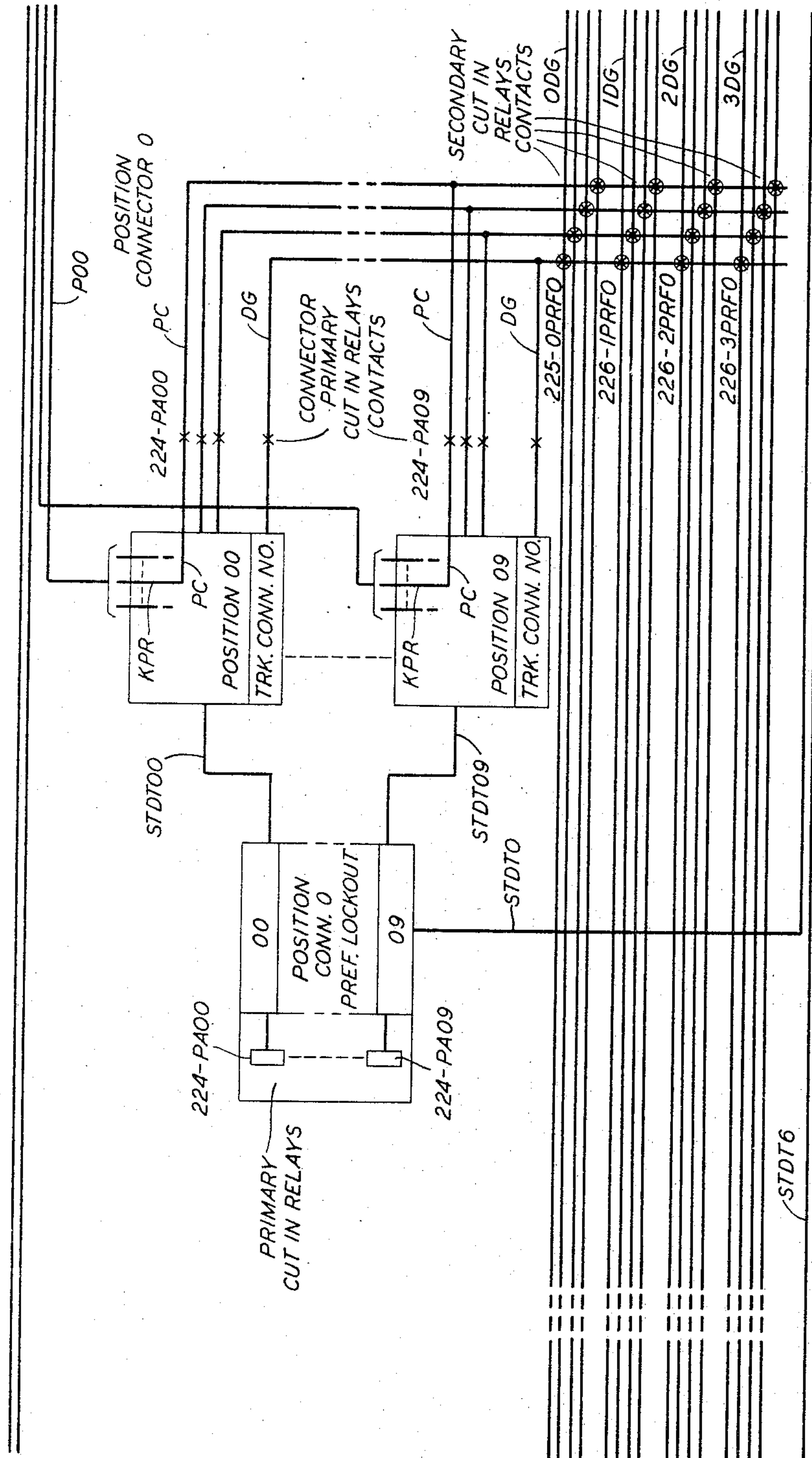
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FIG. 3D





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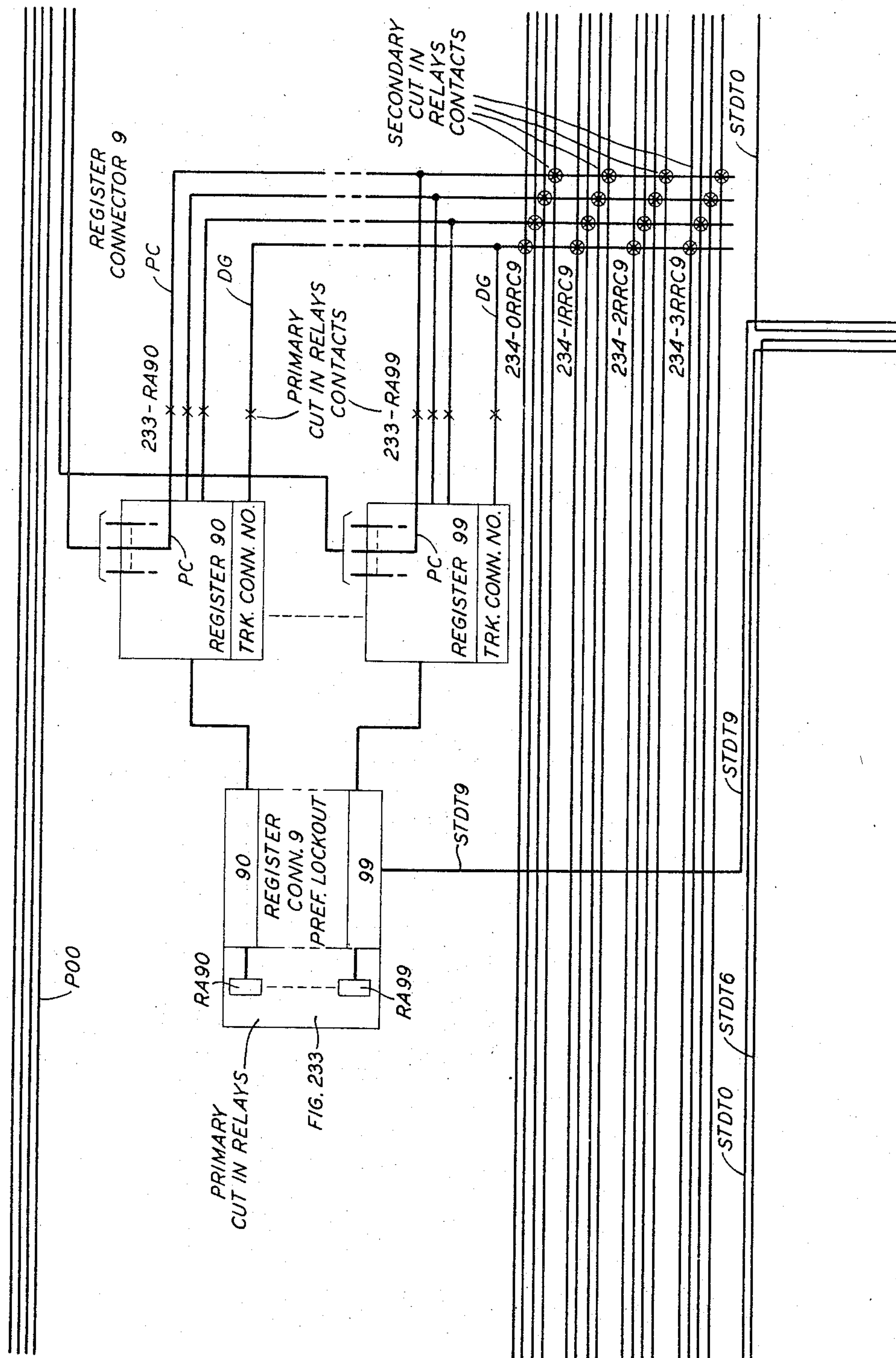
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FIG. 3E





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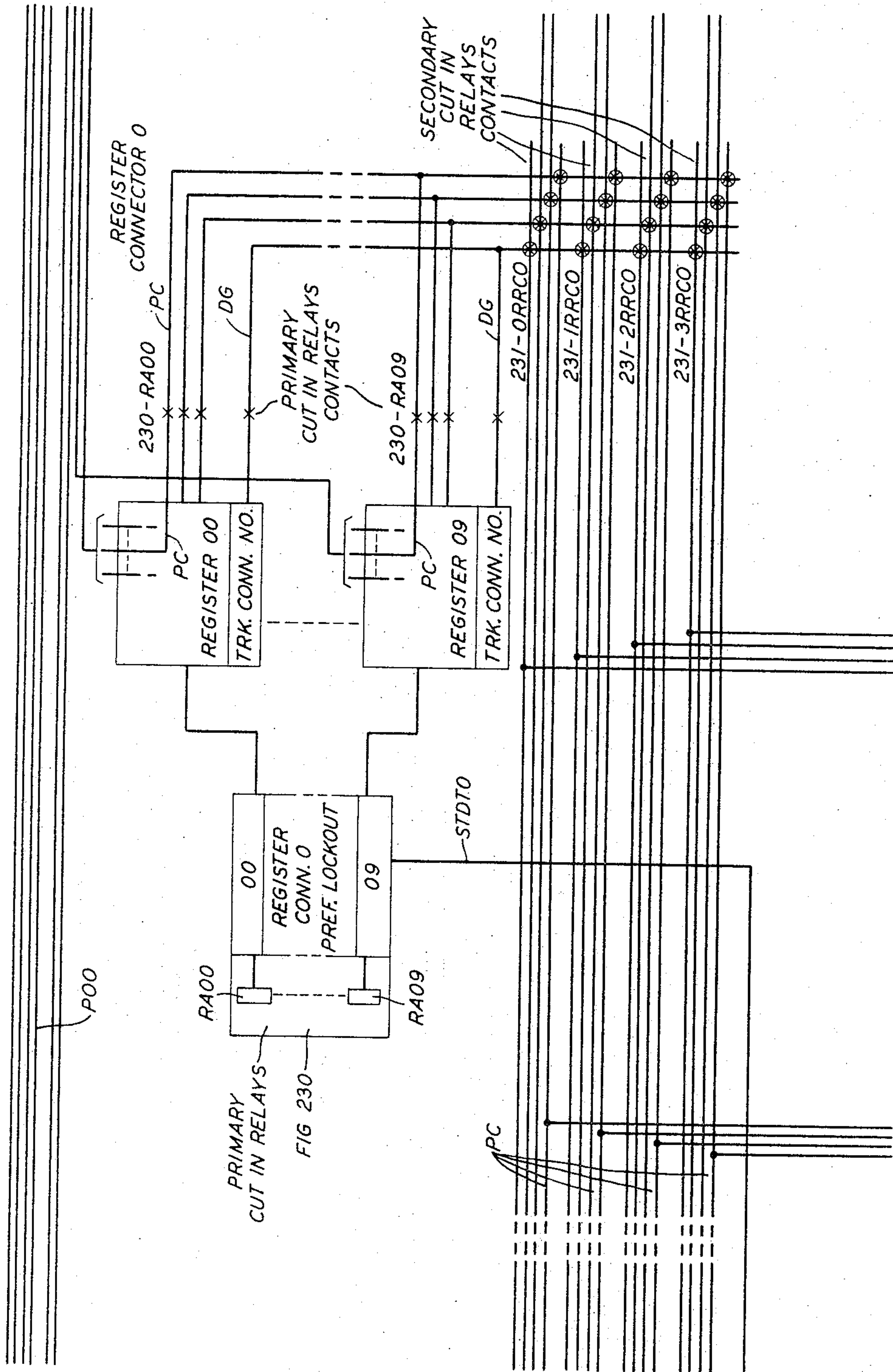
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FIG. 3F





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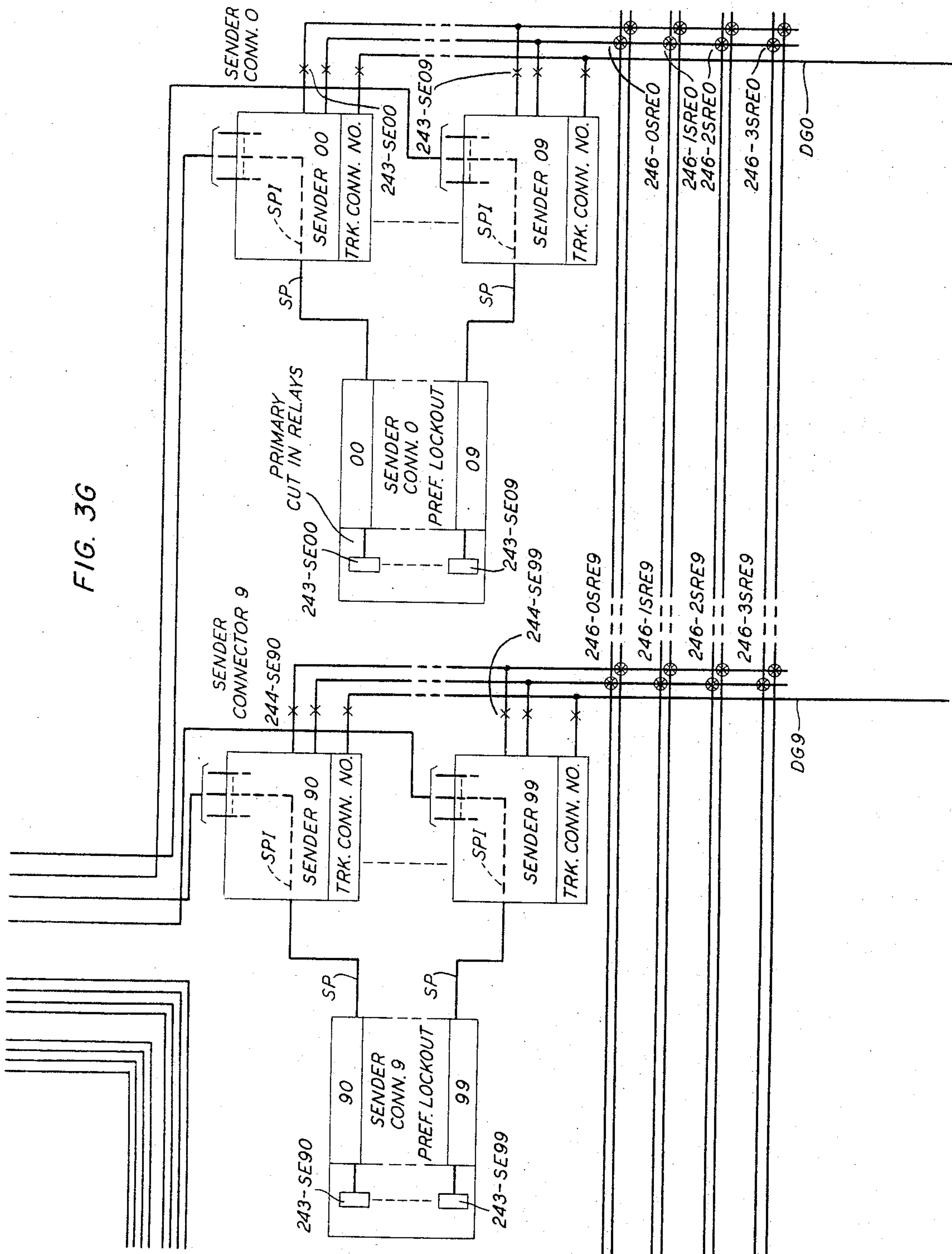
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FIG. 3G





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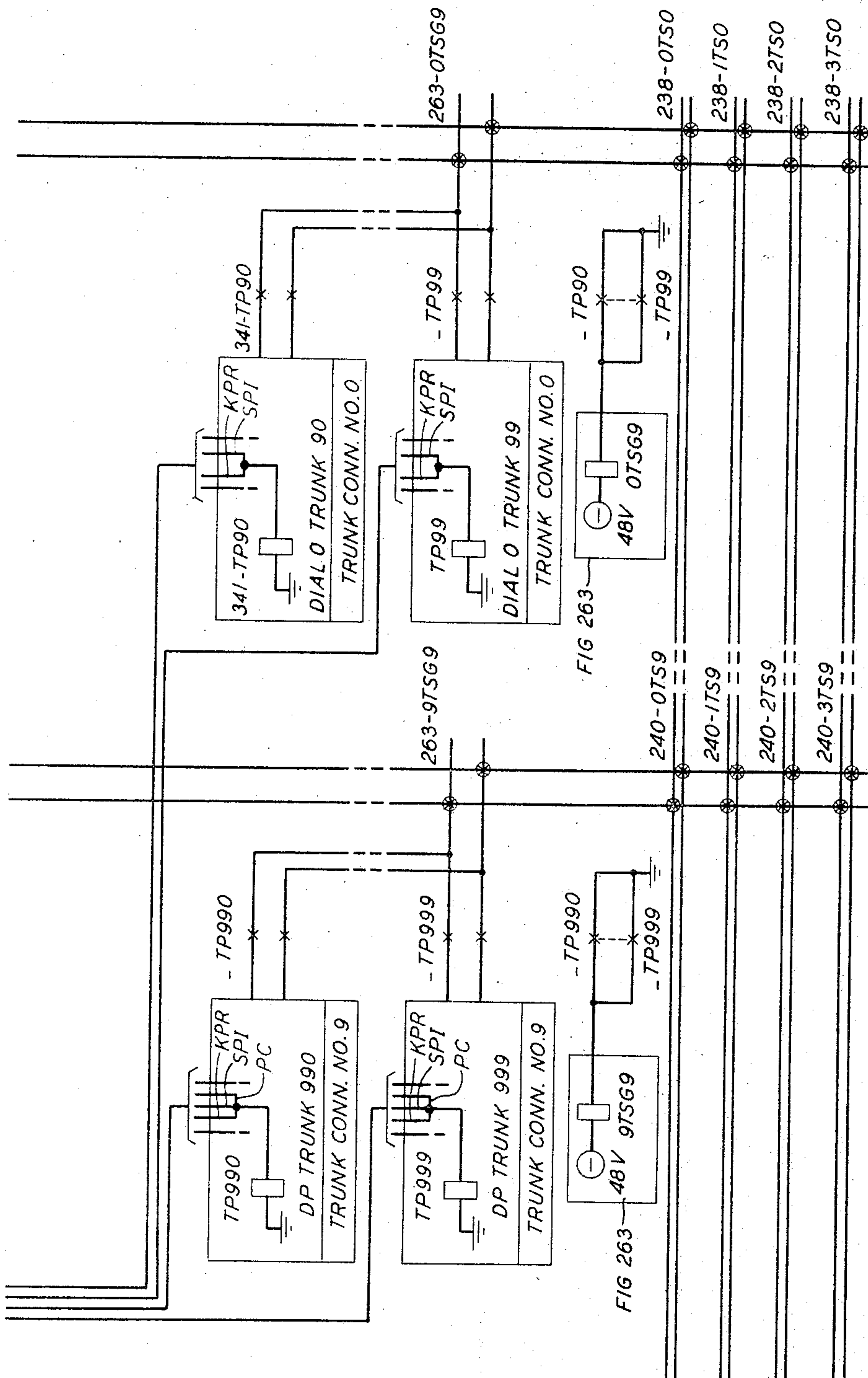


FIG. 3H



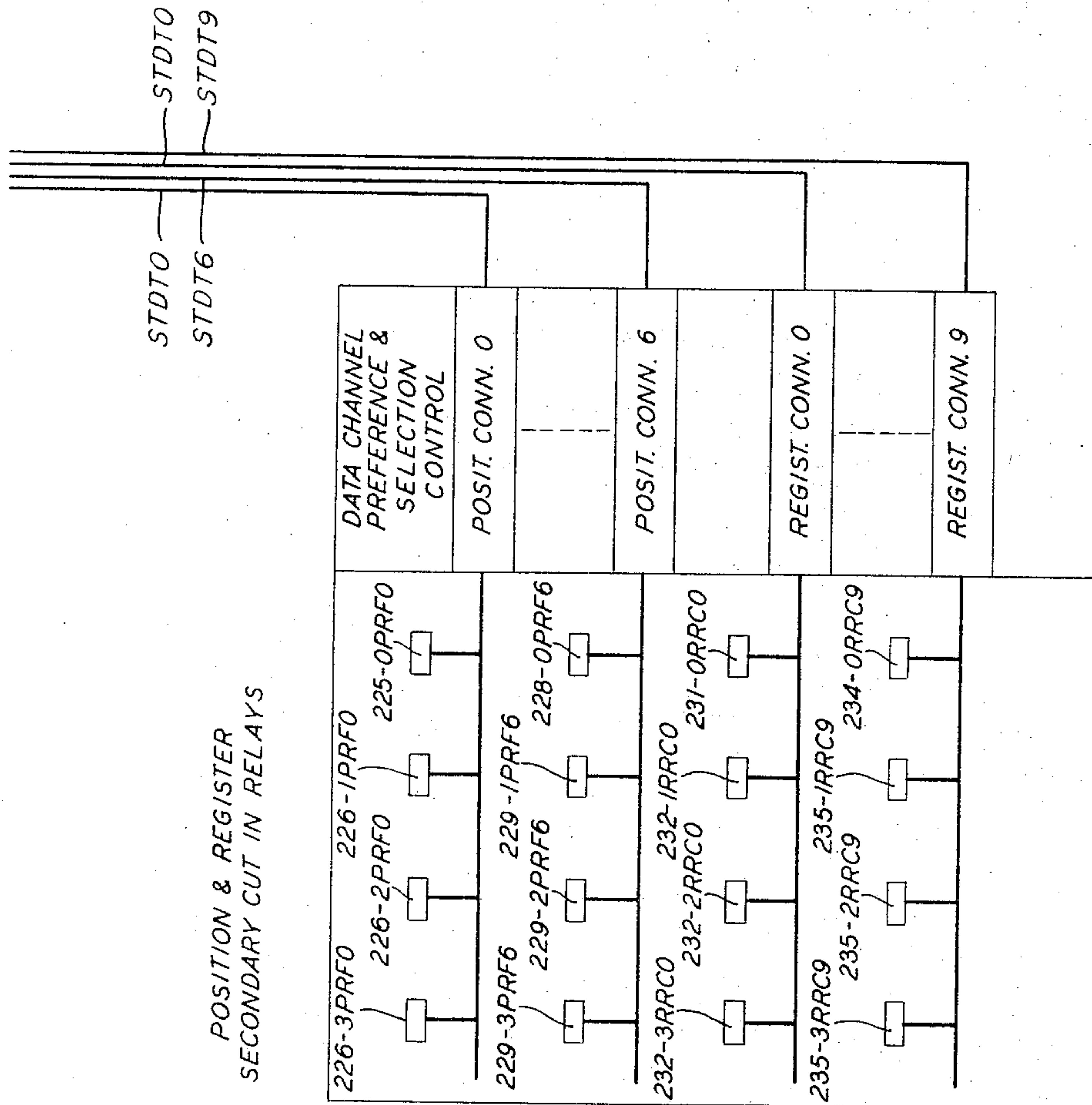
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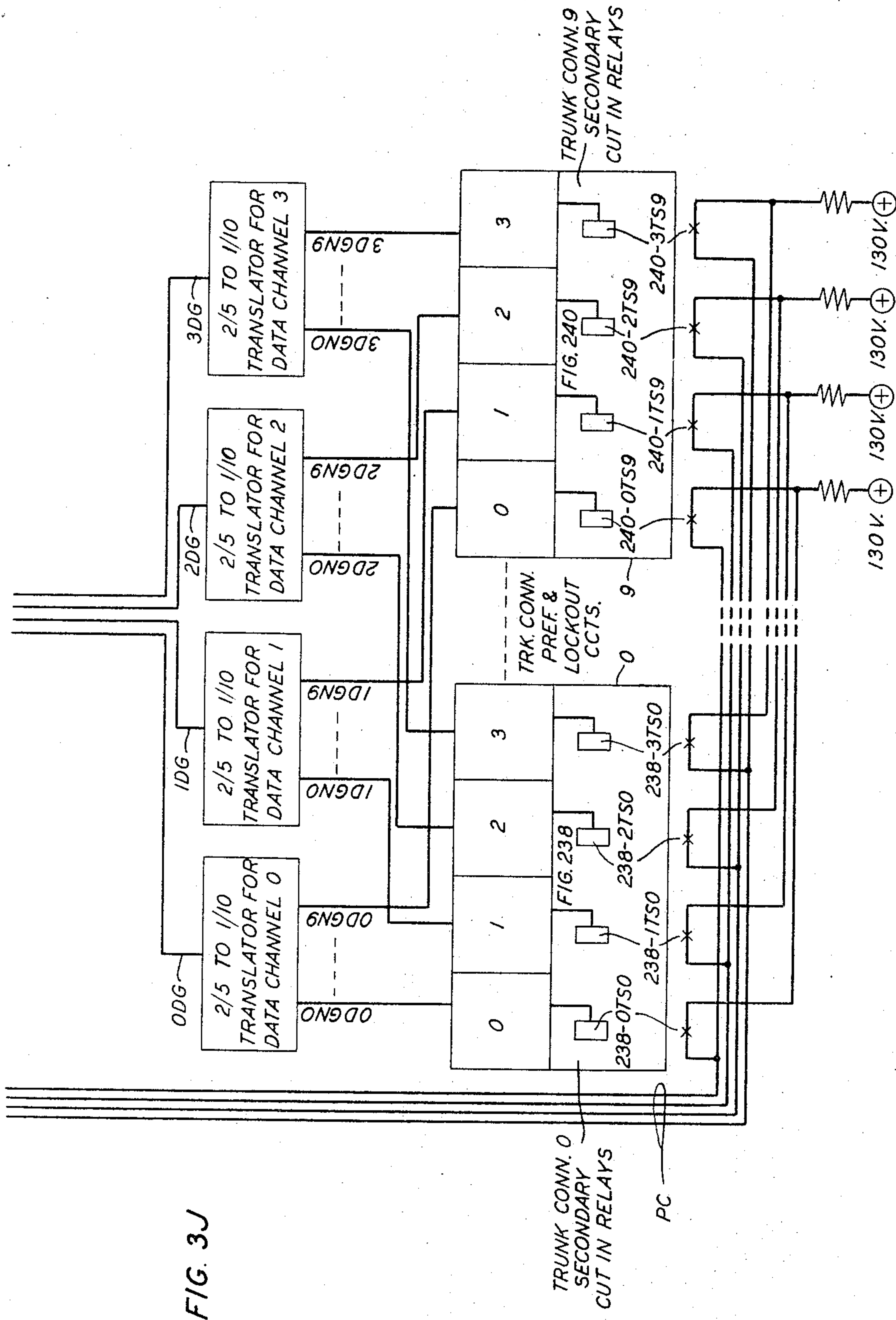
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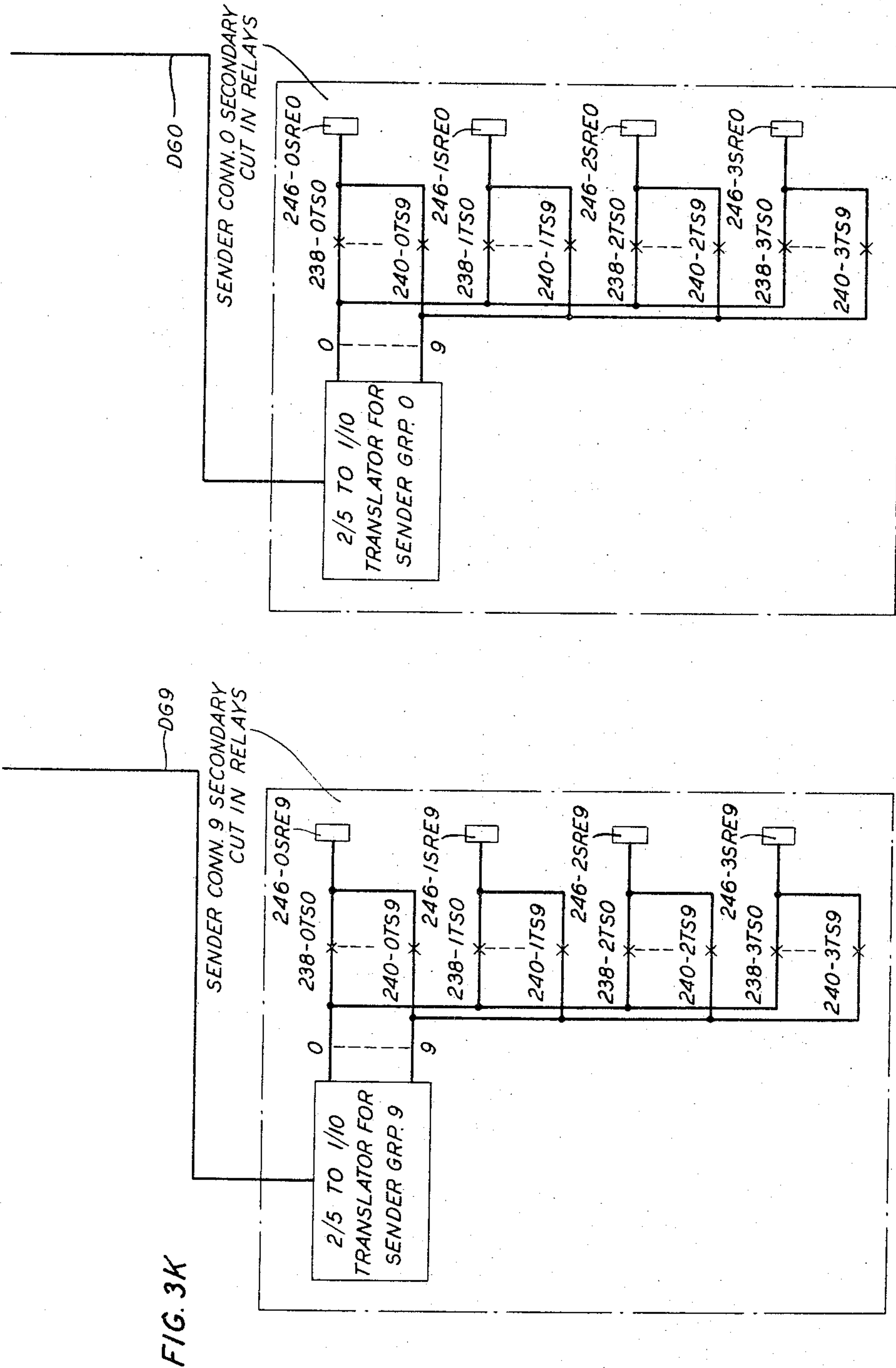
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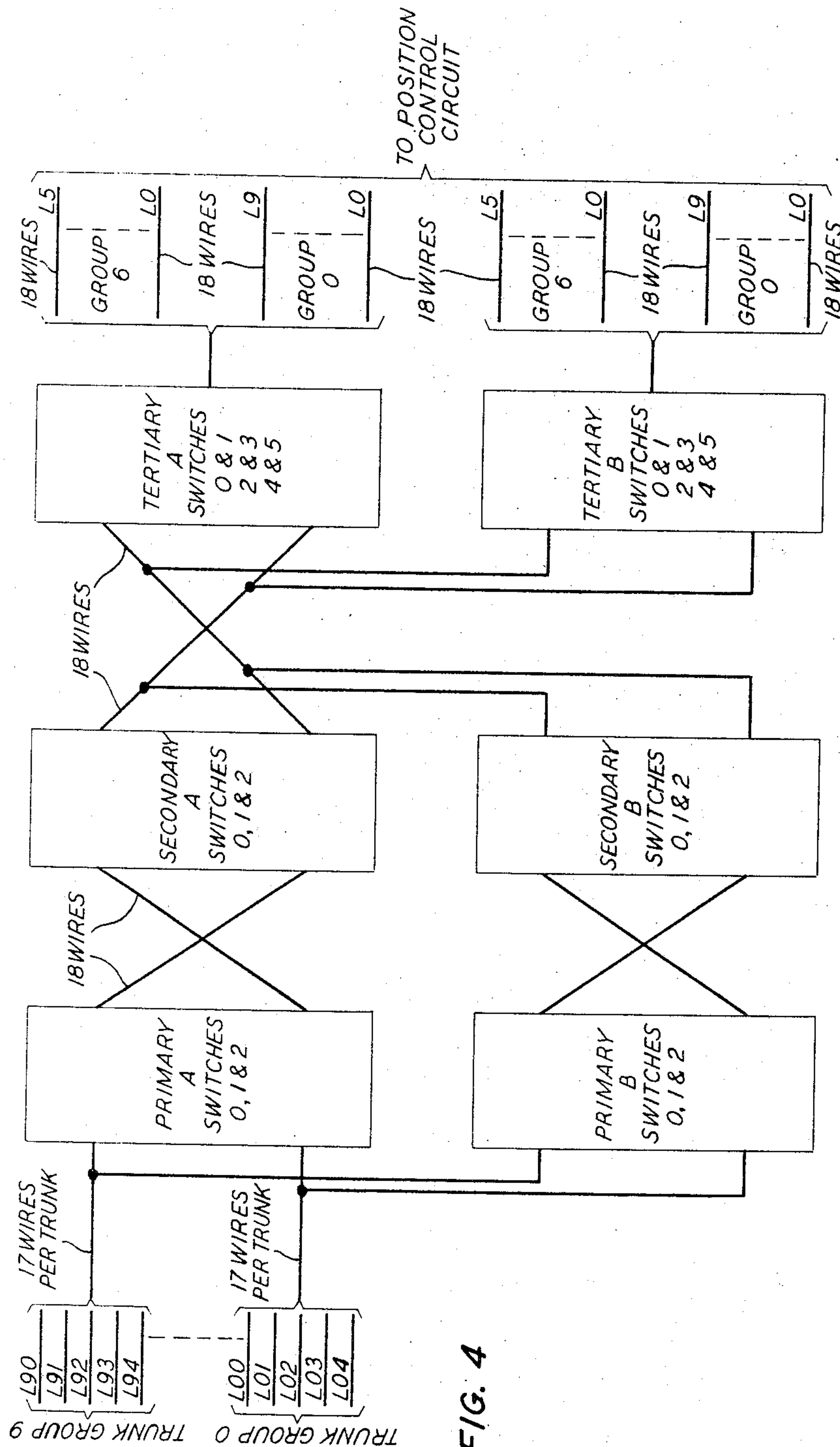


FIG. 4



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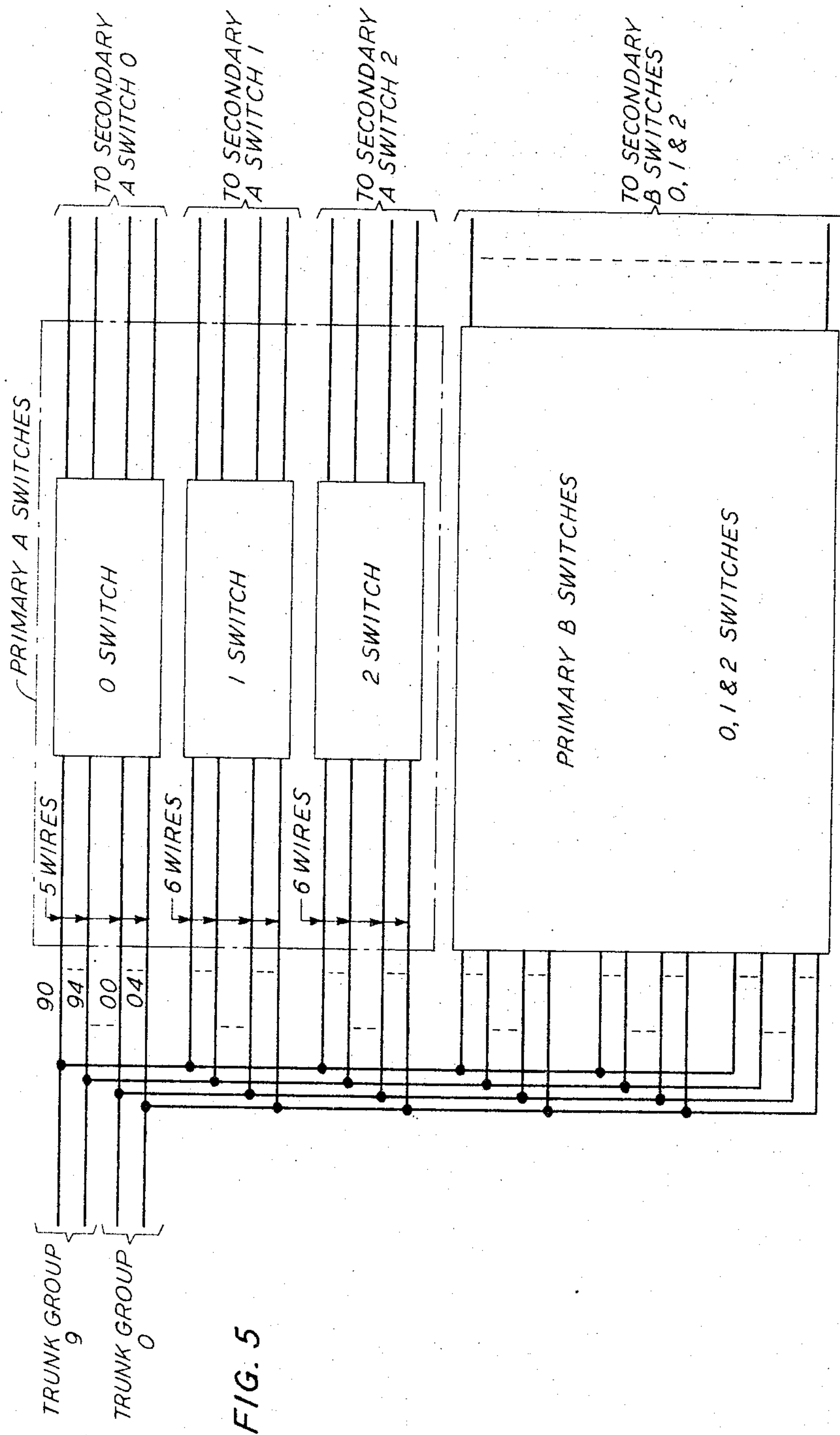
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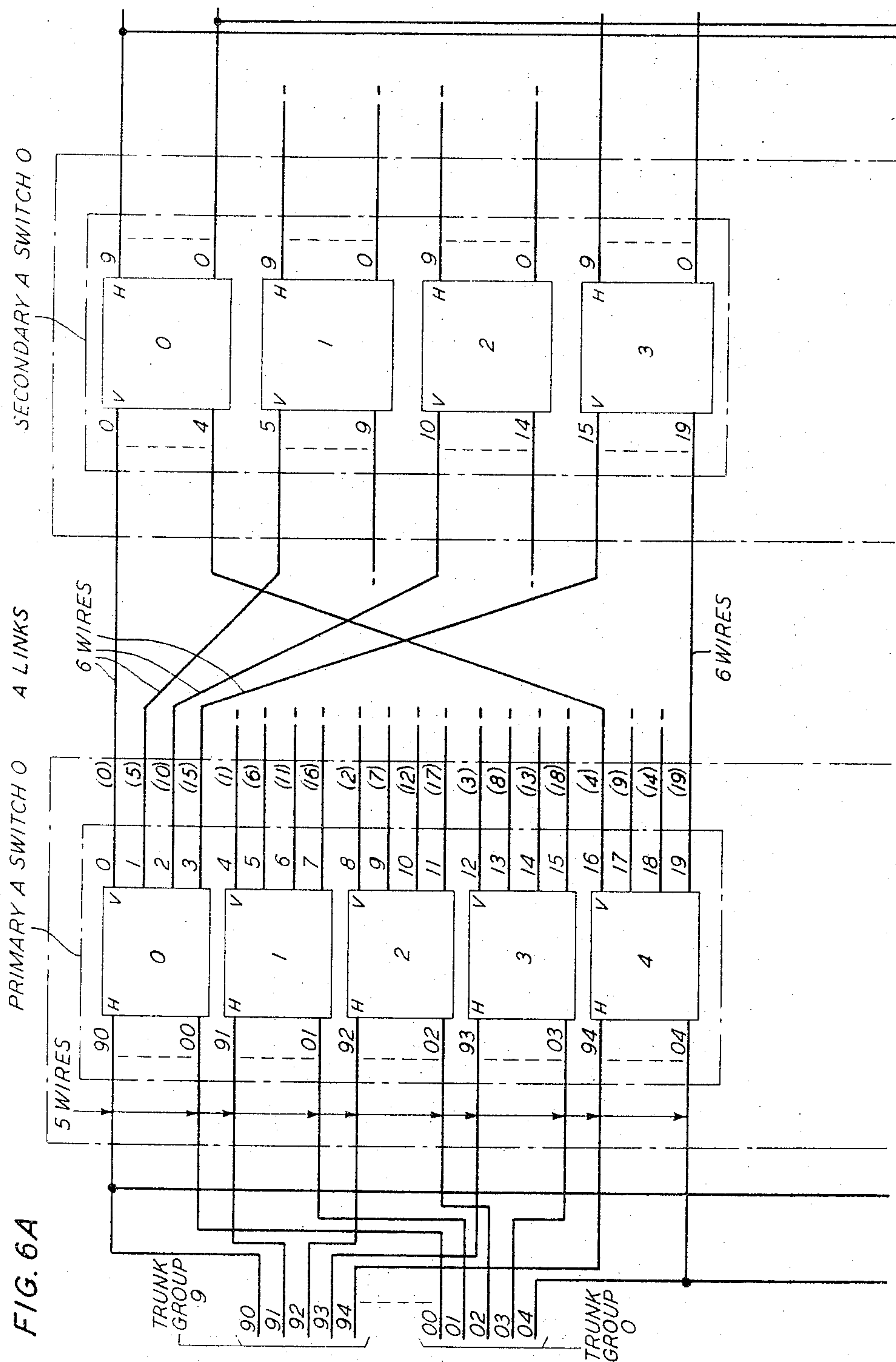
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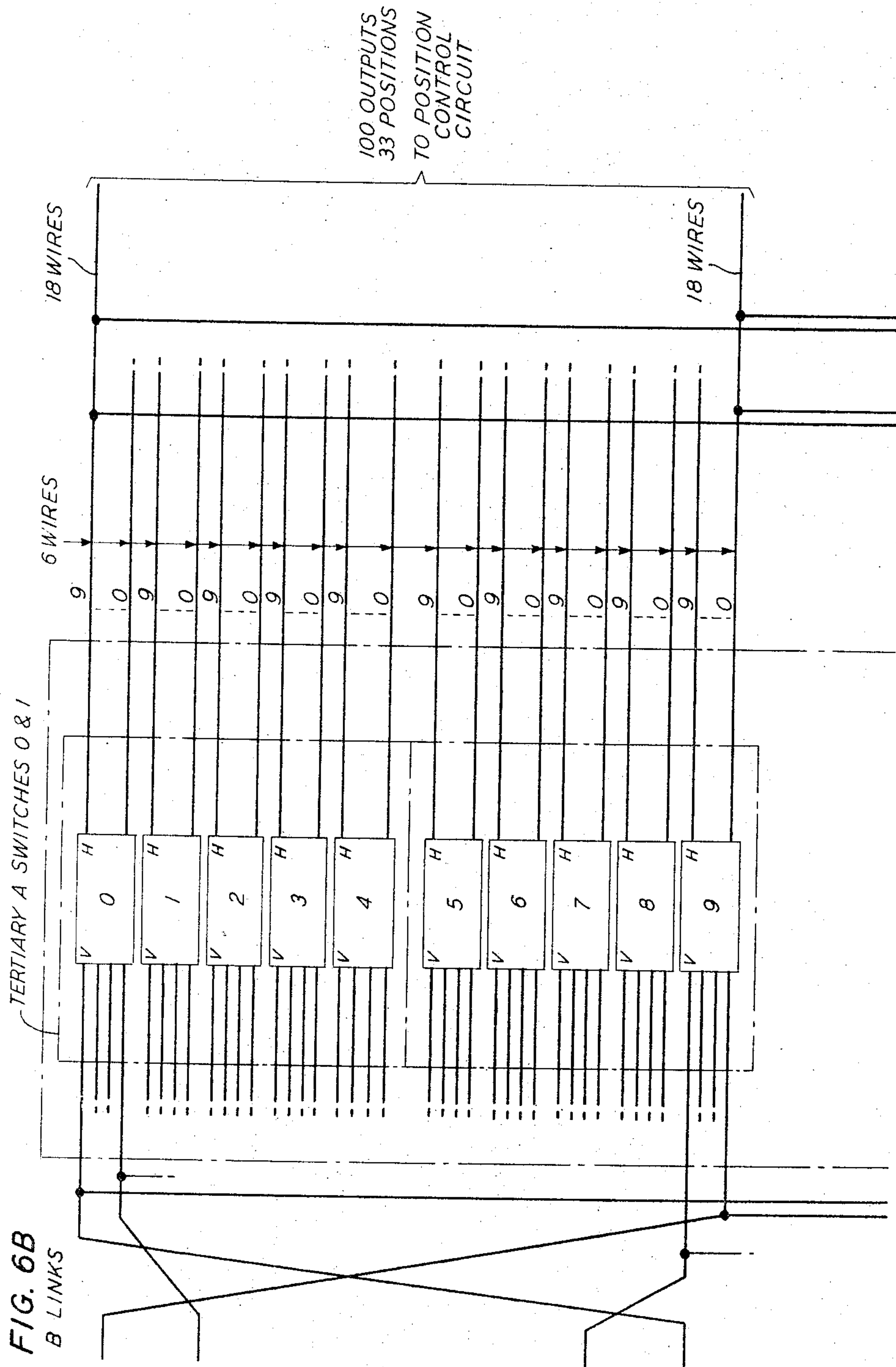
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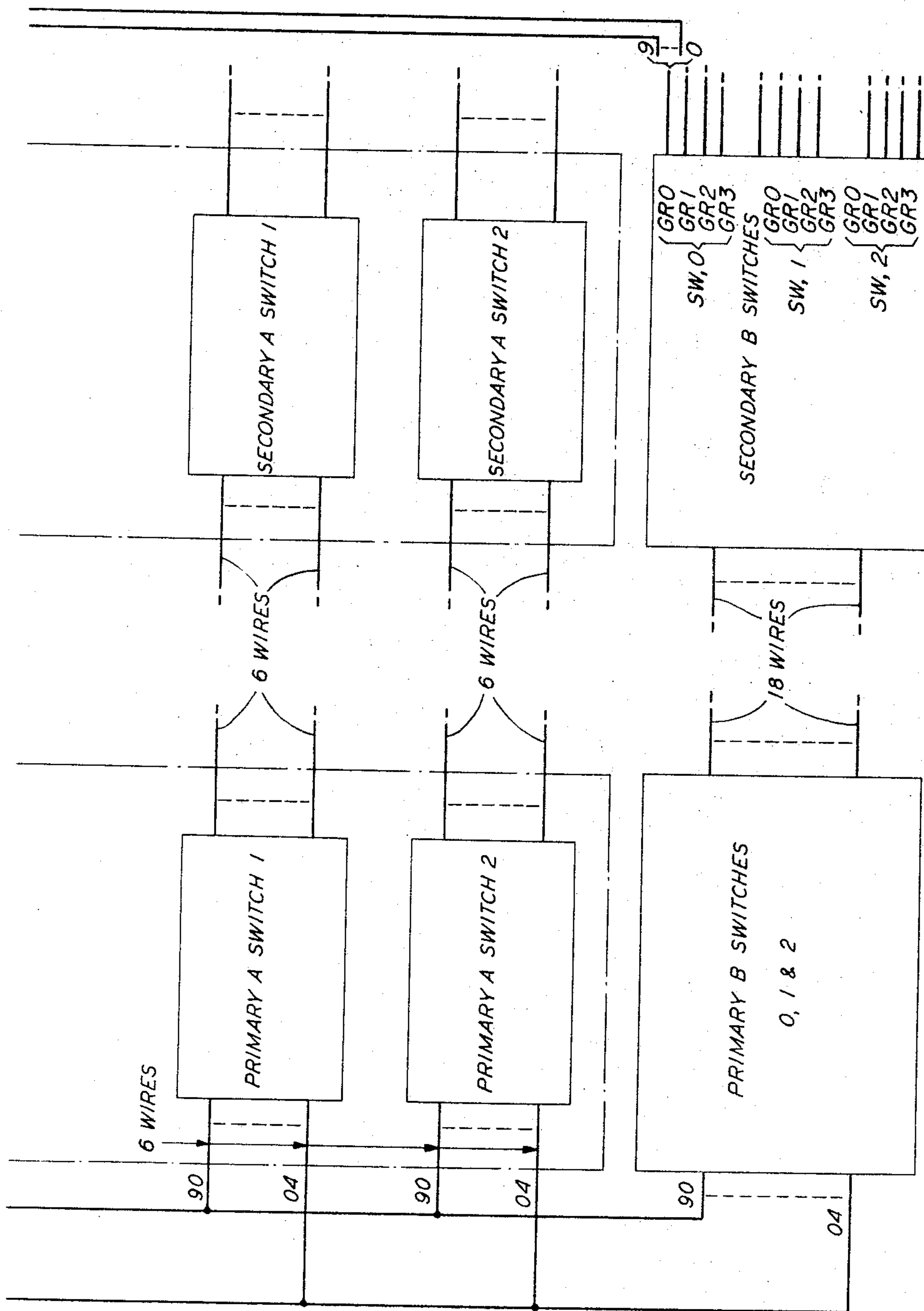


FIG. 6C



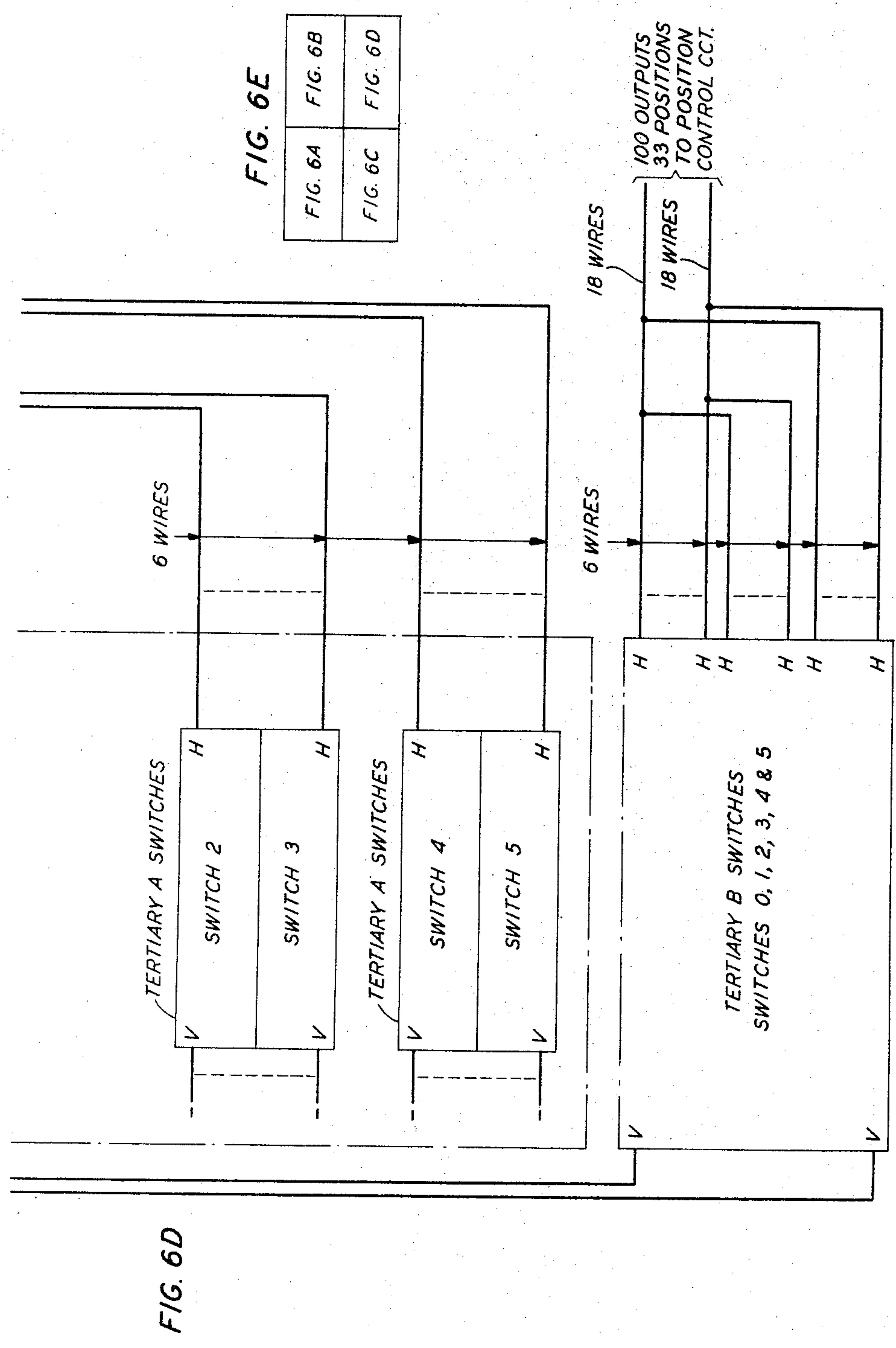
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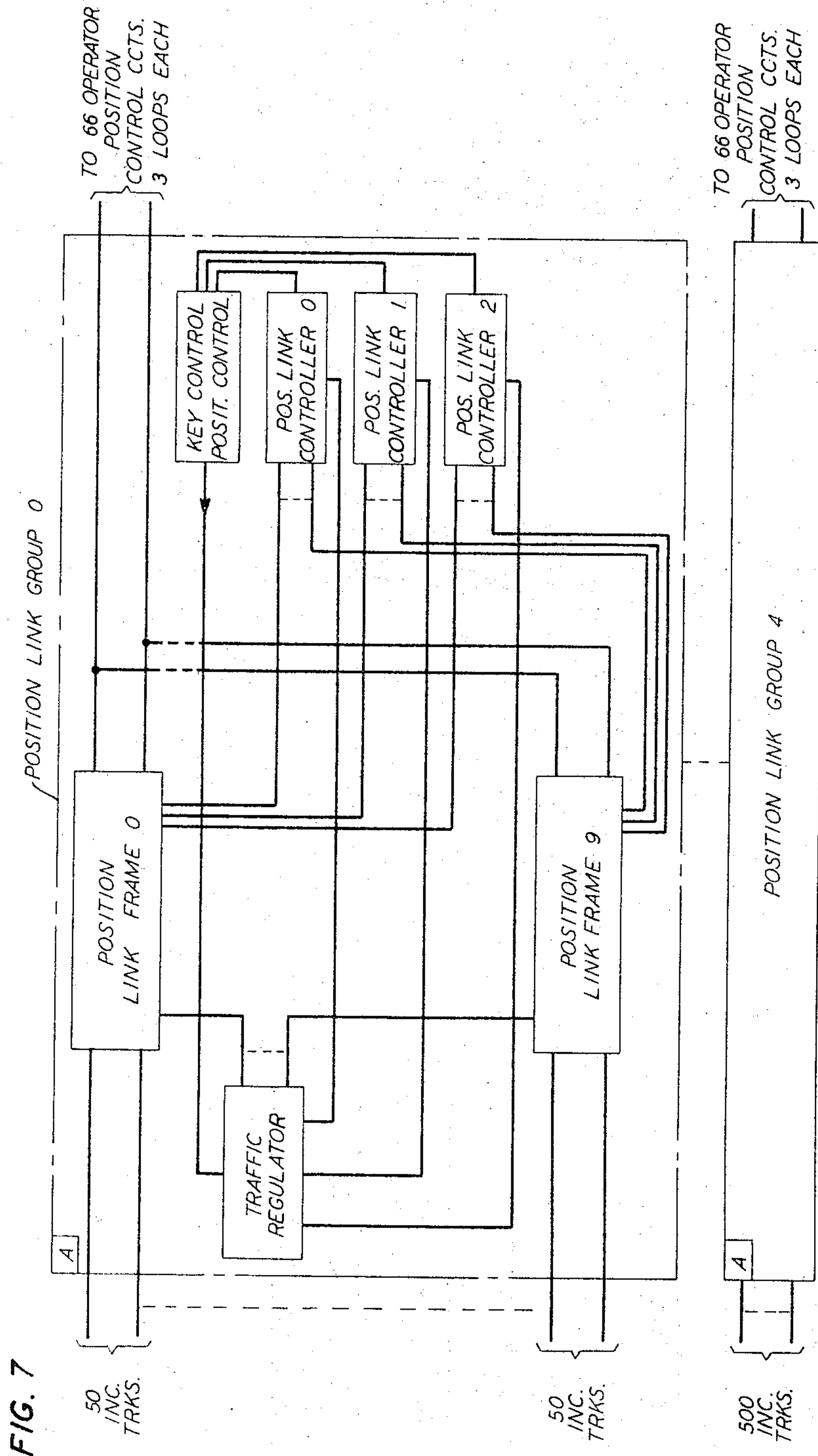
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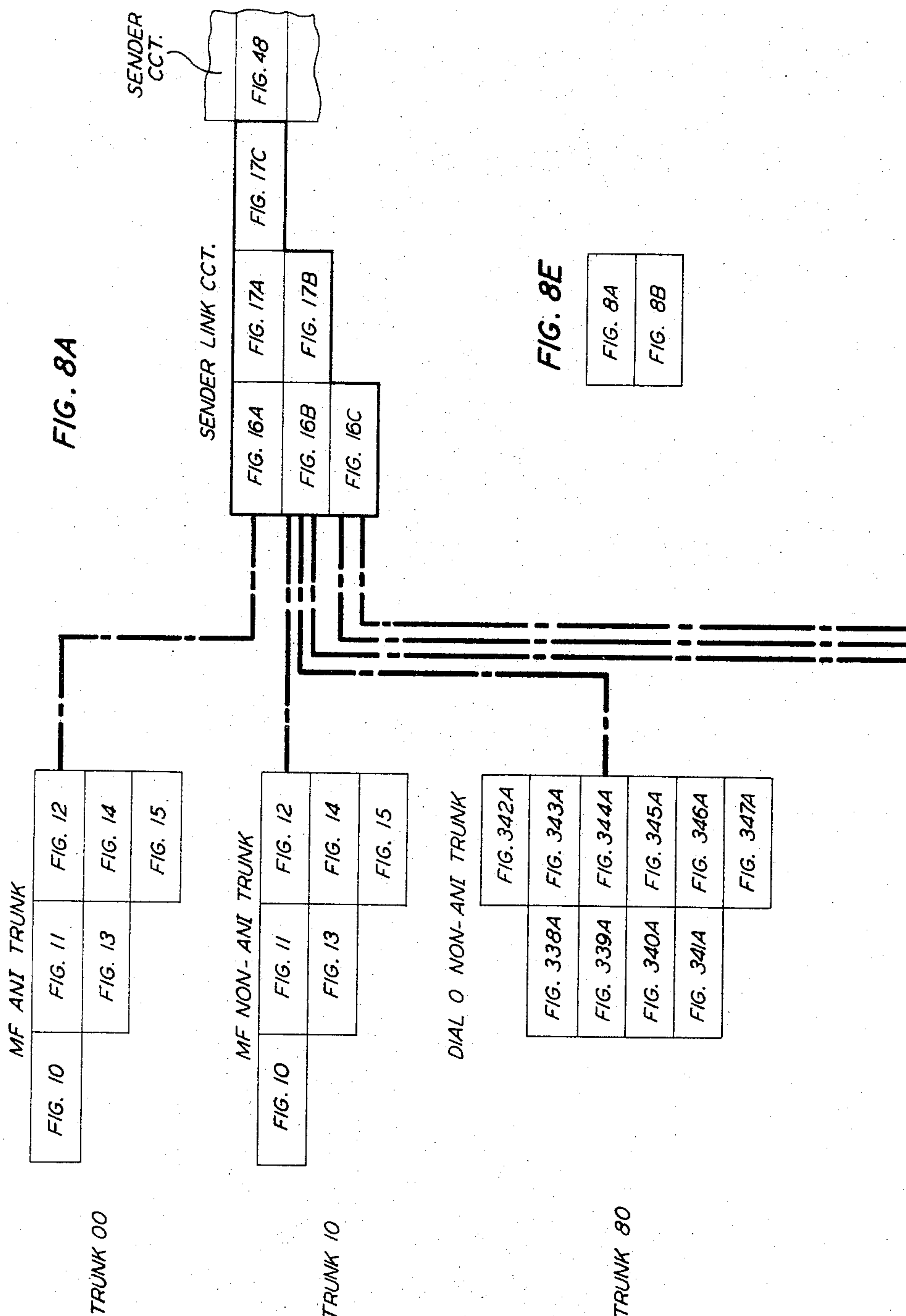
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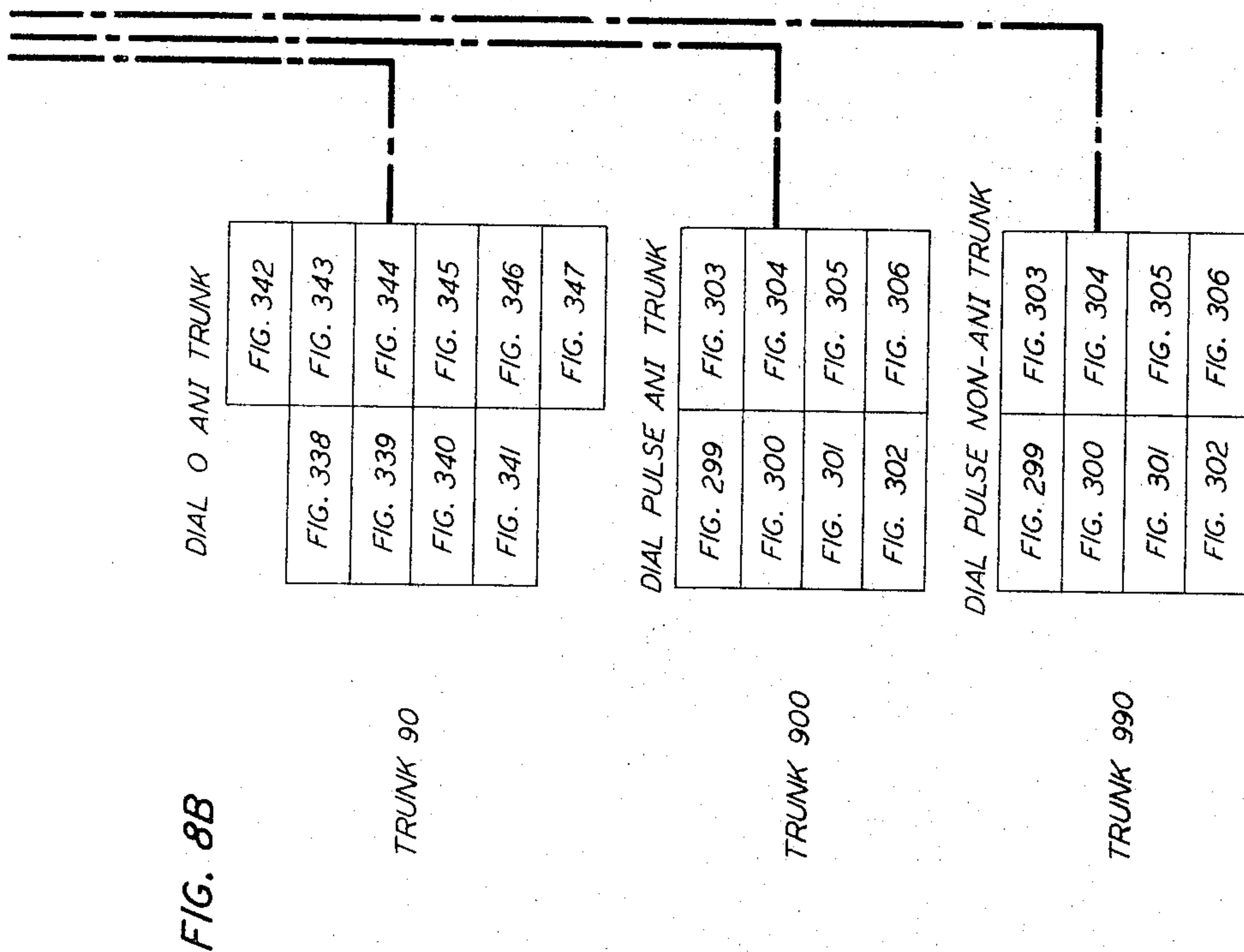
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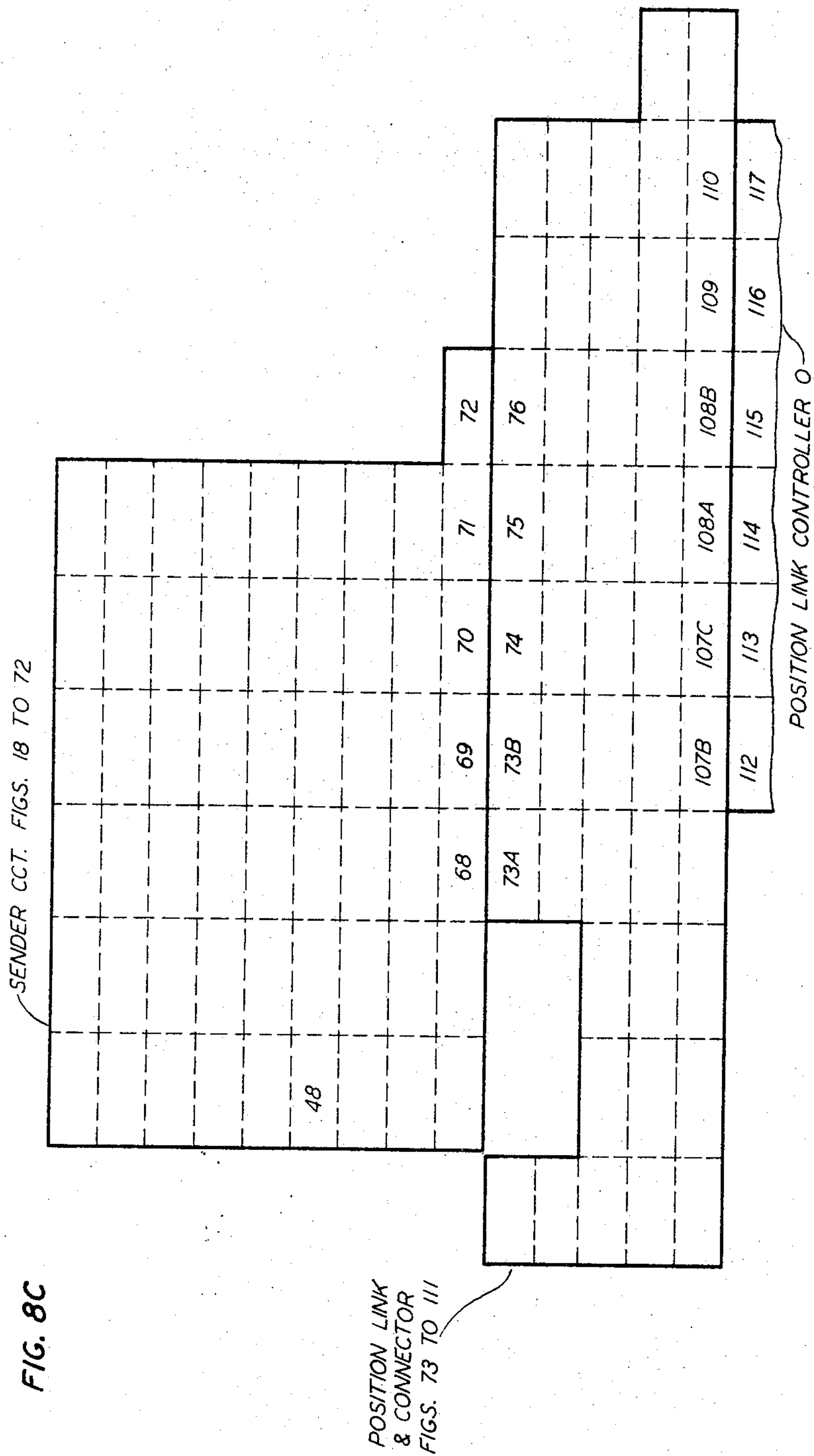
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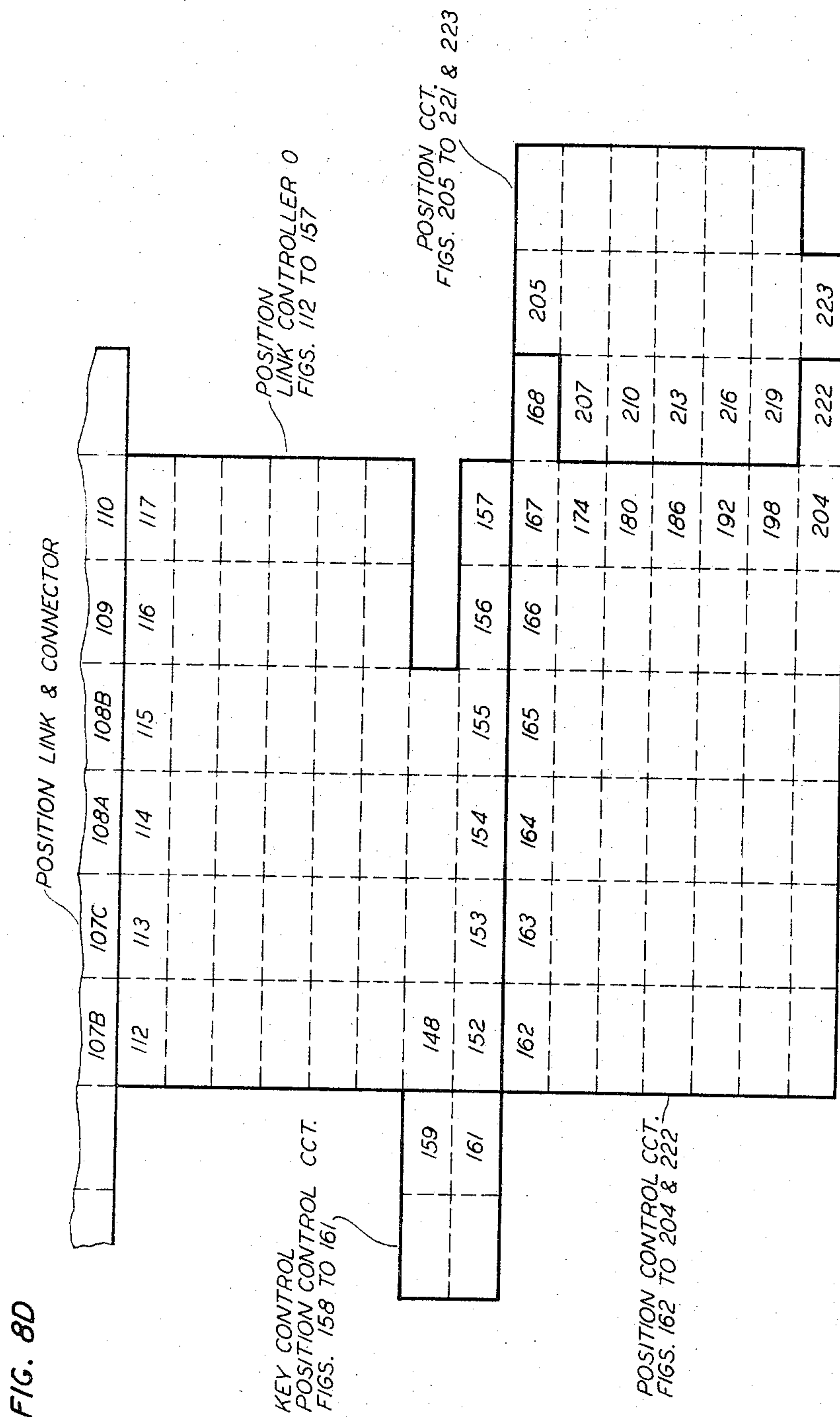
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FIG. 9A

SENDER CCT.

|         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|
| FIG. 18 | FIG. 19 | FIG. 20 | FIG. 21 | FIG. 22 | FIG. 23 |
| FIG. 24 | FIG. 25 | FIG. 26 | FIG. 27 | FIG. 28 | FIG. 29 |
| FIG. 30 | FIG. 31 | FIG. 32 | FIG. 33 | FIG. 34 | FIG. 35 |
| FIG. 36 | FIG. 37 | FIG. 38 | FIG. 39 | FIG. 40 | FIG. 41 |
| FIG. 42 | FIG. 43 | FIG. 44 | FIG. 45 | FIG. 46 | FIG. 47 |
| FIG. 48 | FIG. 49 | FIG. 50 | FIG. 51 | FIG. 52 | FIG. 53 |
| FIG. 54 | FIG. 55 | FIG. 56 | FIG. 57 | FIG. 58 | FIG. 59 |
| FIG. 60 | FIG. 61 | FIG. 62 | FIG. 63 | FIG. 64 | FIG. 65 |
| FIG. 66 | FIG. 67 | FIG. 68 | FIG. 69 | FIG. 70 | FIG. 71 |
|         |         |         |         |         | FIG. 72 |



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**FIG. 9B**

## POSITION LINK & CONNECTOR

[illegible]



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FIG. 9C

POSITION LINK CONTROLLER O

|          |          |          |          |          |          |
|----------|----------|----------|----------|----------|----------|
| FIG. 112 | FIG. 113 | FIG. 114 | FIG. 115 | FIG. 116 | FIG. 117 |
| FIG. 118 | FIG. 119 | FIG. 120 | FIG. 121 | FIG. 122 | FIG. 123 |
| FIG. 124 | FIG. 125 | FIG. 126 | FIG. 127 | FIG. 128 | FIG. 129 |
| FIG. 130 | FIG. 131 | FIG. 132 | FIG. 133 | FIG. 134 | FIG. 135 |
| FIG. 136 | FIG. 137 | FIG. 138 | FIG. 139 | FIG. 140 | FIG. 141 |
| FIG. 142 | FIG. 143 | FIG. 144 | FIG. 145 | FIG. 146 | FIG. 147 |
| FIG. 148 | FIG. 149 | FIG. 150 | FIG. 151 |          |          |
| FIG. 152 | FIG. 153 | FIG. 154 | FIG. 155 | FIG. 156 | FIG. 157 |
| FIG. 158 | FIG. 159 |          |          |          |          |
| FIG. 160 | FIG. 161 |          |          |          |          |

KEY CONTROL  
POSITION CONTROL



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FIG. 9D

| POSITION CONTROL CCT. |          |          |          |          |          |          | POSITION CCT. |          |  |  |
|-----------------------|----------|----------|----------|----------|----------|----------|---------------|----------|--|--|
| FIG. 162              | FIG. 163 | FIG. 164 | FIG. 165 | FIG. 166 | FIG. 167 | FIG. 168 | FIG. 205      | FIG. 206 |  |  |
| FIG. 169              | FIG. 170 | FIG. 171 | FIG. 172 | FIG. 173 | FIG. 174 | FIG. 207 | FIG. 208      | FIG. 209 |  |  |
| FIG. 175              | FIG. 176 | FIG. 177 | FIG. 178 | FIG. 179 | FIG. 180 | FIG. 210 | FIG. 211      | FIG. 212 |  |  |
| FIG. 181              | FIG. 182 | FIG. 183 | FIG. 184 | FIG. 185 | FIG. 186 | FIG. 213 | FIG. 214      | FIG. 215 |  |  |
| FIG. 187              | FIG. 188 | FIG. 189 | FIG. 190 | FIG. 191 | FIG. 192 | FIG. 216 | FIG. 217      | FIG. 218 |  |  |
| FIG. 193              | FIG. 194 | FIG. 195 | FIG. 196 | FIG. 197 | FIG. 198 | FIG. 219 | FIG. 220      | FIG. 221 |  |  |
| FIG. 199              | FIG. 200 | FIG. 201 | FIG. 202 | FIG. 203 | FIG. 204 | FIG. 222 | FIG. 223      |          |  |  |



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FIG. 9E

DATA TRANSFER CCT.

REGISTER & POSITION CONNECTOR  
& CHANNEL SEIZURE

|          |          |          |
|----------|----------|----------|
| FIG. 224 | FIG. 225 | FIG. 226 |
| FIG. 227 | FIG. 228 | FIG. 229 |
| FIG. 230 | FIG. 231 | FIG. 232 |
| FIG. 233 | FIG. 234 | FIG. 235 |

DATA GROUP - TRUNK SELECTION

|          |          |          |
|----------|----------|----------|
| FIG. 236 | FIG. 237 | FIG. 238 |
|          | FIG. 239 | FIG. 240 |

SENDER PREF. & CONN.

|          |          |
|----------|----------|
| FIG. 241 | FIG. 243 |
| FIG. 242 | FIG. 244 |

|          |
|----------|
| FIG. 245 |
|----------|

|          |
|----------|
| FIG. 246 |
|----------|

|          |
|----------|
| FIG. 247 |
|----------|

|          |          |
|----------|----------|
| FIG. 249 | FIG. 250 |
|----------|----------|

|          |          |
|----------|----------|
| FIG. 251 | FIG. 252 |
|----------|----------|

|          |          |
|----------|----------|
| FIG. 253 | FIG. 254 |
|----------|----------|

|          |          |
|----------|----------|
| FIG. 255 | FIG. 256 |
|----------|----------|

|          |          |
|----------|----------|
| FIG. 257 | FIG. 258 |
|----------|----------|



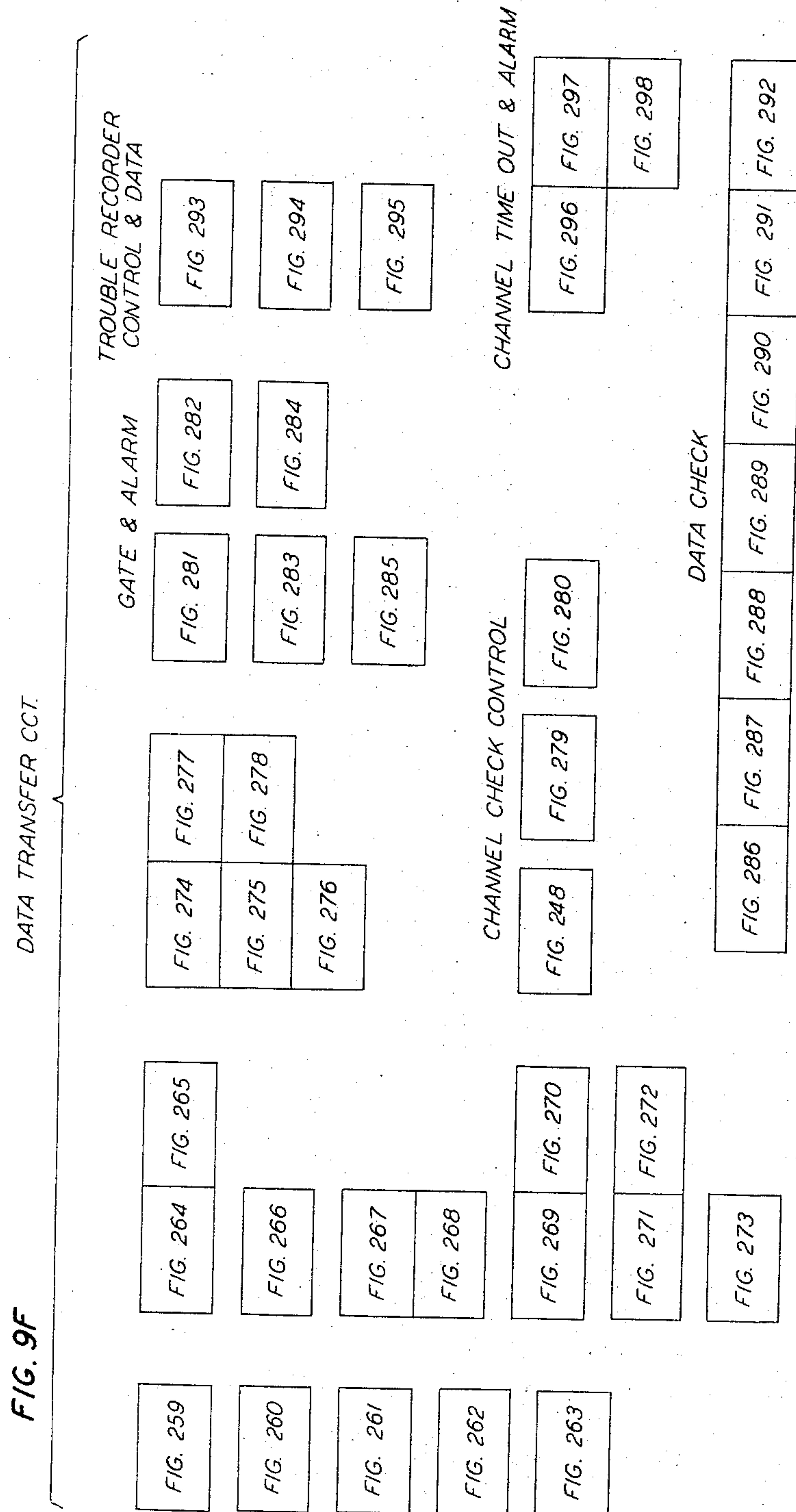
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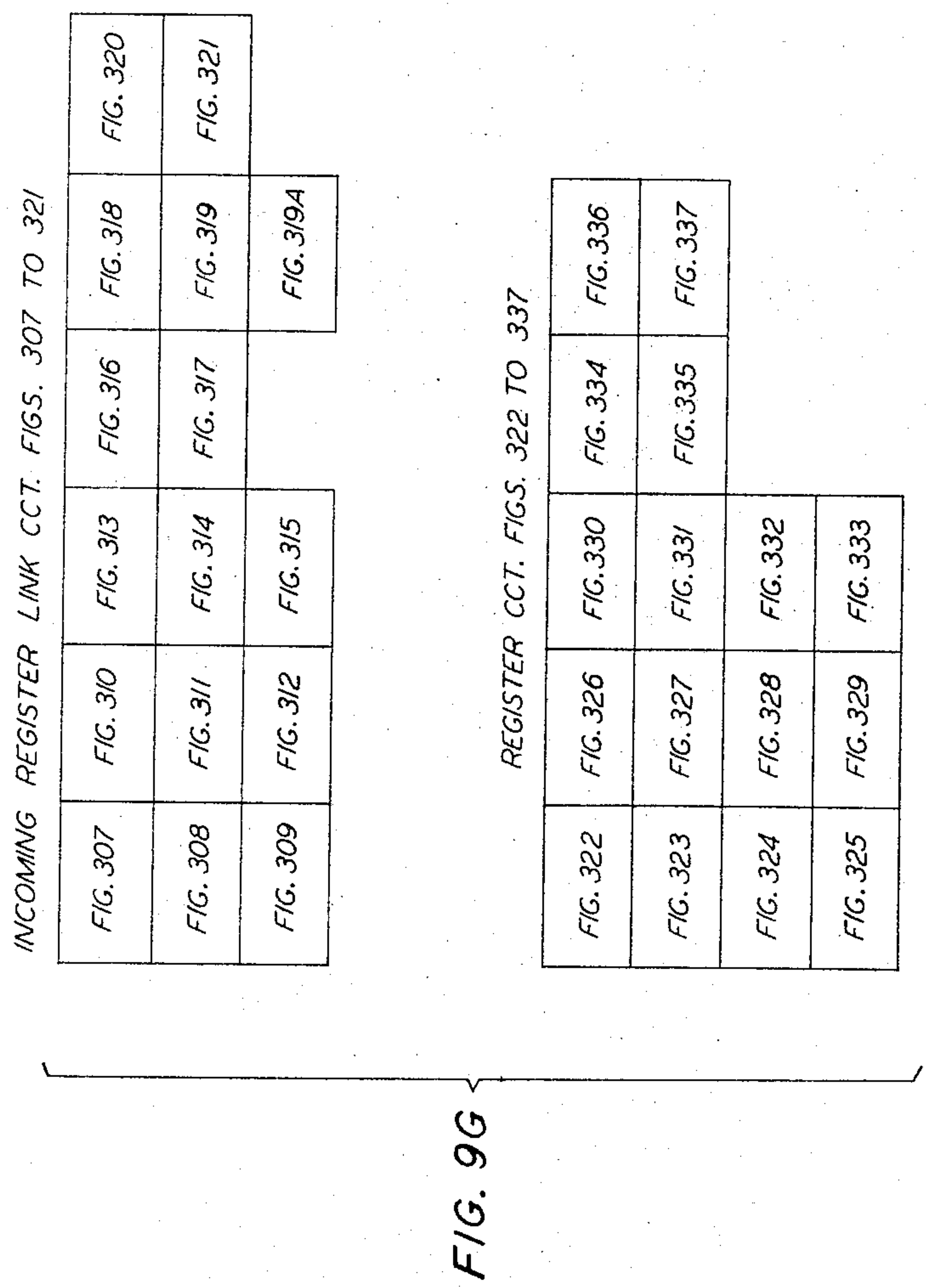
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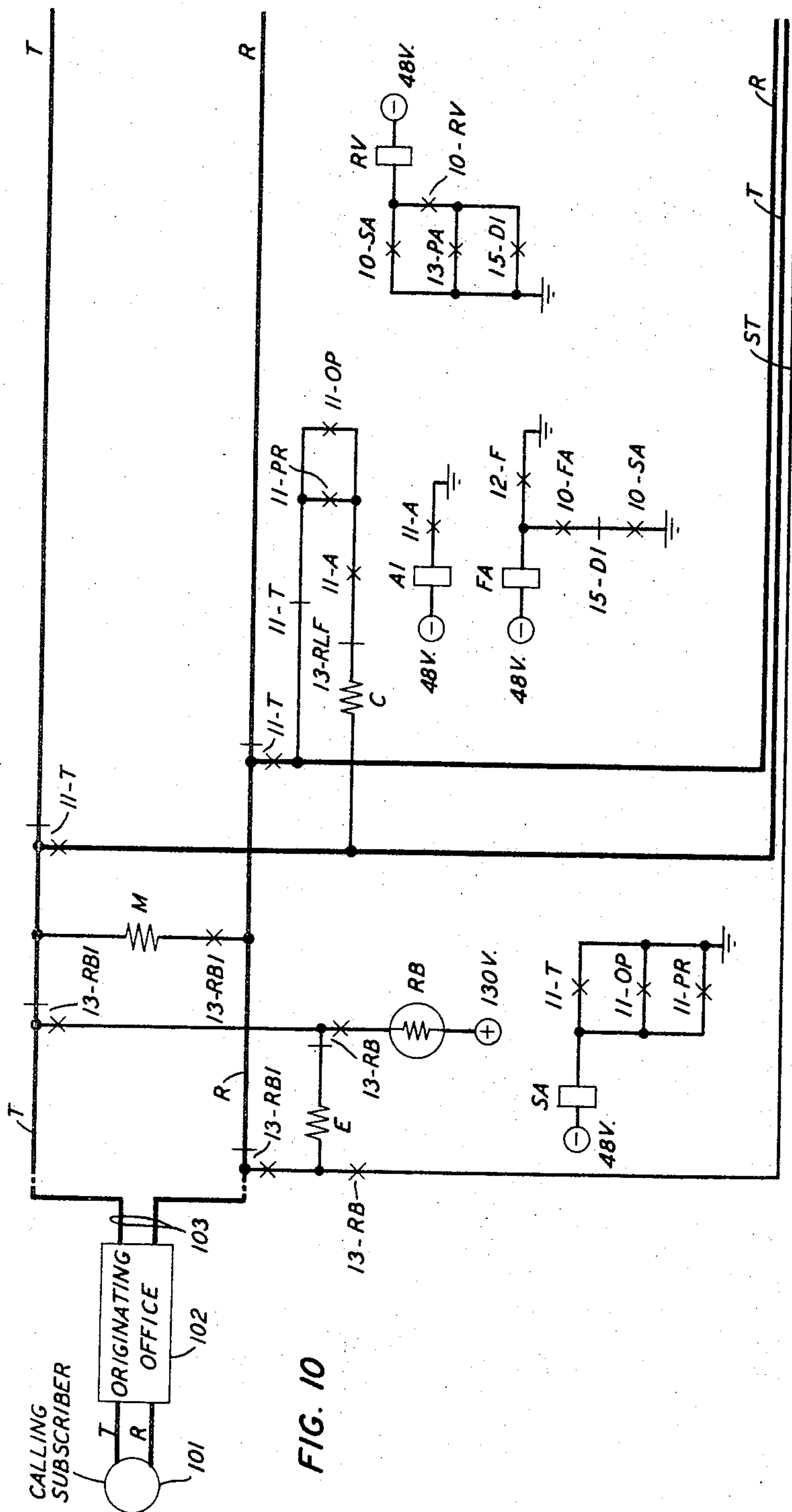


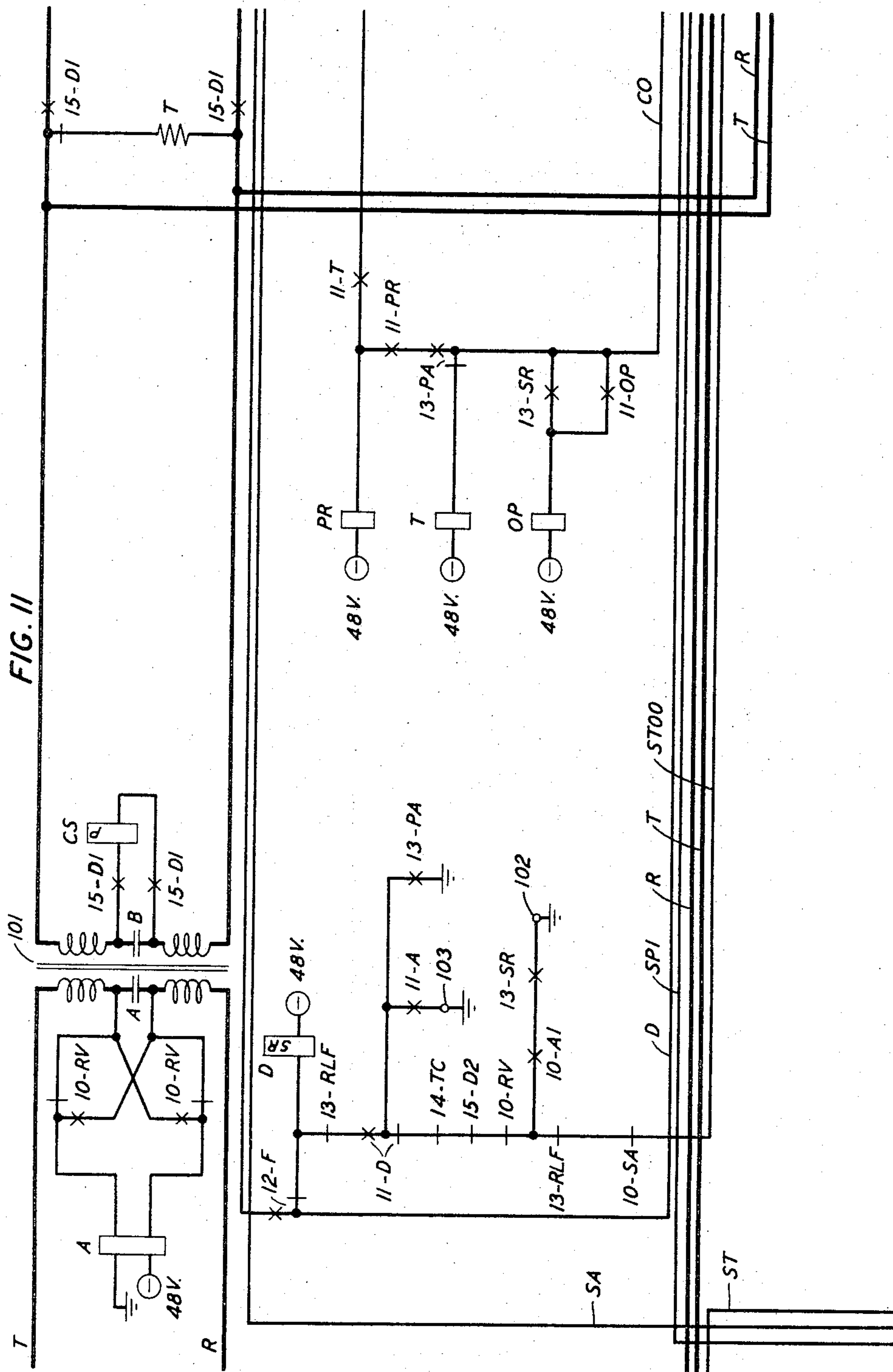
FIG. 10



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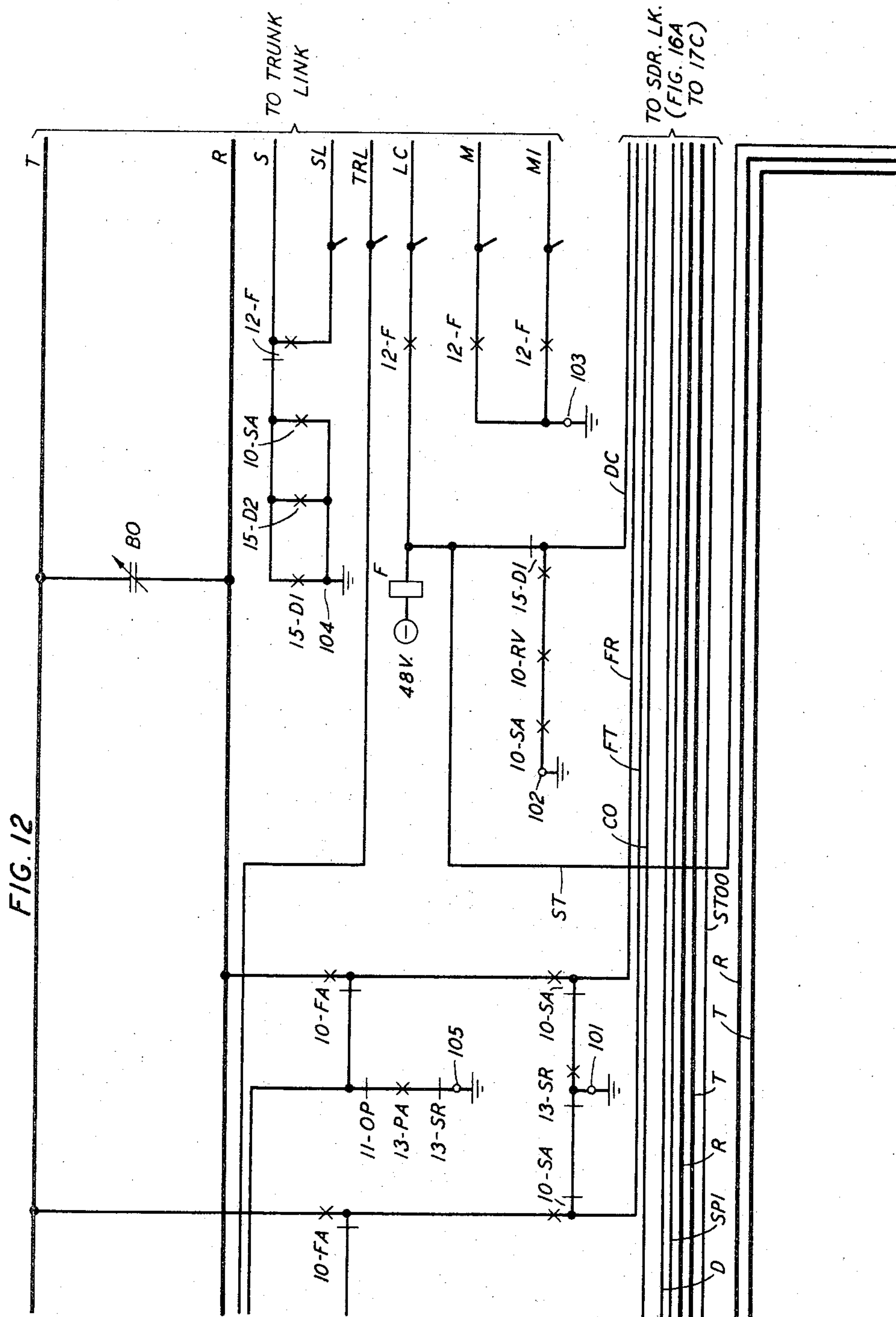
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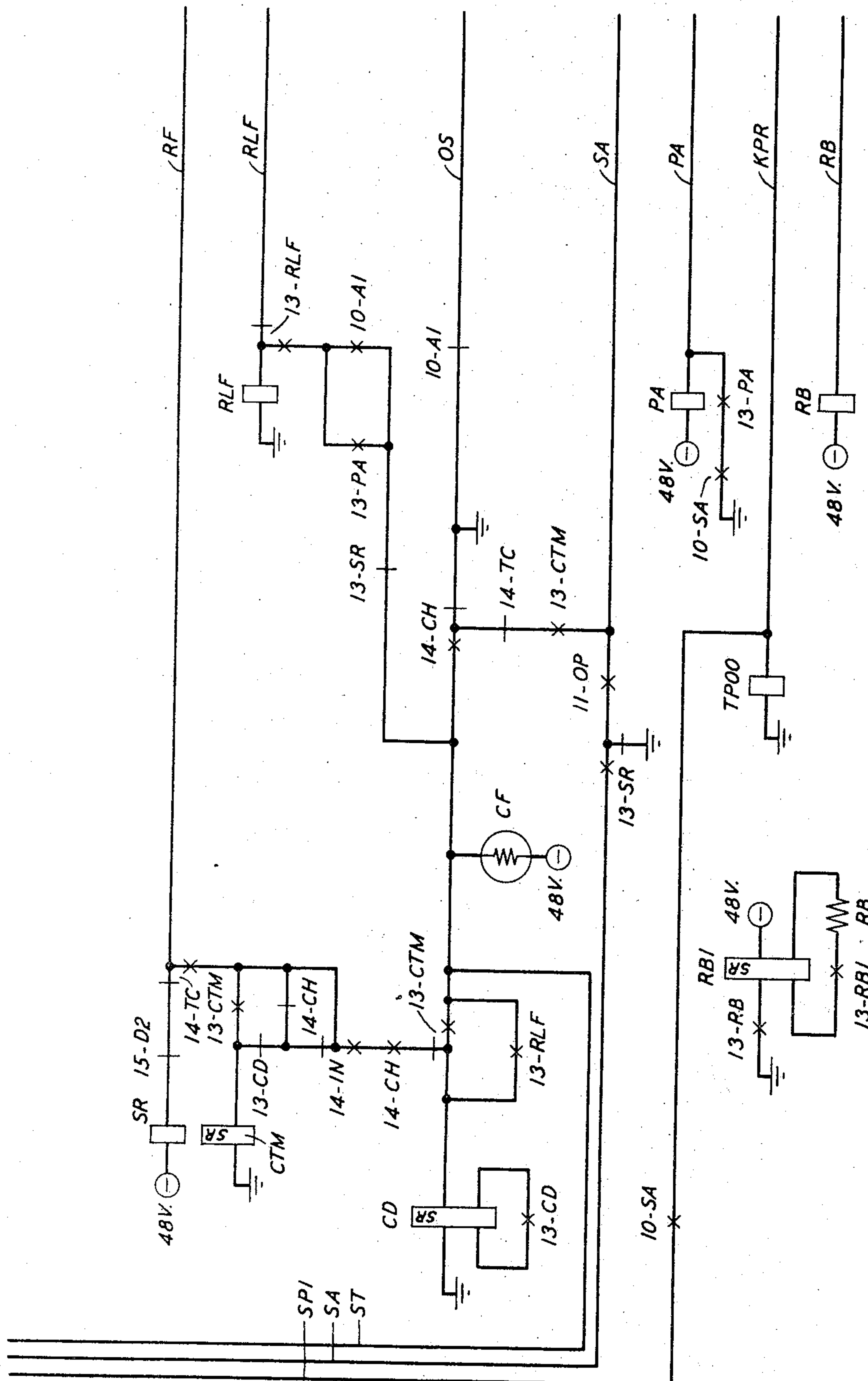


FIG. 13



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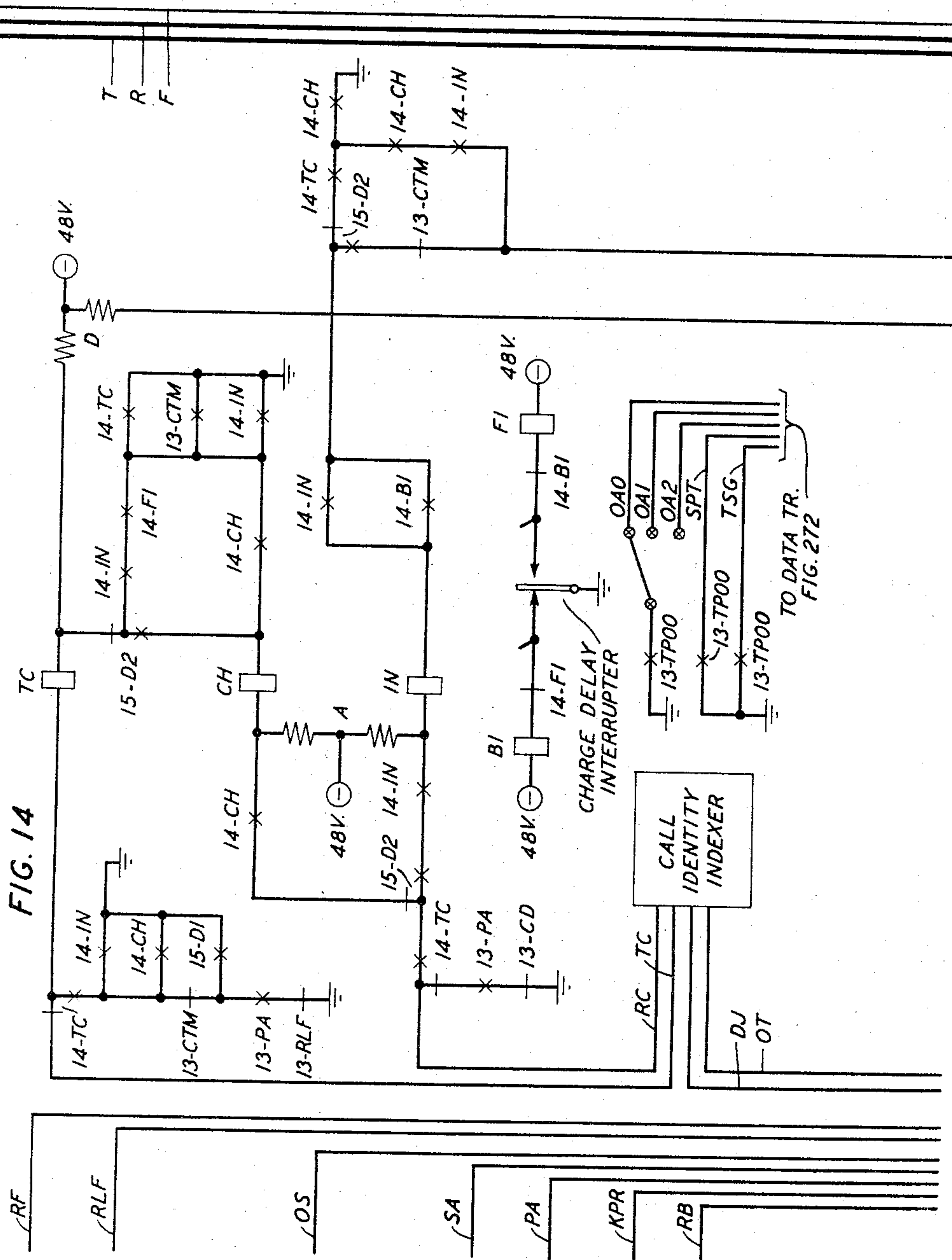
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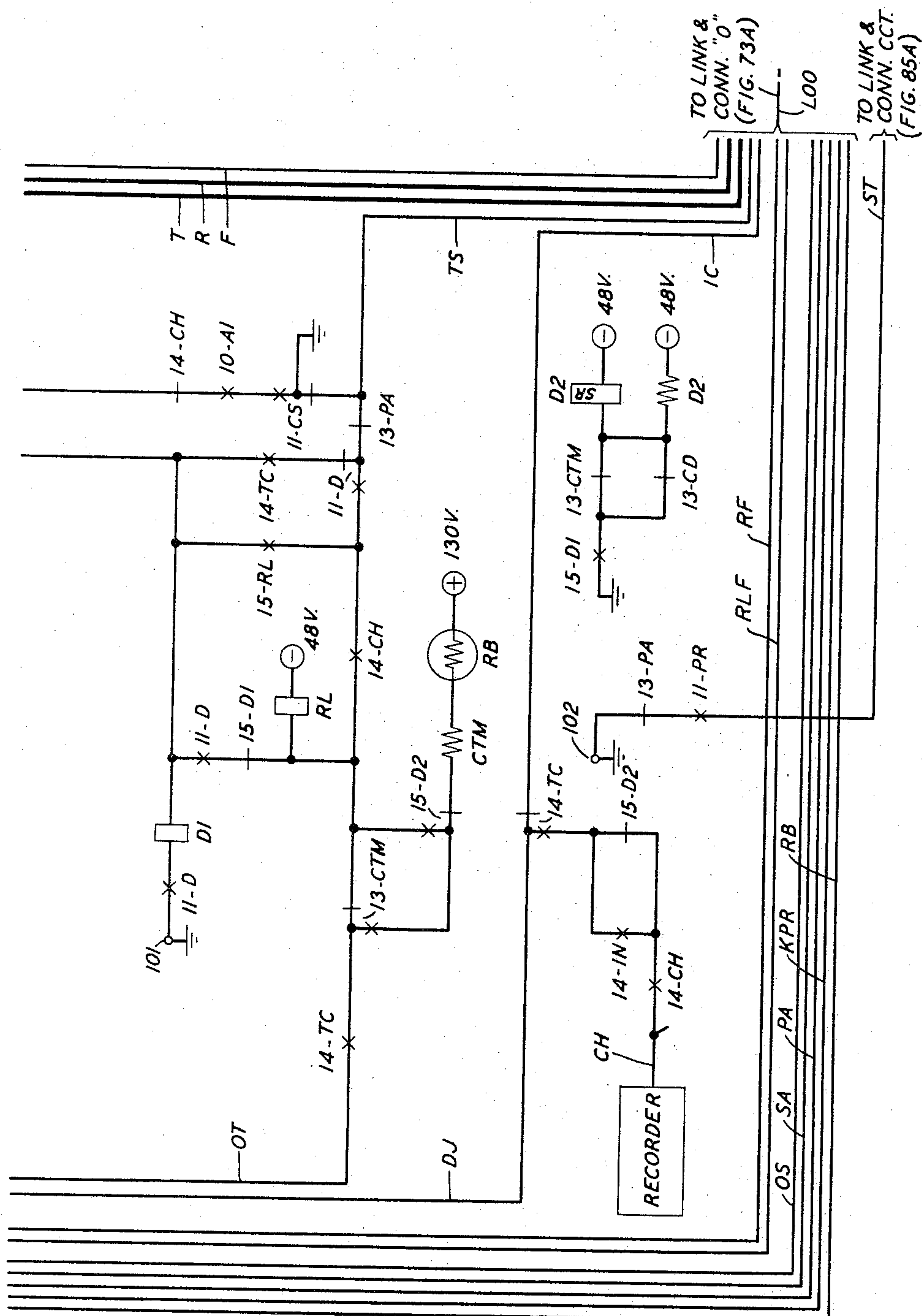




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**FIG. 15**



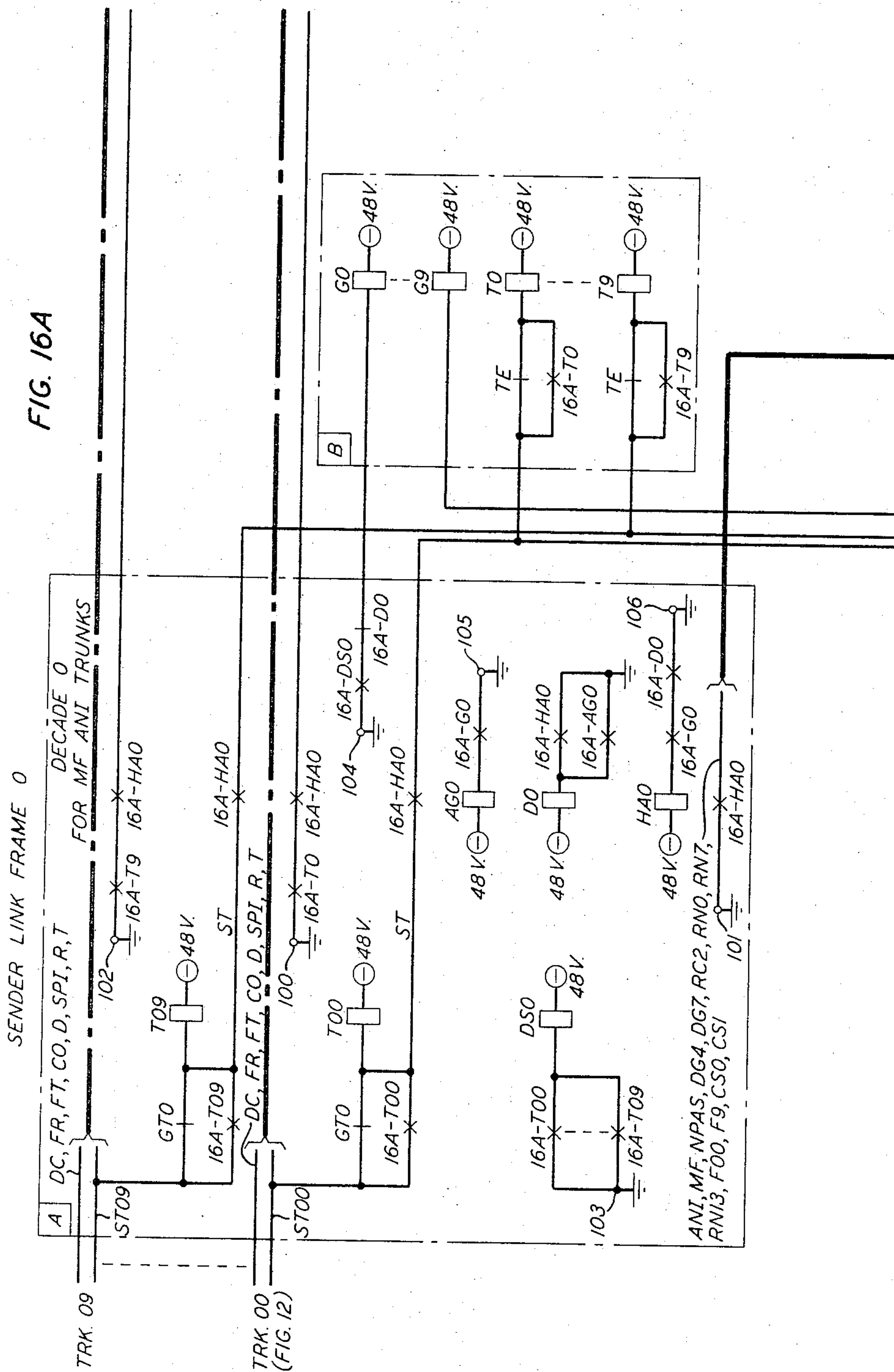
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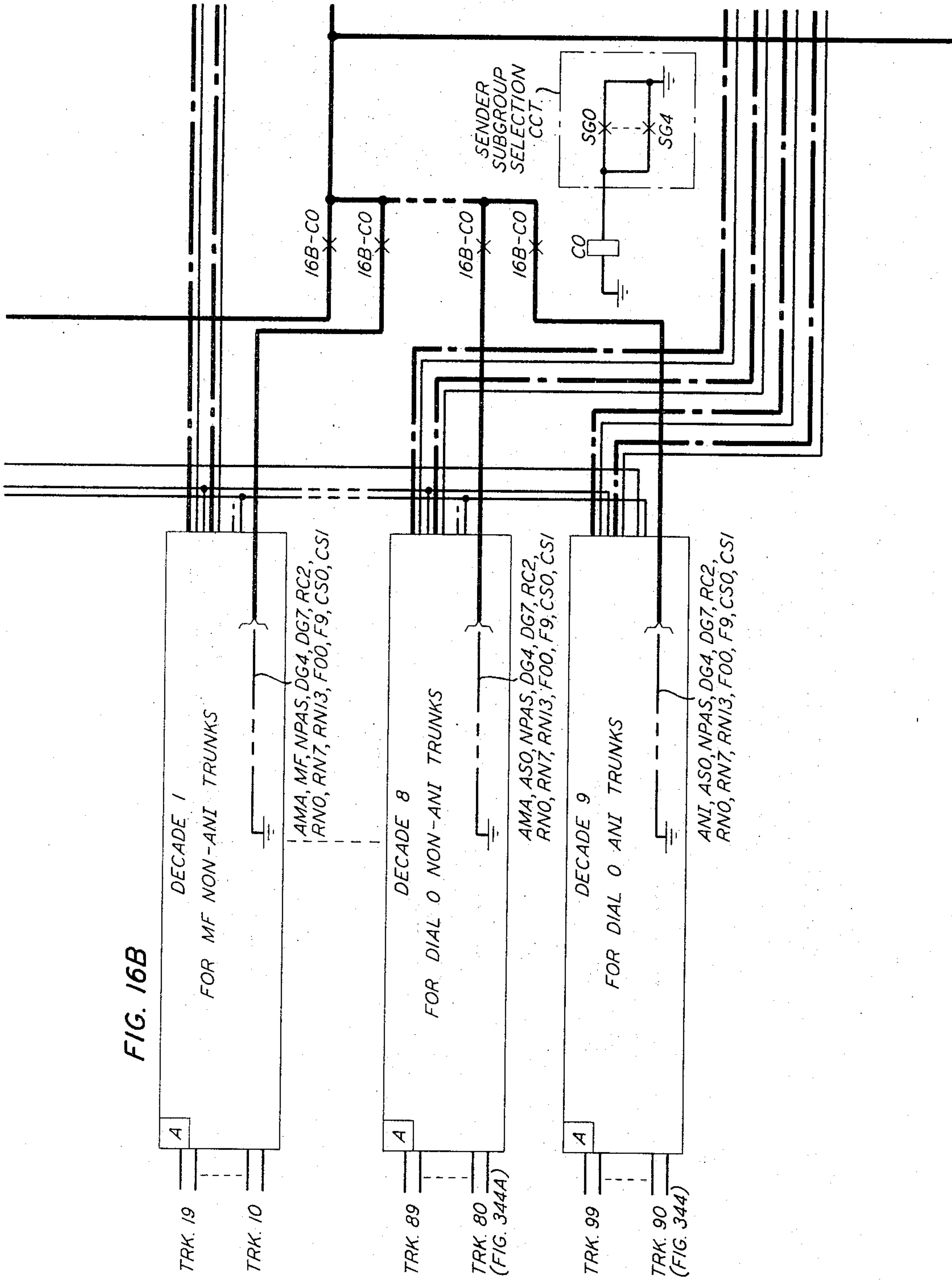
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FIG. 16B





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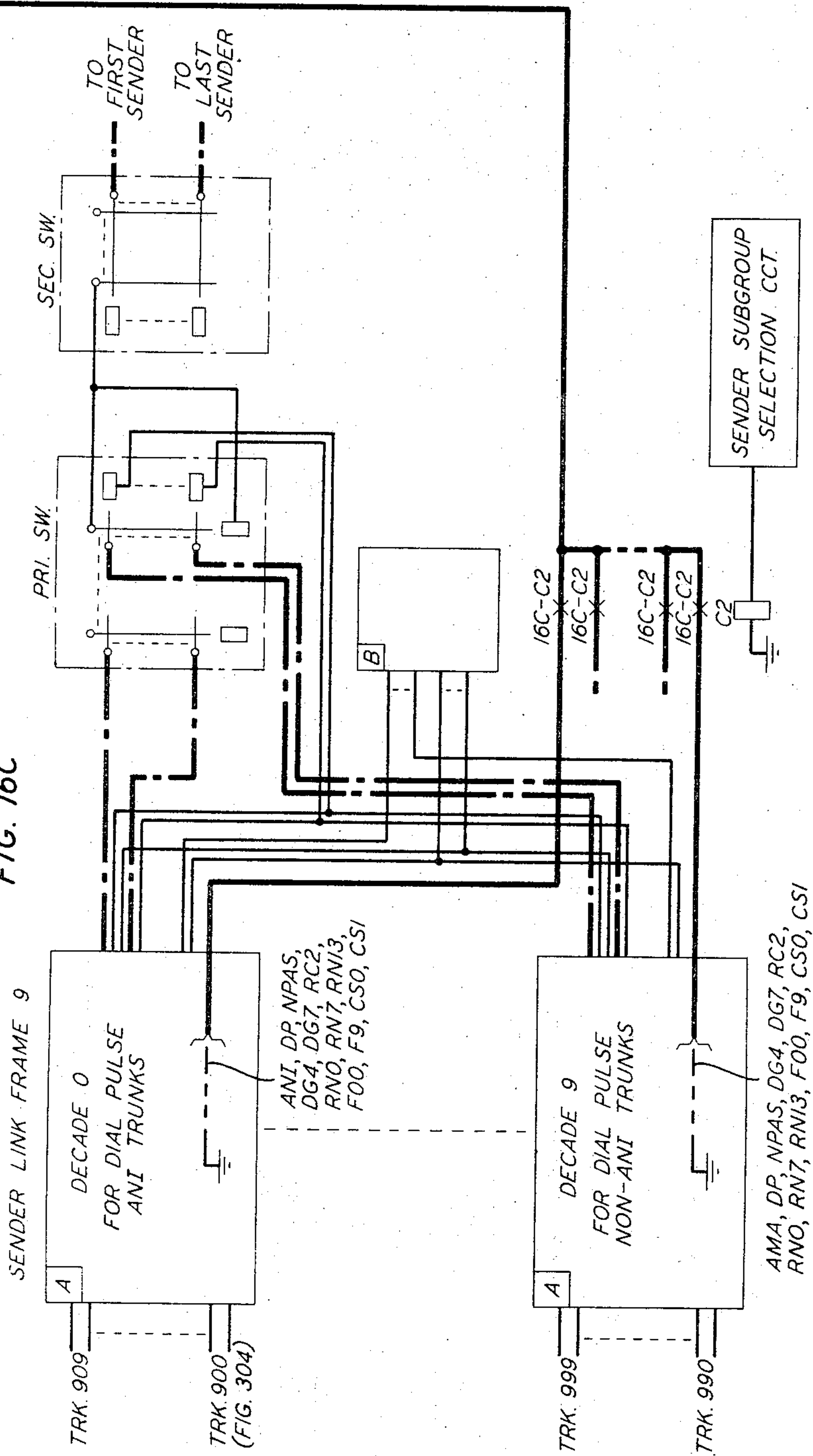
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FIG. 16C





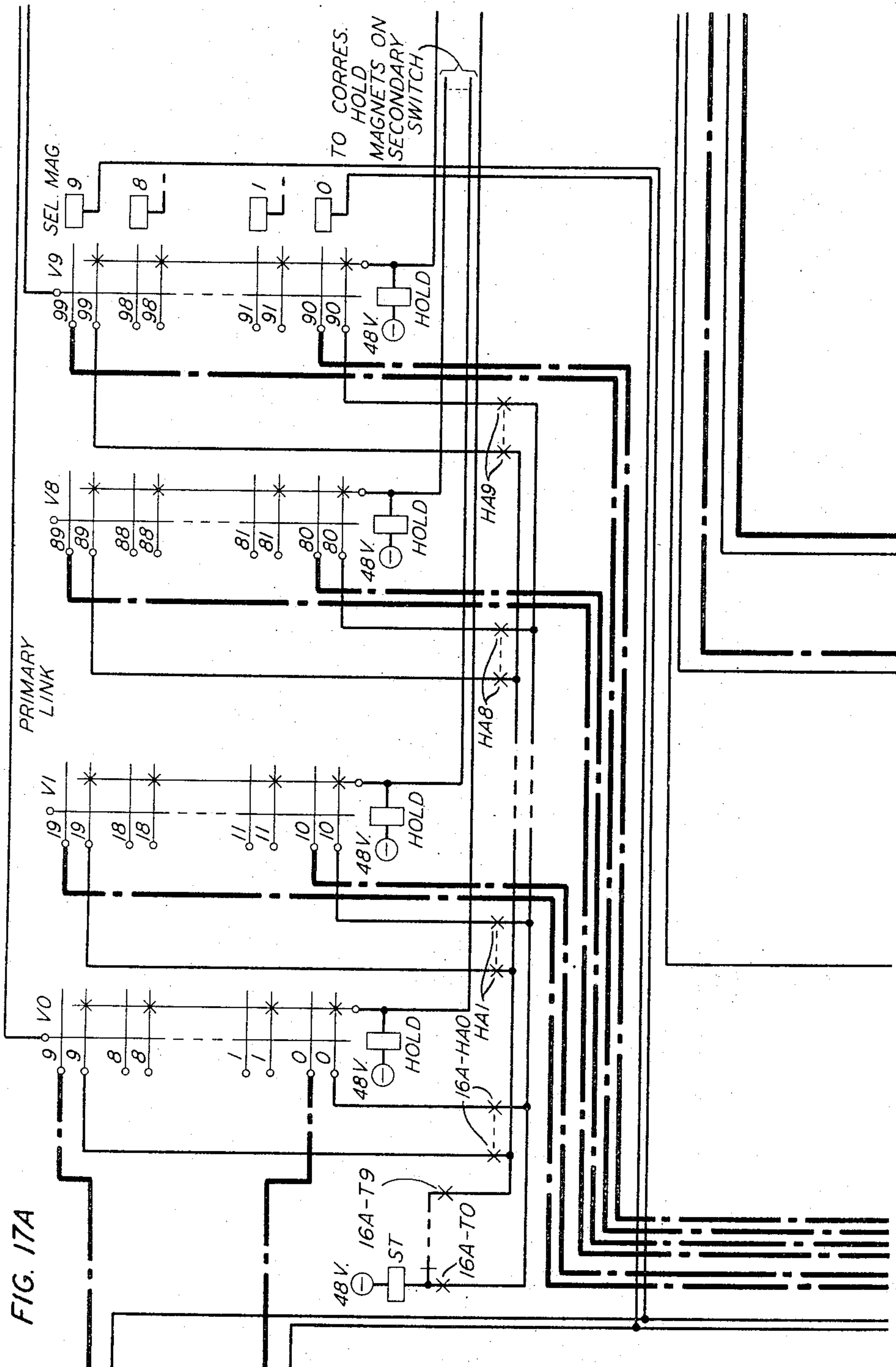
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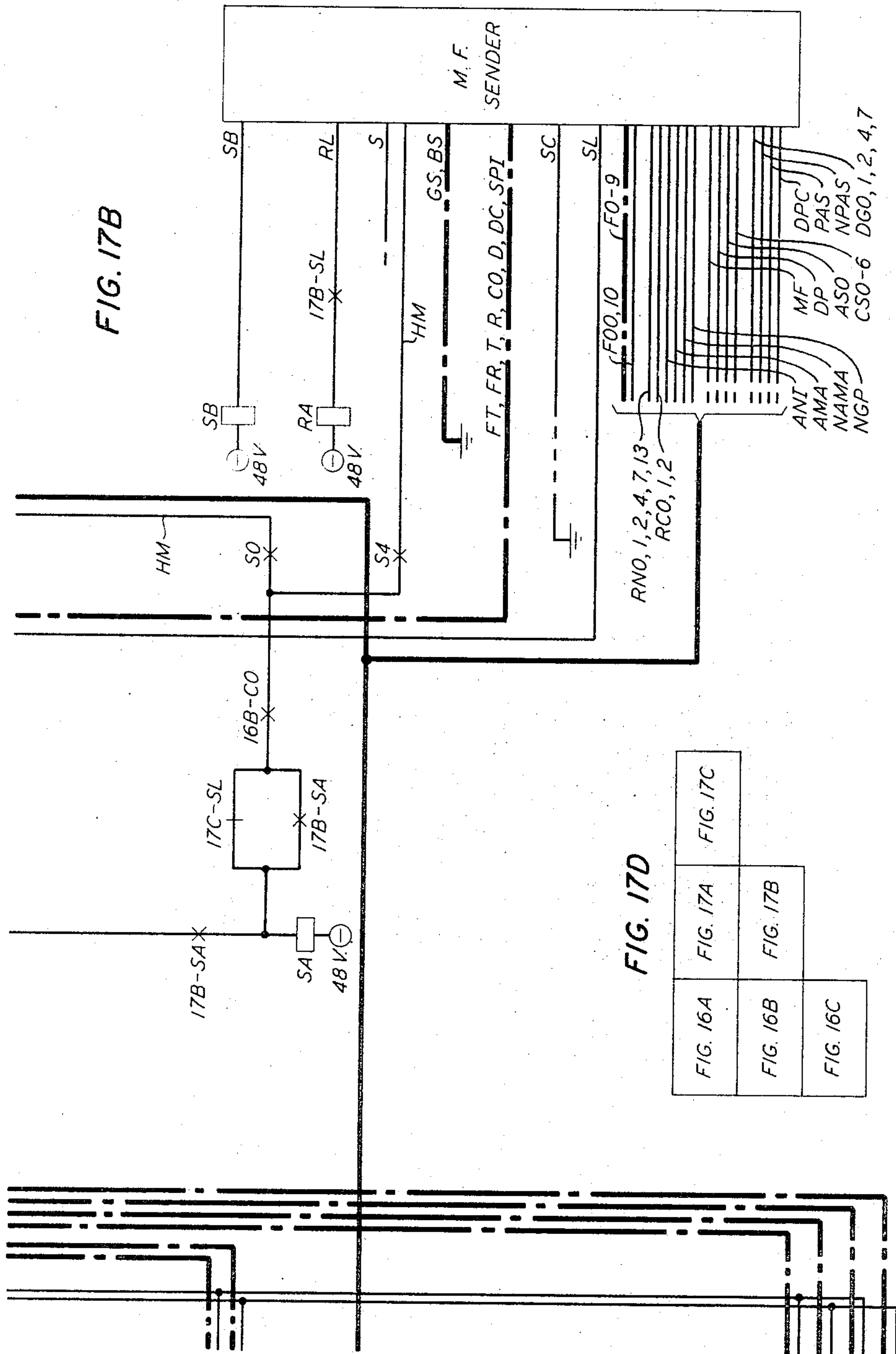
Sept. 12, 1967

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EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
INTERMEDIATE SWITCHING CENTER

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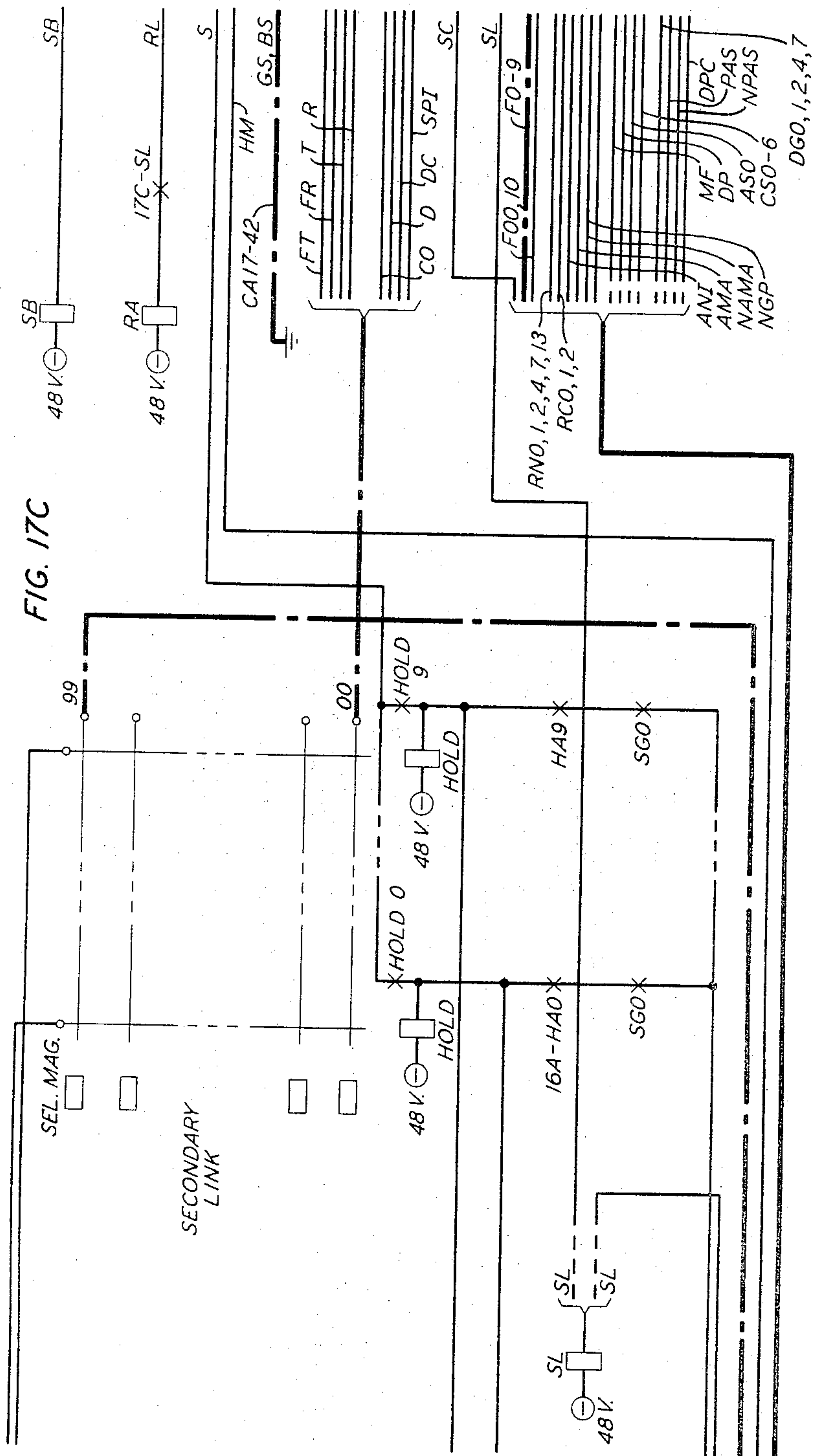
Sept. 12, 1967

R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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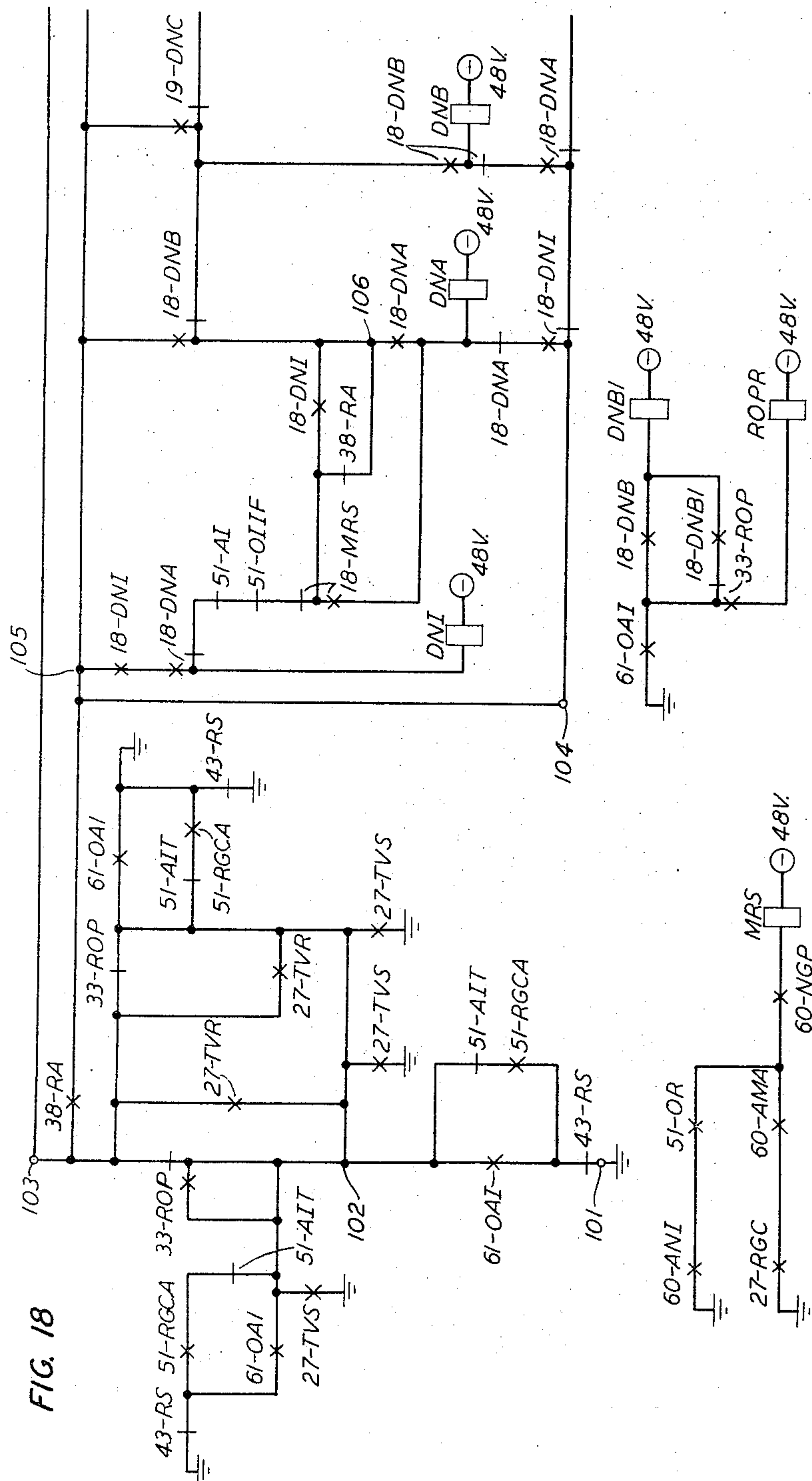




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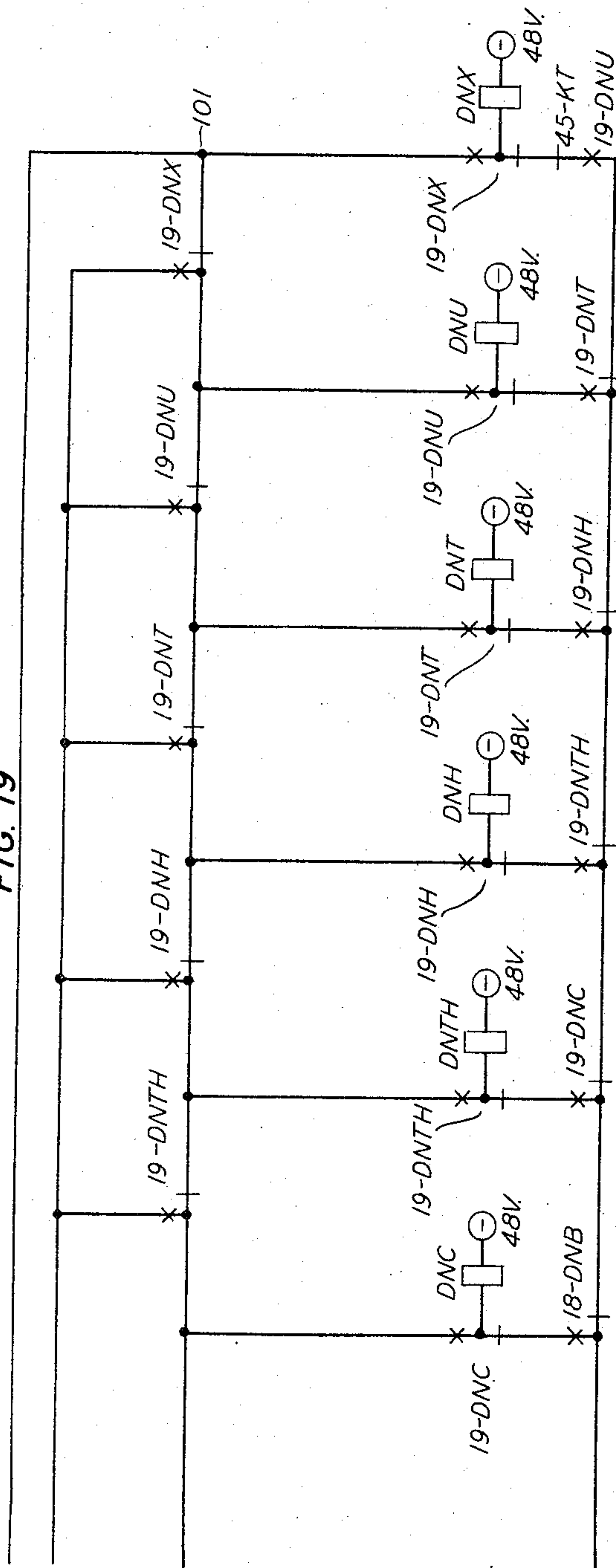
R. B. CURTIS  
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FIG. 19





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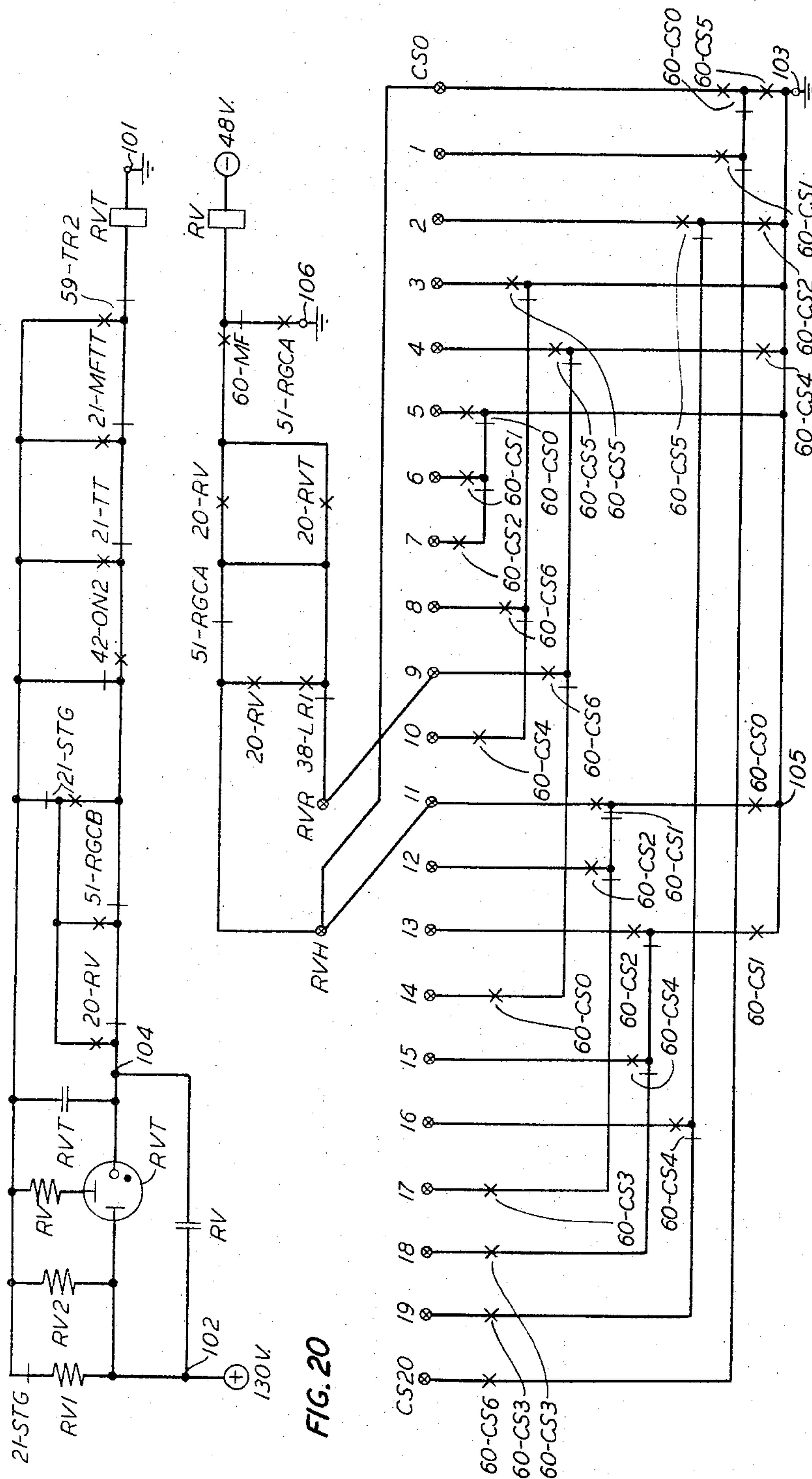
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**FIG. 20**



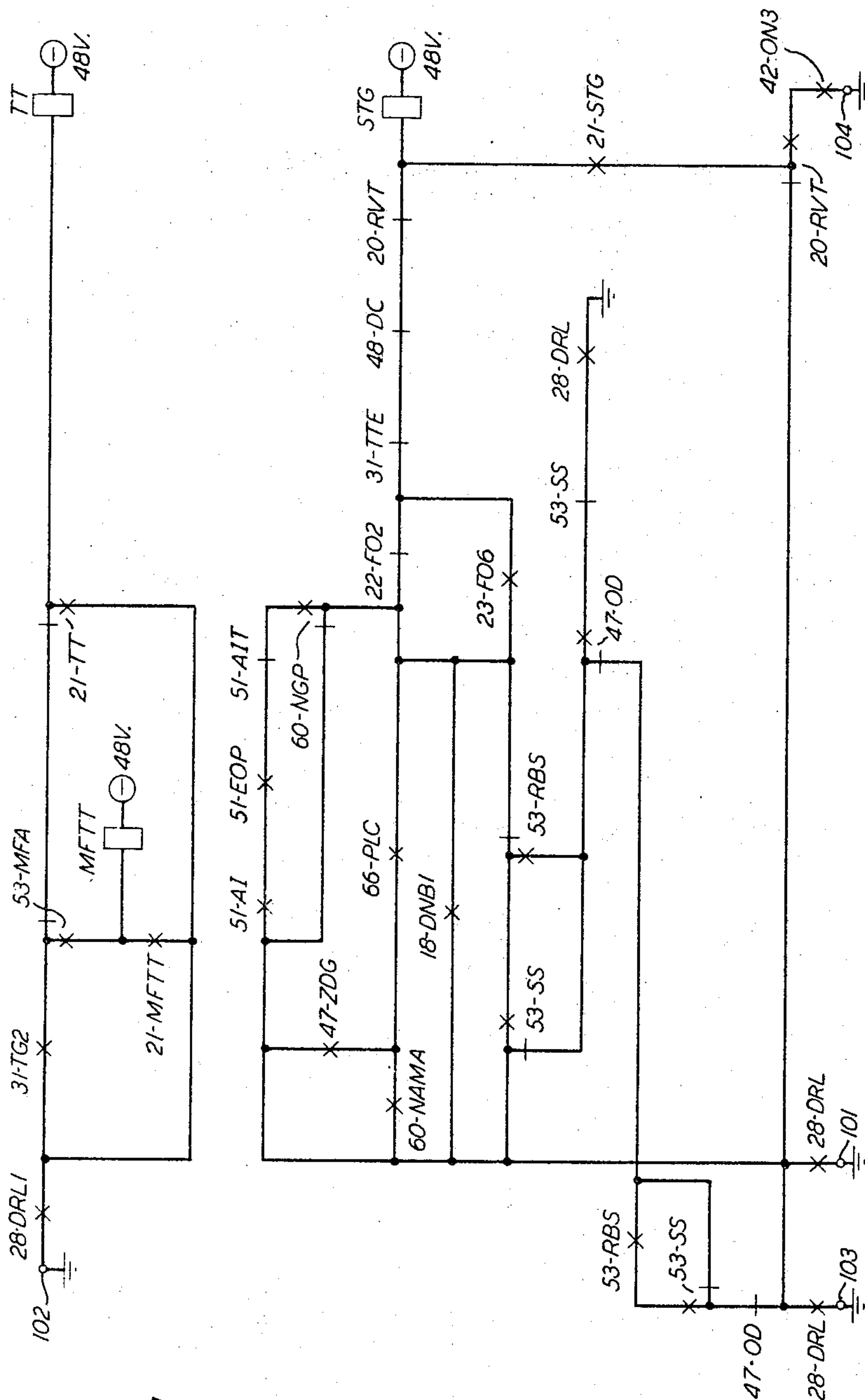
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**FIG. 21**



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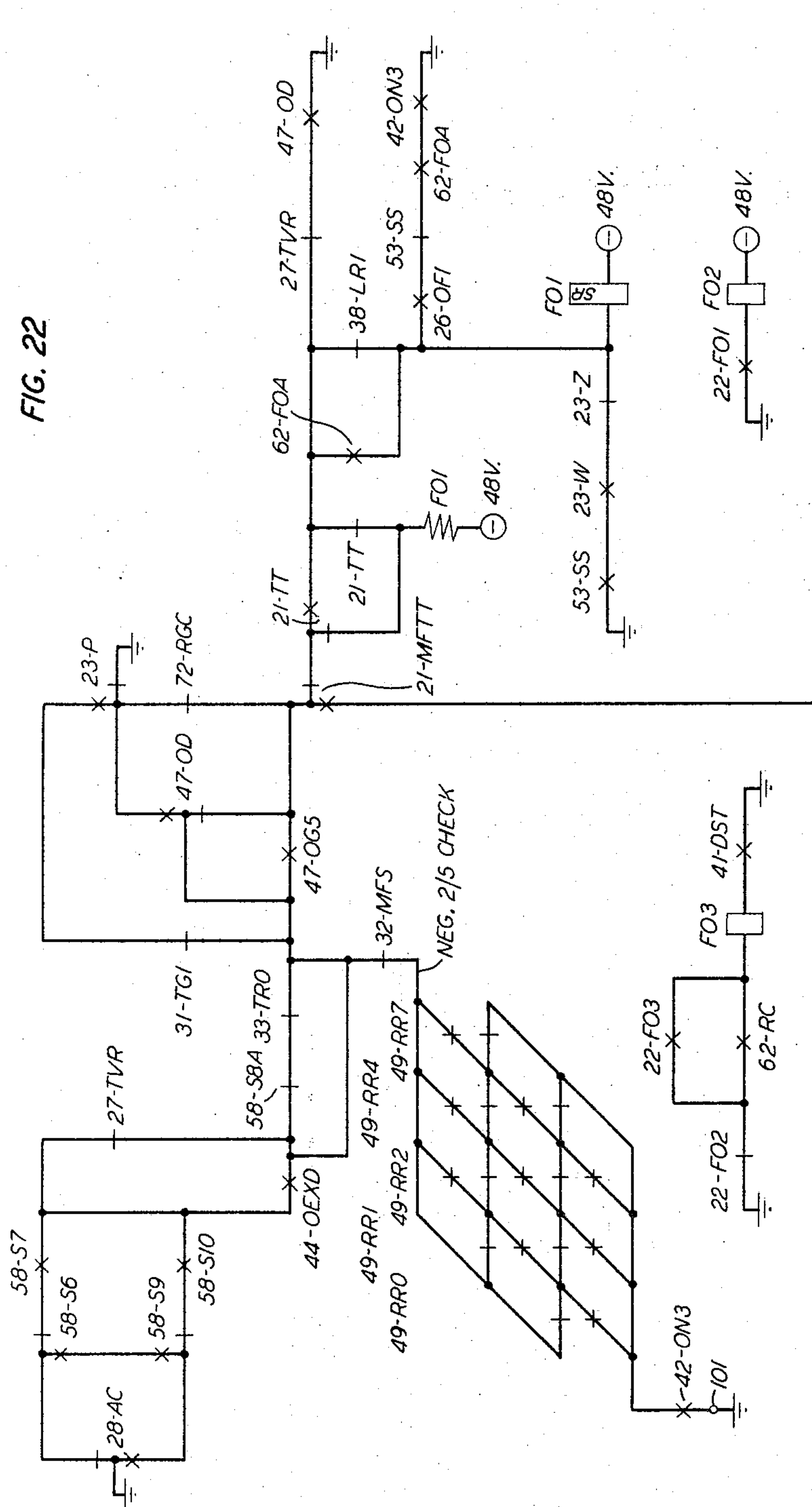
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FIG. 22





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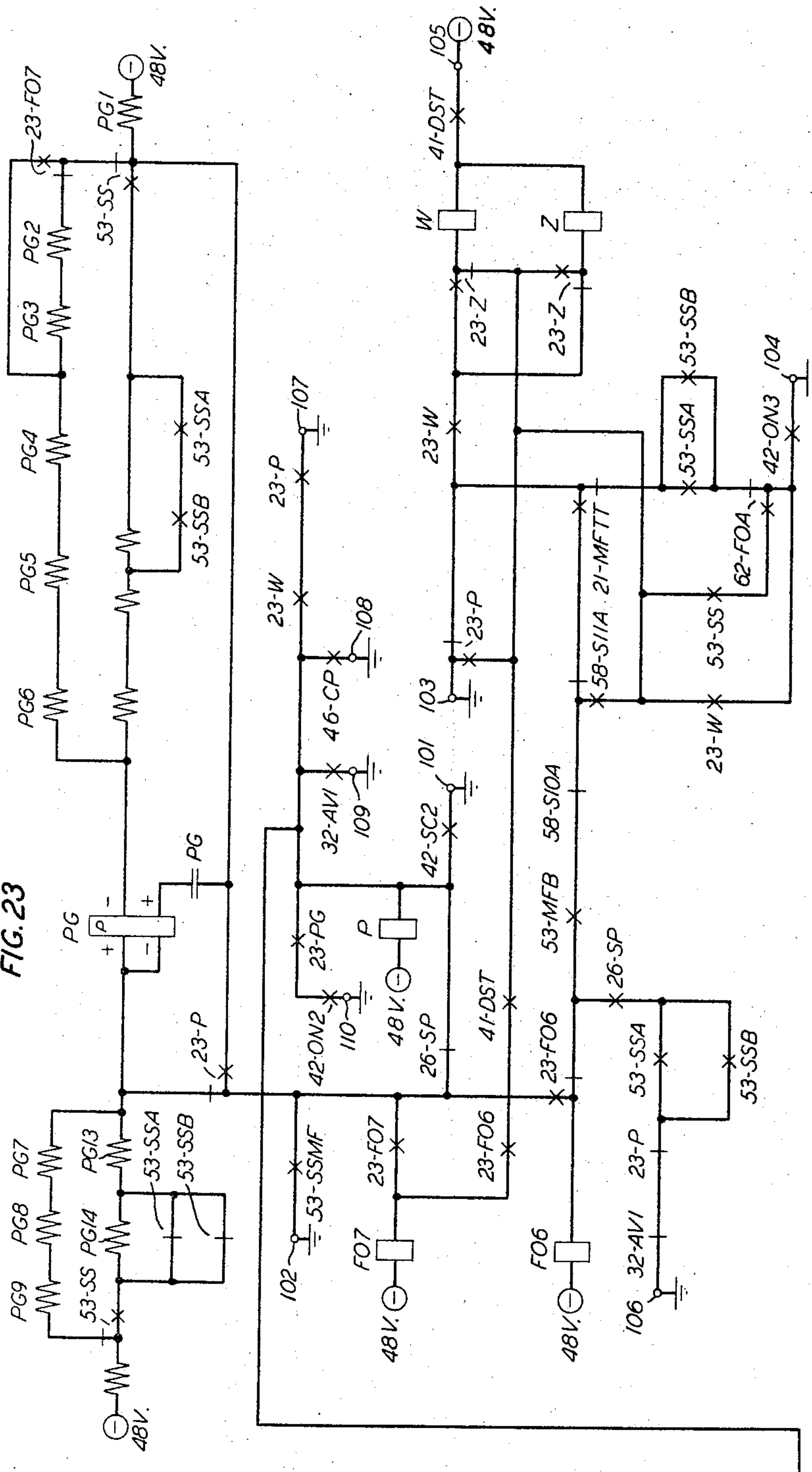
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**FIG. 23**





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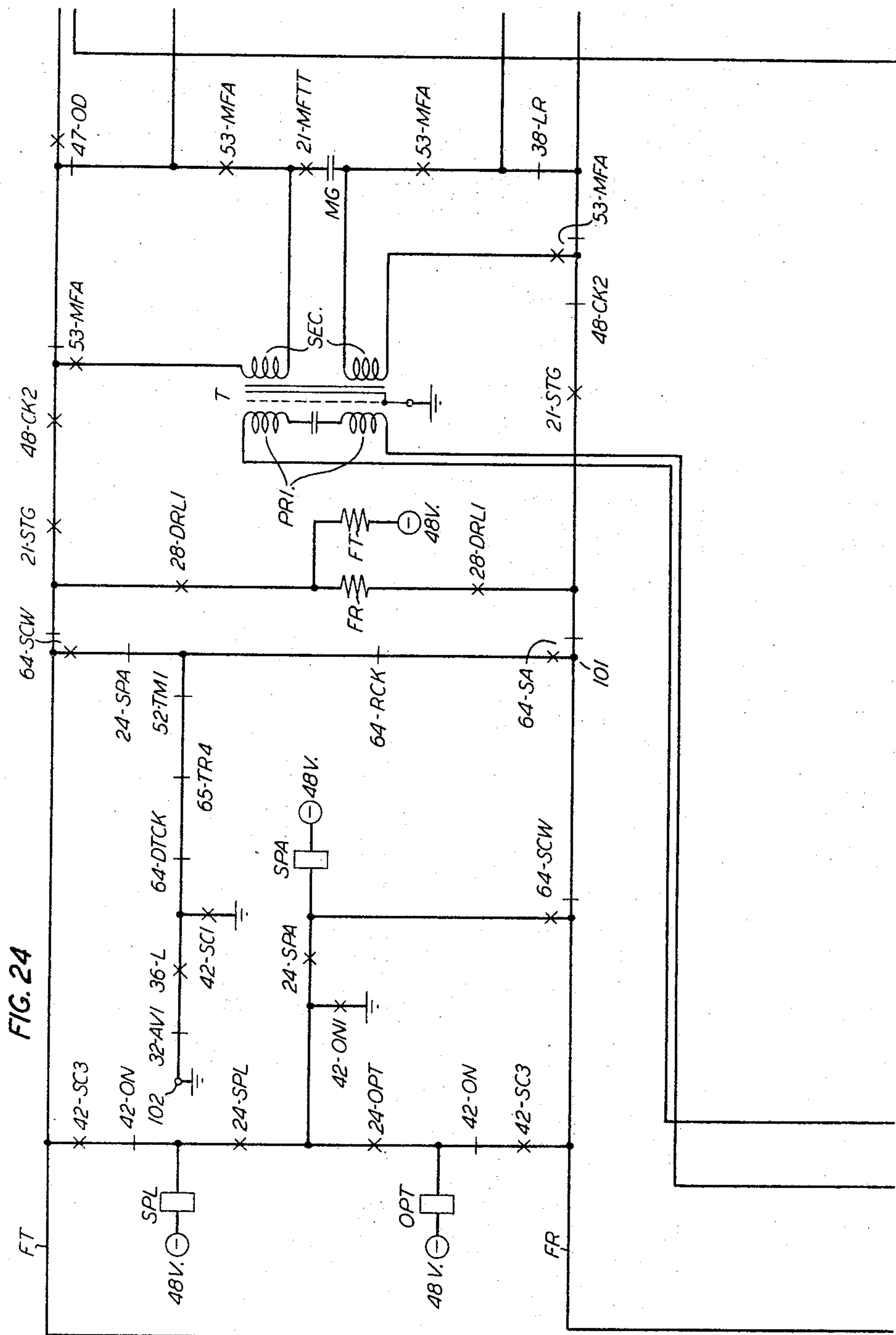
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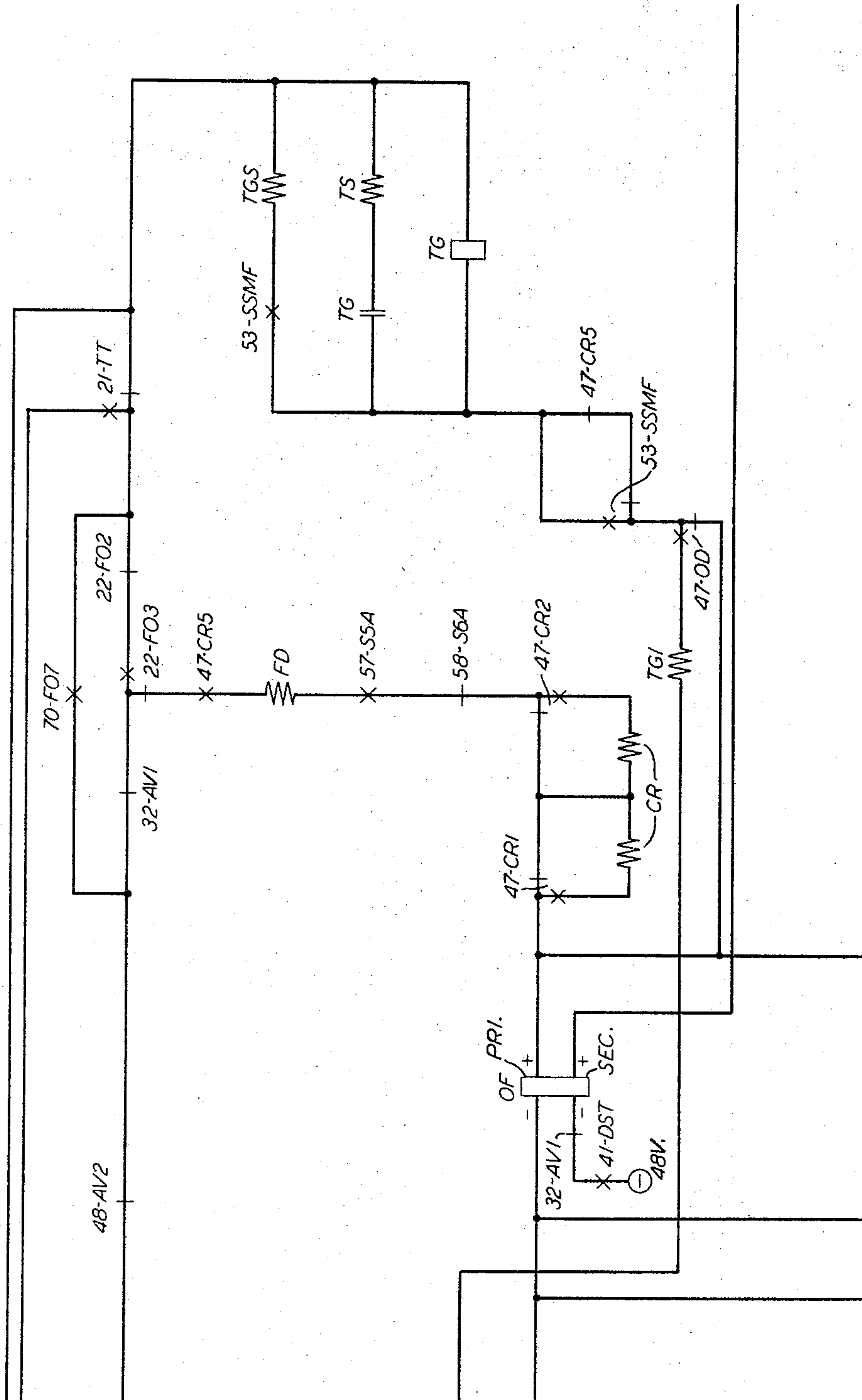
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FIG. 25





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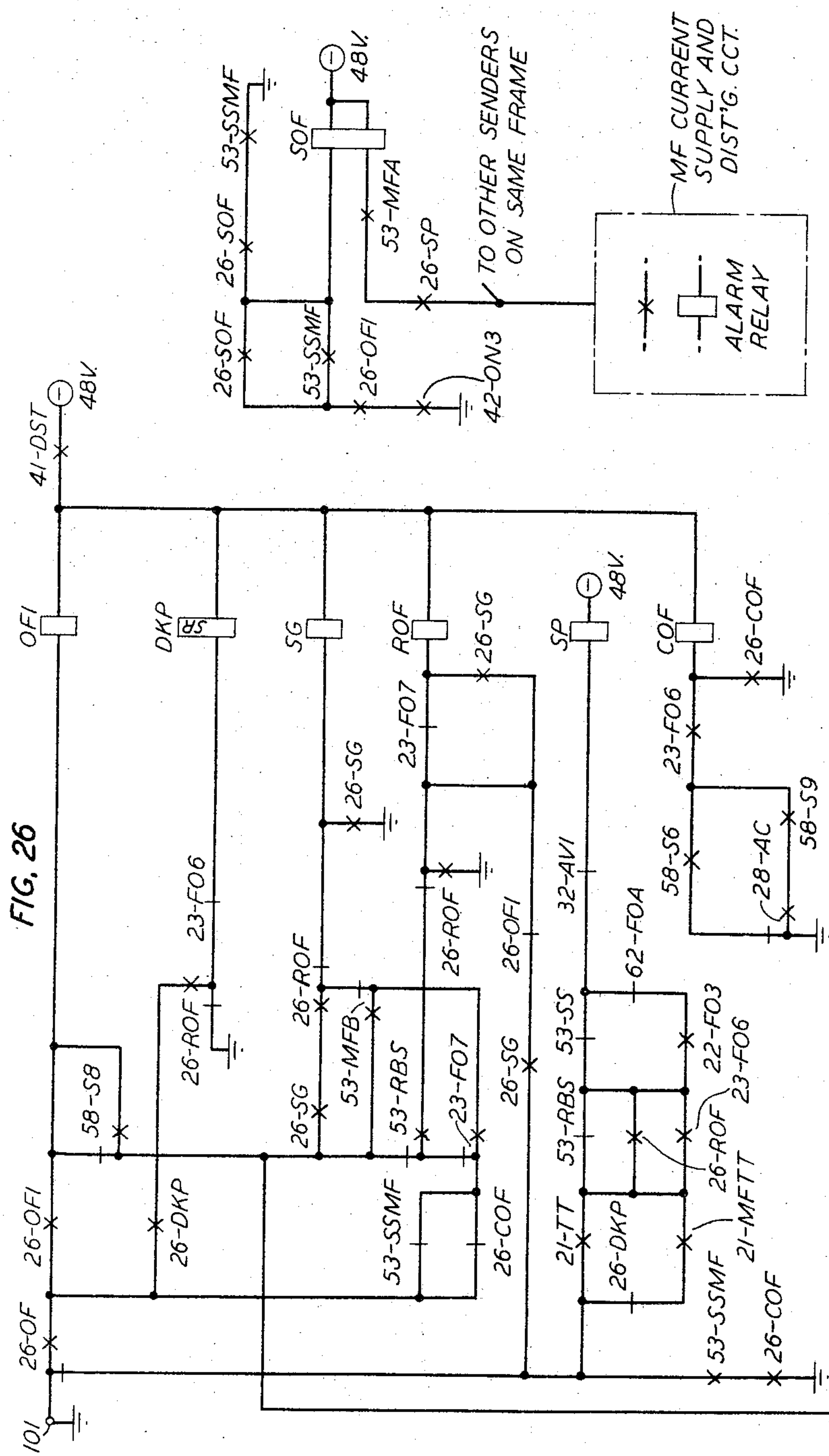
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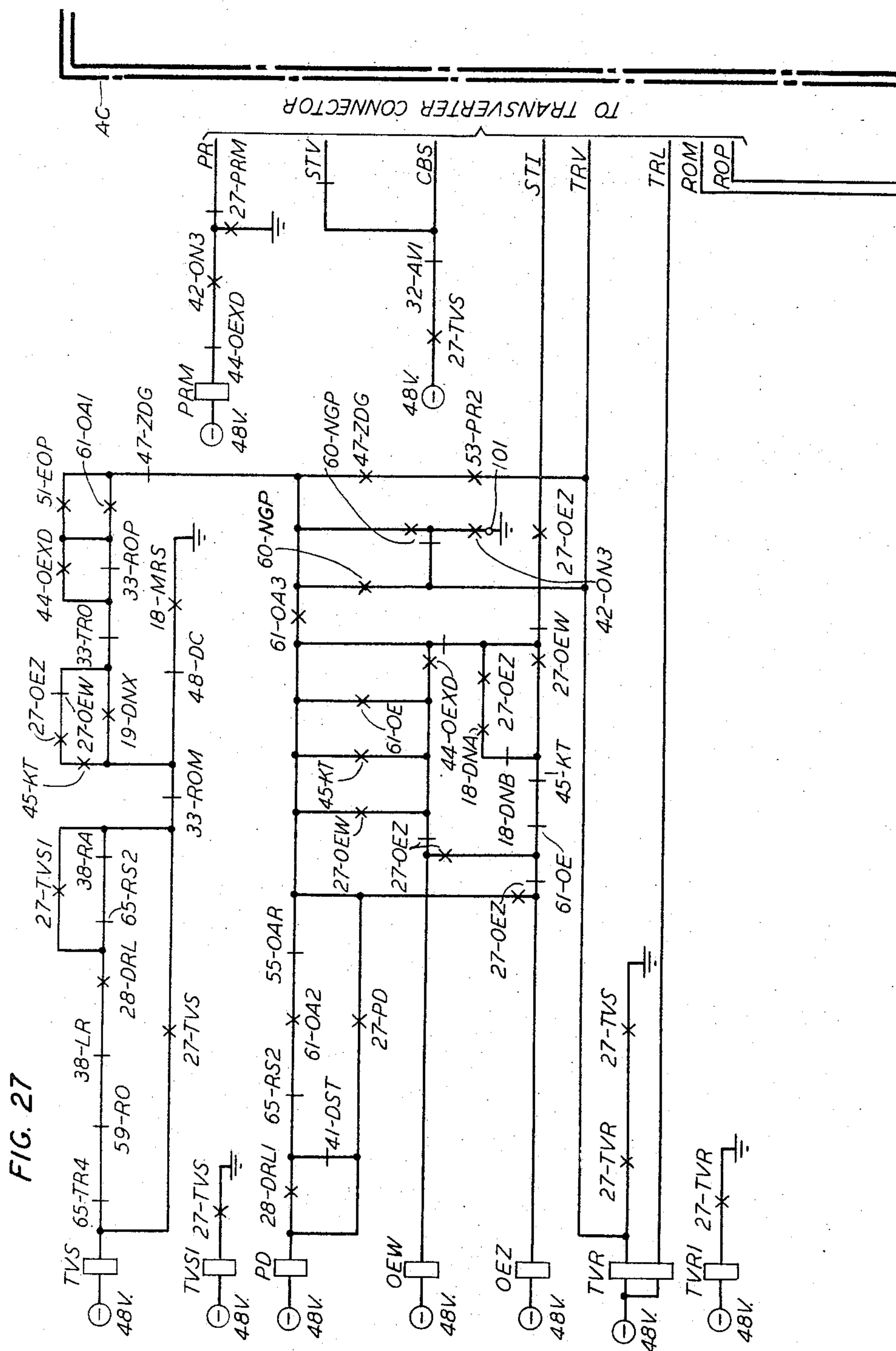




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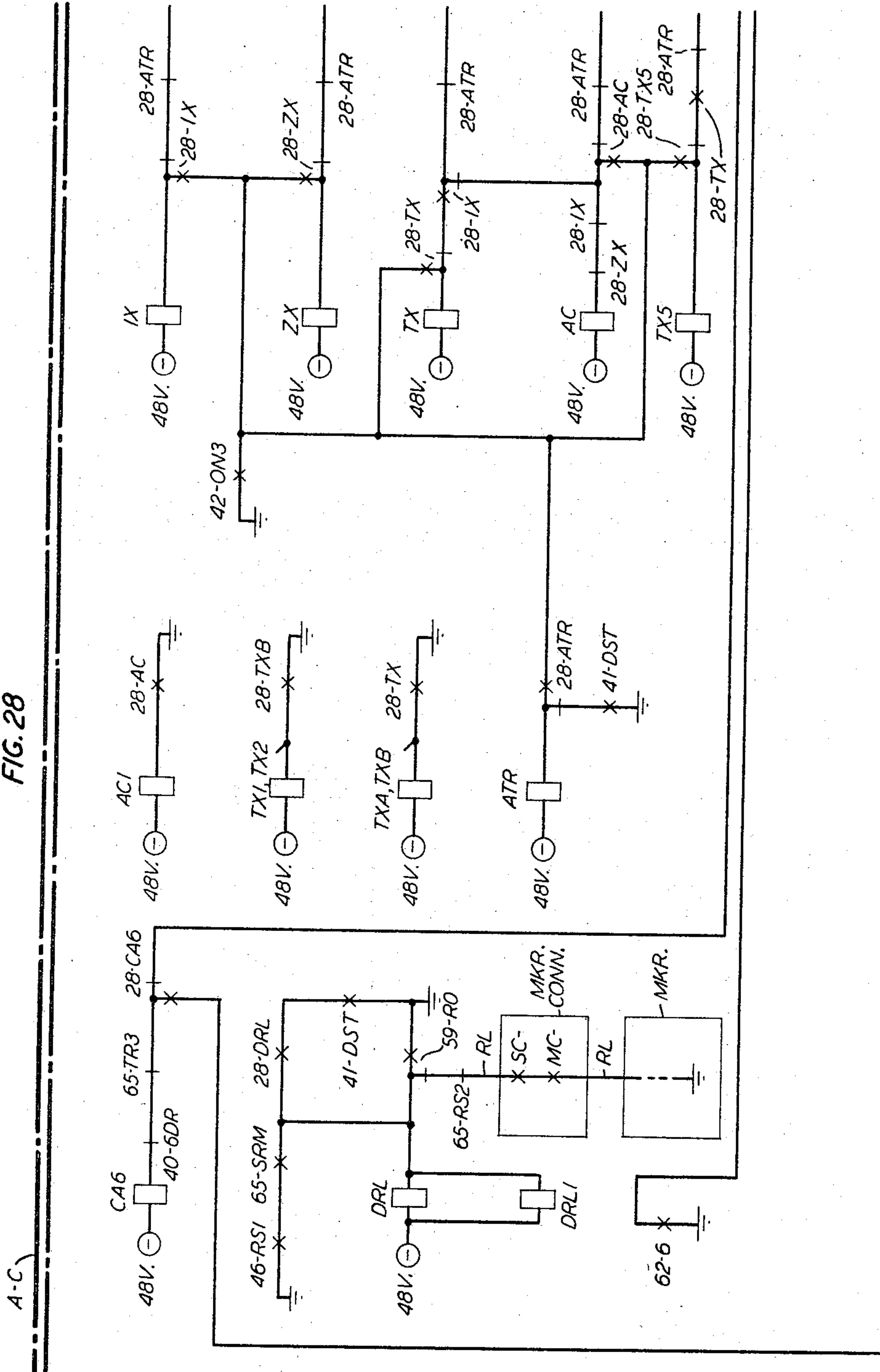
R. B. CURTIS  
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FIG. 28





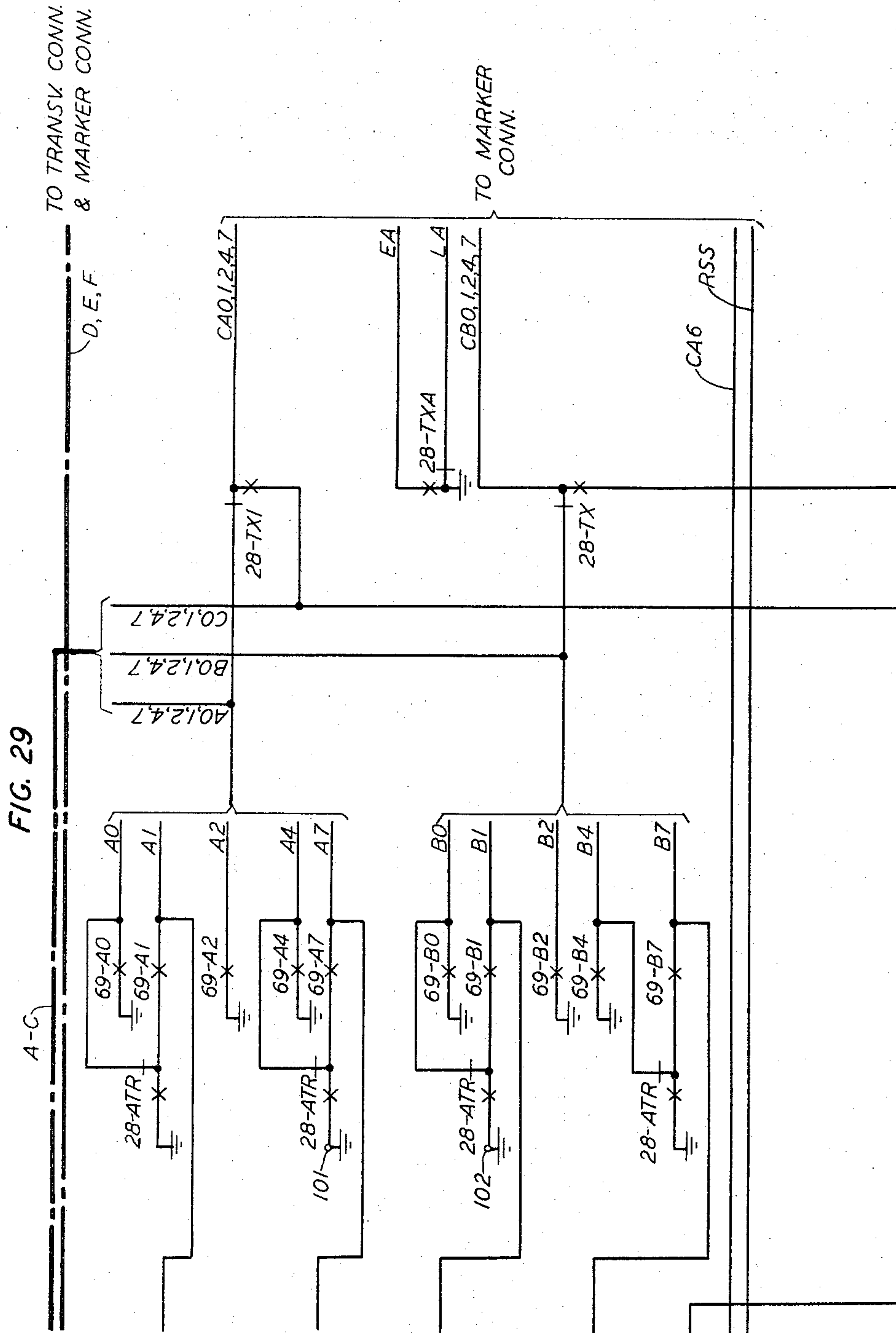
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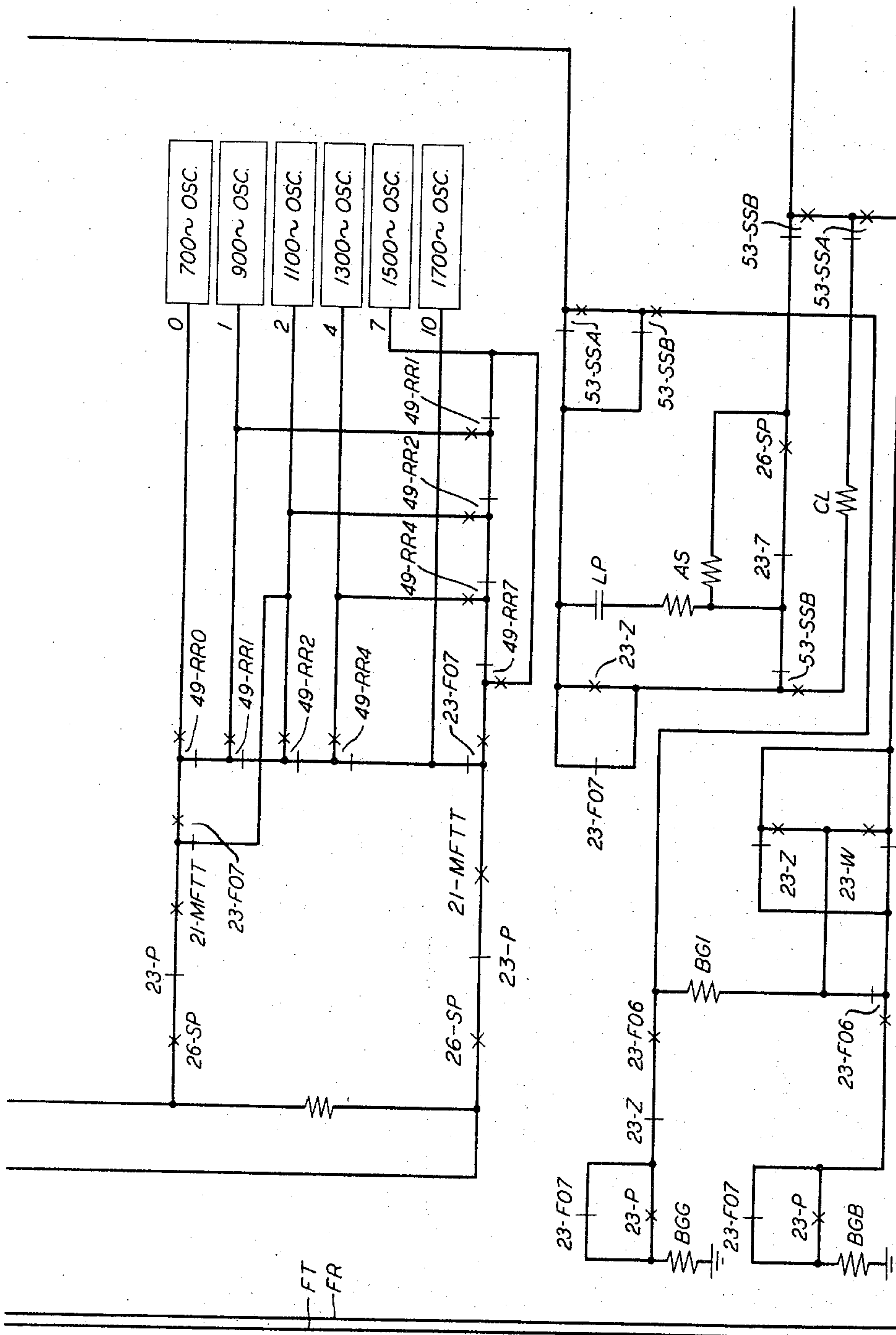
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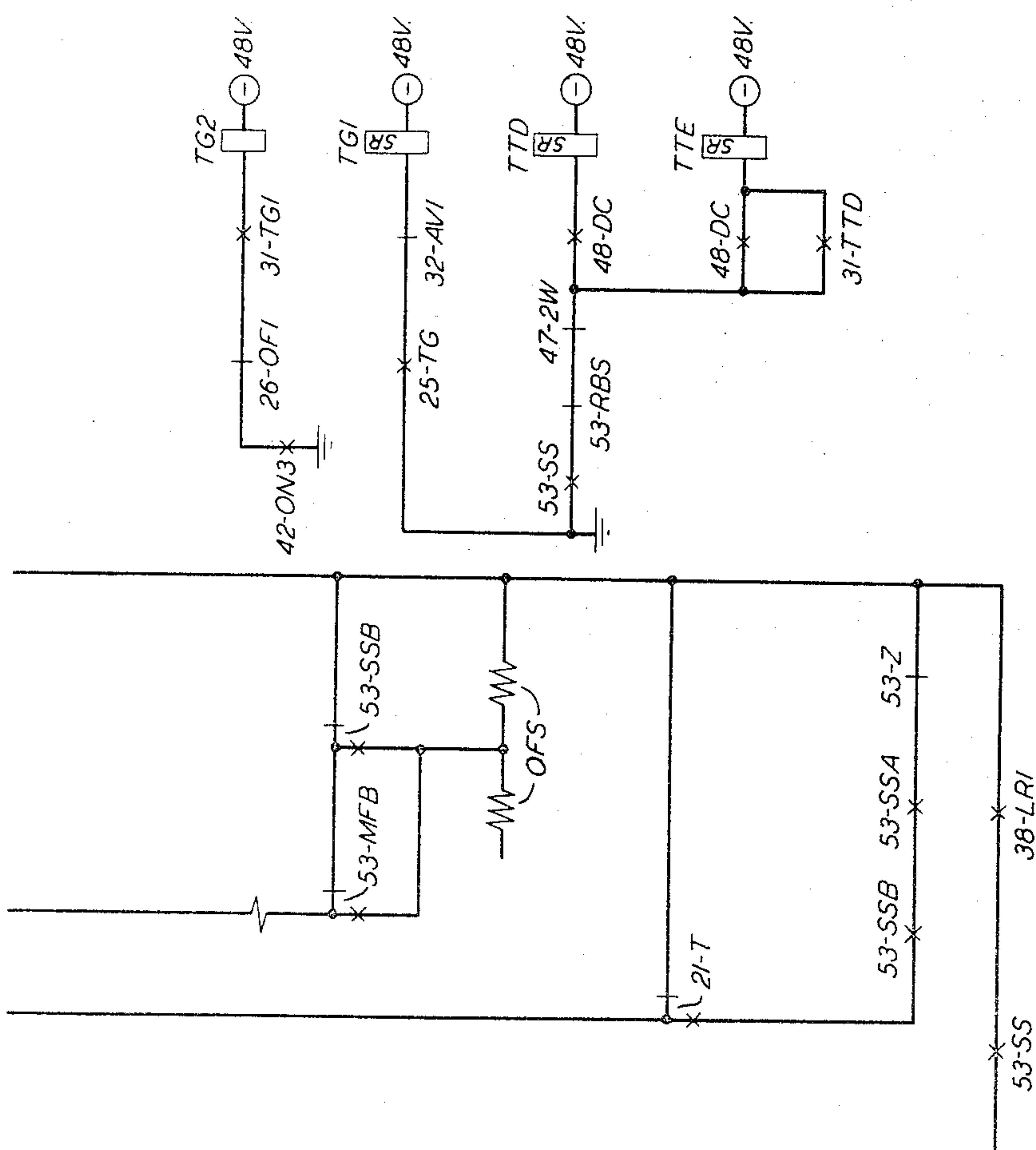
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FIG. 31





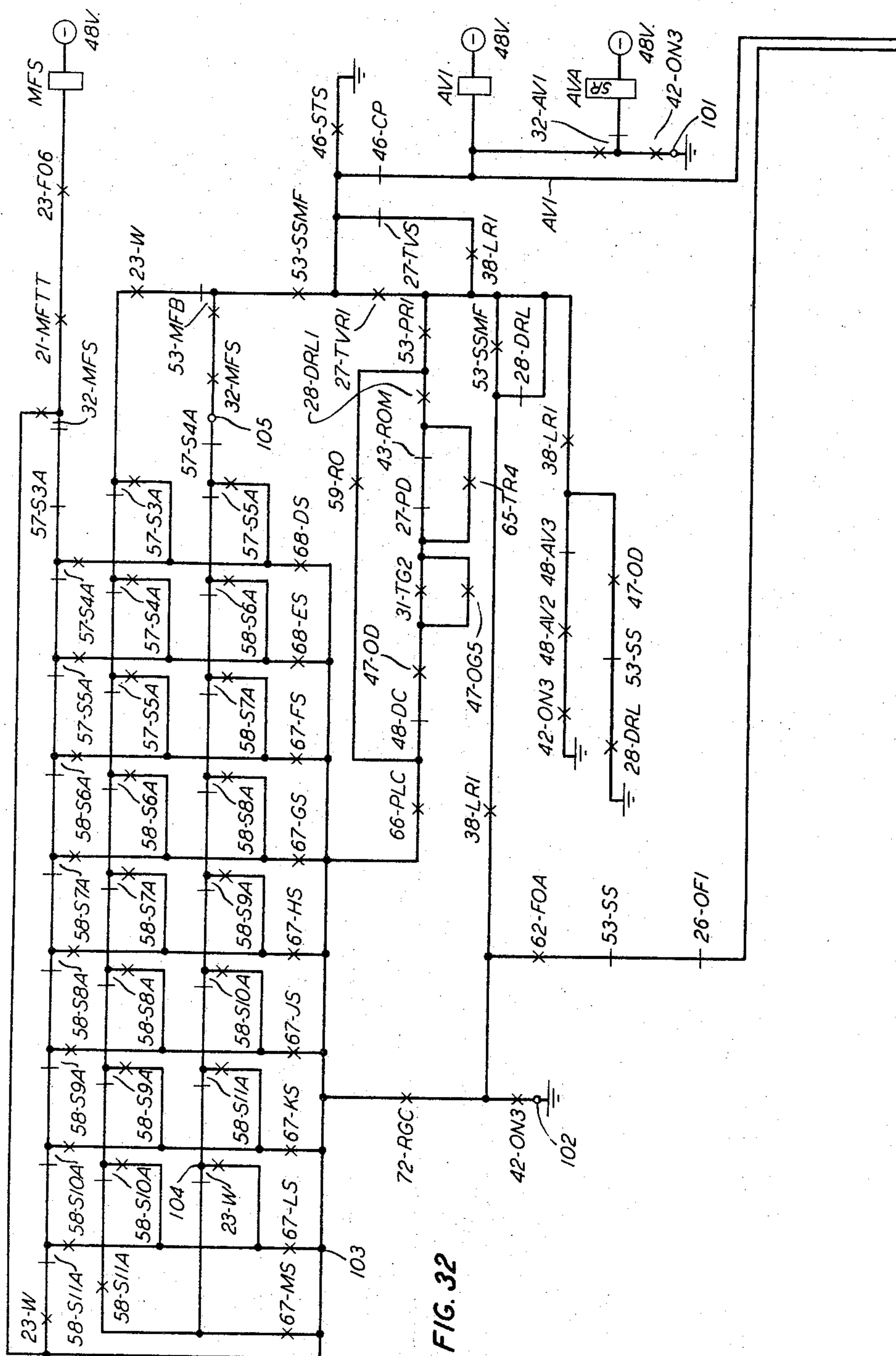
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**FIG. 32**



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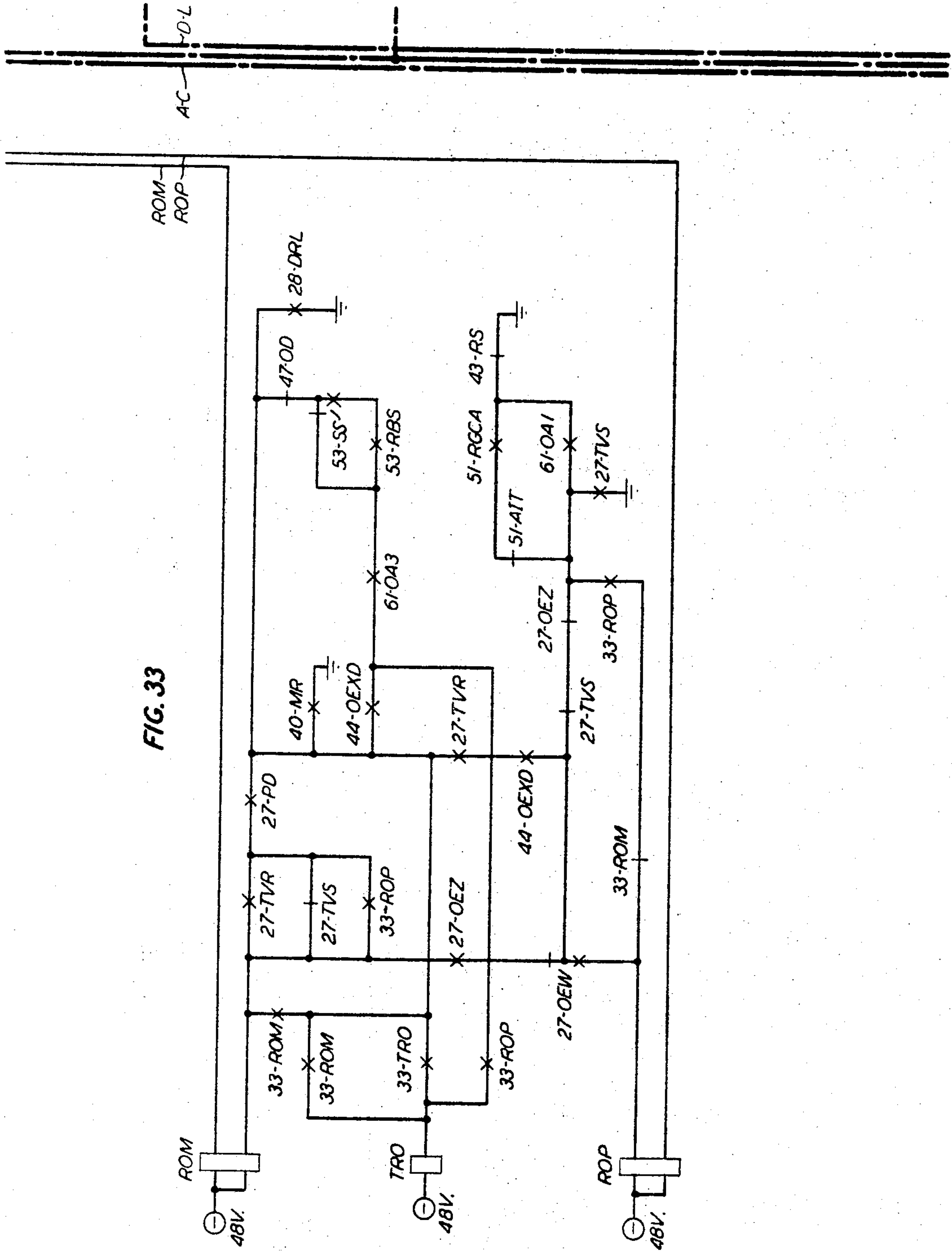
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FIG. 33





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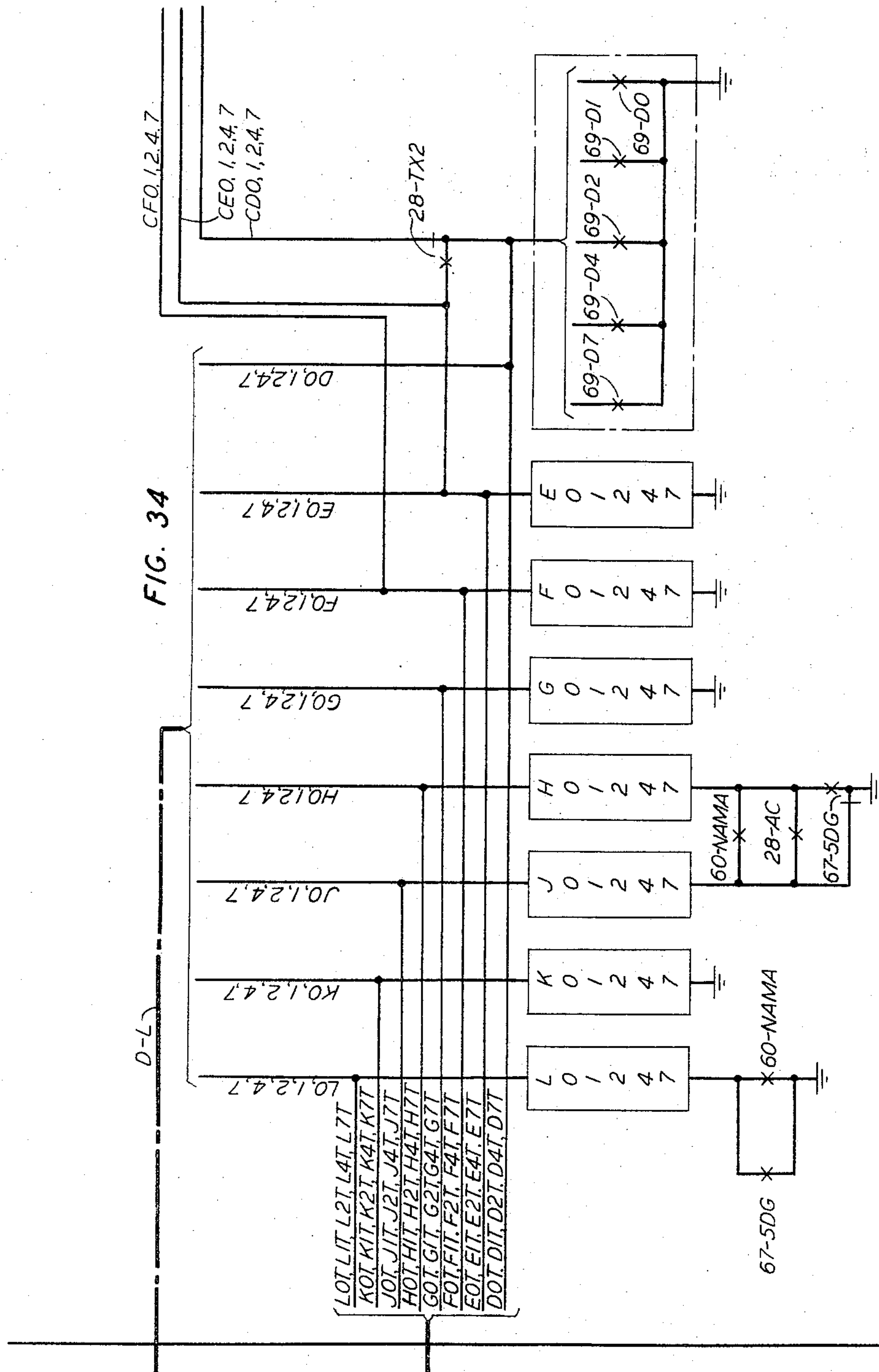
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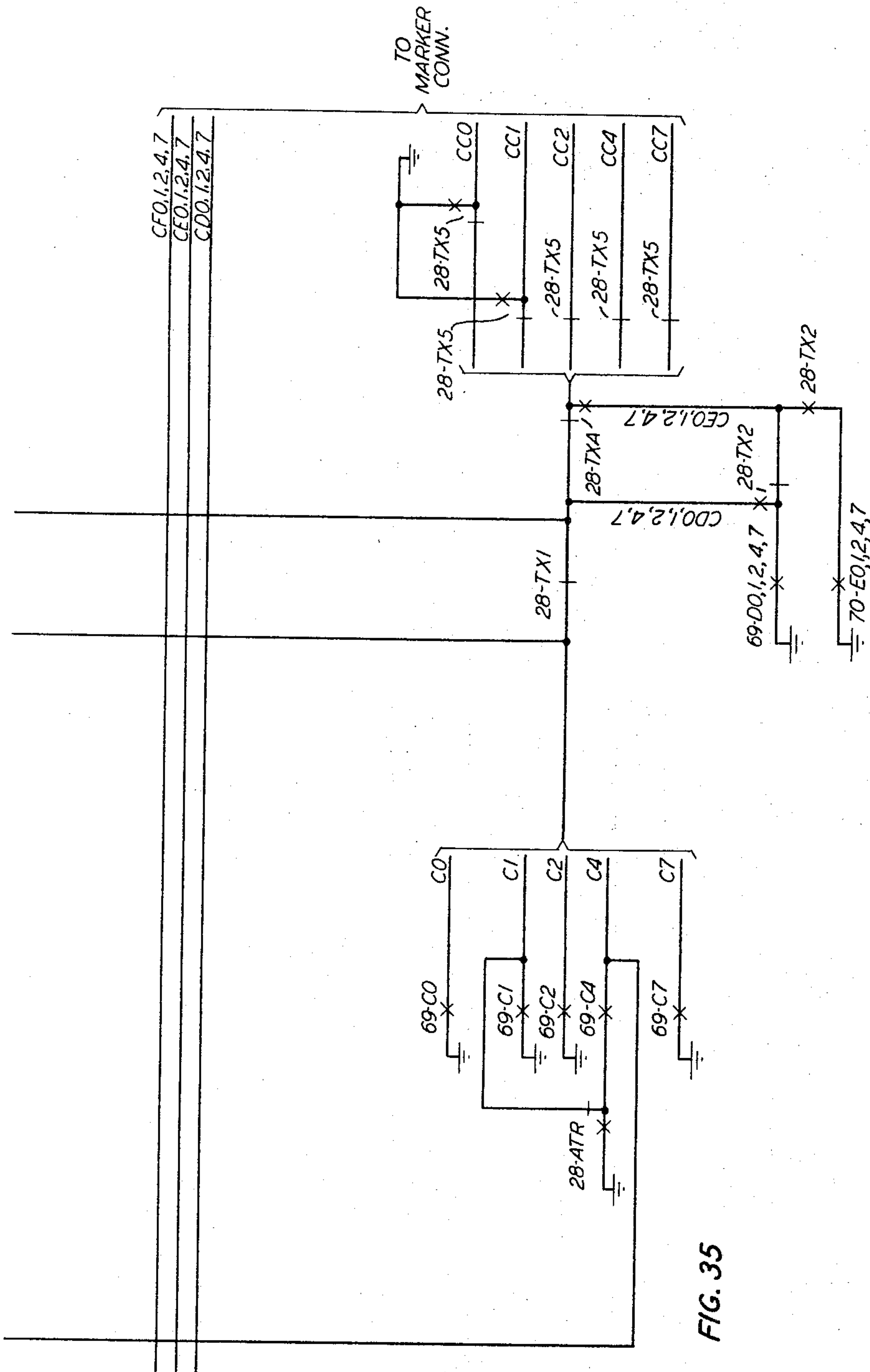


FIG. 35



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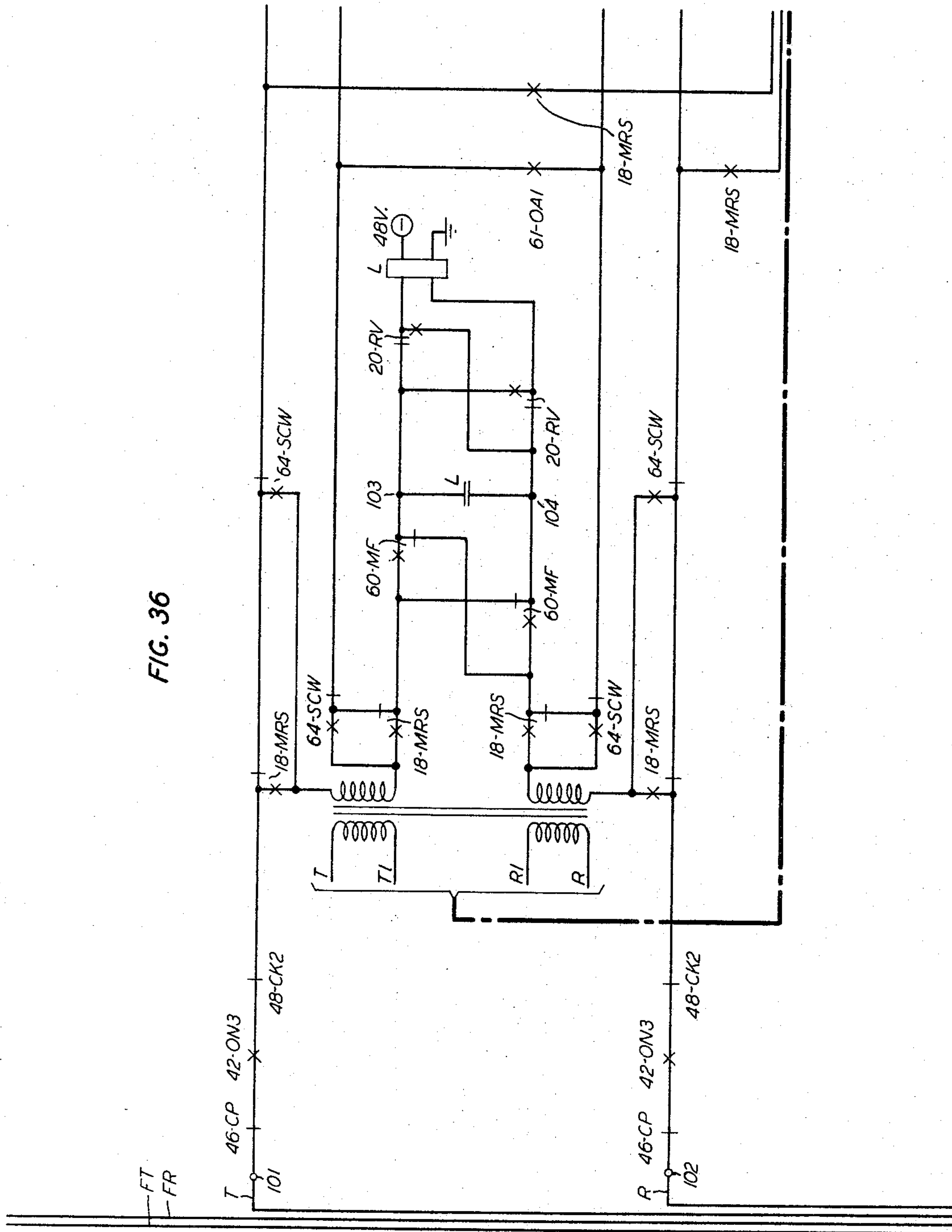
R. B. CURTIS  
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INTERMEDIATE SWITCHING CENTER

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FIG. 36





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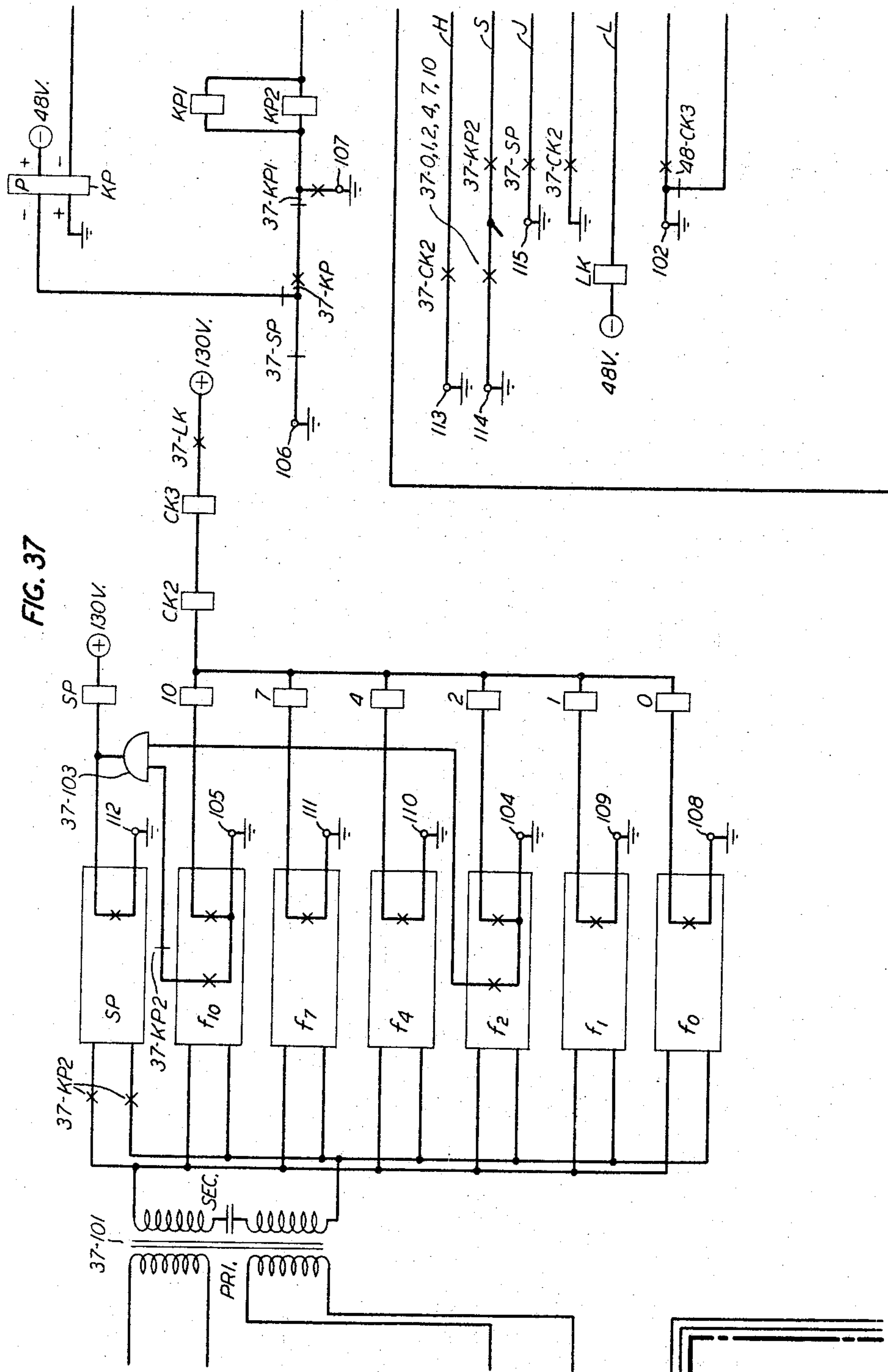
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**FIG. 37**





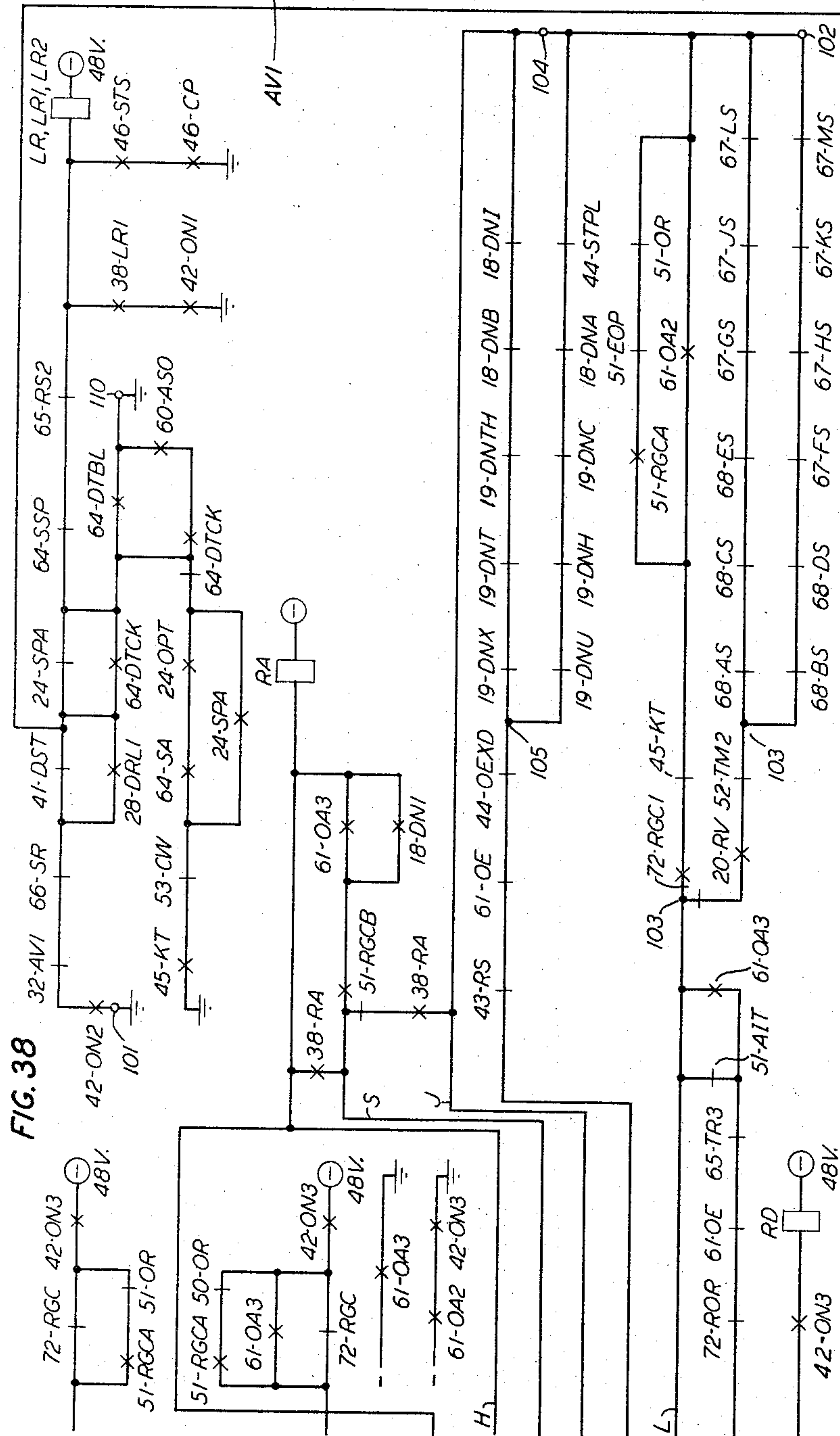
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INTERMEDIATE SWITCHING CENTER

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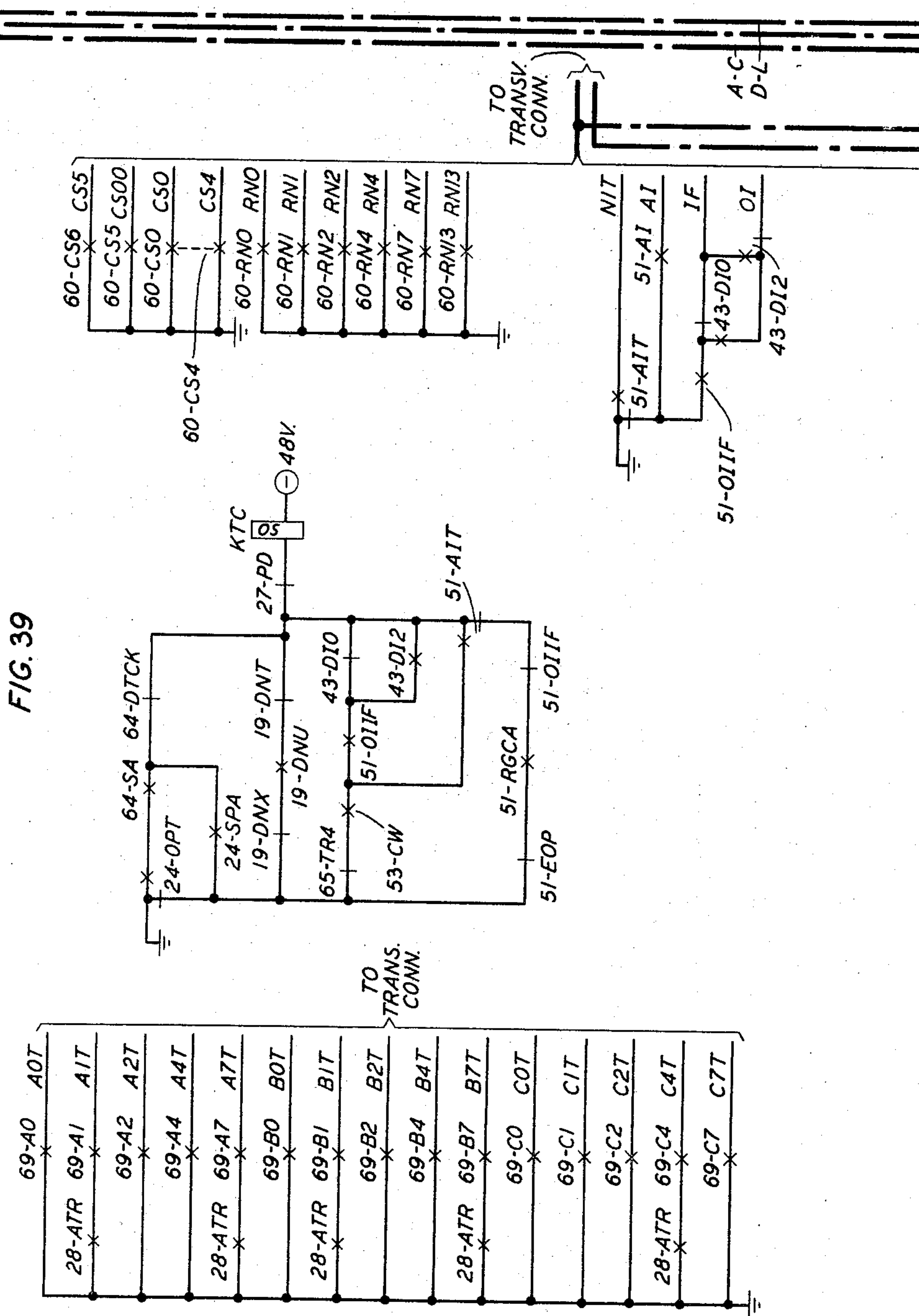


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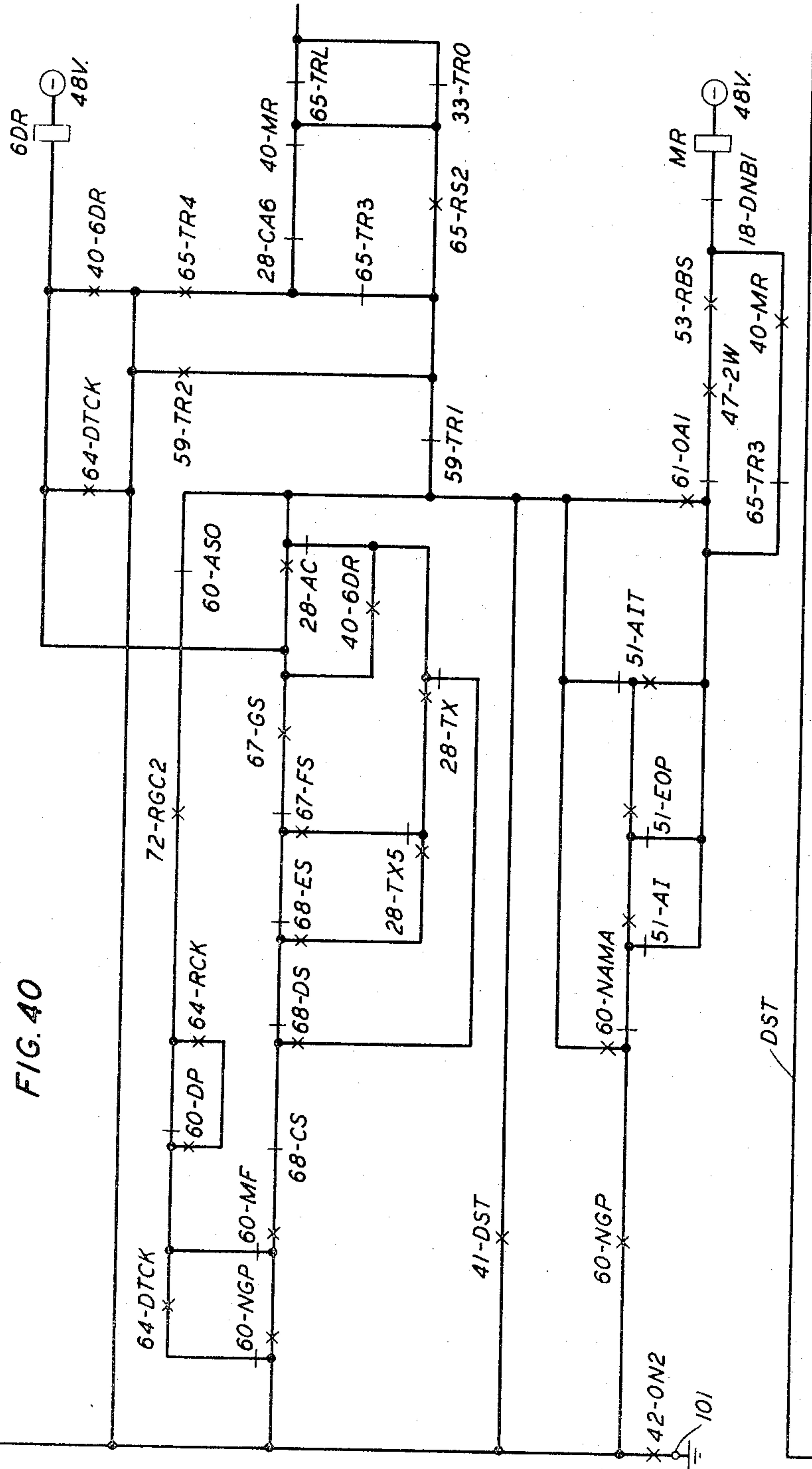
R. B. CURTIS  
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FIG. 40





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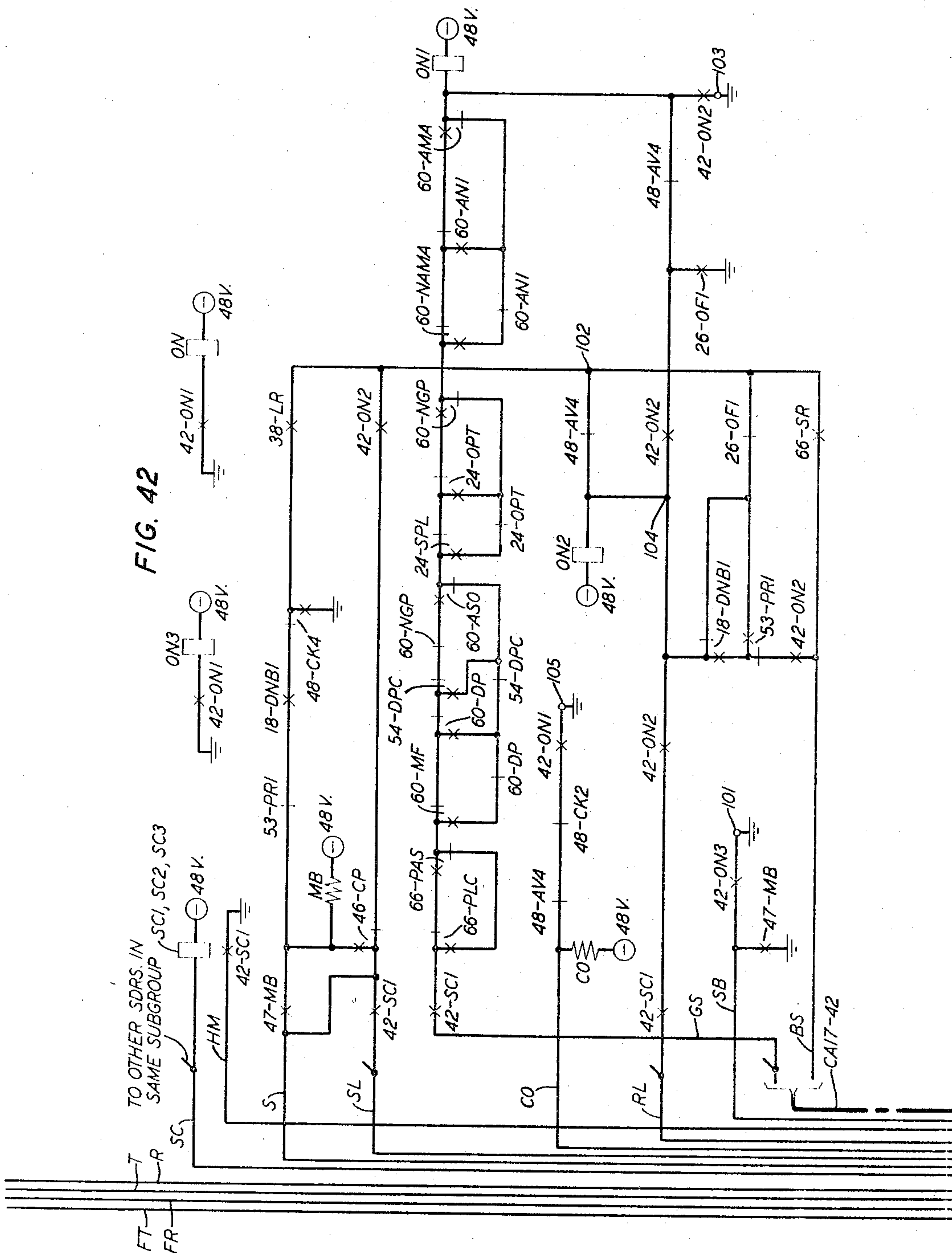
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FIG. 42





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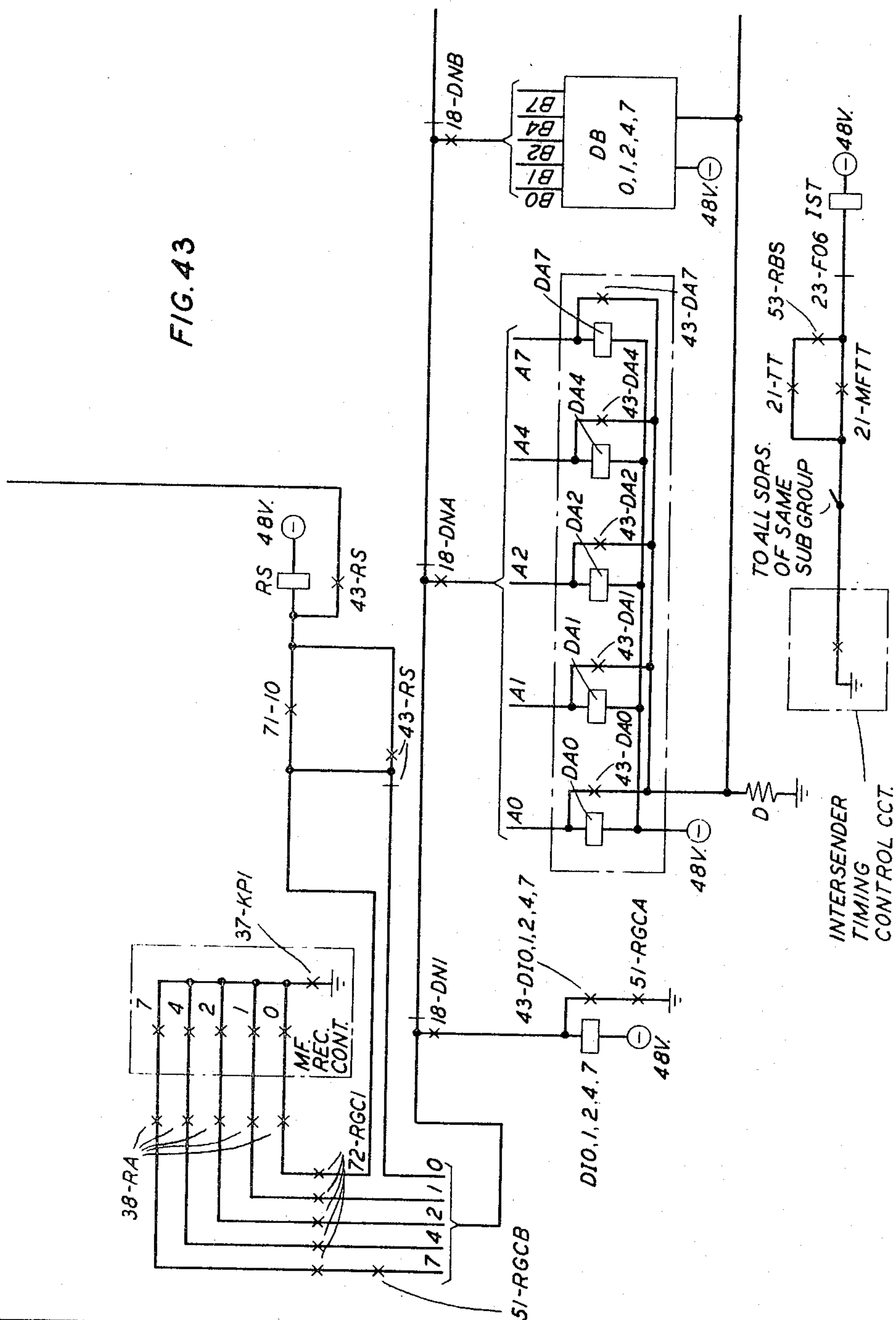
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FIG. 43









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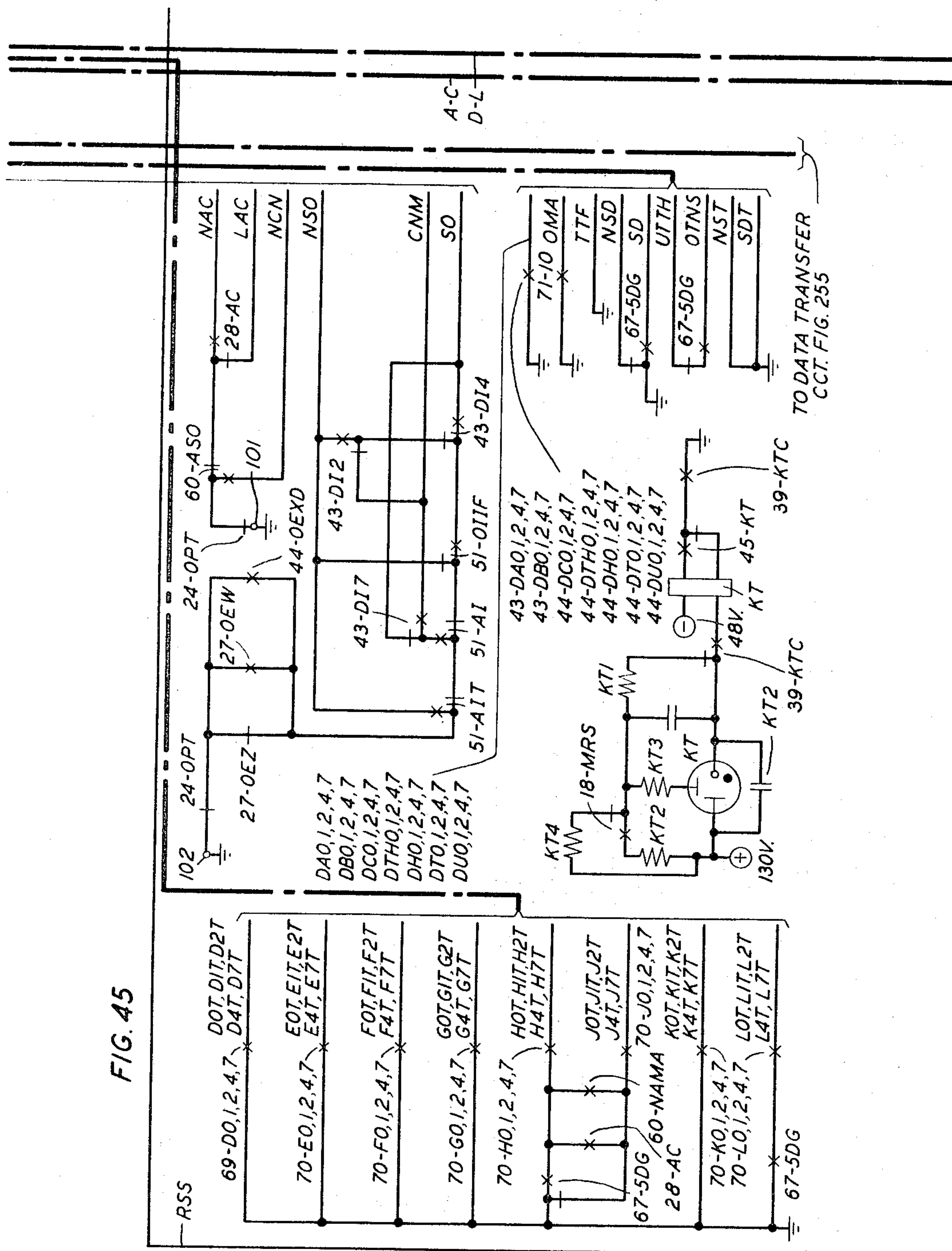
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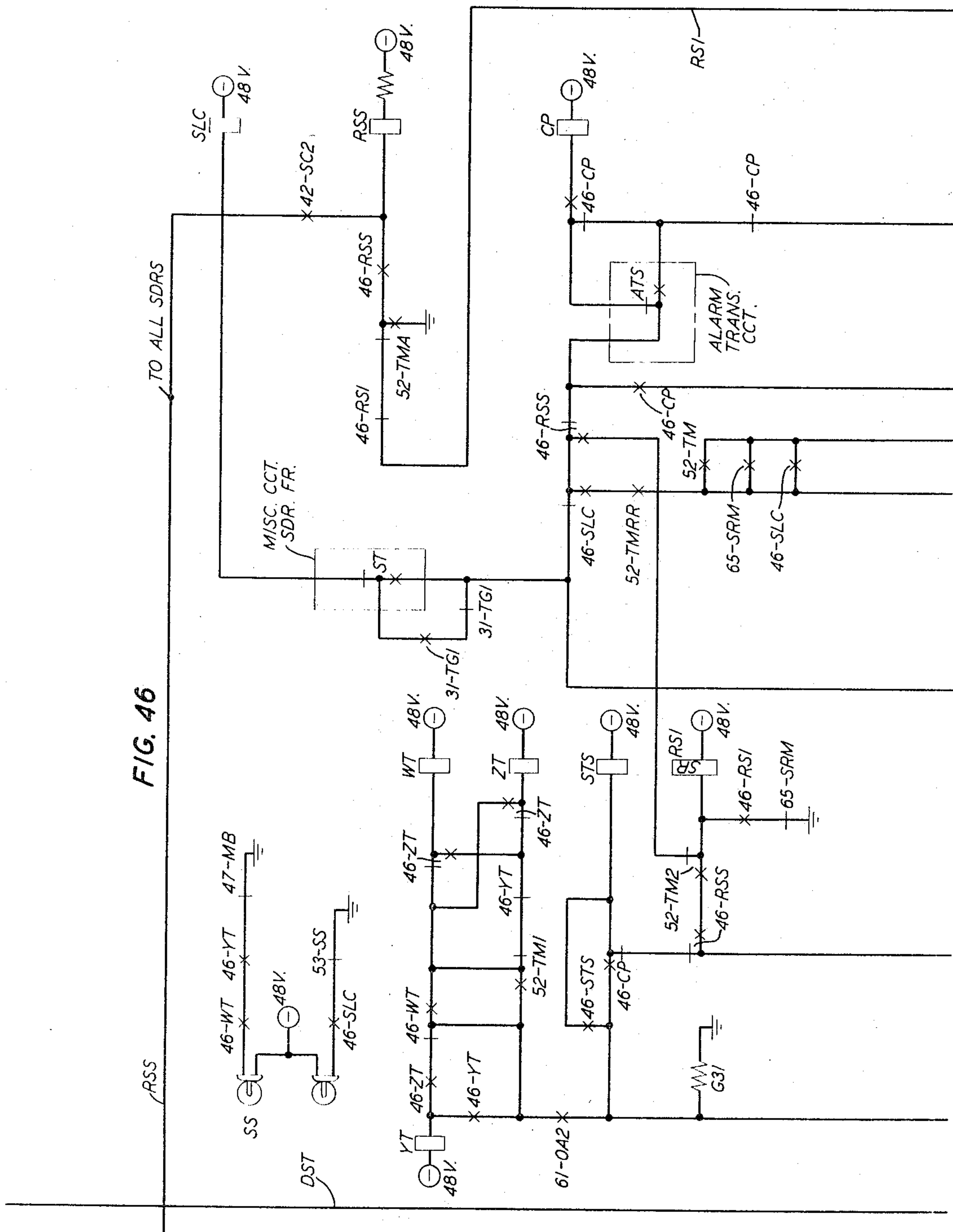
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FIG. 46





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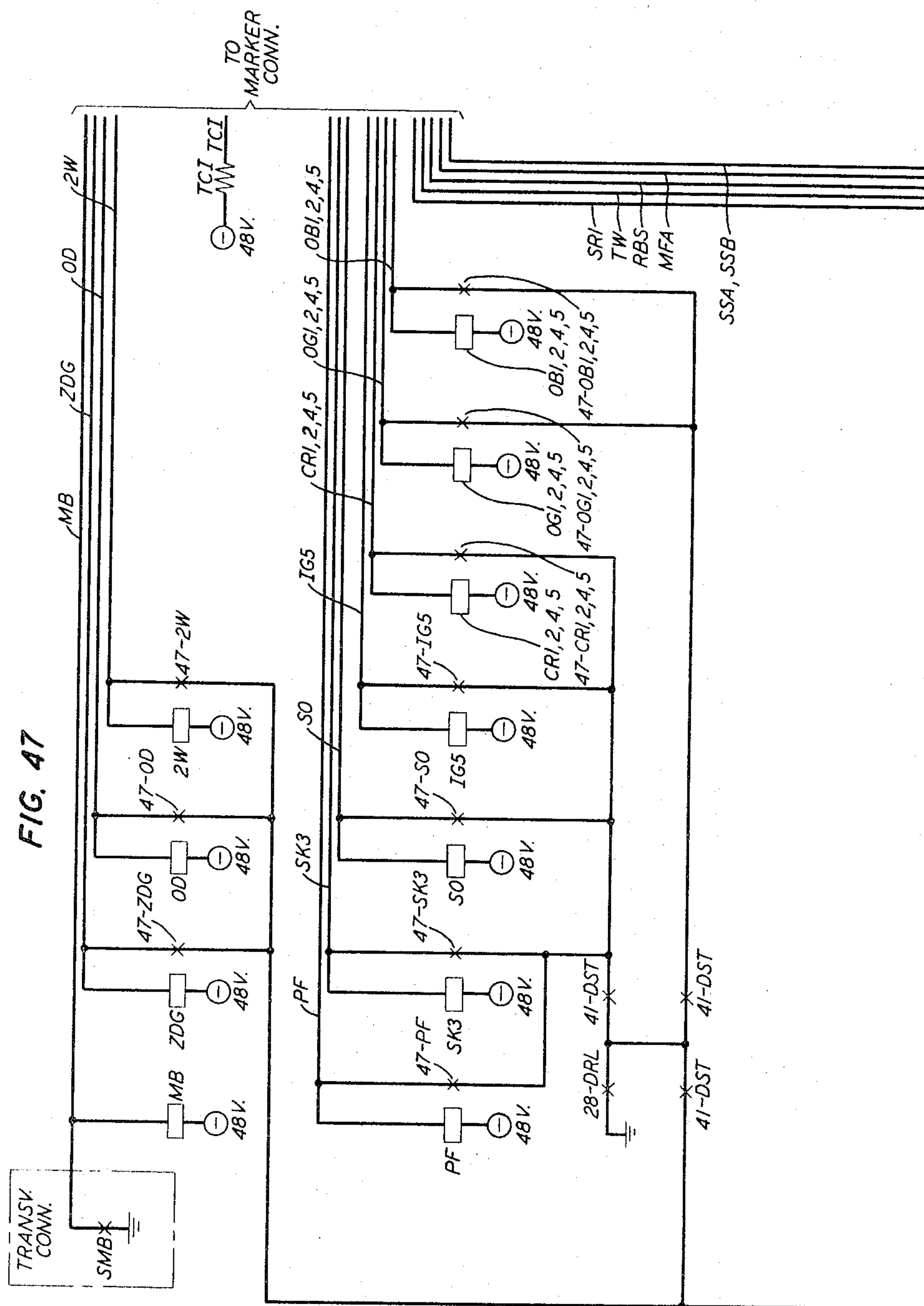
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FIG. 47





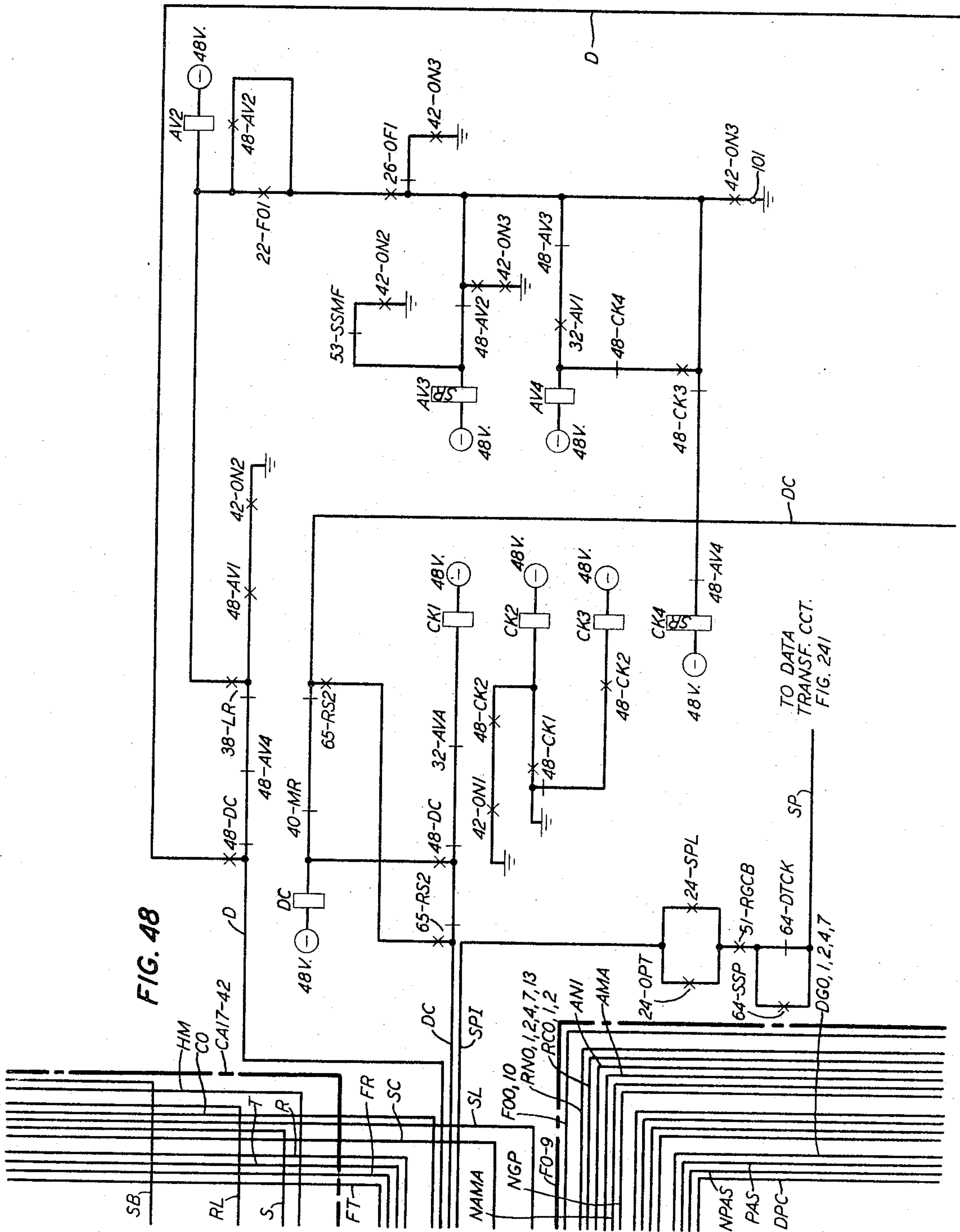
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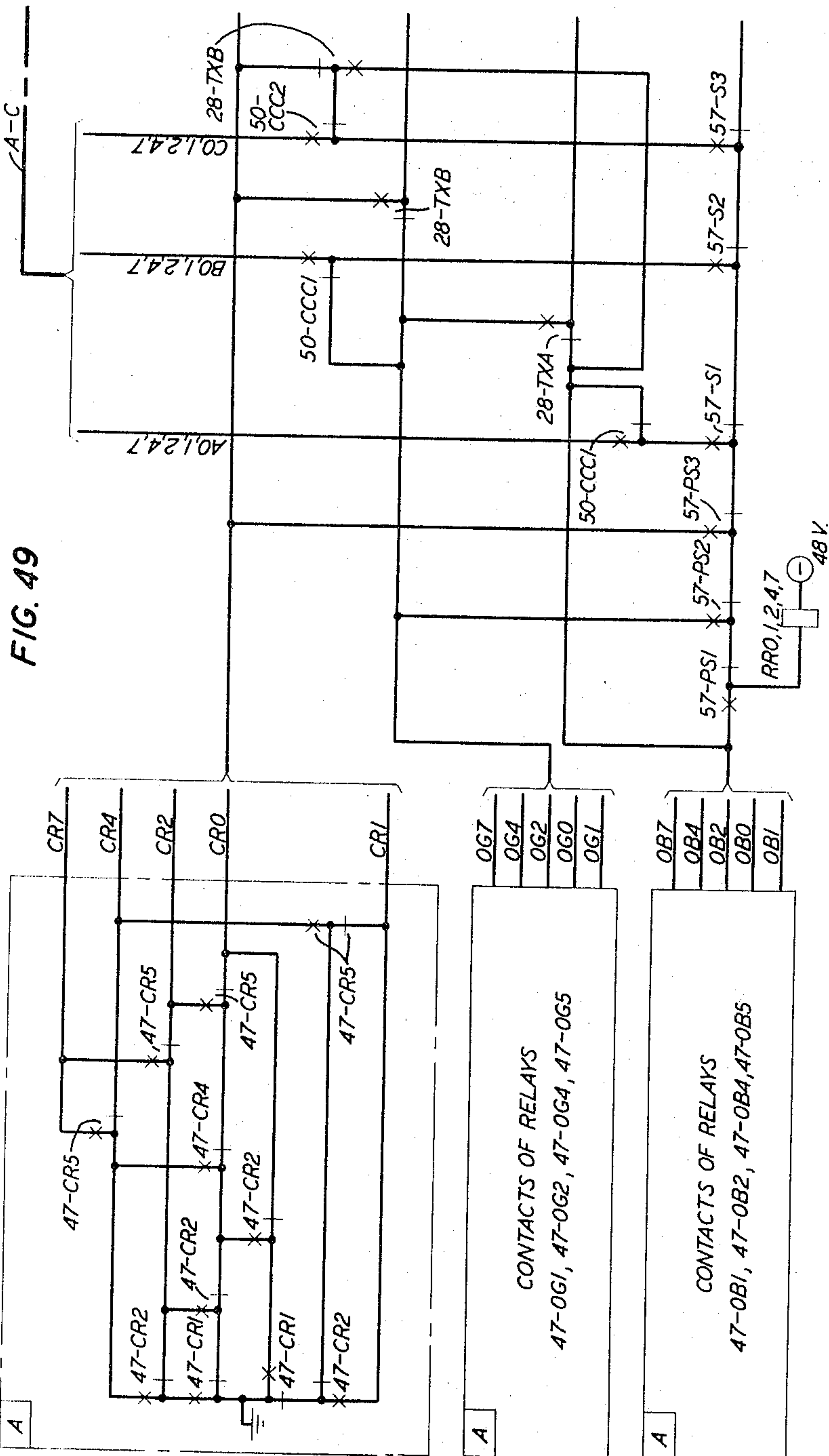
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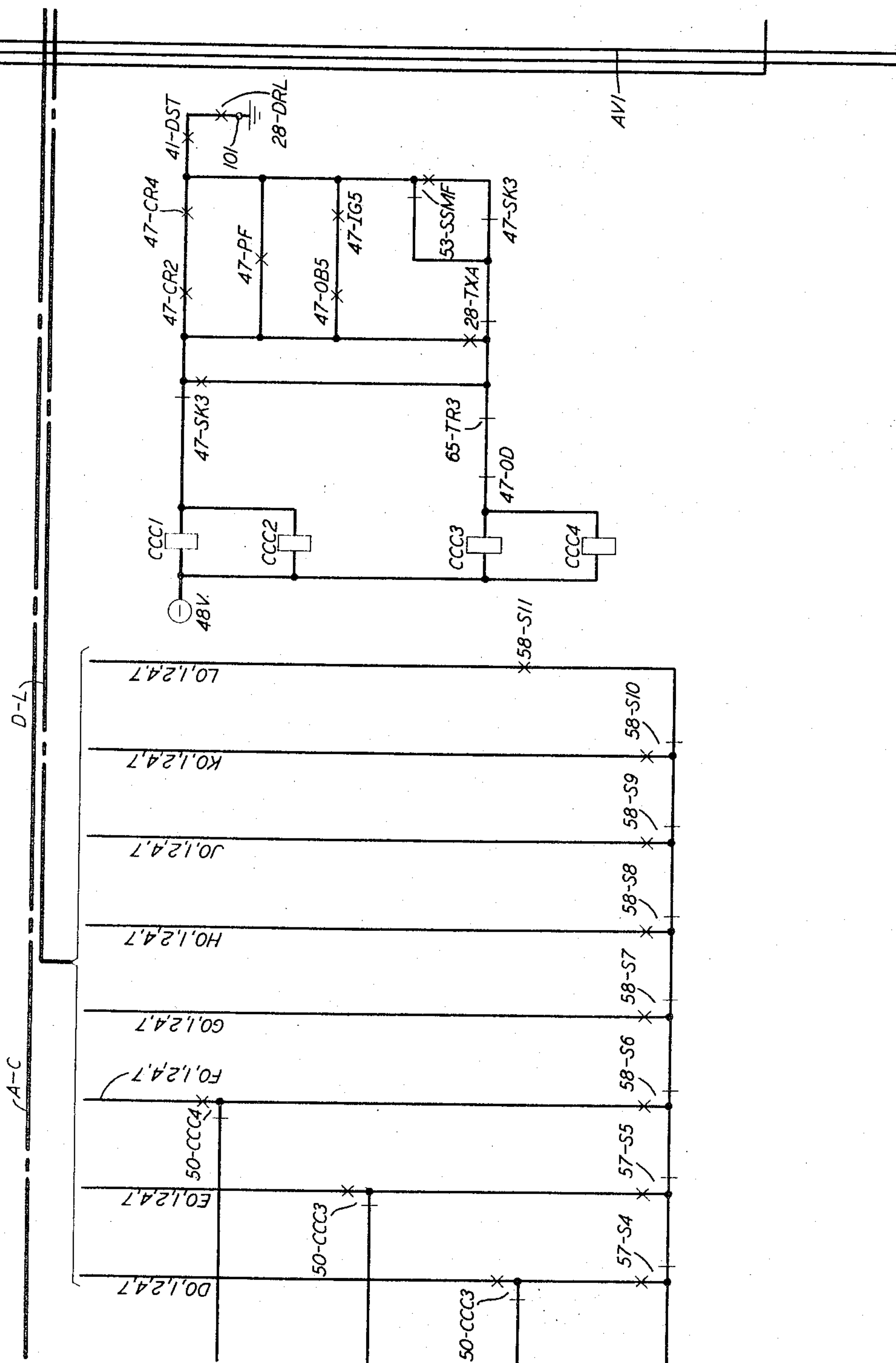
3,341,661

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FIG. 50

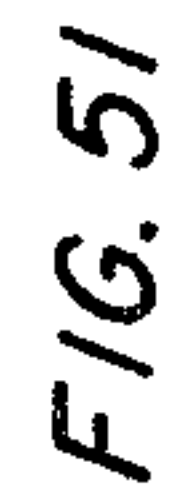




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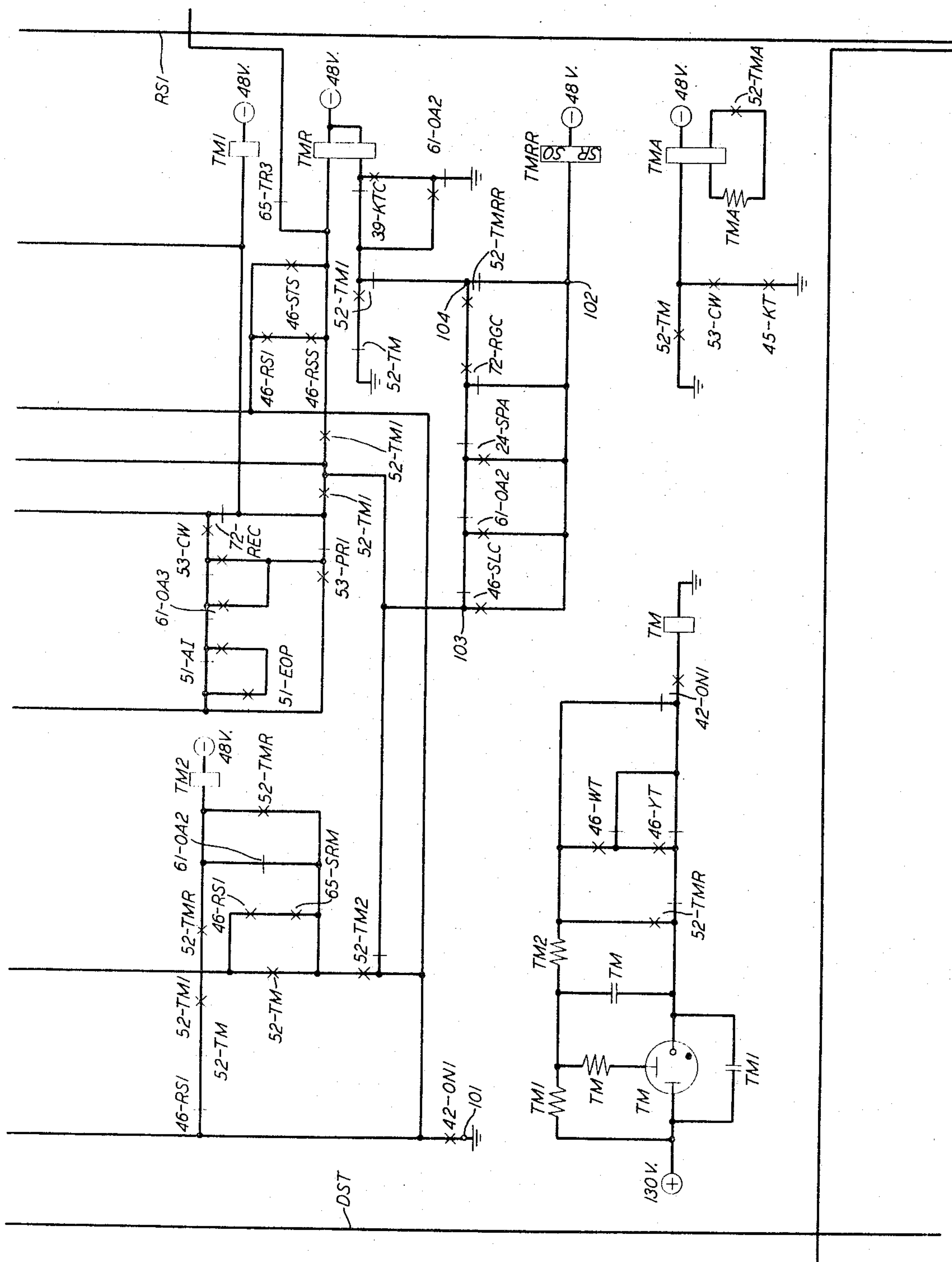


FIG. 52



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FIG. 53



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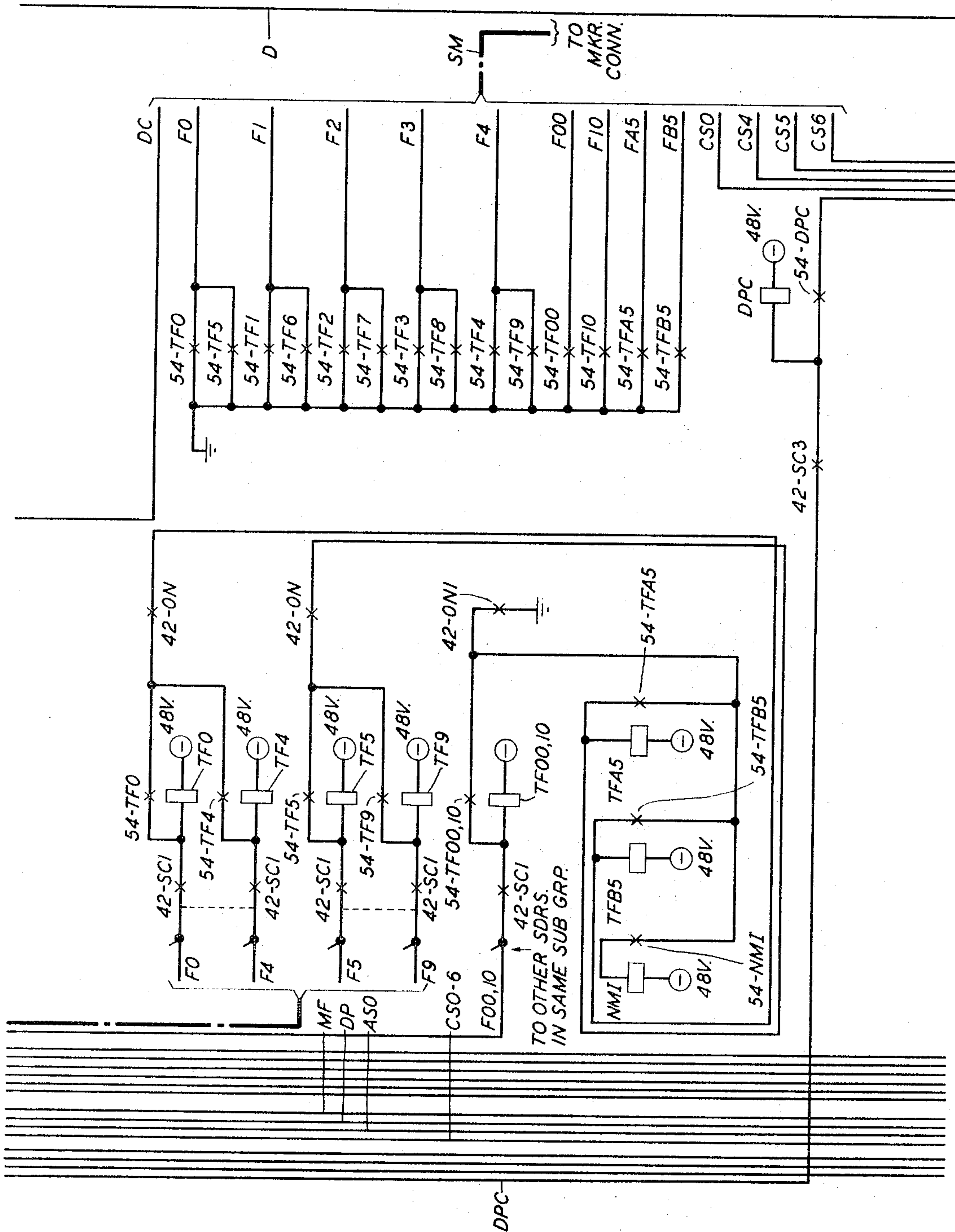


FIG. 54



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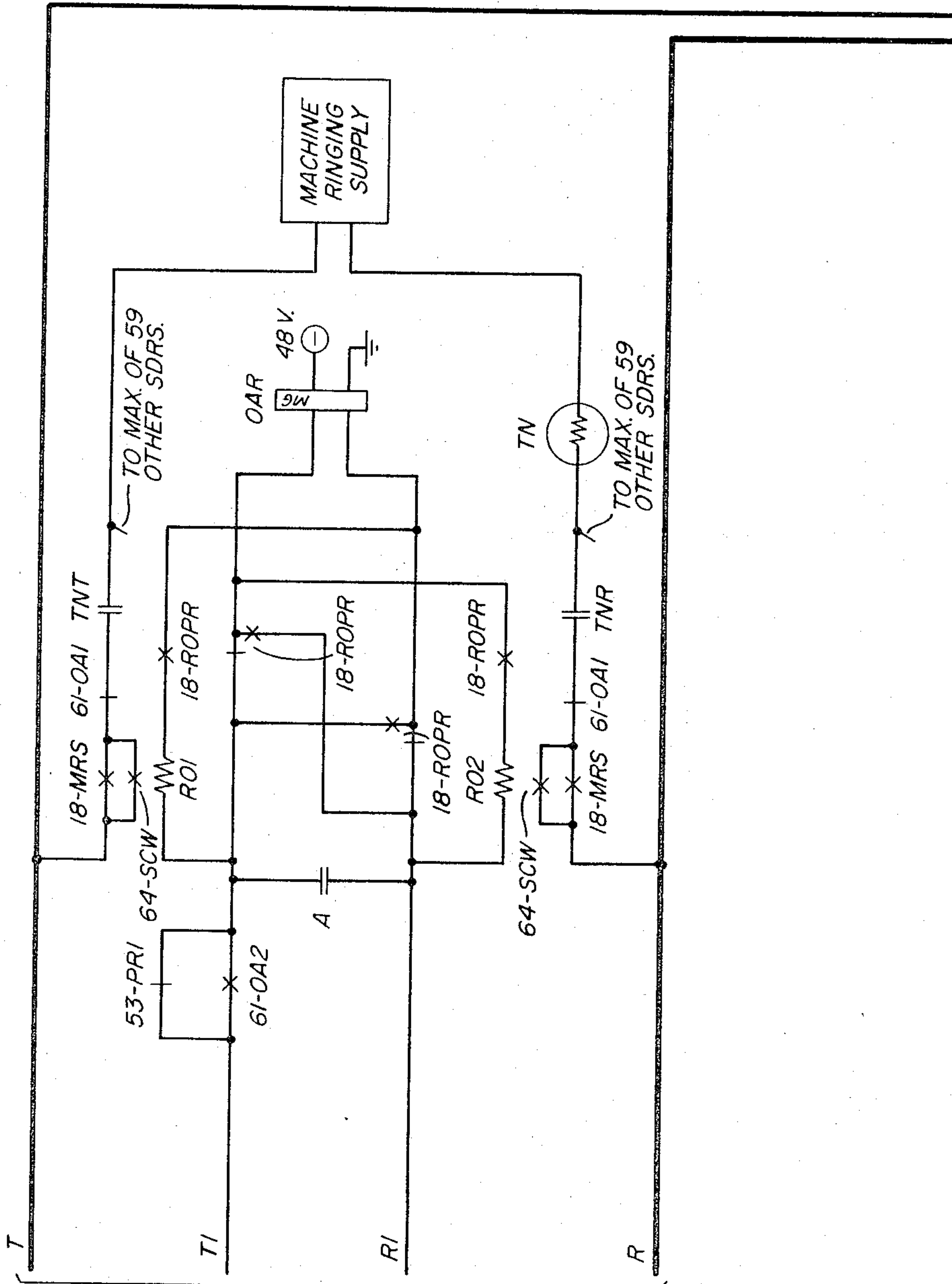
R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
INTERMEDIATE SWITCHING CENTER

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FIG. 55





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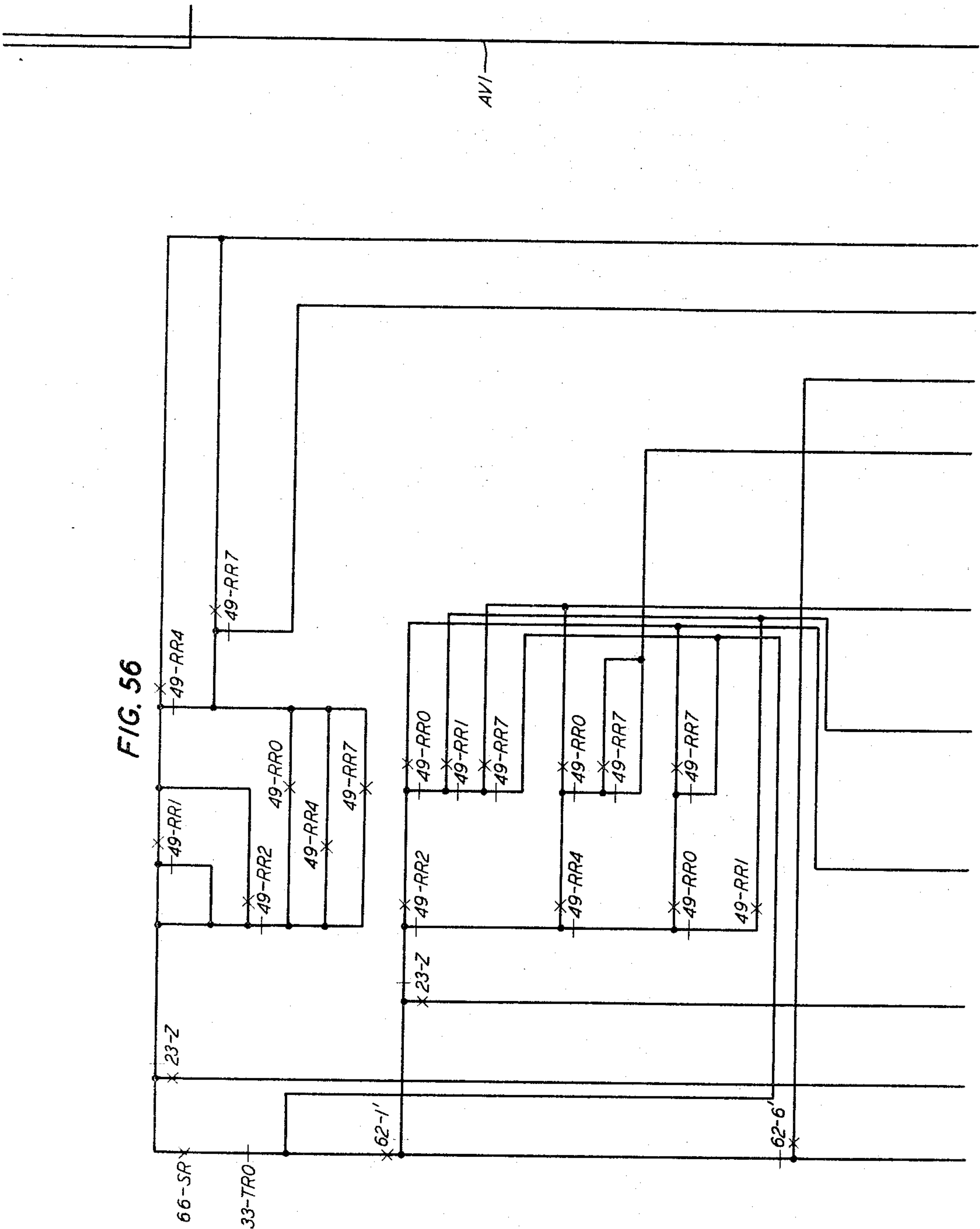
R. B. CURTIS  
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INTERMEDIATE SWITCHING CENTER

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FIG. 56





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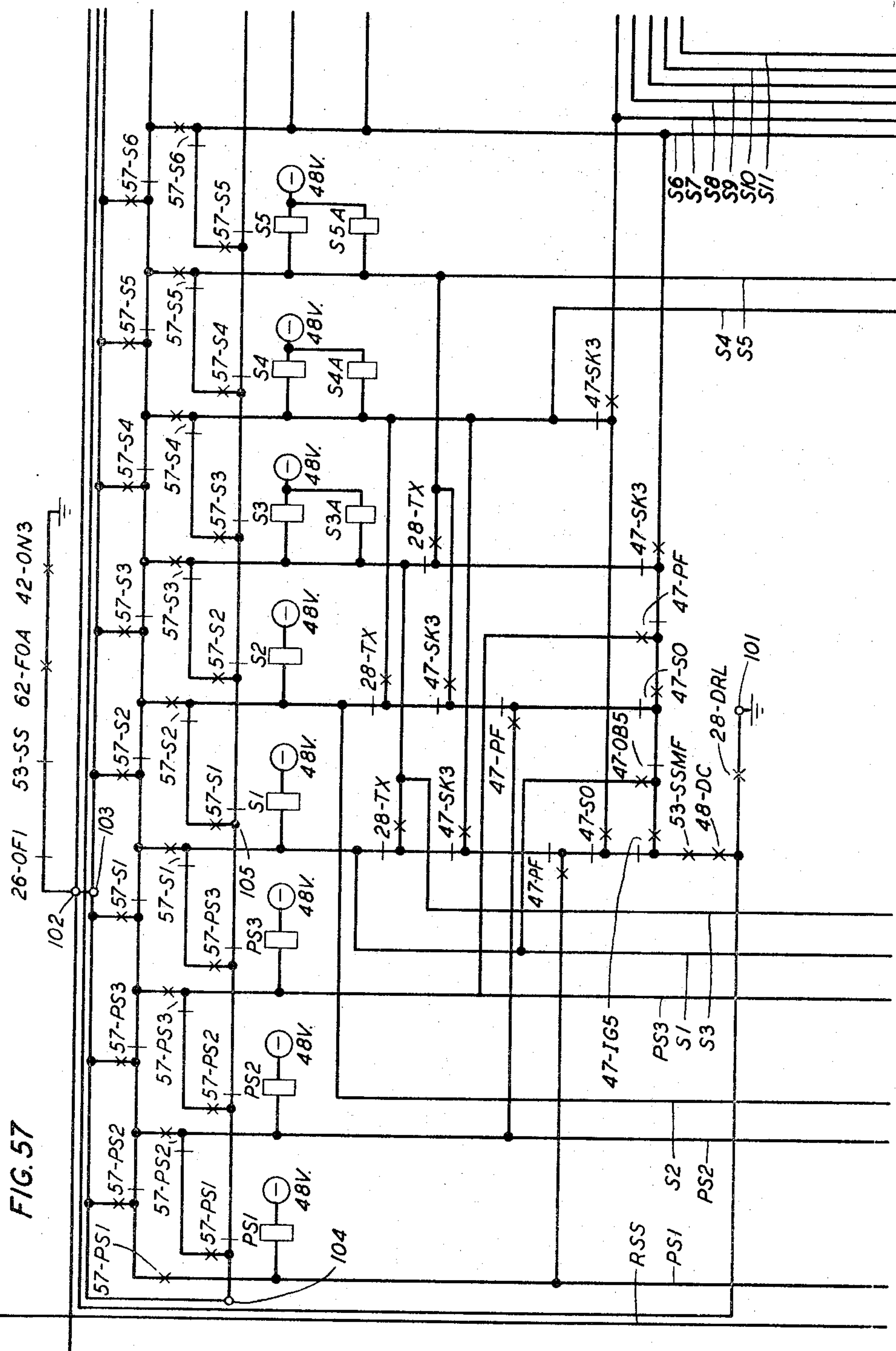
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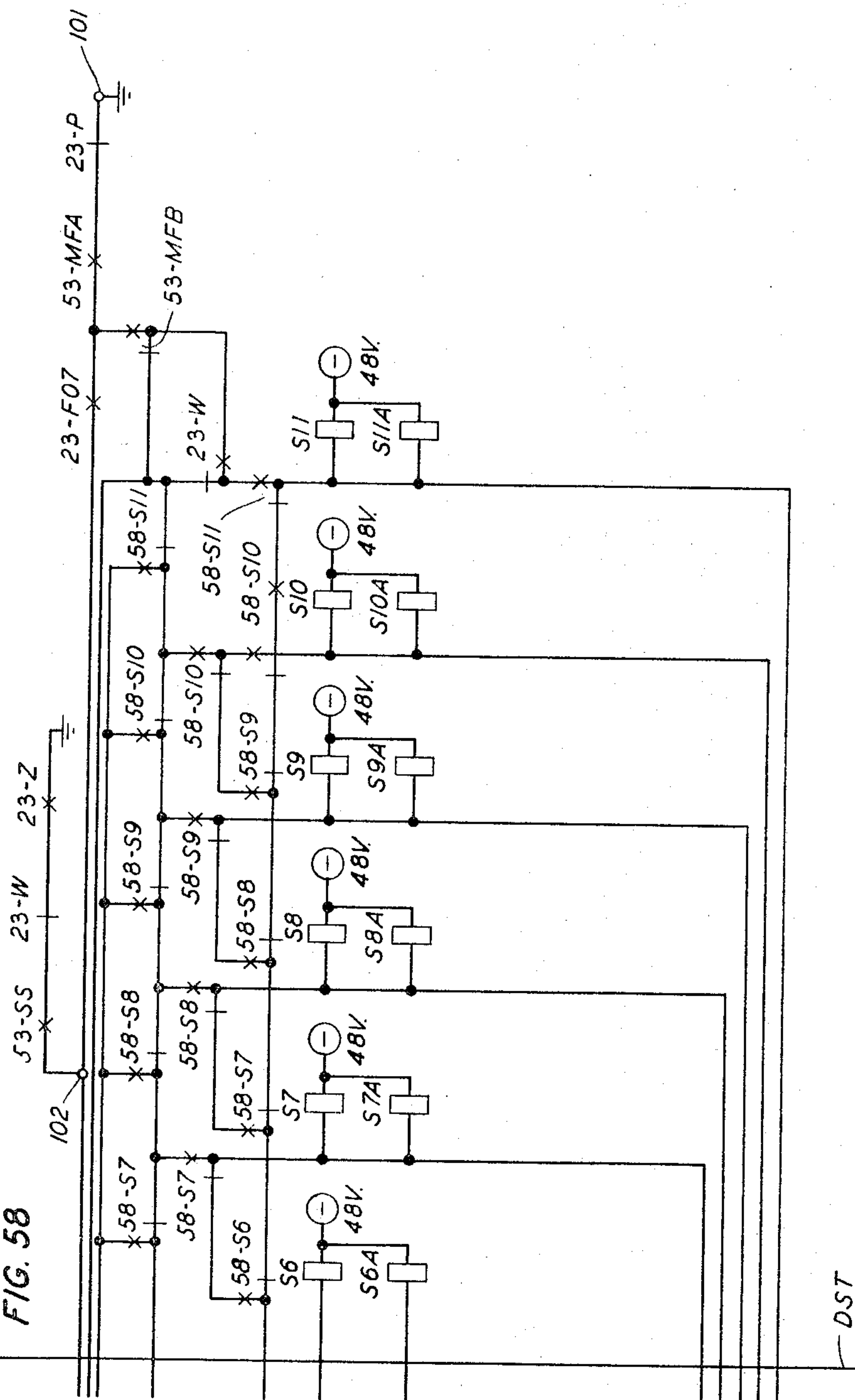
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FIG. 58



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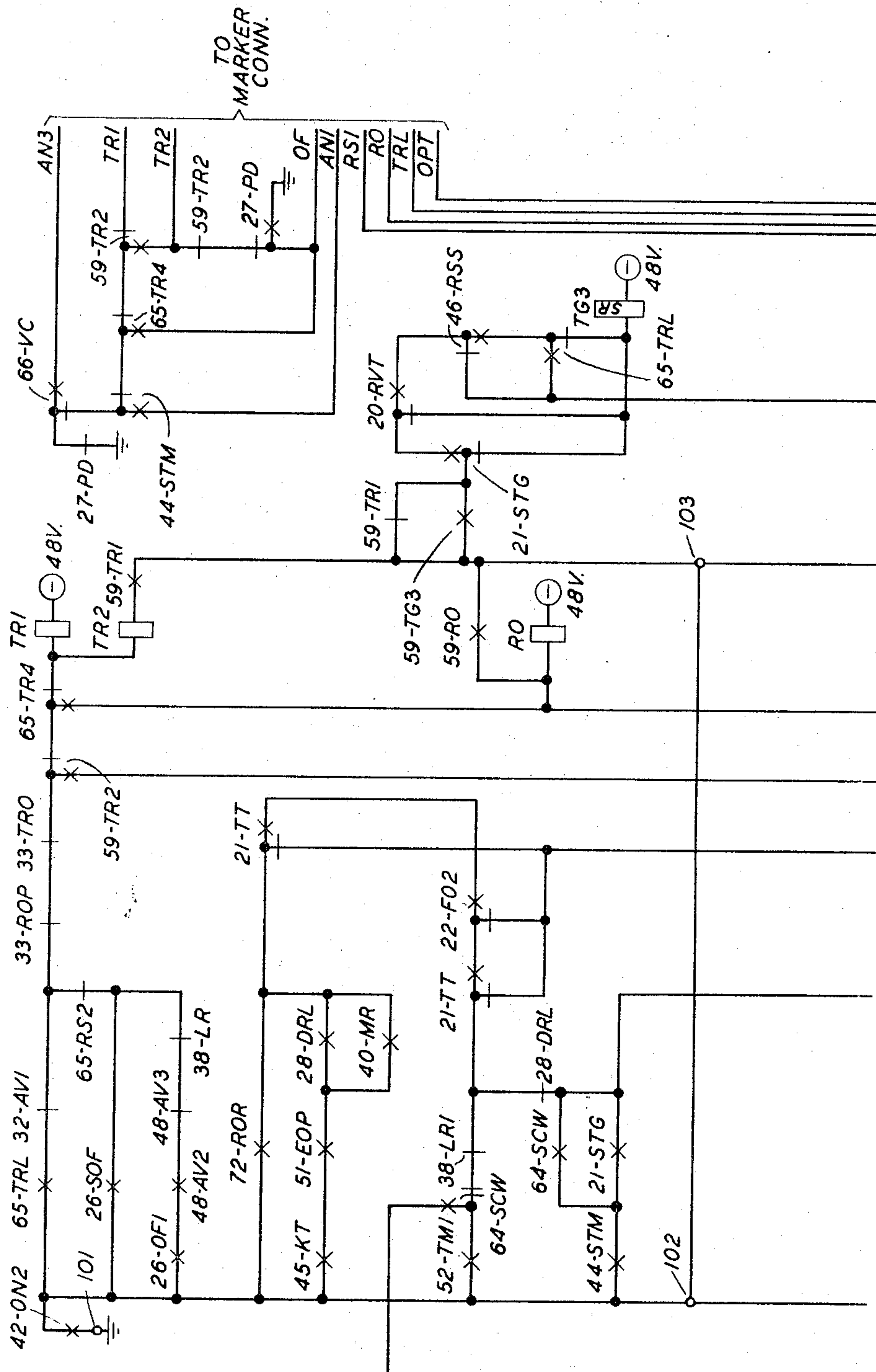
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FIG. 59





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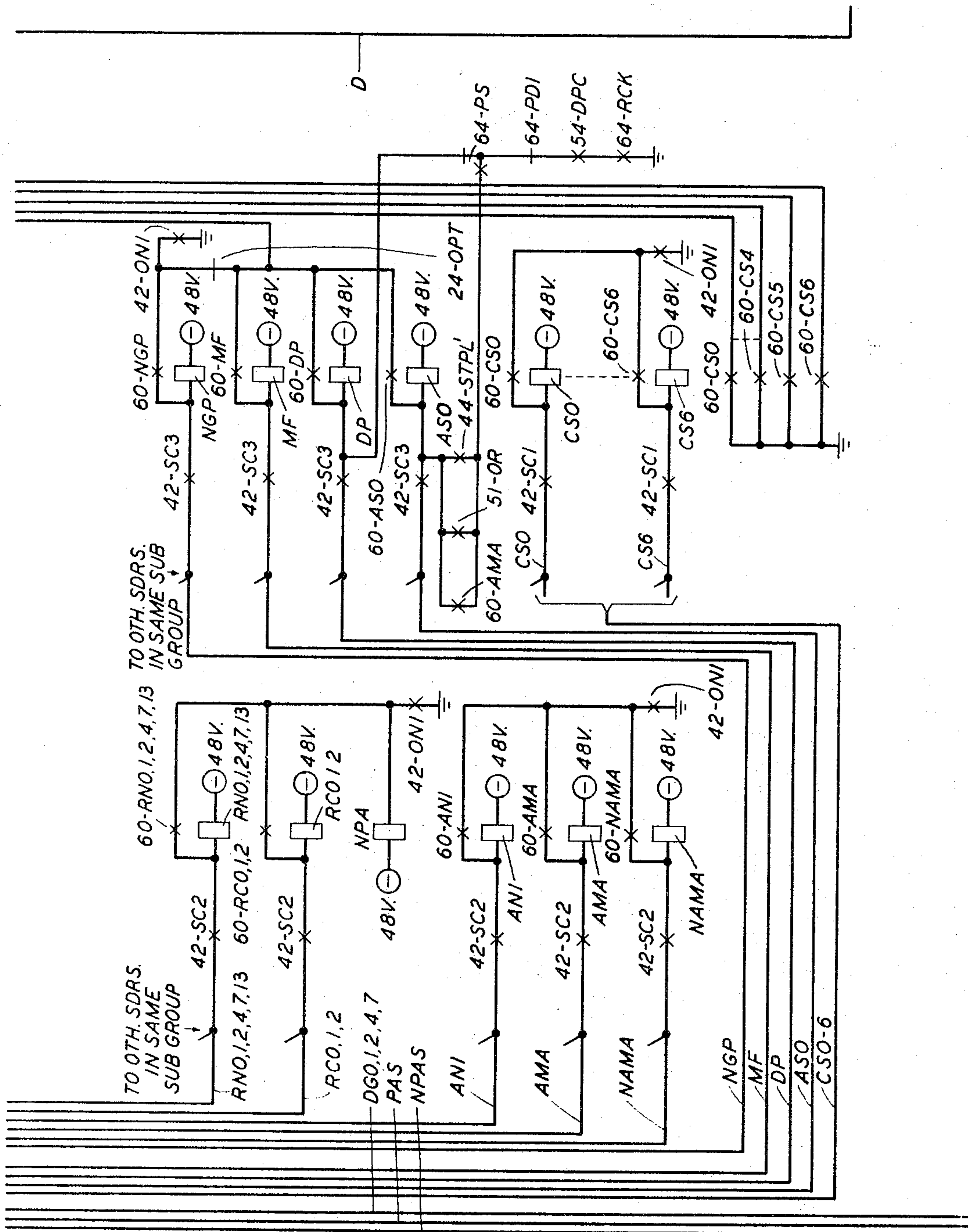


FIG. 60



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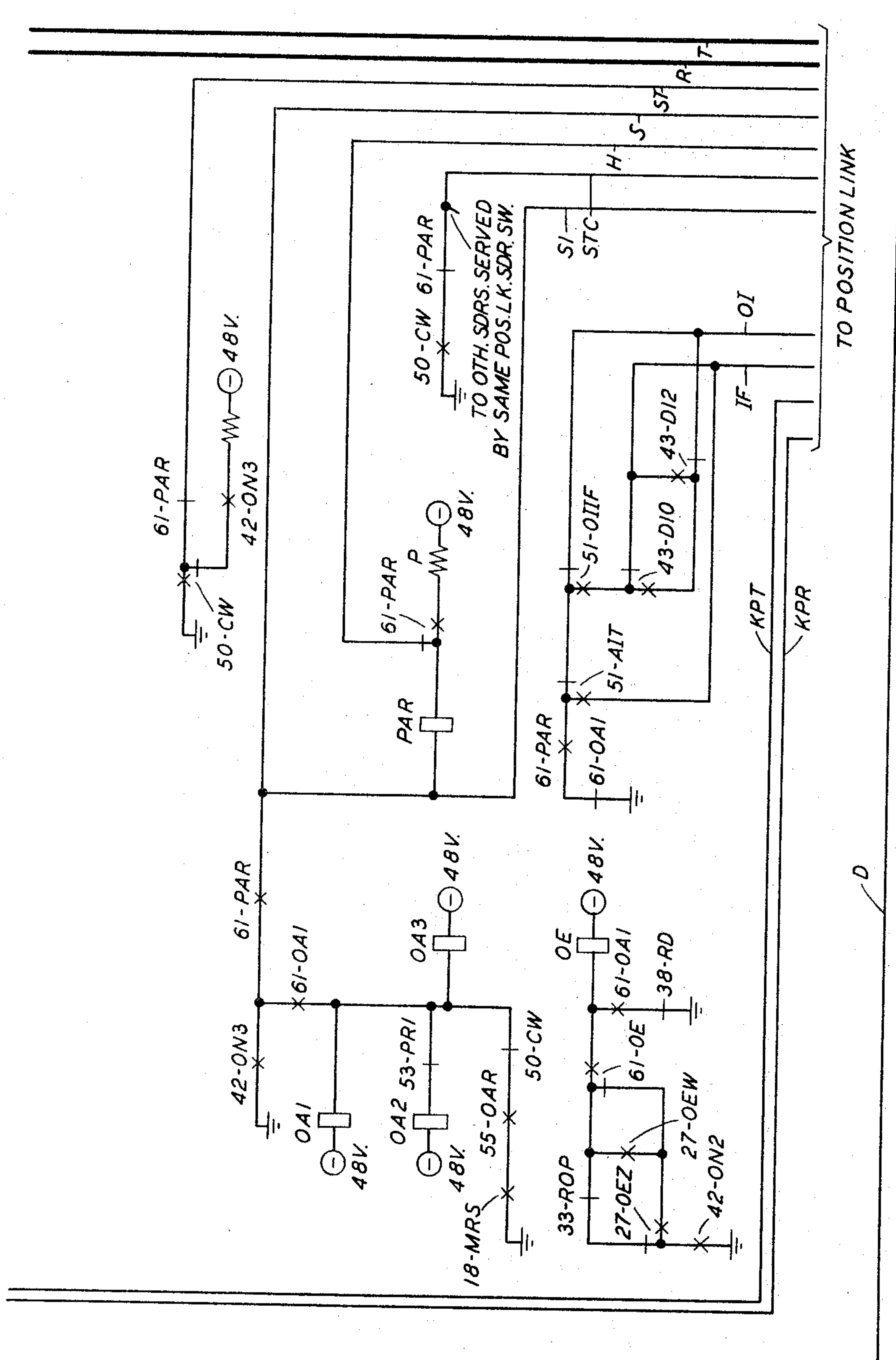


FIG. 61



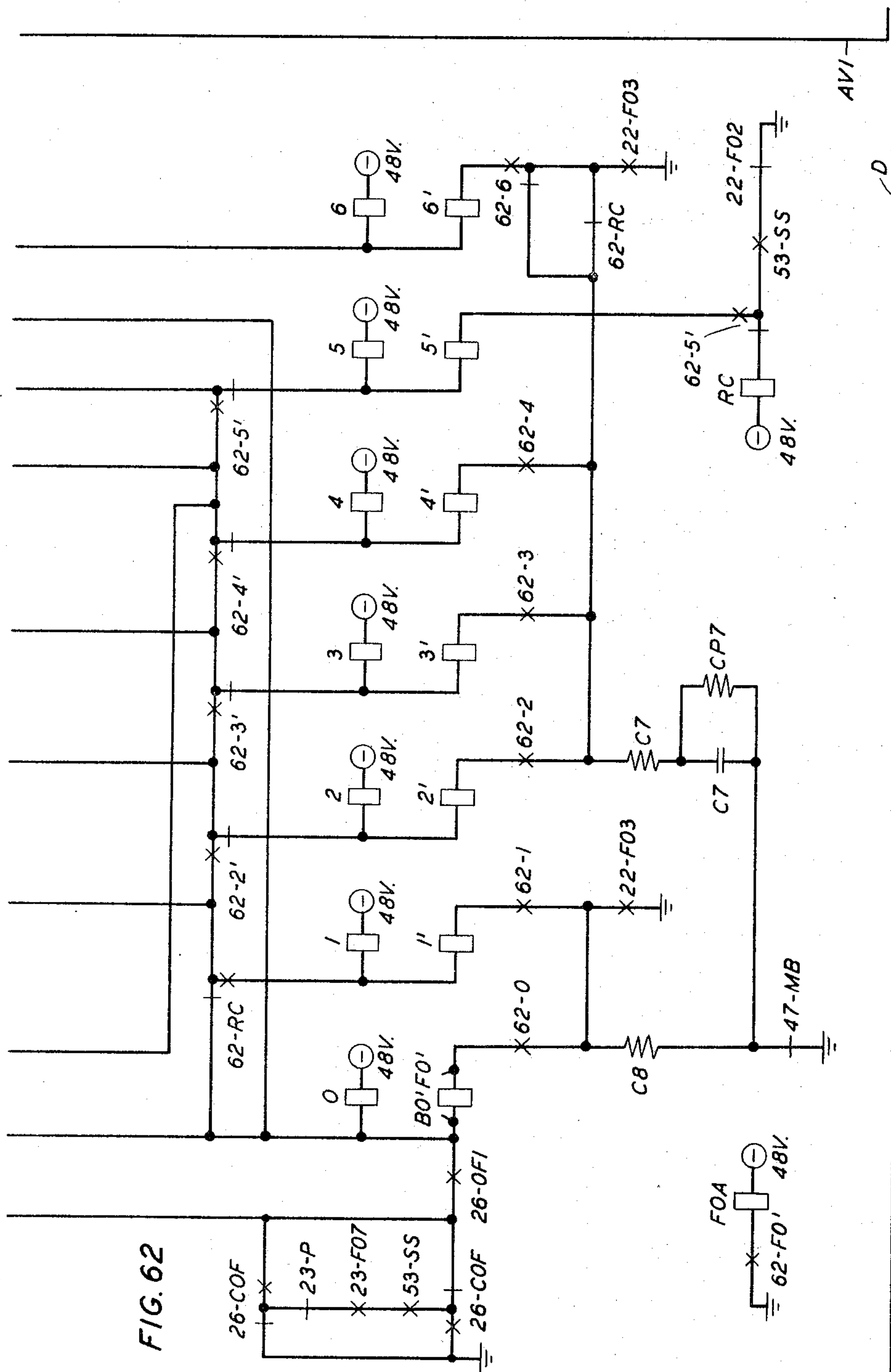
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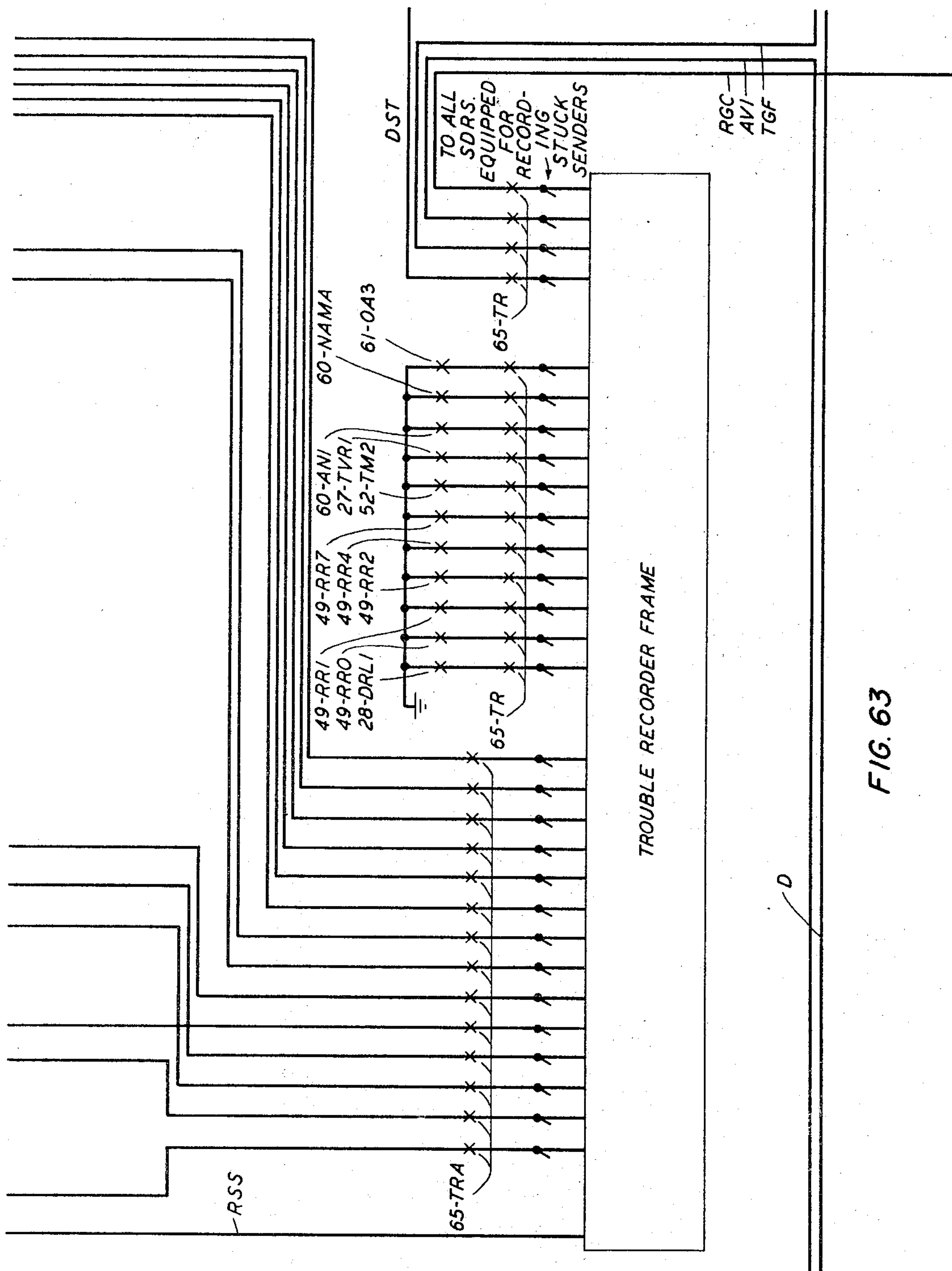


FIG. 63



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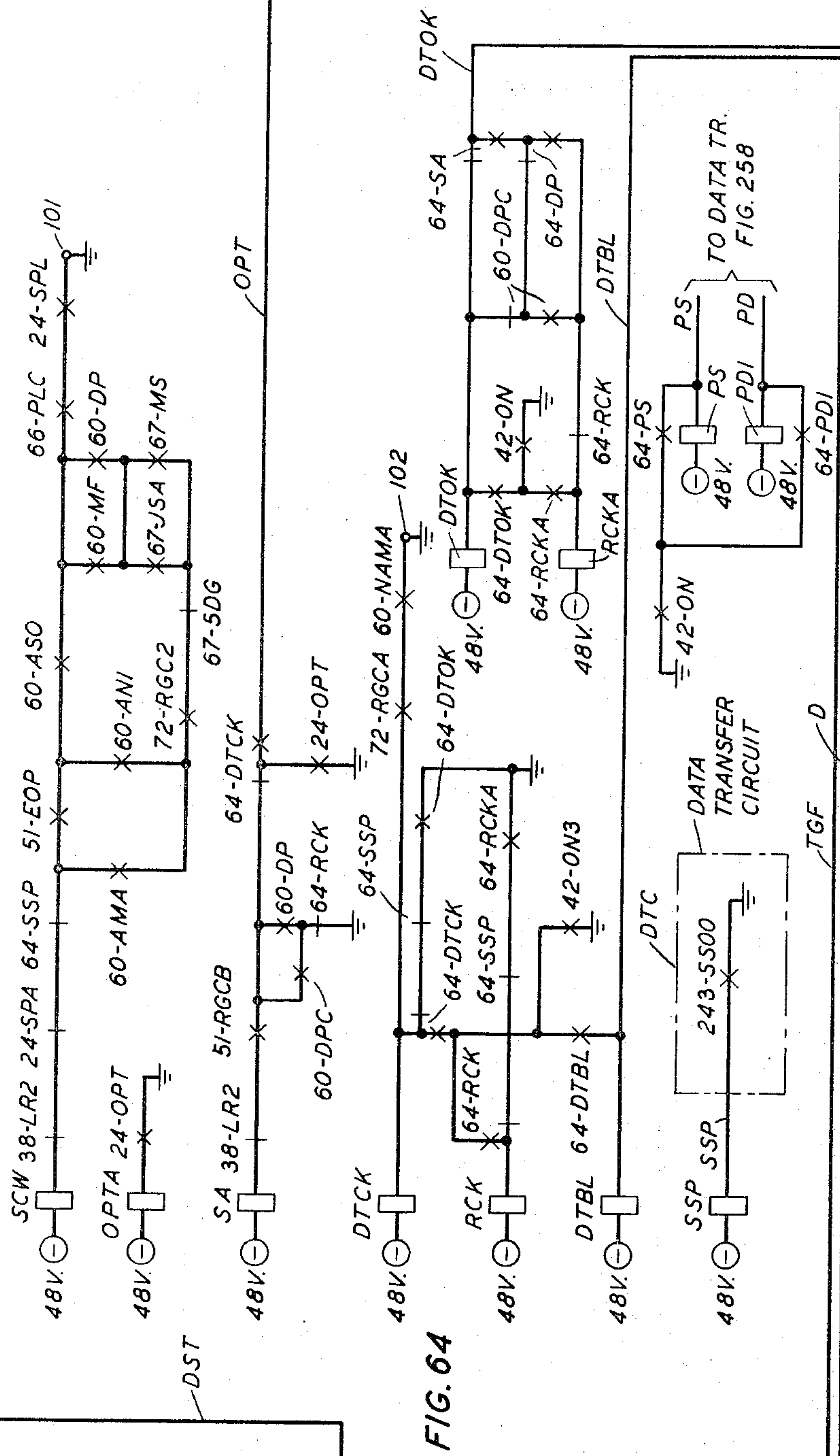
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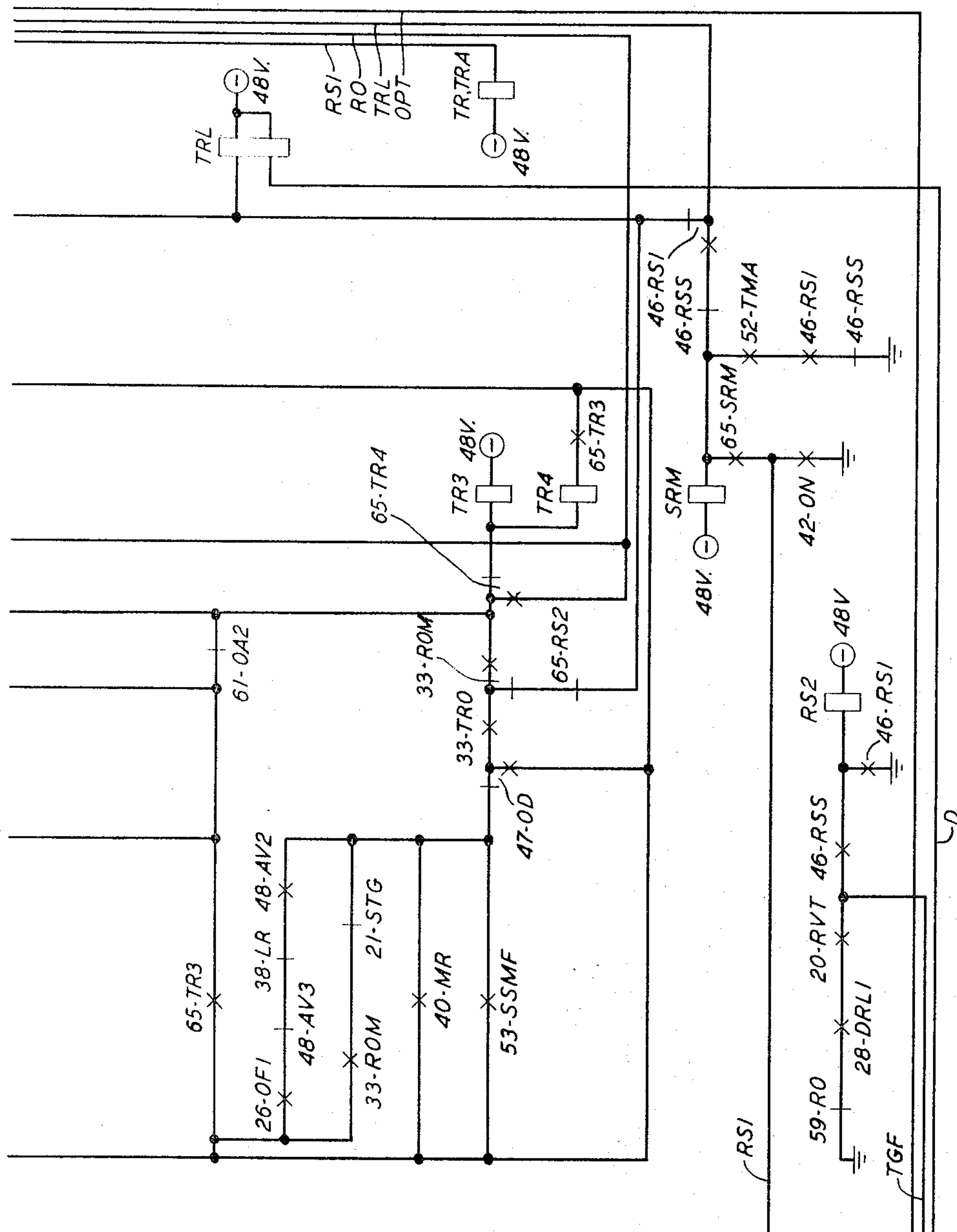


FIG. 65



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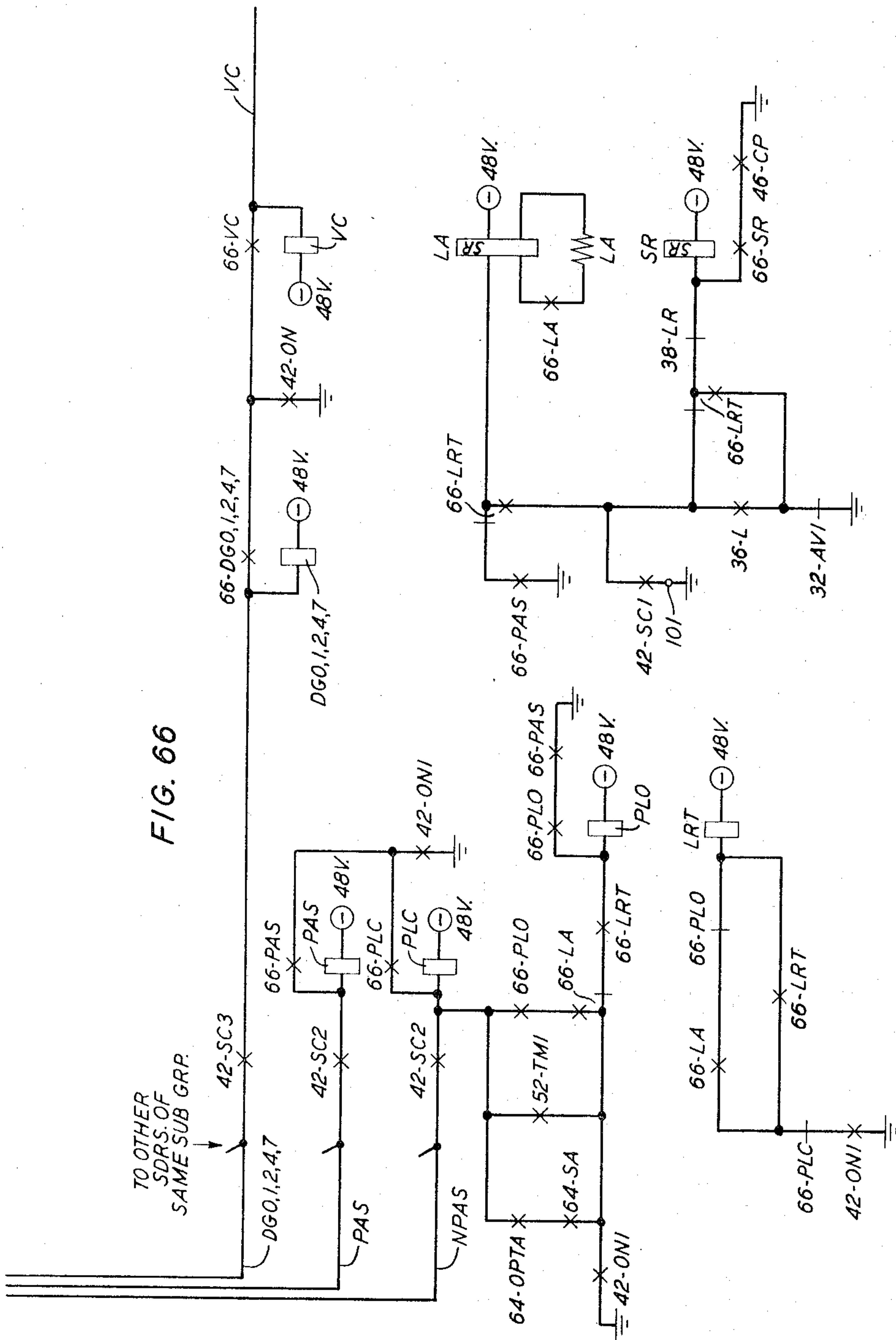
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FIG. 66





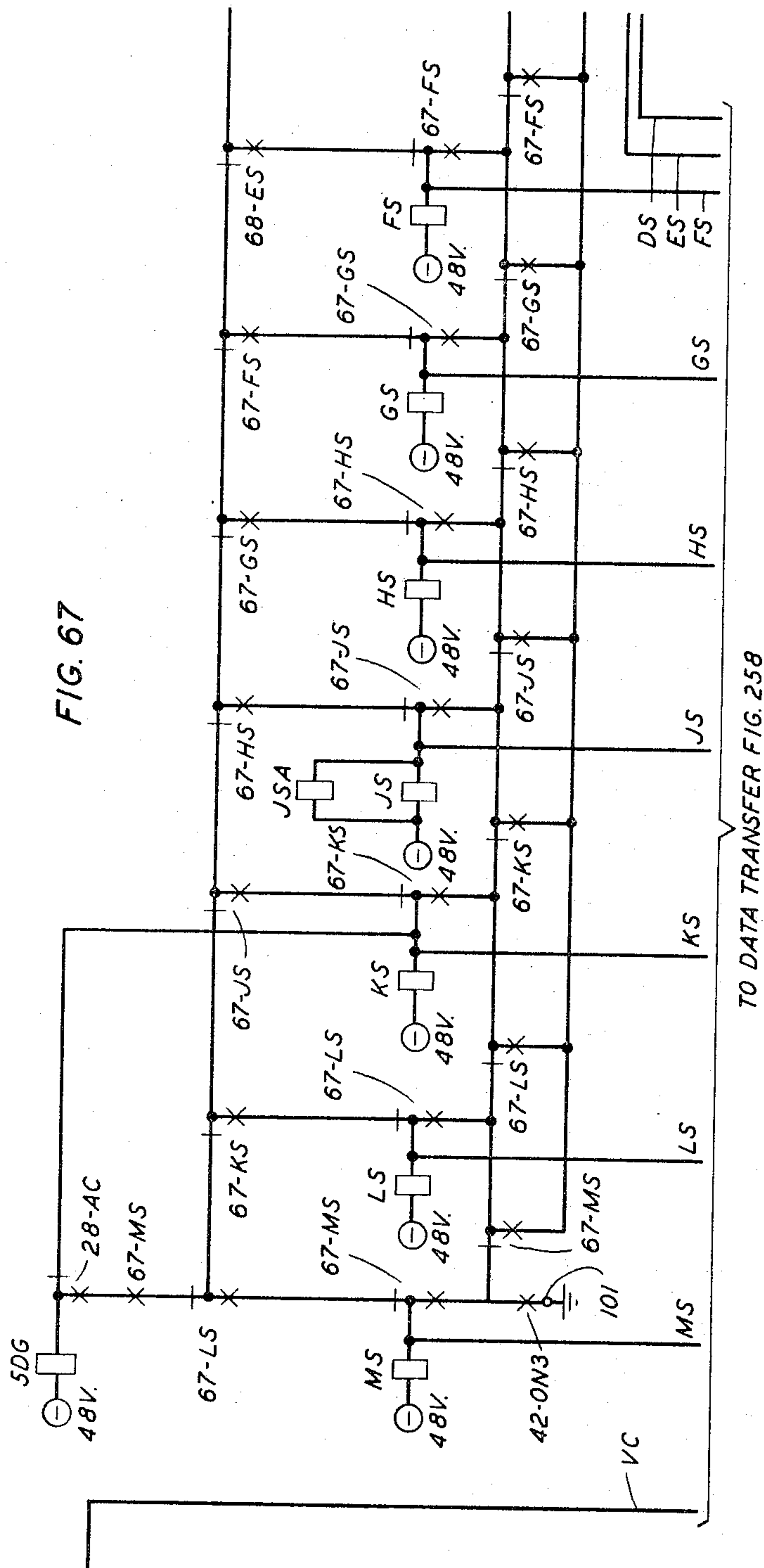
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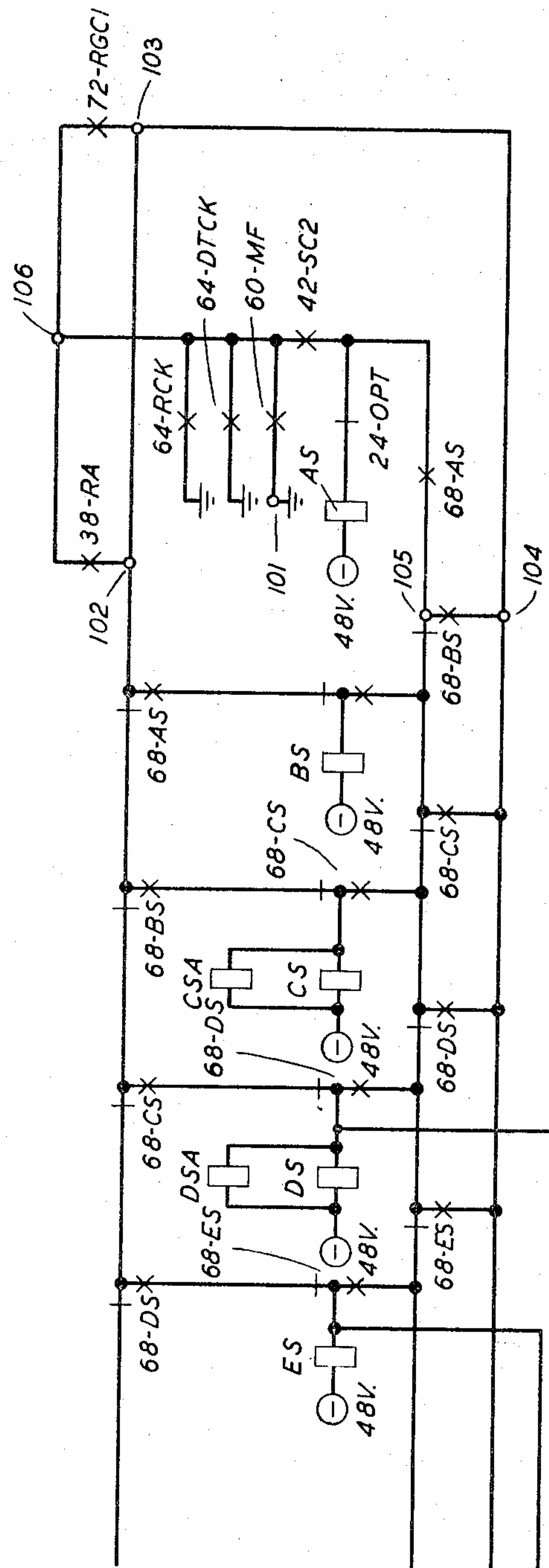
R. B. CURTIS  
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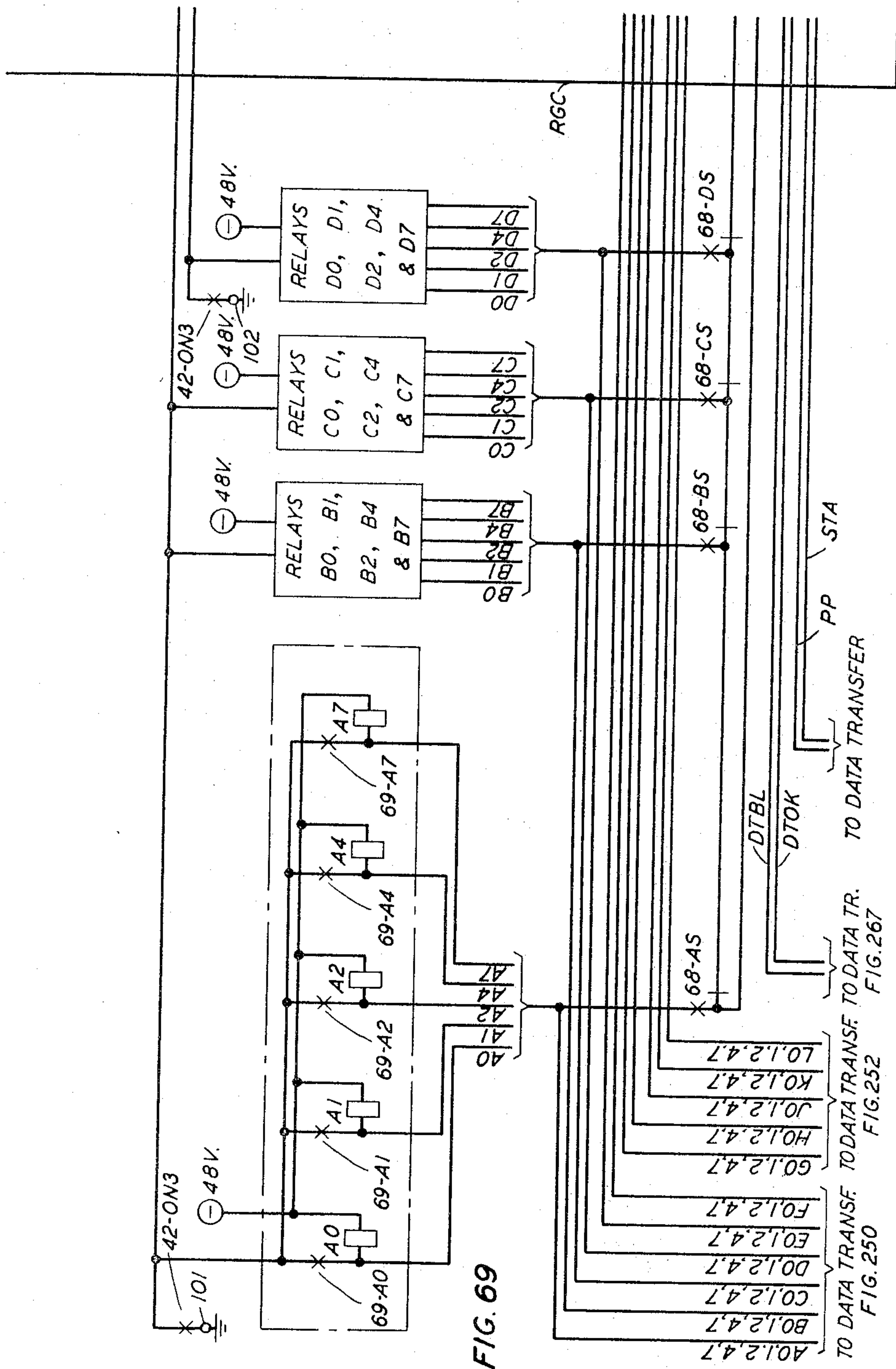
FIG. 68





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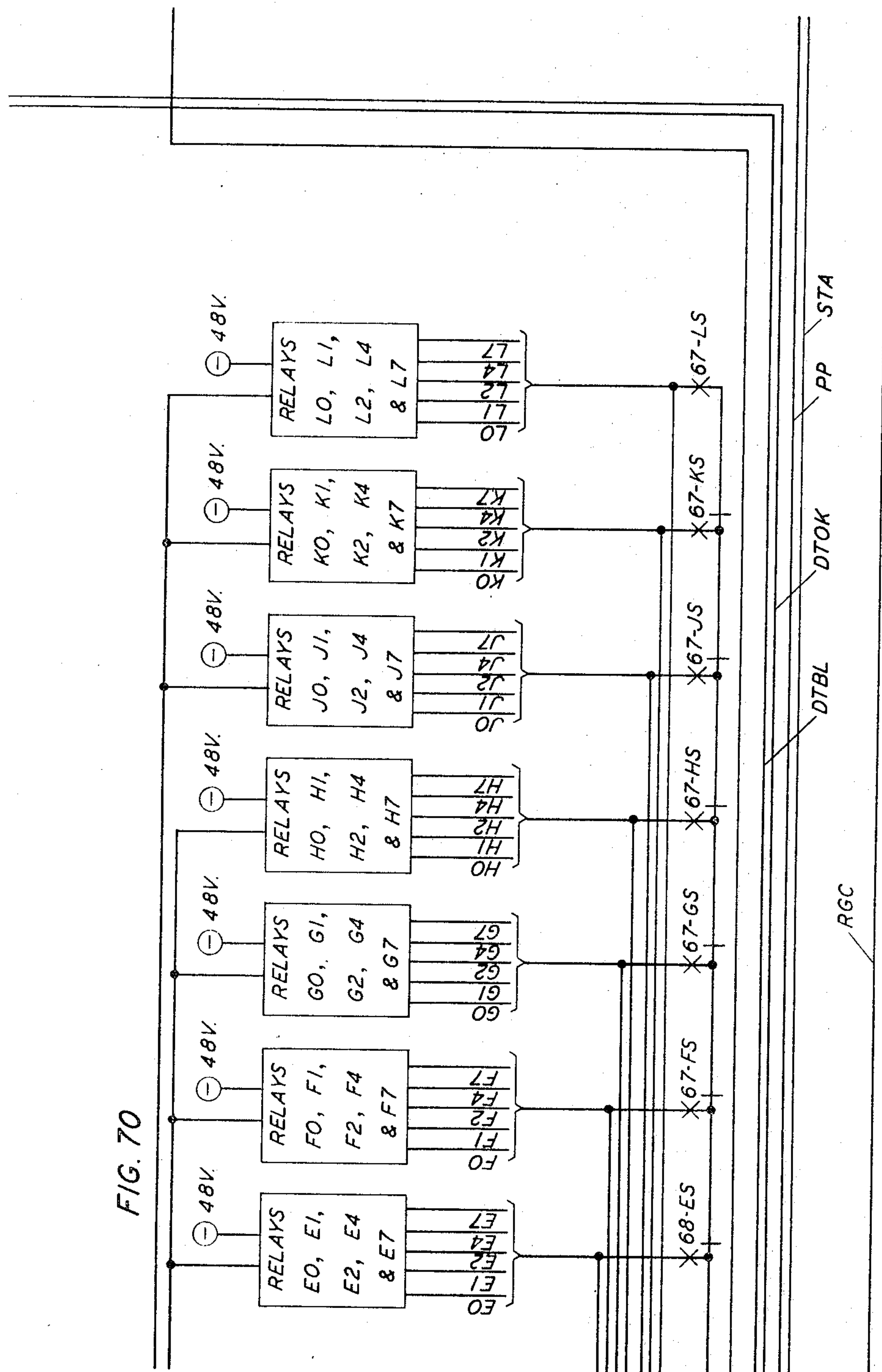
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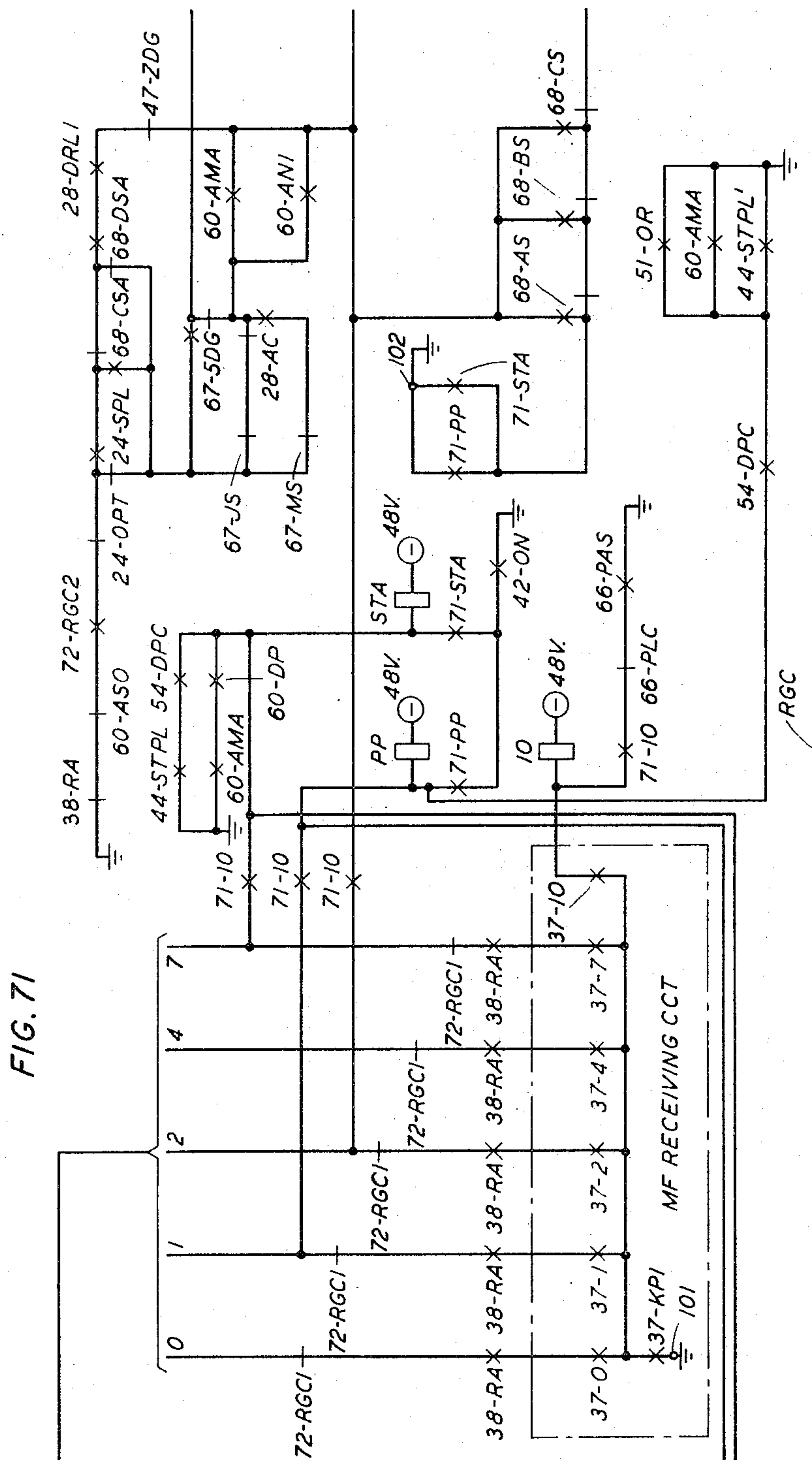




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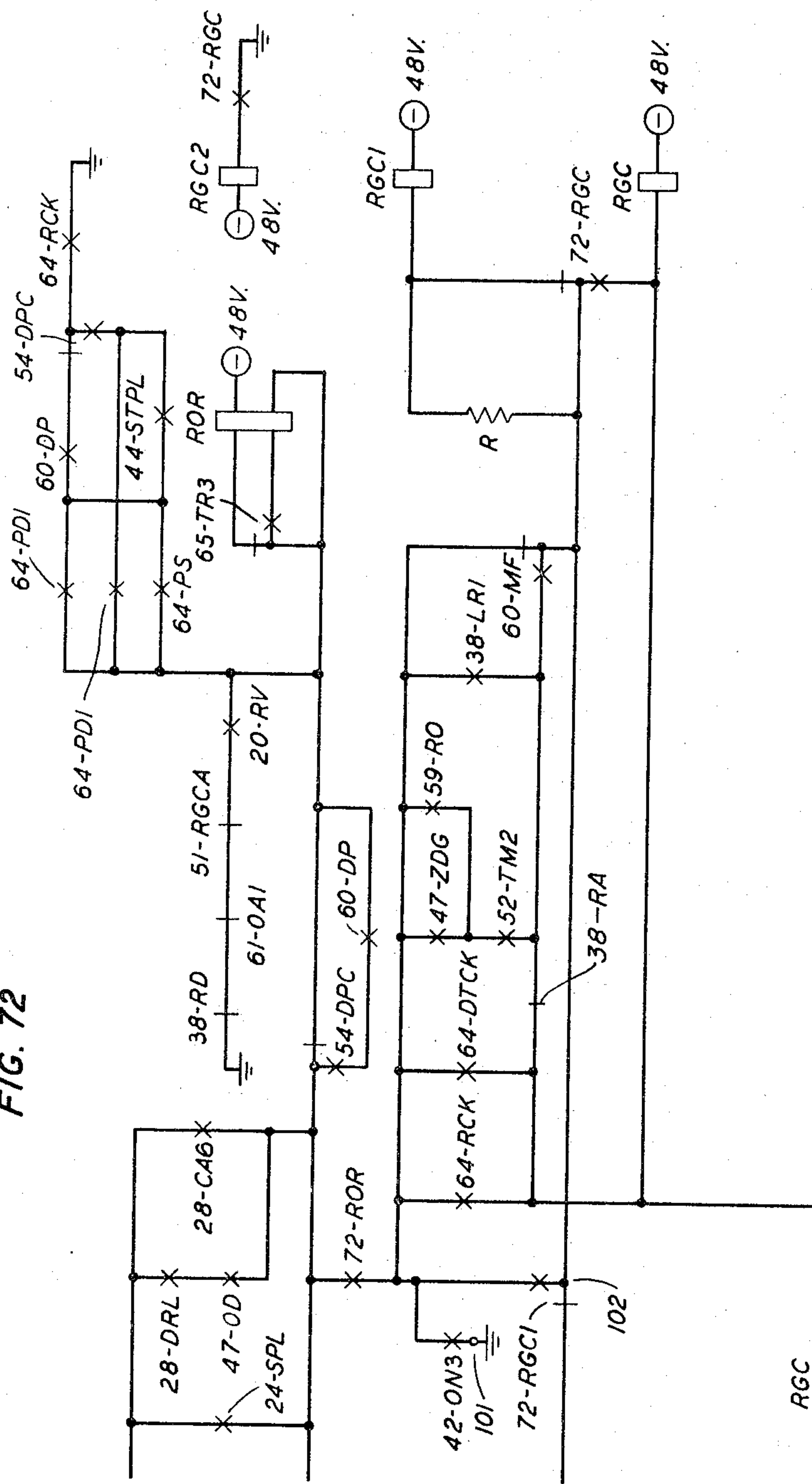
3,341,661

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FIG. 72





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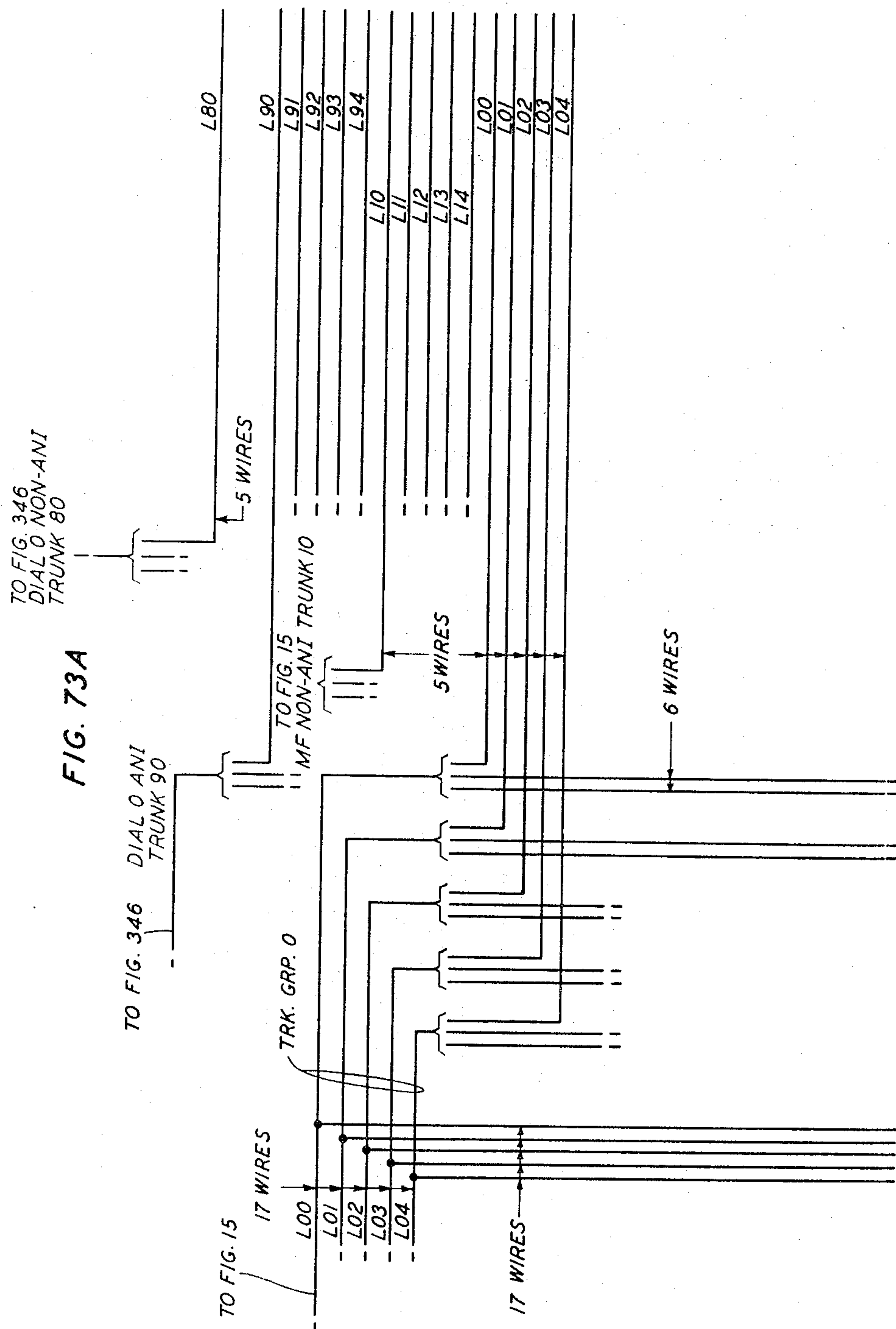
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Sept. 12, 1967

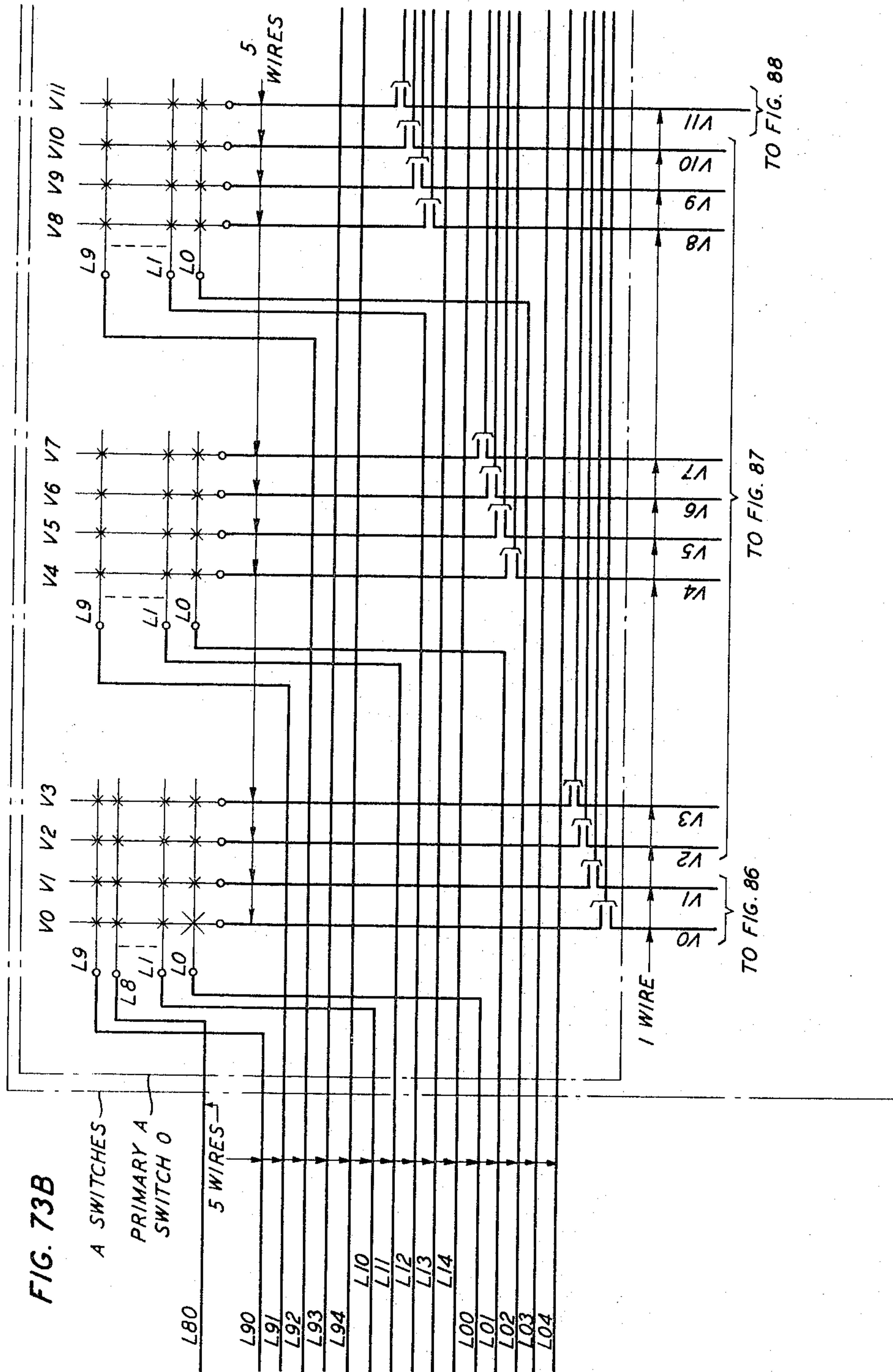
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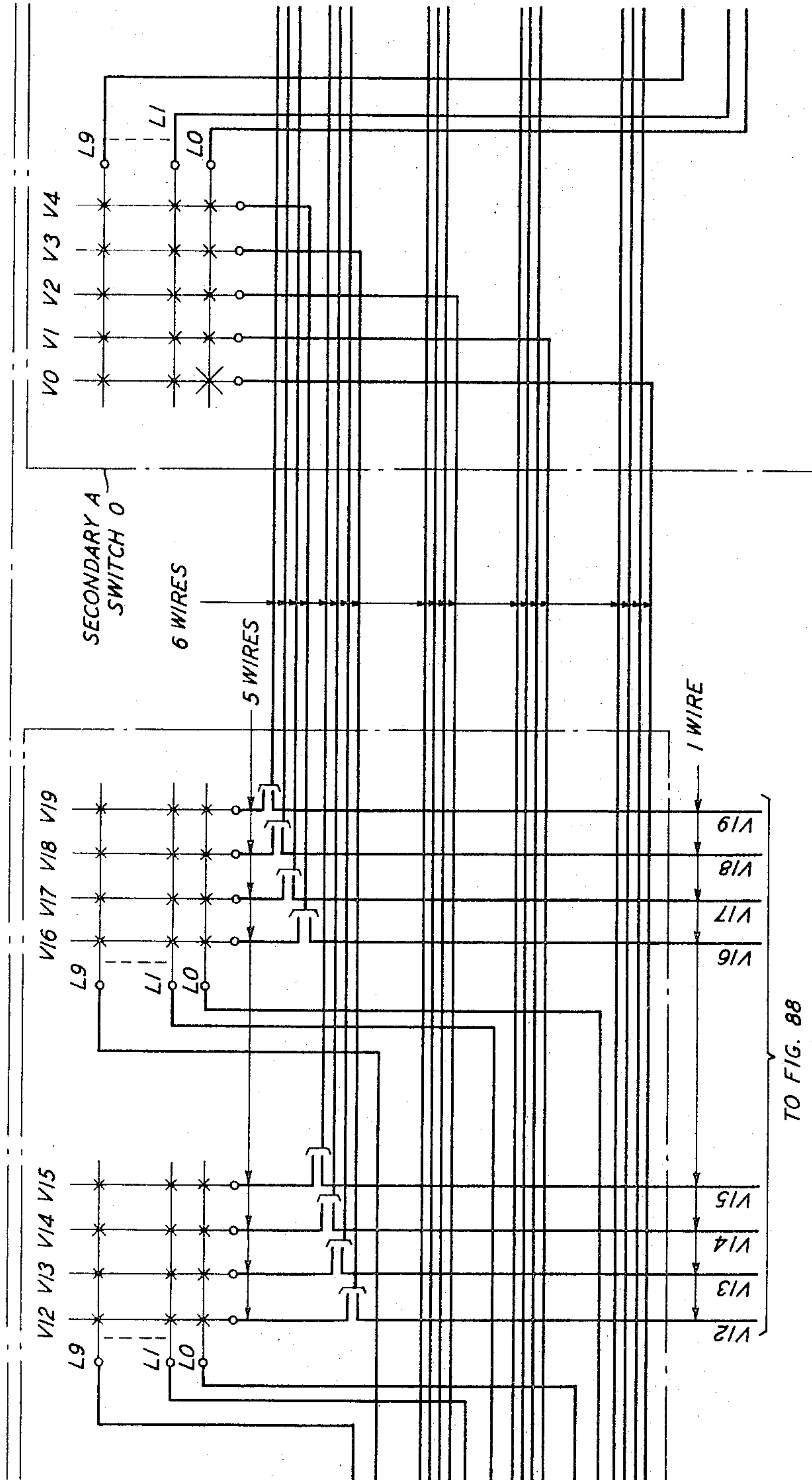
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FIG. 74





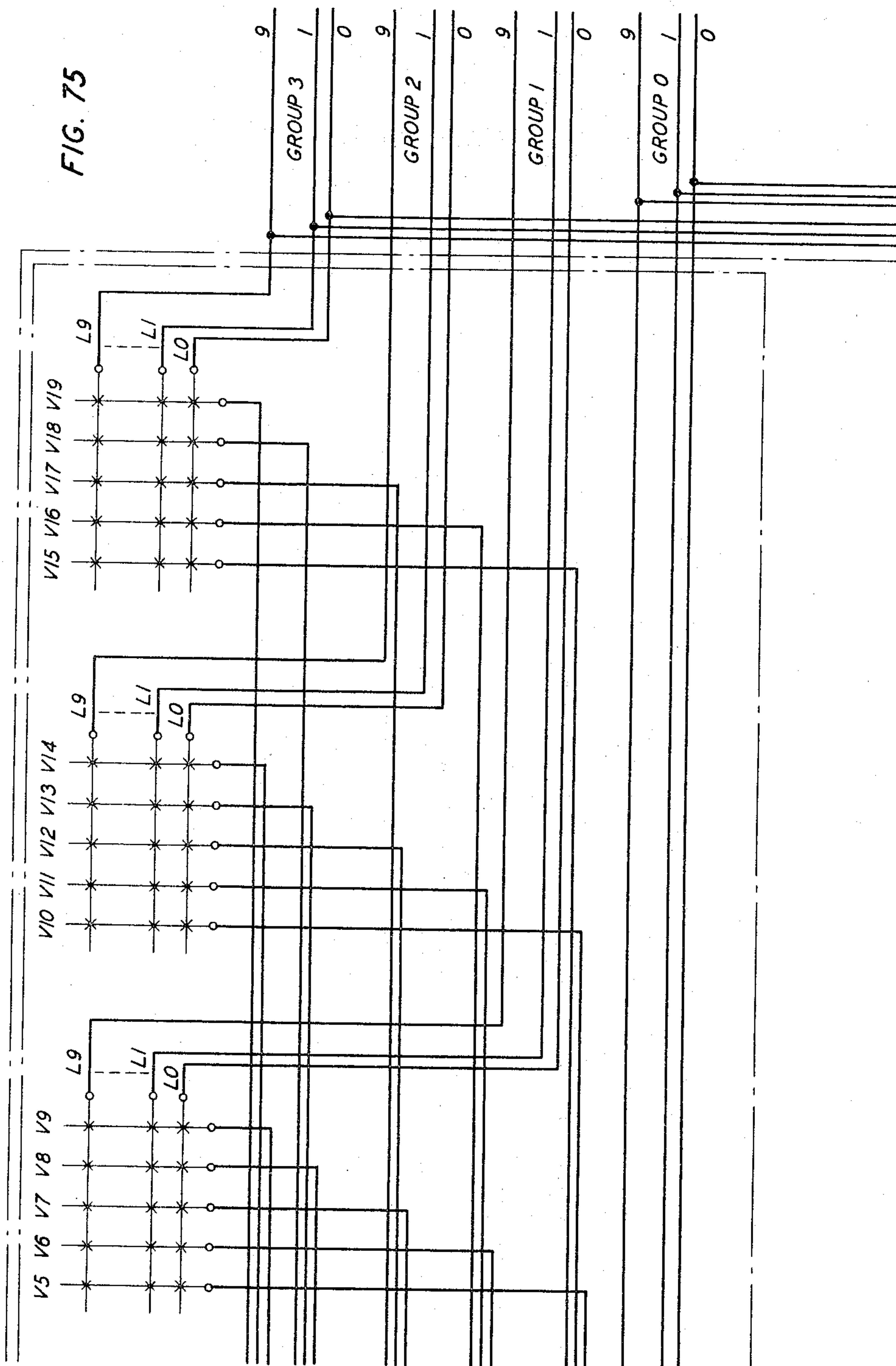
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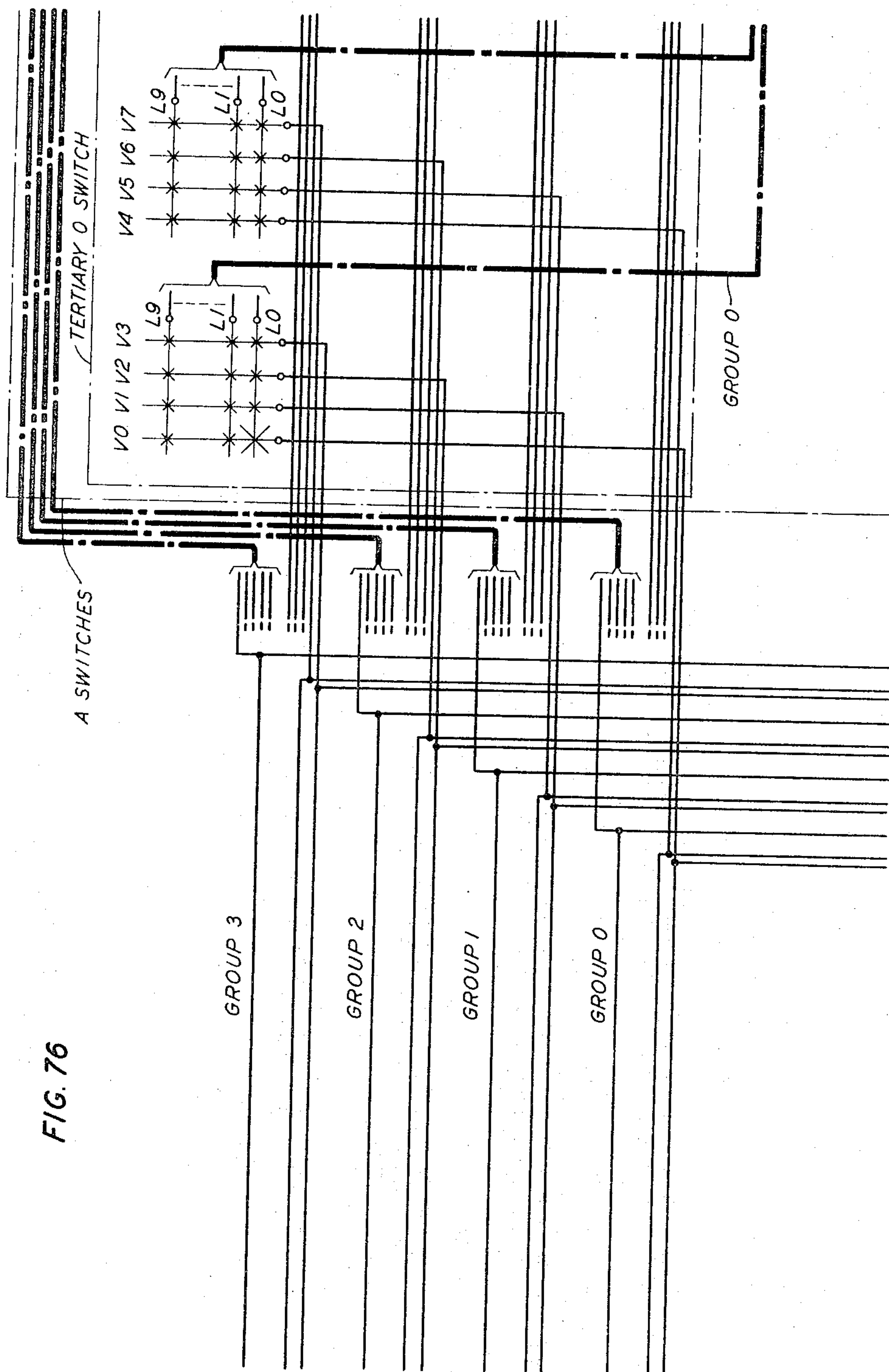
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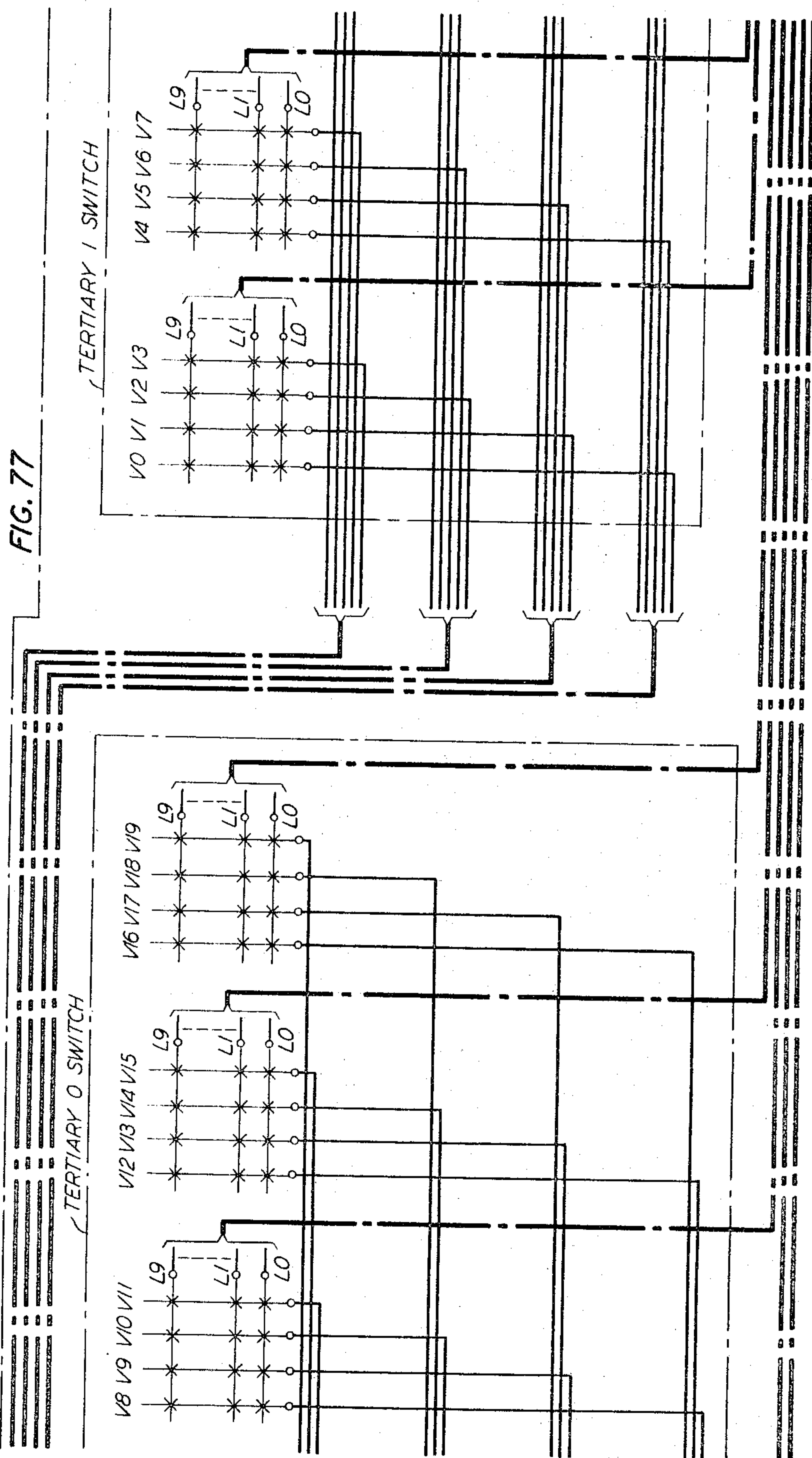
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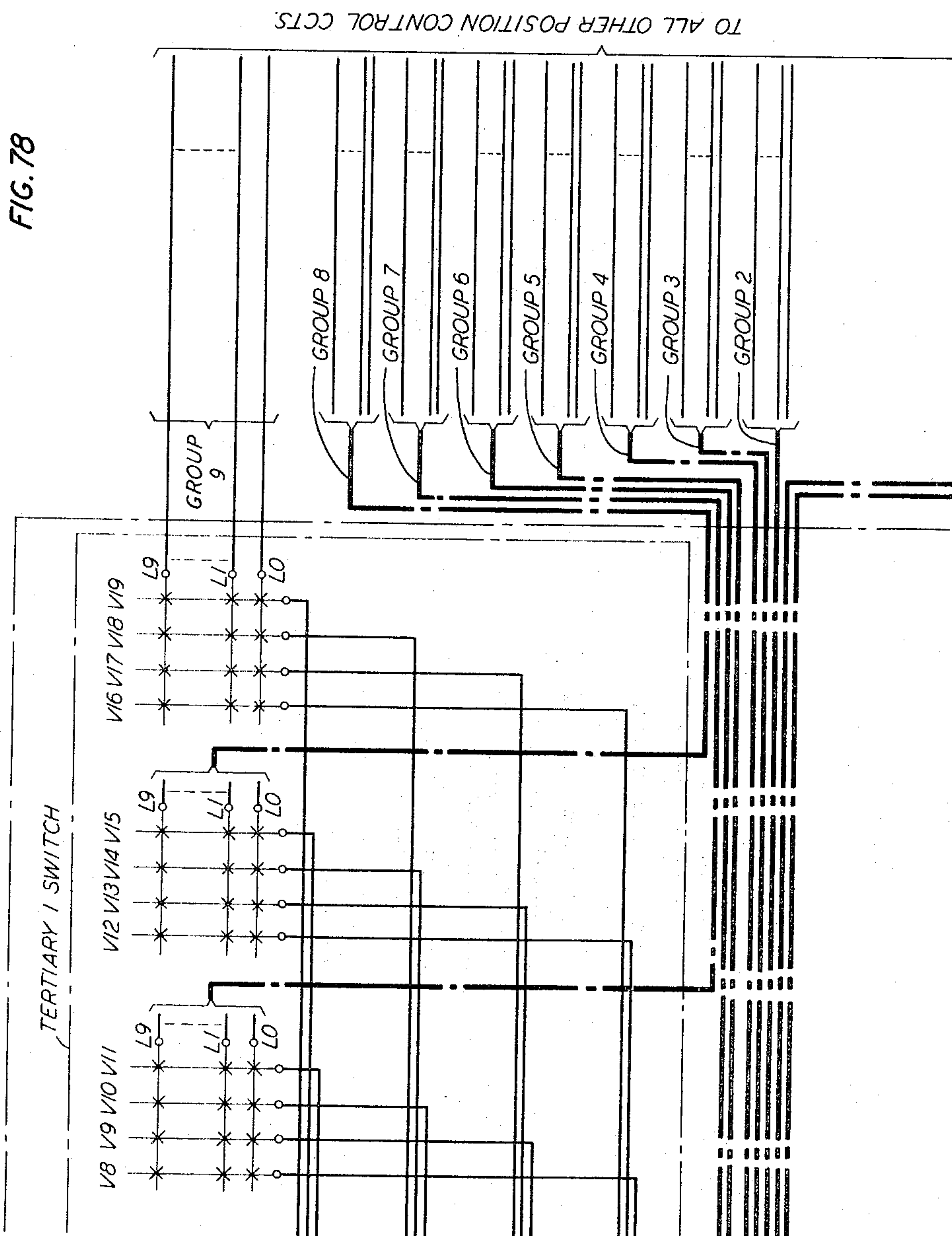
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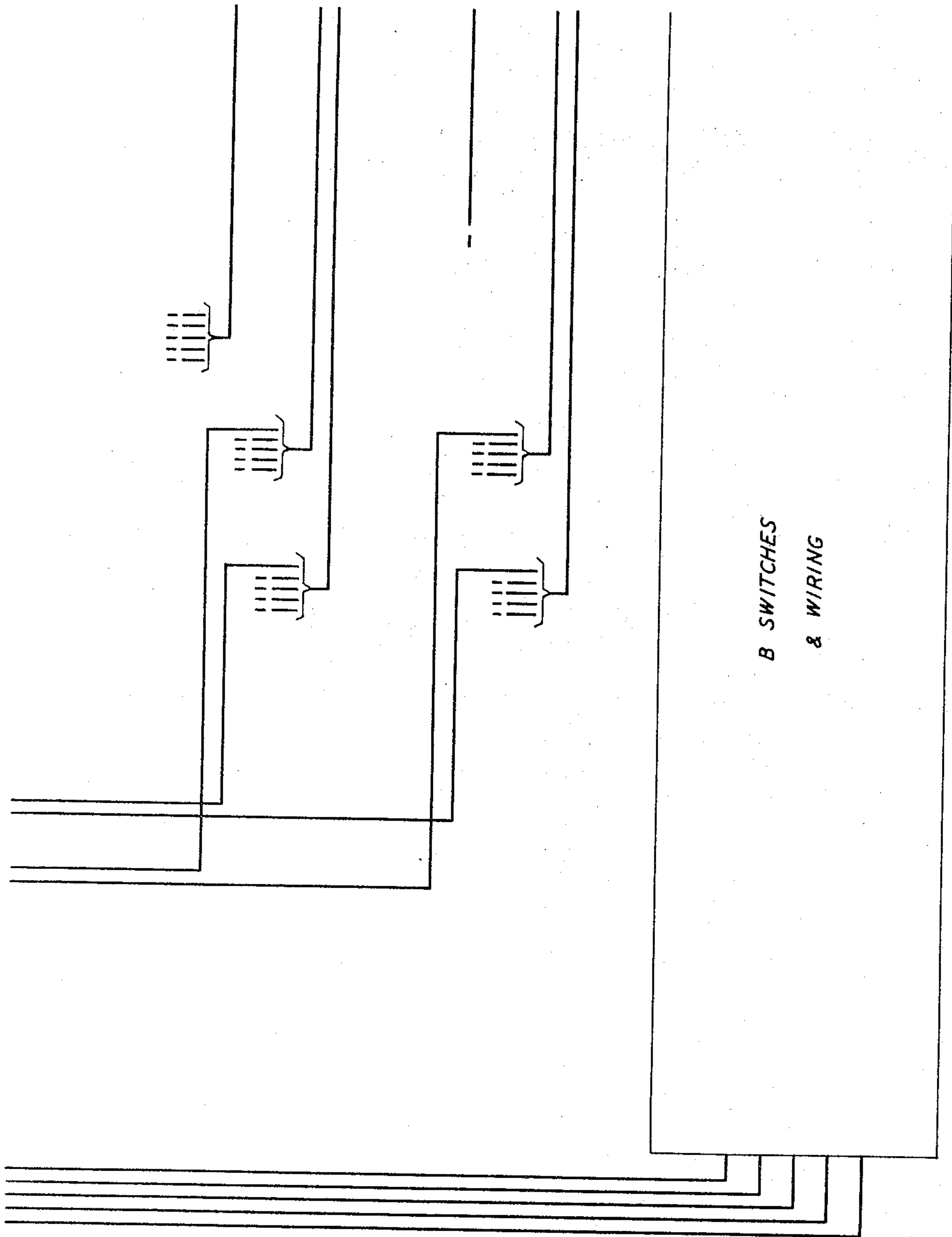
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B SWITCHES  
& WIRING

FIG. 79A



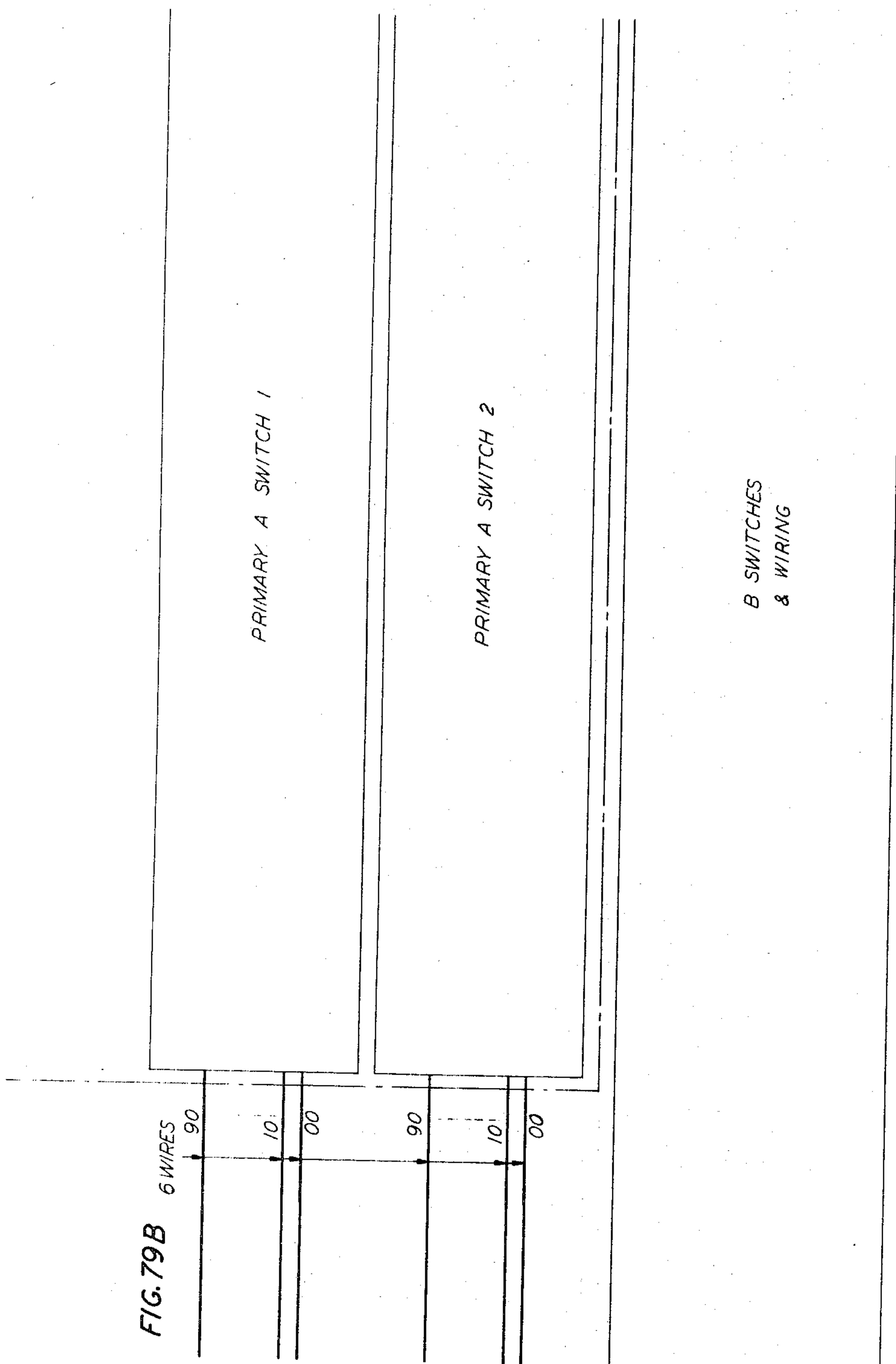
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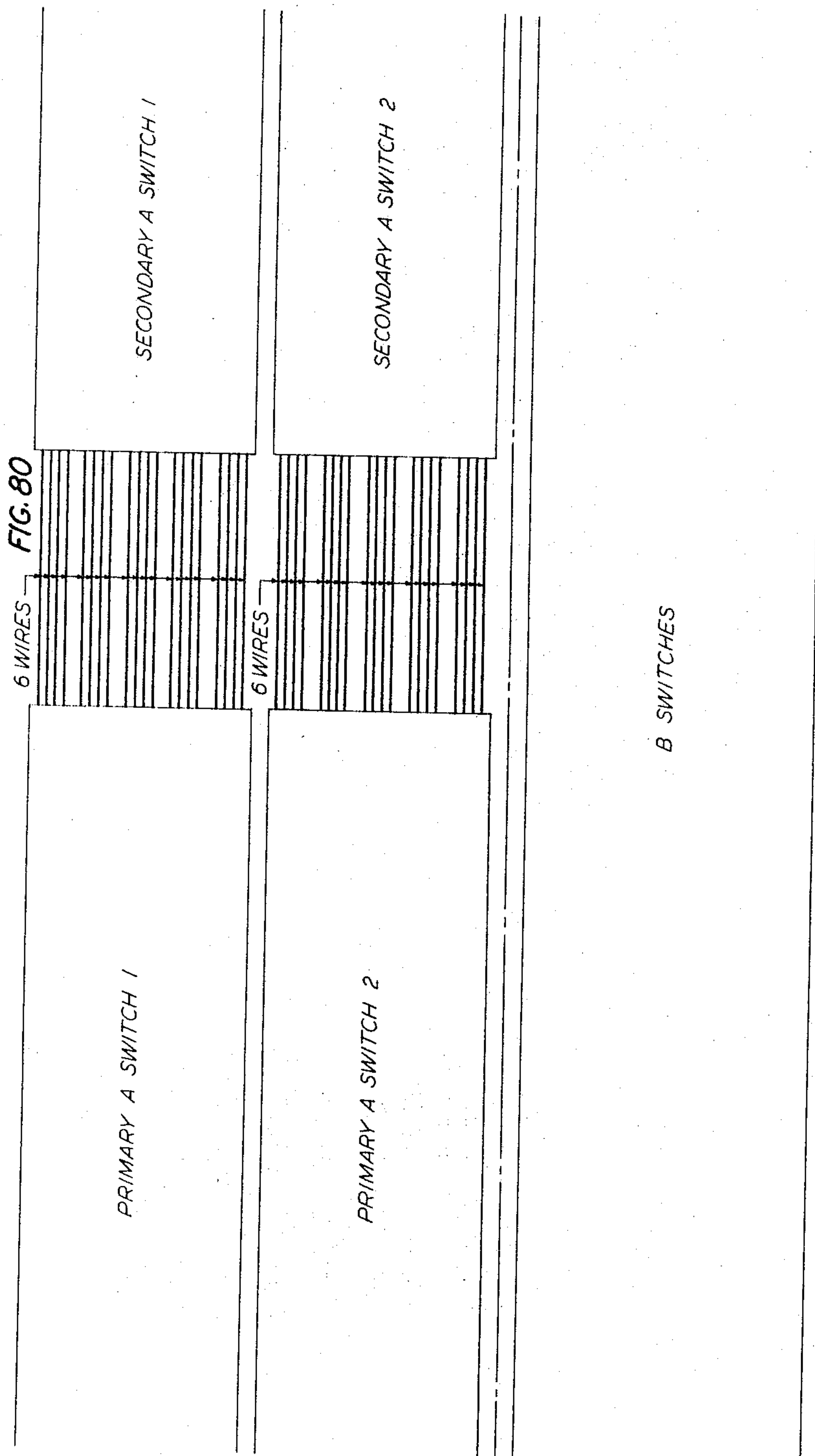
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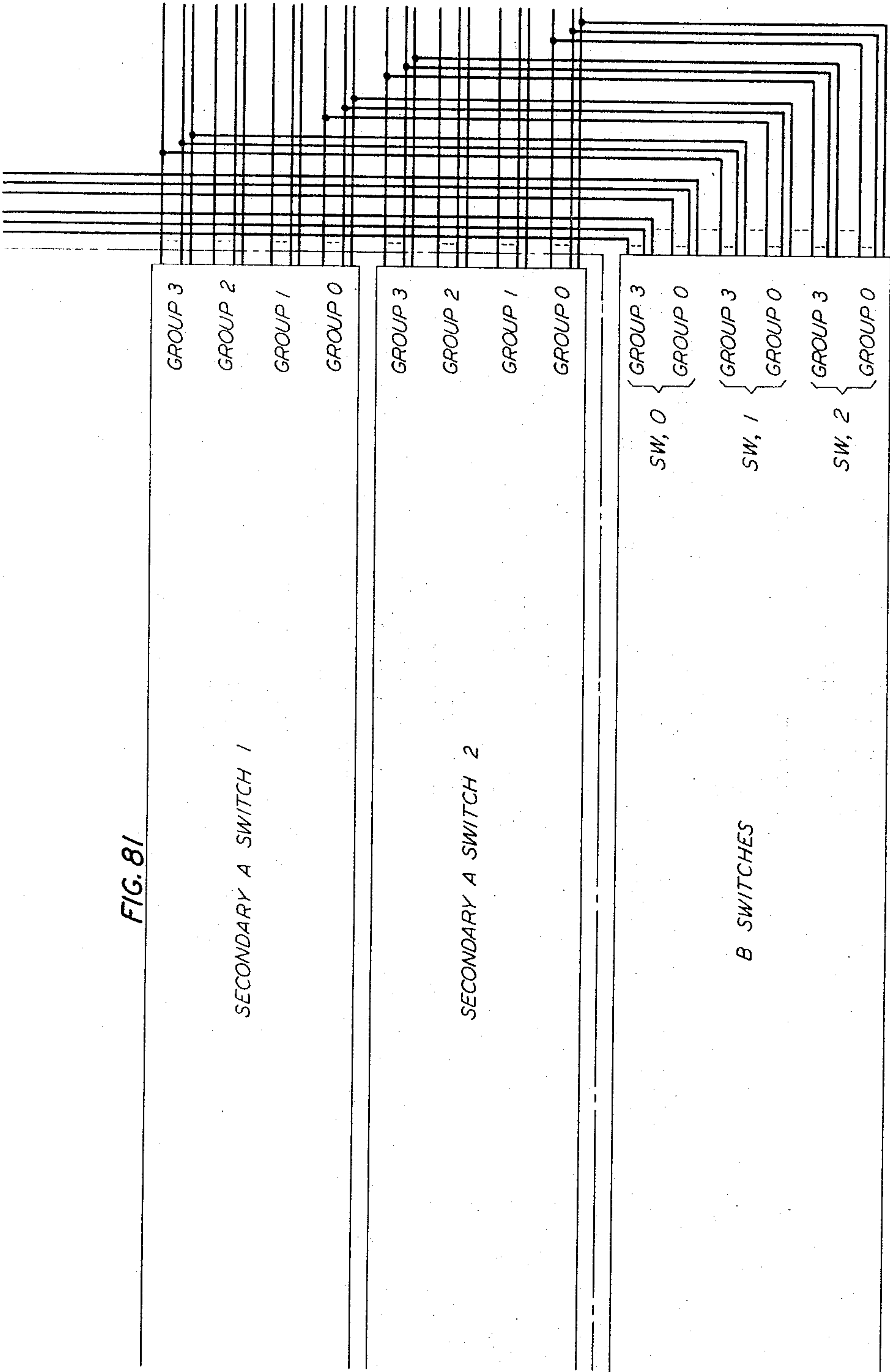
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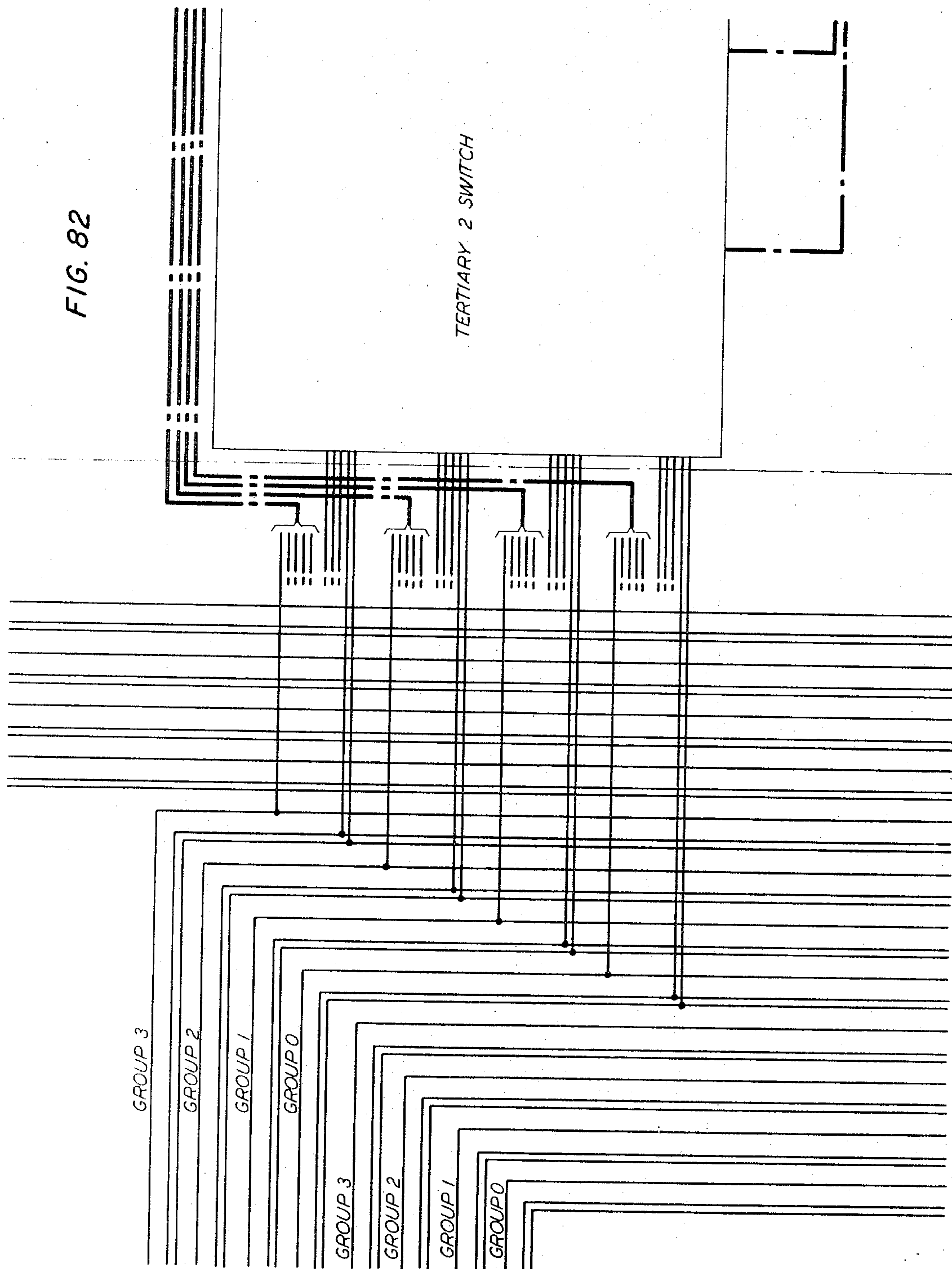
R. B. CURTIS  
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FIG. 82





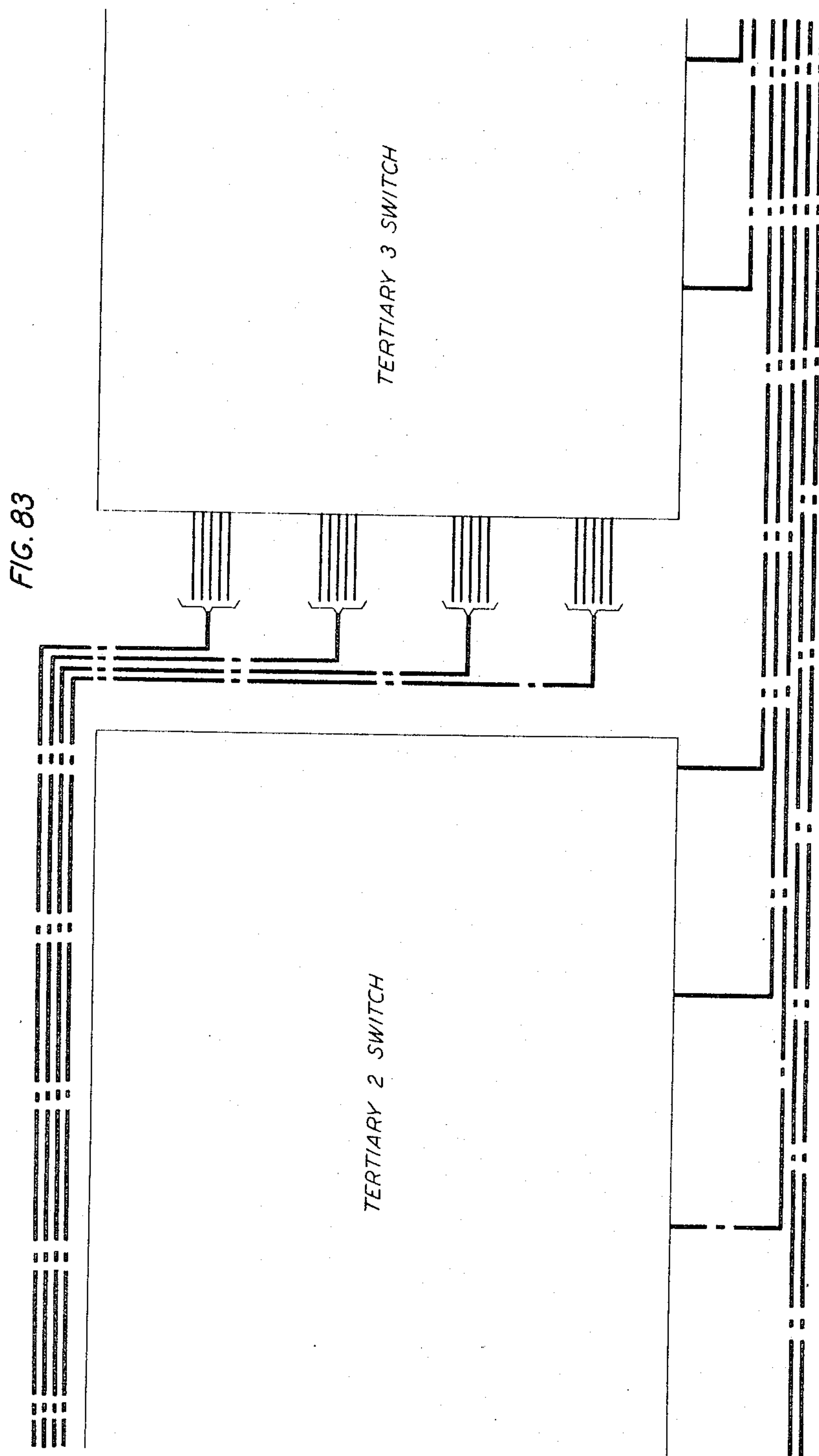
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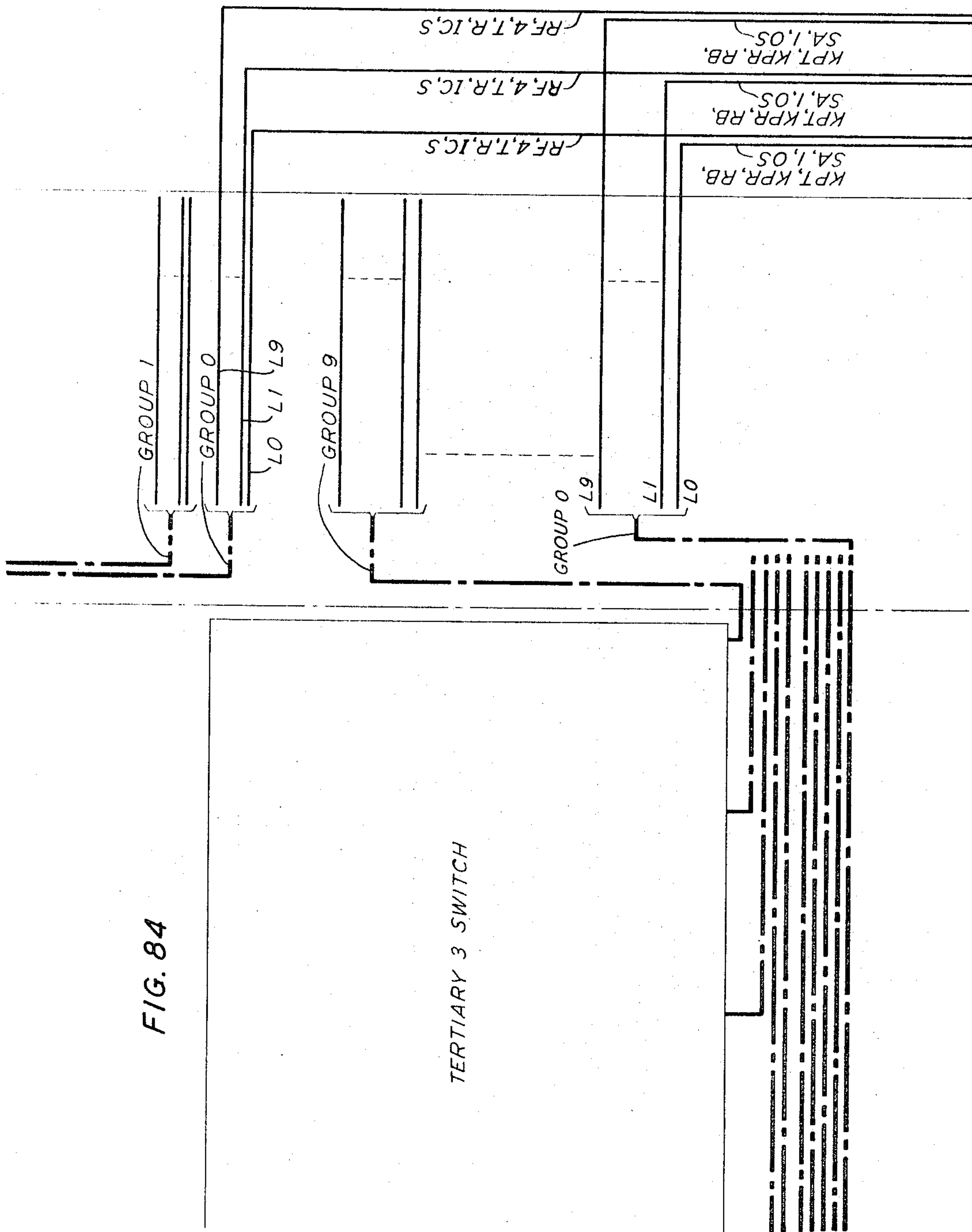


FIG. 84



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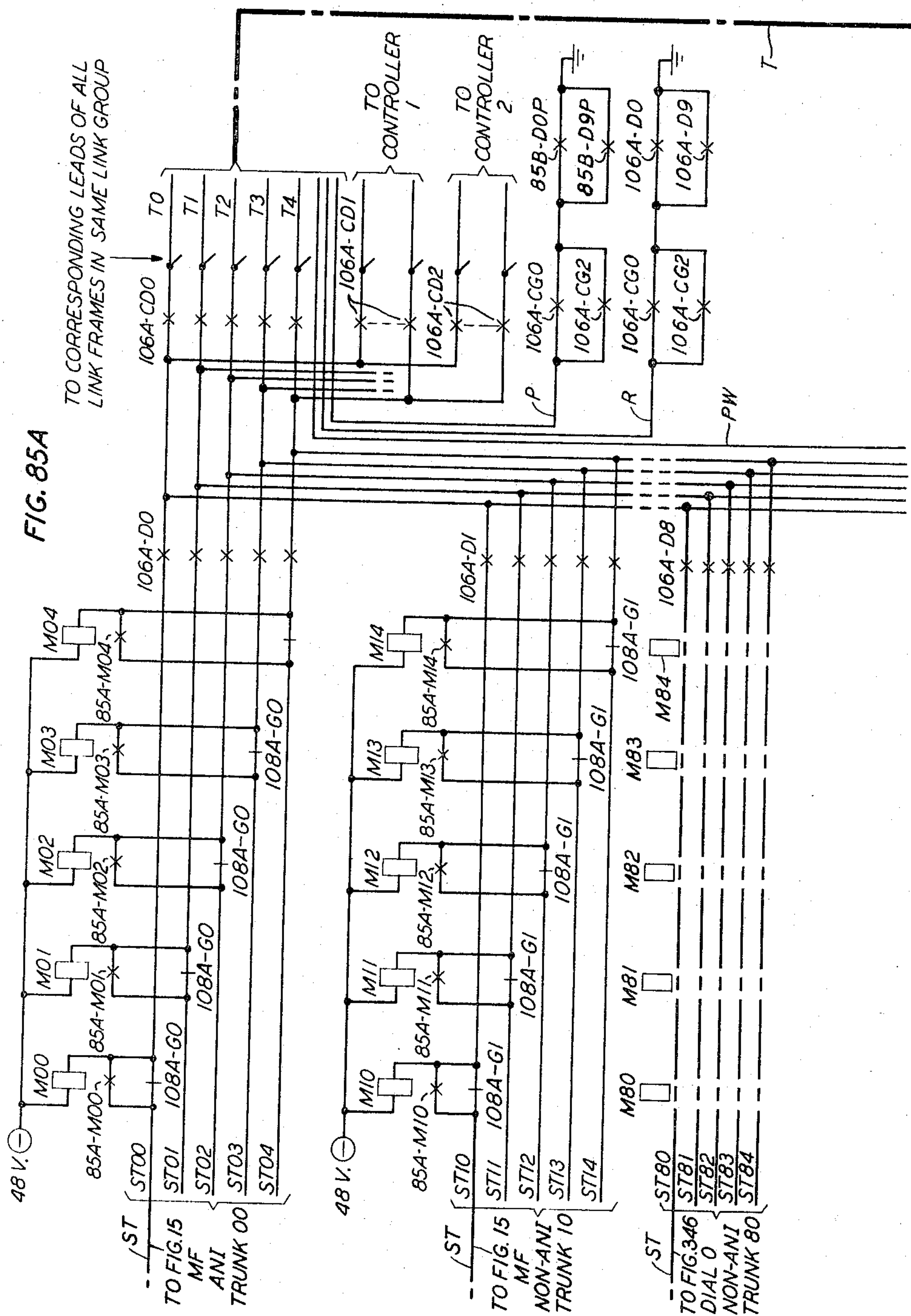
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FIG. 85A





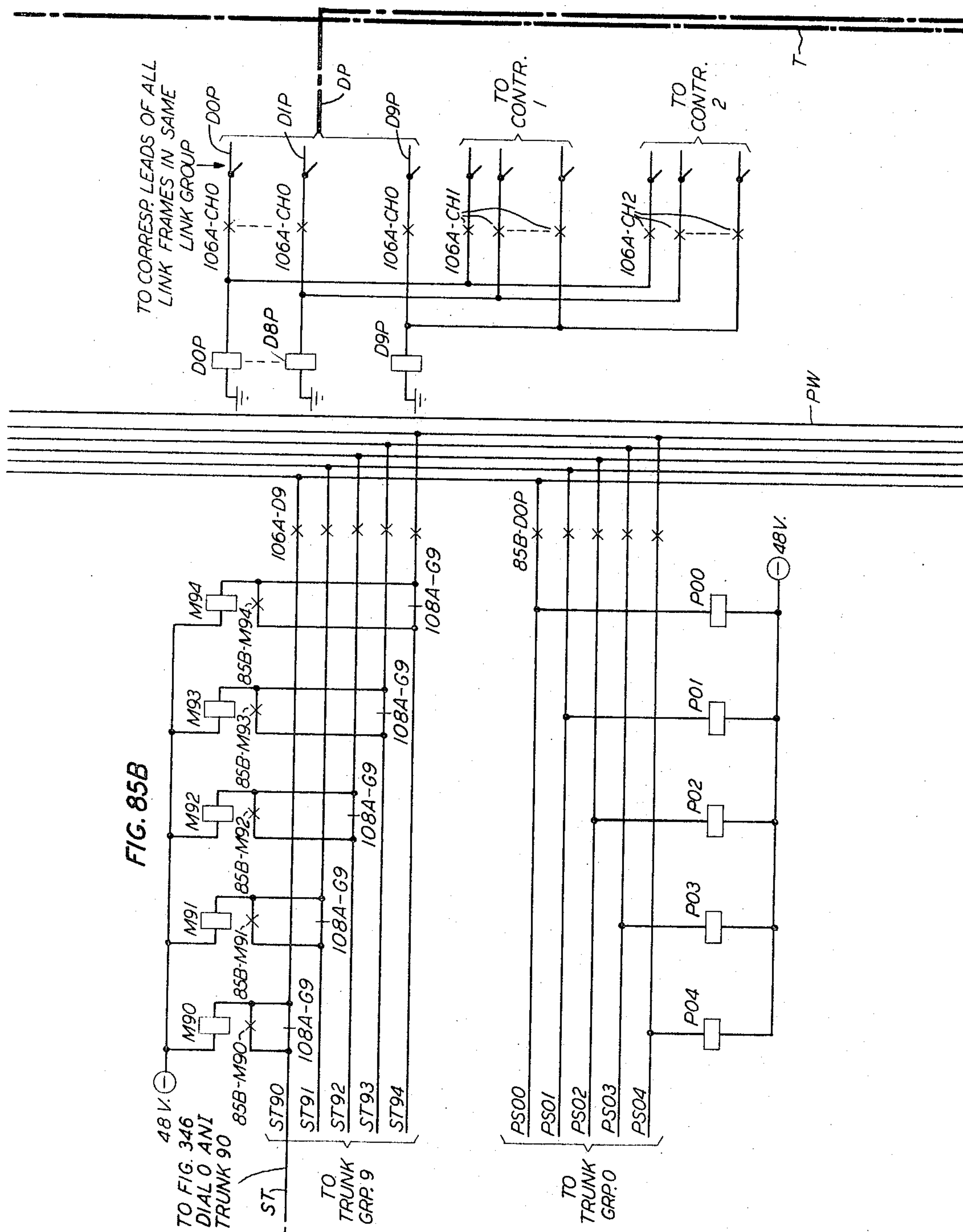
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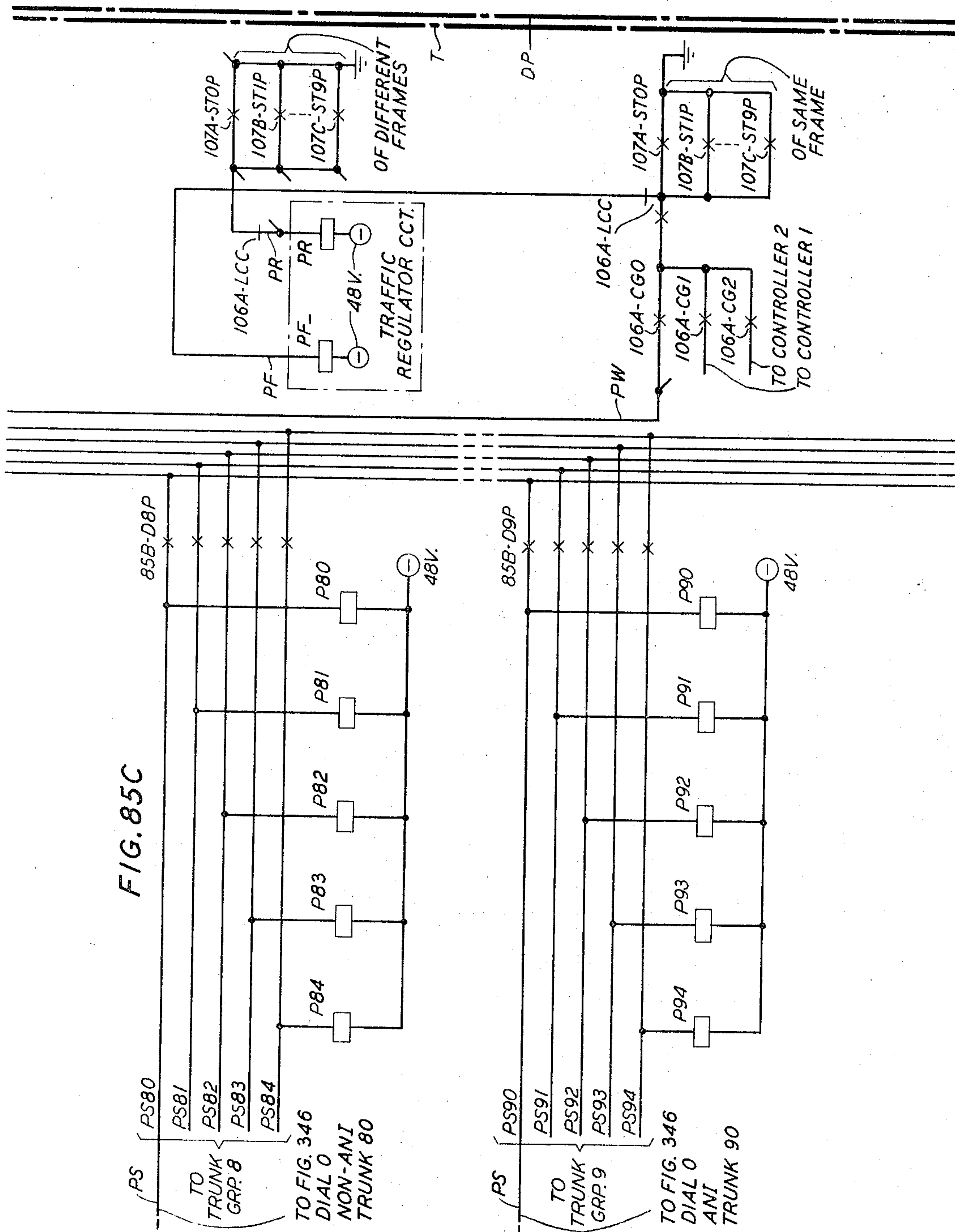
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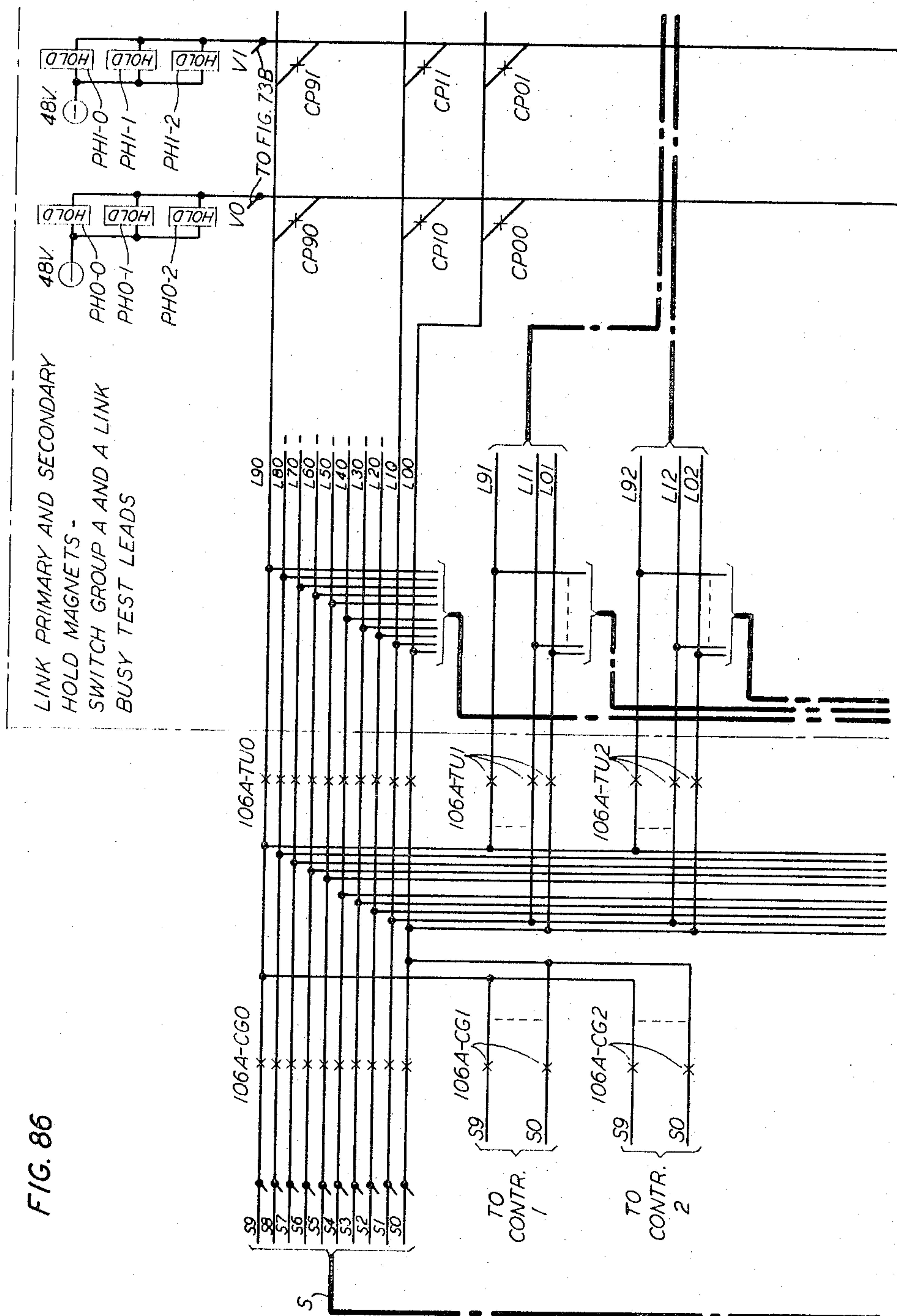
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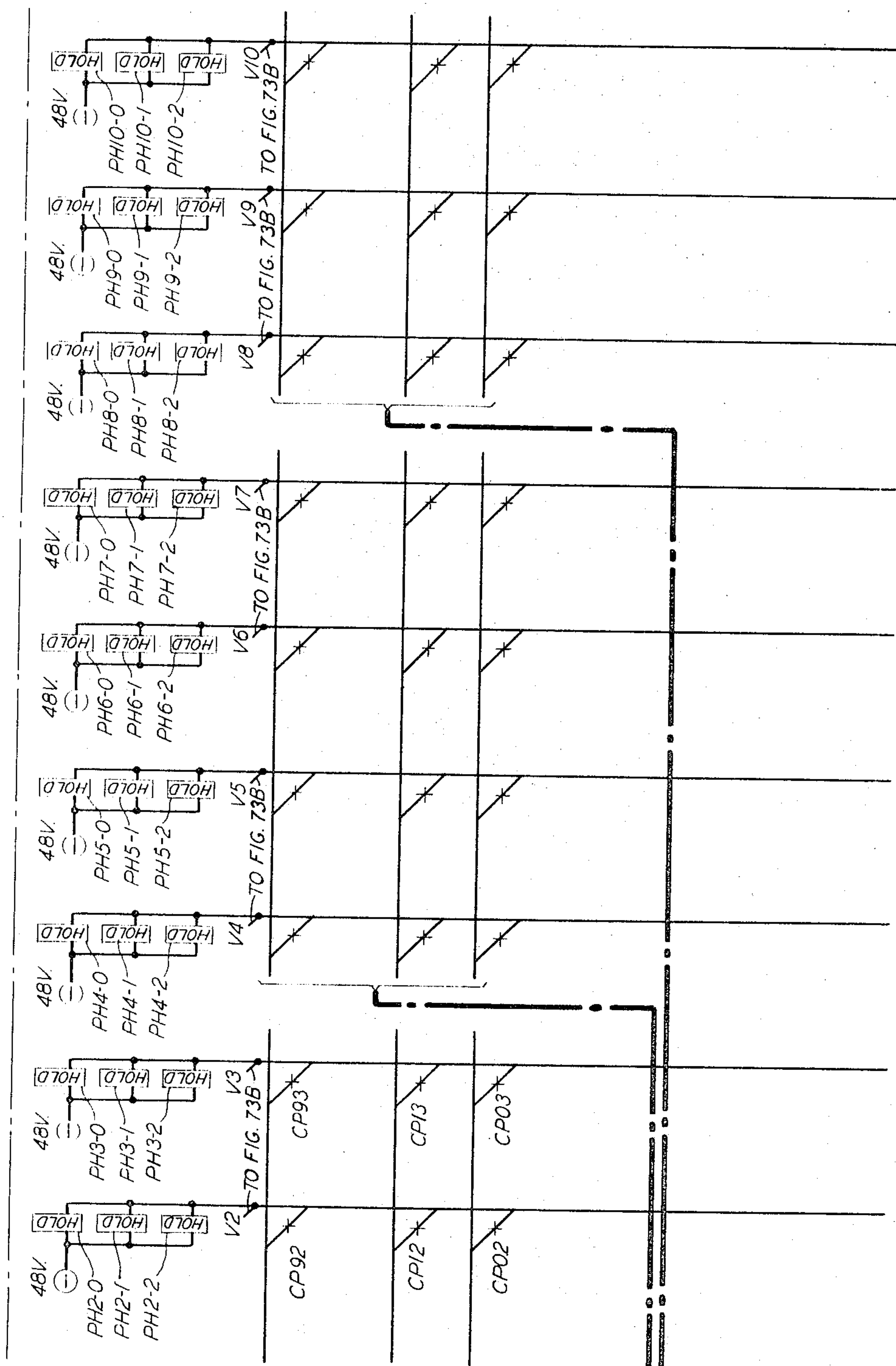
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FIG. 87





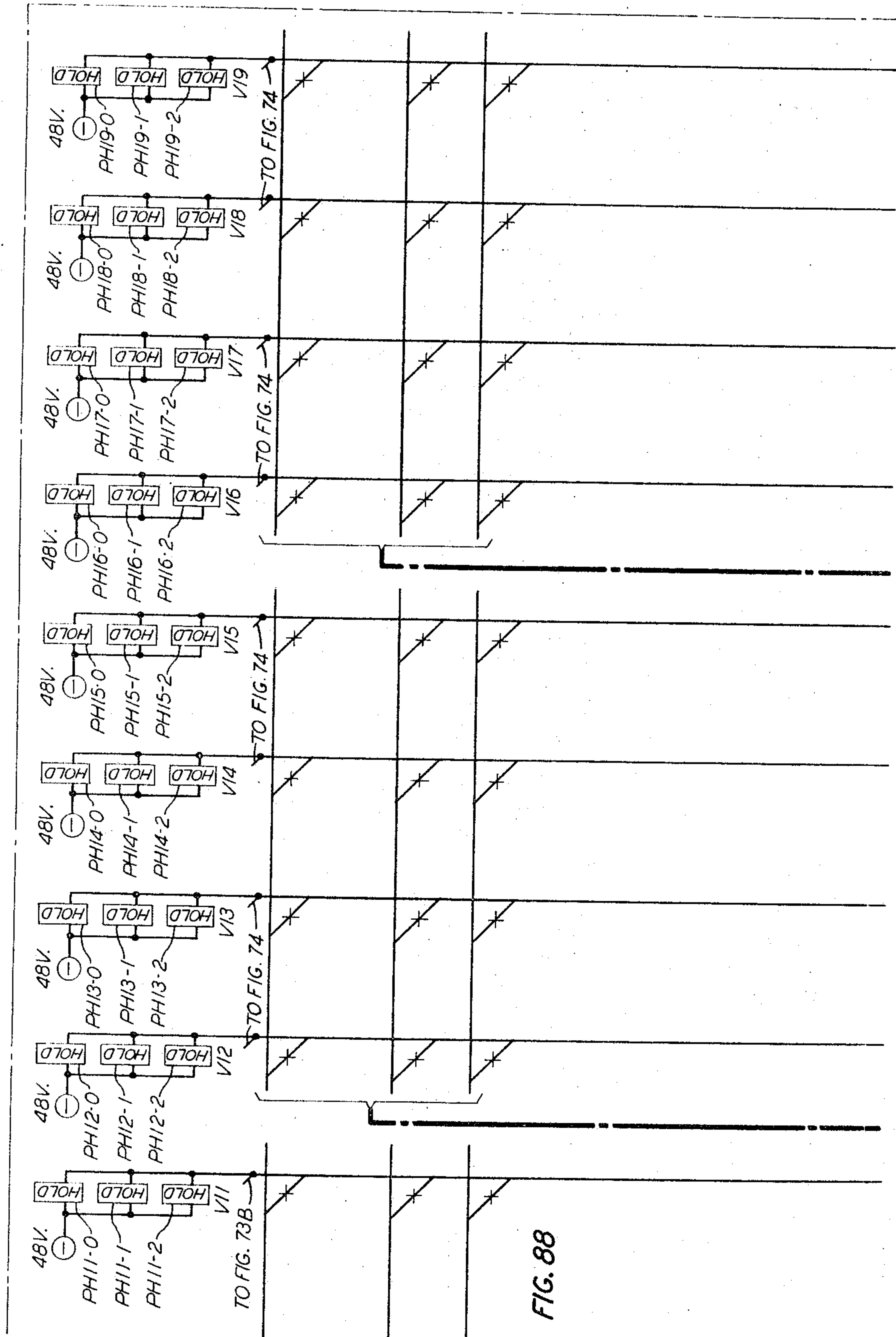
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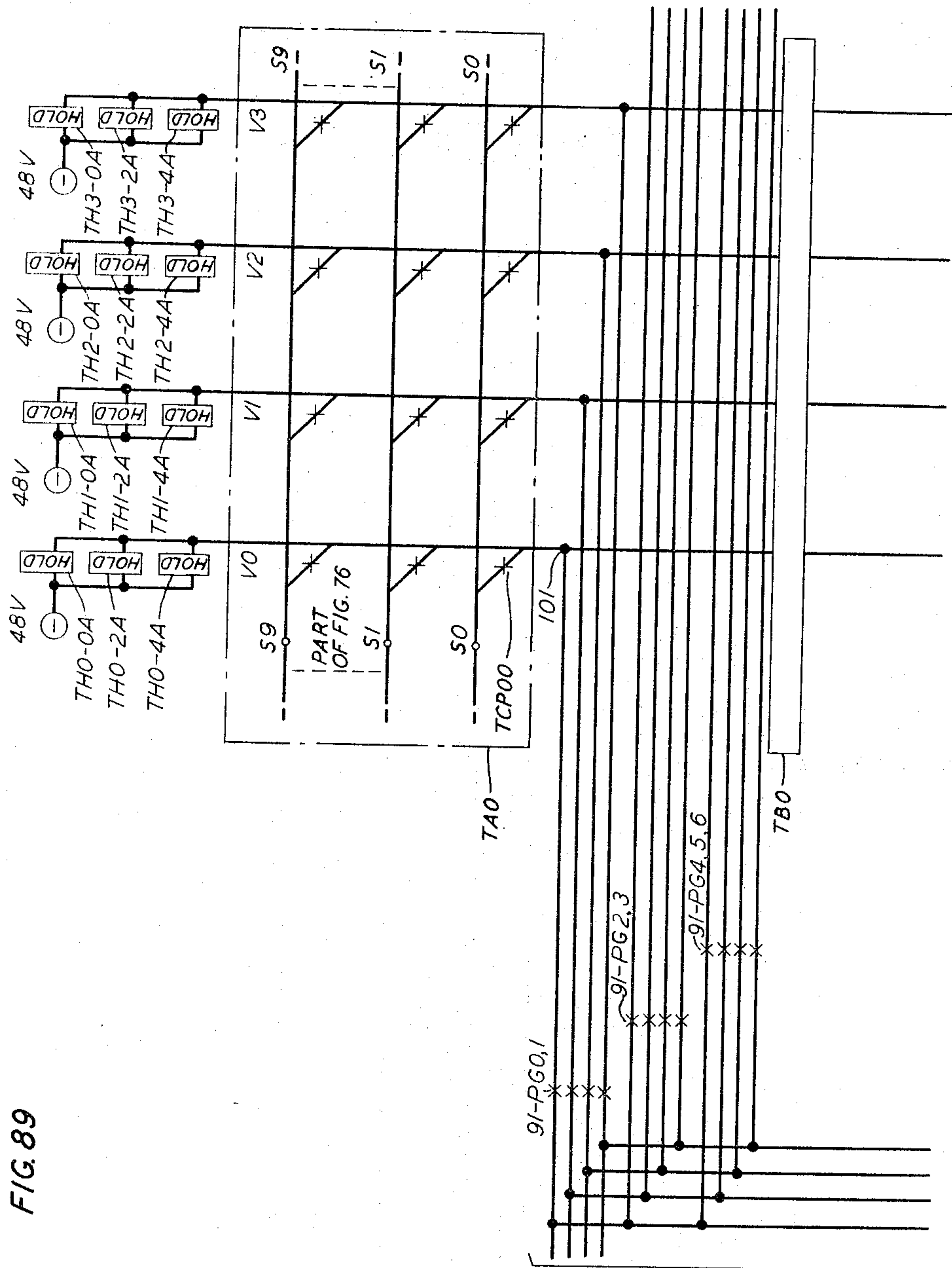
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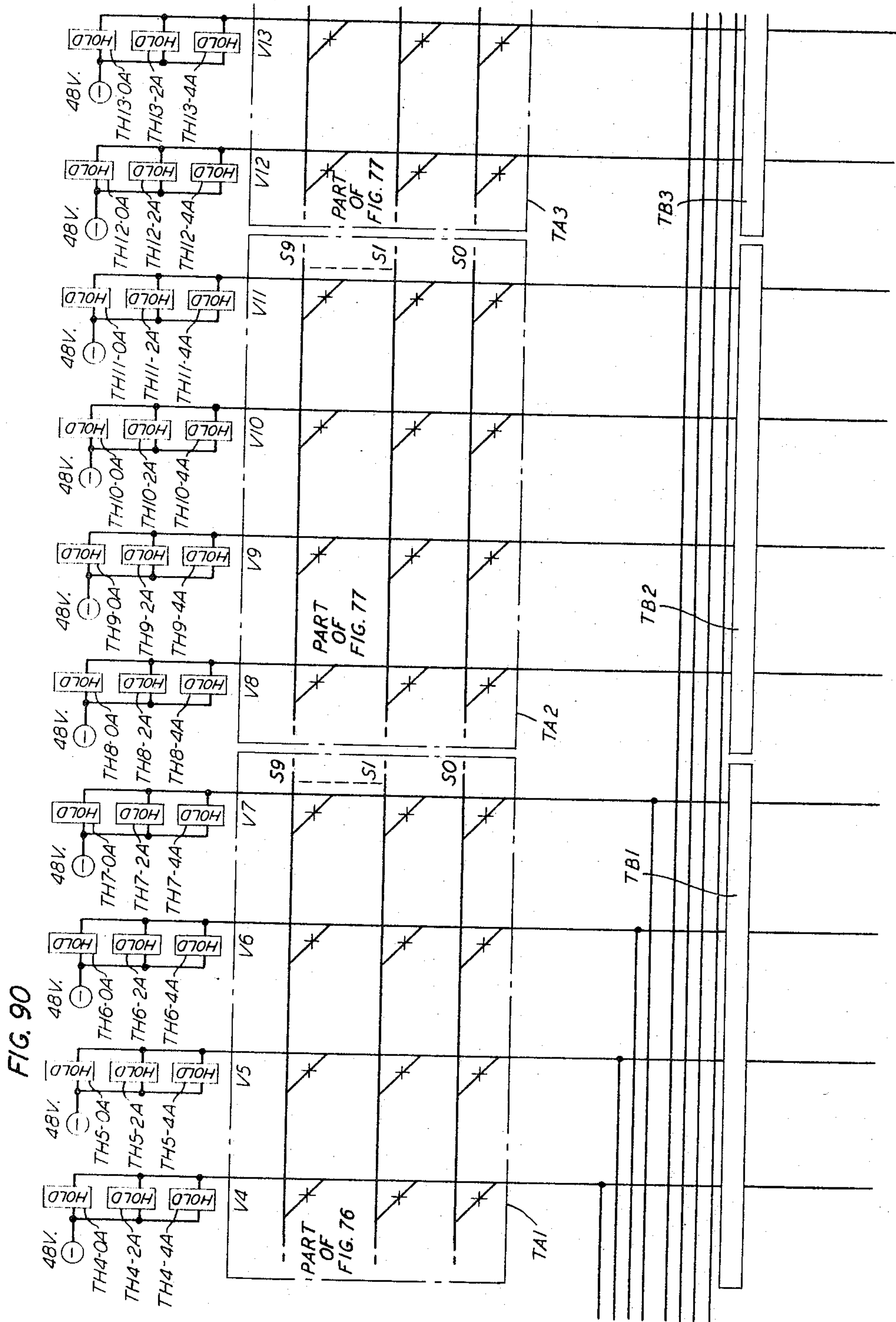
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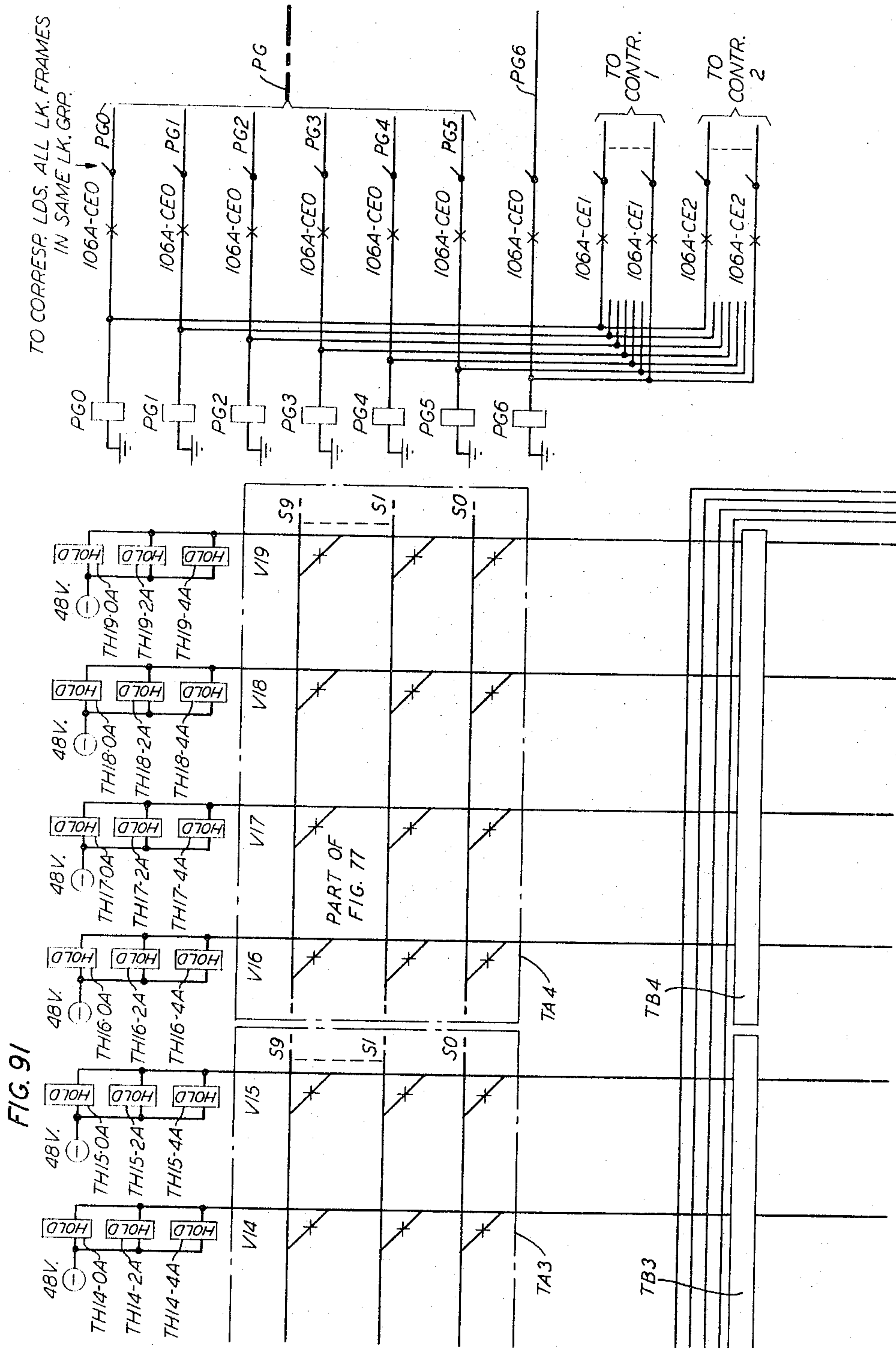
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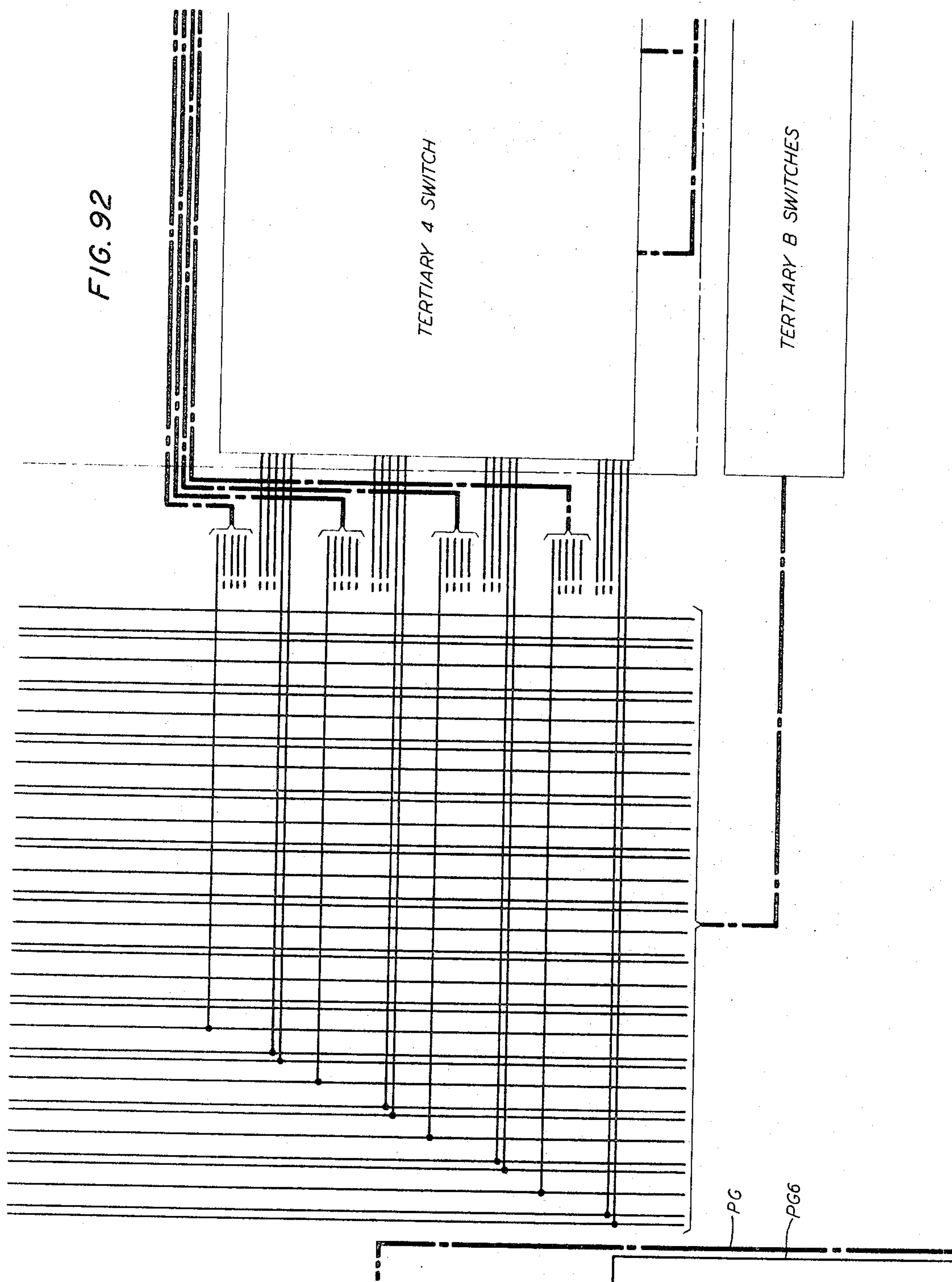
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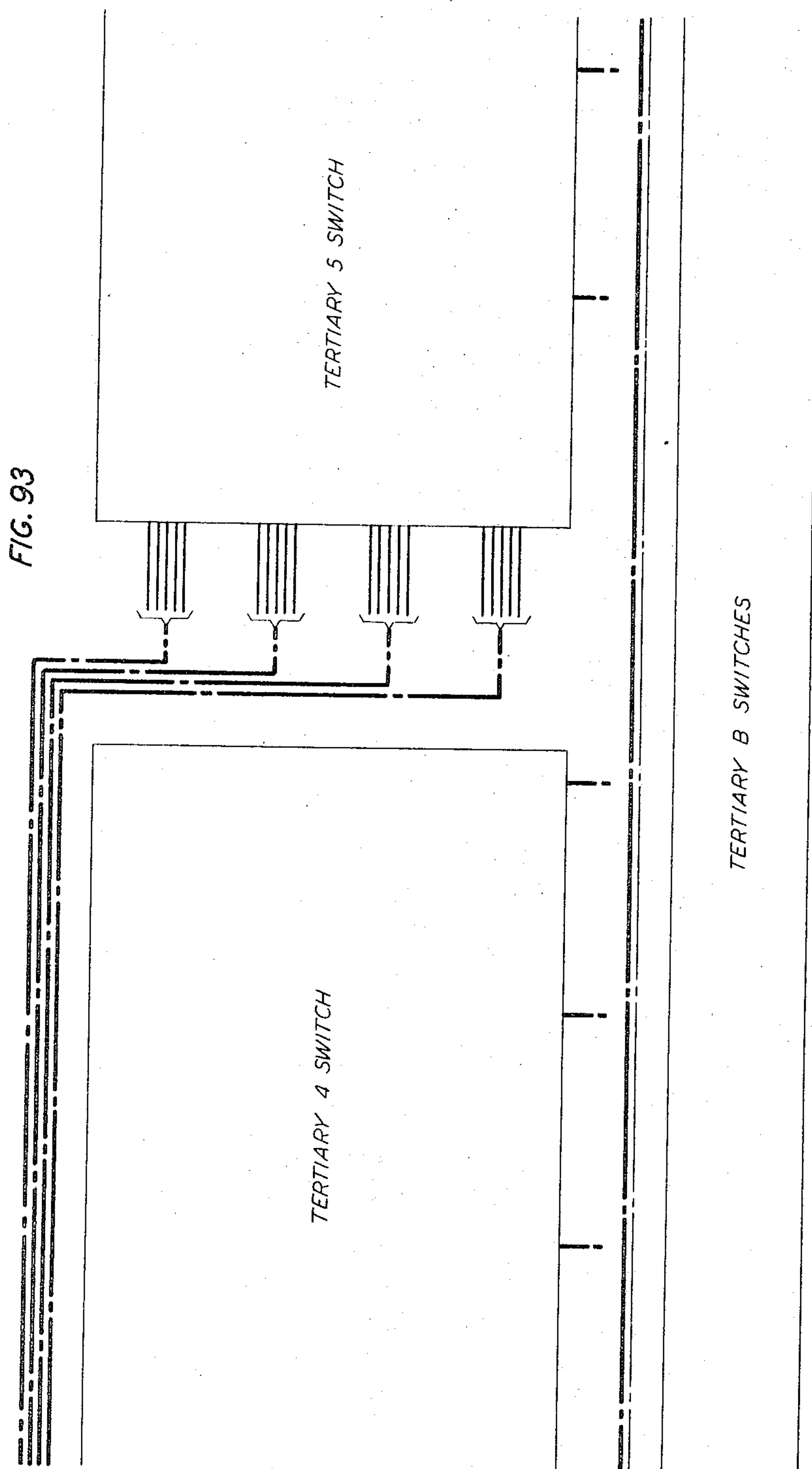
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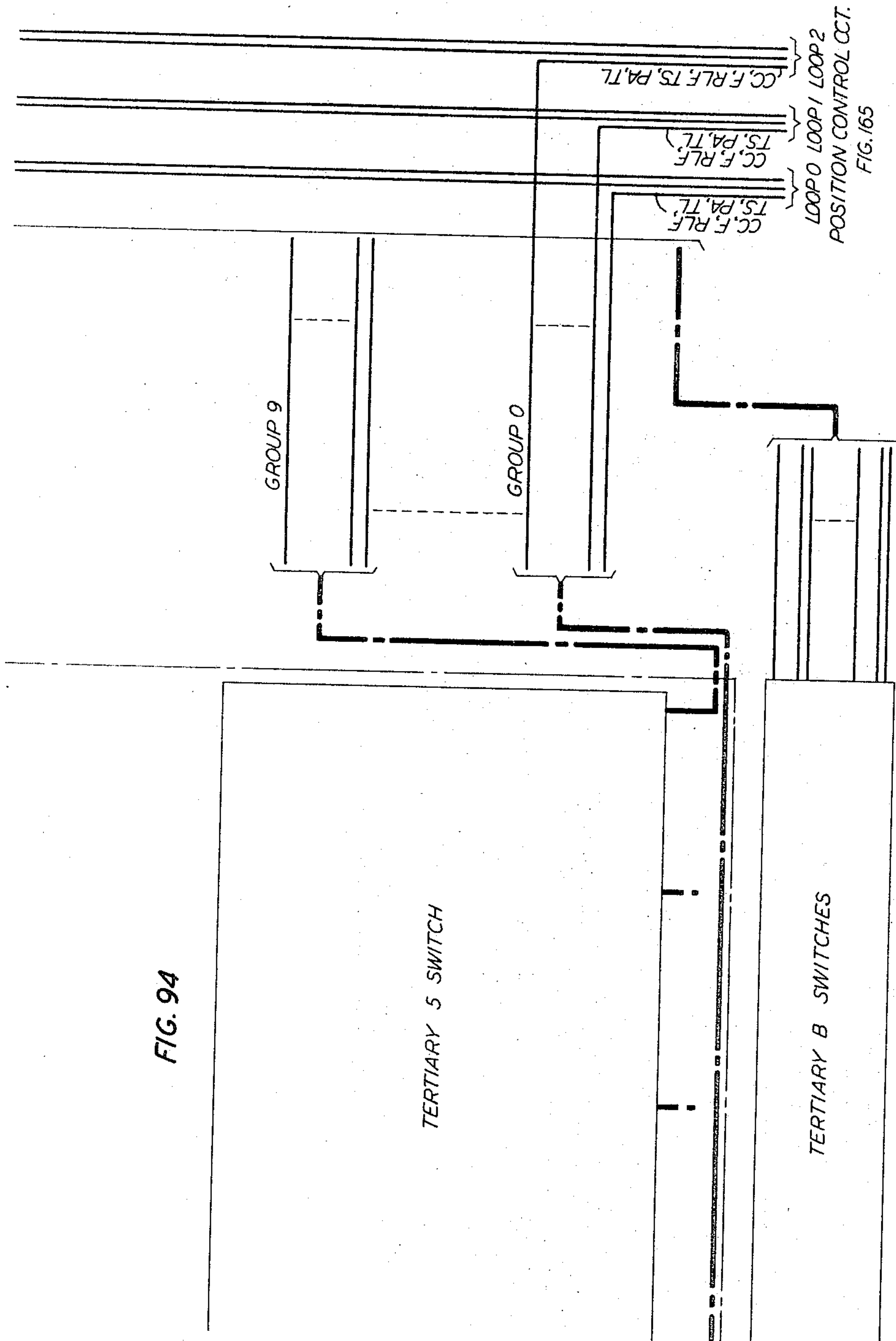
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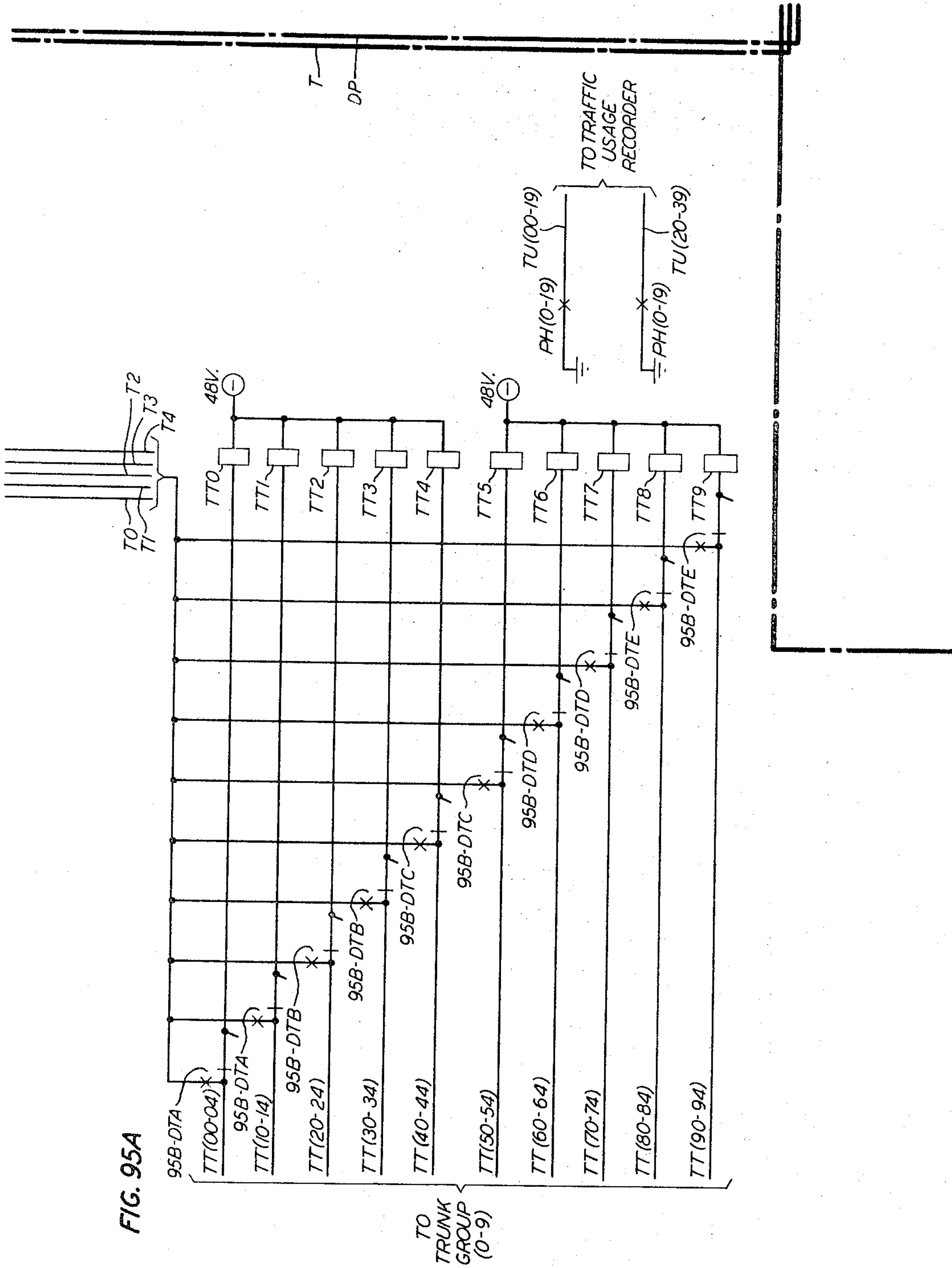
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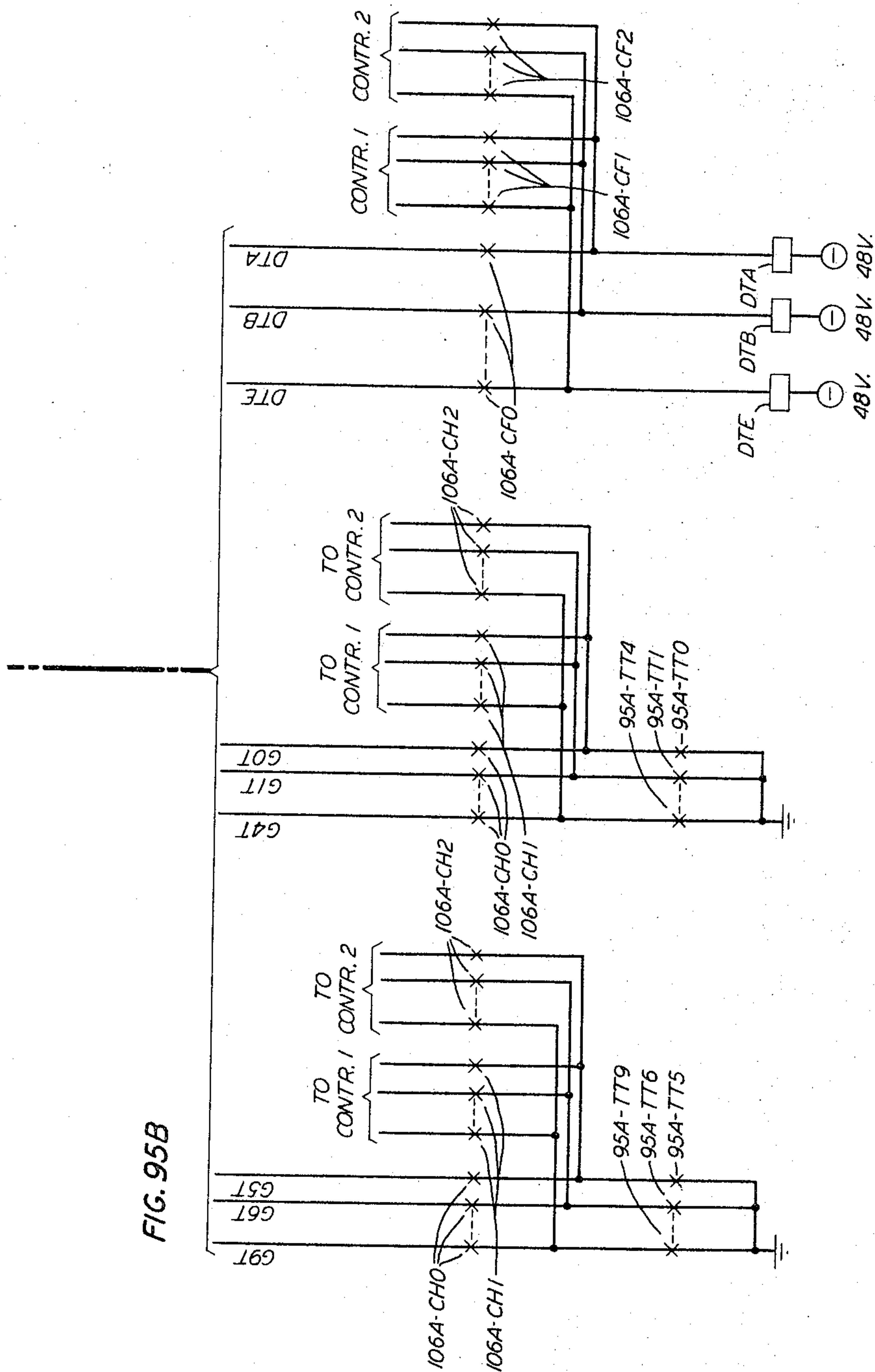
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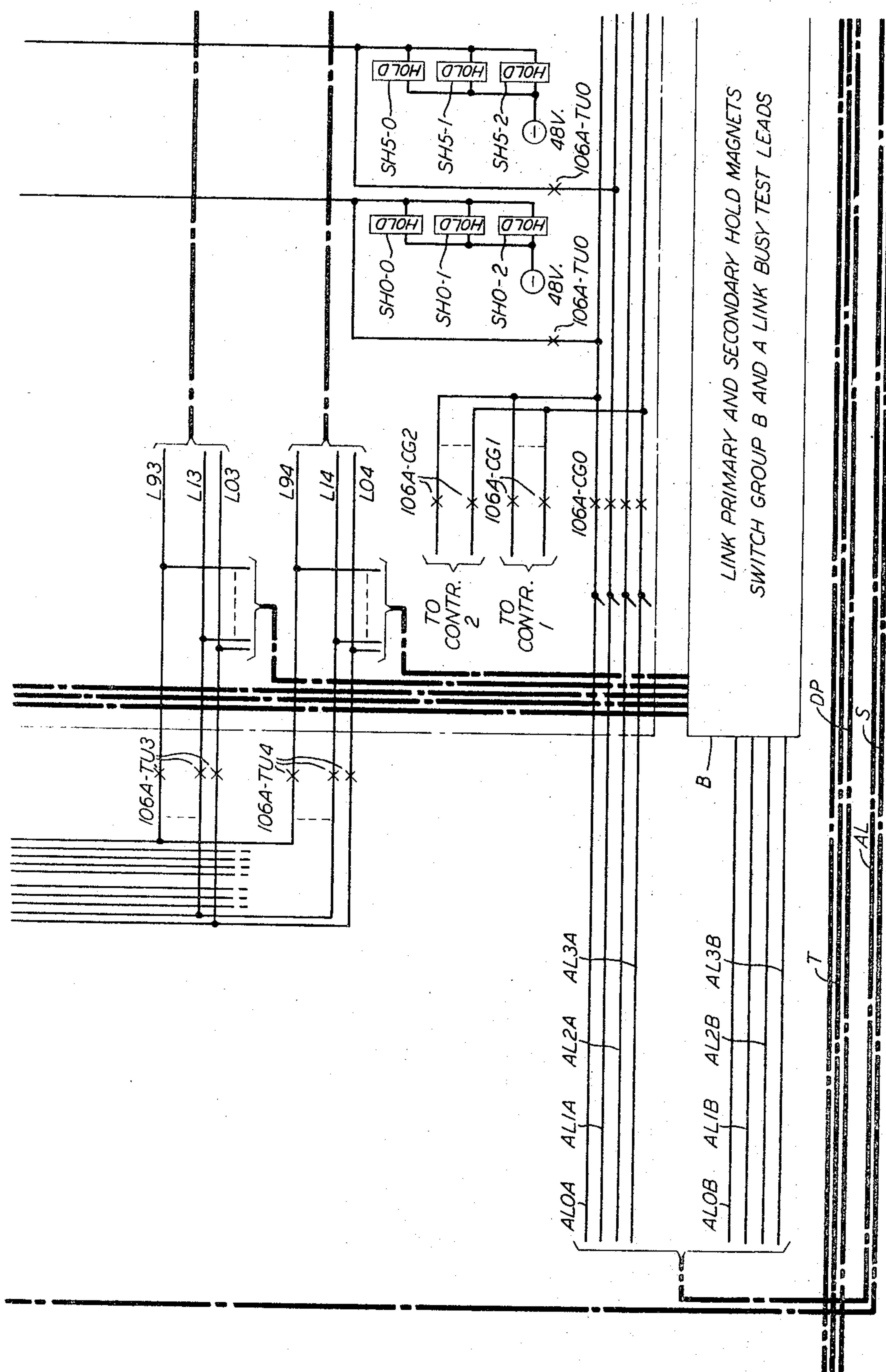
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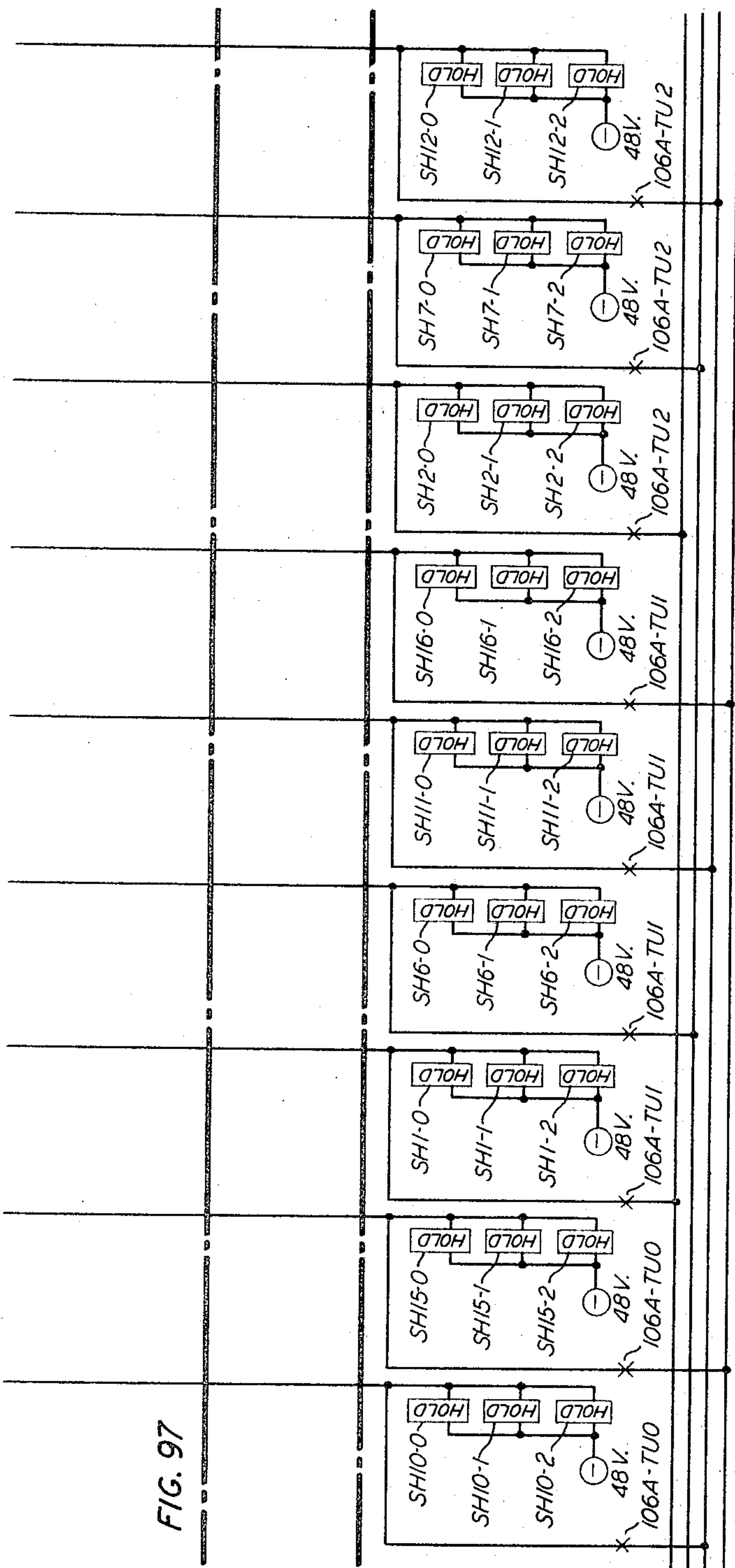
R. B. CURTIS  
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FIG. 97



LINK PRIMARY AND SECONDARY HOLD MAGNETS  
SWITCH GROUP B AND A LINK BUSY TEST LEADS





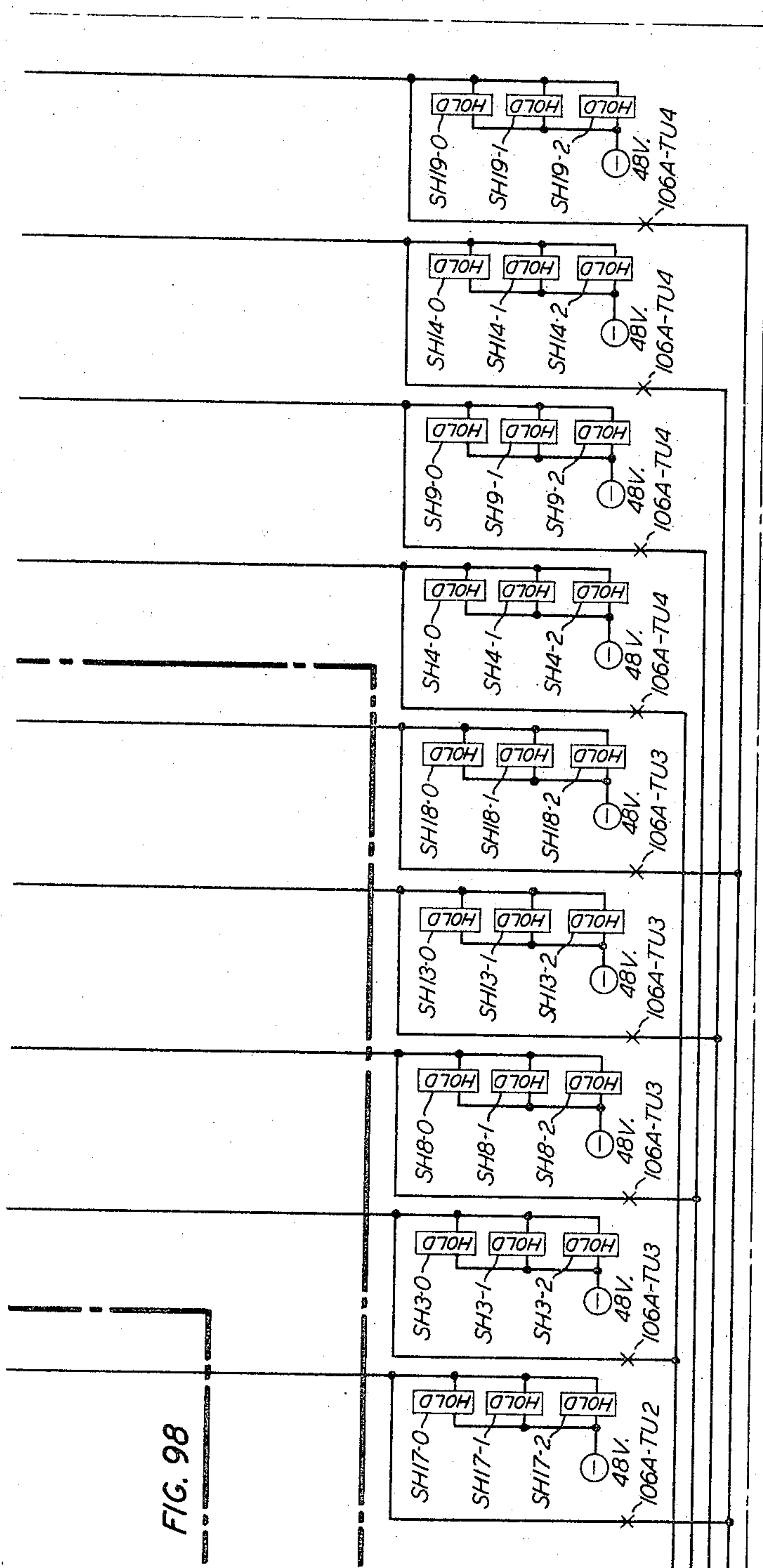
Sept. 12, 1967

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EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
INTERMEDIATE SWITCHING CENTER

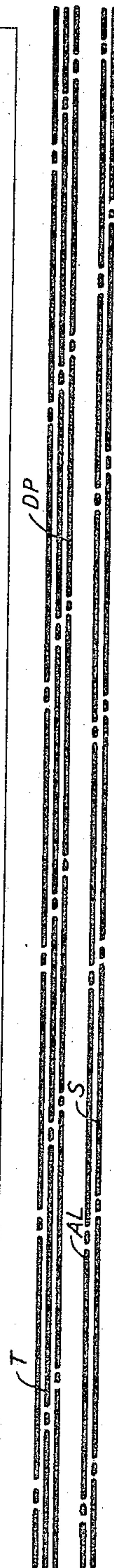
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LINK PRIMARY AND SECONDARY HOLD MAGNETS  
SWITCH GROUP B AND A LINK BUSY TEST LEADS





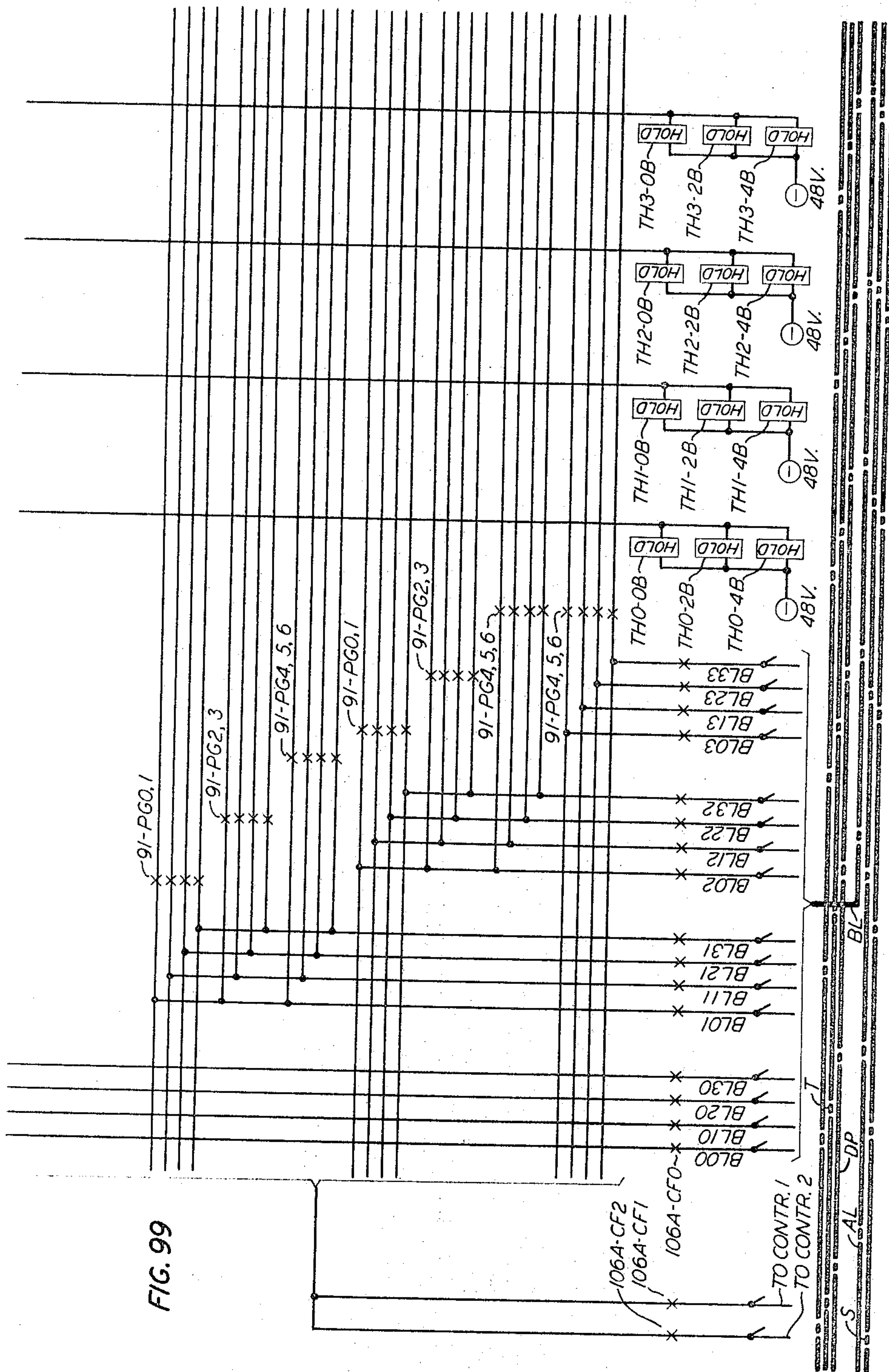
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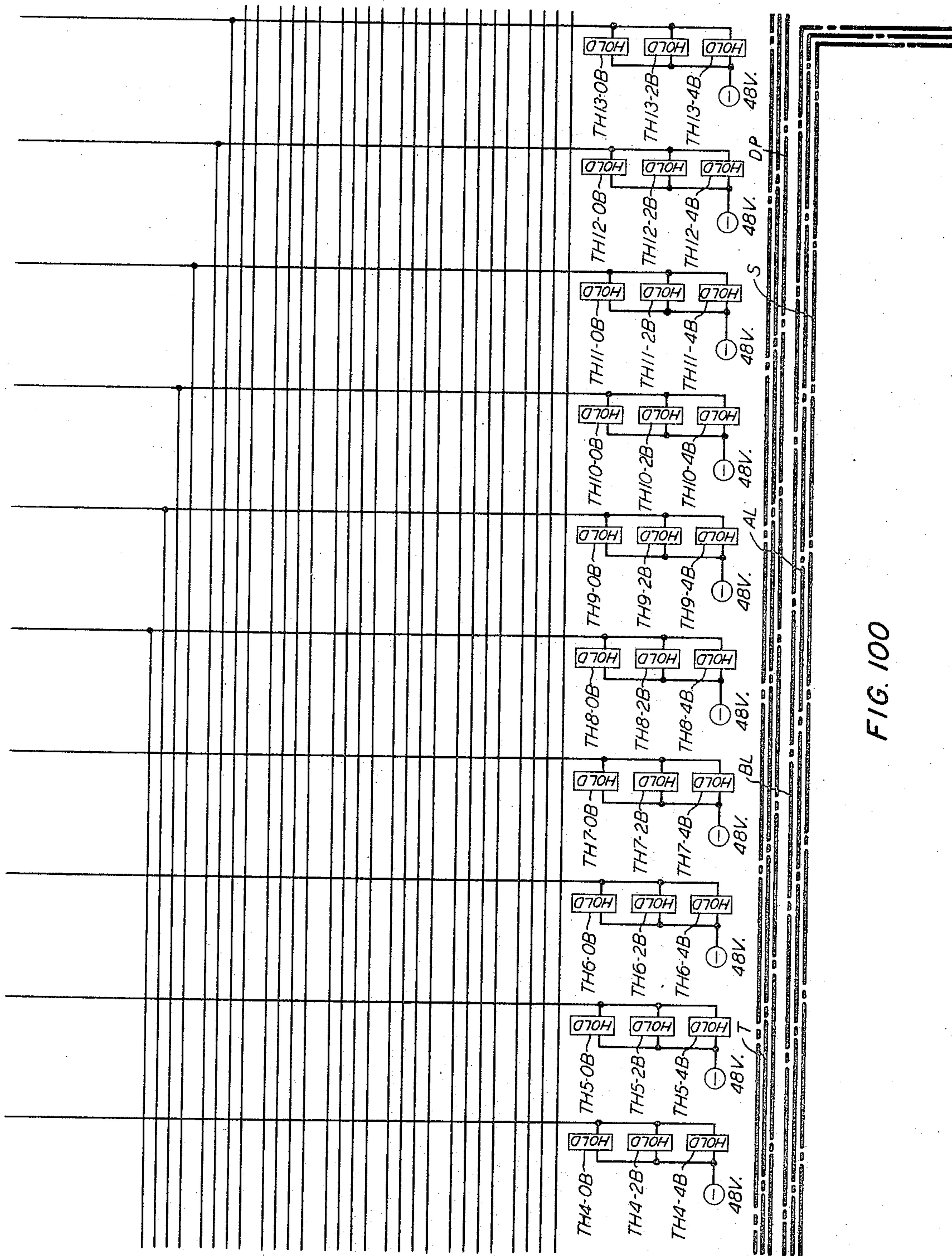
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Sept. 12, 1967

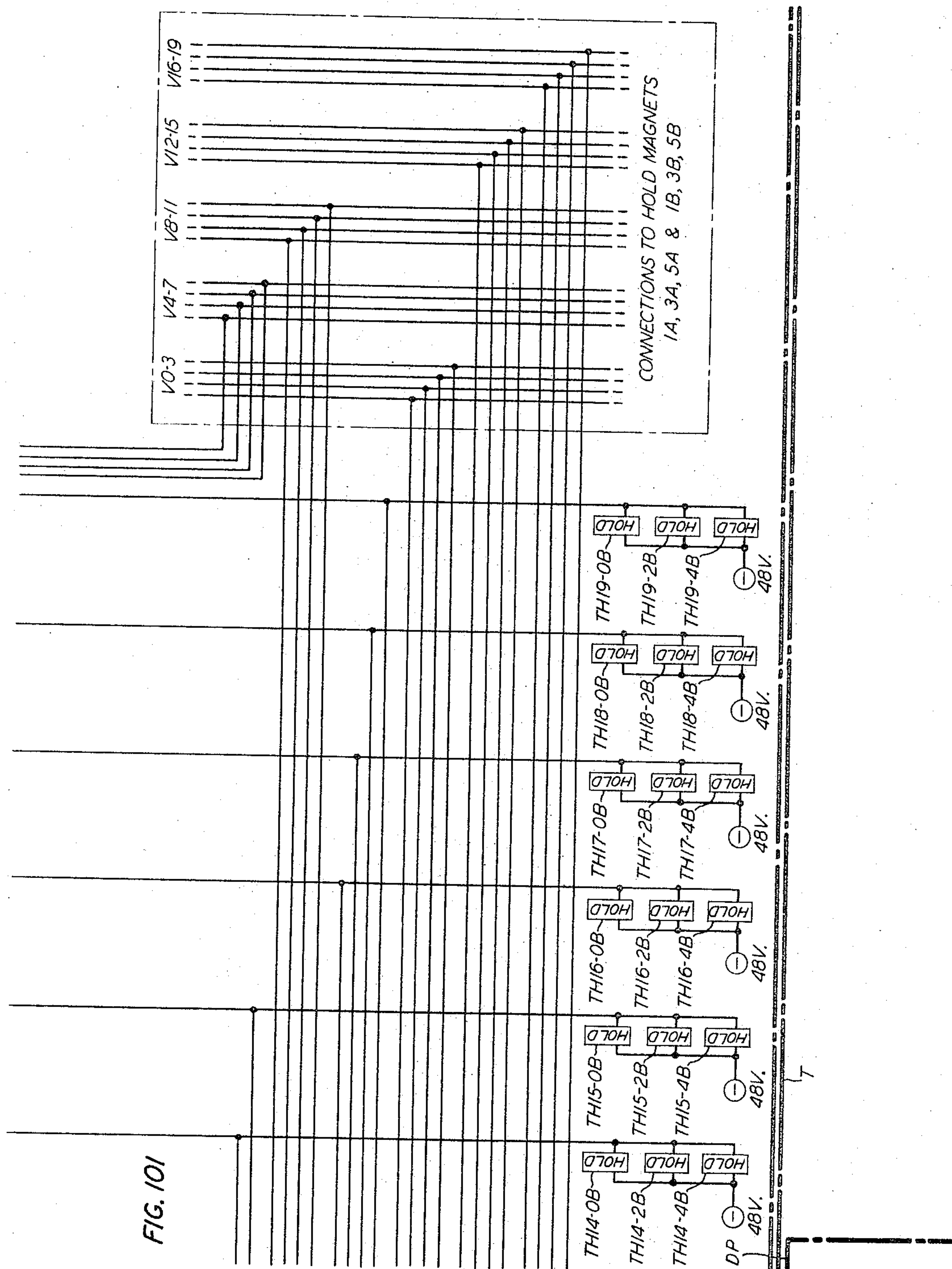
R. B. CURTIS

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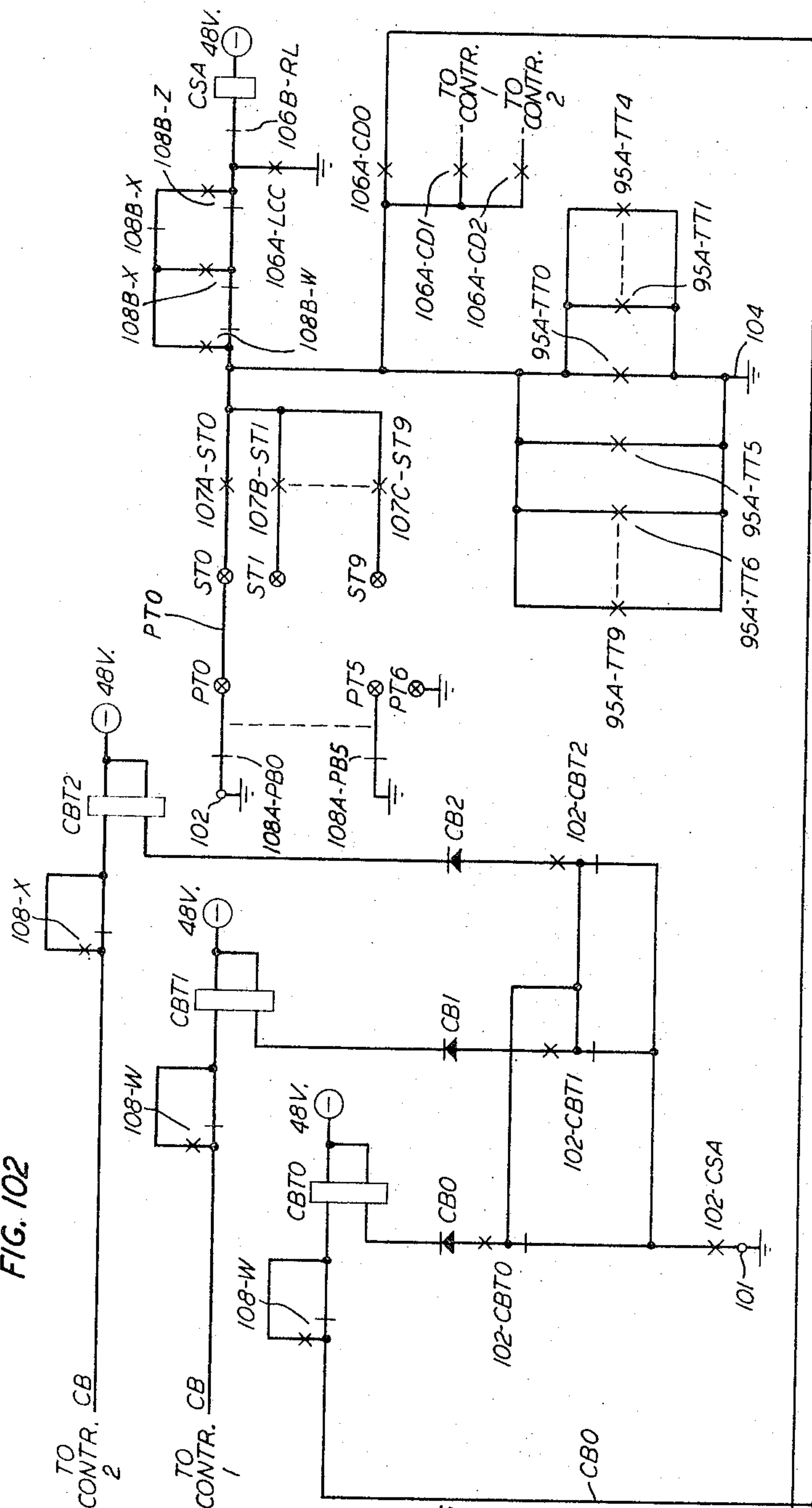
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FIG. 102





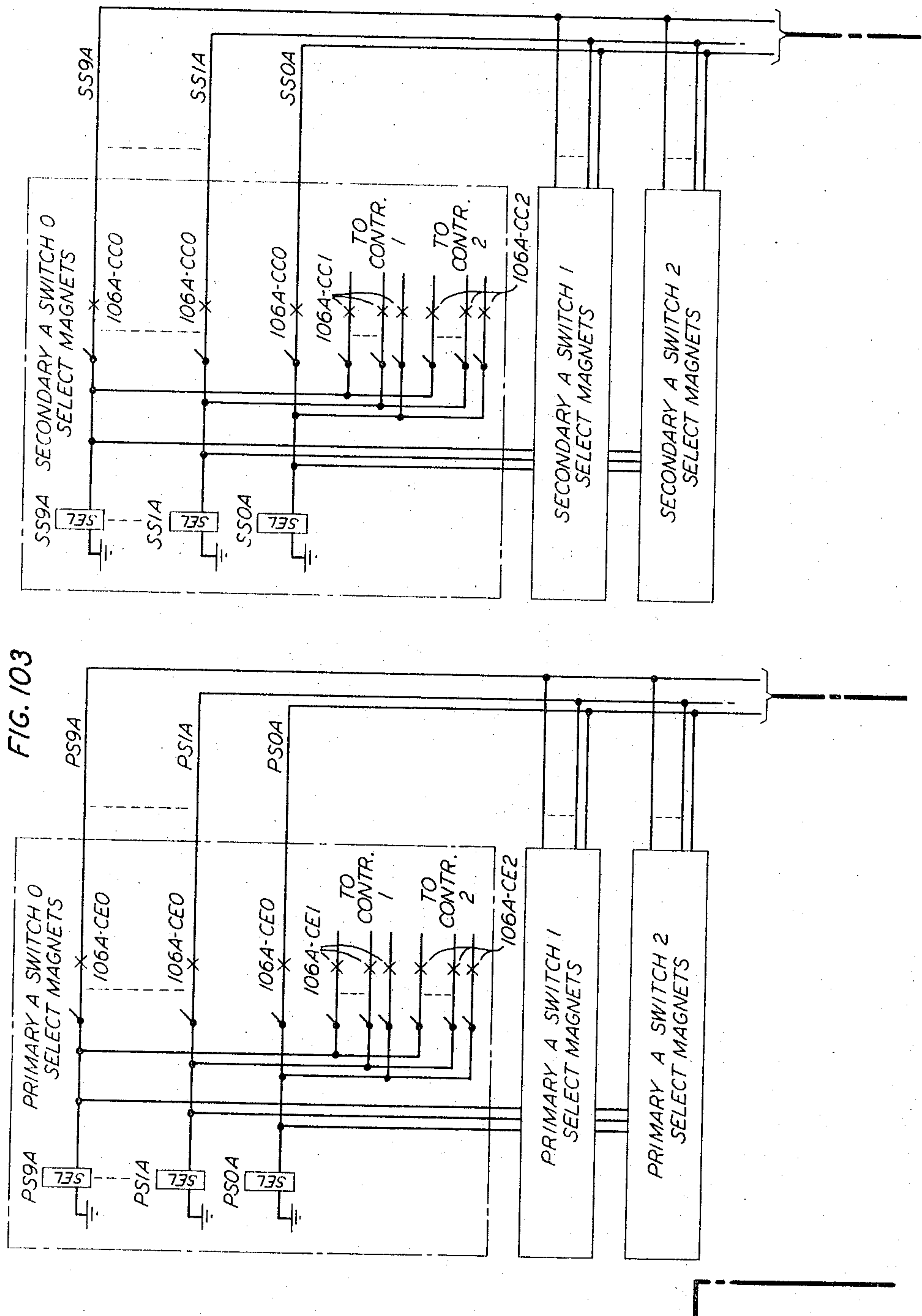
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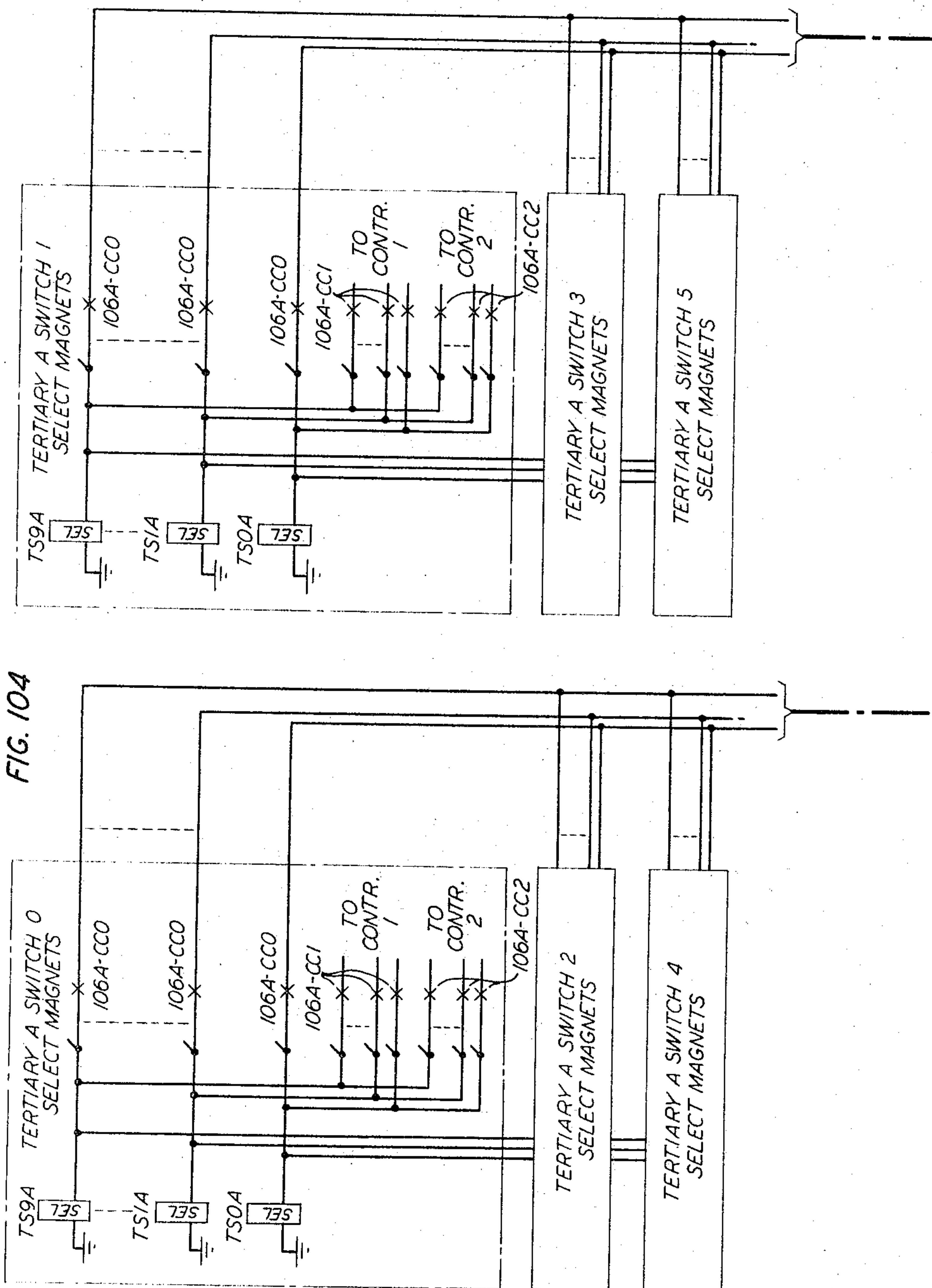
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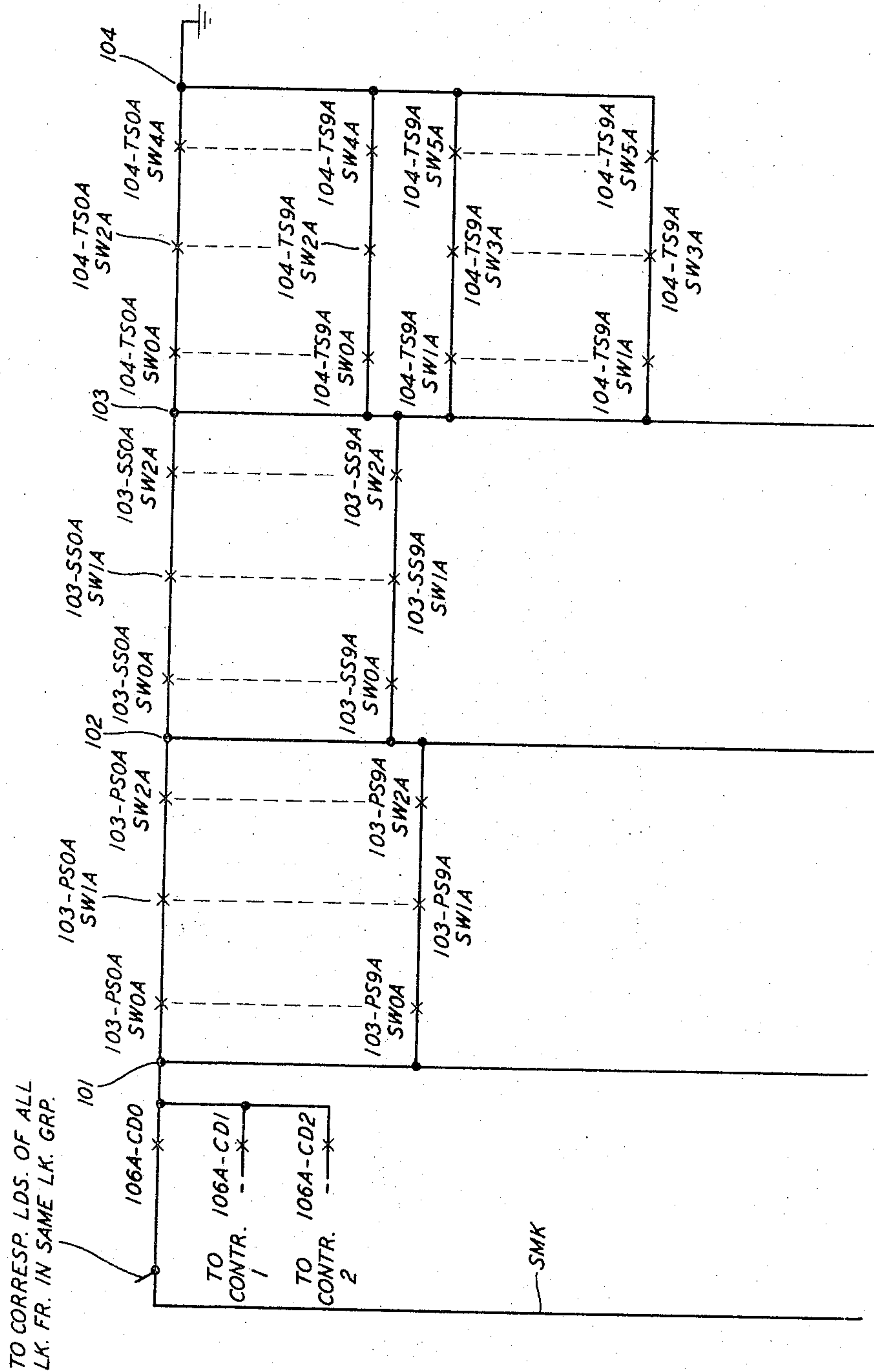
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FIG. 105





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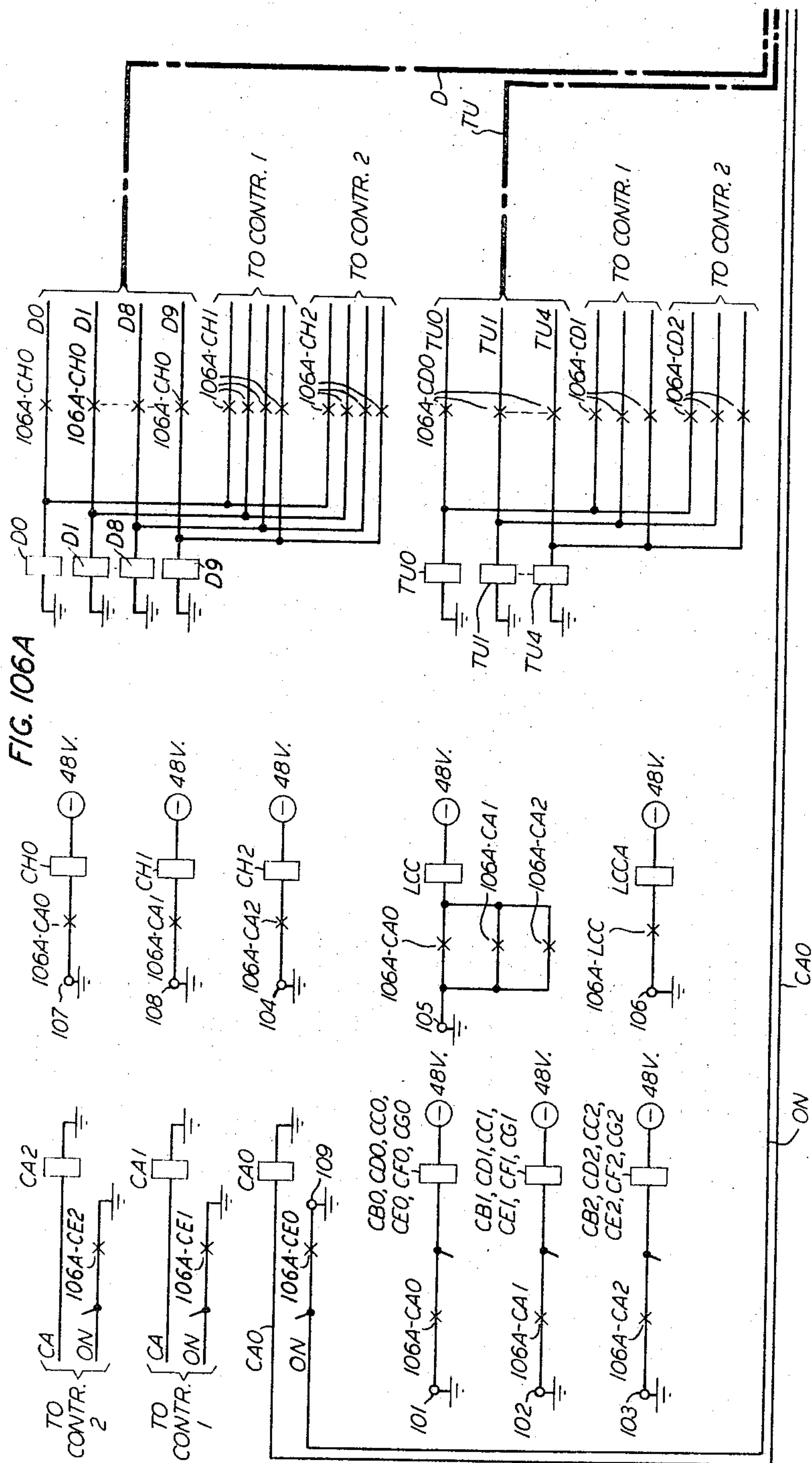
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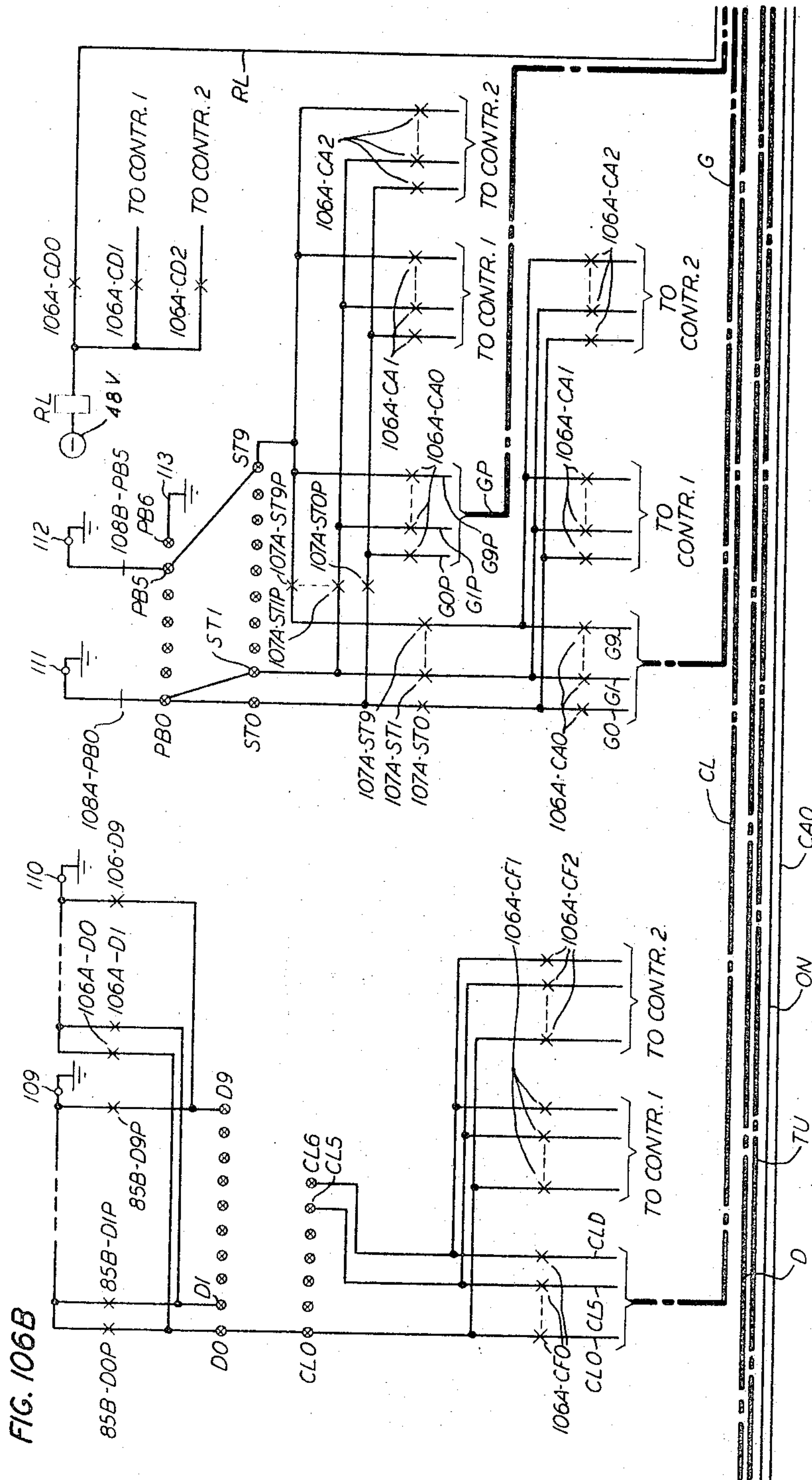
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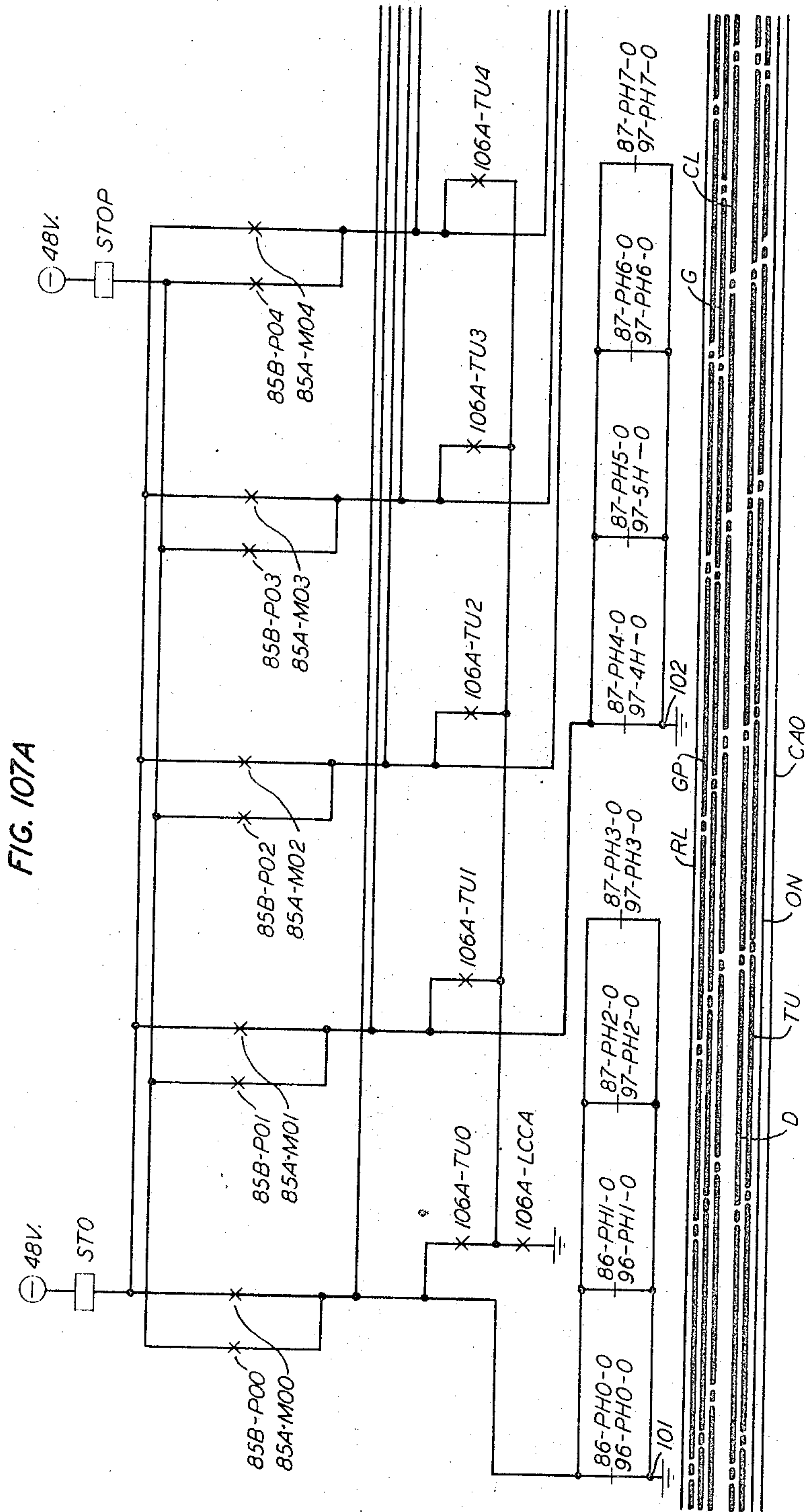
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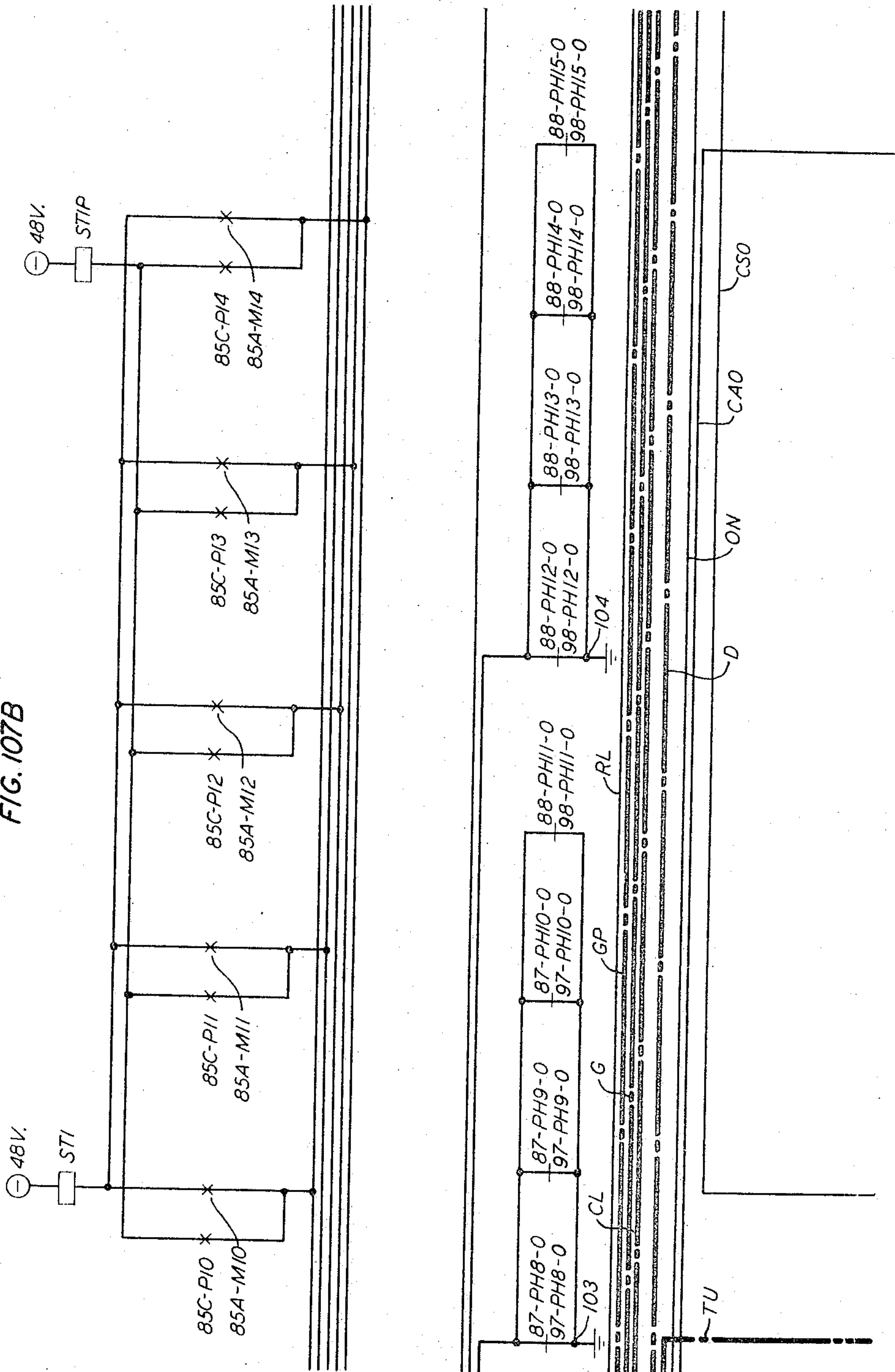
R. B. CURTIS

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FIG. 107B





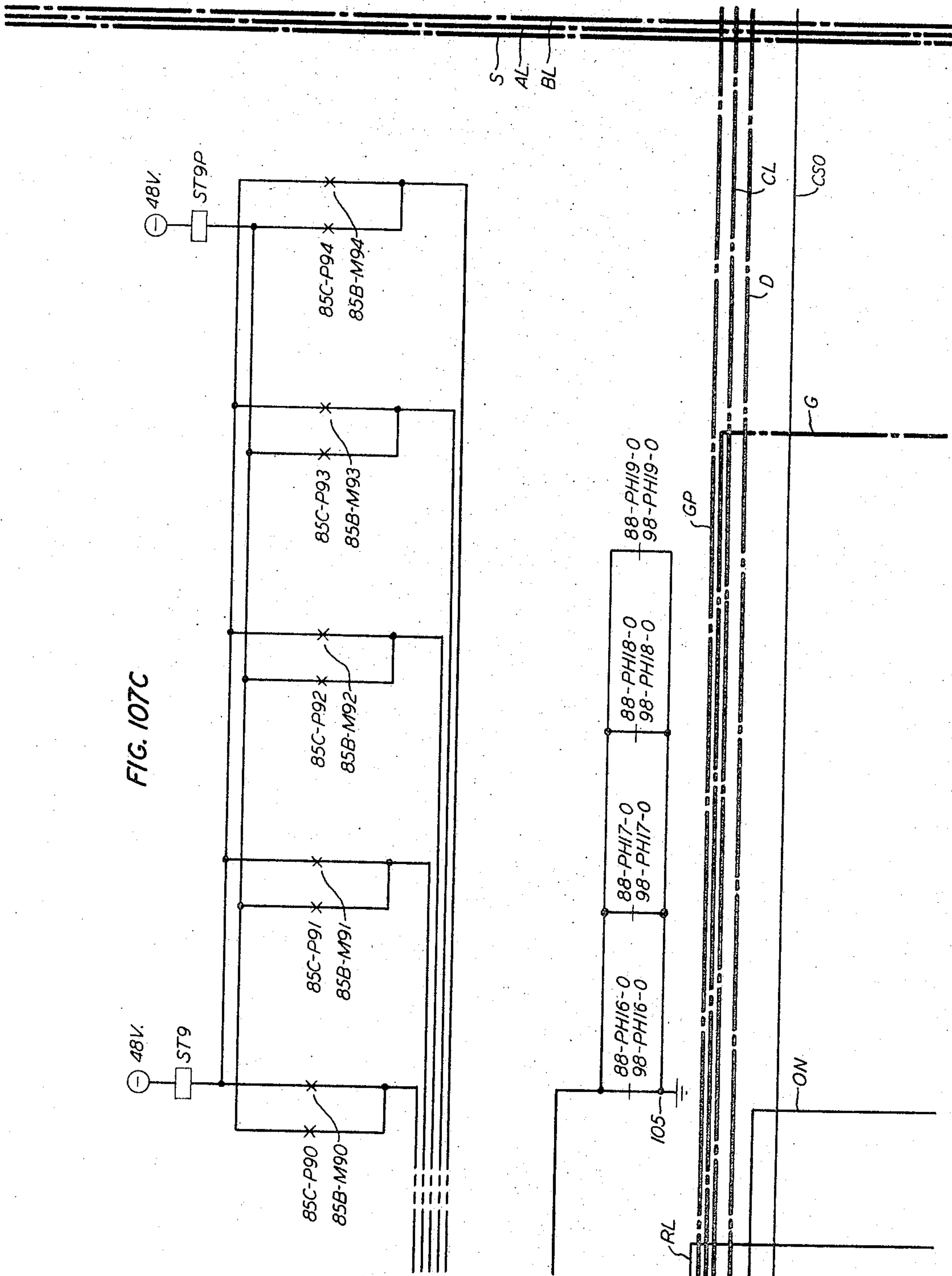
Sept. 12, 1967

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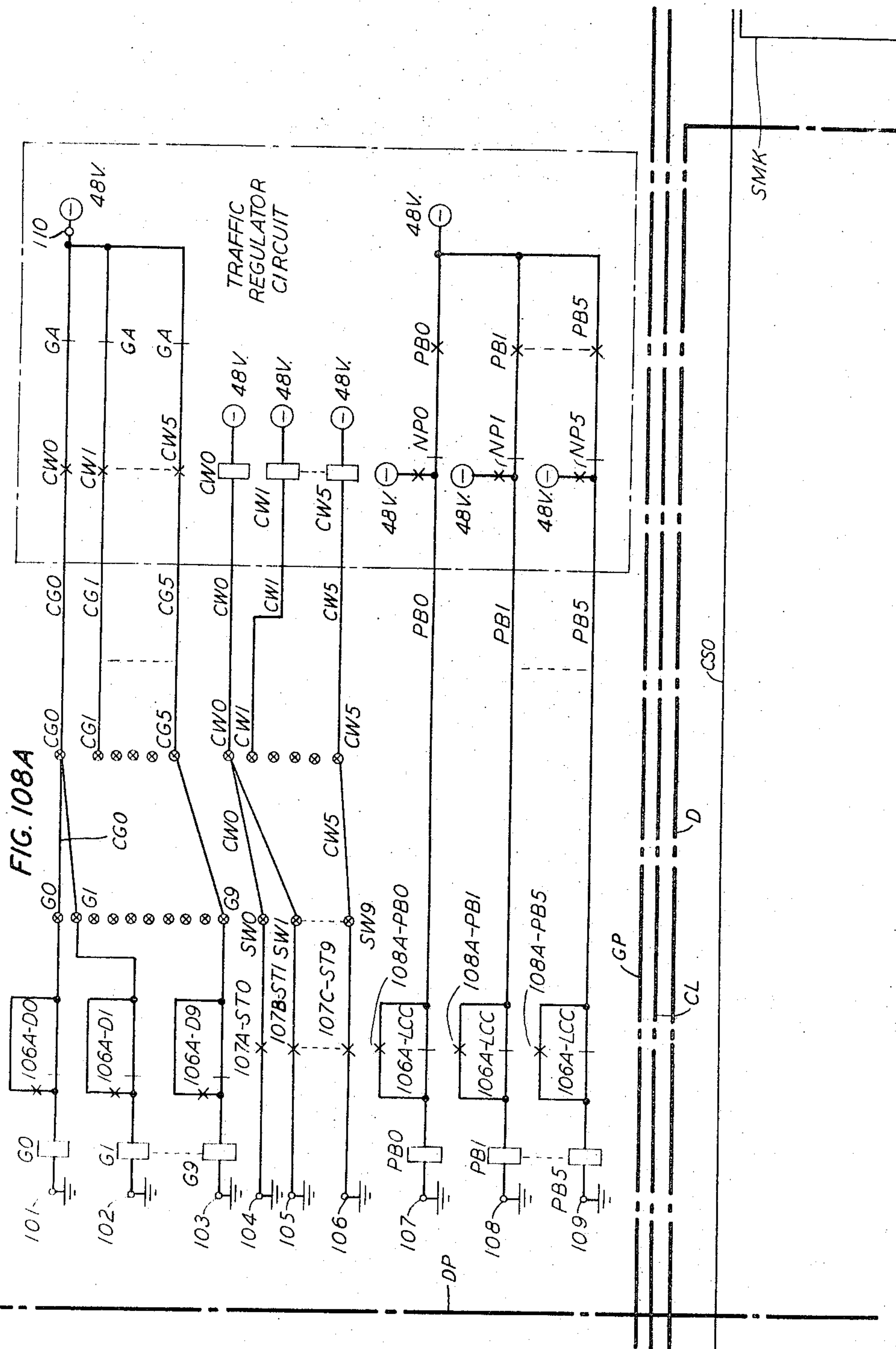
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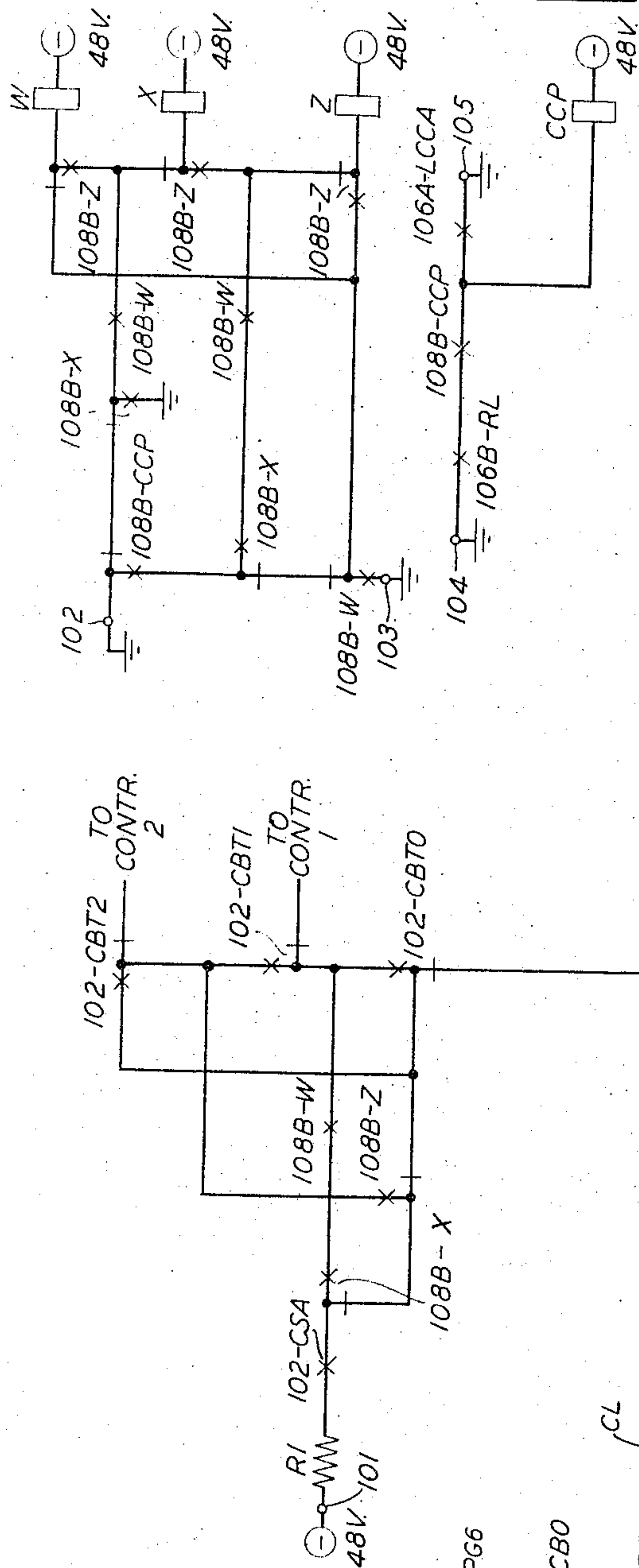
R. B. CURTIS  
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FIG. 108B





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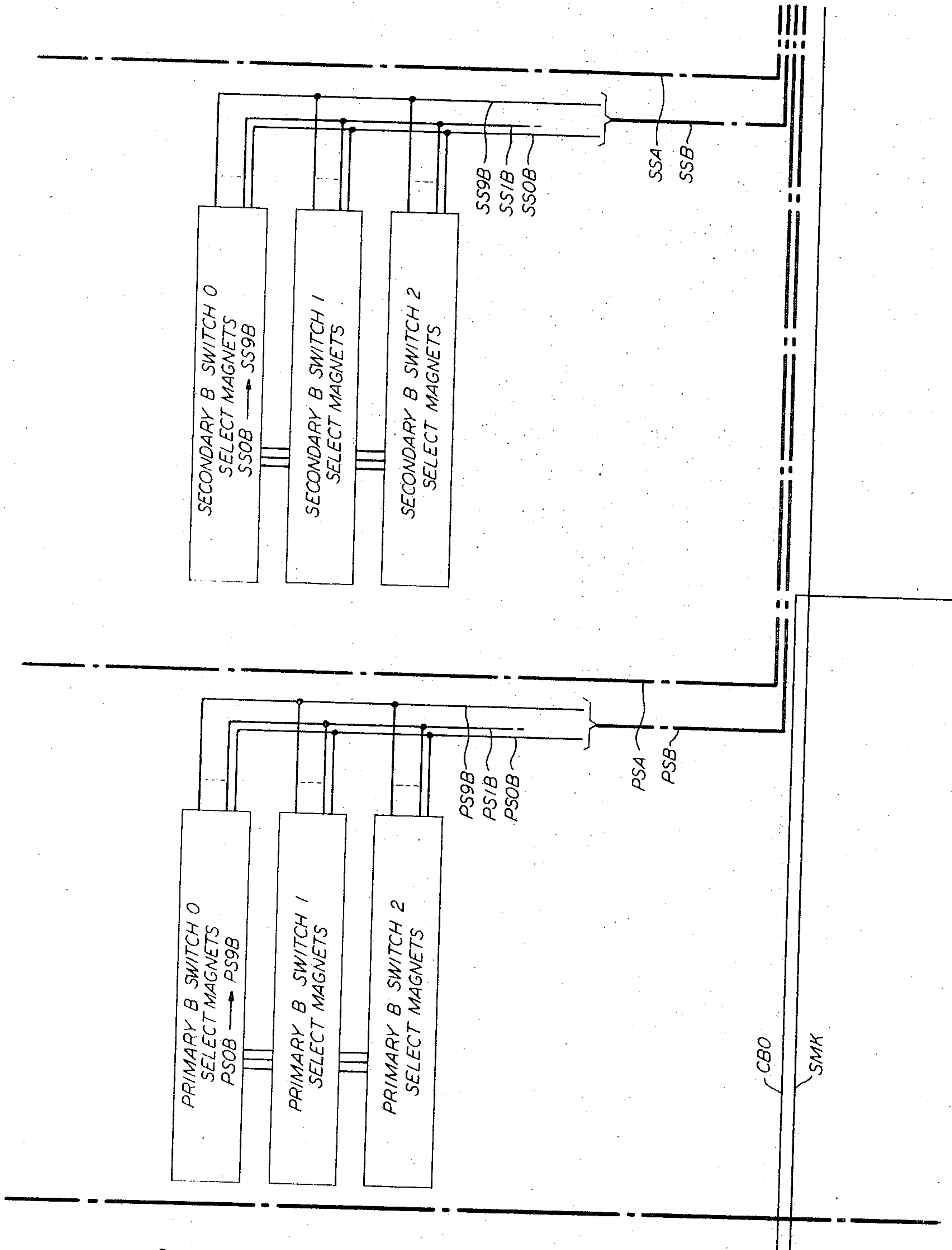


FIG. 109



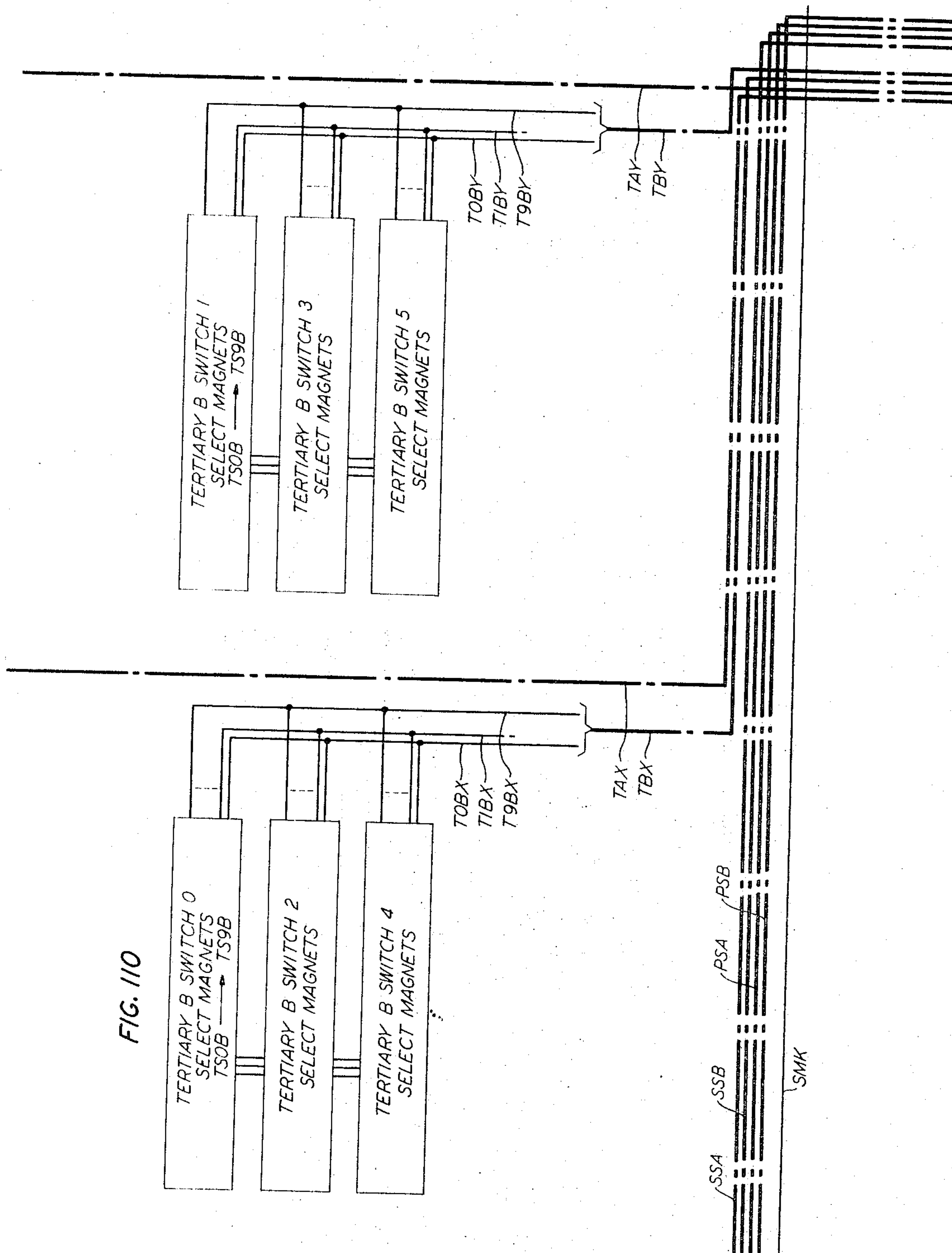
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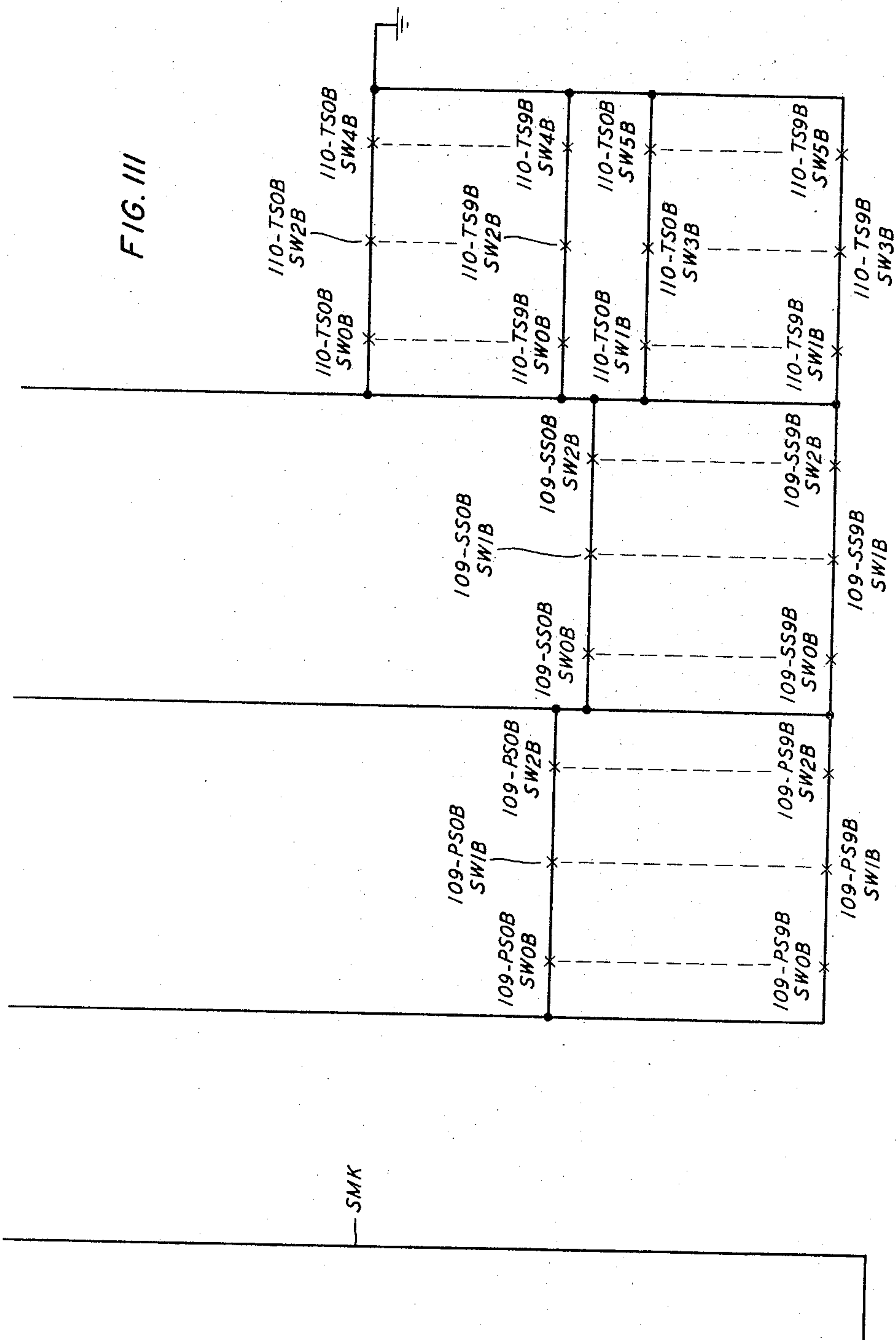
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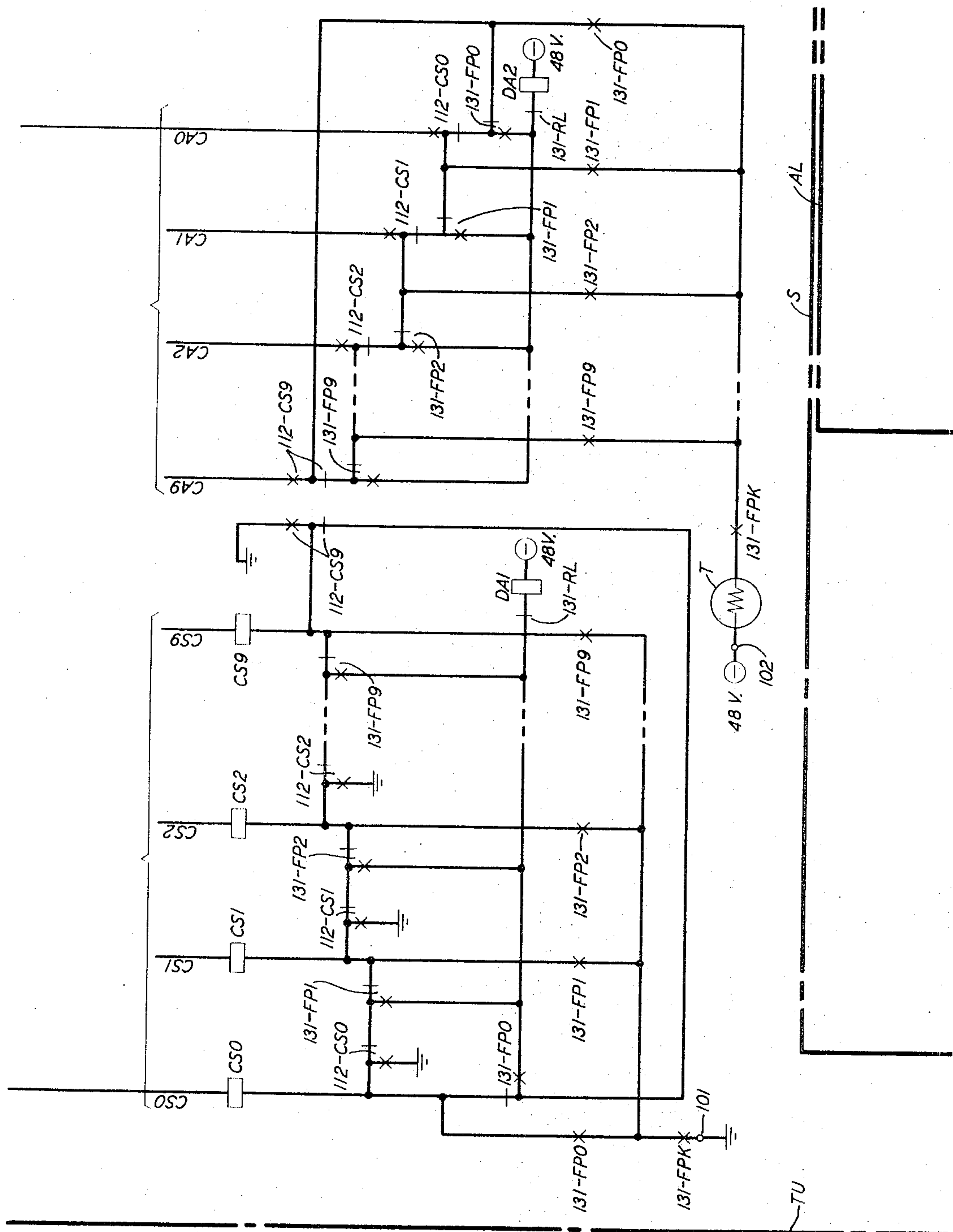


FIG. 112



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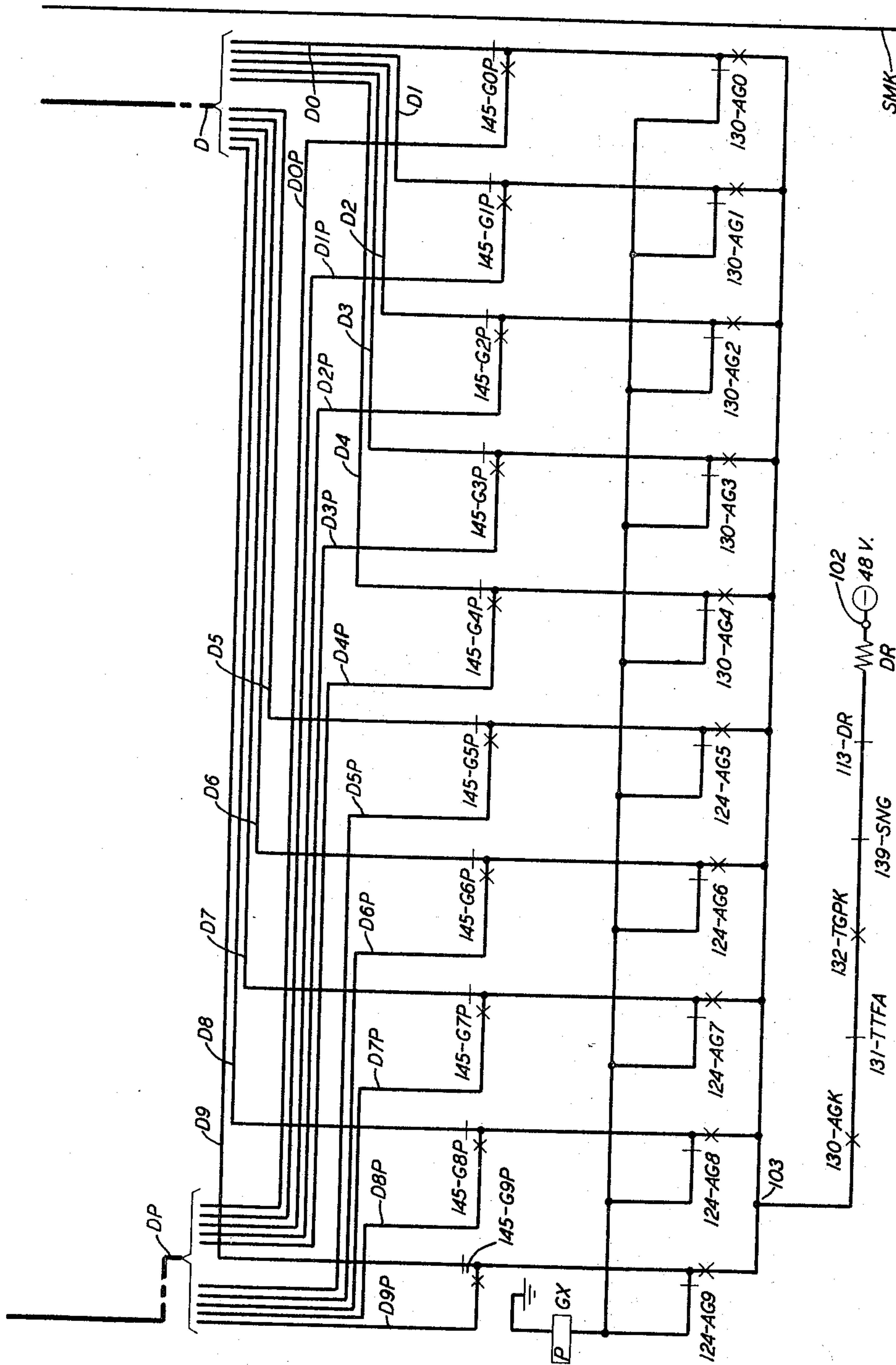


FIG. 114



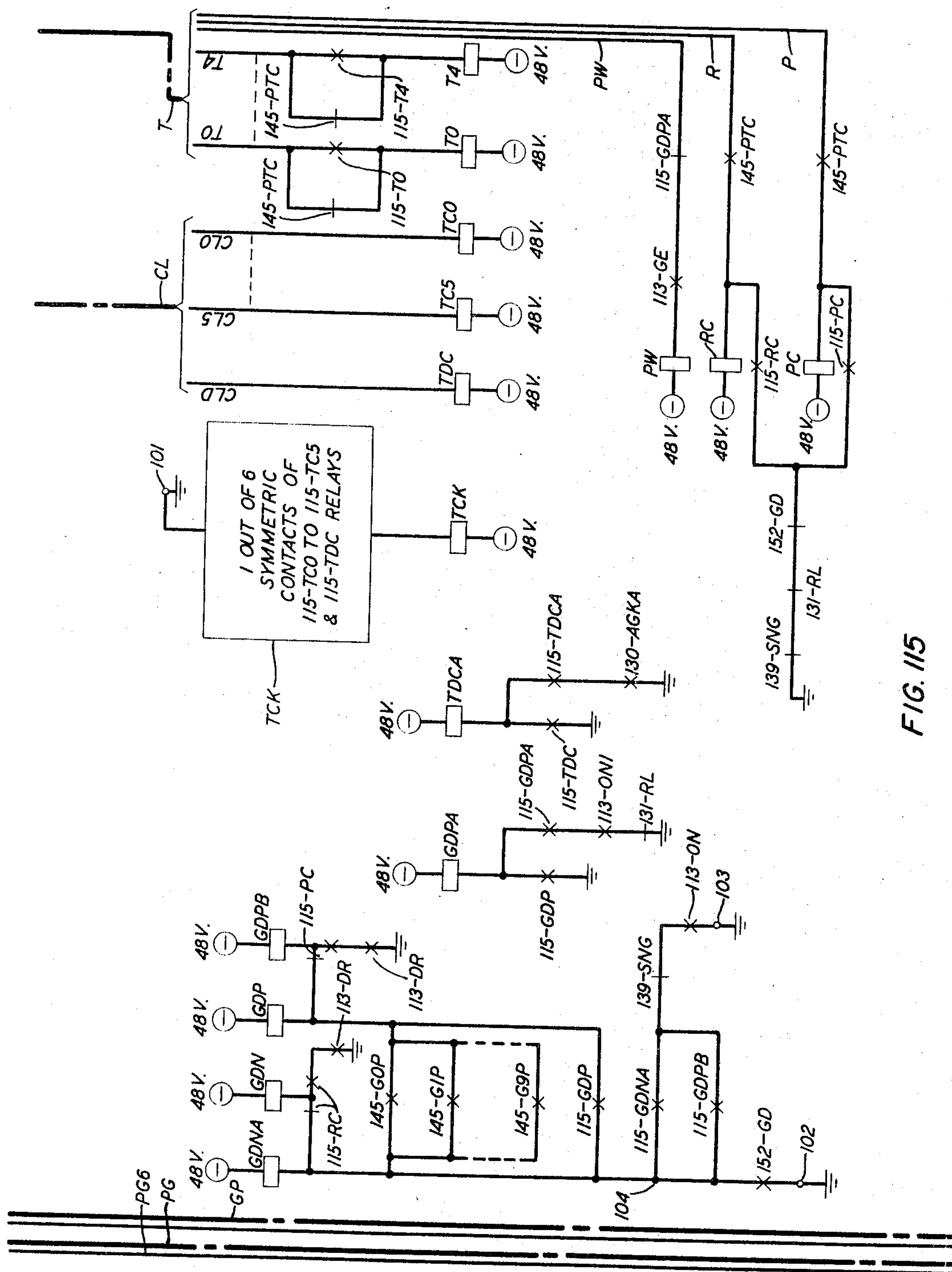
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**FIG. 115**



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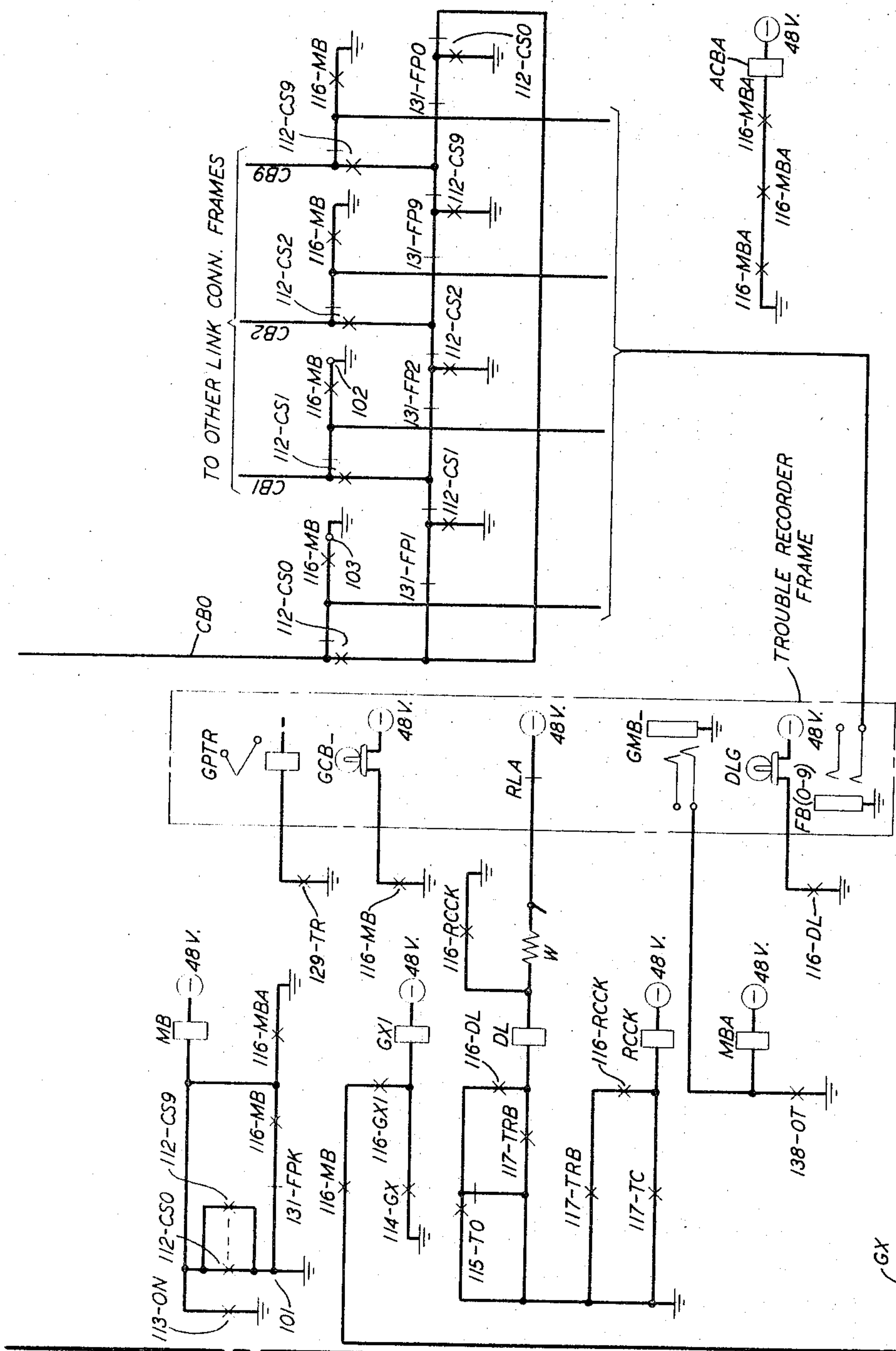


FIG. 116



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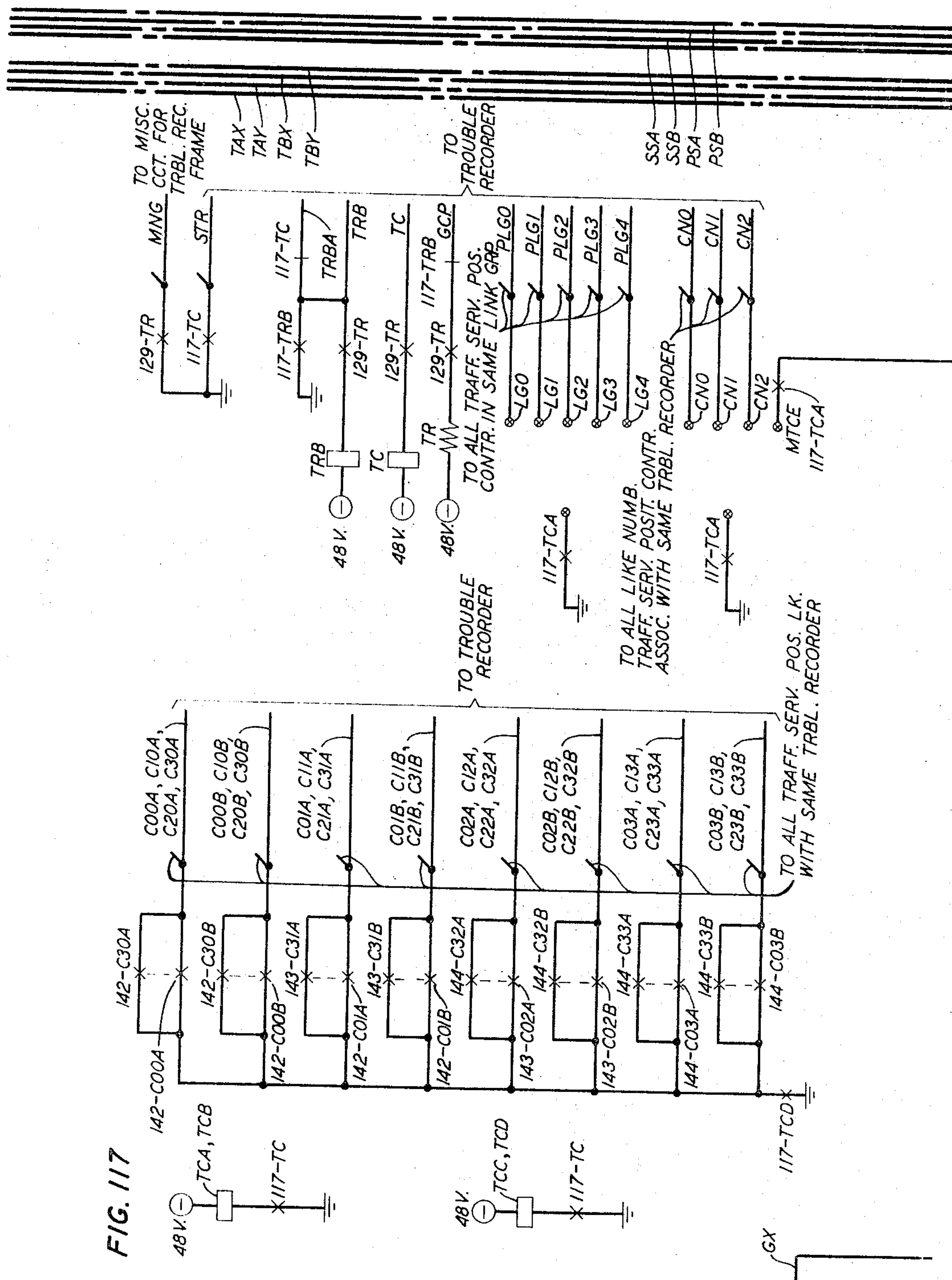
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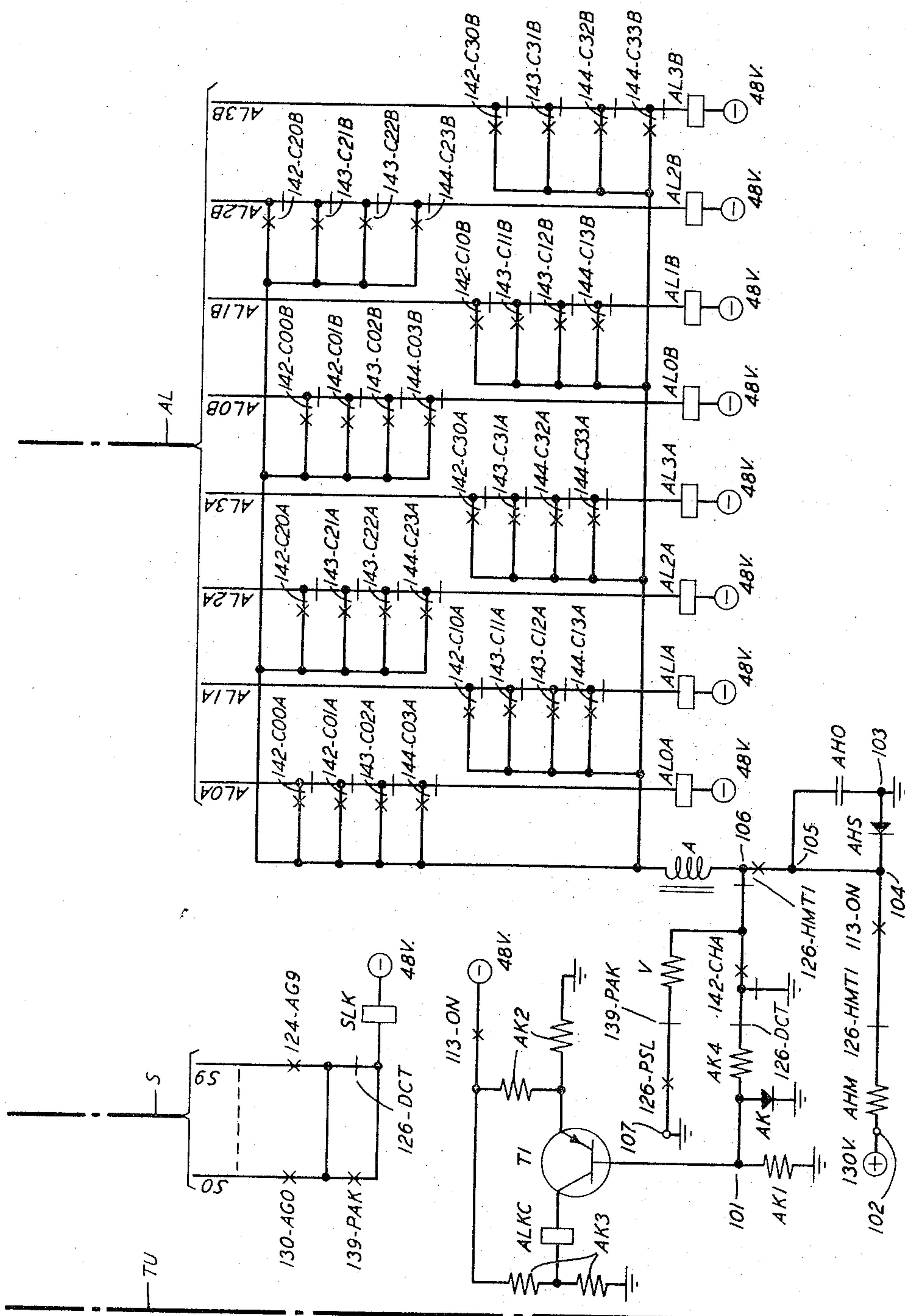


FIG. 118



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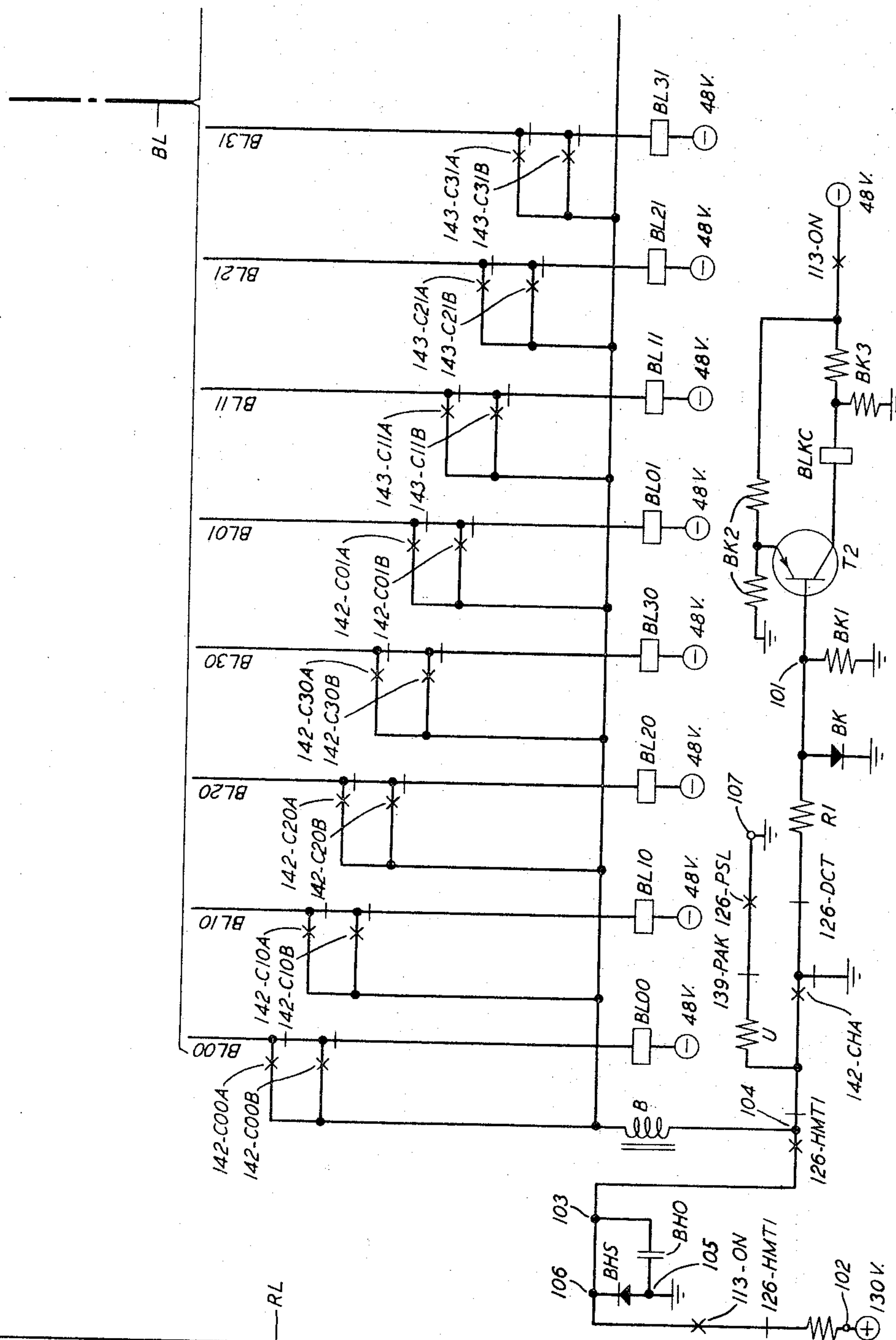


FIG. 119



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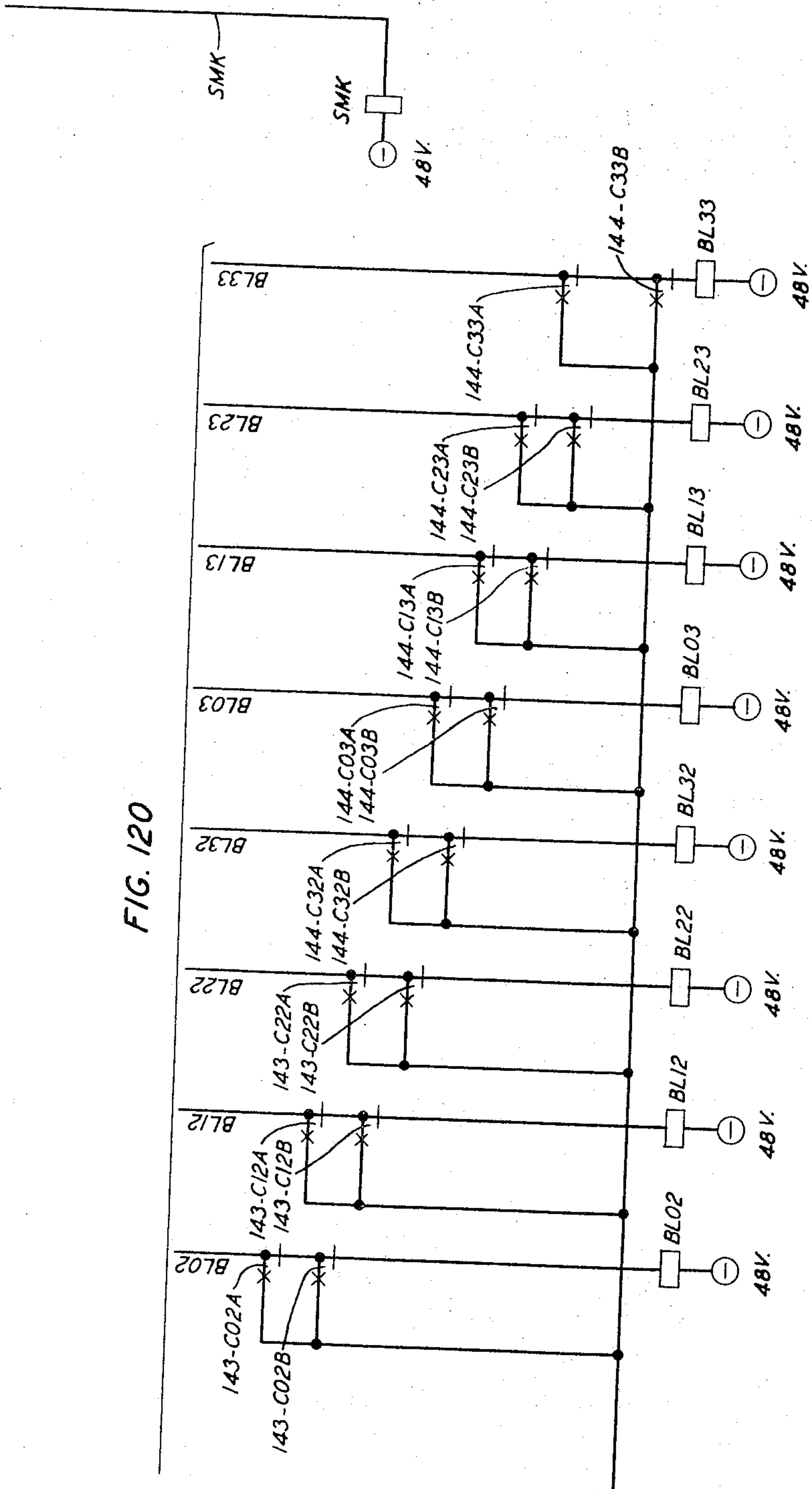
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EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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FIG. 120





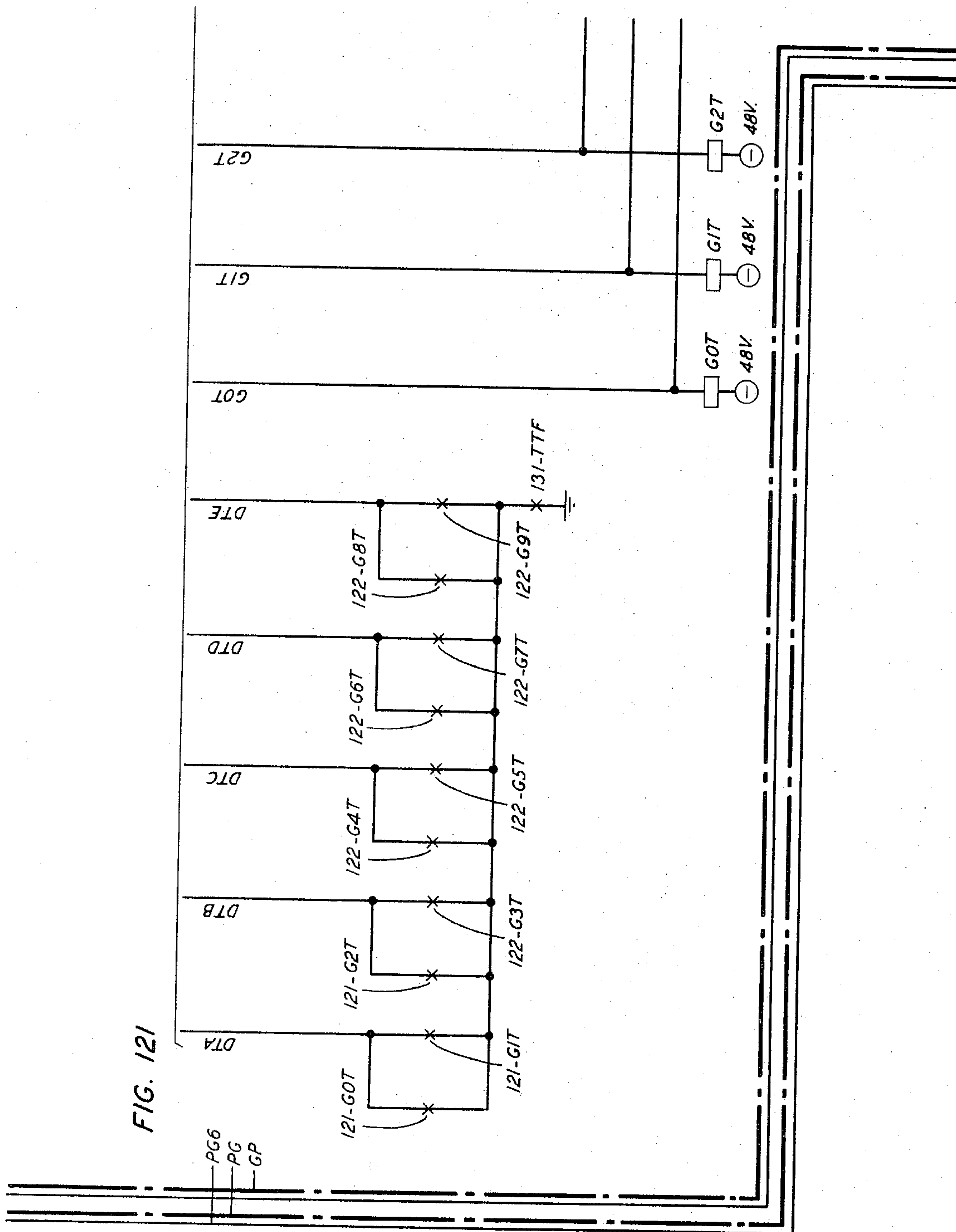
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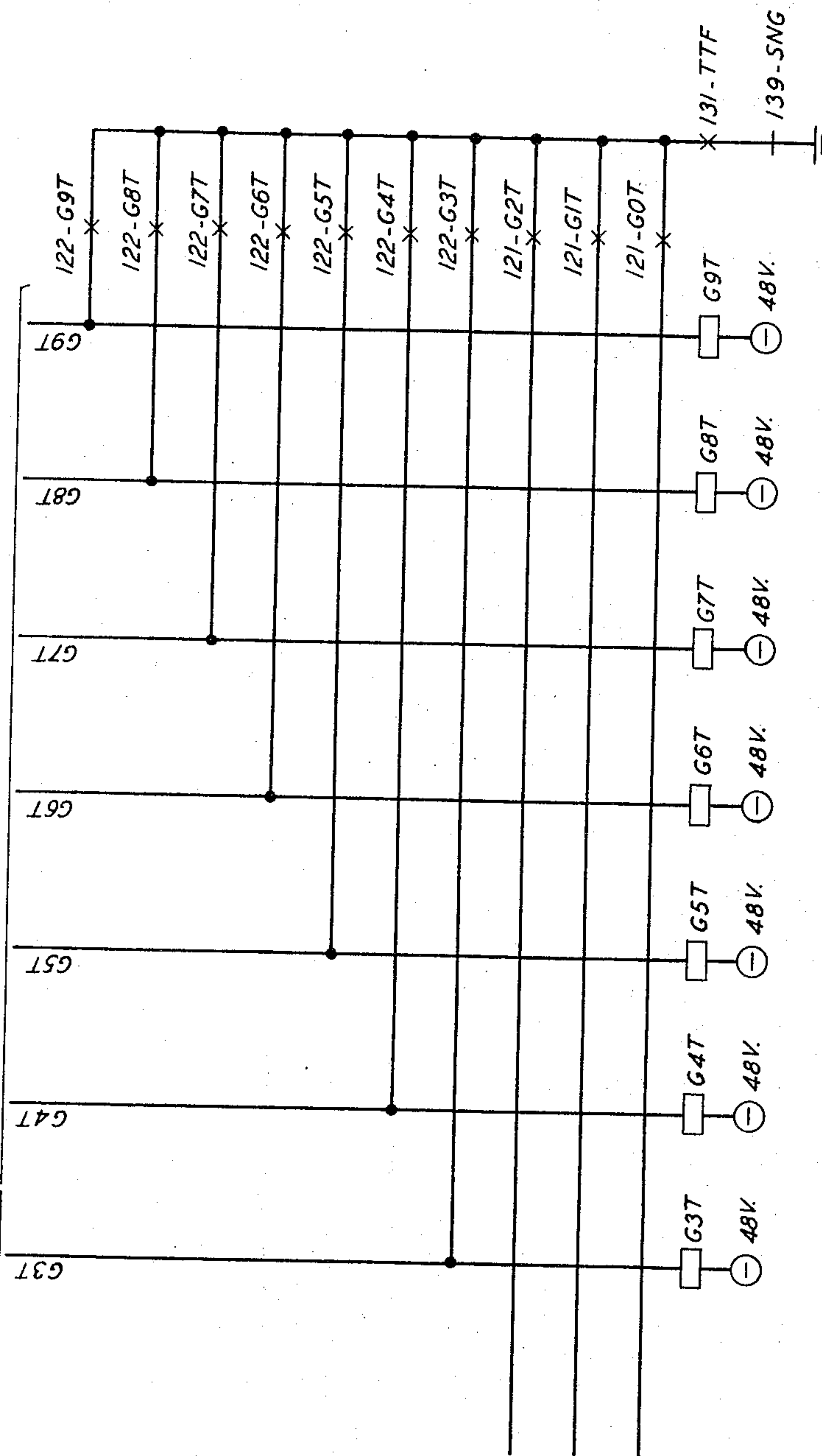
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FIG. 122





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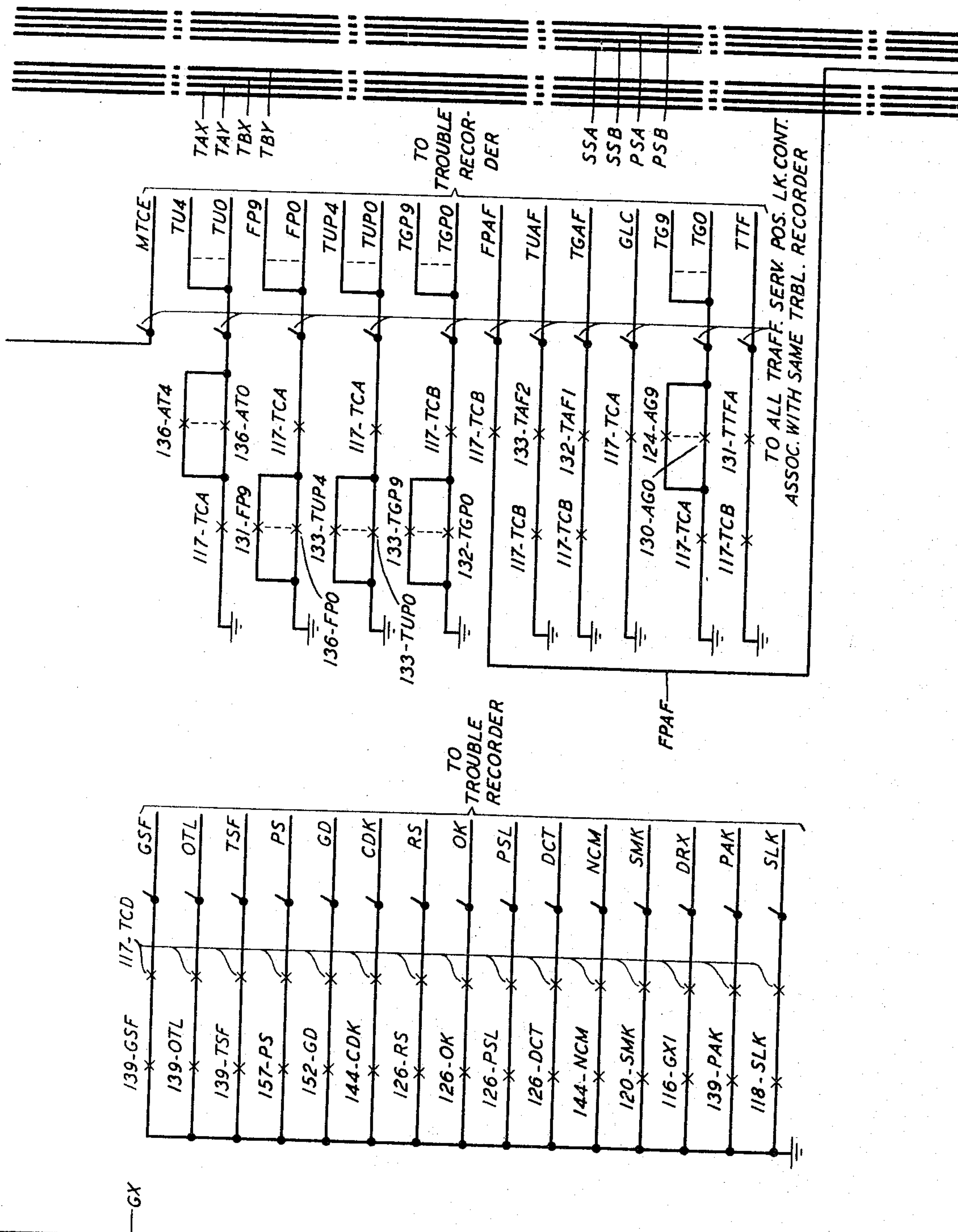


FIG. 123



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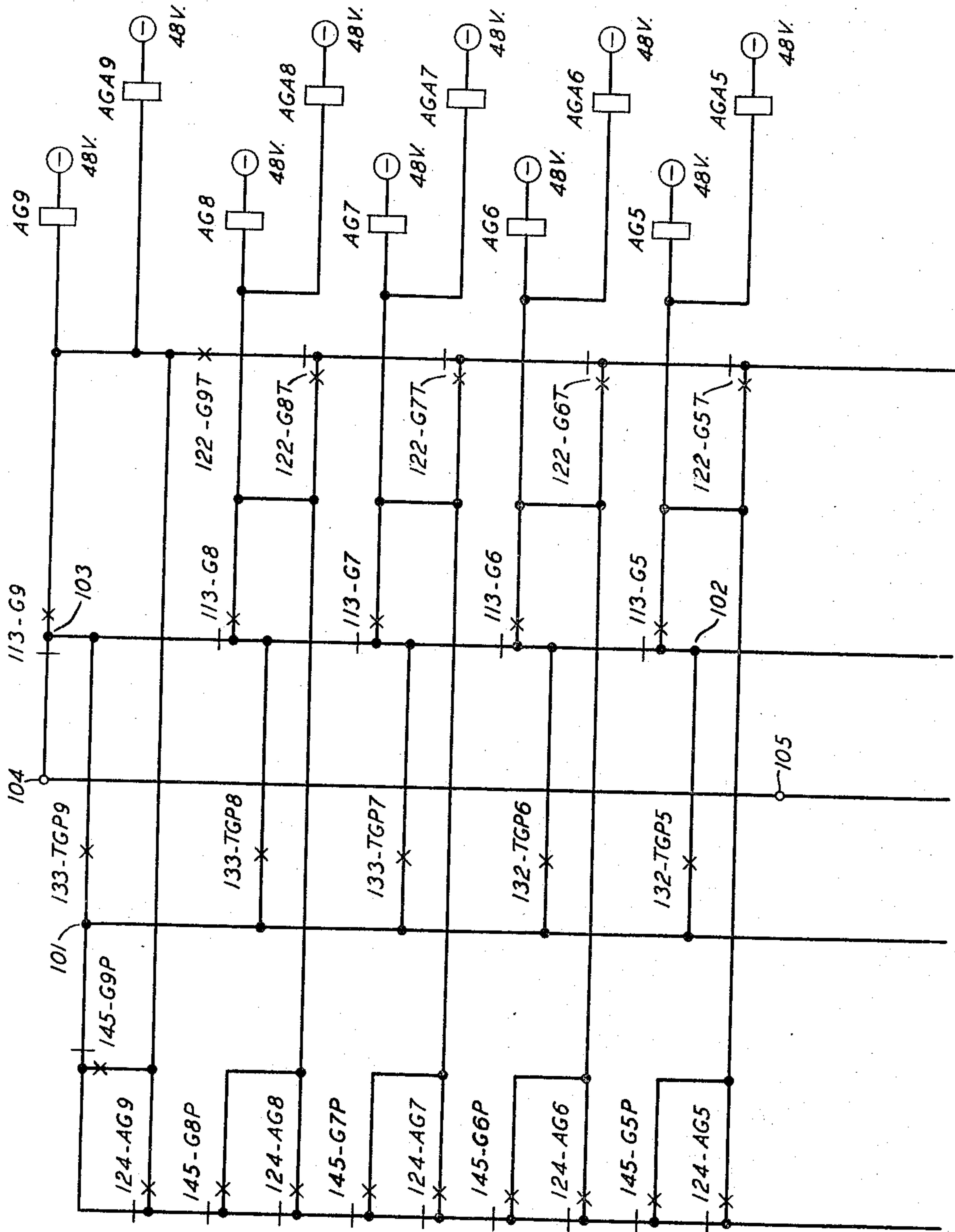
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FIG. 124



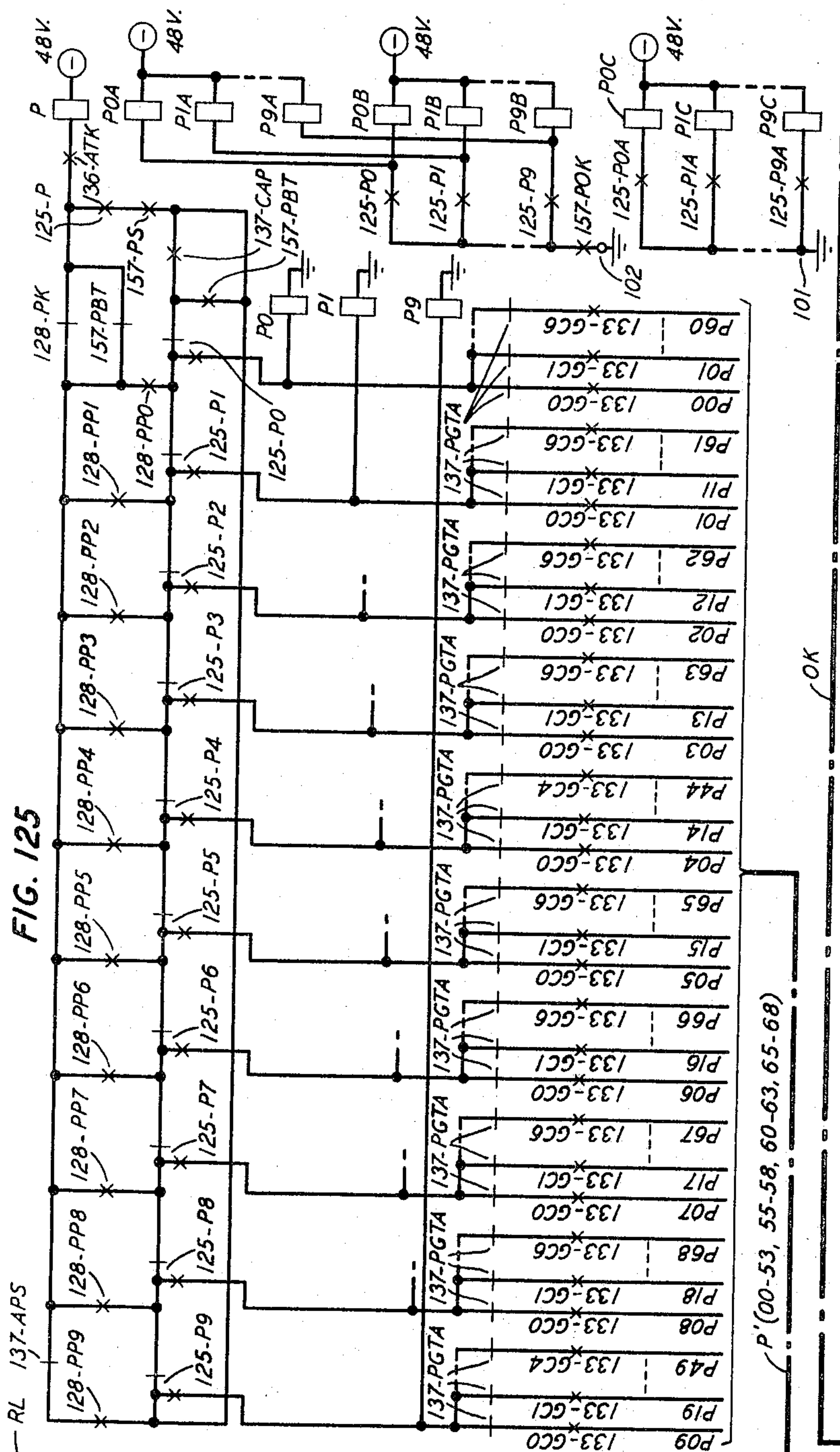


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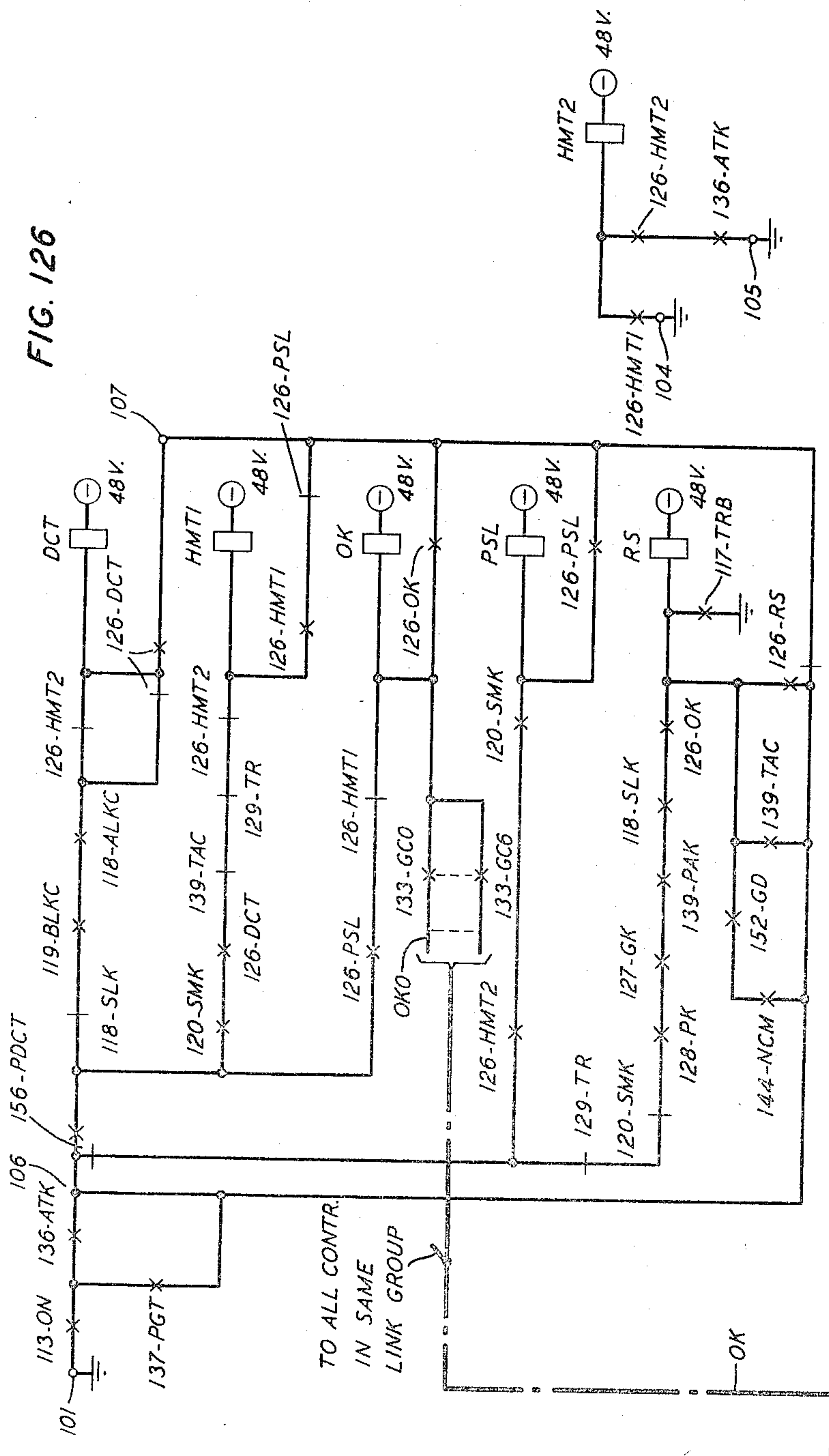
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FIG. 126





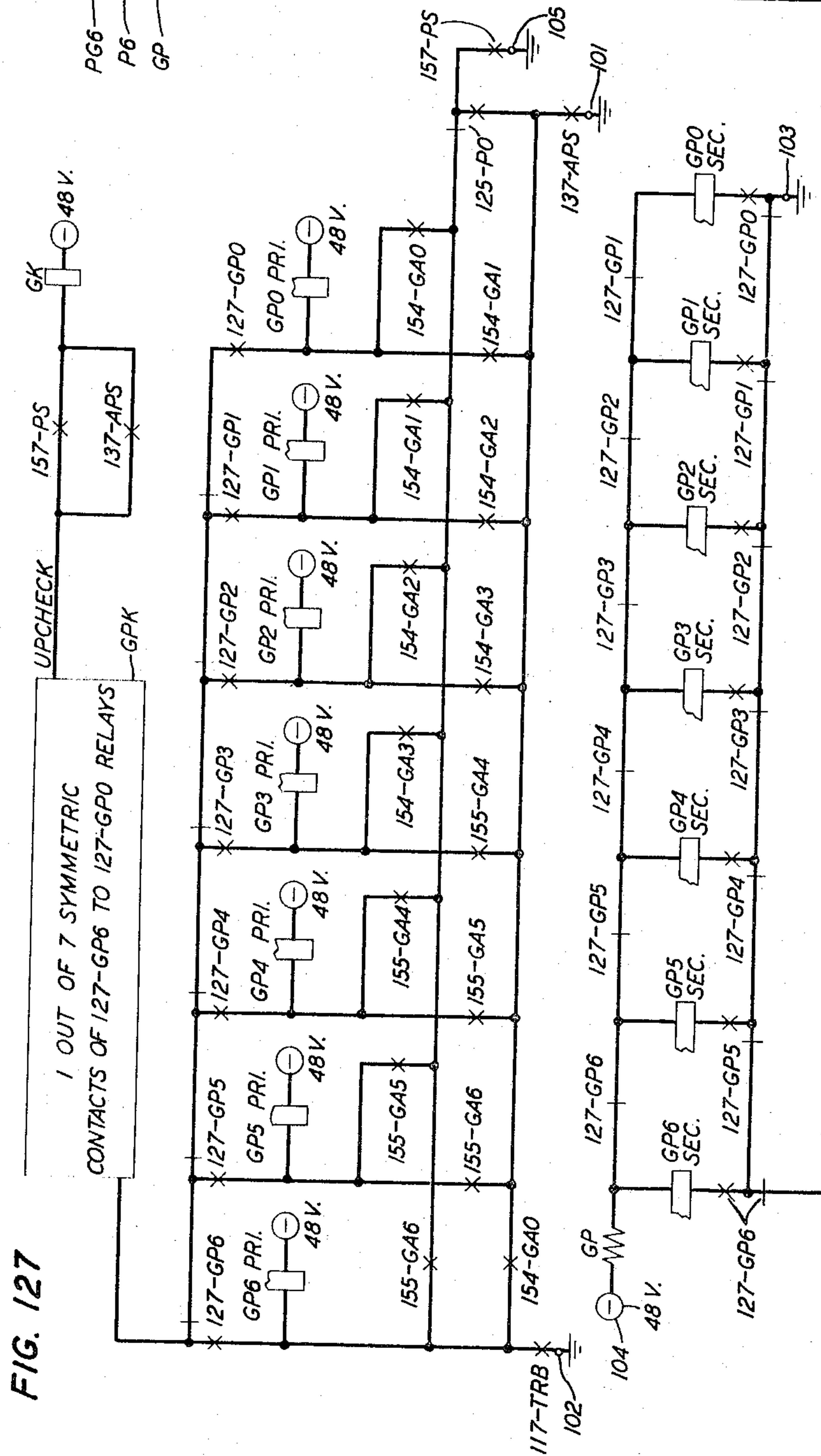
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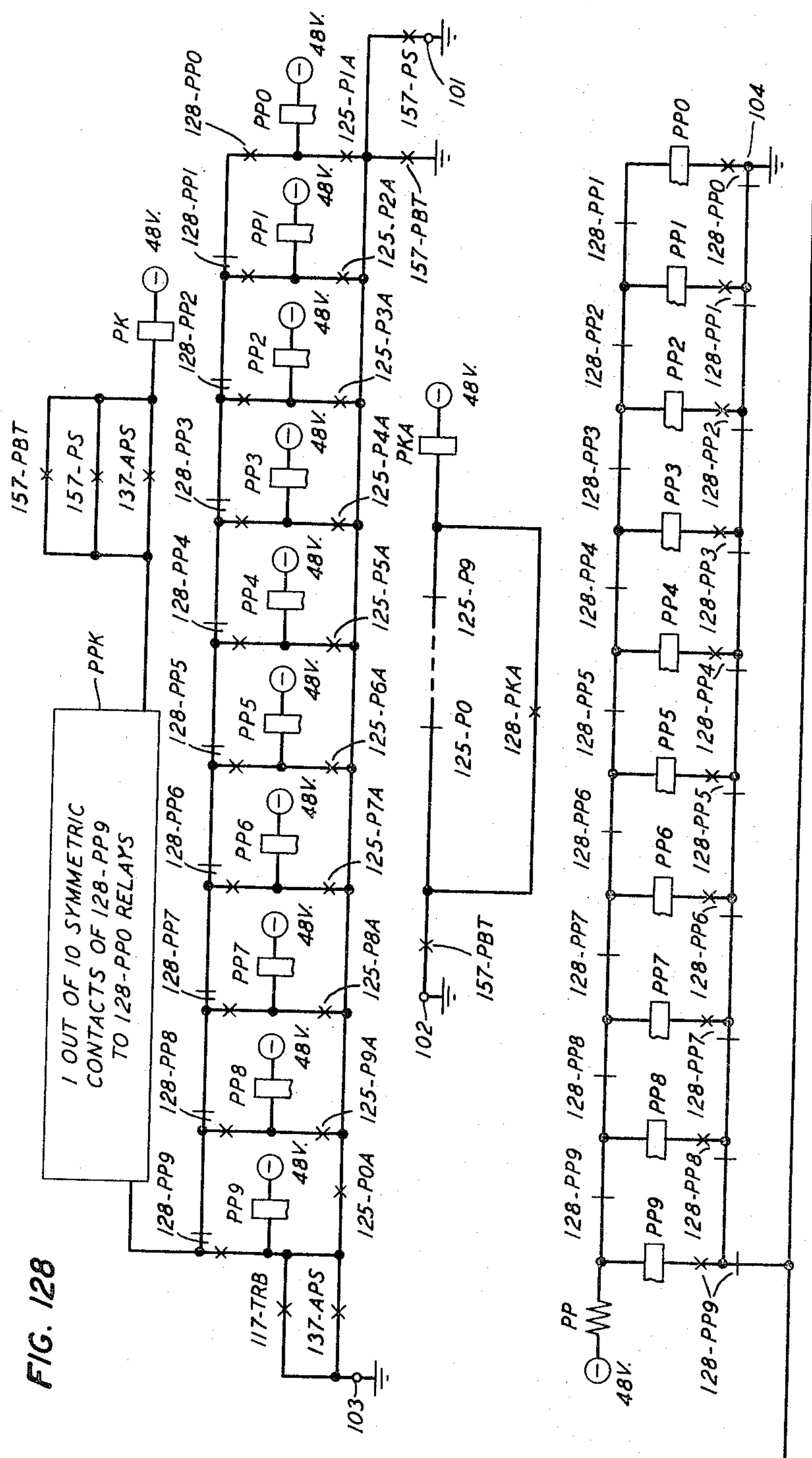
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FIG. 128





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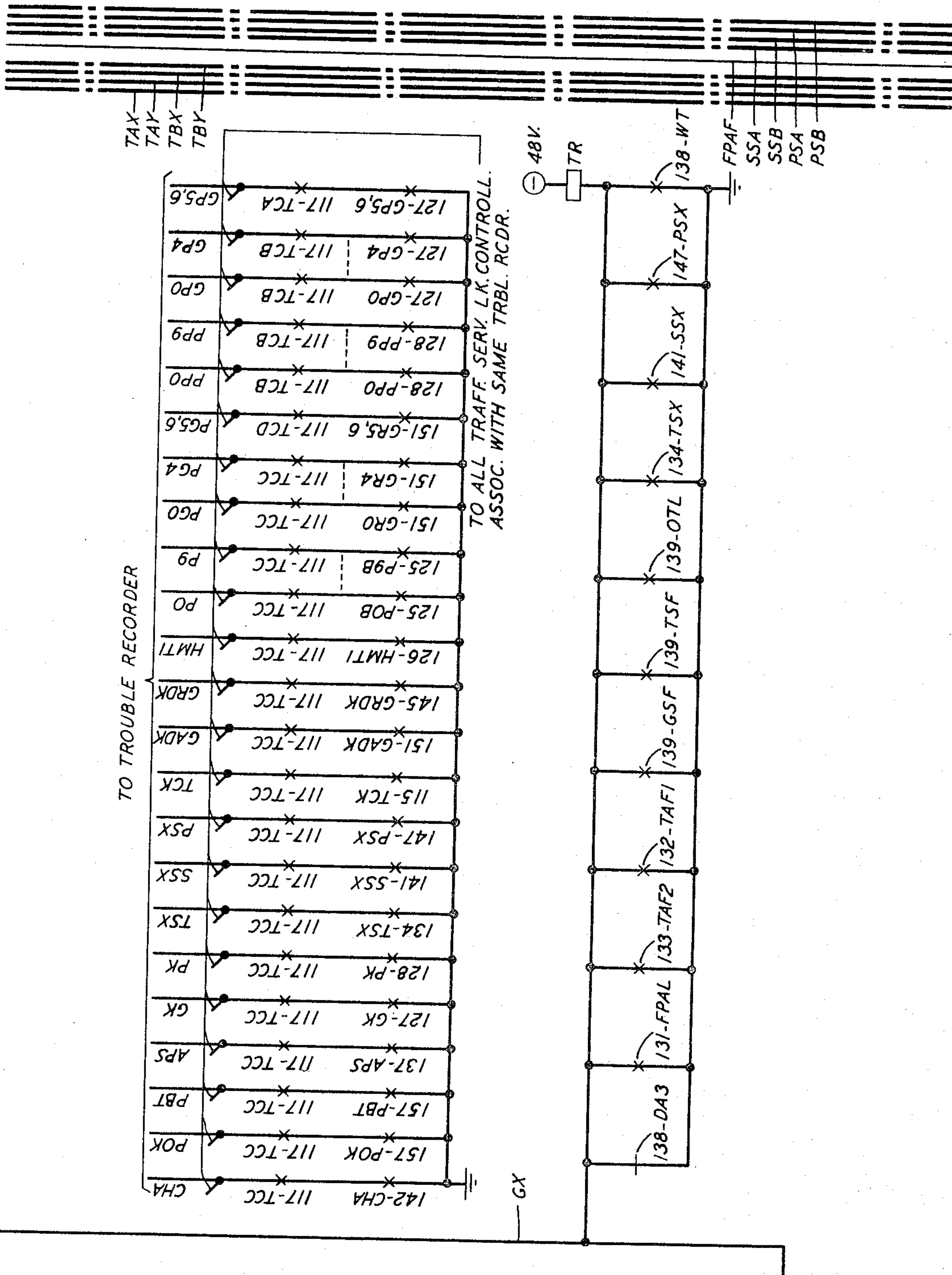


FIG. 129



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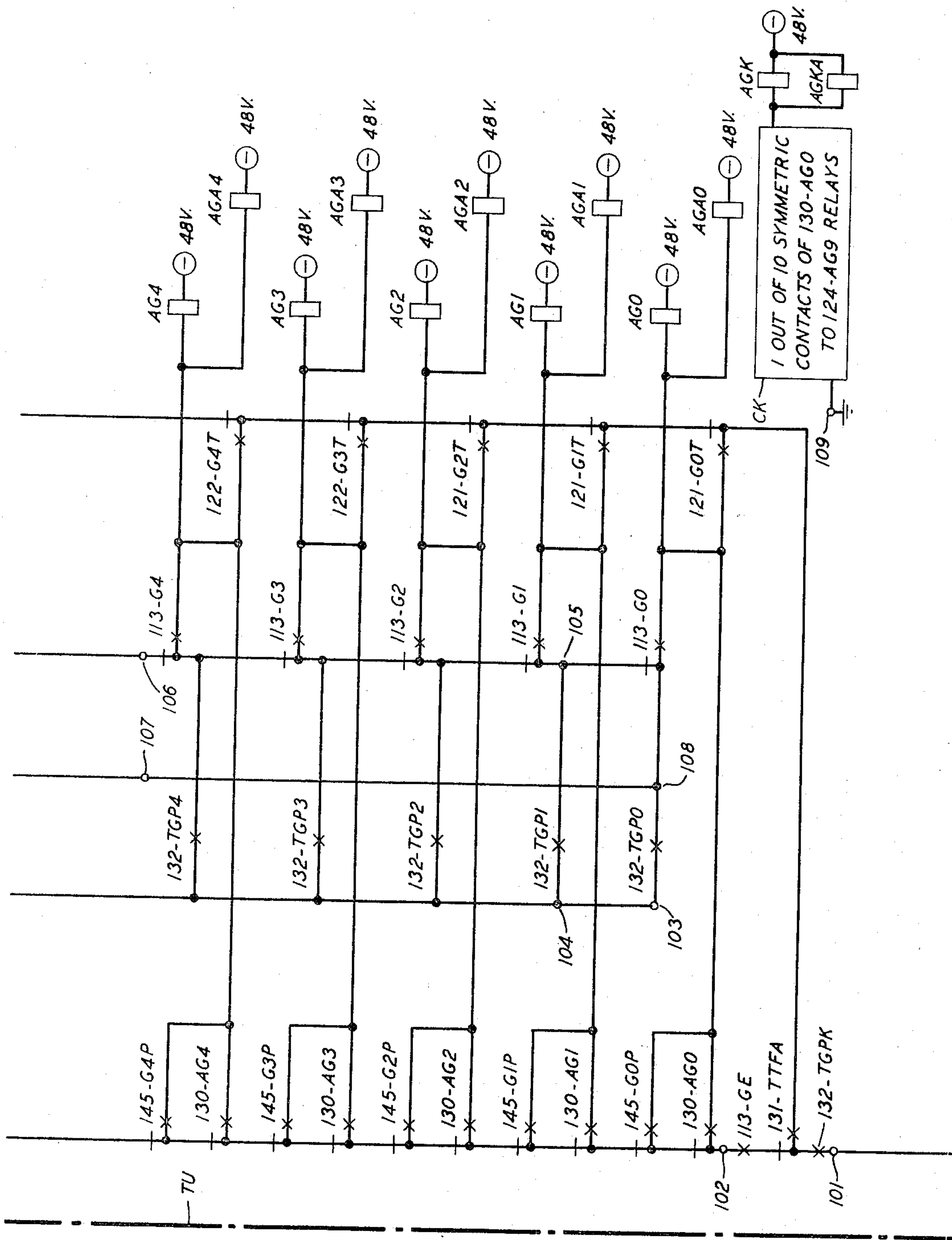


FIG. 130



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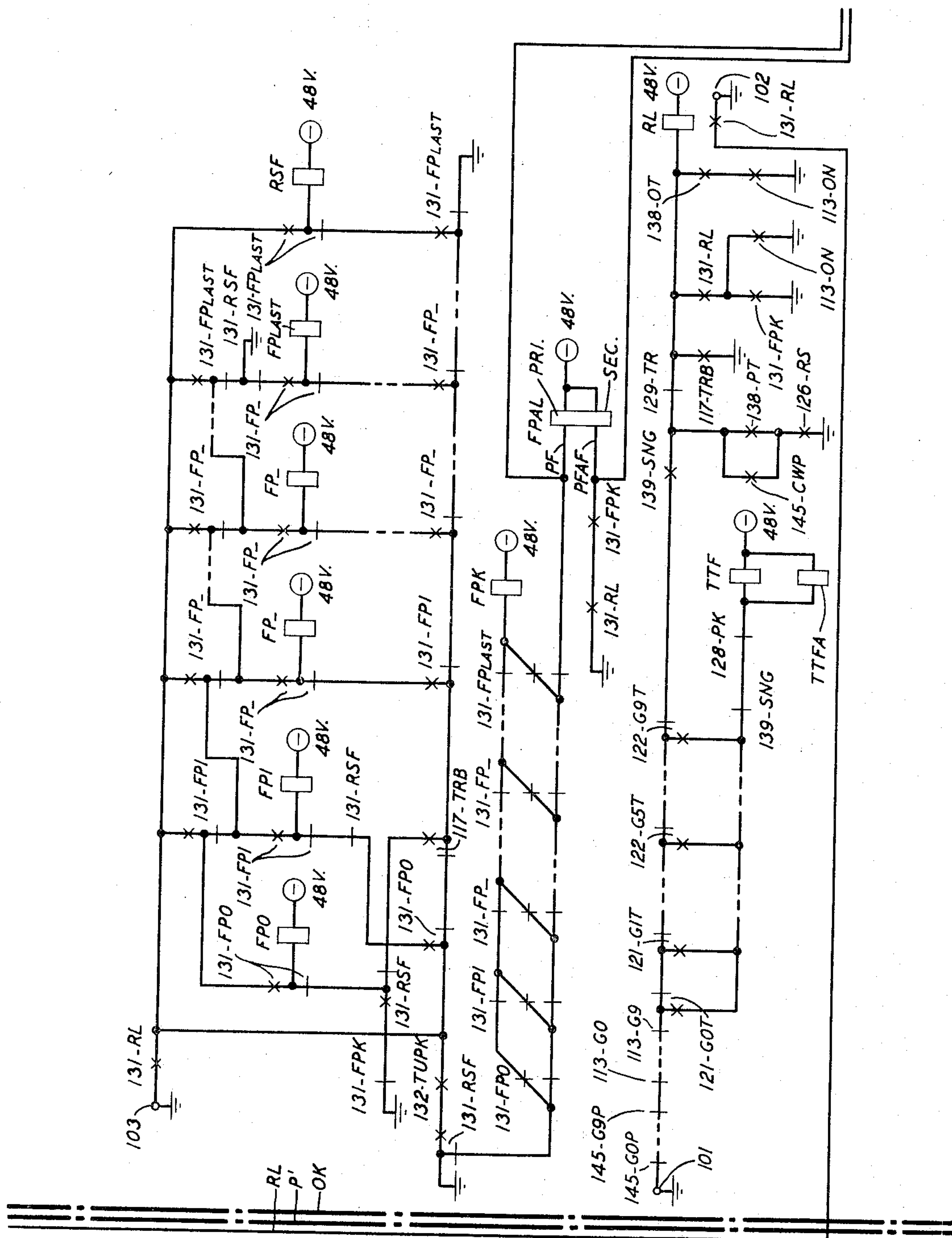
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**FIG. 131**

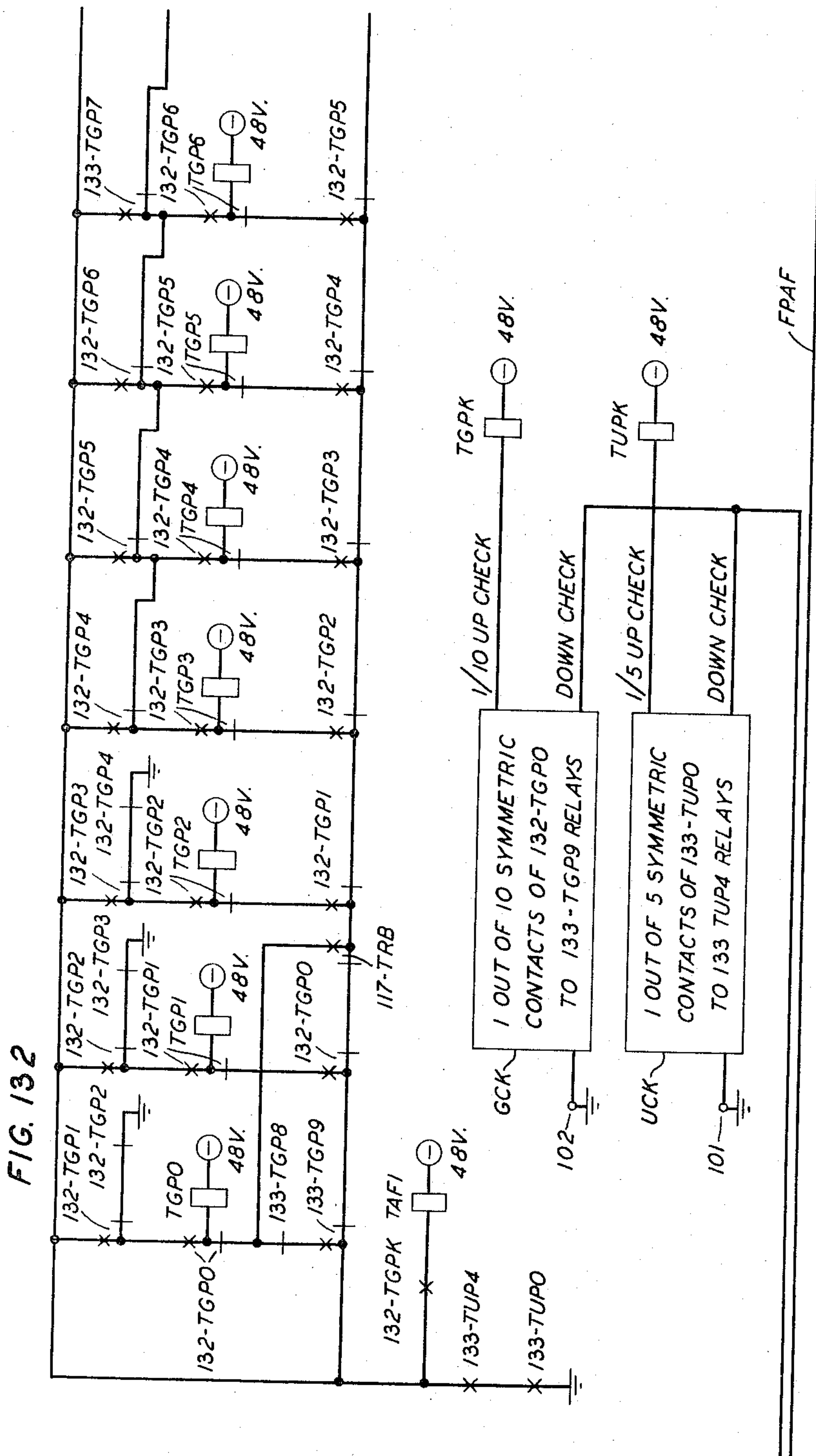


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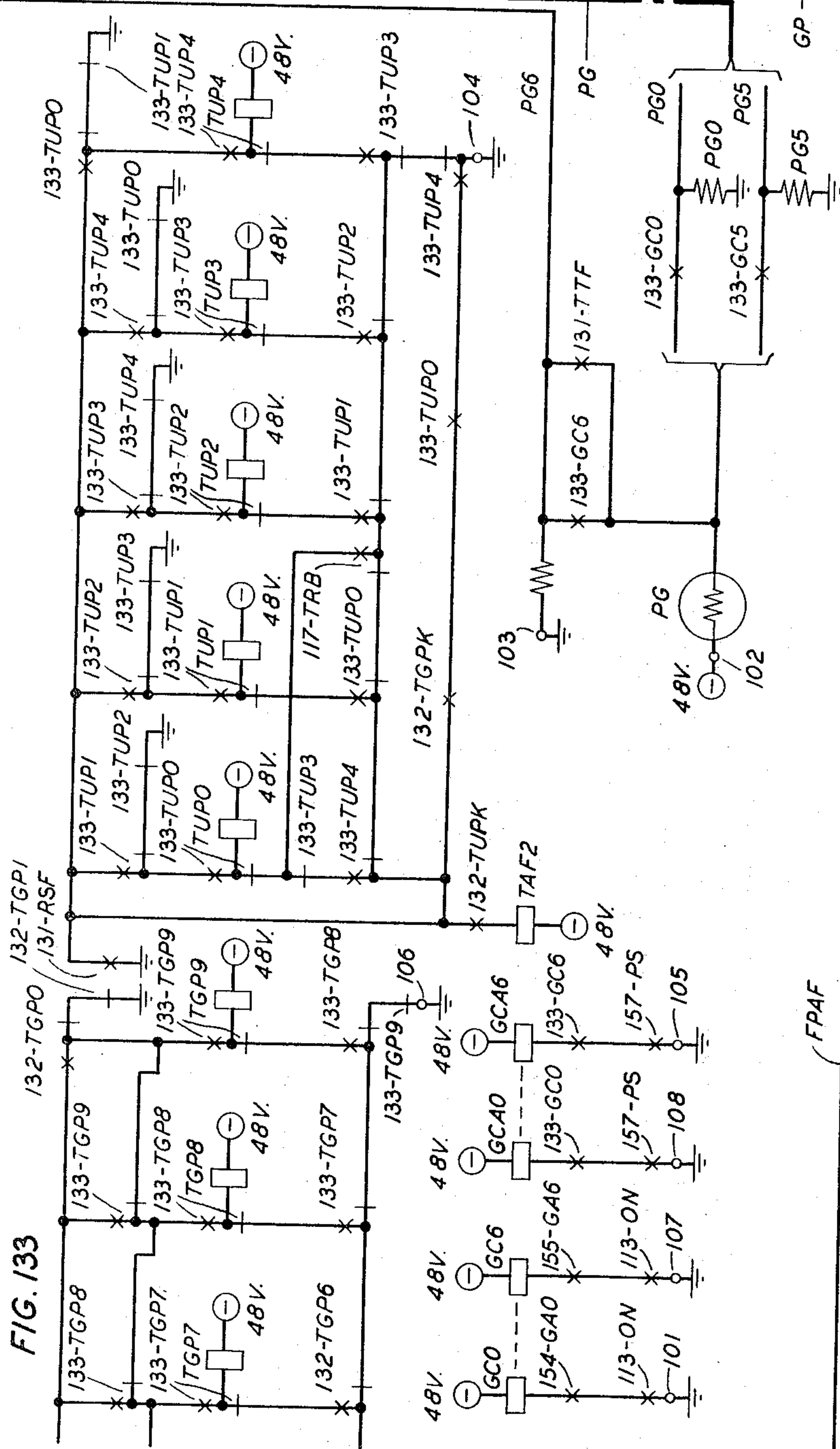




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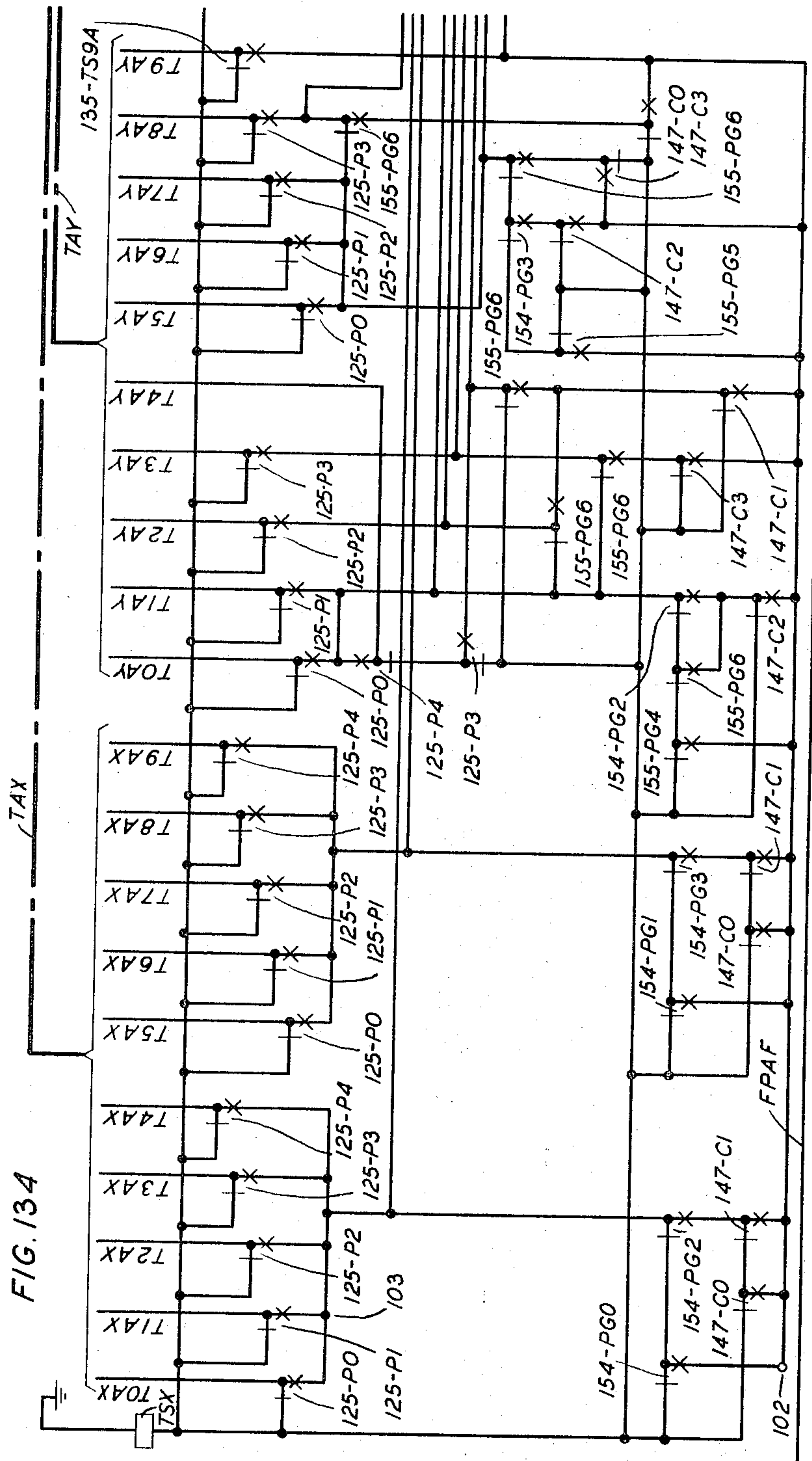
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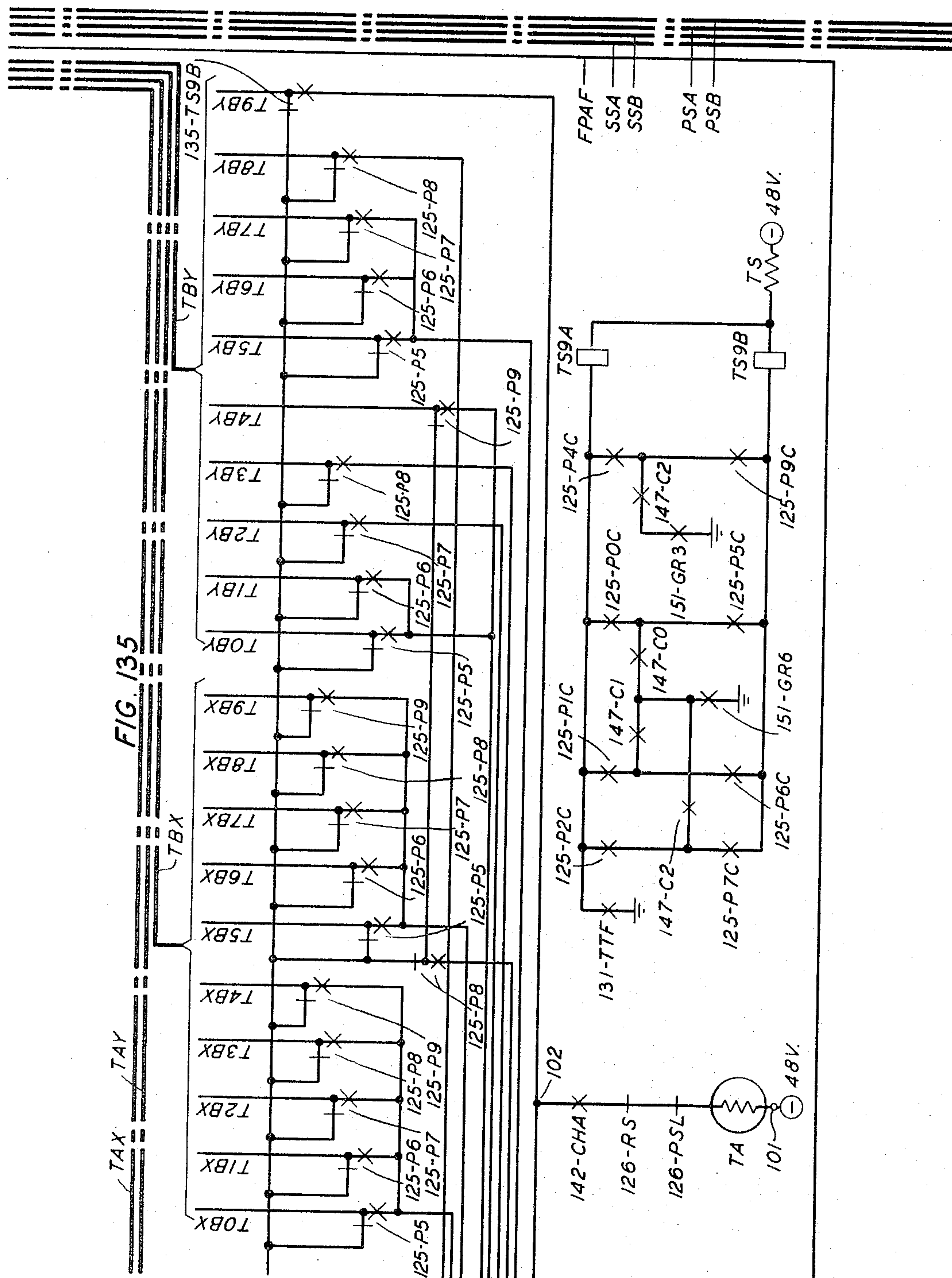
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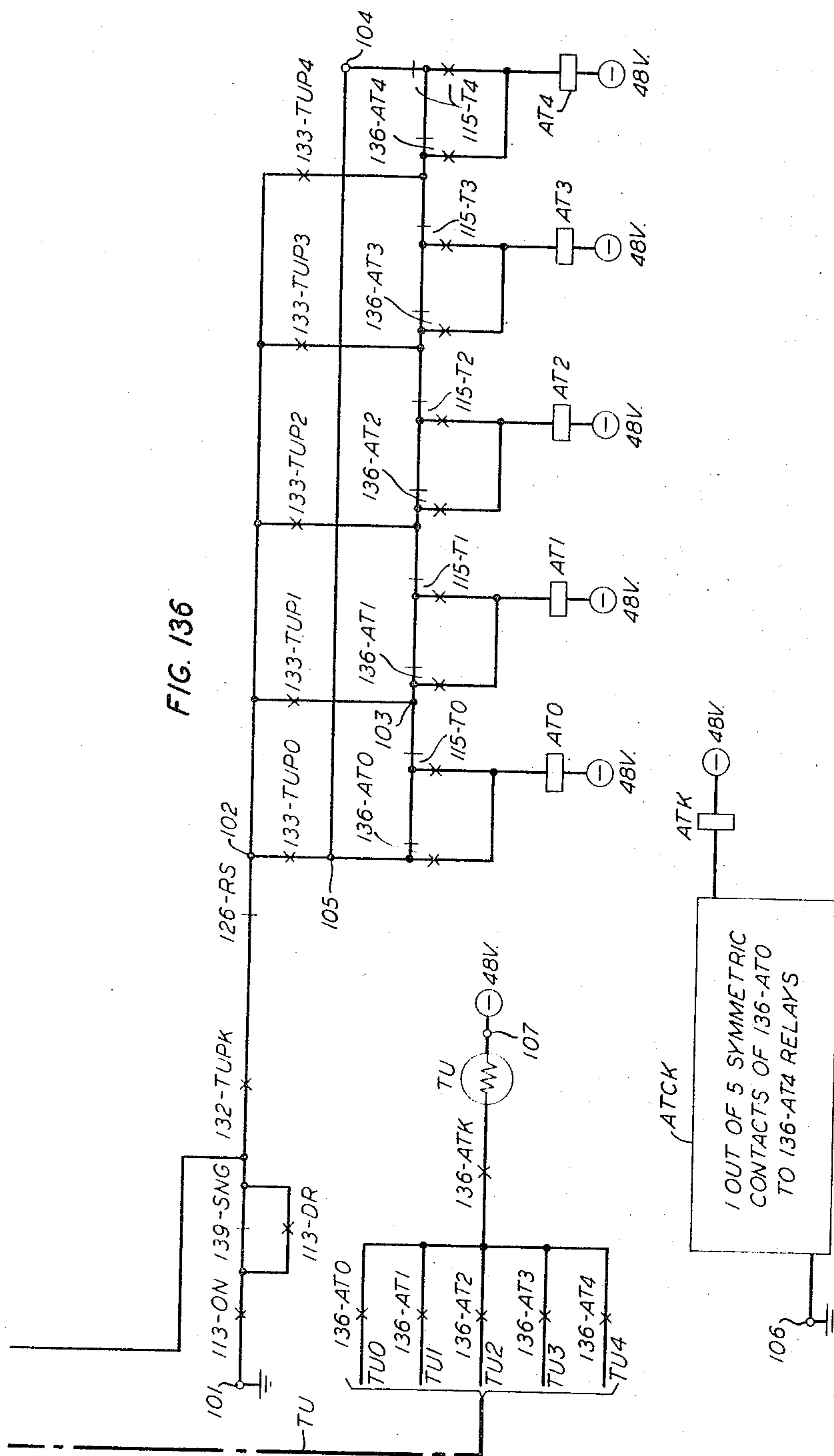




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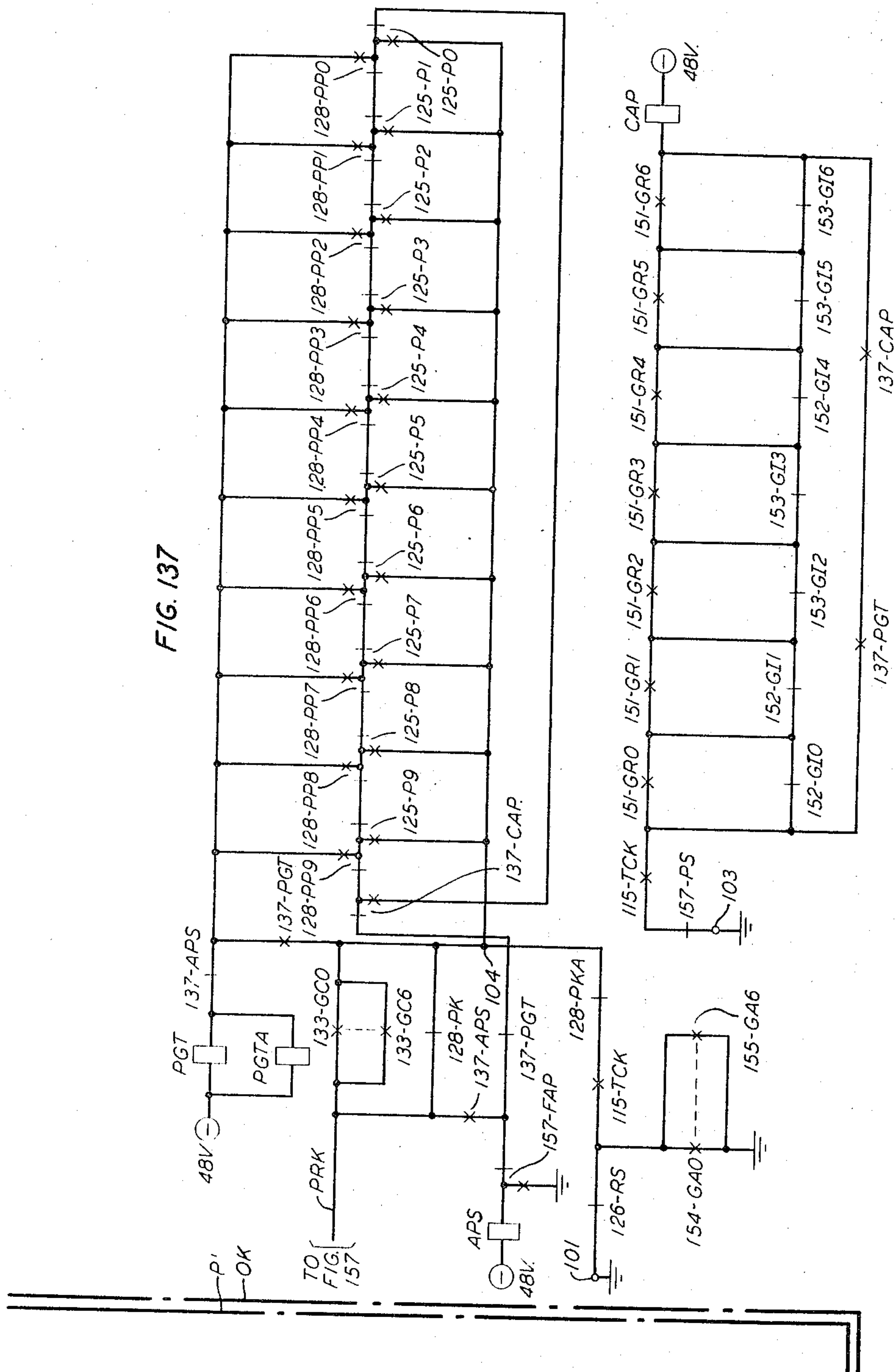


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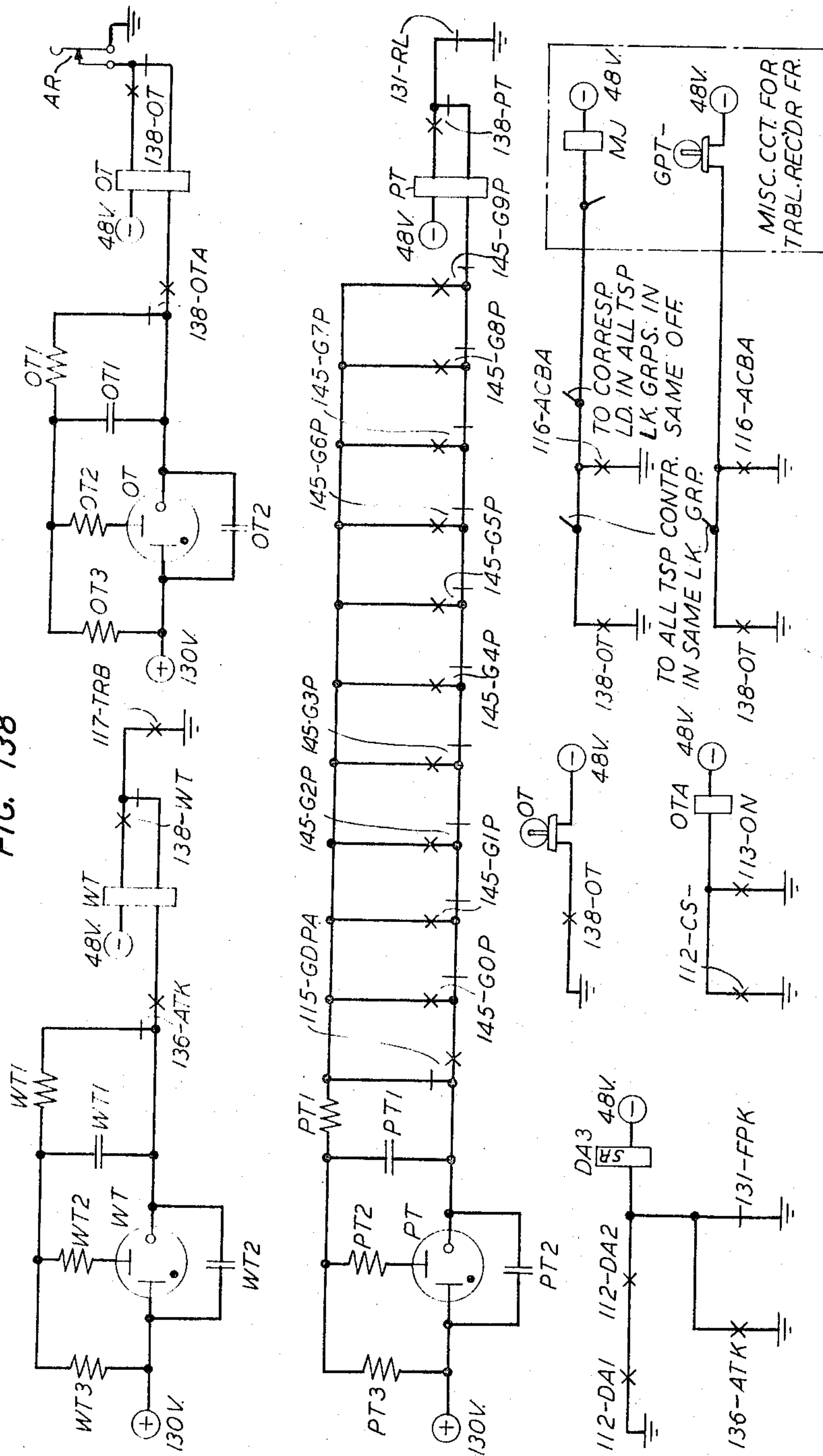
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FIG. 138





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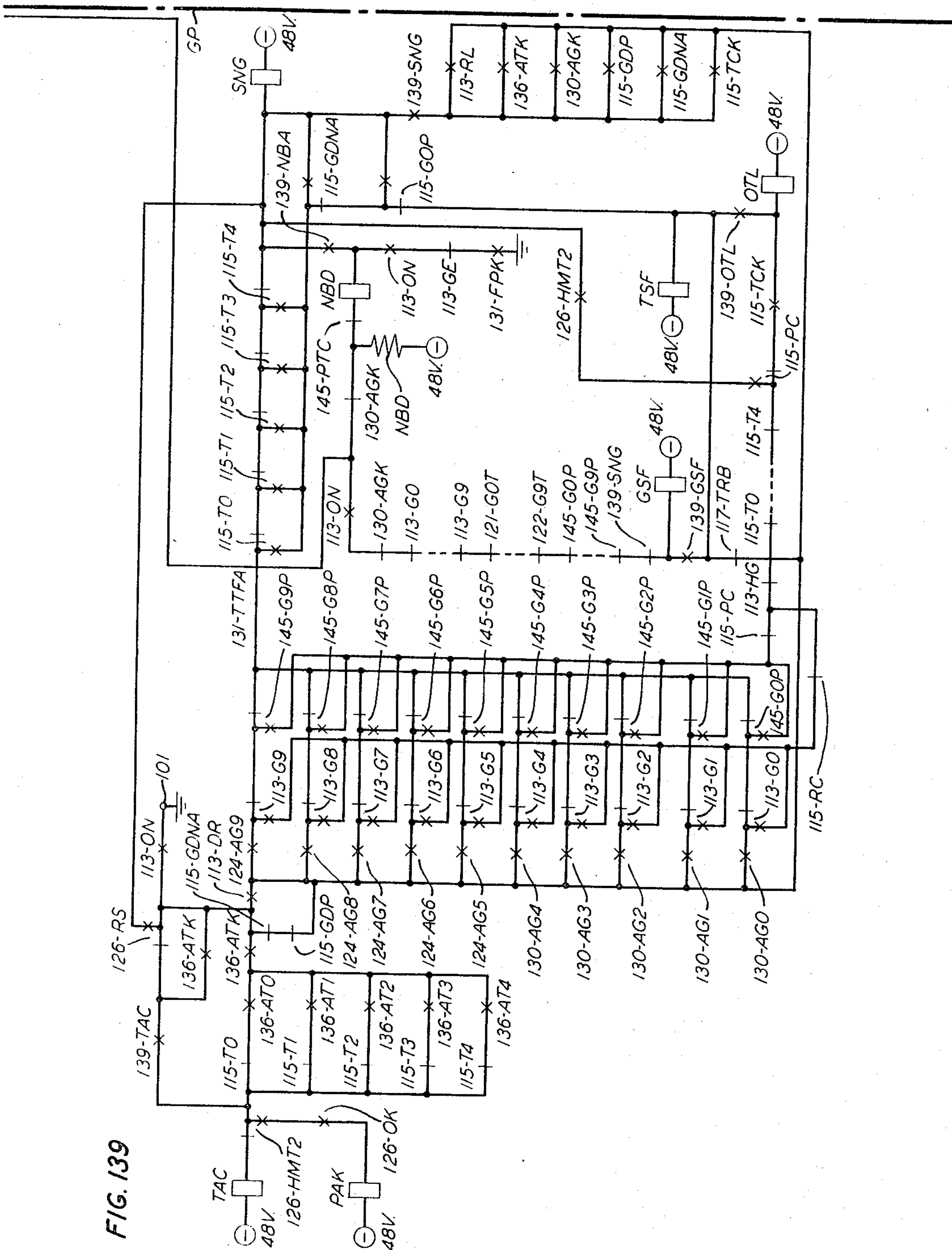
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FIG. 139





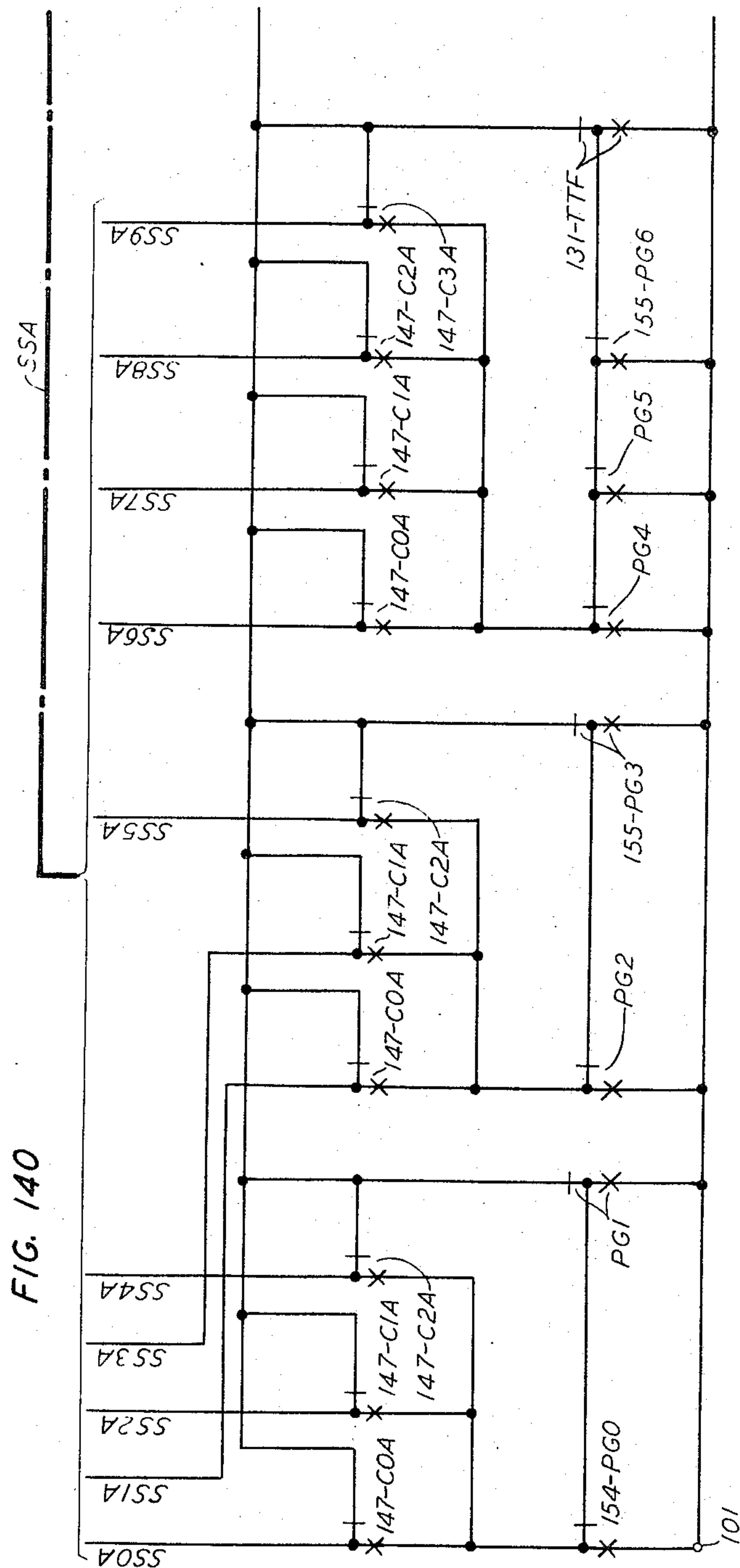
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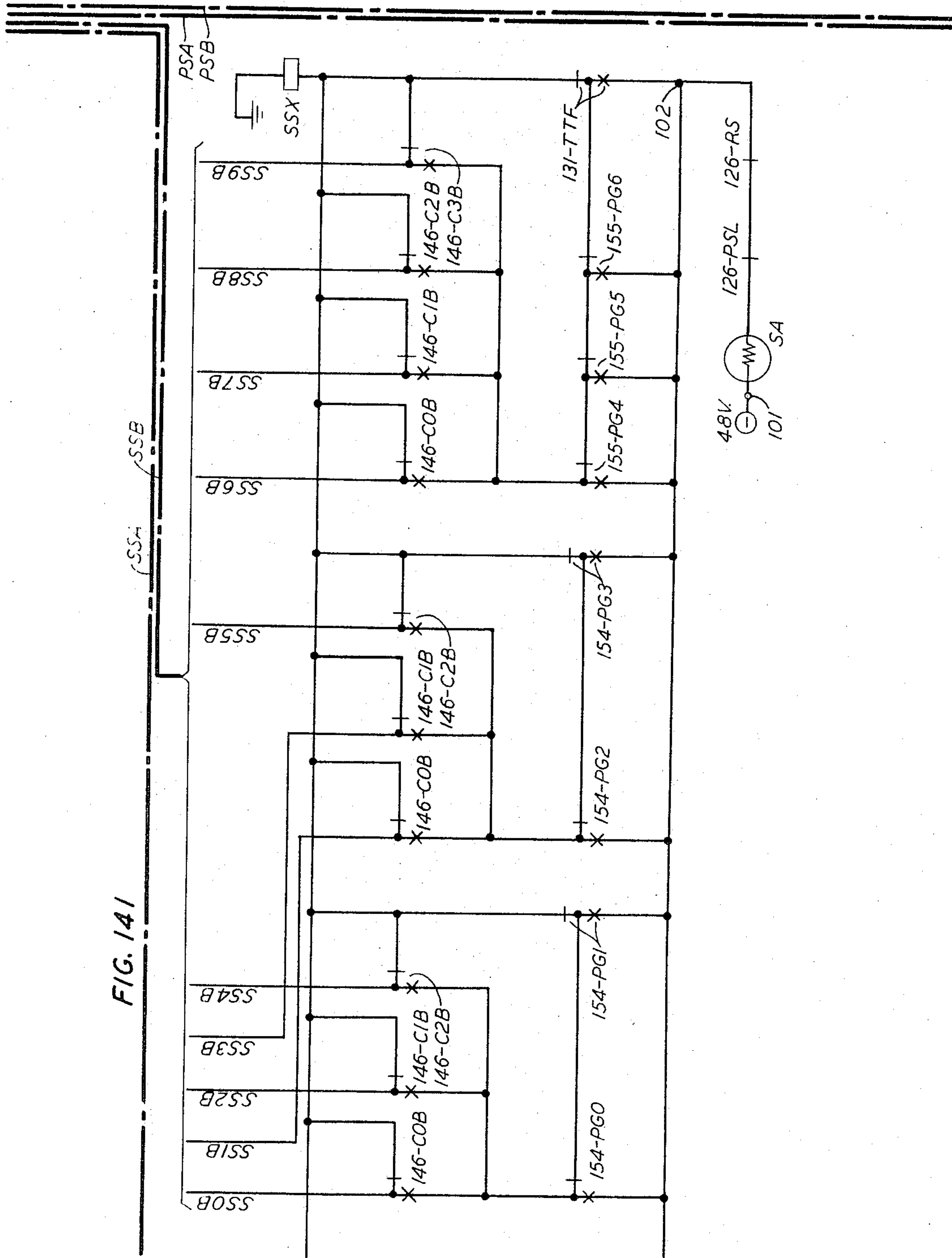
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FIG. 141





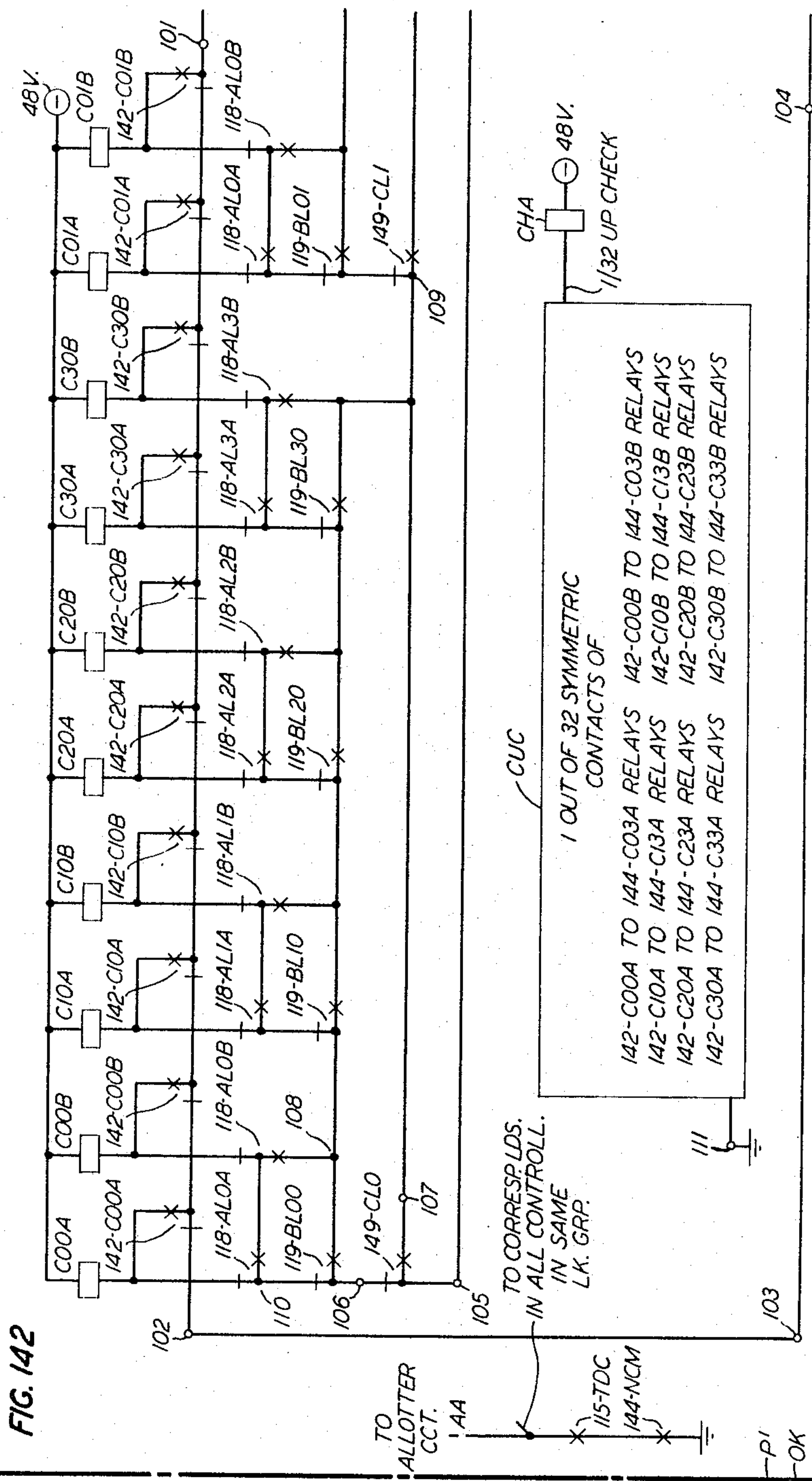
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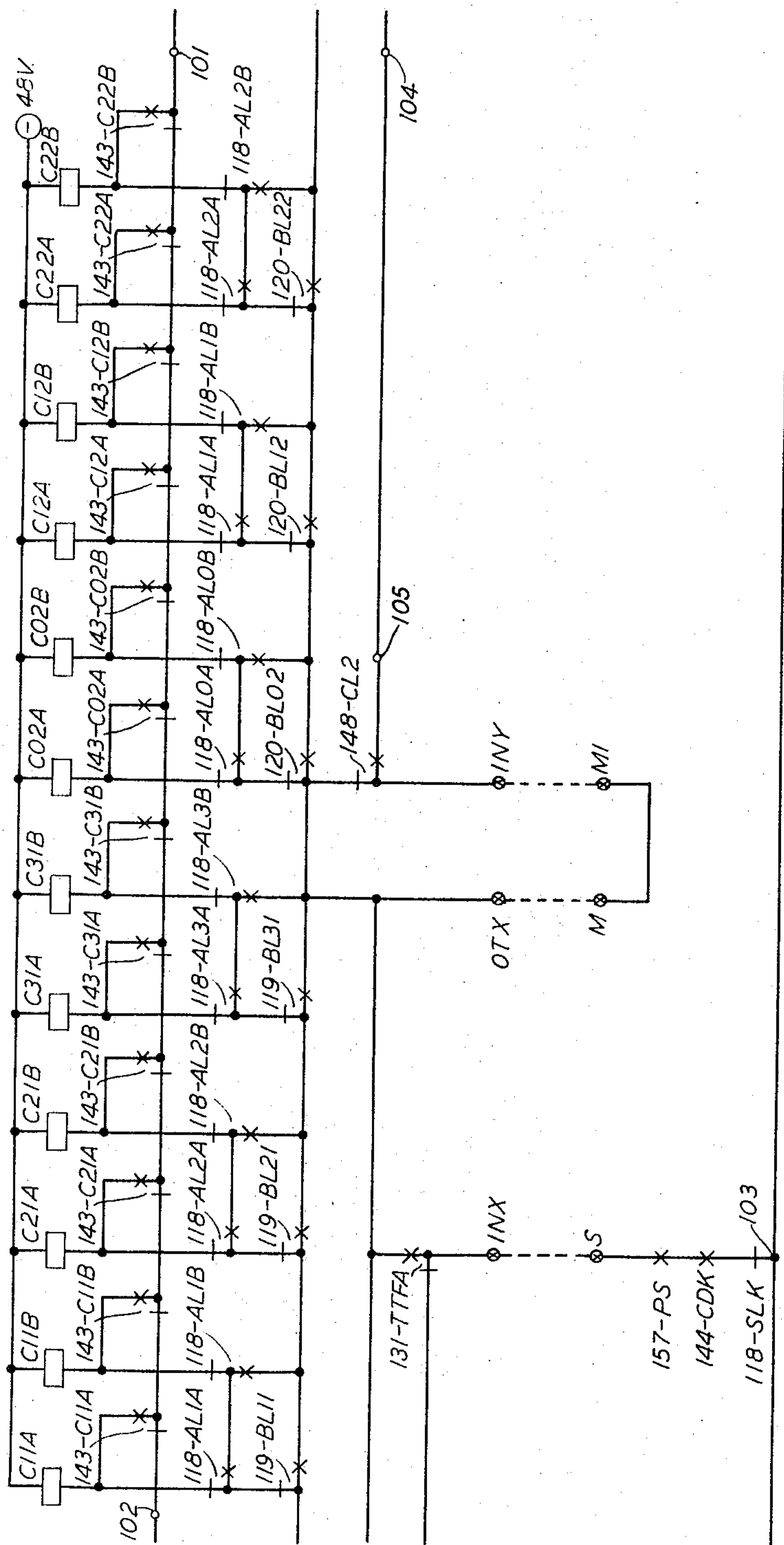
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**FIG. 143**





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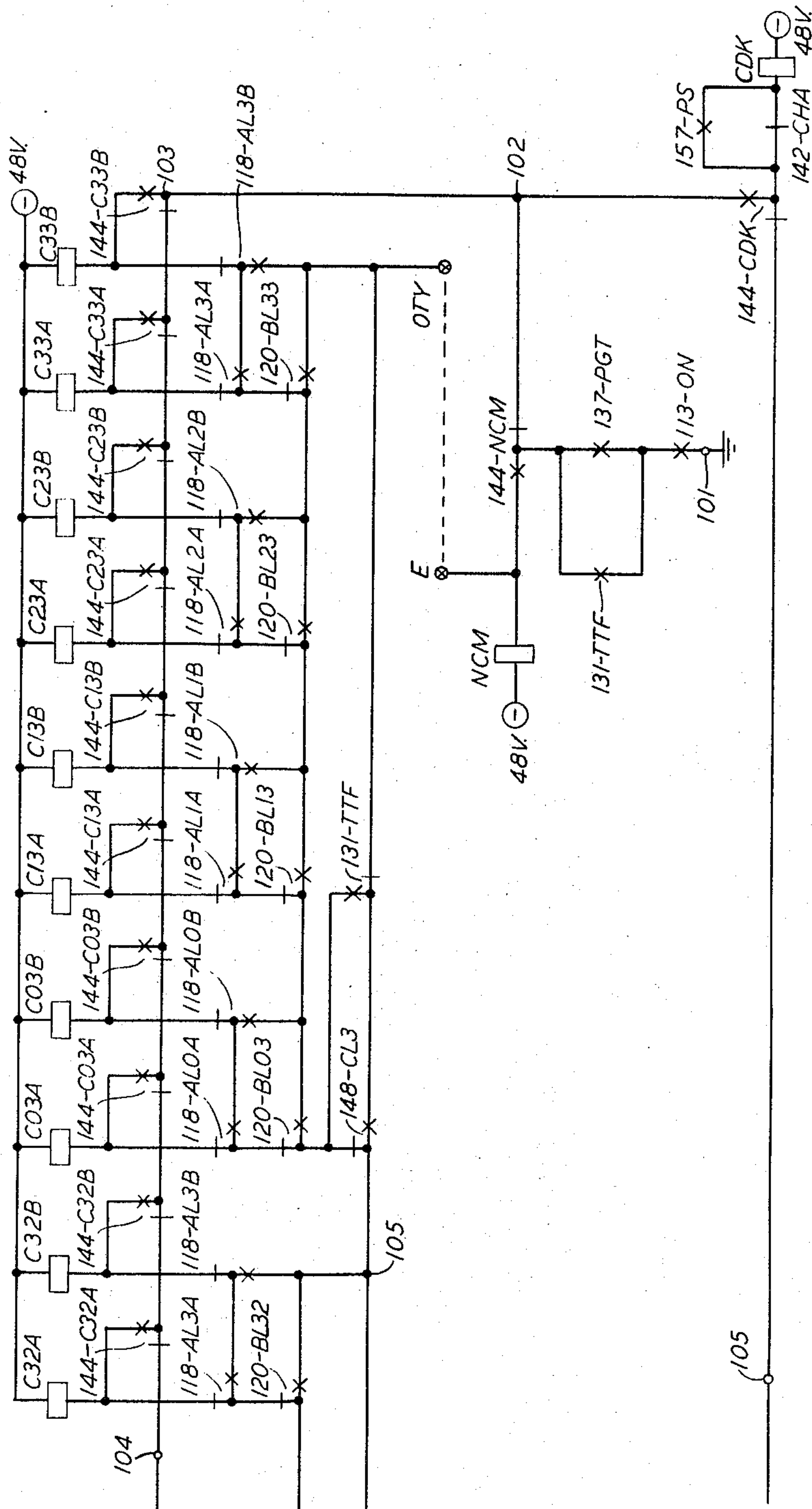
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FIG. 144





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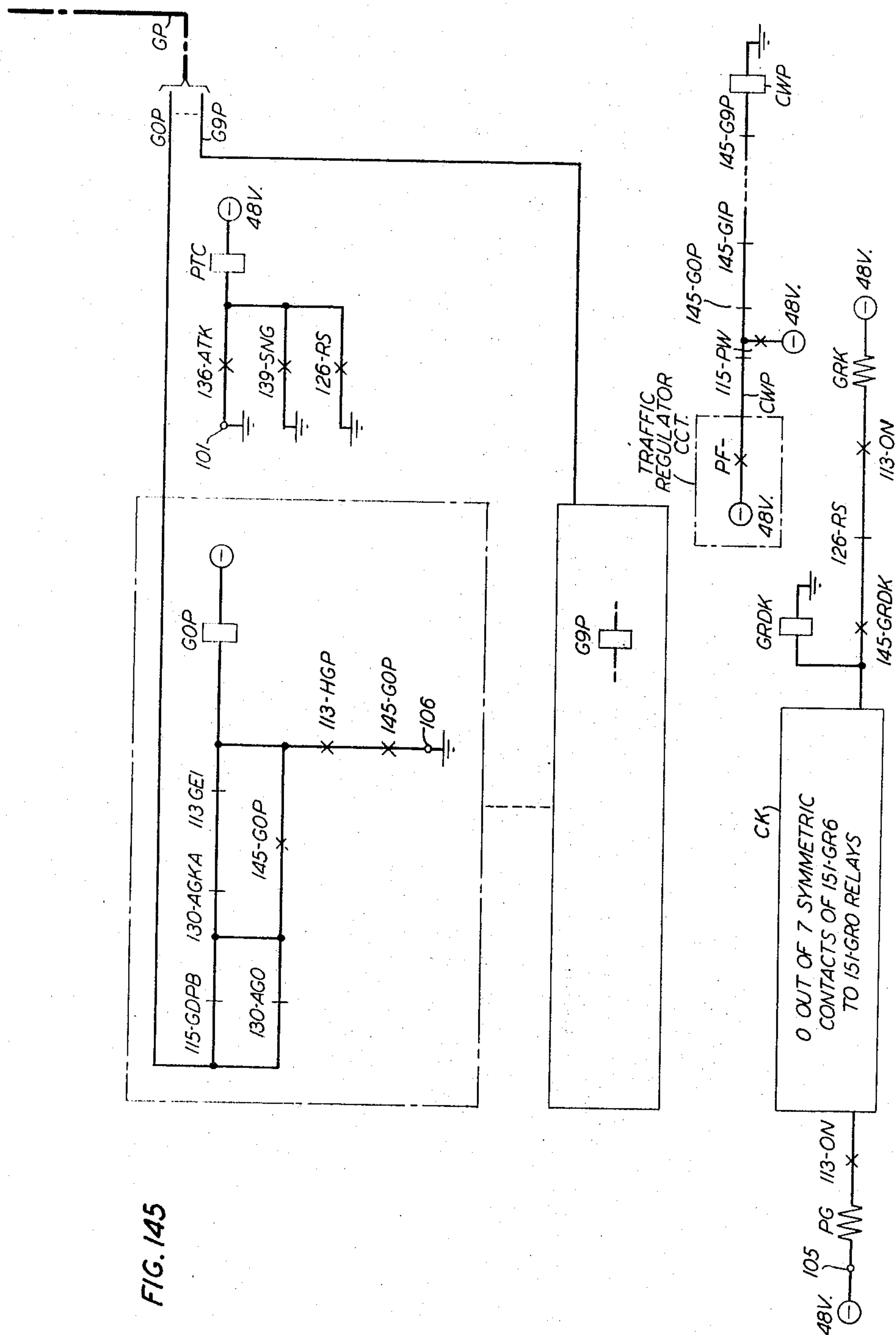
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**FIG. 145**



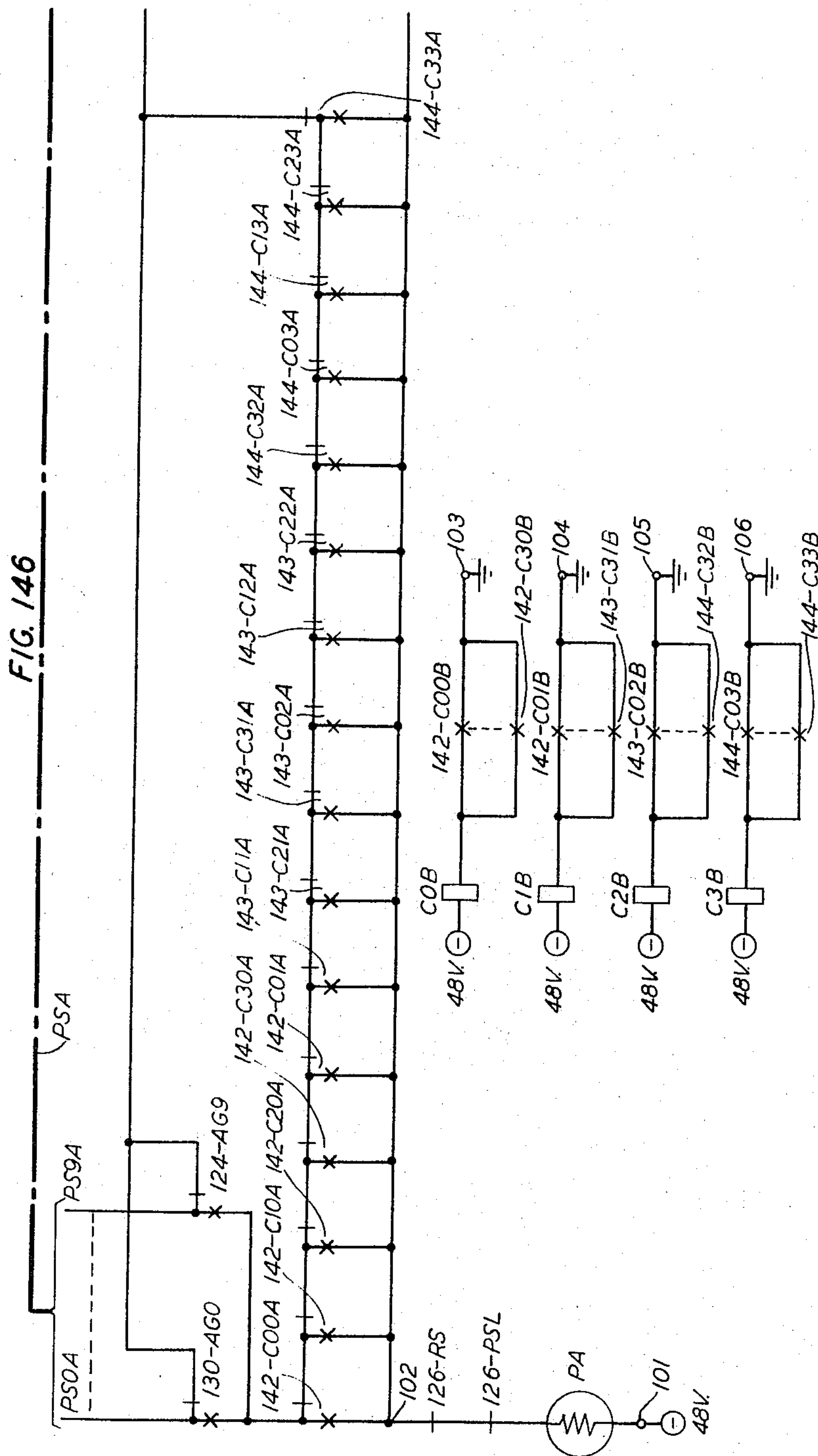
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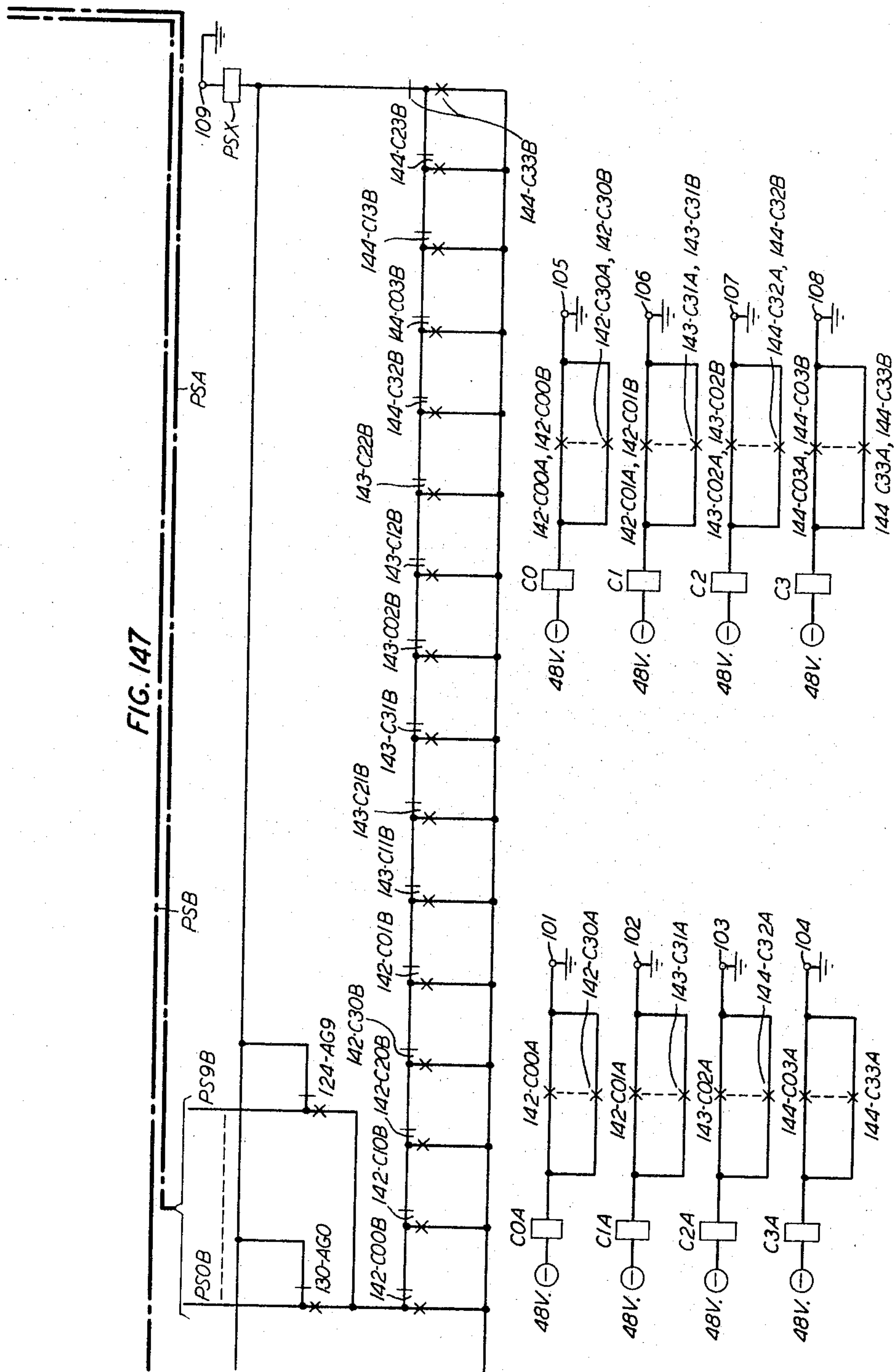
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FIG. 147





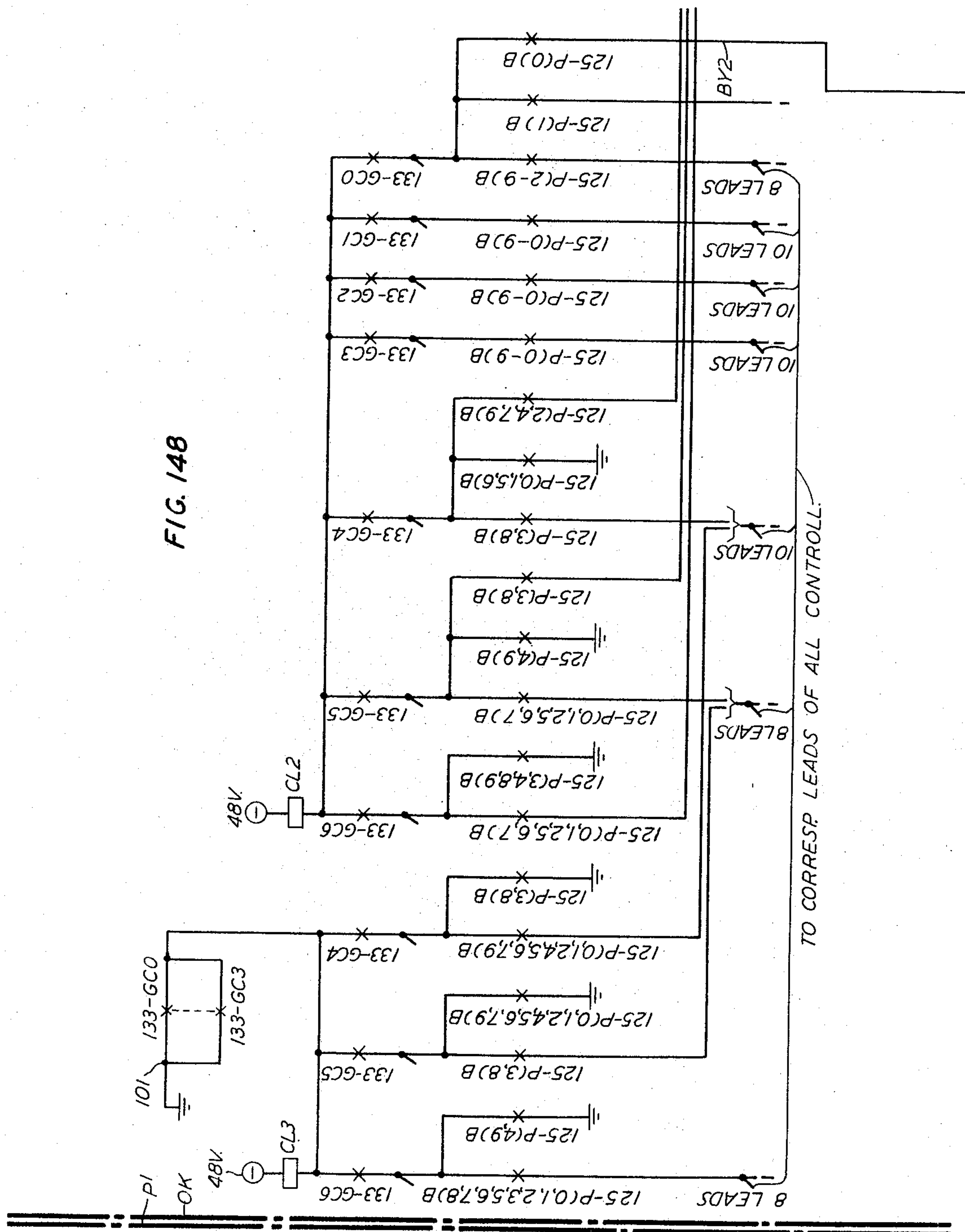
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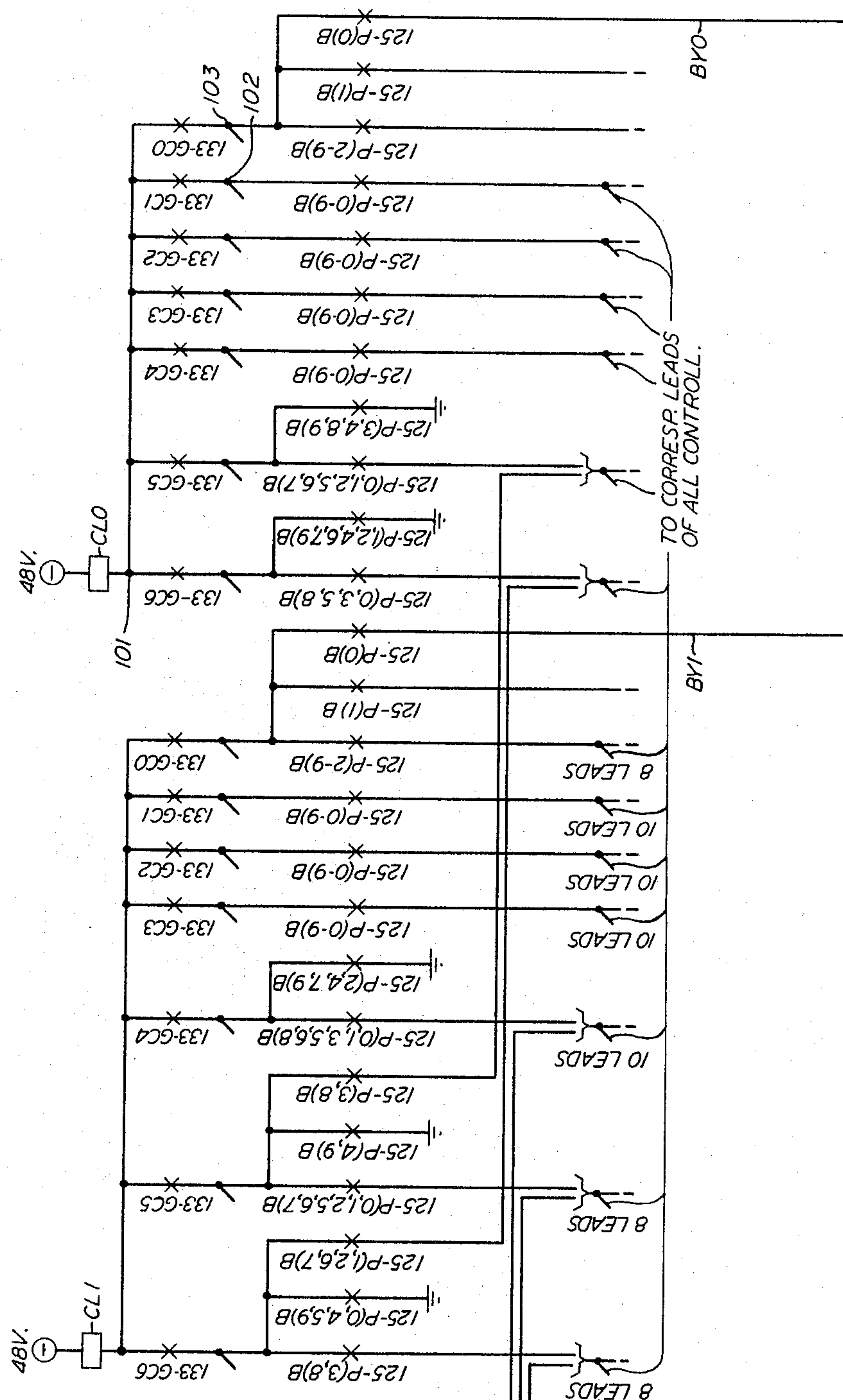
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FIG. 149





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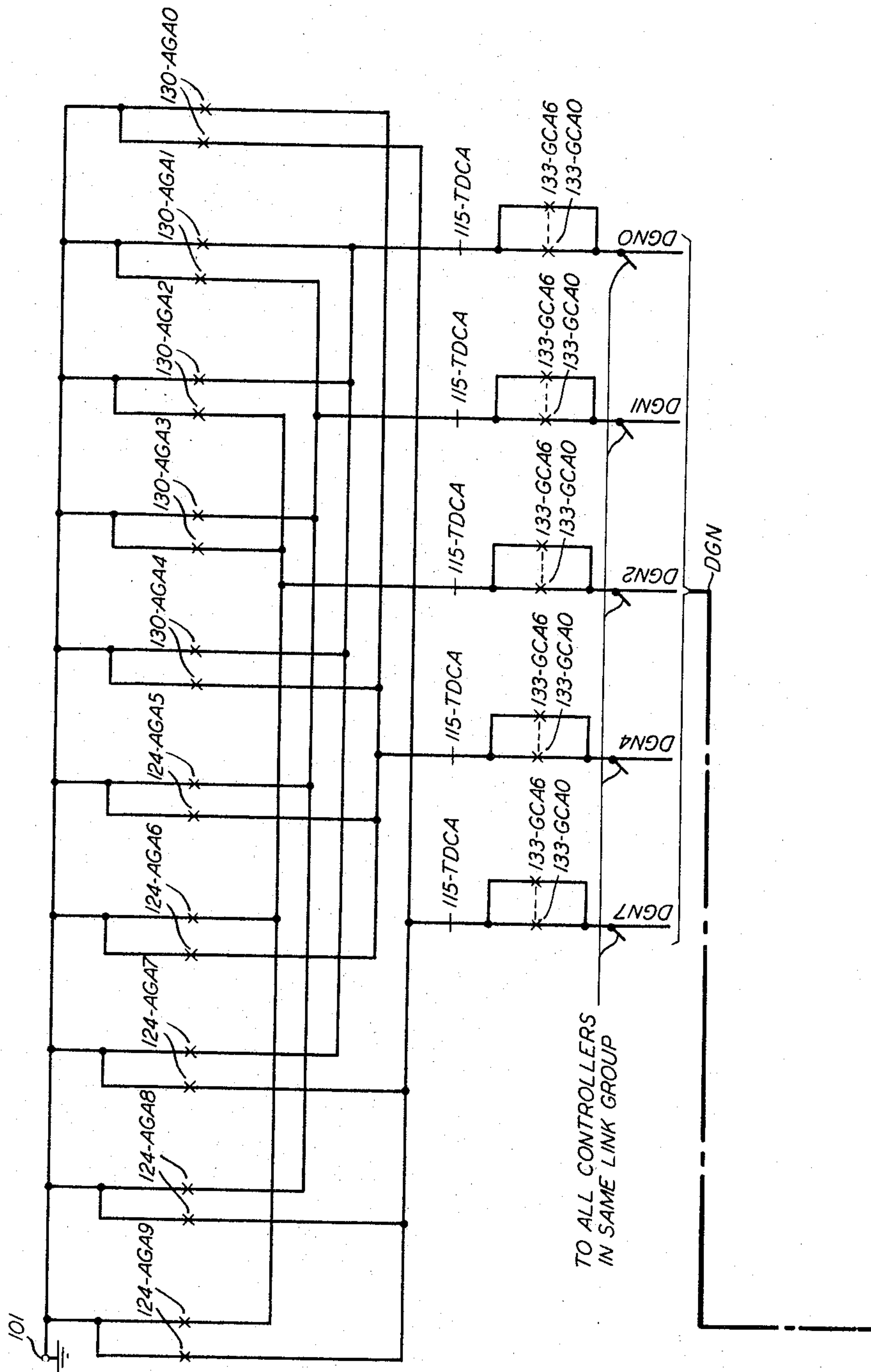
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FIG. 150





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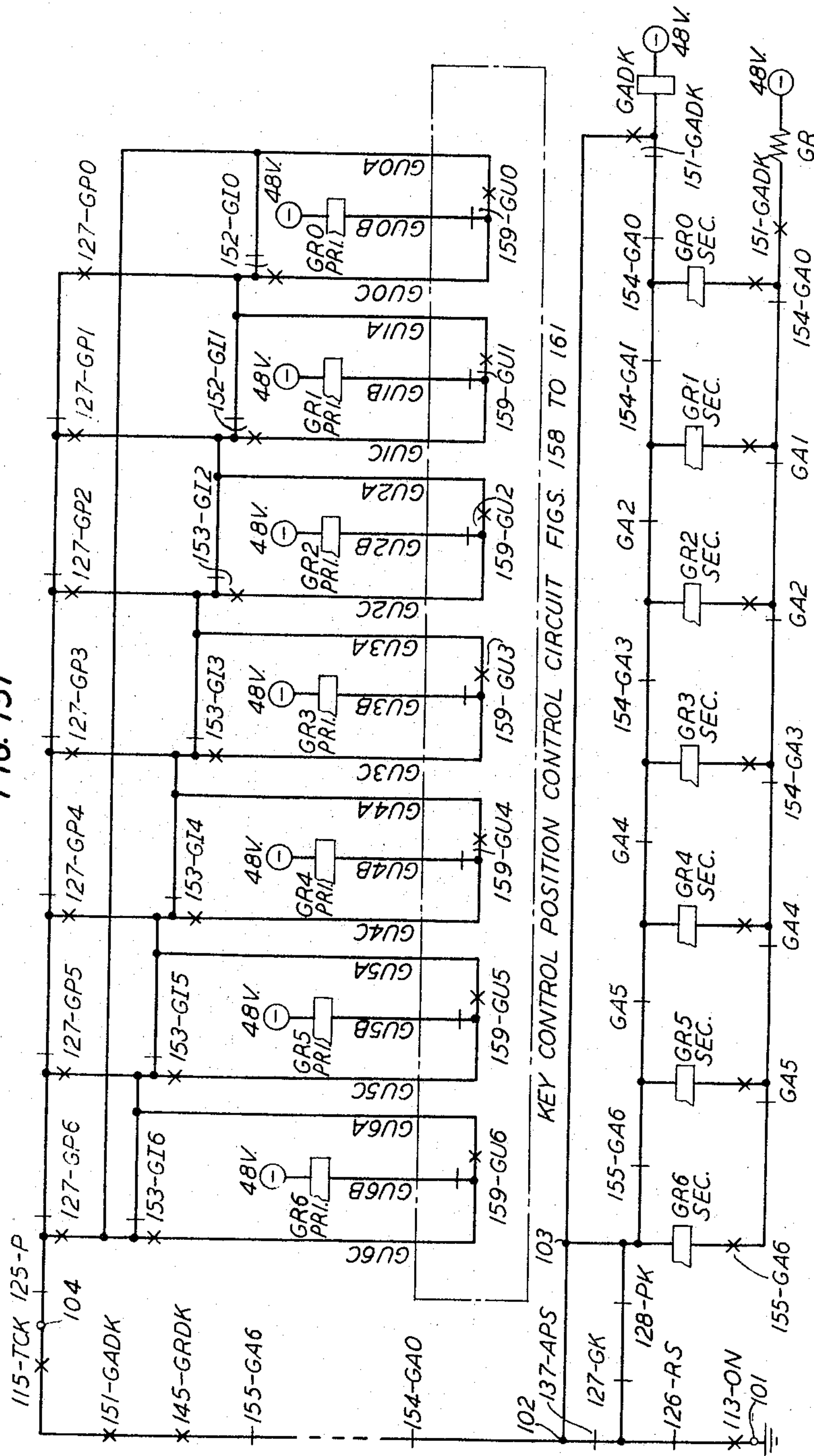
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FIG. 151





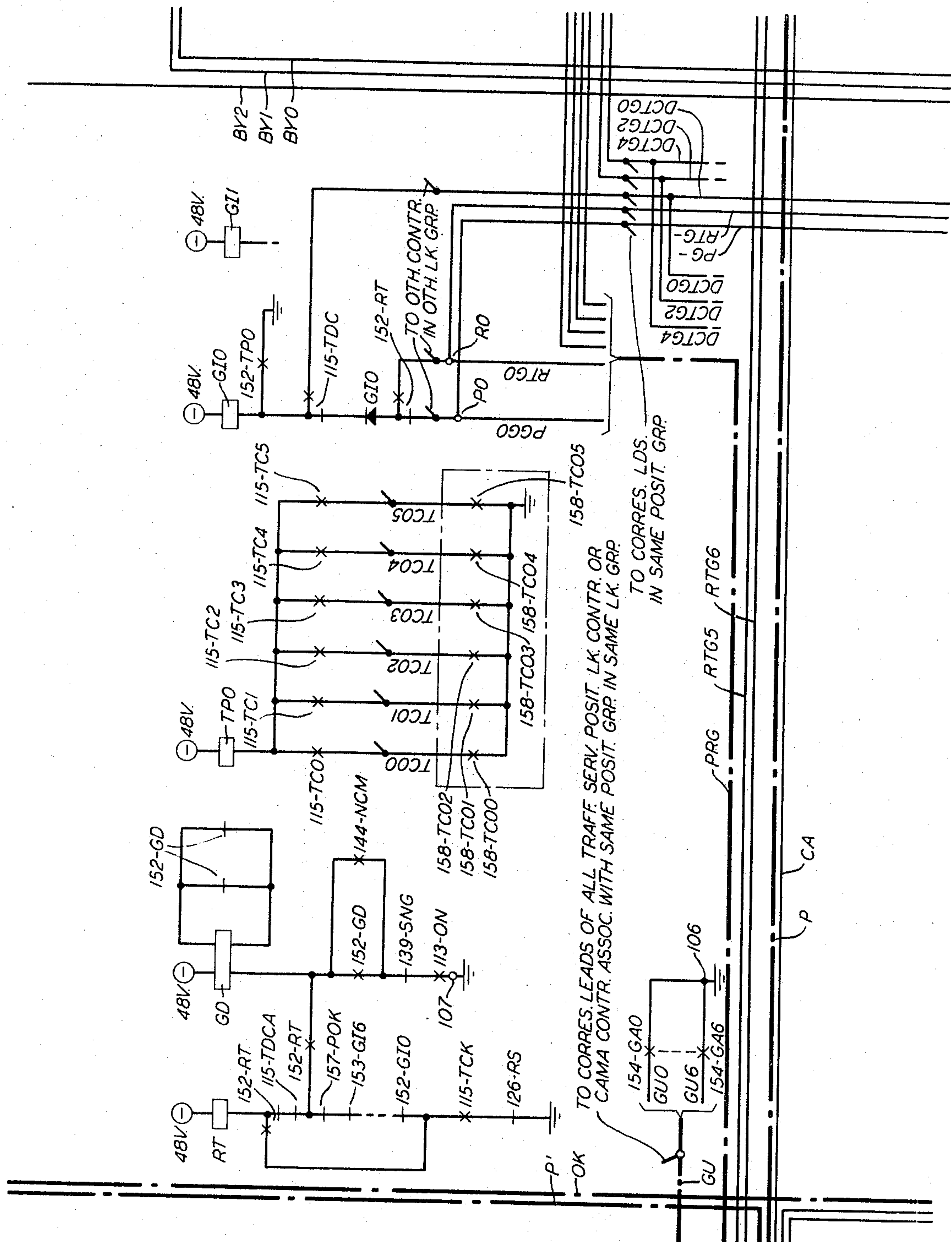
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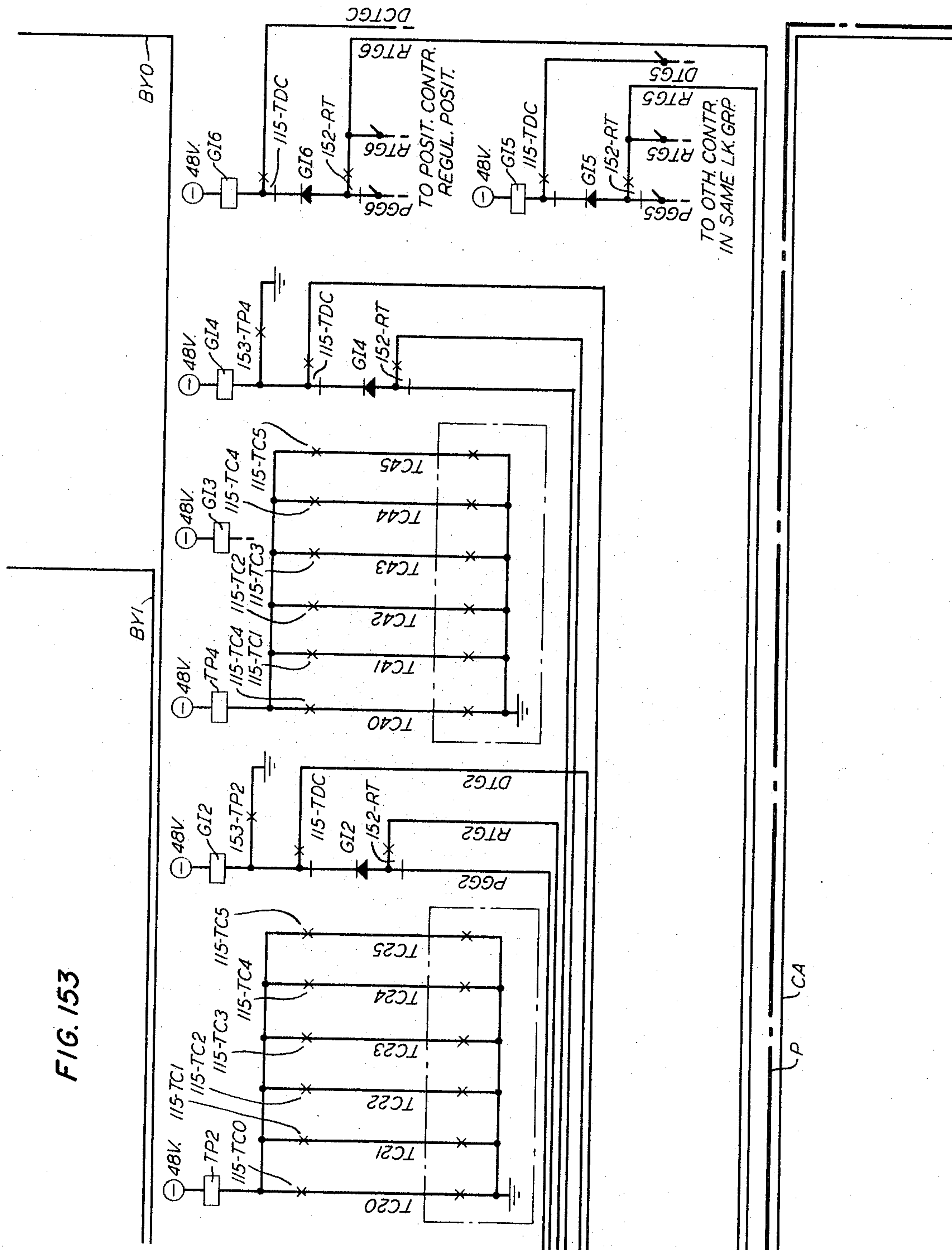
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FIG. 153





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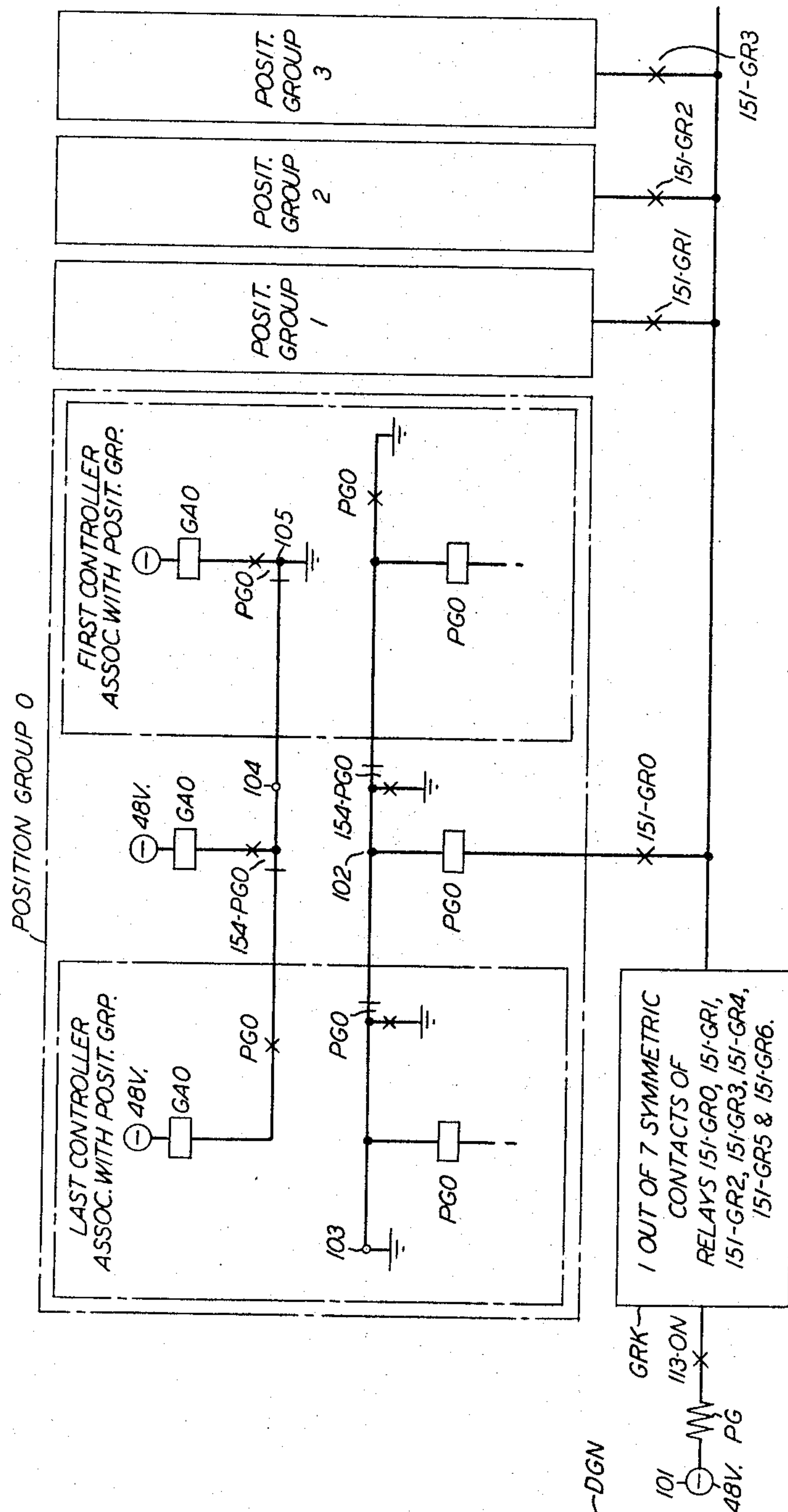
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FIG. 154





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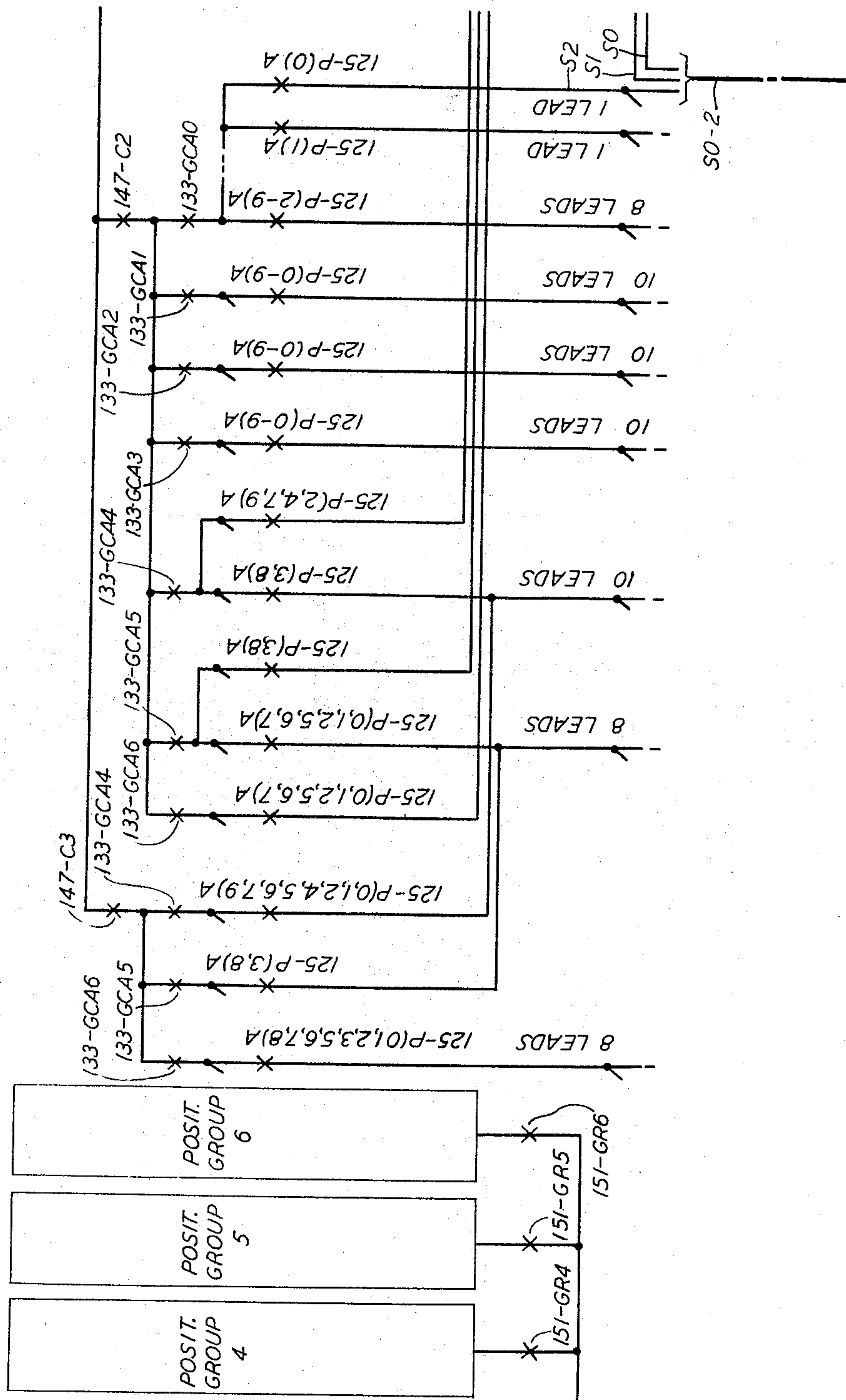
R. B. CURTIS  
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FIG. 155





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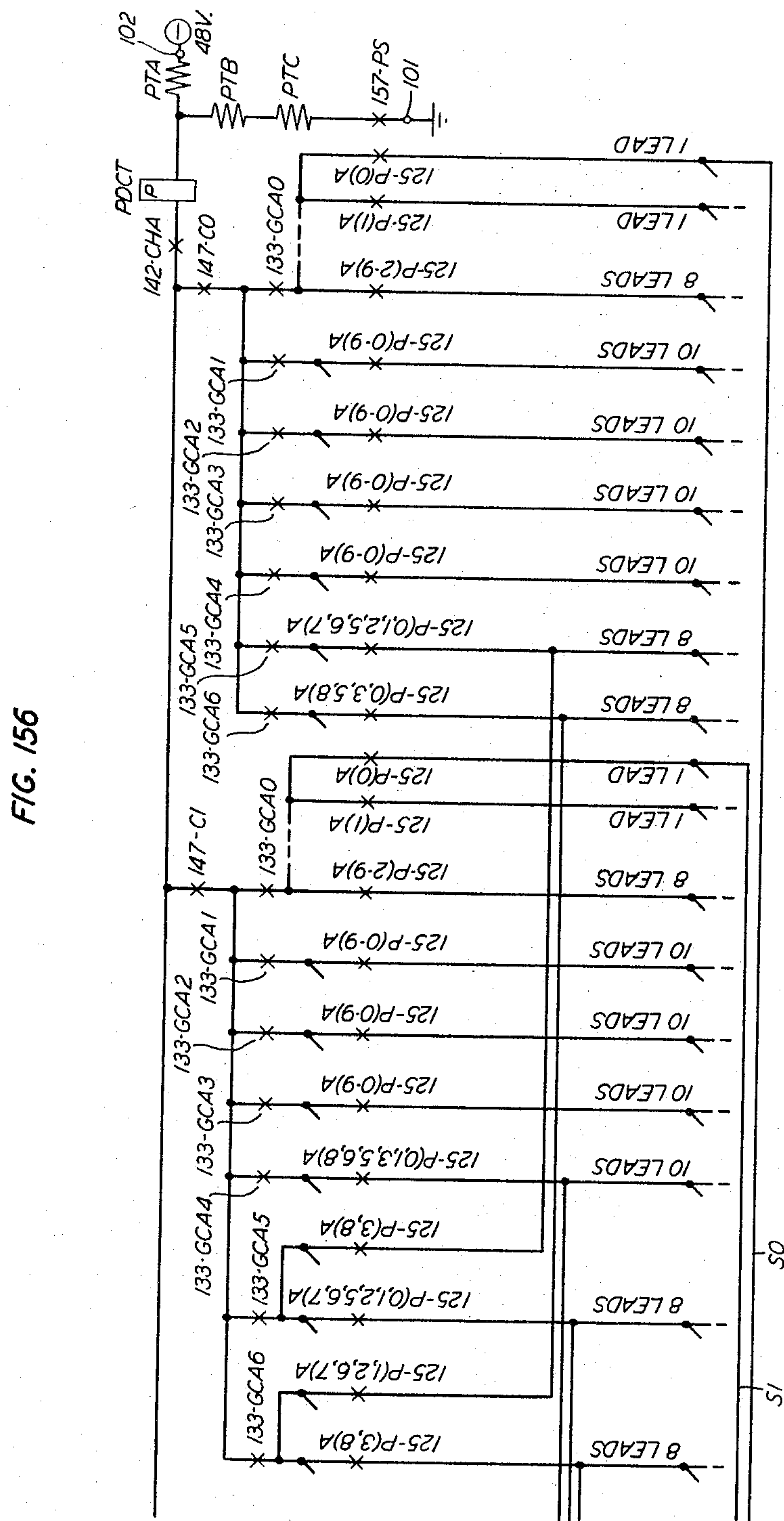
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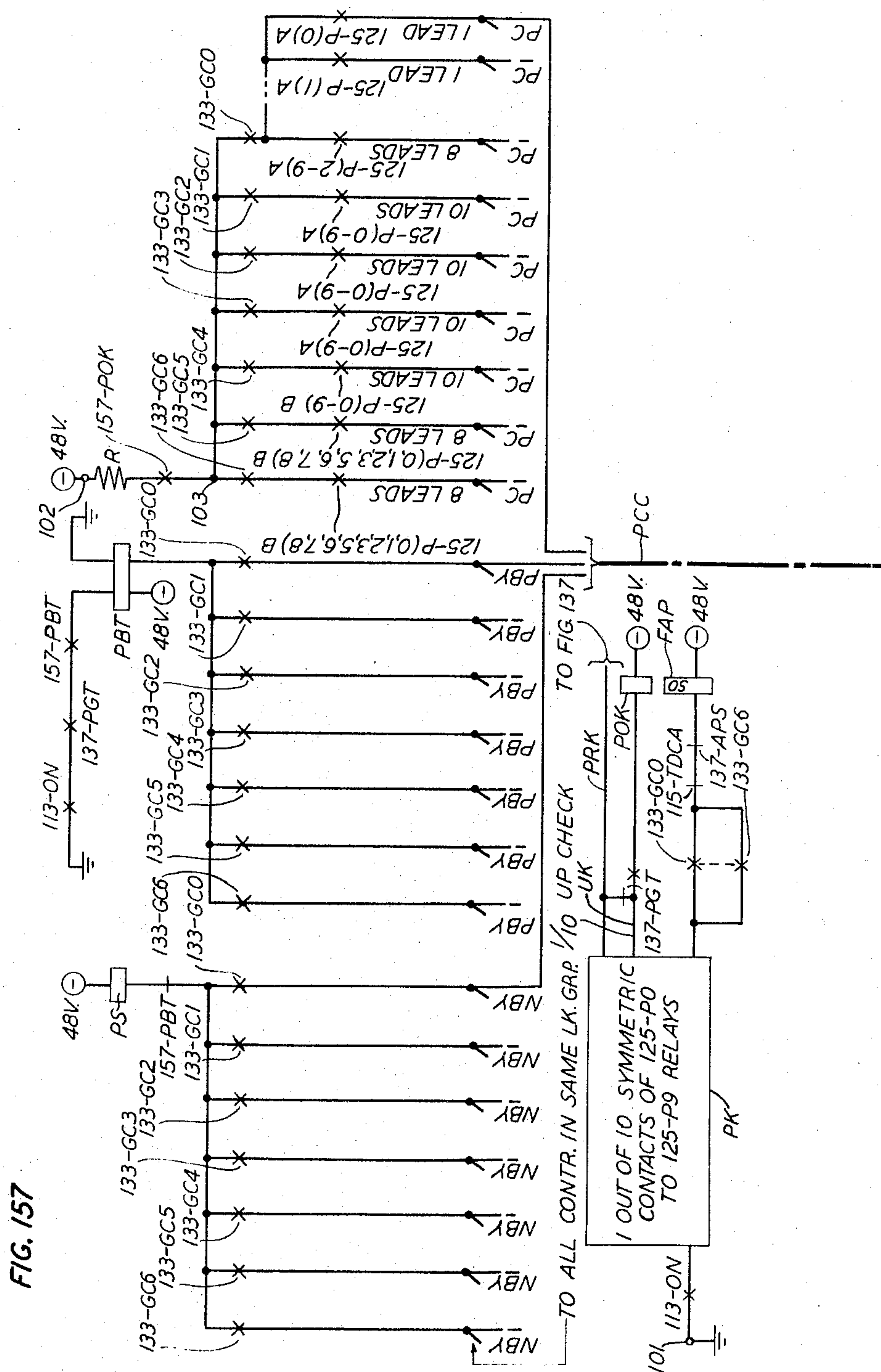
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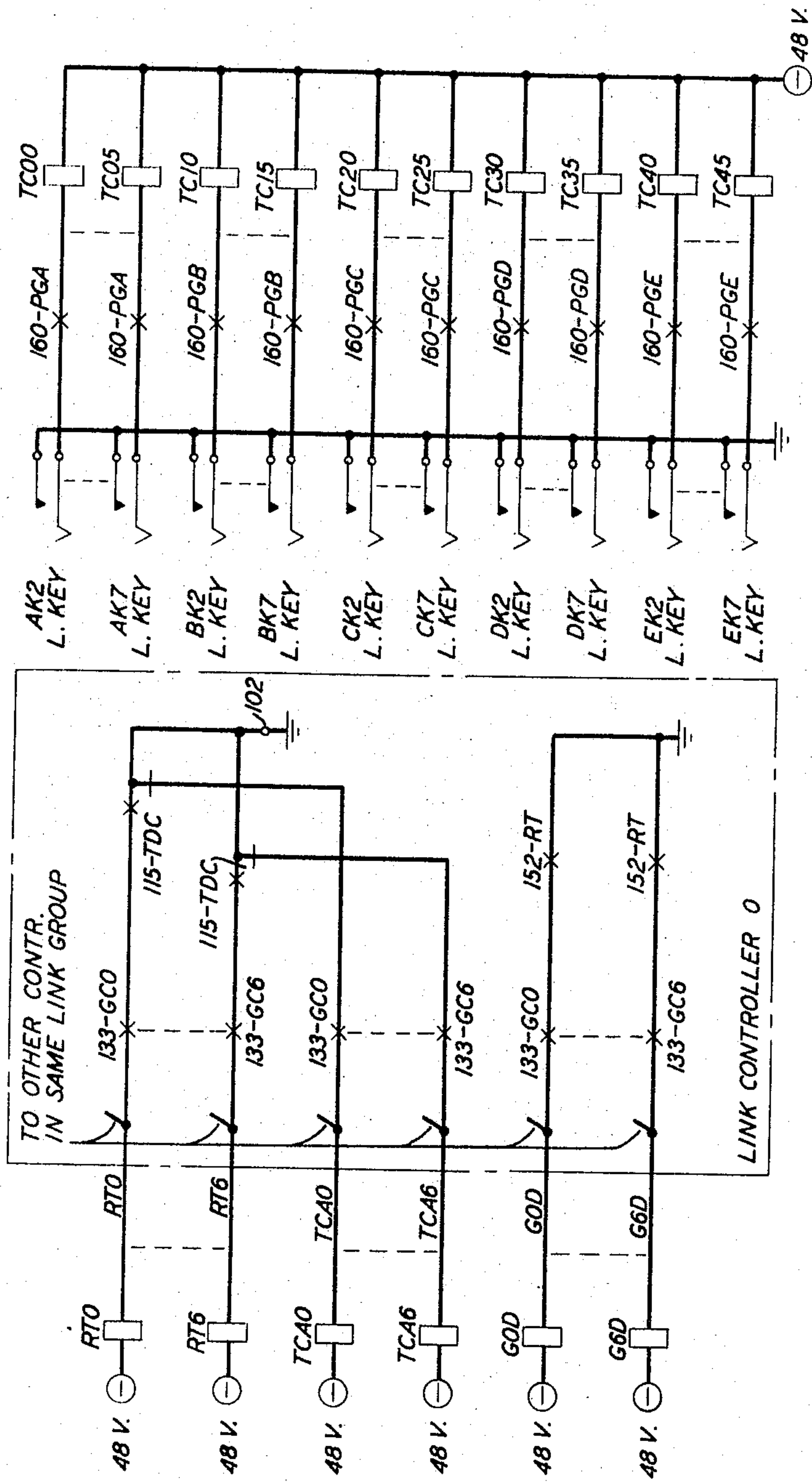
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FIG. 158





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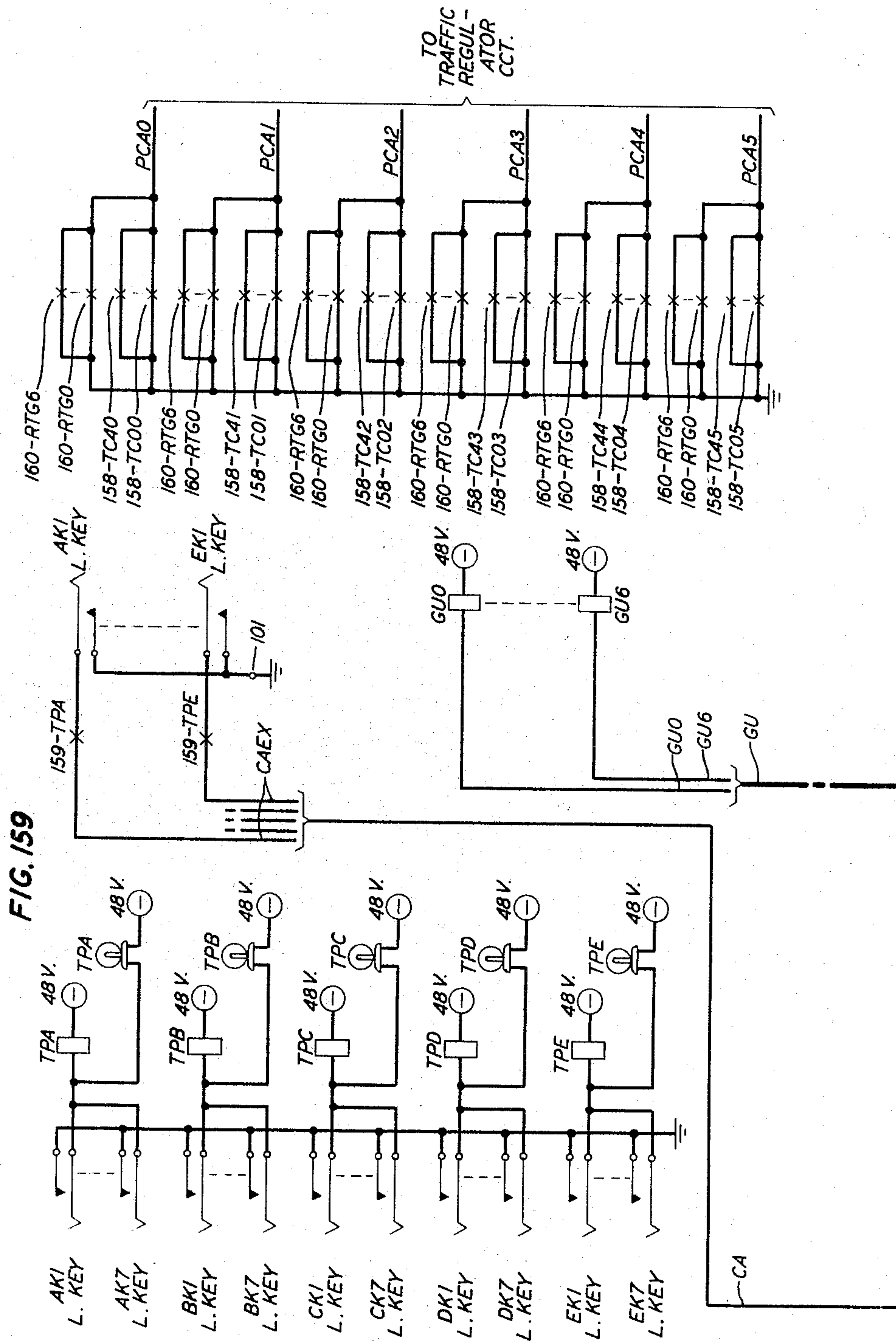
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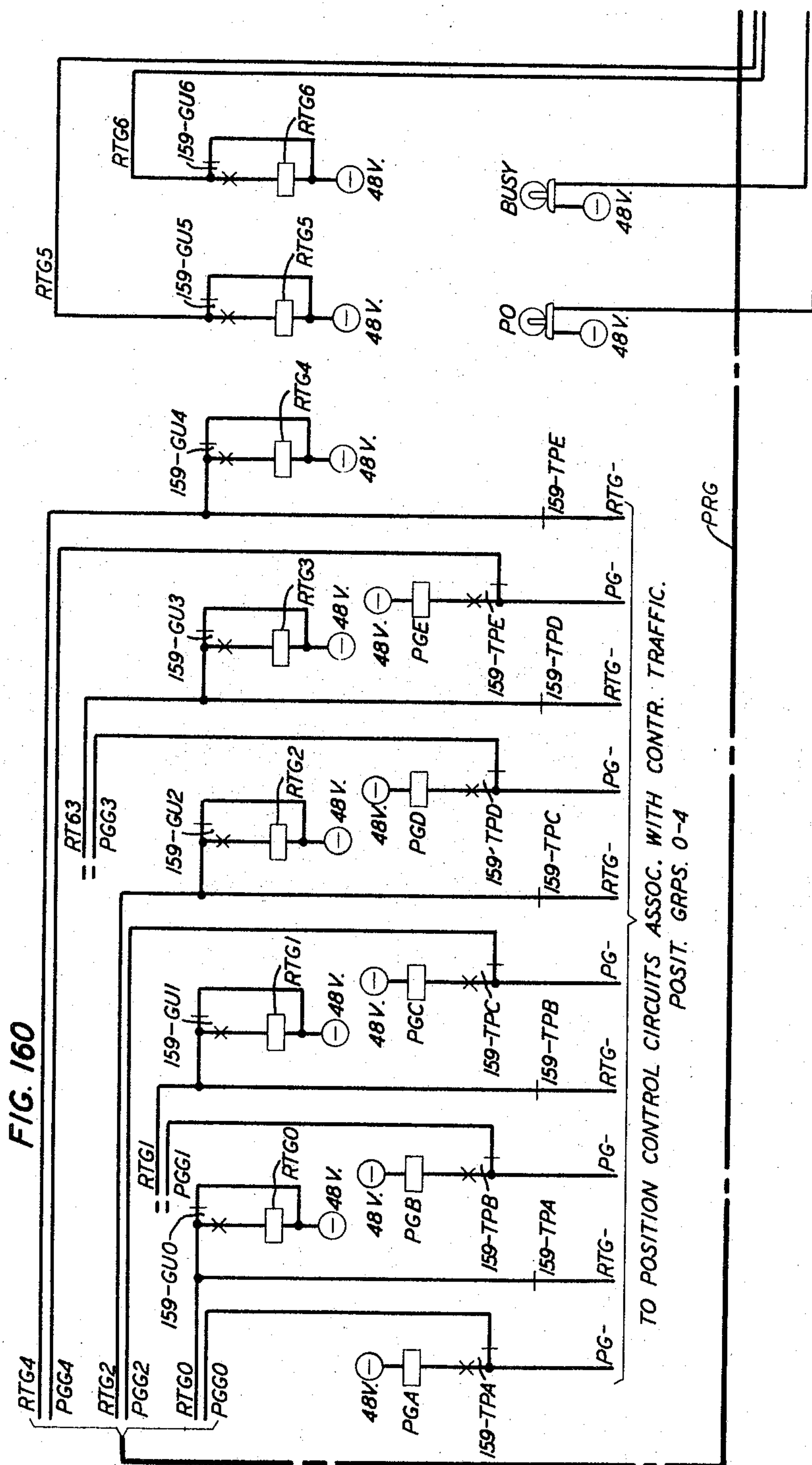
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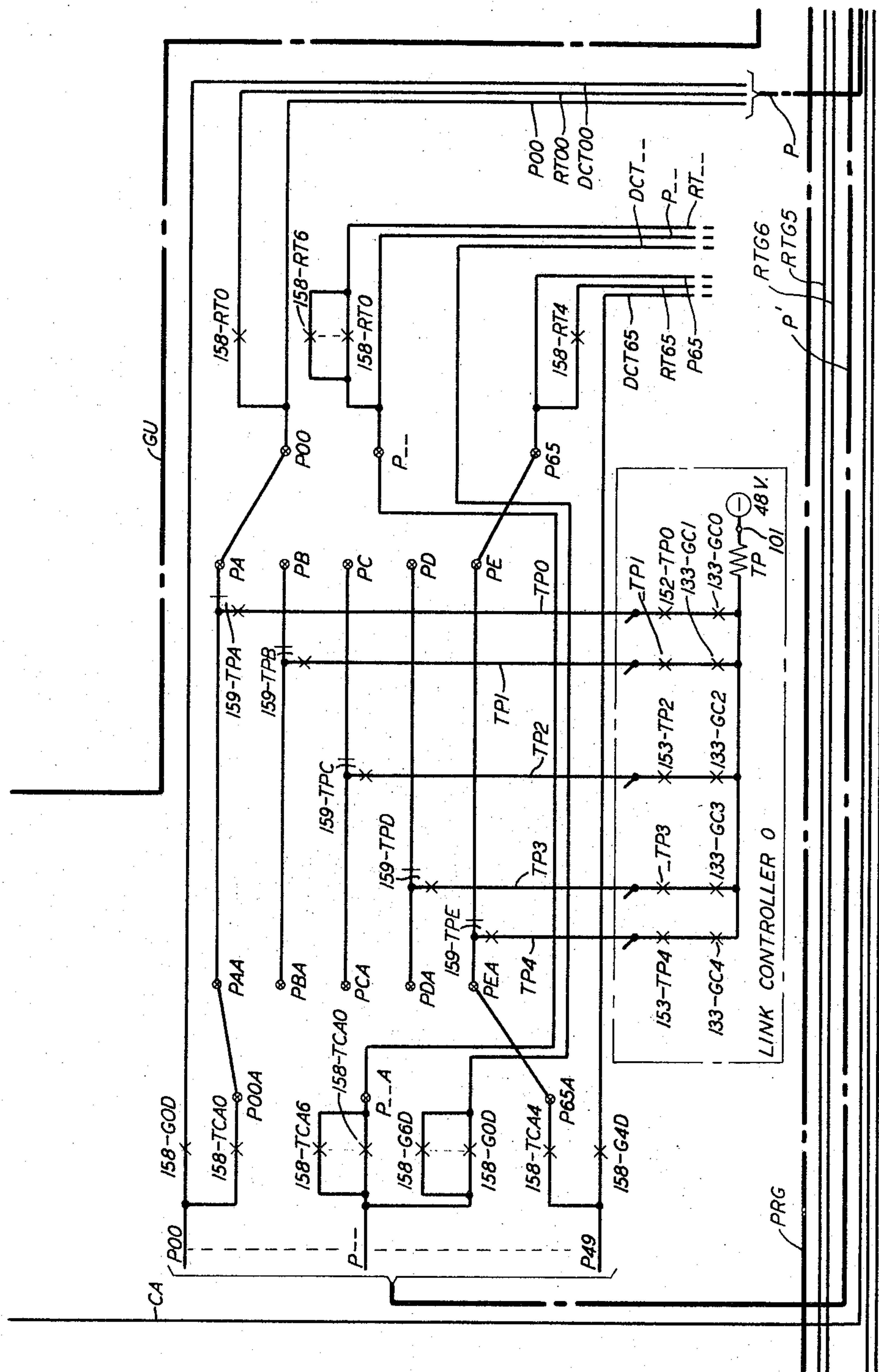
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**FIG. 161**



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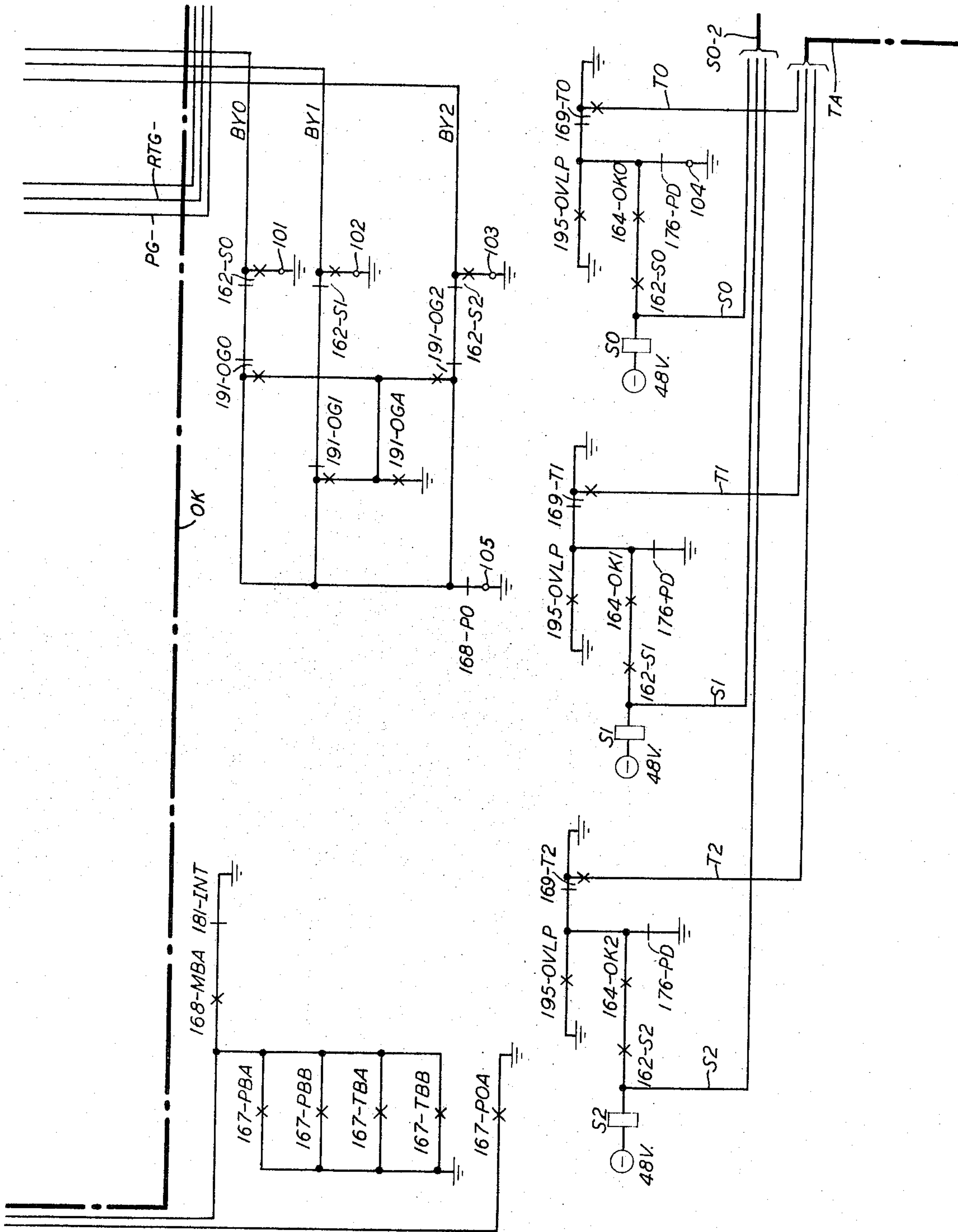


FIG. 162



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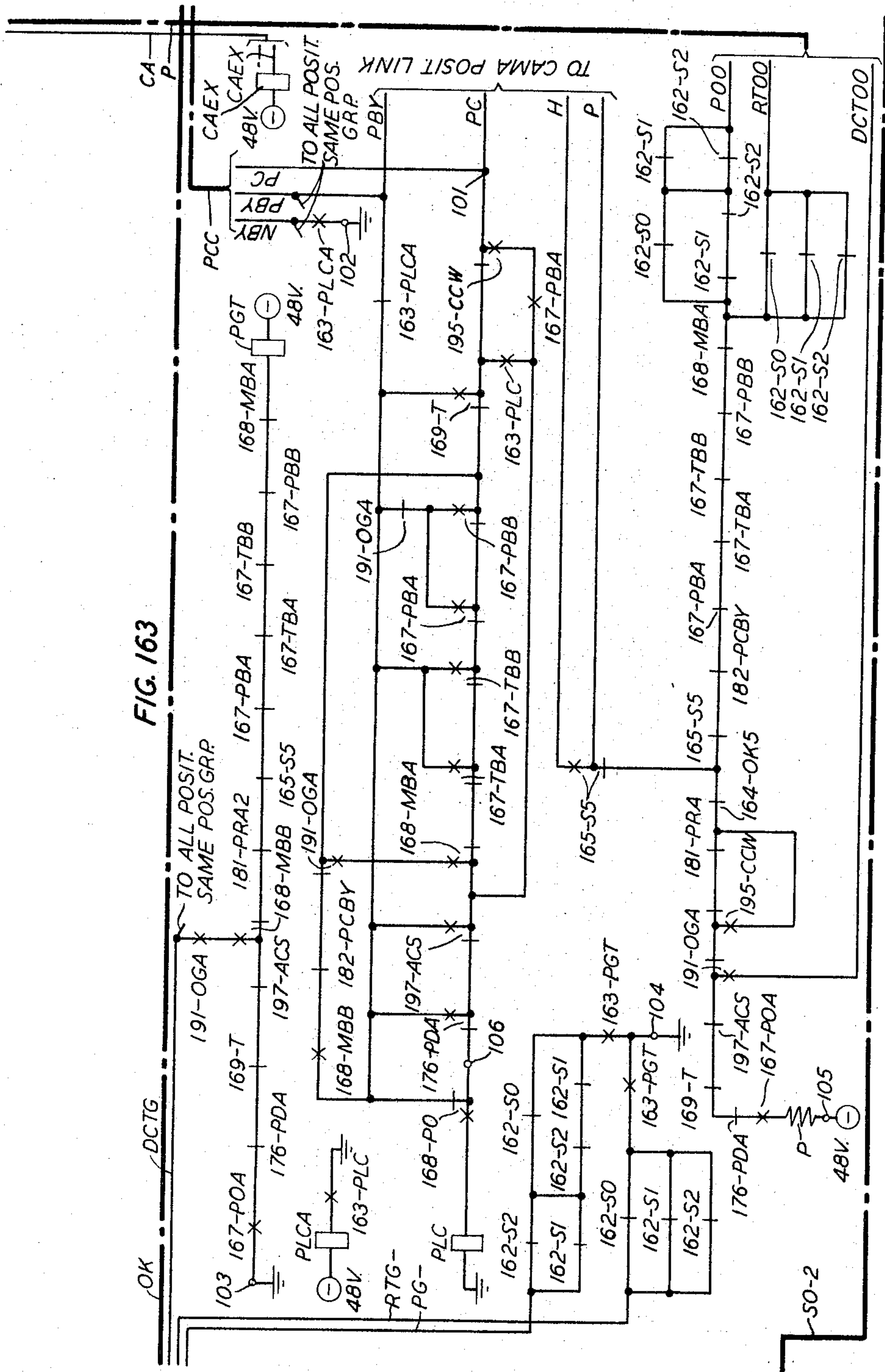
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**FIG. 163**





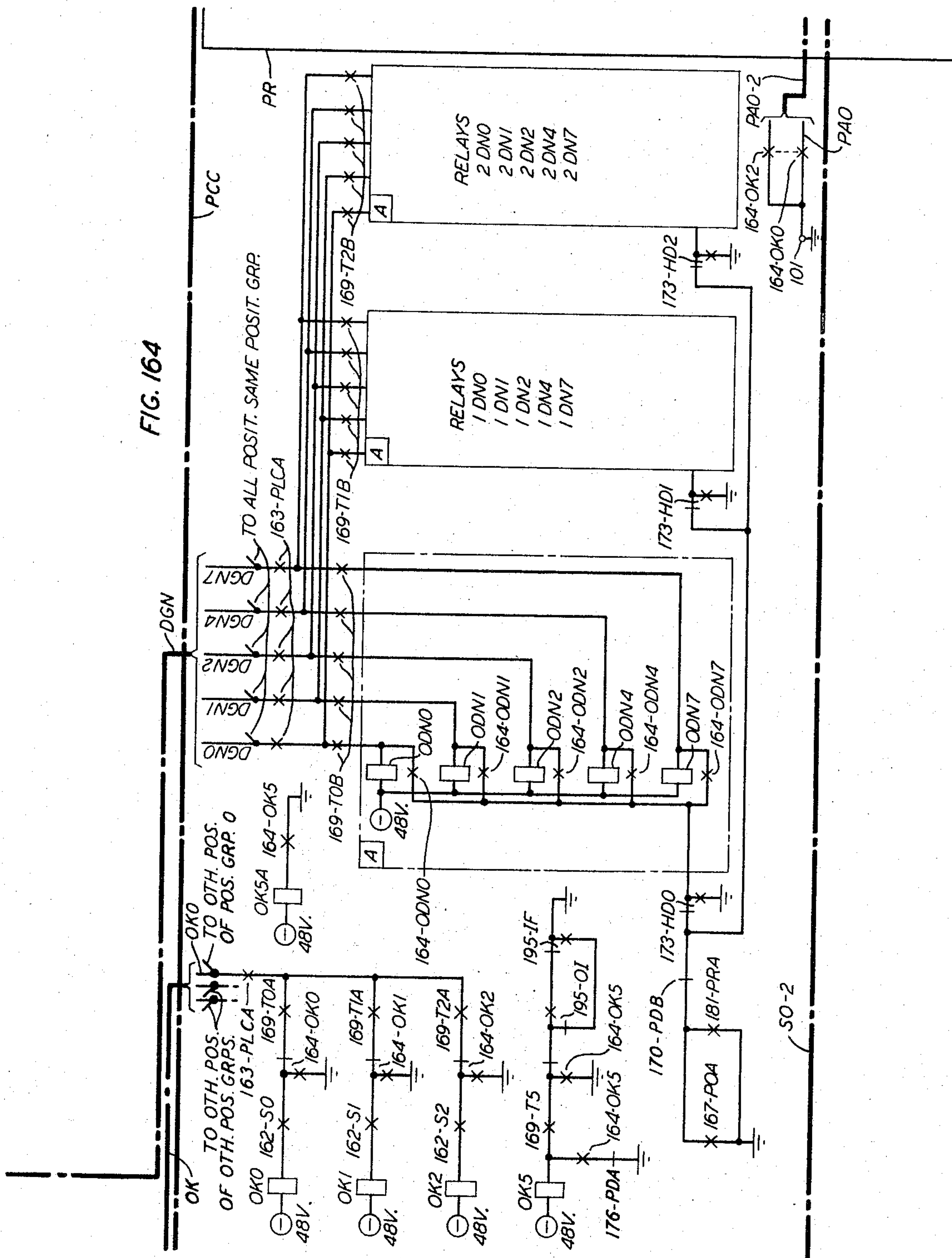
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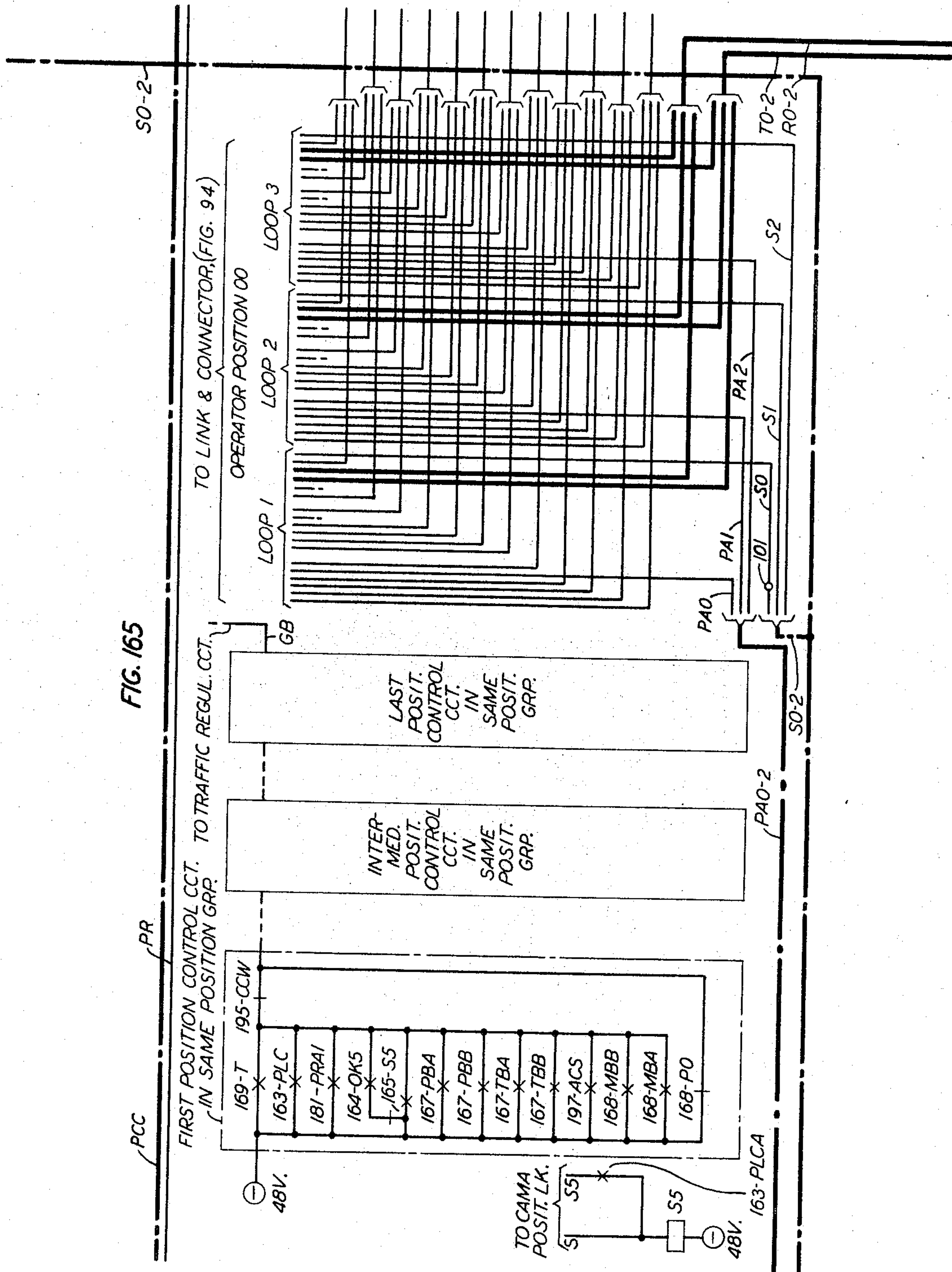
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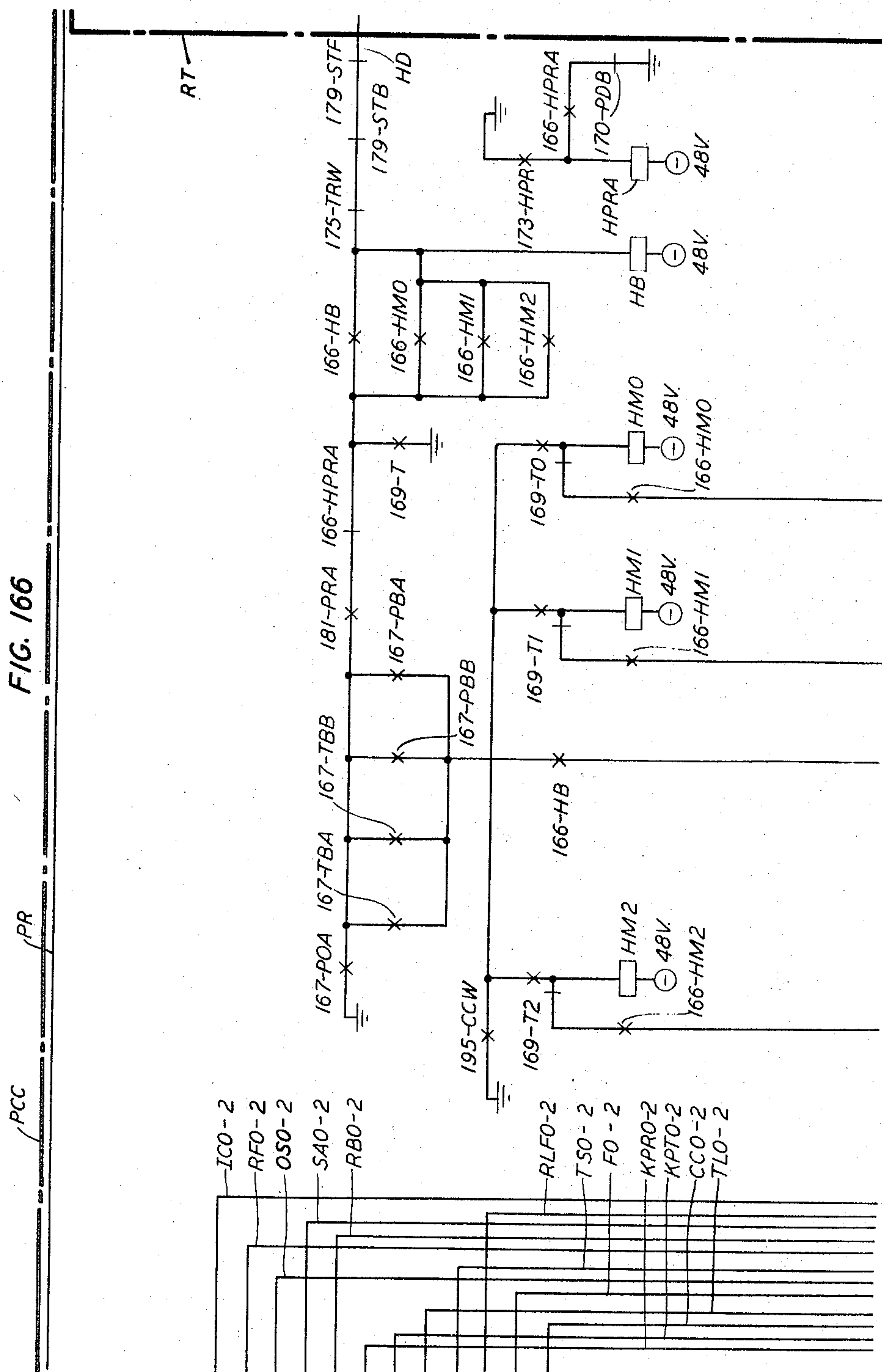
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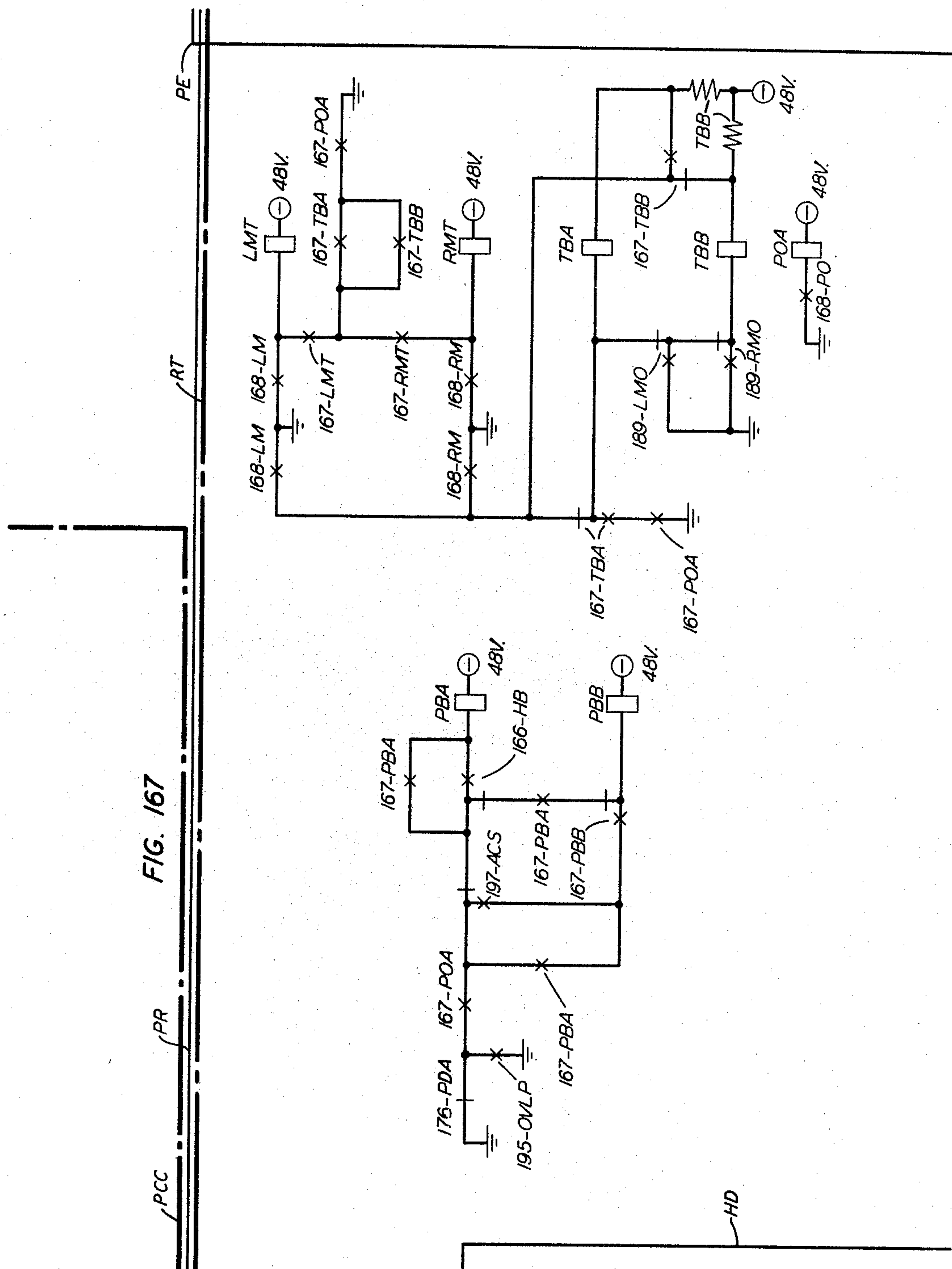
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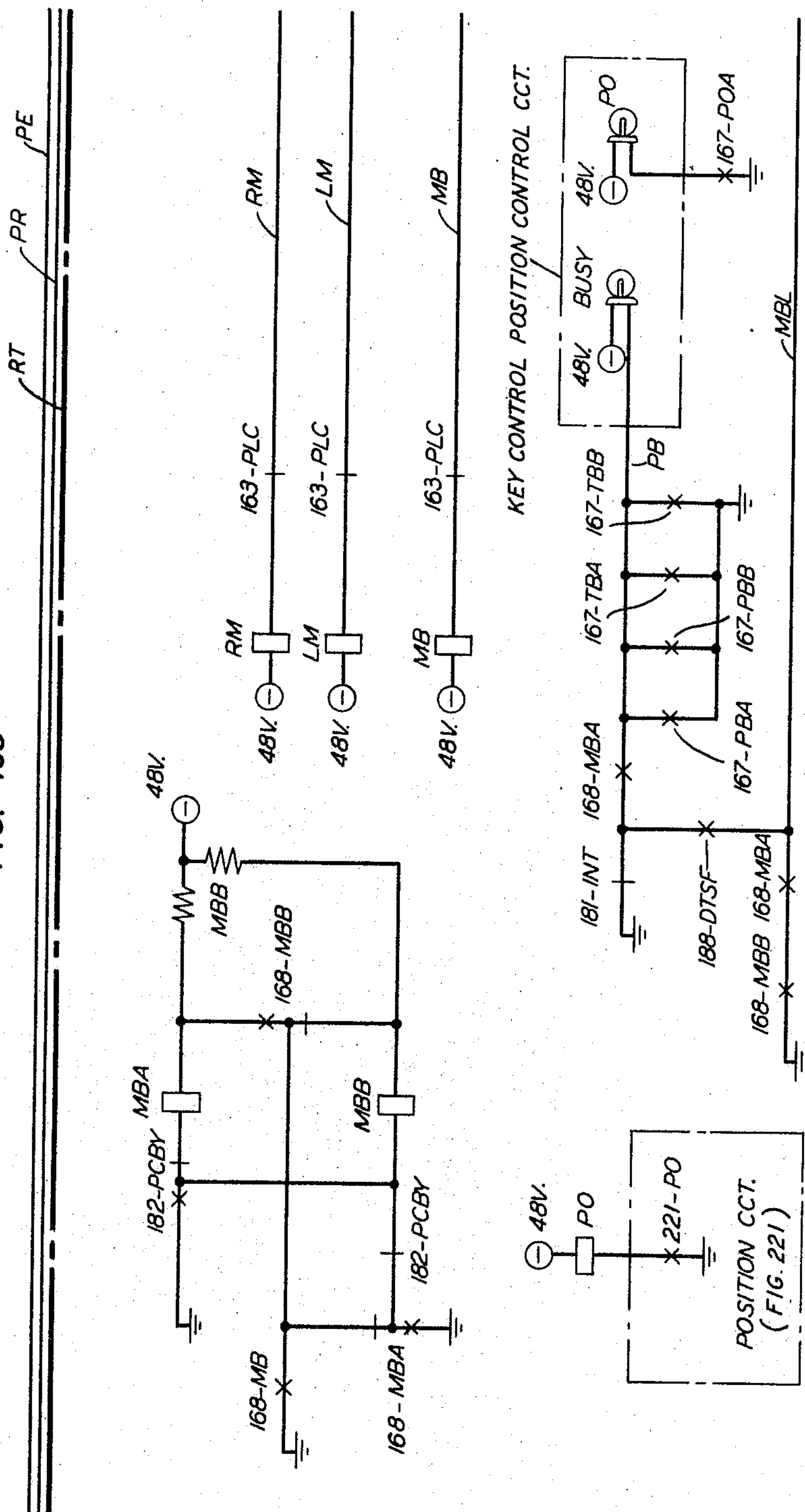
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FIG. 168





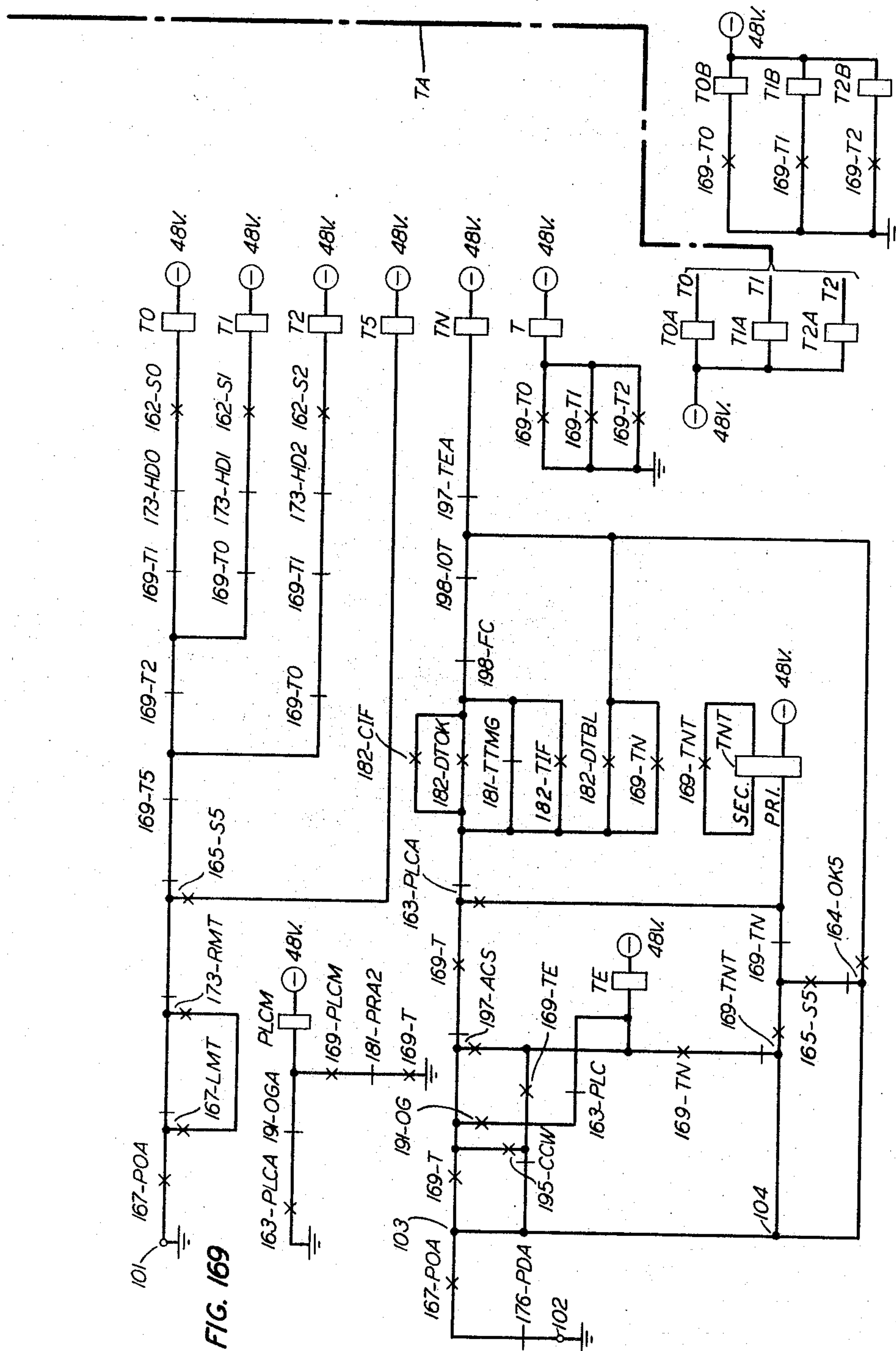
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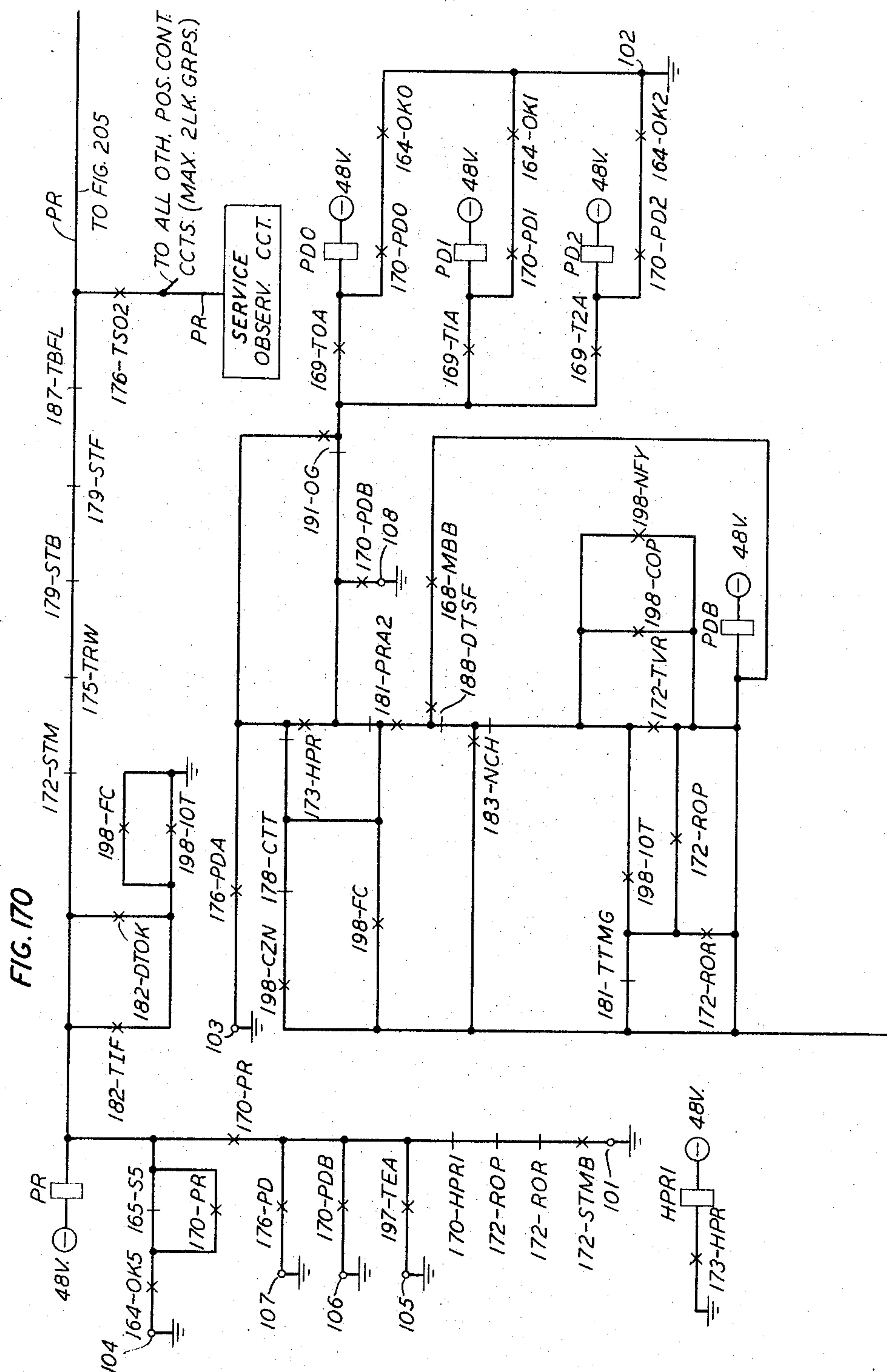
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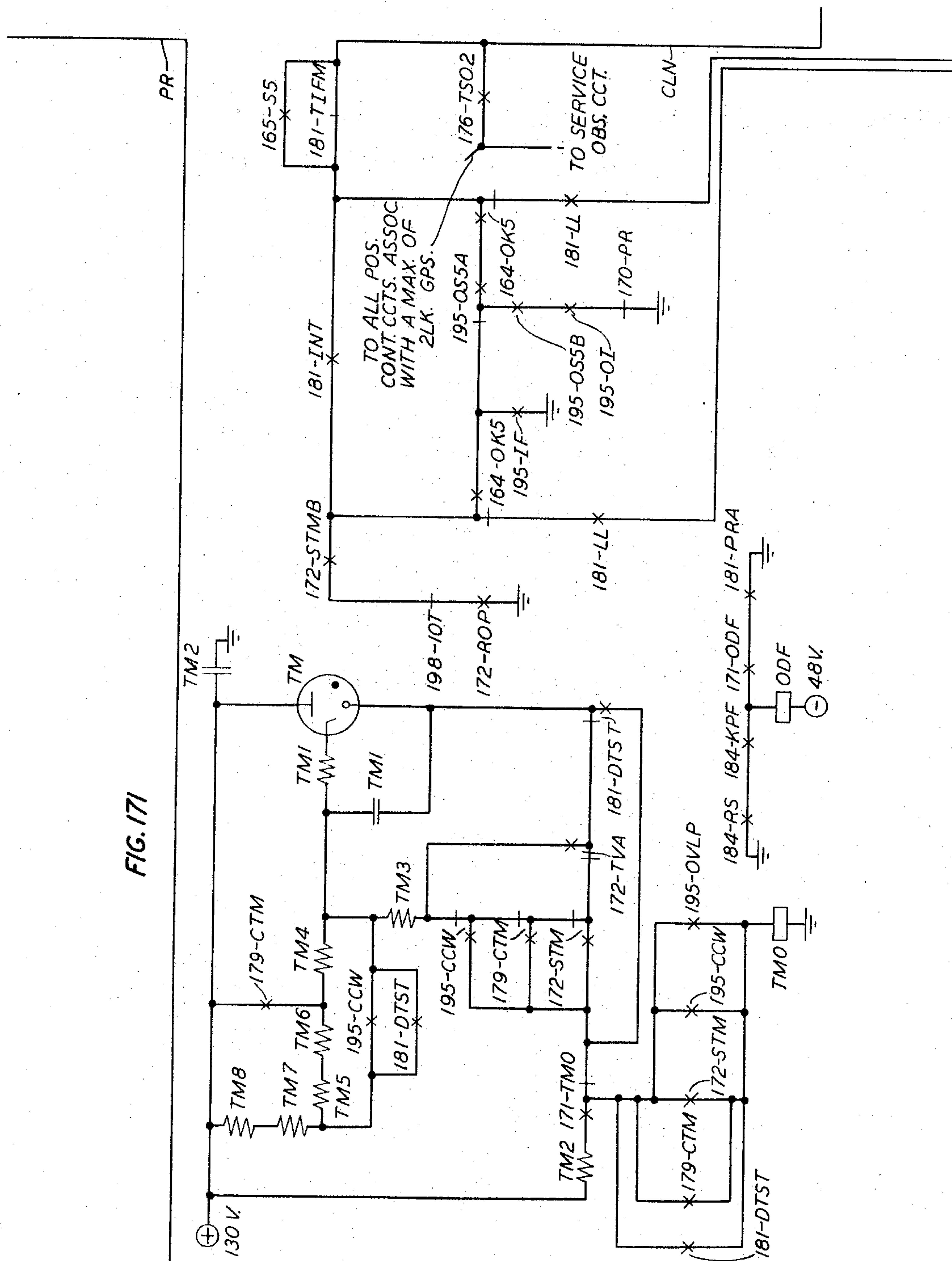
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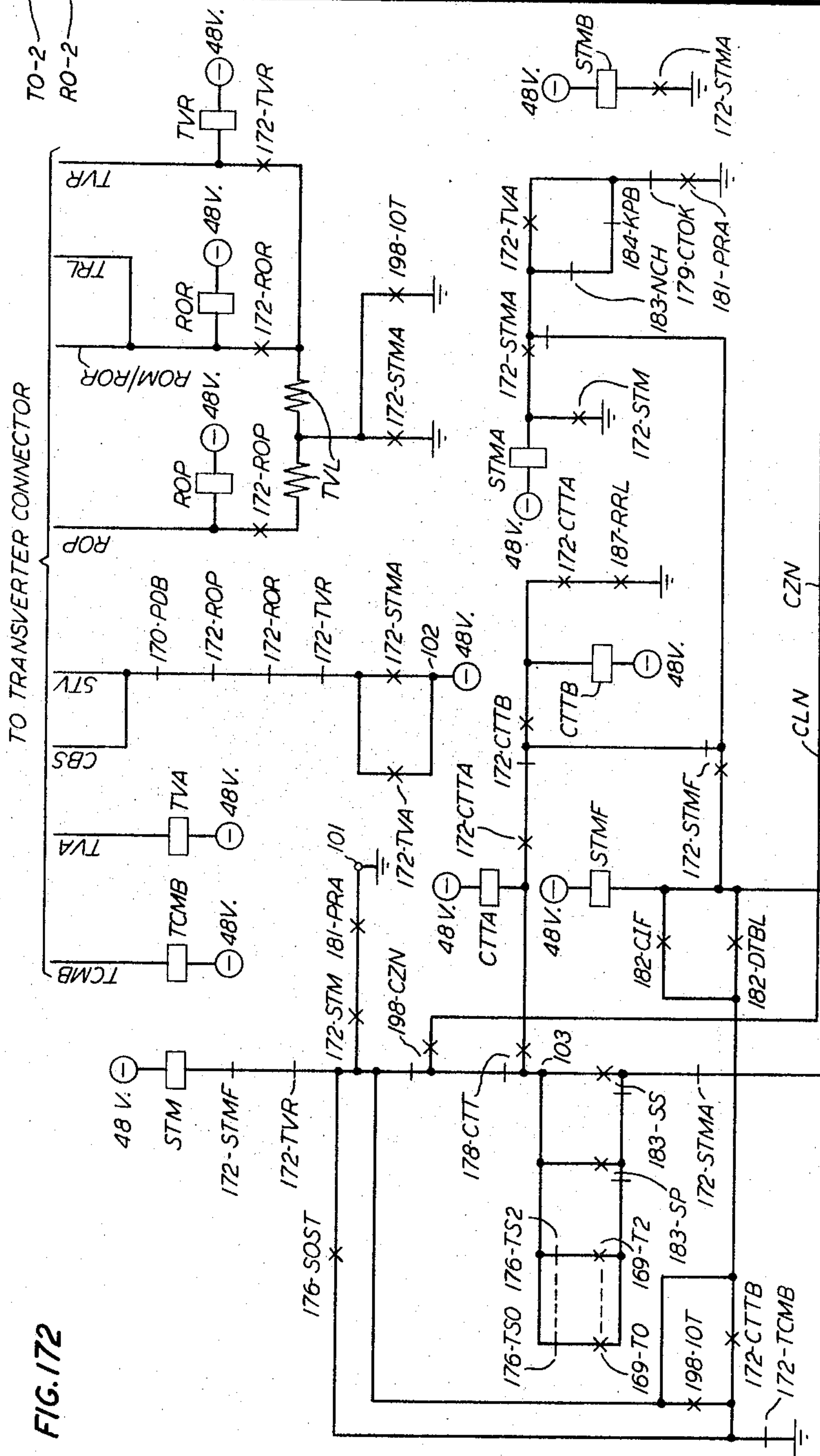


FIG. 172



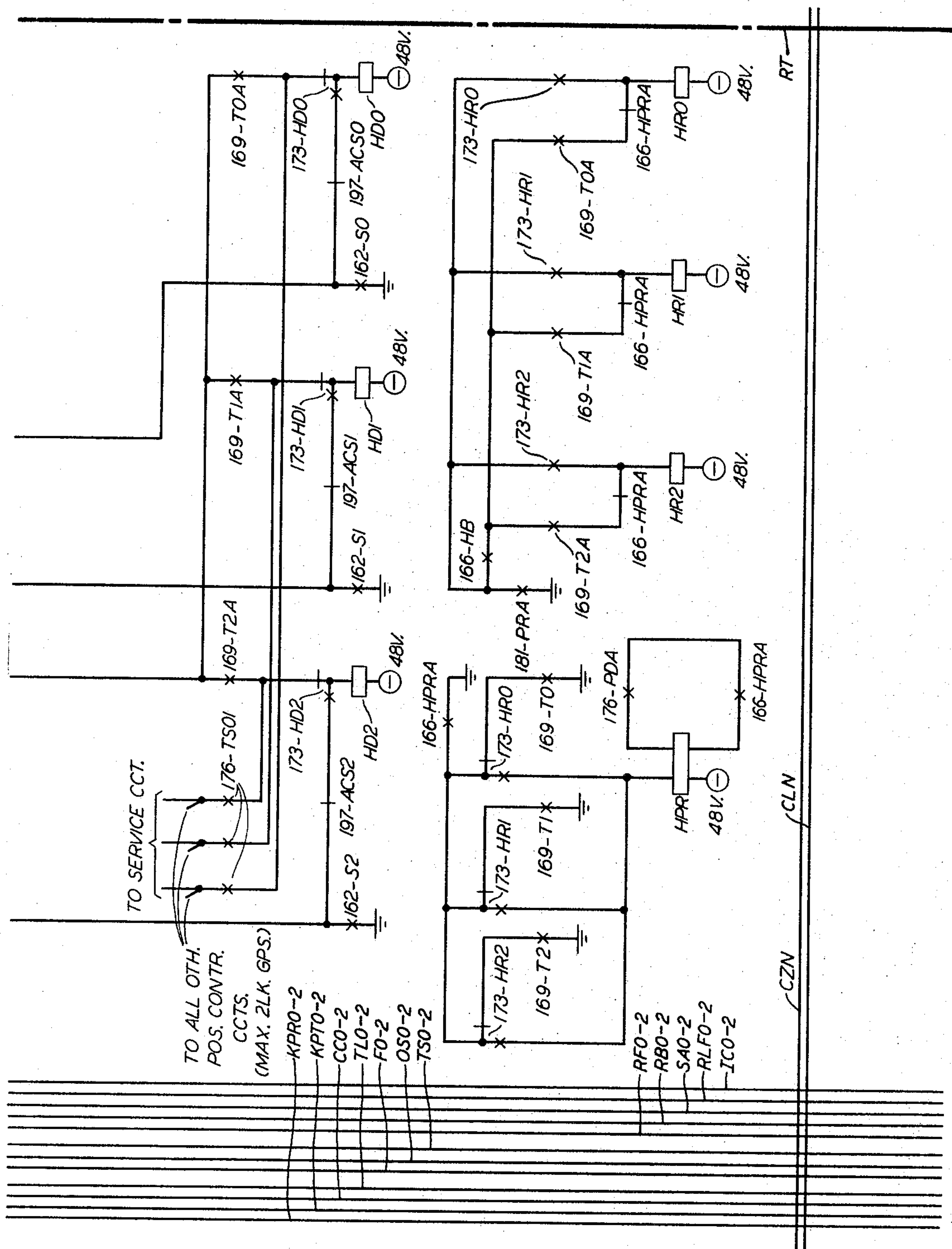
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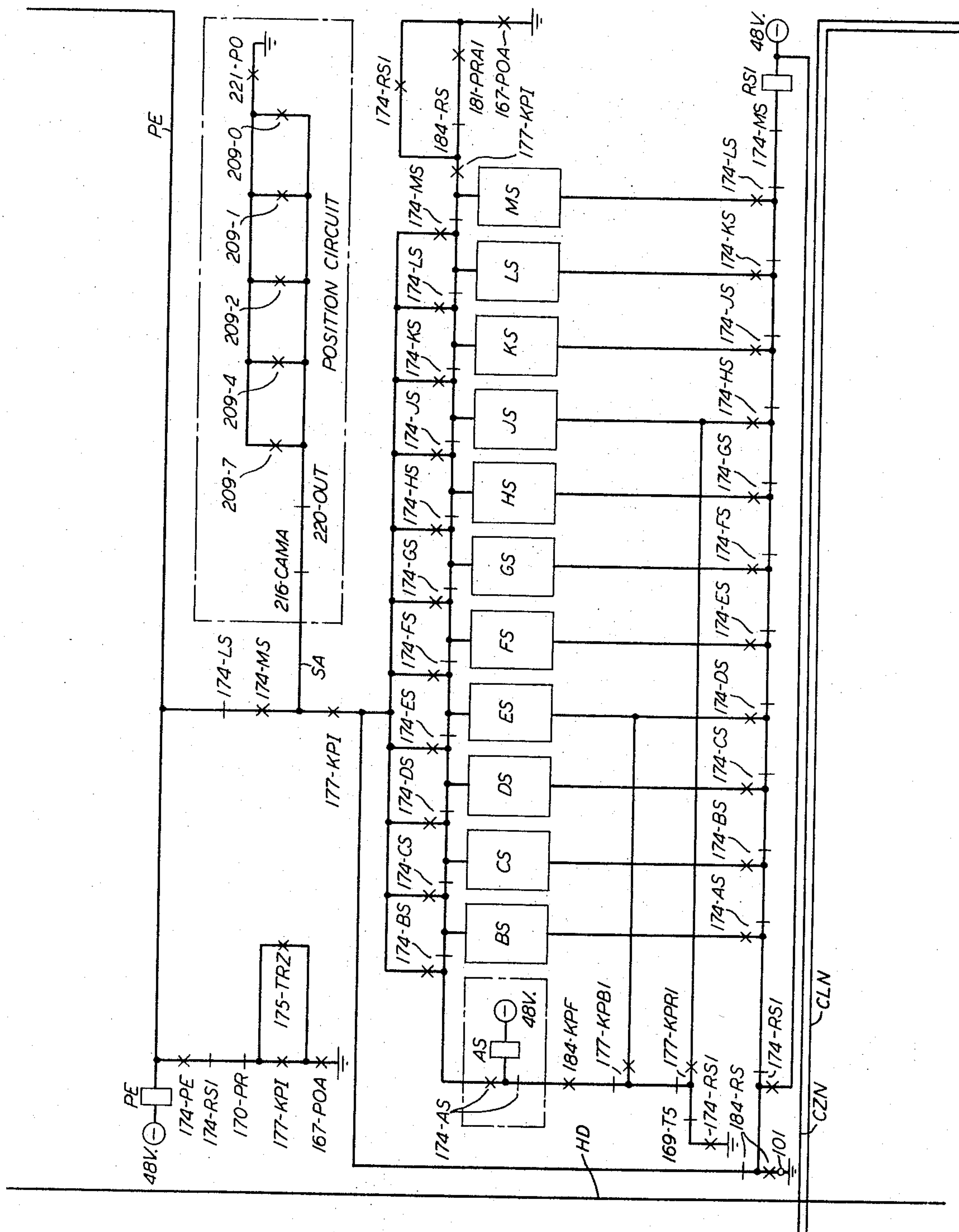
**FIG. 173**



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**FIG. 174**



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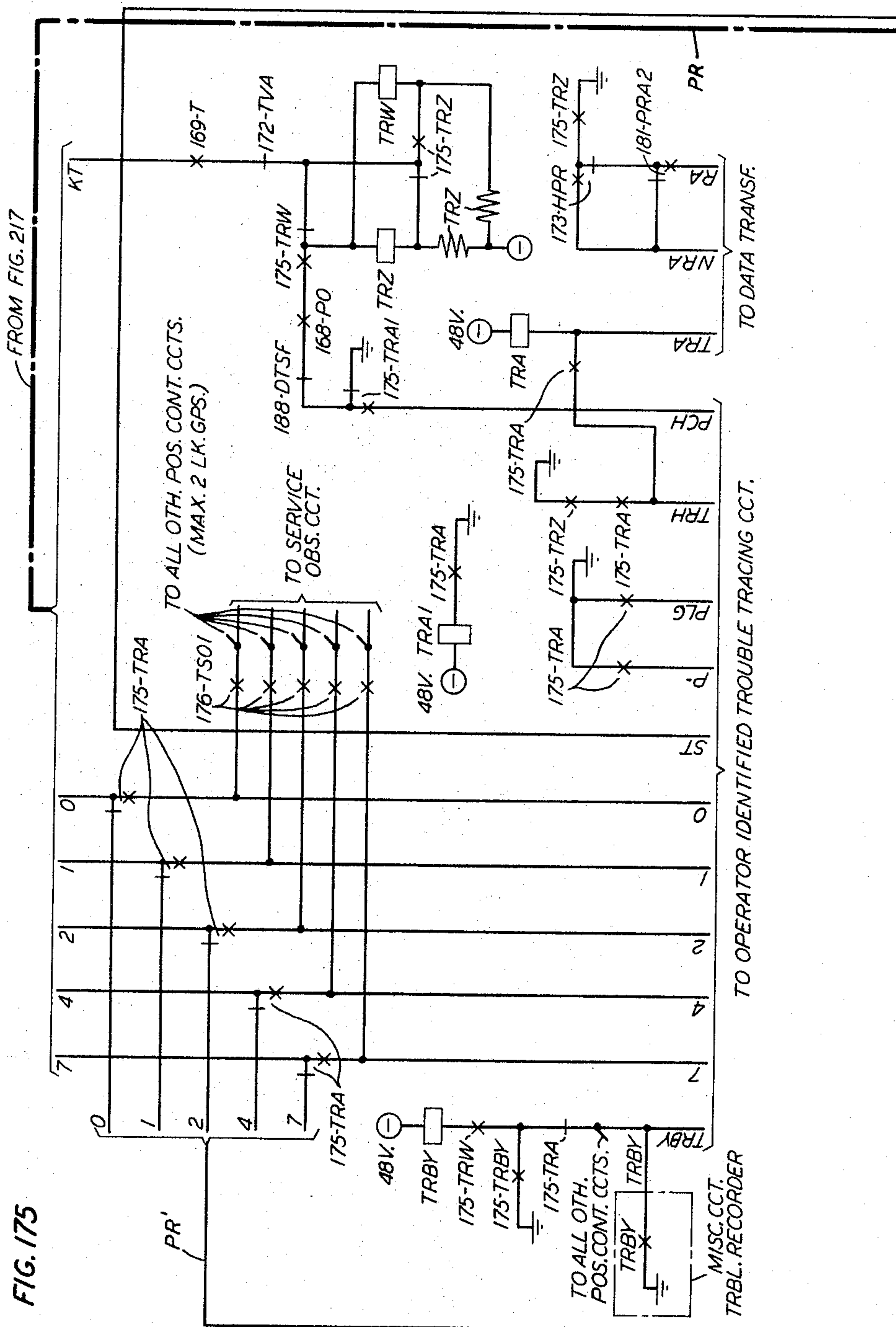
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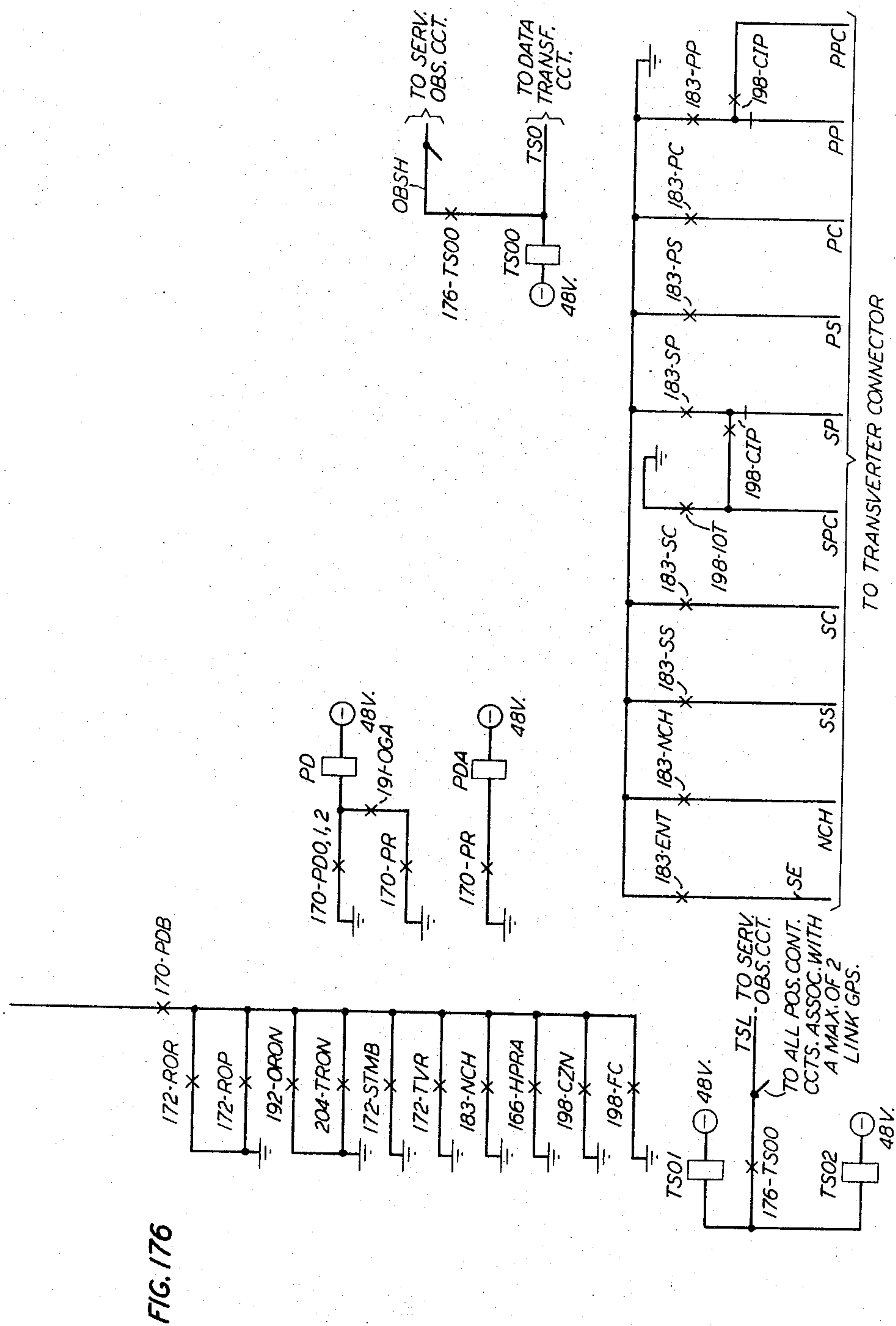
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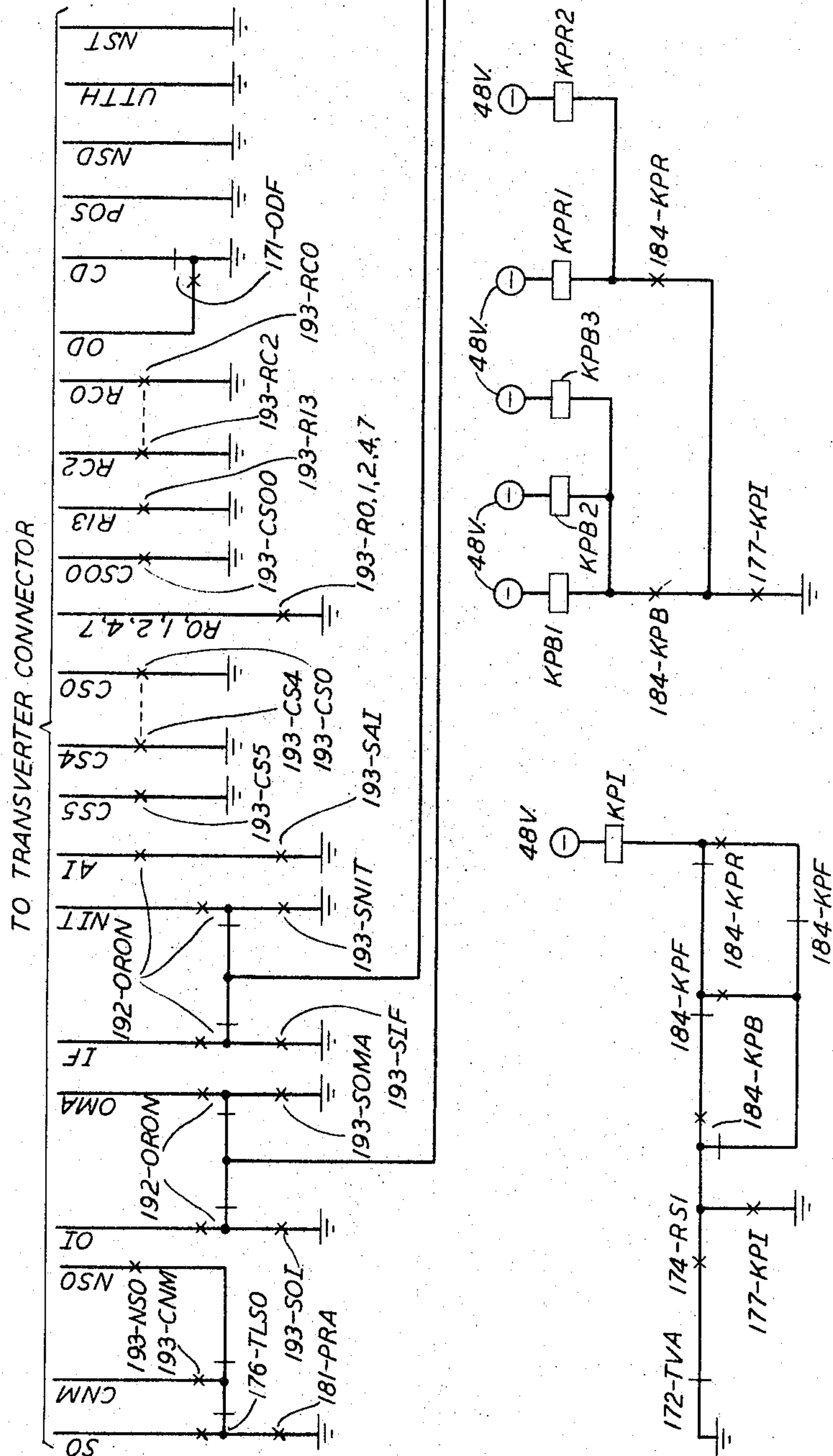
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FIG. 177





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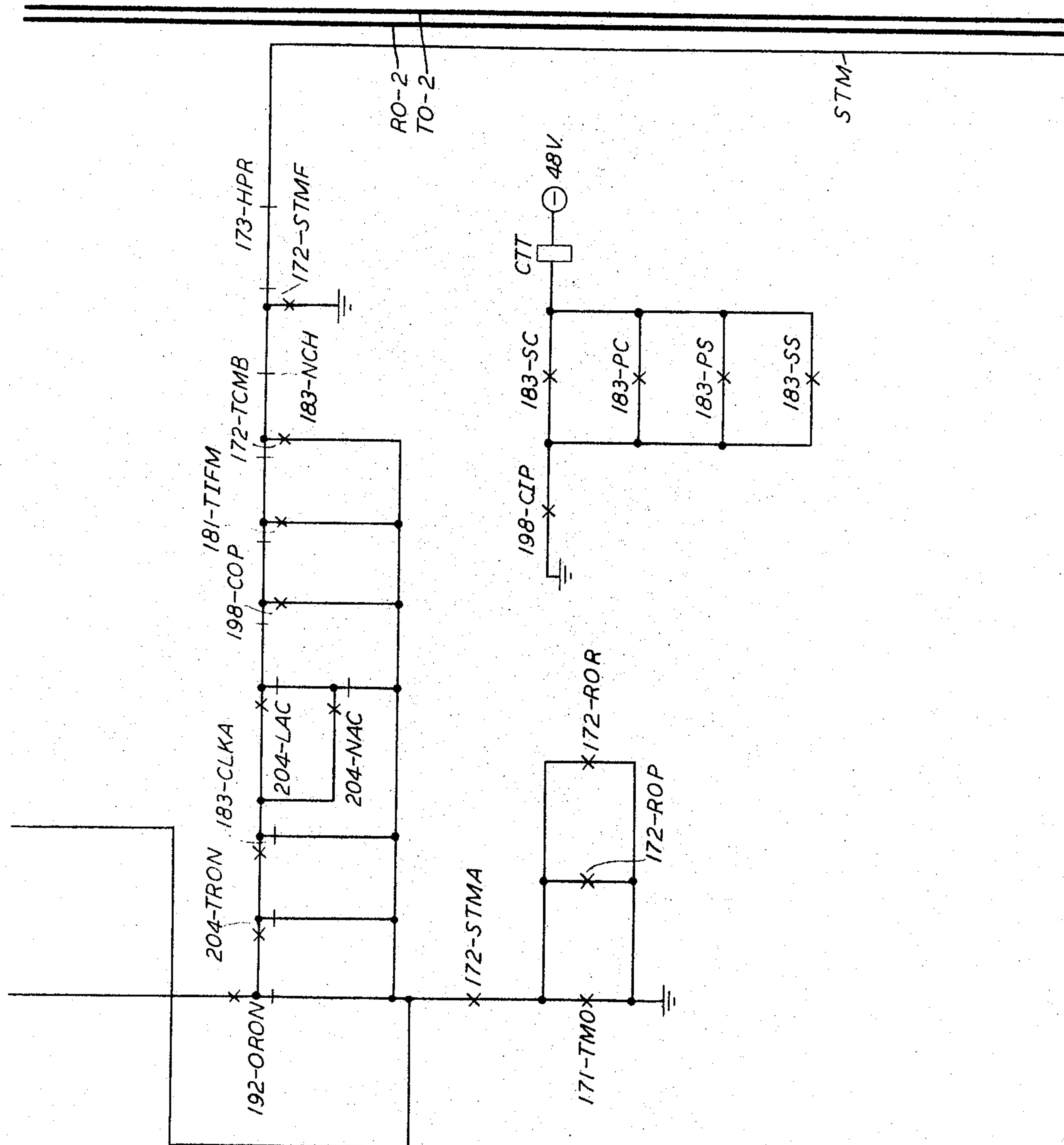


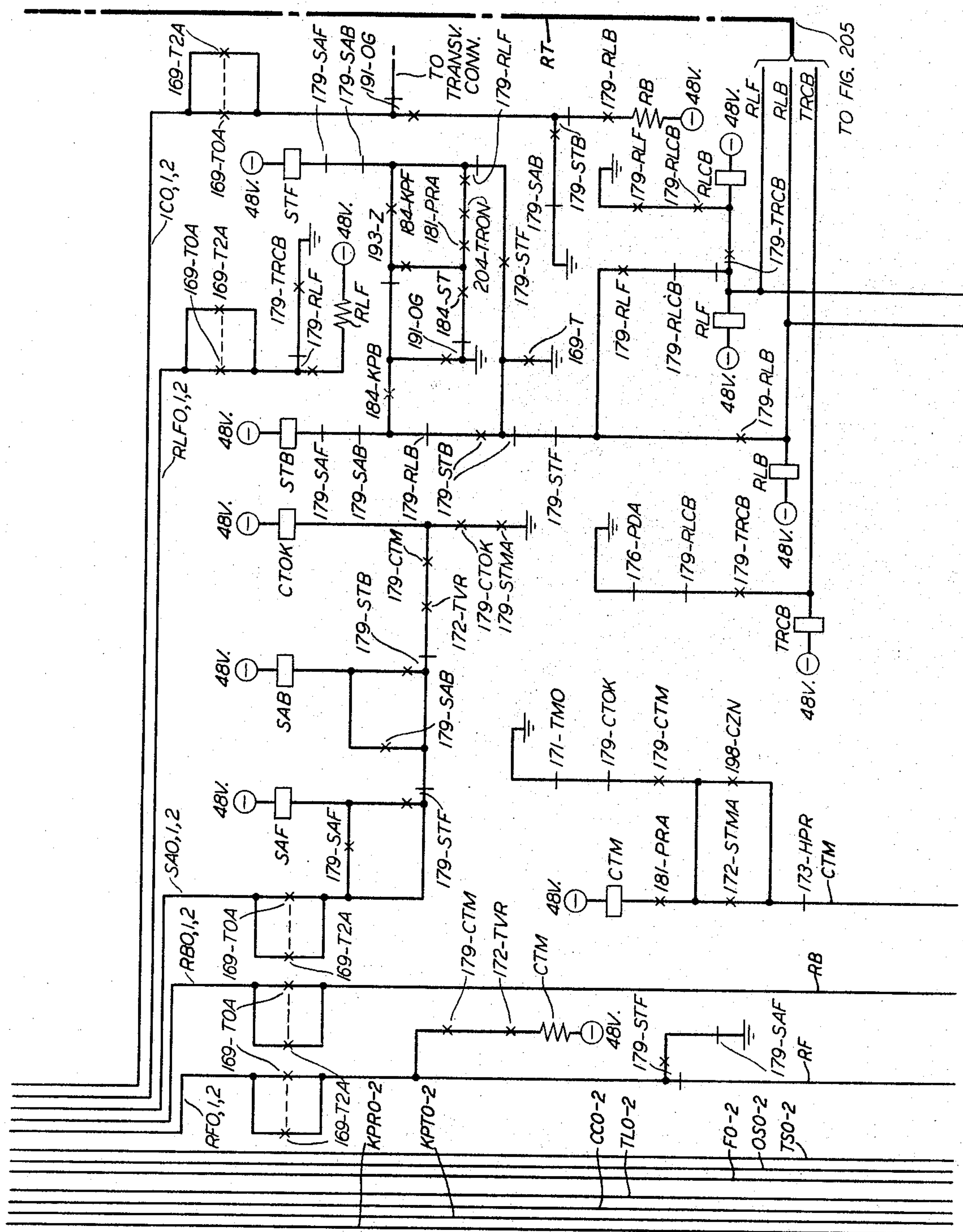
FIG. 178



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**FIG. 179**



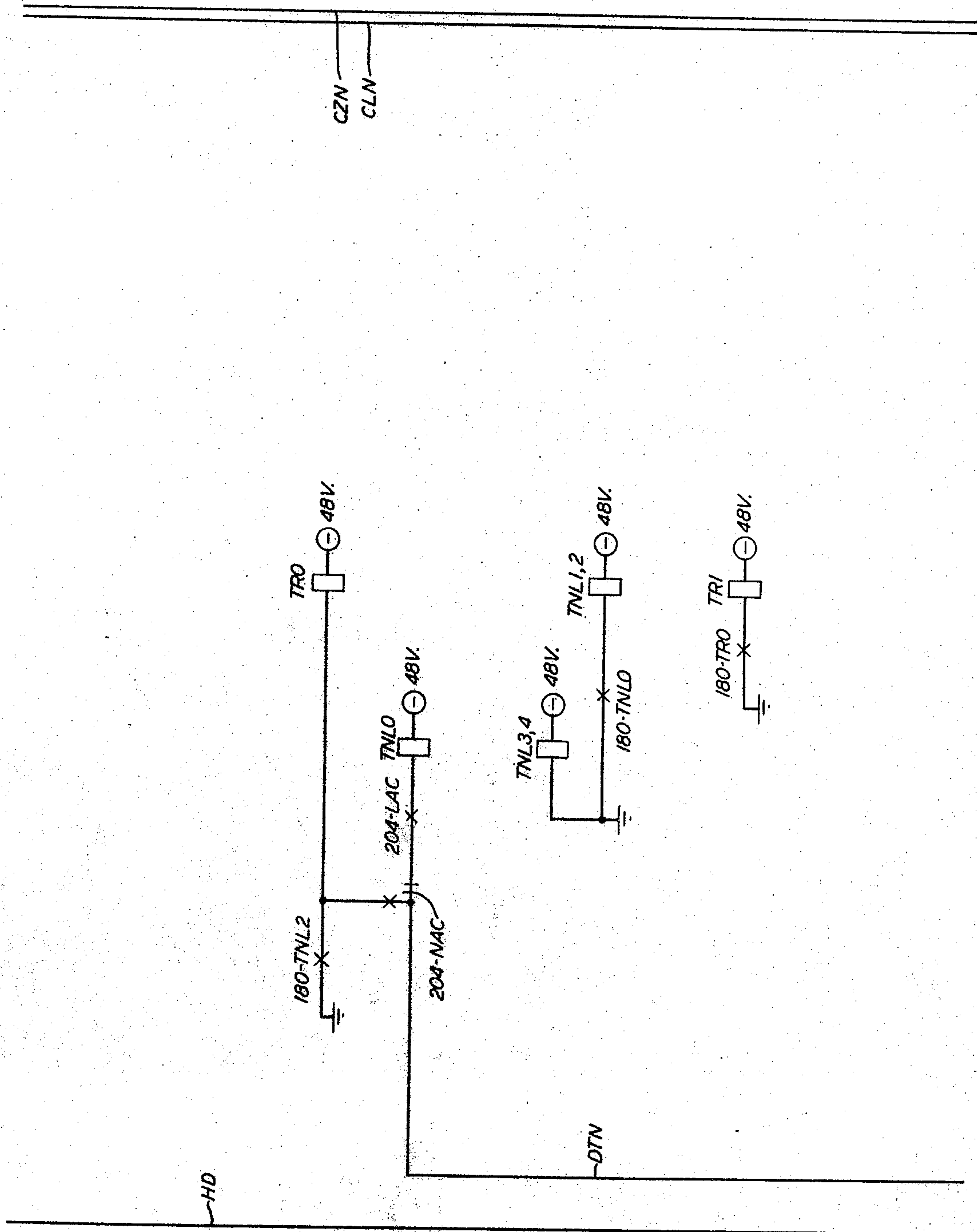
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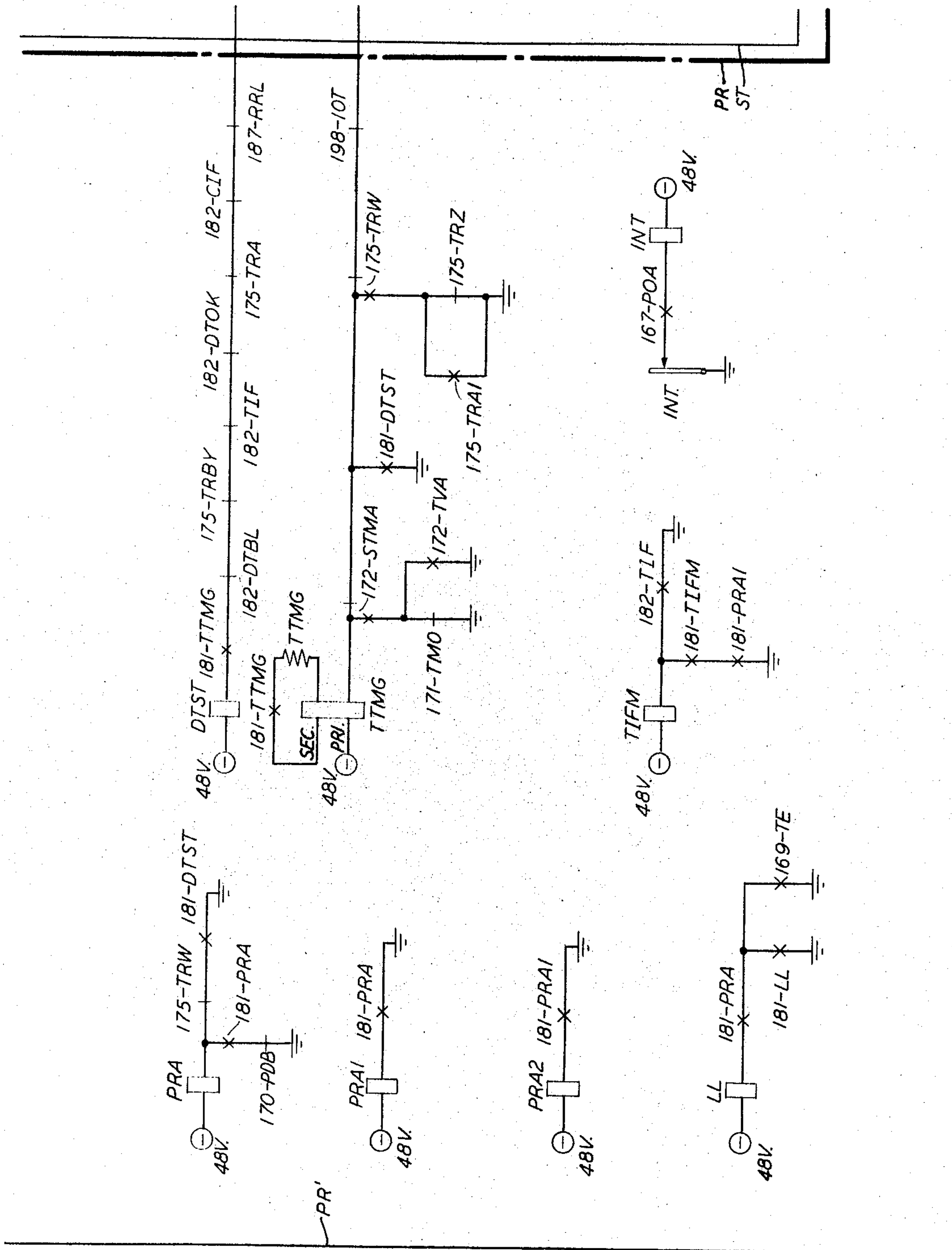


FIG. 181



**Sept. 12, 1967**

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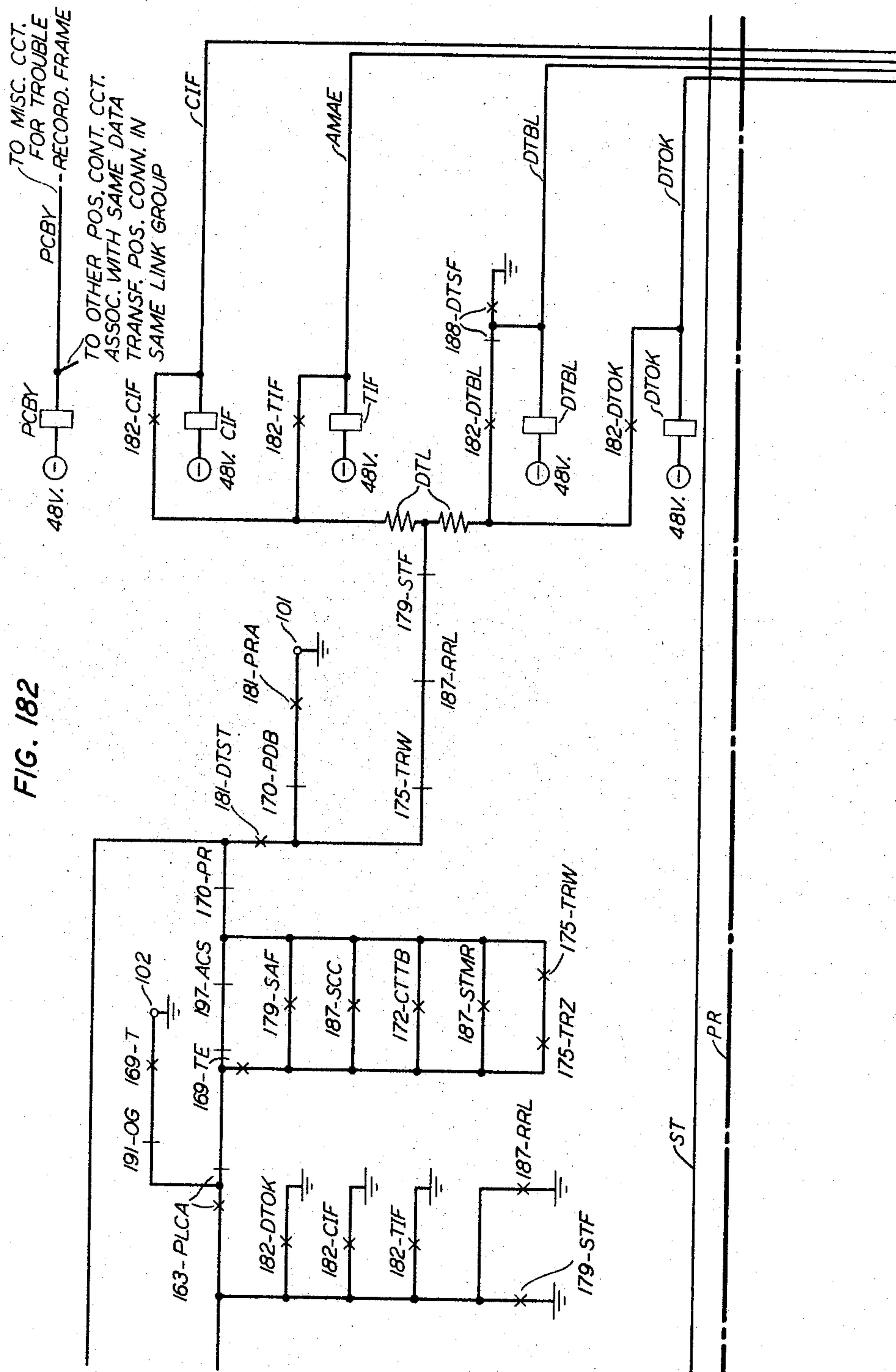
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**FIG. 182**





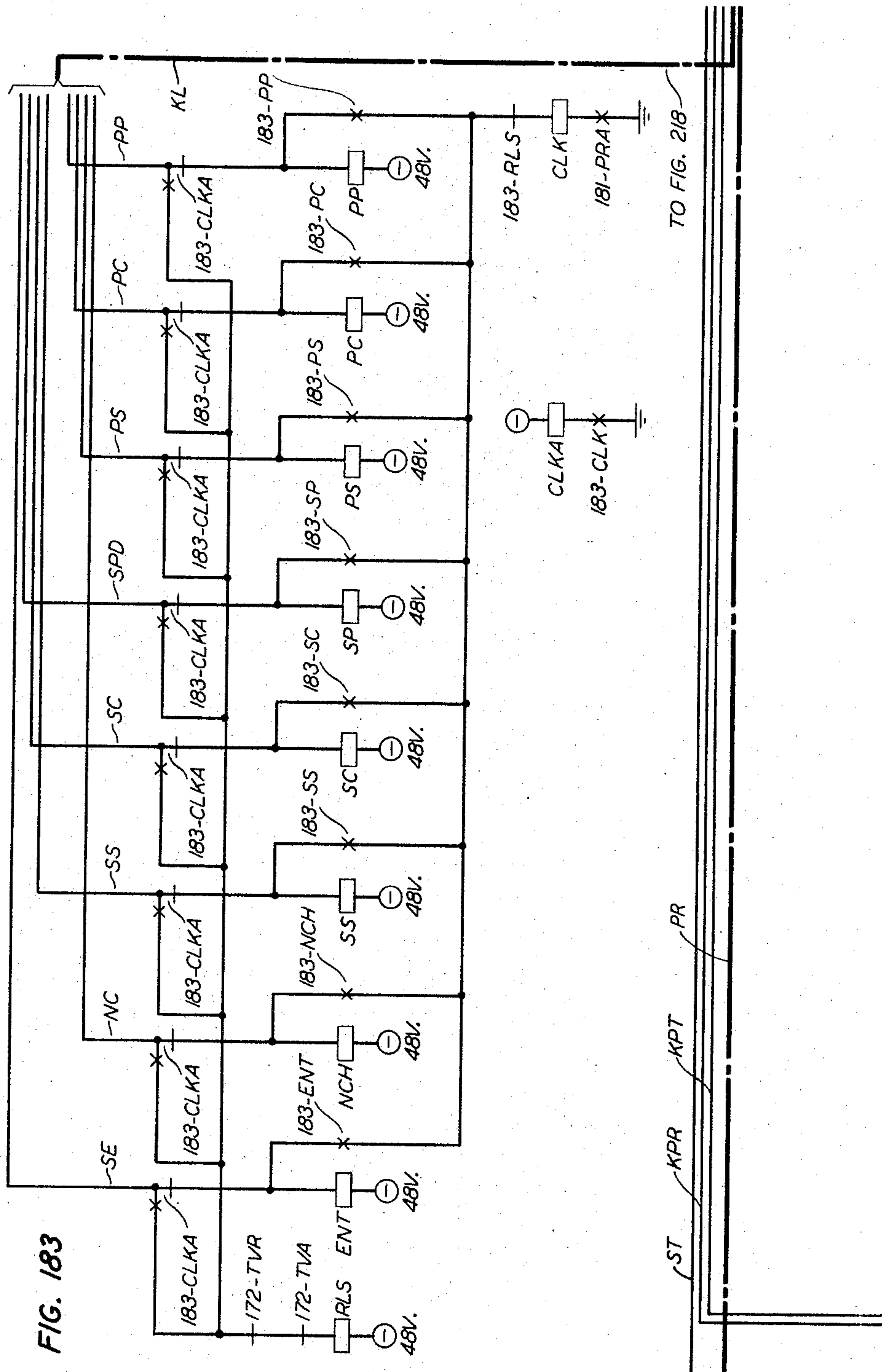
**Sept. 12, 1967**

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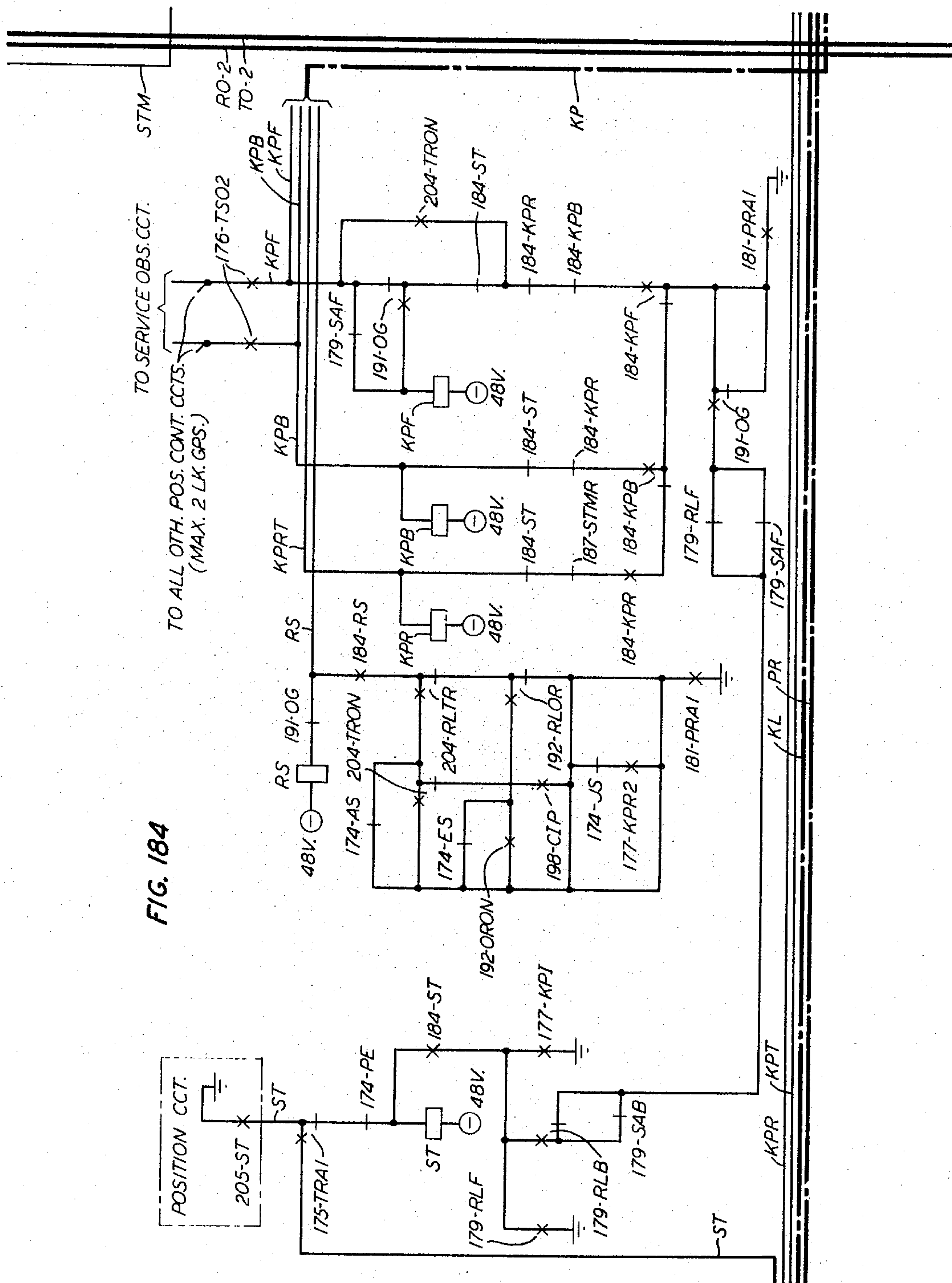
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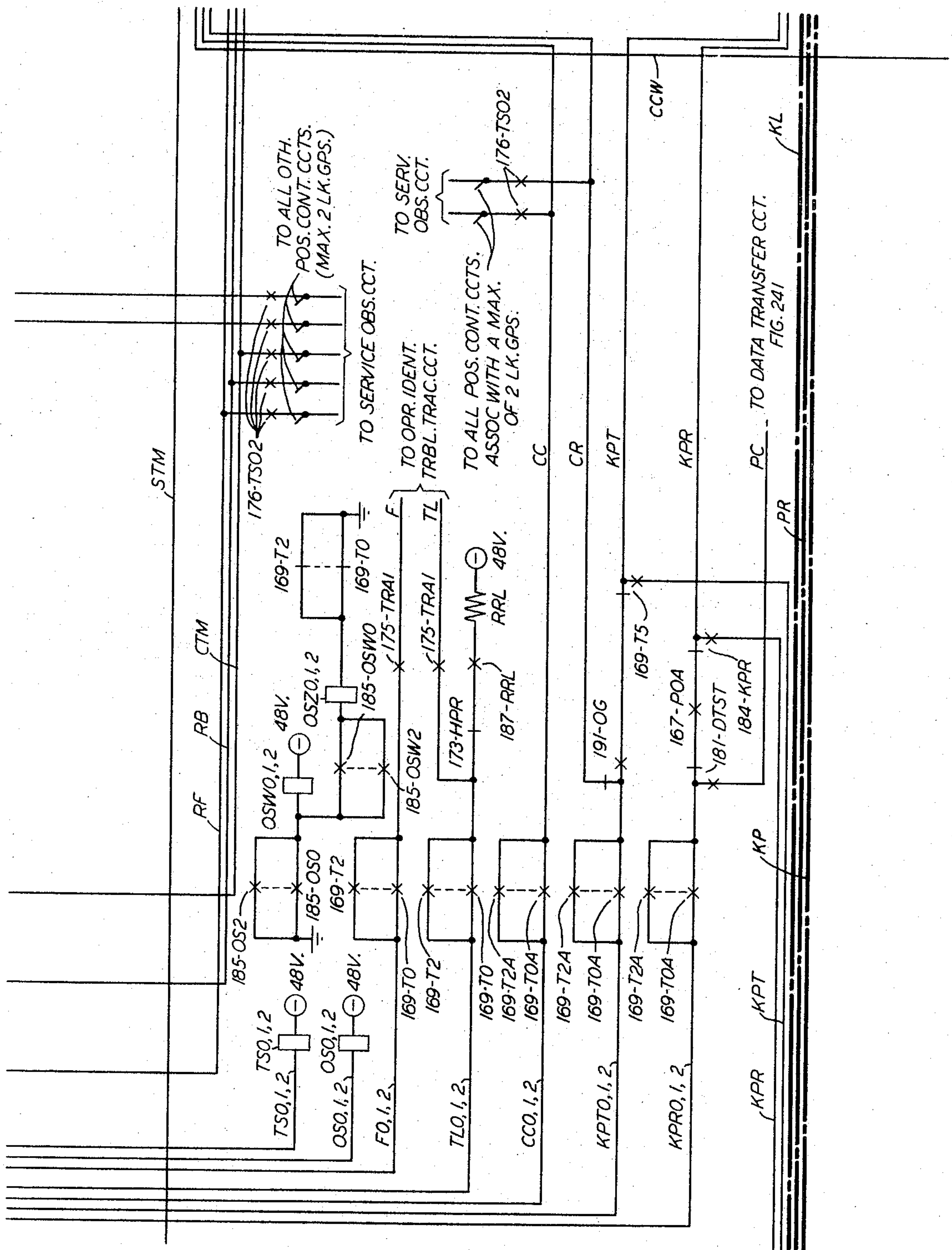


FIG. 185



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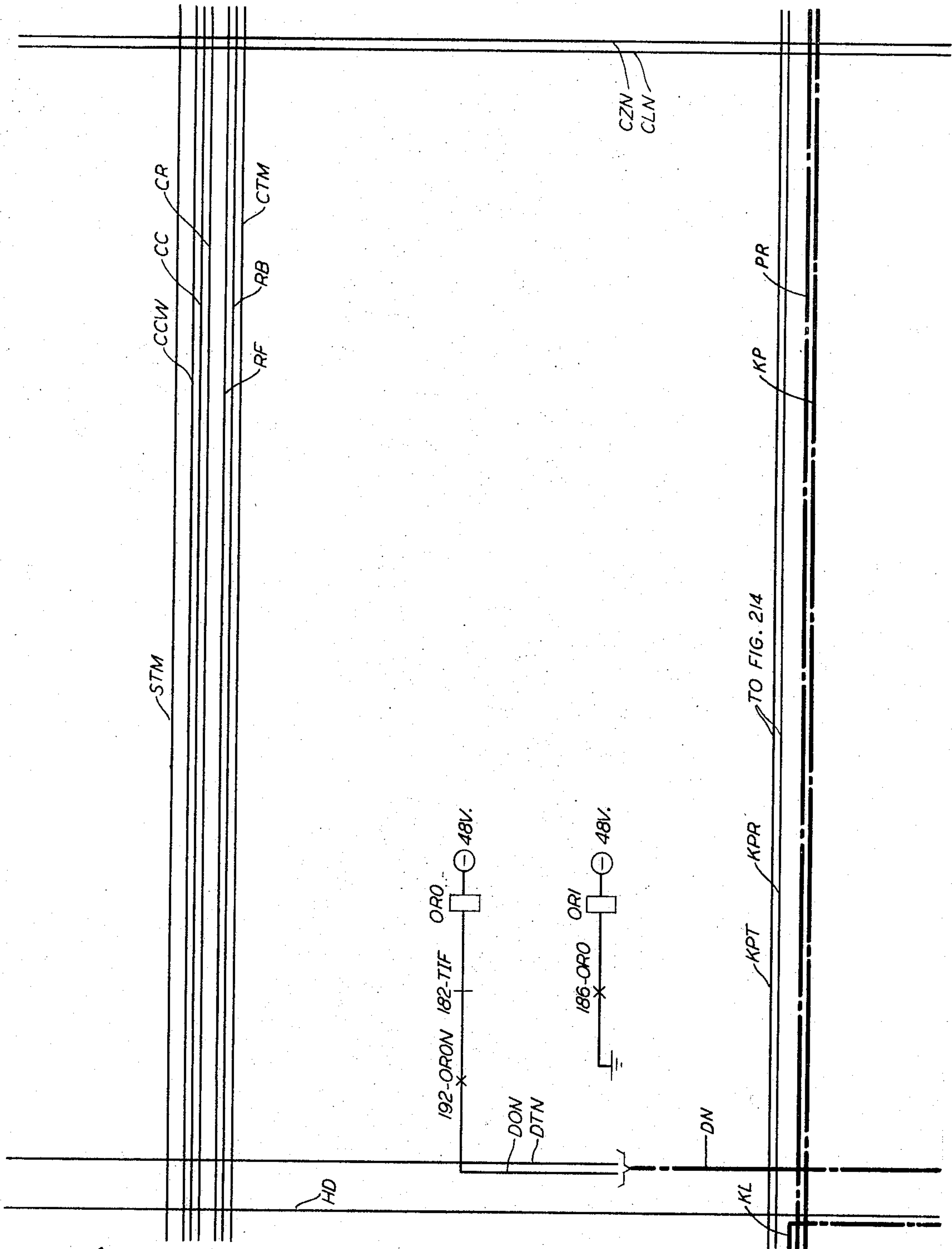


FIG. 186



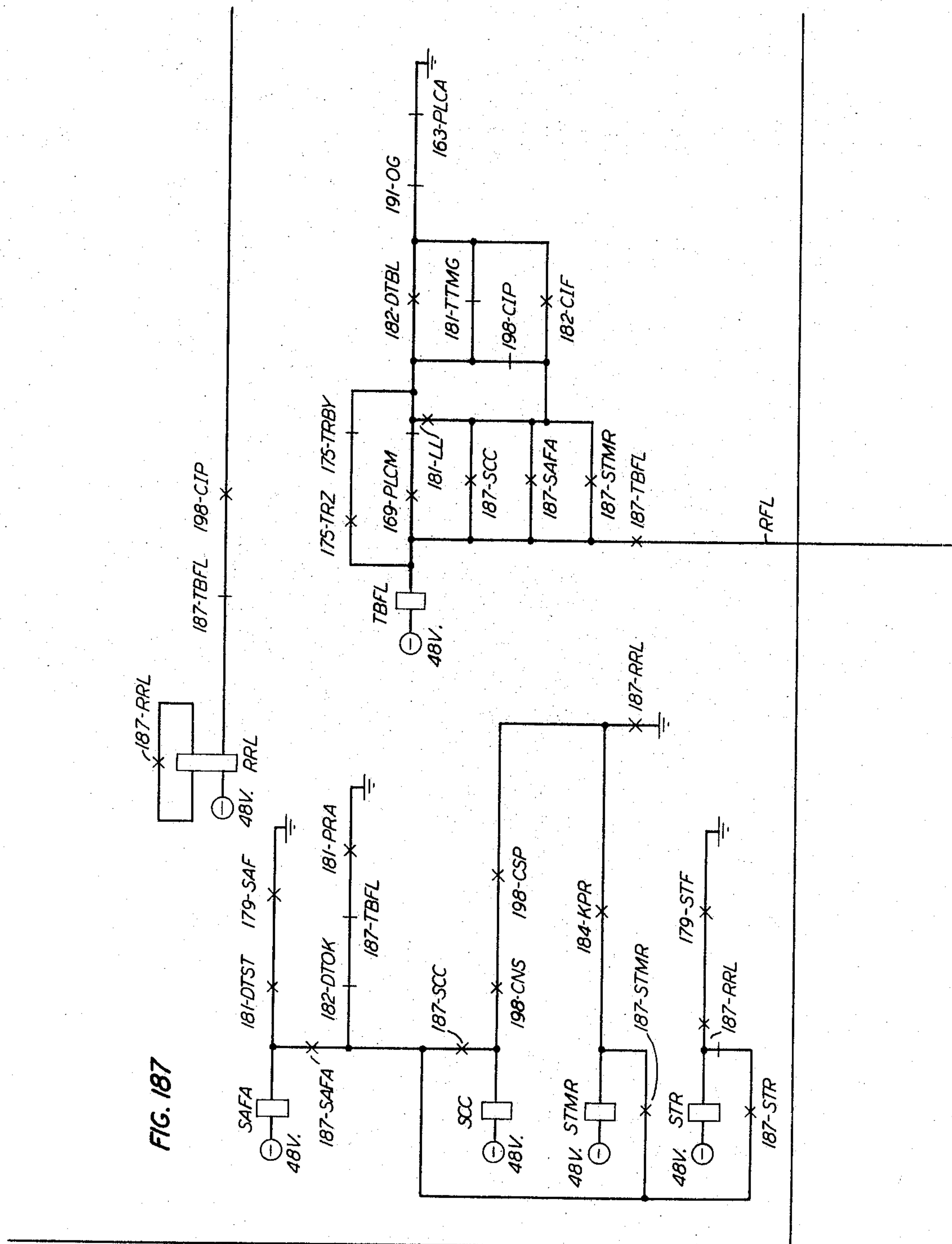
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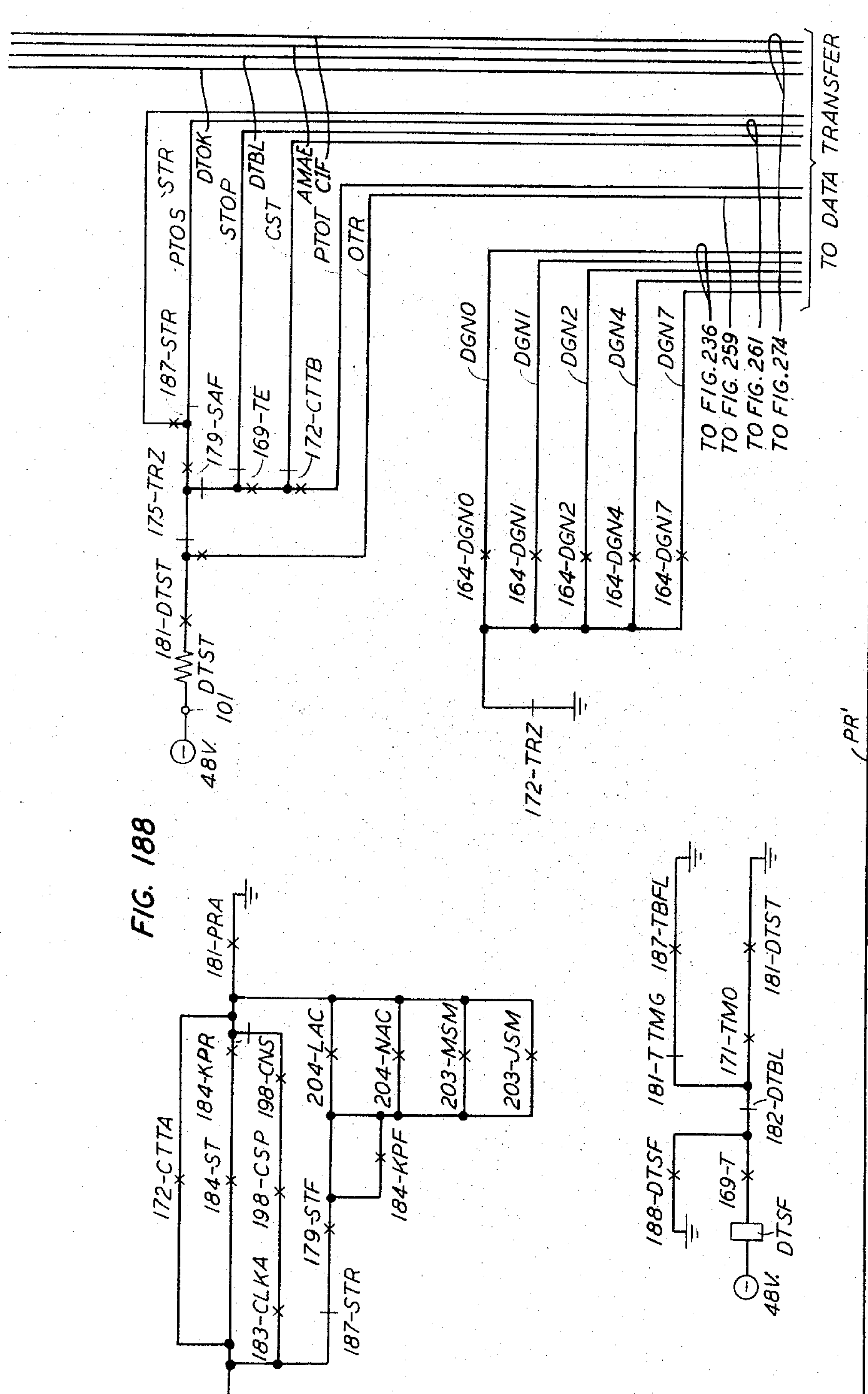
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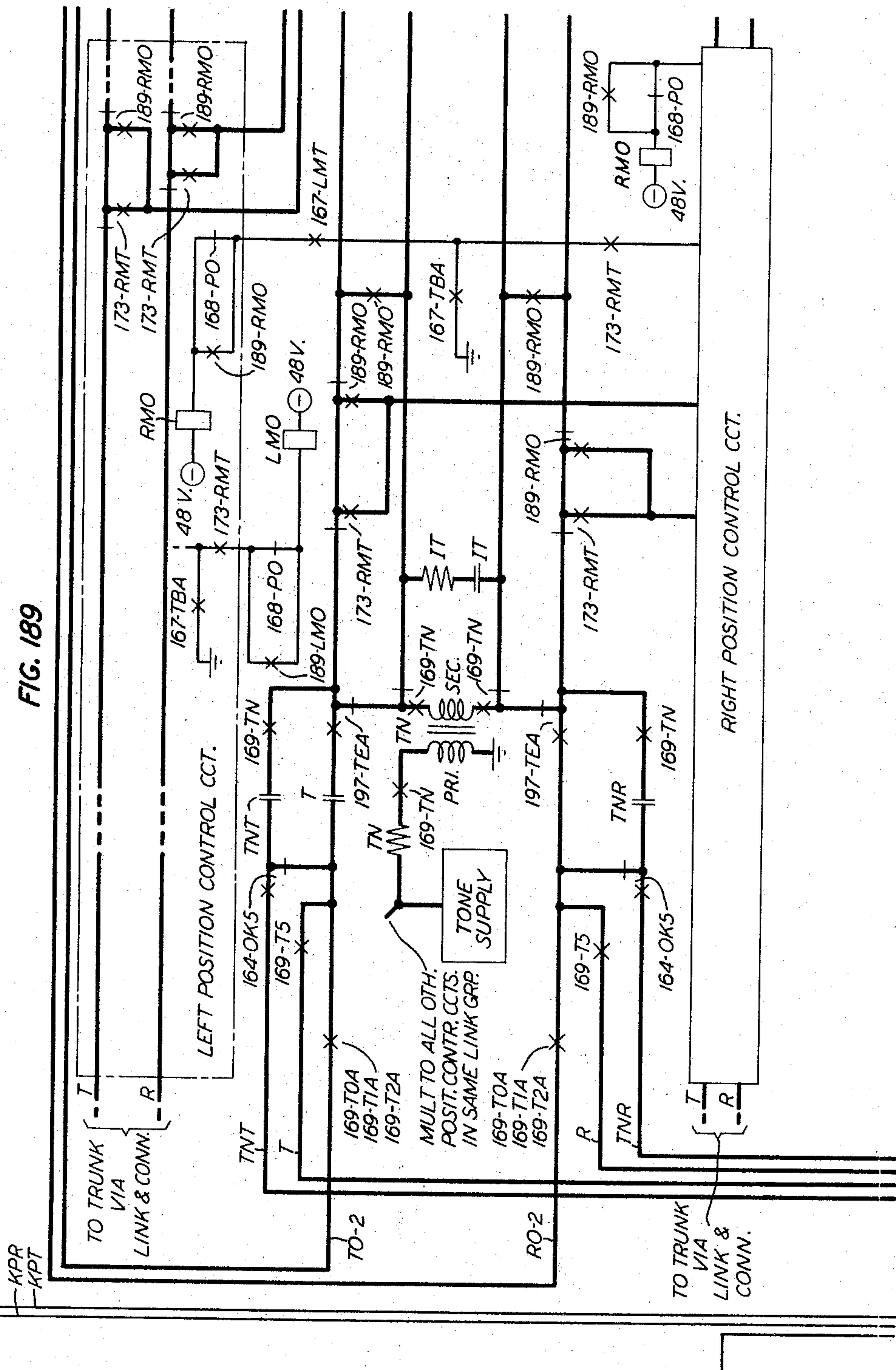
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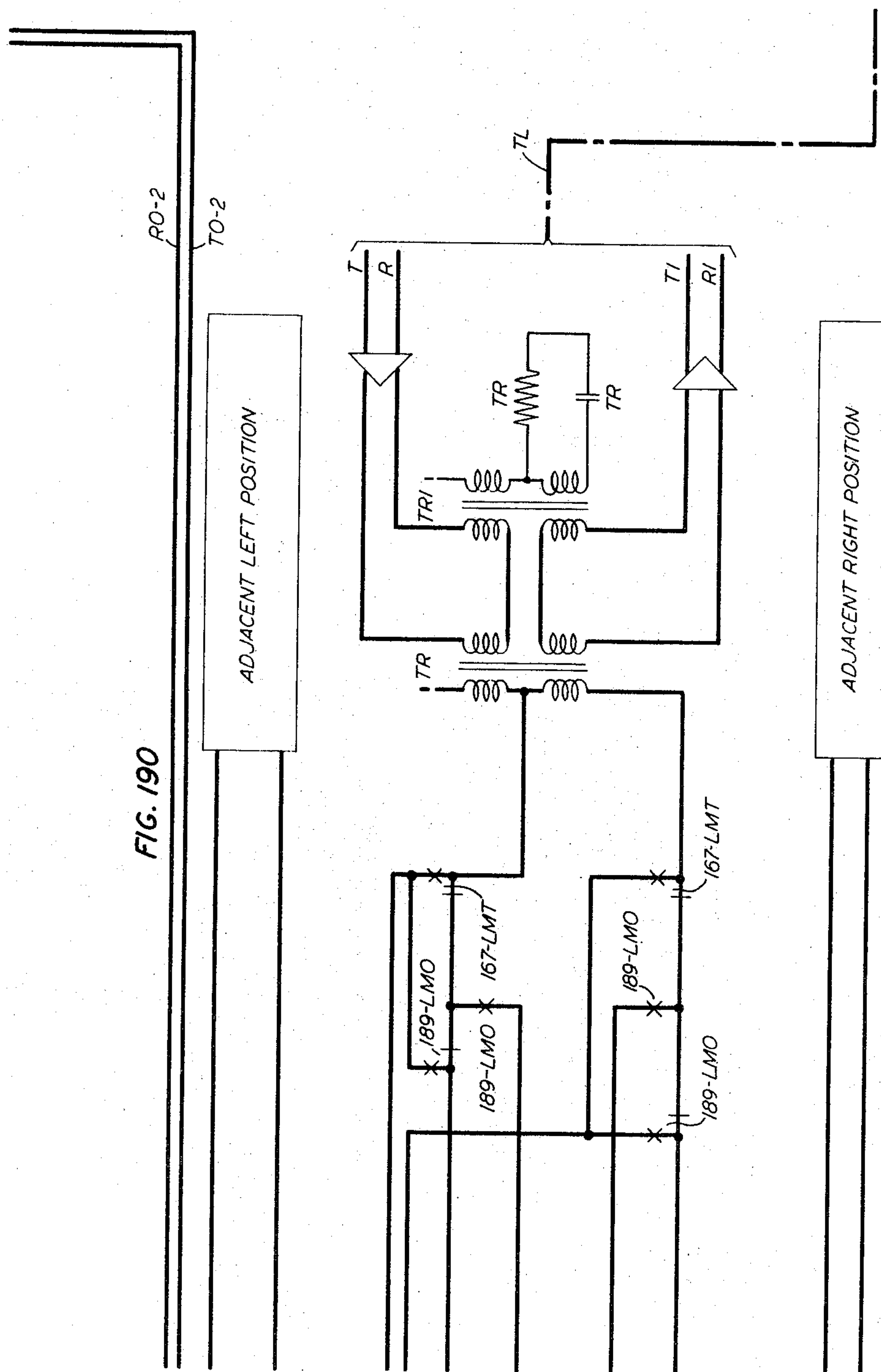
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FIG. 190





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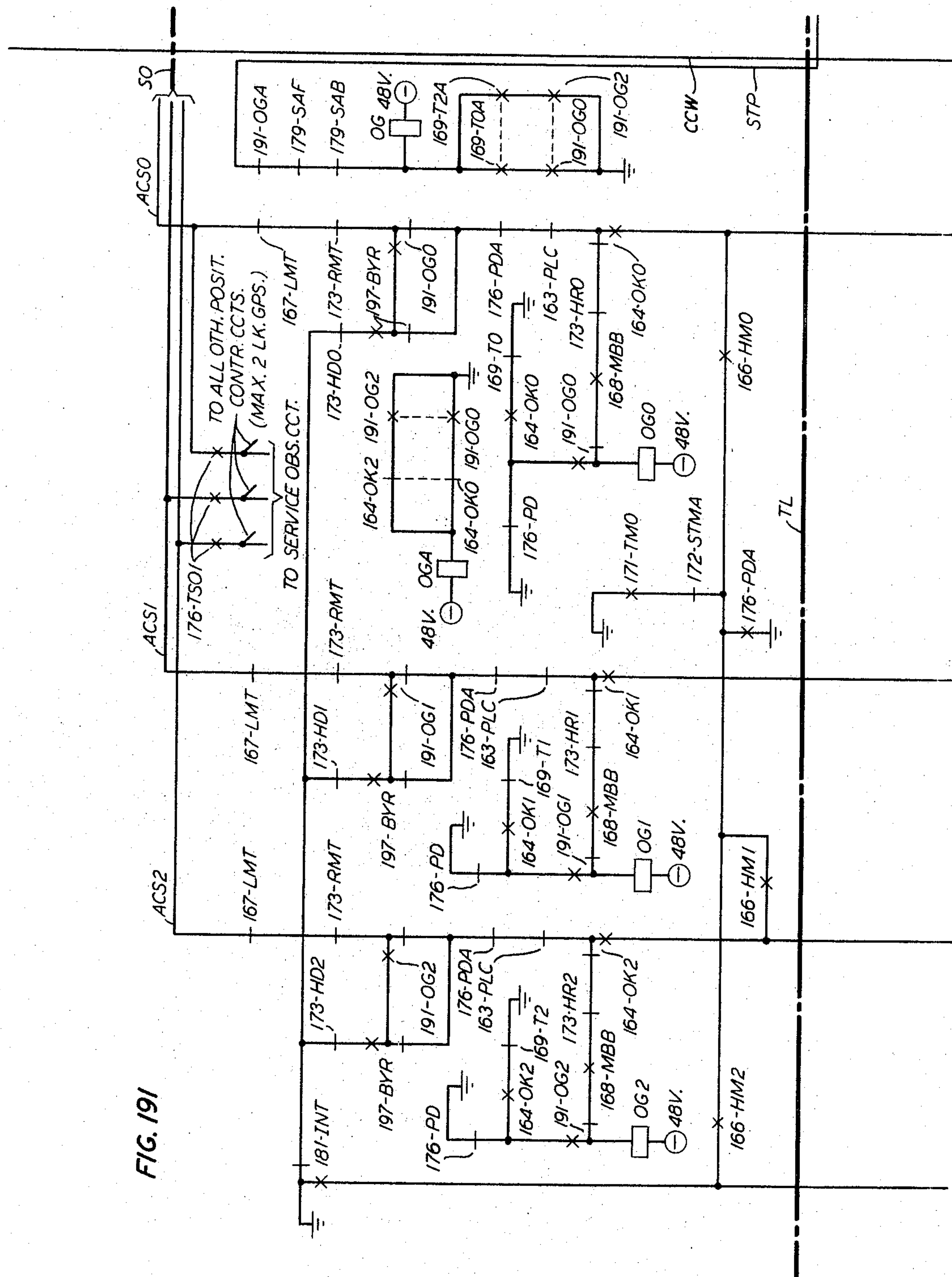
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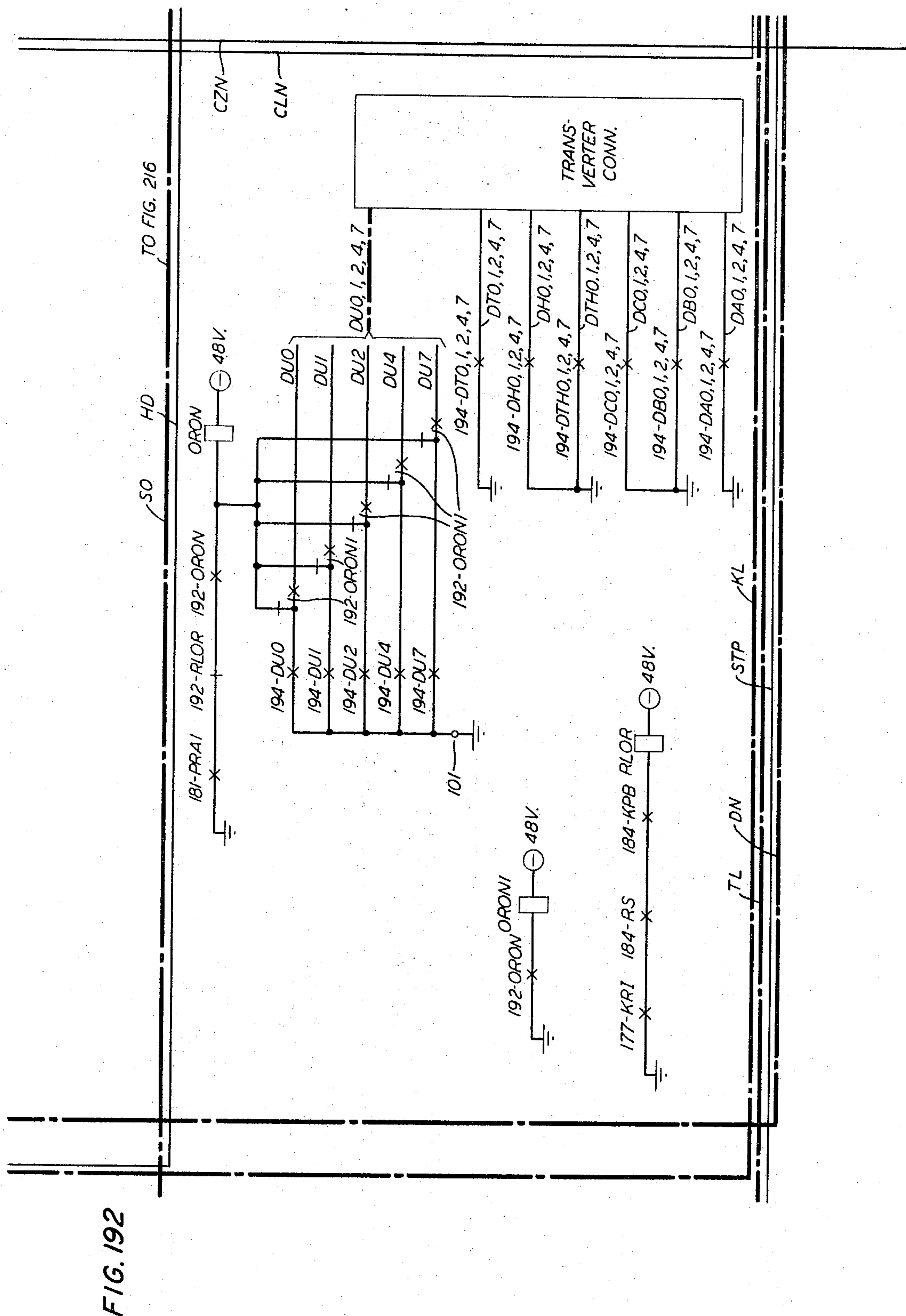
**FIG. 191**



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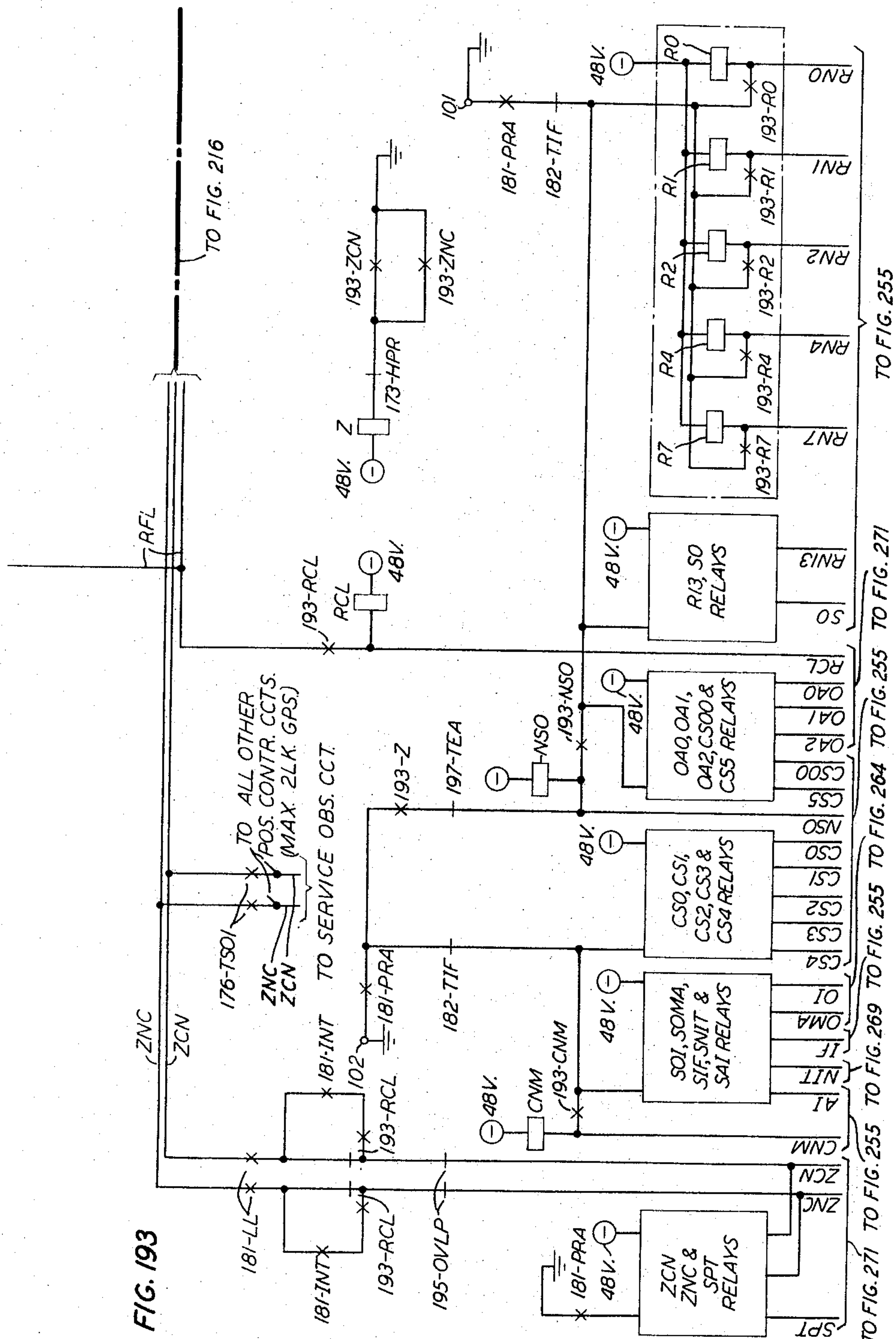
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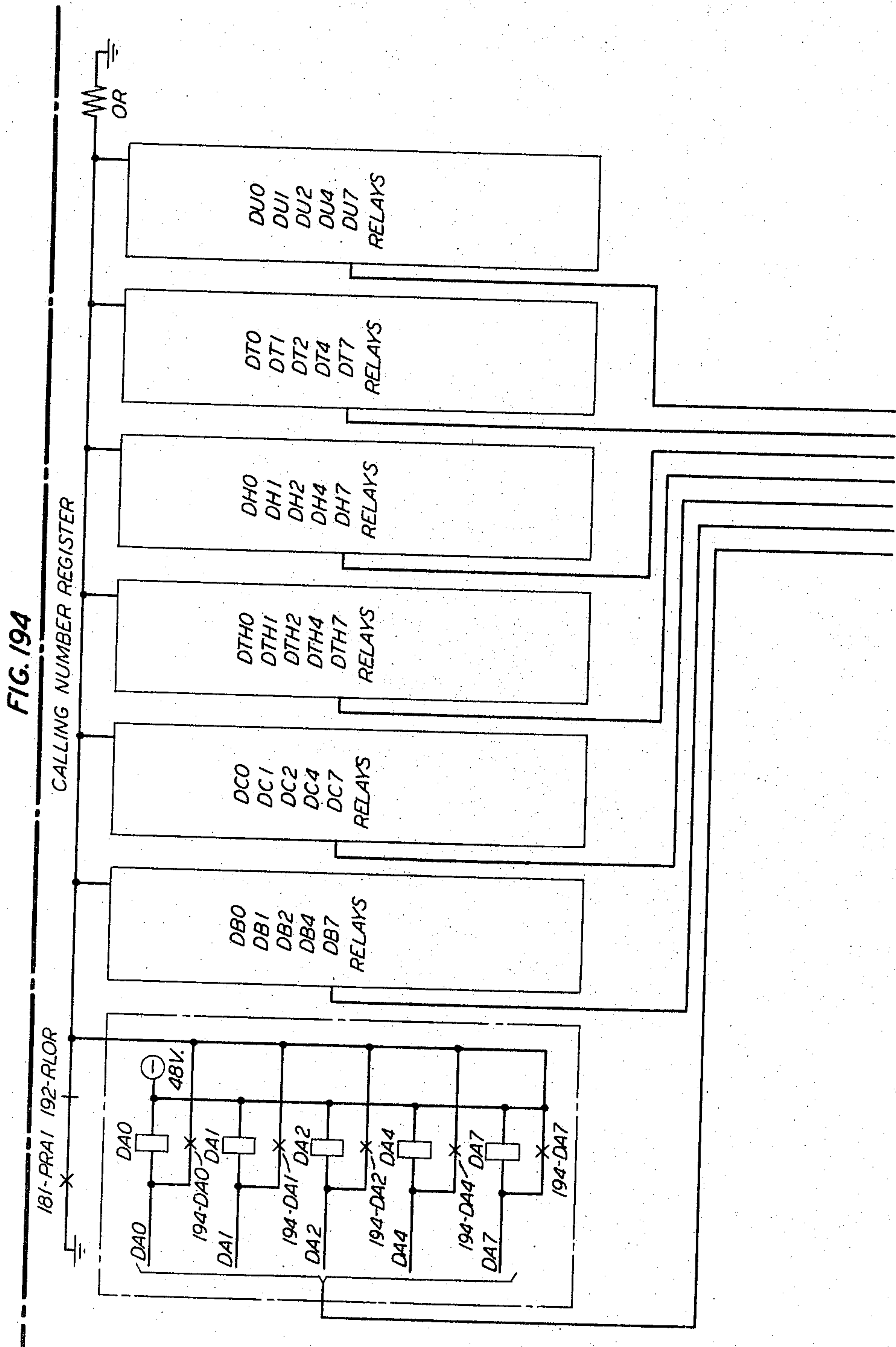
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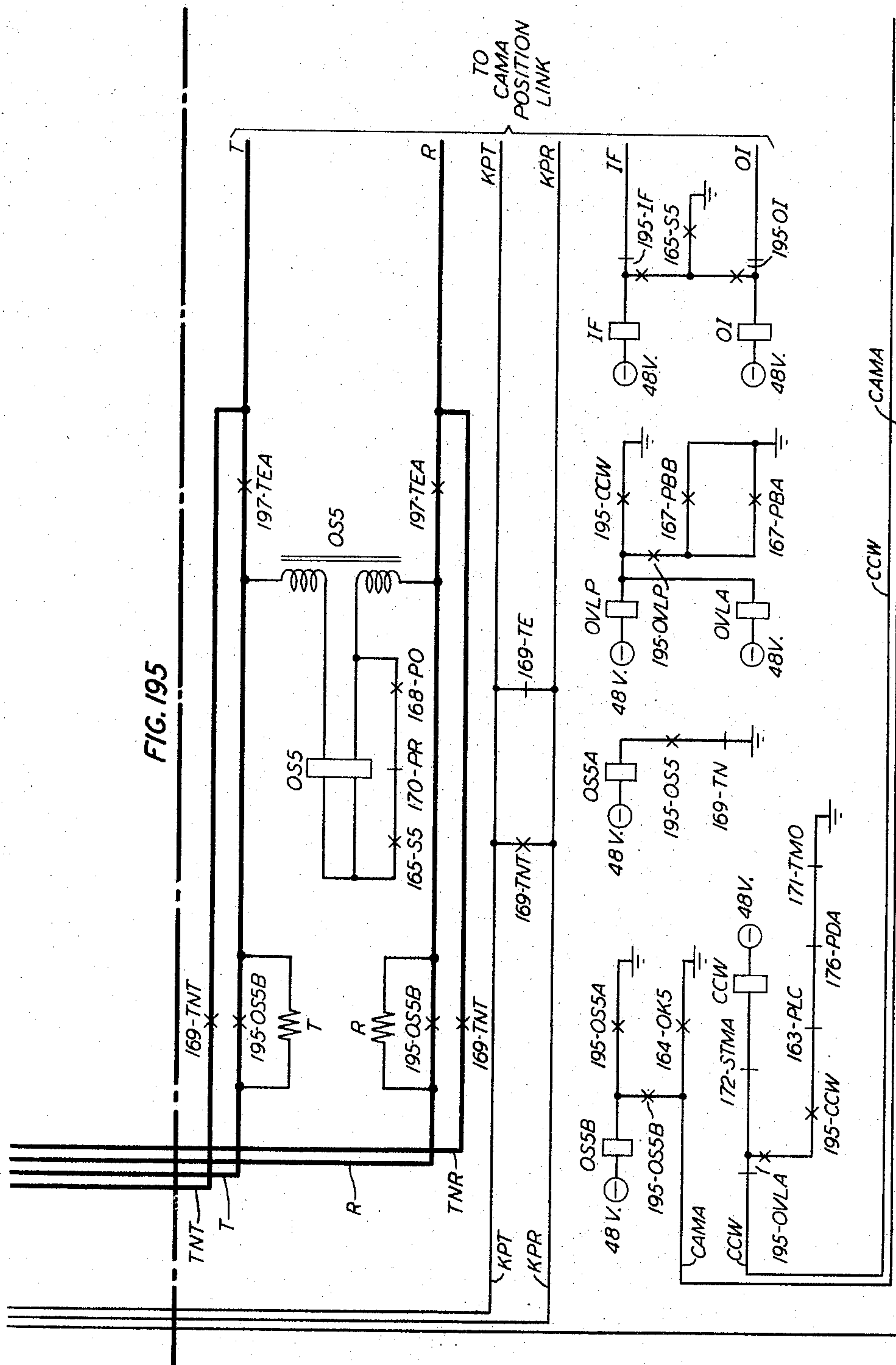
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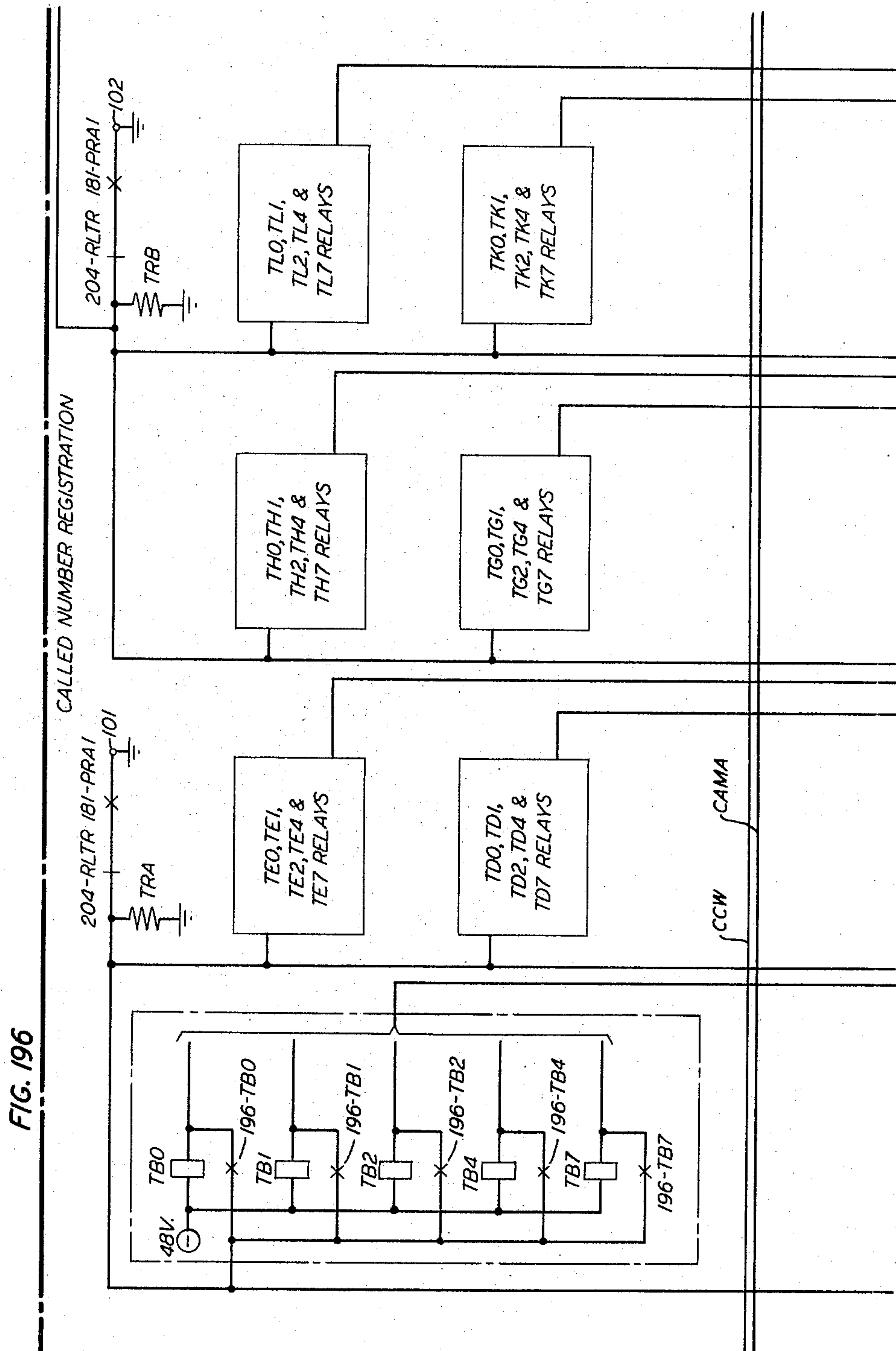
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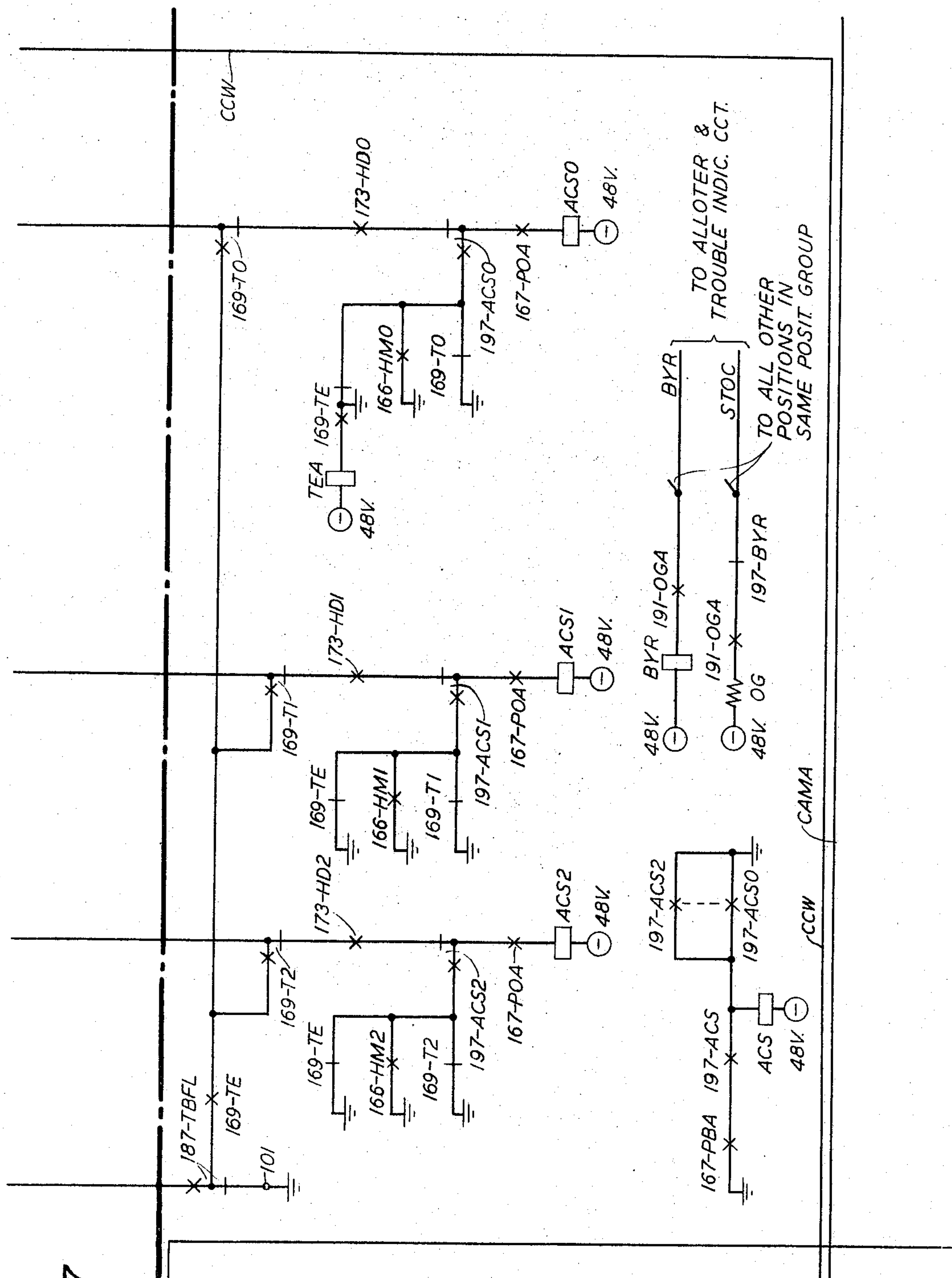


FIG. 197



**Sept. 12, 1967**

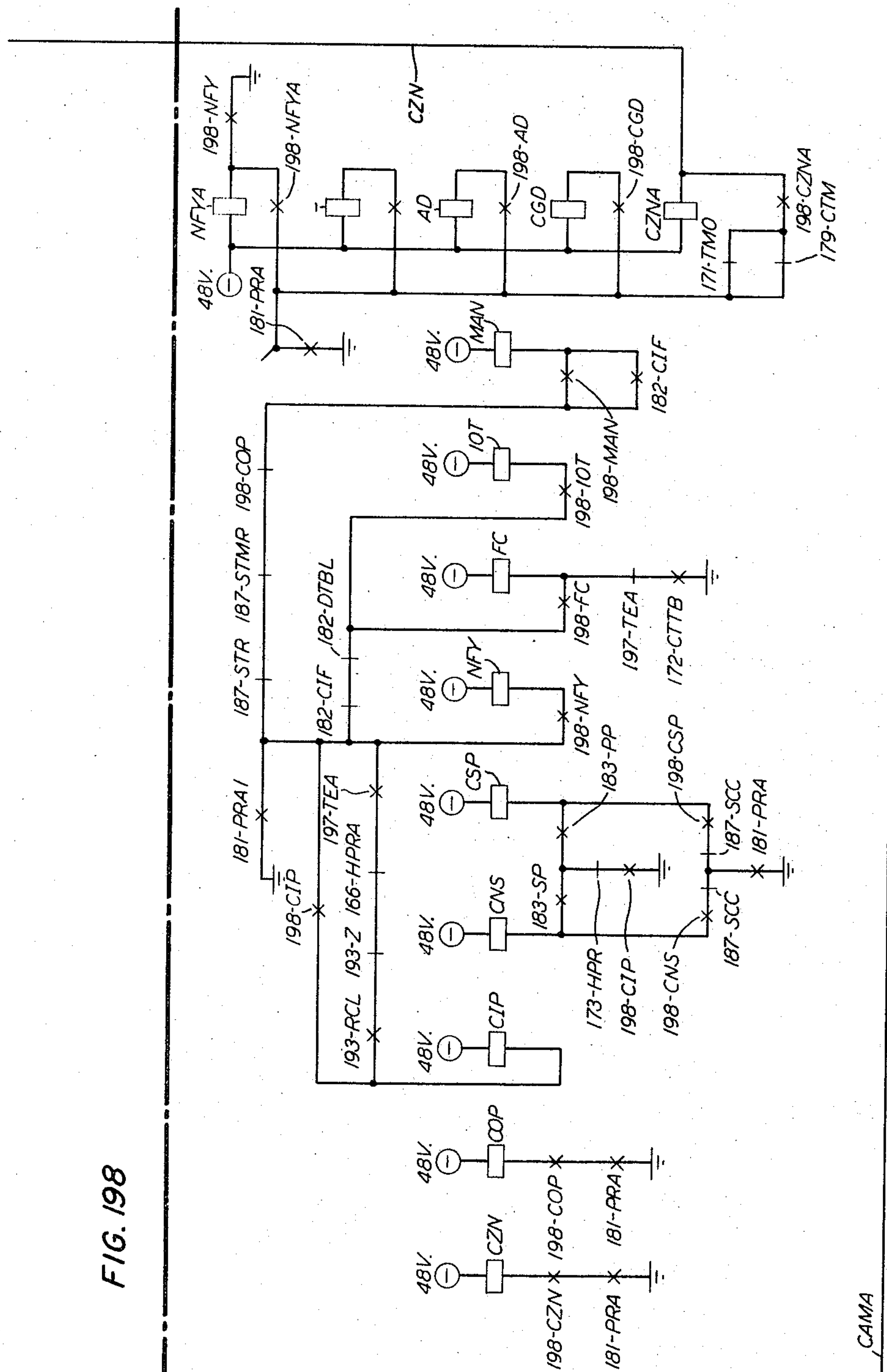
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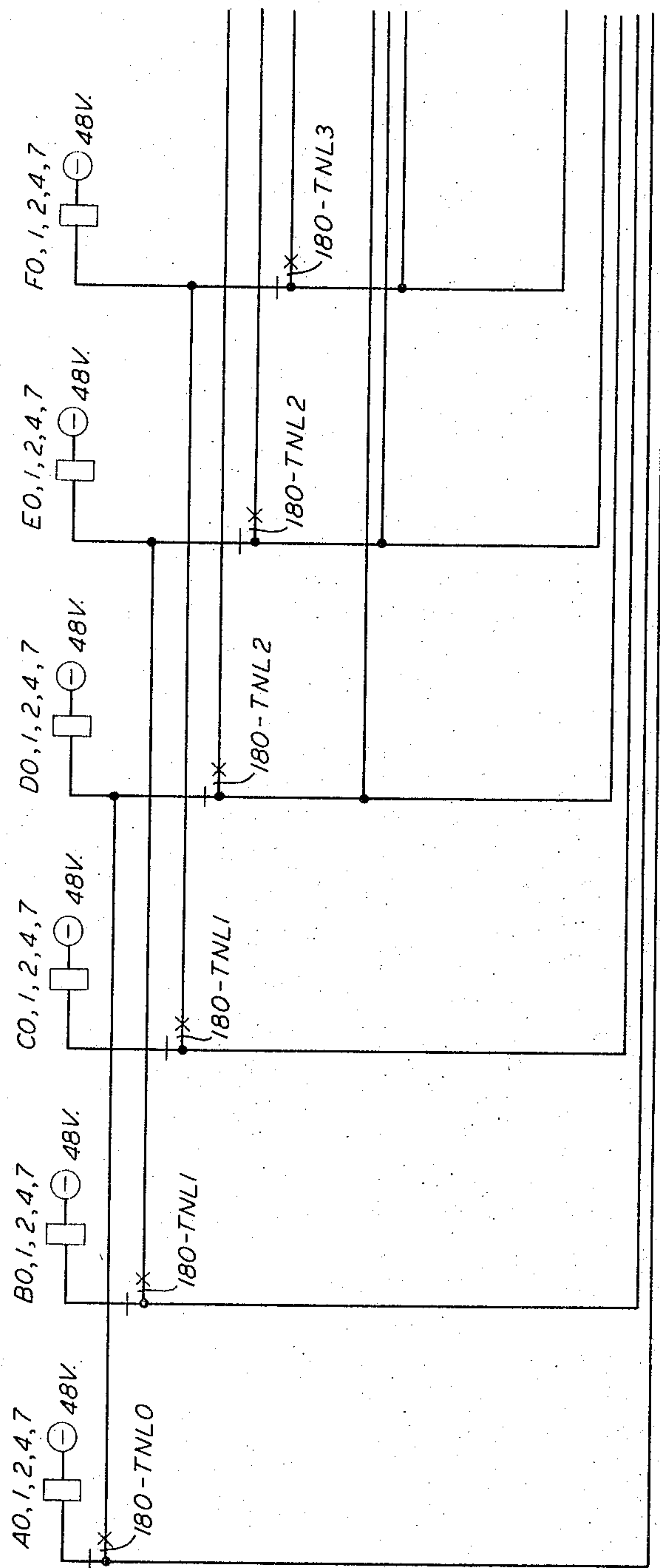
R. B. CURTIS  
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FIG. 199





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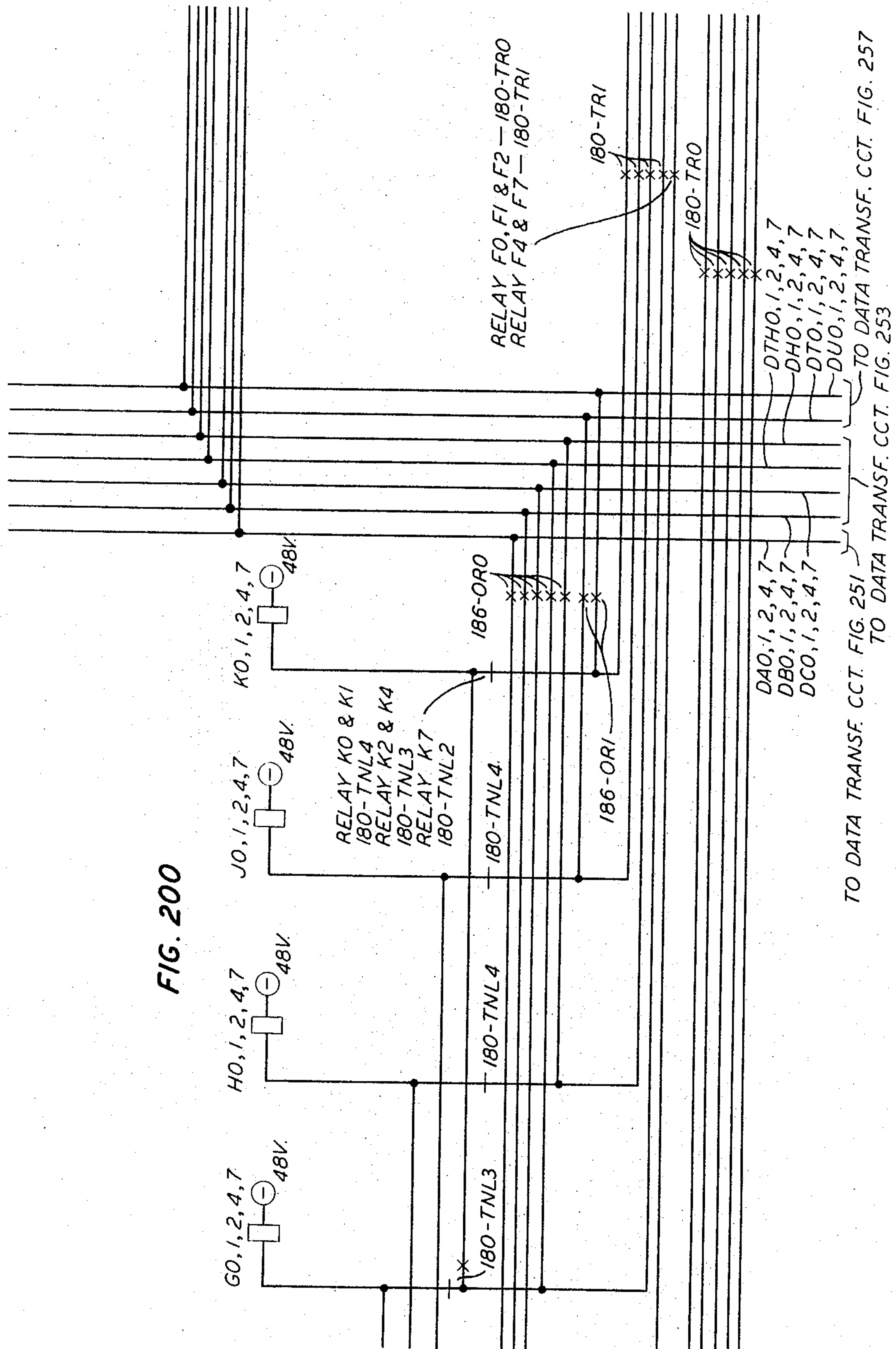
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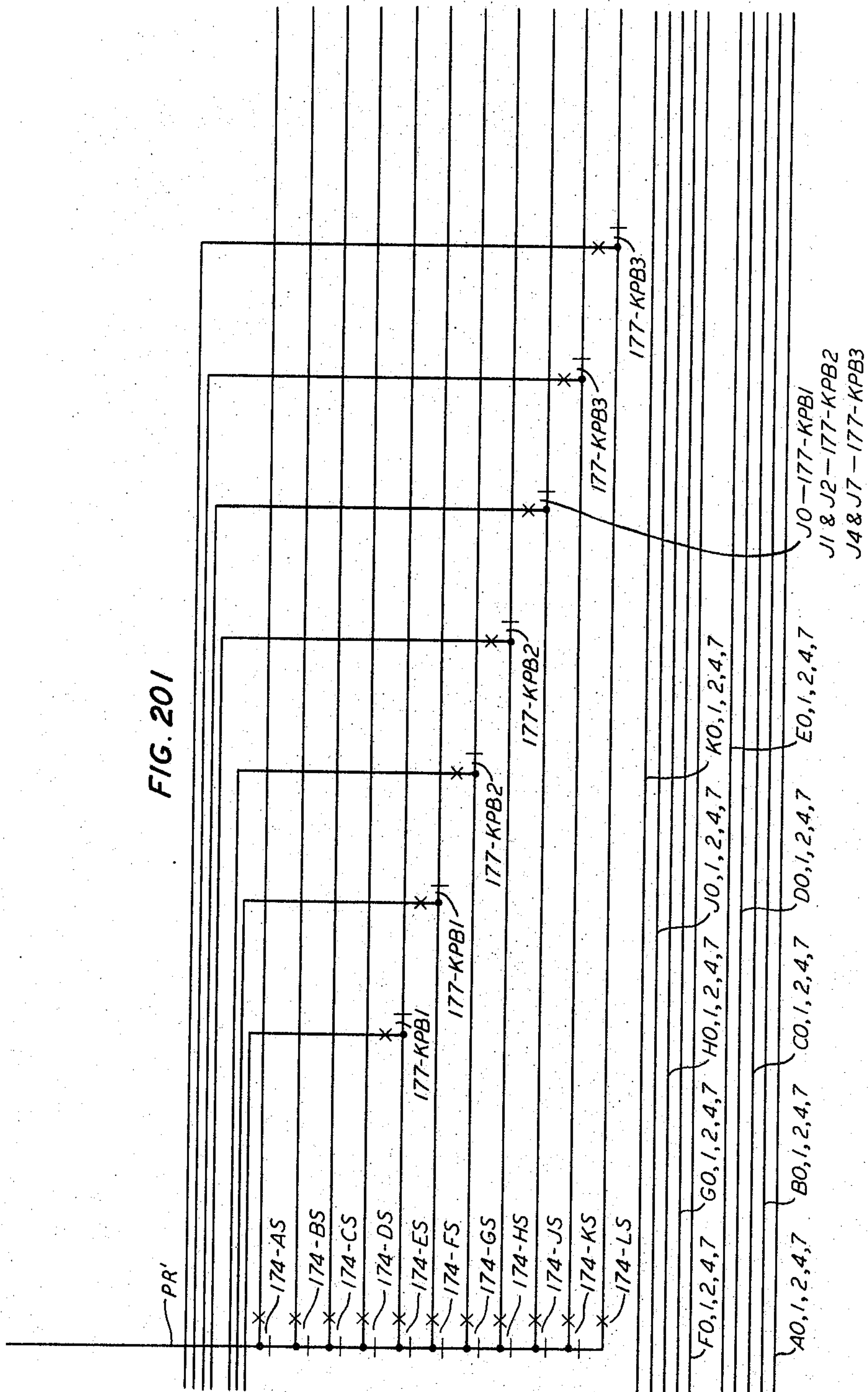
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FIG. 201





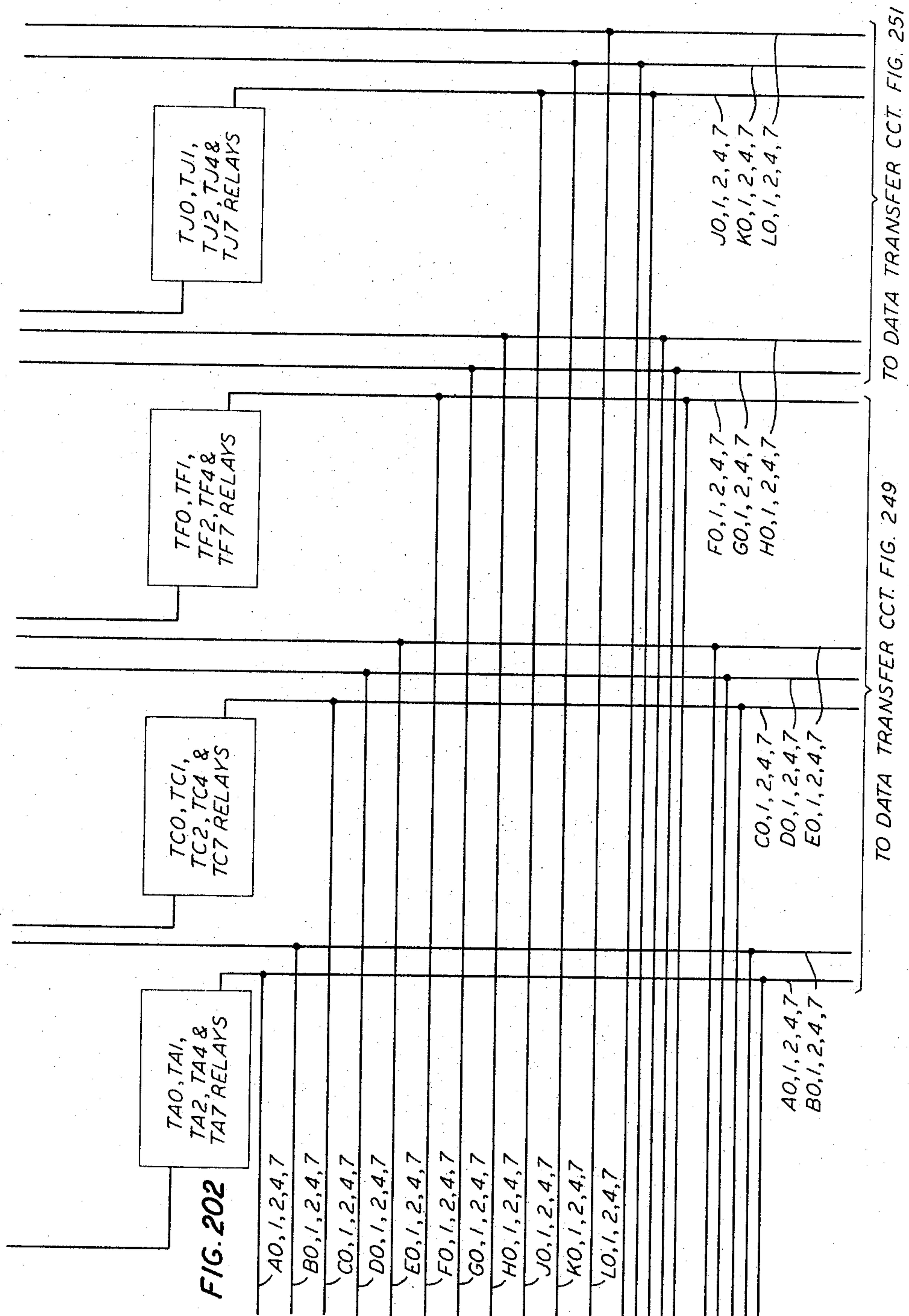
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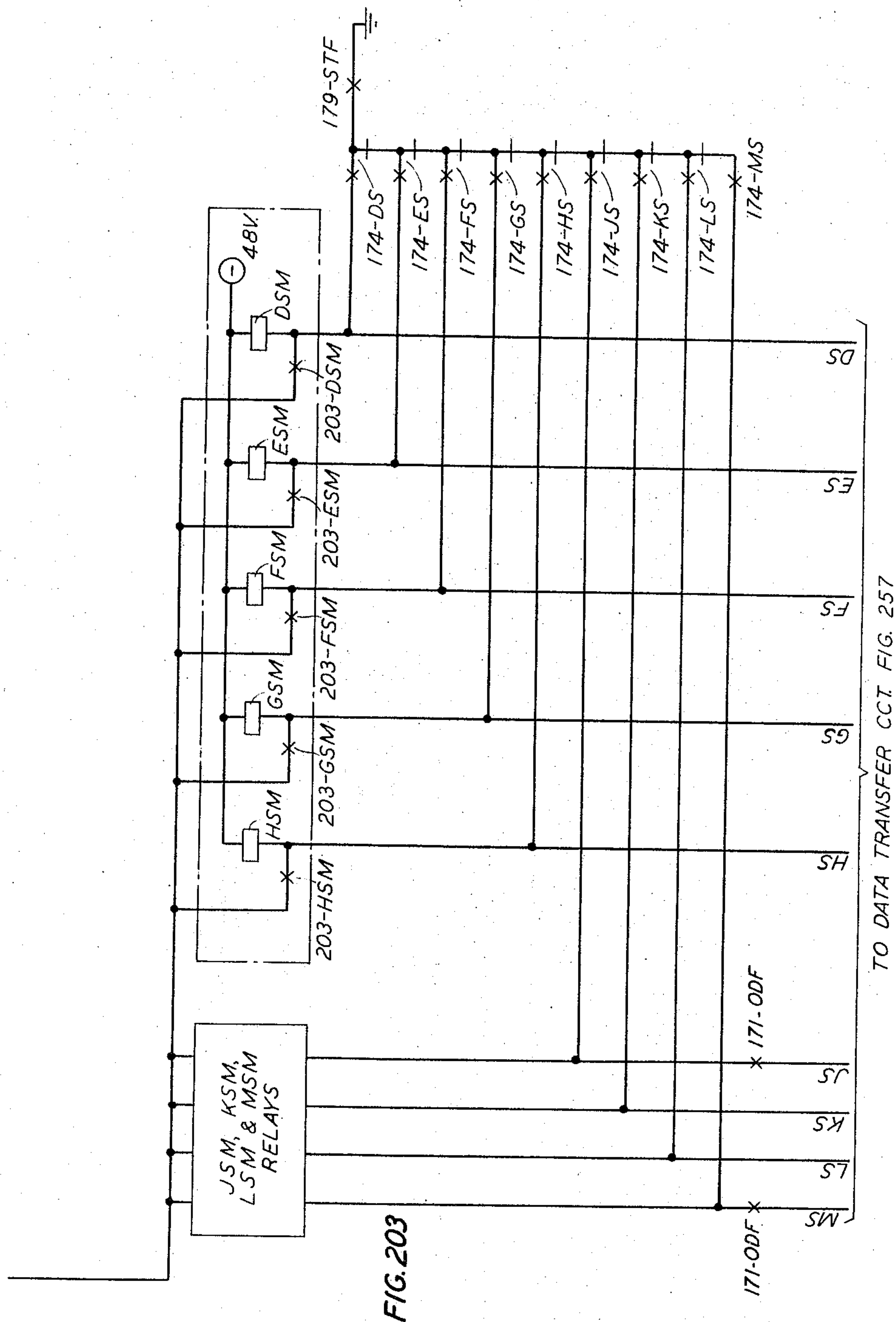
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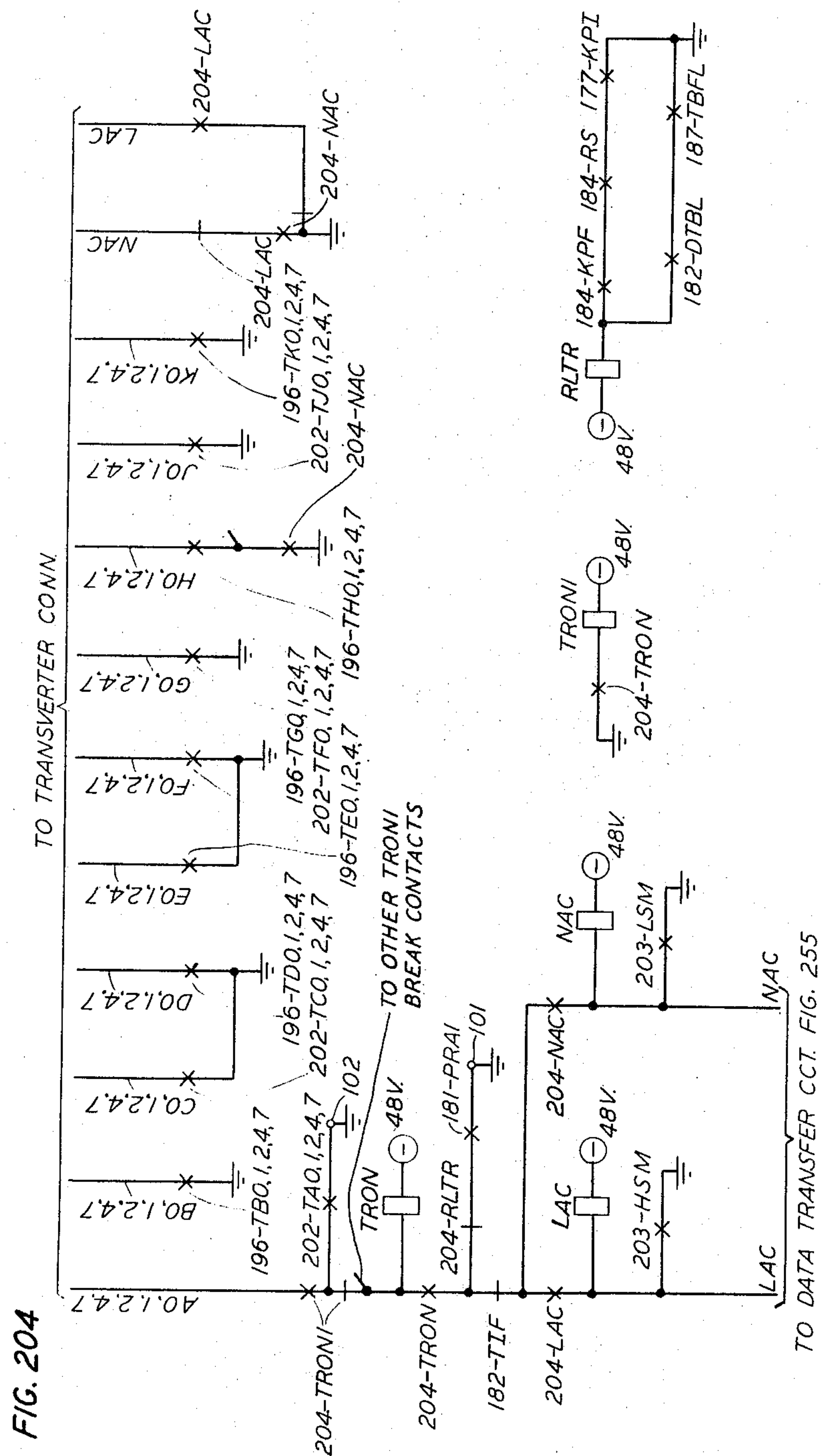
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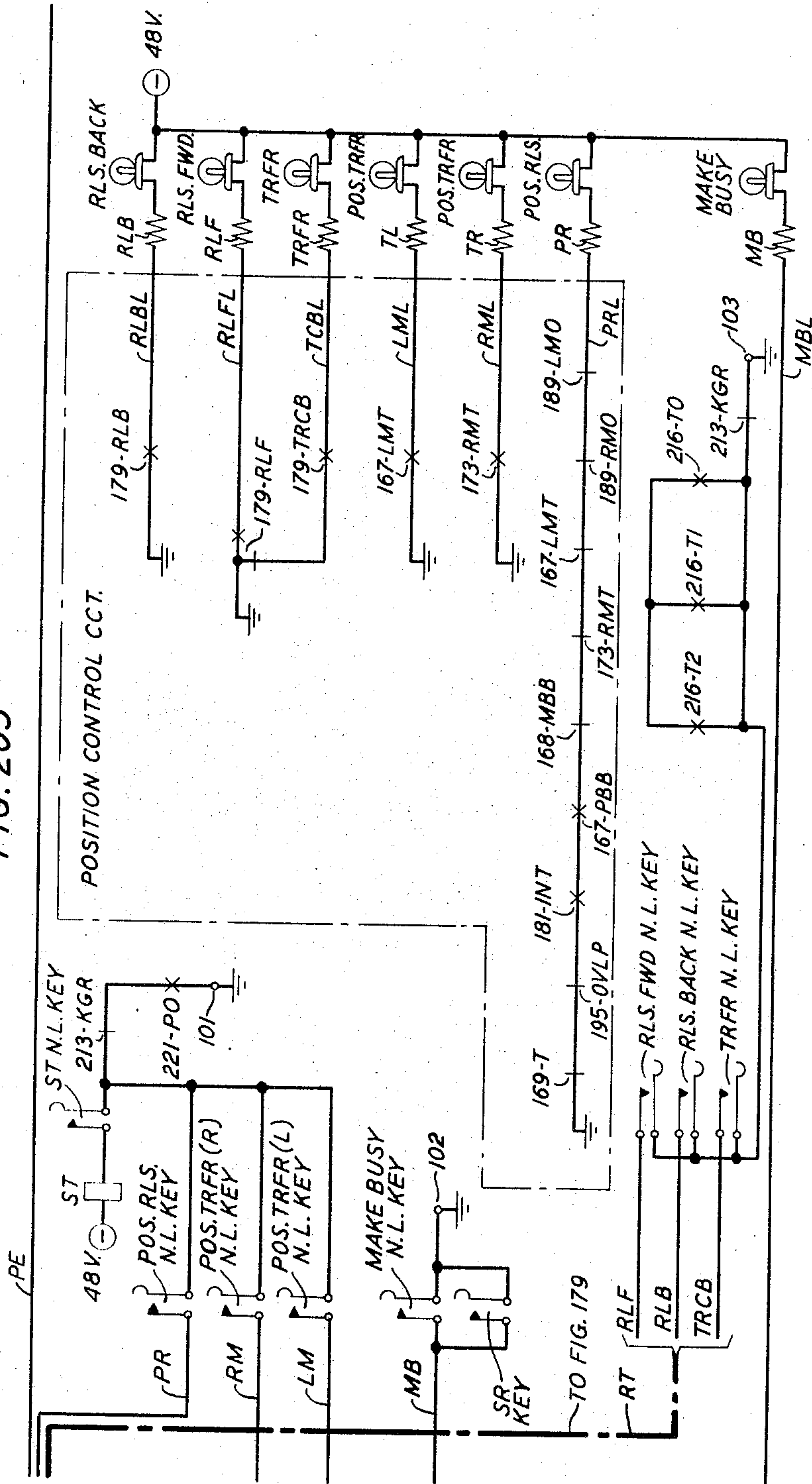
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FIG. 205





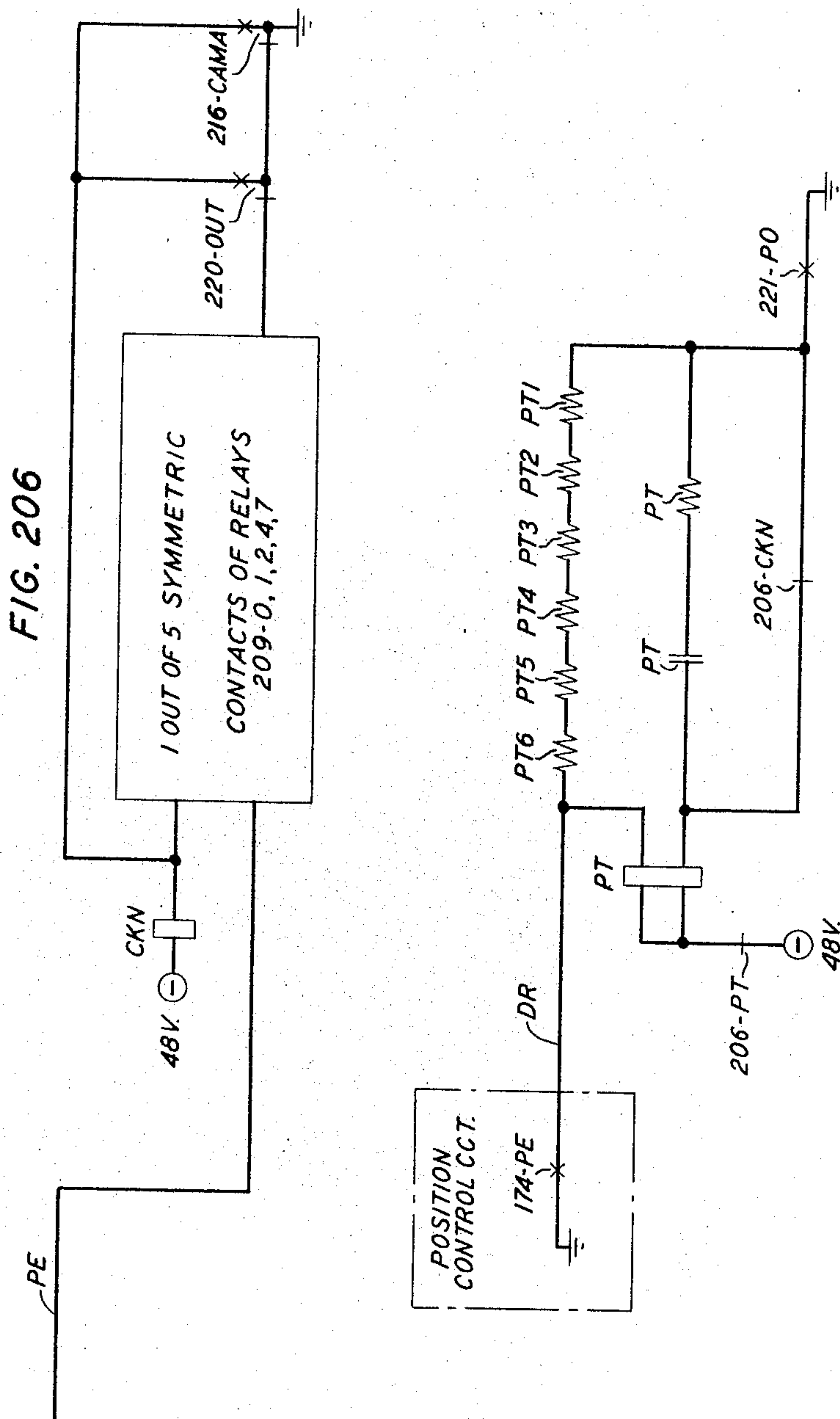
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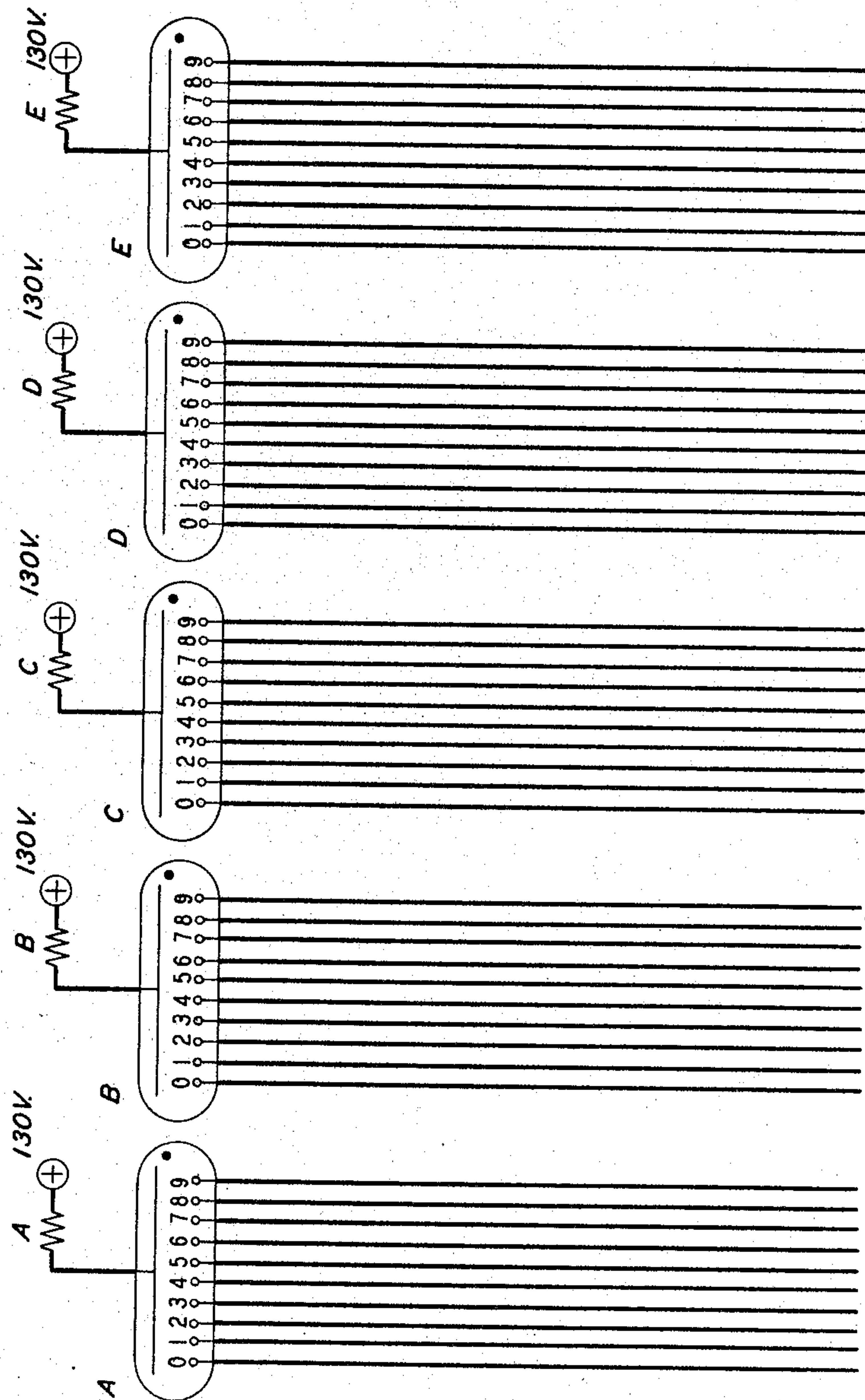
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FIG. 207





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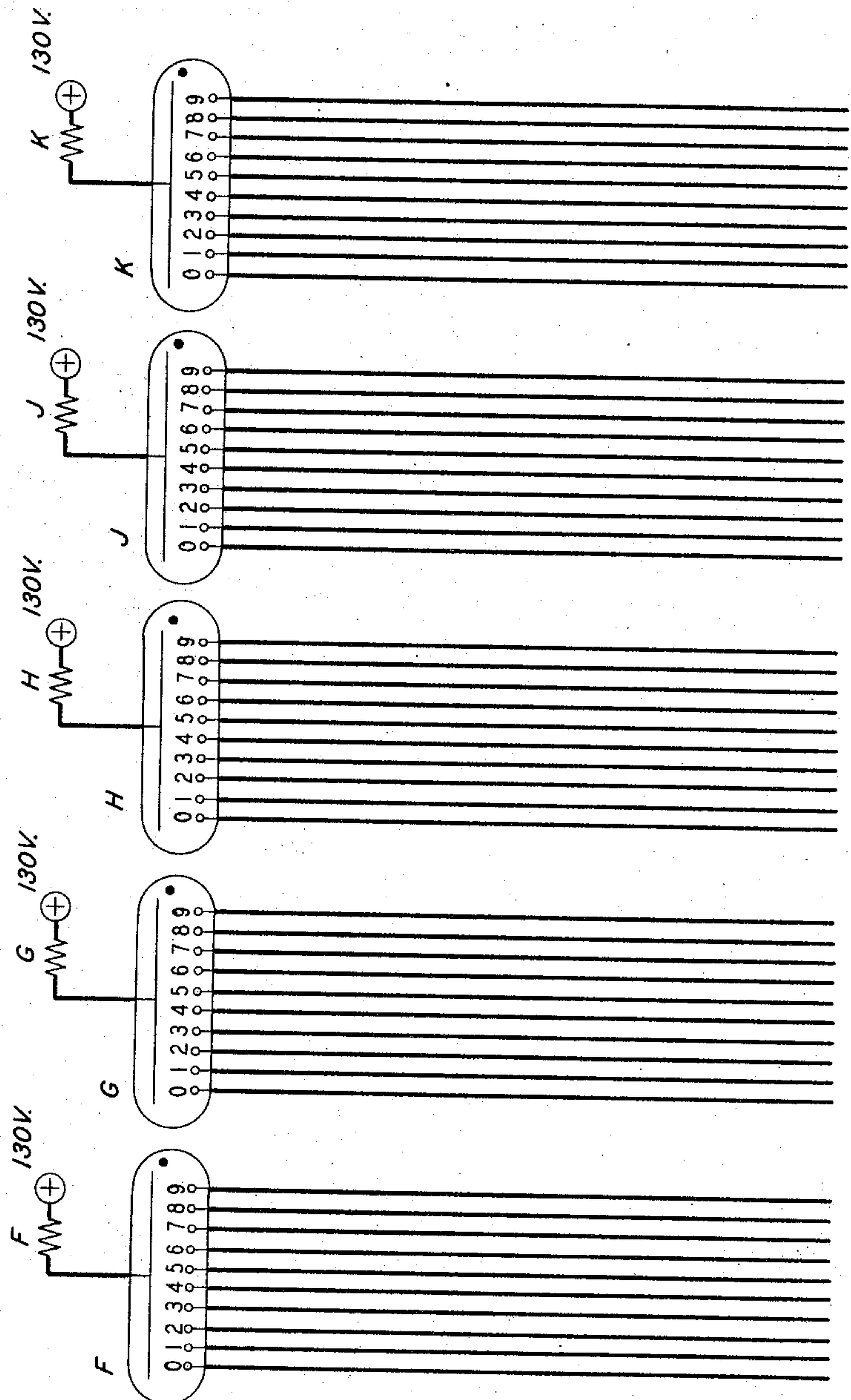
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FIG. 208





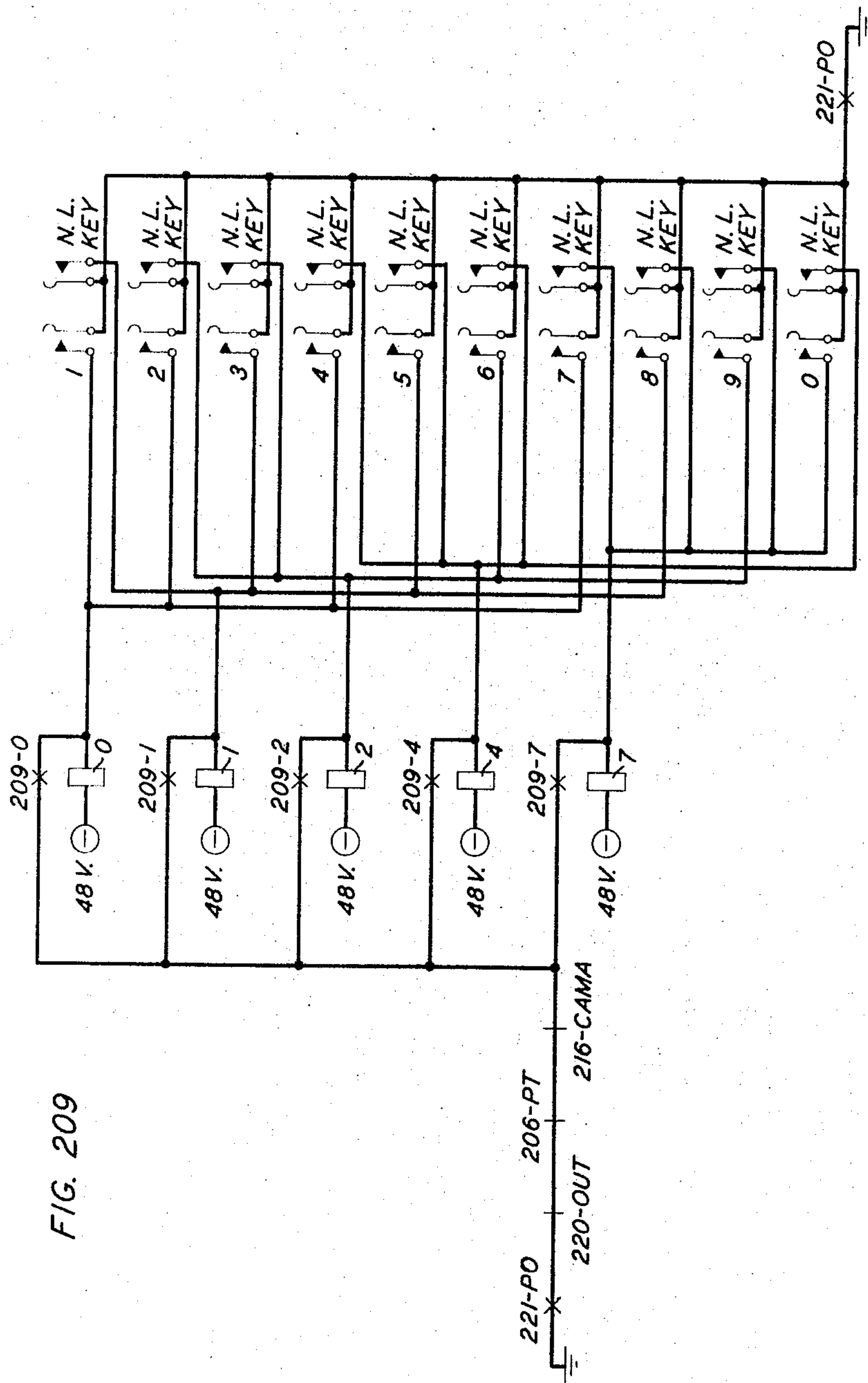
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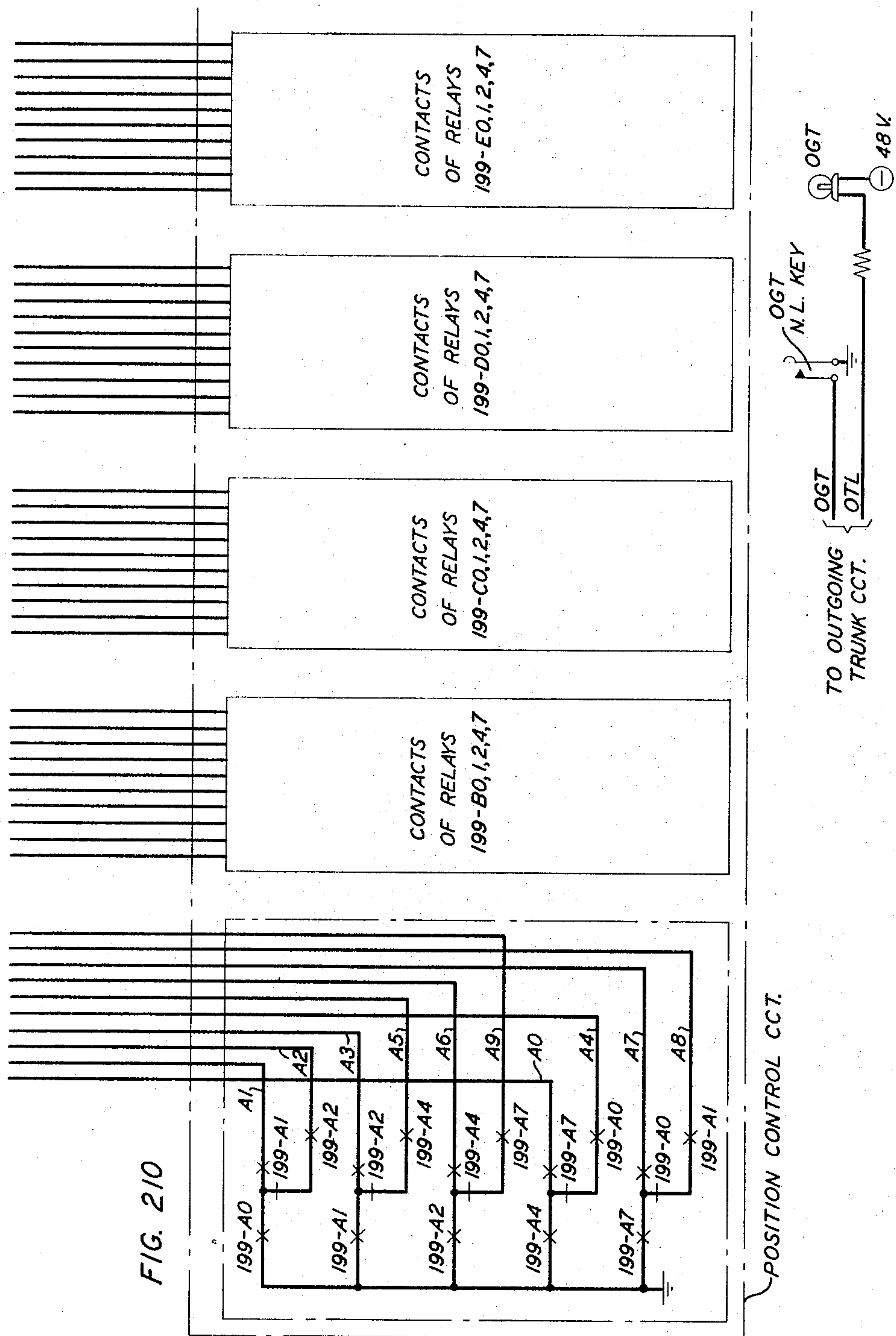
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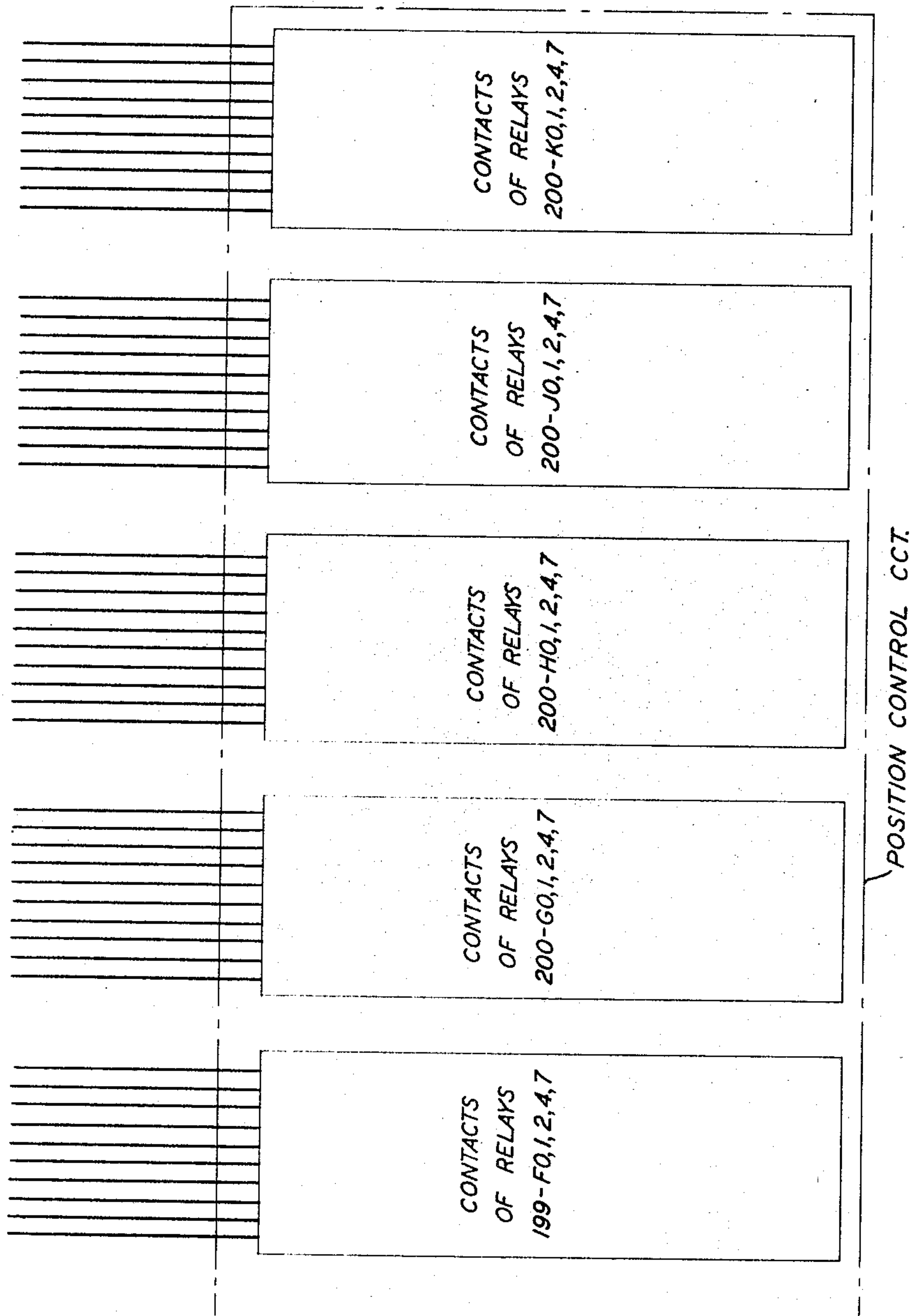
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FIG. 211





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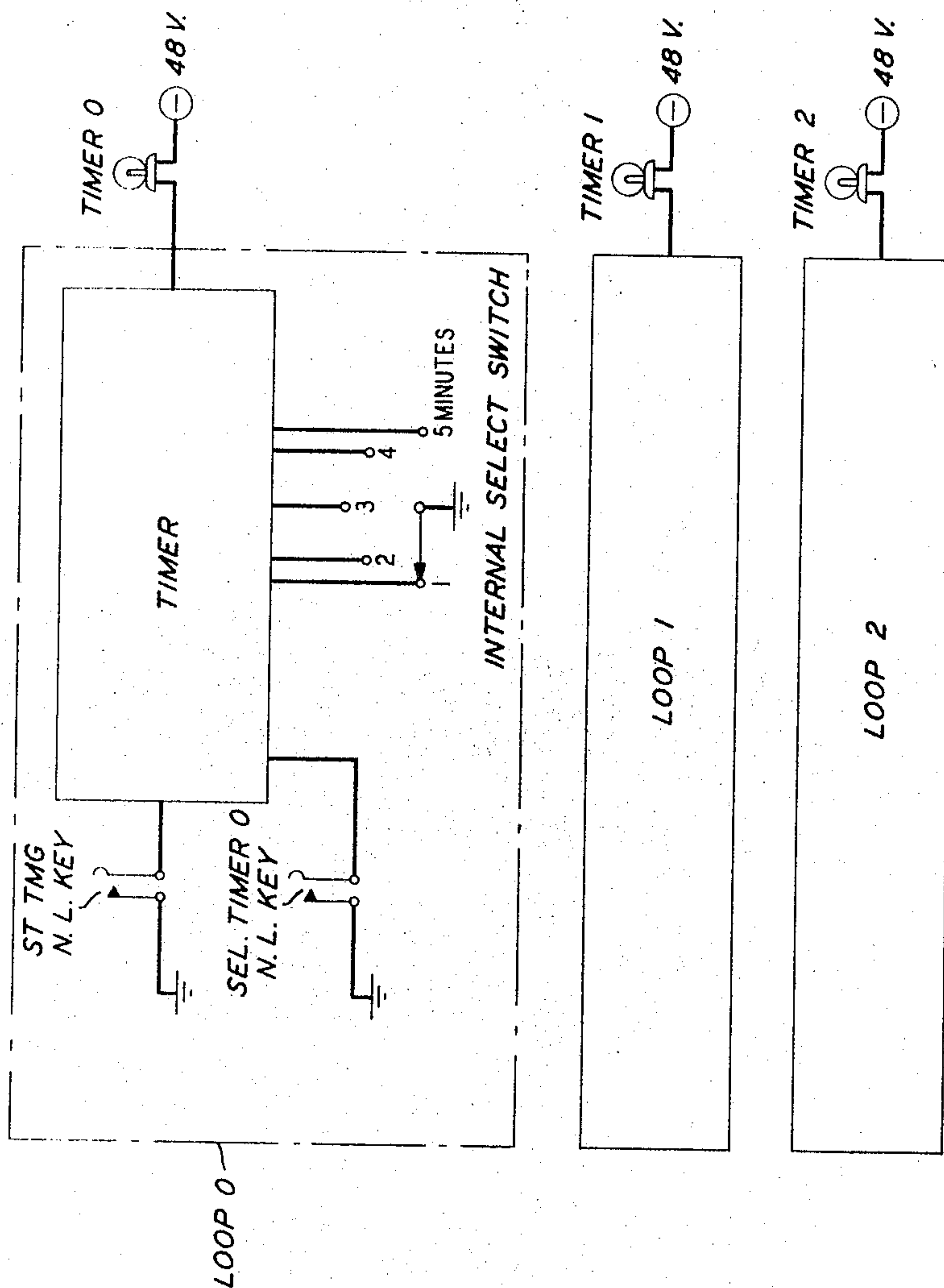


FIG. 212



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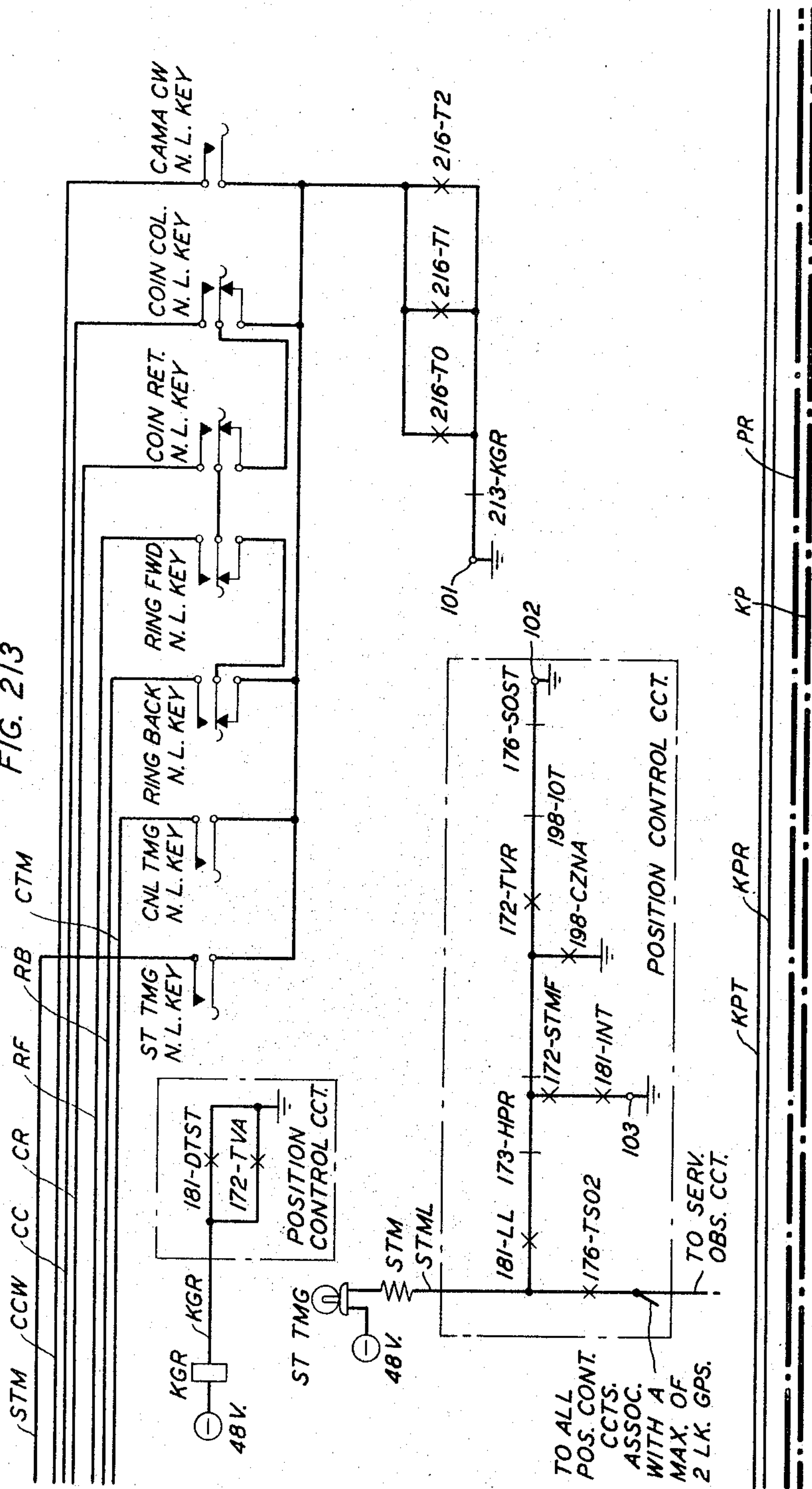
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FIG. 2/3





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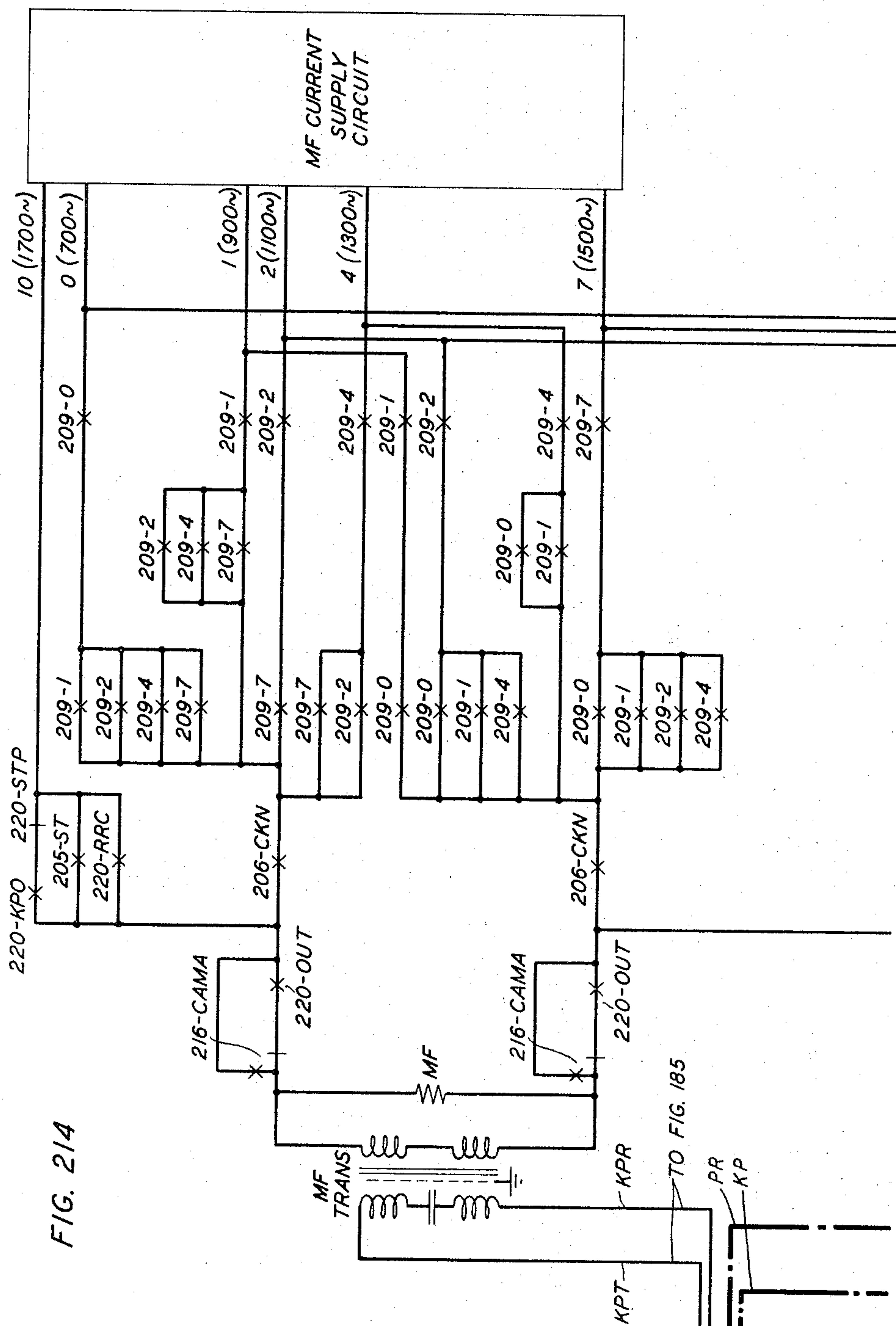


FIG. 214



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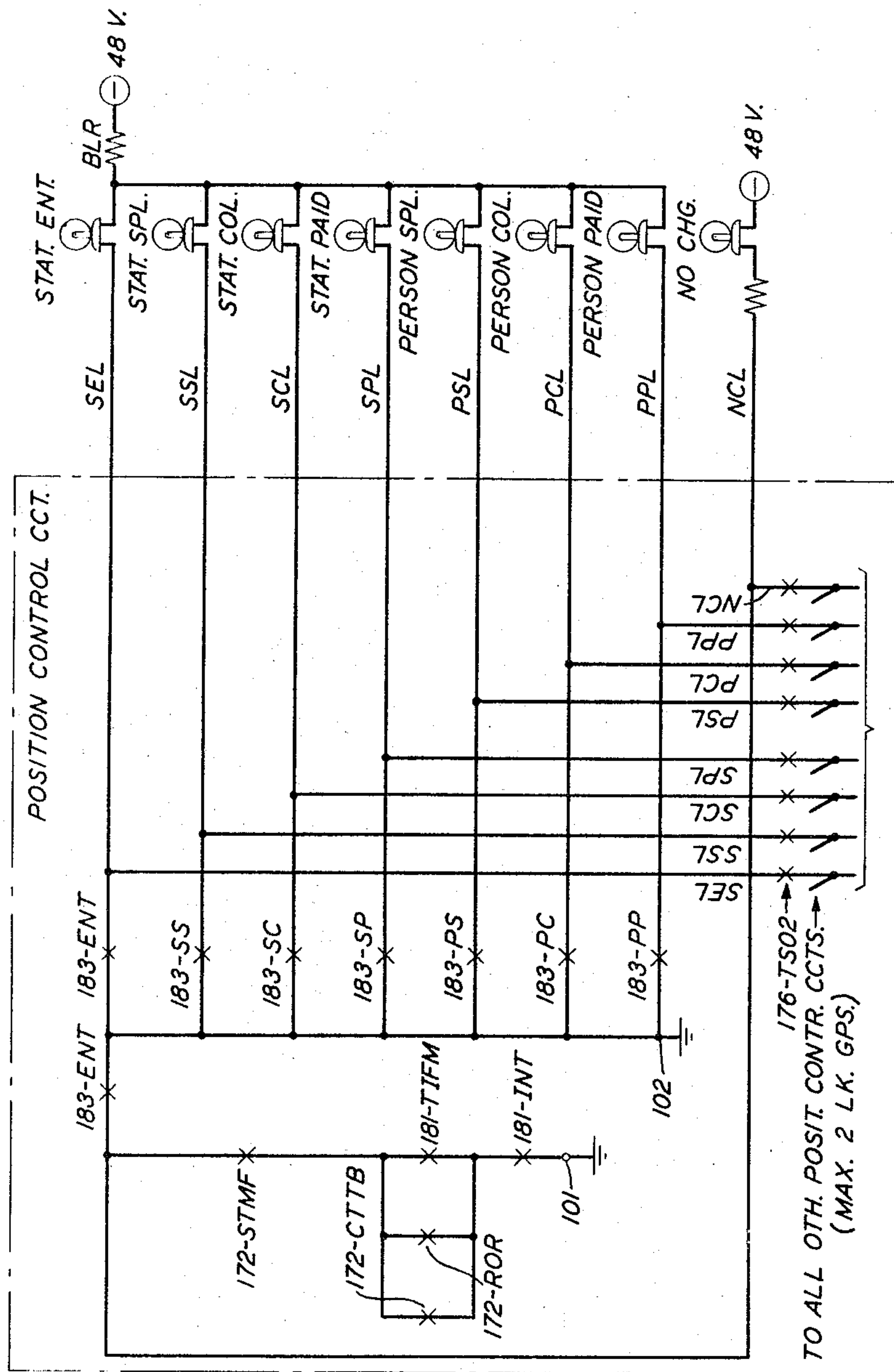


FIG. 2/5



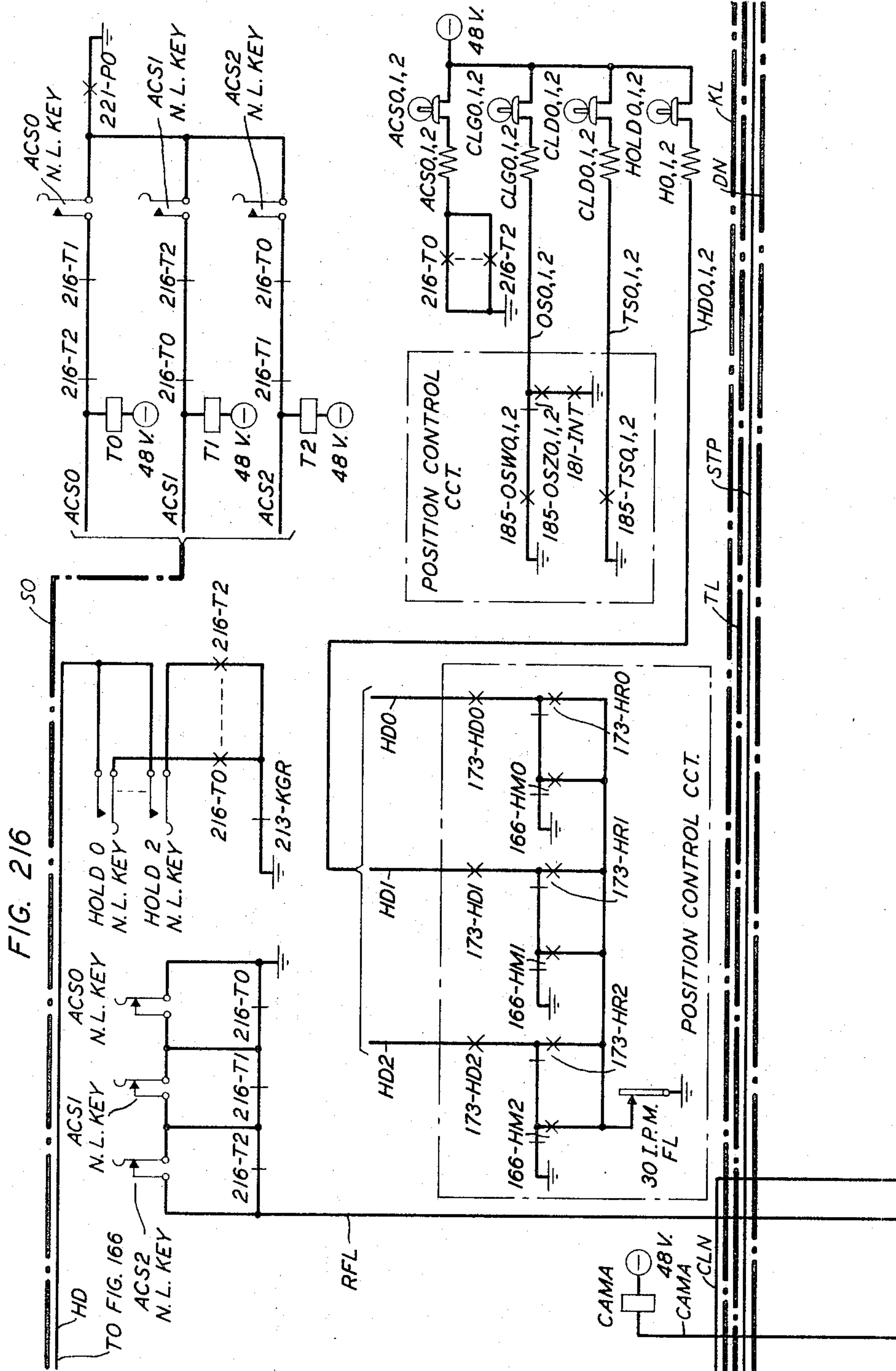
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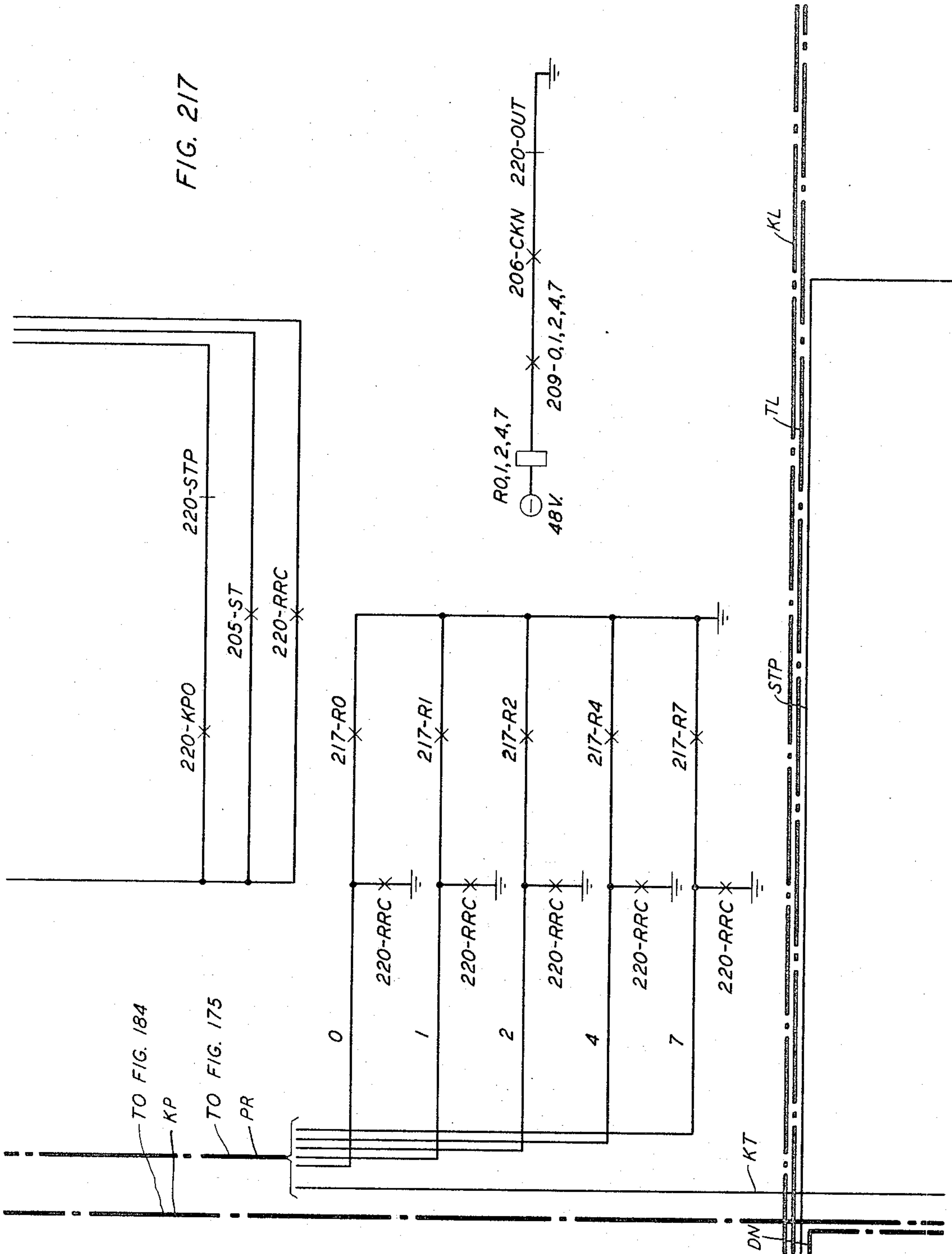
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FIG. 217





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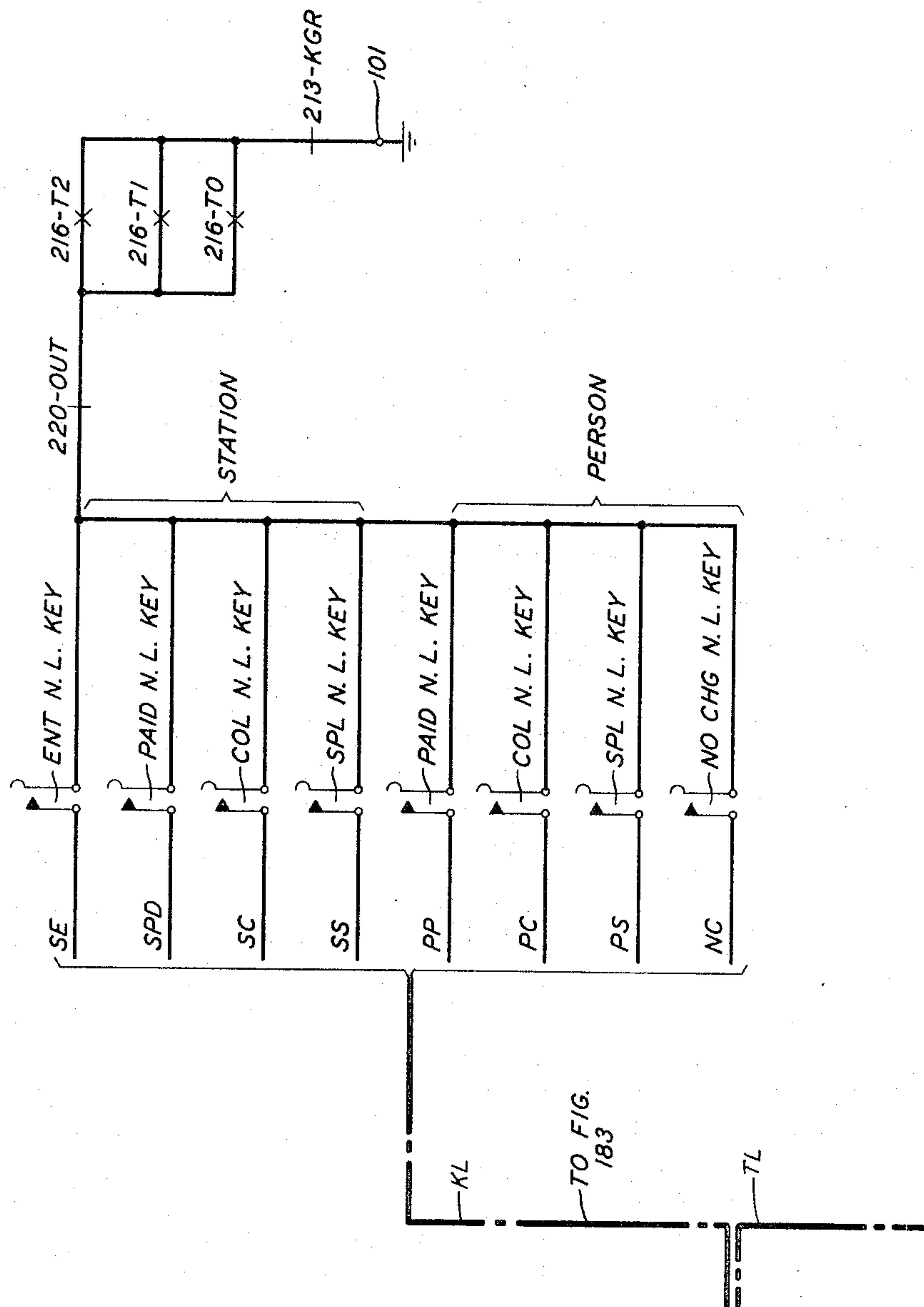
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FIG. 218





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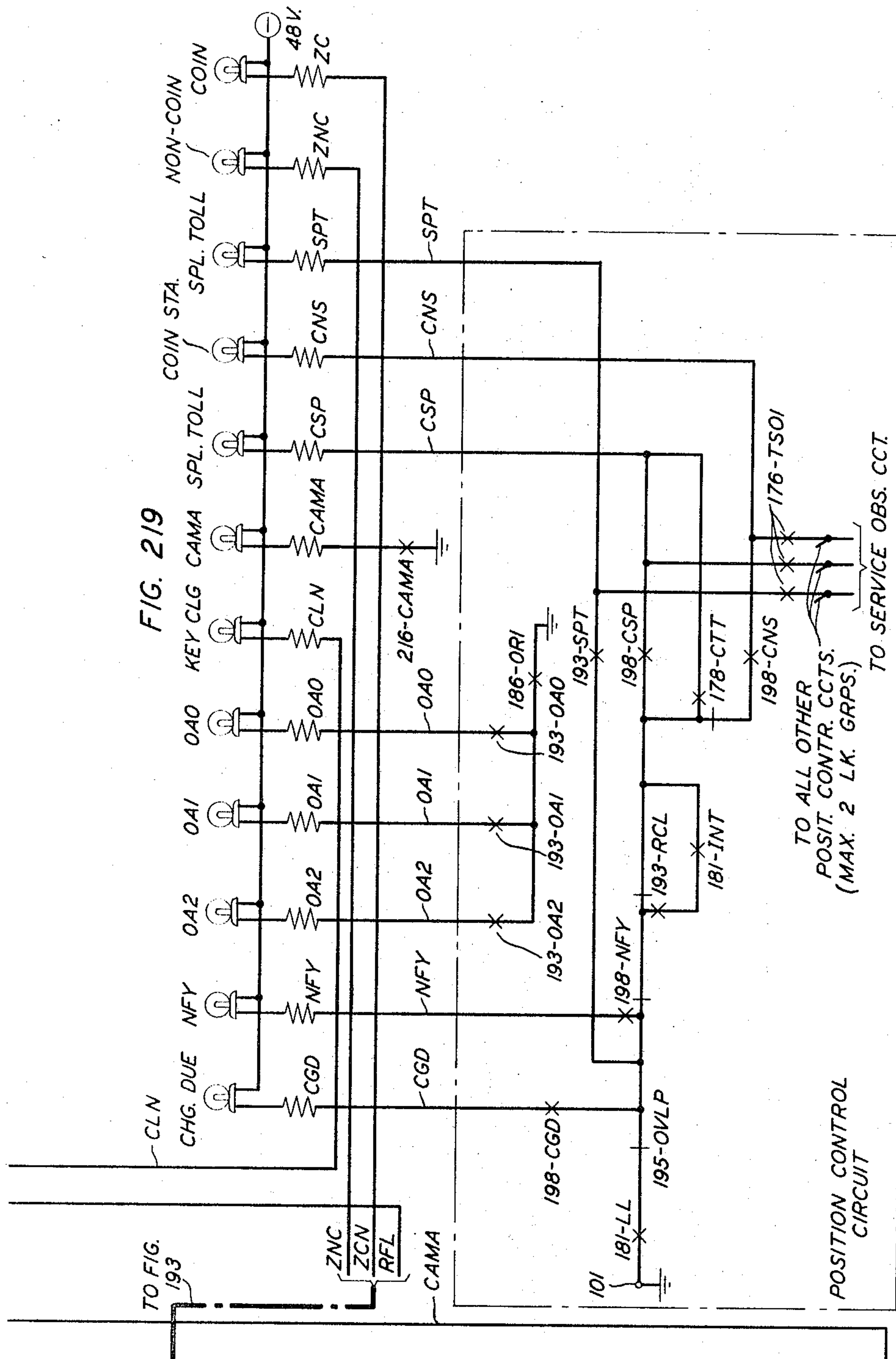
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FIG. 219





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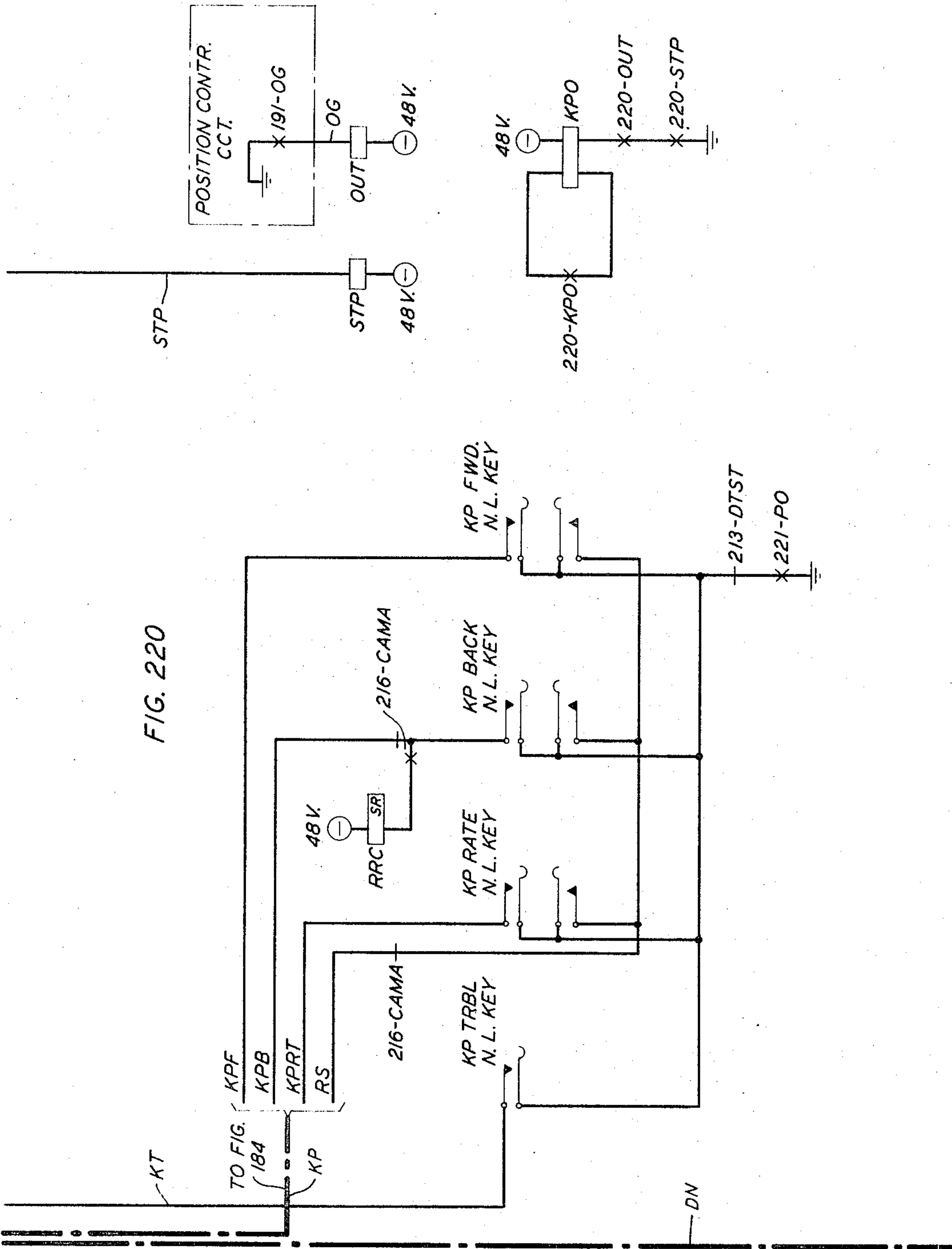
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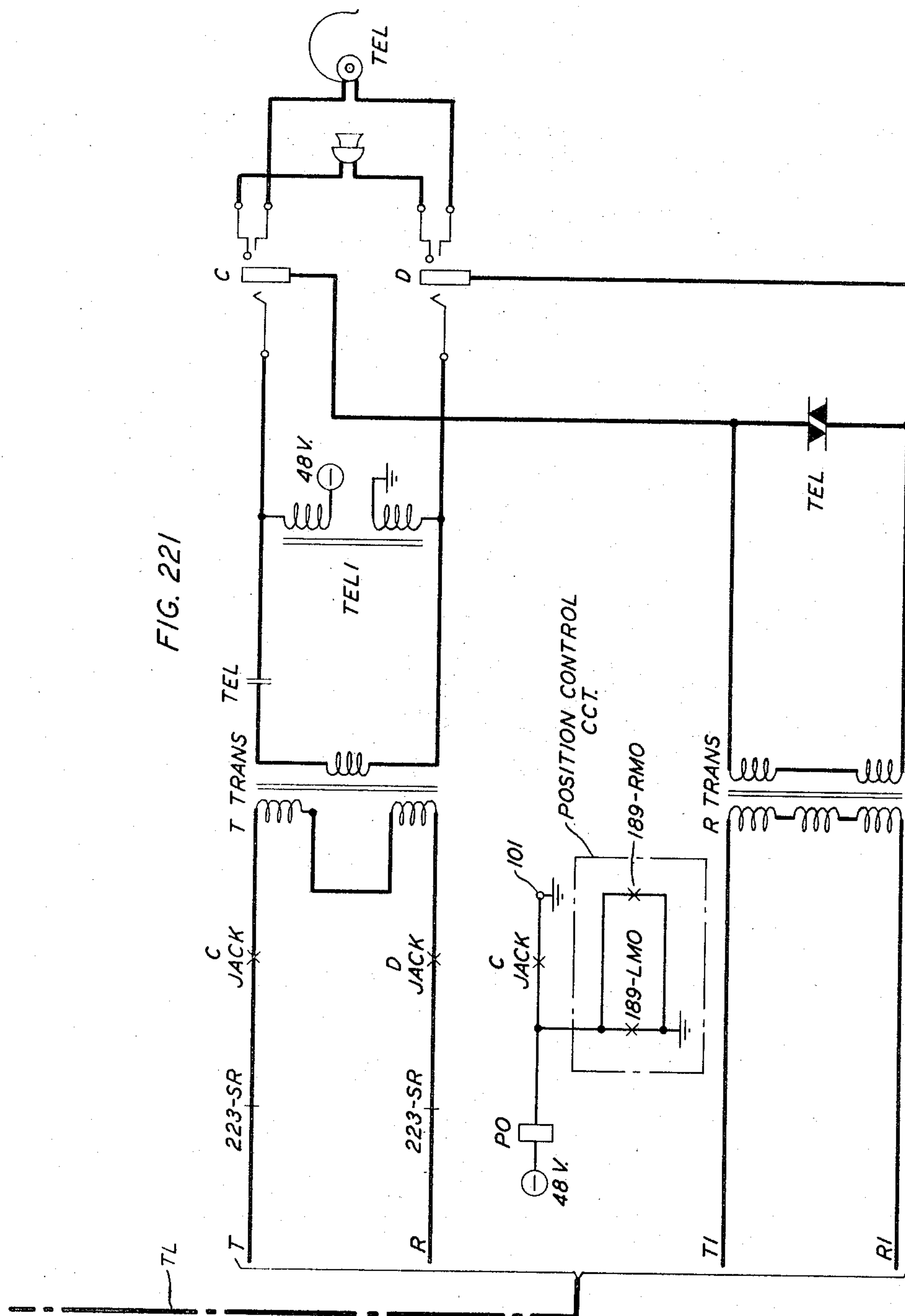


FIG. 221



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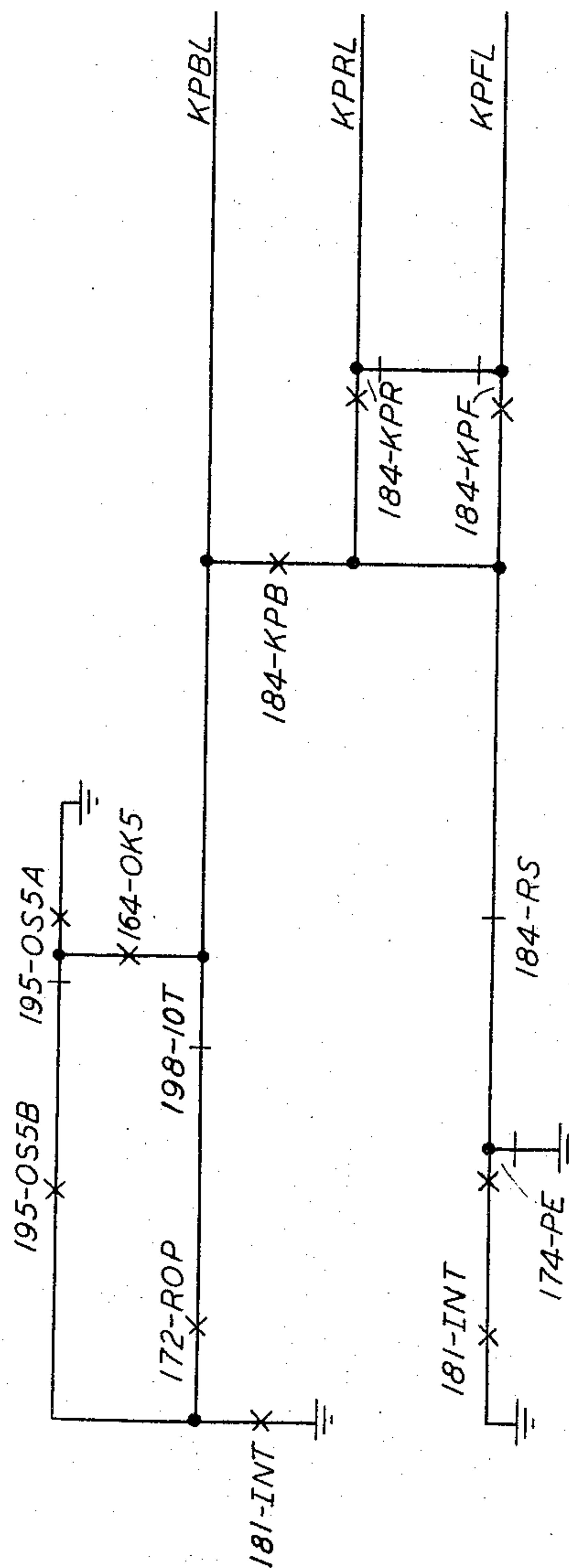
R. B. CURTIS  
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FIG. 222





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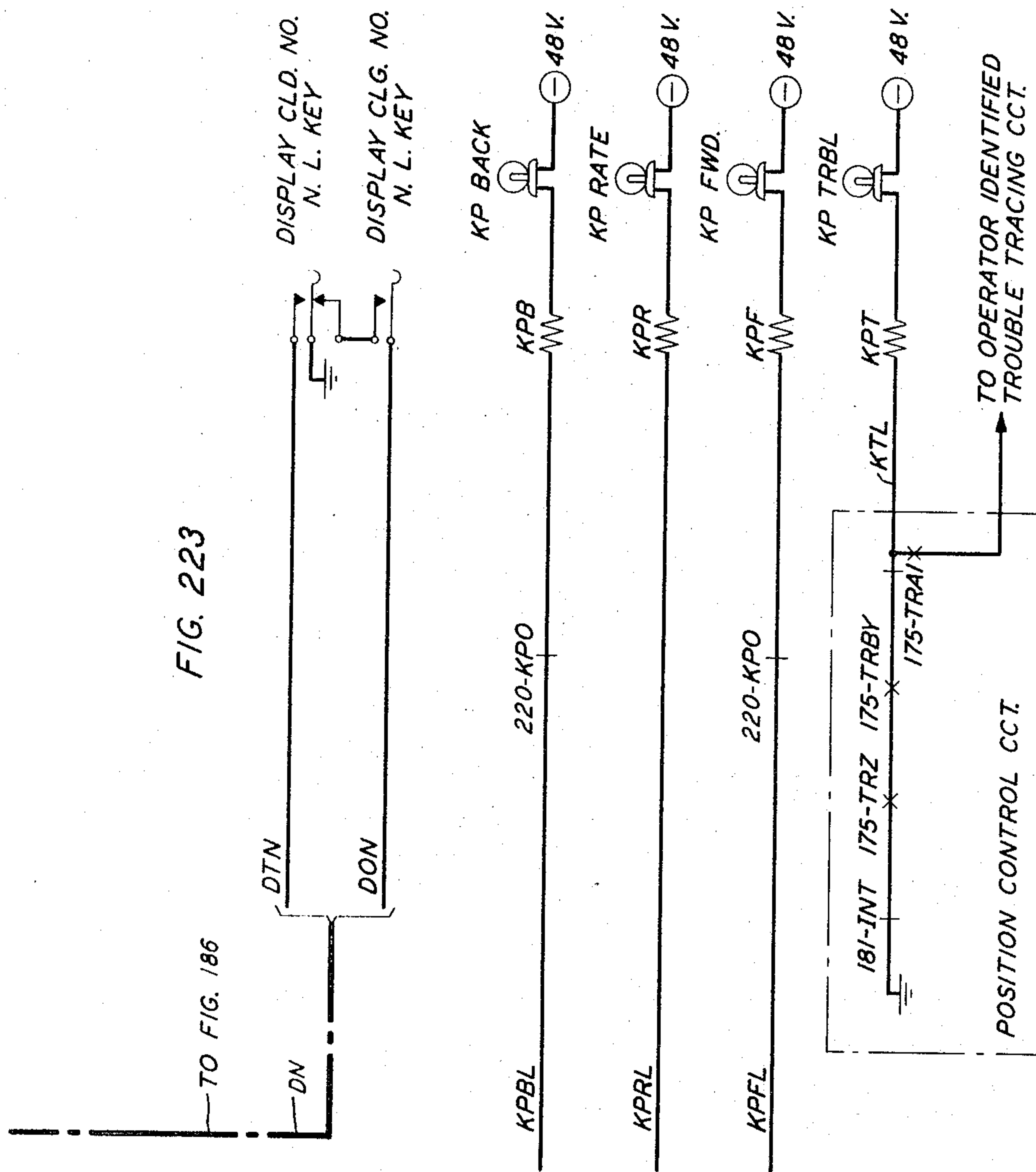
R. B. CURTIS  
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FIG. 223





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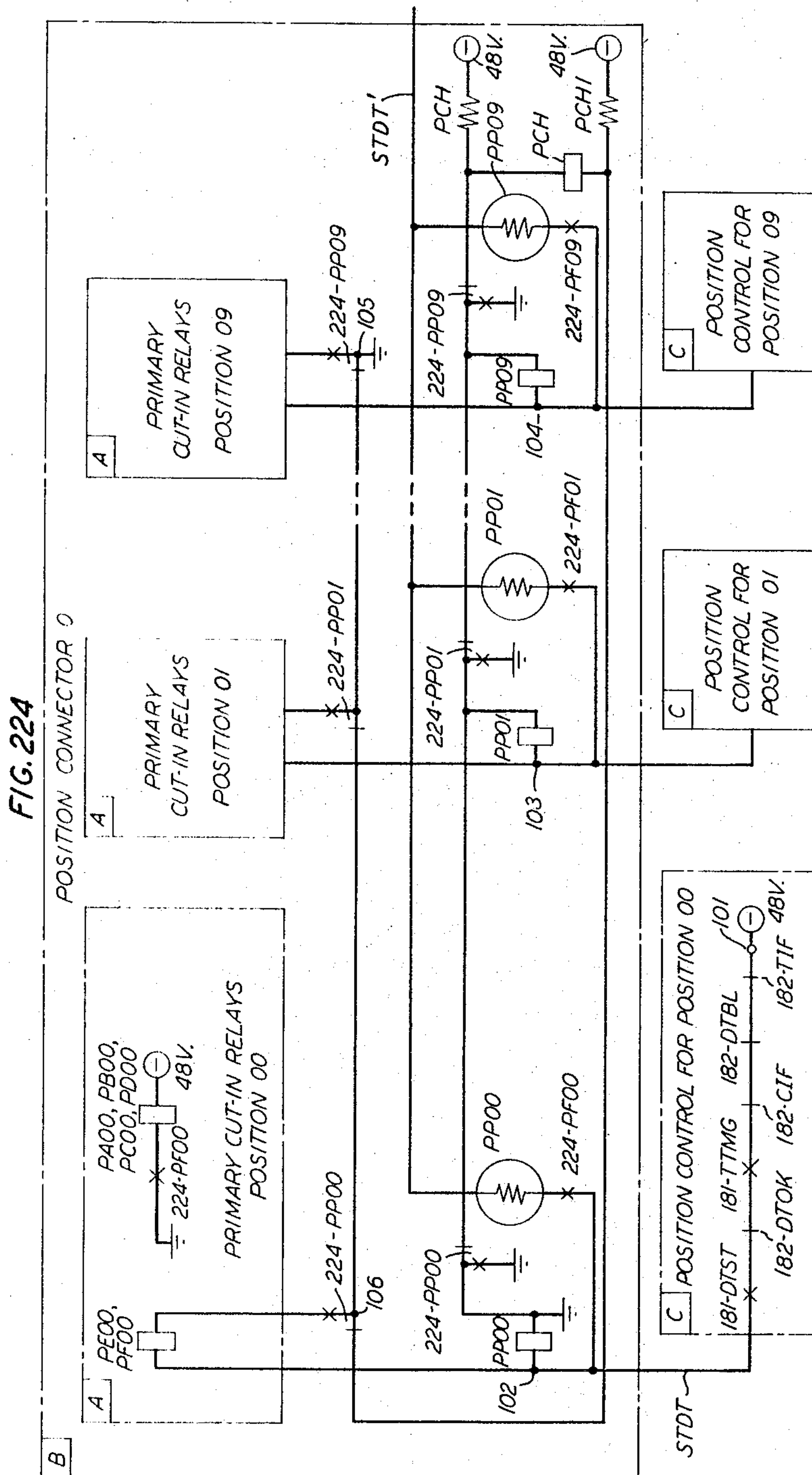
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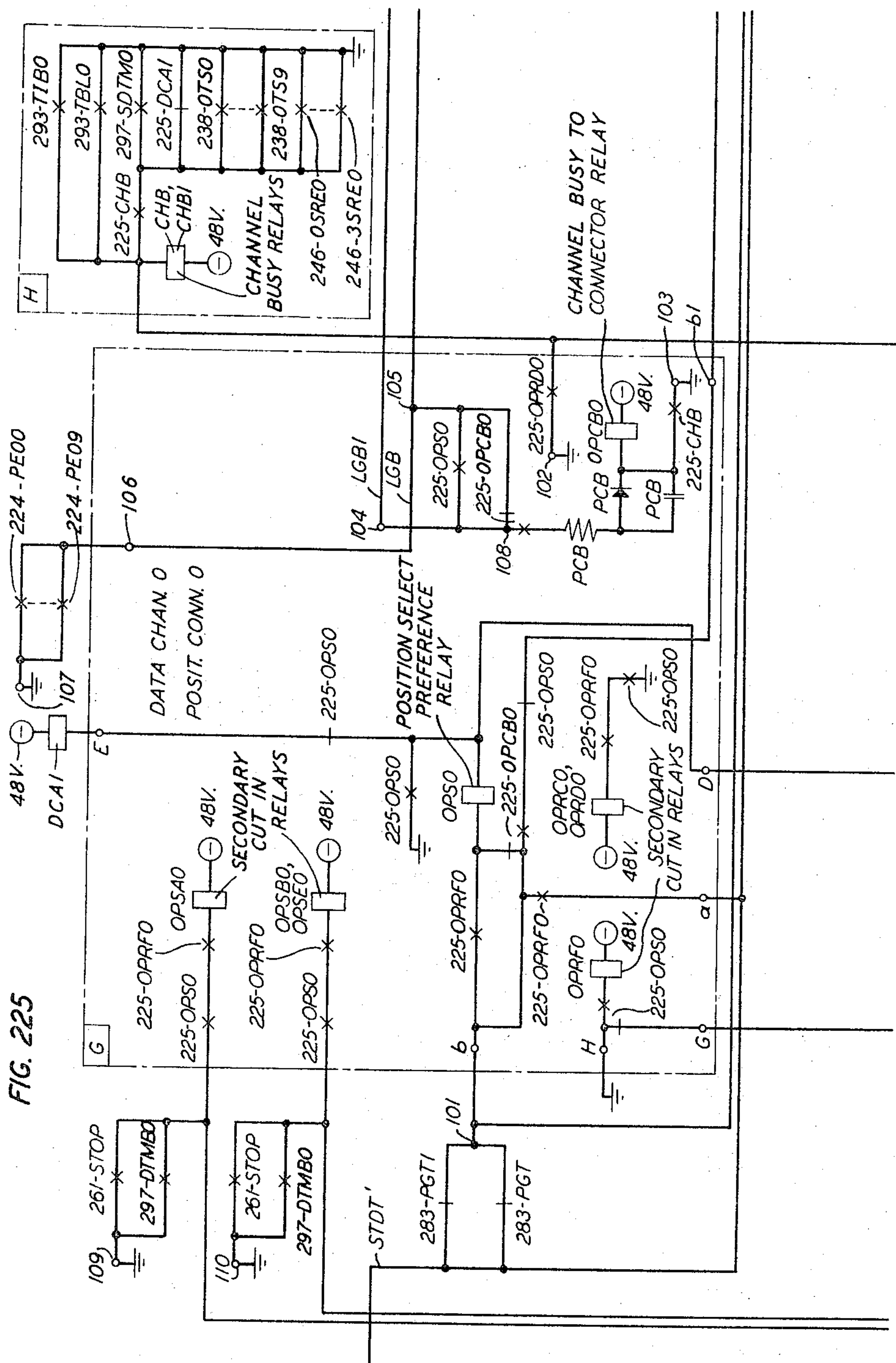
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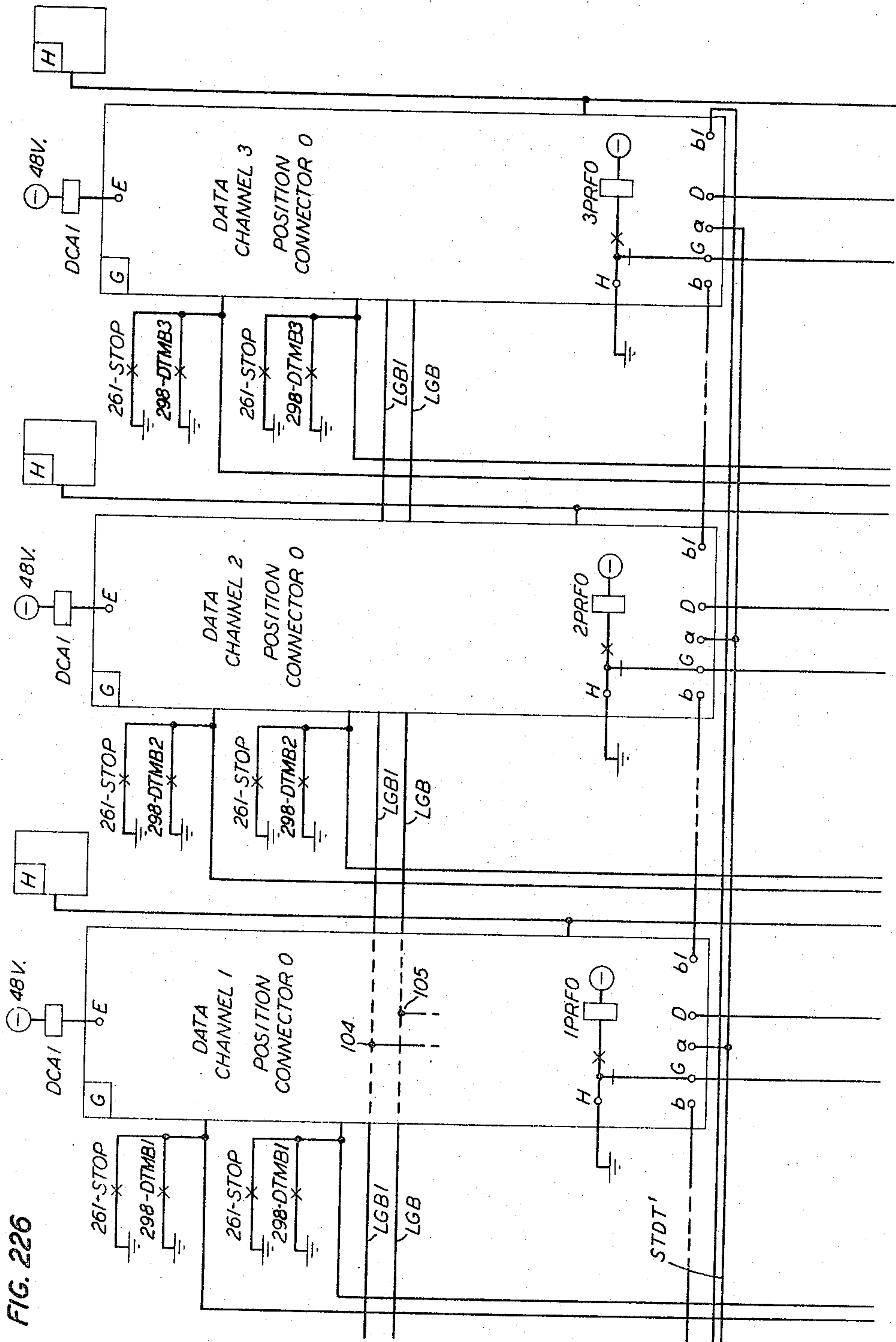


FIG. 226



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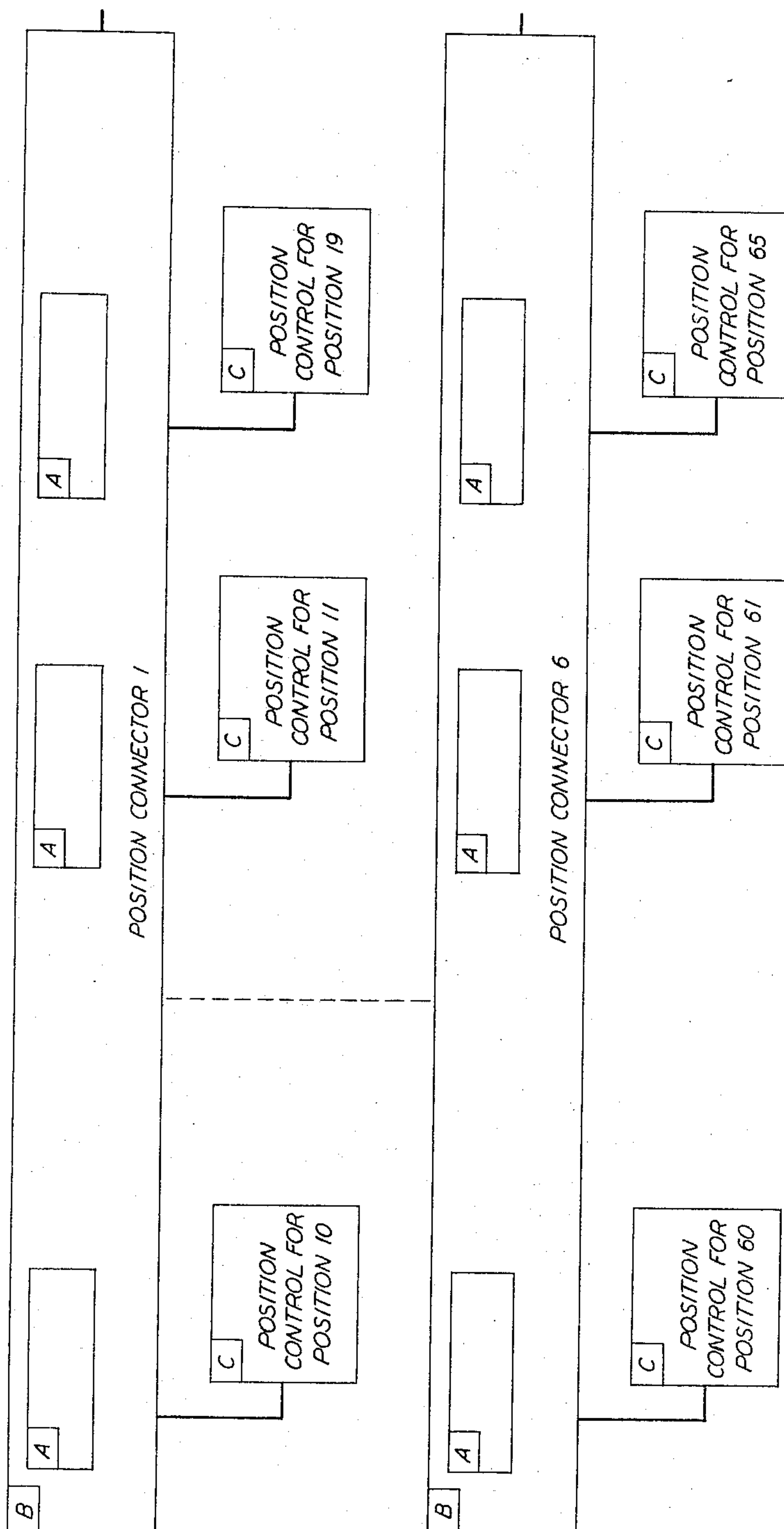
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FIG. 227





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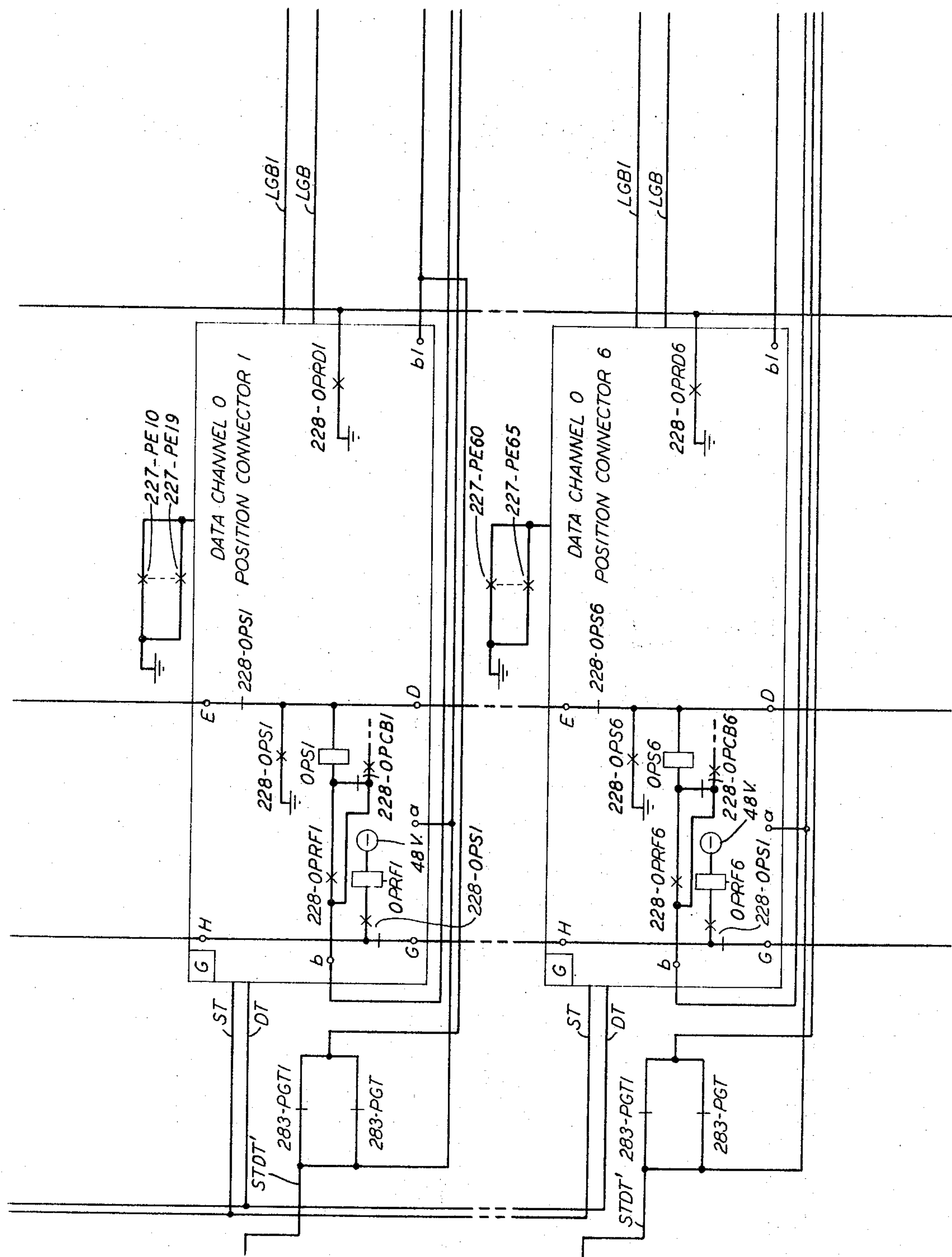


FIG. 228



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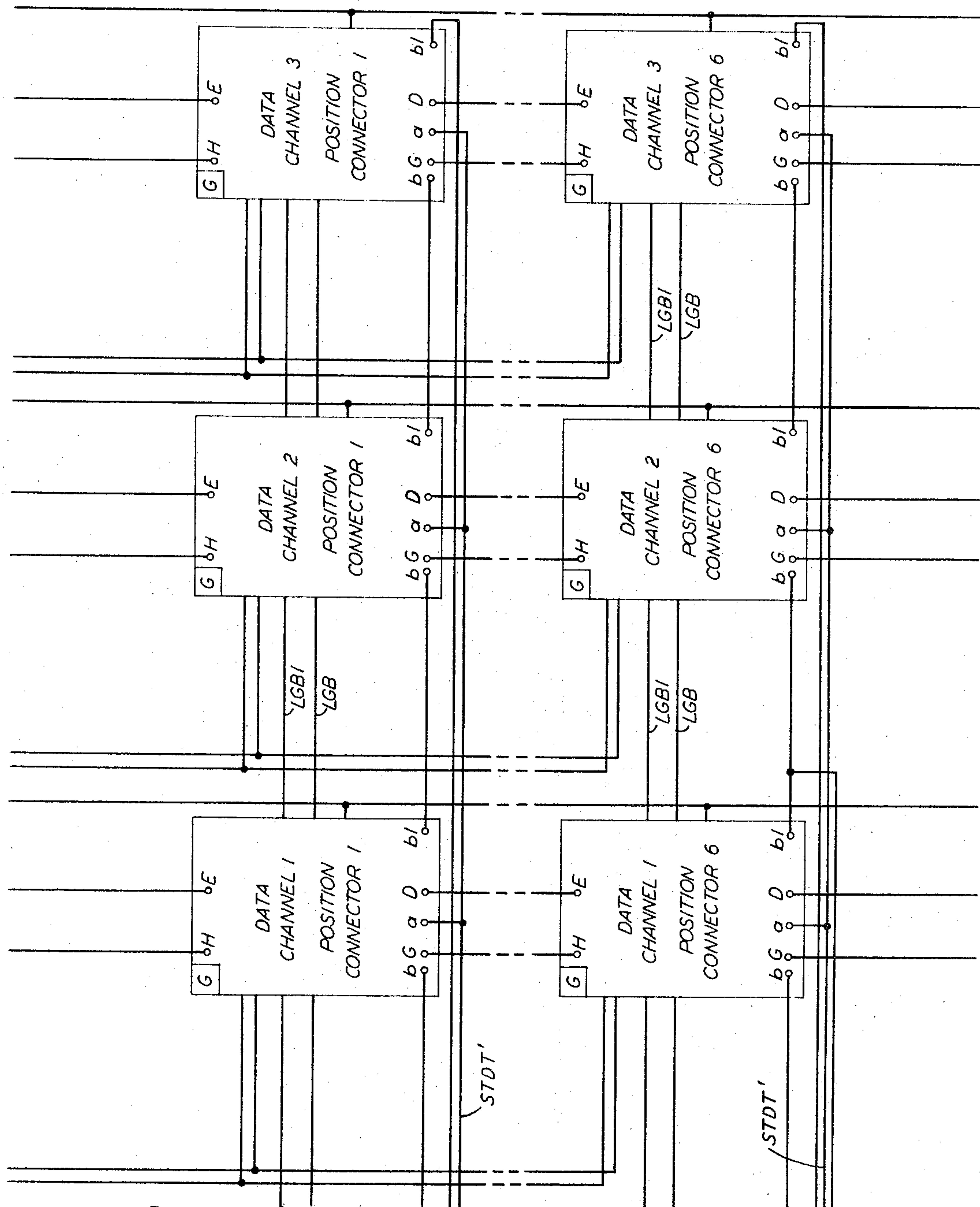


FIG. 229



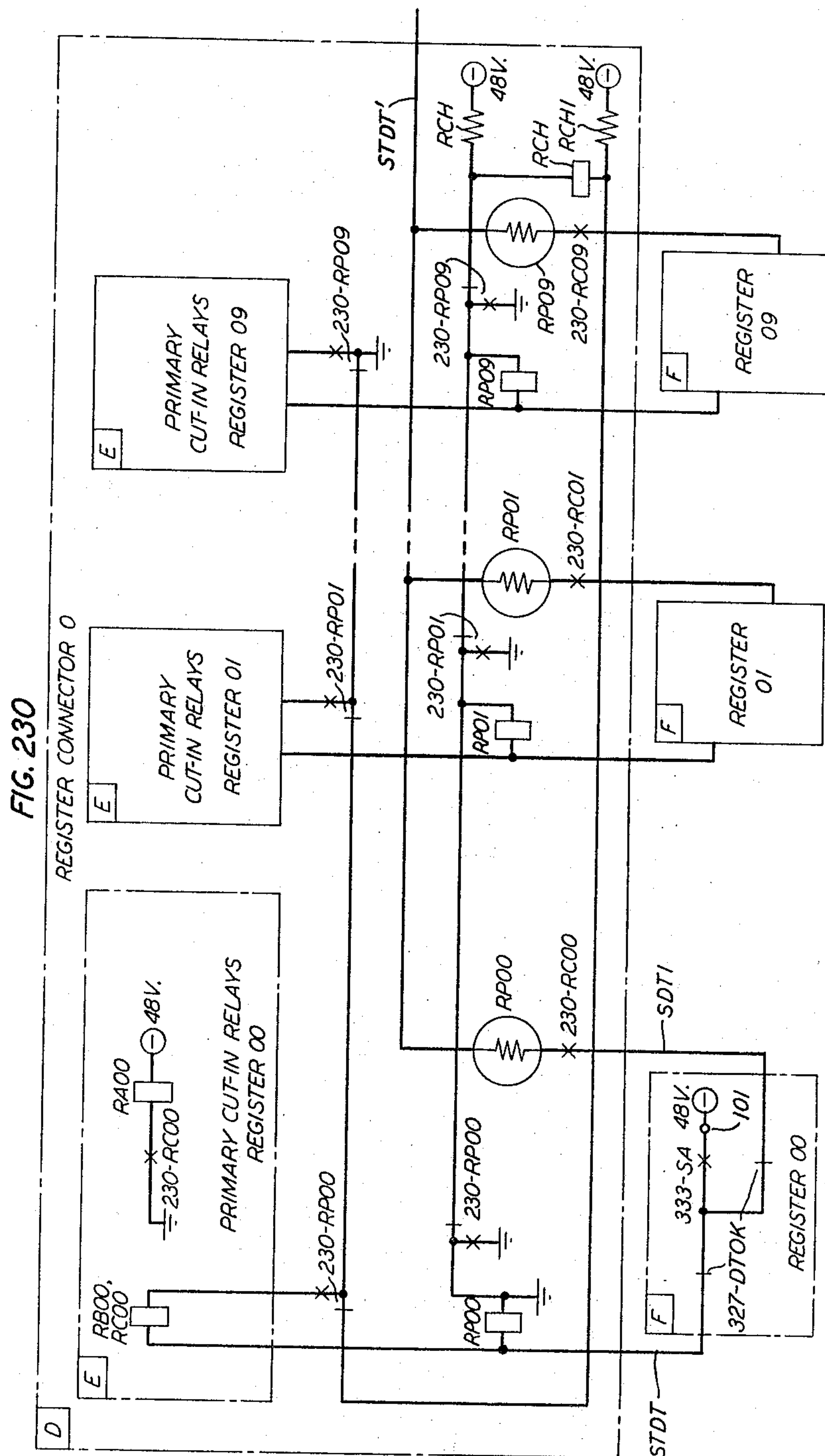
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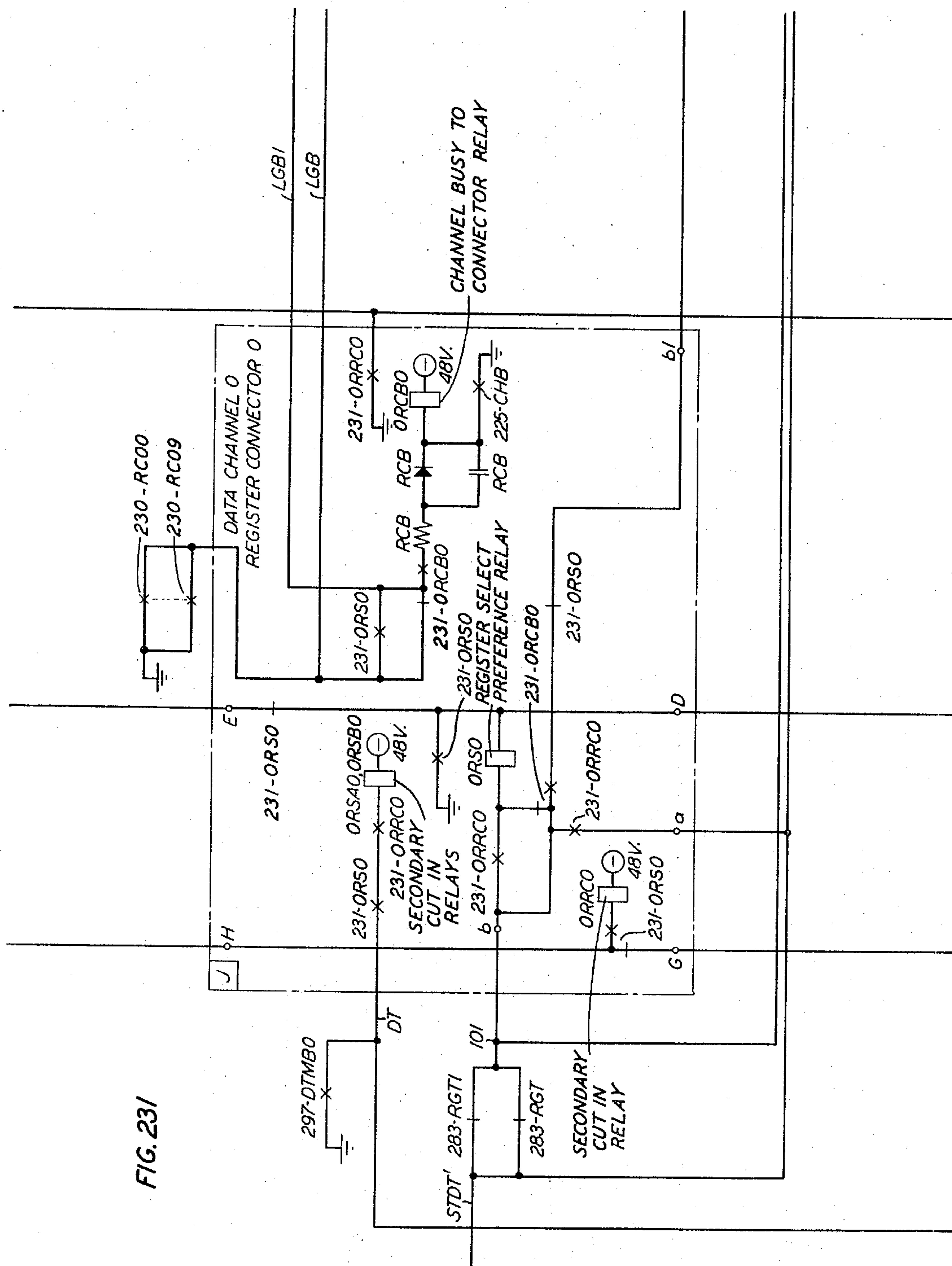
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**FIG. 231**



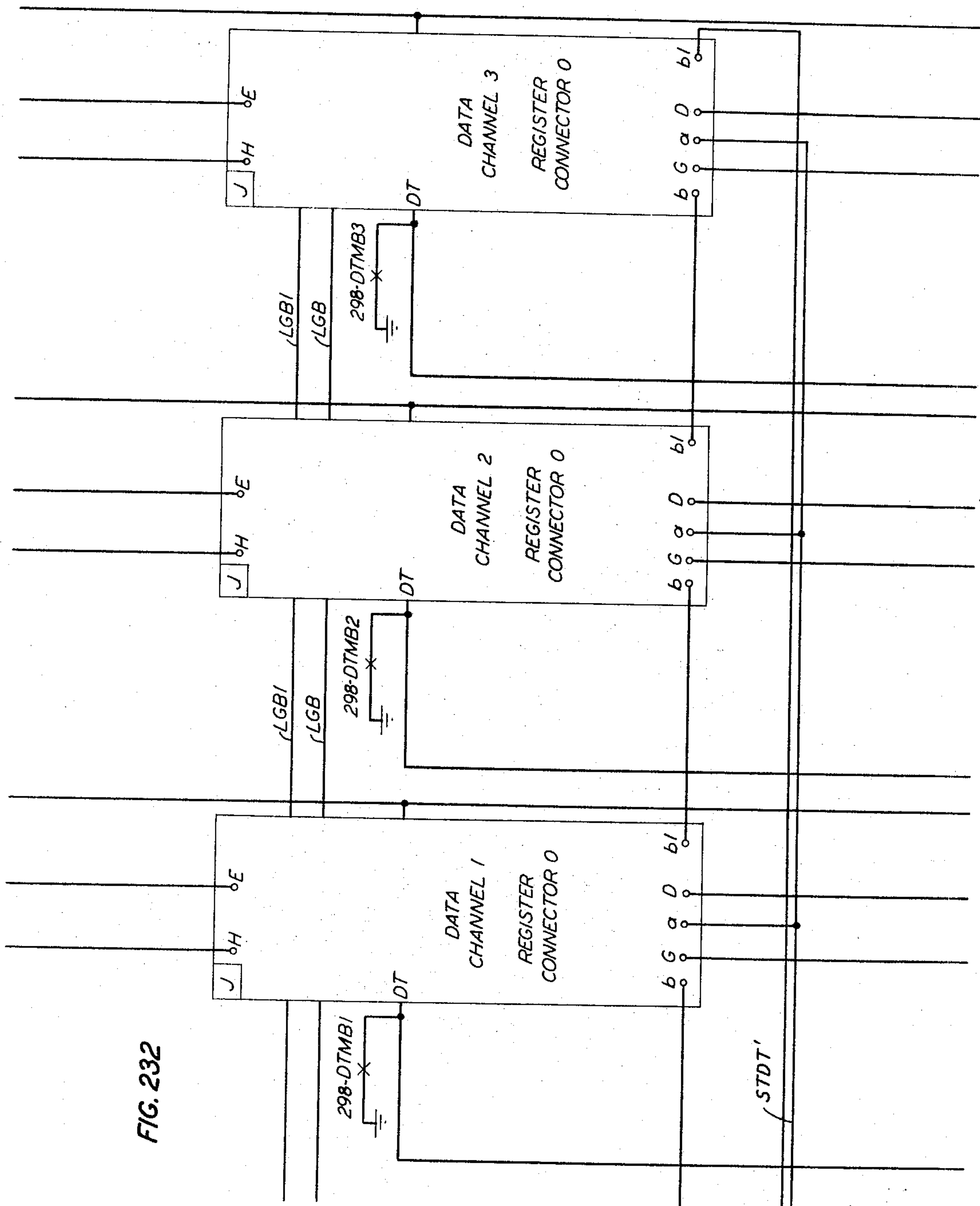
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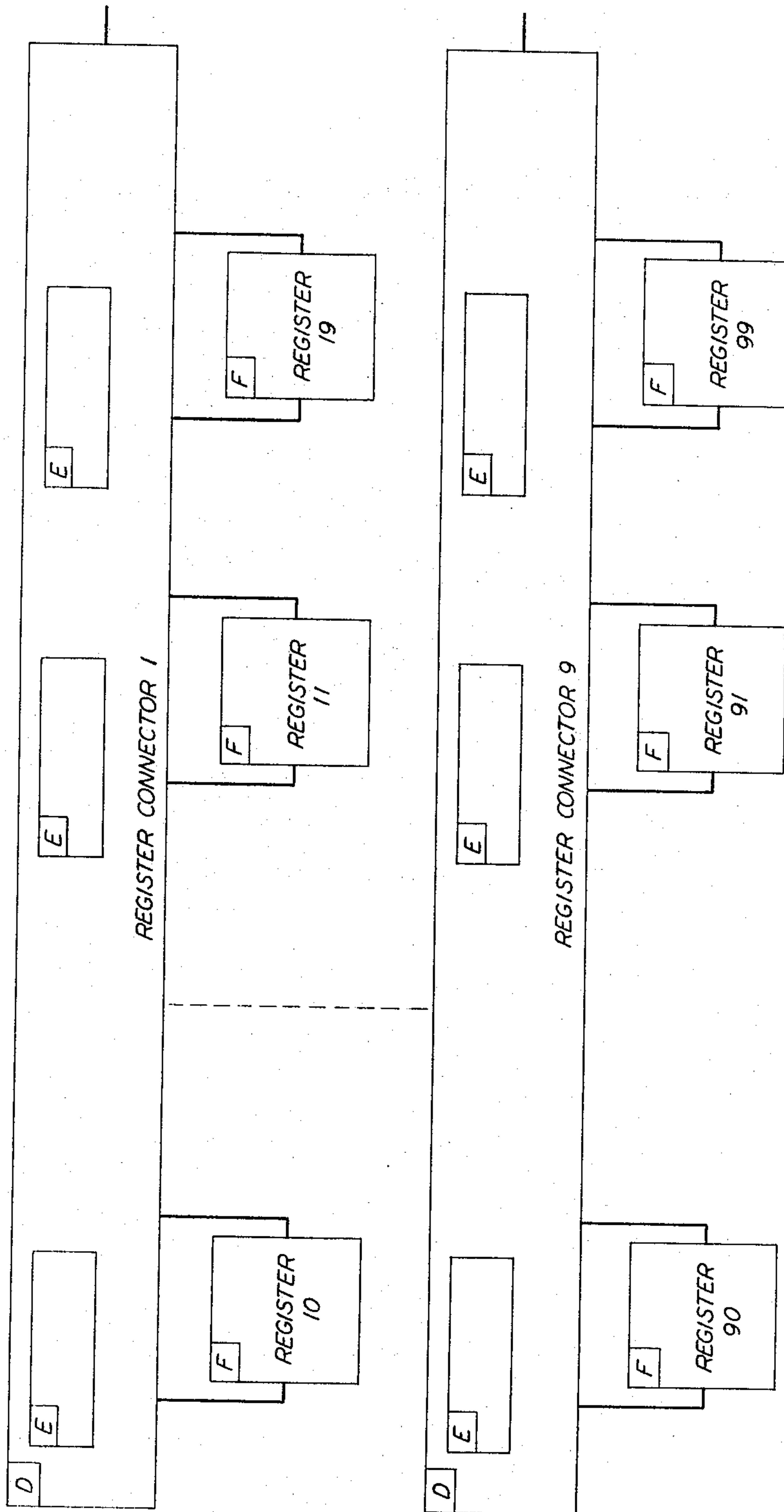
R. B. CURTIS  
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FIG. 233





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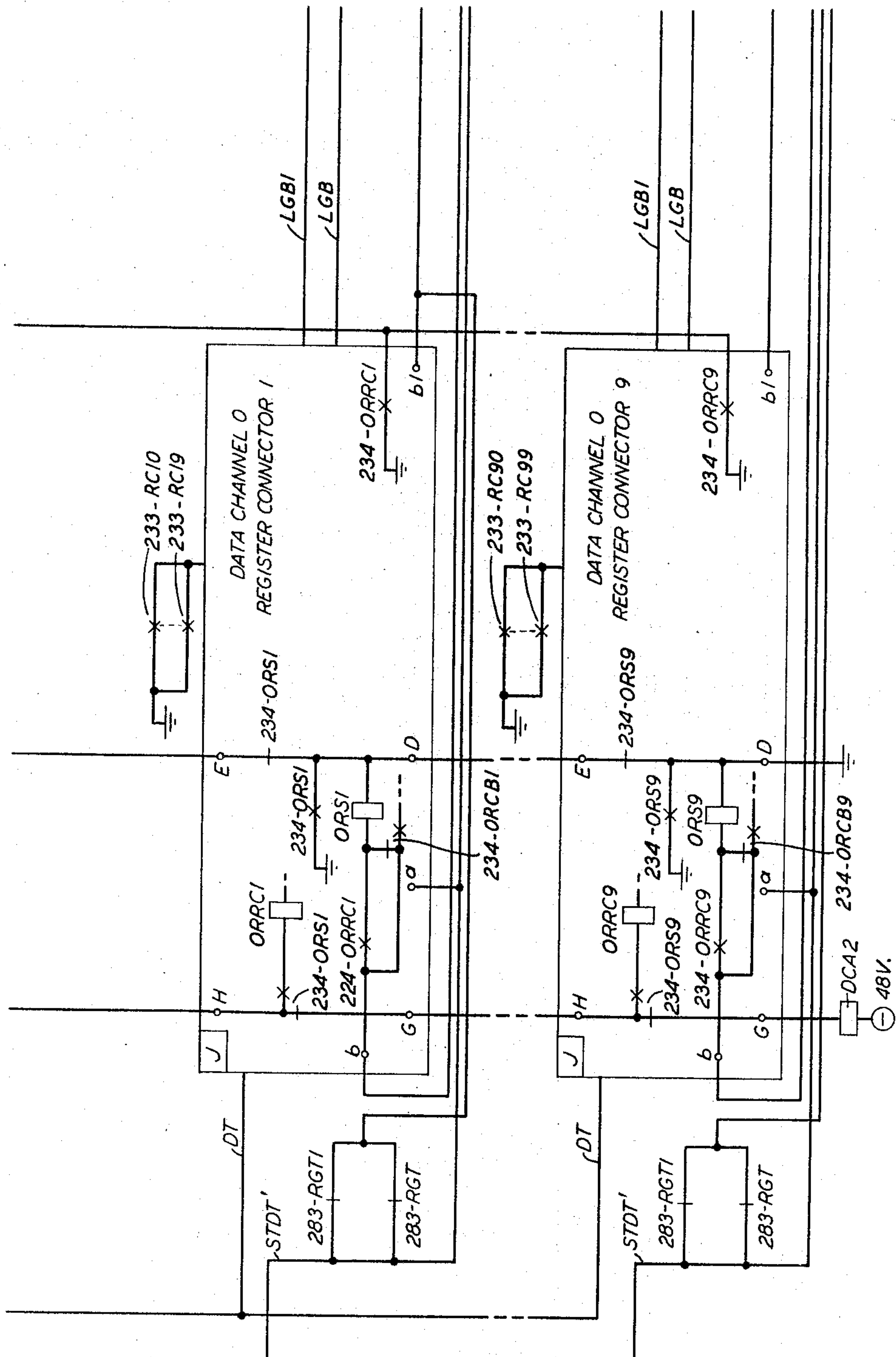


FIG. 234



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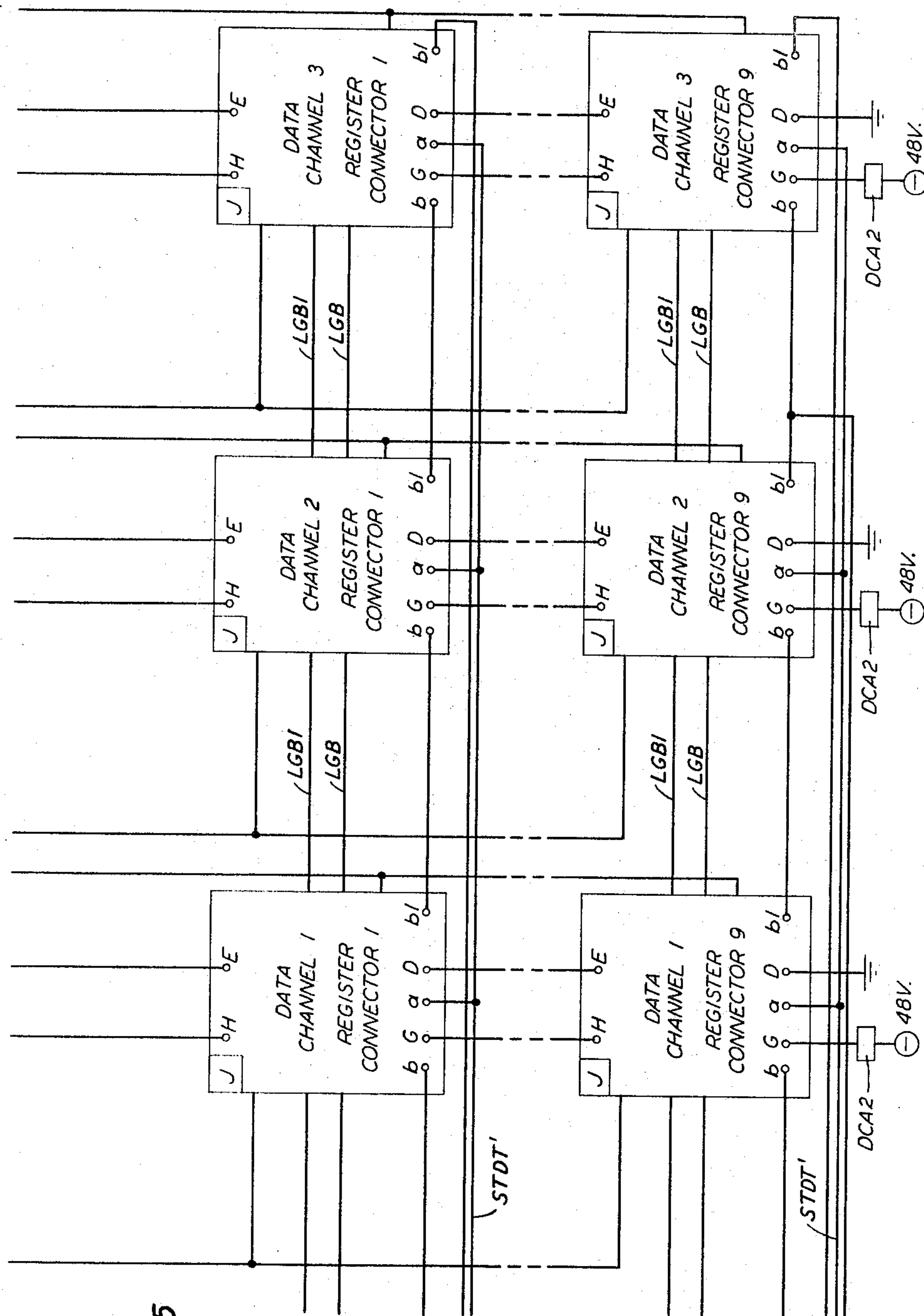


FIG. 235



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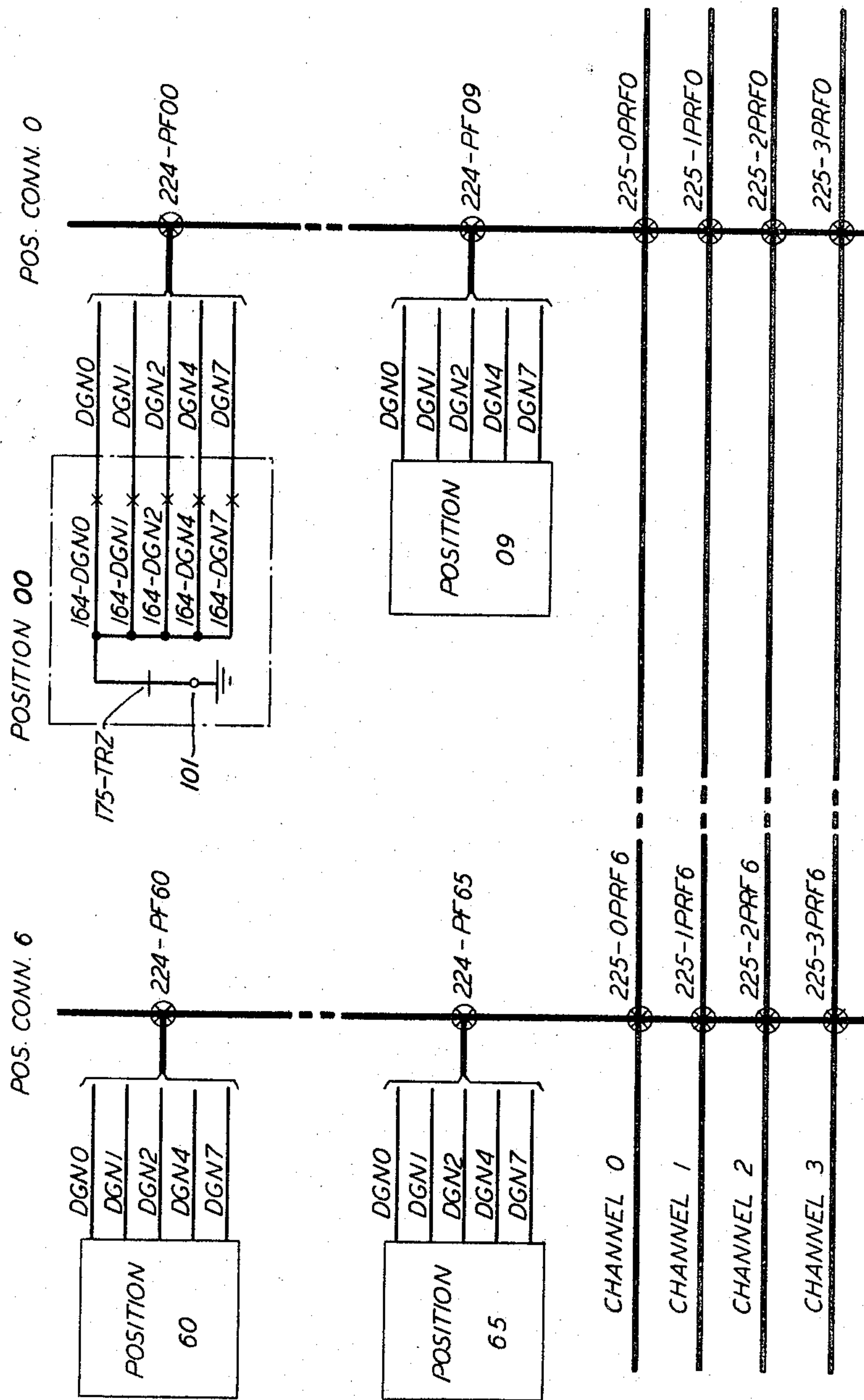


FIG. 236



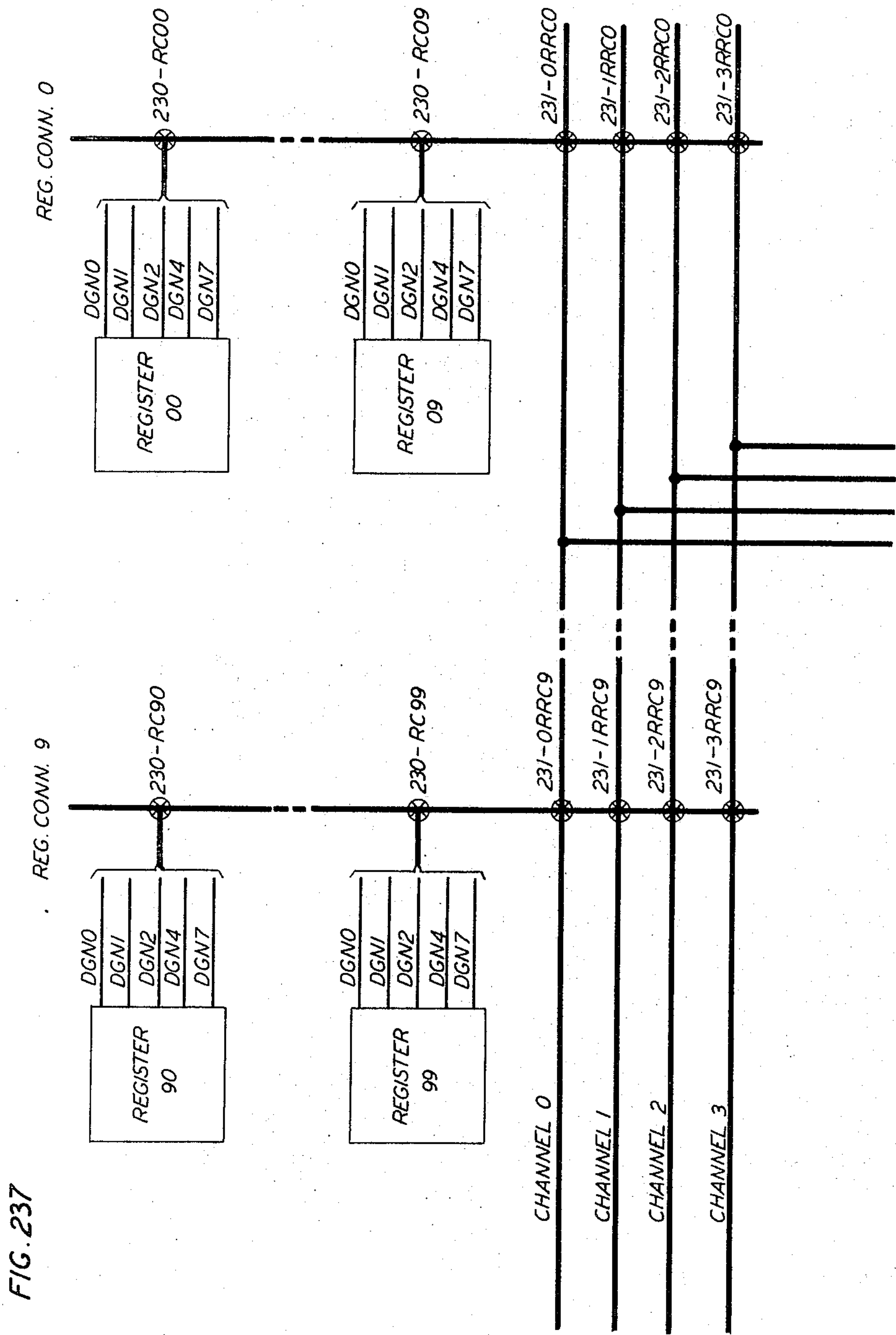
Sept. 12, 1967

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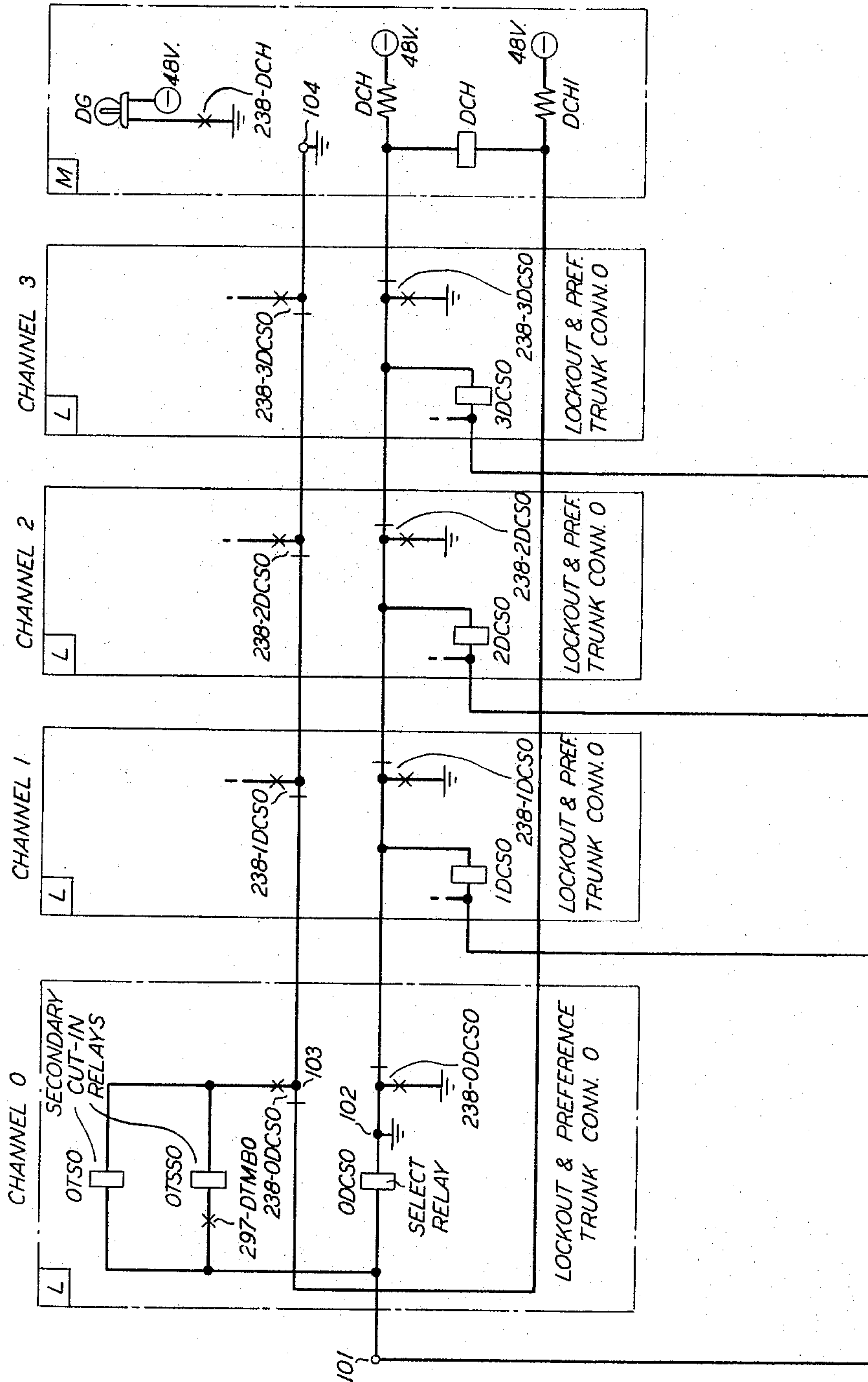
R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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FIG. 238





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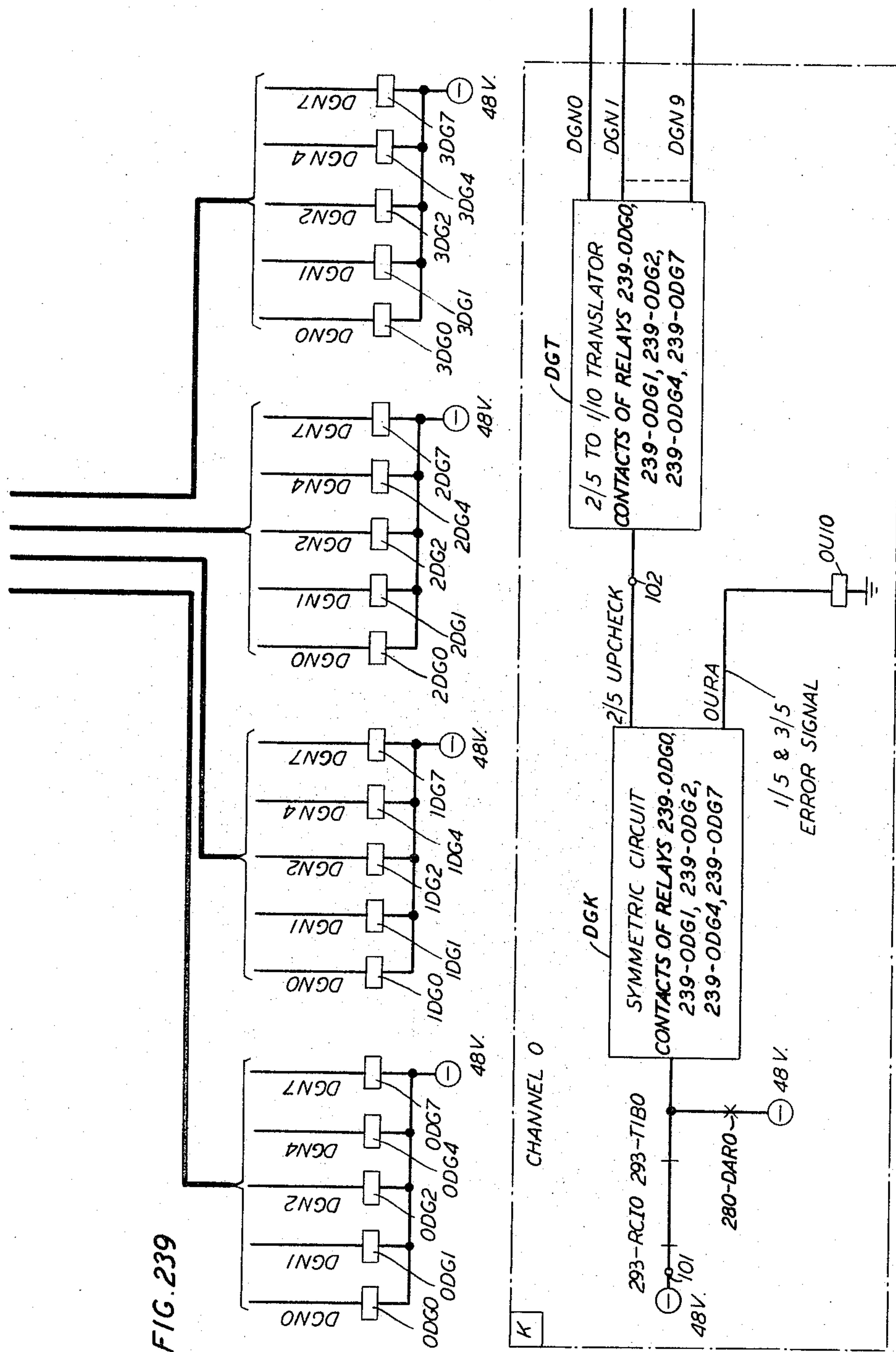
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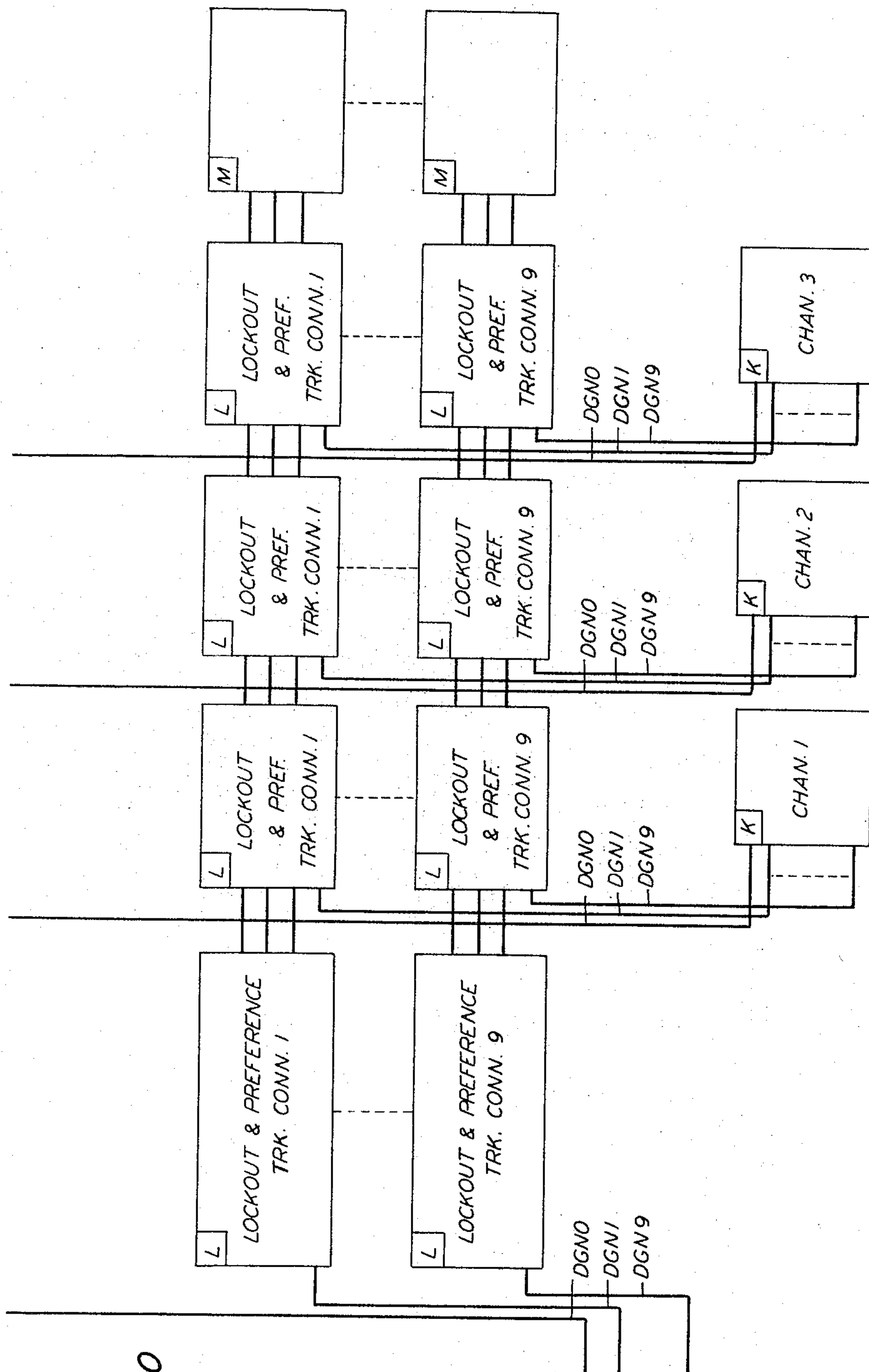


FIG. 240



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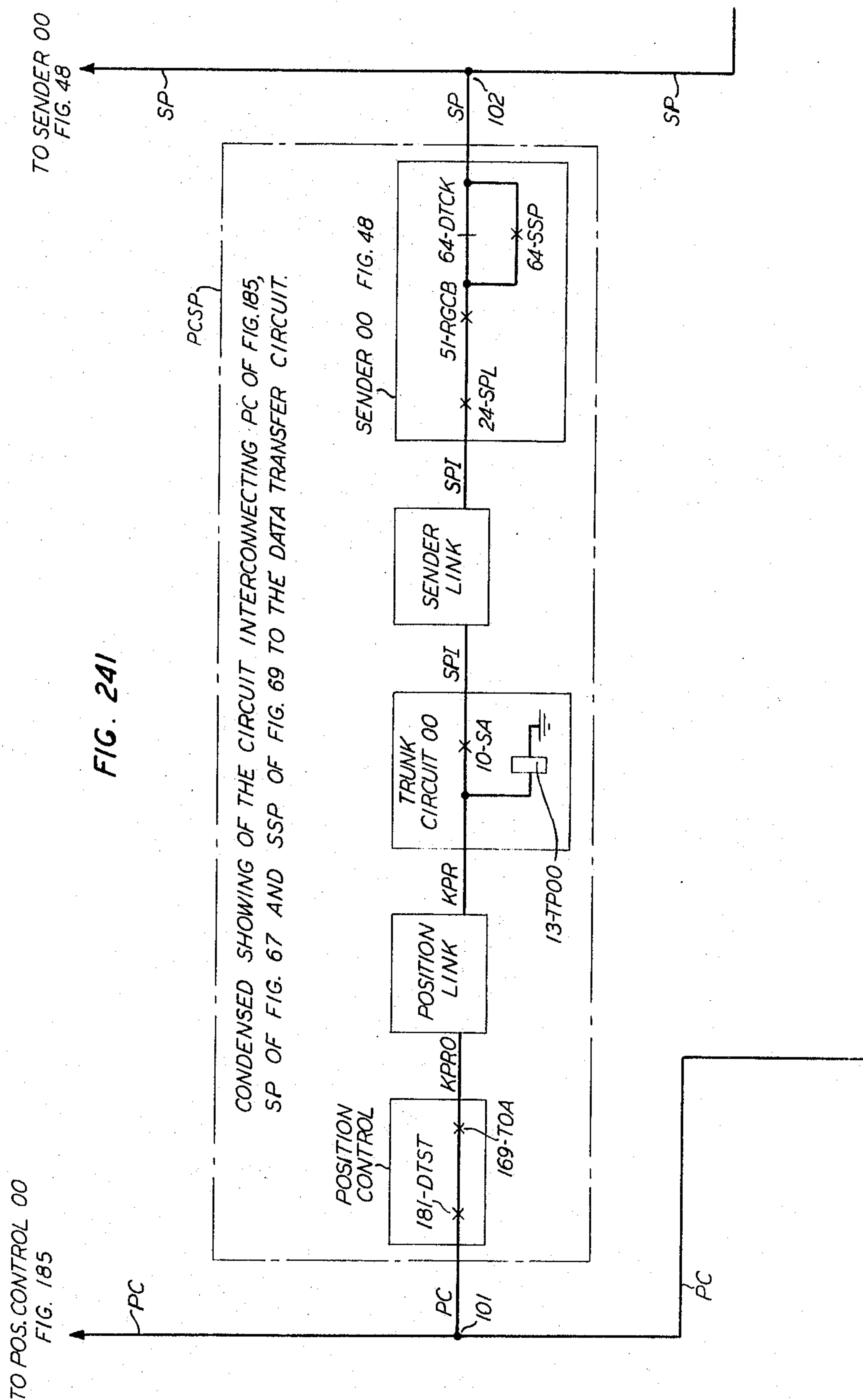
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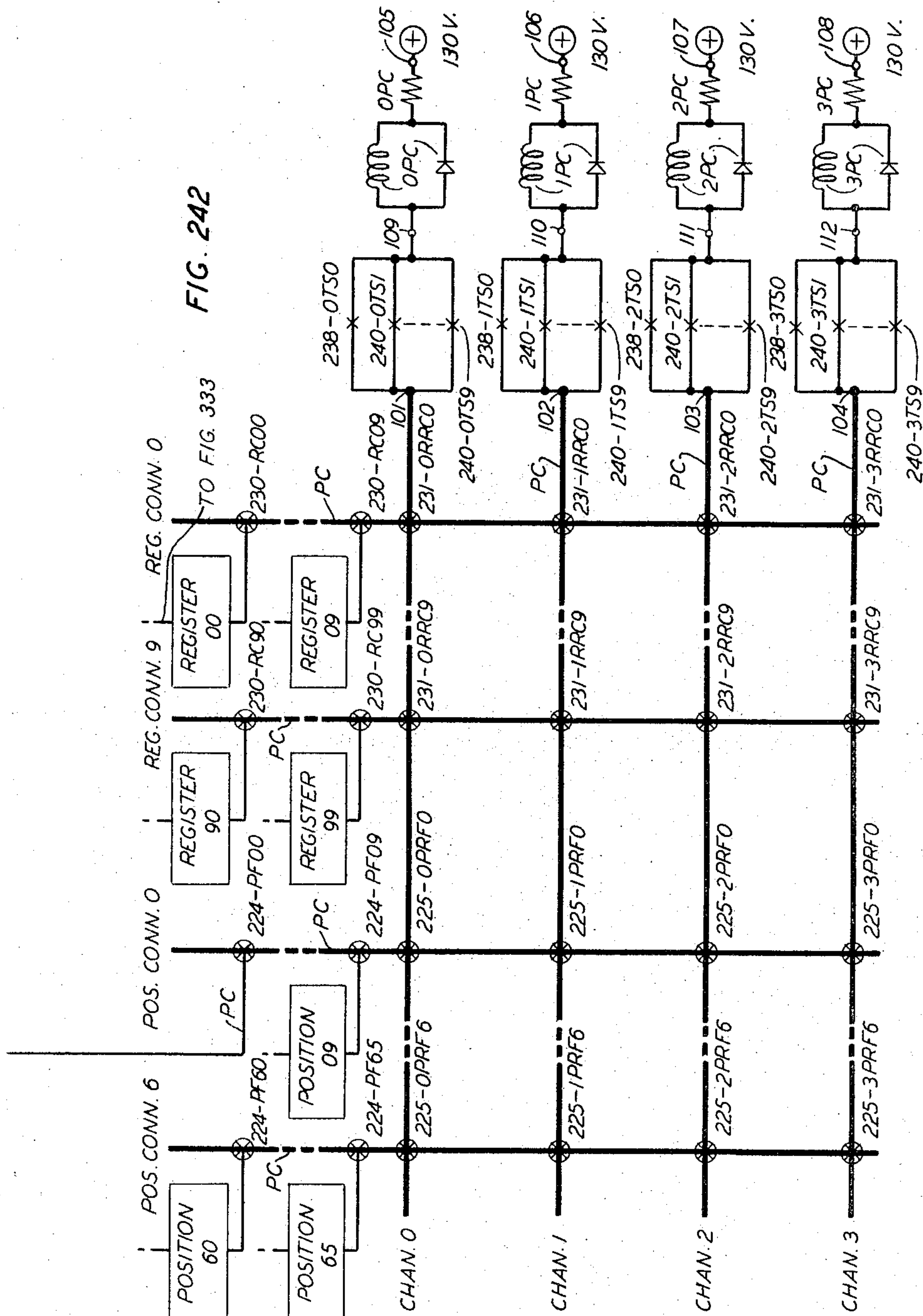
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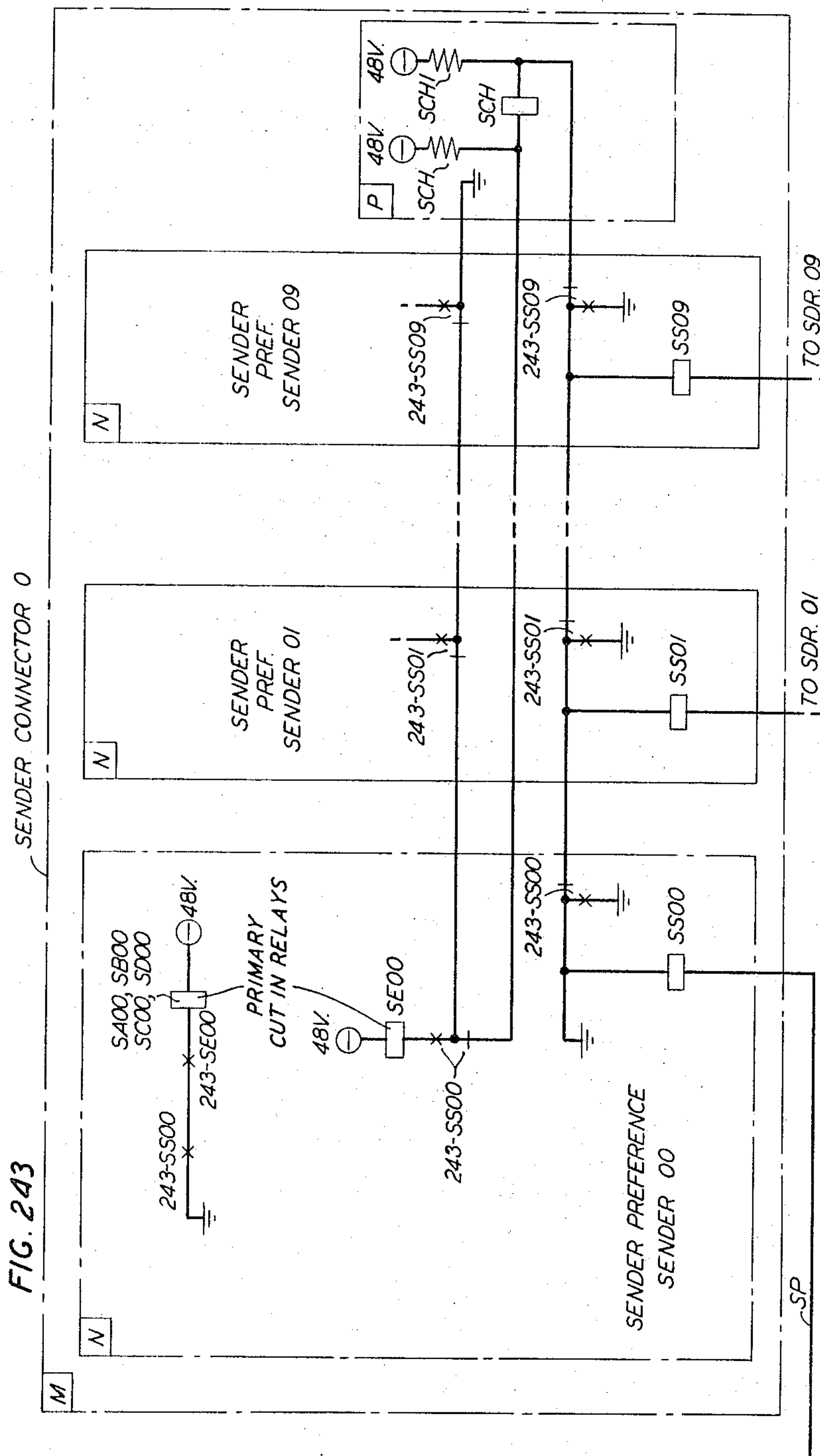
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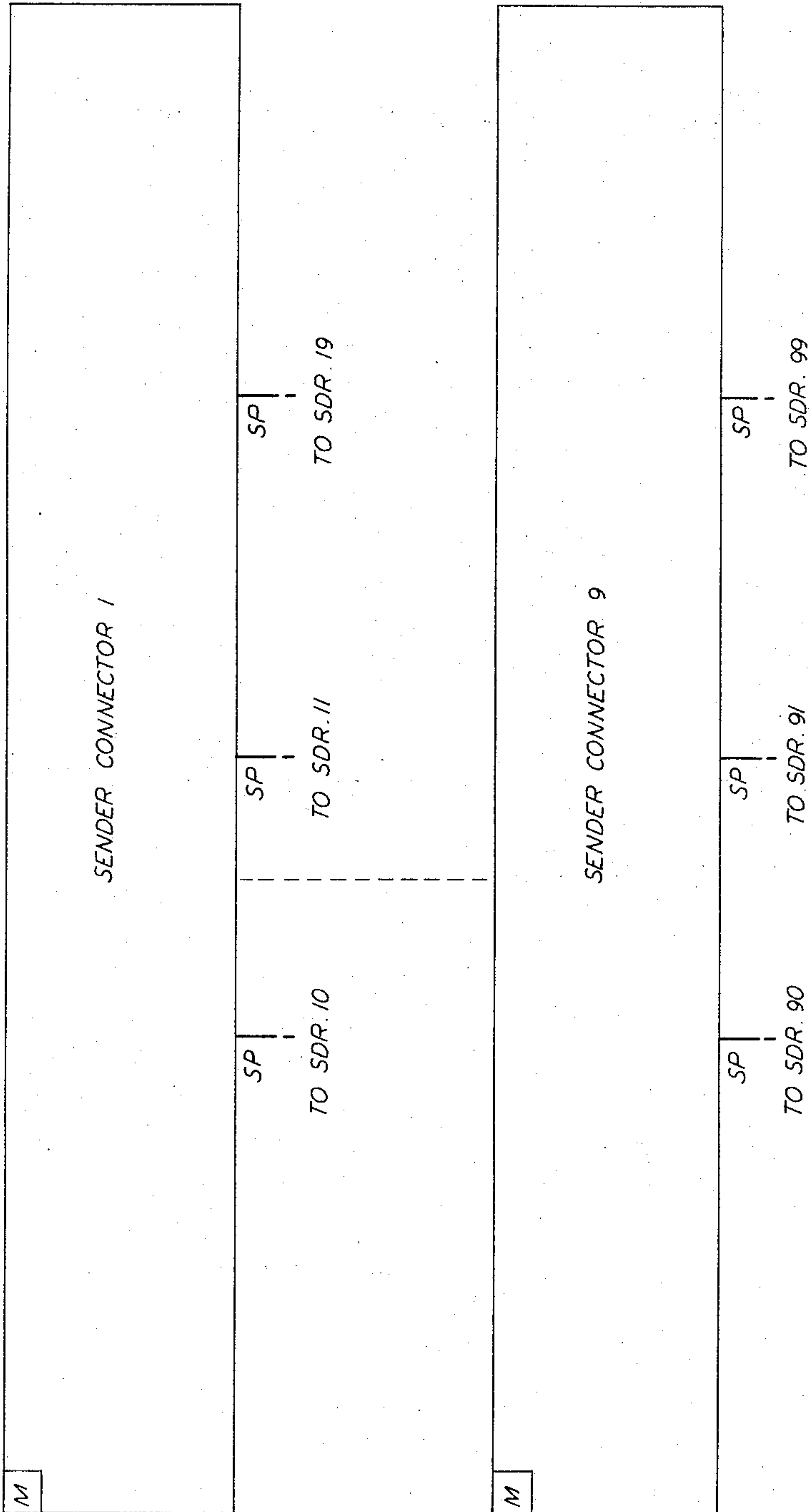
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FIG. 244





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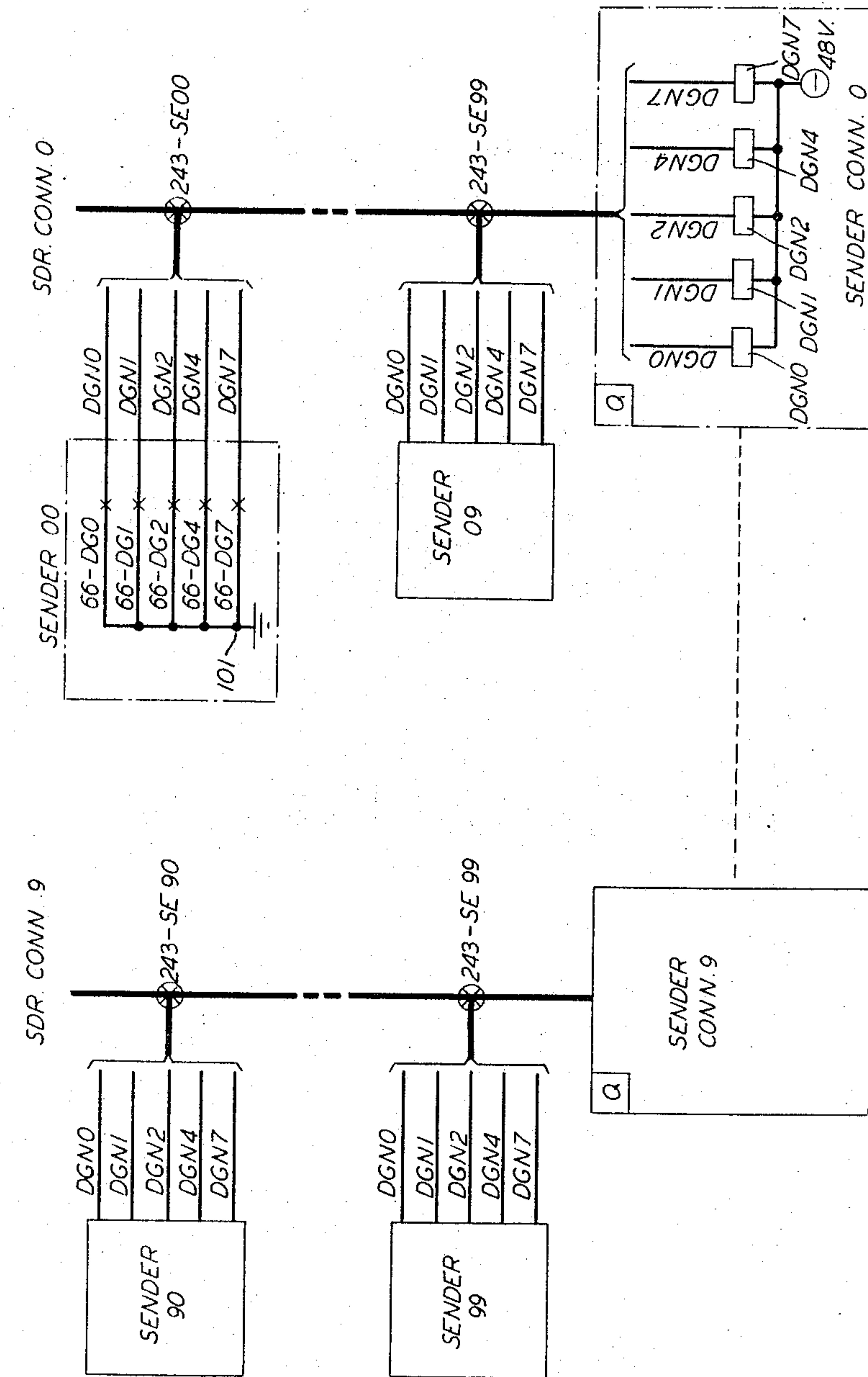
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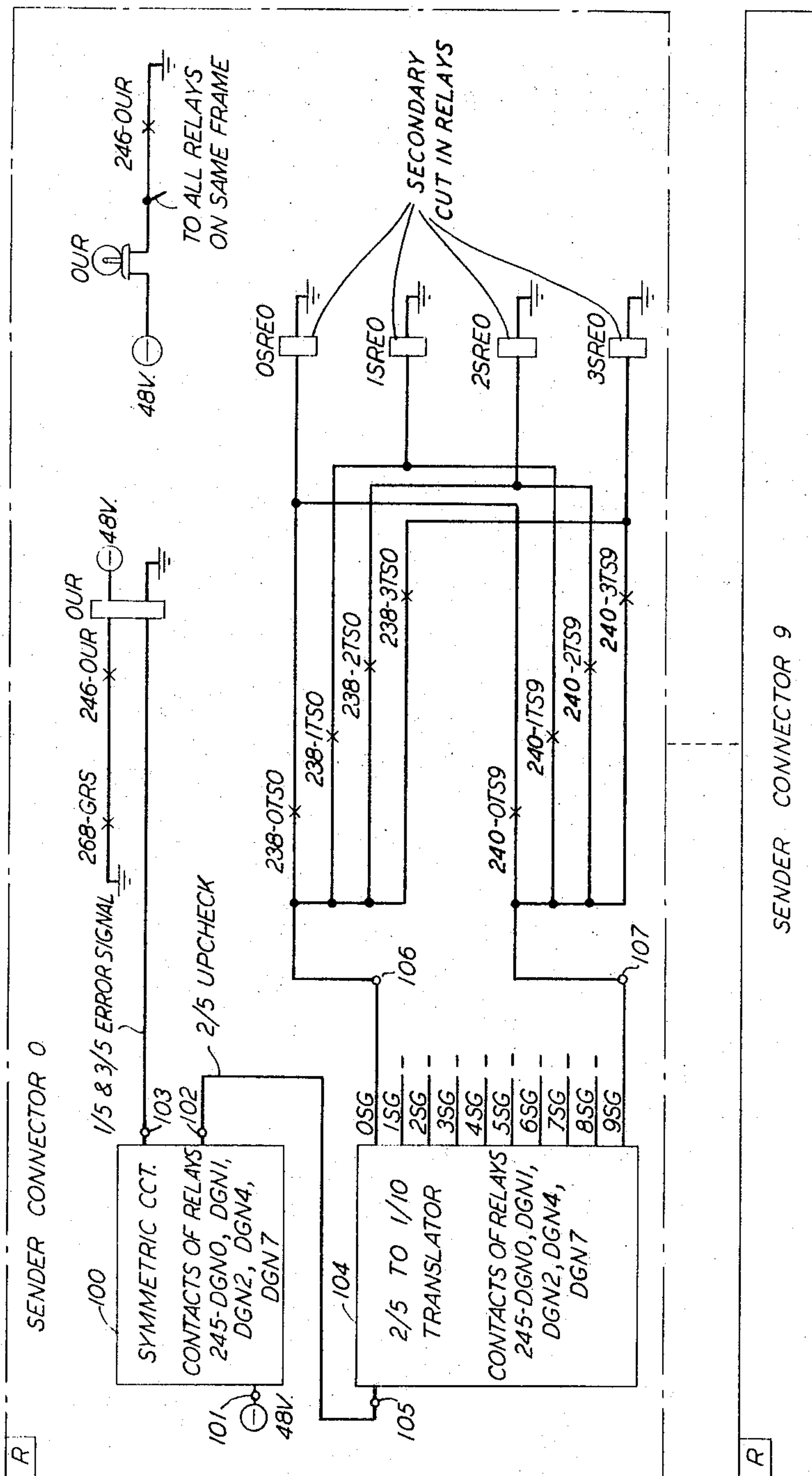
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**FIG. 246**





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R. B. CURTIS

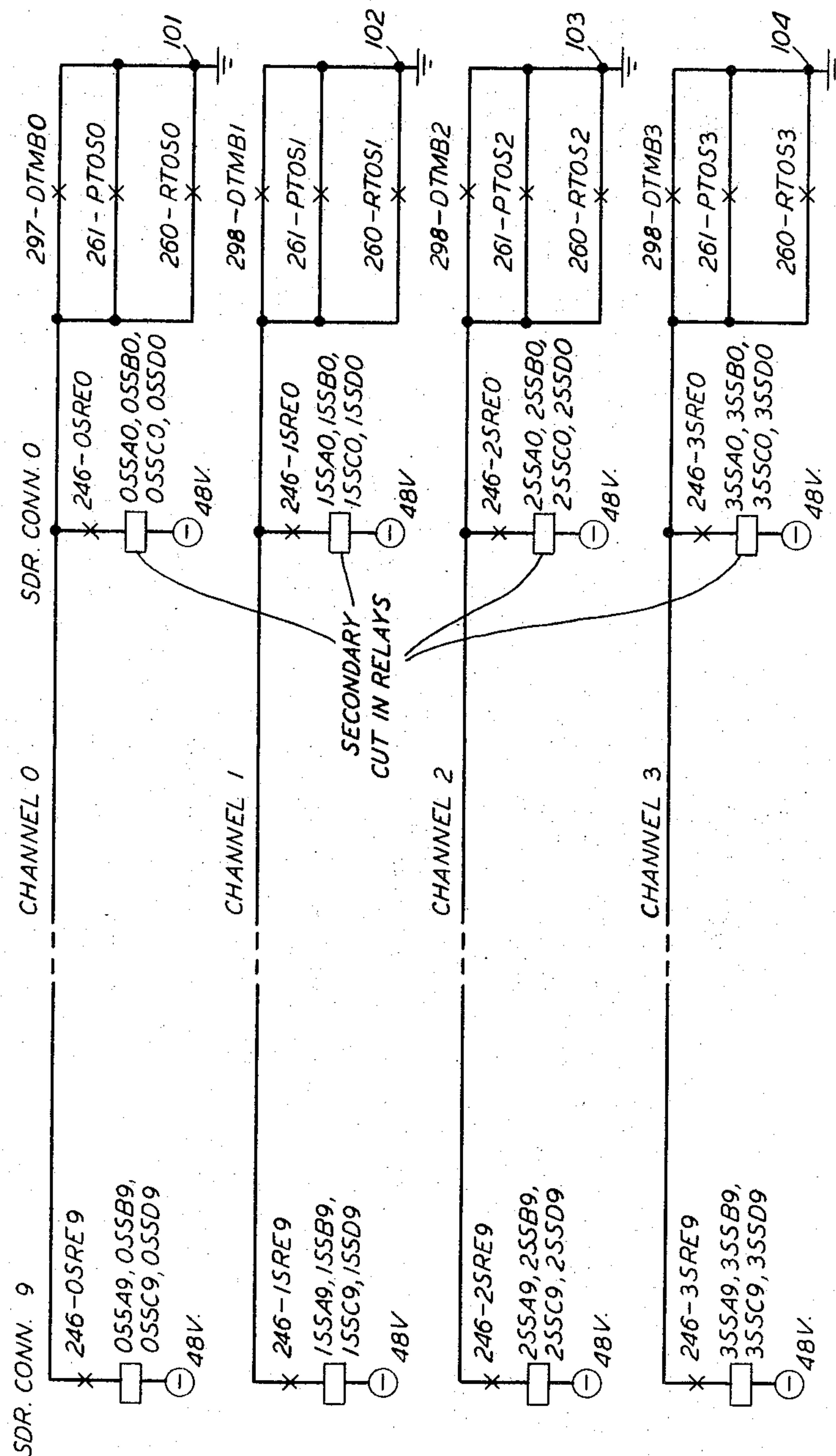
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FIG. 247





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R. B. CURTIS

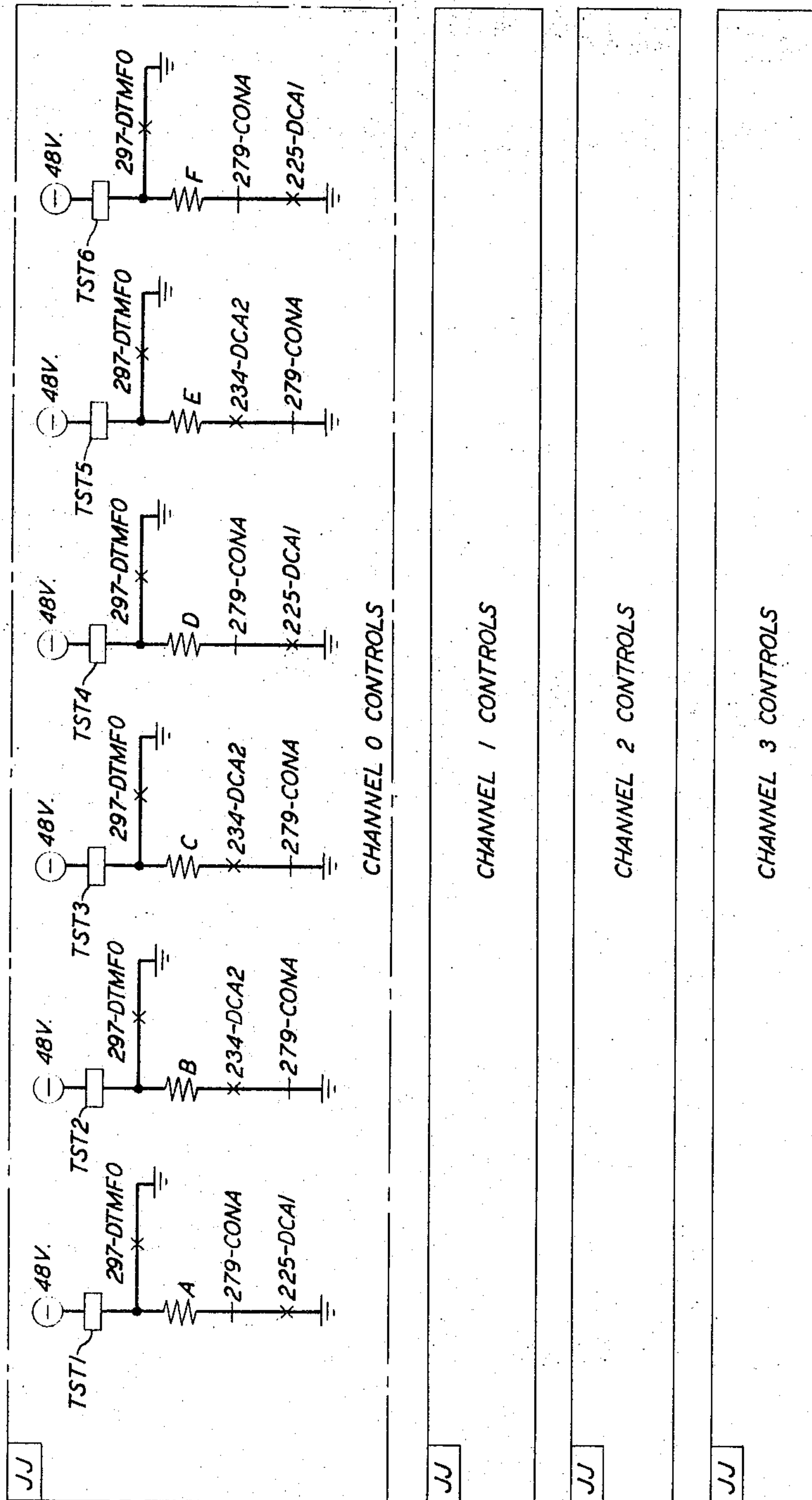
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FIG. 248





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R. B. CURTIS

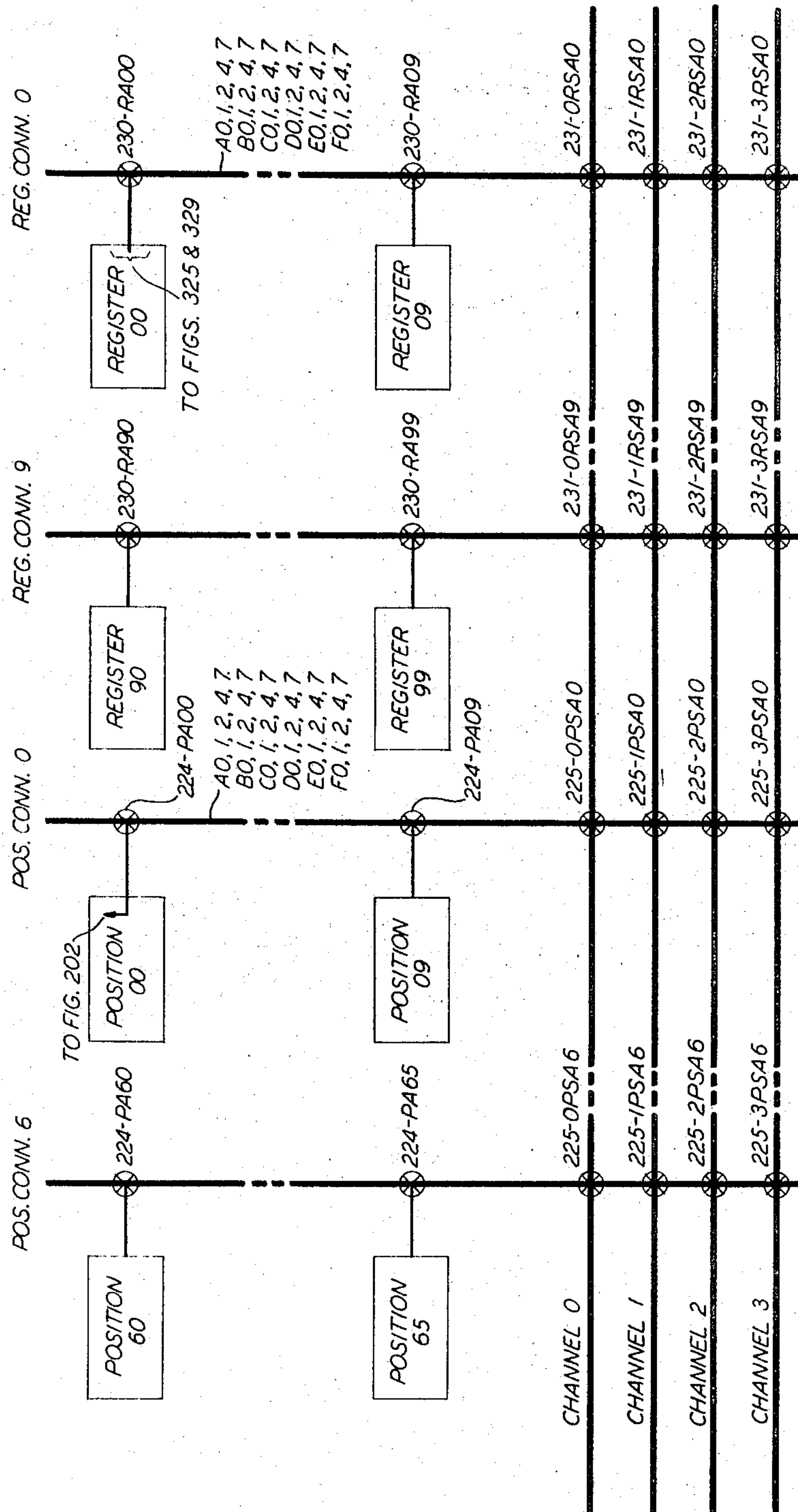
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FIG. 249





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R. B. CURTIS

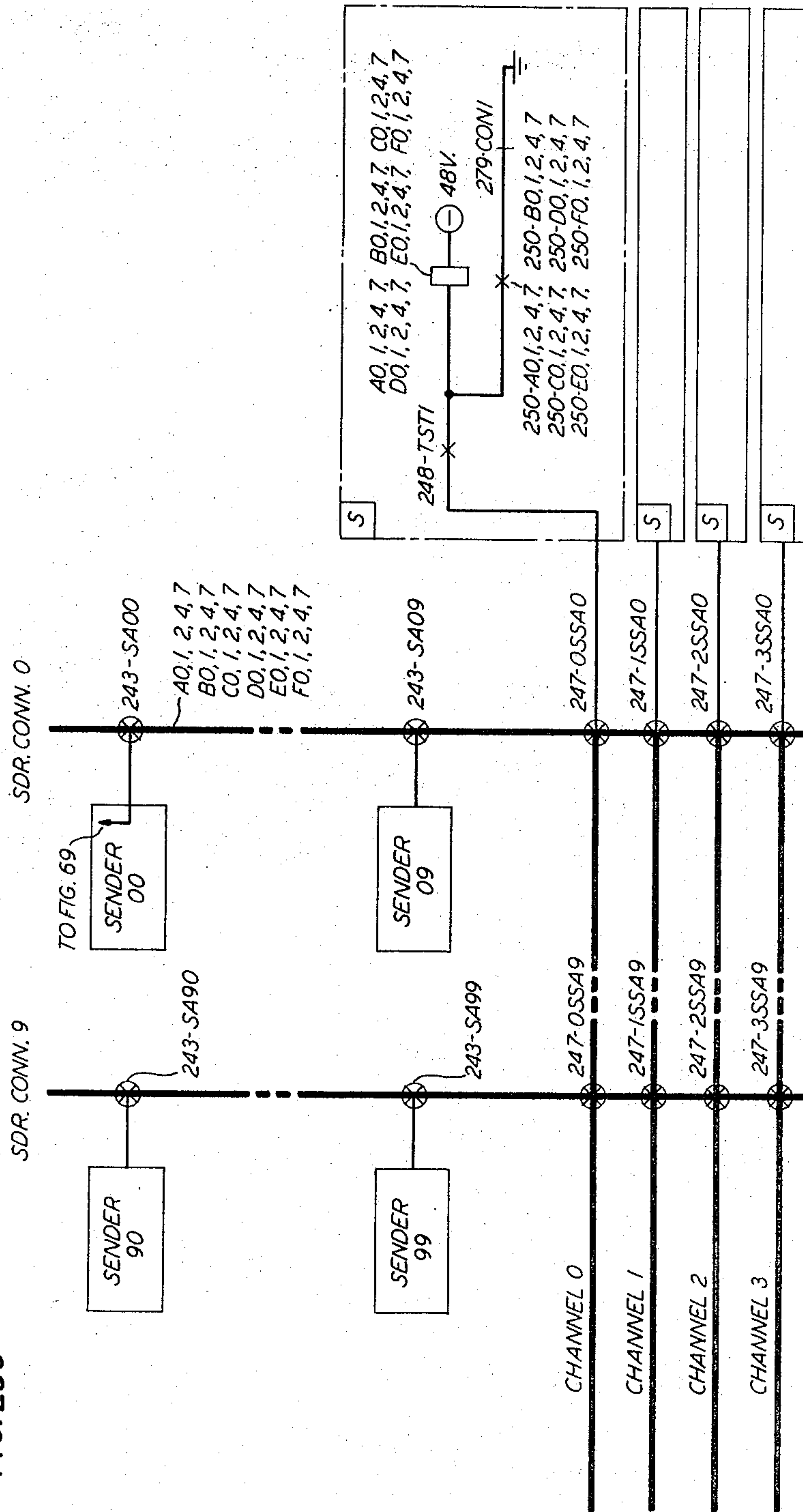
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FIG. 250





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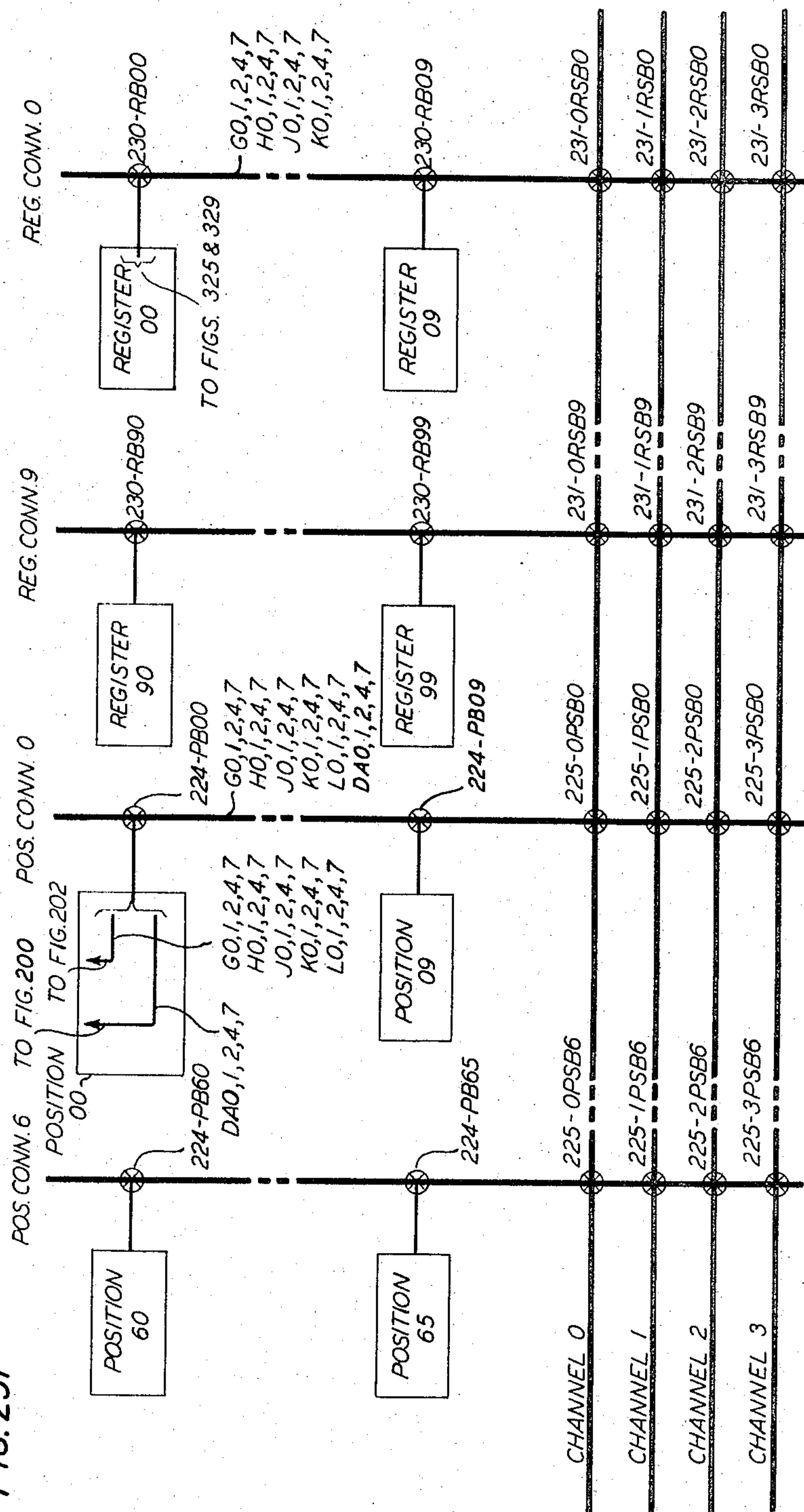
R. B. CURTIS  
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FIG. 251





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R. B. CURTIS

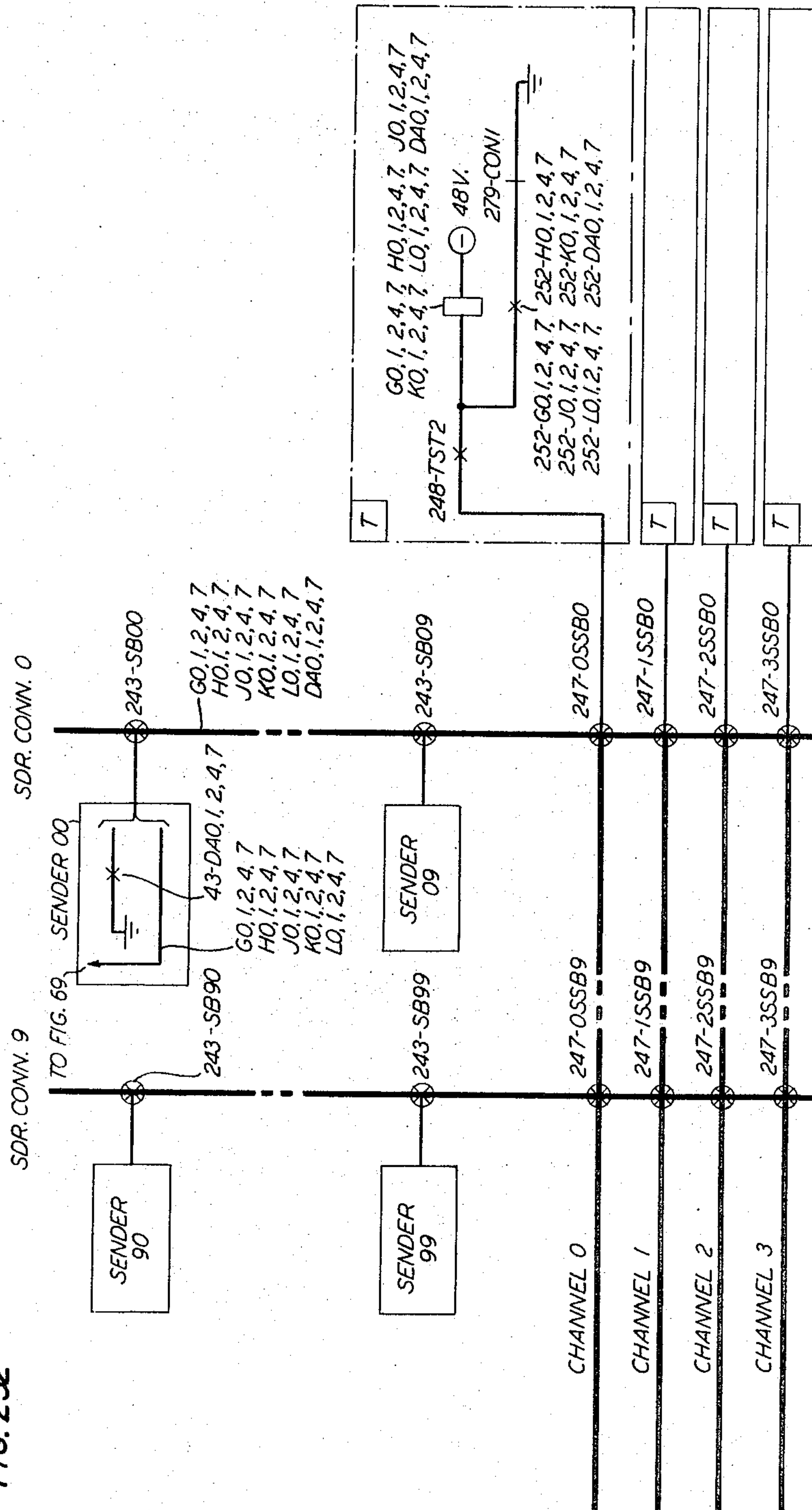
3,341,661

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FIG. 252





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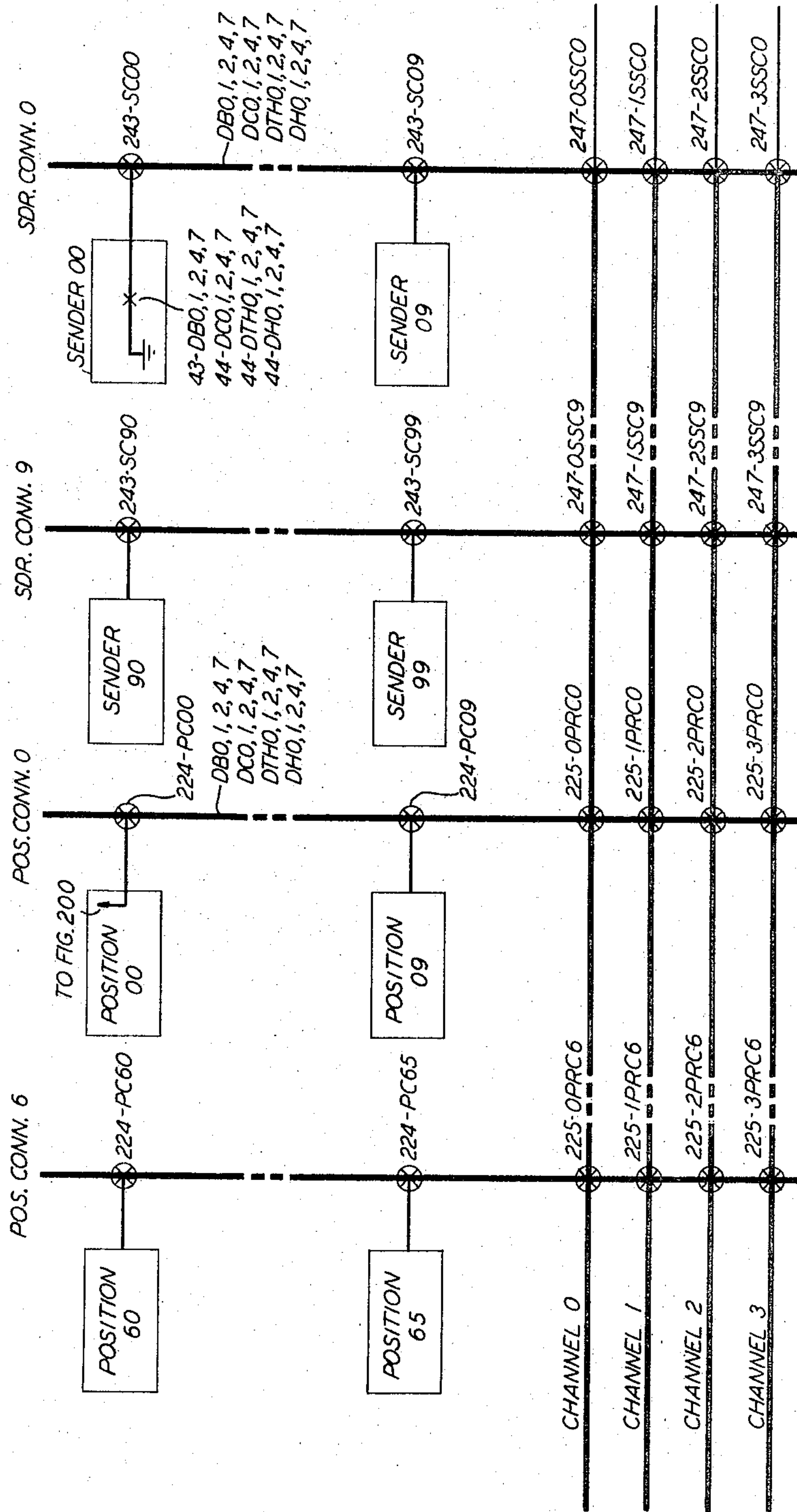
R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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FIG. 253





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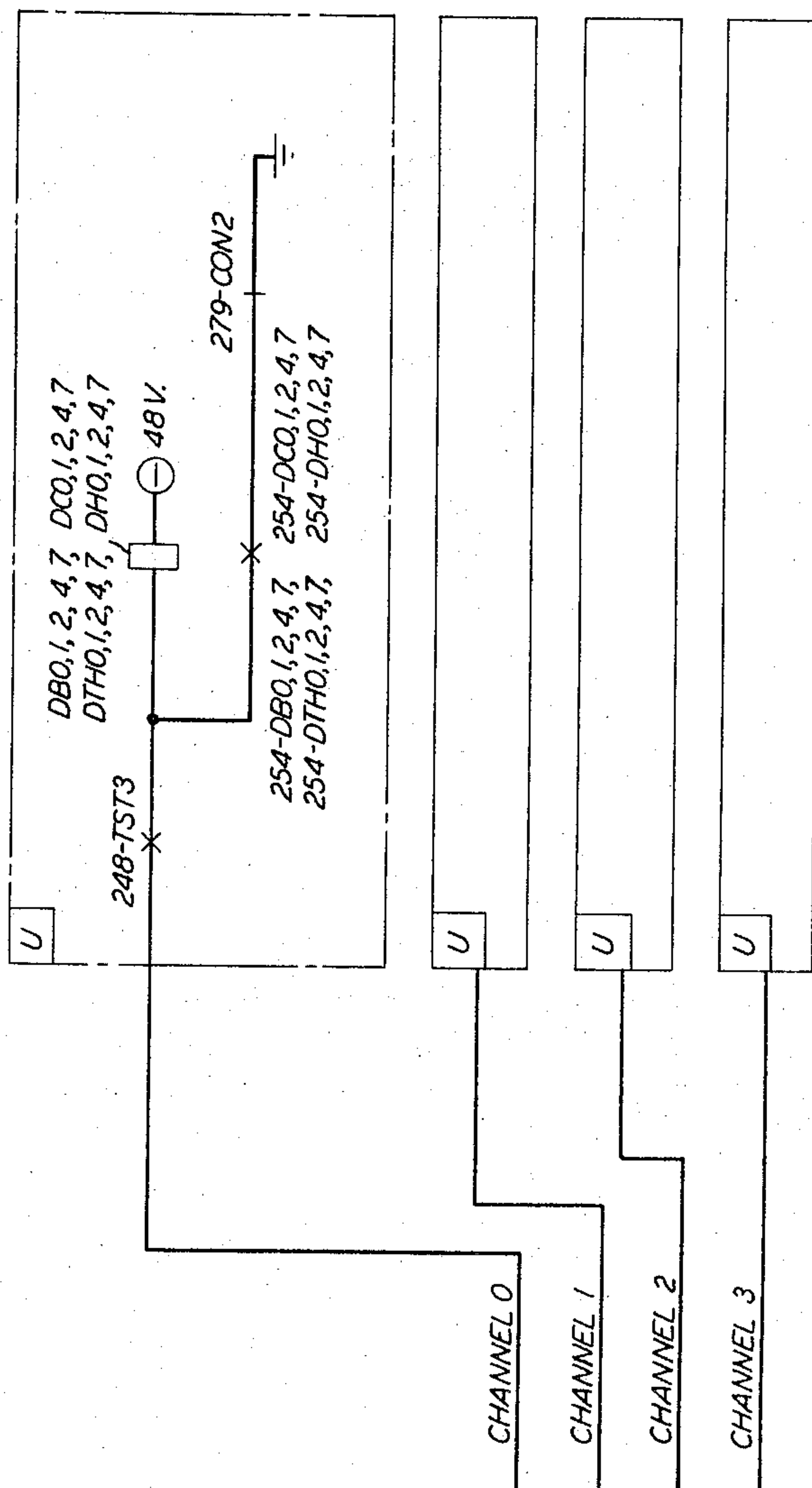
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FIG. 254





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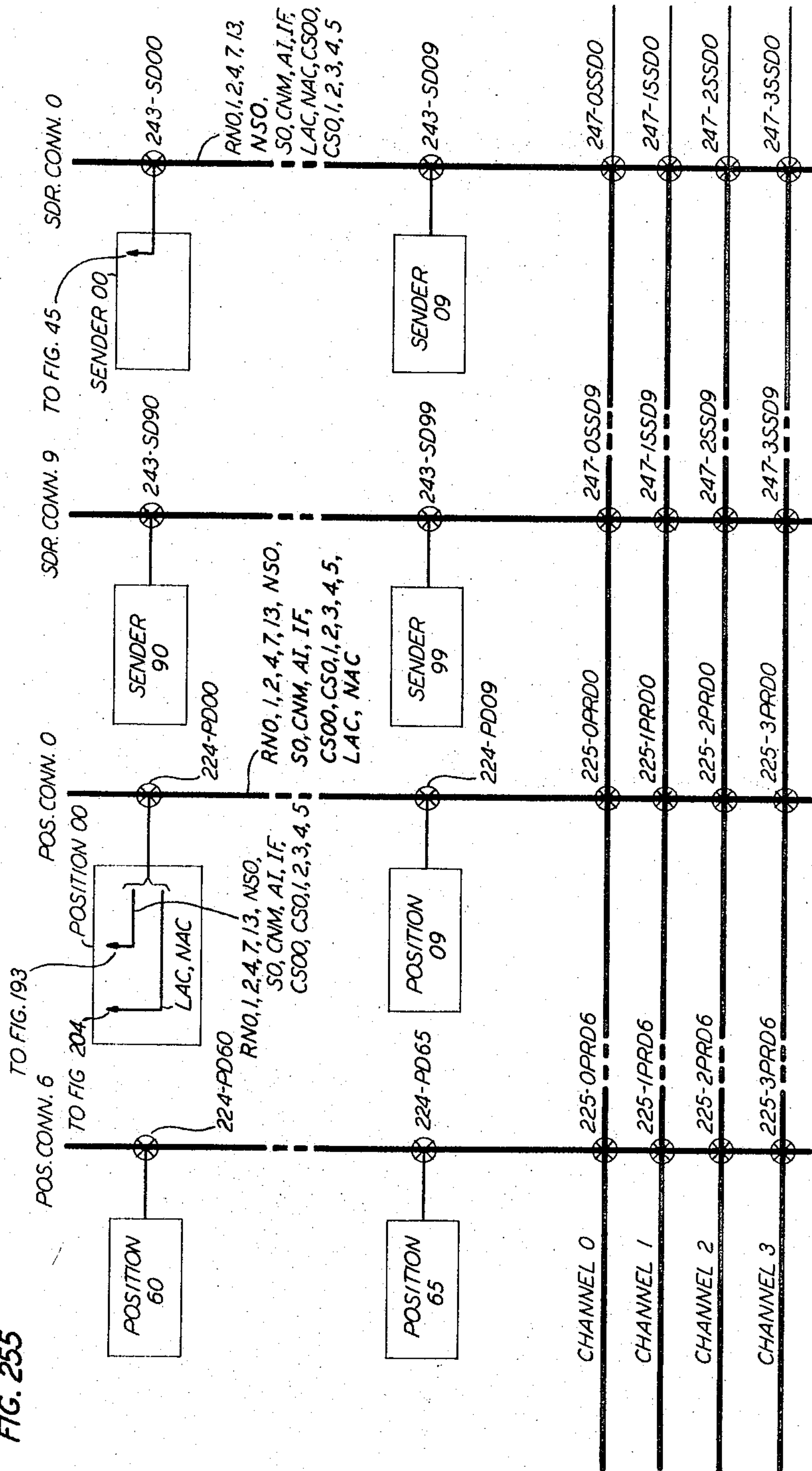
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FIG. 255





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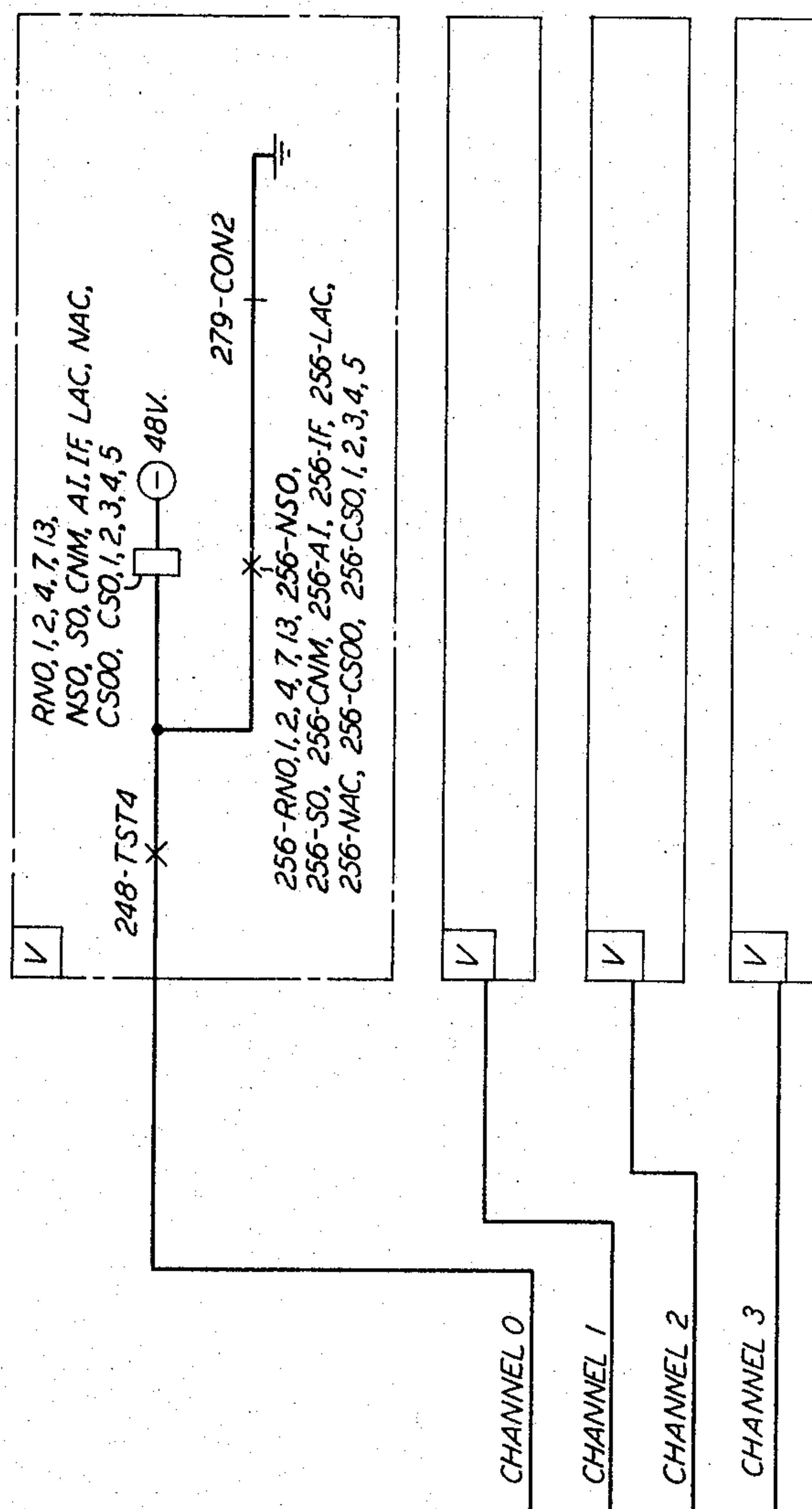
R. B. CURTIS  
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FIG. 256





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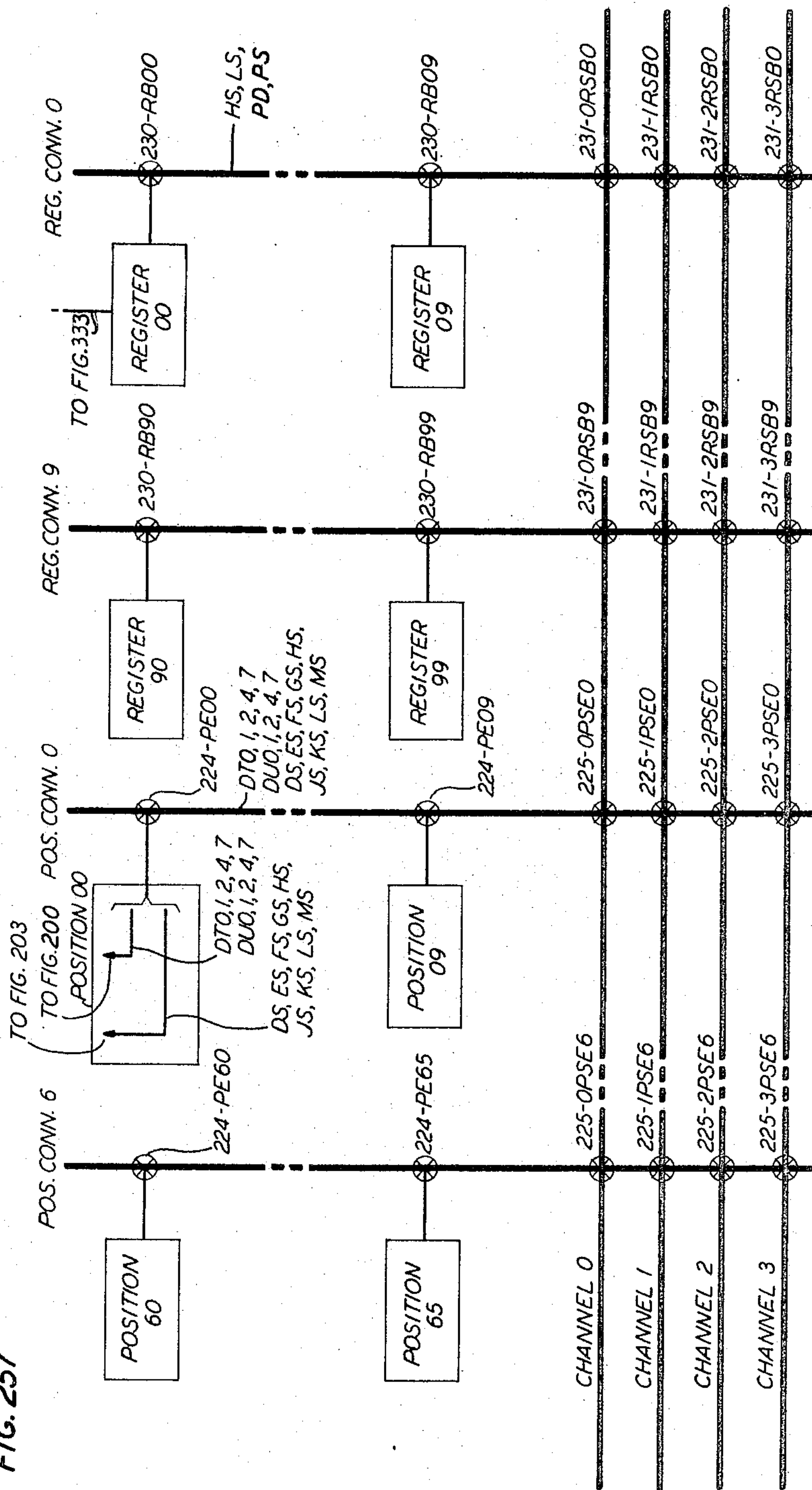
3,341,661

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FIG. 257





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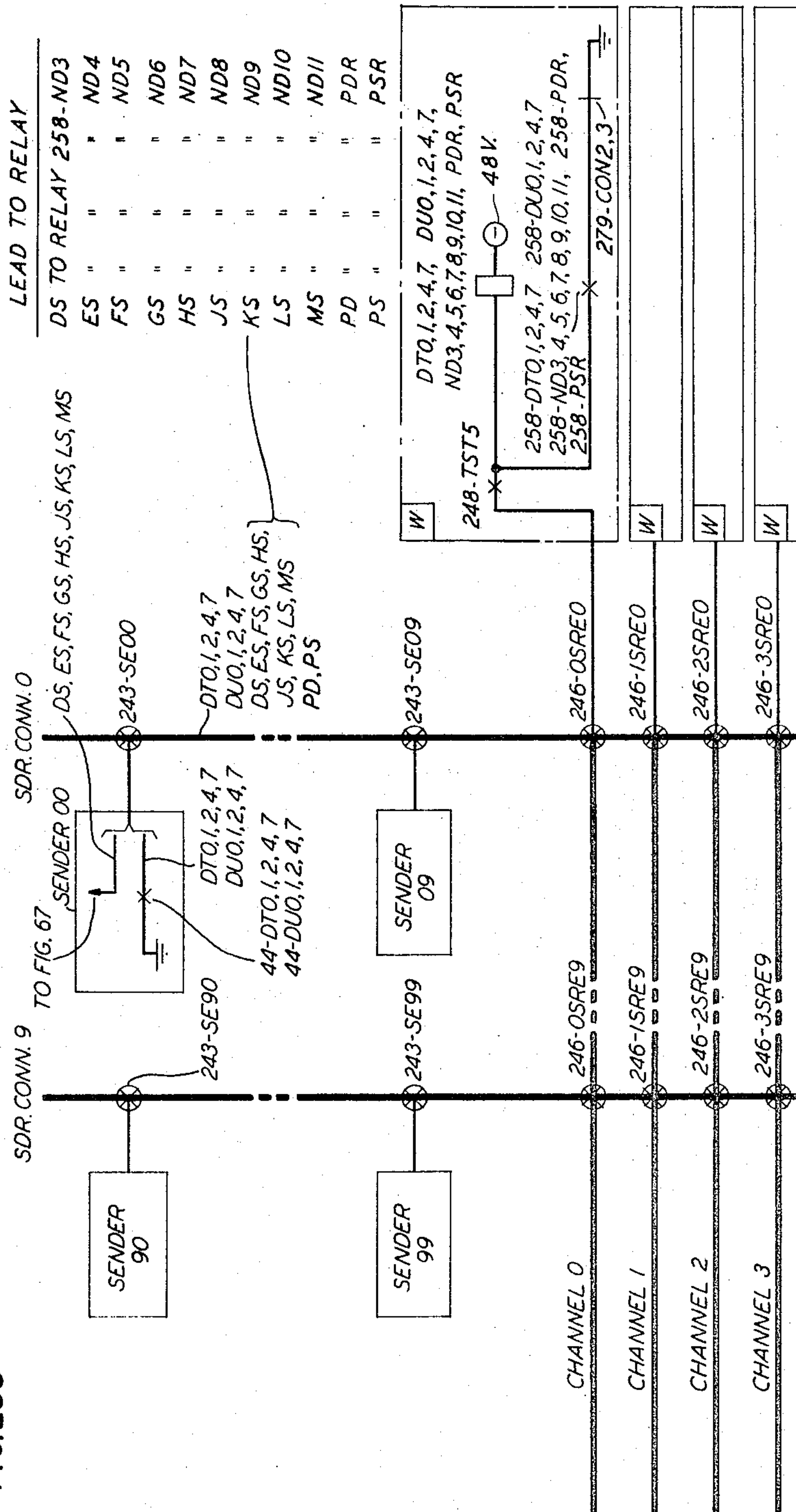
3,341,661

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FIG. 258





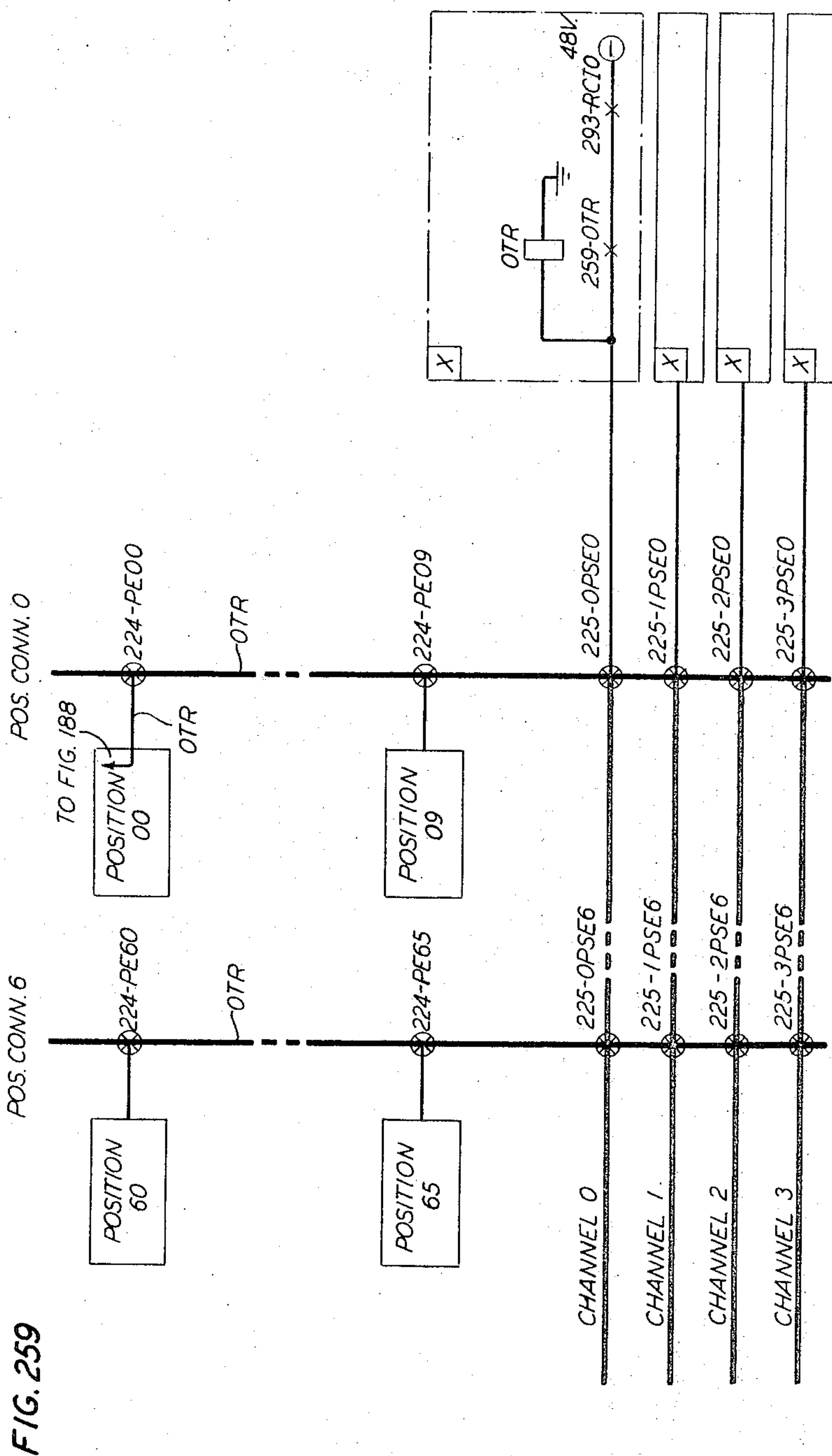
Sept. 12, 1967

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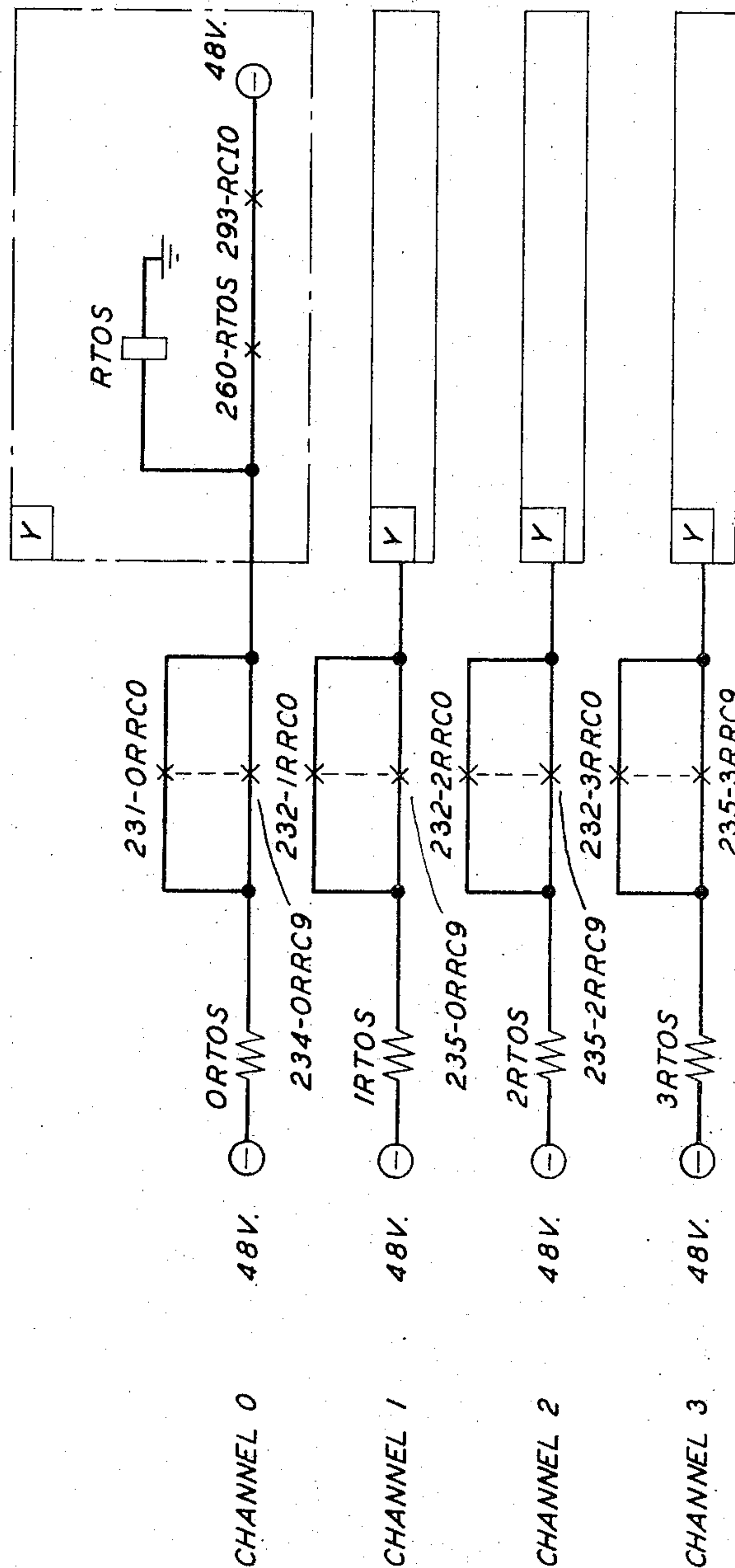
R. B. CURTIS  
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INTERMEDIATE SWITCHING CENTER

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FIG. 260





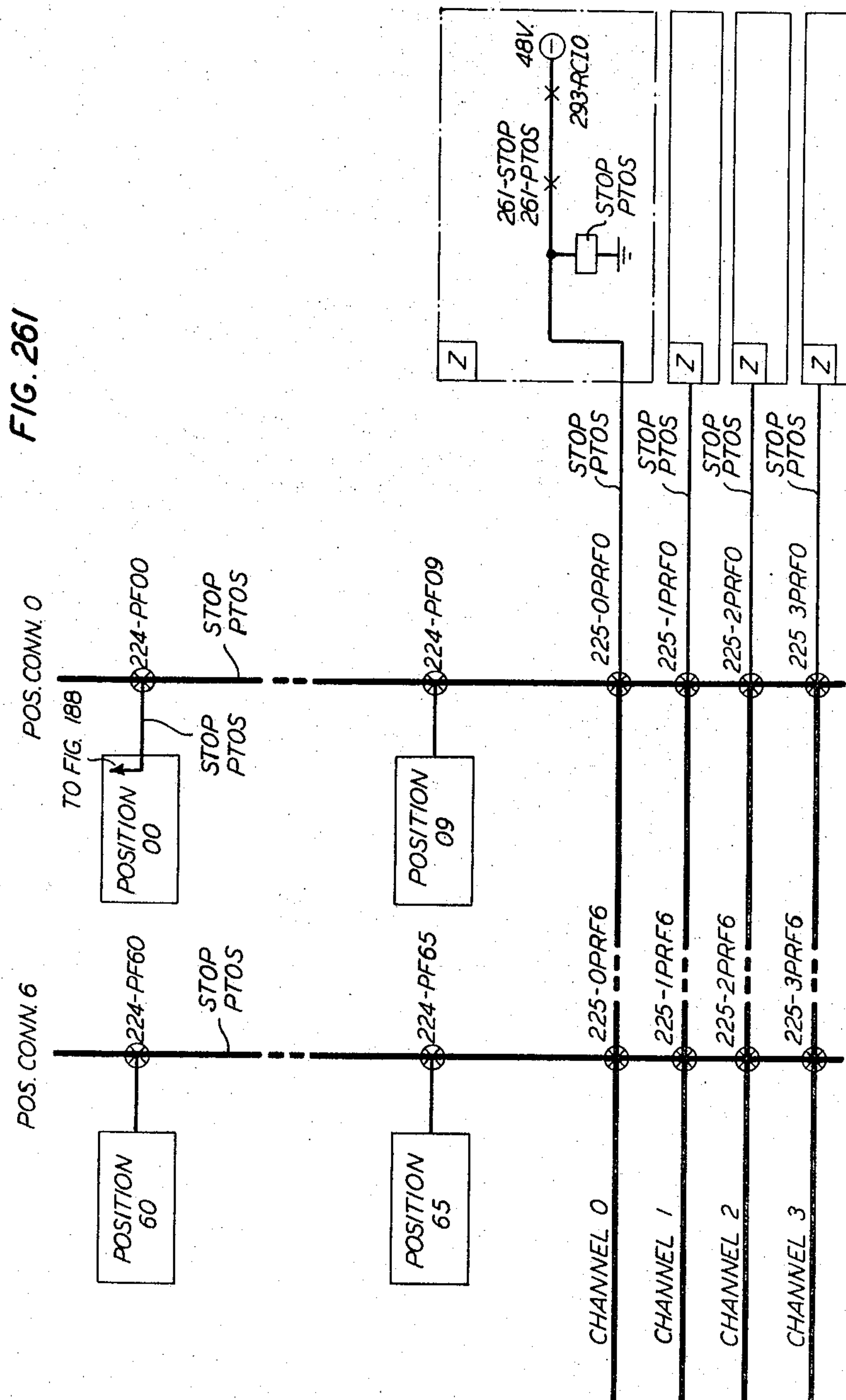
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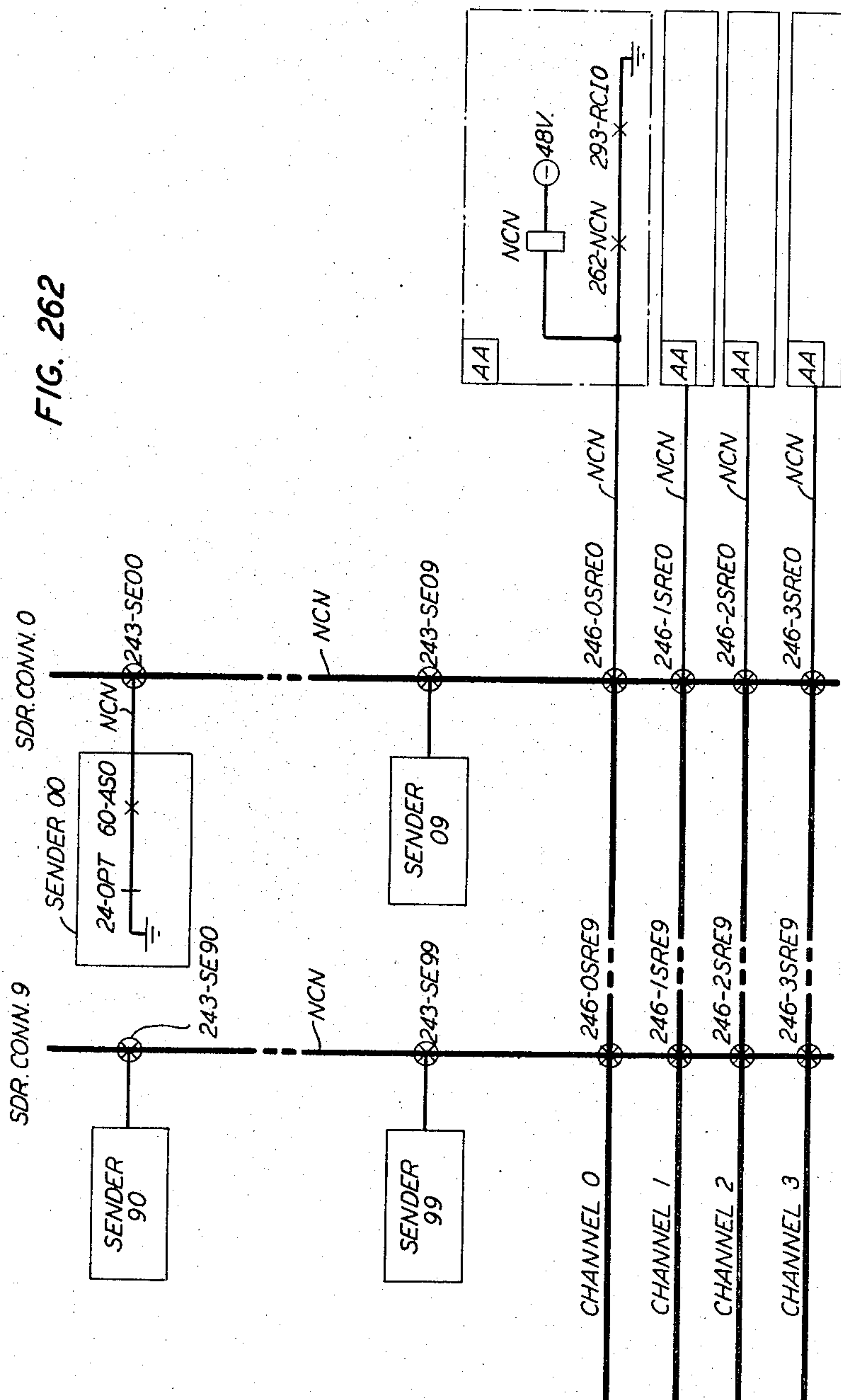
**R. B. CURTIS**

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**FIG. 262**





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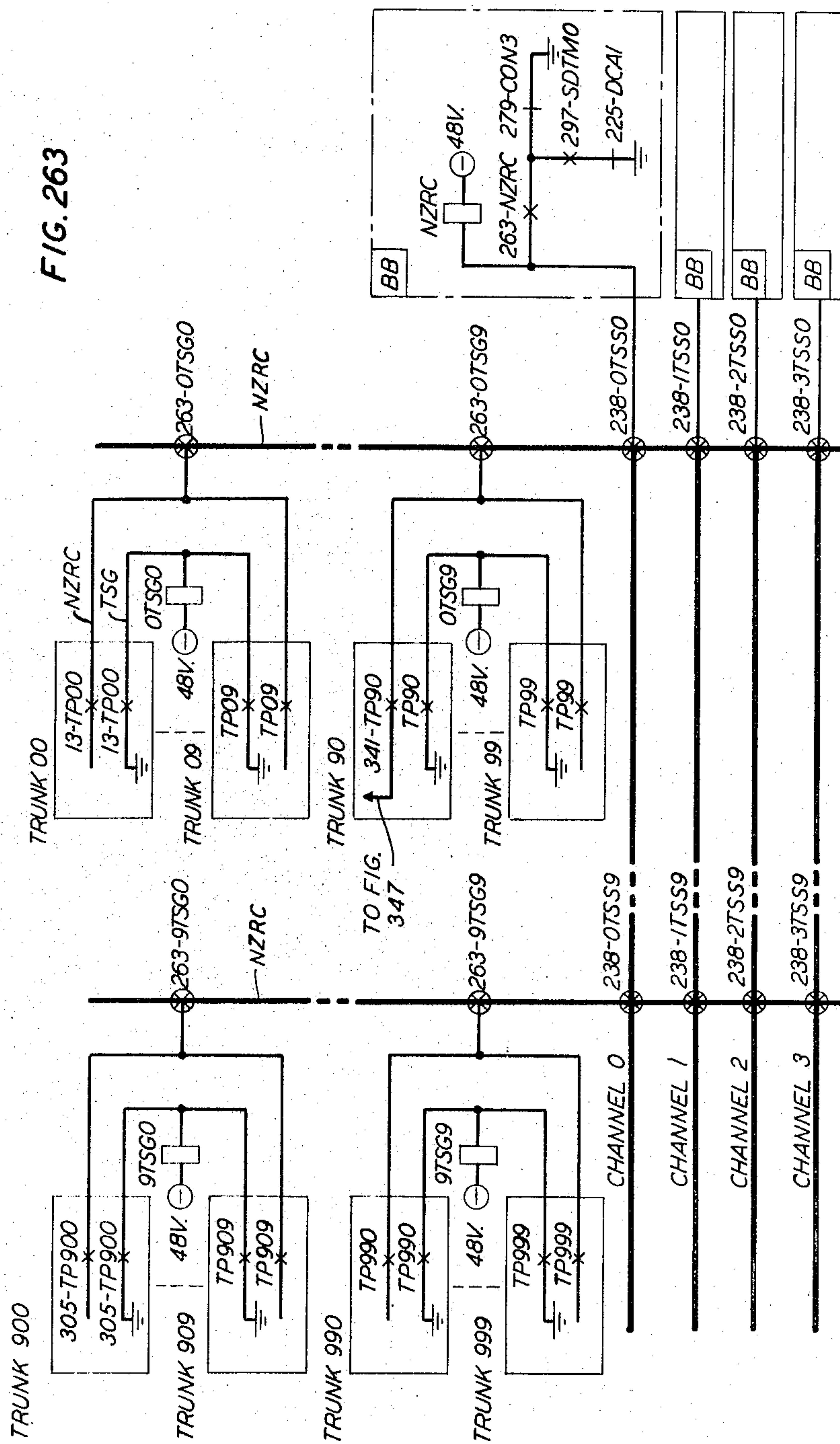
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FIG. 263





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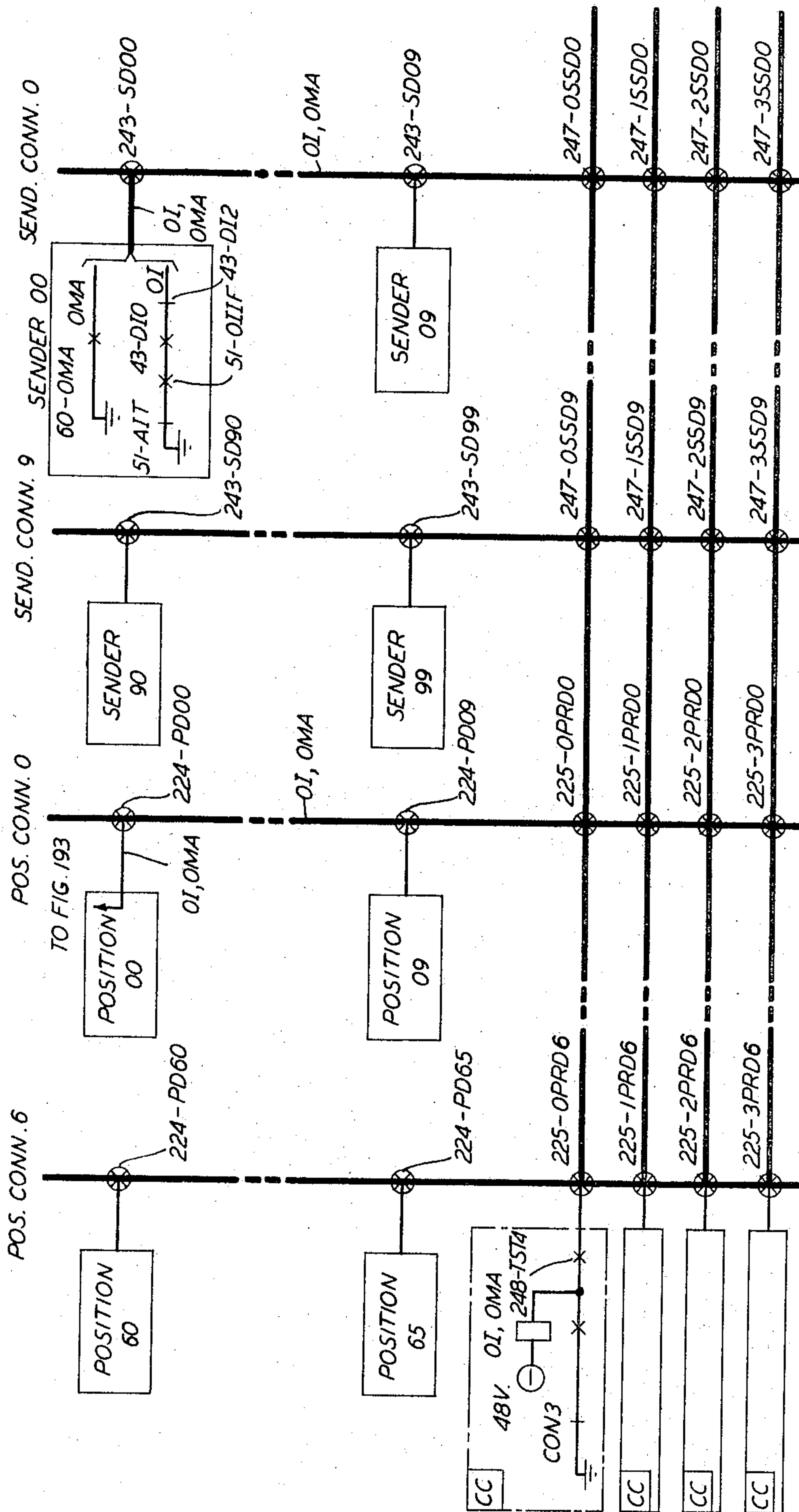
R. B. CURTIS  
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FIG. 264





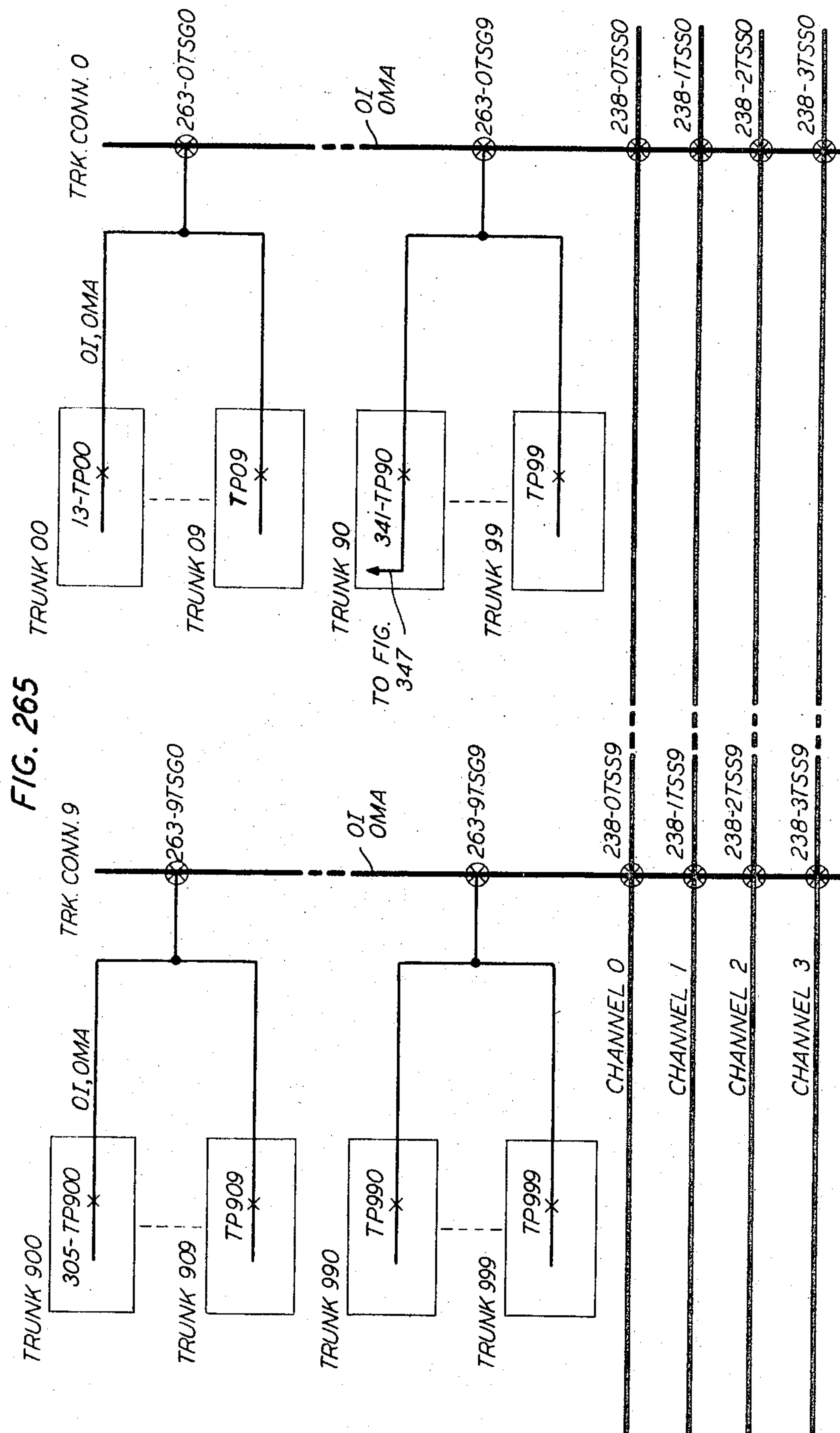
Sept. 12, 1967

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EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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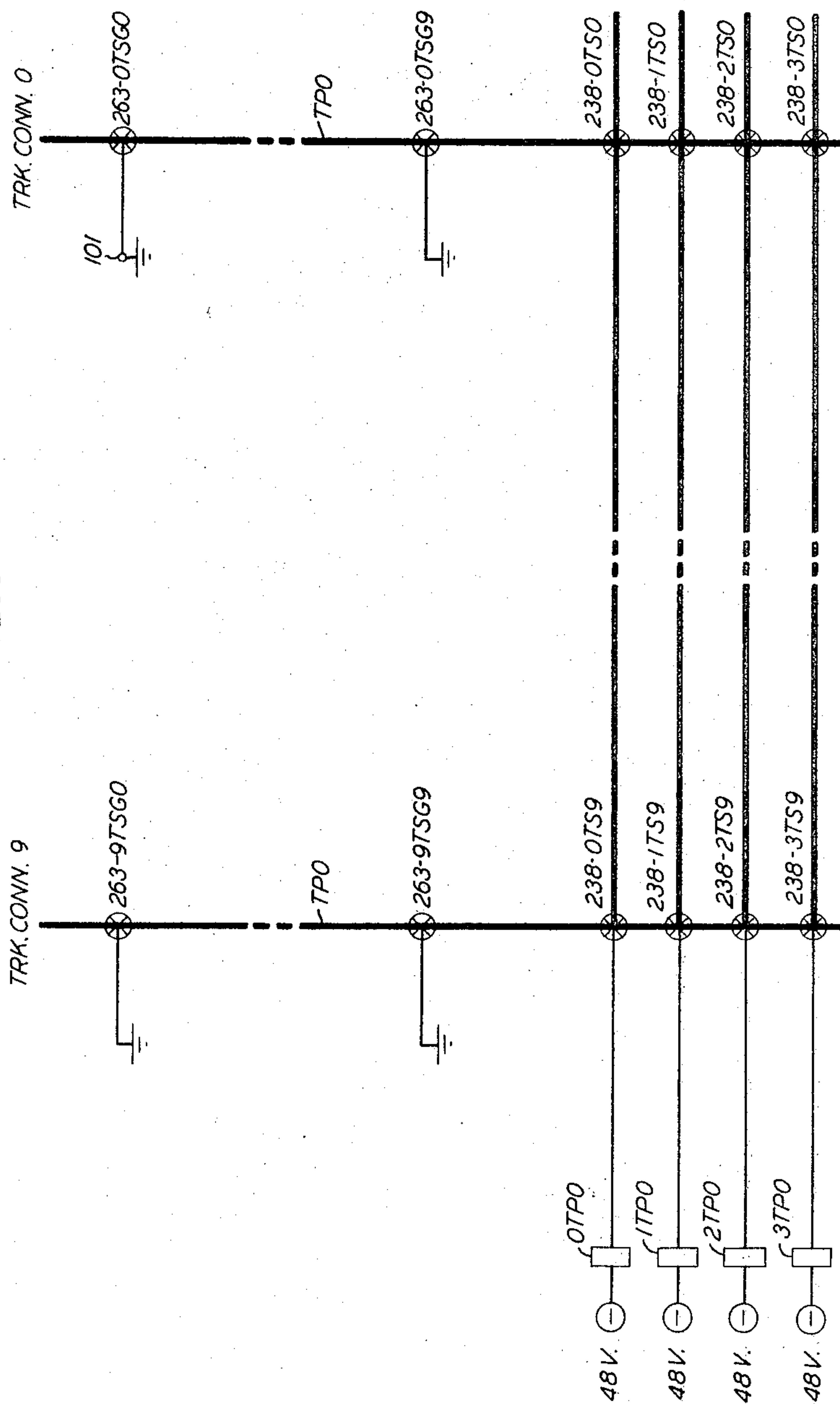
R. B. CURTIS  
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FIG. 266





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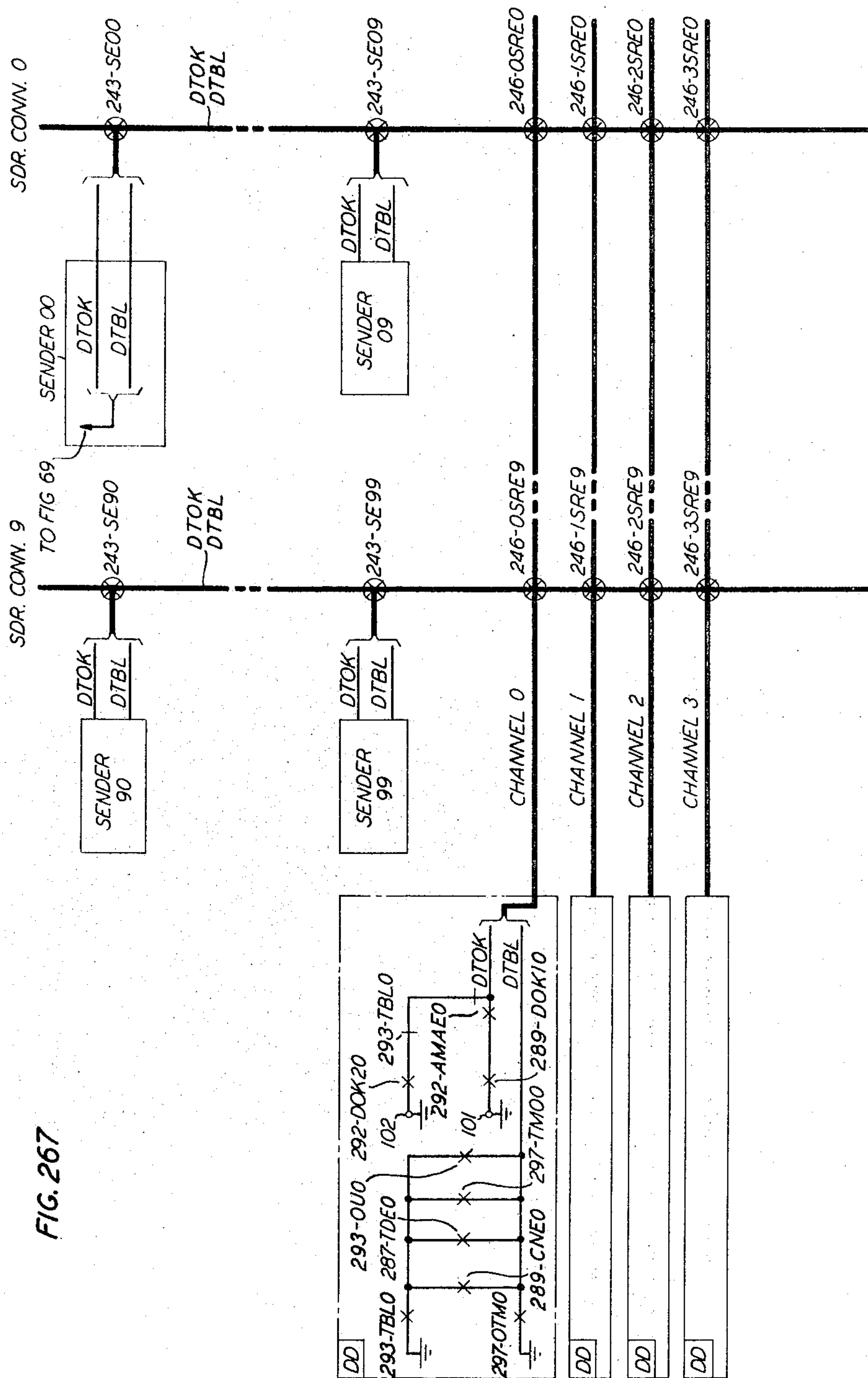


FIG. 267



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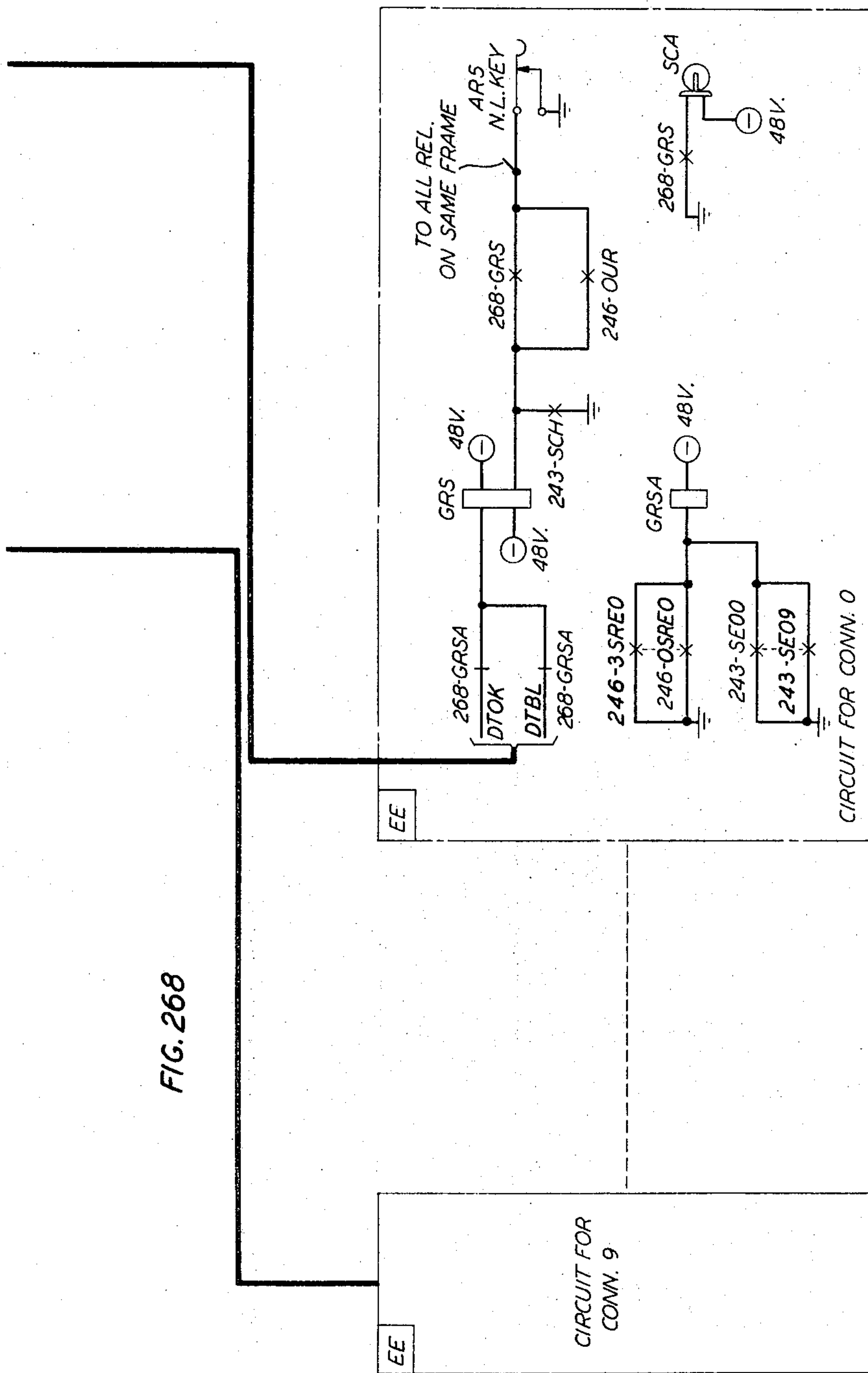
R. B. CURTIS  
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FIG. 268





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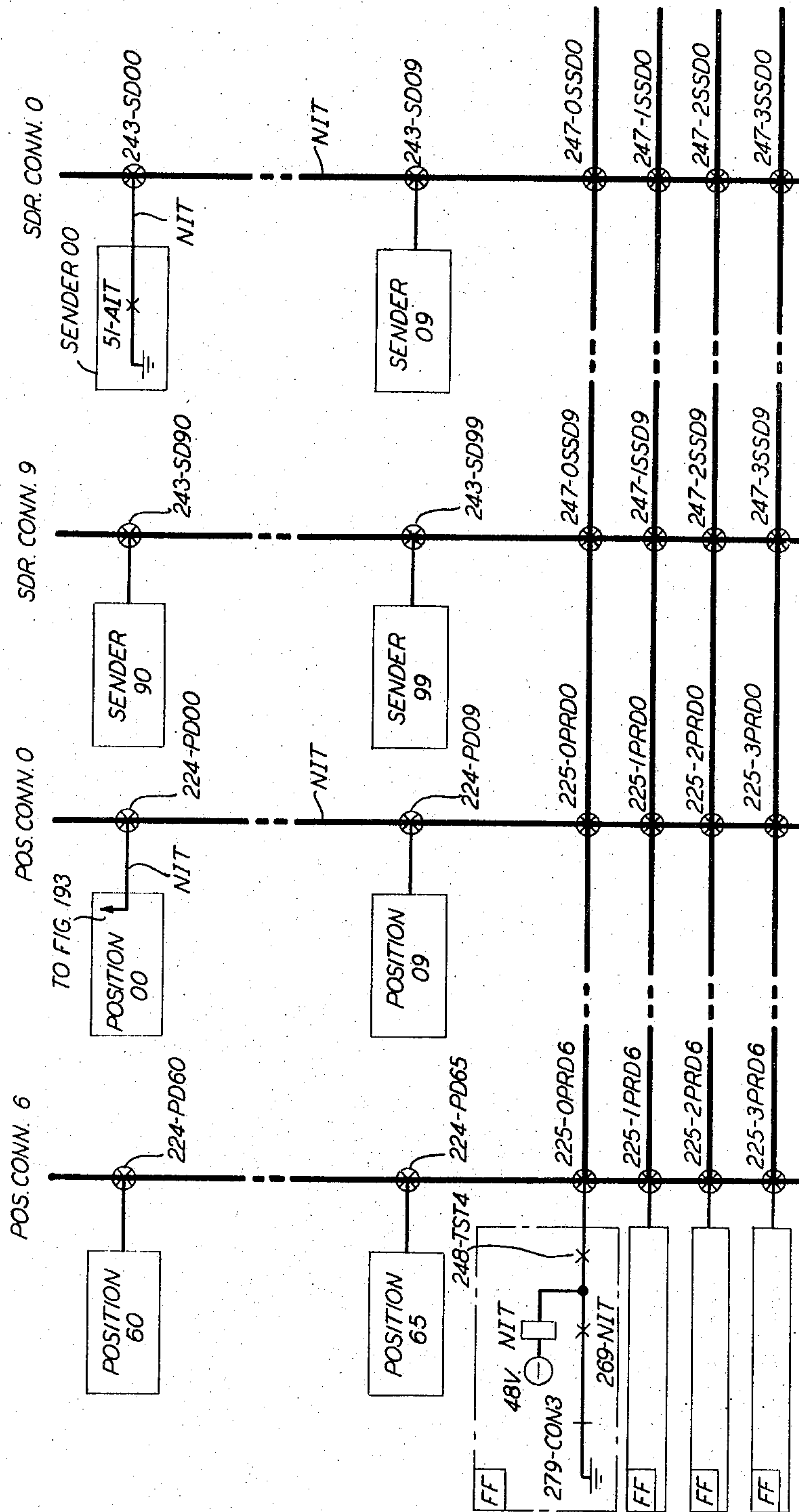
3,341,661

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FIG. 269





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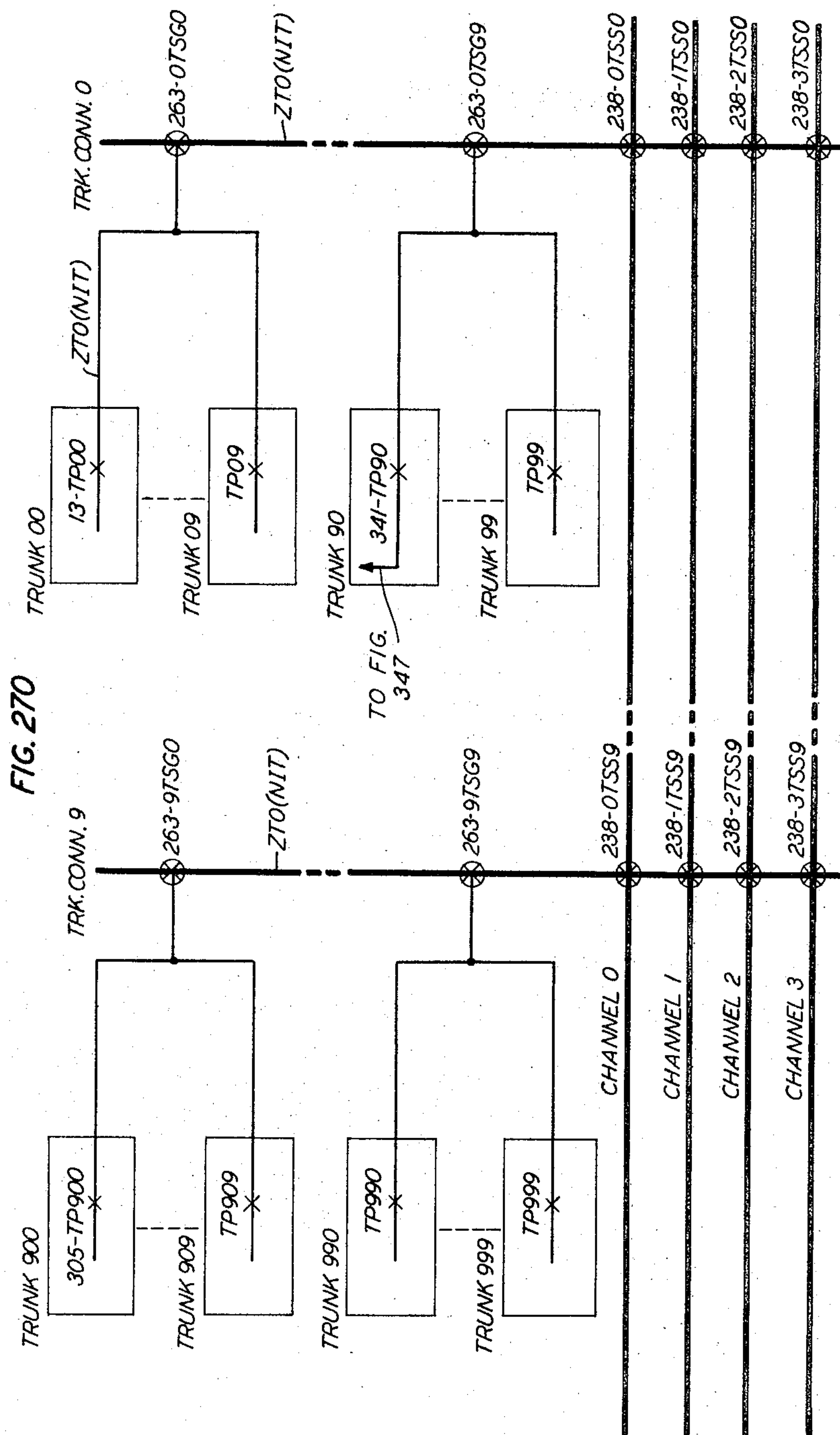
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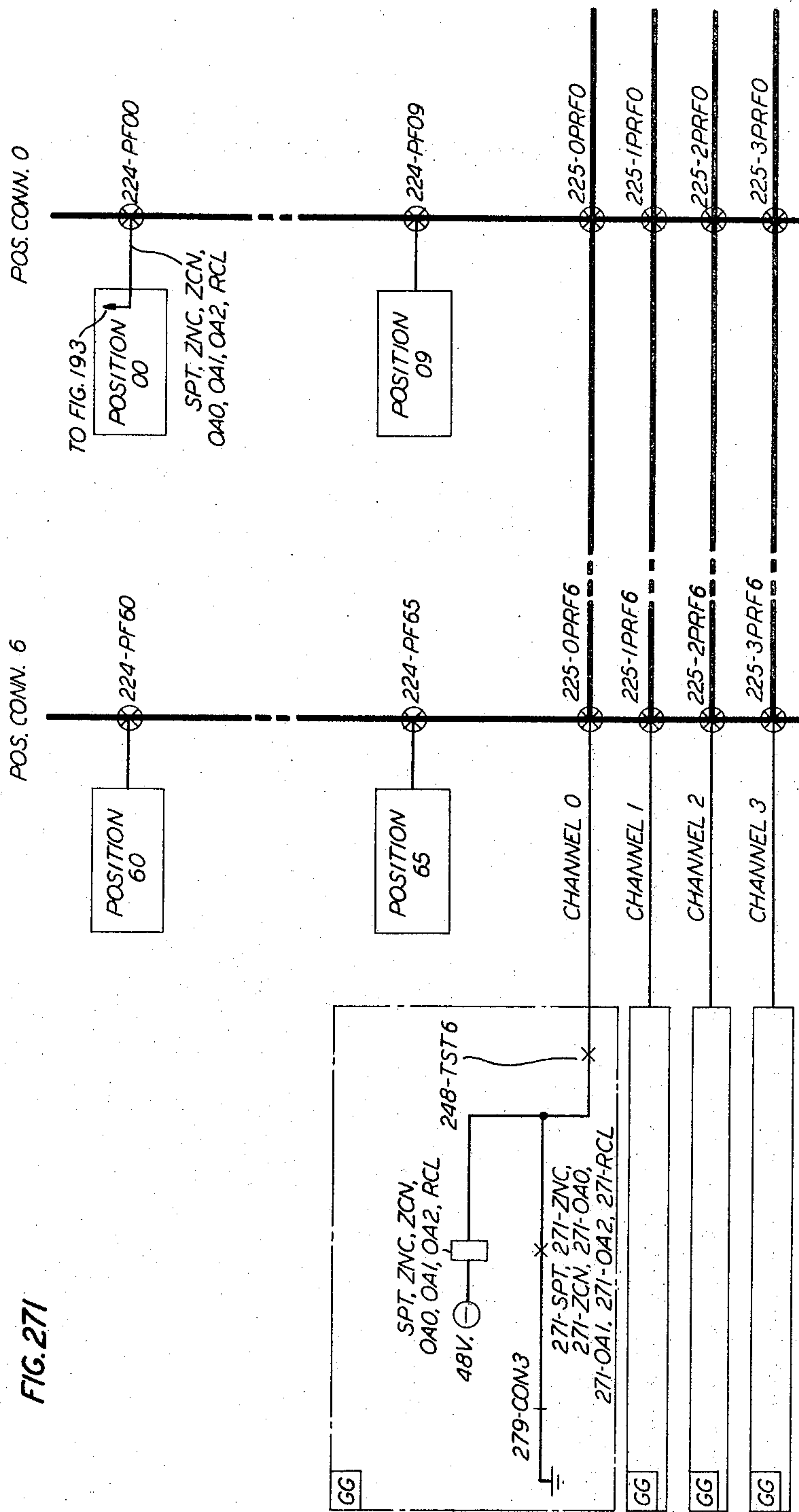
3,341,661

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FIG. 271





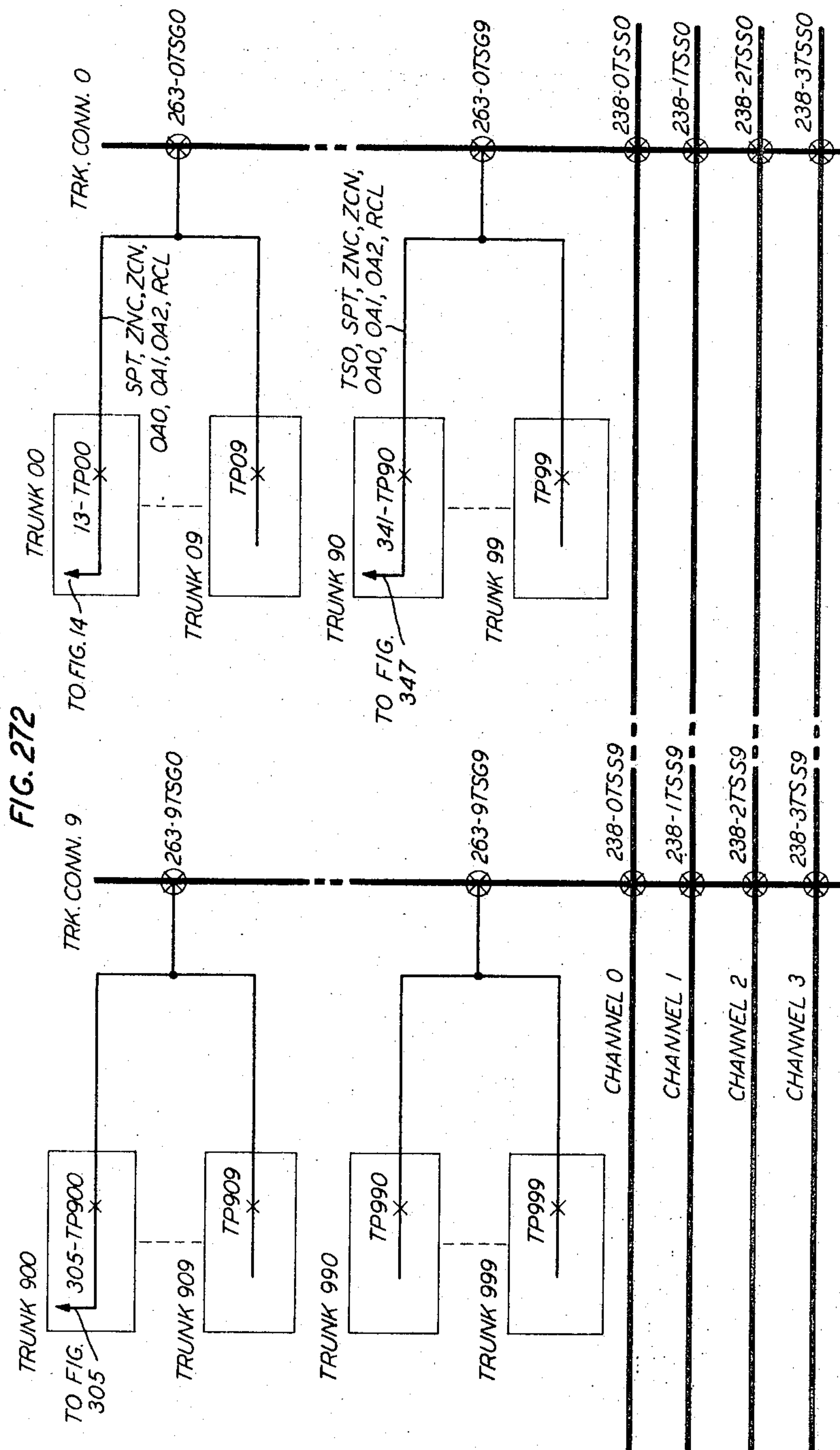
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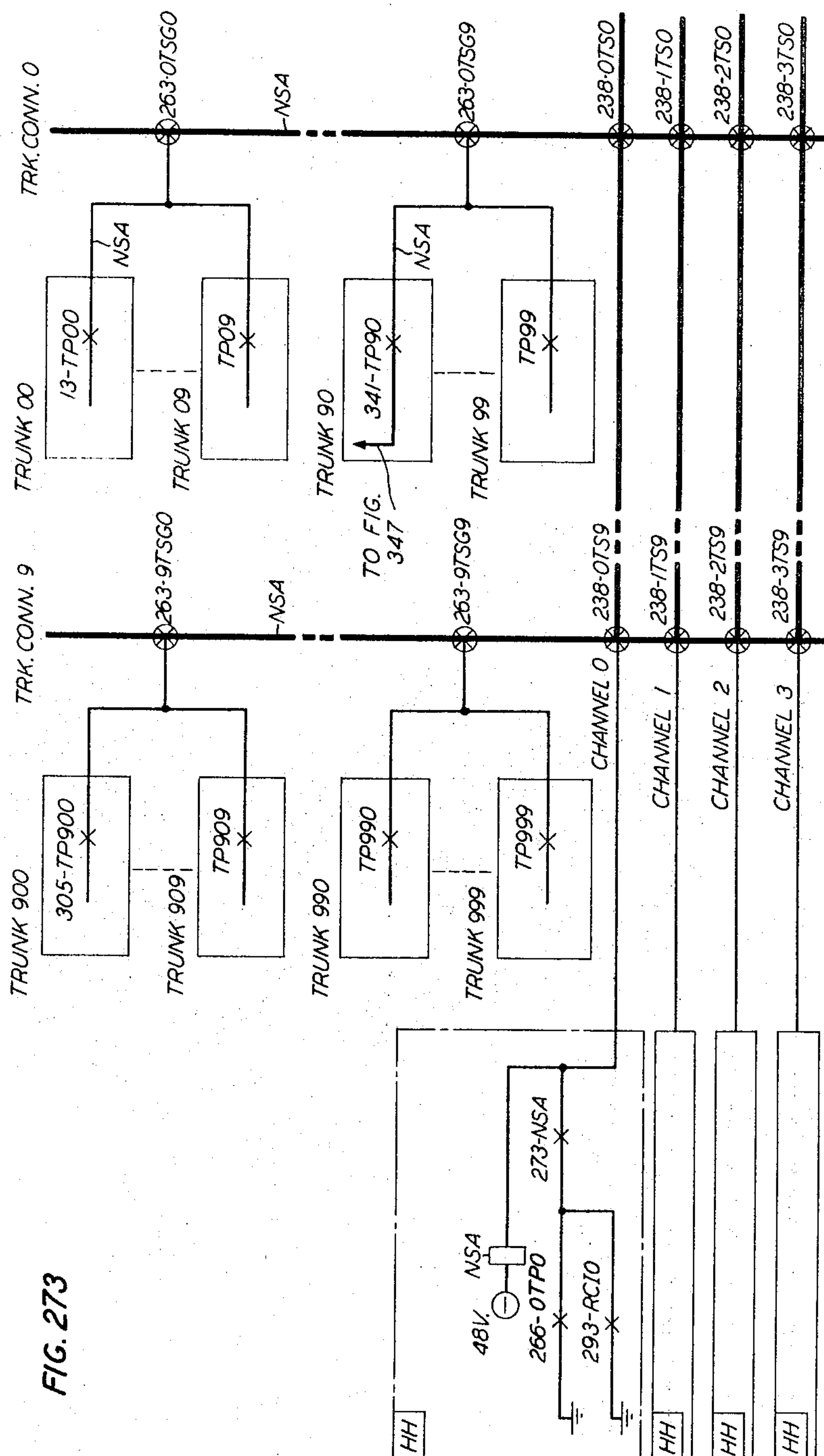
R. B. CURTIS

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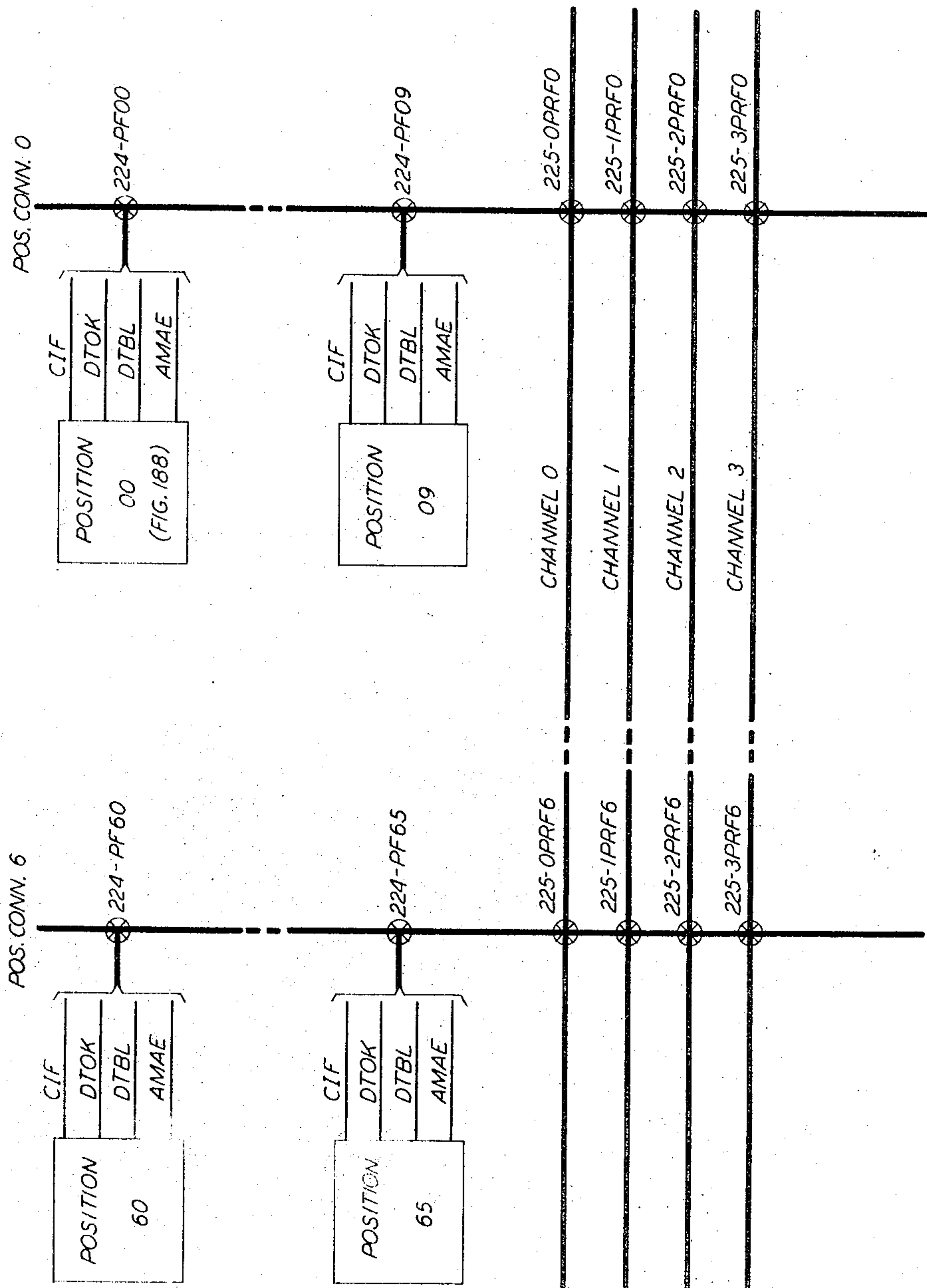
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FIG. 274





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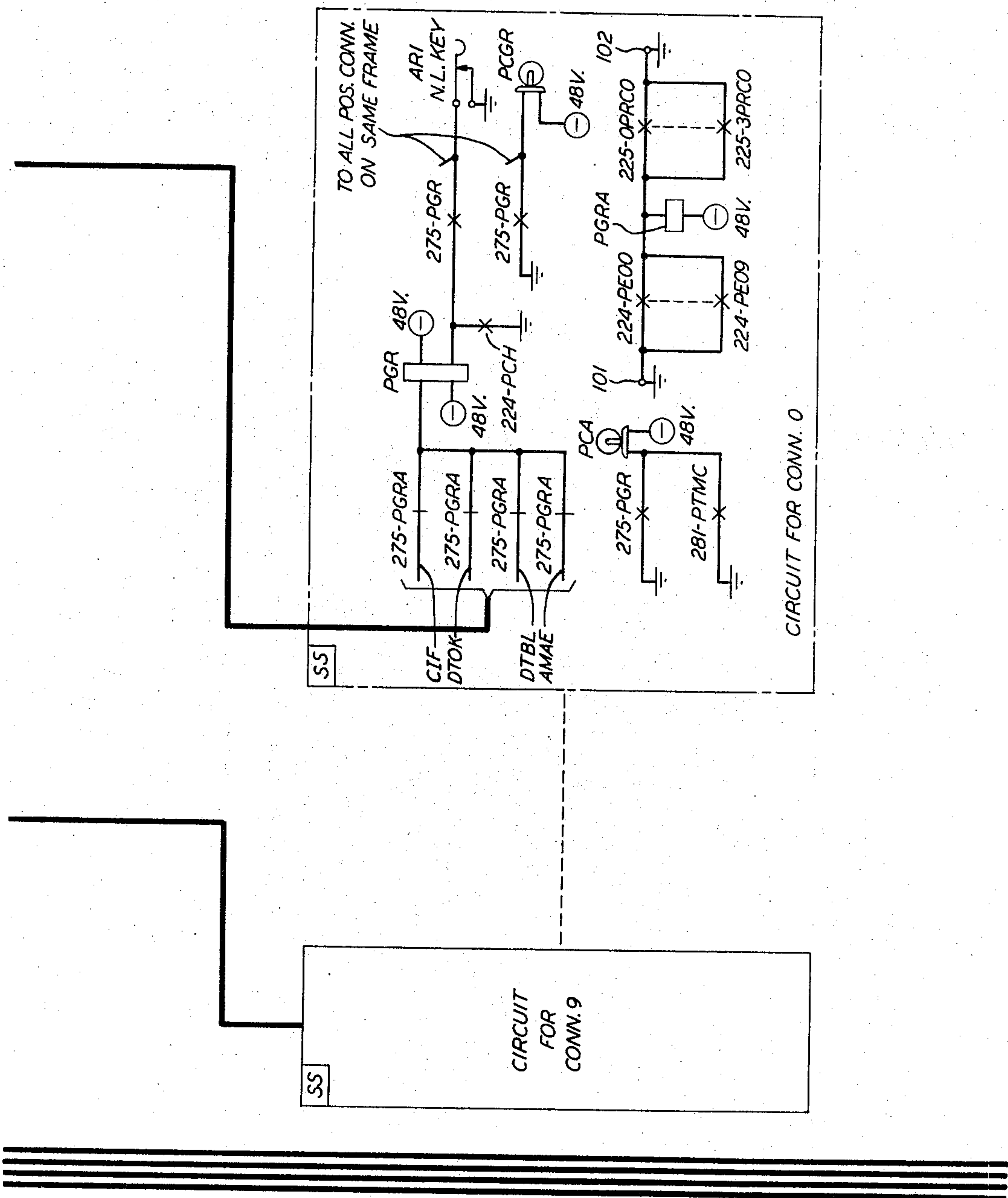
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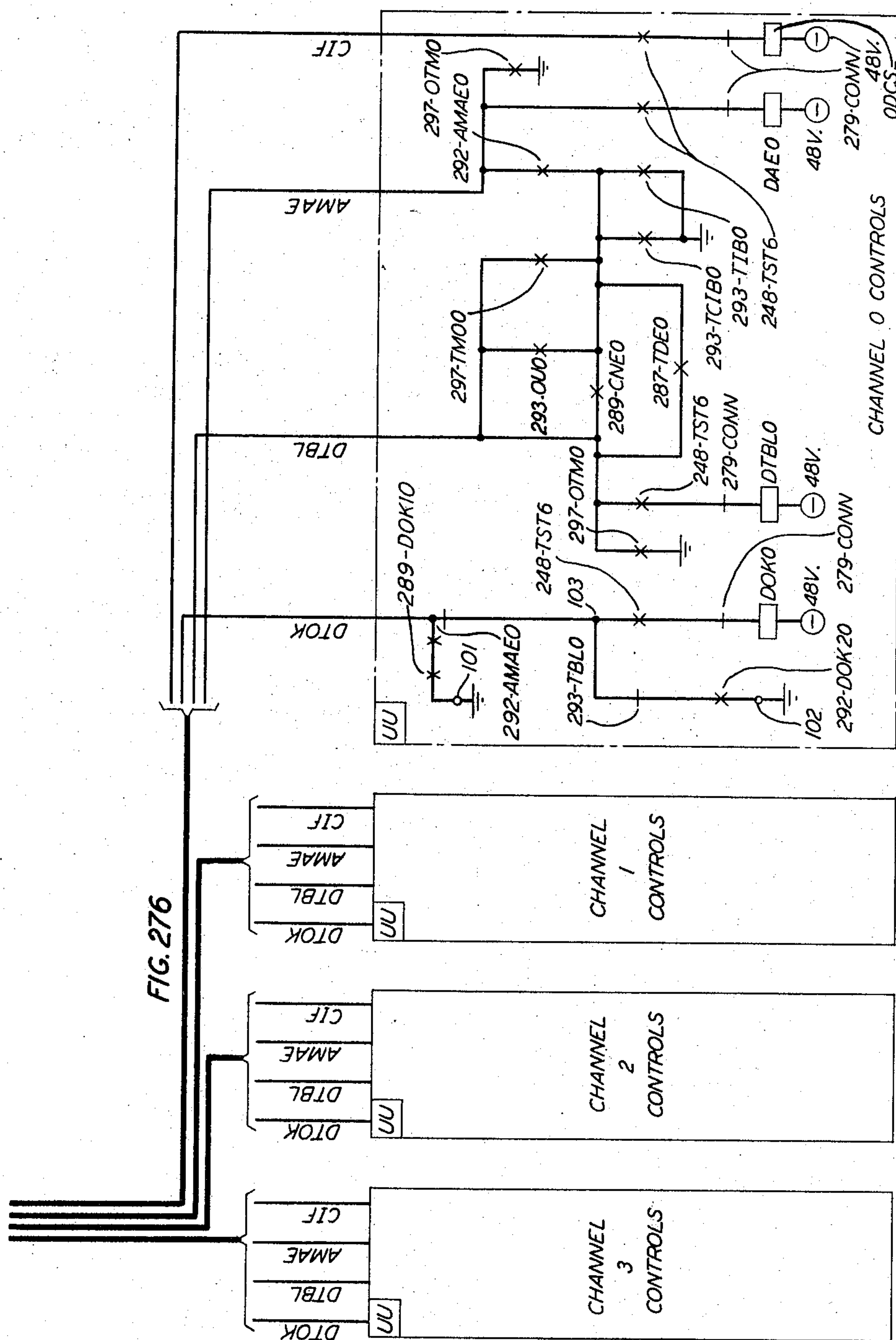
**FIG. 275**



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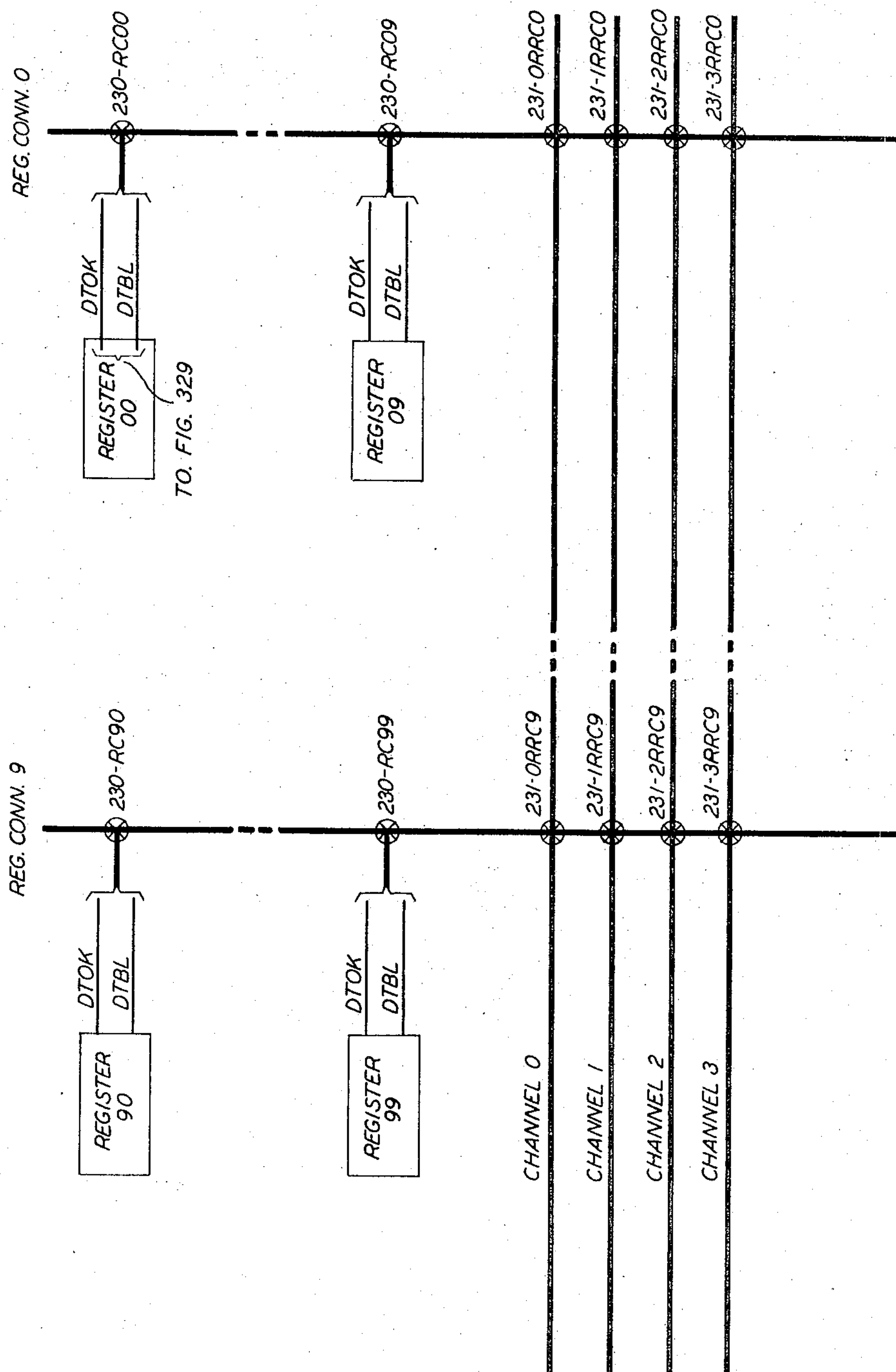
R. B. CURTIS  
EQUIPMENT FOR OPERATOR SERVED CALLS AT AN  
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FIG. 277

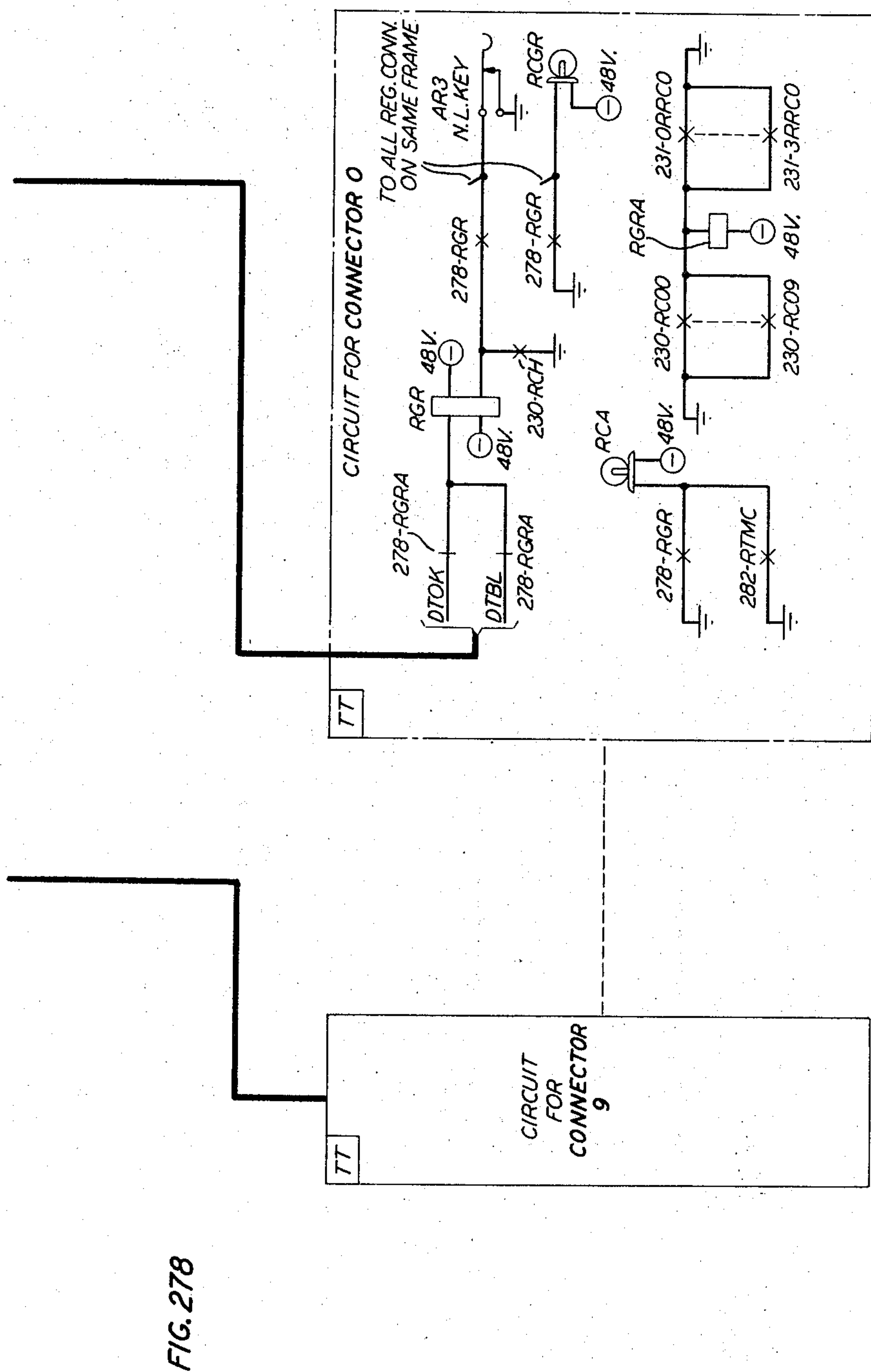




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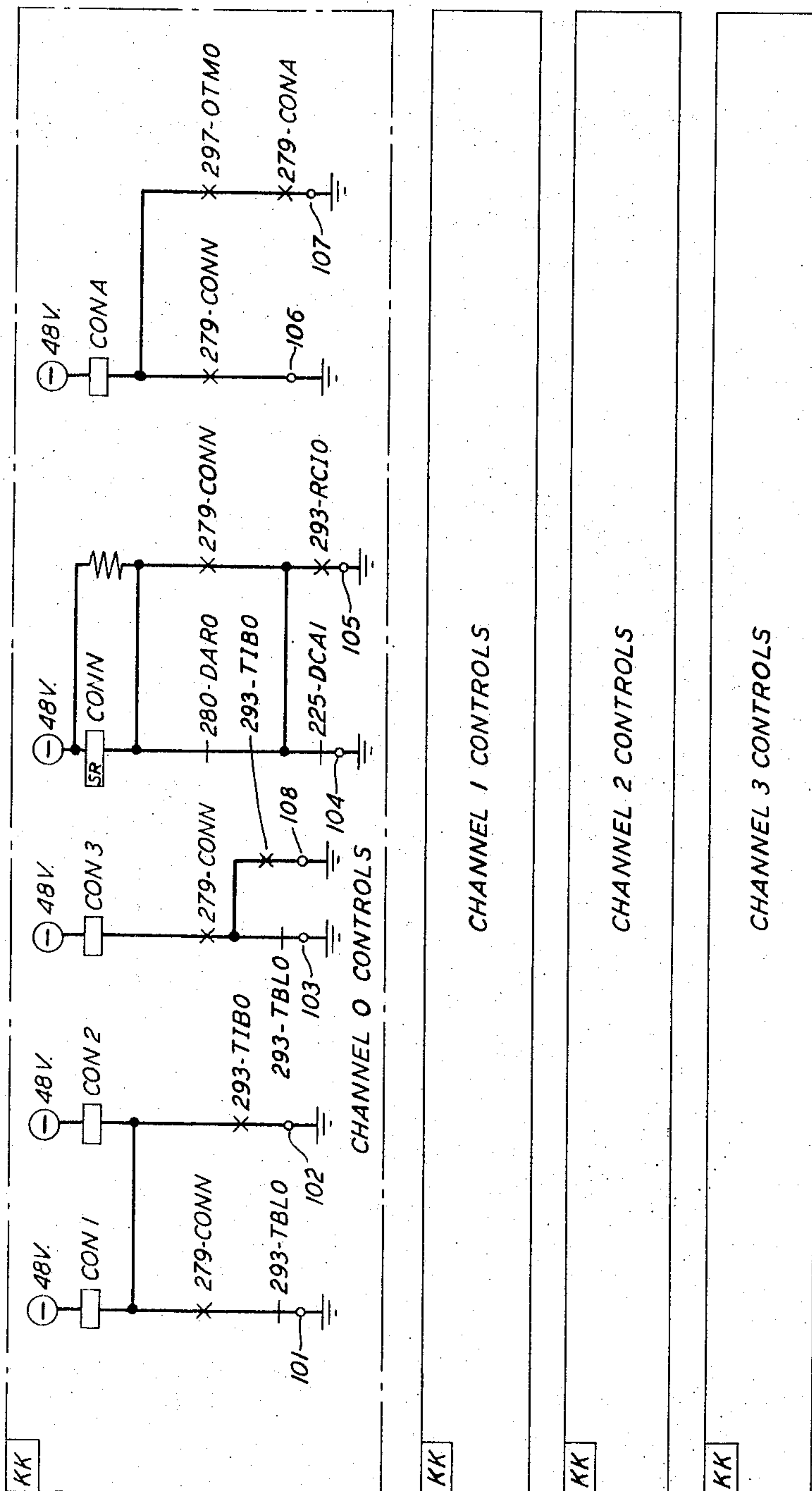
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FIG. 279



CHANNEL 1 CONTROLS

CHANNEL 2 CONTROLS

CHANNEL 3 CONTROLS



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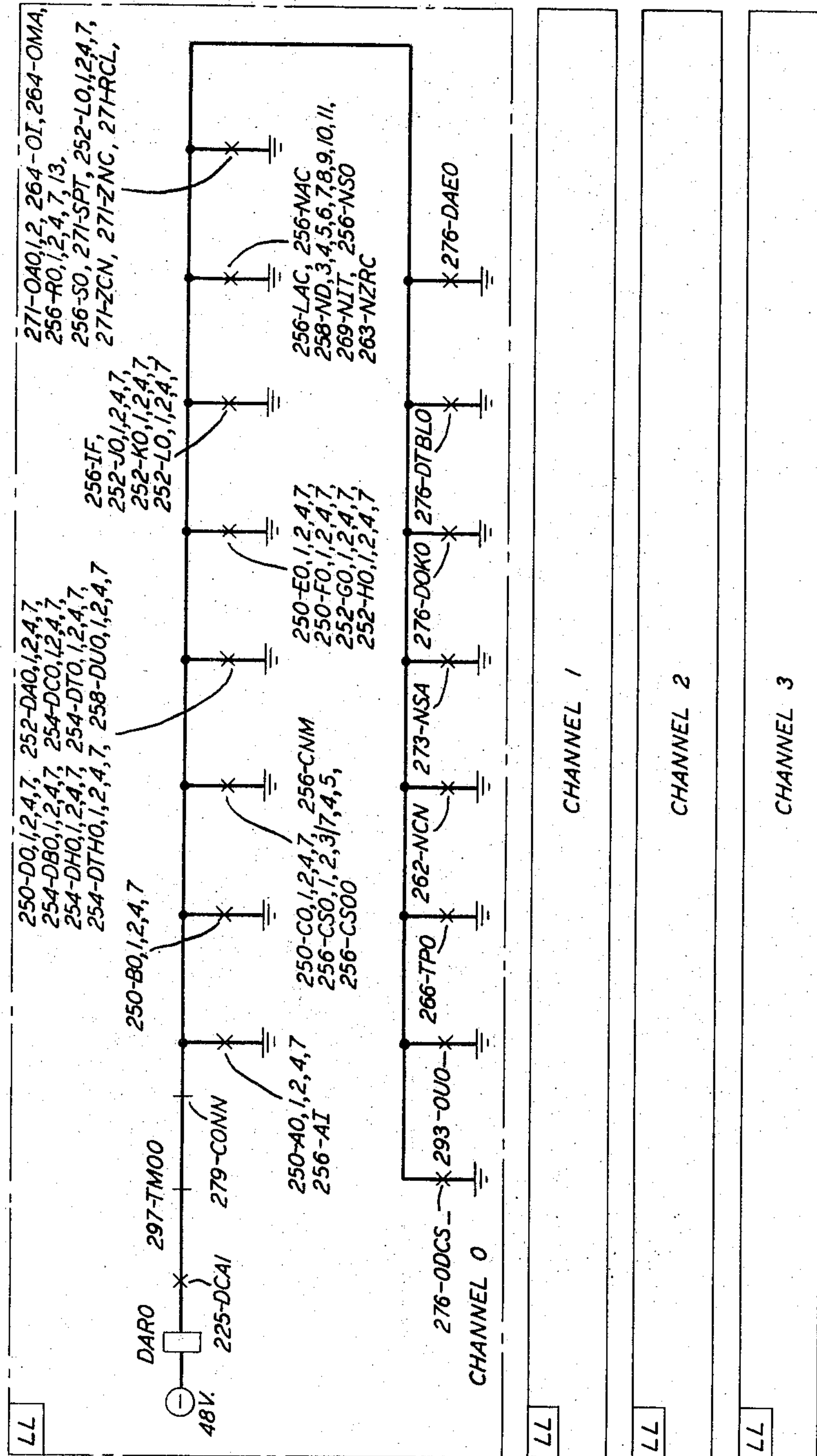
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FIG. 280





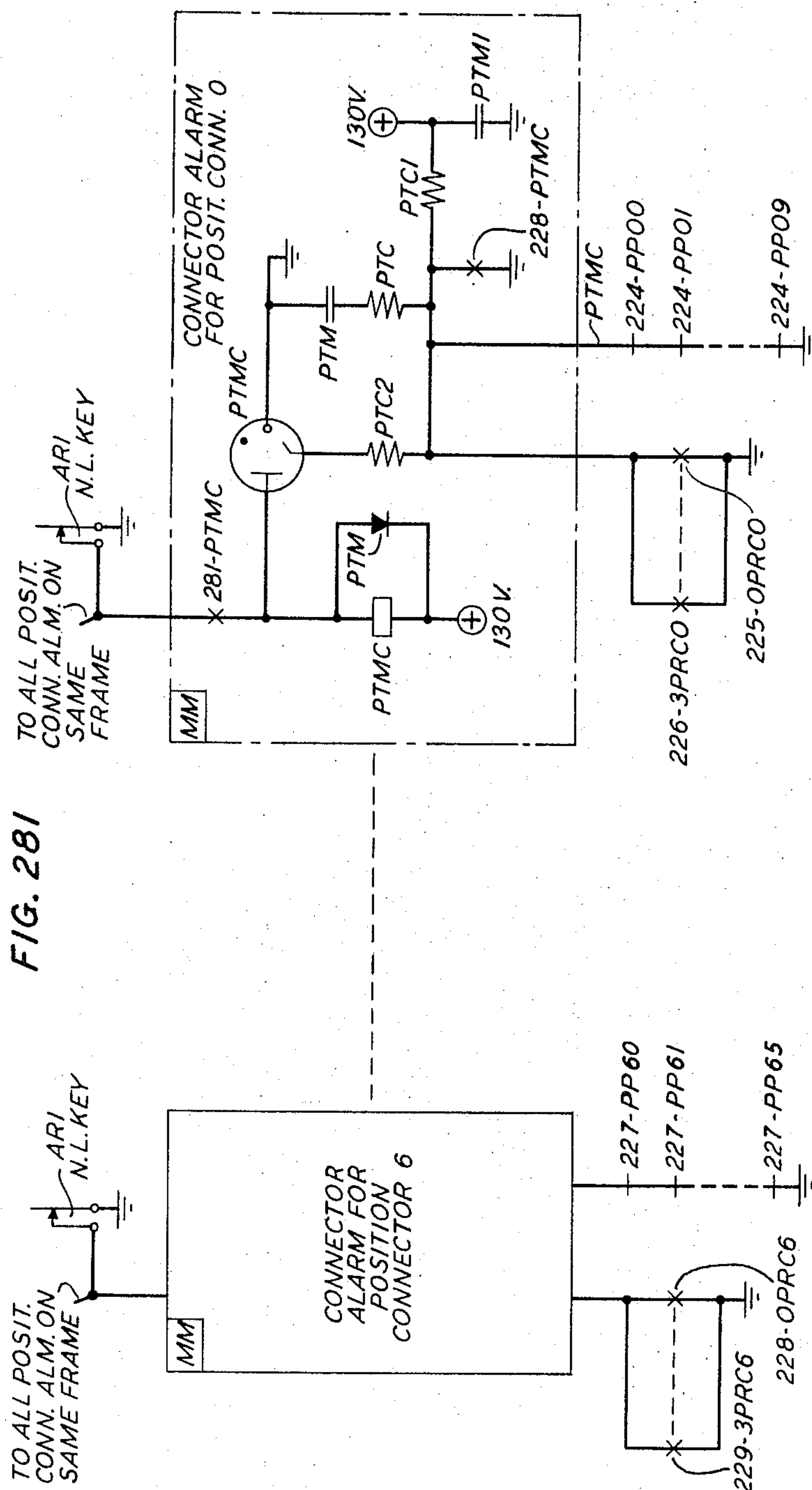
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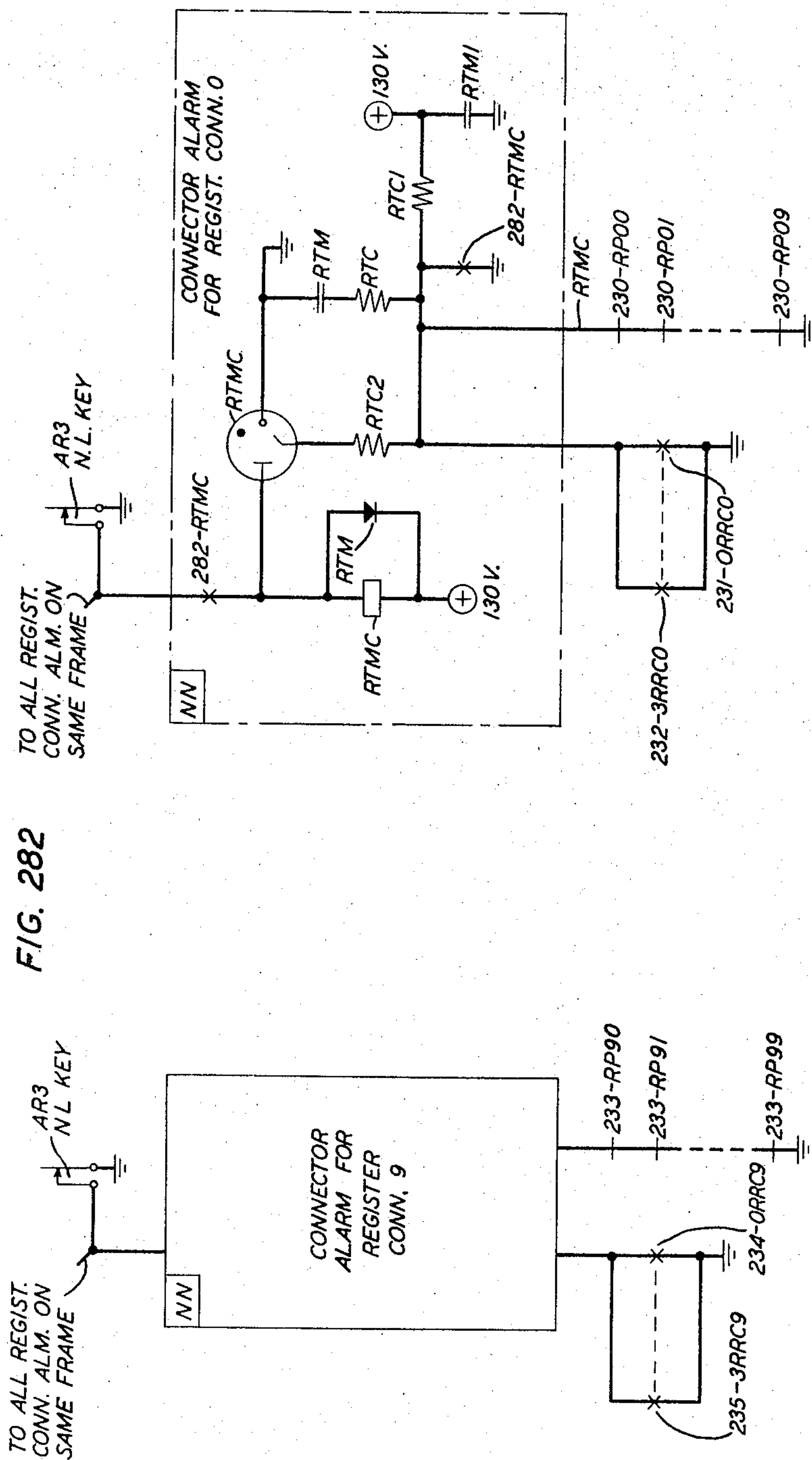
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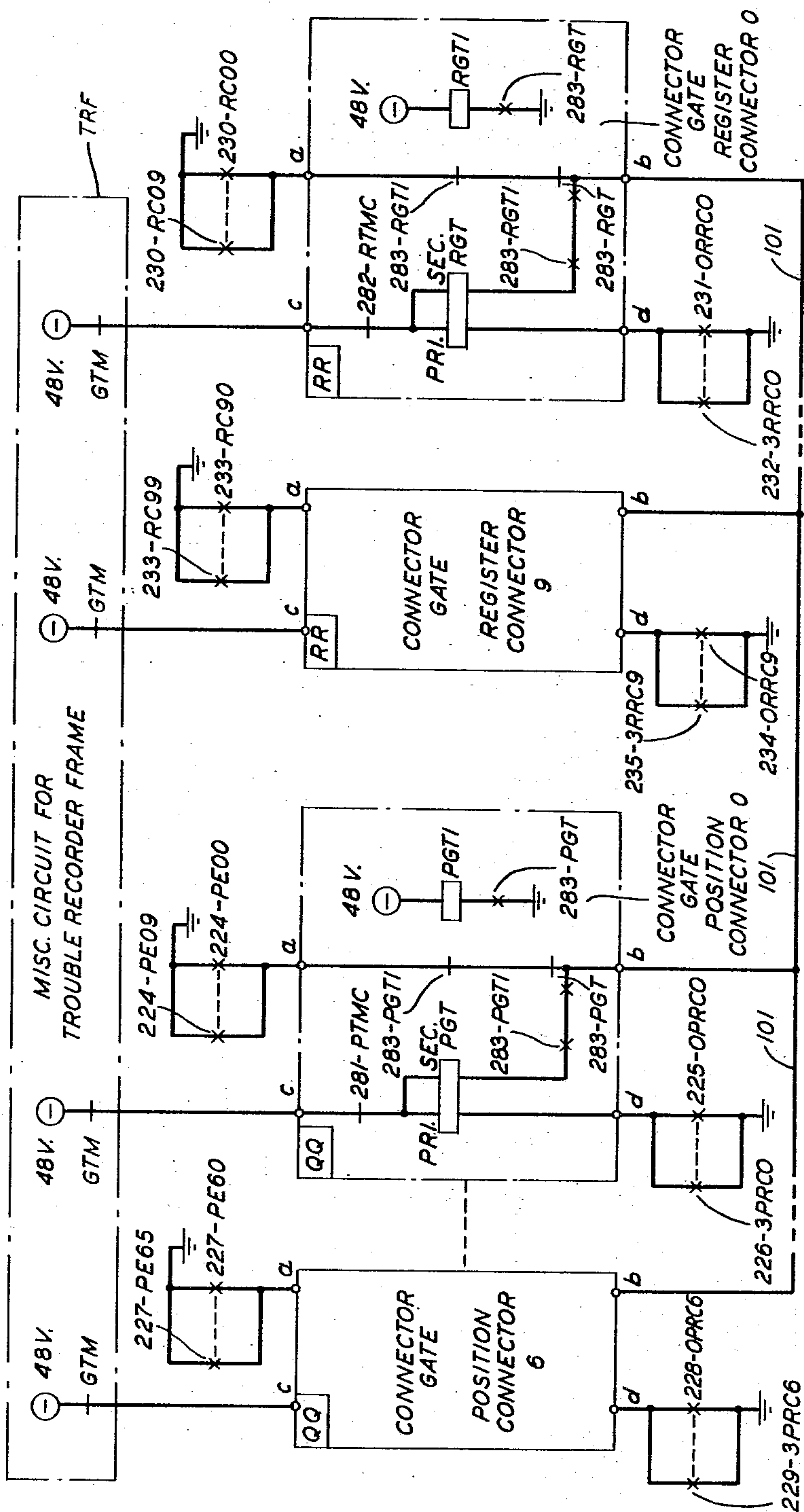
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FIG. 283





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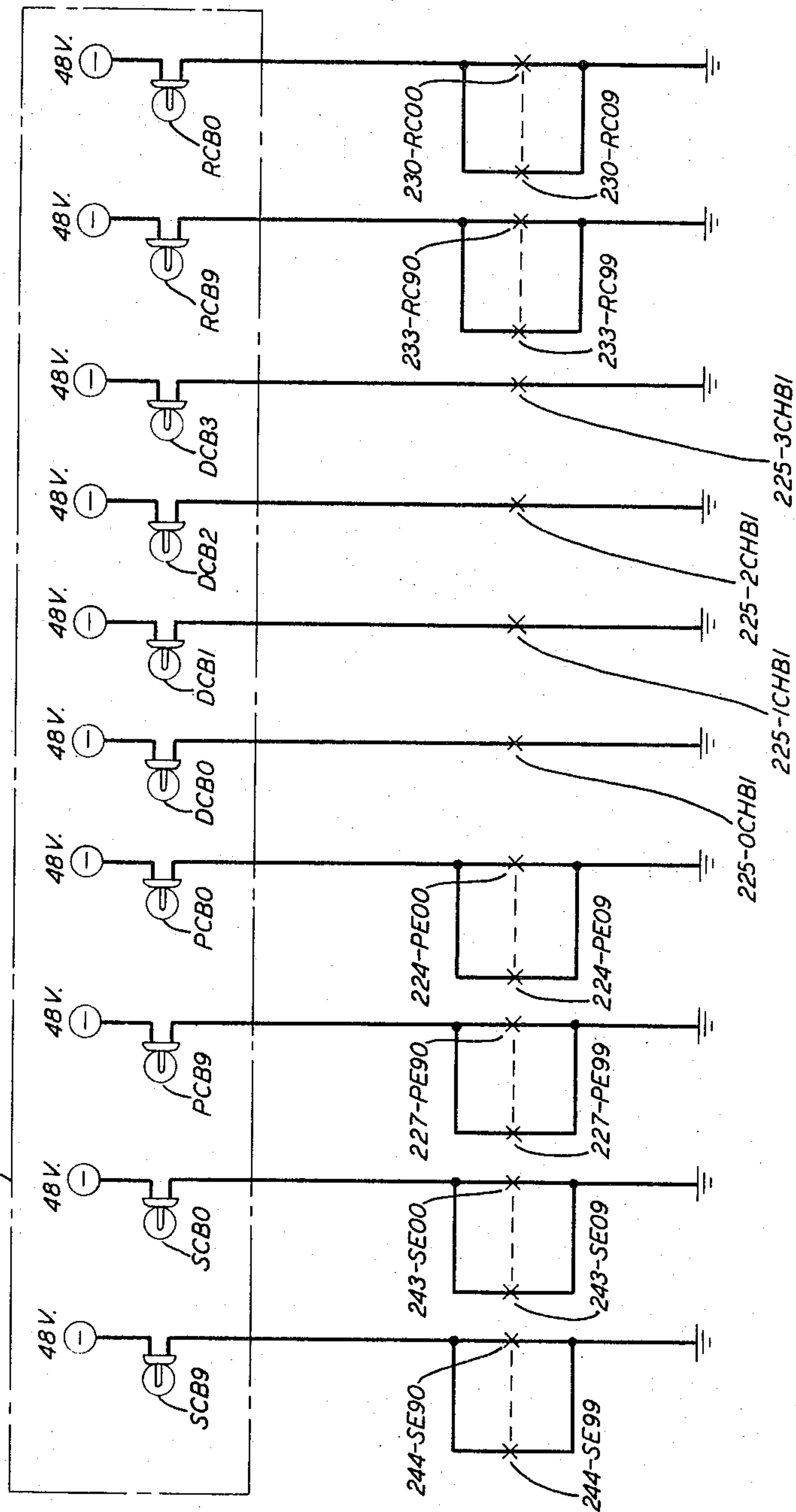
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FIG. 284

MISCELLANEOUS CIRCUIT FOR TROUBLE RECORDER FRAME





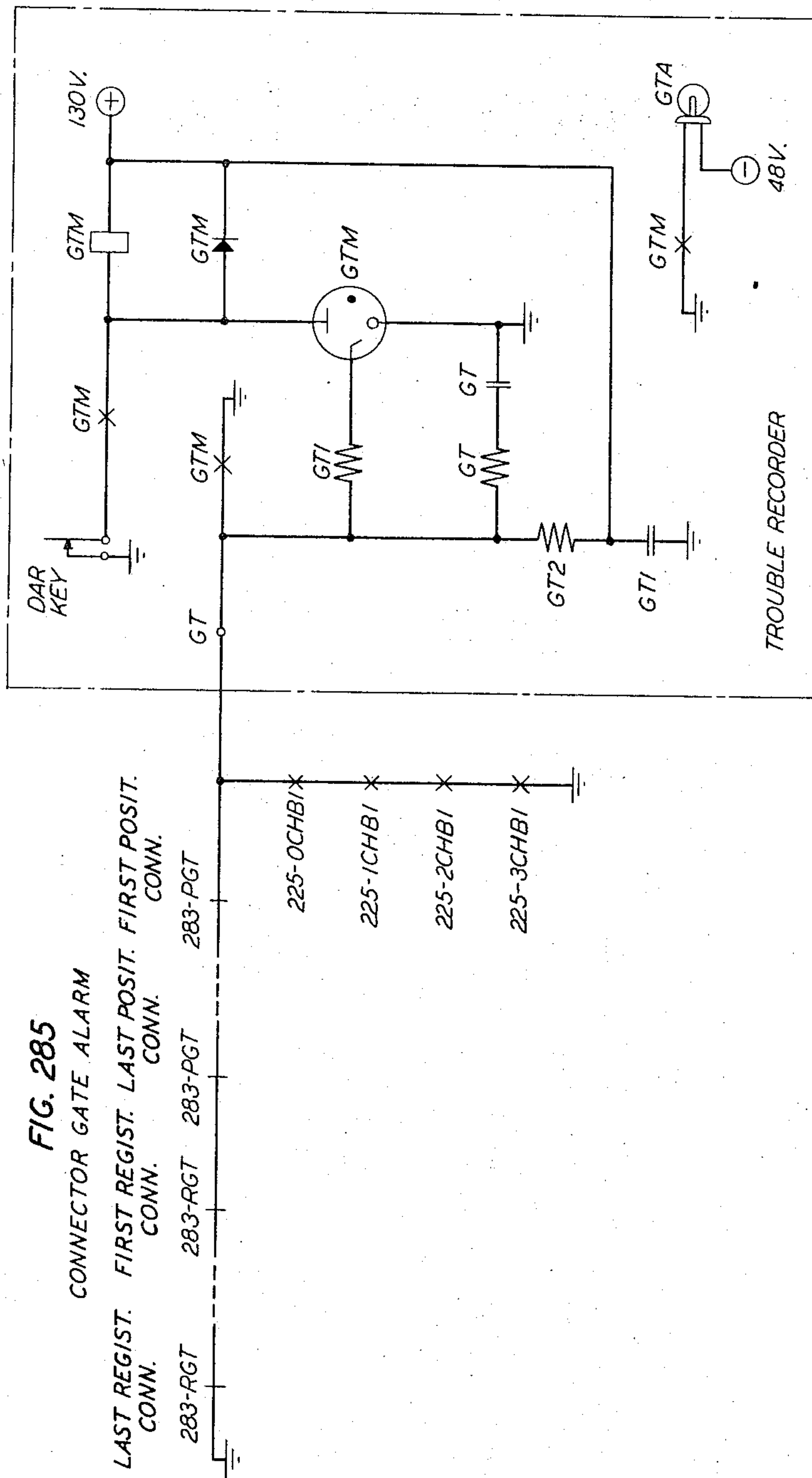
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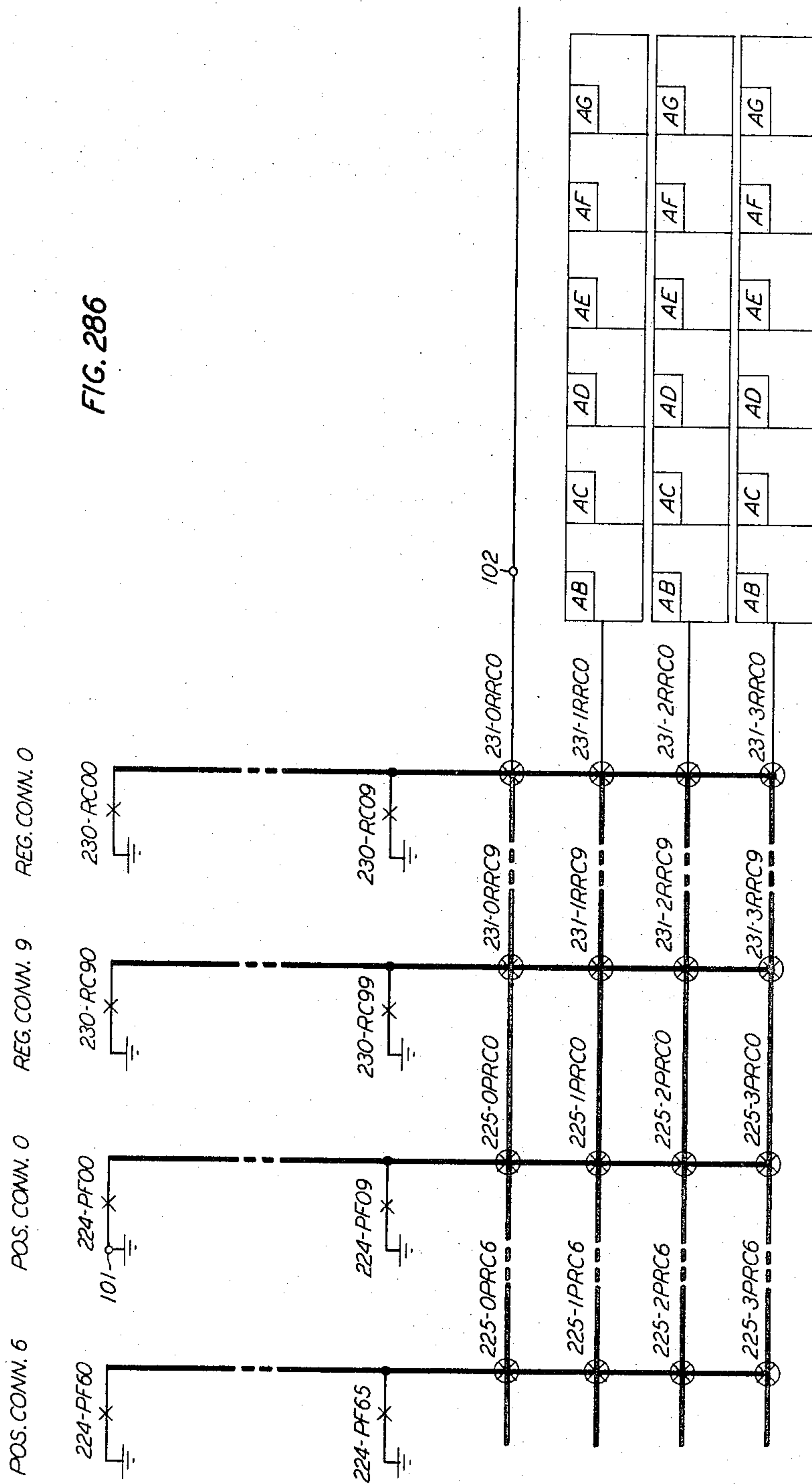
R. B. CURTIS  
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FIG. 286





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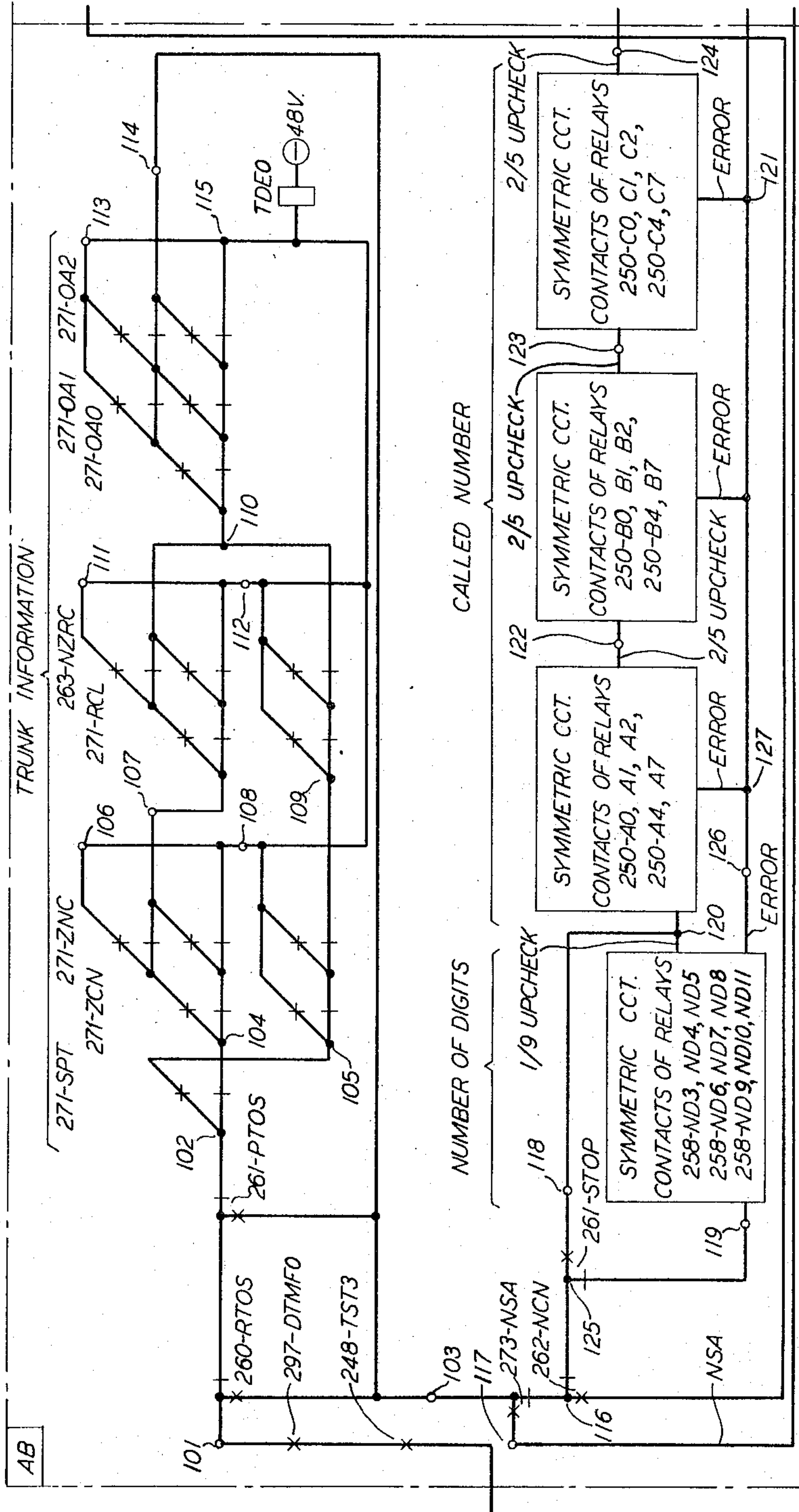
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FIG. 287





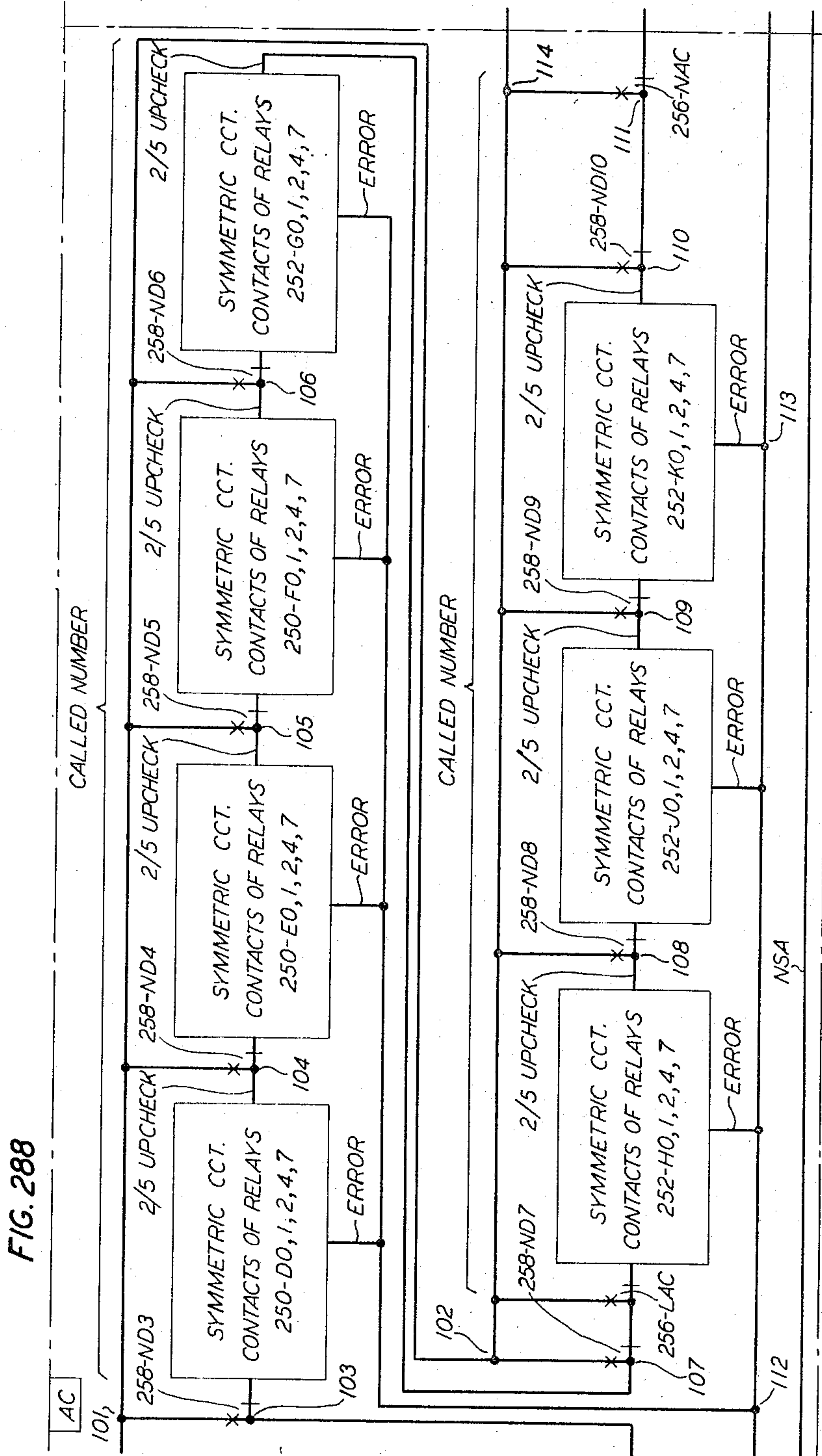
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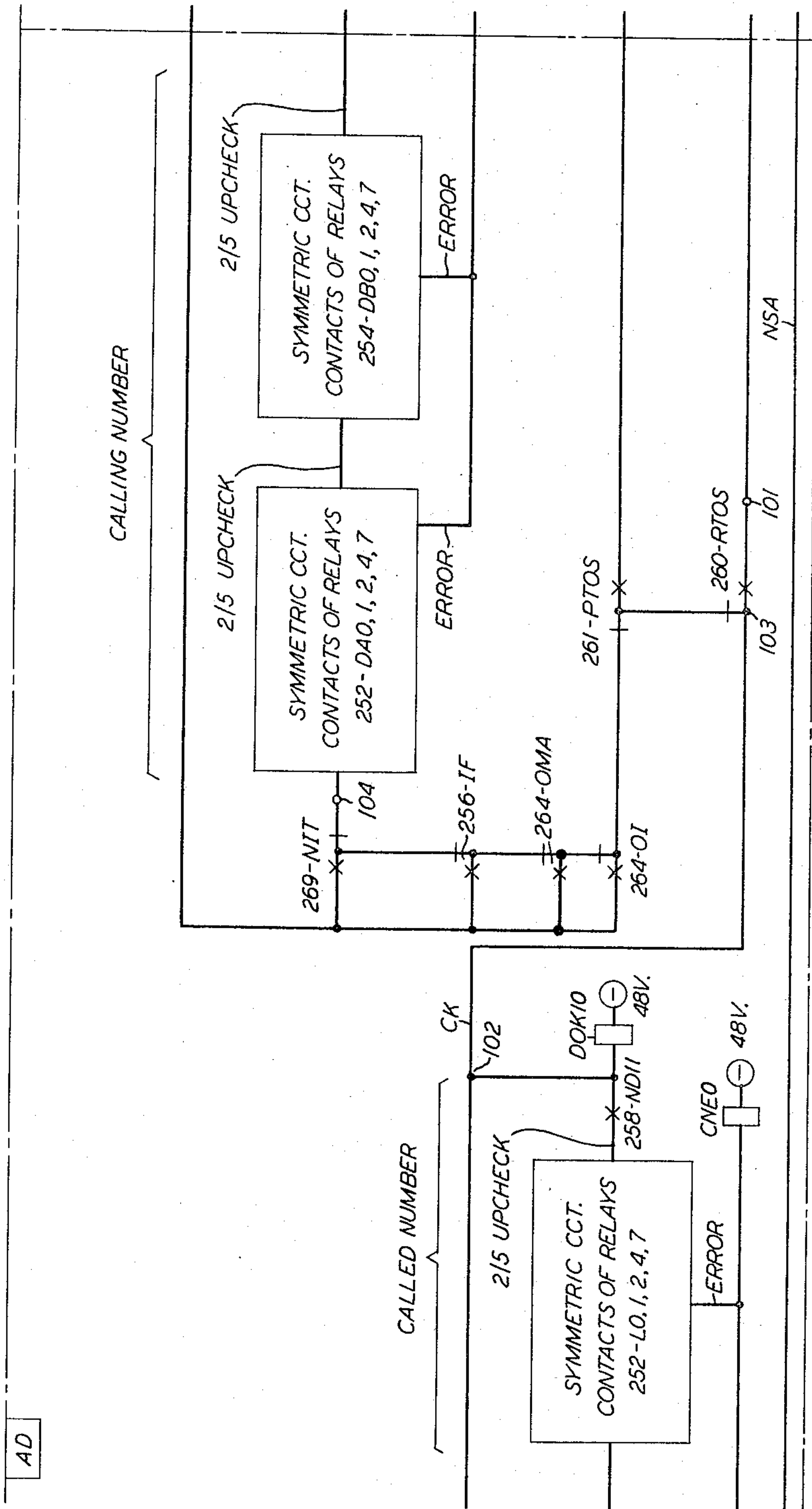
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FIG. 289





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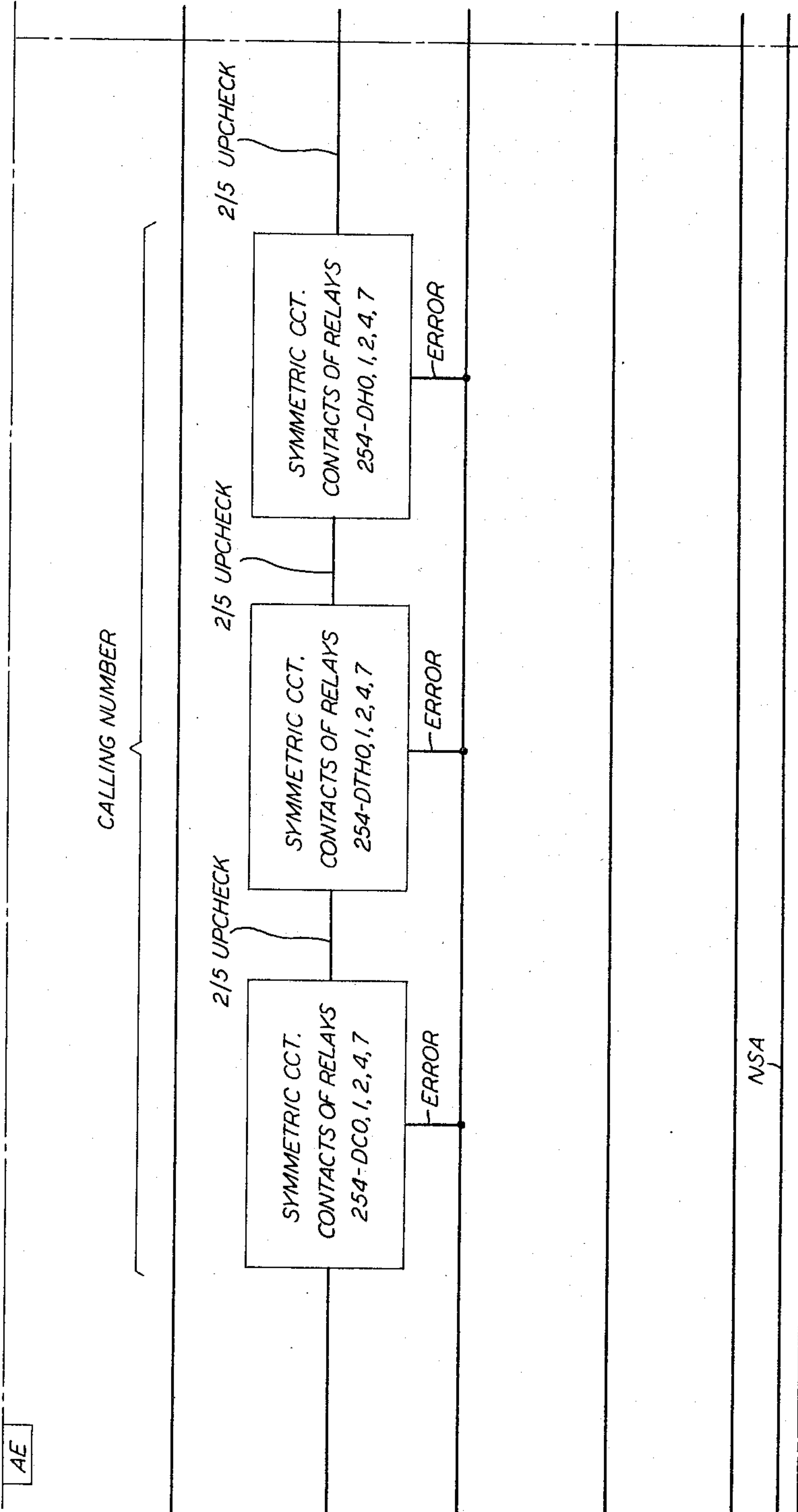
R. B. CURTIS  
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FIG. 290





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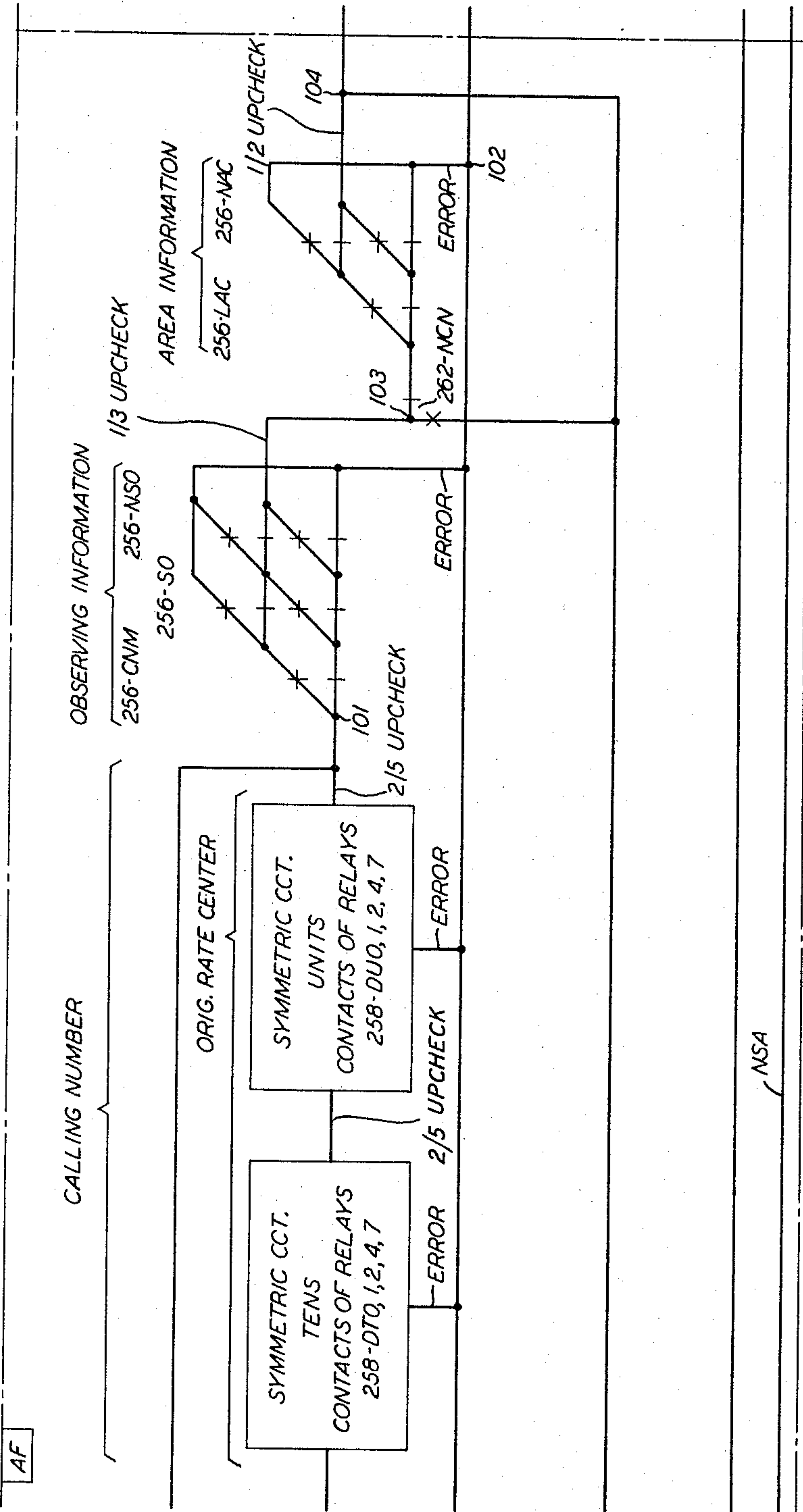
R. B. CURTIS  
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FIG. 291





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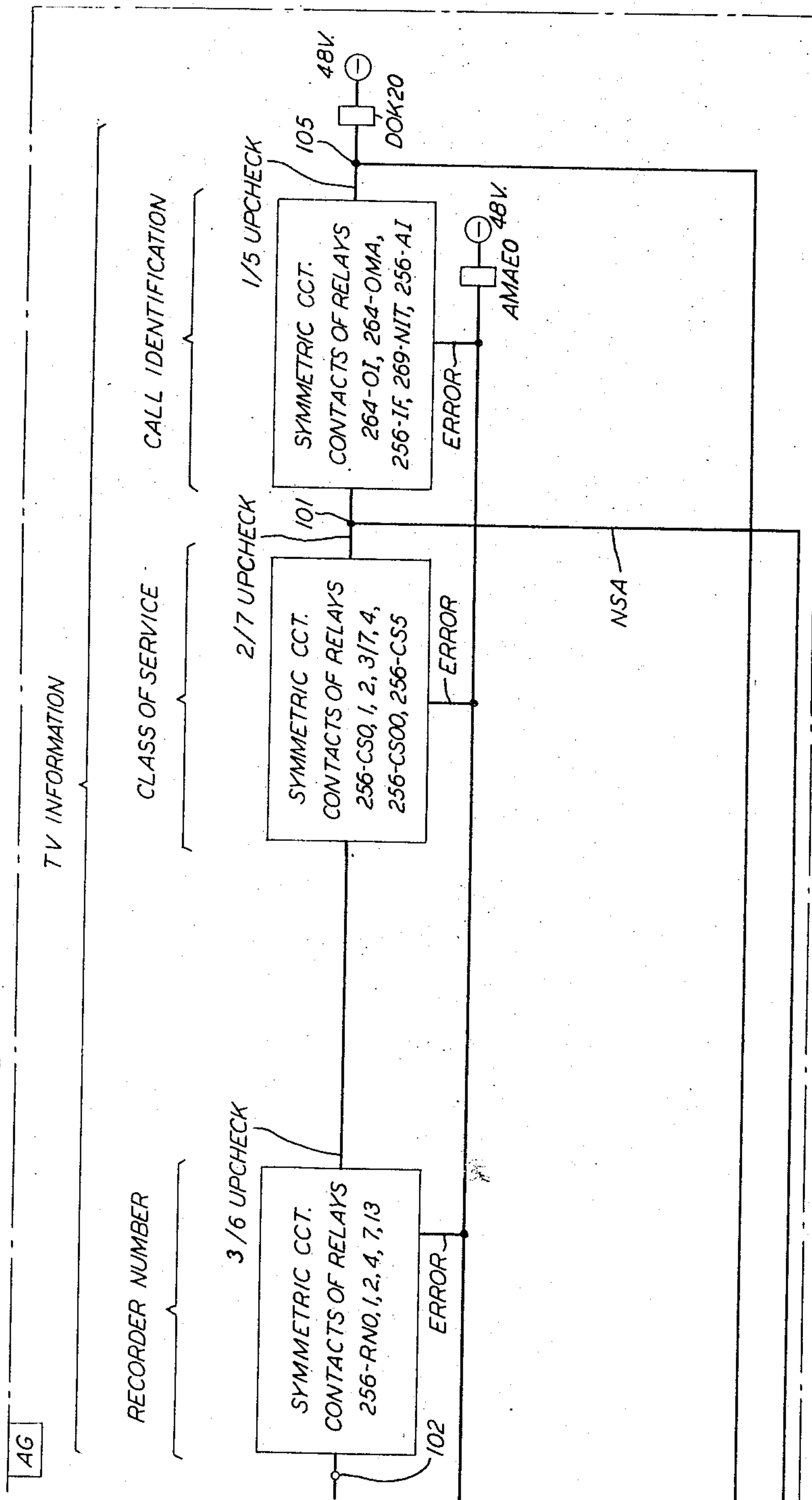
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FIG. 292

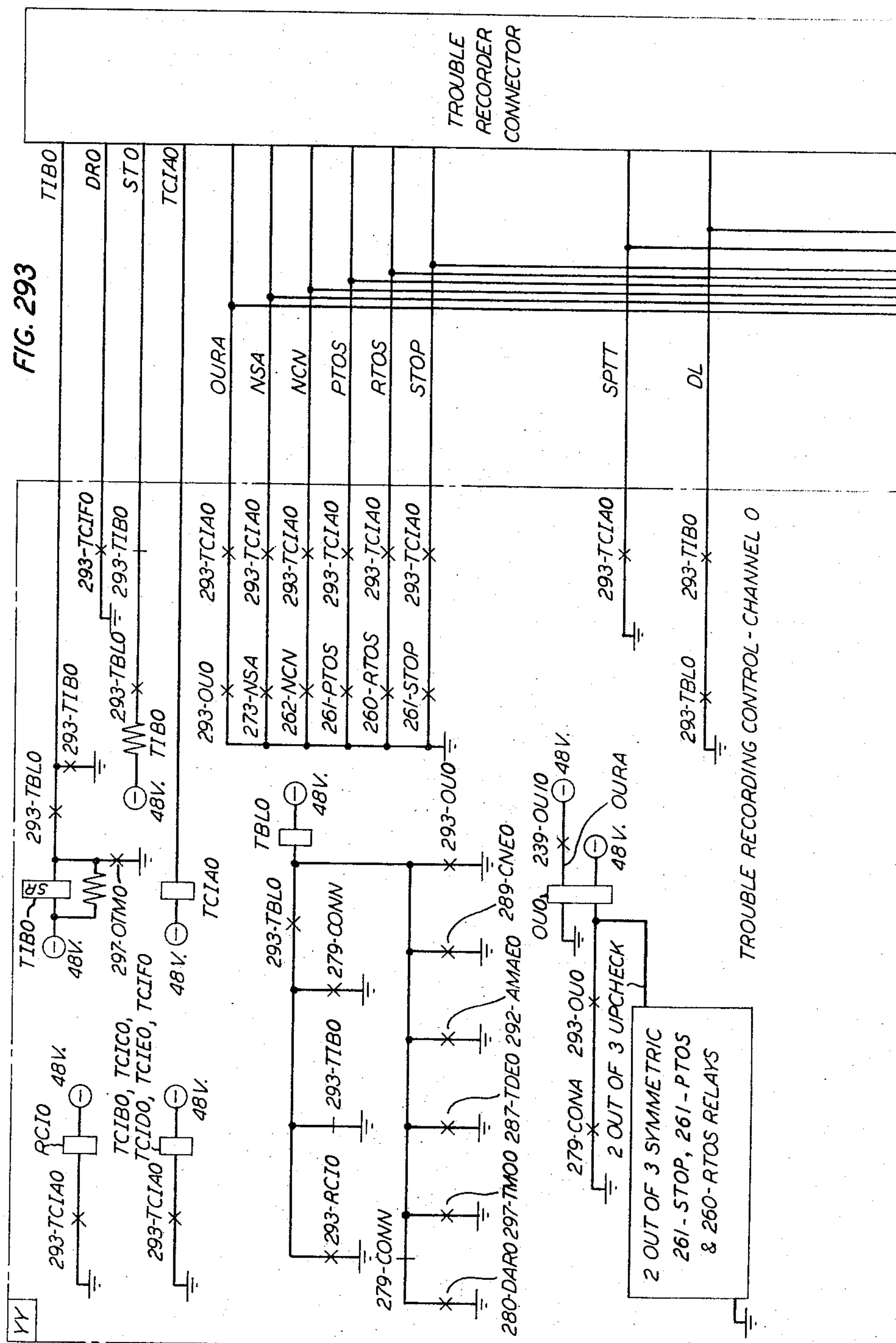




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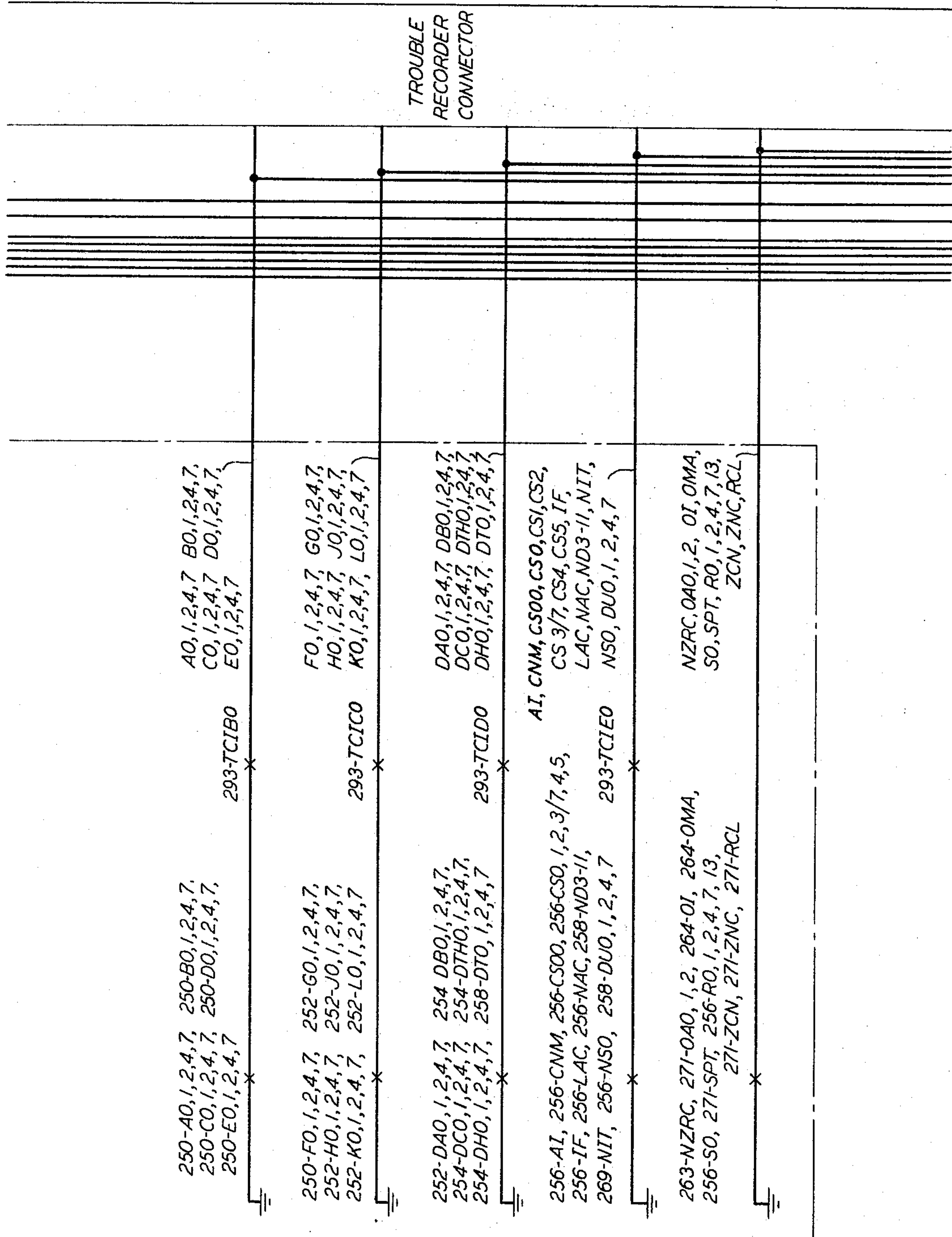


FIG. 294



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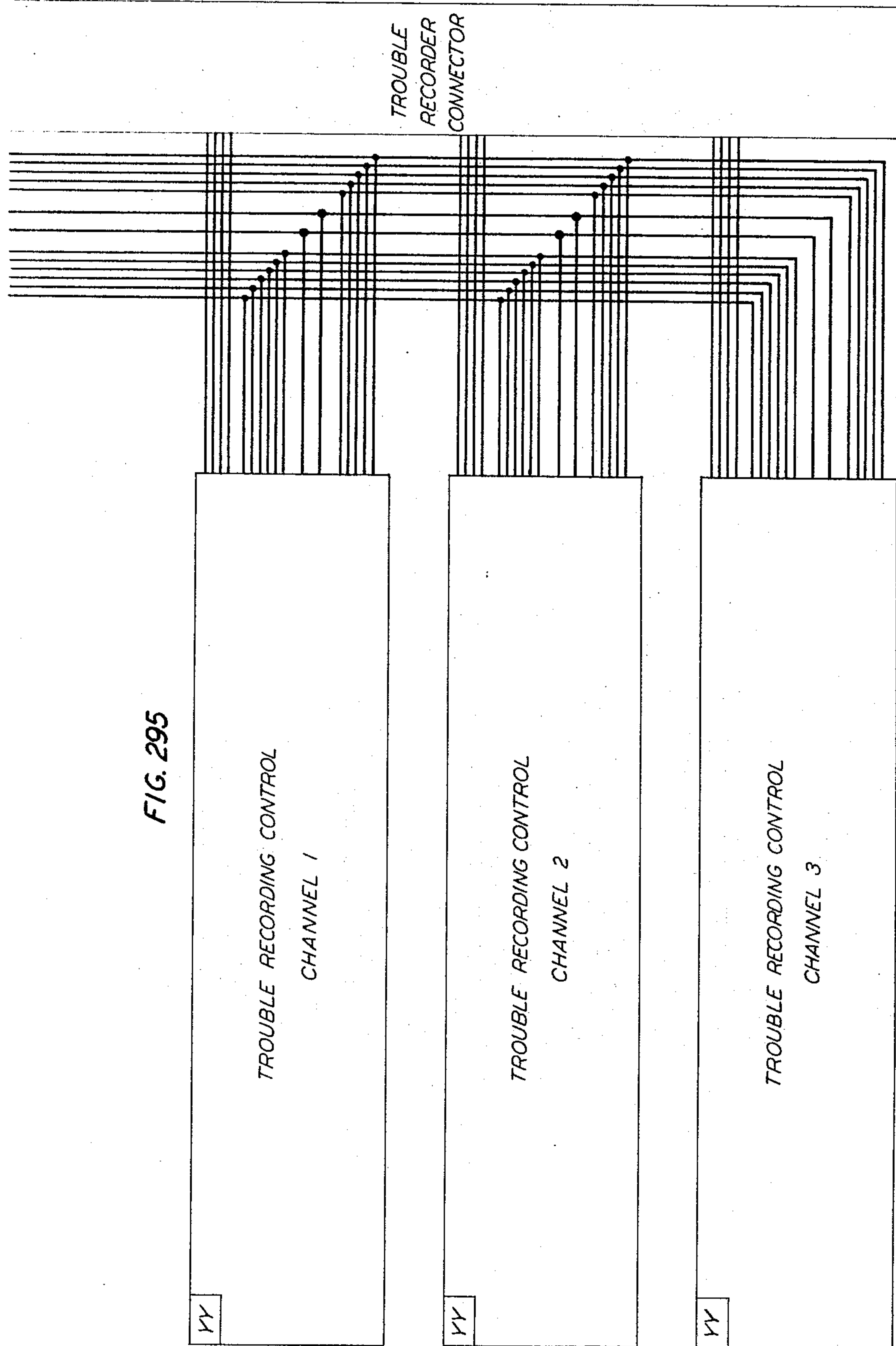
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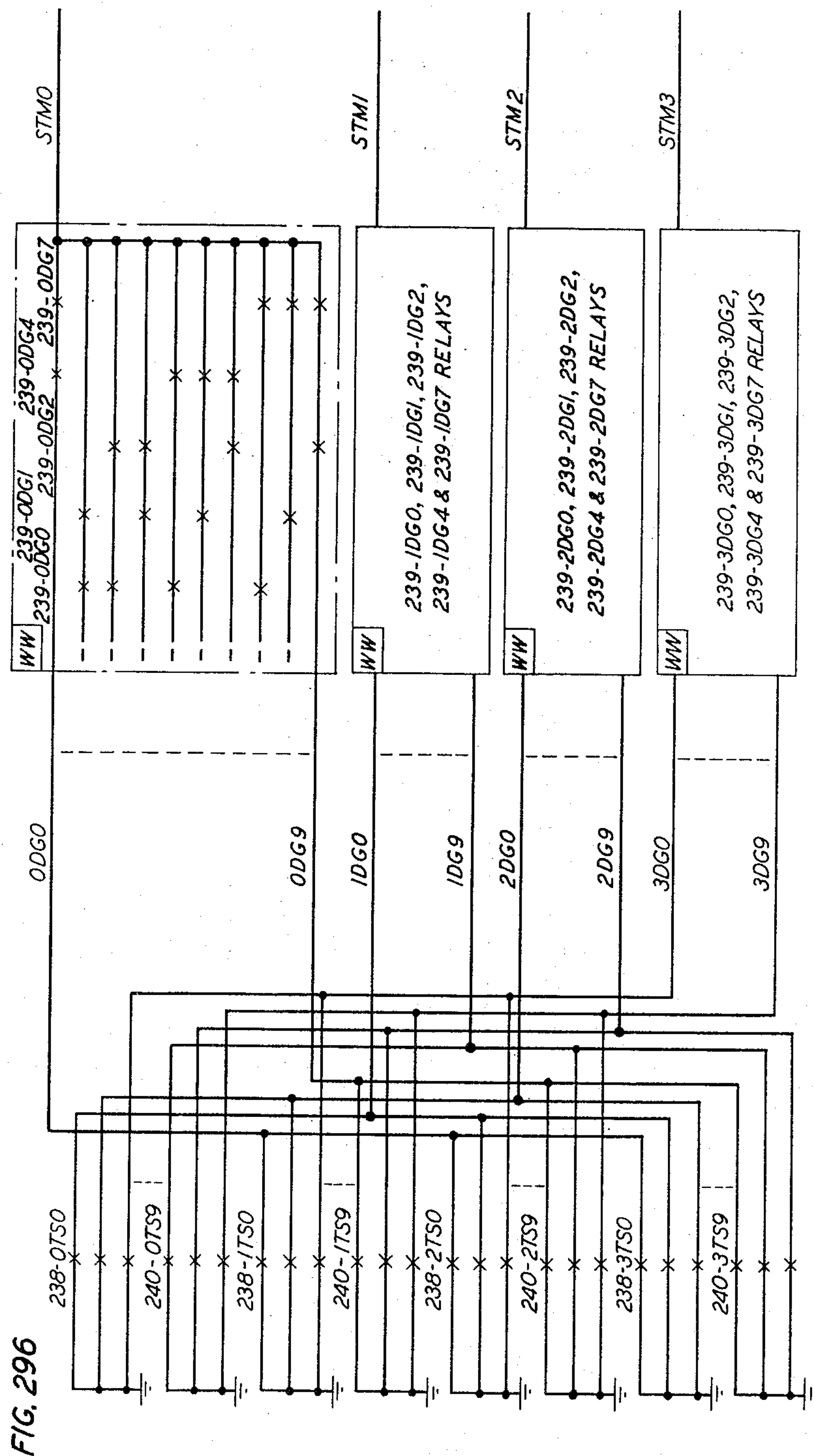
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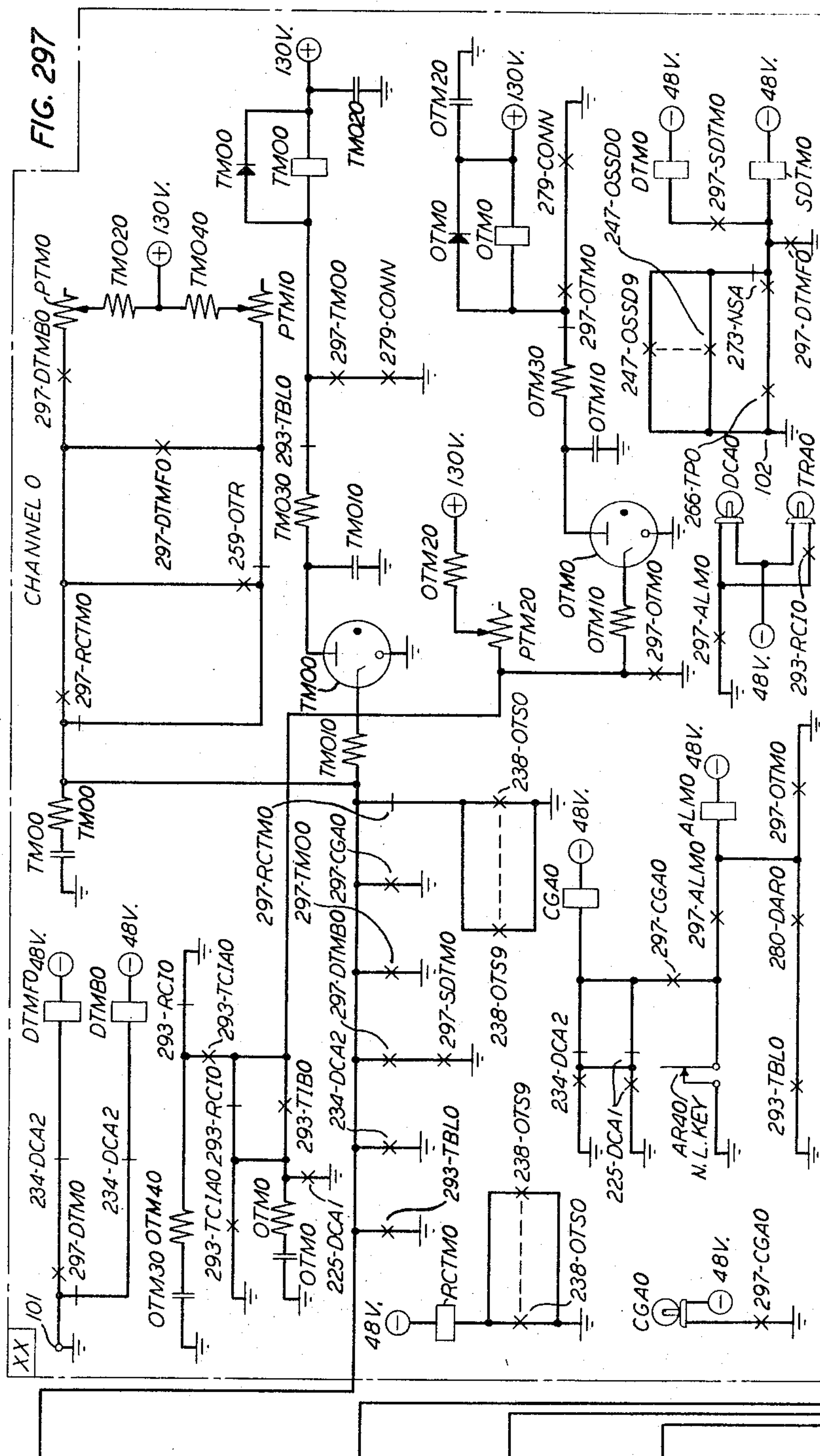
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FIG. 298

CHANNEL 1

CHANNEL 2

CHANNEL 3

XX

XX

XX



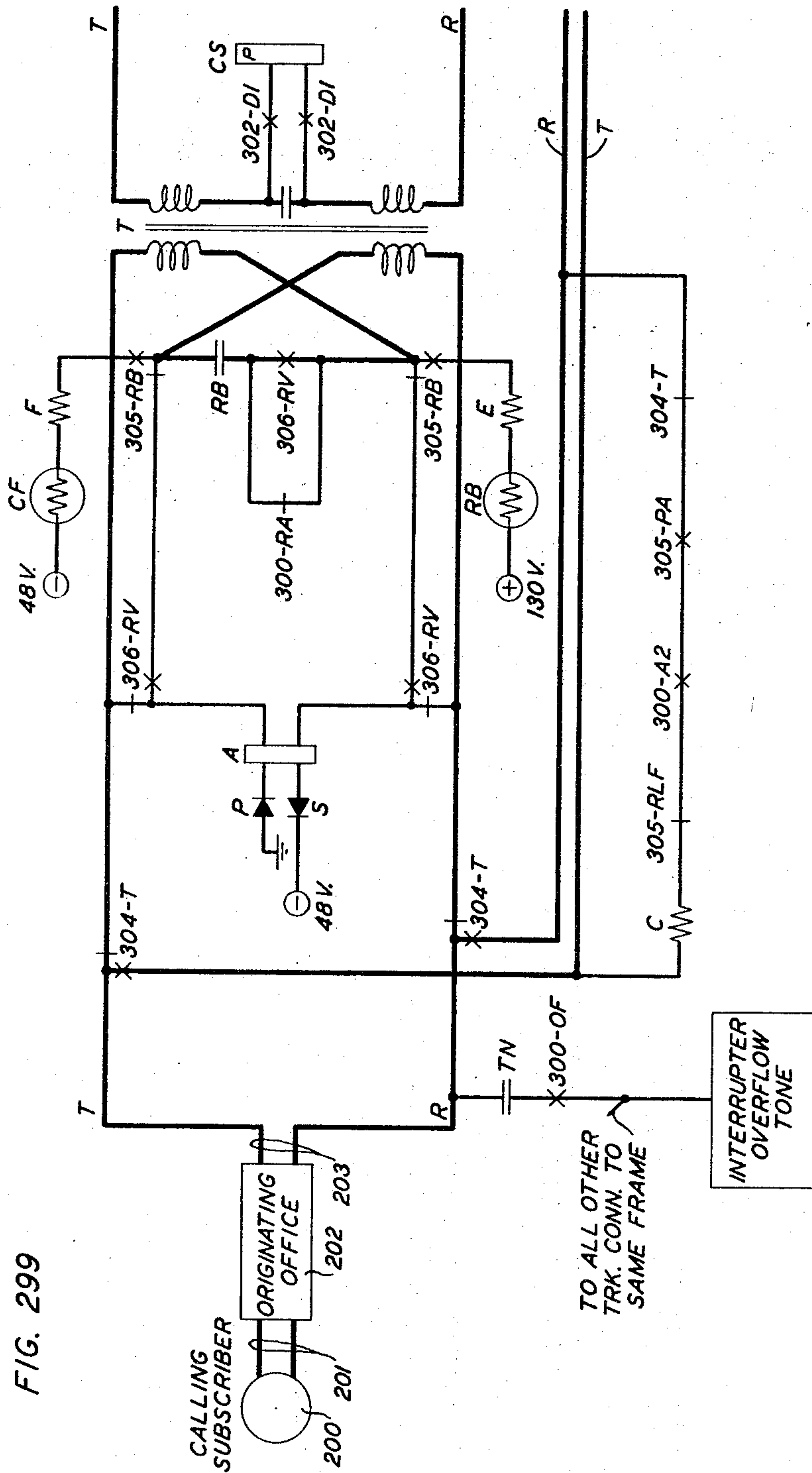
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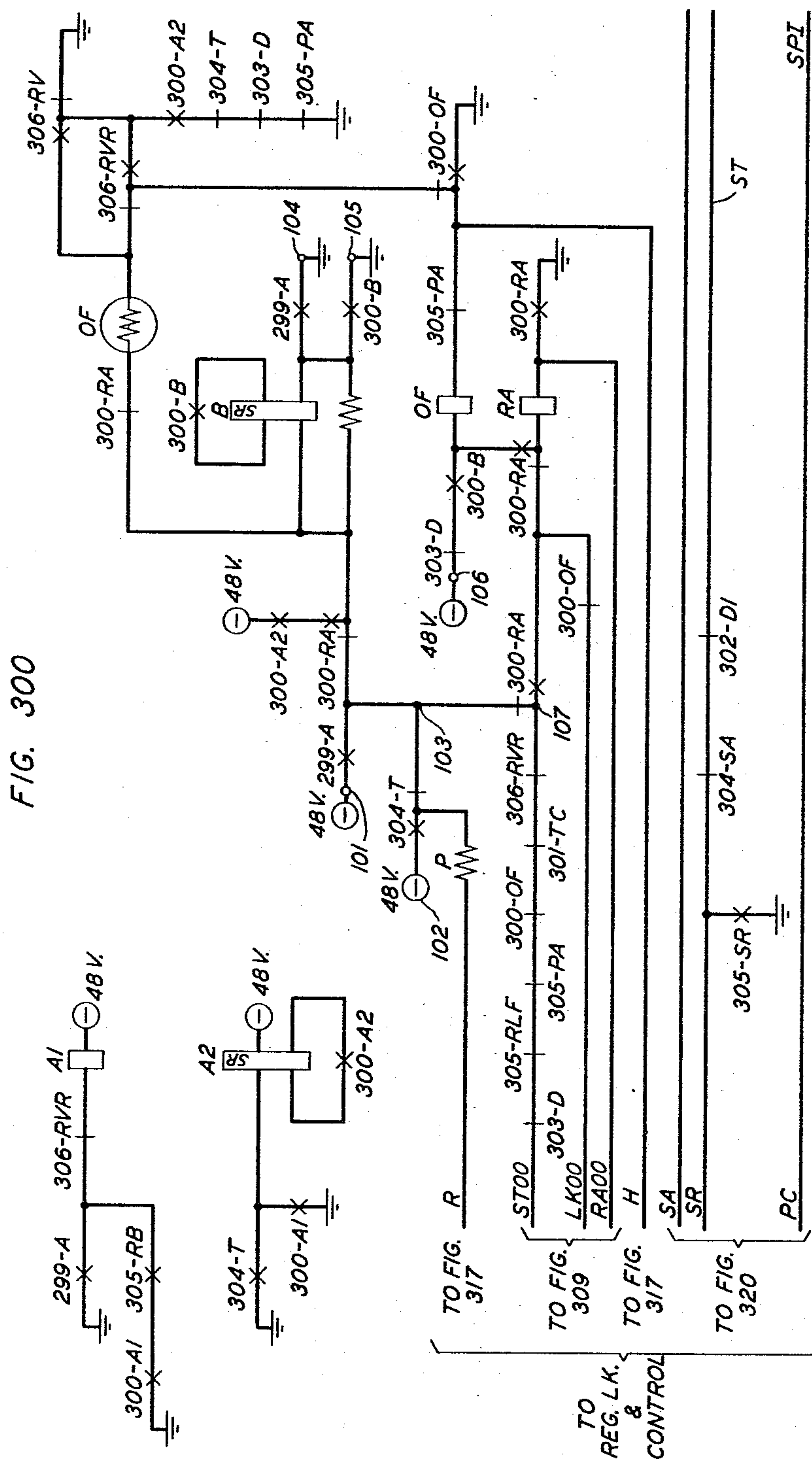




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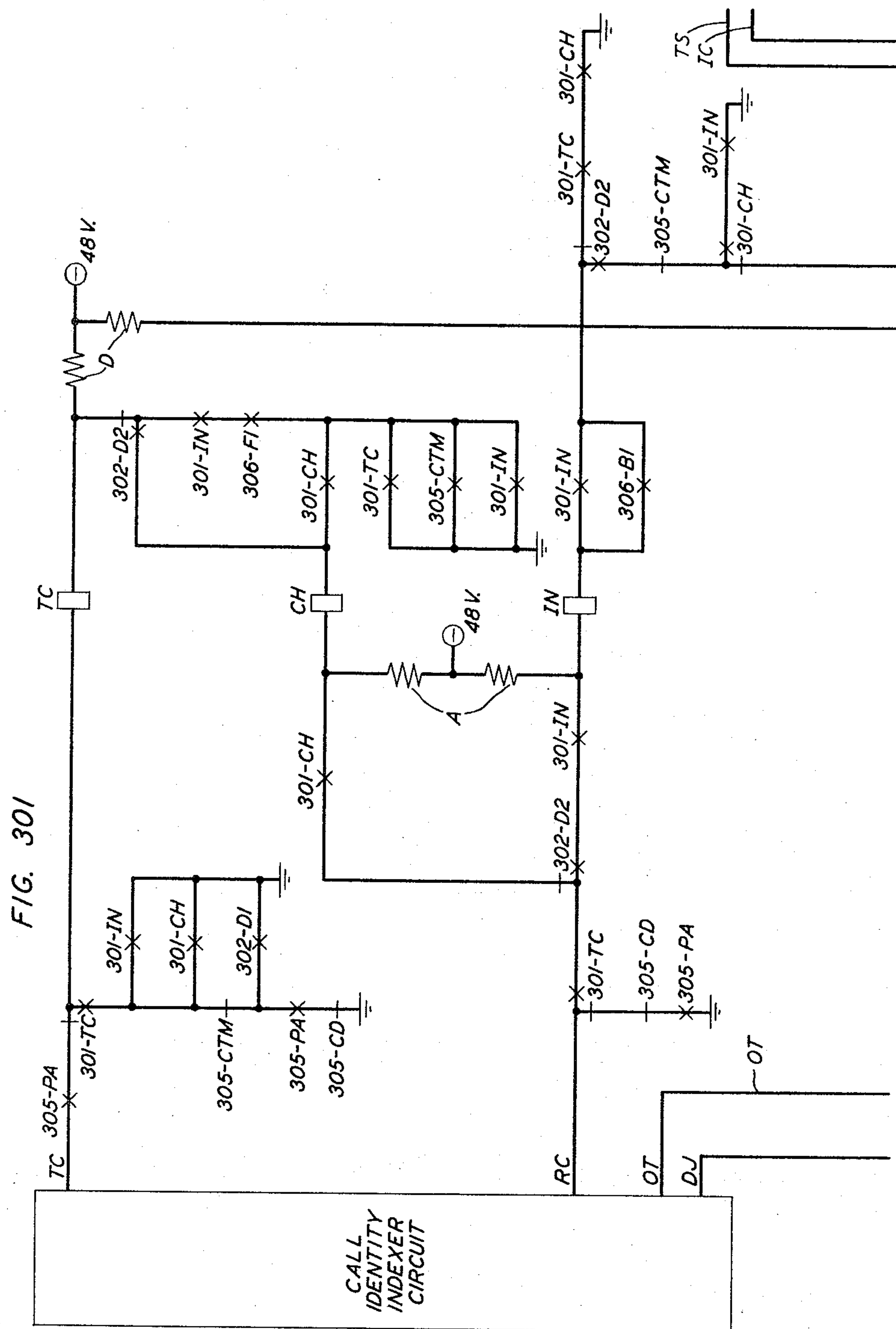
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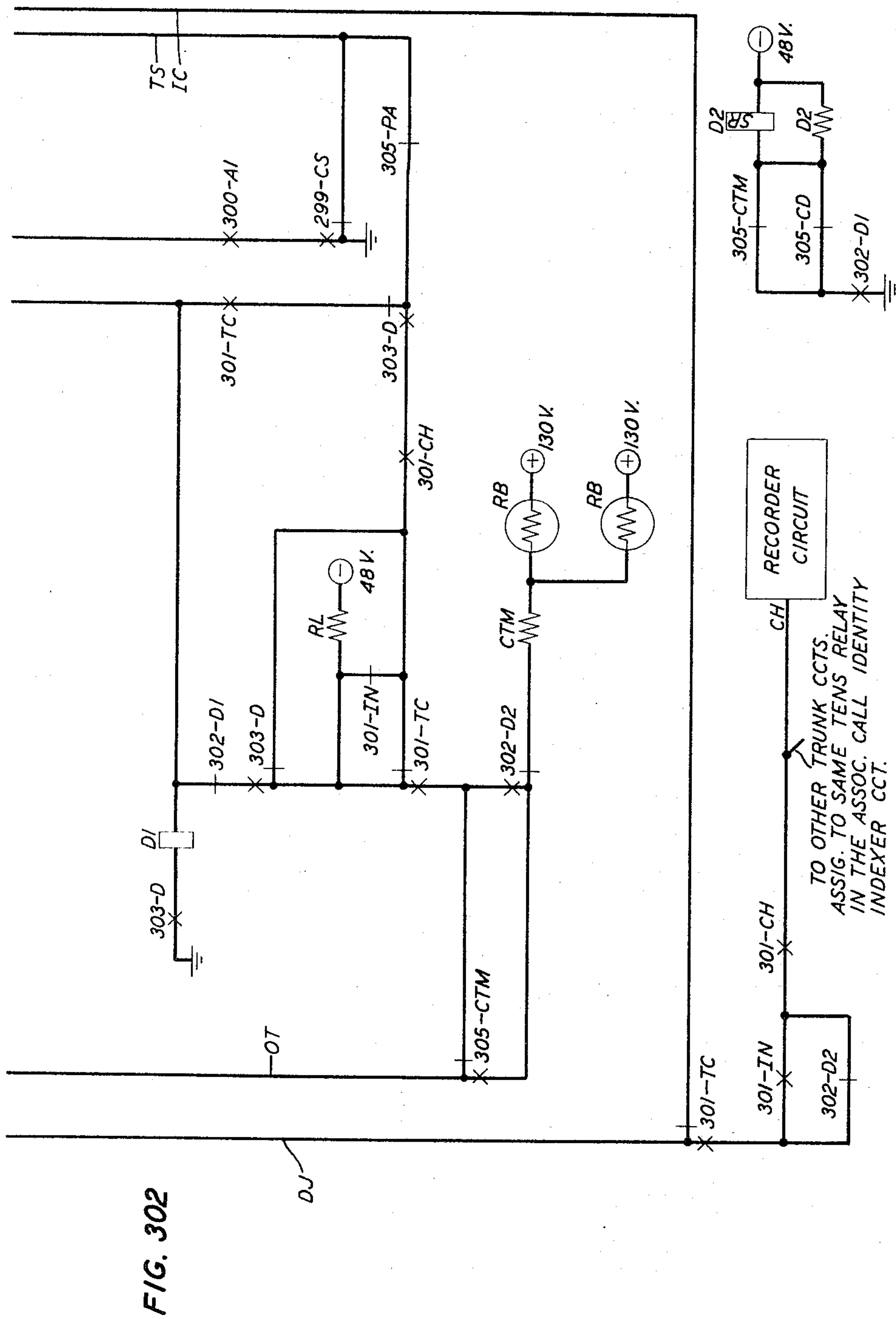




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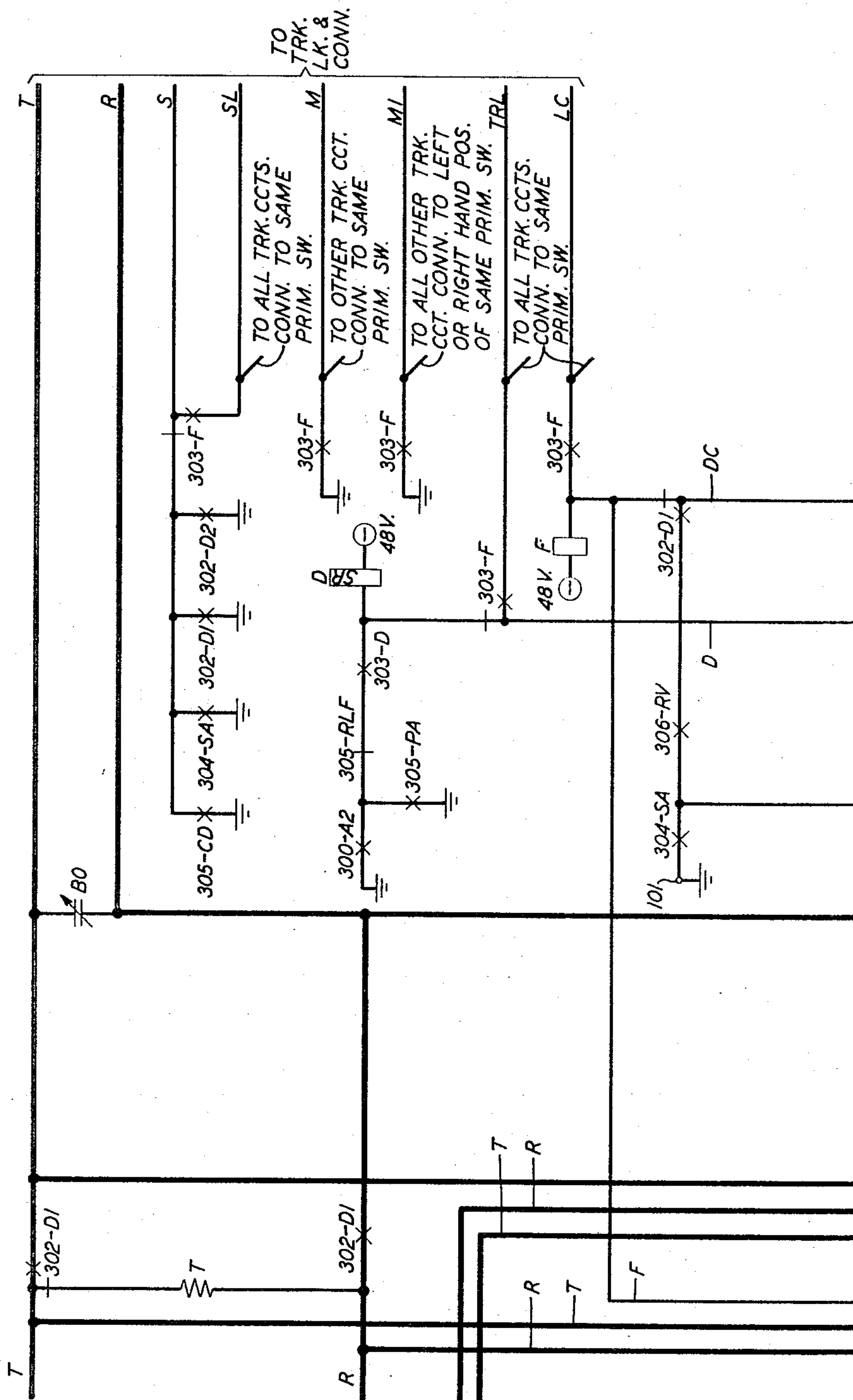
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FIG. 303

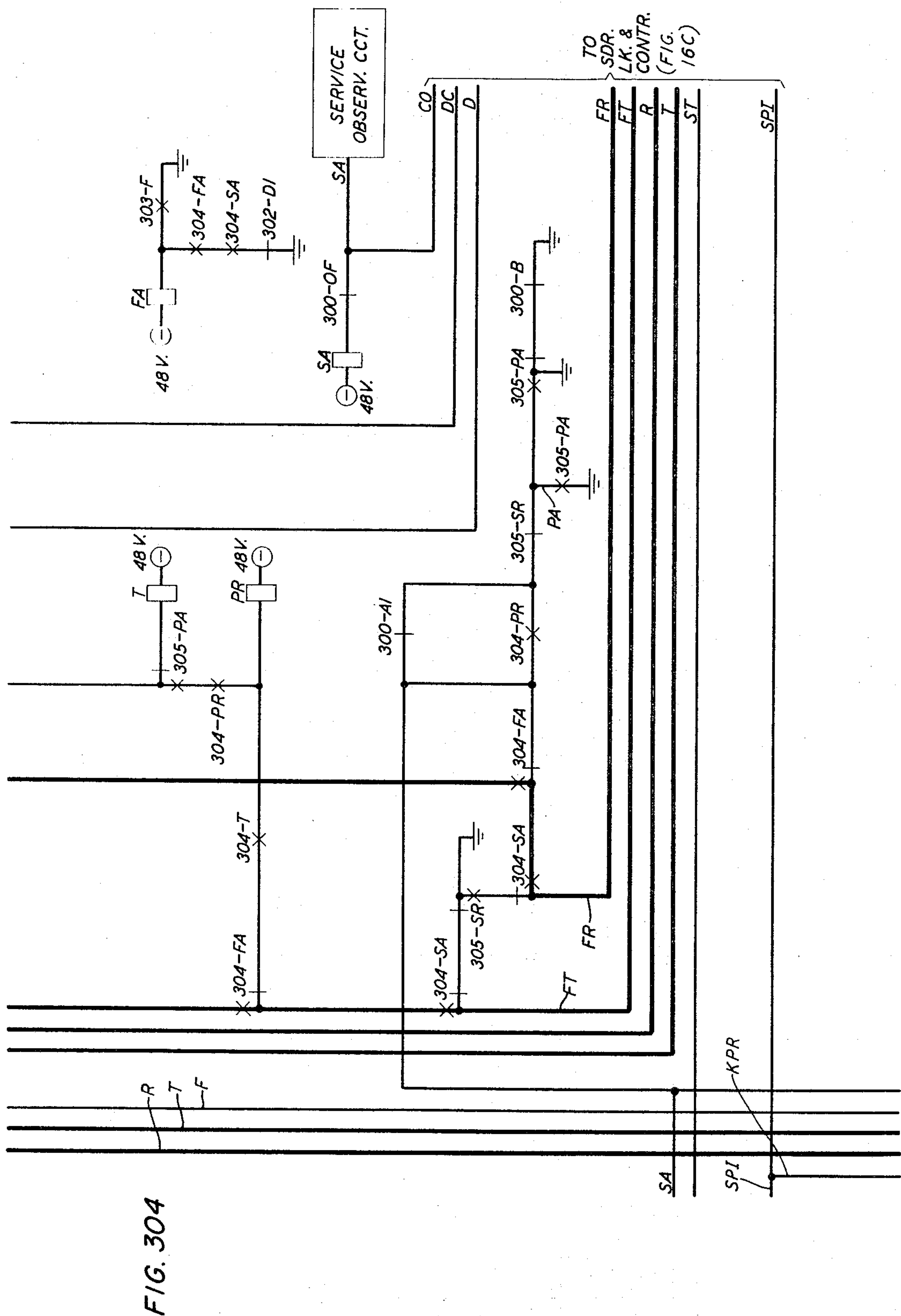




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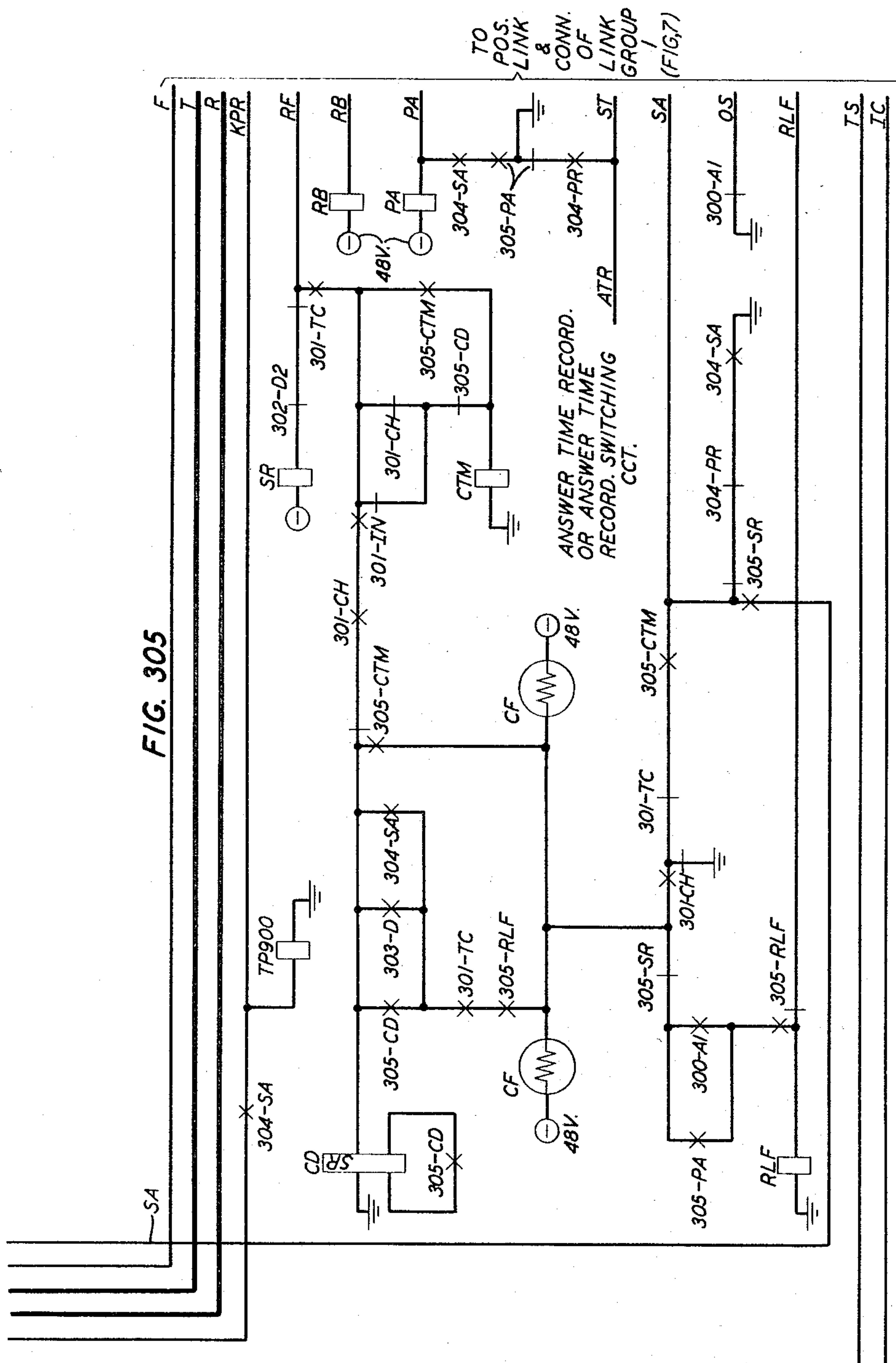




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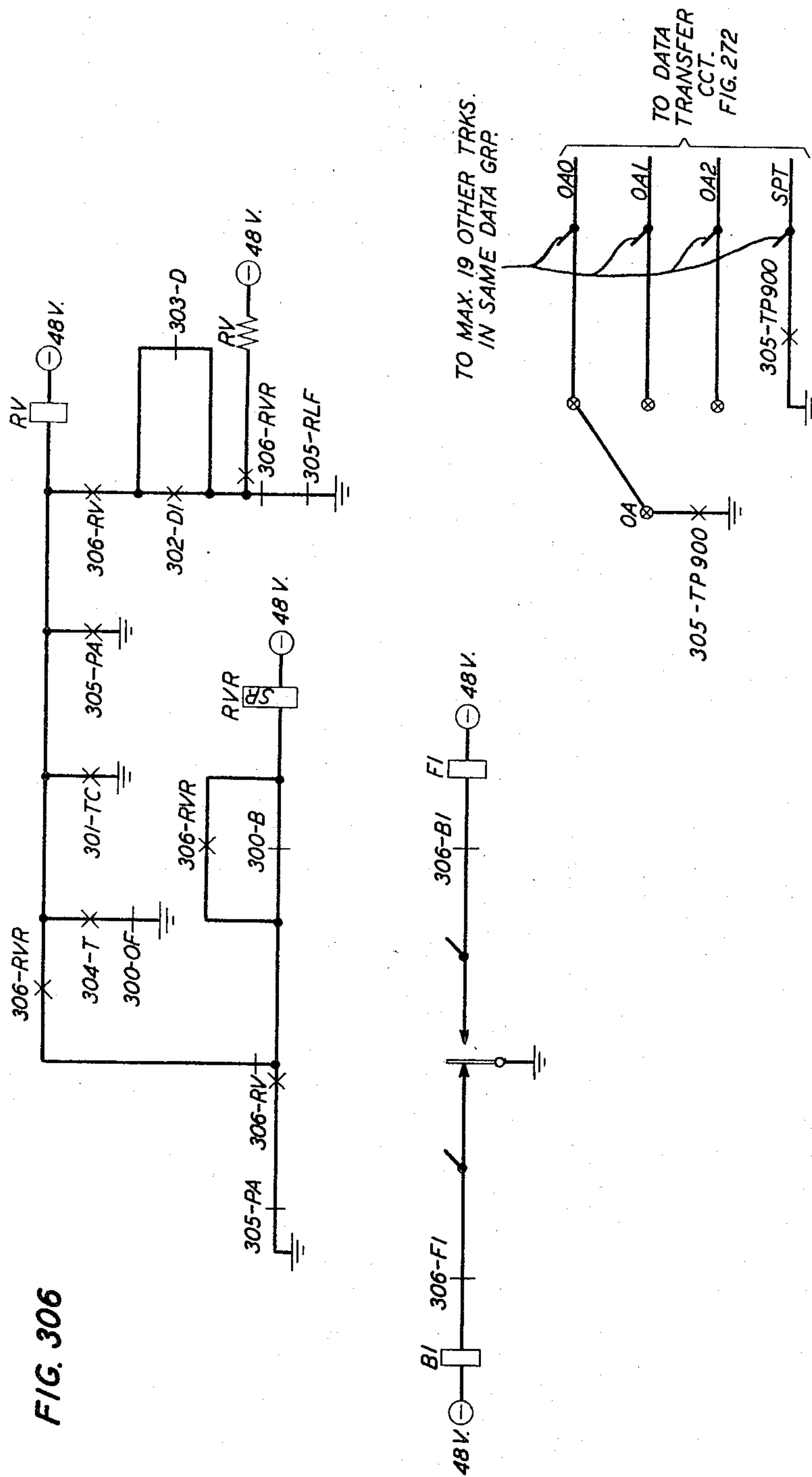
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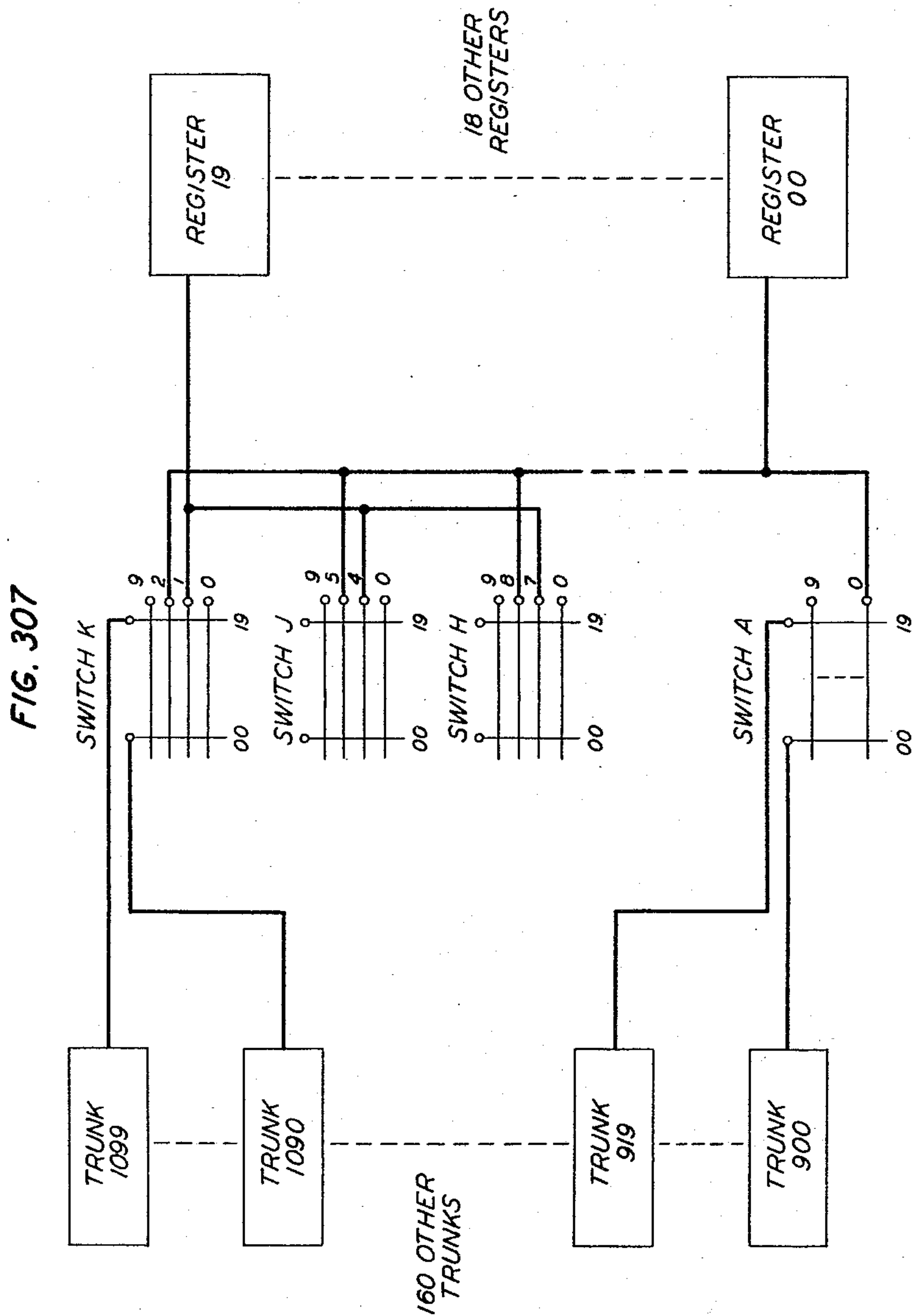
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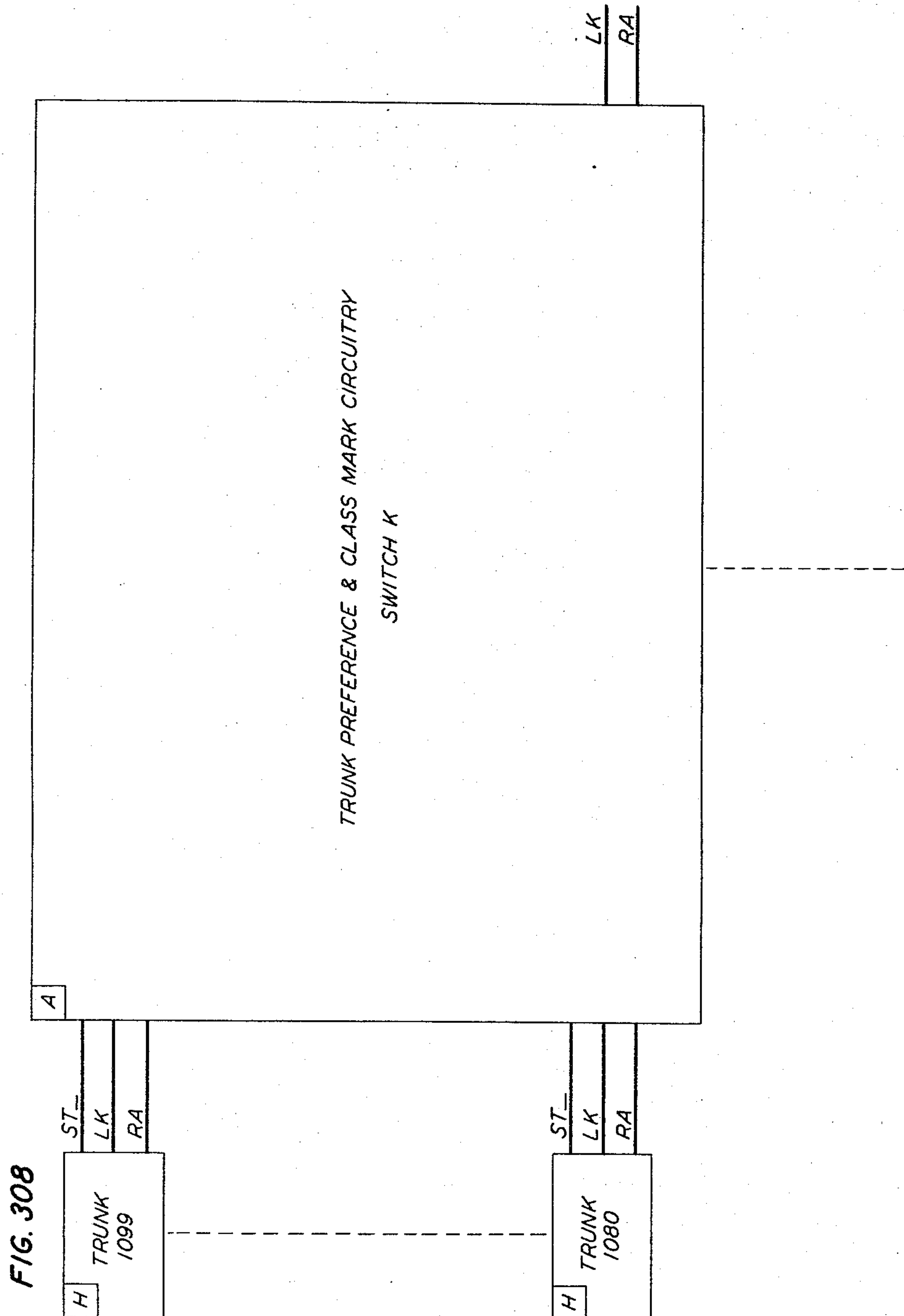
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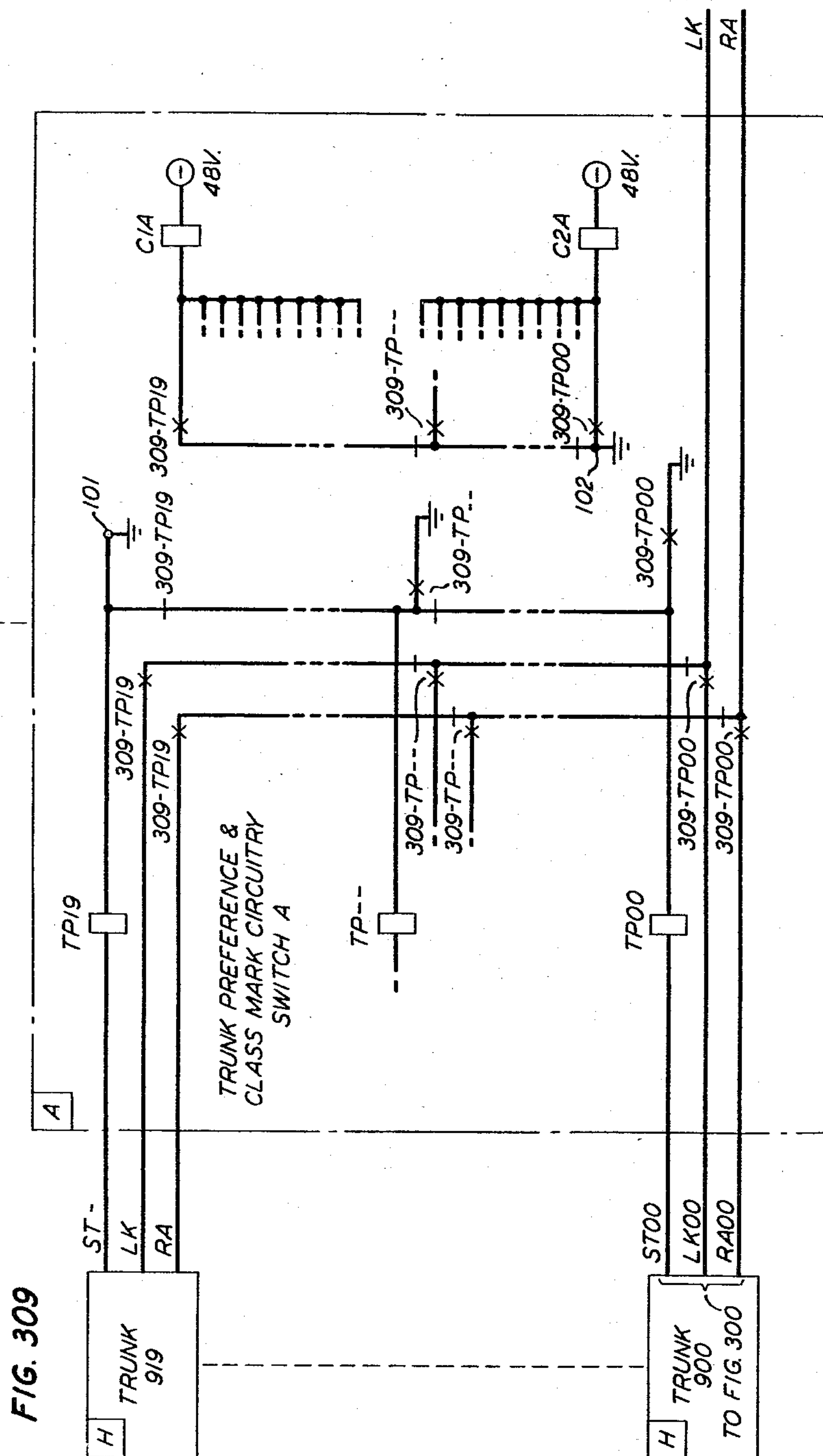
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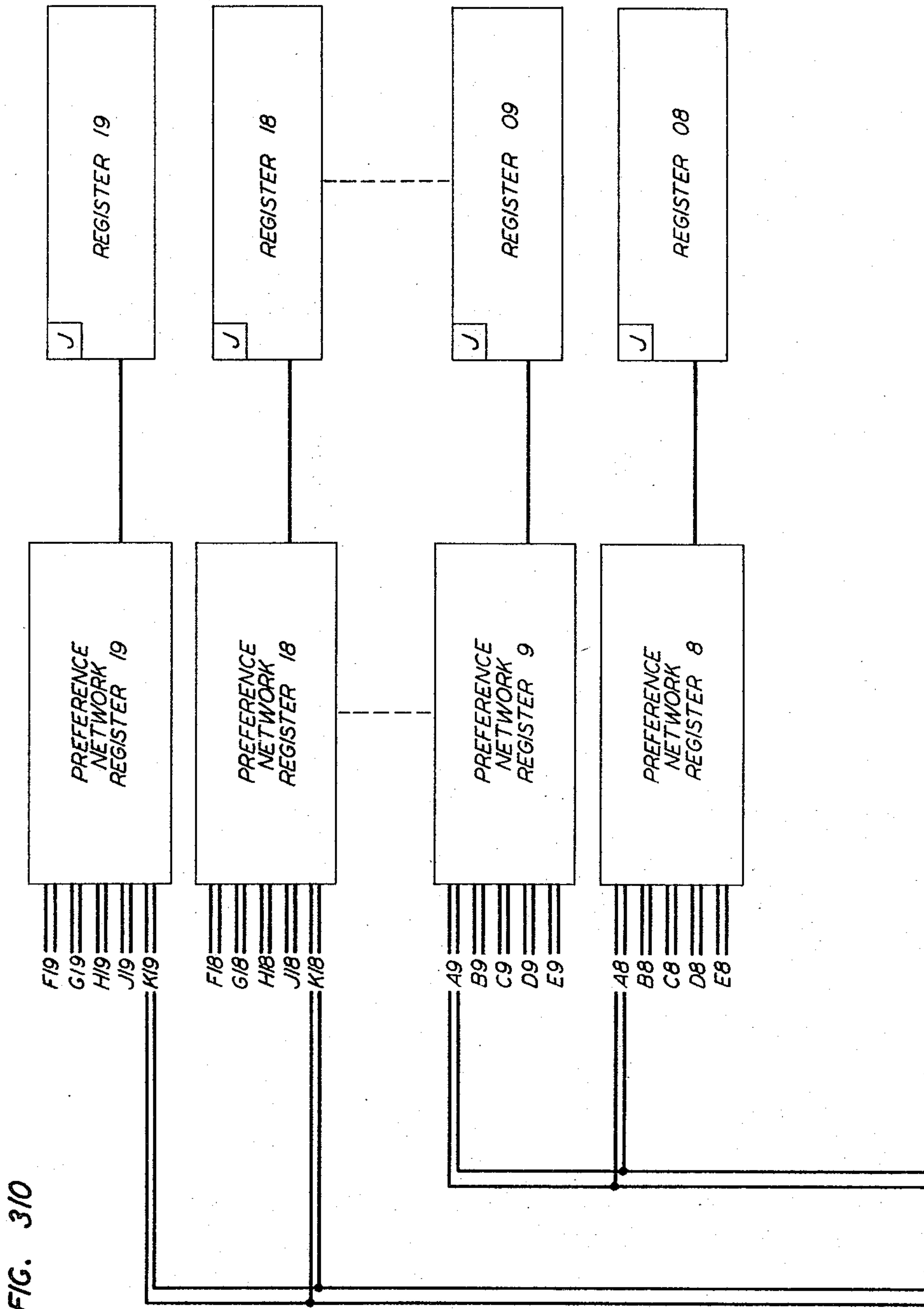
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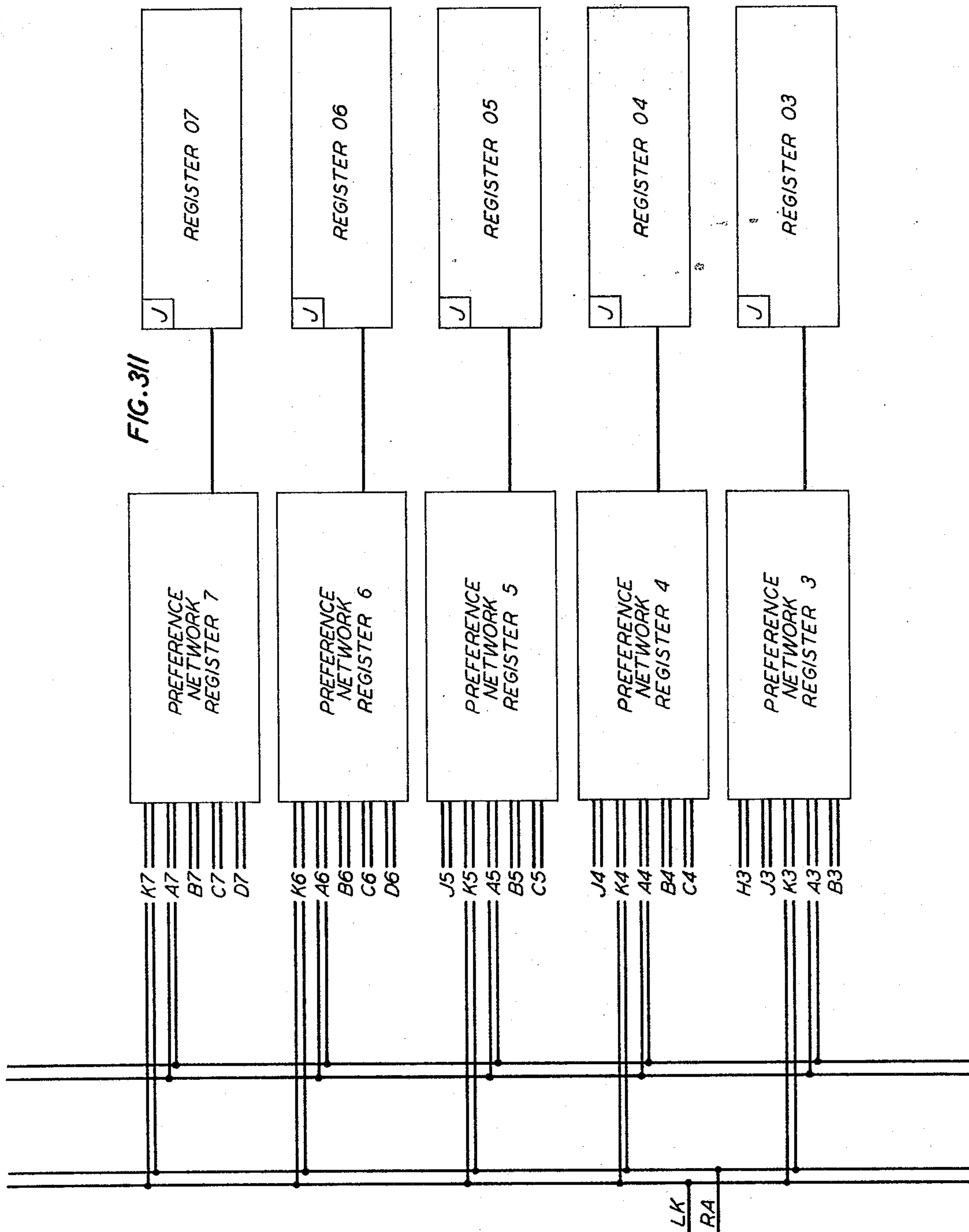
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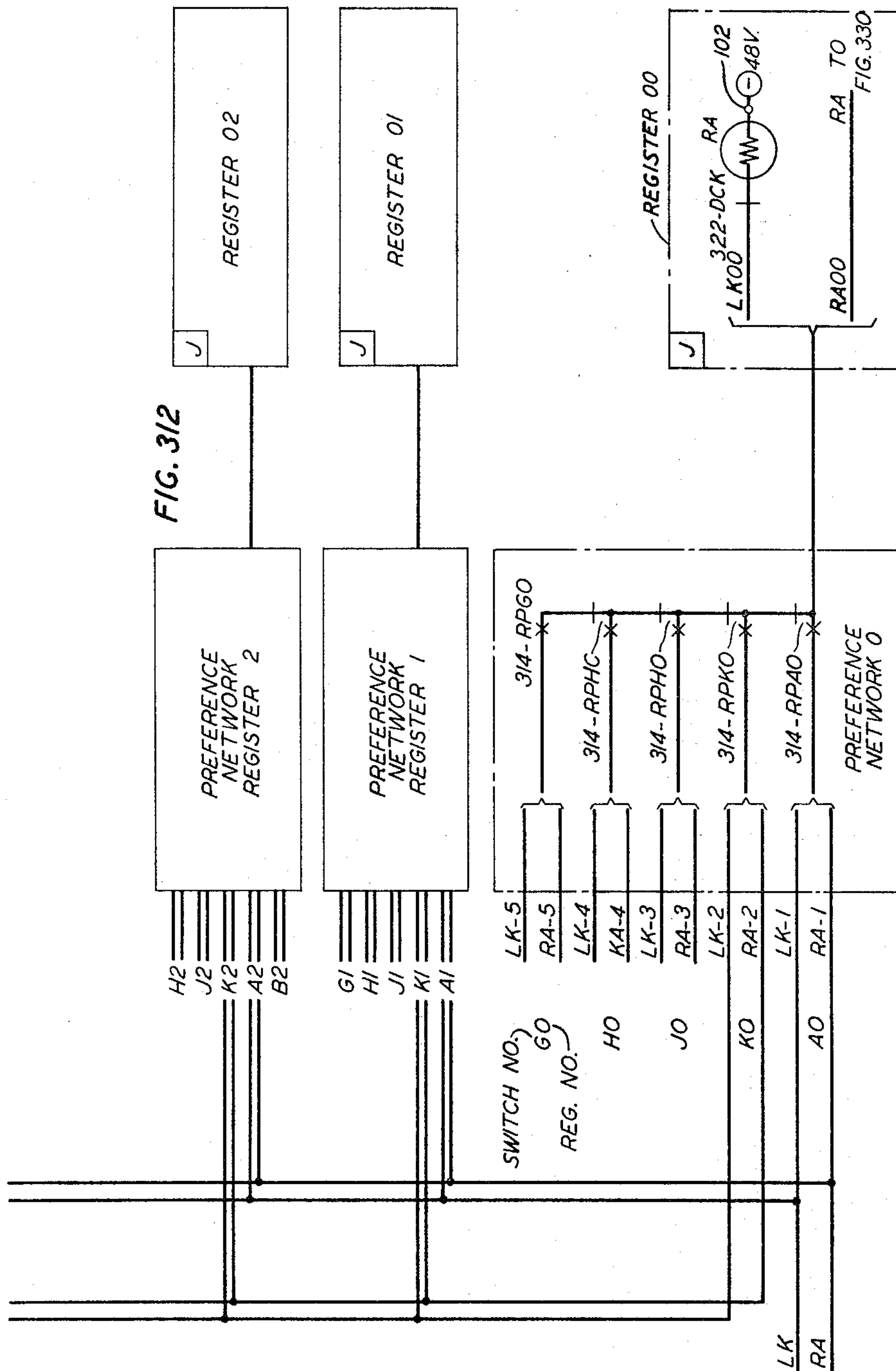
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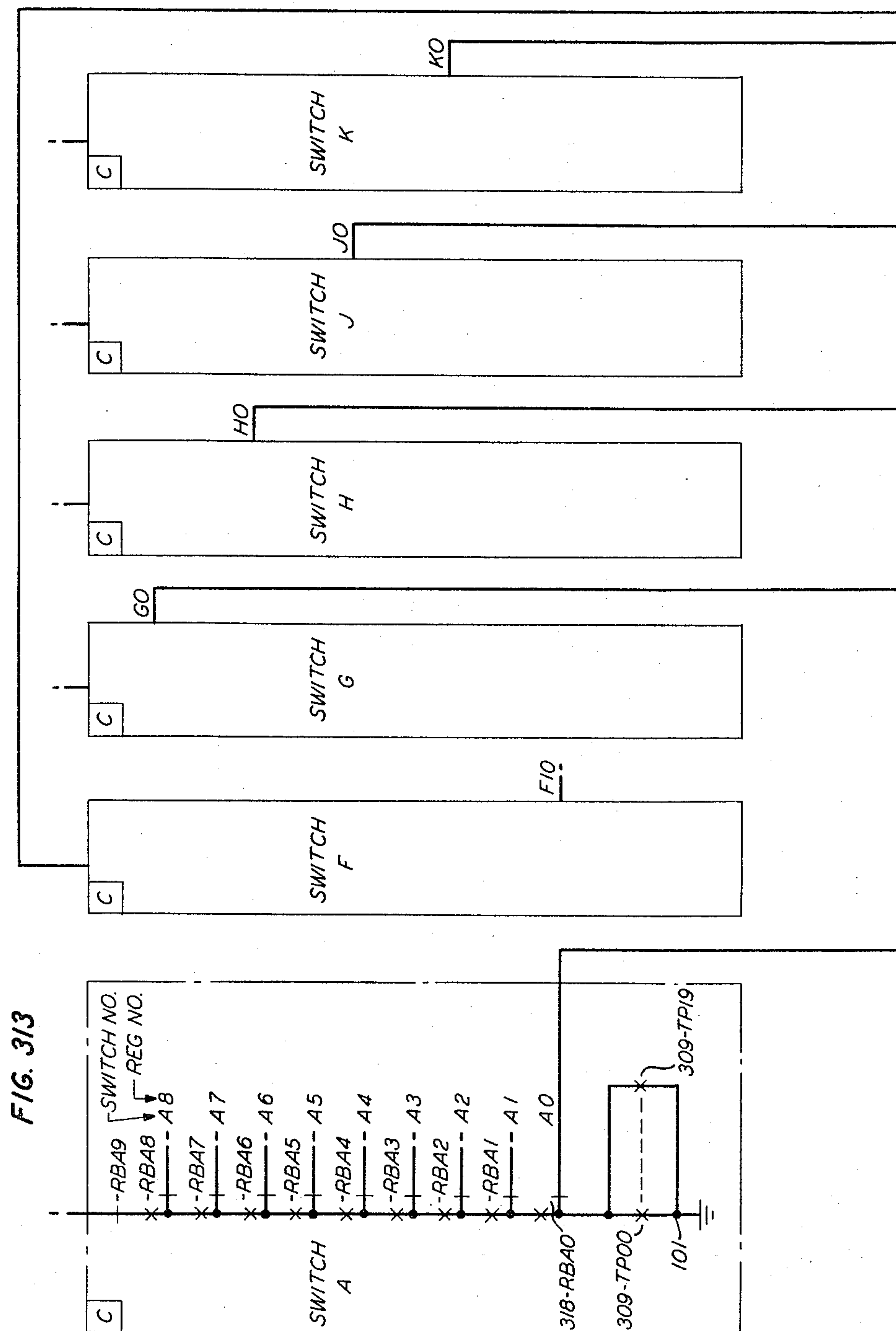
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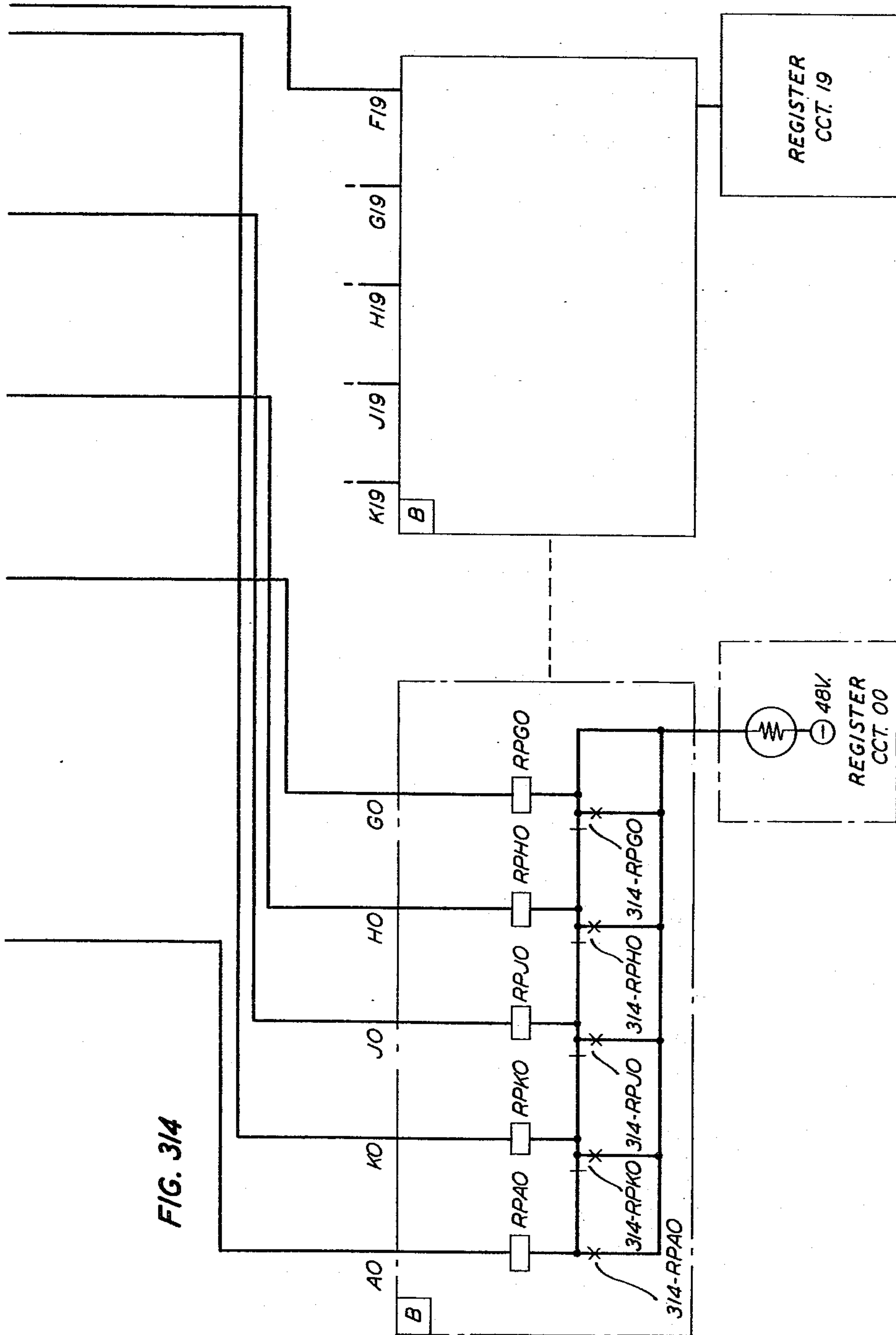
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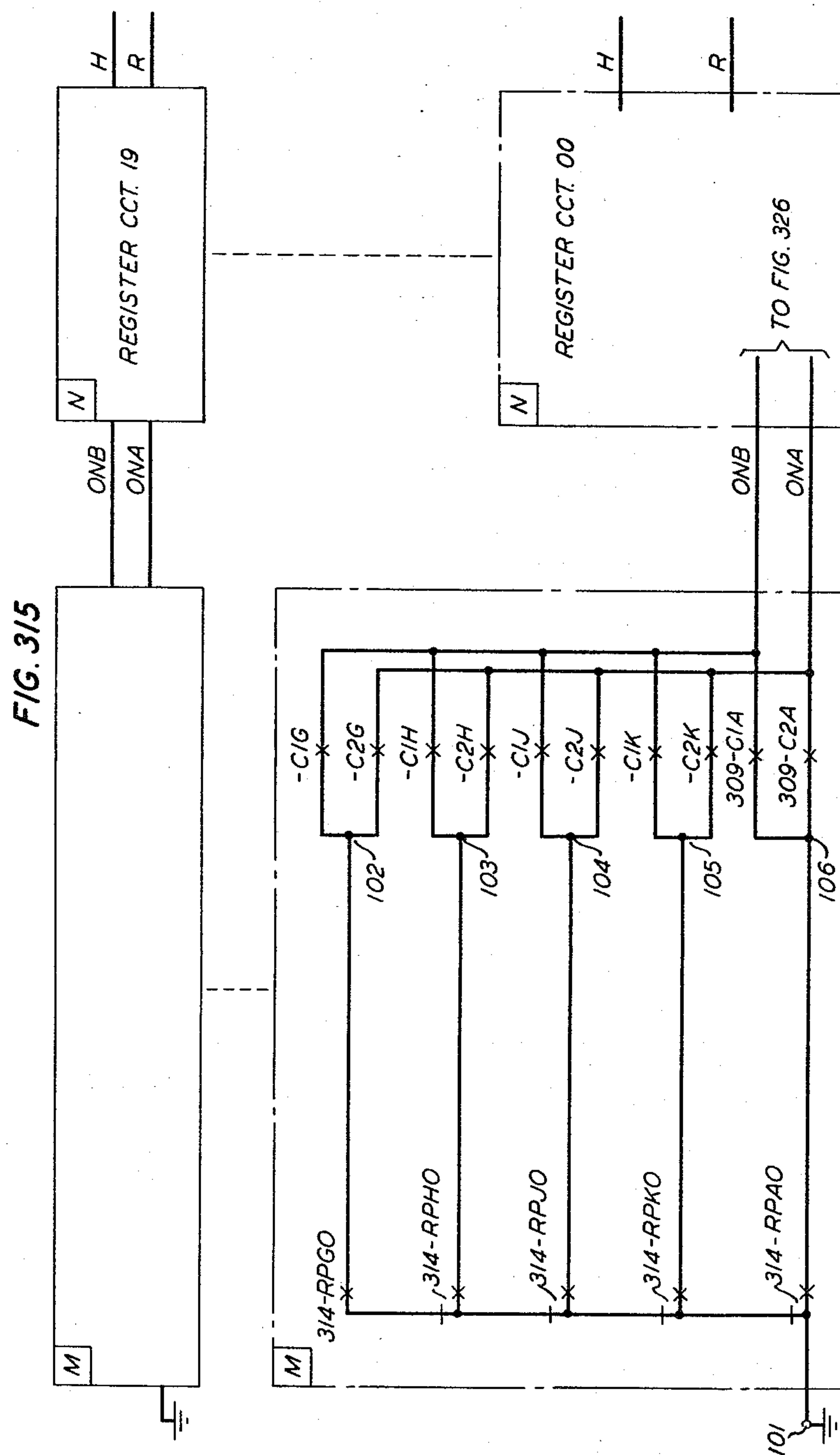
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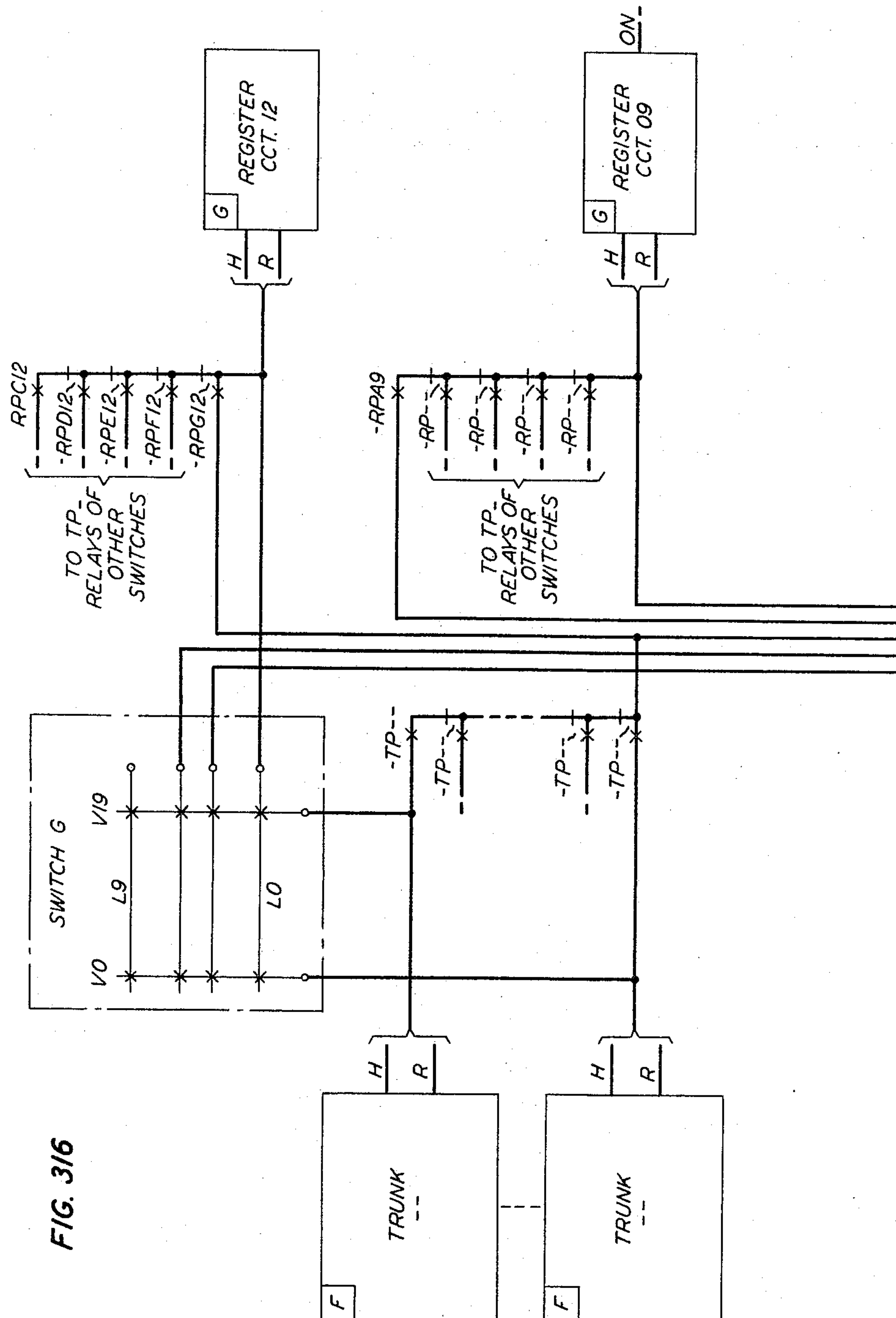


FIG. 316



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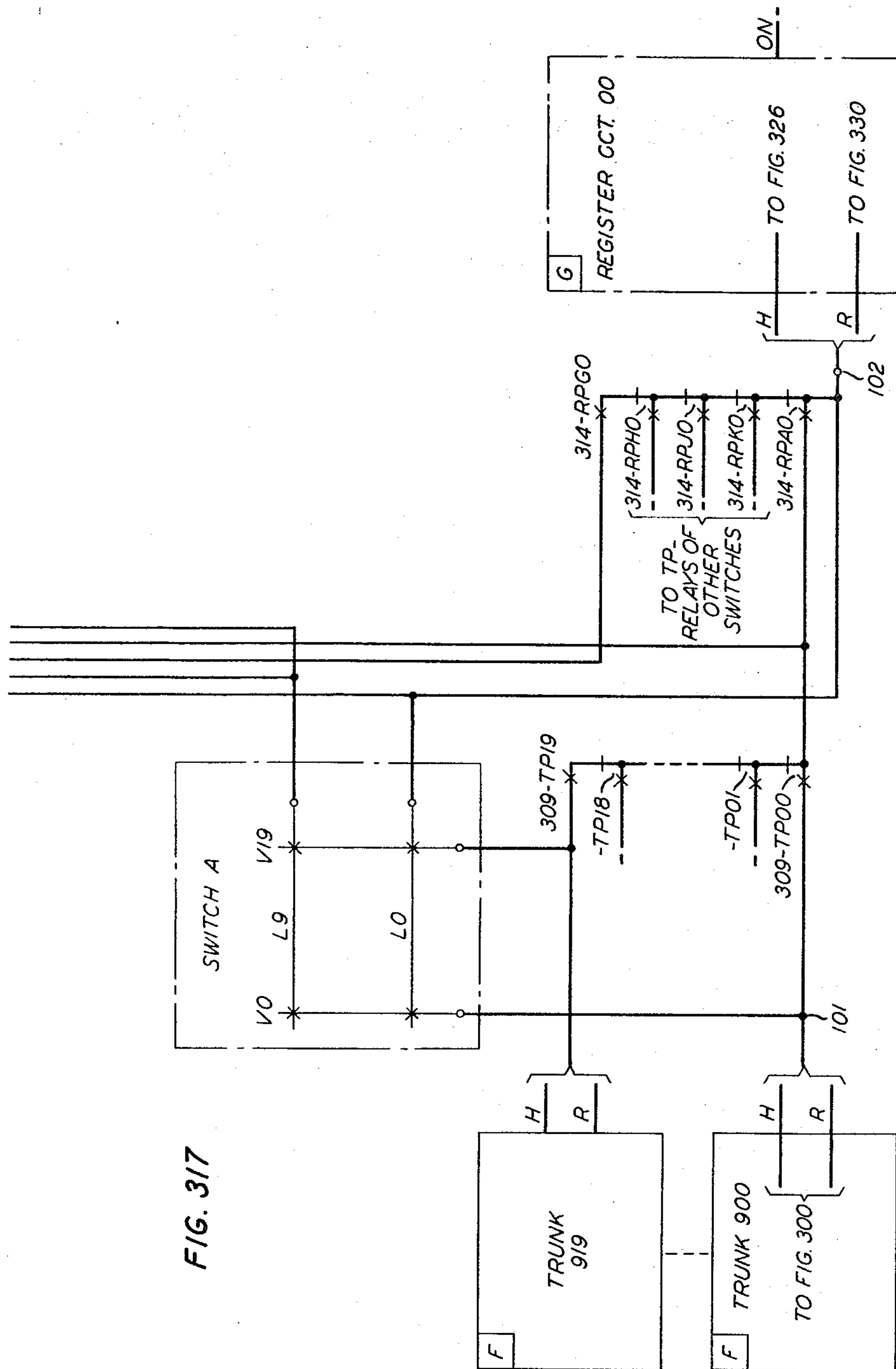
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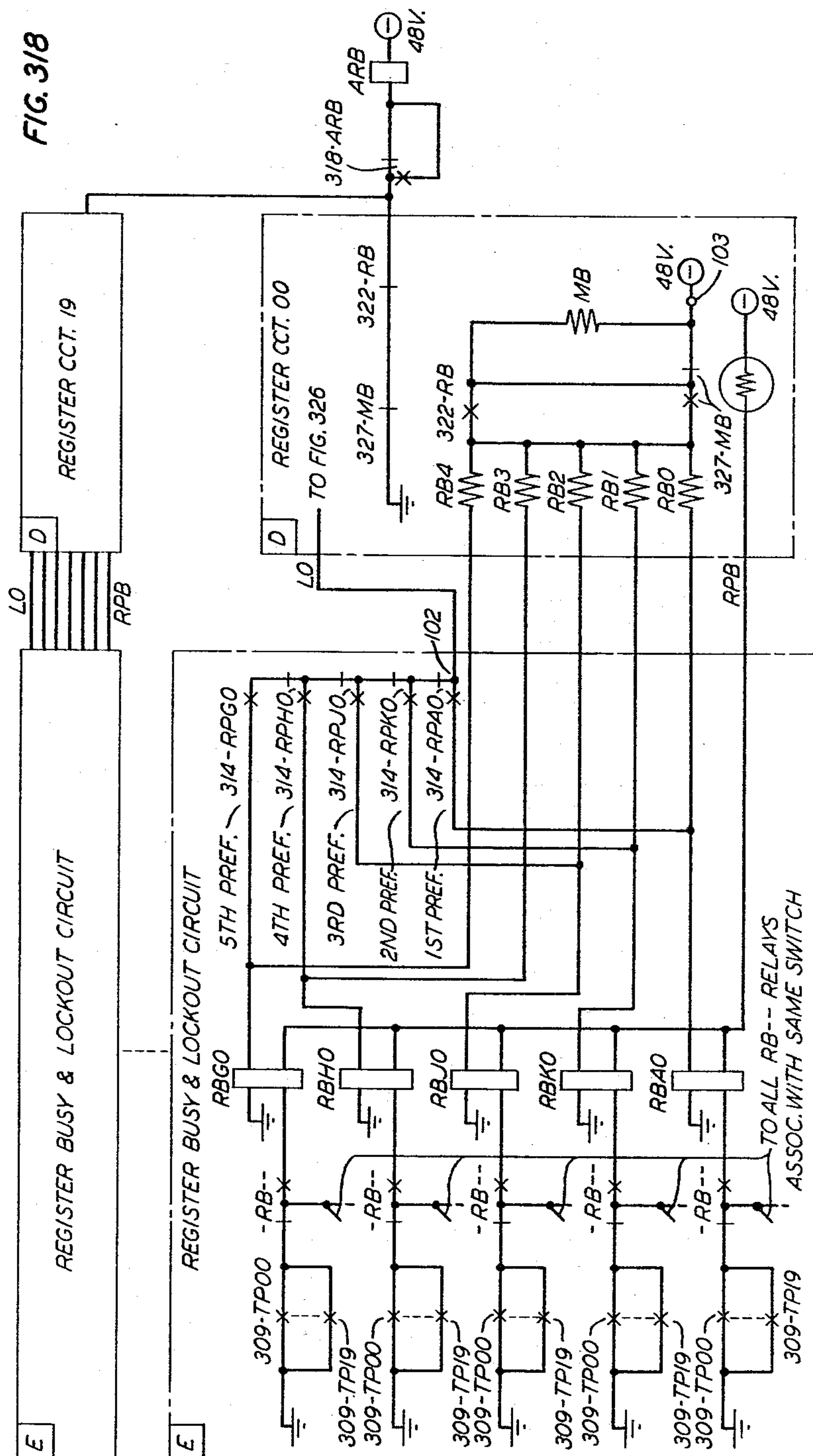
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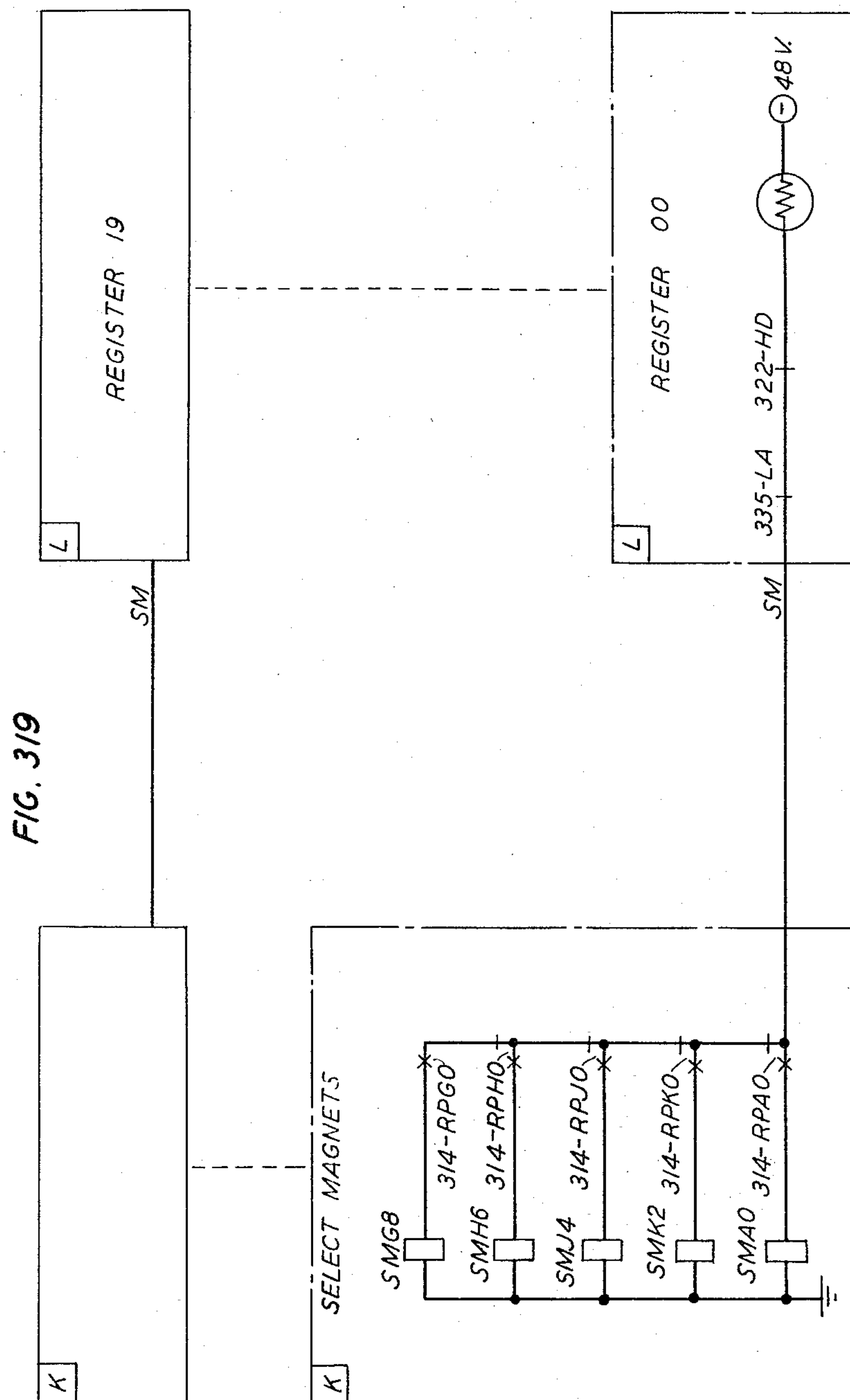
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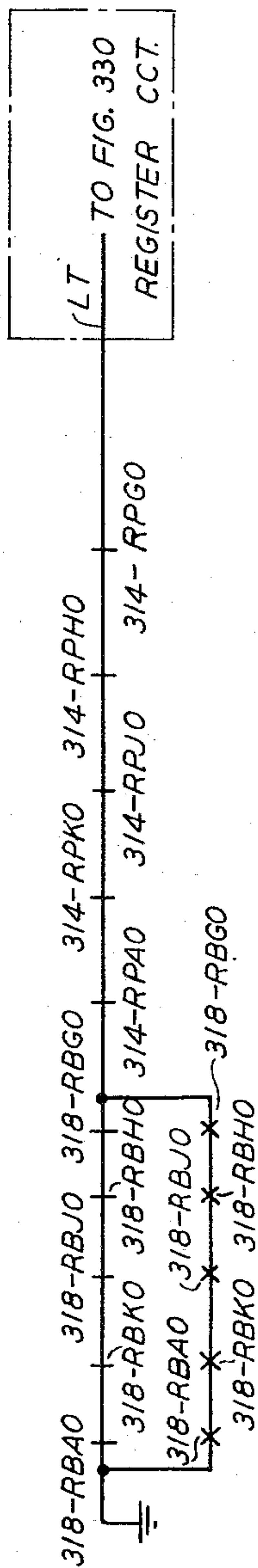
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**FIG. 319A**

REGISTER 19

REGISTER 00





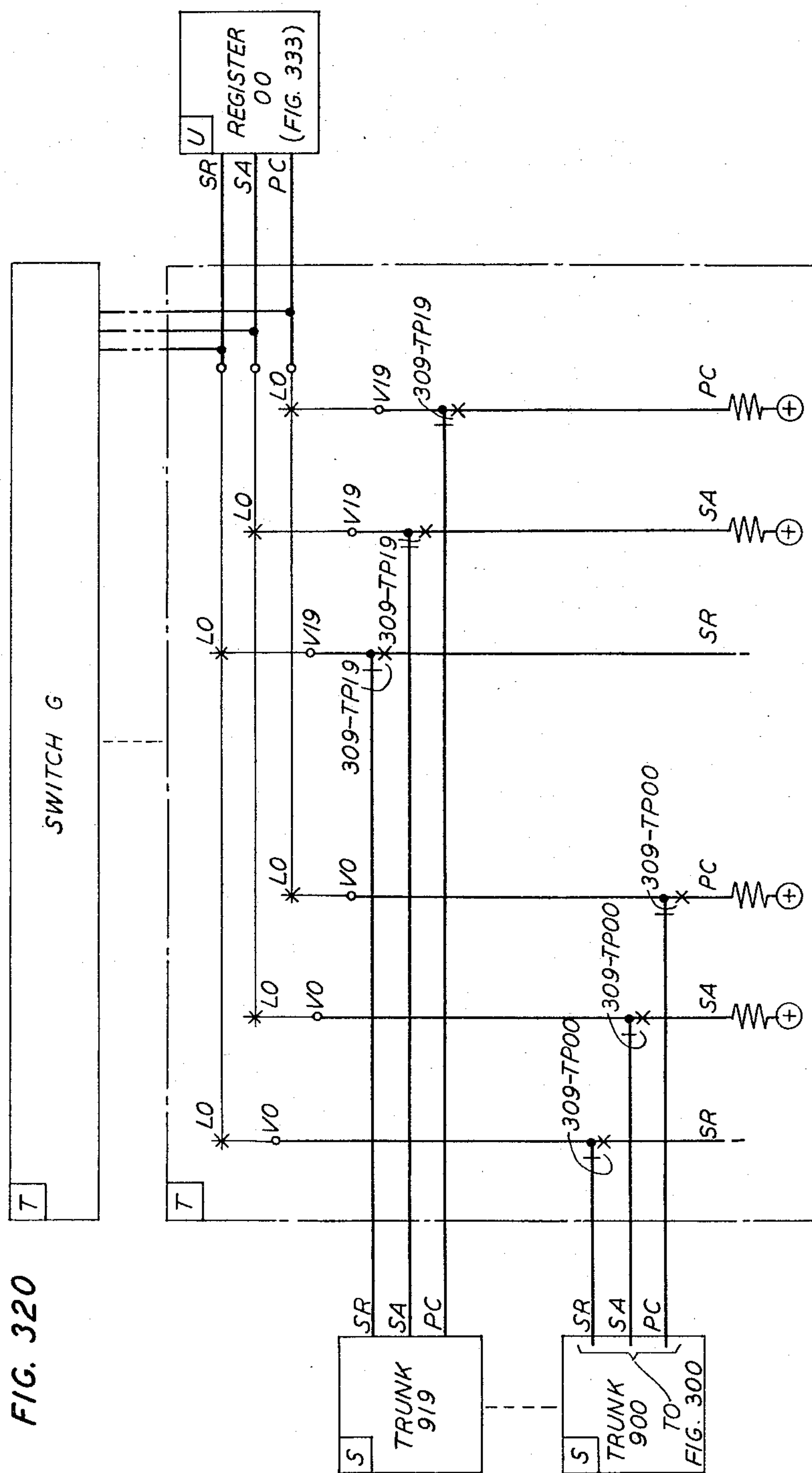
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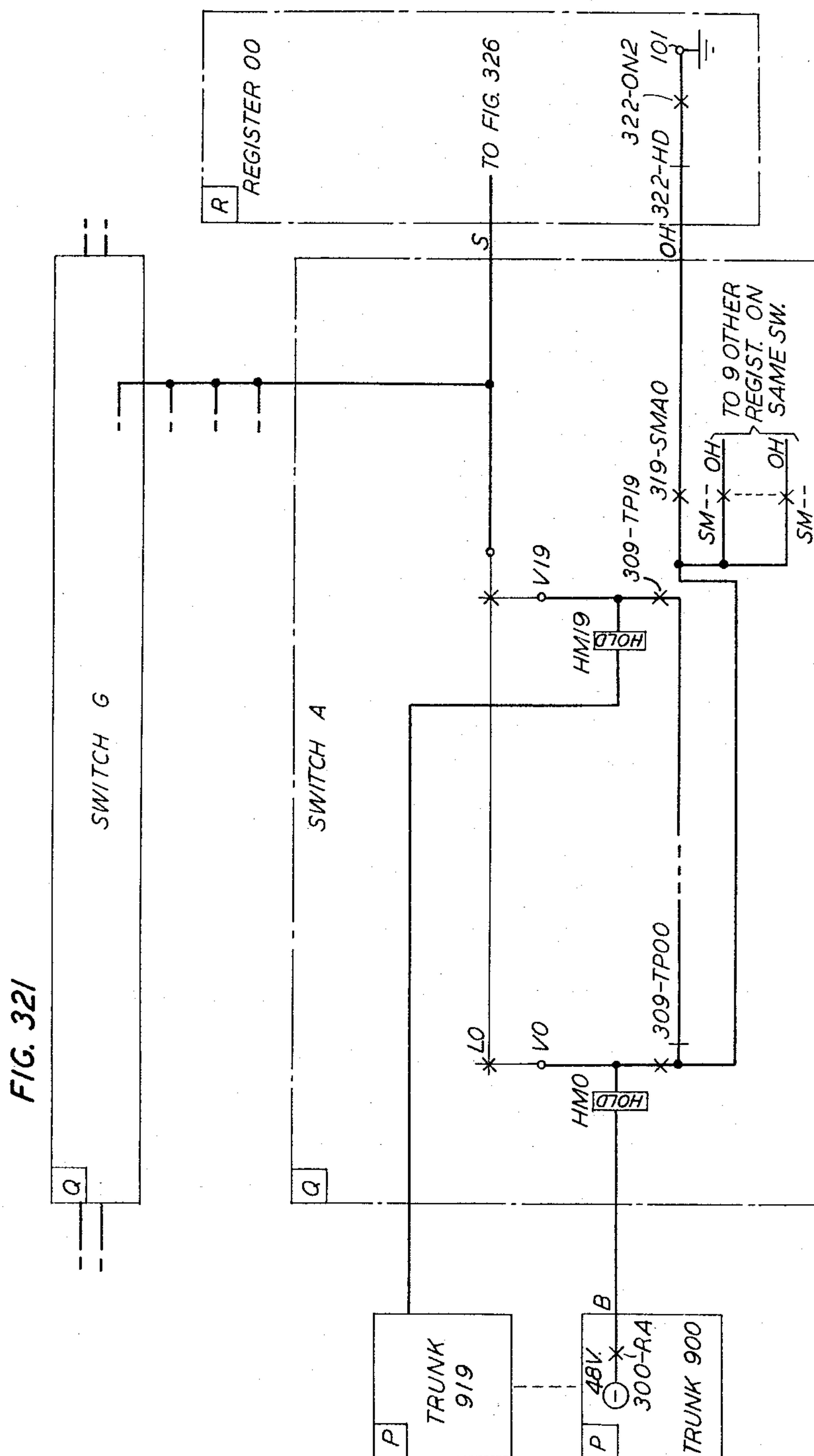
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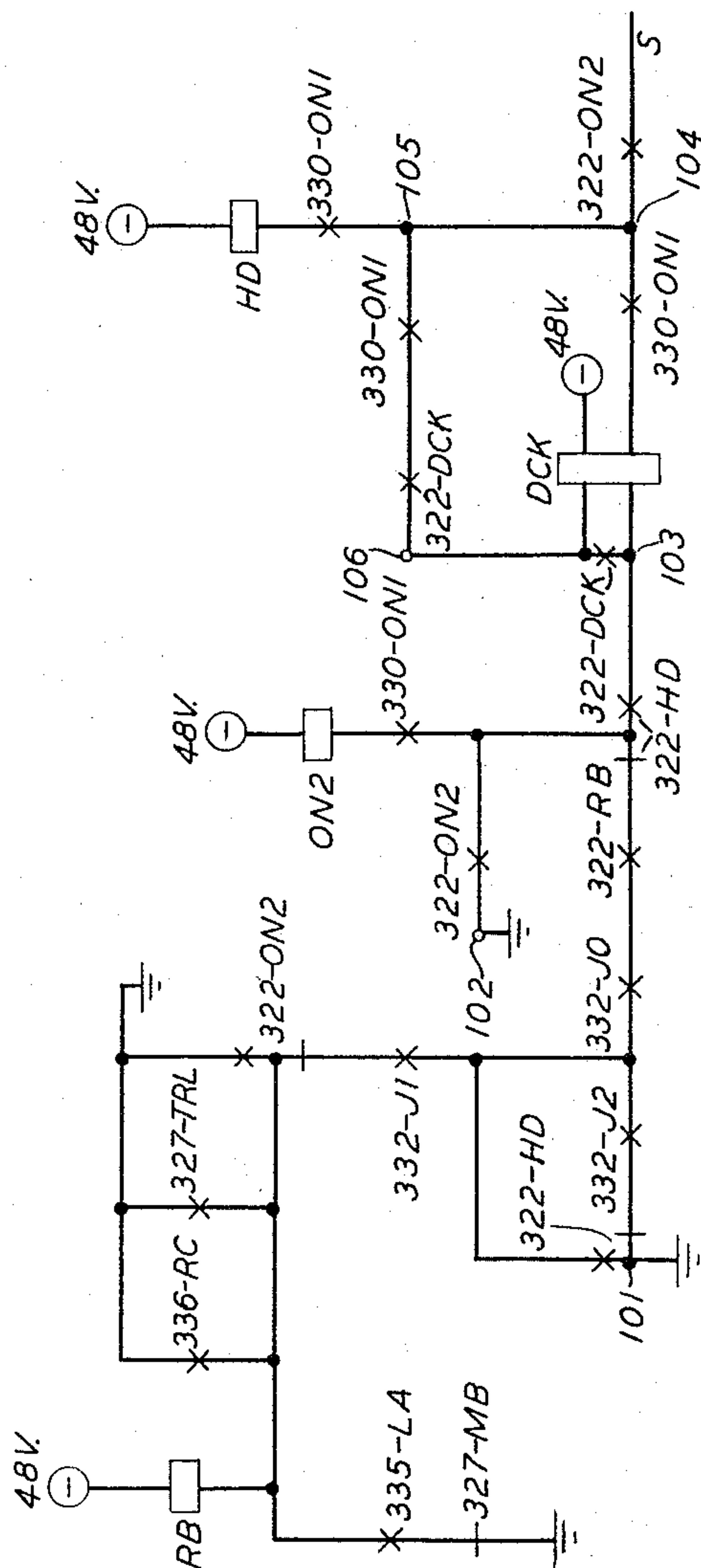
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**FIG. 322**



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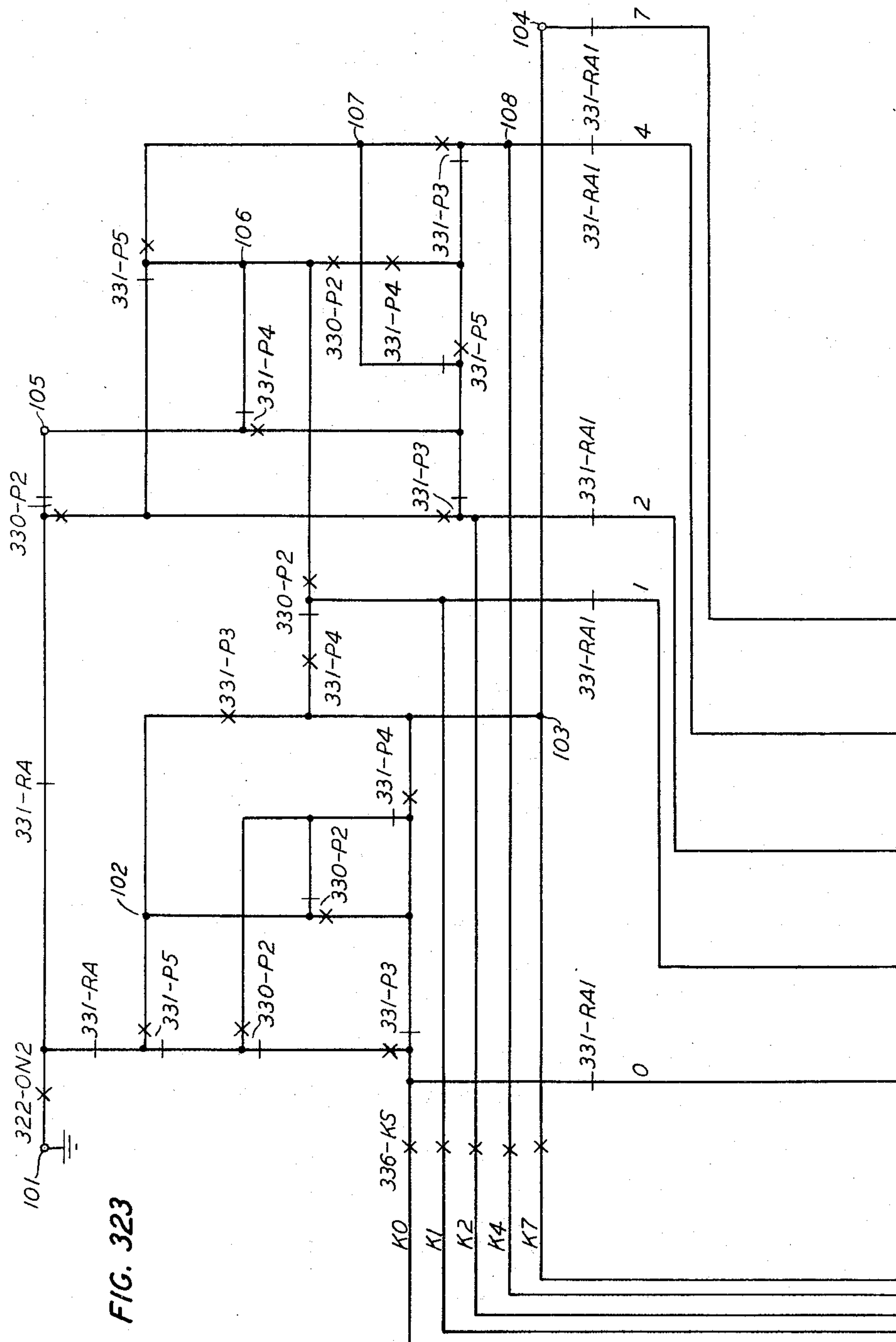


FIG. 323



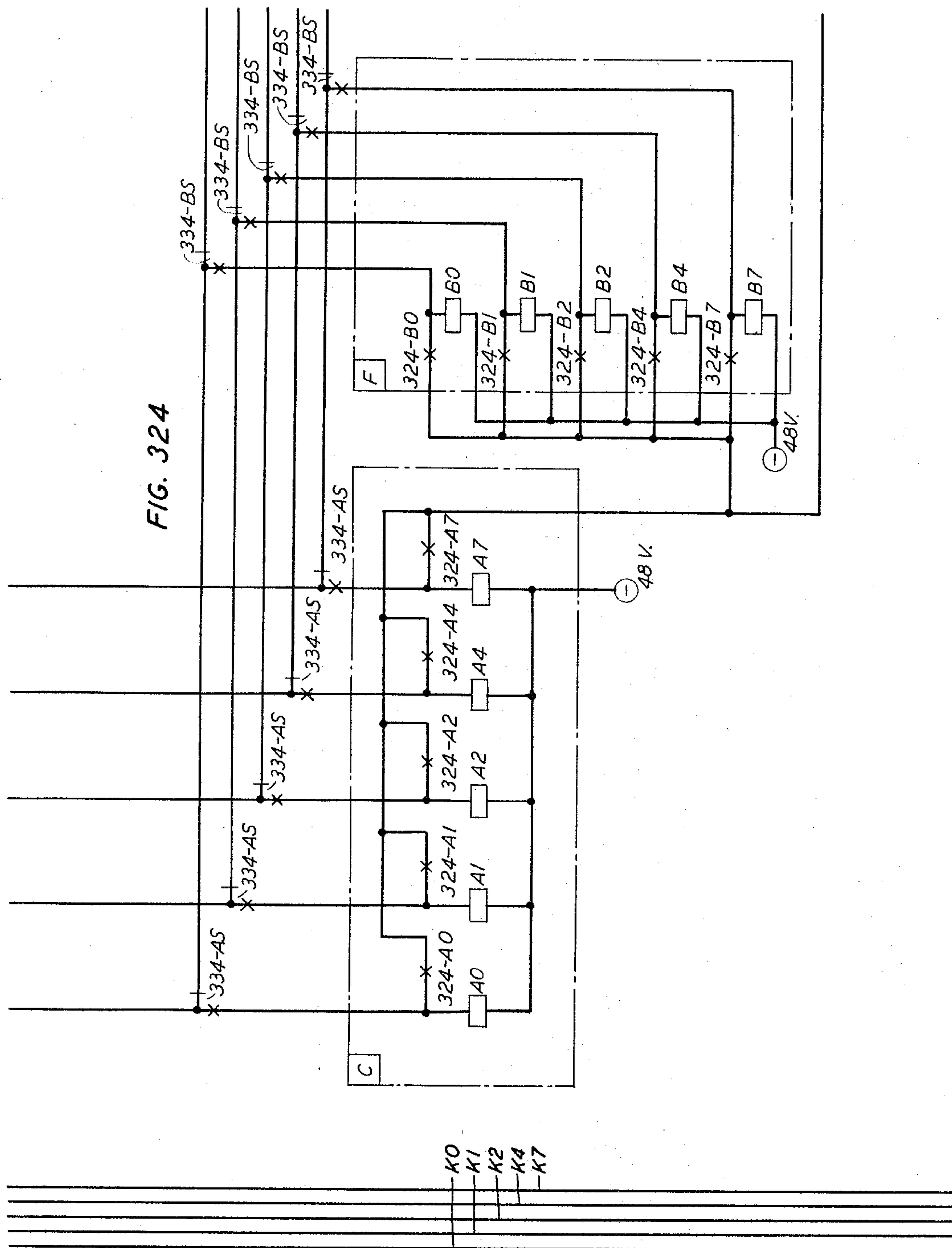
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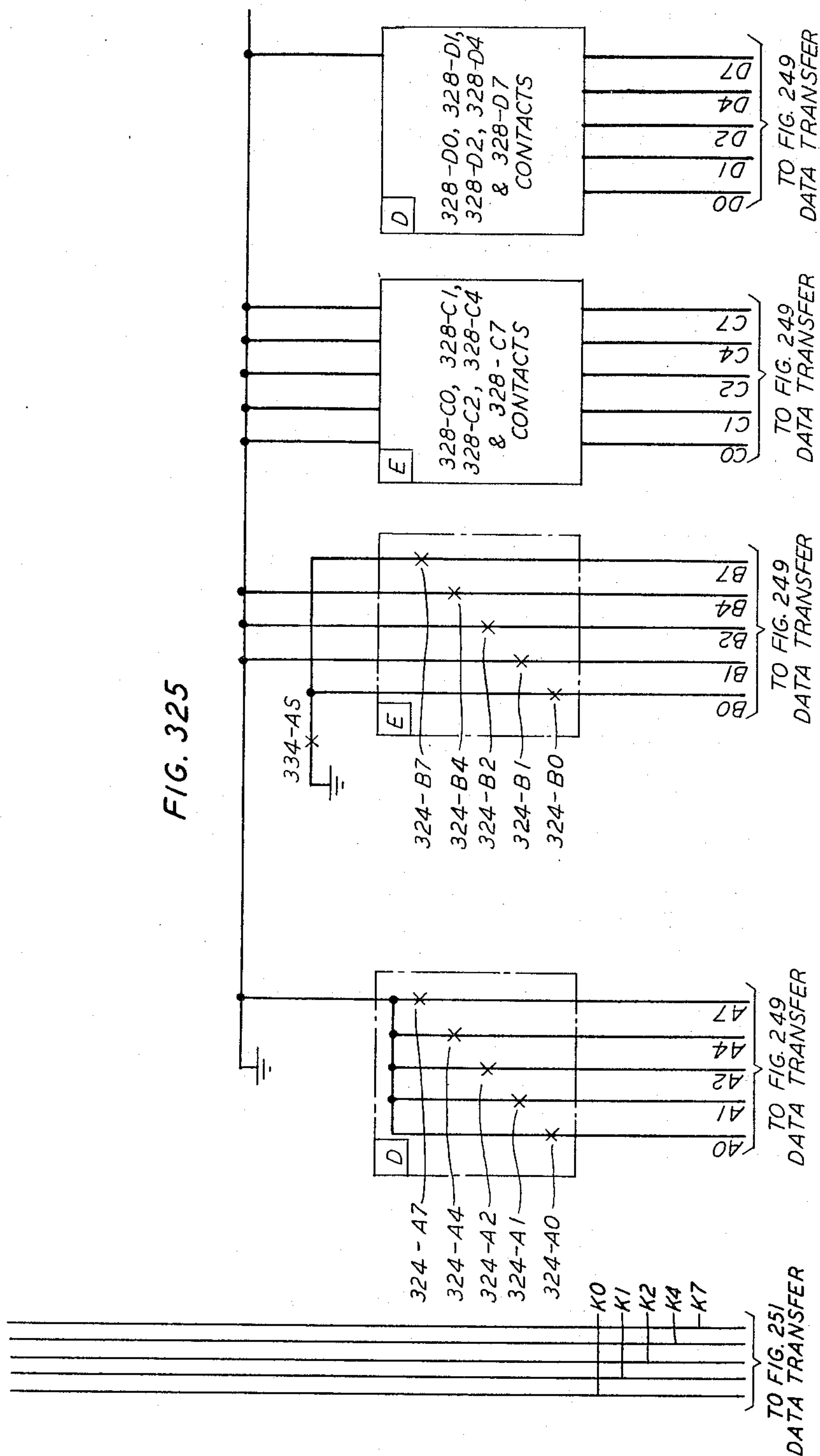
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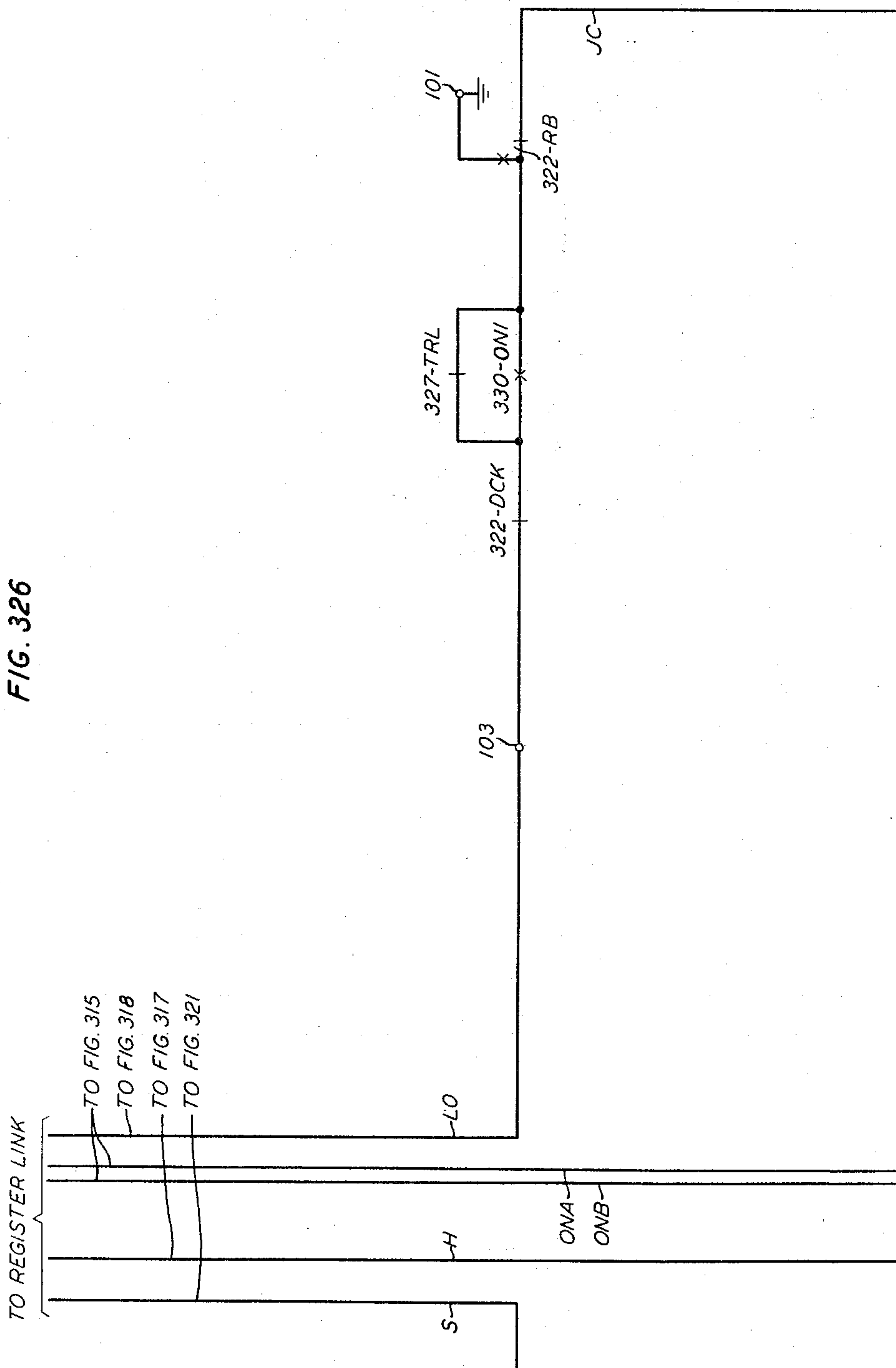
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FIG. 326

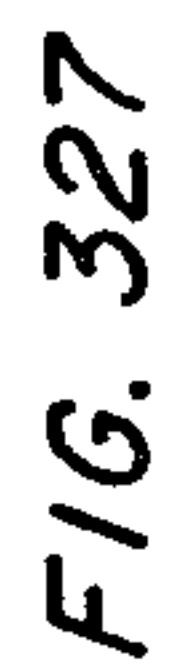




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**FIG. 327**



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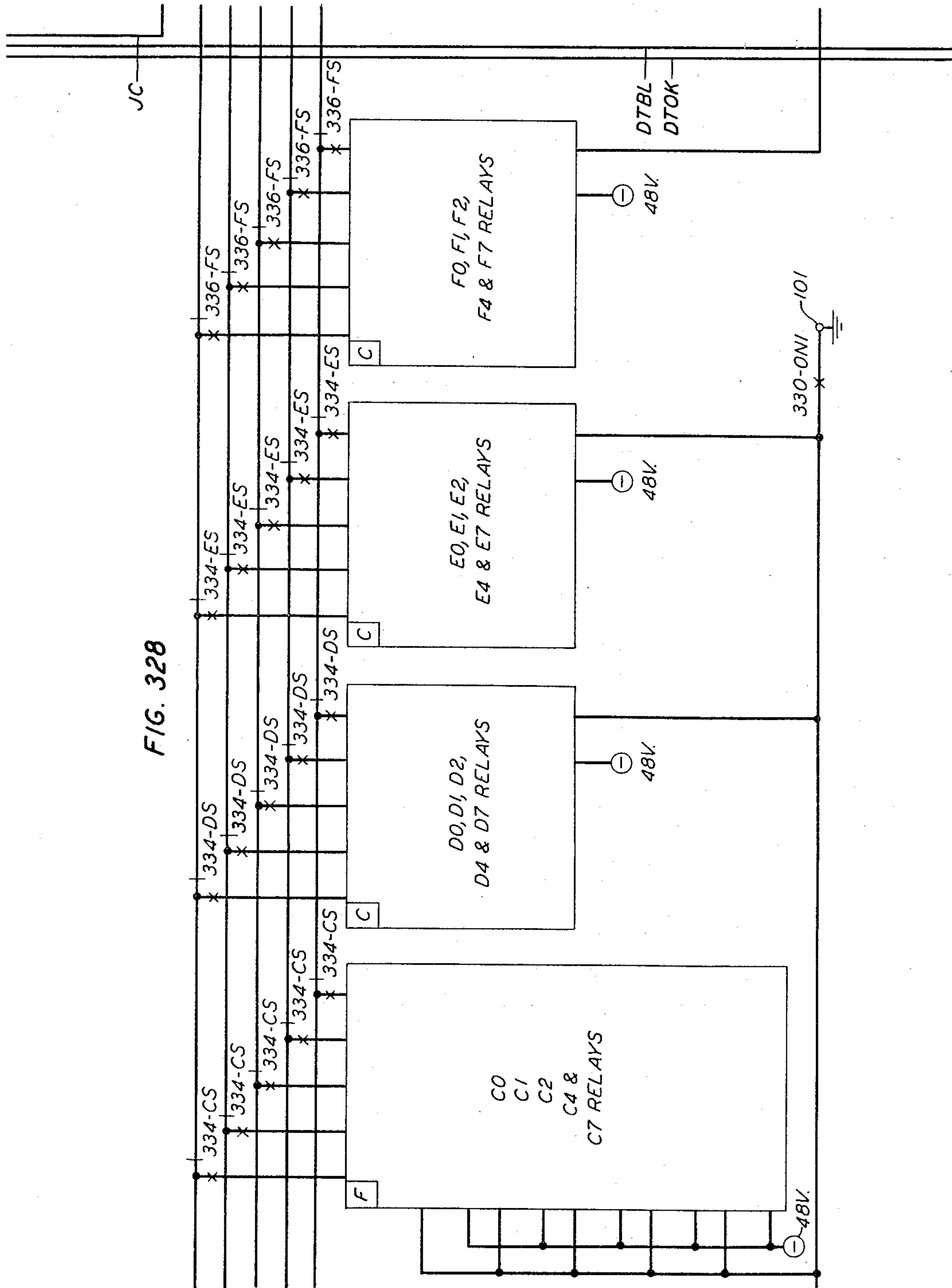
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FIG. 328





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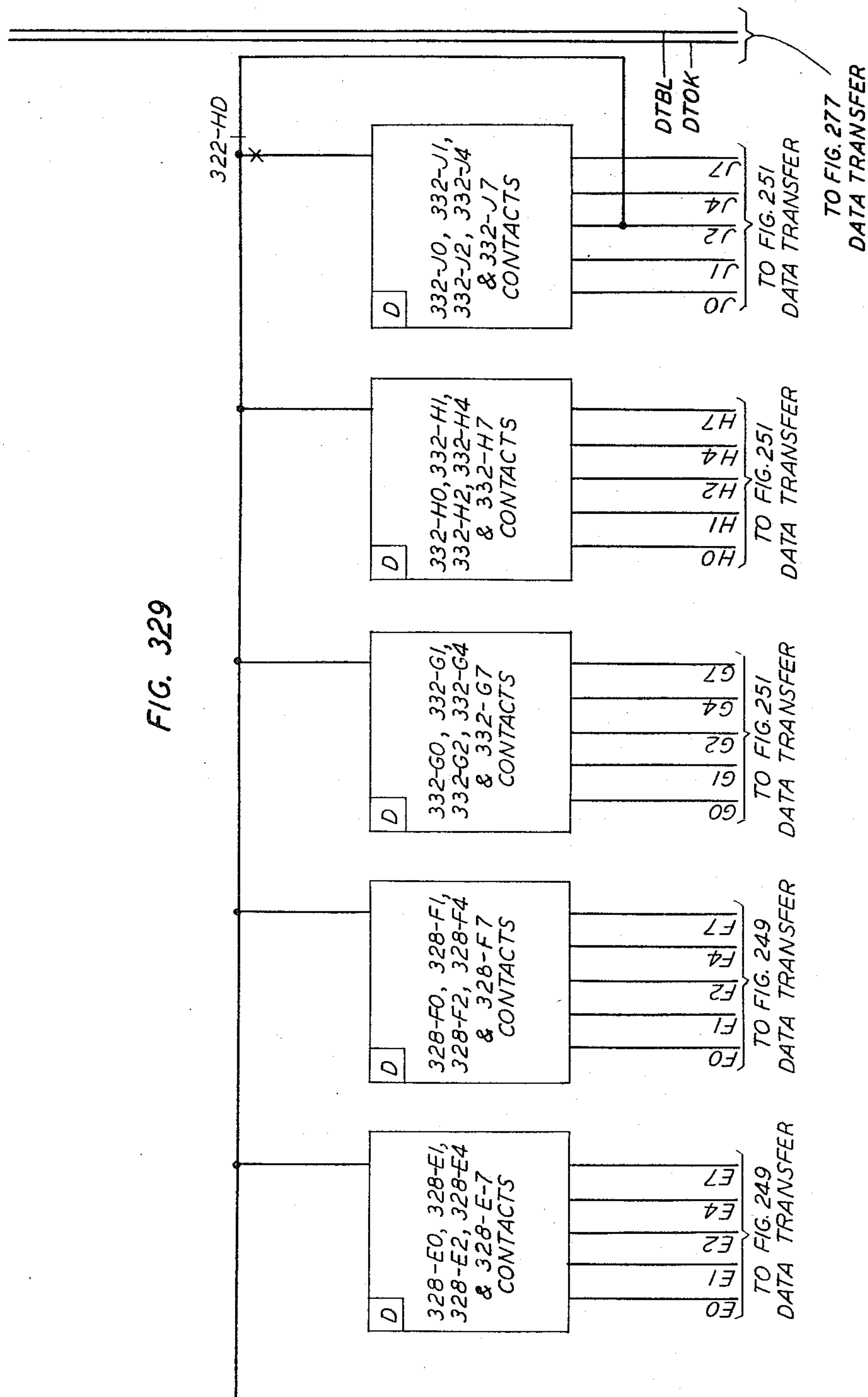
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FIG. 329





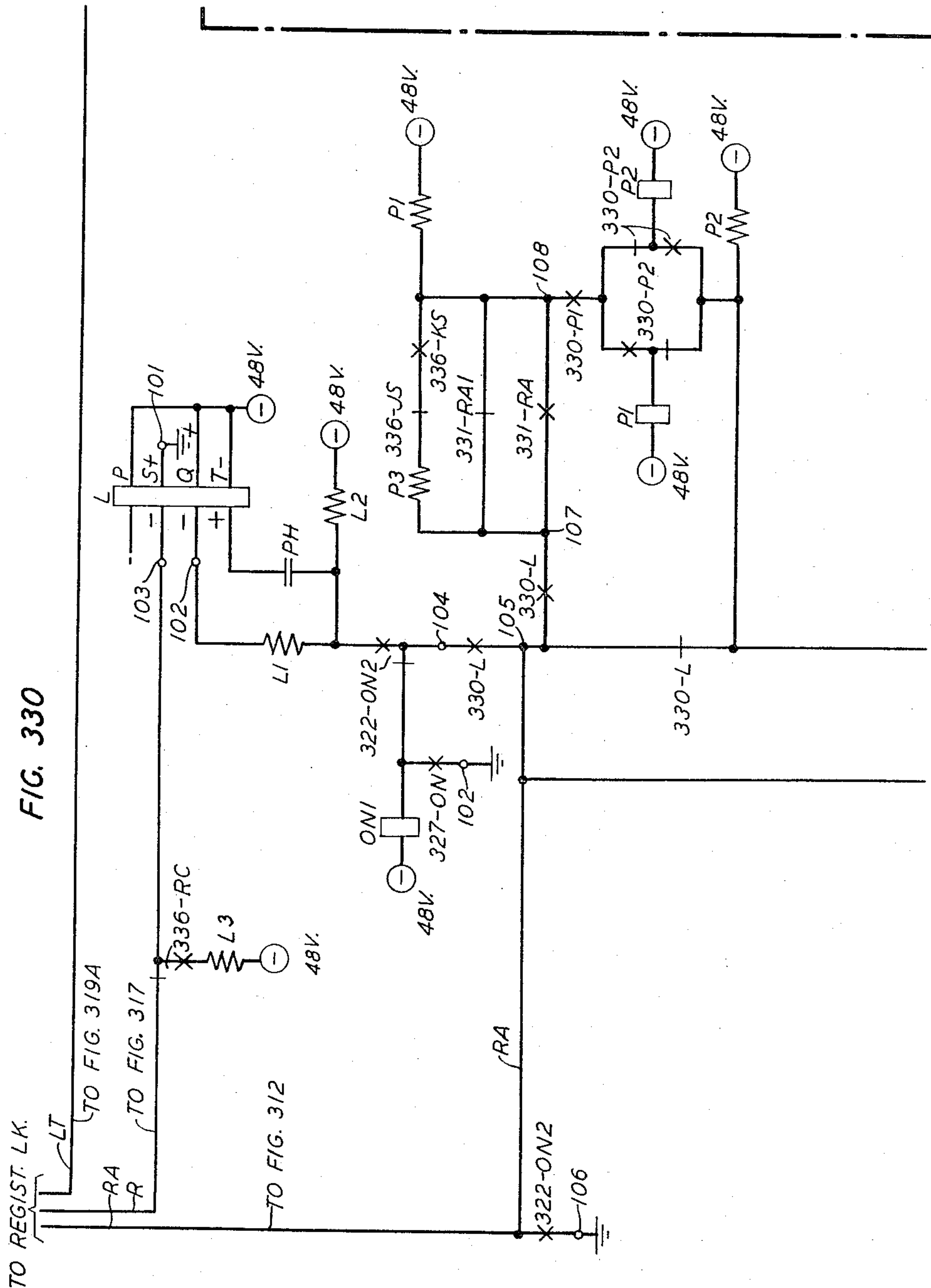
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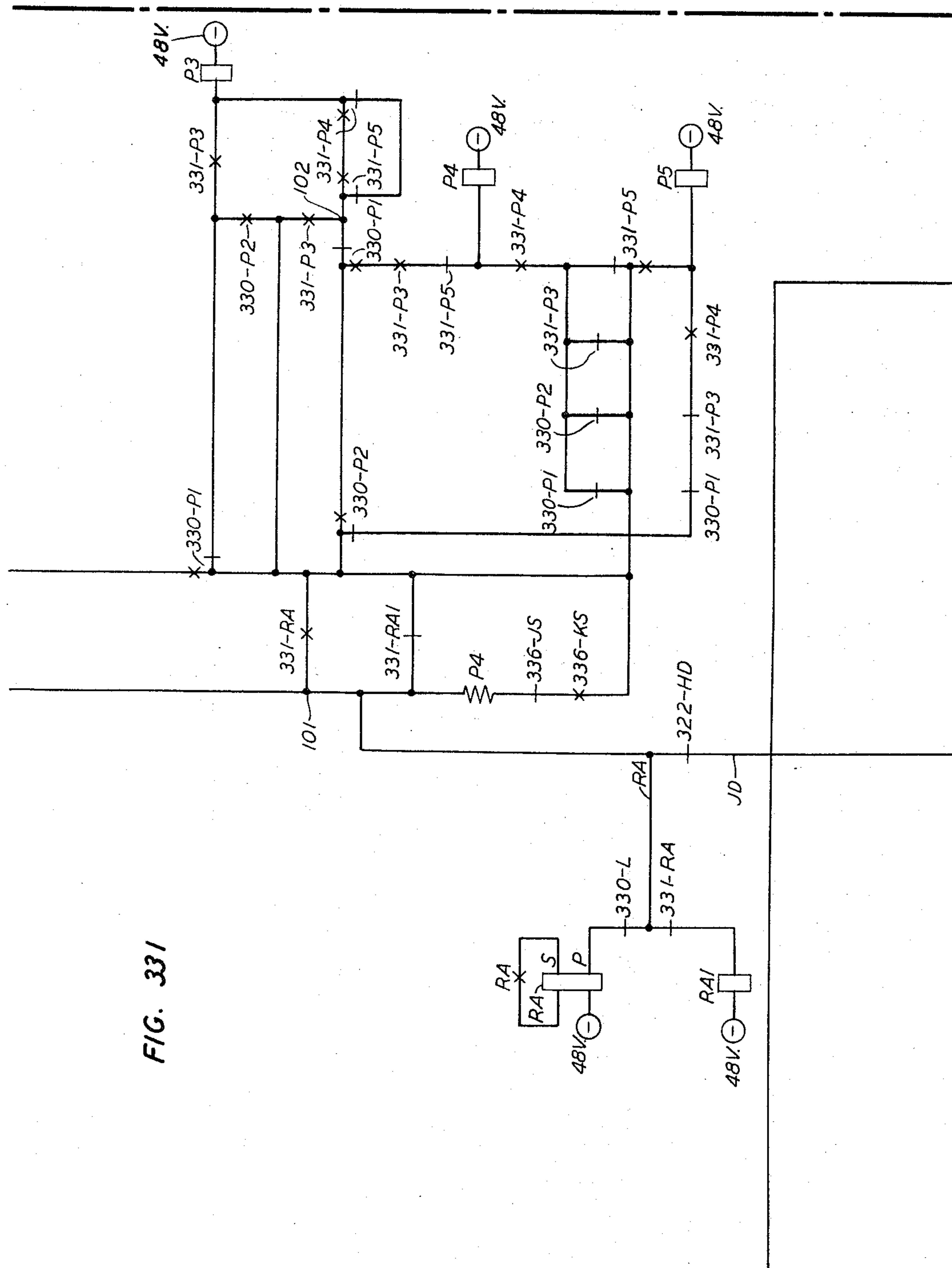


FIG. 331



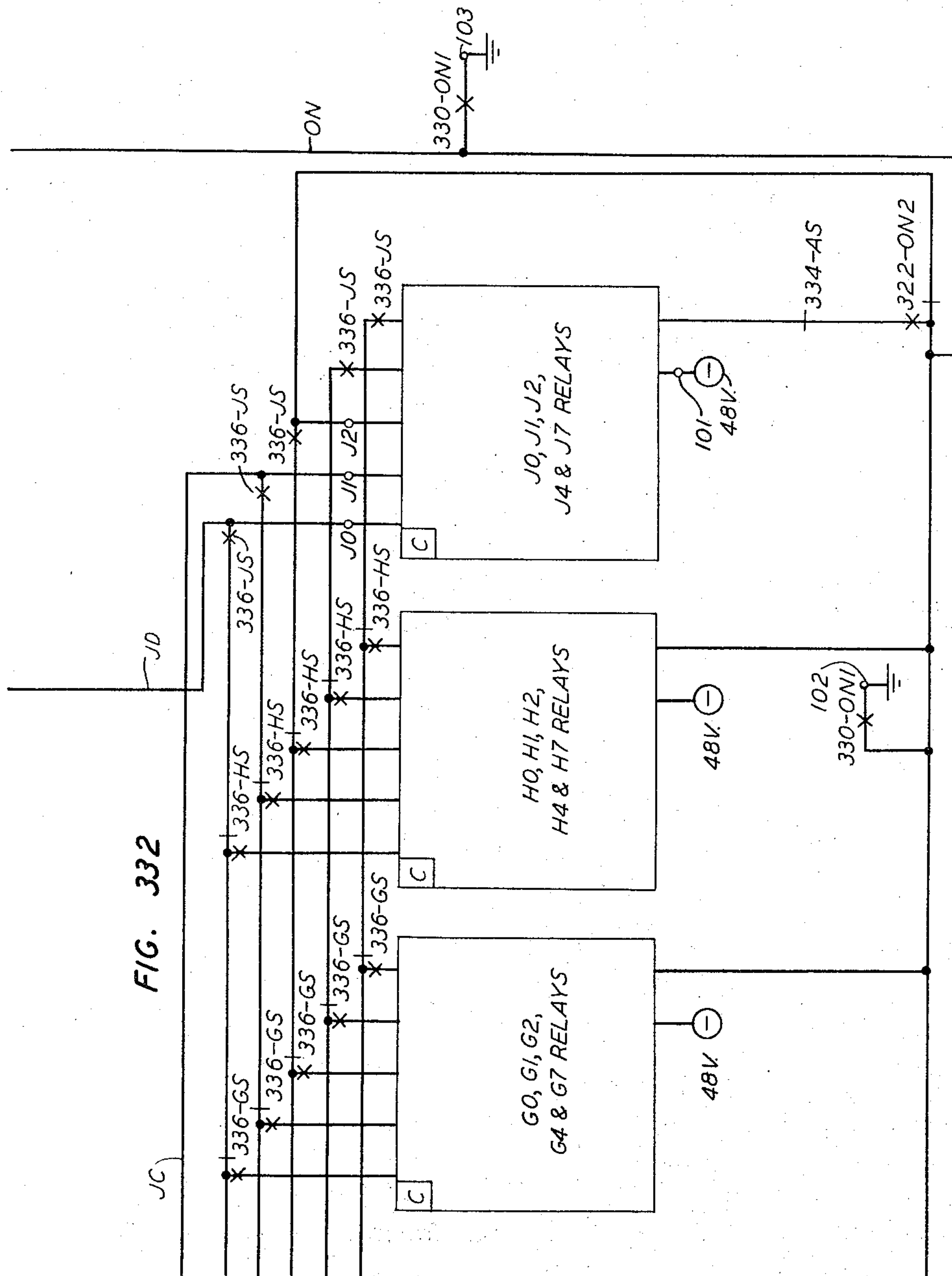
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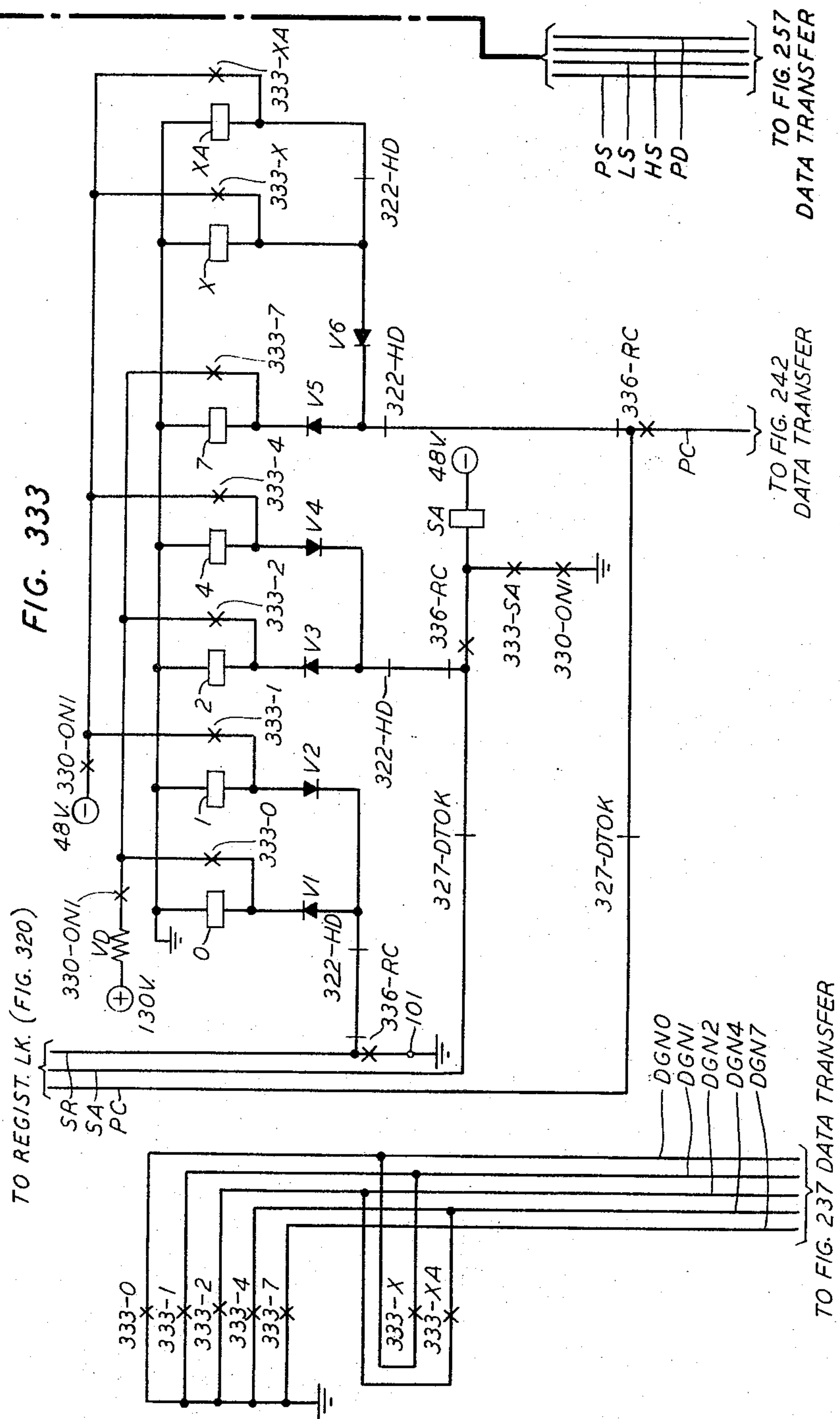
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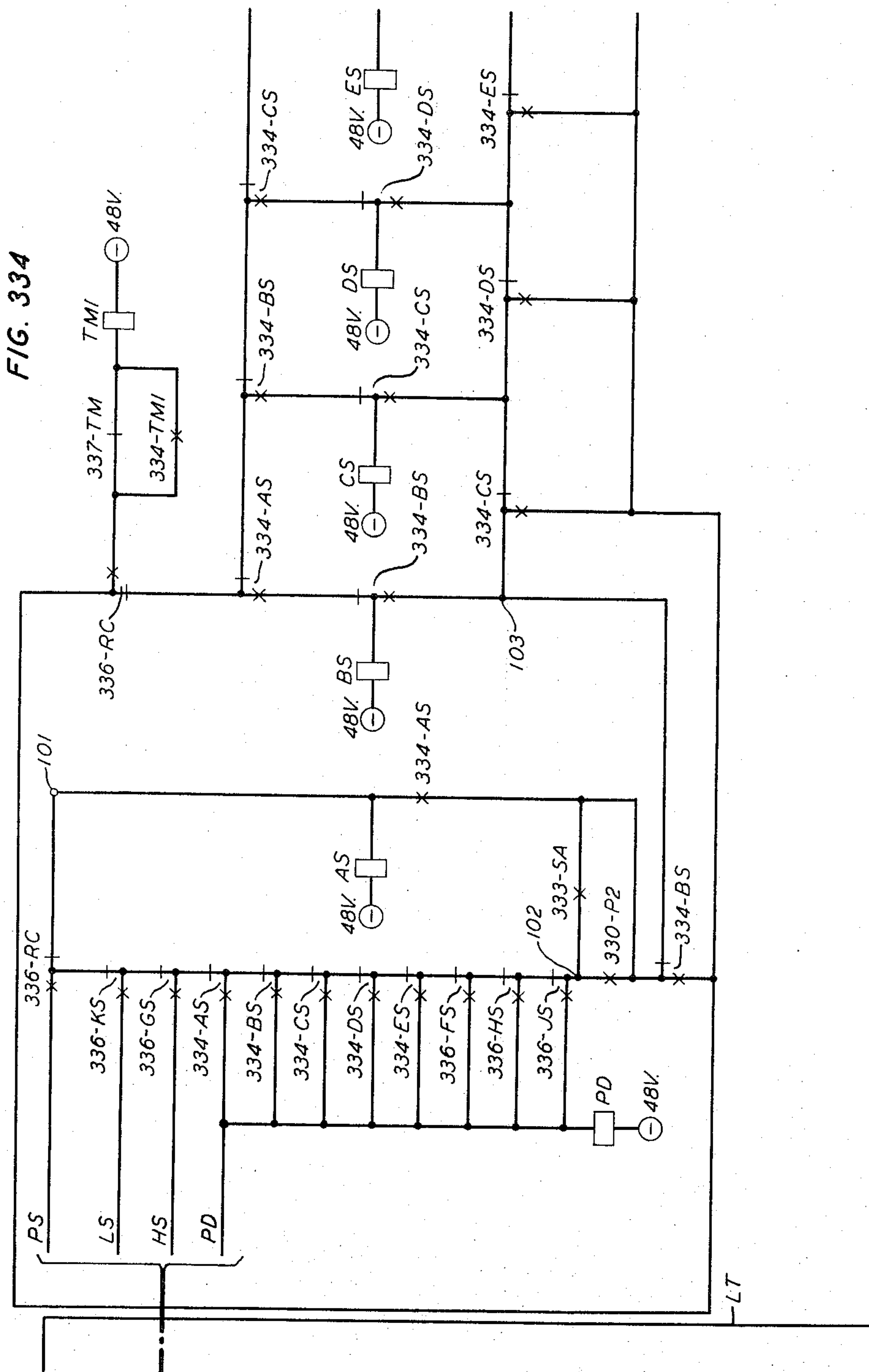
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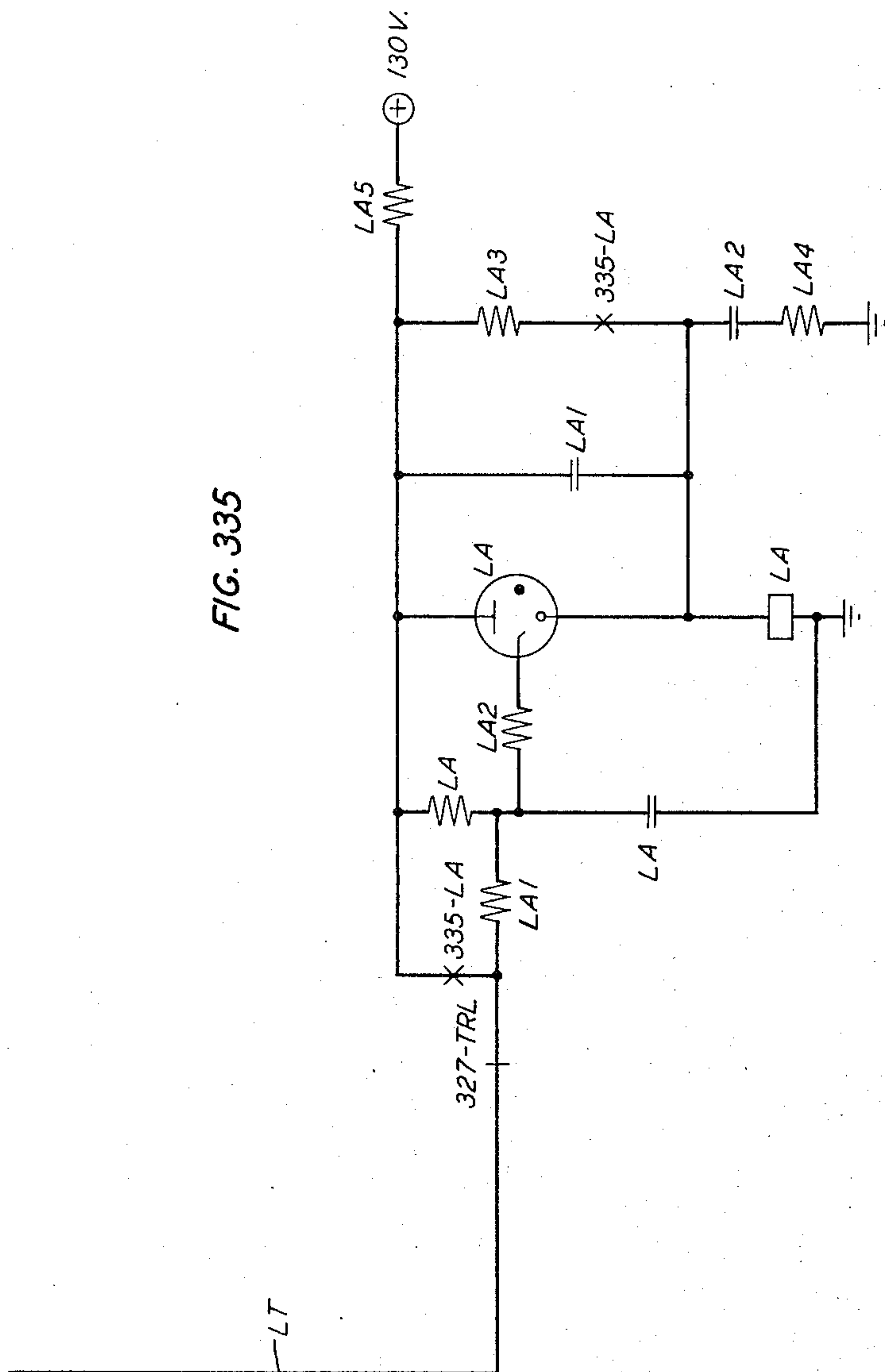
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FIG. 335





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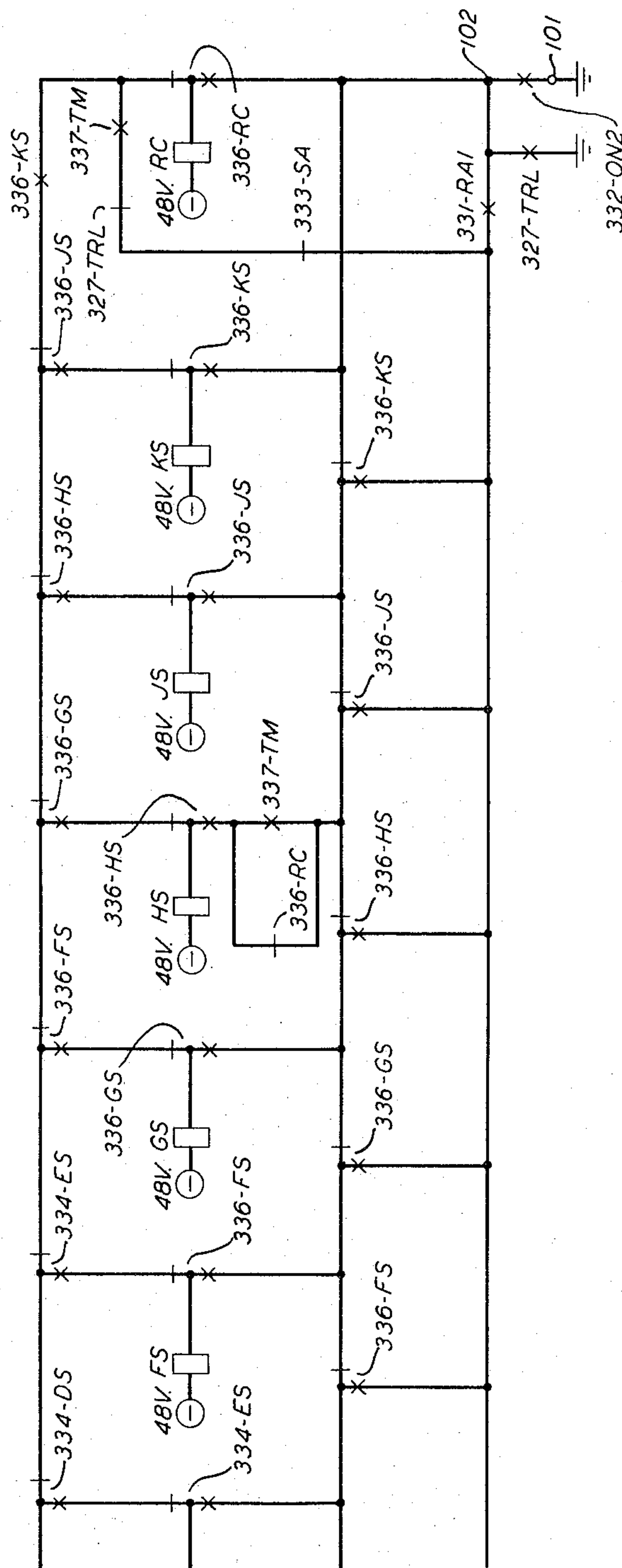
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FIG. 336





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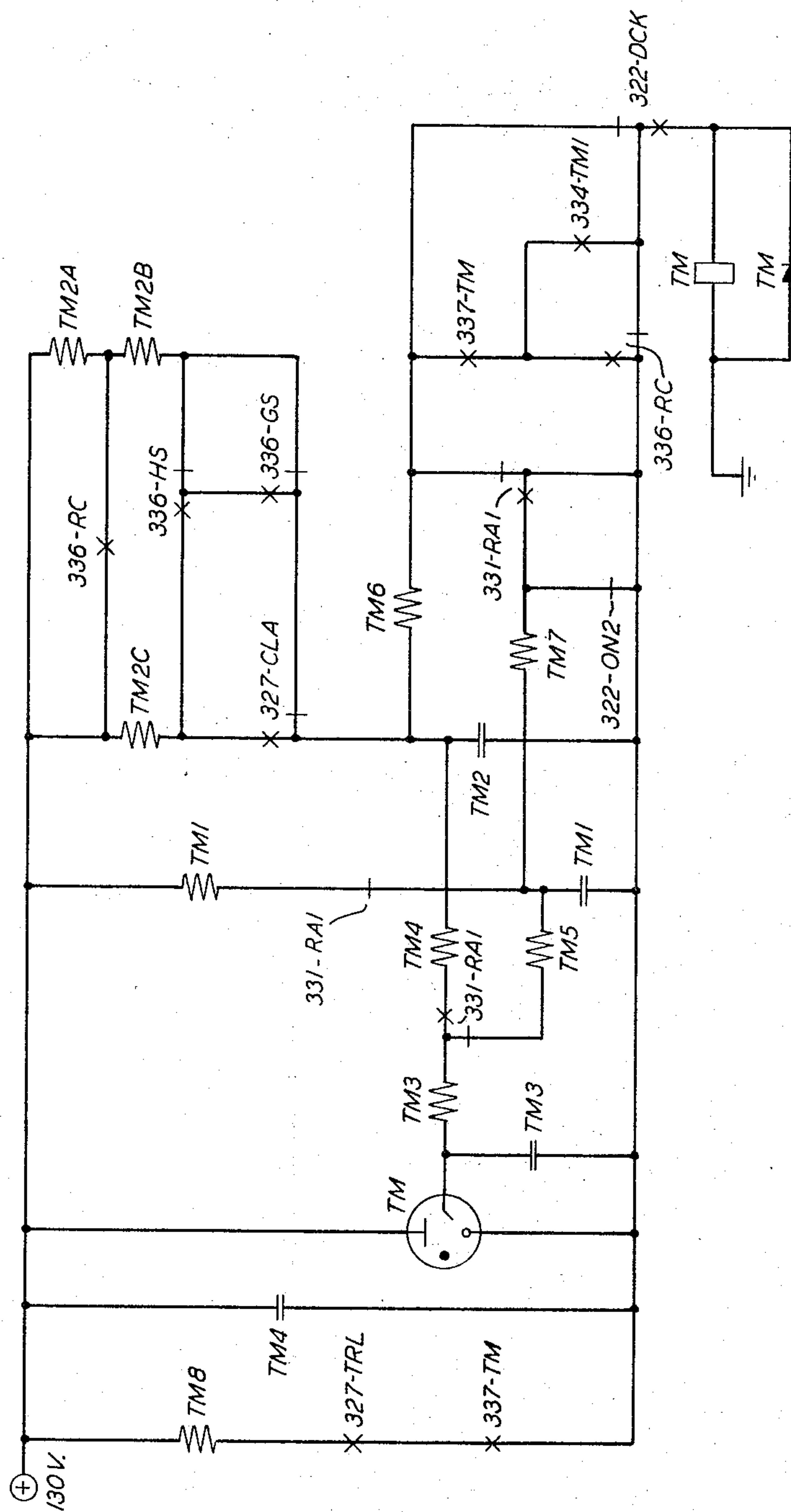
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FIG. 337





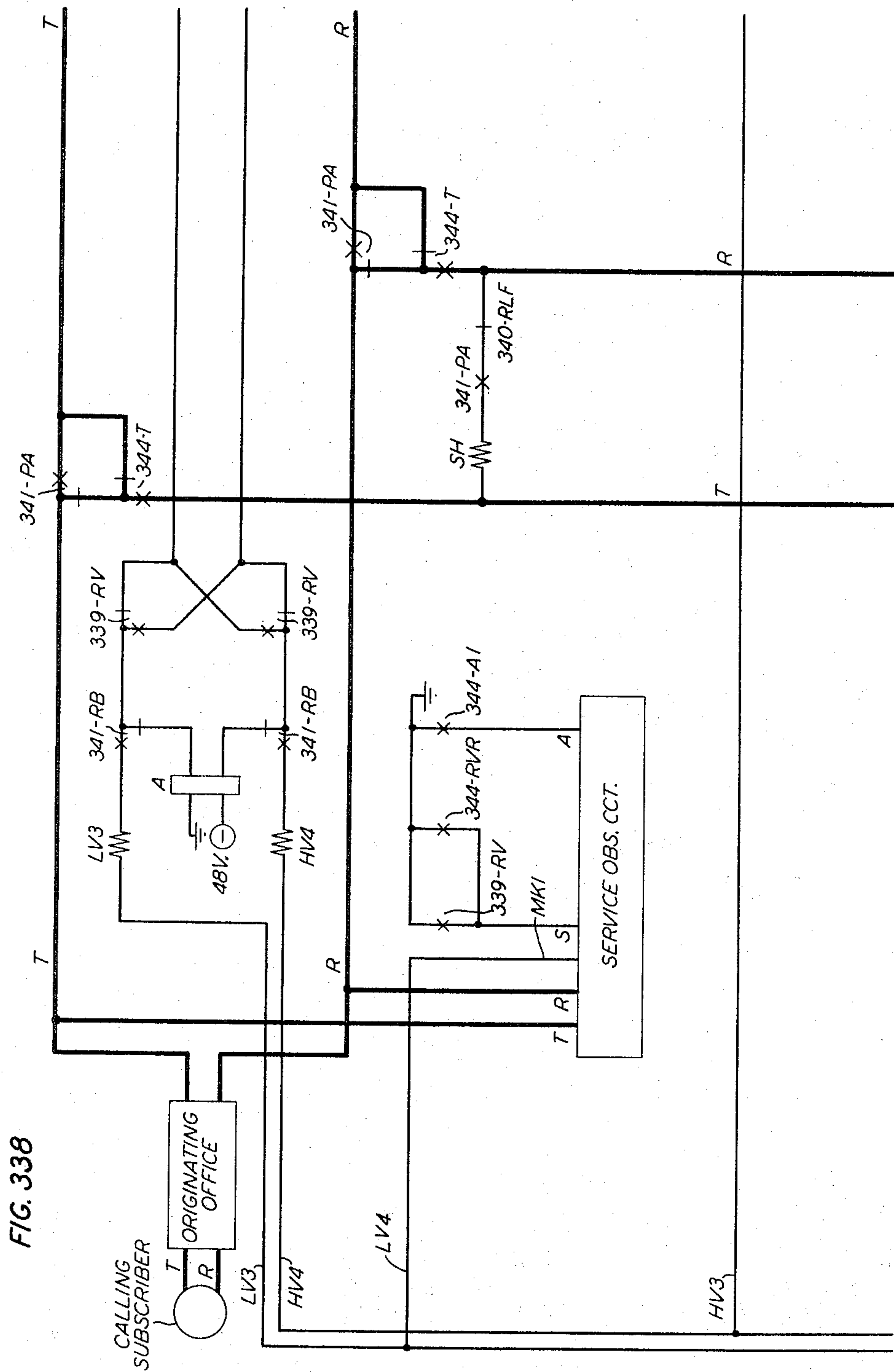
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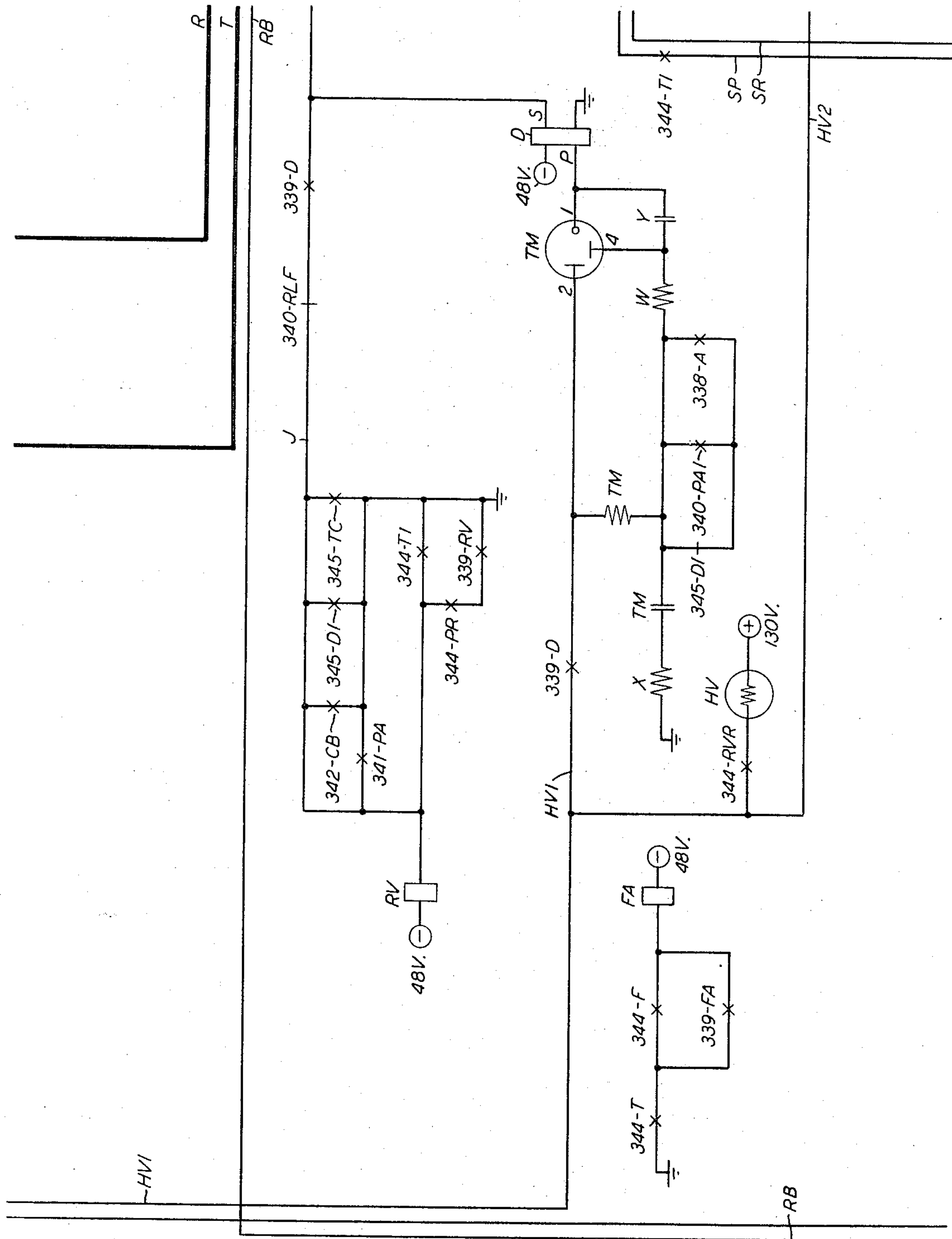


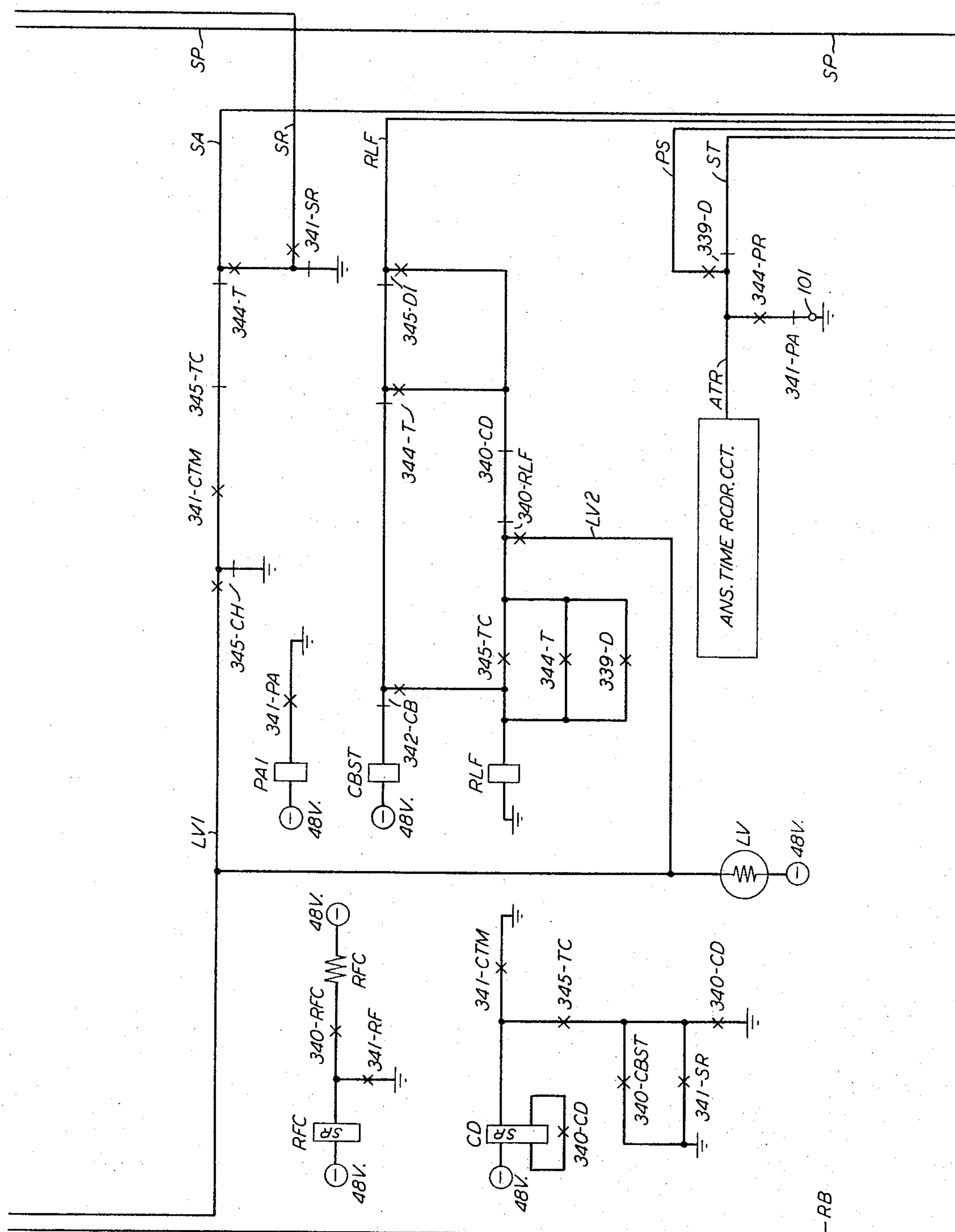
FIG. 339



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**FIG. 340**



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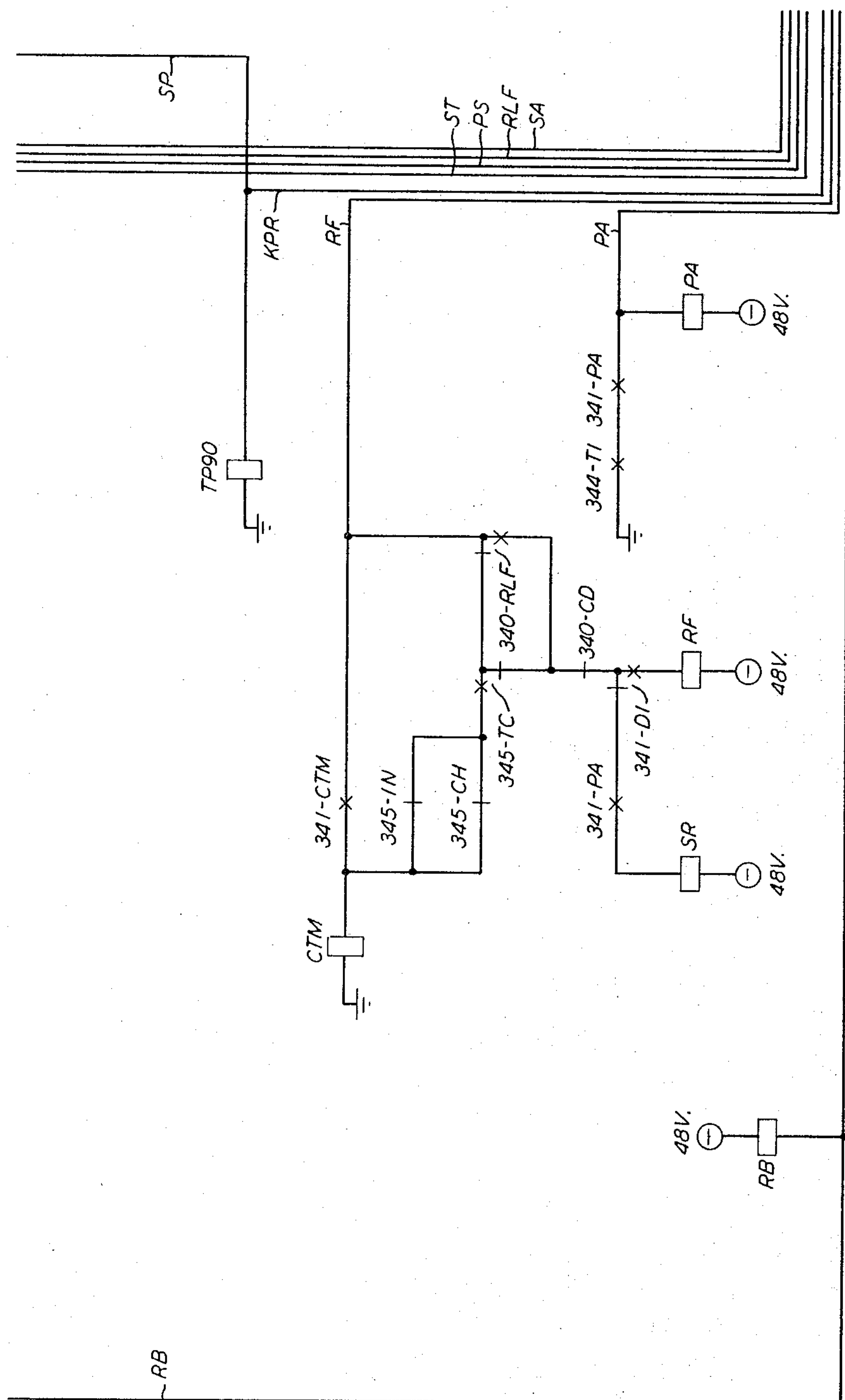


FIG. 341



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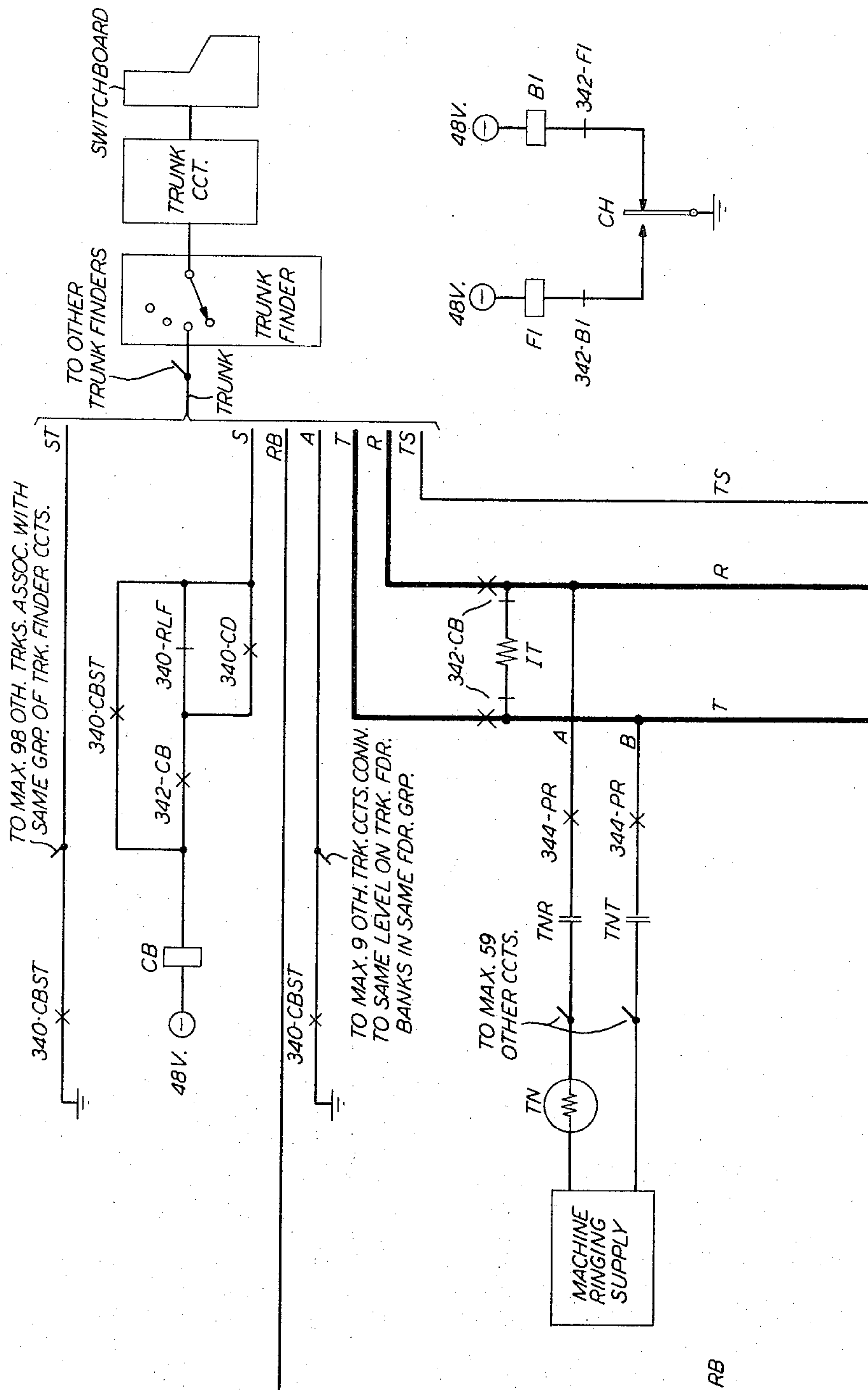
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FIG. 342





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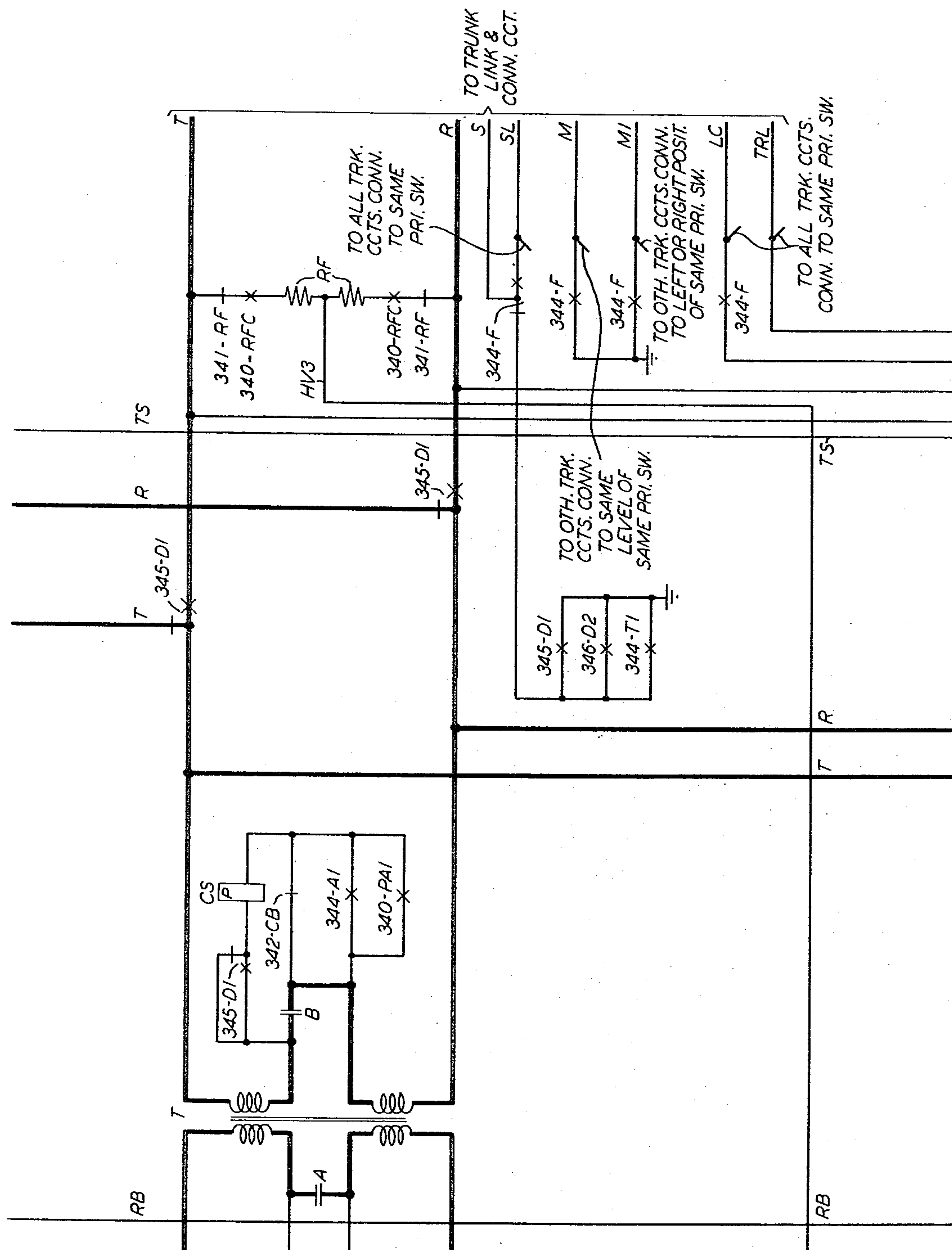


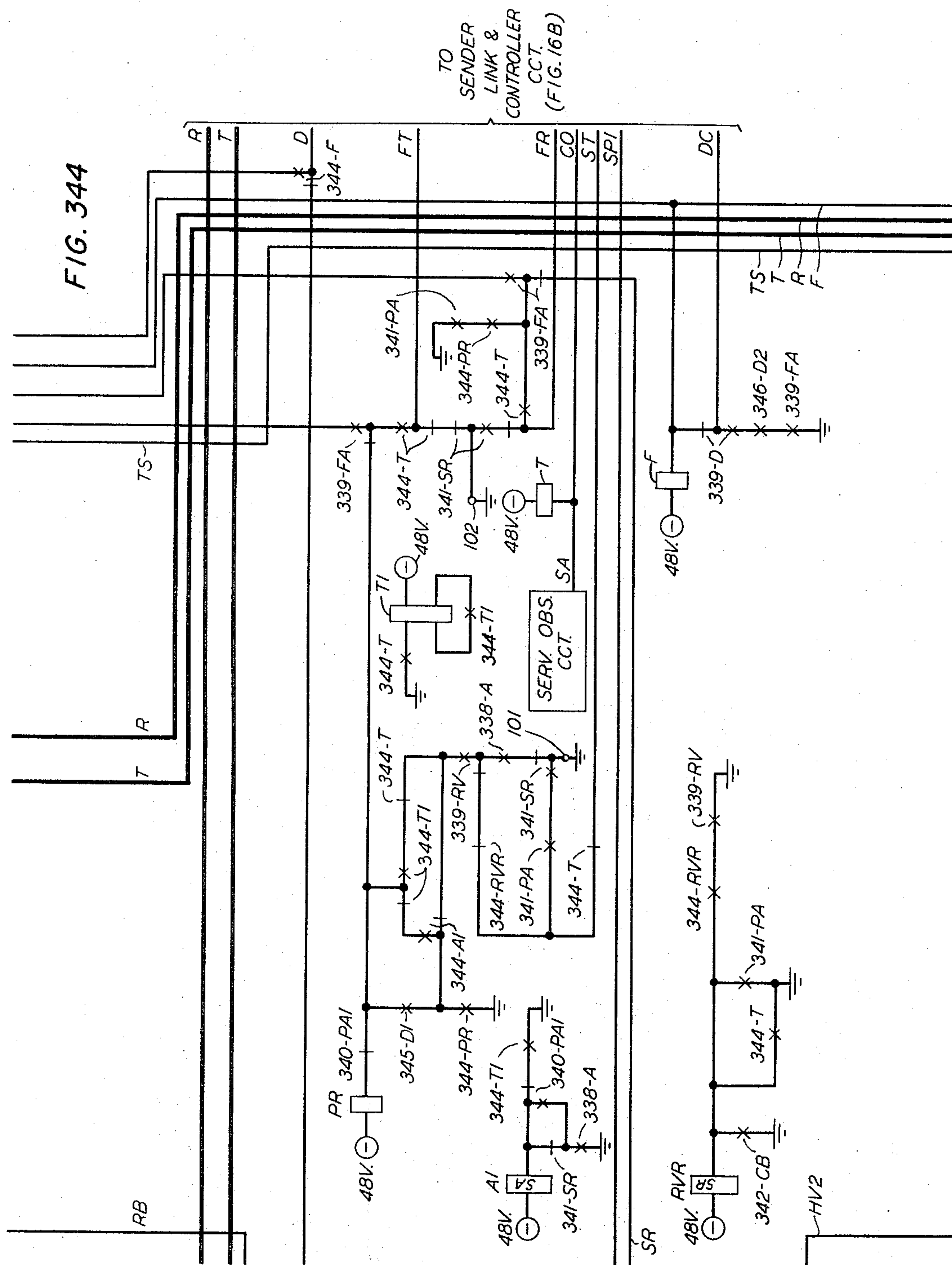
FIG. 343



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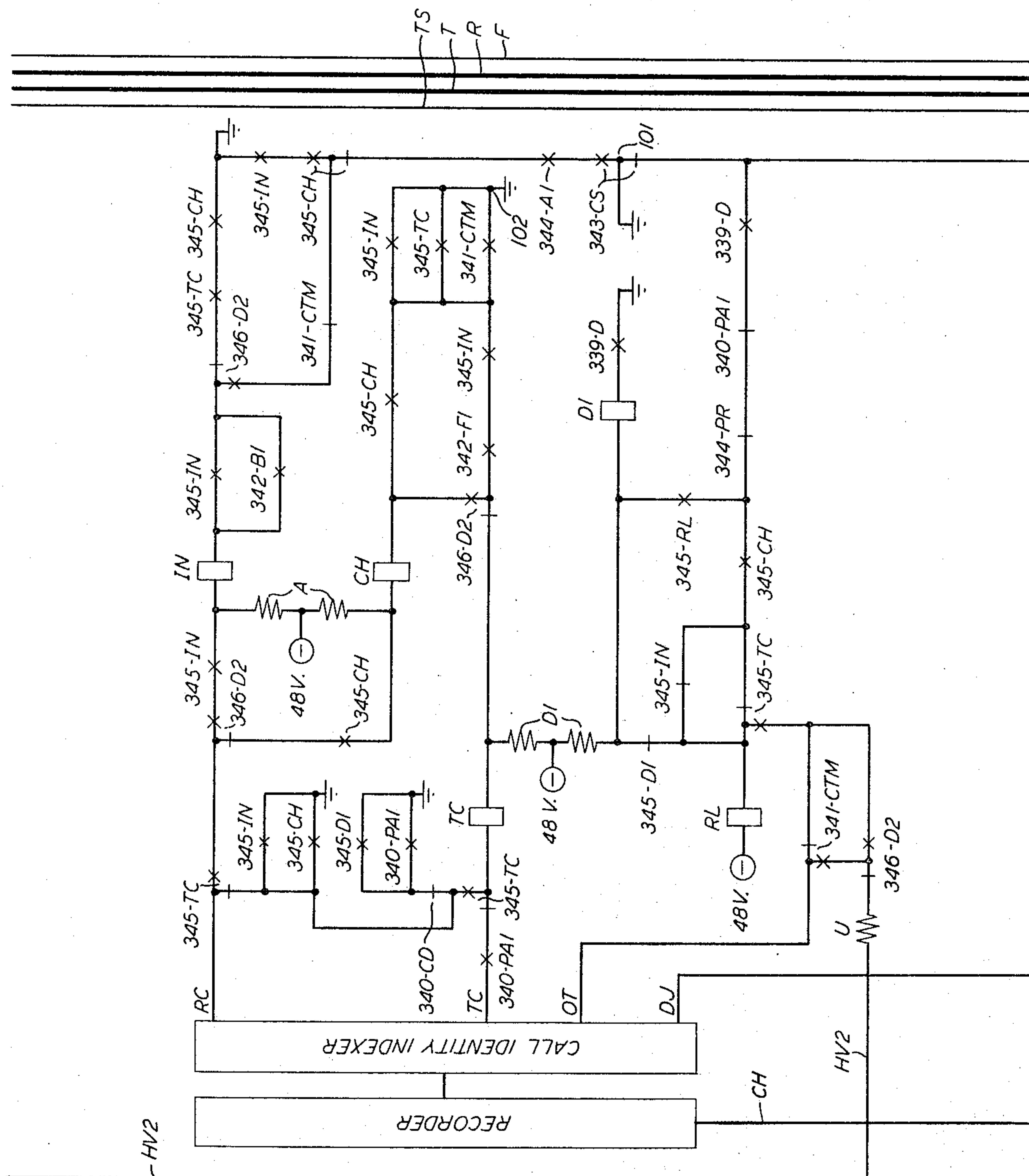


FIG. 345



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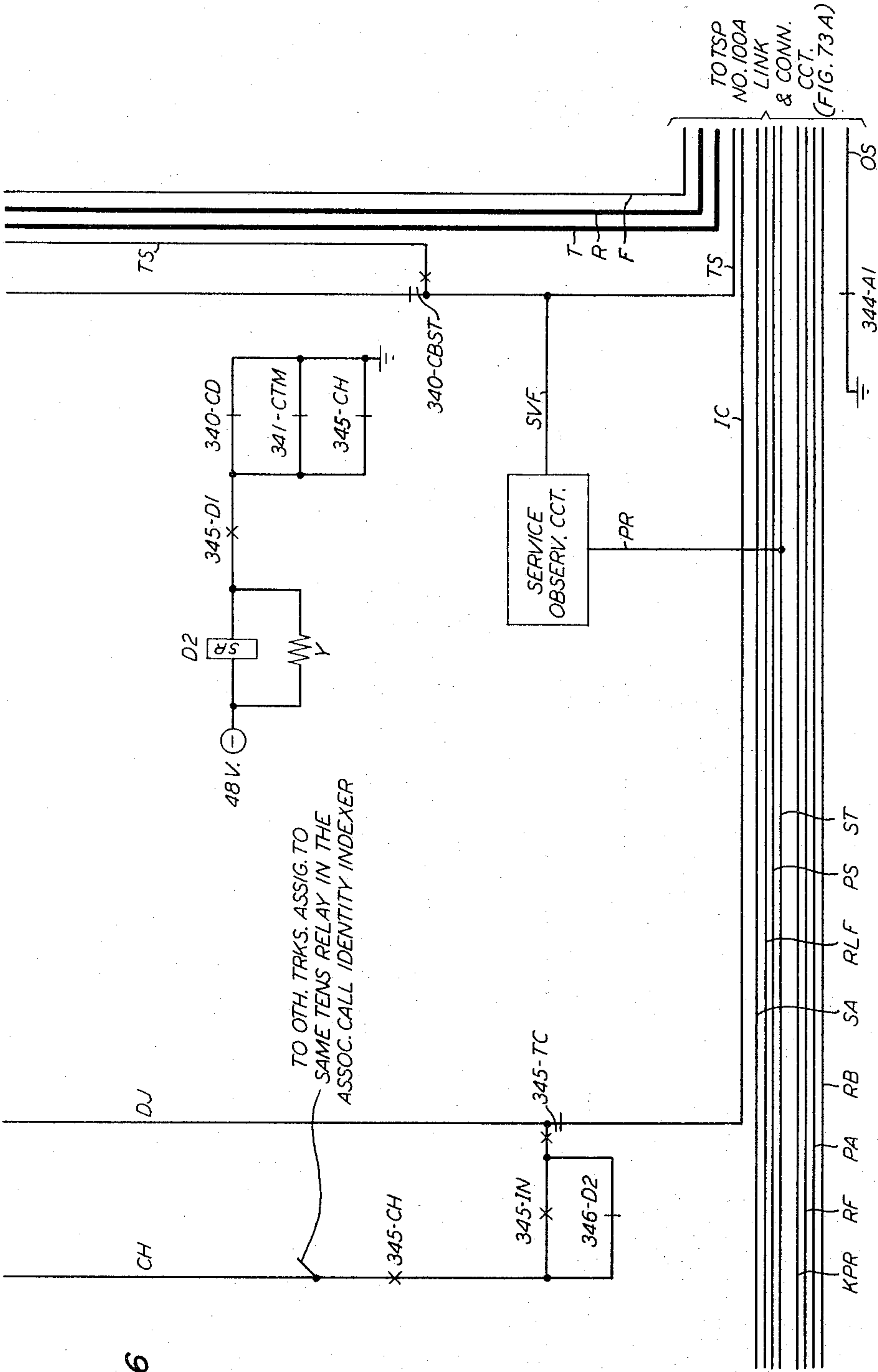


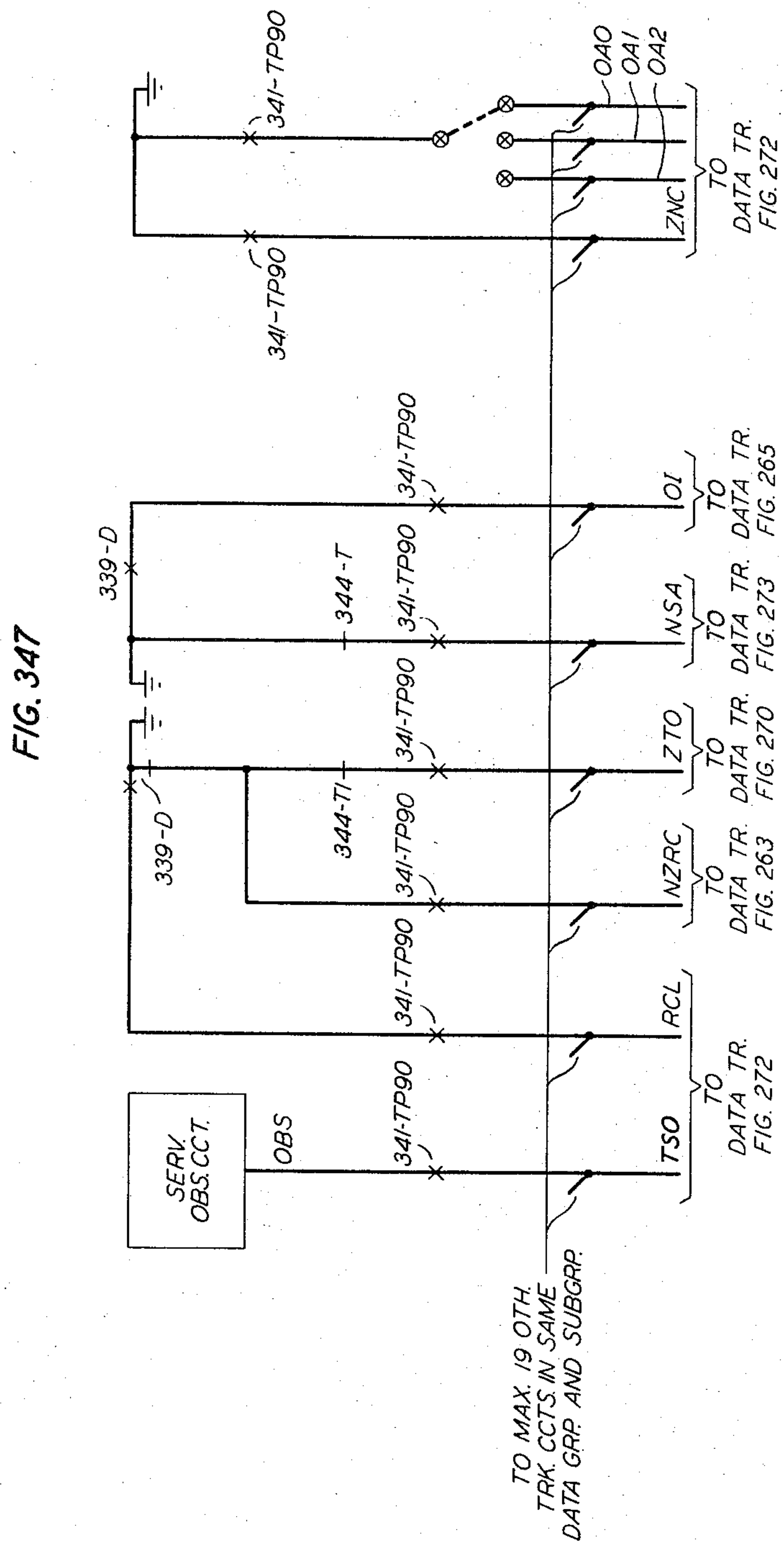
FIG. 346



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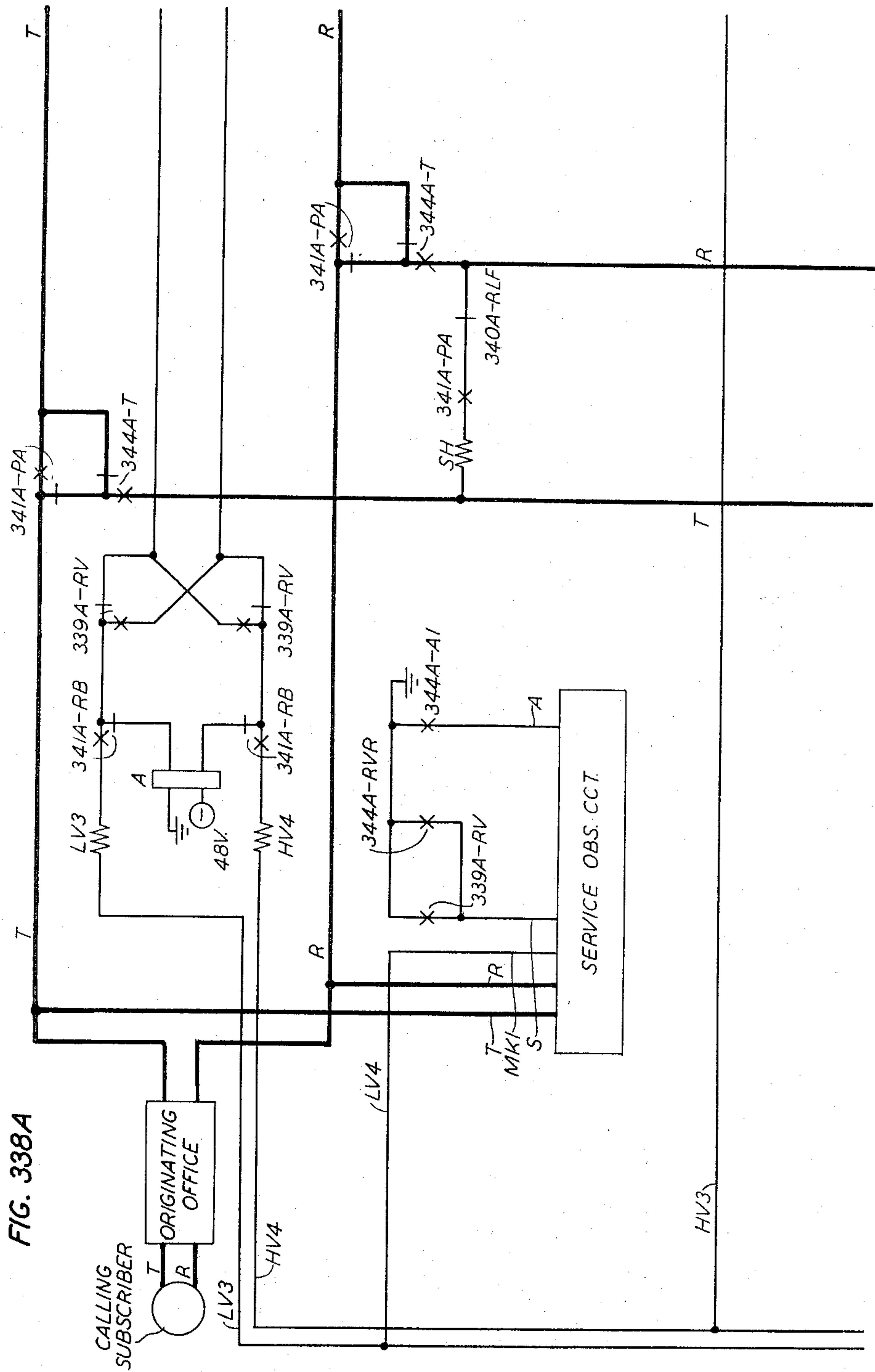
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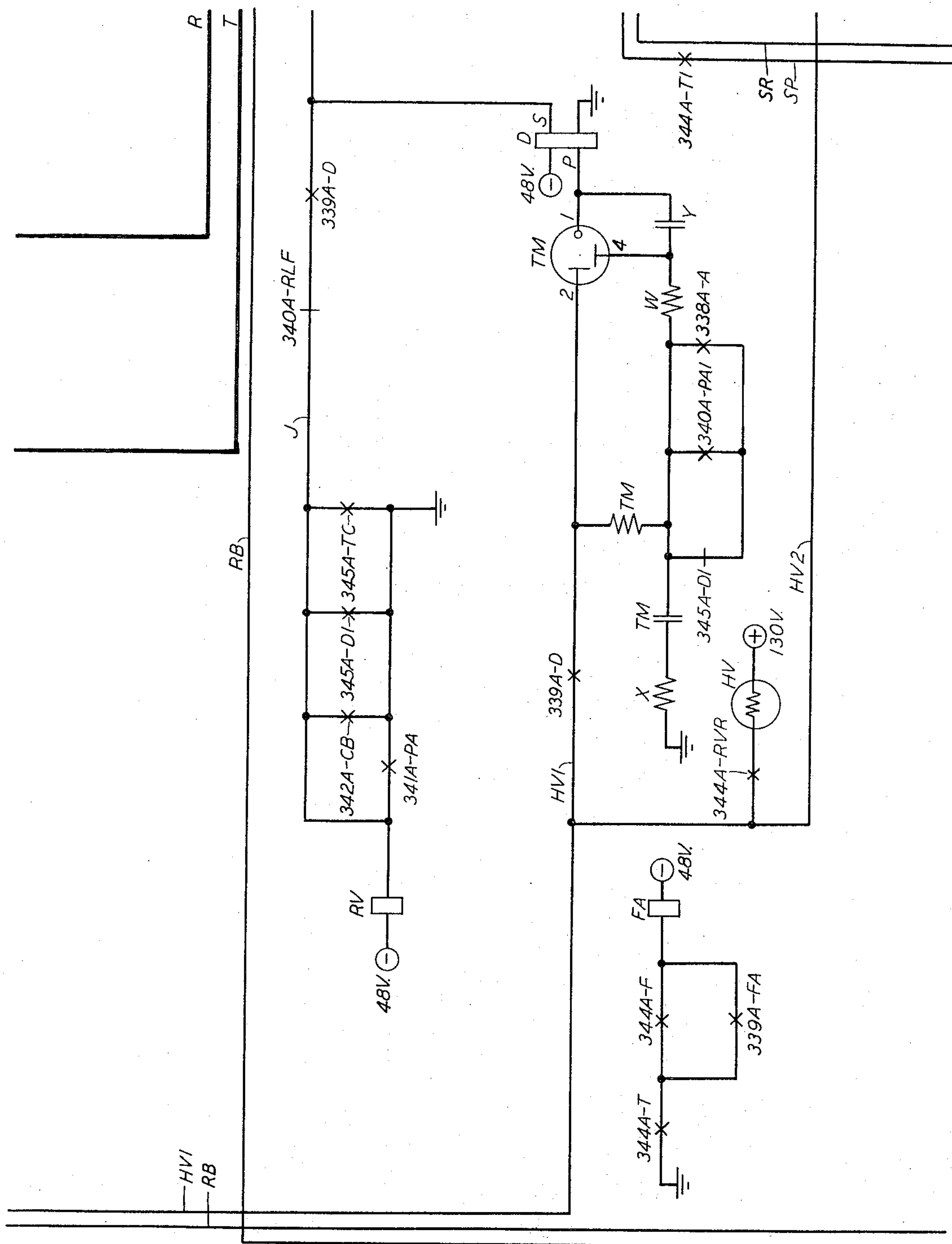


FIG. 339A



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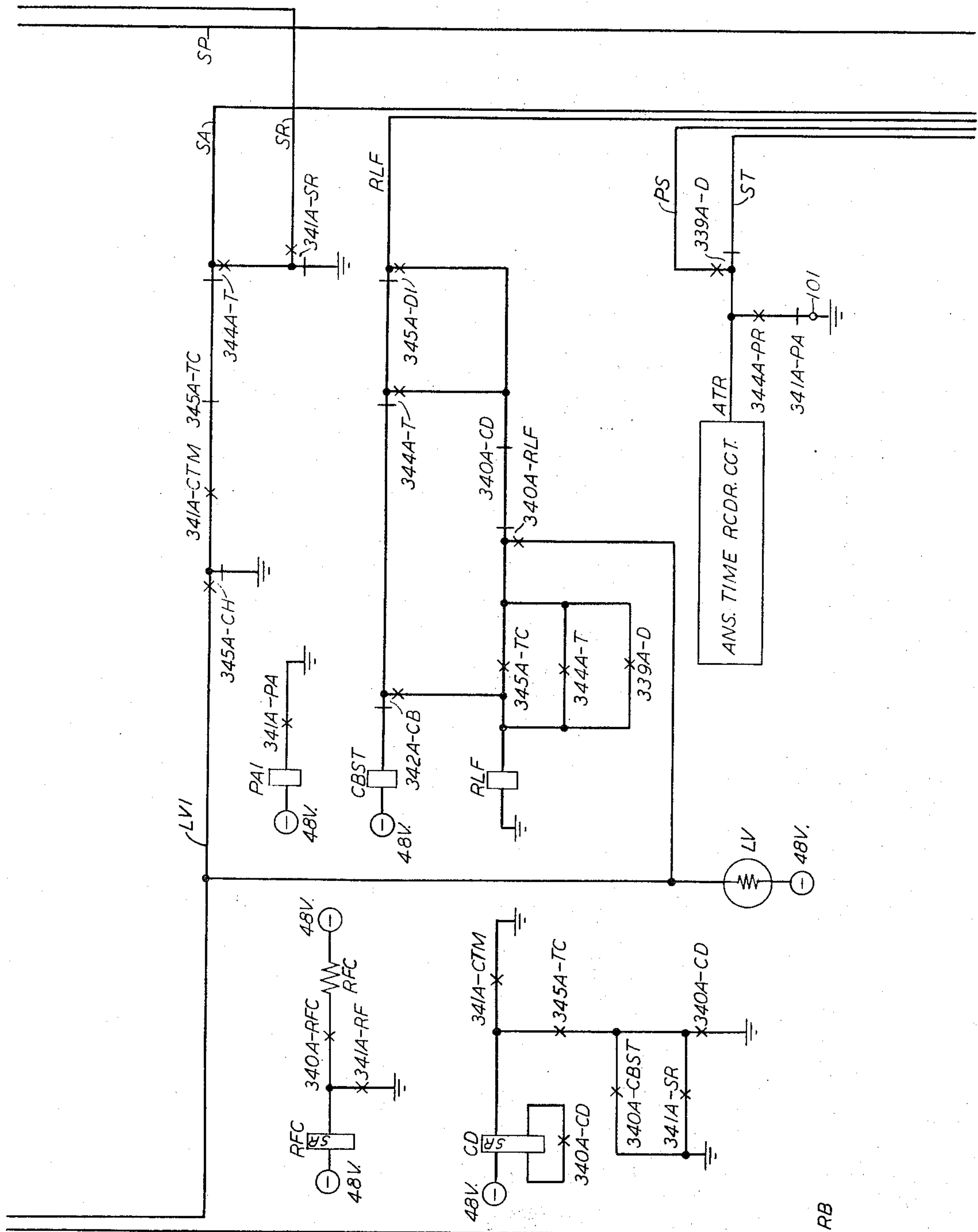


FIG. 340A



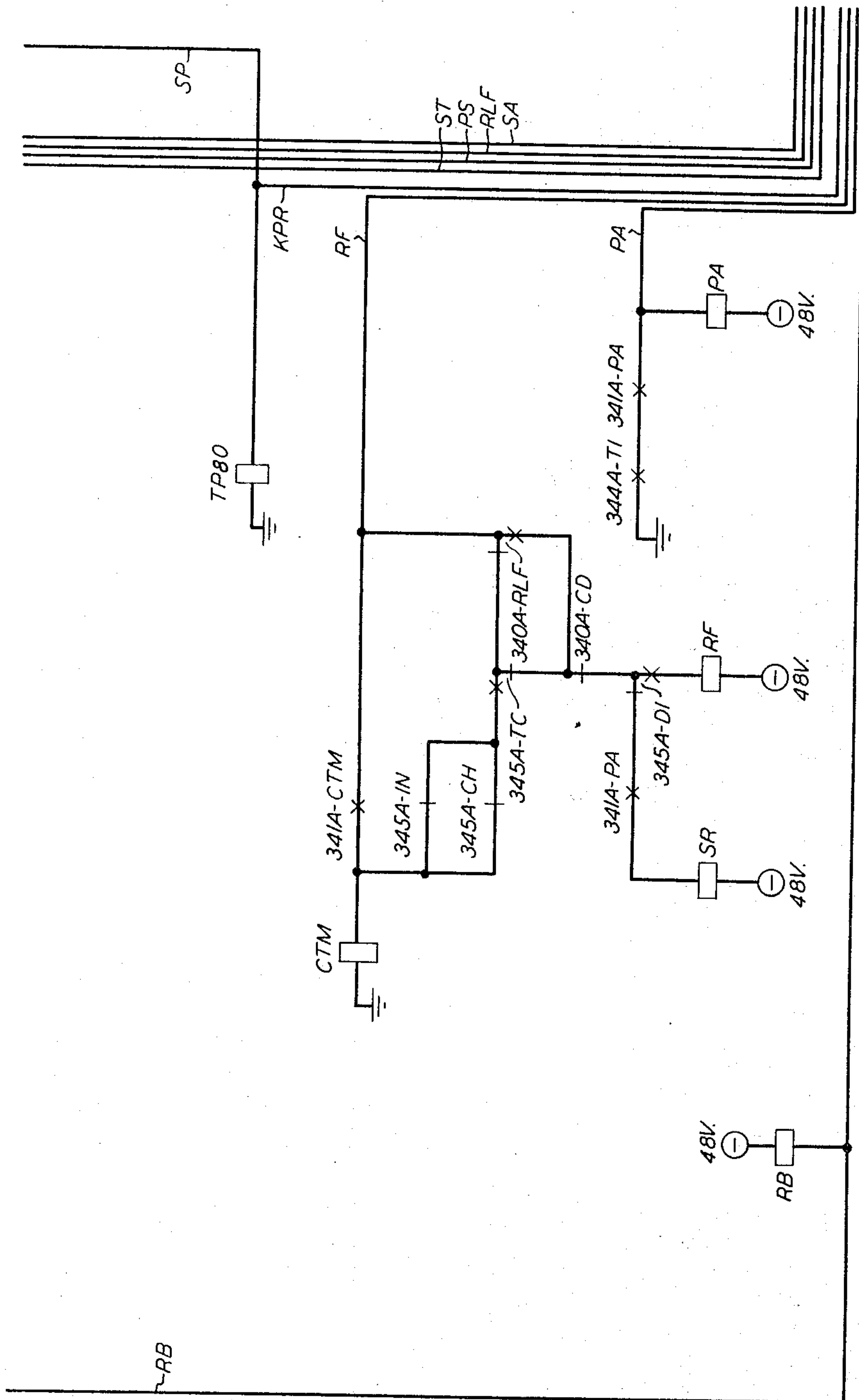
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**FIG. 341A**



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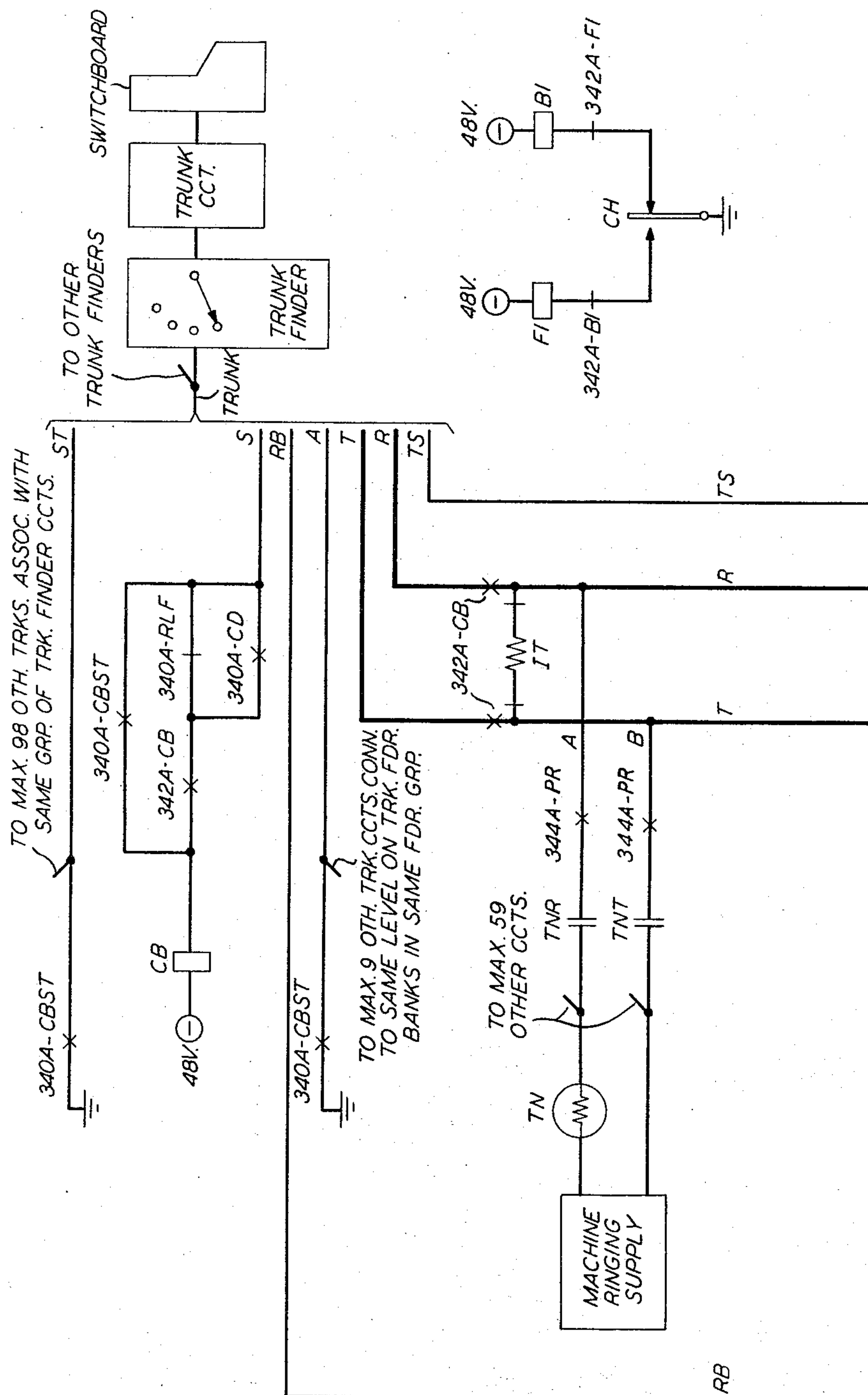
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**FIG. 342A**





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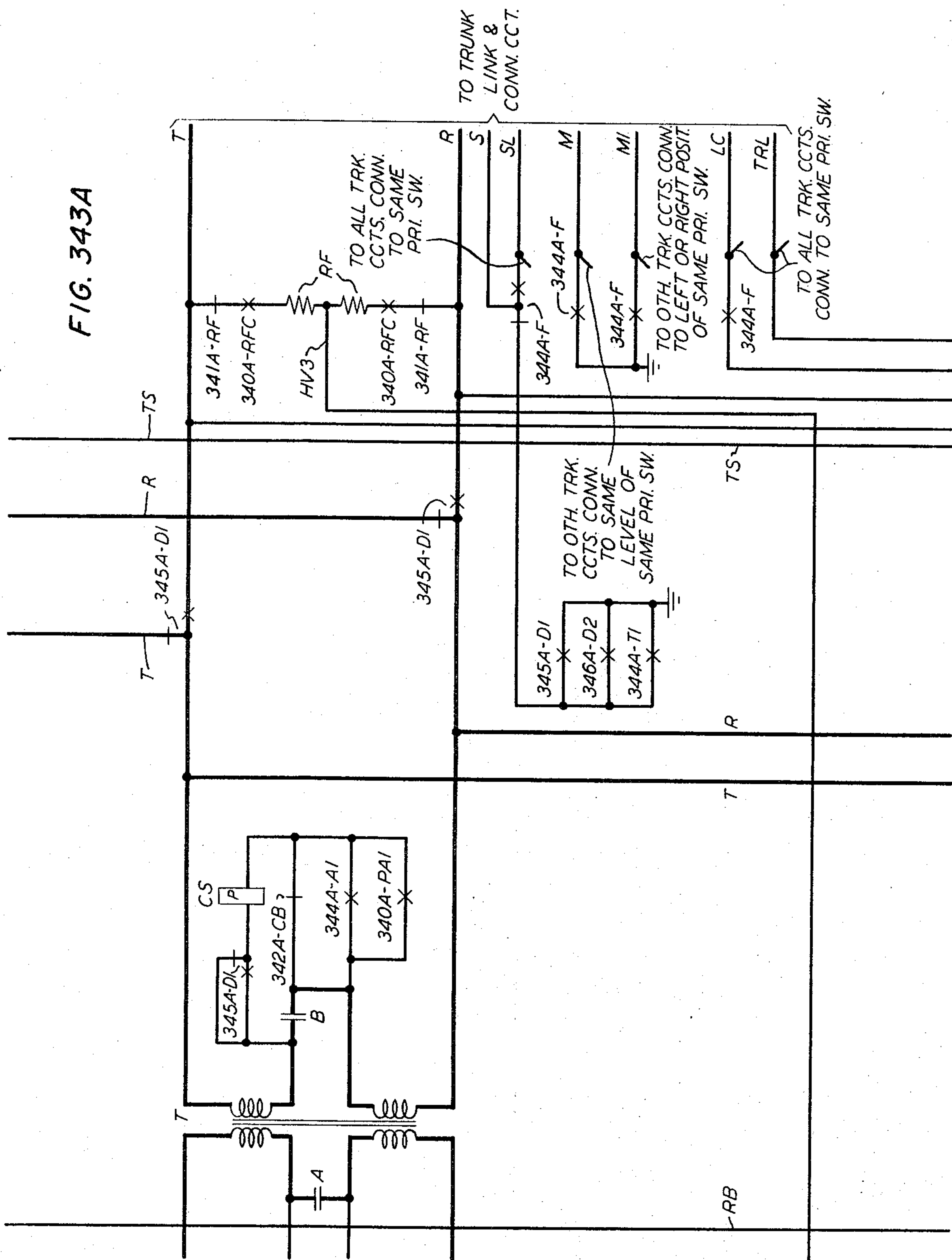
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FIG. 343A





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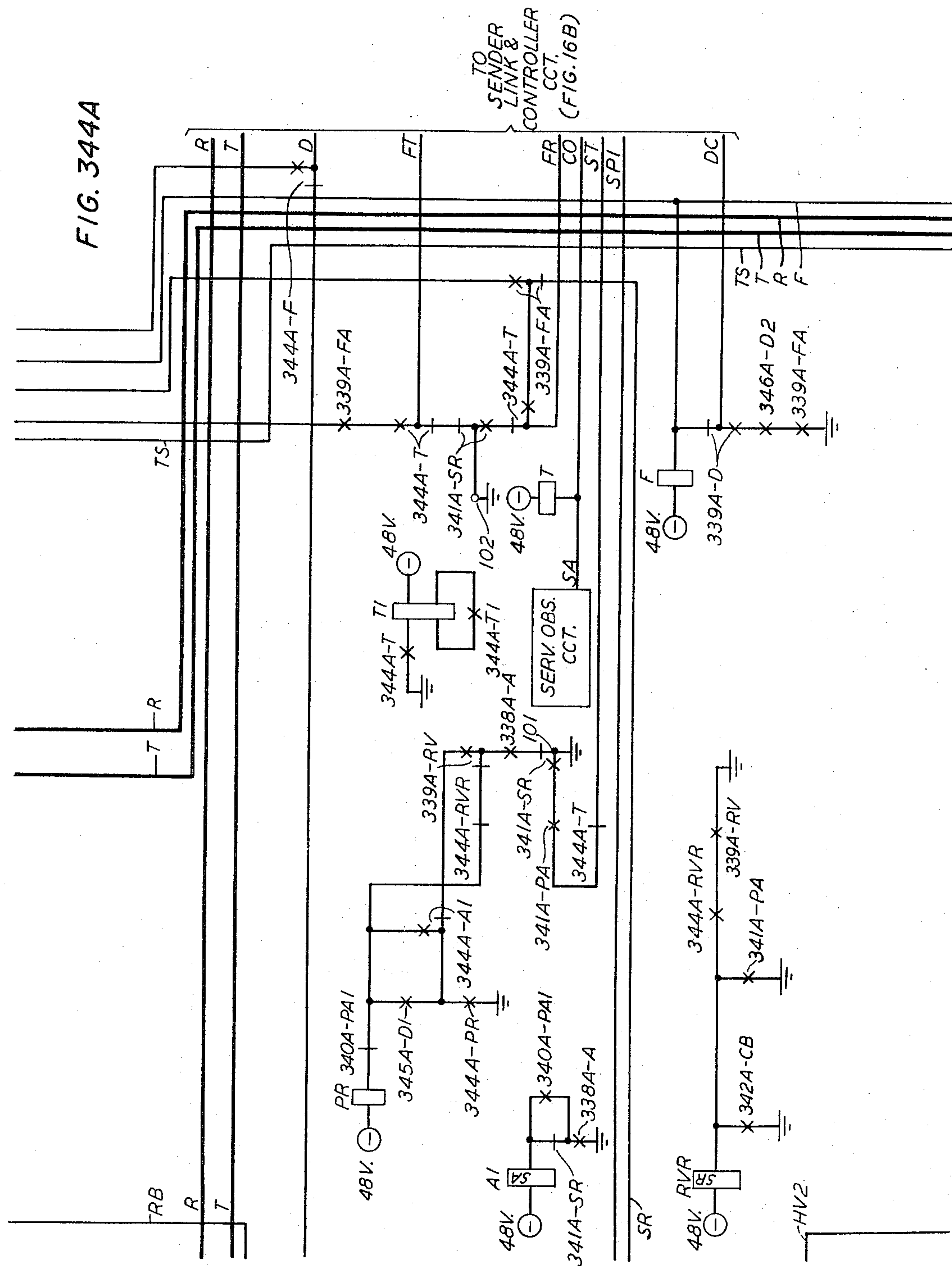
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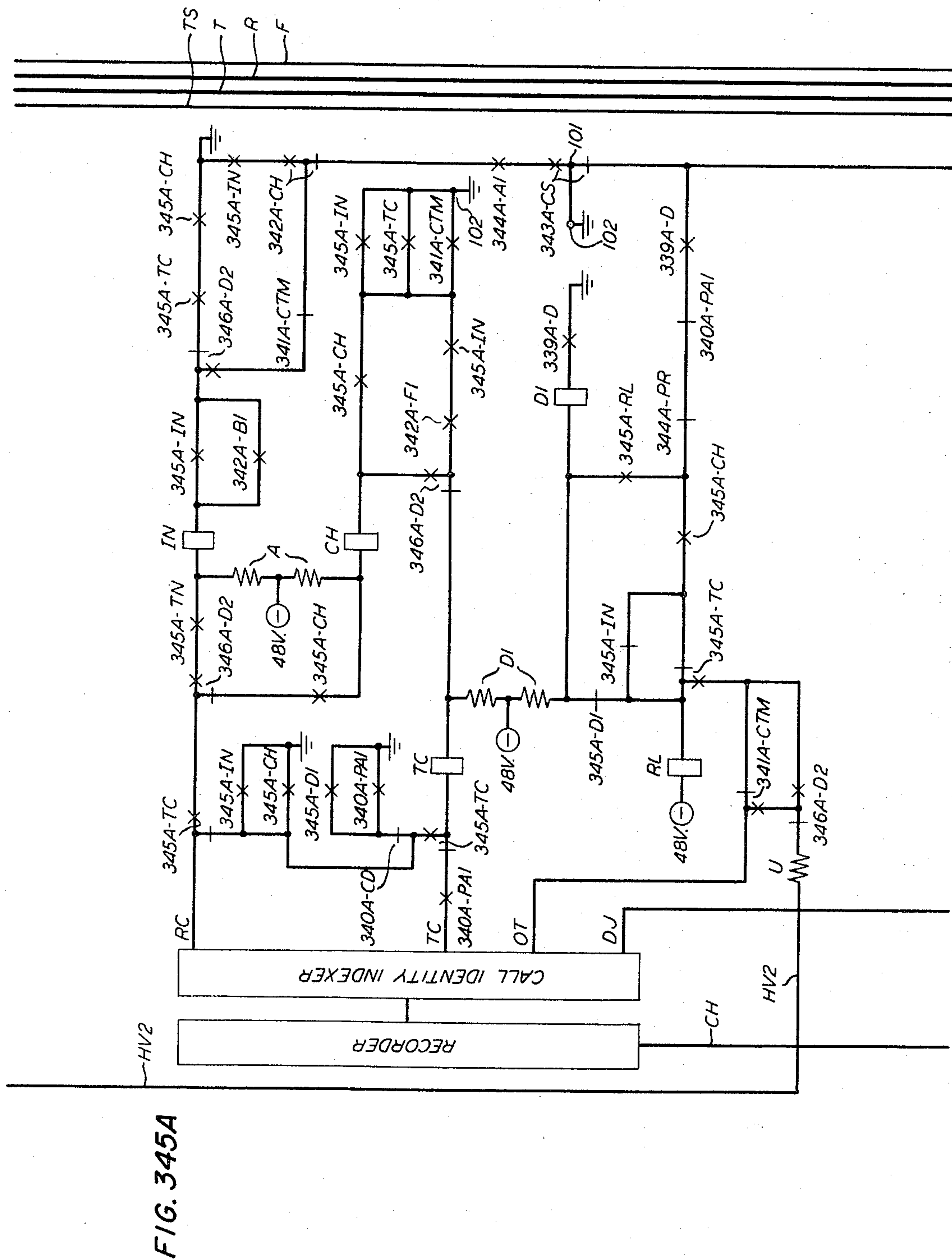
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INTERMEDIATE SWITCHING CENTER

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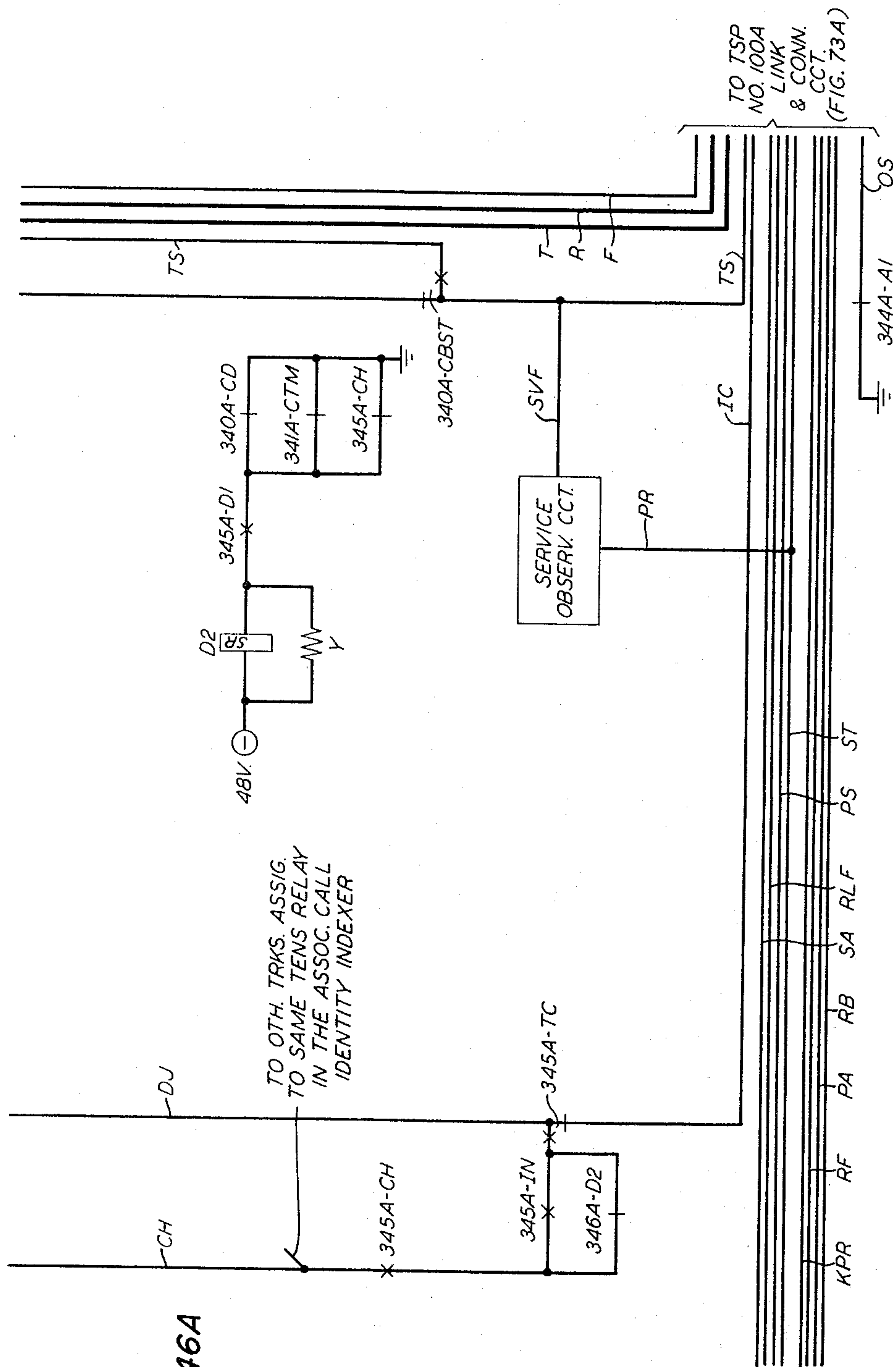
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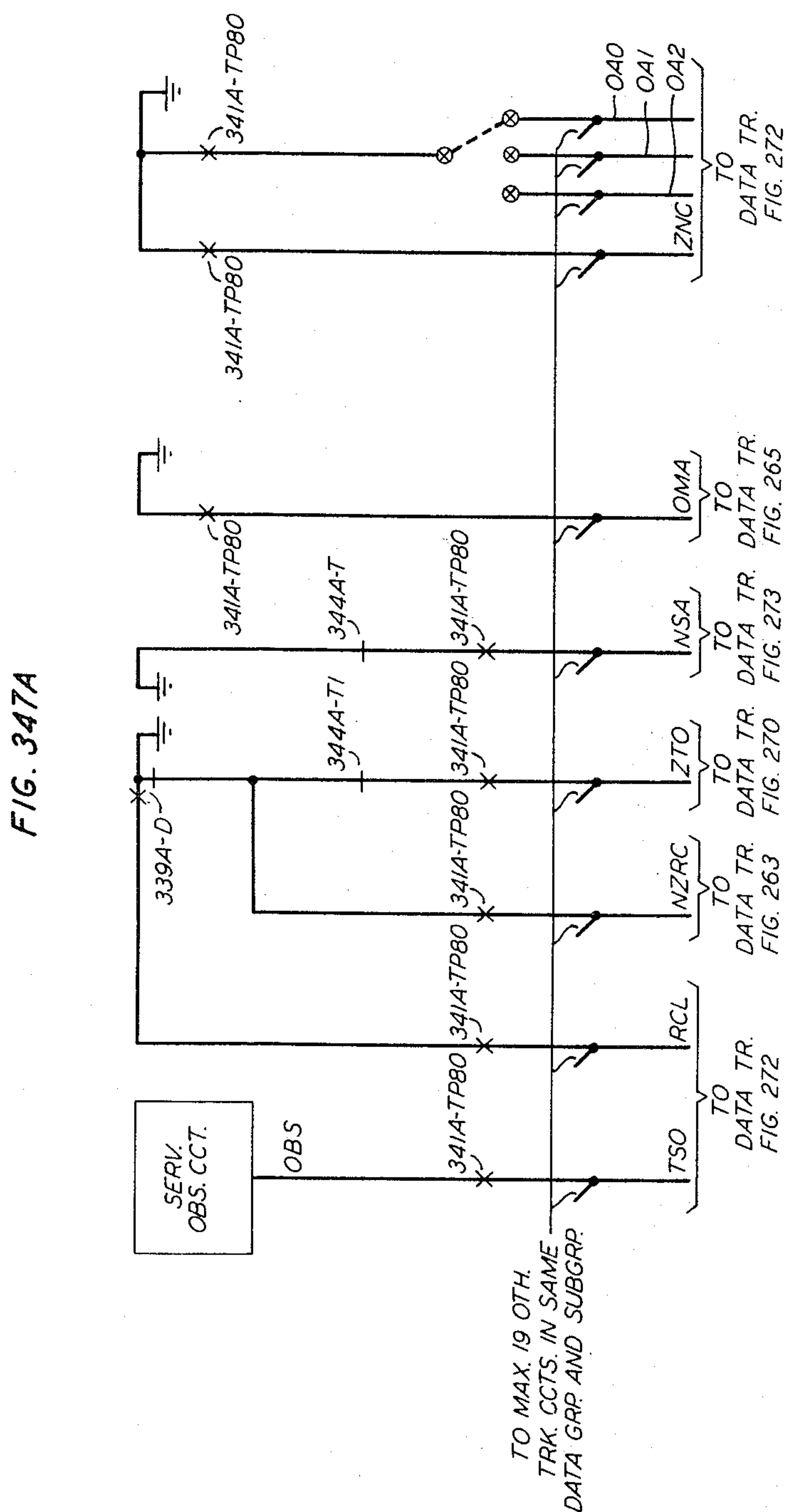
**FIG. 346A**



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## EQUIPMENT FOR OPERATOR SERVED CALLS AT AN INTERMEDIATE SWITCHING CENTER

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Filed Oct. 23, 1963, Ser. No. 318,275

67 Claims. (Cl. 179-27)

### PREAMBLE AND STATEMENT OF INVENTION

This invention relates to a switching system, and more particularly to a telephone switching system which expedites the serving of calls requiring operator assistance for their completion. This invention further relates to a switching system which reduces the operator holding time on assistance calls by minimizing the duties required of the operator during the serving of such calls. This invention still further relates to a switching system which enables a calling subscriber to dial the called station number, including the area code, if any, on many types of calls requiring operator assistance.

Recent advances in the telephone switching and call data recording art have mechanized telephone switching networks to the extent that it is now commonplace for noncoin subscribers to dial practically all of their local calls, and a substantial portion of their station-to-station toll calls, without any operator assistance being required either for the extension of the connection to the called station or for the recording of call charge data. This degree of automation has been brought about by the development of suitable local, tandem, and toll switching centers for serving customer-dialed calls, together with the development of suitable automatic call charge data recording equipment.

However, these advances have merely reduced, rather than eliminated, the need for operators since a substantial percentage of present-day toll calls still require operator assistance for their completion. The term "toll call" as used in this specification includes "long-distance" calls, as well as all other types of calls for which a charge is assessed, other than those of a strictly local nature. Included among the types of toll calls currently requiring operator assistance are: (1) person-to-person, (2) collect, (3) credit card, (4) charge-to-third-party, and (5) a miscellany of other types of calls. The calls in categories (1) through (5) are hereinafter referred to as "special service calls" in that the calling party requires some sort of special service by an operator above and beyond the extension of a connection to the called station, requires special service even for the completion of a station-to-station connection, or requires operator assistance for the extension of a connection to the called station as well as further assistance once the connection is established.

The current operational procedures associated with special service calls is somewhat less than ideal, both for the telephone companies and their subscribers. The provision of the operators required to handle special service calls represents a financial and personnel burden to the telephone companies that is, at times, out of proportion to the extra revenue derived therefrom. Also, special service calls may require a considerable time for their completion because of the operator time and effort involved, and thus, the calling party is often obliged to wait far longer for the completion of such calls than for a comparable station-to-station connection. This wait is occasioned by the fact that the operator must often perform

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essentially three separate functions on such calls. First of all, she must orally ascertain from the calling party and then key into the system the called station number, including area code, if any, in order that the switching equipment may establish the requested connection. Secondly, the operator must additionally ascertain from the calling party and then provide the service required on the call above and beyond that for a comparable station-to-station connection. Thirdly, the operator must obtain the calling station number from the calling party and then manually record both the calling and called station numbers, together with other call data, for subsequent billing purposes.

Recent efforts have been made to minimize the operator holding time for special service calls to called stations to which a station-to-station connection may be completed on a subscriber-dialed basis. The operator holding time has been drastically reduced on these special service calls by having the calling subscriber desiring such service dial a special prefix digit, such as a 0, plus the regular seven or ten digits required for a comparable station-to-station connection. The switching equipment responds to the dialed digits and establishes a connection to the called station in essentially the same manner as for a station-to-station connection. However, the dialing of the prefix digit 0 causes the local switching equipment to bridge onto the calling connection an operator at the originating office who: (1) converses with the calling subscriber, (2) ascertains from him the nature of the assistance required, and (3) furnishes such assistance before permitting the calling and called stations to converse. The operator may also, before releasing from the call, transmit to the automatic call-charge-data recording equipment information signifying the nature of the special service provided.

Although such arrangements represent a substantial step forward in switching art, they still do not constitute a universal solution to the problems associated with special service calls, since only a relatively small percentage of local offices generate a sufficient volume of special service traffic to justify the investment required to station the special service operators and concomitant equipment thereat on a 24-hour basis. This expedient therefore, at the current time appears to be economically justifiable only in local offices which primarily serve business subscribers, since only offices of this type can generate the volume of special service traffic required to warrant the necessary investment.

It may be appreciated from the foregoing that a need exists for a faster and more efficient means of serving special service calls originating in all types of local offices, and especially calls originating in local offices serving primarily suburban and residential areas where the volume of originating special service traffic is not sufficient to warrant a substantial investment thereat.

It is therefore an object of the invention to provide an improved switching system for the serving of special service calls.

It is a further object of the invention to provide an improved switching system for minimizing the completion time of special service calls.

It is a further object of the invention to provide a switching system which minimizes the operator holding time on special service calls.

It is a further object of the invention to provide a switching system which reduces the operator effort on special service calls.



It is a still further object of the invention to provide an improved switching system for the serving of special service calls originating in offices having a relatively low, as well as a relatively high, volume of outgoing special service traffic.

In accordance with the present invention, a switching system is provided having operators and equipment at a tandem switching center for the serving of all the noncoin special service traffic originating in the local offices served on an originating basis by the tandem switching center. Each such special service call incoming to the tandem office is routed to a tandem operator who: (1) converses with the calling party to ascertain the type of service required, (2) furnishes the requested service, (3) controls the recording of the call charge data required for billing purposes, and (4) releases from the completed connection.

The equipment provided at the tandem office in accordance with the present invention minimizes the operator duties on most special service calls and thereby reduces the operator holding time per call as well as the call completion time. The operator duties are minimized by the provision of switching equipment which enables many types of special service calls to be completed on a subscriber-dialed basis to any called station to which a comparable station-to-station connection may be established on a direct-dialed basis. The operator duties are further minimized by the provision of automatic call-charge-data recording equipment which permits the data required for subsequent billing purposes to be recorded automatically for all special service calls, except a relatively limited few which will still require manual ticketing by the operator.

The centralizing of the operators and of the charge recording equipment at the tandem office is advantageous in that it dispenses with the need for operators and recording equipment at the local offices, and thereby enables subscribers in local offices served on an originating basis by the tandem office to be accorded the benefits of reduced operator holding time and direct dialing for many special service calls, even though the volume of special service traffic generated in each local office is insufficient to warrant the installation of special service operators and equipment thereat.

The tandem switching center of the present invention is not limited to the serving of special service calls and, accordingly, it may serve all types of calls which heretofore have typically been served at tandem. Thus, the tandem center may serve station-to-station calls from local offices having their own call recording facilities and for which no data recording operation need be performed at tandem. The only function of the tandem office on calls of this type is to extend a connection therethrough to the following office in response to the information received from the originating office. It may also serve station-to-station calls—which require a call charge-data recording operation at tandem since the originating office is not equipped with charge data recording facilities. It may further serve calls of the latter type for which the calling station number is automatically identified by the originating office and transmitted to tandem, as well as those for which the calling station number is not automatically identified and for which an operator at tandem must orally obtain this information and key it into the system. The tandem office may also serve various types of nonspecial service calls.

The tandem office, in accordance with the present invention, is provided with different types of incoming trunks which may be broadly classified into two groups, namely, nonspecial service and special service. The nonspecial service trunks serve calls which usually do not require operator assistance at tandem. An exception to this are CAMA calls, for which operator assistance is required momentarily at tandem merely for identifying the calling station number and keying it into the system. The special service trunks, on the other hand, as the name im-

plies, receive calls from local offices for which the tandem office must provide some sort of special service in addition to the customary switching operation.

The subdivision of the incoming tandem trunks into nonspecial and special groups requires that each local office served on an originating basis by tandem route its calls to the proper incoming tandem trunk in accordance with the type of service required on each call. This, in turn, requires that the originating office must determine whether each call is of the nonspecial service or special service type. It is presently contemplated that a calling subscriber will dial a directing digit or code, to enable the originating office to determine whether station-to-station or special service is required on the call. For example, the calling subscriber may prefix his normal dialing routine with the digit 1 if station-to-station service is required. On the other hand, he may initiate a special service call either by the dialing of only the digit 0, or some other special code, to reach an operator, or by the dialing of the prefix digit 0 followed by the full complement of digits representing the called station. The specific dialing routine for each special service call depends upon a number of factors, including whether or not a station-to-station call may be completed on a subscriber-dialed basis to the same called station.

Calls for which only the digit 0 is dialed to reach an operator are hereinafter referred to as "dial 0 calls." Such calls may include calls to nondialable destinations, calls originated by handicapped people unable to dial, emergency calls, marine calls, and overseas calls. On calls of this type, the originating office recognizes that no called station digits will be dialed by the calling subscriber and it then establishes a connection to an outgoing trunk extending to the tandem office. The call is received at tandem by a trunk which exclusively serves dial 0 calls and which, upon its seizure, informs the tandem office that no called station information will be outputted by the originating office. The tandem office, in turn, immediately routes the call to an operator who orally obtains the called station information from the calling party, performs whatever dialing operation, if any, may be necessary to control the establishment of the desired connection by the switching apparatus, and, in addition, provides or assists in providing whatever other assistance may be required on the call. The operator depresses a key to initiate the recording of the necessary call charge data and to release her position from the connection either before or after answer occurs at the called station, depending upon whether or not the operator must converse with the person answering the phone at the called station in order to provide the assistance requested by the calling party.

Special service calls for which the calling party dials a prefix digit, such as 0, followed by the called station digits, may include person-to-person, collect, credit card, and charge-to-third-party calls. On these, the originating office responds to the dialed digits, establishes a connection to the tandem office, and outputted the necessary called station information to tandem to enable the switching equipment thereat, as well as that in any succeeding office, to establish a connection to the called station. The connection at the tandem office is simultaneously routed to a tandem operator who normally performs no further dialing operation on such calls and who is bridged onto the calling connection only for furnishing the assistance required above and beyond that for a comparable station-to-station connection, as well as for transmitting to the automatic call charge data recording equipment information signifying the type of assistance provided.

The tandem operators are stationed at cordless positions having facilities enabling them to serve practically all conceivable types of calls incoming to the tandem office and requiring operator assistance. Each operator position is equipped with a plurality of keys, of which there is one for each call function which may be per-



formed by the operator. Included among these is a key for each type of special service having call billing significance, i.e., collect, person-to-person, charge-to-third-party, and credit card. The depression of one of these keys on a call causes the recording equipment to record the data typically recorded on a station-to-station connection and, in addition, causes it to record information signifying the nature of the special service provided.

The varied nature of the special service calls that must be handled by the operators requires an increased capability for data interchange between different circuits of the tandem office on various calls. The combination of circuits that must be interconnected, the quantity of data to be interchanged, the direction of data flow, and the stage of each call at which a data interconnection is required varies in accordance with the call type. The tandem office of the present invention includes a new and novel interconnecting medium, hereinafter referred to as a "data transfer circuit," for performing these complex and varied interconnections.

The various types of special service calls that may be served by the tandem operators are sufficiently different from each other, both insofar as concerns the functioning of the switching equipment and the duties required of the operator, so that the only characteristic common to all might be said to be the fact that some sort of personalized assistance must be provided by the operator in order for the calling party to receive the service he desires on the call. Several factors by which certain special service calls may be classified are as follows: (1) whether or not they are customer-dialed calls, in which the called station digits are outputted to tandem for the originating office, or whether they are dial 0 calls, for which the called station information will have to be orally obtained by the tandem operator and keyed into the system, (2) the type of outputting utilized by the originating office in transmitting the called station digits to the tandem office on customer-dialed special service calls, (3) whether or not the calling station digits will be automatically identified at the originating office and transmitted to tandem, or, alternatively, whether this information will have to be obtained orally by the tandem operator and keyed into the system.

Considering only the foregoing call characteristics, the simplest type of call, insofar as the system operation is concerned, is a customer-dialed special service call, for which the originating office outputted the called station information to tandem in multifrequency (MF) form and, additionally, for which the calling station digits are automatically identified by the originating office and outputted to tandem. The incoming calling tandem trunk on these calls seizes a sender which registers the calling and called station digits outputted from the originating office. The sender then, in the conventional manner, seizes a marker which establishes a connection through the tandem office to an outgoing trunk extending to the terminating office. Once the connection to the outgoing trunk is established, the sender outputted forward via the outgoing trunk whatever call information is needed by the succeeding office or offices to complete the call.

Simultaneously with the extension of the connection to the terminating office and the called station, the sender causes a connection to be established between the incoming calling tandem trunk and an operator position via a position link. The operator converses with the calling party to ascertain the nature of the call assistance required after she is bridged onto the calling connection. Assuming the call to be of the person-to-person type for example, the operator first obtains the name of the person at the called station with whom the calling party desires to converse and then converses with the person answering the phone at the called station in order to determine whether or not he is the individual specified by the calling party. Once the specified party is available, the operator depresses keys at her position to initiate the recording of

call charges and to release her position from the connection.

The foregoing procedure is essentially the same for a collect call, except that in this case the operator ascertains that the called station is willing to assume the charges for the call. Corresponding services are provided on other types of special calls, i.e., credit card, charge-to-third-party, etc.

The foregoing described call may be conveniently referred to as an MF-ANI call where MF signifies multifrequency impulsing from the originating office and where ANI signifies that the originating office is equipped for automatic number identification. Referring back to this call, the incoming trunk is at one time during the course of the call connected via a sender link to a sender and is simultaneously connected via a position link to an operator position. The position link is an interconnecting means of limited capacity and is utilized solely to provide a talking path between the operator position and the trunk as well as to transmit a limited amount of class mark information and control signals from the trunk to the position. However, before it can serve the call, the position circuit requires a large amount of information currently registered in the sender as well as certain information from the incoming trunk. This information includes the call number, the calling number, and additional class mark information. One reason that this information is needed by the operator position circuit is that it is this circuit which subsequently transmits to the automatic call charge recording equipment much of the information needed by it for subsequent billing purposes.

The previously mentioned data transfer circuit comprises a flexible interconnecting medium of large capacity and it is provided at the tandem office to interconnect different combinations of circuits at various times during the serving of different types of calls in order that these circuits may interchange data as required. Thus, for the MF-ANI call, the data transfer circuit interconnects the incoming trunk, the operator position circuit, and the sender in order that the trunk and the sender may transmit call information to the sender, with the information transmitted by the sender at this time including the calling and called station numbers. The data transfer circuit is utilized to interconnect other combinations of circuits on other calls, as is subsequently described.

MF-nonANI calls are handled in essentially the same manner as an MF-ANI call, except that on nonANI calls, the calling station will not be automatically identified at the originating office and therefore the tandem operator must orally obtain this information from the calling party. The sender, in this case, does not receive the calling number from the originating office and therefore, when it is interconnected with the position circuit via the data transfer circuit, it transmits the called station digits to the position circuit, plus a special signal informing the operator that calling station information must be obtained by her. The operator then orally obtains this information from the calling party and keys it into registers at her position from whence it is ultimately transmitted to the recording equipment at the time a charge record is made of the call.

Calls for which the called station information from the originating office is received in dial pulse form are referred to as "DP calls." DP calls may also be either of the ANI or the nonANI type, just as is the case for MF calls. The switching functions at tandem for DP-ANI calls are somewhat more involved than for MF-ANI calls. The incoming trunk, immediately upon its seizure by the preceding office, seizes a dial pulse register via a bylink circuit. The called station information is then received in DP form from the originating office and registered in the DP register. The incoming trunk next seizes a sender via a sender link upon receipt of a signal from the register indicating that all digits of the called station number have been received and registered. The sender then receives the



calling station information in MF form from the originating office via the incoming trunk and sender link and registers it in the same manner as for MF-ANI calls. The called number stored in the register is subsequently transferred to the sender via the data transfer circuit after which the data transfer circuit releases.

The sender now has registered therein the called station number, as received from the register via the data transfer circuit, as well as the calling station number, as received via the incoming trunk from the originating office. The sender next causes the incoming trunk to seize an operator position circuit via the position link. The operator then serves the call in the same manner as for an MF-ANI call and, in connection therewith, the data transfer circuit is utilized to interconnect the incoming trunk, the operator position, and the sender in order that the trunk and the sender may transmit call data to the operator position.

DP-nonANI calls are served in the same manner as DP-ANI calls, with the exception that the calling station information is not automatically received from the originating office and registered in the sender and, therefore, it must be orally obtained and keyed into the system by the operator as for MF-nonANI calls.

The calling party does not dial any called station digits on dial 0 calls but instead merely dial the digit 0, or some other such directing code. The originating office has circuitry within it which responds to the dialing of a single digit of 0 and, in response thereto, routes the call to the tandem office where it is received on an incoming dial 0 trunk. These trunks may be of two types, namely, ANI and nonANI, depending upon whether the originating office is equipped for ANI operation.

A calling dial 0 ANI trunk seizes a sender in the customary manner. The sender next receives from the originating office and registers the calling station information in the same manner as for the MF and DP-ANI calls. The sender is also informed at this time, by means of class mark information from the sender link, that no called number information will be forthcoming from the originating office. Therefore, once the ANI registration is completed, the sender causes the incoming trunk to be interconnected via the position link with an operator position. The data transfer circuit then interconnects the sender with the operator position in order that the sender may transmit the calling station information to the position. The data transfer circuit releases along with the sender after this information is registered in the position circuit.

The operator converses with the calling party, obtains the called station number, and keys it into registers at her position. A signal is then transmitted via the position link and the incoming trunk to cause the trunk to seize an idle sender. Once this is done, the position circuit controls the establishment, via the data transfer circuit, of a connection between itself and the sender. The position then transmits via the data transfer circuit sufficient information to the sender to enable it to establish the required connection with the aid of the marker. The operator finally depresses a key to initiate the recording of the proper call charge information and to release her position from the call.

The serving of a dial 0 nonANI call is different from that of the dial 0 ANI just described in that there is no first usage of a sender immediately upon the seizure of the incoming trunk, and therefore the incoming trunk, immediately upon its seizure, proceeds to establish a connection via the position link to an operator. The data transfer circuit then interconnects the incoming trunk with the operator position in order that the trunk may transmit class mark information to the position circuit. Following this, the data transfer circuit releases. The operator is now bridged on the calling connection and obtains from the calling party both the calling and called numbers and keys both of these into registers at her

position. She then depresses a key which causes the incoming trunk to seize a sender, and which also causes the data transfer circuit to interconnect the trunk, the position, and the sender in order that information may be transmitted to the sender to enable it to establish the call with the aid of the marker. The data transfer circuit releases, following the successful receipt by the sender of this information. The operator may depress a key to initiate the recording of the proper call charges and to release her position from the connection either before or after the called station answers, depending upon whether the call is of the station-to-station type or whether it is of a type which requires conversation with the person answering the phone at the called station.

The operator positions contain sufficient equipment to enable the operators to provide the varied types of service that may be required for serving the different types of special service calls. For example, it frequently occurs on person-to-person calls that the individual designated by the calling party is currently not available at the called station initially reached, but is available at a different station. The operator positions contain facilities whereby, when encountering situations of this type, an operator may depress a key to release the forward connection to the called station initially reached. She then keys into the system the number of the called station at which the individual specified by the calling party is presumed to be available. The calling trunk, in these instances, releases the forward connection under control of the operator and initiates a bid for a new sender to which the digits of the new called station are then transmitted via the data transfer circuit from the operator position.

Each operator position also contains other equipment for serving other miscellaneous types of calls and for providing the assistance required when encountering various situations, as is subsequently described in the detailed portion of the specification.

A review of the circuit operations just described shows that the data transfer circuit comprises a new, novel, versatile, and flexible switching means of large data capacity for interconnecting various combinations of central office circuits on various calls. The specific combination of circuits which are interconnected on each call are dependent on the call type and with the direction and quantity of data flow via the data transfer circuit on each call differs in accordance with the type of call being served. Thus, on both ANI and nonANI MF calls, the data transfer circuit is used once per call to interconnect the incoming trunk, the position circuit, and the sender in order that the trunk and the sender may transmit to the position circuit the information required by the operator for serving the call and for subsequent charge data recording purposes. The information transmitted by the sender includes both the calling and called numbers for ANI calls and only the called number for nonANI calls.

The data transfer circuit is used twice on both ANI and nonANI DP calls. The first usage occurs when the data transfer circuit interconnects the DP register, the incoming trunk, and the sender in order that the trunk and the register may transmit information to the sender. The called station digits are included in the information transmitted from the register to the sender at this time. The second usage of the data transfer circuit occurs when it interconnects the incoming trunk, a position circuit, and the sender in order that the sender and incoming trunk may transmit information to the position circuit. The calling and called numbers are transmitted from the sender to the position circuit at this time for ANI calls. Only the called number is transmitted for nonANI calls.

The data transfer circuit is also used twice on both ANI and nonANI dial 0 calls. The first usage on nonANI dial 0 calls takes place when the data transfer circuit interconnects the incoming trunk with a position circuit in order that the trunk may transmit call setup information to the position. The second usage occurs subsequently when,



after the operator has orally obtained the calling and called numbers from the calling subscriber, the data transfer circuit is called in to interconnect the incoming trunk, the position, and the sender in order that the trunk and the position may transmit the information to the sender required by it to complete the call. The called station number is included in the information transmitted from the position to the sender at this time.

The first usage of the data transfer circuit on a dial 0 ANI call occurs after the sender has registered the calling number. At this time, the data transfer circuit is called in to interconnect the incoming trunk, the position circuit and the sender in order that both the trunk and the sender may transmit information to the position. Included in the information transmitted from the sender to the position at this time is the calling number which is received via ANI and registered in the sender. The second usage of the data transfer circuit is the same as for a dial 0 ANI call, where the data transfer circuit is called in to interconnect the trunk, the sender and the position in order that the trunk and the position may transmit to the sender the information required by it to complete the call.

Reviewing the combinations of circuits interconnected by the data transfer circuit at various times for the different types of calls, it may be seen that the incoming trunk is interconnected sometimes with the position, at other times with the sender, and at other times with both circuits. The sender is interconnected at different times with the register, the trunk, and the position circuit. Similarly, the position circuit is interconnected at various times with the incoming trunk and the sender. The data transfer circuit provides an efficient interconnecting means for performing these varied connecting requirements where the connections may differ from one another both in the circuit interconnected and the direction of data flow between the connected circuits.

A typical office may include 500 to 2,000 incoming trunk circuits, 100 to 330 operator position circuits, 100 to 200 sender circuits, and 100 to 200 register circuits. Heretofore, the interconnection of any two types of circuits in a switching system required the use of separate groups of connectors for each type of interconnection desired. Thus, considering the quantity of circuits and circuit types provided, as well as the number of different interconnections required, it may be seen that a prodigious number of individual connector circuits would be required is such were to be used rather than the disclosed data transfer circuit. The size, quantity, and complexity of the connectors required would, in all probability, be such as to render uneconomical the service provided by the present invention, wherein operator assistance calls are more expeditiously and efficiently served by operators and equipment at a centralized tandem switching center rather than at each and every originating office. My new and novel data transfer circuit makes this entire concept economically feasible by efficiently and expeditiously performing the varied and complex data switching functions required at a tandem switching center operating in accordance with my present invention.

The present invention is shown as part of a tandem or intermediate switching center. It is disclosed in this manner since this is the embodiment in which the invention will initially find its greatest commercial use. However, it is to be understood that the principles of the present invention, including the data transfer circuit, are not limited to use with an intermediate switching center and instead, may, if desired, be used with a local or originating office. The invention will find its greatest use at intermediate switching centers, insofar as the immediate future is concerned, since the expense of the operators and of the required added equipment can be more easily economically justified at an intermediate switching center than it can in most local offices where the volume of special service traffic emanating therefrom would normally not be sufficient to justify the installation of the special service facilities thereat.

An exception to this may be certain local offices which primarily serve business rather than residential customers. In such cases, it well may be that the volume of special services traffic may be sufficient to justify the expense of the special service equipment, including the operators.

A feature of the invention is the provision of a tandem switching center for the serving of operator assistance calls incoming from local offices served on an originating basis by the tandem switching center.

A further feature of the invention is a tandem switching system which, in response to the reception of an operator assistance call, sets up a connection extending to the terminating office in response to information received from the originating office and simultaneously bridges an operator on the incoming connection for providing the assistance requested on the call.

A further feature of the invention is the provision of a tandem switching center having facilities for registering the called station designation on incoming operator assistance calls, for establishing a connection extending to the called station in response to the registration of this information, for simultaneously bridging an operator on the incoming connection, and for automatically recording call charge data under control of an operator.

A further feature of the invention is the provision of a tandem switching system having facilities for directing incoming operator assistance calls to an operator, for registering the called station information orally obtained by the operator, and for recording call charge data under control of an operator.

A further feature of the invention is the provision of a tandem switching system in which a sender simultaneously receives calling information from the originating office for dial pulse calls while it is also receiving called station information from a dial pulse register at the tandem office.

A further feature of the invention is the provision in a switching system of a data transfer circuit for interconnecting the circuits of the system requiring interconnection during the serving of a call.

A further feature of the invention is the provision in a switching system of a flexible interconnecting medium of large data capacity for interconnecting the circuits of the system during the serving of calls.

A further feature of the invention is the provision of a data transfer circuit in a switching system for establishing an auxiliary interconnection between certain circuits on various type of calls.

A further feature of the invention is the provision of a data transfer circuit in a switching system which constitutes a supplementary interconnecting medium for establishing a second interconnection between various circuits which have been priorly interconnected by a first interconnecting medium.

A further feature of the invention is the provision of a data transfer circuit for interconnecting different combinations of circuits in a switching center during the serving of various types of calls by the center.

A further feature of the invention is the provision of a data transfer circuit in a switching system for interconnecting various combinations of circuits in the office at various times during the serving of various types of calls.

A further feature of the invention is the provision of a data transfer circuit in a switching system for interconnecting various numbers of circuits various numbers of times during the serving of various types of calls.

A further feature of the invention is the provision of an interconnecting means connectable to two or more circuits which have been priorly connected for establishing an additional interconnection between the circuits.

A further feature of the invention is the provision of a data transfer circuit in a switching system for interconnecting various combinations of the circuits of the systems on various calls where the circuits to be inter-



connected, the time the circuits are to be interconnected, and the number of times per call the circuits are to be interconnected, vary in accordance with the type of call.

These and other objects and features of the invention may be more readily understood when taken in connection with the following description and drawing which together disclose an exemplary embodiment of the invention and in which drawing FIGS. 1A, 1B, 1C and 1D, when arranged as shown on FIG. 1E, diagrammatically illustrate the relationship between the various units of apparatus comprising the present invention;

FIGS. 2A, 2B, 2C, and 2D, when arranged as shown on FIG. 2E, diagrammatically disclose the data transfer circuits together with the circuits of the office with which it cooperates;

FIGS. 3A through 3K, when arranged as shown on FIG. 3L, diagrammatically disclose in further detail the same circuits and circuit relationships shown in FIGS. 2A through 2D;

FIG. 4 diagrammatically discloses the relationship between the circuit elements comprising a position link frame;

FIG. 5 diagrammatically discloses further details of the primary A and B switches of a position link frame;

FIGS. 6A, 6B, 6C, and 6D, when arranged as shown on FIG. 6E, diagrammatically disclose the link patterns between the primary, secondary, and tertiary switches of a position link frame;

FIG. 7 diagrammatically discloses the interrelationship between the incoming trunks, the position link groups, and the operator positions, as well as the interrelationship between the units of apparatus comprising a position link group;

FIG. 8A discloses the manner in which the drawing figures should be arranged for the MF-ANI trunk circuit, the MF-nonANI trunk circuit, and the dial 0 nonANI trunk circuit; the manner in which the figures comprising the sender link circuit should be arranged; as well as the manner in which certain figures of the MF-ANI trunk, the MF-nonANI trunk, the dial 0 nonANI trunk, the sender link circuit, and the sender circuit should be arranged with respect to each other so as to indicate the cooperation between circuits;

FIG. 8B discloses the manner in which the figures comprising the dial 0 ANI trunk circuit, the dial pulse ANI trunk circuit, and the dial pulse nonANI trunk circuit should be arranged;

FIG. 8C discloses the manner in which certain figures of the sender circuit, the position link and connector circuit, and the position link controller circuit should be arranged with respect to each other so as to indicate the relationship between circuits;

FIG. 8D indicates the manner in which certain figures of the position link and connector circuit, the position link controller circuit, the key control position control circuit, the position control circuit, and the position circuit should be arranged with respect to each other so as to indicate the cooperation between the circuits;

FIG. 8E indicates the manner in which FIGS. 8A and 8B should be arranged;

FIG. 9A indicates the manner in which the figures comprising the sender circuit should be arranged;

FIG. 9B illustrates the manner in which the figures comprising the position link and connector circuit should be arranged;

FIG. 9C indicates the manner in which the figures comprising the position link controller and the key control position control circuit should be arranged;

FIG. 9D discloses the manner in which the figures comprising the position control and the position circuit should be arranged;

FIGS. 9E and 9F illustrate the manner in which the figures comprising the data transfer circuit should be arranged;

FIG. 9G illustrates the manner in which the figures com-

prising the incoming register link circuit and the register circuit should be arranged;

FIGS. 10 through 15 disclose the circuit details of an incoming MF trunk circuit, both of the ANI and nonANI types;

FIGS. 16A, 16B, and 16C, and 17A, 17B, and 17C, when arranged as shown on FIG. 17D, disclose the circuit details of the sender link;

FIGS. 18 through 72 disclose the details of the sender circuit;

FIGS. 73 through 111 disclose the details of the position link and connector circuit;

FIGS. 112 through 157 disclose the details of a position link controller circuit;

FIGS. 158 through 161 disclose the details of the key control position control circuit;

FIGS. 162 through 204 and 222 together disclose the details of a position control circuit;

FIGS. 205 through 221 and 223 disclose the details of an operator position circuit;

FIGS. 224 through 298 disclose the details of the data transfer circuit;

FIGS. 299 through 306 disclose the details of an incoming dial pulse trunk circuit, both of the ANI and non-ANI type;

FIGS. 307 through 321 disclose the details of the incoming register bylink circuit;

FIGS. 322 through 337 disclose the details of a dial pulse register circuit;

FIGS. 338 through 347 disclose the details of an incoming dial 0 trunk circuit equipped for ANI operation; and

FIGS. 338A through 347A disclose the circuit details of an incoming dial 0 trunk circuit equipped for nonANI operation.

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### Apparatus designations

Each relay shown on the drawings is given a designation comprising one or more letters, or one or more digits, or a combination of letters and digits. In some instances these designations are purely arbitrary, while in others they are related to the circuit functions of the relay. Since the detailed circuitry of the present invention is shown on many separate figures, each discussion of a relay in the body of the specification prefixes the normal designation of the relay, as shown on the drawings, with the digits of the drawing figure on which the controlling winding of the relay appears. Thus for example, relay SA on FIG. 10 is referred to as relay 10-SA in any circuit discussion involving relay SA; and, similarly, relay OTA on FIG. 138 is referred to as relay 138-OTA. However, in order to avoid undue repetition, this identification scheme is used selectively; and if repeated reference is made to a particular relay or a particular group of relays, the figure-identifying prefix is utilized only once or twice at the beginning of the discussion and is not repeated each and every time a relay is mentioned. In other words, this identification scheme is used selectively and judiciously in such a manner as to facilitate an identification of the figure on which the controlling winding of each relay is located and, at the same time, to avoid the monotony and repetition that would be the case if each and every occurrence of a relay in the body of the specification were preceded by its figure-identifying prefix.



Relay contacts are shown separated from their associated controlling windings on the drawings. Contacts which are closed when a relay is operated (make contacts) are represented by an X superimposed on the interconnecting conductors. The two portions of a conductor on opposite sides of the superimposed X are not connected with each other until such time as the contacts represented by the X are closed by the controlling relay winding. Contacts which are opened upon the operation of a relay (break contacts) are represented by a short line perpendicular to and intersecting the connecting conductors. The two portions of a conductor on opposite sides of the superimposed break contact symbol are normally connected to each other via the break contacts. The same two conductor portions are disconnected from each other as the break contacts are opened upon the energization of the controlling relay winding.

A considerable portion of the data transfer circuit is disclosed in coordinate form, in which the conductors representing each data channel are shown as horizontal lines while the conductors representing the various connectors having access to each channel are represented as vertical lines. Thus for example, referring to FIG. 274, channels 0, 1, 2, and 3 are represented by the four horizontal lines on the bottom of the figure while the conductors comprising position connectors 0 through 6 are represented as vertical lines.

The intersection of each connector conductor with a channel conductor has superimposed thereon an X enclosed within a small circle whose diameter approximates that of the X. Each such symbol represents a make contact which, when closed, interconnects the data channel conductors and the connector conductors common to the encircled X symbol. Thus for example, on FIG. 274 the encircled X symbol common to data channel 0 and position connector 0 is designated 225-OPRF0. The conductors of channel 0 and position connector 0 are not connected with each other when relay 225-OPRF0 is unoperated. The operation of this relay closes its make contacts common to channel 0 and position connector 0 and thereby interconnects their conductors. The portions of the conductors of channel 0 on each side of make contacts 225-OPRF0 are continuous and are interconnected with each other at all times, regardless of the operated or unoperated condition of the relay contacts. The same is true of the portions of the conductors of position connector 0 shown above and below these contacts. In short, contacts represented by an encircled X may be considered to be analogous to contacts of crossbar switches in that they serve to interconnect, when operated, the vertical conductor and the horizontal conductor common to the contact represented by the encircled X symbolization.

Similarly, an encircled X symbolization is used for the make contacts which may be closed to interconnect the various connectors with the individual circuits served thereby. Thus, contacts 224-PF00 on FIG. 274 may be closed to interconnect the conductors of position connector 0 with those of position circuit 00. Each relay contact is designated in a manner which indicates the figure on which the controlling relay winding appears as well as the drawing designation of the winding. For example, referring to relay RV on FIG. 10, its operating circuit includes make contacts 10-SA; and its holding circuit includes make contacts 13-PA and 15-D1. The controlling windings for these three contacts are shown on FIGS. 10, 13, and 15, respectively, and are respectively designated SA, PA, and D1.

There are a number of instances on the present drawings where groups of relays are disclosed in which each relay in the group has a designation which differs from that of other relays in the group only by a final digit or combination of digits. For example, on FIG. 69 there is a group of relays designated A0, A1, A2, A4, and A7. In the following description, groups of relays such as these are sometimes discussed by identifying the entire group

as the 69-A-relays where the final dash may be understood to represent the numerical designation of each relay in the series. This abbreviated form of designation permits the circuit function of the entire relay group to be discussed conveniently without the necessity of enumerating each and every relay therein each time reference is made to the group.

The system comprising the present invention utilizes circuits of considerable size and complexity. Therefore, in order to minimize the number of circuit drawings required, circuits which, in turn, are composed of a plurality of subcircuits which are identical or similar to each other are illustrated on the present drawings by disclosing the details of each type of subcircuit only once and by disclosing the remaining subcircuits diagrammatically. For example, referring to FIG. 262, the NCN conductor of channel 0 is connected to a relay designated NCN, with the winding of the relay being connectable via make contacts 262-NCN and 293-RC10 to ground. These circuit details are shown only for channel 0 and are enclosed within a rectangle designated AA. The remaining data channels are each similarly connected to an equipment rectangle designated AA. However, no circuit details are shown inside of the AA rectangles for these channels and it is to be understood, in instances such as this, that each AA equipment rectangle having no specific circuitry shown therewithin actually includes circuitry similar or identical to that of the AA rectangle whose details are shown. This expedient reduces considerably the quantity of drawing figures required. For example, FIGS. 293, 294, and 295 disclose a plurality of YY equipment rectangles, with the one YY rectangle whose circuit details are shown being disclosed on FIGS. 293 and 294, while the remaining three YY rectangles are all disclosed on the single FIG. 295.

The size of the present specification has been further minimized by disclosing only diagrammatically various circuits which are by now well known in the switching art. This expedient has been utilized extensively for certain of the many translators, symmetric circuits, and check circuits utilized by the present invention. For example, a plurality of symmetric check circuits are represented by rectangles on the bottom of FIG. 287. All of the symmetric circuits on this figure, as well as those on the other figures, may be of the general type disclosed on page 61 and elsewhere in *The Design of Switching Circuits*, by Keister, Ritchie, and Washburn, D. Van Nostrand Company, 1951, New York City, N.Y. All such symmetric circuits are operable to extend an input signal therethrough to one of a plurality of output conductors in accordance with the number of relays operated whose contacts comprise the symmetric.

Referring to the symmetric which is shown in detail in the upper right-hand corner of FIG. 287, for example, its input may be said to comprise terminal 110, and any potential or signal on its input may be extended through the symmetric to one of output terminals 115, 114, or 113, depending upon whether no relays are operated, one relay is operated, or two relays are operated, respectively. Terminal 115 may be said to be the 0-out-of-3 terminal since it is energized when none of the three OA0, OA1, or OA2 relays are operated. Terminals 114 and 113 may be said to be the 1-out-of-3 and 2-out-of-3 output terminals, respectively, since they will be energized whenever one or two of these relays are operated.

The symmetric circuit shown on the lower left-hand corner of FIG. 287 is represented only diagrammatically by a rectangle, with the identification of the relays whose contacts comprise the symmetric being indicated within the rectangle. This symmetric circuit, as well as all other symmetric circuits shown diagrammatically in the present specification, is similar to the symmetric circuit just described in that its input terminal is always shown on the left side while its output terminals are shown on the right side of the rectangle representing the circuit. Also, each output terminal is designated in such a manner so as to



indicate under what conditions an input signal will be extended through the symmetric to the specified output terminal. Thus, a signal on input terminal 119, for example, will be extended to output terminal 120 whenever one of the nine relays comprising the symmetric is operated. This 1-out-of-9 upcheck signal provides an indication that one, and only one, of the nine relays comprising the symmetric is operated. Information such as this is useful to the circuits comprising the present invention to ensure that information has been received and registered in the proper combinational code form.

Output terminal 126 is shown to indicate an error condition and it is connected to all other levels of the symmetric other than the one associated with specified 1-out-of-9 upcheck terminal which indicates a successful registration. In the symmetric shown on the upper right-hand corner of the figure, output terminal 114 is the 1-out-of-3-upcheck terminal and represents a successful operation of the circuit. Terminals 115 and 113 are, respectively, the 0-out-of-3 and 2-out-of-3 output terminals; they represent undesired circuit conditions and are consequently strapped together and utilized as an error signal by operating relay TDE0.

The symmetric circuits shown diagrammatically elsewhere throughout the present drawing have different ones of their output conductors representing upcheck signals in accordance with the manner in which their associated relays are to be combinationally operated. Thus, for example, the symmetric shown on the lower right-hand corner of FIG. 287 has its 2-out-of-5 output terminal 124 representing an upcheck condition while the remainder of its output terminals represent an error condition and are connected to terminal 121.

Referring now to FIG. 239, there is shown in the lower right-hand corner a rectangle designated 2-out-of-5 to 1-out-of-10 translator. Combinational code translators of this type are also well known in the switching art and, further, such translators are shown on page 298 and elsewhere in the aforementioned Design of Switching Circuits. Terminal 102 on FIG. 239 represents the input terminal of the 2-out-of-5 to 1-out-of-10 translator, and a signal on this input terminal is connected to one out of the ten output conductors DGN0 through DGN9, in accordance with the specific two relays operated of the five relays whose contacts comprise this translator. This translator is designated a 2-out-of-5 to 1-out-of-10 translator since the five relays designated within the confines of the rectangle are operated in 2-out-of-5 code form and, when so operated, permit the aforementioned input signal on terminal 102 to be extended to one of the ten output conductors in accordance with the digit represented in 2-out-of-5 code form by the currently operated relays of the translator.

Other types of translators and check circuits are similarly disclosed only in diagrammatic form throughout the present specification. However, this has been done only with respect to circuits which are well known in the art. The utilization of this expedient minimizes the size and complexity of the drawings and specification and thereby facilitates an understanding of the invention.

#### GENERAL DESCRIPTION

##### *Embodiment of FIGS. 1A, 1B, 1C, and 1D*

The principal circuits of the switching system comprising the present invention, as well as the interrelationship between these circuits, are diagrammatically shown on FIGS. 1A, 1B, 1C, and 1D. The incoming trunk circuits are shown on FIGS. 1A and 1B; the sender link and trunk link on FIG. 1A; the register bylink, the register, the position link and the remainder of the circuits associated with the position link, and the operator position circuit are shown on FIG. 1B; the sender, marker, marker connector, and the outgoing portion of the office, including the office link and the outgoing trunks, are shown in FIG. 1C; the circuits associated with the automatic call

charge data recording operation are shown on FIG. 1D, while the data transfer circuit is shown extending across the bottom of FIGS. 1B and 1D.

The incoming trunks are of two general types, namely, nonspecial service and special service. The present invention does not relate to the form or the manner in which the nonspecial calls are served and, therefore only one nonspecial service trunk is shown. This trunk, which is in the upper left-hand corner of FIG. 1A, may therefore be understood to represent all of the many different types of trunks that may extend nonspecial service calls through the tandem office.

A brief review of the function of the tandem office in serving a nonspecial service call will facilitate an understanding of the manner in which the office serves special service calls. A calling nonspecial service incoming trunk seizes a sender via the sender link and transmits to the sender for registration therein the call information outpulsed from the preceding office. The sender, in response to the registration of this information, calls in a marker via the marker connector and transmits to the marker the information needed by it to set up the call. The marker selects an idle outgoing trunk extending to the called office, and then selects and closes, via the trunk link and office link frames, a connection between the incoming trunk and the selected outgoing trunk. The marker releases, once this path is established, and the sender outpulses forward to the next office, via the sender link and the incoming trunk, the information required by the succeeding office to complete the call. The sender then releases, thereby leaving the connection within the tandem office under control of the incoming trunk.

A nonspecial service call may originate in different types of local offices, and the remainder of the functions of the tandem office in serving such a call vary in accordance with the manner in which the originating office is equipped. For example, the originating office may be equipped with its own AMA or other charge data recording equipment. If this is the case, all call details necessary for charging purposes are recorded at the local office and no recording operation need be performed by tandem; therefore, its functions on such a call are completed once a connection has been established there-through to the terminating office and after the tandem marker and sender have released.

Other types of local offices may not have their own charge data recording equipment, and therefore the extension of a call from such an office through tandem requires that charge data be recorded at tandem. In this case, the call identity indexer obtains and transmits to the recorder the necessary incoming trunk information, while the transverter obtains from the sender and transmits to the recorder the remainder of the call information necessary for billing purposes, including the calling and called numbers. If the originating office is equipped for automatic number identification, this information is outpulsed to the sender along with the called station information, and the charge data recording operation is automatically completed at the tandem office. However, if the originating office is not equipped for automatic number identification, the sender calls in the CAMA position link which interconnects via the position control and operator position circuit an operator onto the calling connection who orally obtains the calling station number and keys it into the sender from her position. This information is then subsequently transmitted by the sender to the transverter along with the called station information to enable the recording equipment to make the necessary call charge records in essentially the same manner as for calls for which the calling and called numbers are received automatically from the originating office.

The operation of the tandem office of the present invention for the serving of the three most prevalent types of nonspecial service calls has just been described. The tandem office may also serve a miscellany of other types



of nonspecial service calls; however, these are both comparatively infrequent and of a sufficiently specialized nature so that no further discussion of them is required.

Special service calls are received on one of the special service trunks at tandem in accordance with the manner in which the originating office is equipped. The special service trunks may be generally classified in accordance with two parameters of the associated originating office for calls extended to each special service trunk, namely, the type of outpulsing (or a lack thereof) utilized by the originating office for the called number information, as well as whether or not the originating office is equipped for automatic number identification. Thus, of the six special service trunks shown on FIGS. 1A and 1B, there are two MF trunks, two dial 0 trunks, and two dial pulse trunks. One of the two trunks in each class is associated with an originating office equipped for ANI operation while the other trunk is associated with an office equipped for nonANI operation. The MF trunks serve calls from originating offices which outpulse called number information forward in MF form, the dial pulse trunks serve calls from offices which outpulse called number information in dial pulse form, while the dial 0 trunks serve calls for which no called number is outpulsed by the originating office. The ANI information is always outpulsed by the originating office is MF form, regardless of whether the call is of the MF, DP, or the dial 0 type.

A calling MF-ANI trunk seizes a sender via the sender link and transmits calling and called number information thereto from the originating office. The sender registers this information and transmits either all or a portion of it to the marker, which sets up a connection between the incoming trunk and a selected outgoing trunk in the same manner as described for nonspecial service calls. Next, the sender transmits a signal, via the sender link, instructing the trunk to seize the position link, which, in turn, interconnects the calling trunk with an operator via the position control and position circuit. While the position circuit is being attached, the sender outpulses via the sender link and the incoming trunk the information forward to the next office to enable that office to either complete or further extend the connection. The operator who is connected to the calling connection at the incoming trunk; converses with the calling party to ascertain the nature of special services required on the call, and then furnishes these services before releasing from the connection.

It is necessary that the operator receive at her position, from the trunk and the sender, various items of data concerning the call. This is necessary both for her own information and because of the fact that the transverter obtains from the position control circuit a number of items of call data which must be recorded for subsequent billing purposes. Thus, immediately after the position control circuit is interconnected with the incoming trunk via the position link, the data transfer circuit interconnects the calling trunk, the position control circuit, and the sender, via the conductors T, P, and S, respectively, in order that the trunk and the sender may transmit various items of call data to the position control circuit. The data transfer circuit releases after this information is received and registered in the position control circuit. The operator, after having furnished the required call assistance, depresses keys at her position which transmit to the transverter via the transverter connector the information required by the recorder for subsequent billing purposes, and which finally release her connection with the incoming trunk via the position link.

The system operation is essentially the same for MF-nonANI calls, except that in this case the calling station number is not received automatically from the originating office and registered in the sender. Instead, the operator receives an indication instructing her to orally obtain this information from the calling subscriber and key it into registers at her position.

A calling dial 0 ANI trunk immediately seizes a sender via the sender link and transmits the calling number to the sender. The sender also receives an indication that no called station information will be automatically forthcoming on this call. It therefore instructs the incoming trunk to interconnect itself with an operator position circuit via the position link. The data transfer circuit then interconnects the incoming trunk, the position circuit, and the sender in order that the trunk and the sender may transmit information to the position circuit, with the information transmitted by the sender including the calling station number. The data transfer circuit releases after this information is received and registered in the position circuit. The sender and the sender link also release at this time.

The operator has by now received a signal informing her that this is a dial 0 call and that, therefore, she will have to obtain the called station number orally from the calling subscriber and key it into the system. After she has obtained and keyed this information into registers at her position, she depresses a key which transmits a signal via the position link to the trunk instructing it to bid for a connection to a sender. Once the sender is attached, the trunk, the position, and the sender are interconnected via the data transfer circuit in order that the information required for the completion of the call by the remainder of the office may be transmitted from the position and trunk to the sender. The data transfer circuit releases, once this information is received and registered in the sender, following which the sender, together with the marker, establish the remainder of the connection to the called office in the same manner as previously described. The operator may, after the called station answers, furnish any further required assistance before releasing from the call and causing the recording of the necessary charge information.

The system operation for a dial 0 nonANI call is similar to that of a dial 0 ANI call, except that only one usage of a sender is involved. In this case, the incoming dial 0 nonANI trunk immediately interconnects itself with an operator position circuit via the position link. The data transfer circuit then interconnects the incoming trunk and the position circuit in order that the trunk may transmit call data to the position. Included in this data is an indication that this is a dial 0 nonANI call and that therefore the operator will have to obtain orally and key into registers at her position both the calling and called station numbers. Once having done this, she causes the incoming trunk to bid for a connection to a sender via the sender link. The data transfer circuit then interconnects the incoming trunk, the position circuit, and the sender in order that the information required by the rest of the office to extend the call may be transmitted from the position circuit to the sender. Following this, the connection to the terminating office is established and the necessary call assistance is provided by the operator in the same manner as on dial 0 ANI calls.

A calling dial pulse ANI trunk first seizes a register via the register link. The register then registers the called station information received in dial pulse form from the originating office. Following this, the register instructs the trunk to seize a sender via the sender link. The sender then registers the ANI information which is received in MF form. At the same time, once the called station information has been received by the register, the data transfer circuit interconnects the incoming trunk, the register, and the sender, in order that the trunk and the register may transmit information to the sender, with a portion of the information transmitted by the register including the called station digits. The data transfer circuit releases following the successful registration of this information in the sender.

The sender by now has registered therein both the calling and called station numbers, as well as other information pertaining to the call, and it now causes the incoming trunk to seize a position circuit via the position link.



Once this connection is established, the data transfer circuit is called in to interconnect the incoming trunk, the position and the sender, in order that the trunk and the sender may transmit call information to the position circuit. The data transfer circuit releases as soon as this information is successfully registered in the position circuit. The marker and the sender cooperate in the same manner as previously described to set up the connection forward to the called station, following which the operator furnishes the requested assistance on the call before releasing from the connection and initiating the recording of the necessary charge data.

Dial pulse nonANI calls are served in the same manner as the dial pulse ANI calls, with the exception that the calling station information is not automatically received from the originating office and registered in the sender, and therefore, it is orally obtained by the operator and keyed into the system as is the case for MF-nonANI calls.

The present invention is not concerned with the details of the circuits comprising the outgoing portion of the office which extends a connection from the incoming trunk to the terminating office. Further, the invention is not concerned with the circuit details of the circuits involved in the call, charge-data recording operation or with the circuit details of the CAMA position link. None of these circuits are shown in the present specification except on the block diagram of FIG. 1 since either similar, analogous, or identical circuits are well known in the various tandem switching systems of the prior art. For example, Patent 2,848,543 of Aug. 19, 1958, to R. N. Breed et al., together with the patents referred to therein, discloses a crossbar tandem switching system equipped for CAMA operator identification of the calling station together with the automatic recording of charge data for the CAMA calls served by the office. Reference is hereby made to the Breed et al. patent, together with the patents cited therein, for a detailed description of the marker, the marker connector, the trunk link, the office link, the outgoing link, the recorder, the transverter and transverter connector, the billing indexer, the master timing circuit, and the call identity indexer circuit.

The system of the present invention transmits call data to recording equipment which by now is well known to those skilled in the art as Automatic Message Accounting Equipment (AMA), in which three entries, designated as an initial entry, an answer entry, and a disconnect entry, are placed on a record chronologically in the order of their production and are interspersed among similar entries for other calls established by other trunks served by the recording equipment. This recording equipment comprises the call identity indexer, the recorder, the master timing circuit, the transverter and transverter connector, as well as the billing indexer shown on FIG. 1D of the drawings. A similar recording system is described in the aforementioned Breed et al. patent and is further described in detail in Patent 2,688,658 of Sept. 7, 1954, to W. W. Carpenter et al., as well as in the prior art patents referred to therein. Another crossbar tandem system of the prior art is shown in Patent 2,559,312 of July 3, 1951, to J. B. Newsom, together with the patents referred to therein.

The details of the terminating or succeeding offices to which call information is outpulsed by the tandem sender are of no consequence to the present invention, and therefore, such offices may be of any suitable type well known in the prior art. The same is true of the local offices served on an originating basis by the present invention, and therefore they too may be of any type well known in the art. The operation of the system comprising the present invention is described in detail for calls incoming from offices utilizing multifrequency and dial pulse outpulsing of the called number information, as well as from offices which, for some calls at least, outpulse no called number information. All such types of outpulsing are by now well known in the art, and therefore the present invention is not concerned with the details of how the calls are

served in the originating office, nor in the manner in which the outpulsed information is generated.

The operation of the system comprising the present invention is also described for calls incoming from offices equipped for automatic number identification as well as from offices which are not equipped with such facilities. The automatic number identification equipment at the local offices may advantageously be of the type shown in Patent 3,071,650 of Jan. 1, 1963, to H. D. Cahill et al., or of the type shown in Patent 2,672,515 of Mar. 16, 1954, to D. S. Barlow. The Cahill et al. patent, together with the patents cited therein, discloses an originating office equipped for automatic calling number identification in which the originating office extends a connection to a tandem or toll switching center and then identifies and automatically outpulses calling station information to the sender in the next office in response to a polarity reversal of the outgoing trunk, by the tandem or toll office as it is ready to receive the calling station information. The tandem sender of the present invention is designed to work with automatic number identification facilities of this type, and it is described in detail in the present invention how the tandem sender reverses the trunk polarity back to the originating office when it is ready to receive calling station identification information. It is further described herein in detail how this information is subsequently registered in the sender.

A substantial portion of the novelty of the present invention relates to the interrelationship between the special service trunks, the position link and link controller, the position control circuit, the position circuit, and the operator position, the sender, the register and register link, and the data transfer circuit, including the manner in which the data transfer circuit is operable to interconnect various combinations of trunks, registers, positions, and senders on different calls. The interrelationship between these circuits is subsequently discussed generally in connection with the drawings comprising the various FIGS. 2. It is discussed in further detail in connection with the drawings comprising the various FIGS. 3, and is discussed in complete detail in connection with the detailed drawings. The key control position control circuit and the traffic regulator are shown and described in the detailed portion of the specification. The only thing that need be understood concerning these two circuits at the present time is that they control the position link and the position control circuits so as to provide equitable service for the different types of incoming special service calls, as well as to provide an equitable distribution of these incoming calls to the various operator position circuits in accordance with the type of traffic that may be served by each position circuit.

Each operator is associated with an operator position which comprises the physical switchboard at which the operator is stationed, an operator position circuit which includes the electrical components within her switchboard, and a position control circuit. This latter circuit includes the circuitry which cooperates with the data transfer circuit, the link controller, the key control position control circuit, the transverter connector, and the CAMA position link circuit, for receiving from these various circuits information required by the operator position circuit. The position control circuit also transmits to these same circuits information from the operator position circuit. The position control circuit, the position circuit, and the operator position are shown to comprise three different units of apparatus, rather than one, for the sole reason that each of the three may be physically separated from the other two by varying distances, depending upon the requirements of the office. However, for simplicity in discussion and ease of understanding, these three circuits may be considered as one and may be generically referred to as the operator position circuit. This terminology is used extensively throughout the remainder of the specification, and therefore it is to be understood that when a state-



ment is made indicating that a connection is made to, or that information is transmitted to or from, an operator position circuit, it is to be understood that this, of necessity, includes the related operator position control circuit and the related operator position apparatus.

*Basic layout of data transfer network—embodiment of FIGS. 2A-2D*

FIGS. 2A through 2D diagrammatically disclose the data transfer circuit together with the different central office circuits which may be interconnected with one another via the data transfer circuit during the serving of calls. The data transfer circuit may be functionally divided into two parts, namely, control circuitry and interconnecting circuitry. The control circuitry is that which directs and regulates the operation of the overall circuit; the interconnecting circuitry comprises the circuit paths which may be closed to interconnect the central office circuits served by the data transfer circuit. The data transfer circuit is disclosed on FIGS. 2A through 2D in a manner which highlights its interconnecting functions in order that the basic overall operation and purpose of the circuit may be better understood. The control circuitry is subsequently described in some detail in connection with FIGS. 3A through 3K.

Referring again to the drawings, the data transfer circuit is shown mostly on FIGS. 2C and 2D, while the position and position control circuits, the registers, senders, and trunk circuits which may be interconnected via the data transfer circuit are shown on FIGS. 2A and 2B. FIG. 2B also shows a link connector, a register link, and a sender link, since some of the functions performed by these circuits are intimately involved in the overall operation of the data transfer circuit.

**DATA CHANNELS**

The data transfer circuit, for the purpose of disclosing a greatly simplified version thereof, is shown as being basically comprised of four data channels, or groups of communication paths, which are represented by the four horizontal lines on the lower portion of FIGS. 2C and 2D. Each channel can, independently of the other three channels, interconnect the combination of central office circuits requiring interconnection on a call; thus, the provision of four channels enables the data transfer circuit to serve four different calls simultaneously. Inasmuch as the present drawings are essentially diagrammatic in nature, it is to be understood that each line representing a circuit path may comprise a plurality of conductors and that the specific number of conductors is irrelevant to the present discussion.

**ACCESS CAPABILITIES**

The central office circuits which may be interconnected by the data transfer circuit are functionally divided into groups, and each circuit is connectable to the four data channels via a connector individual to its group. The present disclosure assumes that the data transfer circuit serves 66 operator positions, 100 registers (FIG. 2A), 100 senders and 1000 trunk circuits (FIG. 2B). The 66 position circuits, designated "00" through "65," are divided into seven groups, comprising six groups of ten and one group of six, each such group being individual to and served by one of the position connectors "0" through "6" (FIG. 2C). The registers (FIG. 2A) and senders (FIG. 2B) are divided into ten groups of ten. Each such register group is served by one of the ten register connectors "0" through "9" (FIG. 2C), and each sender group is served by one of the ten sender connectors "0" through "9" (FIG. 2D). The 1000 trunk circuits (FIG. 2B) are divided into ten groups of 100 circuits, each such group being served by one of the trunk connectors "0" through "9" (FIG. 2D).

**FUNCTIONAL DESCRIPTION**

An interconnection is completed between two or more circuits via the data transfer circuit by first closing the

contacts common to the circuits to be interconnected and to their connectors and, secondly, by closing the contacts common to these connectors and to the data channel that will serve the call. The relays which control the closure of the contacts interconnecting a connector with one of the circuits served by it are designated "primary relays"; the relays which control the contacts interconnecting a connector with one of the four data channels are designated "secondary relays."

**BIDDING FOR DATA CHANNEL**

Each position circuit and each register circuit can apply a signal to its respective connector requesting interconnection via an idle data channel to other circuits of the office. The remaining circuits, namely, the senders and trunks, may be connected to a data channel only in response to a request to that effect from either a position or a register circuit. The function of the data transfer circuit in response to a bid from a register is to interconnect the bidding register with the sender serving the same call, in order that information, including the called number, may be transmitted from the register to the sender. The function of the data transfer circuit in response to a bid from a position is to interconnect the bidding position with the trunk and the sender serving the same call, in order that these circuits may interchange call data. The precise nature and quantity of the information interchanged, as well as the direction of data flow, varies for different types of calls.

**BID BY REGISTER**

If a register is the bidding circuit, the register connector serving the bidding register connects itself to the register and then, in turn, signals a request for a connection to an idle data channel. The control circuitry (FIG. 2D) receives this request and connects the bidding register connector to an idle data channel. Once the connection between the bidding register connector and a data channel is completed, the register transmits information to the control circuitry, which enables the channel to extend the connection from the bidding register to the sender serving the same call. The connection between the channel and the sender is established by first closing the necessary contacts to interconnect the sender with its sender connector, and by then closing the contacts necessary to interconnect this sender connector with the proper data channel. The register transmits called number information to the sender when the connection via the data channel to the sender is completed. After this information is satisfactorily registered in the sender and checked by the control circuitry, the register and the sender are released from the data channel, thereby enabling the register and sender connectors, as well as the data channel, to release and serve subsequent calls.

**BID BY POSITION**

If a position is the bidding circuit, the position connector associated with the bidding position receives the bid and interconnects itself with the bidding position. Once this connection is established, the position connector transmits a request for a connection to an idle data channel. The control circuitry closes the necessary contacts to connect the bidding connector with an idle data channel. The bidding position next transmits information to the control circuitry, which information enables the data transfer circuit to determine the identity of the trunk and of the sender with which it is to be interconnected via the data channel. The data channel interconnects itself with the identified trunk circuit by first closing the contacts common to the channel and to the trunk connector associated with the trunk, and by then causing the necessary contacts to be closed to interconnect this trunk connector with the proper trunk. At the same time that the data channel is extending a connection between itself and the trunk, it transmits a signal via the position connector, the bidding position, the link connector, and the sender link to the



sender, on calls where a sender is associated with and is serving the same call. The sender, in response to this signal, controls the establishment of a connection, via its sender connector, to the data channel serving the call. Once the position, sender, and trunk circuits are all connected to the same data channel, the necessary call data is interchanged via the data channel. The precise nature of the data interchanged, as well as the direction of data flow, varies with the type of call. After the transmitted data is satisfactorily registered in the receiving circuits, the position, sender, and trunk connectors, as well as the data channel utilized, are all released, thereby freeing them for the serving of subsequent calls.

#### *Illustration of specific calls*

##### *MF Call—Position to sender and trunk connection*

In order to illustrate the functions of the data transfer circuit during the serving of a specific call, let it be assumed that MF trunk "00" is currently serving an incoming call; that it is currently connected to sender "00" via the sender link; and that, in addition, it is currently connected via the link connector (FIG. 2B) to position "00" (FIG. 2A). Trunk "00," being of the multifrequency (MF) type, does not require the services of a dial pulse register. This being the case, the function of the data transfer circuit for this call is to interconnect position "00" with sender "00" and trunk "00" in response to a bid from the position.

Position "00" (FIG. 2A) sends a "start" signal to position connector "0" (FIG. 2C), requesting a data channel in response to a signal from sender "00" (FIG. 2B). This signal is transmitted from the sender, via the closed crosspoints of the sender link, through MF trunk circuit "00," through the closed crosspoints of the link connector (FIG. 2B), to position "00" (FIG. 2A). Upon the reception of this "start" signal, position "00" transmits a bid for an idle data channel to position connector "0" (FIG. 2C) which serves positions "00" through "09." This position connector, as well as all other position and register connectors, has preference circuitry which ensures that only one of a plurality of simultaneously bidding circuits may be successful in obtaining a connection to it. Let it be assumed that position "00" is the only bidding position in its group or, that in the event of simultaneous bids, it is the preferred one and is, therefore, successful in obtaining a connection to its connector. The interconnection of position "00" with position connector "0" closes primary contacts P00 (FIG. 2C) which are common both to the conductors of position "00" and to those of position connector "0."

##### *BID FOR IDLE DATA CHANNEL*

Once position "00" (FIG. 2A) is connected to position connector "0," the connector initiates a bid for a connection to an idle one of the four data channels. Each register connector and position connector is connectable to the data channels under control of preference circuitry which equitably allocates between the four data channels all requests for service and, additionally, provides for an orderly sequence of operation in the event of simultaneous requests for a connection to the same data channel. Let it be assumed that position connector "0" is successful in obtaining, for example, the services of channel "0" (FIGS. 2C and 2D). This results in the closure of secondary relay contacts OPS-0 (FIG. 2C), common to the conductors of channel "0" and of position connector "0."

##### *ASCERTAIN TRUNK IDENTITY*

The next step in interconnecting position "00" (FIG. 2A), trunk "00" and sender "00" (FIG. 2B), once position "00" has been connected to data channel "0," is for the data transfer channel control circuit (FIG. 2D) to ascertain which trunk connector serves trunk "00," and then to close the appropriate trunk secondary relay contacts common to data channel "0" and to this trunk connector.

It may be seen from a study of FIGS. 2B and 2D that trunk "00" is served by trunk connector "0"; and, thus, trunk secondary relay contacts OTS-0 (FIG. 2D) are the ones which should be closed to connect data channel "0" to this trunk connector.

Position "00" receives a plurality of items of information concerning the call, incident to its interconnection with trunk "00" via the link connector. Part of this information represents an identification of the trunk connector associated with the calling trunk. Thus, for this call, position "00" receives information signifying that trunk connector "0" serves the trunk (trunk "00") with which position "00" is currently interconnected via the link connector. The position, in turn, transmits this trunk connector number to the data transfer circuit control circuitry which, in response thereto, closes contacts OTS-0 common to data channel "0" and to trunk connector "0" (FIG. 2D).

##### *CONNECT TRUNK TO CHANNEL*

The data transfer circuit next transmits a signal via data channel "0," contacts OPS-0, position connector "0," contacts P00 (FIG. 2C), position "00" (FIG. 2A), and the closed crosspoints of the link connector to trunk "00" (FIG. 2B). The reception of this signal by trunk "00" causes contacts TP00 (FIG. 2B) to close, thereby interconnecting the conductors of this trunk circuit with those extending to make contacts OTSG0 (FIG. 2D), which are still open. The closure of make contacts TP00 causes make contacts OTSG0 in trunk connector "0" to be closed, thereby completing the interconnection of trunk "00" with data channel "0" and with position "00."

It will be recalled that trunk "00" is currently interconnected with sender "00" via the sender link. The signal transmitted from the data transfer circuit to the trunk, which controls the closing of contacts TP00, is also transmitted through the sender link circuit to sender "00" (FIG. 2B), where it causes the sender to bid for a connection to its sender connector. This service request is received by sender connector "0" (FIG. 2D); and assuming that sender "00" is the only sender of its group currently bidding, or that it is the preferred sender in the event of simultaneous bids, primary contacts S00 common to the conductors of sender "00" and to sender connector "0" are now closed.

##### *CONNECT SENDER TO CHANNEL*

The sender transmits a plurality of items of information to the data transfer circuit, incident to its interconnection with sender connector "0" (FIG. 2D). Included in this information is the number of the trunk connector serving the trunk to which this sender is currently connected via the sender link. Trunk connector "0" (FIG. 2D) serves calling trunk "00" (FIG. 2B) and, therefore, a trunk connector number of "0" was registered in sender "00" (FIG. 2B) at the time it was interconnected with the calling trunk via the sender link. This trunk connector number is transmitted to the data transfer circuit when sender "00" is connected to sender connector "0" by the closure of the sender primary relay contacts S00 (FIG. 2D). The data transfer circuit had priorly received the same trunk connector number from position "00," incident to establishing a connection between position "00" and trunk "00." Therefore, the reception of a trunk connector number of "0" from sender "00," via its sender connector, in essence, constitutes a request that sender connector "0" be connected to the same data channel that is currently connected to trunk connector "0." This request is received by the data transfer circuit and, by means which are described in greater detail in connection with FIGS. 3, the data transfer circuit first ascertains which one of its four channels is currently connected to trunk connector "0," and then closes the proper sender secondary relay contacts to connect sender connector "0" to this channel. Specifically, for the present call, the data transfer circuit ascertains that



channel "0" is currently connected to trunk connector "0," since contacts OTS-0 (FIG. 2D) are closed. It then closes sender secondary relay contacts OSS-0 (FIG. 2D) to interconnect channel "0" with sender "00" (FIG. 2B) via sender connector "0" (FIG. 2D). The closure of these contacts completes the interconnection functions of the data transfer circuit on this call, since position "00," trunk "00" and sender "00" are now interconnected via data channel "0." These three circuits may now exchange the information required for the successful serving of the call.

#### RELEASE OF CONNECTION TO CHANNEL

The position circuit signals the data transfer circuit to release its connection with its sender and with the trunk as soon as it has been determined that the required information has been registered in the receiving circuits. This determination is made by check circuitry associated with the channel serving the call, which check circuit, after ascertaining that the proper registrations have been made, notifies the position to this effect. The release of the data channel "0" from this connection frees the channel for the serving of other calls. The position circuit remains connected to the trunk, via the link connector, until the operator releases the connection after having completed the required services for the call. Thus, for example, on a person-to-person call, the operator would not release the connection, via the link connector, with the trunk until the called station has answered and the operator has determined that the specified called party is available.

#### *DP call—Position to sender and trunk connection and register to sender connection*

It has been described how the data transfer circuit functions in connection with the serving of a typical incoming multifrequency (MF) call. An MF call does not use either the register shown on FIG. 2A or the register links shown on FIG. 2B, since these circuits are utilized only on calls for which the called station information is received in dial pulse (DP) rather than multifrequency (MF) form.

The data transfer circuit is used on DP calls to interconnect a position, a calling trunk, and a sender in a manner similar to that already described for MF calls. Also, the data transfer circuit is utilized earlier on each DP call to interconnect the register with the sender, in order that the called station number, including area code, if any, may be transferred from the register to the sender. The data transfer circuit is first seized on a DP call when the register bids for and obtains a connection to an idle data channel after it has received the called station number and area code digits from the trunk. At this time, by expedients similar to those already described, the data transfer circuit extends a connection, via one of its data channels, from the bidding register to the particular sender which, at this time, is connected via the sender link to the trunk associated with the bidding register. The register transmits the called number to the sender as soon as this connection is established and then releases itself and the data transfer circuit, thereby freeing both of these circuits to serve other calls. The call then progresses to the point where the position, the sender, and the trunk are interconnected in the manner just described for MF calls.

#### *Dial 0 operator call—Sender to position and trunk connection*

The data transfer circuit is used twice on dial 0 calls and the sender is used either once or twice, depending upon whether the call is of the nonANI or ANI type, respectively. For an ANI call, the data transfer circuit on its first usage interconnects the trunk, the position, and the sender, in order that the trunk and the sender may transmit call information to the position, with the call information transmitted by the sender at this time including the calling station information which was automatically received from the originating office. The data transfer

circuit and the sender release after the data transmission operation is terminated. The operator answers the call, determines the called number from the calling party, keys the called number into storage registers at her position, and then depresses a key which causes the data transfer circuit to interconnect the trunk, the position, and a sender, in order that the position may transmit the called number information to the sender. The data transfer circuit releases after ascertaining that this information has been satisfactorily transmitted to and stored in the sender.

On nonANI calls the sender is not seized immediately since no calling station information will be automatically forthcoming from the originating office, and, as a consequence, the incoming trunk, immediately upon its seizure, obtains a connection to an operator position which, in turn, requests an interconnection via the data transfer circuit with the incoming trunk. The data transfer circuit completes this interconnection, and call setup information is then transmitted from the trunk, via the data transfer circuit, to the position circuit. The data transfer circuit releases after ascertaining that this data has been satisfactorily received and registered in the position. The operator now must converse with the calling party and determine from him the calling station number, as well as that of the desired called station. Both numbers are then keyed into storage registers at the position. Following this, the operator depresses a key which, in the manner described for the dial 0-ANI call, causes the data transfer circuit to interconnect the trunk, the position, and a sender, in order that the position may transmit the called station information to the sender. The data transfer circuit releases after this information is received by the sender, and the sender then proceeds with its operation with the marker to complete the remainder of the call.

#### *Block diagram—Embodiment of FIGS. 3A through 3K*

FIGS. 3A through 3K disclose the same basic system relationships as do FIGS. 2A through 2D. In addition, FIGS. 3 contain sufficient added detail to facilitate an understanding of the circuitry utilized to control the interconnecting functions of the data transfer circuit.

#### *Access capabilities*

The embodiment of FIGS. 3A through 3K is similar to that of FIGS. 2A through 2D in that it comprises 66 position circuits "00" through "65" served by 7 position connectors "0" through "6" (FIGS. 3C and 3D), 100 register circuits "00" through "99" served by 10 register connectors "0" through "9" (FIGS. 3E and 3F), 100 sender circuits "00" through "99" served by 10 sender connectors "0" through "9" (FIG. 3G), and 1000 trunk circuits "00" through "999" served by trunk connectors "0" through "9" (FIGS. 3B and 3H). Each trunk connector, in turn, is served by 10 subgroup relays individual thereto, with the subgroup relays for trunk connector "0" being designated 263-0TSG0 through 263-0TSG9, and, likewise, with the subgroup relays for trunk connector "9" being designated 263-9TSG0 through 263-9TSG9 (FIGS. 3B and 3H). FIG. 3A also contains a link connector, a register link, and a sender link for performing the same interconnecting functions priorly described for FIGS. 2A through 2D. The data transfer circuit, similarly, comprises four channels, respectively designated "0" through "3," which are represented by the four groups of conductors extending horizontally between figures (FIGS. 3C through 3H).

#### *Elementary description of functional units and terms used*

There are a number of distinctions between the showing of FIGS. 2A through 2D and that of FIGS. 3A through 3K which deserve comment at this point. All of these distinctions relate to the manner in which added detail has been incorporated into the embodiment of FIGS. 3. Each channel is represented by a single line on FIGS. 2. It was priorly explained in connection there-



with that each such line may comprise as many conductors as may be necessary for performing the required interconnecting functions. Each data channel on FIGS. 3 is shown, not as a single line, but instead, as a plurality or group of lines. On FIGS. 3C through 3F, each channel comprises four such lines; while on FIGS. 3G and 3H, each channel comprises two lines. Except where indicated to the contrary, it is to be understood that each line does not comprise a single conductor, but, instead, comprises a plurality of conductors, the specific number of conductors being irrelevant to the present discussion. The fact that four lines are associated with each data channel on FIGS. 3C through 3F, and that only two lines are associated therewith on FIGS. 3G and 3H, functionally indicates that the quantity of data transmitted over the channels on FIGS. 3G and 3H is less than for the channels on FIGS. 3C through 3F.

The expedient of representing a plurality of conductors by a single line has been extensively used on FIGS. 3 to facilitate an understanding of the circuit concepts involved. A departure has been made from this expedient in a few instances in order to describe certain aspects of the channel control circuitry. Other than where stated to the contrary, however, it should be understood that each line may represent as many conductors as may be necessary to perform the indicated functions of the circuitry represented by the line.

A further distinction between the showing of FIGS. 2 and that of FIGS. 3 is that the circuit components, including relays and their contacts, are designated in a simplified manner on FIGS. 2 as compared to the designation of the same elements on the detailed drawings. This was done for FIGS. 2 in order that an understanding of the overall functions of the circuit would not be impeded by the complexity of the designations used.

On the other hand, each element on FIGS. 3 bears the same designation it does on the detailed drawings, in order to facilitate a comparison between the detailed drawings and those of FIGS. 3. In order to further facilitate this comparison, many circuit elements, including relay windings, are enclosed within rectangles having designations indicating the figure number of the detailed drawings on which the elements may be found. Also, for those relays whose windings are shown on the figures of the detailed disclosure, the functional designation of the contacts thereof is preceded by a dash and a figure number (e.g., "13-TP00," FIG. 3B), the prescribed figure number indicating where the relay winding controlling the operation of the contacts may be found on the detailed drawings. For those relay contacts whose functional designation is preceded merely by a dash (e.g., "-TP909," FIG. 3B), the absence of a prescribed figure number indicates that such a relay does not appear on any figure of the detailed disclosure. The reason for this will be apparent when it is considered that for the disclosed system a large number of certain circuits, for example, trunk circuits, are required. In the detailed disclosure it is neither necessary nor desirable to show a large number of such circuits. One of such trunk circuits (e.g., multifrequency trunk MF00) is shown in detail on FIGS. 10 through 15, and FIG. 13 thereof includes relay TP00, the contacts of which (i.e., 13-TP00) also appear in FIG. 3B of the block diagram. However, in order to explain the operation of the system, certain corresponding relay contacts (i.e., -TP09) of certain other trunks of the same type are shown in the block diagram, but the details of such other trunks are not shown on any figure of the detailed disclosure. It was considered highly important in connection with the showing of FIGS. 3 that the designations facilitate such a comparison in order that the detailed drawings, together with the accompanying detailed description, may be better understood by reference to the diagrammatic showing of FIGS. 3.

Just as was the case of FIGS. 2, the various elements of FIGS. 3 may be best described in connection with a call that is assumed to be served by MF trunk "00" (FIG. 3B), operator position "00" (FIG. 3D), and sender "00" (FIG. 3G). A priorly described, trunk "00" is first connected via the sender link (FIG. 3A) to sender "00," and is subsequently connected via the link connector (FIG. 3A) to position "00" while it remains connected to the sender via the sender link. Once the call has progressed to this point, it is then required that position "00," sender "00" and trunk "00" all be interconnected via the data transfer circuit in order that they may interchange call data. Position "00" receives a signal from sender "00," via the connection established through the sender link and the link connector, instructing it to request a connection via its position connector (FIG. 3D) to a data channel. The position, in response to this signal, applies a start signal over conductor STDT00 (FIG. 3D) extending to the preference and lockout circuitry for position connector "0." This circuit equitably allocates the services of the position connector to the ten positions associated therewith, namely, "00" through "09." As part of this function, it provides for an orderly sequence of circuit operations in the event that two or more of its positions simultaneously bid for its services. Each of the remaining position connectors and register connectors also has similar preference and lockout circuitry.

Let it be assumed that position "00" (FIG. 3D) is currently the only position bidding for position connector "0" or, alternatively, in the event that two or more of the positions "00" through "09" are simultaneously bidding, that position "00" is preferred at this time. This being the case, under either alternative, the signal on conductor STDT00 is now extended by the preference circuit to the winding of relay 224-PA00 (FIG. 3D) to operate it. Each position served by position connector "0" is individually associated with one of a plurality of relays shown within the rectangle designated "Position Connector '0' Preference Lockout." For example, position "00" is associated with relay 224-PA00 while position "09" is associated with relay 224-PA09. These relays comprise the primary cut-in relays for the connector, and the operation of any relay connects the conductors of its position to those of its position connector. Thus, for example, the operation of relay 224-PA00 connects the conductors of position "00" to those of position connector "0." The operating circuit of these relays includes preference circuitry which permits only one of them to be operated at a time. The remaining positions and position connectors (FIG. 3C), as well as the registers and register connectors (FIGS. 3E and 3F), have similarly arranged primary cut-in relays each of which is individually associated with the respective one of the positions or registers served by the connector and which, when operated under control of the preference circuit, interconnects the conductors of its respective register or position with those of the connector.

#### DATA CHANNEL PREFERENCE AND SELECTION CIRCUIT

The preference and lockout circuit for position connector "0," having interconnected position "00" with position connector "0" via make contacts 224-PA00, now transmits a start signal over conductor STDT0 from FIG. 3D to the data channel preference and selection control circuit on FIG. 3I. This circuit comprises a two-dimensional preference circuit which, first of all, arranges each of the four data channels in a fixed order of preference with respect to each position and register connector taken individually and, secondly, arranges all register and position connectors in a predetermined order of priority with respect to each other for each individual channel, so that an orderly sequence of circuit operations



will occur in the event of simultaneous bids for a particular channel. Thus, the preference circuit controls the order in which each connector attempts to seize the different data channels. For example, position connector "0" (FIG. 3D) may prefer to bid for channels "0," "1," "2," or "3" in that order, while position connector "6" (FIG. 3C) may prefer to bid for channels "3," "2," "1," or "0" in that order. Also the preference circuitry for each channel ensures that only one out of a plurality of simultaneously bidding connectors will be successful in obtaining the services of the channel.

Let it be assumed at this time that position connector "0" prefers data channel "0," and that it is the only bidding connector out of all the position and register connectors, or that it is the preferred and successful bidding connector in the event of simultaneous bids. This being the case, the potential applied by position connector "0" to conductor STDT0 is extended by means of the circuitry of FIG. 3I to operate relay 225-0PRF0. This relay, together with the remainder of the relays shown within the leftmost rectangle on FIG. 3I, comprises the secondary cut-in relays for the position and register connectors. These relays are operated under control of the data channel preference and selection control circuitry which regulates the operation of the position and register secondary cut-in relays. Each connector includes four secondary cut-in relays, one for each of the four data channels, and the closure of any secondary cut-in relay interconnects the multiples of its connector with those of the data channel served by the relay. The operation of relay 225-0PRF0 (FIG. 3I) closes its make contacts shown on FIG. 3D, thereby interconnecting position connector "0" with channel "0."

Neglecting the figure identification preceding the functional designation of each relay, and still referring to FIG. 3I, it may be seen that all of the relays 0PRF0 through 0PRF6, and 0RRC0 through 0RRC9, are associated with channel "0." Each of the other three channels also has similar relays associated therewith, as will be further evident from FIGS. 3C-3F. The initial digit in each relay's functional designation represents the channel with which the relay is associated, while the final digit of the designation represents the connector number with which the relay is associated. Thus, relay 3PRF0 serves channel "3" and position connector "0."

#### TRUNK CONNECTOR IDENTIFICATION

Position "00" (FIG. 3D) is now interconnected with channel "0," since connector primary cut-in relay 224-PA00 (FIG. 3D) and connector secondary cut-in relay 225-0PRF0 (FIG. 3I) are both operated at this time. Position "00" received a plurality of items of information concerning the calling trunk "0" (FIG. 3B), incident to its connection therewith via the link connector (FIG. 3A). One such item is the number of the trunk connector (FIG. 3B) serving trunk "00," which connector must be operated in order to interconnect trunk "00" and position "00" via a channel of the data transfer circuit. The trunk connector number is registered in 2-out-of-5 code form in the position circuit. The closure of the position primary contacts 224-PA00 and the position secondary contacts 225-0PRF0 causes the number of the registered trunk connector to be transmitted from the position, over circuit path DG and 0DG (FIG. 3D), to the 2-out-of-5 to 1-out-of-10 translator for channel "0" on FIG. 3J.

Referring to FIG. 3I, it contains the priorly described data channel preference and selection control circuitry. FIG. 3J contains circuitry for registering and translating the trunk connector number for all calls served by the data channels. This equipment includes a translator for each data channel which receives on each call, in 2-out-of-5 code form, the trunk connector number information from the register or position. Thus, for the present call, the translator for channel "0" receives a trunk connector number of "0" from position "00."

The trunk connector number information received by a translator is converted to a 1-out-of-10 indication, and an output potential is applied to the appropriate one out of its ten output conductors. The ten output conductors of each translator are connected to ten trunk connector preference and lockout circuits (FIG. 3J) in such a manner that the numerical designation of each output conductor corresponds to the numerical designation of the trunk connector number.

Thus, the "0" output conductor of the translator for the "0" channel (FIG. 3J) is connected to the trunk connector preference and lockout circuit for trunk connector "0," while the "9" output conductor for the same translator is connected to the trunk connector preference and lockout circuit for trunk connector "9."

#### TRUNK CONNECTOR PREFERENCE AND LOCKOUT

The trunk connector preference and lockout circuitry (FIG. 3J) cooperates with the 2-out-of-5 to 1-out-of-10 translator for each channel to facilitate an identification of the trunk connector which must be seized in order to serve the call currently served by the channel. This preference and lockout circuitry also contains the necessary preference circuitry to ensure that only one channel out of a plurality of simultaneously bidding channels will be successful in obtaining a connection to a single trunk connector. To this end, the four input conductors of each trunk connector preference and lockout circuit are connected to the output conductor in each of the four translators whose numerical designation equals the numerical designation of the trunk connector. Referring to the trunk preference and lockout circuit for trunk connector "9," its four input conductors are connected to the "9" output conductor in each translator. Each trunk connector preference and lockout circuit includes four relays, each of which is individual to a different channel. The four relays of trunk connector "0" are designated 238-0TS0, 238-1TS0, 238-2TS0, and 238-3TS0. The first digit of the functional designation represents the channel number with which the relay is associated, while the last digit represents the trunk connector number. Thus, relay 238-0TS0 serves channel "0" and trunk connector "0," while relay 238-3TS0 serves channel "3" and trunk connector "0." In a similar manner, the four relays for trunk connector "9" are designated 240-0TS9, 240-1TS9, 240-2TS9 and 240-3TS9, and they comprise the secondary cut-in relays for the four channels for trunk connector "9." The four secondary cut-in relays of each trunk connector are connected to the output of the trunk connector preference and lockout circuitry for the connector in order to ensure that only one channel at a time will be connected to the connector.

Recalling that position "00" (FIG. 3D) is now connected to data channel "0" via the closed primary cut-in contacts 224-PA00 and the closed secondary cut-in contacts 225-0PRF0, a trunk connector number of "0" is now applied over circuit paths DG and 0DG, in 2-out-of-5 code form, to the 2-out-of-5 to 1-out-of-10 translator (FIG. 3J) for data channel "0." This information is translated and results in an output on conductor 0DGN0 extending to the "0" channel portion of the preference and lockout circuitry for trunk connector "0." The signal on this conductor represents a bid for a connection by channel "0" to trunk connector "0." The remaining conductors, which could also bid for trunk connector "0" are 1DGN0, 2DGN0, and 3DGN0. A potential on one or more of these conductors would represent requests by channels "1," "2," and "3," respectively, for the services of trunk connector "0." Assuming conductor 0DGN0 to be the only conductor bidding at this time, or alternatively, assuming it to be the preferred one of a plurality of bidding conductors, the potential on this conductor operates relay 238-0TS0 which comprises the secondary cut-in relay common to data channel "0" and trunk connector "0." The operation of this relay closes its contacts on FIG.



3H to interconnect the multiple of channel "0" with that of trunk connector "0" (FIGS. 3B and 3H).

Pausing briefly to review the circuit action described so far, it may be seen that in attempting to interconnect itself with trunk "00" (FIG. 3B), position "00" (FIG. 3D) has first obtained the services of channel "0" (FIGS. 3C-3H) as a consequence of the closure of contacts 224-PA00 and 225-OPRF0 (FIG. 3D), and, secondly, has seized trunk connector "0" (FIGS. 3B and 3H) by operating relay 238-OTS0 (FIG. 3J). It is obvious from an inspection of FIGS. 3B and 3H that contacts 13-TP00 and 263-OTS0 must yet be closed to complete the interconnection of position "00" and trunk "00" via channel "0."

#### TRUNK OPERATION

The operation of relay 238-OTS0 (FIG. 3J), as a consequence of the successful seizure of trunk connector "0," extends a positive 130-volt resistance battery through its make contacts, over the PC conductor of channel "0," extending from FIG. 3J to FIG. 3D, via make contacts 225-OPRF0, conductor PC for position connector "0," make contacts 224-PA00, conductor PC, which passes through position "00" and becomes conductor KPR, and thence via cable P00 extending from FIG. 3D to the link connector on FIG. 3A, through the closed crosspoints of the link connector, via conductor KPR of cable T00, to operate relay 13-TP00 in trunk "00" on FIG. 3B. The operation of this relay closes its make contacts to complete an obvious circuit immediately below trunk "09" on FIG. 3B to operate relay 263-OTS0. The operation of relay 13-TP00 also closes its make contacts immediately to the right of trunk "00" on FIG. 3B.

Each trunk connector serves 100 trunks which are, in turn, subdivided into 10 groups of 10 trunks each. Thus, trunk connector "0" serves trunks "00" through "99," with these 100 trunks being divided into subgroups of 10 trunks each, via the make contacts of trunk subgroup relays 263-OTS0 (FIG. 3B) through 263-OTS09 (FIG. 3H). The first of these relays, 263-OTS0, serves trunks "00" through "09" by means of its contacts to the right of trunk "09" on FIG. 3B. Similarly, trunk subgroup relay 263-OTS09 serves trunks "90" through "99." Each subgroup relay is operated as a consequence of the operation of any of the TP- - relays in the trunks of its subgroup. Thus, trunk subgroup relay 263-OTS0 is operated as a consequence of the operation of any of relays 13-TP00 through -TP09. The operation of the -TP- - relay individual to a trunk, as well as the operation of the associated subgroup relay, is required in order to connect the multiples of a trunk to those of its trunk connector.

The operation of relay 13-TP00 closes its make contacts as described, thereby preparing a path to connect the trunk with its connector. The operation of relay 263-OTS0 closes its make contacts to the right of trunk "09," thereby completing the interconnecting of trunk "00" with its connector. This operation also completes the interconnection of trunk "00" (FIG. 3B) with position "00" (FIG. 3D), since the make contacts of trunk connector "0" secondary cut-in relay 238-OTS0 were previously operated.

#### SENDER CONNECTOR PREFERENCE AND LOCKOUT

Now that trunk "00" (FIG. 3B) and position "00" (FIG. 3D) are interconnected via data channel "0," it may be appreciated from a study of FIG. 3G that the connecting of sender "00" to the same data channel, requires the closing of make contacts 243-SE00 and 246-OSRE0 of sender connector "0." It will be recalled at this time that sender "00" is currently connected via the sender link (FIG. 3A) to trunk "00" by means of cable S00 on the sender side of the link, and cable T00 on the trunk side of the link. Cable S00 extending into the sender, also includes a conductor SPI which is now connected to the

KPR conductor of trunk "00," since the sender and the trunk are currently connected via the sender link. Therefore, the positive 130-volt potential transmitted from the data transfer circuit over the KPR conductor, as already described, is also received by sender "00" (FIG. 3G) on its SPI lead via the sender link. This potential received by the sender is applied therethrough as a "start" signal on its SP lead to the sender connector preference lockout circuit (FIG. 3G) for sender connector "0" (FIG. 3G).

The purpose of this circuit is to ensure an orderly sequence of operations in the event that two or more of senders "00" through "09" should simultaneously request connection to sender connector "0." Assuming that sender "00" is the only sender currently bidding, or, alternatively, assuming that it is the preferred one of a plurality of bidding senders, the potential now on conductor PC for sender "00" is cut through by the connector preference and lockout circuitry to operate relay 243-SE00 (FIG. 3G).

Sender "00" has previously received a plurality of items of information concerning the call, as a consequence of its connection to the calling trunk. One of these items received is the associated trunk connector number, which is received and registered in 2/5 code form in essentially the same manner as was previously described for the position "00."

#### TRANSLATING THE TRUNK CONNECTOR NUMBER

The operation of relay 243-SE00 (FIG. 3G) closes its make contacts, thereby connecting the trunk connector number register of sender "00" with cable DG0 extending to a 2-out-of-5 to a 1-out-of-10 translator (FIG. 3K) common to the ten senders served by sender connector "0." This translator now translates the trunk connector number of "0" registered in sender "0" from a 2-out-of-5 code to a 1-out-of-10 indication, and applies an output potential to its output conductor "0." The potential on this output conductor signifies that sender "00" is currently connected via the sender link (FIG. 3A) to a trunk served by trunk connector "0" (FIG. 3B). The overall object of the circuit of FIG. 3K for the present call is to ascertain which of the four data channels is currently connected to trunk connector "0," and, having ascertained this, to interconnect sender connector "0" with this particular data channel. Referring to FIG. 3J for a moment, it will be recalled that a position or register requiring an interconnection via a data channel with one of the trunks served by trunk connector "0," operates one of relays 238-OTS0 through 238-3TS0, depending upon the particular data channel serving the call. Thus, if channel "3" has been seized for this purpose, relay 238-3TS0 would be operated; for channel "2," 238-2TS0 would be operated; and similarly, 238-1TS0 or 238-OTS0 would be operated for channel "1" or "0," respectively.

#### SENDER CONNECTOR

Returning now to FIG. 3K, the "0" output conductor of the translator for sender connector "0" is connectable through the make contacts of the four relays 238-OTS0, 238-1TS0, 238-2TS0, and 238-3TS0 to relays 246-OSRE0, 246-1SRE0, 246-2SRE0, and 246-3SRE0, respectively, depending upon the data channel currently connected to trunk connector "0" as determined by the circuitry of FIG. 3J. In this manner, the circuitry of FIGS. 3J and 3K together enable the sender connector to determine which data channel it should seize, by ascertaining which data channel is connected to the same trunk to which the sender is connected via the sender link. Recalling that the currently described call is served by data channel "0," the output on conductor "0" of the translator (FIG. 3K), for sender connector "0" (FIG. 3G), may be extended through make contacts 238-OTS0 to operate relay 246-OSRE0 (FIG. 3K), which constitutes the secondary cut-in relay for the "0" channel of sender connector "0."



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The operation of relay 246-0SRE0 (FIG. 3K) closes its make contacts (FIG. 3G) common to the conductors of sender connector "0" and data channel "0" and, since make contacts 243-SE00 (FIG. 3G) were priorly operated, sender "00" (FIG. 3G) is thereby connected to data channel "0." This completes the interconnection of trunk "00," sender "00," and position "00," thereby permitting these circuits to interchange the information necessary for the serving of the call.

#### *Dial pulse calls*

It has been described how the data transfer circuit functions in connection with the serving of a typical MF call which requires the interconnection by the data transfer circuit of the incoming trunk, the sender, and the position. MF calls do not require the services of either registers or register links, since these are utilized only for calls in which the called station number is received in dial pulse (DP) rather than multifrequency (MF) form.

The data transfer circuit is used twice on DP calls. The first use of the circuit takes place as soon as the called station information is received by the register connected to the DP trunk, such as trunk 900, via the register link. On this usage, the register requests the data transfer circuit to interconnect it via one of the data channels with the sender serving the call, in order that the register may transmit the called number via the data channel to the sender. The manner in which the bidding register and the data transfer circuit cooperate to interconnect the register via one of the data channels with the sender is analogous in all respects to the operation just described for a call on which a position is the bidding circuit, and, therefore, a detailed description of this operation is not believed necessary.

The second usage of the data transfer circuit on DP calls takes place when the position initiates a bid for a data channel and then, having secured the same, proceeds to interconnect itself via the data channel with the calling trunk and its associated sender. The operation of the circuits resulting from their usage in connection with DP trunk calls is identical to those already described in connection with MF calls.

#### *Dial 0 calls—ANI operation*

The data transfer circuit is also used twice on dial 0-ANI calls. The first use of the data transfer circuit takes place as soon as the calling number information has been received by the sender from the originating office on an ANI call. The sender is first called in on the initial seizure of the trunk for the sole purpose of receiving the calling number information, and, upon registering it, sends a request via the sender and position link to the position to request a connection to it via the data transfer circuit in order to transfer the calling number to the position for charge purposes. The sender is disconnected from the call as soon as the calling number is registered in the position and the data transfer circuit releases.

The second usage on dial 0 operator calls occurs when the operator has secured the called number from information furnished orally by the subscriber; and, having registered it in the position control circuit, a request is made by it to transfer it via the data transfer circuit to the sender, which has been called in a second time to set the call up forward to the called subscriber station. The circuit action on these types of calls is similar to those previously described for transmission of data from or to the sender and trunk from the position.

#### *Dial 0 calls—NonANI operation*

The first usage of the data transfer circuit on a nonANI dial 0 call is different from that of the dial 0-ANI call in that no sender operation is involved, and therefore the data transfer circuit on its first usage interconnects only the incoming trunk and the position circuit in order that the trunk may transmit call setup information to the posi-

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tion. The data transfer circuit releases after performing this function. The operator now orally ascertains and then registers in her position the calling, as well as the called, number. She then depresses a key which initiates a second usage of the data transfer circuit, in the manner described for dial 0-ANI calls, wherein the data transfer circuit sets up an interconnection between the trunk, the position, and the sender, in order that the position may transmit the called number information to the sender.

### DETAILED DESCRIPTION

#### *MF calls general discussion*

##### *Incoming trunk circuit arranged for MF signaling*

The system comprising the present invention may be associated with a plurality of different types of incoming trunk circuits at the tandem office, in order that calls from different offices, and calls requiring different classes of service may be served. The incoming trunk circuit shown on FIGS. 10 through 15 is designed to receive multifrequency signals representing both the calling and called station numbers.

#### *General discussion of functions*

A general discussion of the various functions of this trunk circuit during the serving of the call is presented at this time, in order to facilitate a better understanding of the circuit. This is believed desirable, since a detailed discussion of the trunk circuit as a separate entity is not set forth in the specification, and, also, since the trunk circuit functions throughout the entire duration of a call.

#### SEIZURE OF TRUNK

The trunk circuit is seized by the preceding, or originating, office 102 (FIG. 10) as a connection is established thereby to the outgoing trunk circuit 103 within that office. The outgoing trunk circuit 103 is connected to the incoming tandem trunk circuit shown on FIGS. 10 through 15. Relay 11-A operates, followed by relay 10-A1, as a consequence of the seizure, and, at contact 11-A, grounds the ST00 lead (FIG. 11) to the sender link circuit. The ground on lead ST00 causes the sender link to bid for an idle sender, preparatory to interconnecting the sender with the trunk circuit. A sender, once it is seized by the sender link, grounds its CO (FIG. 48) lead as a signal that it has been attached to the sender link. This ground is transmitted over the sender link and is received by the trunk circuit on its CO lead (FIG. 11). This ground operates relay 11-T which, at contacts 11-T (FIG. 10), transfers the incoming trunk T and R leads from the on-hook battery and ground applied through the windings of the 11-A relay, to the T and R leads (FIG. 12) to the sender link (FIGS. 16A, 17A and 17C), and thence, via leads FT and FR (FIG. 17C), to a reversed (off-hook) polarity, via leads FT and FR (FIG. 48) in the sender. Relay 11-T, operated, operates relay 10-SA.

#### SEIZURE OF SENDER

When the sender is ready to receive multifrequency (MF) pulsing from the preceding office, it reverses to restore the polarity of the FT and FR conductors to the original on-hook condition, as a signal to the originating office to start outpulsing. After the called number is registered by the sender, it reverses the trunk polarity of leads FT and FR once more to an off-hook condition, as a request for calling number information if the originating office is arranged for ANI (automatic number identification). When the calling number is registered, or a signal is received by the sender indicating that operator identification is required, the sender requests that an operator position be connected to the trunk circuit via the link connector. If the originating office is not arranged for ANI, the sender requests a position as soon as the called number is registered. The position request signal from the sender comprises a ground extended via conductor FT



(FIG. 12), which operates relay 11-PR. The operation of relay 11-PR, at contacts 11-PR (FIG. 15), grounds conductor ST (FIG. 15) to the link connector circuit (FIG. 85A) which, in response to this ground, functions to connect an idle operator position with the trunk circuit.

#### OPERATOR POSITION ATTACHED

When an operator position is attached, a ground is received over conductor PA (FIG. 15) from the link and connector circuit (FIG. 73A) to operate relay 13-PA. The operation of relay 13-PA, at contacts 13-PA (FIG. 11), releases relay 11-T which, at contacts 11-T (FIG. 10), restores the incoming trunk loop to on-hook battery and ground through the windings of relay 11-A. Relay 10-RV operates at this time from ground through contacts 10-SA. A ground is now transmitted over conductor FR (FIG. 12), via the sender link, to the FR lead (FIG. 48) of the sender, as a signal that an operator position is attached.

#### CLOSURE OF CLASS LEADS

At the same time that the trunk receives a position-attached signal, the selected position circuit, via lead KPR in cable L00 (FIG. 73A) of the link and connector circuit, connects battery to lead KPR (FIG. 15) to operate relay 13-TP00. The operation of relay 13-TP00 closes a plurality of leads on FIG. 14 extending to FIGS. 263 and 272 of the data transfer circuit. These leads are used for subsequently transferring trunk class information to the sender and to the operator position circuit when both of these latter two circuits are connected via a channel of the data transfer circuit to the trunk circuit. The battery on lead KPR (FIG. 15) is extended through make contacts 10-SA (FIG. 13), through FIGS. 16A, 17A, and 17C of the sender link, to the sender (FIG. 48), via lead SPI (FIG. 12). The receipt of this potential causes the sender to effect the necessary circuit actions to interconnect itself with the same data channel of the data transfer circuit to which the operator position and the trunk circuit of FIGS. 10 through 15 are currently connected. After this connection is established, the sender then transmits some of the call information stored therein to the operator position. If all information is not transferred satisfactorily to the position, the trunk number and its location is identified through contacts of relay 13-TP00 to the trouble recorder. When the call data is transferred to the position satisfactorily, relay 13-TP00 and the sender data channel relays are released, thereby releasing the trunk and the sender from the position circuit, the operator is given a signal indicating that she is connected to a call, and the sender proceeds to set the call up forward towards the next succeeding office.

#### SEIZURE OF MARKER

The sender proceeds with the call and seizes a marker to set up a connection to an outgoing trunk to the terminating office (not shown—see Breed et al. Patent 2,848,543). The marker determines whether there is an idle outgoing trunk available, identifies the location of the incoming trunk circuit on the trunk link frame, and sets up a connection between the incoming and outgoing trunks. In establishing this connection, the marker causes the sender to extend ground, via lead DC (FIG. 48), through the sender link circuit (FIGS. 17C, 17A and 16A) to lead DC (FIG. 12), thereby operating relay 12-F, followed, in turn, by the operation of relay 10-FA. A ground is also extended at this time via the LC lead (FIG. 12) to a link connector relay in the trunk link frame (see Breed et al. Patent 2,848,543) which operates and extends the ground back to the marker through a marker connector. The 12-F relay, when it operates, also supplies ground for operating the trunk link primary select magnets associated with this trunk circuit. At make contacts 12-F (FIG. 12) it connects together the leads S and SL (FIG. 12) extending to the trunk link circuit.

The marker supplies a ground over this path while setting up the connection between the trunk link and the office link frames. When the marker has checked the connection to the outgoing trunk, relay 12-F is released. The release of relay 12-F, at contacts 12-F (FIG. 12), transfers the sleeve ground supply from lead SL to the S lead of the trunk circuit which now controls the hold magnet in the trunk link. The marker checks for this ground and releases or gives a trouble indication if the circuit is not completed.

The sender (FIG. 48), via the sender link circuit (FIGS. 17C, 17A and 16A), is now connected to the outgoing tip-and-ring leads of this trunk circuit over the FT and FR leads (FIG. 12), and over this path it outputpulses the digits required for completing the connection in the subsequent office. After outputpulsing is completed, the sender extends ground via the lead D (FIG. 48), the sender link (FIGS. 17C, 17A and 16A), and lead D (FIG. 12) to operate relay 11-D which, in turn, operates relay 15-D1. The sender now releases, and the operator is bridged onto the connection on the output side of the trunk circuit via leads T and R in cable L00 (FIG. 15) and link and connector circuit (FIG. 73A). No further circuit action takes place until the called party answers.

#### CALLED-PARTY-ANSWER SIGNAL

A called party answer is indicated by a reversal of the polarity on the T and R leads (FIG. 12) from the called office. This reversal of polarity operates polarized relay 11-CS. The trunk is now in a condition to control the making of an entry on the AMA tapes. On a majority of the calls, it is necessary for the operator to determine that the connection desired by the calling party has been established, such as for example, that the proper person is available on a person-to-person call, or that the called party will accept the charges on a collect call. Therefore, the initial entry on the AMA tape is not perforated automatically but, instead, is under the control of the operator. All the data required for the initial entry has priorly been registered at the operator position; and when the operator requests the entry to be made, a transverter is associated with her position to perforate the initial entry for the call. After the initial entry is made and perforated, the recorder (FIG. 15), via lead DJ, applies ground to lead TC (FIG. 14), via the call identity indexer, to operate relay 14-TC, which remains operated until the end of the call.

#### ENTRY-COMPLETED SIGNAL

The operator receives an entry-completed signal and then depresses a key at her position to release the position from the trunk circuit. While the operator is connected, however, she is in control of the connection and receives continuous supervision from both ends of the connection via leads OS and TS in cable L00 (FIG. 15) and the link and connector circuit (FIG. 73A), and can talk to both subscribers over the tip-and-ring bridge. After the initial entry, the operator, on normal calls, releases from the connection which, in turn, releases the link connection and, in turn, relay 13-PA. The release of relay 13-PA permits the trunk circuit to control the connection.

Depending upon the type of call, the operator may make the initial entry either before or after answer by the called party. Since the call may be abandoned just as it is answered, relays 11-A1 and 11-CS must remain operated for a minimum of two to five seconds for the trunk circuit to recognize a legitimate "called party answer." This interval is controlled by relays 14-B1 and 14-F1 from ground through the charge delay interrupter (FIG. 14) and results in the operation of relays 14-IN and 14-CH. In either case, the answer entry will not be made until completion of both the initial entry and the answer delay cycle and the concomitant operation of relay 14-CH. When this occurs, a path between lead CH (FIG. 15) to



the recorder, and lead DJ (FIG. 15) to the call identity indexer is closed via contacts 14-CH and 14TC (FIG. 15). When a recorder is available to this trunk, lead CH will be grounded, and the ground extending over the DJ lead acts as a "start" signal and results in leads OT, TC and RC (FIG. 14) being connected through the call identity indexer to the recorder.

When the answer entry is recorded, ground is connected to lead RC (FIG. 14), thereby shunting down relay 14-IN. The release of relay 14-IN, at contacts 14-IN (FIG. 15), opens the lead RC, as a signal to the recorder, and the above-described path between leads CH and DJ is opened to disconnect the recorder. After the recording of the answer entry and the release of relay 14-IN, no further action takes place until the calling or called party disconnects from the call.

#### CALLING PARTY DISCONNECTS

When the calling party disconnects, relays 11-A and 10-A1 release. The release of these relays initiates further circuit actions to release the connection both forward and backward, so that the other offices involved in the call will similarly release from the connection. The release of these relays also initiates the circuit action whereby a recorder is seized to make the disconnect entry for the call.

#### CALLS NOT REQUIRING INITIAL ENTRY

On certain calls, such as for example, those completed to free numbers, or calls which must be timed and ticketed manually by the operator, the operator does not make an initial entry, and consequently relay 14-TC is not operated. Leads DJ and CH (FIG. 15) are not connected together, and, consequently, there is no request for answer or disconnect entries.

#### LINE BUSY

When a line busy condition is encountered, polarity reversals from the called office on the T and R leads (FIG. 12) alternately operate and release polarized relay 11-CS. This flashing condition is not mistaken for an answer condition, since relay 11-CS must remain operated for a minimum of two seconds before an answer entry will be made. Relay 11-CS, by operating and releasing at contacts 11-CS (FIG. 15), connects intermittent ground to lead TS in cable L00 (FIG. 15) to flash the operator's supervisory lamp. Interrupted tone from the called office may be returned to the calling subscriber, and the operator can inform the calling subscriber of the busy condition and then release the connection, or set up a new connection forward if the calling party so desires.

If the marker meets trouble in setting up the connection, it grounds trunk link lead TRL (FIG. 12), which ground is extended via contacts 12-F (FIG. 11), lead D (FIG. 12), sender link connector (FIGS. 16A, 17A, and 17C), and to lead D in the sender (FIG. 48), as a signal to make another trial. After a second unsuccessful trial, the sender routes the call to overflow.

#### OPERATOR RELEASES SWITCHBOARD LINK

After the operator has released the switchboard link, the calling subscriber is normally in control of the connection. He is not permitted, however, to hold a connection to the called party indefinitely if the called party hangs up. Normally, both subscribers hang up within a few seconds of each other and no special action is taken. When the called subscribers hangs up, relay 11-CS releases and, at back contacts 11-CS (FIG. 15), extends ground to energize thermal relay 15-RL, which ground is also extended to lead OT (FIG. 15). If the calling party does not disconnect within 13 to 32 seconds, relay 15-RL operates to release the connection to make a "disconnect" entry. When the disconnect entry is made, the ground on lead OT (FIG. 15) informs the recorder that the disconnect was caused by a timed release. This results in a special mark being perforated on the AMA tape, so the

accounting center can compensate for the timed disconnect in computing the elapsed time of the call.

#### CANCEL ENTRY

After the initial entry has been made under operator control, it may be desirable to cancel the entry because of a change in call classification or because the entry was made too soon. If the position registers still contain the call data required for the initial entry, the operator can originate a "cancel timing" request which connects battery to lead RF in cable L00 (FIG. 15) over the link connector (FIG. 73A). If the call has not yet been answered, relay 13-CTM operates, causing the release of relay 14-TC and, through contacts 13-CTM (FIG. 13), ground is connected via link lead SA in cable L00 (FIG. 15) to the link connector circuit (FIG. 73A) for the duration of the release time of relay 13-CTM, to inform the operator that the entry signal in the trunk circuit has been canceled. Since only an initial entry will be found by the accounting center, no charge will be made.

#### SPECIAL DISCONNECT ENTRY

If the call has been answered before the cancel timing request is made, it is necessary to make a special disconnect entry in addition to restoring the trunk circuit to the no entry condition. The operation of relay 13-CTM causes the release of relay 15-D2 to request a disconnect entry, and positive 130-volt potential is applied to lead OT (FIG. 15). When the disconnect entry is made, the high voltage on lead OT informs the recorder that the entry is made because of a cancel timing request. This results in a special mark being perforated on the AMA tape which the accounting center will recognize to disregard the call entries and make no charge.

If the answer entry is being made when the cancel signal is received on lead RF (FIG. 15), relay 13-CD operates to prevent starting the cancel entry until the answer entry is completed. When the cancel entry is completed, the release of relay 14-TC connects ground to lead SA in cable L00 (FIG. 15) to the link and connector circuit (FIG. 73A) which informs the operator that the entries have been canceled. If the cancel timing disconnect entry is not made within two to five seconds, the timer circuit returns the trunk circuit to the "no entry" condition and removes the entry request. Battery is connected to lead SA (FIG. 15) which informs the operator that the cancel timing entry was not made and that she must prepare a manual ticket to have the call properly charged.

#### RELEASE FORWARD CONNECTION

The operator may release the forward connection without losing the trunk circuit connection to the calling subscriber. The release forward signal from the operator is battery extended from the link and connector circuit (FIG. 73A), via lead RLF in cable L00 (FIG. 15) to operate relay 13-RLF, which holds operated under control of relay 13-SR, or jointly by relays 13-PA and 10-A1. If the sender is still attached, the operation of relay 13-RLF opens the T and R bridge (resistor C, FIG. 10) to the sender, which releases, and the forward connection is not set up. If the connection has been established forward, the release forward is handled somewhat differently, depending upon the supervisory and AMA entry condition. If the called party has not answered or if the trunk circuit is in the no-entry condition, the forward connection is released and there is no charging for the previously established connection.

If the connection being released forward has been answered and the initial and "start" timing entries have been made, a disconnect entry is made on the AMA tape when the forward connection is released. In this case, the call is charged for up to the time of the release of the forward connection.



## OPERATOR SETS UP NEW FORWARD CONNECTION

When the operator sets up a new connection forward, the operation of relay 13-SR releases relays 13-RLF and 13-CD, while, if the operator releases the trunk circuit without setting up a new connection, the release of relays 13-PA and 10-A1 causes the release of relay 13-RLF, followed by the release of relay 13-CD. In this case, the break contacts (FIG. 10) of relay 13-RLF keeps the lead ST00 (FIG. 15) to the sender link connector (FIG. 16) open until relays 11-A and 10-A1 release, to prevent a false sender start if the originating subscriber is off-hook when the operator disconnects.

After a connection has been released forward, the operator can establish a new connection to a called subscriber. When the operator attempts to set up a new connection forward, ground extended via the link and connector circuit (FIG. 73A) and lead RF in cable L00 (FIG. 15) operates relay 13-SR, which releases relay 13-RLF which, in turn, releases relay 13-CD. Ground extended via make contacts 13-SR (FIG. 11) and lead ST00 (FIG. 12) to the sender link circuit (FIG. 16A) connects a sender to the trunk and ground extended via make contact 13-SR (FIG. 12), lead FR (FIG. 12), via the sender link circuit (FIGS. 16A, 17A, and 17C), informs the sender that this is an operator request. When the sender (FIG. 48) is attached, it extends ground via the sender link circuit (FIGS. 17C, 17A, and 16A) and lead CO (FIG. 12), thereby operating relay 11-OP and, in turn, operating relay 10-SA. The sender holding bridge on leads T and R, at contacts 11-OP (FIG. 10), is closed through resistor 10-C. When the sender is ready to receive pulses, it connects ground, via the sender link circuit to lead FR (FIG. 12); and this ground is also extended, via lead SA in cable L00 (FIG. 15), and the link and connector circuit (FIG. 73A) to the switchboard position. The position then removes ground from lead RF (FIG. 15) to release relay 13-SR, requests a data transfer channel, and connects battery, via the link and connector circuit (FIG. 73A) to lead KPR (FIG. 15). The battery on lead KPR operates relay 13-TP00 and is also extended via lead SPI (FIG. 12) and the sender link circuit (FIGS. 16A, 17A, and 17C) to the sender (FIG. 48), to connect the sender to the data channel. The called digits and class information are transferred to the sender, after which the data link is released, and battery is removed from lead KPR to release relay 13-TP00. The sender then proceeds to set up the desired call forward.

## RINGBACK ORIGINATING SUBSCRIBER

When a connected operator wishes to ring back on a connection to recall an originating subscriber, ground is extended via the link and connector circuit (FIG. 73A) and is connected to lead RB in cable L00 (FIG. 15), thereby operating relay 13-RB. Relay 13-RB, in turn, operates relay 13-RB1, which connects +130 volts and -48 volts to the trunk T and R leads, respectively, (FIG. 10). This causes the originating office circuits to apply a ringing signal to the calling subscriber line. Relay 13-RB1 also connects resistor 10-M across the trunk circuit T and R leads to hold relay 11-A operated. When ground is removed from lead RB (FIG. 15), relay 13-RB releases and, in turn, open the operating path for relay 13-RB1, which is slow-releasing. Relay 13-RB, released, removes +130 volts and -48 volts from the originating office T and R leads (FIG. 10) and connects resistor 10-E across the T and R leads to discharge the loop. When relay 13-RB1 releases, the loop is returned to normal.

*Detailed description of a special service call served by an incoming MF-ANI trunk*

This portion of the specification describes an MF call incoming from an originating office having ANI facilities. Calls from such offices are served by MF-ANI incoming trunks at tandem. One such trunk circuit of this

type is shown in detail on FIGS. 10 through 15, and it is assumed that this specific trunk serves the MF-ANI call described in this section. It is further assumed, in order to illustrate the features of the present invention, that the call is of the person-to-person or collect type, or of some other type that requires the services of a special operator at tandem.

Referring to FIG. 10, the call is initiated in the conventional manner, as the calling subscriber at station 101 removes his receiver from its switchhook and dials the necessary special service directing code (advantageously a "0"), the area code if required, and the directory number of the called station. The originating office 102 responds to the dialed digits and establishes a connection from the calling line to an outgoing trunk 103 extending to the tandem office. Since the incoming tandem trunk circuit shown on FIGS. 10 through 15 will serve this call, the originating office 102 establishes a connection from the calling line to an outgoing trunk circuit therein, which is interconnected over a trunk pair 103 with the trunk circuit of FIGS. 10 through 15.

*Incoming trunk seizure*

Equipment within the originating office closes a dry metallic loop, in the customary manner, across the T and R conductors of trunk 103 as a seizure signal to the tandem office, and in particular to the trunk circuit of FIGS. 10 through 15. The closure of this loop provides the following path to operate relay 11-A in the incoming trunk circuit: ground through the upper winding of the relay, break contacts 10-RV, the upper primary winding of transformer 101, break contacts 11-T and 13-RB1, the T conductor of the trunk extending to the originating office 102, the dry loop within the office, the R conductor of the trunk, break contacts 13-RB1 and 11-T, the lower primary winding of transformer 101, and break contacts 10-RV, to negative battery on the lower winding of relay 11-A. Circuitry within the originating office 102 detects the ground on the trunk T conductor and the negative battery on the trunk R conductor at this time and, for reasons explained in detail hereinafter, construes this particular polarity condition as an "on-hook" condition of the trunk.

The operation of relay 11-A closes an obvious path to operate relay 10-A1. The operation of relay 11-A also closes the following path to ground conductor ST00 (FIG. 12) extending to the sender link circuit of FIGS. 16 and 17: ground on terminal 11-103, make contacts 11-A, break contacts 11-D, 14-TC, 15-D2, 10-RV, 13-RLF, and 10-SA to conductor ST00 extending from FIG. 12 to the sender link. The ground on this conductor comprises a seizure signal for the sender link, which functions in the manner described in the following paragraphs to interconnect the trunk circuit of FIGS. 10 through 15 with an available sender circuit.

*Seizure of the sender link circuit*

The sender link circuit is shown on FIGS. 16A, 16B, 16C, 17A, 17B, and 17C and is essentially similar to sender links of the prior art, including the one shown and described in the R. N. Breed et al. Patent 2,848,543. Therefore, since the details of the sender link forms no part of the present invention, only so much of it is shown as is necessary to facilitate an understanding of said invention. However, even though sender links are by now well known in the art, certain details of the sender link circuit utilized by the system of the present invention are shown in order that an understanding may be had of the manner in which a sender receive different class mark information from the sender link during the serving of the different types of calls described in the present specification.

Referring to drawing FIGS. 16A, B, and C, and 17A, B, and C, it may be seen that the sender link comprises a primary link switch as shown on FIG. 17A, a secondary



link switch as shown on FIG. 17C, junctors interconnecting the two links, trunk conductors connected to the horizontals of the primary link, sender conductors connected to the horizontals of the secondary link, control circuitry for the primary link as shown on FIGS. 16A and 16B, and control circuitry for the secondary link as shown on FIG. 17B.

The sender links are arranged into link frames, with each frame comprising ten decades designated 0 through 9. Each decade serves ten trunks, and each link frame serves 100 trunks. The circuitry for link frame 0 is shown in some detail on FIGS. 16A, 16B, 17A, 17B, and 17C, while sender link frame 9 is shown diagrammatically on FIG. 16C. The incoming trunks are subdivided into groups in accordance with the incoming traffic served thereby, and each such group of trunks is connected to one of the ten decades of a link frame. The control circuitry common to a decade is enclosed within an "A" equipment rectangle, and the control circuitry common to all ten decades of a frame is enclosed within a "B" equipment rectangle. With this arrangement, a sender link frame, by means of its different decades, may serve different classes of calls. However, all trunks within a single decade must be of the same type.

The seizure of the sender link by an incoming calling trunk causes the sender link to close a connection, via its primary and secondary links, to interconnect the conductors of the calling trunk with those of an idle sender. The sender link also completes circuit paths originating within it to transmit class mark and other information to the sender to inform the sender, regarding the class of traffic handled by the trunk to which the sender is now connected.

Returning now to the present call, the application of ground to conductor ST00 by the trunk circuit shown on FIGS. 10 through 15 is extended through break contacts GT0 on FIG. 16A to the winding of relay 16A-T00 to operate it. The operation of this relay extends the ground from terminal 103 on FIG. 16A to operate relay 16A-DS0. The operation of relay DS0 closes its make contacts to extend the ground on terminal 104 of FIG. 16A to the winding of relay 16A-G0 to operate it. The series of relays G0 through G9 within the "B" equipment rectangle on FIG. 16A are associated with the ten decades of link frame 0, and each G- relay is individually associated with the correspondingly numbered decade of the link frame. The operation of any G- relay on a call identifies the decade containing the calling trunk. Therefore, the operation of relay G0 at this time indicates that a trunk within decade 0 is bidding for service.

The operation of relay G0 closes an obvious path to operate relay AG0 on FIG. 16A. The operation of relay 16A-G0, in turn, closes the following path to operate relay 16A-HA0: Ground on terminal 106 of FIG. 16A, make contacts 16A-D0 and 16A-G0, to the winding of relay HA0 to operate it.

The "B" equipment rectangle on FIG. 16A also contains a series of ten relays designated T0 through T9. The operation of any T- relay indicates the units digit of the calling trunk. Thus, relay T0 is associated with trunks 00, 10, 20, etc., while relay T9 is associated with trunks 09, 19, etc. The operation of relay 16A-T00 and relay HA0 together closes their make contacts to extend the ground on conductor ST00 through break contacts TE to the winding of relay T0 to operate it. The operation of relays G0 and T0 together indicates that trunk 00 in decade 0 is currently bidding for service.

Referring to the relationship between the primary links and the incoming trunks as shown on FIG. 17A, it may be seen that the trunks are connected to the horizontals on the switch and that the ten trunks associated with a decade have their conductors connected to the ten levels of the same switch vertical. The horizontal conductors are not strapped between verticals, as is sometimes the

case, and, therefore, each set of ten horizontal conductors is served by a single vertical. The conductors for the ten trunks associated with decade 0 are connected to horizontal 0 through 9 of vertical 0; the trunk conductors for decade 1 are connected to the ten horizontals of vertical 1; while the trunk conductors of the ninth decade are connected to the ten horizontals served by vertical 9.

The operation of relays 16A-T0 and 16A-HA0 extend the ground on terminal 100 of FIG. 16A to the winding of the select magnet for level 0 of the primary switch to operate it. The sender link proceeds with its operation to establish a connection between trunk 00 now being served and an available sender. Associated with this circuit is the sender subgroup selection circuit which determines which of the senders in the sender subgroup available to link frame 0 is currently idle. Assuming that a sender in subgroup 0 is idle, make contacts SG0 on FIG. 16B close to operate relay 16B-C0. Once a sender in the sender subgroup 0 is selected, the sender link next selects an idle one of the senders in subgroup 0. Let it be assumed that sender 0 is selected at this time. The select magnet for level 0 of the secondary link is operated, by circuits not shown, as a consequence of this selection. The seizure by the sender link of sender 0 in subgroup 0 causes the sender to apply a ground to its conductor HM shown in the upper right-hand corner of FIG. 17C. This ground may now be extended through make contacts S0 of a sender subgroup relay on FIG. 17B, make contacts 16B-C0, and break contacts 17C-SL, to the winding of relay 17B-SA. Relay SA in operating closes its own make contacts, which extends its operating ground through make contacts SG0 on FIG. 17C and make contacts 16A-HA0, to the winding of hold magnet 0 for the secondary switch, thereby closing and locking in the crosspoints common to hold magnet 0 and level 0. This operating ground for hold magnet 0 of the secondary switch is extended to hold magnet 0 on the primary switch which, in operating, further extends the operating ground through the crosspoint contacts for vertical 0 and horizontal 0, and make contacts 16A-HA0 and 16A-T0 to operate relay 17A-ST.

The operation of the aforementioned relays and the closure of the crosspoints on the primary and secondary switches interconnects conductors DC, FR, FT, CO, D, SPI, R, and T of trunk 00 on FIG. 16A with the correspondingly designated conductors extending from FIG. 17C to sender 0 shown on FIGS. 18 through 72. Also, the operation of relays 16B-C0 and 16A-HA0 closes paths from ground on terminal 101 of FIG. 16A to conductors of the cable extending to sender 0. This cable comprises a plurality of conductors as shown on FIGS. 16A and 17C. These cable conductors are the class mark conductors for the sender, and various combinations of them are grounded on the different calls served by the sender. The specific combination of class mark conductors grounded on any call depends on the nature of the trunk being served. Thus, assuming that the ten decades comprising link frame 0 each serve different types of trunks, the specific combination of sender class mark conductors grounded as a consequence of the operation of relay 16B-C0 will differ for the trunks of each decade. Referring to the specific arrangement of trunks shown on link frame 0, the operation of relays 16B-C0 and 16A-HA0 supplies class mark information to the sender pertaining to MF-ANI trunks. The operation of relay 16B-C0 and the relay corresponding to HO0 for decade 1 supplies class mark information for MF-nonANI trunks. Similarly, the operation of relay 16B-C0 for the serving of trunks in other decades of the frame causes class mark information to be transmitted to the sender pertaining to trunks of the type indicated for each decade.

The dial pulse ANI and nonANI trunks are shown on decades 0 and 9, respectively, of link frame 9 on FIG. 16C. This link frame is connectable to any sender in the same manner as is link frame 0, and, as a result of such a



connection, the decade circuitry for link frame 9 similarly transmits class mark information to the sender to which one of its calling trunks is interconnected. Thus, for an incoming call on either a dial pulse ANI trunk or a dial pulse nonANI trunk, relay 16C-C2 together with the relays individual to the decade in which the calling trunk is located will be operated to ground a specific combination of class mark leads and thereby supply class mark information to the sender for calls for the type associated with the decade circuitry.

#### *Sender seizure—General*

When the sender link receives a signal from an incoming trunk to connect the trunk with an idle sender, the link control circuit grounds conductor SC (FIG. 17C) to the parallel-connected windings of the 42-SC1, -SC2, and -SC3 relays of the sender to cause them to operate; and by their make contacts to close a large number of leads momentarily between the link and the sender. The link operates relays in the sender over these common leads to register the trunk link frame number, the class of service, AMA or nonAMA data, PAS or nonPAS data (panel auxiliary sender), ANI or ANIS rate class data, the recorder group number, MF, DP or ASO data, and the trunk connector number of the calling trunk. The link connector also closes crosspoints on the link crossbar switches to provide connection of seven individual leads from the sender to the trunk for the duration of the sender holding time. These leads (FIG. 48) are the T and R leads which receive supervision and multifrequency pulsing from the originating end, and which provide a talking path from a CAMA operator to the calling customer; the CO, D, and DC leads, for mutual control between sender and trunk; the FT and FR leads which are used primarily for outpulsing to the terminating office and for supervision on other than regular AMA, ANI and NAMA (nonAMA) calls. Ground, via lead FT operates relay 24-SPL, and relay 24-OPT operates to ground over lead FR. The S lead crosspoint provides a path for holding the link switches closed until the sender completes the call.

#### *Seizure of sender—Operation with sender link and controller*

The sender link having selected an idle sender, grounds lead SC (FIG. 17C) individual to the sender shown in detail on the present drawings. The grounding of this lead closes the following path to operate relays 42-SC1, -SC2, and -SC3: ground on terminal 16A-101, via make contacts 16A-HA0 and 16B-C0 and conductor SC to the windings of relays 42-SC1, -SC2, and -SC3. As a check that this signal was received and that the proper relays operated, the sender grounds conductor HM on FIG. 42 by means of make contacts 42-SC1. This results in the operation of both the primary and secondary hold magnets of the sender link as already described. In the link circuit of (FIG. 17B), the ground on conductor HM passes through break contacts 17C-SL to operate relay 17-SA and, additionally, passes over conductors extending to the secondary and primary hold magnets to operate them. The operation of the primary hold magnet on FIG. 17A completes a path over its make contacts to operate relay 17A-ST. The operation of the secondary hold magnet on FIG. 17C closes a path over its make contacts to apply ground to conductor S extending back into the sender (FIG. 48). Thus, the ground supplied on conductor HM from the sender is ultimately applied by means of circuitry in the sender link to conductor S extending back to the sender. The ground on conductor S then passes through circuitry in the sender and reappears as a ground on conductor SL (FIG. 48), extending to the winding of relay 17C-SL in the link circuit, to operate it. The continuity of this ground essentially checks the continuity of the sleeve lead. The aforementioned circuit, over which relay 17C-SL operated, may be traced as follows: from ground on conductor S (FIG. 17C) ex-

tending into the sender from the link: conductor S on FIGS. 48 and 42, make contacts 42-SC1, and out over conductor SL extending to the winding of relay 17C-SL to operate it. The operation of relay 42-SC2 also extends ground from terminal 23-101, through make contacts 42-SC2, to the winding of relay 23-P, causing it to operate.

Satisfied that the sender is ready to proceed with the call, and after making a test to guard against a double connection, the link controller applies a ground to conductor GS (FIG. 17C) which is extended over the following path to operate relay 42-ON1: ground on conductor GS (in cable CA17-42) extending to FIG. 42, make contacts 42-SC1, make contacts 66-PLC, break contacts 66-PAS, make contacts 60-MF, break contacts 60-DP, break contacts 54-DPC, break contacts 60-ASO, make contacts 24-SPL, break contacts 24-OPT, break contacts 60-NGP, break contacts 60-NAMA, make contacts 60-ANI, and break contacts 60-AMA, to the winding of relay 42-ON1, to operate it.

#### *Receipt of class information by sender*

The operation of relays 42-SC1, -SC2, and -SC3 prepares a large number of paths over which the sender link transmits class information to the sender in order to apprise it of the characteristics of the trunk now being served. The trunk frame "units" digit is registered in one of the ten relays 54-TF0 through 54-TF9, while the trunk frame tens digit is registered in either relay 54-TF00 or 54-TF10, depending upon whether the "tens" digit is a one or a zero. These two groups of relays, together, enable trunk frame numbers from 00 to 19 to be registered. Let it be assumed that the frame number of the trunk now being served is 09. This being the case, the following circuits are now completed to operate relays 54-TF9 and 54-TF00: ground on terminal 16A-101, make contacts 16A-HA0, and 16B-C0, conductor F9 in cable FO-9, and conductor F00, through make contacts 42-SC1 on FIG. 54, to the windings of relays 54-TF9 and 54-TF00, respectively, to operate them.

The class of service of the incoming trunk is registered in 2-out-of-7 code form in the seven relays 60-CS0 through 60-CS6. Let it be assumed that the class of service of the trunk now being served is 01. This being the case, relays 60-CS0 and 60-CS1 are now operated over the following circuit: ground on terminal 16A-101, through make contacts 16A-HA0, 16B-C, over conductors CS0 and CS1, respectively, through make contacts 42-SC1 to the windings of relays 60-CS0 and 60-CS1, both of which now operate. Each of these relays in operating completes a locking path for itself over its own make contacts, and through make contacts 42-ON1 to ground.

Relay 60-AMA is not operated on the present call. It is associated with trunks requesting service where the trunk serves originating offices not equipped for local charging and not equipped for automatic number identification. The operation of this relay signifies the call to be a standard AMA type call, which is handled in crossbar tandem offices in the manner described in the aforementioned Breed et al. patent.

Relay 60-NAMA is, similarly, not operated on the present call. It is operated for nonspecial types of calls where an AMA record is not to be produced for the call by the tandem office. Examples of such calls would be those from local offices having their own AMA recording facilities.

Relay 60-ANI is operated to indicate that the trunk requesting service serves local offices equipped for automatic number identification. The circuit over which this relay operates is as follows: ground on terminal 16A-101, through make contacts 16A-HA0, 16B-C, conductor ANI, to FIG. 60, make contacts 42-SC2, to the winding of relay 60-ANI. The operation of this relay closes an obvious locking path for itself over its own make contacts and those of relay 42-ON1 to ground.



As explained in detail in the aforementioned Breed et al. patent, each recorder serves a different group of trunks, and each recorder in an office is assigned a recorder number which identifies both the recorder and the trunk group served thereby. The recorder number information is transmitted to the sender on each call over three of the six RN- leads -1, -2, -4, -7, and -13. On each call the recorder number is transmitted over these leads on a 3-out-of-6 code basis, to give 20 possible combinations as shown on the following table:

| Redr No. | RN- Leads Grounded |   |    | Redr No. | RN- Leads Grounded |   |    |
|----------|--------------------|---|----|----------|--------------------|---|----|
| 0-----   | 0                  | 7 | 13 | 10-----  | 1                  | 2 | 7  |
| 1-----   | 1                  | 7 | 13 | 11-----  | 0                  | 4 | 7  |
| 2-----   | 2                  | 7 | 13 | 12-----  | 1                  | 4 | 7  |
| 3-----   | 0                  | 1 | 2  | 13-----  | 2                  | 4 | 7  |
| 4-----   | 4                  | 7 | 13 | 14-----  | 0                  | 1 | 13 |
| 5-----   | 0                  | 1 | 4  | 15-----  | 0                  | 2 | 13 |
| 6-----   | 0                  | 2 | 4  | 16-----  | 1                  | 2 | 13 |
| 7-----   | 1                  | 2 | 4  | 17-----  | 0                  | 4 | 13 |
| 8-----   | 0                  | 1 | 7  | 18-----  | 1                  | 4 | 13 |
| 9-----   | 0                  | 2 | 7  | 19-----  | 2                  | 4 | 13 |

Let it be assumed, for example, that the number of the recorder serving the trunk on which the incoming call now being served appears is 0. In this case, relays 60-RN0, 60-RN7, and 60-RN13 are operated from the grounds applied to RN- conductors -0, -7, and -13, in series with make contacts 42-SC2, to the windings of these relays. These relays, in operating, complete obvious holding paths for themselves to ground on make contacts 42-ON1.

Rate class information is received by the sender in order that it, in turn, may pass the information to the transverter, which utilizes it in determining the charge rate for the call.

Class mark information is transmitted to the sender over either conductor PAS or NPAS (FIG. 17C) extending over to FIG. 66. Conductor PAS is grounded only in connection with the serving of calls from panel offices. On calls from other than panel offices, lead NPAS is grounded to operate relay 66-PLC on the present call.

Relay 60-MF is operated by the sender link for calls from trunks serving offices which outpulse on an MF basis. It is assumed that this is the case for the present call and, therefore, relay 60-MF is operated at this time by the sender link over the following circuit: ground on terminal 16A-101, make contacts 16A-HA0 and 16B-C0, conductor MF extending to FIG. 60, make contacts 42-SC3, to the winding of relay 60-MF to operate it. The operation of this relay closes a holding path for itself over its make contacts, through break contacts 24-OPT to ground through make contacts 42-ON1.

Pulsing relay 23-P is operated from ground on terminal 23-101 extended through make contacts 42-SC2.

Relay 60-DP is operated when the preceding office outpulses on a dial pulse basis. This is not the case for the present call and, therefore, this relay is not currently operated. Relay 60-AS0 is operated by the sender link only for calls received over dial 0 trunks. This is not the case for the present call and, therefore, this relay is not operated at this time.

Relay 60-NGP is operated by the sender link only for nongeneral purpose calls. The present call is assumed to be of the general purpose type in that it uses the new and novel operator switchboard disclosed herein. Therefore, the relay 60-NGP is not operated on this call.

Relays 24-SPL and 24-OPT are also class relays, and they are operated on certain calls to supply information concerning the trunk circuit being served. Both relays are operated only for special service calls as previously defined, i.e., person-to-person, collect, etc. Relay 24-SPL is operated by the trunk, to signify that the calling and called station information will be received during a customer usage of the trunk circuit. The term "customer usage" distinguishes this usage of the trunk circuit from

a condition known as "operator usage," wherein relay 24-OPT operates. An operator usage takes place during calls requiring rerouting, such as for example, a call for which the called party is not at the station originally dialed. The special service operator handling such a call then controls the sender by connections through the incoming trunk circuit and causes the station number to be registered in the sender via the data transfer circuit. Relay 24-OPT is operated on such calls to notify the sender that the called station information about to be received via the data transfer circuit will be received from the special service operator position on an operator usage, rather than from the originating office on a customer usage.

The current usage of the trunk during the call now being described is a customer usage and, therefore, the following path may be closed to operate relay 24-SPL: ground on terminal 12-101, break contacts 13-SR, 10-5A, conductor FT (FIG. 15), the sender link crosspoints, conductor FT from FIG. 17C, via FIGS. 48, 42, 36, 30 and 24, make contacts 42-SC3, break contacts 42-ON, to the winding of relay 24-SPL to operate it. Upon operating, the relay closes a holding circuit for itself over make contacts 24-SPL to ground on make contacts 42-ON1.

Relays 66-DG0, -1, -2, -4, and -7 are used to register trunk connector number information in the sender. Each incoming trunk is assigned a trunk connector number in accordance with the number of the trunk connector in the data transfer circuit which serves each trunk. In a manner hereinafter described, the trunk connector number is subsequently transmitted to the data transfer circuit at the time that it is seized to complete an interconnection between various circuits. The data transfer circuit utilizes the received trunk connector number as address information to enable it to make an interconnection of the circuits requiring interconnection. Let it be assumed, for example, that the trunk connector number of the trunk circuit currently being served is 0. The following circuit is now closed to enter the digit 0 on a 2-out-of-5 code basis in the DG- relays of FIG. 66, as exemplified by the operation of relays 66-DG4 and 66-DG7: ground on terminal 16A-101, make contacts 16A-HA0, 16B-C0, conductors DG4 and DG7 extending over FIGS. 17C, 48, 54, 60 and 66, make contacts 42-SC3, to the windings of relays 66-DG4 and 66-DG7. Each of these two relays, in operating, completes a holding path for itself over its own make contacts, and through make contacts 42-ON to ground.

The operation of relay 60-MF closes the following path to operate relay 68-AS: ground on terminal 68-101, make contacts 60-MF, make contacts 42-SC2, break contacts 24-OPT, to the winding of relay 68-AS to operate it. The circuit functions ensuing from the operation of this relay are later described in connection with steering the called number information.

The aforementioned operation of relay 42-SC1 completes the following path to operate relay 66-SR: ground on terminal 66-101, make contacts 42-SC1, break contacts 66-LRT, and 38-LR, to the winding of relay 66-SR to operate it. The operation of this relay closes an obvious holding path for itself over a set of its own make contacts to ground on make contacts 46-CP. The operation of relay 66-SR controls the manner in which the sender releases as it completes the serving of the call. This is described later, in further detail.

The operation of relay 42-ON1, as previously described, completes an obvious path to operate relay 42-ON3. The operation of relay 42-ON3 completes the following path to operate relay 17C-SB in the sender link: ground on terminal 42-101, make contacts 42-ON3, conductor SB extending from FIG. 42 via FIG. 48 to FIG. 17C, to the winding of relay 17C-SB to operate it. This relay, in operating, applies a ground to conductor BS in cable CA17-42 extending from FIG. 17C via FIG. 48



to FIG. 42, make contacts 66-SR, break contacts 48-AV4, to the winding of relay 42-ON2 to operate it. The operation of this relay closes the following circuit to apply ground to conductor S: ground on terminal 42-103, make contacts 42-ON2, break contacts 48-AV4, make contacts 42-ON2, terminal 104, break contacts 48-AV4, terminal 102, make contacts 42-ON2, break contacts 46-CP, to conductor S. The ground on this conductor is extended over FIGS. 42, 48, and 17C where it is applied to the hold magnets of both the primary and secondary crossbar switches to maintain them operated.

The ground on terminal 42-104 is also extended over make contacts 42-ON2 and 42-SC1 to conductor RL. The ground on conductor RL is extended over FIGS. 42, 48, and 17C, through make contacts 17C-SL, to the winding of relay 17C-RA to operate it. The operation of this relay controls the release of the controller portion of the sender link, as described in detail in the aforementioned Breed et al. patent. The release of the controller portion of the sender link removes ground from the conductor SC (FIG. 17C), thereby releasing relays 42-SC1, -SC2, and -SC3. The release of these relays opens the leads interconnecting the sender and the sender link, over which class information was transmitted to the sender, as already described. However, the sender link maintains the connections between the sender and the incoming trunk through the primary and secondary crossbar switches, which are held operated at this time by ground on conductor S (FIG. 17C) from the sender, as described.

Relays 42-ON1 and 42-ON2 close locking paths for themselves; they supply a number of off-normal ground leads to hold other relays operated, as later described in connection with the operation of such various relays; they hold the sender link switches by grounding conductor S, as described; and guard against the intrusion of other sender links, by grounding the 42-SB lead. Also, as is later described, relay 42-ON2 starts the timing which will reverse the T and R leads to the originating office, as a "start outpulsing signal."

On FIG. 38, make contacts 42-ON2 are operable to close a circuit from ground on terminal 101 through a break contact of relay 66-SR to the windings of relays 38-LR, -LR1, and -LR2, so that the latter will operate on an abandoned call when relay 66-SR releases before the completion of the call, after once having been operated. The operating path of relays 38-LR, -LR1, and -LR2, includes break contacts of relays 41-DST, to prevent the operation of any of these three relays while the sender is connected to a marker. The circuit for the operation of relays 38-LR, -LR1, and -LR2 also includes break contacts of relays 64-SSP, 24-SPA, and make contacts of relay 64-DTCK, to prevent the operation of the -LR relays while the sender is attached to the data transfer circuit, as later described.

The operation of relay 42-ON1, as previously described, completes the following path to operate relay 11-T in the trunk circuit: ground on terminal 42-105, make contacts 42-ON1, break contacts 48-CK2 and 48-AV4, conductor CO extending from FIG. 42 via FIGS. 48 and 17C through the established circuit through the crossbar switches in the sender link, conductor CO (FIG. 12), break contacts 13-PA, to the winding of relay 11-T to operate it. The operation of relay 11-T, at contacts 11-T (FIG. 10), closes a path to operate relay 10-SA. The operation of relay 10-SA, in turn, at contacts 10-SA, closes a path to operate relay 10-RV. The operation of relay 11-T, at its transfer contacts 11-T (FIG. 10), also releases relay 11-A by transferring the incoming T and R conductors 103 from the trunk T and R conductors (FIG. 11) to the T and R conductors (FIG. 12) extending to the sender via the sender link on FIGS. 16A, 17A, and 17C, and FIGS. 48, 42 and 36 of the sender circuit. The release of relay 11-A, in turn, releases relay 10-A1. The transfer of the incoming T and R conductors 103, as described, transfers

the control of the connection from the trunk circuit to the sender.

The transfer of the incoming T and R conductors 103 from supervision by the trunk circuit to supervision by the sender also reverses the polarity of the potential applied to conductors 103. It may be observed that, with supervision by the trunk circuit, a ground is normally applied to the T conductor in series with the upper winding of relay 11-A, the break contacts of relay 10-RV, and the upper primary winding of transformer 101; while a negative potential is applied to the R conductor in series with the lower winding of relay 11-A, the break contacts of relay 10-RV, and the lower primary winding of transformer 101.

Remembering that the trunk circuit has at this time applied negative battery to the R conductor (FIG. 11) and ground potential to the T conductor (FIG. 11), and referring to FIG. 36 of the drawings, it may be seen that the incoming R conductor 103 is at this time connected over conductor R (FIG. 12) to terminal 36-102, and that the incoming trunk T conductor 103 is now connected over conductor T (FIG. 12) to terminal 36-101. The following path may now be traced to supply ground to conductor R (FIG. 12): terminal 36-102, break contacts 46-CP, make contacts 42-ON3, break contacts 48-CK2, 18-MRS, 64-SCW, the lower primary winding of transformer 37-101, break contacts 64-SCW, 18-MRS, make contacts 60-MF, break contacts 20-RV, and over the lower winding of relay 36-L to ground. The following path may now be traced to supply negative battery to conductor T (FIG. 12): terminal 36-101, break contacts 46-CP, make contacts 42-ON3, break contacts 48-CK2, 18-MRS, 64-SCW, the upper primary winding of transformer 37-101, break contacts 64-SCW, 18-MRS, make contacts 60-MF, break contacts 20-RV, and over the upper winding of relay 36-L to negative battery. Thus, it may be seen from the foregoing that the transfer of the incoming trunk conductors T and R 103 from the trunk circuit to the sender reverses the potentials applied to the incoming trunk, since the sender now applies ground to the R conductor 103 and negative battery to the T conductor 103, while the trunk had, immediately before the transfer, applied negative battery to the R conductor and ground to the T conductor. The operation of relay 42-ON1 closes an obvious path to operate relay 42-ON.

It was previously mentioned how a trunk frame number of 09 was registered in the sender by the operation of relays 54-TF9 and 54-TF00. Referring to FIG. 54, it may be seen that a path is closed to operate relay 54-TFA5 whenever any one of the relays 54-TF5 through 54-TF9 is operated, and that, similarly, a path is closed to operate relay 54-TFB5 whenever any one of the relays 54-TF0 through 54-TF4 is operated. Accordingly, since at this time it is assumed that relay 54-TF9 is operated, a path is also closed to extend the operating ground for relay 54-TF9 over its make contacts, through make contacts 42-ON, to the winding of relay 54-TFA5 to operate it. The operation of relay 54-TFA5 closes a holding path for itself over its own make contacts and make contacts of relay 42-ON1 to ground. Relays 54-TFA5 and 54-TFB5 are provided in order that the trunk frame information may be transmitted to the marker and marker connector on a biquinary code basis. Thus, referring to the right-hand side of FIG. 54, where the contacts of the various trunk frame relays are shown, it may be seen that contacts 54-TF00 are closed for any of the trunk frame numbers 00-09; while contacts 54-TF10 are closed for any trunk frame numbers 10 through 19. Also, contacts 54-TFB5 are closed for any trunk frame numbers 0 through 4, or 10 through 14; while contacts 54-TFA5 are closed for any of the trunk frame numbers 05 through 09, or 15 through 19. The arranging of the output contacts of the trunk frame relays in this manner minimizes the number of leads required to transmit and register the trunk frame information in the marker connector.



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Make contacts of relay 42-ON2, on FIG. 48, complete an obvious path in series with break contacts 53-SSMF to operate relay 48-AV3. The operation of relay 42-ON3 also closes the following path to operate relay 48-CK4: ground on terminal 48-101, make contacts 42-ON3, break contacts 48-CK3, and 48-AV4, to the winding of relay 48-CK4 to operate it.

Relay 36-L operates as the incoming trunk is extended to terminals 36-101 and 36-102 upon the operation of relay 11-T in the trunk circuit, as previously described.

The operation of relay 42-ON3 also completes the following path to operate relay 38-RD: ground on terminal 37-102, break contacts 48-CK3, make contacts 42-ON3, to the winding of relay 38-RD to operate it.

The operation of relay 42-ON3 also completes the following path to operate relay 27-TVR: ground on terminal 27-101, make contacts 42-ON3, break contacts 60-NGP, to the upper winding of relay 27-TVR to operate it.

The following path is now closed on FIG. 53 to operate relays 53-PR1 and 53-PR2: ground on terminal 53-101, make contacts 42-ON3, and 27-TVR, and break contacts 44-OEXD, to the windings of relays 53-PR1 and 53-PR2, thereby operating them.

Also, at this time the following path is closed to operate relay 22-FO1: ground on terminal 22-101, make contacts 42-ON3, break contacts of relays 49-RR7, -RR4, -RR2, -RR1, -RR0, 32-MFS, 47-OD, 21-MFTT, 21-TT, another set of break contacts 21-TT, and break contacts 38-LR1, to the winding of relay 22-FO1 to operate it. The circuit operations resulting from the operation of relays 22-FO1, 53-PR1, and 53-PR2 are hereinafter described.

#### Supervision

Supervision is maintained in the sender by relay 66-SR in conjunction with relay 36-L. Relay 66-SR is a slow-release relay and holds for the duration of any momentary open on the line. It is operated on seizure of the sender, under control of the operation of relay 42-SC1, as already described. When the T and R leads 103 (FIG. 10) are cut through from the incoming trunk to the sender, relay 36-L operates, and relay 42-SC1 subsequently releases, thereby placing relay 66-SR under control of make contacts of relay 36-L. Relay 36-L may release during the interval of the line reversal, but it will immediately reoperate to hold relay 66-SR, unless the call has been abandoned. If relay 66-SR releases, it causes relays 38-LR, -LR1, and -LR2 to operate, as hereinafter described in connection with the discussion of abandoned calls.

#### Receiving the called number

It has previously been discussed how relay 42-ON2 operates. The operation of this relay closes the following path to operate relay 17-RA in the sender link: ground on terminal 42-103, make contacts 42-ON2, break contacts 48-AV4, make contacts 42-ON2, another set of make contacts on relay 42-ON2, make contacts 42-SC1, conductor RL extending from FIG. 42 via FIG. 48 to FIG. 17, and make contacts 17C-L to the winding of relay 17-RA to operate it. The operation of relay 17C-RA closes a circuit (shown only diagrammatically on FIGS. 16A, 16B, 17B, 17A, and 17C) for removing the ground from conductor SC extending from FIG. 17C, via FIGS. 48 and 42. The removal of this ground, in turn, causes the release of relays 42-SC1, -SC2, and -SC3. The release of relay 42-SC2 opens a path on FIG. 23 interconnecting the winding of relay 23-P with ground on terminal 23-101, thereby causing relay 23-P to release.

The operation of relay 42-ON3, as previously described, closes the following path to operate relay 32-AVA: ground on terminal 32-101, make contacts 42-ON3, break contacts 32-AV1, to the winding of relay 32-AVA to operate it. The operation of relay 42-ON2, as already described, closes the following path to operate

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relay 59-TG3: ground on terminal 59-101, make contacts 42-ON2, downwards on FIG. 59 to terminal 59-102, to the right on the same figure to terminal 59-103, upwards on the same figure and through break contacts 59-TR1, break contacts 21-STG, to the winding of relay 59-TG3 to operate it.

A reverse-battery "start pulsing" signal is required by the originating operator or sender on MF calls. On both dial pulse and MF calls, a discrete time interval is needed to ensure that the sender is attached before the sender itself is seized by a data transfer circuit, as hereinafter described. The RVT tube on FIG. 20 is used in conjunction with relay 20-RVT to measure an interval of from 150 to 320 milliseconds, measured from the initial seizure of the sender, before the "start" signal is returned to the originating office, or before the "sender attached" signal is provided. The timing interval is initiated by the operation of relay 42-ON2. It is assumed that the disclosed equipment for the presently described MF call supplies what is known as a "wink" start-pulsing signal back to the originating office, as a consequence of the seizure of the tandem office by the outgoing calling trunk at the originating office. In this connection, the circuit is arranged so that the seizure of the incoming trunk in the tandem office supplies a normal on-hook polarity back to the originating office. This arrangement is predicated on the assumption that the normal condition of the trunk is the "noncharge" condition. An on-hook condition may be defined as one in which a ground potential is found on T conductor 103, and a negative potential is found on R conductor 103. This is the case for the initial seizure of the incoming trunk circuit disclosed on FIGS. 10 through 15 since, from a study of FIGS. 10 and 11, it may be seen that the upper and lower windings of relay 11-A and the back contacts of relay 10-RV (released) respectively supply ground to the T conductor 103 and negative potential to the R conductor 103 when the trunk is initially seized.

Following the seizure of the incoming trunk, it is hereinafter described how the attachment of an available sender to the trunk by the sender link causes relay 11-T to operate and thereby transfer the incoming trunk conductors T and R 103 (FIG. 10) from the incoming trunk circuit to the sender, and particularly to FIGS. 36 and 37 thereof which, together, supply a battery of a reversed polarity from that supplied initially by the incoming trunk circuit. Thus, recalling that the trunk circuit (FIG. 11) initially supplied ground to the T and battery to the R conductors 103, it may be seen that the sender now supplies battery to the T conductor and ground to the R conductor.

As is described in the immediately following paragraphs, the seizure of the sender operates relay 42-ON2, which initiates the operation of the timing circuit on FIG. 20 so that, after a predetermined time interval, relay 20-RVT operates, followed by the operation of relay 20-RV which again reverses the polarity applied to the T and R conductors 103, and thereby restores them to their original on-hook condition in which ground is applied to conductor T103 and a negative potential is applied to conductor R103. Therefore, in partial summary, it may be seen that the seizure of the tandem office by an incoming trunk causes a "wink" signal comprising a first polarity condition, followed by a second or reverse polarity condition and, in turn, by a reversion to the first polarity condition to be applied over the trunk T and R conductors 103 back to the originating office which, in response thereto, proceeds to output called number information, on an MF basis, to the tandem office.

The operation of relay 42-ON2, as previously described, closes the following path to apply ground potential to terminal 20-104: ground on terminal 20-101, the winding of relay 20-RVT, break contacts 59-TR2, 21-MFTT, break contacts 21-TT, make contacts 42-ON2, break contacts 51-RGCB, 20-RV, to terminal



20-104. One side of the RVT capacitor is connected to this terminal, while the other side of the capacitor is connected through break contacts 21-STG and resistor RV1, paralleled by resistor RV2 to a positive 130-volt potential on terminal 20-102. The closure of this circuit, upon the operation of relay 40-ON2, thereby completes the path over which capacitor RVT may charge to the 130-volt potential at a rate determined by its capacitance and the resistance of resistor RV1. The "start" anode of tube RVT is connected through resistor RV to the top side of capacitor RVT and, therefore, rises in potential as the capacitor charges. After a predetermined time interval, as the capacitor charges, the "start" gap of tube RVT, comprising the starter anode and the cathode, breaks down, and immediately thereafter conduction takes place across the main gap of the tube. The current across the main gap of the tube is sufficient to operate relay 20-RVT. The circuitry comprising the operate path for relay 20-RV controls the time when the relay will operate and when it will release for different types of calls, and also controls when it will operate and release for various abnormal conditions, such as for example, abandoned calls.

The circuitry on the lower half of FIG. 20, essentially, comprises a 2-out-of-7 to 1-out-of-20 code translator, controlled by the contacts of relays 60-CS0 through 60-CS6. This translator network translates the class-of-service indication registered in 2-out-of-7 code form, on the CS-relays of FIG. 60, into a 1-out-of-20 indication, whereby class-of-service indication 0 through 20 may be indicated by potentials appearing on terminals CS0 through CS20, respectively. Each class-of-service indication represents a different type of incoming call, as hereinabove described. A CS-terminal is cross-connected to either terminal RVH or RVR if it is desired to have the tandem office transmit a "wink" signal back to the preceding office. When the call is an MF call, requiring the use of an MF trunk, a particular CS-terminal on FIG. 20 is cross-connected to either terminal 20-RVH or 20-RVR to cause the tandem office to transmit back to the originating office a "wink" signal, whereby to control outpulsing in the originating office. On the other hand, for other types of calls, such as for example, DP calls, where the outpulsed information will not be on an MF basis, a CS-terminal is not cross-connected to either terminal 20-RVH or to terminal 20-RVR and, accordingly, a "wink" signal is not transmitted back to the originating office when the sender is attached to the trunk, and as relay 20-RV subsequently operates. A particular CS-terminal is connected to either terminal 20-RVH or 20-RVR, depending upon whether or not it is desired to have relay 20-RV release before the release of the sender itself on abandoned calls. As hereinafter described, relay 38-LR1 operates upon the abandonment of a call, and at its break contacts 38-LR1 disconnects terminal 20-RVR from the winding of the 20-RV relay, and at make contacts 38-LR1 transfers the circuit to maintain an interconnection between the winding of relay 20-RV and terminal 20-RVH. The release of relay 20-RV before the sender is disconnected from the trunk on abandoned calls causes a polarity reversal which may cause the originating sender to outpulse the ANI information. However, such action does not always occur in the originating offices following call abandonment, and a determination of whether such action does or does not occur on a particular call depends upon the details of the circuitry within the originating office. Suffice it to say, it is undesirable to have the ANI information outpulsed on abandoned calls.

Thus, a particular CS-terminal of FIG. 20 is cross-connected with terminal 20-RVH if it is desired to hold relay 20-RV operated on an abandoned call until the sender is released. On the other hand, if the circuitry of the originating office is such that the holding of relay 20-RV is of no consequence, a CS-terminal may be con-

nected to terminal 20-RVR, thereby permitting relay 20-RV to release immediately upon the operation of relay 38-LR1, as a call abandonment is detected.

It has hereinbefore been described how the class-of-service class mark information for the present call was registered in the sender upon the operation of relays 60-CS0 and 60-CS1. The following path may now be traced to operate relay 20-RV: ground on terminal 20-103, terminal 20-105, make contacts 60-CS0, 60-CS1, to terminal 20-CS11. Let it be assumed, for example, that terminal 20-CS11 is cross-connected with terminal 20-RVH, thereby indicating that a call of the type presently being described requires that relay 20-RV remain operated should the call be abandoned, thereby preventing a polarity reversal from being transmitted back to the originating office, and thereby preventing a possible erroneous outpulsing of ANI information on abandoned calls. Continuing, the ground on terminal 20-CS11 may now be extended over the cross-connection to terminal 20-RVH, through break contacts 51-RGCA, make contacts 20-RVT and 60-MF to the winding of relay 20-RV to operate it.

It has hereinbefore been described how, at this time, T conductor 103 (FIG. 10) is connected to terminal 36-103, and from there to negative battery on the upper winding of relay 36-L, and how R conductor 103 (FIG. 10) is connected to terminal 36-104, and from there to ground on the lower winding of relay 36-L. The operation of relay 20-RV opens its break contacts and closes its make contacts on FIG. 36 to effect a reversal of polarity, so that terminal 36-103 and T conductor 103 are no longer connected to negative battery but, instead, are connected through make contacts 20-RV to ground via the lower winding of relay L; and so that terminal 36-104 and R conductor 103 are no longer connected to ground but, instead, are connected through make contacts 20-RV to negative battery via the upper winding of relay 36-L. This reversal of polarity represents an on-hook condition and constitutes a signal to the originating office that the tandem sender is now ready to receive MF outpulsing.

Each MF digit transmitted by the originating office comprises a unique combination of 2-out-of-5 audio frequencies. The frequencies employed for the MF digits are 700, 900, 1100, 1300, and 1500 cycles per second, designated  $f_0$ ,  $f_1$ ,  $f_2$ ,  $f_4$ , and  $f_7$ , respectively. In addition to the MF digits, a key pulse signal using the above-mentioned frequency  $f_2$  and a frequency of 1700 cycles, designated  $f_{10}$ , is transmitted as a gate opener; and a "start" pulse using the frequencies  $f_7$  and  $f_{10}$  is transmitted after the last digit as an end of pulsing signal. The entire code used is as follows:

| Digit                          | Frequency Designations   | Frequency Cycles per second |
|--------------------------------|--------------------------|-----------------------------|
| 0                              | $f_4, f_7$               | 1300, 1500                  |
| 1                              | $f_0, f_1$               | 700, 900                    |
| 2                              | $f_0, f_2$               | 700, 1100                   |
| 3                              | $f_1, f_2$               | 900, 1100                   |
| 4                              | $f_0, f_4$               | 700, 1300                   |
| 5                              | $f_1, f_4$               | 900, 1300                   |
| 6                              | $f_2, f_4$               | 1100, 1300                  |
| 7                              | $f_0, f_7$               | 700, 1500                   |
| 8                              | $f_1, f_7$               | 900, 1500                   |
| 9                              | $f_2, f_7$               | 1100, 1500                  |
| KP                             | $f_2, f_{10}$            | 1100, 1700                  |
| Start ( $f_7, f_{10}$ noncoin) | ( $f_7, f_{10}$ noncoin) | 1500, 1700                  |

From the above it may be seen that the standard additive 2-out-of-5 code is used for frequency designation purposes. It is apparent that the sum of the two frequency designations is equal to the corresponding digit for digits "1" through "9"; whereas the combination of the frequencies  $f_4$  and  $f_7$  is arbitrarily assigned to represent the digit "0."

As described, the originating office starts its MF outpulsing operations at this time, and first transmits a KP



signal composed of the frequencies  $f_2'$  and  $2_{10}$ . These signals are received on the incoming T and R conductors 103 (FIG. 10); and since relay 11-T is operated at this time to connect the T and R conductors 103 with the sender, the frequencies are transmitted over conductors T and R (FIG. 12), via FIGS. 16A, 17A, and 17C of the sender link circuit and FIGS. 48, 42 and 36 of the sender. On FIG. 36 they are further transmitted over break contacts of relay 46CP, make contacts of relay 42-ON3, break contacts of relay 48-CK2, 18-MRS, 64-SCW to the two primary windings of transformer 37-101. The secondary windings of the same transformer apply the received MF signals to the MF detectors comprising the plurality of rectangles 37- $f_0$ , 37- $f_1$ , 37- $f_2$ , 37- $f_4$ , 37- $f_7$ , 37- $f_{10}$ , and 37-SP. Each rectangle is individually associated with one of the plurality of MF frequencies and each such rectangle may be understood to contain whatever apparatus is necessary to detect its associated frequency and, as a consequence of the detection, to close the make contacts shown inside the rectangle. Thus, for example, the reception of the MF frequency  $f_0$  is understood to be detected by the rectangle 37- $f_0$  and, in response thereto, to close the make contacts shown on the right-hand portion of rectangle 37- $f_0$ . Similarly, a reception of the MF frequency  $f_{10}$  is detected by the rectangle 37- $f_{10}$  and results in the closure of the two sets of make contacts contained within the rectangle 37- $f_{10}$ .

It has previously been described how a KP signal comprises the MF frequencies  $f_2$  and  $f_{10}$ . These two signals are detected by the equipment within the rectangles designated 37- $f_2$  and 37- $f_{10}$  which, in response thereto, closes the make contacts in both of these rectangles. The closure of the right-hand set of make contacts in each of the rectangles 37- $f_2$  and 37- $f_{10}$  performs no useful function at this time. The closure of the left-hand set of contacts in each of the rectangles 37- $f_2$  and 37- $f_{10}$  completes the following path to energize "AND" gate 37-103: ground on terminal 37-104, through the left-hand set of make contacts in rectangle 37- $f_2$ , to the right-hand input of "AND" gate 37-103, and ground on terminal 37-105, through the left-hand set of make contacts in rectangle 37- $f_{10}$ , break contacts 37-KP2 to the left-hand input of the "AND" gate. The concurrent application of ground to both of the inputs of the "AND" gate permits the applied grounds to pass therethrough and energize the winding of relay 37-SP to operate it.

Prior to the time relay 37-SP operated and subsequent to the operation of relay 42-ON3, the following circuit existed to energize both windings of polarized relay 37-KP: negative battery on its upper winding, through the upper winding, break contacts 37-KP and 37-SP to ground on terminal 37-106. The circuit for the lower winding of relay 37-KP is completed at this time over the following path: ground on the lower winding, through the lower winding, break contacts 72-RGC, make contacts 42-ON3 to negative battery. Thus, with the closure of the two described paths for the windings of relay 37-KP, current flows through both windings thereof. The upper winding of relay 37-KP has more ampere turns than its lower windings and, in addition, the direction of the current through the upper winding opposes the polarities required for the operation of the relay. This being the case, the current through the upper winding of relay 37-KP not only opposes the current through its lower winding but, in addition, is sufficient to maintain the relay nonoperated.

The operation of relay 37-SP, as described, opens its break contacts 37-SP in series with its upper winding of relay 37-KP, thereby terminating the flow of current therethrough. The cessation of current in the upper winding of relay 37-KP permits the current flowing in its lower winding to operate it, since the direction of the current in the lower winding aids the polarities required for the operation of the relay. The operation of relay 37-SP also closes the following paths to operate relay 37-LK:

ground on terminal 37-115, make contacts 37-SP, conductor J extending from FIGS. 37 to 38, over conductor J on FIG. 38 to terminal 38-102, break contacts 67-MS, 67-KS, 67-HS, 67-FS, 68-DS, 68-BS, 52-TM2, make contacts 20-RV, break contacts 72-RGC1, and conductor L to FIG. 37 to the winding of relay 37-LK to operate it.

The operation of relay 37-KP opens its break contacts in the energizing circuit for its upper winding and holds this set of break contacts open for the time during which relay 37-KP remains operated. The termination of the transmission of the KP signal permits the make contacts in rectangles 37- $f_2$  and 37- $f_{10}$  to release, thereby releasing relay 37-SP. The release of relay 37-SP opens its make contacts interconnecting the ground on terminal 37-115 with the J conductor, and thereby opens the circuit for relay 37-LK to release it.

The release of relay 37-SP completes the following path to operate relays 37-KP1 and 37-KP2 on terminal 37-106, break contacts 37-SP, make contacts 37-KP, break contacts 37-KP1, the parallel-connected windings of relays 37-KP1 and -KP2 through break contacts 72-RGC, and make contacts 42-ON3 to negative battery. The operation of relay 37-KP1 completes a locking path for itself, as well as relay 37-KP2, to ground on terminal 37-107 over make contacts 37-KP1. This holding path prevents relays 37-KP1 and 37-KP2 from releasing upon the subsequent reoperation of relay 37-SP when the next MF signal is received.

In connection with the reception of the MF signals outpulsed from the preceding office, it has been described, so far, how the circuit responded to the reception of the KP pulse which is used to unlock the MF receiver. Let it next be assumed, for example, that the digit "2" is received, as manifested by the reception of the MF frequencies  $f_0$  and  $f_2$ .

The operation of relay 37-KP2 closes its make contacts 37-KP2 to interconnect the secondary windings of transformer 37-101 with the input of the MF frequency detector 37-SP. This detector may advantageously comprise a broad band detecting device which will respond to the presence of any MF signal and, in response thereto, operate the make contacts shown within the rectangle 37-SP.

The reception of the MF frequencies  $f_0$  and  $f_2$  energizes the MF detectors 37- $f_0$  and 37- $f_2$  to close the make contacts contained therein, and in addition, energizes the MF detector 37-SP to close the make contacts contained within rectangle 37-SP. The closure of the make contacts within rectangle 37- $f_0$  completes the following path to operate relay 37-0: ground on terminal 37-108, the make contacts within rectangle 37- $f_0$ , the winding of relay 37-0, and through the series-connected windings of relays 37-CK2 and 37-CK3, through make contacts 37-LK to a positive 130-volt potential. The current through this circuit operates relay 37-0. The reception of the MF frequency  $f_2$  completes the following circuit to operate relay 37-2: ground on terminal 37-104, the right-hand set of make contacts within rectangle 37- $f_2$ , the winding of relay 37-2, the series-connected windings of relays 37-CK2 and 37-CK3, make contacts 37-LK to the positive 130-volt potential.

Relays 37-CK2 and 37-CK3 are marginal relays, with relay 37-CK2 operated whenever the operating current for two or more of the relays 37-0, -1, -2, -4, -7, or -10 flows therethrough, while relay 37-CK3 operates only when the operating current for three or more of the MF frequency detecting relays 37-0, -1, -2, -4, -7, or -10 flows therethrough. Of the MF relays, only 37-0, and 37-2 are operated at this time, and their operating current also flows through the series-connected windings of relays 37-CK2 and 37-CK3. Hence, relay 37-CK3 does not operate at this time. However, the current through the winding of relay 37-CK2 is sufficient to operate it, and, therefore, relay 37-CK2 operates at this time.



Relays 37-KP1 and 37-KP2 operated as described during the reception of the KP pulse. They remain operated for the period of time that all the MF information is received. The broadband MF frequency detector 37-SP remains interconnected with the secondary windings of transformer 37-101 as long as relay 37-KP2 is operated. Therefore, the reception of the MF frequencies  $f_0$  and  $f_2$  energizes the detector 37-SP which closes its make contacts to complete a path to operate relay 37-SP. Relay 37-SP, operated, completes a path, similar to that previously described, from ground on terminal 37-115 via the J conductor on FIG. 38, to operate relay 37-LK. Relay 37-LK, operated, closes its make contacts 37-LK to connect the positive 130-volt battery potential through the series-connected windings of relays 37-CK2 and 37-CK3 to the windings of the MF frequency detecting relays 37-0, -1, -2, -4, -7, and -10, respectively, associated with the MF frequency detectors 37- $f_0$ , - $f_1$ , - $f_2$ , - $f_4$ , - $f_7$ , and - $f_{10}$ .

The operation of relay 37-CK2 indicates that only two of the frequency detecting relays have operated. The operation of relay 37-CK2 completes the following path to operate relay 38-RA; ground on terminal 37-113, make contacts 37-CK2, conductor H extending from FIG. 37 to FIG. 38, to the winding of relay 38-RA to operate it. Relay 38-RA, in operating, completes the following path to lock itself operated to ground on the J lead: ground on terminal 37-115, make contacts 37-SP, the J conductor, make contacts 38-RA, break contacts 51-RGCB, make contacts 38-RA to the winding of relay 38-RA.

The operation of MF frequency detecting relays 37-0 and 37-2 completes the following path to provide a supplementary holding circuit for relay 38-RA: ground on terminal 37-114, make contacts 37-0 and 37-2 in parallel, make contacts 37-KP2, the S conductor extending from FIG. 37 to FIG. 38, make contacts 38-RA to the winding of relay 38-RA.

Recalling the previous operation of relay 68-AS, the operation of relay 38-RA completes the following path to operate relay 68-BS: ground on terminal 68-101, make contacts 60-MF, 38-RA (terminal 68-102), make contacts 68-AS, break contacts 68-BS, to the winding of relay 68-BS to operate it.

The called number information, received on an MF basis from the originating office, is detected by the MF receiving and control circuitry on FIGS. 37 and 38, and is registered in the called number registers of FIGS. 69 and 70. The first digit received is registered in 2-out-of-5 code form in the "A" register, shown on the leftmost portion of FIG. 69; in the second digit received is stored in the B register of FIG. 69; and, in turn, each of the successively received called number digits is respectively registered and stored in successive ones of the C and D registers of FIG. 69, and of the E, F through L registers of FIG. 70. The first digit received is a "2," as manifested by the operation of frequency detecting relays 37-0 and 37-2. This being the case, the following circuits are now closed to operate relays 69-A0 and 69-A2, thereby registering the digit "2" in 2-out-of-5 code form: ground on terminal 71-101, make contacts 37-KP1, make contacts of both relays 37-0 and 37-2 of the MF receiving circuit, make contacts 38-RA for each circuit, break contacts 72-RGC1 for each circuit, conductors 0 and 2 extending from FIG. 71 over FIG. 70 to FIG. 69, make contacts 68-AS for each circuit, conductors 69-A0 and 69-A2, to the windings of relays 69-A0 and 69-A2, respectively, thereby operating them. Both of the relays 69-A0 and 69-A2, in operating, complete a holding path for themselves over their respective make contacts through make contacts 42-ON3 to ground on terminal 69-101.

In summary, it may be seen that, so far, the reception of the MF frequencies  $f_0$  and  $f_2$ , for an "A" digit of "2," operates the channel relays 37-0 and 37-2 which,

in turn, by concurrently operating relays 69-A0 and 69-A2, enters an "A" digit of "2" into the called number register circuit of FIGS. 69 and 70. Relays 69-A0 and 69-A2, together, represent an "A" digit of "2" in 2-out-of-5 code form.

It has hereinbefore been described how the conjunctive operation of relays 38-RA and 68-AS provide a path to operate relay 68-BS.

Referring momentarily to FIG. 38, and in particular to the contact network comprising contacts of steering relays 68-AS, -CS, -ES, 67-GS, -JS, and -LS, and 68-BS, -DS, 67-FS, -HS, -KS, and -MS which, in conjunction with contacts 52-TM2, 20-RV, and 72-RGC1, interconnect terminals 38-103 and 38-102, it may be appreciated that these two terminals will be interconnected as long as two successive steering relays, such as for example, 68-AS and 68-BS, or 68-BS and 68-CS, etc., are not operated at the same time. Continuity is maintained between these two terminals whenever only a single relay, such as for example, 68-AS is operated, since the continuity is still maintained by the lower contact network, beginning with contact 68-BS and terminating with contact 67-MS.

Recalling now that both relays 68-AS and 68-BS are operated, it may be appreciated that the ground supplied from terminal 37-115, through make contacts 37-SP, over the J conductor, to operate relay 37-LK is now broken in the portion of the path intermediate to terminals 38-102 and 38-103, since both the break contacts of relays 68-AS and 68-BS are now opened. The disconnection of ground causes relay 37-LK to release. The release of relay 37-LK opens its make contacts 37-LK, thereby disconnecting the 130-volt potential from the series-connected windings of relays 37-CK3 and 37-CK2, and from the MF frequency detecting relays 37-0, -1, -2, -4, -7, and -10, whereupon relays 37-CK2, 37-0 and 37-2 release. If by this time the reception of the MF signal for the "A" digit is ended, the MF frequency detector 37-SP will be de-energized, and the opening of the make contacts in the right-hand portion of the rectangle 37-SP will have opened the circuit for the relay 37-SP, causing it to release. The release of relay 37-SP, in turn, opens its make contacts 37-SP to remove ground from the J conductor of FIGS. 37 and 38, thereby opening the holding path for relay 38-RA and causing it to release. If, however, the MF signal pulse is still present, relay 37-SP will remain operated and, in turn, will hold relay 38-RA operated over the J conductor ground until the MF signal is no longer received. This interlocking feature is provided to ensure that each MF pulse locks in until it has been recorded and that the register does not advance to the next digit until the end of the reception of the MF frequencies for the previous digit.

#### Digit steering circuit

The digit steering circuit on FIGS. 67 and 68 comprises a single relay per digit. It is advanced by contacts on the register advance relay 38-RA if the relay 60-MF is operated, as is always the case for the reception of information on an MF basis. On the seizure of the sender, as previously described, relay 42-SC2 operates and, at its make contacts, operates relay 68-AS in preparation for the reception of the first digit pulsed into the sender. Relay 68-AS locks itself through a chain of series-connected break contacts on all of the succeeding steering relays, and contacts 42-ON3 to ground. The subsequent release of the sender link control circuit causes relay 42-SC2 to release, thereby opening the operating path of relay 68-AS. On the first operation of relay 38-RA, as the MF signals for the "A" digit are received, relay 68-BS operates, as described, through make contacts of relay 68-AS in series with make contacts on relay 38-RA. Relay 68-BS, in operating, locks through break contacts of relay 68-CS and the series-connected break contacts on each of the succeeding relays in the



chain to a ground on make contacts 42-ON3 in the lower left-hand corner of FIG. 67. Relay 68-BS in operating, at break contacts 68-BS, also opens its own operating circuit. The transfer contacts, comprising the make and break contact set of relay 68-BS connected to the winding thereof, are of the continuity transfer type, whereby energization of the winding causes the set of make contacts to be closed before the set of break contacts is opened. The same is true of the corresponding contacts of each of the other digit steering relays 68-CS, -DS, -ES, and 67-FS, -GS, -HS, -JS, -KS, -LS, and -MS. Relay 68-BS, in operating, also closes continuity transfer contacts 68-BS connected to terminal 68-105, thereby transferring the locking circuit of relay 68-AS from the off-normal ground, originating on terminal 67-101, to the ground supplied to terminals 68-104, 68-103, and to terminal 68-102 connected to ground by make contacts 38-RA and 60-MF. This transfer of the holding ground for relay 68-AS permits it to release under control of contacts 38-RA as relay 38-RA releases upon the termination of reception of the MF signals for the "A" digit.

The next operation of relay 38-RA, as the MF signals are received for the "B" digit, operates relay 68-CS through the break contacts of relay 68-AS in series with make contacts of relay 68-BS. The subsequent release of relay 38-RA, upon the termination of the reception of MF signals for the "B" digit, releases relay 68-BS in essentially the same manner relay 68-AS released at the termination of the reception of MF signals for the "A" digit. This action continues and is repeated for each operation of relay 38-RA, thereby operating the steering relay for the next digit; and each release of relay 38-RA releases the steering relay for the digit just registered. The steering relays 68-CS, 68-DS, and 67-JS have auxiliary relays 68-CSA, 68-DSA, and 67-JSA, respectively, associated therewith to perform the additional switching functions associated with the operation of these relays. The reasons for this, together with the circuits controlled by these relays, are hereinafter described.

#### Digit registration

On the seizure of the sender for MF calls, the first "A" digit steering relay 68-AS is operated under control of relay 42-SC2, as above described. When the "A" digit frequencies enter the MF receiver, the signal present detector 37-SP is energized, thereby operating relay 37-SP. The operation of relay 37-SP connects ground on terminal 37-115 to the J lead, which is connected to a two-branch parallel circuit, each branch of which contains a chain of series-connected break contacts of the steering relays 68-AS, 68-BS, etc. The circuit is designed so that, if a break contact of any particular steering relay is in one branch, the next succeeding steering relay has a break contact in the other branch. Both branches will, therefore, be open-circuited whenever a digit steering relay and its next succeeding digit steering relay are concurrently operated. Since only relay 68-AS is initially operated, one branch of the parallel check circuit is therefore closed and the ground on the J conductor is returned to the MF receiver, over the L lead, to operate relay 37-LK. Relay 37-LK operates and connects battery to the MF frequency detecting relays 37-0, 37-1, etc. When the channel detectors 37-f<sub>0</sub>, 37-f<sub>1</sub>, etc. are energized corresponding to the frequencies received, their associated MF frequency detecting relays 37-0, 37-1, etc., operate to connect ground to the corresponding leads to the sender. When the receiving circuit detects that two of the frequency detecting relays have operated, the receiver check relay 37-CK2 operates, thereby connecting ground on terminal 37-113, via the H lead to the sender, thereby operating the sender register advance relay 38-RA. Relay 38-RA locks, as previously described, to the J lead, to which ground is connected through make con-

tacts of the MF signal present relay 37-SP or relay 37-CK2. Locking ground for relay 38-RA is also extended from terminal 37-114 to the S lead, which is controlled by the parallel-connected contacts of the MF frequency detecting relays 37-0, 37-1, etc. Relay 38-RA, in operating, closes the 0, 1, 2, 4 and 7 leads on FIG. 71 to a chain of steering relay contacts which direct these leads to the inputs of the proper digit register. With relay 68-AS operated, the leads are connected to the "A" digit register of FIG. 69 to operate two of the five relays 69-A0, 69-A1, 69-A2, 69-A4, and 69-A7, corresponding to the two grounded leads from FIG. 71. The operated register relays 69-A0, etc., on FIG. 69 then close locking paths for themselves to ground via make contacts 42-ON3. Relay 38-RA also operates the next steering relay which, in this case, is relay 68-BS which, at contact 68-BS, causes the other leg of the parallel check circuit between the J and L leads of FIG. 38 to be open-circuited, thereby allowing relay 37-LK to release. Relay 37-LK, in releasing, releases relay 37-CK2 and the MF frequency detecting relays 37-0, 37-1, etc. If the next MF signal pulse is ended, or when it does end, relay 37-SP will release. With relays 37-SP and 37-CK2 and the frequency detecting relays released, relay 38-RA will release. The release of relay 38-RA opens its make contacts, thereby releasing relay 68-AS, thus completing the steering advance. The release of relay 68-AS recloses one leg of the circuit between the J and L leads of FIG. 38. Either leg being closed enables the relays of the receiver to respond to the reception of the MF signals for the next digit.

The "B" digit is recorded in the same manner as above described for the "A" digit. The "B" digit frequencies are detected and the receiver signal-present relay 37-SP operates. Relay 37-LK operates to enable the MF frequency detecting relays 37-0, 37-1, etc., two of which operate, causing the operation of relay 37-CK2. The sender relay 38-RA operates and, in turn, operates steering relay 68-CS to open the J and L lead circuit (FIG. 38), thereby releasing relay 37-CK, which then releases the operated frequency detecting relays and relay 37-CK2. The "B" digit register relays operate from the frequency detecting relays. The subsequent digits are received and recorded in a similar manner.

The preceding paragraphs have adequately described the operation of the called number register on FIGS. 69 and 70, the steering circuit for the called number register on FIGS. 67 and 68 together with the MF receiver on FIG. 37, and the control circuit for the MF receiver together with the called number register as shown on FIG. 38. It should be apparent from the foregoing discussion how the circuitry, in combination on the above-described figures, cooperates and responds to the reception of MF signals to register any combination of digits representing a called number.

To facilitate the description of the remaining portion of the call, a specific called number will be assumed for purposes of discussion. Therefore, let it be assumed, for example, that the called subscriber for the present call is in area 212 and that his listed directory number is CH3-1000 (243-1000).

The operation of the MF receiver, the called number register, and the steering circuit therefor, together with its control circuit, have been described in connection with the reception of an "A" digit of "2." It is not believed necessary, in view of the already extended discussion of the called number register, to trace in detail each and every circuit path associated with the operation of the called number register relays, the steering circuit, and the MF receiver, as the subsequent digits are received on an MF basis from the preceding office. Therefore, in describing the manner in which the subsequent digits are received, only those circuit details will be discussed which have not already been described. The prior operation of relay 68-BS, at its transfer contacts, disconnected the



holding circuit for relay 68-AS from ground extended over make contacts 42-ON3 and the chain of series-connected break contacts, and in lieu thereof connected the holding circuit to terminal 68-104, connected through make contacts 38-RA and 60-MF to ground on terminal 68-101. The subsequent release of relay 38-RA, upon the termination of reception of MF frequencies for the "A" digit, opens make contacts 38-RA, thereby breaking the holding circuit for relay 68-AS, causing it to release.

The reception of the "B" digit of "1" is manifested by the reception of MF frequencies  $f_0$  and  $f_1$ . The reception of these two frequencies operates relay 37-SP. The operation of relay 37-SP closes its contacts 37-SP to extend the ground on terminal 37-115 to the J conductor on FIG. 38. Relay 68-AS is released at this time and, therefore, of the steering relays of FIGS. 67 and 68, only relay 68-BS is now operated. Therefore, the check circuit comprising the chain of series-connected break contacts of the steering relays connected intermediate the terminals 38-102 and 38-103 on FIG. 38 is now closed, thereby permitting the ground on the J conductor to be extended over the L conductor to relay 37-LK, causing it to operate. Relay 37-LK, in operating, closes its make contacts on FIG. 37 to supply positive 130-volt potential, via the series-connected windings of relays 37-CK2 and 37-CK3, to the MF frequency detecting relays 37-0, 37-1, etc. The closure of this circuit operates relays 37-0 and 37-1 which, together, represents the "B" digit of "1." The closure of the operating circuit for these latter two relays, in turn, operates relay 37-CK2. The operation of MF frequency detecting relays 37-0 and 37-1 applies a ground on FIG. 71, via make contacts 38-RA and break contacts 72-RGC1, to conductors 0 and 1. The grounds on these two conductors are extended over FIGS. 70 and 69, and then through break contacts of relay 68-AS and make contacts of steering relay 68-BS, to conductors B0 and B1 extending to the "B" digit register. This, in turn, causes relays 69-B0 and 69-B1 of that register to operate and lock, and thereby register the "B" digit of "1." The operation of relay 37-CK2 closes a previously-described path to operate relay 38-RA.

On FIG. 68, the operation of relay 38-RA extends the ground on terminal 68-106 to terminal 68-102. Relay 68-AS is now released, while relay 68-BS is operated and, therefore, the ground on terminal 68-102 may be extended through the break contacts of relay 68-AS and the make contacts of relay 68-BS to operate relay 68-CS, which then locks through the series-connected back contacts, and make contacts 42-ON3, to the ground on terminal 67-101.

On FIG. 38, the break contacts of relay 68-CS open the operating circuit for relay 37-LK, since relay 68-BS is also operated at this time, and thereby releases relay 37-LK. The release of relay 37-LK, in turn, removes the positive 130-volt potential on FIG. 37 from the series-connected windings of relay 37-CK2 and 37-CK3, and from the windings of MF frequency detecting relays 37-0, 37-1, etc., thereby causing them to release.

The end of the reception of the MF frequencies  $f_0$  and  $f_1$  for the "B" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which, at its make contacts on FIG. 68, opens the locking circuit for steering relay 68-BS, causing it to release.

The reception of the MF frequencies  $f_0$  and  $f_2$  for the "C" digit of "2" operates relay 37-SP. The operation of relay 37-SP applies ground on terminal 37-115 to the J conductor on FIG. 38, and via the above-described contact network to conductor L, thereby operating relay 37-LK, since only relay 68-CS of the steering relays is now operated. The operation of relay 37-LK, in the manner above described, reapplies the positive 130-volt potential to the circuit for the MF frequency detecting relays, thereby operating relays 37-0, 37-2, and 37-CK2. The operation of relays 37-0 and 37-2, in the manner above described, applies grounds to conductors 0 and 2 on FIG.

71. The grounds on these two conductors are extended over FIGS. 70 and 69, break contacts 68-AS and 68-BS, and make contacts on steering relay 68-CS, thereby entering a "C" digit of "2" in the "C" digit register of FIG. 69 by applying grounds to conductors C0 and C2.

The operation of relay 37-CK2, in the manner above described, operates relay 38-RA. The operation of relay 38-RA, in turn, and in the above-described manner, operates steering relay 68-DS and its parallel-connected auxiliary relay 68-DSA. The operation of steering relay 68-DS, while steering relay 68-CS is still operated, opens the check circuit on FIG. 38, thereby releasing relay 37-LK. The release of relay 37-LK, in turn, and in the above-described manner, releases relay 37-CK2 and the MF frequency detecting relays 37-0 and 37-2.

The end of the reception of the MF frequencies  $f_0$  and  $f_2$  for the "C" digit releases relay 37-SP which, in turn, as previously described, releases relay 38-RA. The release of relay 38-RA, in the manner above described, releases steering relay 68-CS.

The reception of the "D" digit of "2" is manifested by the reception of MF frequencies  $f_0$  and  $f_2$ . The reception of these two frequencies operates relay 37-SP which, in turn, as hereinbefore described, operates relay 37-LK. The operation of relay 37-LK, in turn, as above described, operates relay 37-CK2 and MF frequency detecting relays 37-0 and 37-2 for the "D" digit of "2." The operation of relay 37-CK2, as previously described, also operates relay 38-RA.

The operation of relay 38-RA, together with the operation of the MF frequency detecting relays 37-0 and 37-2, as above described, applies grounds to conductors 0 and 2 on FIG. 71. The grounds on these two conductors are extended over FIGS. 70 and 69, break contacts 68-AS, 68-BS, 68-CS, and make contacts of steering relay 68-DS, to enter a "D" digit of "2" in the "D" digit register of FIG. 69 by applying ground to conductors D0 and D2. The operation of relay 38-RA, in a previously described manner, also closes a path to operate steering relay 68-ES. The operation of relay 68-ES, in turn, and in a previously-described manner, opens the check circuit of FIG. 38, thereby releasing relay 37-LK. The release of relay 37-LK, in the manner previously described, releases relay 37-CK2 and MF frequency detecting relays 37-0 and 37-2. The end of the reception of the MF frequencies  $f_0$  and  $f_2$  for the "D" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA, which causes the release of relays 68-DS and 68-DSA, in a manner previously described.

The reception of the "E" digit of "4" is manifested by the reception of MF frequencies  $f_0$  and  $f_4$ . The reception of these frequencies operates relay 37-SP which, in turn, as previously described, operates relay 37-LK. The operation of relay 37-LK, in turn, in a previously-described manner, operates relay 37-CK2 and MF frequency detecting relays 37-0 and 37-4. The operation of relay 37-CK2, as previously described, operates relay 38-RA. The operation of relay 38-RA, in conjunction with the operation of MF frequency detecting relays 37-0 and 37-4, as previously described, applies grounds to conductors 0 and 4 on FIG. 71. The grounds on these two conductors are extended over FIGS. 70 and 69, and over break contacts 68-AS, 68-BS, 68-CS, and 68-DS, and make contacts of steering relay 68-ES, to enter an "E" digit of "4" in the "E" digit register of FIG. 70 by applying ground to conductors E0 and E4.

The operation of relay 38-RA, in a previously-described manner, also closes an operating path for steering relay 67-FS. The operation of relay 67-FS, in a previously-described manner releases relay 37-LK which, in releasing, in turn, releases relay 37-CK2 and the MF frequency detecting relays 37-0 and 37-4.

The end of the reception of the MF frequencies  $f_0$  and  $f_4$  for the "E" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes



the release of steering relay 68-ES, in a manner previously described.

Next, the reception of the "F" digit of "3" is manifested by the reception of MF frequencies,  $f_1$  and  $f_2$ . The reception of these two frequencies, in a manner hereinbefore described, causes the operation of relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-1 and 37-2. Relay 37-CK2 operated, as previously described, also operates relay 38-RA. The operation of the aforementioned relays closes a previously-described circuit on FIG. 71, whereby grounds on conductors 1 and 2 are extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, and -ES, and make contacts 67-FS, to enter an "F" digit of "3" in the "F" register of FIG. 70 by grounding conductors F1 and F2. The operation of relay 38-RA, in a previously-described manner, also operates steering relay 67-GS. Since steering relays 67-FS and 67-GS are concurrently operated, relay 37-LK now releases. The release of relay 37-LK, as previously described, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-1 and 37-2.

The end of the reception of the MF frequencies  $f_1$  and  $f_2$  for the "F" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes the release of steering relay 67-FS, in a manner previously described.

Next, reception of the "G" digit of "1" is manifested by the reception of MF frequencies  $f_0$  and  $f_1$ . The reception of these two frequencies, in a manner previously described, causes the operation of relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-0 and 37-1. The operation of relay 37-CK2, as previously described, operates relay 38-RA. The operation of these relays closes a previously-described path on FIG. 71, whereby grounds on conductors 0 and 1 are extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, 67-ES, -FS, and make contacts 67-GS of steering relay 67-GS, to enter a "G" digit of "1" in the "G" digit register of FIG. 70 by applying grounds to conductors G0 and G1. The operation of relay 38-RA, in a previously-described manner, also operates the steering relay 67-HS. Since steering relays 67-HS and 67-GS are concurrently operated, relay 37-LK now releases. The release of relay 37-LK, as previously described, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-0 and 37-1.

The end of the reception of the MF frequencies  $f_0$  and  $f_1$  for the "G" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes the release of steering relay 67-GS, in a manner previously described.

Next, reception of the "H" digit of "0" is manifested by the reception of MF frequencies  $f_4$  and  $f_7$ . The reception of these two frequencies, in a manner previously described, causes the operation of relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-4 and 37-7. The operation of relay 37-CK2, as previously described, operates relay 38-RA. The operation of these relays closes a previously-described path on FIG. 71, whereby grounds on conductors 7 and 4 are extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, -ES, 67-FS, -GS, and make contacts 67-HS of steering relay 67-HS, to enter an "H" digit of "0" in the "H" register on FIG. 70, by applying grounds to conductors H4 and H7. The operation of relay 38-RA, in a previously-described manner, also operates the steering relay 67-JS. Since two of the steering relays, 67-HS and 67-JS, are concurrently operated, relay 37-LK now releases. The release of relay 37-LK, as previously described, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-4 and 37-7.

The end of the reception of the MF frequencies  $f_4$  and  $f_7$  for the "H" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes

the release of steering relay 67-HS, in a previously-described manner.

Next, the "J" digit of "0," manifested by the reception of MF frequencies  $f_4$  and  $f_7$ , in the above-described manner, causes the operation of relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-4 and 37-7. The operation of relay 37-CK2, as above described, operates relay 38-RA. The operation of these relays closes a previously-described path on FIG. 71, whereby grounds on conductors 4 and 7 are extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, -ES, 67-FS, -GS, -HS, and make contacts 67-JS on steering relay 67-JS, to enter a "J" digit of "0" in the "J" digit register on FIG. 70, by applying grounds to conductors J4 and J7. The operation of relay 38-RA, in a previously-described manner, also operates the steering relay 67-KS to prepare for the reception of the "K" digit. Two steering relays, 67-JS and 67-KS, are now operated and, therefore, relay 37-LK now releases. The release of relay 37-LK, as above described, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-4 and 37-7.

The end of the reception of the MF frequencies  $f_4$  and  $f_7$  for the "J" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes the release of steering relay 67-JS, in a previously-described manner.

Next, the "K" digit of "0," manifested by the reception of MF frequencies  $f_4$  and  $f_7$ , in the above-described manner, causes the operation of relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-4 and 37-7. The operation of relay 37-CK2, as above described, operates relay 38-RA. The operation of these relays closes a previously-described path on FIG. 71, whereby grounds on conductors 4 and 7 are extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, -ES, 67-FS, -GS, -HS, -JS, and make contacts 67-KS of steering relay 67-KS, to enter a "K" digit of "0" in the "K" digit register of FIG. 70, by applying grounds to conductors K4 and K7.

The operation of relay 38-RA, as above described, also operates the steering relay 67-LS. Two steering relays, 67-KS and 67-LS, are now operated and, therefore, relay 37-LK now releases. The release of relay 37-LK, as above described, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-4 and 37-7.

The end of the reception of the MF frequencies  $f_4$  and  $f_7$  for the "K" digit releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA which causes the release of steering relay 67-KS, in a previously-described manner.

Pausing to review the circuit actions associated with the called number registration, it may be seen that the ten digits comprising the area code of 212, the called office code 243 (CH3), and the called station number 1000 have now been received in MF form from the originating office and entered in the "A" through "K" digit registers of FIGS. 69 and 70. The "L" digit register of FIG. 70 is provided for the registration of the last digit on eleven-digit calls. This register, however, is not used for the registration of a digit on the present exemplary call which, as is evident, is assumed to be of the ten-digit type. It is hereinbefore described, in connection with MF signaling, how the originating office transmits a "start" pulse comprising the MF frequencies  $f_7$  and  $f_{10}$ , following the termination of the transmission of the digits of the called station number. Therefore, a "start" pulse comprising the MF frequencies  $f_7$  and  $f_{10}$  is now received. The reception of these two frequencies, in a manner previously described, causes the operation of relays 37-SP, -LK, -CK2, MF frequency detecting relays 37-7 and 37-10, and relay 38-RA. The operation of MF frequency detecting relay 37-10 closes the following circuit on FIG. 71 to operate relay 71-10: ground on terminal 71-101,



make contacts 37-KP1, make contacts 37-10, to the winding of relay 71-10, causing it to operate.

The operation of relay 37-CK2, as above described, operates relay 38-RA. The operation of relay 38-RA, in a previously-described manner, operates steering relay 67-MS and, additionally, closes a circuit on FIG. 71 to apply ground, via a previously-described path, to conductor 7. The ground on conductor 7 is extended through FIGS. 70 and 69, break contacts 68-AS, -BS, -CS, -DS, -ES, 67-FS, -GS, -HS, -JS, -KS, and make contacts 67-LS of steering relay 67-LS to conductor L7, thereby operating the L7 relay (not shown) in the "L" digit register of FIG. 70, the operation of which performs no useful function at this time, and is of no significance for the type of call discussed in the foregoing description. The operation of MF frequency detecting relay 37-7 closes the following circuit to operate relay 71-STA: ground on terminal 71-101, make contacts 37-KP1, make contacts 37-7, 38-RA, break contacts 72-RGC1, make contacts 71-10, to the winding of relay 71-STA, causing it to operate and lock up to ground through make contacts 71-STA and 42-ON. The following circuit is now closed to operate relay 72-RGC1 as an indication of the completion of the registration of the called number: ground on terminal 71-102, make contacts 71-STA, break contacts 68-AS, 68-BS, 68-CS, 72-RGC1, break contacts 72-RGC, shunted by resistor R, to the winding of relay 72-RGC1, causing it to operate and lock up through break contacts 72-RGC, make contacts 72-RGC1, and make contacts 42-ON3, to ground on terminal 72-101. Relay 72-RGC1, in operating, opens its break contacts connected to terminal 38-103, thereby opening the circuit connecting the J conductor ground to the winding of relay 37-LK, thereby causing it to release. The release of relay 37-LK, as above described, releases relay 37-CK2 and MF frequency detecting relays 37-7 and 37-10. The release of MF frequency detecting relay 37-10 releases relay 71-10 at this time, since the contingent holding circuit therefor is opened at make contacts 66-PAS.

The end of the reception of the MF frequencies  $f_7$  and  $f_{10}$  for the "start" pulse releases relay 37-SP. The release of relay 37-SP, in turn, releases relay 38-RA. The release of relay 38-RA closes the following path to operate relay 72-RGC, thereby indicating the completion of the registration of the digits of the called number, as well as the termination of the reception of the "start" digit: ground on terminal 71-102 (as above described in connection with the operation of relay 72-RGC1), make contacts 60-MF, break contacts 38-RA, to the winding of relay 72-RGC, causing it to operate. Relay 72-RGC, in operating, closes an obvious holding path for itself over a set of its own make contacts, to ground on terminal 72-102. Relay 72-RGC, in operating, at contacts 72-RGC, closes an operating circuit for relay 72-RGC2, causing it to operate.

The last two steering relays, namely 67-LS and 67-MS, remain locked operated for the time being, with relay 67-MS being locked over make contacts 67-MS and 42-ON3 to ground on terminal 67-101; while relay 67-LS remains locked operated over a circuit including make contacts 67-LS and 67-MS, to ground on terminal 68-104. The ground is supplied to terminal 68-104 by the closure of make contacts 72-RGC1, which supplies the same ground as was previously extended through the closed make contacts 38-RA. Relay 37-KP is released at this time as negative battery, is disconnected from its lower winding by the opening of break contacts 72-RGC on FIG. 38. Also, relays 37-KP1 and 37-KP2 are released as battery is disconnected from their parallel-connected windings by the opening of another set of break contacts 72-RGC on FIG. 38.

#### Sender timing circuit

The sender contains a timing circuit which measures the time elapsing between the starting and the completion

of the various operations and, in the event that any timed operation is not completed within its allotted time interval, to cause the sender to "time out" and, in certain instances, block the further progress of the call. One such interval to be measured is the time from seizure of the sender to the completion of the called number registration. Reverting, for the moment, to the circuit condition obtaining at the instant of sender seizure, the normal operation of the timing circuit for this function is as follows: referring to FIG. 52, relay 42-ON1, in operating, operates relay 52-TMR and starts to operate the slow-to-operate and slow-to-release relay 52-TMRR. When relay 52-TMRR operates it releases relay 52-TMR, thereby starting the TM timer. When the registration of the called number is complete, relay 72-RGC, in operating, operates relay 52-TMR and, at the same time, starts the release of relay 52-TMRR. Relay 52-TMR, in operating, opens the operate path for relay 52-TM and recycles the tube TM. When relay 52-TMRR releases, relay 52-TMR is released, thereby again starting the timing cycle, to measure the time interval, either to the release of the position or to the time that the operator is attached.

Referring to the immediately preceding paragraph, relay 52-TMR operates over the following path upon the operation of relay 42-ON1: ground on terminal 52-101, make contacts 42-ON1, break contacts 52-TM2, terminal 52-103, break contacts 46-SLC, 61-OA2, 24-SPA, 72-RGC, terminal 52-102, break contacts 52-TMRR 52-TM1, 39-KTC, to the lower winding of relay 52-TMR, causing it to operate. The ground on terminal 52-102 operates the slow-to-operate and slow-to-release relay 52-TMRR after a predetermined delay time has elapsed. The release of relay 52-TMRR opens its break contacts connected to terminal 52-102, thereby releasing relay 52-TMR. The release of relay 52-TMR starts the timer associated with the TM tube. When the registration of the called number is complete, as already described, relay 72-RGC closes its make contacts on FIG. 52 to extend the ground on terminal 52-103 through make contacts of relay 52-TMRR (which remains operated), and thence over the remainder of the priorly described operating path for relay 52-TMR, causing it to operate. The operation of relay 72-RGC, at its break contacts, also opens the holding circuit for relay 52-TMRR, thereby causing it to start its release. Relay 52-TMR, in operating, opens its break contacts in the operating circuit for tube TM, thereby causing it to recycle. The subsequent release of relay 52-TMRR opens its make contacts and removes the ground from terminal 52-104, thereby causing the release of relay 52-TMR which, in releasing, causes the recycling of the timing interval of the TM timer.

If the called number registration operation had not been completed within a predetermined interval, relay 72-RGC would not have operated in time to close the path to re-operate relay 52-TMR before the TM tube had ionized and energized the TM timer.

#### Sender operation with automatic number identification in local originating offices

This section describes the circuit operations associated with the reception on an MF basis of the ANI digits from the preceding office.

The operation of relay 72-RGC, as hereinbefore described, at the termination of the registration of the digits of the called number, completes the following path to operate relay 51-RGCB: ground on terminal 51-101, make contacts 72-RGC, 60-MF, terminal 51-103, to the winding of relay 51-RGCB, causing it to operate. The ground on terminal 51-103 is also extended at this time over break contacts 24-OPT and make contacts 60-ANI to the winding of slow-operate relay 51-RGCA, causing it to operate. The operation of relay 51-RGCA closes its make contacts on FIG. 38 to apply negative battery to the lower winding of relay 37-KP and to the parallel-connected windings of relays 37-KP1 and 37-KP2 to thereby prepare the MF receiver for operation.



## PREPARATION FOR MF-ANI OUTPULSING

The operation of the relay 51-RGCA completes the following path to operate relay 18-DNI: ground on terminal 18-101, break contacts 43-RS, make contacts 51-RGCA, break contacts 51-AIT, terminal 18-102, break contacts 33-ROP, terminal 18-103, over the top conductor on FIG. 18 to FIG. 19, terminal 19-101, break contacts 19-DNX, -DNU, -DNT, -DNH, -DNTH, -DNC, 18-DNB, terminal 18-104, break contacts 38-RA, 18-MRS, 51-OIIF, 51-AI, 18-DNA, to the winding of relay 18-DNI, causing it to operate.

The operation of relay 51-RGCA opens its break contacts in the holding circuit for relay 20-RV, thereby causing its release. The release of relay 20-RV releases its two sets of transfer contacts respectively connected to the windings of relay 36-L, thereby reversing the polarity of the T and R conductors extending back, via conductors T and R (103), the originating office 102 (FIG. 10). The originating office recognizes this polarity reversal as a request for ANI information and, in the manner described in the aforementioned Patent No. 3,071,650 granted to H. D. Cahill et al., Jan. 1, 1963, proceeds to outpulse the ANI information identifying the calling number. As hereinbefore described, the originating office prefixes the outpulsing of the actual ANI digits with a KP signal, in order to unlock the MF receiver in the sender.

## RECEPTION OF KEY PULSE SIGNAL

The reception of the KP signal is manifested by the detection of MF frequencies  $f_2$  and  $f_{10}$  which operate MF frequency detecting relays 37-2 and 37-10, and also energize "AND" gate 37-103 to operate relay 37-SP, in the manner hereinbefore described in connection with reception of the KP pulse for the called number registration operation. In the same manner as before described, the operation of relay 37-SP causes the operation of relays 37-KP and 37-LK. Relay 37-SP releases at the termination of the reception of the MF frequencies  $f_2$  and  $f_{10}$  for the KP pulse and, in turn, releases relay 37-LK. The release of relay 37-SP also operates relays 37-KP1 and -KP2 as hereinbefore described. As before described, relays 37-KP, -KP1 and -KP2 remain locked operated until the MF signaling has been completed.

## RECEPTION OF IDENTIFICATION PULSE

The originating office next outpulses what is known as an "identification pulse," to denote information concerning the calling circuit. Let it be assumed, for example, that the reception of the identification pulse is manifested by the reception of two of the MF frequencies,  $f_4$  and  $f_7$ , indicative of a "0." The specific purpose of the information represented by the reception of these two particular frequencies is to operate a pair of register relays to register the identification digit "0." The reception of these two frequencies, in a manner previously described, operates relays 37-SP, -LK, and -CK2, together with MF frequency detecting relays 37-4 and 37-7. The operation of relay 37-CK2, in turn, operates relay 38-RA. The operation of relay 38-RA closes a circuit on FIG. 43 which includes make contacts 37-KP1, MF frequency detecting relay contacts 37-4, make contacts 38-RA, and 72-RGC1, to apply ground to conductor 4, and make contacts 37-KP1, MF frequency detecting relay contact 37-7, make contacts 38-RA, 72-RGC1 and 51-RGCB, to apply ground to conductor 7. The grounds on conductors 4 and 7 are extended over transfer make contacts 18-DNI to the windings of relays 43-DI4 and 43-DI7, respectively, causing them to operate to register the identification digit "0." These relays, in operating, complete a holding circuit for themselves over their own make contacts and make contacts 51-RGCA to ground.

Recalling the previously-described operate path for relay 18-DNI, the operation of relay 38-RA closes the following path to operate steering relay 18-DNA (whose purpose is to steer the next received MF digit into the "A" digit register of the calling number register on FIGS.

43 and 44): ground on terminal 18-103, through make contacts 38-RA, to terminal 38-104, make contacts 18-DNI, break contacts 18-DNA, to the winding of relay 18-DNA, causing it to operate. Relay 18-DNA, in operating, closes a holding circuit for itself through its own make contacts to ground on terminal 18-106. The ground on terminal 18-106 remains until one of the steering relays succeeding relay 18-DNA operates, at which time ground is disconnected from terminal 18-106. Specifically, as hereinafter described, relay 18-DNB operates immediately prior to the reception of the "B" digit of the calling number, and its operation, at transfer break contacts 18-DNB, opens the holding circuit for relay 18-DNA.

The circuit over which relay 37-LK operated, it will be remembered, includes conductor L and the series-connected break contacts of the steering relays for the calling number register, shown intermediate terminals 38-104 and 38-105. This contact arrangement provides an interconnection between terminals 38-104 and 38-105 only when two successive steering relays are not concurrently operated. This arrangement functions in exactly the same manner as was the case for the series-connected contacts of the steering relays of the called number register, shown intermediate terminals 38-102 and 38-103. Two successive steering relays, namely 18-DNI and 18-DNA, are operated at this time and, therefore, the portion of the holding circuit for relay 37-LK intermediate terminals 38-104 and 38-105 is opened, thereby releasing relay 37-LK. The release of relay 37-LK opens its break contacts to remove the positive 130-volt potential connected in series with the windings of relays 37-CK3 and 37-CK2, and to the windings of the MF frequency detecting relays 37-4 and 37-7, thereby releasing relays 37-CK2, 37-4 and 37-7.

Relay 37-SP releases at the end of the reception of the MF frequencies for the identification pulse and, in turn, releases relay 38-RA. The release of relay 38-RA opens the path interconnecting terminal 18-105 with terminal 18-103, thereby disconnecting the ground from terminal 18-105. The disconnection of ground from terminal 18-105 opens the holding circuit for relay 18-DNI, thereby causing it to release. The following path is now closed to operate relay 51-AI: ground on terminal 51-104, break contacts 18-DNI, 43-DI0, 43-DI2, make contacts 43-DI4, and 43-DI7, to the winding of relay 51-AI, causing it to operate. The operation of relay 51-AI signifies that the calling number is to be automatically identified by the local office.

## RECEIVING THE CALLING NUMBER

Next, the "A" digit of the calling number is received. It has been assumed, for example, that the "A" digit of the calling number is a "5" and, therefore, the reception of this digit is manifested by the reception of MF frequencies  $f_1$  and  $f_4$ . The reception of these two frequencies, in a manner hereinbefore described, operates relays 37-SP, -LK, -CK2, and MF frequency detecting relays 37-1 and 37-4. The operation of these relays, in turn, in a manner previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-1 and 37-4, make contacts 38-RA and 72-RGC1, to conductors 4 and 1. The grounds on these conductors are then extended over transfer break contacts 18-DNI and transfer make contacts 18-DNA to the windings of relays 43-DA1 and 43-DA4, respectively, in the "A" register to operate them. Relays 43-DA1 and 43-DA4, in operating, close holding paths for themselves, through their own make contacts, to ground through resistance D. Relays 43-DA1 and 43-DA4, operated together, represent, in 2-out-of-5 code form, the calling number "A" digit "5."

The operation of relay 38-RA reapplies ground, via a previously-described path, to terminal 18-104. The ground



on terminal 18-104 is then extended through break contacts 18-DNI, make contacts 18-DNA, and break contacts 18-DNB, to the winding of relay 18-DNB to operate it. Relay 18-DNB, in operating, closes a holding path for itself through its own make contacts and the series-connected break contacts 19-DNC, -DNTH, -DNH, -DNT, -DNU, and -DNX of the succeeding steering relays in the chain to ground on terminal 19-101. Two successive steering relays are now operated, namely, 18-DNA and 18-DNB and, therefore, the holding circuit for relay 37-LK is opened, thereby causing it to release. The release of relay 37-LK, in the manner previously described, releases relay 37-CK2 and MF frequency detecting relays 37-1 and 37-4.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "A" digit, and in turn, releases relay 38-RA. The release of relay 38-RA opens the path interconnecting terminal 18-105 with terminal 18-103, thereby disconnecting ground from terminal 18-105 and causing relay 18-DNA to release.

Next, the "B" digit of the calling number which, for example, is assumed to be an "8," is received, as manifested by reception of MF frequencies  $f_1$  and  $f_7$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, 37-LK, 37-CK2, and MF frequency detecting relays 37-1 and 37-7. The operation of these relays, in a manner previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-1 and 37-7, make contacts 38-RA, 72-RGC1, and 51-RGCB, to conductors 1 and 7. The grounds on these conductors are then extended over break contacts 18-DNI and 18-DNA, and make contacts 18-DNB to the windings of relays 43-DB1 and 43-DB7, respectively, in the "B" digit register to operate them. The concurrent operation of these two relays represents, in 2-out-of-5 code form, the calling number "B" digit "8."

A path is now closed, under the control of relay 38-RA operated, and similar to that previously described, to operate steering relay 19-DNC. Upon the operation of steering relay 19-DNC, both it and the steering relay 18-DNB are operated, thereby opening the holding circuit for relay 37-LK and causing it to release. The release of relay 37-LK, in turn, and as previously described, releases relay 37-CK2 and MF frequency detecting relays 37-1 and 37-7.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "B" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner similar to that previously described for the preceding steering relays, releases steering relay 18-DNB.

Next, the "C" digit of the calling number which, for example, is assumed to be a "2" is received, as manifested by a reception of MF frequency digits  $f_0$  and  $f_2$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, -LK, and -CK2, and MF frequency detecting relays 37-0 and 37-2. The operation of these relays, in a manner previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-0 and 37-2, make contacts 38-RA and 72-RGC1 to conductors 0 and 2. The grounds on these conductors are then extended over break contacts 18-DNI, 18-DNA and 18-DNB, and make contacts 19-DNC, to the windings of relays 44-DC0 and -DC2, respectively, in the "C" digit register to operate them. The concurrent operation of these two relays represents, in 2-out-of-5 code form, the calling number "C" digit "2."

The operation of relay 38-RA, in a manner similar to that previously described, also operates steering relay 19-DNTH. Two successive steering relays, 19-DNC and 19-DNTH, are now operated, thereby opening the holding circuit for relay 37-LK and causing it to release. The release of relay 37-LK, in turn, and as previously de-

scribed, releases relay 37-CK2 and MF frequency detecting relays 37-0 and 37-2.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "C" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner similar to that previously described for the preceding steering relays, releases steering relay 18-DNC.

Next, the "thousands" digit of the calling number, assumed, for example, to be a "4," is received, as manifested by the reception of MF frequencies  $f_0$  and  $f_4$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, -LK, and -CK2, and MF frequency detecting relays 37-0 and 37-4. The operation of these relays, in a manner previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-0 and 37-4, make contacts 38-RA and 72-RGC1, to conductors 0 and 4. The grounds on these conductors are then extended, in a previously-described manner, over the series-connected transfer break contacts of the relays for the "A," "B" and "C" digits, and over the transfer make contacts for steering relay 19-DNTH, to apply ground to conductors TH0 and TH4, thereby registering the "thousands" digit "4" in 2-out-of-5 code form, in the DTH register of FIG. 44.

The operation of relay 38-RA, in a manner similar to that previously described, also operates steering relay 19-DNH. Two successive steering relays, 19-DNTH and 19-DNH, are now operated, thereby opening the holding circuit for relay 37-LK and causing it to release. The release of relay 37-LK, in turn, and as previously described, releases relay 37-CK2 and MF frequency detecting relays 37-0 and 37-4.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "TH" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner similar to the previously described for the preceding steering relays, releases steering relay 19-DNTH.

Next, the "hundreds" digit of the calling number, assumed, for example, to be a "1," is received, as manifested by the reception of MF frequencies  $f_0$  and  $f_1$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, -LK, and -CK2, and MF frequency detecting relays 37-0 and 37-1. The operation of these relays, in a manner previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-0 and 37-1, make contacts 38-RA and 72-RGC1 to conductors 0 and 1. The grounds on these conductors are then extended over circuitry similar to that already described in connection with preceding called number digits, and over transfer make contacts of steering relay 19-DNH, to apply ground to conductors H0 and H1, thereby registering the "hundreds" digit of "1" in the DH register of FIG. 44.

The operation of relay 38-RA, in a manner similar to that previously described, also operates steering relay 19-DNT. Two successive steering relays, 19-DNH and 19-DNT, are now operated, thereby opening the holding circuit for relay 37-LK and causing it to release. The release of relay 37-LK, in turn, and as previously described, releases relay 37-CK2 and MF frequency detecting relays 37-0 and 37-1.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "H" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner similar to that previously described for the preceding steering relays, releases steering relay 19-DNH.

Next, the "tens" digit of the calling number, assumed, for example, to be a "0," is received, as manifested by the reception of MF frequencies  $f_4$  and  $f_7$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, 37-LK, and 37-CK2, and MF frequency detecting relays 37-4 and 37-7. The operation of these relays, in a manner previously described, oper-



ates relay 38-RA. A path is now closed on FIG. 43 to apply ground over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-4 and 37-7, make contacts 38-RA, 72-RGC1, and 51-RGCB, to conductors 4 and 7. The grounds on these conductors are then extended, over circuitry similar to that already described in connection with preceding called number digits, and over transfer make contacts of steering relay 19-DNT, to apply grounds to conductors T4 and T7, thereby registering the "tens" digit of "0" in the DT register of FIG. 44.

The operation of relay 38-RA, in a manner similar to that previously described, also operates steering relay 19-DNU. Two successive steering relays, 19-DNT and 19-DNU, are now operated, thereby opening the holding circuit for relay 37-LK and causing it to release. The release of relay 37-LK, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-4 and 37-7.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "tens" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner previously described, releases steering relay 19-DNT.

Next, the "units" digit of the calling number, assumed, for example, to be a "6," is received, as manifested by the reception of MF frequencies  $f_2$  and  $f_4$ . The reception of these two frequencies, in a manner previously described, operates relays 37-SP, 37-LK, and 37-CK2, and MF frequency detecting relays 37-2 and 37-4. The operation of these relays, as previously described, operates relay 38-RA. A path is now closed on FIG. 43 to apply grounds over make contacts 37-KP1, make contacts of MF frequency detecting relays 37-2 and 37-4, make contacts 38-RA and 72-RGC1 to conductors 2 and 4. The grounds on these conductors are then extended, over circuitry similar to that already described in connection with preceding called number digits, and over transfer make contacts of steering relay 19-DNU, to apply grounds to conductors U2 and U4, thereby registering the "units" digit of "6" in the DU register of FIG. 44.

The operation of relay 38-RA, in a manner similar to that previously described, also operates steering relay 19-DNX as an indication of the completion of the registration of the digits of the calling number. Relay 19-DNX may be considered to be a steering relay and, therefore, since two successive steering relays, 19-DNU and 19-DNX, are operated, the holding circuit for relay 37-LK is opened, causing it to release. The release of relay 37-LK, in turn, releases relay 37-CK2 and MF frequency detecting relays 37-2 and 37-4.

Relay 37-SP releases at the end of the reception of the MF frequencies for the "units" digit and, in turn, releases relay 38-RA. The release of relay 38-RA, in a manner previously described, releases steering relay 19-DNU.

Next, the originating office transmits a "start" pulse, comprising the MF frequencies  $f_7$  and  $f_{10}$ , as an indication that the MF pulsing is now terminated. The reception of MF frequencies  $f_7$  and  $f_{10}$  causes the operation of relays 37-SP, -LK, -CK2, and MF frequency detecting relays 37-7 and 37-10, and relay 38-RA, in a manner similar to that already described in connection with preceding calling number digits. The operation of channel relay 37-10 closes a circuit on FIG. 71 to extend ground on terminal 71-101 through make contacts 37-KP1 and 37-10, to operate relay 71-10.

The following circuit is now closed on FIG. 43 to operate relay 44-STPL: ground through make contacts 37-KP1, make contacts of MF frequency detecting relay 37-7, make contacts 38-RA, 72-RGC1, 51-RGCB, conductor 7, the series-connected transfer break contacts of all of the steering relays on FIGS. 43 and 44, including transfer break contacts 19-DNT, conductor 7 on FIG. 44, transfer break contacts 19-DNU, make contacts 71-10, break contacts 44-OEXD, to the winding of relay 44-

STPL, causing it to operate. Relay 44-STPL, in operating, closes a holding circuit for itself over its own make contacts and through break contacts 54-DPC, 33-ROP, 51-AIT, make contacts 51-RGCA, and break contacts 43-RS to ground. Relay 37-SP releases at the end of the reception of the MF frequencies for the "start" signal and, in turn, releases relays 37-LK and -CK2 together with the MF frequency detecting relays 37-7 and 37-10. The release of MF frequency detecting relay 37-10 releases relay 71-10 since the contingent holding circuit for relay 71-10 is open at make contacts 66-PAS which, for the type of call being described, is not operated at this time. The release of these relays, in a manner similar to that previously described, also releases relay 38-RA.

The following path is now closed to operate relay 51-EOP: ground on terminal 51-105, make contacts 51-RGCA, 51-AI, 44-STPL, break contacts 51-AIT, and 71-10, to winding of relay 51-EOP, causing it to operate and lock up to ground through make contacts 51-EOP and 51-RGCA. The operation of relay 51-EOP indicates that the incoming MF pulsing operation is now ended.

#### *Operator identification for special calls*

The operation of relay 51-EOP at the termination of MF pulsing closes the following circuit to operate relay 64-SCW: ground on terminal 64-101, make contacts 24-SPL, 66-PLC, 60-MF, 67-MS, break contacts 67-SDG, make contacts 72-RGC2, make contacts 60-ANI, 51-EOP, break contacts 64-SSP, 24-SPA, and 38-LR2, to the winding of relay 64-SCW, causing it to operate. The operation of relay 64-SCW closes the following circuit on FIG. 24 to apply ground to conductor FT: ground on terminal 24-102, break contacts 32-AV1, make contacts 36-L, break contacts 64-DTCK, 65-TR4, 52-TM1, 24-SPA, make contacts 64-SCW, to conductor FT. The ground on conductor FT is extended over FIGS. 24, 30, 36, 42, and 48, through the crosspoints of the sender link on FIGS. 16A, 17A, and 17C, to the incoming trunk circuit on FIG. 12, through make contacts 10-SA, break contacts 10-FA, make contacts 11-T, to the winding of relay 11-PR, causing it to operate. The operation of relay 11-PR closes the following circuit to apply ground to conductor ST extending to the link and connector: ground on terminal 15-102, break contacts 13-PA, make contacts 11-PR to conductor ST (FIG. 15). The ground on conductor ST comprises a "start" signal to initiate the circuit actions required to interconnect the trunk circuit with an available operator position.

As is shown in the block diagram, FIGS. 2A-2D, and FIGS. 3A-3K, and as already described in connection therewith, a plurality of special service operator positions are provided to serve the incoming calls. Generally speaking, a call is extended to an operator position from the trunk circuit serving the call after the sender has progressed with the serving of the call to that point, determined by it, where a "position request" signal is sent to the trunk to operate a "position request" (PR) relay. The operation of this relay applies ground to a control conductor which initiates the necessary circuit action to interconnect the calling trunk with an available operator position.

Thus, referring now to the details of the present call, the sender, after registering the called and calling number information, as above described, operated its relay 51-EOP as an "end-of-pulsing" indication. This, in turn, operated relay 64-SCW as an indication that the sender is now waiting for other circuits to proceed with their functions in connection with serving the call. The operation of relay 64-SCW, as stated above, applied ground to conductor FT (FIG. 24) extending from the sender, via the sender link, to the trunk to operate relay 11-PR. The operation of relay 11-PR, in turn, and as above described, applied ground to conductor ST (FIG. 15) to initiate the circuit actions required to interconnect the trunk with an available operator position.



*General organization of circuits*

The incoming trunk circuits are connectable with the available operator position circuits under the control of a plurality of circuits which work in conjunction with each other to perform this function. Included among these circuits, as is shown on the block diagram figures, are link connector circuits, position link controller circuits, together with a position circuit for each operator position. The purpose of the link connector circuits is to provide the interconnection media for implementing the necessary interconnection operations. The purpose of the position link controllers is to control, on an equitable basis, the usage of the equipment by the calls from the various incoming trunks, and to interconnect the trunks with the various operator positions when available. The position control circuits and the position circuits are individual to each operator position, and serve to extend the connections from the link connectors to the operator positions.

More particularly, the purpose of the link connector circuit is to connect a multiplicity of leads from any one of a plurality of trunks to any one of a plurality of operator positions.

*Trunk link and connector organization*

As is shown in the block diagram, FIGS. 4, 5, and 6A through 6C, the link connector frame is composed of crossbar switches arranged in a three-stage grid array consisting of primary, secondary, and tertiary switch groups. Trunk circuits served by the link frames are connected to the primary switch horizontals, as may be seen from block diagram FIGS. 4, 5, 6A, and 6C; and the tertiary switch horizontals provide access to the position circuits, as may be seen from block diagram FIGS. 6B and 6D. When a trunk group requests a connection to an operator position, it grounds a "start" lead to the link and connector circuit which is arranged to connect the trunk to an operator position over one of three possible operator loops at each position, as may be seen from detailed circuit FIGS. 78, 84, and 94. The establishment of a connection from a trunk to an operator position is controlled by any one of a group of three link controller circuits to which the link frame may be automatically connected, as may be seen from detailed circuit FIGS. 106A and 106B. The connection of the link controller circuit, however, is only established if there is an idle operator capable of handling the type of traffic offered by the bidding trunk. The link controller circuit, when connected, identifies, and admits behind a gate, calls from any of the trunk groups which indicate that they have calls waiting at the time of the connection. The link controller then selects the most preferred trunk group from among those groups having calls waiting, and then selects the most preferred calling trunk within that group chosen. The link frame, then informed of the identity of the trunk being served, transmits a "trunk class" signal to the link controller to enable it to initiate its position selection sequence. The link controller must be apprised of the "trunk class" in order to select a position capable of serving the type of traffic generated by the calling trunk.

When an operator position is selected, the controller scans all possible channels through the crossbar switches which are capable of connecting the trunk circuit and the operator position circuit. If an idle channel is available, the link controller will operate the associated primary, secondary, and tertiary select magnets on the link frame switches. After a suitable timing interval has elapsed, the hold magnets are operated, thus closing a path through the switches from the calling trunk to one of the three operator loops of the selected position. The circuitry provides for the connection of a maximum of eighteen leads therebetween through the crossbar switch linkages. When the requested connection from a trunk to an operator position is satisfactorily completed, it is held under control of the operator at the position. The link

controller will then serve other calling trunks within the connected trunk group, and will then advance to other trunk groups that had been initially recognized as having trunks with waiting calls.

After having served all trunk groups requesting normal or priority service, the link controller then checks to determine if any trunk is under test by the automatic trunk test frame. If there is a trunk under test, the link controller will serve it in the normal manner, but instead of the trunk-to-position connection being completed to one of the regular operator positions, it will be completed to a simulated link position at the automatic trunk test frame, which simulated link position is located on the tertiary switch terminals. When the controller shall have served all trunks which had initiated bids for service at the time the link frame-to-controller connection was established, it signals the link frame which responds by terminating the controller "start" signal. This begins the release sequence, thereby enabling both the link frame and the link controller circuits to restore to normal.

*Summary of call progress*

Pausing briefly to recapitulate the manner in which the call has been served so far, it may be seen that the incoming trunk circuit when seized by the incoming call, in turn, seized a sender link to interconnect itself with an available sender. Class mark data representing various characteristics of the call and of the calling circuits were then transmitted to the sender by the sender link and the trunk circuit. Following this, the sender received the called and calling numbers via MF signaling from the originating office. At the termination of registration of the calling number, the sender signaled the trunk to request an interconnection with an operator position circuit. The trunk, in response to this signal, applied a ground to its conductor ST (FIG. 15) to initiate the circuit actions required to interconnect with an operator position.

*General discussion of operator positions and position control circuits*

The presently disclosed embodiment assumes that 66 operator positions are provided for serving incoming calls. Each operator position is provided with three loop circuits, where each loop circuit comprises the equipment at the operator position necessary for the serving of a call. An operator can actively serve only one call at a time even though three separate loops are provided. Further, when an operator is actively serving a call on one loop, the link appearances of the remaining two loops will appear busy and no calls will be offered to these loops at this time. Three loop circuits are provided at each position since on some calls, such as for example, delayed calls, the calling loop is utilized for the entire duration of the call; and, if only one loop were provided at the position, the operator would be idle and would have no functions to perform for the duration of the call, once having completed the required services in connection with its completion.

The providing of the three loops enables calls to be offered to any idle loop when a loop is held on a call for which the operator has completed the active serving thereof. The link appearances of the unused loops change from a busy to an idle indication on a call of this type as soon as the operator completes the active serving of it. Thus, the serving of these 198 circuits by 66 operators enables a plurality of incoming calls to be extended to and served by a plurality of operators with a minimum of waiting time by the operators between calls. Each operator position circuit is associated with an individual position control circuit; and just as there are 66 operator position circuits, so are there 66 position control circuits.

*General discussion of link connectors and link controllers*

Referring to the block diagram of FIGS. 1, it may be seen that the link connector and the link controller



together provide the means for interconnecting a calling trunk with an operator. The link connectors comprise the actual interconnecting means, while the link controllers, as their name implies, perform the controlling functions of the link connectors to interconnect, on an equitable basis, the calling trunks with the 66 operator positions. Included among the functions of the link controllers is: providing equitable service to all incoming trunks, so that during periods of heavy traffic the trunks will be served on an equitable basis, with calls being served in the approximate order in which they are presented for service in order to distribute the incoming calls, on an equitable basis, to the available operator positions. Also, as is subsequently described, means is provided for giving priority service to certain classes of trunks so that calls incoming on these trunks will be served before those on the nonpriority trunks. A preference-and-allotter circuit is also provided for the priority trunks so that they also will be served on an equitable basis.

The incoming calls to the tandem office are arbitrarily divided into different classifications which, in the present embodiment, are six in number. Therefore, each call is assigned one of the digits "0" through "5," insofar as the link and connector and operator position circuits are concerned. The particular classification assigned to each call is dependent upon a large number of factors, most of which are dependent upon the service required by the call and the nature of the circuits serving the call in the preceding office. Provision is made at the operator positions whereby a position may either serve all five classes of calls or, if for whatever reason it may be desired, some positions may be arranged to exclude calls of certain types. The controller, as one of its functions, ascertains in which class each incoming call is classified and simultaneously keeps a running check on the positions available to serve the various classes of calls. Provision is made by the controller so that in the event one or more operator positions are not available for serving certain types of calls, the remaining types of calls will be served without delay regardless of such unavailability of positions for the other types of calls.

Each link connector frame in the presently disclosed embodiment has a maximum of 50 trunks connected to its input circuits and a maximum of 66 operator positions of three loop circuits each connected to its output circuits (see block diagram FIGS. 6A-6D). By this expedient, as already mentioned, each link frame is able to interconnect any calling trunk circuit with any available operator position.

The link connector frames are arranged into groups of ten, and each such group of ten comprises a link connector group. A group of 66 operator positions are connected to the ten frames of a link group, and three link controllers are provided to control the interconnection of the calling trunks with the operator positions. Preference and allotter circuits are included in the controllers to insure that equitable service will be given to the incoming traffic on each link frame of a group, as well as to ensure that the incoming calls will be equitably distributed to the available operator positions.

Each link frame in the presently disclosed embodiment serves a maximum of 50 incoming trunks and, therefore, a link group of ten link frames each serves a maximum of 500 incoming trunks. An office may be equipped with more than one link connector group if desired. In this case, each group will be provided with three controllers individual to the group and 66 operator positions individual to the group.

#### *Discussion of link patterns of link connectors*

FIG. 4 discloses, in diagrammatic form, the interrelationship of the elements comprising a single link connector frame. As may be seen from a study of this figure, each link frame comprises an "A" switching network and a "B" switching network of three stages each. The 50

incoming trunks served by the frame are divided into ten groups of five trunks each, with the trunks comprising group "0" being designated L00-01, -02, -03, and -04, and with the trunks of group "9" being designated 90, 91, 92, 93, and 94. Each trunk, although represented symbolically as a single conductor on FIG. 4, may comprise a maximum of 17 individual conductors in accordance with the present embodiment. The number of conductors or wires varies, and some trunk circuits will extend less than 17 wires to the link connector frame, depending upon their specific requirements. Each incoming trunk is connected to an appearance on the "A" switching network, as well as on the "B" switching network. Each network comprises a primary, a secondary, and a tertiary stage, with each primary stage utilizing three crossbar switches, each secondary stage utilizing three crossbar switches, and with each tertiary stage utilizing six crossbar switches. The output of the primary stage of each network is connected to the input of the secondary stage of the same network, while the outputs of the secondary stages of the two networks are paralleled and then fed in parallel to the input of the tertiary stage of each network. Each tertiary stage has 100 output circuits divided into ten groups of ten circuits each. Thus, the two tertiary stages together have 200 output circuits. These 200 output circuits are utilized to interconnect to the three circuits of each of the 66 operator positions. This utilizes 3 times 66, or 198, of the available output circuits. The remaining two are reserved as spares.

FIG. 5 discloses, in diagrammatic form, additional details concerning the interrelationship of elements comprising the primary stages of both the "A" and "B" switching networks of FIG. 4. As may be seen from a study of FIG. 5, the primary stage of each network includes three crossbar switches designated, respectively, "0 switch," "1 switch," and "2 switch." Each incoming trunk circuit has conductors extending to the corresponding appearance on each switch of the "A" network, as well as to the corresponding switches and corresponding appearances thereof of the "B" network. It is necessary to connect conductors from each trunk circuit to appearances on each of the three switches of each network since, at the present state of the art, crossbar switches are not readily available having more than six contacts per crosspoint. Therefore, since the trunk circuits disclosed in the present invention may extend 17 conductors through the link connector to the operator positions, it is apparent that three crossbar switch crosspoints are required at each stage of the network. Thus, considering the 17 conductors that a trunk circuit may have, five of these conductors are connected to an appearance of the "0" primary switch of the "A" network, six conductors are connected to the corresponding appearance of the "1 switch" while the remaining six conductors are connected to the corresponding appearance on the number "2 switch." Also, the 17 conductors from the same trunk circuit are connected to the corresponding appearances on the three switches of the "B" network. Connecting the trunk circuits to the switches in this manner and, referring, briefly, back to FIG. 4, interconnecting the outputs of the secondary stage of each network in parallel enables a call on an incoming trunk to be extended through either the "A" network or the "B" network or a combination of both to the operator positions.

FIGS. 6A, 6B, 6C and 6D together show diagrammatically but in further detail the interrelationship of elements comprising the switching networks of FIG. 4. FIG. 6A discloses in some detail the "0" switches of both the primary and secondary stages of the "A" network, including the manner in which the incoming trunks are connected to the input of the "primary A switch 0" and the manner in which output of this switch is connected to the input of the "secondary A switch 0." FIGS. 6A, 6B and 6D show the manner in which the output of the "secondary A switch 0" is interconnected to the input



of the tertiary "A" switches on FIGS. 6B and 6D. The connection shown on FIG. 6A assumes the use of a ten-by-twenty crossbar switch for both the primary and secondary switches. The series of numbers "0" through "19" on the right-hand side of the primary "A" switch represents the 20 verticals of the switch. Referring to the topmost rectangle designated "0" of the "primary A switch 0" on FIG. 6A, it may be seen that it comprises the first four verticals, "0"-"3" of the switch, together with the ten horizontals, "00," "10," "20," "30," . . . "90," associated with these first four verticals. Connected to these ten horizontals are the conductors from the ten trunks "00," "10," "20," "30," . . . "90."

Similarly, the rectangle "1" associated with the "primary A switch 0" includes the next four verticals, "4"-"7," of the switch, together with the ten horizontals, "01," "21," "31," . . . "91," associated therewith. Connected to these horizontals are conductors from trunks "01," "21," "31," . . . "91." Similarly, the rectangles designated "2," "3," and "4" are each respectively associated with an individual set of four of the remaining verticals on the switch. Connected to the ten horizontals associated therewith are conductors from the trunks designated in the manner shown, with the ten trunks having a "units" digit of "2" being connected to the horizontals of the rectangle designated "2," the ten trunks having a "units" digit of "3" being connected to the horizontals of the rectangle designated "3," and with the ten trunks having a "units" digit of "4" being connected to the ten horizontals of the rectangle designated "4."

The rectangles on FIG. 6C, respectively designated "primary A switch 1" and "primary A switch 2," each comprise a ten-by-twenty crossbar switch, and the corresponding horizontals and verticals thereof are connected in precisely the same manner as above described for "primary A switch 0" on FIG. 6A. Thus, the horizontals of primary "A" switches "1" and "2" are connected to the same trunk circuits as are the corresponding horizontals of "primary A switch 0" on FIG. 6A. Also, the verticals of the primary "A" switches "1" and "2" are respectively connected to the verticals of secondary "A" switches "1" and "2" in the same manner as shown on FIG. 6A for "primary A switch 0" and "secondary A switch 0."

Referring to "secondary A switch 0," it may be seen that the verticals of the "primary A switch 0" are connected to the verticals of the "secondary A switch 0." Also, the horizontals of the "secondary A switch 0" are connected to the verticals of the tertiary switches on FIGS. 6B and 6D. "Secondary A switch 0" may be functionally subdivided into four subswitches, respectively designated "0," "1," "2," and "3," each having five verticals and ten horizontals, as shown on FIG. 6A, in a manner similar to that already explained for the primary switches.

The "B" switching network is shown only as a large rectangle representing each switching stage, since the "B" network is identical to the "A" network. FIGS. 6B and 6D disclose the interrelationship of the elements comprising the tertiary stages of both the "A" and "B" networks. The tertiary stage of each network comprises six ten-by-twenty crossbar switches, respectively designated "0," "1," "2," "3," "4," and "5." The first two switches, "0" and "1," of the tertiary "A" stage are shown in some detail on FIG. 6B, while the last four switches of the tertiary "A" stage, "2"-"5," and the entirety of the tertiary "B" stage are shown in somewhat less detail on FIG. 6D.

Reviewing the foregoing, each primary switch is functionally subdivided into five parts, each of which parts comprises four primary verticals; similarly, each secondary switch is functionally subdivided into four parts, each of which parts comprises five secondary verticals, together with the ten secondary horizontals serving these five verticals. The tertiary verticals comprise the input to the tertiary stage and they are connected to the horizontals of the secondary stage. The horizontals of the tertiary

stage comprise the output circuits to which the position control circuits are connected. Each of the tertiary "A" or "B" switches "0"-"5" comprises five groups of ten horizontals so that each tertiary switch has 50 outputs.

Therefore, it will be seen that the two tertiary "A" switches "0" and "1" of FIG. 6B, together, have 100 output conductors. The outputs of the tertiary "A" switches "2" and "3," and of "4" and "5" are each, respectively, associated with the same position control circuits as are the corresponding output conductors or appearances of the tertiary "A," "0" and "1" switches. As already stated, three switches per stage per connection are required because the interconnection of a single trunk circuit with an operator position may require the connecting through of as many as 17 individual conductors, whereas a single crossbar switch is capable of closing only six contacts per crosspoint. Therefore, the interconnection of an incoming trunk circuit with an operator position requires the closure of three crosspoints at every stage of the switching network.

The "tertiary B switches" are represented only by a large rectangle on FIG. 6D, since they are similar in detail to the "tertiary A switches" whose details are shown. The "tertiary B switches," similarly, have 100 separate output appearances, as do the above-described "tertiary A switches." The two tertiary switches "A" and "B," together, thereby provide 200 output appearances by which to connect the three loops of each of the 66 operator positions. Since 3 times 66, or 198, of the available output conductors are required to connect the 66 operator positions, the two remaining output conductors are reserved as spares.

FIG. 7 shows the interrelationship between the incoming trunks, the operator position circuits, and the position link frames, as well as the interrelationship between the link frames comprising a position link group. FIG. 7 shows five link groups numbered "0" through "4," each of which serves a maximum of 500 incoming trunk circuits and 66 operator positions. Thus, the five link groups together serve a maximum of 2500 incoming trunk circuits and 330 operator positions.

Each link group comprises ten position link frames designated "0" through "9," a traffic regulator, a key-control position-control circuit, and three position link controllers designated "0," "1," and "2." Each position link frame comprises an "A" and a "B" set of primary, secondary, and tertiary crossbar switches, as shown diagrammatically on FIGS. 4, 5, and 6, with each link frame in a link group serving a different group of 50 incoming trunks and with all ten link frames within a link group serving a common group of 66 operator positions.

The crossbar switches of each link frame are the actual interconnecting means for extending a calling incoming trunk to a selected operator position circuit. A link frame which has been seized by an incoming trunk cannot by itself cause its crossbar switches to operate in the proper manner to interconnect the calling trunk with an idle operator position. Instead, it must associate itself with a link controller in order to extend this connection. The link controller is somewhat analogous to a marker in its operation in that, after it is connected to a bidding link frame, it checks for and selects a most-preferred idle operator position, checks for the availability of an idle path through the link frame between the calling trunk and the selected operator position, and then controls the operation of the crossbar switches comprising the preferred link path to interconnect the calling trunk with the selected operator position. The controller releases from the link frame, once the connection is established, in order to free itself for the serving of subsequent calls on either other link frames or on the same link frame.

Three controllers are provided in every link group to serve the calls appearing on the ten link frames in the same link group. The ten link frames and the three controllers in each group are each interconnected via the



necessary preference circuitry so that (1) two or more bidding link frames cannot simultaneously seize the same controller, (2) each link frame distributes its bid equitably among the three controllers, and (3) each controller equitably distributes its availability among the ten link frames.

Each link group may serve different classes of calls. Normally, each operator position serves calls of all classes. However, there are certain instances in which it is desired to restrict the classes of calls incoming to designated ones of the operator positions, not exceeding five. An example of this might occur when a new operator who has been trained to serve only a limited number of call classes is manning a position, or when it is desired to restrict certain classes of calls from certain operator positions for various operational reasons. The key-control position-control circuit keeps a running account of the positions available to serve the various classes of calls while the traffic regulator maintains a continuous supervision over the backlog of calls waiting for service in each call class. The two circuits together cooperate to provide equitable service to all classes of calls and to connect them to the operator positions in accordance with the classes of calls served by each position. Thus, for example, if the traffic regulator ascertains that one class of call has a very short waiting time while another class has a very long waiting time, it may redistribute the waiting time for each class so that equitable service will be provided to all classes.

#### *Discussion of input circuitry of link connectors*

Continuing with the description of the present call, it is assumed that link connector "0" serves the present call and, therefore, only the details of this connector are shown on the drawings. The circuit details of the switching network of an exemplary link connector, identified as "0," are disclosed on FIGS. 73A, 73B, 74 through 78, 79A, 79B, 80 through 84, and 92 through 94. It is also assumed that the trunk circuit shown on FIGS. 10 through 15, which is serving the currently described call, is trunk "0" in trunk group "0." This being the case, with but one exception, all of the conductors shown on FIG. 15, and indicated as extending to link connector "0," will be connected to the input cable designated L00 on FIG. 73A. Each such cable may represent as many as 17 conductors, which number exceeds the capability of any one set of crosspoints; and, therefore, the conductors comprising this cable are subdivided as required and are connected to corresponding input appearances of primary "A" switches "0," "1," and "2." Also, the conductors comprising this cable are similarly connected to the corresponding appearances of the primary "B" switches.

Referring now to the trunk circuit, the conductor designated ST (FIG. 15) is the exception priorly referred to, since it does not extend to the crossbar switch field of the link connector "0." Instead, it comprises the "start" lead over which the trunk bids for the link connector, and this conductor is extended from the trunk circuit to the "start" lead on FIG. 85A, which is further identified as ST00, indicating it as being associated with trunk "00," which is the first trunk of trunk group "0."

The "start" or control leads for link connector "0," including the above-described lead (further identified as "ST00"), are shown on FIGS. 85A, B, and C. These comprise 50 nonpriority "start" leads and 50 priority "start" leads. These two sets of leads are each subdivided into ten groups of five each, just as are the trunks circuits connected to the input of the crossbar switching network associated with the link circuit. The 50 nonpriority "start" leads are shown in part and are identified as ST00 through ST04, ST10 through ST14, ST80 through ST84, and ST90 through ST94. The 50 priority "start" leads are identified in a similar manner, but the identifying prefix is PS- instead of ST-. Thus, the first priority group is identified as PS00 through PS04, while the last group is identified as PS90 through PS94.

#### *Calling trunk "00" bids for the services of a link connector*

Referring to the nonpriority "start" leads, when a trunk circuit requires connection to an operator position, it transmits a ground signal to the link connector frame via its ST lead, as already described. On FIG. 85A or 85B each of the ST leads is respectively connected in series with a break contact of a "group-gating" (-G-) relay and terminates on the winding of a relay designated -M-. If the associated -G- relay is normal, the associated -M- relay operates in response to a ground signal and locks itself to ground supplied via the "start" lead. If at least one of the primary to secondary switch linkages available to the calling trunk is idle, a corresponding group "start" relay ST will now operate. Thus, for example, the ground on conductor ST00 on FIG. 85A may be extended over break contacts 108A-G0 to the winding of relay 850A-M00 to operate it.

The "start" relays are shown on FIGS. 107A, B, and C. The nonpriority "start" relays are designated ST0 through ST9, while the priority "start" relays are designated ST0P through ST9P. The circuit over which a "start" relay operates as a consequence of the operation of its associated -M- relay on FIG. 85A includes the break contacts associated with the hold magnets serving the links over which this particular trunk group may be interconnected to the secondary switches. Thus, referring to relay 107A-ST0, and recalling that relay 85A-M00 is operated in connection with the call now being served, it may be seen that the condition of parallel-connected hold magnet break contacts 86-PH0-0, 86-PH1-0, 87-PH2-0, 87-PH3-0 of switch "A," and 96-PH0-0, 96-PH1-0, 97-PH2-0, and 97-PH3-0 of switch "B," determines whether or not the ground on terminal 107A-101 may be extended through make contacts 85A-M00 to operate relay 107A-ST0. It will be recalled from the preceding description of the switch linkages, and referring in particular to FIG. 6A, that the conductors of any trunk may be connected to the secondary switches over any one of four circuit paths on the "A" switches and any one of four circuit paths on the "B" switches. Thus, referring to trunk "00" on FIG. 6A, it may be seen that it may be connected to the secondary "A" switches via any one of four conductor paths comprising verticals "0," "1," "2," and "3" of the primary "A" switches. Each vertical is associated with and controlled by its related hold magnet. The break contacts of these hold magnets are shown on FIGS. 107A, B, and C. Thus, referring again to relay 107A-ST0, and assuming that relay 85A-M00 operated as before described, the determination of whether or not relay 107A-ST0 will operate is dependent upon whether or not one of the four hold magnets serving this trunk in the "A" switches, or one of the four hold magnets serving the same trunk in the "B" switches is normal at this time. Assuming that one of them is normal, the ground on terminal 107A-101 will now be extended through the break contacts of any such normal hold magnet and through make contacts 85A-M00 to the winding of relay 107A-ST0, causing it to operate.

It has hereinbefore been explained that there is a maximum of 50 trunks associated with each link frame and that these 50 trunks are divided into ten groups of five trunks each. All trunks within a group must be of the same class, i.e., they must serve the same type of call. Although the circuit may theoretically accommodate ten different trunk classes, since there are ten incoming trunk groups, it is actually arranged for only seven classes. These are designated as classes "0" through "6." The digits "0" to "5" are arbitrarily assigned to designate any trunk class, while the digit "6" is reserved as a designation for "delayed call" trunks, in a manner described hereinafter.

#### *Discussion of traffic regulator circuit of FIG. 108A*

The ST relays on FIGS. 107A, 107B, and 107C, which operate to indicate a trunk service request, are used to signify the calling trunk class by means of a cross-con-



nection arrangement shown on FIG. 108A. When one or more ST- relays operate on a link frame, ground signals are transmitted over the CW0 through CW5 leads to the traffic regulator circuit to indicate to that circuit that there are calls waiting in the system, as well as the class of such calls. The proper CW- lead is grounded by associating the ST- relays with the various CW- leads by means of a cross-connecting arrangement. Thus, the operation of relay 107A-ST0, as above described, extends the ground on terminal 108A-104, over its make contacts, terminal 108A-SW0, cross-connection CW0, terminal 108A-CW0, conductor CW0, to the winding of relay 108A-CW0 in the traffic regulator circuit, causing it to operate, thereby indicating to that circuit that a class "0" call is currently waiting to be served. When the traffic regulator is informed that a call of a particular class is waiting on a link frame, it, in turn, grounds a CG- lead (the numerical designation of which corresponds to the class designation of the waiting call) to every link frame in the associated link group. A ground signal on the CG- lead operates the G relays associated with those groups which are composed of trunks of the same class as the waiting call. Thus, for example, negative battery on terminal 108A-110 is extended through break contacts GA, make contacts CW0, and conductor CG0 of the traffic regulator, terminal 108A-CG0, cross-connection CG0, terminal 108A-C0, break contacts 106A-D0, and the winding of relay 108A-G0 to ground on terminal 108A-101, causing relay 108A-G0 to operate. This prevents registration of any more requests for service from trunks of this class, on any link frame, until all recognized requests of the same class have been served. It accomplishes this function by disconnecting the M relays from their respective "start" (ST) leads. Thus, referring to FIG. 85A, once relay 108A-G0 is operated as above described, it may be seen that all of the "start" leads of the "0" trunk group, respectively identified as ST00 through ST04, are disconnected from their respective relays 85A-M00 through 85A-M04, with the exception of any M relays already operated. Any M relays that are already operated remain locked over their respective make contacts to their respective "start" leads. The foregoing arrangement provides a means of "gating" all classes of trunks independently.

The traffic regulator circuit maintains a constant check on all operator positions to determine, on a per class basis, whether there are any operator positions available to serve a calling trunk. If there are no positions available to serve the traffic generated by a particular type of trunk, the traffic regulator circuit will operate a particular one of the all-positions-busy relays 108A-PB0 through 108A-PB5, the numerical designation of which corresponds to the class of traffic. There is no PB6 relays, since delayed call trunks initiate a bid in response to a request for such a connection from an operator position. The traffic regulator circuit can only operate the 108A-PB- relays when the link frame is not connected to a controller, although it can hold all operated -PB- relays as long as the all-positions-busy condition exists.

#### *Link connector "0" bids for controller "0"*

Whenever any ST- relays of FIGS. 107A, 107B, and 107C are operated, thereby indicating that one or more trunks are bidding for an operator position, and assuming that the PB- relay (FIG. 108A) associated with the operated ST- relay is released, a path will be closed to operate the controller "start" relay 102-CSA. Referring back to the present call which resulted in the operation of relay 107A-ST0, and assuming that there is an available position for serving a class "0" call (as indicated by the unoperated condition of relay 108A-PB0), the following path may now be traced to operate relay 102-CSA: ground on terminal 102 of FIG. 102, break contacts 108A-PB0, terminal 102-PT0, cross-connection PT0, terminal 102-ST0, make contacts 107A-ST0, break

contacts 108B-W, 108B-X, 108B-Z, 106B-RL, to the winding of relay 102-CSA, causing it to operate.

The portion of the link connector which controls the seizure of an available controller is shown in FIG. 108B. The circuit shown on that figure divides and allocates the request for controller service among the three available controllers serving the particular link group of which the disclosed link is a part. Specifically, the circuit on FIG. 108B allocates its requests for service among controllers "0," "1," and "2," depending upon the operated or nonoperated condition of the various make and break contacts included in the circuit. The manner in which succeeding requests for controller service are allocated to different controllers is explained in detail hereinafter. Of the three controllers which would normally be available to serve the link controllers, only the circuit of controller "0" is shown on the drawings and, therefore, it will be assumed that it is this controller which serves the present call. Each controller has a controller "start" relay (CS-) respectively associated with each link frame from which it may accept calls. These CS- relays (CS0, CS1, etc.) are shown on FIG. 112. The controller "start" relays are included within the controller circuit to enable a frame-preference arrangement to be incorporated within each controller and to be controlled thereby.

The following circuit is now closed to operate relay 112-CS0, thereby enabling controller "0" to serve the present call: 48-volt battery on terminal 108B-101, resistor R1, make contacts 102-CSA, break contacts 108B-X, 108B-Z, 102-CBT0, conductor CS0 extending over FIGS. 108B, 108A, 107C, 107B and 112 to the winding of relay 112-CS0. It may be assumed for purposes of discussion, and in a manner described in detail hereinafter, that relays 131-FP0 and 131-FPK are both operated. Therefore, the 48-volt battery extended to one side of the winding of relay 112-CS0 may be extended through the winding of the relay and over make contacts 131-FP0 and 131-FPK to ground, thereby operating relay 112-CS0.

The operation of relay 112-CS0, when controller "0" is seized by link connector "0," closes the following path to operate relay 116-MB: ground on terminal 101 on FIG. 116, make contacts 112-CS0, to the winding of relay 116-MB, causing it to operate. The operation of relay 116-MB grounds all the controller busy (CB) leads to all link frames, with the exception of the CB- lead associated with the link frame "0" now connected to this controller. The "make busy" circuit also includes a frame-preference arrangement consisting of contacts of the 131-FP- relays shown on FIG. 116. This circuitry functions to apply ground to the CB- leads to all nonpreferred link frames when more than one CS- relay of FIG. 112 is operated, as would be the case when simultaneous "controller starts" are received from a plurality of link connector frames. Referring to FIG. 116, it may be seen that upon the operation of relay 116-MB, a ground will be applied to the CB- lead extending to any link connector frame which is currently not bidding for the services of the controller, as evidenced by the released condition of the 112-CS- relay associated with the nonbidding link connector frame. For example, assume that the link frame, to which the CB1 conductor on FIG. 116 extends, is currently not bidding for the services of the controller. In this case, relay 112-CS1 associated with this link frame will be unoperated. Therefore, upon the operation of relay 166-MB, a ground will be extended from terminal 102 on FIG. 116, through make contacts 116-MB and break contacts 112-CS1, to conductor CB1 extending to link frame "1." By similar circuitry, grounds will be placed on all other CB- leads of FIG. 116 whose associated links are not bidding for the services of a controller. The ground on conductor CB1 of FIG. 116 is extended to a circuit in its associated link connector, similar to that shown on FIG. 102, to operate one of the CBT- relays thereon. The operation of one of the CBT- relays opens



its associated break contacts and alters the preference circuit associated with the circuit on FIG. 108B, which seizes an idle controller. Specifically if the link connector associated with conductor CB1 on FIG. 116 should have its relay 108B-CBT0 operated as a consequence of the ground on this conductor, the circuit in this link connector, corresponding to that of FIG. 108B, would open its lead corresponding to conductor "0" (FIG. 108B) so that this link connector could not, in the event of a subsequently arriving call, attempt to seize controller "0."

The operation of relay 116-MB does not apply ground to conductor CB0 (FIG. 116), since the ground from terminal 116-103 and make contacts 116-MB is opened at break contacts of relay 112-CS0, which is operated at this time. The same would be true for the CB- lead on FIG. 116 associated with any other link connector, which in bidding for the services of this controller, had succeeded in operating its associated CS- relay on FIG. 112.

*Link connector "0" is connected to controller "0"*

Referring now to FIG. 112, the operation of relay 112-CS0 completes a circuit to apply negative battery to conductor CA0, extending to link connector "0," in the event that only relay 112-CS0 of all the CS- relays on FIG. 12 is operated. In the event that two or more CS- relays are operated, negative battery will be applied to only one of the CA- leads, under control of the preference circuit comprising the contacts of relays 131-FP-. The details of the preference circuit and the manner in which the preference is rotated is hereinafter explained. Let it be assumed at this time, to facilitate understanding, that only relay 112-CS0 is operated, and, also, let it be assumed that relay 131-FP1 is operated. Let it be further assumed that the check relay 131-FPK is operated, as is hereinafter described. Bearing these assumptions in mind, the following circuit is now closed to apply battery to conductor CA0: battery on terminal 112-102, the thermal resistance "T," make contacts 131-FPK, 131-FP1, and 112-CS0 to conductor CA0. The ground on conductor CA0 is then extended over conductor CA0, through FIGS. 107B, 107A, 106B, and 106A, to the winding of relay 106A-CA0, causing it to operate. The operation of relay 106A-CA0 operates a plurality of multi-contact relays to connect a multiplicity of information and control leads to controller "0." Thus, the ground on terminal 101 of FIG. 106A is now extended through make contacts 106A-CA0 to operate relays 106A-CB0, -CD0, -CC0, -CE0, -CF0, and CG0.

The operation of relay 106A-CA0 closes its make contacts to extend the ground on terminal 106A-107 to the winding of relay 106A-CH0 to operate it, and extends the ground on terminal 106A-105 over its make contacts to the winding of relay 106A-LCC to operate it. The operation of relay 106A-LCC, in turn, extends the ground on terminal 106A-106 over its make contacts to relay 106A-LCCA to operate it. The operation of relay 106A-LCC also provides an obvious holding path for relay 102-CSA.

The operation of relay 106-LCCA completes the following circuit to operate relay 108B-CCP: ground on terminal 105 of FIG. 108B, make contacts 106A-LCCA to the winding of relay 108B-CCP to operate it. The operation of relay 108B-CCP closes its make contacts to extend the ground on terminal 102 of FIG. 108B to advance the WXZ relay walking circuit one step. The stepping of the walking circuit alternates the preference circuit, interconnecting the battery on terminal 108B-101 with the seizure leads to the various controllers, so that upon the serving of the next call by this link connector, a different controller will be seized. The preference advance of this circuit is completed by the subsequent release of relay 108B-CCP when the link-to-controller connection is terminated.

The operation of relay 106A-CE0 closes the following path to operate relay 113-ON: ground on terminal 109

of FIG. 106A, make contacts 106A-CE0, conductor ON extending through FIGS. 106A, 106B, 107A, 107B, 107C, and 113, to the winding of relay 113-ON, causing it to operate. The operation of relay 113-ON, in turn, closes an operating circuit for relay 113-ON1, causing it to operate.

Referring now to FIG. 106B, the cross-connecting terminals PB0 through PB5 are associated with the six different classes into which the calling trunks may be arbitrarily subdivided. The break contacts intermediate each PB- terminal and ground are normal if an operator position is currently available to serve calls of the type represented by the PB- terminal, while the break contacts are opened to remove ground from the terminal in the event that no operator position is available. Thus, for example, referring to cross-connecting terminal PB0, ground from terminal 106B-111 will be applied through break contacts 108A-PB0 only in the event that an operator position is available to serve class "0" calls.

The cross-connection between the PB0 through PB5 cross-connecting terminals and the ST0 through ST9 cross-connecting terminals identifies each of the ten groups of incoming trunks of link frame "0" with one of the classes of service "0" to "5." It has been assumed that the call currently being described is of the class "0" type, that the incoming trunk serving the call is in trunk group "0" on link connector "0," and that it has already operated relay 107A-ST0. Consequently, cross-connecting terminal ST0 is cross-connected to cross-connecting terminal PB0, thereby indicating that all calls served by trunk group "0" on this link connector frame will be of the class "0" type. There are ten cross-connecting terminals ST0 through ST9, and there are only six cross-connecting terminals PB0 to PB5 and, therefore, certain of the PB- terminals must be connected to more than one of the ST- terminals. Thus, cross-connecting terminal PB0 is shown cross-connected to cross-connecting terminals ST0 and ST1. This indicates that the calls incoming on trunk group "1," although they will operate relay 107B-ST1, will also be assigned to the class "0" and will be served only in the event that relay 108A-PB0 is normal, thereby indicating that an operator position is currently available to serve class "0" calls.

The following circuit is now closed to operate relay 113-G0: ground on terminal 111 of FIG. 106B, break contacts 108A-PB0, terminal PB0, terminal ST0, make contacts 107A-ST0, 106-CA0, conductor G0 extending via cable G to FIG. 113, conductor G0, parallel-connected break contacts 115-GDN and 130-AG0, break contacts 113-GE, to the winding of relay 113-G0 to operate it. Relay 113-G0, in operating, closes a circuit over its make contacts to bypass break contacts 113-GE. The operation of relay 113-G0 completes the following path to operate relay 113-GE: ground on terminal 104 of FIG. 113, make contacts 113-G0, to the winding of relay 113-GE to operate it. The operation of relay 113-GE opens its break contacts in the previously-described operating circuit for relay 113-G0, so that relay 113-G0 is currently held operated only over its make contacts.

#### *Summary of call progress in link connector and controller*

Reviewing the circuit actions just described, and referring to FIG. 106B, it may be seen that when the controller is connected to a link frame, grounds will appear on one or more of the group "start" leads G0 through G9, respectively, corresponding to those groups on the link connector containing trunks that are bidding for service. The relays 113-G0 through 113-G9 associated with the grounded group "start" leads operate and, in turn, operate relay 113-GE, which functions as a gate to prevent the controller from recognizing the subsequent appearance of a ground on any of "start" leads G0 through G9 that are not grounded at this time. Those of the group relays 113-G0 through 113-G9 which have operated lock themselves to their respective "start" leads. In this manner, the



controller has recorded the groups containing bidding trunks and will serve only those groups on this particular controller usage, with the exception of test calls, as hereinafter described. In addition, only the trunks within the groups recorded which have bids for service at this time will be served. This is accomplished by an auxiliary gating system on the link connector frame and, in particular, the M- and G- relay contacts on FIGS. 85A and 85B, respectively, associated with each "start" lead for the link connector.

*Controller selects the calling trunk group to be served*

Having registered the bidding group, or groups of trunks in the event that more than one group is currently bidding (as would be the case in the event that more than one of the relays 113-G0 through 113-G9 is currently operating), the controller at this time selects and serves the group which is highest in preference. This action is initiated by the operation of relay 113-GE, as described, which closes a ground to a selection circuit (comprising FIGS. 124, 130 and 136), and resulting in operation of one of the auxiliary group relays 130-AG0 through 130-AG4, and 124-AG5 through 124-AG9. The selection circuit consists of a closed ring of transfer contacts whose entry point is determined by the trunk group preference relays 132-TGP0 through 132-TGP6, and 133-TGP7 through 133-TGP9, one of which will have been previously operated. The specific manner in which a preference relay is always operated is hereinafter described. This selection circuit is designed so that only one of the auxiliary group (AG-) relays will operate. The operation of one of the AG- relays determines the trunk group which will be served in the event that two or more such groups are bidding. The 130-AGK and 130-AGKA relays are then operated as a check that an AG- relay has operated and as a further check that only one such relay has operated.

The ground on terminal 101 in FIG. 136 may now be extended through make contacts 113-ON, break contacts 139-SNG, to terminal 101 on FIG. 130. The ground on terminal 130-101 may be then extended through make contacts of relay 132-TGPK, which is a preference check relay whose operation is hereinafter described. Suffice it to say, at this point, that relay 132-TGPK operates whenever the proper number of relays in its associated check circuit are operated. The ground extended through make contacts 132-TGPK may then be extended upward through break contacts 131-TTFA, make contacts 113-GE to terminal 130-102. Ground on terminal 130-102 may then be extended upwards to terminal 101 on FIG. 124 via interspersed series-connected break contacts on the 130-AG0 through 124-AG9 relays and the 145-G0P through 145-G9P relays. Terminal 101 of FIG. 124 may be considered to be the entry point of the preference circuit comprising the 132-TGP5, 132-TGP6, 133-TGP7 through 133-TGP9, and the 132-TGP0 through 132-TGP4 relays. The contacts of the TGP- relays on FIGS. 124 and 130 comprise a preference circuit to operate only the most preferred of the AG0 to AG9 relays on FIGS. 130 and 124 in the event that more than one of the 113-G0 through -G9 relays is currently operated. In order to illustrate the various features of this circuit, it will initially be assumed that preference relay 132-TGP0 is operated, thereby giving preference to the operation of relay 130-AG0. The ground on terminal 101 of FIG. 124 may now be extended downward to terminal 103 on FIG. 130, and from there through make contacts 132-TGP0 and 113-G0, to the parallel-connected windings of relays 130-AG0 and 130-AGA0, to operate them.

Now to vary the circuit condition somewhat, let it be assumed, for example, that relay 132-TGP1 is operated instead of relay 132-TGP0, thereby giving preference to the operation of relay 130-AG1. Let it also be assumed, for example, that only trunk group "0" is bidding. Under this assumption, the following circuit now may be traced

from terminal 101 on FIG. 124 to operate relay 130-AG0: downwards on FIG. 124 from terminal 101 to terminal 104 on FIG. 130, through make contacts 132-TGP1, to terminal 130-105, through the series of break contacts 113-G1 through 113-G4, terminal 130-106, terminal 102 on FIG. 124, through the series of break contacts 113-G5 through 113-G9, terminal 104 on FIG. 124, downwards to terminal 124-105, to terminal 107 on FIG. 130, to terminal 130-108, through make contacts 113-G0 to the parallel-connected windings of relays 130-AG0 and 130-AGA0, to operate them. Thus, with the closure of contacts 113-G0 on FIG. 130, and with only one trunk group bidding for service, it may be seen that relays 130-AG0 and 130-AGA0 will be operated without regard to which one of the preference relays 132-TGP0 through 132-TGP6 or 133-TGP7 through 133-TGP9 is operated. Also, studying the circuitry just described, it may be appreciated that in the event that two trunk groups are simultaneously bidding, such as for example, trunk groups "0" and "1," relay 130-AG0 will be operated, provided that preference relay 132-TGP0 is operated; or relay 130-AG1 will be operated in the event that preference relay 132-TGP1 is operated.

The operation of one of the relays AG0 through AG9 on FIGS. 130 and 124, as described, and, in particular, the operation of relay 130-AG0 in connection with the present call, closes a path from ground on terminal 109 of FIG. 130, through the 1-out-of-10 symmetric check circuit, indicated by rectangle CK on FIG. 130, comprising the contacts of relays 130-AG0 through 124-AG9, to the parallel-connected windings of the relays 130-AGK and 130-AGKA, to operate them as a check that one, and only one, of the relays 130-AG0 through 124-AG9 is currently operated.

Referring now to FIG. 106A, it may be seen that there are ten D- relays, 106-D0 through 106-D9, each of which is individual to a different incoming trunk group served by the frame. The operation of the controller, as described, constitutes a selection of the particular trunk group it will serve, and the following path is now closed to operate relay 106A-D0 as an indication that the controller will serve trunk group "0": battery on terminal 102 of FIG. 114, resistor DR, break contacts 113-DR, 139-SNG, make contacts 132-TKPK, break contacts 131-TTFA, make contacts 130-AGK, terminal 114-103, make contacts 130-AG0, break contacts 145-G0P, conductor D0, via cable D extending from FIG. 114 to FIG. 106A, conductor D0, make contacts 106A-CH0, to the winding relay 106A-D0, to operate it.

On FIG. 114 a "group cross" relay, 114-GX is provided, which will operate if two or more of the D0 through D9 leads are crossed. Relay 114-GX is a sensitive relay, having a low resistance winding, which acts as shunt around the winding of all of the relays 106A-D0 through -D9, except for the one to be operated. If the operating lead for the D- relay selected for operation is inadvertently crossed to the operating lead for one of the other D- relays, caused, for example, by a solder short, then relay 114-GX will shunt all of the other D- relays in the group and, hence, normally, none of them will operate. The operation of relay 114-GX blocks the call and causes a request for connection to be made to the trouble recorder circuit, in order to automatically record the existence of this type of trouble.

The above-described operation of relay 113-ON closes the following path to operate relay 151-GADK: ground on terminal 101 of FIG. 151, make contacts 113-ON, break contacts 126-RS, 137-APS, terminal 151-102, terminal 151-103, series-connected break contacts of relays 155-GA6 through 154-GA0, 151-GADK, to the winding of relay 151-GADK, to operate it. Relay 151-GADK, in operating, closes a holding path for itself over its own make contacts to ground on terminal 151-103. The above-described operating path for relay 151-GADK constitutes a downcheck to ensure that one



of the 151-GA- relays are operated at the beginning of the controller operation. A similar check is made on the relays 151-GR0 through 151-GR6 to ensure that none of them are initially operated when the controller is seized. This check path comprises the winding of relay 145-GRDK, a 0-out-of-7 symmetric check circuit, indicated by rectangle CK on FIG. 145, comprising break contacts of relays 151-GR0 through 151-GR6, make contacts of relay 113-ON, and negative battery from terminal 146-105, through resistor PG. This circuit operates relay 145-GRDK in the event that none of the relays 151-GR0 through 151-GR6 are initially operated. When relay 145-GRDK operates, it locks up to negative 48-volts through resistor GRK, make contacts 113-ON break contacts 126-RS, and make contacts 145-GRDK to ground on the winding of relay 145-GRDK.

#### *Summary of circuit operation*

Pausing briefly to review the circuit action described so far, and referring to FIGS. 85A through 85C, it may be seen that the "start" leads, for the "nonpriority" seizure of the link connector by the first group of the ten trunk groups, are represented by the group of conductors ST00 through ST04; and similarly, the "start" leads for the last group of the ten trunk groups are represented by conductors ST90 through ST94. The "start" leads for an intermediate trunk group ST10 through ST14 are similarly shown. The ten groups of "priority start" leads are designated in a similar manner with the exception that the numerical portion of the designation is prefixed by the letters "PS," which signify "priority start." The trunk serving the present call is assumed to be trunk "00" in trunk group "0," and, therefore, its seizure of the link connector resulted in, among other things, the operation of relay 85A-M00 associated with trunk "00," as hereinbefore described. The link connector, in turn, requested the services of a controller and succeeded in connecting itself to controller "0." This connection, as hereinbefore described, operated relays 106A-CA0 through 106A-CH0. This connection also resulted in the closure of the five make contacts designated 106A-CD0 on FIG. 85A, each connected in series with one of the conductors T0 through T4 in cable T extending through FIGS. 85A, 85B, 85C, 95A, 96, 97, 98, 99, 100, 101, 102, 108B, and 115 to controller "0." The closure of these contacts prepared a path to interconnect the "start" lead of the calling trunk with its associated conductor in the conductor group T0 through T4 on FIG. 85A extending over cable 85A-T, as described, to the controller. The controller, as a consequence of its seizure by this link connector, examined all trunk groups to see which groups were currently requesting service, seized only the most-preferred group in the event that two or more trunk groups were bidding, as a consequence of such preference determined trunk group "0" to be the most-preferred trunk group, and extended an operating potential to relay 106-D0, thereby informing the link conductor that a calling trunk in its trunk group "0" would now be served.

#### *Controller receives class information from the link connector*

The operation of relay 106A-D0 closes the five make contacts designated 106A-D0 on FIG. 85A, thereby extending the "start" leads of trunks "00" through "04" over series-connected make contacts 106A-D0 and 106A-CD0 to conductors T4 through T4 extending over cable T to FIG. 115 to the correspondingly designated conductors T0 through T4 each of which is connected to the correspondingly designated one of the five controller relays 115-T0 through T4.

Trunk "00" is assumed to be serving the present call and, therefore, the ground on conductor 85A-ST00 may now be extended over make contacts 85A-M00, 106A-D0, 106A-CD0, and conductor T0 in cable T extending to conductor T0 of FIG. 115 of the controller, through break

contacts 145-PTC, to the winding of relay 115-T0 to operate it. Any other of the relays 115-T0 through -T4, respectively associated with another calling trunk in trunk group "0" and currently connected to the controller, would also now be operated by the ground on its associated conductor in the group ST00 through ST04 of FIG. 85A. The operation of relay 115-T0 on FIG. 115, as well as the operation of any of the other T- relays on this figure closes a holding circuit for itself over its own make contacts to ground on its associated T- conductor, thereby shunting the break contacts 145-PTC.

The series of relays 115-TC0 through -TC5 provides a means of registering class information in the controller concerning the calling trunk. The conductors CL0 through CL5, respectively connected to the windings of these relays, are in cable CL, extended through FIGS. 108B, 108A, 107C, 107B, 107A, and 106B to like designated conductors, and through make contacts 106A-CF0, and respectively terminate on the correspondingly designated terminals CL0 through CL5. Also associated with this circuit is relay 115-TDC (trunk delayed class) the winding of which is connected to conductor CLD in cable CL, and thence, as above described, to FIG. 106B where it terminates on terminal CL6. Terminals CL0 through CL6 are, in turn, cross-connectable to the terminals D0 through D9, each of which is associated with the correspondingly designated trunk groups "0" through "9." A ground is placed on a D- terminal whenever its associated trunk group is selected for service by the controller circuit. The grounding of the D- terminal, in turn, grounds the cross-connected CL- terminal which, in turn, operates its associated one of the relays TC0 through TC5 on FIG. 115, thereby signifying to the link controller certain class information concerning the calling trunk group. On FIG. 106B, terminal D0 is cross-connected to terminal CL0, thereby providing a means whereby a class-of-service "0" digit is supplied to the controller each time that trunk group "0" is selected for service.

This being the case, the following circuit is now closed to operate relay 115-TC0: ground on terminal 110 on FIG. 106B, make contacts 106-D0, terminal D0, over the indicated cross connection to terminal CL0, make contacts 106A-CF0, conductor CL0 in cable CL on FIG. 115, to the winding of relay 115-TC0 to operate it. The operation of relay 115-TC0 registers a trunk class digit of "0" in the controller circuit. The operation of relay 115-TC0 also closes a circuit to operate the check relay 115-TCK. This circuit includes ground from terminal 101 of FIG. 115, through the 1-out-of-6 symmetric circuit comprising the contacts of relays 115-TC0 through 115-TC5 and 115-TCD, indicated by rectangle CK, to the winding of relay 115-TCK. Relay 115-TCK operates only in the event that one, and only one, of the six relays of the symmetric circuit is operated.

Referring to FIGS. 132 and 133, relays 132-TGP0 through 133-TGP9 comprise a preference circuit for the trunk group section, while relays 133-TUP0 through 133-TUP4 comprise a preference circuit for the trunk "units" selection. The details of both of these preference circuits are hereinafter described. However, it should be mentioned at this point, assuming that both of these preference circuits are operating properly, one, and only one, relay in each preference circuit will normally be operated at any one time, except when the preference is being shifted. Bearing this fact in mind, an obvious circuit is closed on FIG. 132 to operate the check relay 132-TGPK for the trunk-group-preference circuit; which operating circuit includes a 1-out-of-10 symmetric circuit, indicated by rectangle GCK, comprising the contacts of the ten relays in the trunk-group-preference circuit.

Similarly, the check relay 132-TUPK for the trunk "units" selection is operated over an obvious circuit including a 1-out-of-5 symmetric circuit, indicated by rectangle UCK comprising the contacts of the five relays in the trunk-units-preference circuit.



*Trunk "units" selection by controller*

Having selected trunk group "0" as the group whose calls will now be served, and having registered the bidding trunks within this selected group, as evidenced by the operation of relays 115-T0 together with any other T-relays associated with a bidding trunk, the controller now proceeds to select the trunk "units" which are highest in order of preference. This selection circuit is shown on FIG. 136 and comprises a closed ring of transfer contacts whose entry point is determined by the operation of one of the trunk-units-preference relays 133-TUP0 through 133-TUP4. This enables the operation of one of the relays 136-AT0 through 136-AT4, the operated relay corresponding to the "units" designation of the trunk selected to be operated. The 136-ATK relay is then operated as a check that one, and only one, AT-relay has been operated.

Assuming, for example, that trunk-units-preference relay 133-TUP0 is operated, the following path is now closed to operate relay 136-AT0: ground on terminal 101 of FIG. 136, make contacts 113-ON, break contacts 139-SNG, make contacts 132-TUPK, break contacts 126-RS, make contacts 133-TUP0, break contacts 136-AT0, and make contacts 115-T0, to the winding of relay 136-AT0 to operate it. Studying the circuit just described (FIG. 136), it may be seen that with relay 133-TUP0 operated, relay 136-AT1 would have operated over a similar path in the event that relay 115-T1, rather than 115-T0, had been operated at this time. Also, it may be appreciated that if both relays 115-T0 and 115-T1 were simultaneously operated at this time, relay 136-AT0 would have operated, rather than relay 136-AT1, by virtue of the trunk-units-preference circuit currently giving preference to relay 136-AT0 as indicated by the operation of relay 133-TUP0. Also, in the event that preference relay 133-TUP1 had been operated, rather than relay 133-TUP0, and in the further event that both relays 115-T0 and 115-T1 were operated, relay 136-AT1 would have operated, thereby giving preference to trunk "units 1" rather than trunk "units 0." Also, if only relay 115-T0 had been operated while trunk-units-preference relay 133-TUP1 was operated, the following circuit would have been closed to operate relay 136-AT0: ground on terminal 136-102, make contacts 133-TUP1, terminal 103, to the interspersed series-connected transfer break contacts of the various 136-AT- and 115-T- relays, to terminal 136-104, leftwards to terminal 136-105, transfer break contacts 136-AT0, transfer make contacts 115-T0, to the winding of relay 136-AT0 to operate it.

In summation, it may be seen that the operating circuit for the various 136-AT- relays includes a preference circuit to select a preferred bidding trunk out of a plurality of bidding trunks. The operation of relay 136-AT0 closes an obvious path to operate relay 136-ATK. Relay 136-ATK constitutes a check relay for the five relays 136-AT0 through 136-AT4, and on its operating circuit includes a 1-out-of-5 symmetric circuit, indicated by rectangle ATCK, comprising the contacts of these five AT-relays. This ensures that the check relay will operate only whenever one and only one of the trunk "units" AT-relays is operated.

The operation of the relay 136-ATK extends negative battery via one of the five leads TU0 through TU4 on FIG. 136 to the selected link frame, the proper lead having been preselected by the operation of one of the 136-AT- relays. The negative potential thus transmitted to the link connector circuit causes the operation of that one of the relays 106A-TU0 through 106A-TU4 therein which corresponds to the trunk "units" being served. The operated 106A-TU- relay cuts in the required information and control leads associated with the selected trunk to the controller circuit. This being the case, the following circuit is now closed to operate relay 106A-TU0, thereby indicating to the link connector that trunk "units 0" in trunk group "0" is to be served by the controller:

battery from terminal 107 on FIG. 136, resistor TU, make contacts 136-ATK, 136-AT0, conductor TU0, in cable TU extending through FIGS. 136, 130, 124, 118, 112, 107B, 107A, 106B, and 106A, make contacts 106A-CD0, to the winding of relay 106A-TU0 to operate it.

Referring to FIG. 106A of the link connector circuit, it may be seen that it contains five relays, 106A-TU0 through 106A-TU4, each of which represents one of the trunk "units" digits "0" through "4." FIG. 106A also contains the ten "decade" relays, 106A-D0 through 106A-D9, each of which represents one of the trunk group digits "0" to "9." On each call, one of the 106A-D- and one of the 106A-TU- relays is operated by the controller to indicate to the link connector the trunk group selected for service together with the "units" designation of the particular one of the five trunks in the group that is to be served. Thus, it has been assumed that the call presently described is on trunk "0" and in trunk group "0," and that the controller has determined that this trunk is now to be served. Therefore, relays 106A-D0 and 106A-TU0 are operated. It is explained in detail hereinafter how the operation of relay 106A-TU0 serves to cut in the necessary busy test leads from a link connector to the controller, so that the controller may later ascertain whether or not any of the eight possible links between the trunk being served and the operator position selected are idle.

*Priority service*

Digressing for a moment from the presently described call, this section describes how a link connector may be seized on a priority basis. Each link connector frame provides priority "start" leads for those of its associated trunks which may, at times, request priority service. The priority "start" leads are shown on FIGS. 85B and 85C and are designated PS00 through PS04, PS10 through PS14, and so on, up to and including PS90 through PS94. If a trunk is arranged to receive priority service, rather than regular service, it grounds its PS- rather than its ST- (FIG. 15) "start" lead. The circuitry of the link connector and link controller cooperate to serve all bidding trunks arranged for priority service ahead of bidding trunks arranged for nonpriority service.

Assume, for example, that trunk "00" requests priority service. In this case, conductor PS00 on FIG. 85B is grounded, thereby operating relay 85B-P00, in a manner similar to that hereinbefore described in reference to relay 85A-M00. Referring to FIG. 107A, the above-described operation of relay 85B-P00 closes make contacts 85B-P00 to extend the ground from terminal 107A-101, through the parallel-connected hold magnet break contacts 86-PH0-0 through 87-PH3-0 of switches "A," 96-PH0-0 through 97-PH3-0 of switches "B," and through make contacts 85B-P00 to the winding of relay 107A-ST0P to operate it. The operation of relay 107A-ST0P initiates the auxiliary circuit actions required to provide priority service for this interconnection.

Referring to FIG. 85C, if the link frame is not connected to a controller, the relay 106A-LCC (link controller connected) will be unoperated. Under this condition, when it recognizes a request for priority service, it signals the traffic regulator by placing grounds on the PF and PR leads to that circuit, to operate a PF- and the PR relay therein.

On any given frame, the operation of any one of the ST-P relays, for example, 107A-ST0P, will extend ground through one of its parallel-connected make contacts (e.g., 107A-ST0P), and the transfer break contacts 106A-LCC, via lead PF, to the winding of the PF- (priority frame) relay associated with that particular frame, thereby indicating the number of the frame whereon is located the particular ST-P relay which caused its operation. Concurrently, the operation of any ST-P relay on any frame will extend ground through another one of its parallel-connected make contacts (e.g., 107A-ST0P), and break contacts 106A-LCC, via lead PR, to the winding of the



PR relay, thereby indicating that on some frame, some one of the ST-P relays is operated.

On the other hand, if the relay 106A-LCC (link controller connected) is operated, the operation of any one of the ST-P relays will extend ground through its parallel-connected make contacts (e.g., 107A-STOP), transfer make contacts 106A-LCC, one of the parallel-connected make contacts of relay 106A-CG (e.g., 106A-CG0), via conductor PW in cable T extending, as hereinabove described, to FIG. 115, through break contacts 115-GDPA, and make contacts 113-GE, to the winding of relay 115-PW (priority waiting), causing it to operate, and thereby indicating that a priority call is awaiting service. When the traffic regulator receives a signal from a link frame that one or more priority calls are waiting, it handicaps all other link frames in their bids for a controller by operating all relays in the nonpriority bidding connectors comparable to relays 108A-PB0 through 108A-PB5 of link connector "0." The operation of these relays in the other connectors makes all operator positions appear busy. The traffic regulator also at this time signals all controllers that there are priority calls waiting in the system. If a busy controller receives such a signal and if the frame to which it is attached does not have any priority calls waiting, it will complete the connection for the trunk it is in the process of serving and will then disconnect itself from the link connector frame, so that it will be available for connection to one of the link connectors having priority calls waiting. This circuit is shown on FIG. 145, where the traffic regulator is shown to extend negative battery, through the traffic regulator make contacts PF, conductor CWP, break contacts 115-PW, series-connected break contacts 145-G0P through 145-G9P, to the winding of relay 145-CWP, causing it to operate. The designation CWP functionally represents calls waiting priority. If the controller is, however, at this time connected to a link connector frame having a trunk bidding for priority service, one of the relays 145-G0P through 145-G9P will be operated, thereby preventing the operation of relay 145-CWP. If a link frame is connected to a controller when a trunk initiates a bid for priority service, this link frame will not signal the traffic regulator circuit to this effect. In this manner, all busy controllers are informed that there is at least one priority call in the system on one or more link frames which are not connected to controllers. Therefore, if relay 145-CWP operates in a busy controller, the controller will complete the connection to a position for the trunk it is serving and will then disconnect itself from the link connector, so that it will be available for connection to a frame having priority calls waiting.

Once a controller is connected to a link connector having trunks requesting priority service, the circuitry of FIG. 106B of the link connector transmits information to FIG. 145 of the controller, thereby signifying the trunk groups having priority requesting trunks. Thus, assuming that trunk "00" is bidding for priority service, and referring to FIG. 106B, the ground on terminal 106B-111 may be extended through break contacts 108A-PB0, terminal PB0 over the cross connection to terminal ST0, through make contacts 107A-STOP and 106A-CA0 to conductor G0P in cable GP, extending through FIGS. 106B, 107A, 107B, 107C, 108A, 108B, 115, 121, 127, 133, 139, and 145, through paralleled break contacts 115-GDPB, and 130-AG0, break contacts 130-AGKA, and 113-GE1 to the winding of relay 145-G0P to operate it. Relay 145-G0P, in operating, prepares a holding path to ground on terminal 145-106 for itself over its own make contacts. Thus, since trunk "00" is assumed to be requesting priority service, controller "0," after connecting itself to link connector "0," has its relay 145-G0P operated, thereby indicating that a trunk in trunk group "0" is requesting priority service.

Referring to FIGS. 124, 130 and 136, the controller "trunk groups selection circuit" is designed so that pri-

ority groups are preferred over all others. Therefore, when group selection is made, if one of the relays 145-G0P through 145-G9P is operated, the correspondingly numbered one of relays 130-AG0 through 130-AG4, and 124-AG5 through 124-AG9 operates, together with its corresponding auxiliary relay (e.g., 130-AGA0) and, in turn, operates relays 130-AGK and 130-AGKA. The operation of relay 130-AGK in conjunction with one of the relays 130-AG0 through 124-AG9 and with one of the relays 145-G0P through 145-G9P functions to operate the correspondingly designated one of the relays 85B-D0P through 85B-D9P on the connected link frame. Thus, for the present call, relay 145-G0P is operated and, therefore, a path is now closed to operate relay 130-AG0. The operation of this relay operates parallel-connected relays 130-AGK and 130-AGKA. The operation of the foregoing relays closes the following circuit to operate relay 85B-D0P: battery on terminal 102 of FIG. 114 in the controller, resistor DR, break contacts 113-DR, 139-SNG, make contacts 132-TGPK, break contacts 131-TTFA, make contacts 130-AGK, terminal 114-103, make contacts 130-AG0, transfer make contacts 145-G0P to conductor D0P in cable DP, extending through FIGS. 114, 108A, 101, 100, 99, 98, 97, 96, 95A, 85C, and 85B, make contacts 106A-CH0, to the winding of relay 85B-D0P to operate it. The operation of relay 85B-D0P closes its make contacts shown on FIG. 85B to extend the priority "start" leads of trunk group "0" through make contacts 106A-CD0 on FIG. 85A which, in turn, extend via the cable T, through FIG. 85A to FIG. 115, as hereinbefore described, where, in a manner similar to that previously described, one of the T0 to T4 relays is operated in accordance with the numerical designation of the priority bidding trunks in trunk group "0." It has been assumed that trunk "00" is bidding for priority service and, therefore, relay 115-T0 will be operated at this time.

The controller is now connected to the five trunks of trunk group "0" on link connector frame "0." In the event of bids from more than one of these trunks at this time, the controller now proceeds to select the particular one trunk which it will attempt to serve in the normal manner. Since the priority "start" leads are not gated by the link frame, the controller must prevent the registration of new bids within the trunk group to which it is now connected and serving. Such new bids may be initiated at a crucial interval. To prevent the registration of such new bids within the group to which it is now connected and serving, the controller operates relay 145-PTC (priority trunk class) subsequent to the operation of relay 136-ATK. On FIG. 115, the break contacts of operated relay 145-PTC function as a gate to prevent the operation of any of the relays 115-T0 through 115-T4 not operated at the time that the controller is cut through to the priority "start" leads of the group selected for service.

After having selected the particular trunk to be served, the controller proceeds to complete its functions of position selection followed by channel selection, and the establishment of a connection thereover between the trunk and the operator in the normal manner.

Since the remainder of the circuit operations associated with the serving of priority calls is analogous to that already described for nonpriority calls, they need not be discussed further.

*Controller tests for ground on sleeves of available links*

All the trunks within a trunk group on a link frame must be of the same type and of the same class. The controller must, at this stage of the connection, be apprised of the type of trunk being served so that an operator position may be selected that is capable of handling the type of traffic served by this trunk. The previously operated D-relay on FIG. 106A, or if a priority request is being served, the previously-operated 85B-D-P relay, in addition to connecting the appropriate trunk "start" leads to the controller, also functions to ground 1-out-of-7



leads to the controller as an indication of the trunk class. These leads are designated CL0 through CL5 and CL6 on FIG. 106B with CL6 lead indicating a "delayed call" class. It is assumed that trunk "00" serves class "0" calls and, therefore, terminals D0 and CL0 on FIG. 106B are cross-connected and, in the manner hereinbefore described, have operated relay 115-TC0. The operation of relay 115-TC0 closes an obvious path to ground on terminal 115-101, to operate check relay 115-TCK. A portion of this path includes the 1-out-of-6 symmetric check circuit comprising the contacts of relays 115-TC0 through 115-TC5 and relay 115-TDC. Relay 115-TCK operates when one, and only one, of these seven relays is operated.

The controller now proceeds to make a test for a premature ground on the sleeve lead of the links which may be used in extending a connection from the calling trunk end of the link connector to the operator position selected to serve the call. The operation of relay 130-AG0 extends a connection from the winding of the sleeve check relay 118-SLK to the sleeve lead corresponding to the selected trunk on the trunk side of the primary crossbar switch unit. This is done prior to progressing further, to test the sleeve lead for false ground. If relay 118-SLK is operated at this time, it will open the operating path of the channel selection relays as hereinafter described. This, in turn, blocks the further progress of the call. The work-timer gas tube circuit (FIG. 138) then will "time out" to cause relay 138-WT to operate, which, in turn, causes relay 129-TR to operate which, in its turn, requests connection to the trouble recorder circuit (FIG. 116), so as to automatically record the existence of this trouble.

Thus, the following circuit is now closed to connect relay 118-SLK to the sleeve lead of trunk "00" on FIG. 86: the winding of relay 118-SLK, break contacts 126-DCT, make contacts 130-AG0, conductor S0 in cable S extending through FIGS. 118, 112, 113, 107C, 100 99, 98, 97, 96, and 86, make contacts 106A-CG0, 106A-TU0 to conductor L00. Conductor L00 is connectable by means of four contacts 86-CP00, 86-CP01, 87-CP02, and 87-CP03 to the primary hold magnets 86-PH0-0, -1 and -2, 86-PH1-0, -1 and -2, 87-PH2-0, -1 and -2, and 87-PH3-0, -1, and -2, for columns "0" through "3" of the three primary "A" switches as well as the hold magnets for the three secondary "A" switches 96-SH0-0, -1 and -2, 96-SH5-0, -1, and -2, 97-SH10-0, -1 and -2, and 97-SH15-0, -1 and -2. If, at this time, the switches are operated as a consequence of the serving of a previous call and due to a present circuit defect, ground from the operator position circuit serving this previous call will now be extended (in a manner to be described) through the crosspoints of the switching network which are erroneously held operated and will be applied to conductor L00 through the crosspoints erroneously held operated. The ground on conductor L00 will then be extended over the circuitry just described to relay 118-SLK, thereby operating it and blocking the further progress of the call.

It is believed that, at this point in the description, a few comments concerning the switching networks shown on FIGS. 73A through 78, 79A through 84, and 92 through 94, together with their relationship to the circuitry of FIGS. 86 through 88, and 96 through 98, will be beneficial and will facilitate an understanding of circuit operations yet to be described. It should be appreciated, as a general proposition, that the interconnection of a calling trunk circuit with an operator position requires the cut through of a varying plurality of leads or conductors, the specific number of leads required on any one call being dependent upon the characteristics of the trunk serving the call, and the maximum number in any event being 17 leads. In addition to a maximum of 17 trunk conductors, the link connector also cuts through to an operator position a conductor which does not extend back to a trunk, but which conductor, however, is individual to each incoming

trunk served by the link. This conductor for trunk "00" is represented as conductor L00 on FIG. 86. The fact that the link connector contains a conductor individual to each incoming trunk and, when serving a trunk to an operator position, extends this conductor through to the operator position accounts for the fact, as may be seen on block diagram FIG. 4, that the cables extending to the operator position are shown as having 18 conductors per circuit, while the cables on the left side of the figure extending to the trunks are shown as having 17 conductors per trunk.

Referring to block diagrams FIGS. 6A-6D, it may also be seen that the output of the switching network extends 18 wires to each loop of each operator position, with the 18 wires being served equally by three tertiary switches each of which cuts through six wires from the secondary switches. Working backwards, the three groups of six wires per circuit are cut through the secondary stage by the three switches respectively designated secondary "A" or "B," switches "0," "1," and "2." The left-hand sides of the secondary switches are connected by links to the right-hand sides of the primary switches as shown on FIGS. 6A and 6B and, therefore, the three groups of six wires each per switch are connected and cut through by the three primary switches designated primary "A" or "B," switches "0," "1," and "2." The left-hand sides of FIGS. 6A and 6B show each trunk circuit extending a maximum of 17 wires to the inputs of the primary switches, with five of the 17 wires going to "primary A switch 0," with a first group of six of these 17 wires going to "primary A switch 1," and with a second group of six of these 17 wires being served by "primary A switch 2." An eighteenth wire, associated with but not extending to each trunk, is not shown on FIGS. 6 since these figures are presented only to show switch relationships and link distributions, and each wire thereon does not represent an individual conductor but, instead, represents a cable or a plurality of conductors. Actually, if FIGS. 6A and 6B were shown in greater detail and were not limited to switch cables and link distributions, they would show the primary "A" switches as extending 18 wires per trunk from the left-hand sides of the switches on FIGS. 6A and 6B to the right-hand sides of the switches. This eighteenth wire, as already mentioned, does not extend to the trunk circuit.

Once again referring to trunk "00," which on FIG. 6A is shown as extending five of its 17 wires to "primary A switch 0," conductor L00 on FIG. 86 is also associated with trunk "00" and, when serving a call on trunk "00," the switching network shown on block diagram FIG. 6 extends a maximum of 18, rather than 17, conductors to an operator position, with 17 of the conductors coming from the trunk circuit itself, and with the eighteenth conductor being conductor L00 on FIG. 86. This conductor L00 is internally connected to the "00" input of rectangle "0" on FIG. 6A for the "primary A switch 0," just as are the five wires extending from trunk "00" to this switch. Therefore, referring only to "primary A switch 0," it cuts through six wires when serving a call on trunk "00," or any other trunk, just as do primary "A" switches "1" and "2." The only difference is that the six wires served by primary "A" switches "1" and "2" all come from the trunk circuit itself, while one of the six wires cut through by "primary A switch 0" does not come from the trunk circuit, even though it is exclusively associated with the trunk circuit.

Recalling the circuit relationships just described, let us now consider the link connector switch arrangement and link distribution shown in greater detail in FIGS. 73A through 78, 79A through 84, and 92 through 94. These figures show the same equipment arrangements disclosed in block diagram FIG. 6. Therefore, in extending a connection from a calling trunk to an operator position, the equipment shown on these figures receives a maximum of 17 wires from the calling trunk, and extends to the



operator position these 17 wires along with an additional wire exclusively associated with the trunk but local to the link connector, for a maximum total of 18 conductors in all. Thus, referring again to trunk "00," the maximum of 17 conductors from this trunk are distributed among the three primary "A" switches, with five of the 17 conductors being connected to "primary A switch 0," a first group of six of the 17 conductors being connected to "primary A switch 1," and with the remaining six of the 17 conductors being connected to "primary A switch 2." As already explained in connection with the block diagram figures, "primary A switch 0" likewise connects through six, rather than five, conductors per trunk, and the additional conductor so connected but not shown on FIG. 73A, is conductor L00 on FIG. 86. Differently stated, the serving of a call on a trunk is accomplished with a "primary A switch 0" on FIGS. 73A, 73B, and 74 cutting through five of the 17 wires from the calling trunk. Yet this crossbar switch has six make contacts per crosspoint which are operated whenever the crosspoint is closed. Five of these six crosspoints are occupied by the conductors on FIG. 73A incoming from the calling trunk. Thus, on FIG. 73B, five of the conductors from trunk L00 are connected to five make contacts of crosspoint "00." The sixth make contact set of this crosspoint serves conductor L00 on FIG. 86, and the extension of this connection through the switch field to an operator position extends conductor L00 through to the operator position, just as are the 17 wires from the calling trunk.

FIGS. 86 through 88, and 96 through 98 disclose the hold magnets for the three primary "A" switches, the hold magnets for the three secondary "A" switches, and diagrammatically indicate the hold magnets for the three primary "B" switches, and the hold magnets for the three secondary "B" switches. These figures also show the sleeve test lead for each trunk which, as described, constitutes the eighteenth wire cut through by the switching network to an operator position on a call, together with the manner in which the hold magnets and the sleeve test leads are connected to each other. Also shown on these same figures is the manner in which the "B" switches of both the primary and secondary stages are connected to the sleeve test leads. The leftmost group of hold magnets on FIG. 86 are designated PH0-0, PH0-1, and PH0-2. These three hold magnets serve the "0" column of "primary A switch 0," "primary A switch 1," and "primary A switch 2," respectively. Similarly, the other group of three hold magnets on FIG. 86 are designated PH1-0, PH1-1, and PH1-2 and serve the column "1" position in "primary A switch 0," "primary A switch 1," and "primary A switch 2," respectively. Referring momentarily to FIGS. 73B and 74, it may be seen that vertical V0 of "primary A switch 0" is connected to vertical V0 of "secondary A switch 0." Therefore, it is quite apparent that the closure of a connection between vertical V0 on FIG. 73B and any of the ten horizontals associated therewith requires the closure of a connection between vertical V0 on "secondary A switch 0" of FIG. 74 and one of the ten horizontals associated therewith if the connection is to be extended further through the switching network. Thus, this being the case, it is necessary that the hold magnet serving vertical V0 on FIG. 73B be operated whenever the hold magnet serving vertical V0 on FIG. 74 is operated, and vice-versa, in order that a connection may be extended through the switching network.

The link distribution between "primary A switch 1" and "secondary A switch 1" and the distribution between "primary A switch 2" and "secondary A switch 2" is the same as that shown in detail for the "0" switches of the primary and secondary stages. Therefore, the hold magnets operate in the secondary "1" and "2" switches whenever the hold magnets operate in the primary switches which are respectively interconnected by links to the secondary switches, as was just described for

switches "0" in the primary and secondary stages. Also, the three hold magnets for corresponding columns of the primary "A" switches should be parallel-connected, so that all three operate simultaneously, inasmuch as the corresponding crosspoints of the three primary "A" switches are connected to and serve conductors of the same trunk circuit. Thus, in view of the considerations just described, the operation of a single hold magnet for "primary A switch 0" simultaneously requires the operation of the corresponding hold magnets in primary "A" switches "1" and "2," as well as the three hold magnets in the secondary "A" switches "0," "1," and "2" to which the verticals served by the operated primary "A" hold magnets are connected via links in the secondary switches. The circuits of FIGS. 86 through 88, and 96 through 98 perform this desired interconnection, since the three hold magnets respectively serving the corresponding verticals in the primary switches are connected in parallel to the parallel-connected hold magnets respectively serving the verticals in the secondary switches to which the verticals in the primary switches are connected by means of their respective links. Thus, the three hold magnets 86-PH0-0, 86-PH0-1, and 86-PH0-2 are parallel-connected, since it is required that the corresponding hold magnets of the three primary "A" switches operate concurrently in serving a call. Also, these three hold magnets are connected to the three parallel-connected secondary hold magnets 96-SH0-0, 96-SH0-1, and 96-SH0-2, which also operate concurrently and serve the three V0 verticals of the three secondary "A" switches. Similarly, the three primary hold magnets 86-PH1-0, 86-PH1-1, and 86-PH1-2 are connected in parallel and are connected to the three parallel-connected secondary hold magnets 96-SH5-0, 96-SH5-1, and 96-SH5-2. The three hold magnets for column "1" (verticals V1) of the primary switches are connected to the three hold magnets for column "5" (verticals V5) of the secondary switches since, as may be seen by referring to FIGS. 73B and 74, verticals V1 of the primary switches are connected to verticals V5 of the secondary switches. The remaining primary hold magnets on FIGS. 86 through 88 are interconnected with the hold magnets of the secondary switches on FIGS. 96 through 98 to implement the link distribution pattern shown on FIGS. 73B through 75.

The vertical of each crossbar switch is associated with and serves ten horizontals. Thus, vertical V0 on FIG. 73B serves the ten levels L0 through L9. The wire V0 extending vertically between FIGS. 86 and 96, and interconnecting the three parallel-connected primary switch hold magnets 86-PH0-0, 86-PH0-1, and 86-PH0-2 and the three parallel-connected secondary switch hold magnets 96-SH0-0, 96-SH0-1, and 96-SH0-2 actually constitutes one of the six conductors in the cable or plurality of conductors associated with vertical V0 on FIG. 73B. The same is true of the interconnections between the remaining primary and secondary switch hold magnets on FIGS. 86 through 88, and 96 through 98. Thus, just as the group of six conductors represented by the cables associated with vertical V0 on FIG. 73B is designated V0, so is the conductor extending vertically between FIGS. 86 and 96 designated V0, which conductor, as above explained, interconnects the hold magnets for verticals V0 of the primary "A" switches "0," "1," and "2" with the hold magnets for verticals V0 of the secondary "A" switches "0," "1," and "2." Conductor V0 on FIG. 86 is connected to the make contacts CP00, CP10 . . . CP90. The make contacts CP00, interconnecting conductor V0 with conductor L00, actually comprise one of the six make contacts constituting crosspoint 00 of "primary A switch 0" on FIG. 73B, but which, to facilitate explanation, are shown separated therefrom. Similarly, make contacts designated CP10, CP90 respectively comprise one of the six make contacts constituting crosspoints 10 and 90 of "primary A switch 0." The remaining make contacts in the series which are not shown in detail are, similarly, re-



lated to the crosspoints of "primary A switch 0," However, only the crosspoints for levels 0, 1, and 9 are shown in detail. These three crosspoints are respectively designated CP00, CP10, and CP90. They are designated in this manner since they afford connections to conductors L00, L10, and L90, serving trunks 00, 10, and 90, respectively. In a similar manner, on FIGS. 86 and 96, the conductor V1 is connectable by means of crosspoints CP01, CP11 . . . CP91 to the ten conductors designated L00, 10 . . . 90. The same relationship exists between the make contacts associated with each of the conductors designated V1 . . . V19, shown on FIGS. 86 through 88, and the correspondingly designated verticals of the primary "A" switches on FIGS. 73B and 74.

Thus, from the foregoing description, it should be appreciated that the closure of any primary "A" switch crosspoints on FIGS. 73B and 74, in addition to cutting through a maximum of 17 conductors for the trunk being served, also cuts through that one of the conductors on FIGS. 86 and 96 which is respectively associated with, and is actually controlled by, the sixth make contact of the six make contacts associated with the closed crosspoint on FIGS. 73B and 74.

In view of the foregoing, it may be better appreciated that, at the time the link connector and controller cooperate to connect the test relay 118-SLK to the L- conductor (on FIG. 86) associated with the trunk currently being served, if for any reason, such as equipment or circuit malfunction, the crosspoints utilized on a previous call are still closed, the L- conductor (on FIG. 86) will be cut through by the operated crosspoints of the primary, secondary and tertiary switching stages to the operator position utilized on the previous call, and the ground supplied by this operator position will now be applied to the L- lead (of FIG. 86), thereby operating relay 118-SLK to block further progress of the call.

Any trunk may be connected to any one of the three operator loops on any one of a maximum of 66 traffic service operator positions. These operator positions are arranged in seven groups, with five of the groups having ten operator positions each, and with the sixth and seventh groups having only eight operator positions. Having selected a trunk and having been apprised of its class, the controller now selects an operator position group which has one or more positions idle and available and capable of handling the traffic offered by the calling trunk. After having selected a position group, the controller bids for connection to the selected group. In bidding for the selected group, the controller competes with all other controllers which can function with the same group. If the controller successfully seizes the desired group, it then locks out all other controllers capable of seizing that group. The controller then extends the negative potential on terminal 133-102, through resistor PG, to one of the PG0-6 leads (FIG. 133) extending to the link frame (FIG. 91) corresponding to the selected group, thereby, in turn, operating the similarly designated one of the relays 91-PG0 through 91-PG6 on the link frame. The controller next selects the most-preferred position that is idle and available in the second group and then seizes it.

Position control circuits, which are associated with the traffic service positions, function to provide the information and to energize the control leads required by controller to set up a connection. The position control circuits are divided into seven groups, with five of the groups having ten position control circuits each and with the sixth and seventh groups each consisting of eight position control circuits. Each of the position control circuits has three "group-idle" test leads which are multiplied to all other position control circuits in the same group. These "group-idle" test leads, designated PG-, RTG-, and DCTG-, are shown on the bottom of FIGS. 152 and 153. They function as follows: (a) The PG- lead is grounded by the position control circuit when the associated operator is available and more than one operator loop is idle.

(b) The RTG- lead is grounded by the position control circuit when the associated operator is available and one or more of the operator loops is idle. (c) The DCTG- lead is grounded by the position control circuit when the associated operator requests a connection to a delayed call trunk. The ground for these "group-idle" test leads is supplied from terminal 104 in FIG. 163. A "group-idle" indicator relay is provided for each position group, respectively designated 152-GI0, 152-GI1, 153-GI2, and 153-GI3 through 153-GI6. For all classes of trunks, other than delay call trunks, the relay 115-TDC is normal and one of the above-mentioned -GI- relays will operate if there is at least one available operator position in the corresponding group, with more than one operator position loop idle. This check is made by connecting the -GI- relays to the corresponding PG- leads of the associated groups of operator positions.

If no -GI- relay operates, the controller then operates relay 152-RT, in a manner hereinafter described, to transfer the operate paths for the -GI- relays from the respectively associated PG- leads to the respectively associated RTG- leads. The -GI- relays will now operate if there is at least one operator position available in the corresponding group, with at least one operator loop idle.

If no group has an operator position available to serve the bidding trunk, the slow-operate group disconnect relay 152-GD will operate. Since the operation of relay 152-GD indicates that there is no operator position available to serve the bidding trunk, and since all trunks in the group being served are of the same type, no trunk can be served. The relay 152-GD functions to disconnect the group being served. The controller will then select for service the group of trunks having the next highest order of preference.

Provision is made for controlling the traffic to one of the traffic service operator positions in each of the position groups "0" through "4." The associated position control circuits will connect the PG- and RTG- leads to the key-control position-control circuits instead of multiplying these leads to the other position control circuits in their respective groups.

The key-control position-control circuit (FIGS. 158 through 161) provides a set of locking keys for each of the positions under its control, with a maximum of five positions. These keys enable the manual selection of the type of traffic acceptable to the controlled operator positions. Each key controls that class of traffic that an operator may be required to handle.

If none of the keys (FIG. 159) associated with a position are operated this circuit will distribute calls to the controlled traffic positions in the same manner as to any other position. If any key is operated, only the type of traffic corresponding to the operated key will be offered to an operator at the controlled position, and all other types of traffic will be excluded from that position. Any of the other keys may be subsequently operated to enable the operator at the corresponding position to handle any desired combination of traffic.

When one of the relays 115-TC0 through 115-TC5 is operated within the controller to indicate the type of traffic being offered by the trunk, a lead is closed through the key-control position-control circuit from the corresponding one of relays 152-TP0 and 153-TP2 through 153-TP4. If a key corresponding to the type of traffic indicated by the operated one of the relays 115-TC- is operated for any of the five controlled traffic positions, the associated -TP- relay on FIGS. 152 and 153 will operate, thereby, in turn, operating the corresponding one of the -GI- relays on the same figures. In this manner, a ground on a PG- lead of the controlled traffic position is passed to the associated -GI- relay only if the type of traffic desired corresponds to the offered traffic. Thus, it may be seen that the relays -GI0 through GI4 may be operated by ground on the PG- or RTG- leads multiplied from regular positions, or by the relays -TP0



through -TP4, respectively, thereby indicating that at least one operator position is available to serve the offered traffic, with no distinctions between regular and controlled traffic positions. Further details of the key-control position-control circuit are described hereinafter.

Let it be assumed, for example, for the present discussion, that all of the relays -GI0 through -GI6 on FIGS. 152 and 153 operate, thereby indicating to the controller that operators are available in all seven groups to serve the present call. The specific circuit paths over which these -GI- relays operate are hereinafter described in connection with the detailed description of the key-control position-control circuit, and the position control circuits.

The controller has no registered the position groups which have at least one operator position available to serve the offered traffic, as indicated by the operated -GI- relays on FIGS. 152 and 153. The controller now selects one of these groups. The selection circuit consists of a closed ring of transfer contacts on the relays 151-GR0 through 151-GR6 in the controller, and on the relays 159-GU0 through 159-GU6 in the key-control position-control circuit. One or more of the relays 159-GU0 through 159-GU6 operated indicates that the corresponding operator position group has been seized by some other controller and, hence, cannot be seized by this one. The entry points of the closed ring of transfer contacts is selected by the group preference relays 127-GP0 through 127-GP6, one of which relays is always operated, in a manner hereinafter described. All that need be understood at the present time is that the particular -GP- relay associated with the preferred group is operated whenever its associated group is preferred for the serving of a call. That one of the relays 151-GR0 through 151-GR6 which is operated is the one which is associated with the most-preferred group currently available to this controller in the serving of the call.

Let it be assumed, for example, that preference relay 127-GP0 is operated to cause the controller to prefer operator position group "0"; let it be further assumed that none of the relays 159-GU0 through 159-GU6 is currently operated, thereby indicating that operator position group "0" is currently not seized by another controller; and let it be additionally assumed that the controller is successful in operating relay 151-GR0. This being the case, the following circuit may now be completed to operate relay 151-GR0: ground on terminal 101 of FIG. 151, make contacts 113-ON, break contacts 126-RS, 137-APS, terminal 151-102, break contacts 154-GA0 through 155-GA6, make contacts 145-GRDK, 151-GADK, 115-TCK, to terminal 151-104. Relay 145-GRDK is a downcheck relay which operates whenever all of the relays 151-GR0 through 151-GR6 are normal. Its operating path is quite conventional, as shown on FIG. 145, and includes a 0-out-of-7 symmetric circuit, indicated by rectangle CK, comprising break contacts of relay 151-GR0 through 151-GR6. Relay 151-GADK is also a downcheck relay and is operated from ground on terminal 151-102 over an obvious circuit shown on FIG. 151. Relay 115-TCK is also a check relay and its operation has been hereinbefore described.

The ground on terminal 151-104 may be extended through break contacts 125-P, series-connected break contacts on preference relays 127-GP6 through 127-GP1, make contacts 127-GP0 (since this relay has been assumed to be operated), make contacts 152-GI0, break contacts 159-GU0 in the key control position control circuit, to the primary winding of relay 151-GR0, to operate it.

In order to prevent the possibility of two controllers trying to set up a connection to the same operator position, the controller circuits are arranged so that seizure of a position group by any controller locks out all other controllers which can function with the same group of operator positions. Referring to FIG. 154 and the left-

hand portion of FIG. 155, it may be seen that certain equipment is associated with each of the operator position groups "0" through "6," the equipment for operator position group "0" being shown in detail on FIG. 154. The equipment for the remaining groups is shown only diagrammatically. The three rectangles designated position groups "1," "2," and "3" are shown on the right-hand portion of FIG. 154, and the three rectangles designated position groups "4," "5," and "6" are shown on the left-hand portion of FIG. 155. Referring now to the equipment for position group "0" (FIG. 154), it may be seen that each controller associated with an operator position contains a GA- relay and a PG- relay, with, for example, the comparable relays associated with the position group "0" being designated GA0 and PG0. The -GA- and -PG- relays in the various controllers associated with the same position are connected in a circuit which prevents more than one controller from seizing the same operator position. Thus, the operation of one of the GR- relays on FIG. 151, as hereinabove described relative to relay 151-GR0, applies a negative voltage to the corresponding -PG- relay through a checking circuit which insures that one and only one -GR- relay is operated. The -PG- relay (e.g., 154-PG0) is chained to all correspondingly numbered -PG- relays of all other controllers which can function with the same position group, so that the last controller has preference. The -PG- relay will operate if the corresponding -PG- relay of associated controllers which have lower orders of preference in this position group are in a nonoperated condition. Thus, the operation of relay 151-GR0, as already described, as controller "0" attempts to seize operator position group "0," closes the following path to operate relay 154-PG0 (center of FIG. 154): battery on terminal 101 of FIG. 154, resistor PG, make contacts 113-ON, the 1-out-of-7 symmetric circuit indicated by rectangle GRK for relays 151-GR0 through 151-GR6 (thereby ensuring that one and only one of these seven relays is operated), make contacts 151-GR0 (since this relay was operated as controller "0" selected position group "0" for the serving of this call), through the winding of relay 154-PG0 to terminal 154-102. The path may be extended leftward from terminal 154-102 through transfer break contacts of the relay 154-PG0 for the last controller associated with this same position group, to ground on terminal 154-103. It may be seen from the path just described that the extension to terminal 154-102 of the ground on terminal 154-103 depends upon the operated or nonoperated condition of relay 154-PG0 in the last controller associated with the position group (e.g., group "0"). If this relay is normal, as was assumed, terminal 154-102 will be grounded. On the other hand, if this relay is operated, terminal 154-102 cannot be grounded and relay 154-PG0 (center of FIG. 154) in the present controller cannot be operated. Also, referring to relay 154-PG0 in the first controller, it may be seen that it will be operated only when the relay 154-PG0 in each other controller associated with this operator group is normal.

The operation of a -PG- relay closes a circuit which operates the associated "group attached" relay -GA-, provided that the -PG- relays in controllers having a higher priority are nonoperated. The -GA- relays are chained through contacts of the -PG- relays of all controllers which can function with the same group of positions in such a manner that the first controller in the chain has the highest preference. The double chain controlling the operation of the -PG- and -GA- relays ensures the lockout of all but one controller from any group of positions. Thus, referring to relay 154-GA0 for the present controller, the operation of relay 154-PG0, as described, extends a connection from one side of the winding of relay 154-GA-, through transfer make contacts 154-PG0, to terminal 154-104. The circuit may be further extended to the right through transfer break contacts 154-PG0 of the relay 154-PG0 in the first con-



troller to ground on terminal 154-105. The successful extension of a connection from terminal 154-104 to ground on terminal 154-105 closes the circuit to operate relay 154-GA0 (center of FIG. 154). The operation of a -GA- relay in this circuit (e.g., 154-GA0) grounds the corresponding GU- lead in cable GU, to the key-control position-control circuit, causing the operation of a "group unavailable" relay 159-GU-, which, in operating, controls the selection of a 154-GR- relay, as hereinabove explained. Thus, the following circuit is now closed to operate relay 159-GU0, thereby indicating to all other controllers the unavailability of group "0": ground on terminal 106 of FIG. 152, make contacts 154-GA0, conductor 154-GU0 in cable GU through FIGS. 152, 161, and 159, to the winding of relay 159-GU0 to operate it.

Relay 151-GR0, in operating, completes the following locking path for itself: ground on terminal 151-102 as formerly described, terminal 151-103, through series-connected break contacts of relays 155-GA6 through 154-GA1, to the secondary winding of relay 151-GR0, through make contacts 154-GA0 and 151-GADK, through resistor GR, to negative battery. Thus, the successful connection of this controller to position group "0," as manifested by the operation of relay 154-GA0, completes the aforementioned locking circuit for relay 151-GR0.

The operation of relay 154-GA0 closes the following path to operate relay 133-GC0: ground on terminal 133-101, make contacts 113-ON, 154-GA0, to the winding of relay 133-GC0 to operate it. The operation of relay 133-GC0 closes the following circuit to operate relay 91-PG0: negative battery on terminal 102 of FIG. 133, resistance PG, make contacts 133-GC0, conductor PG0 in cable PG extending through FIGS. 133, 127, 121, 115, 108B, 102, 92 and 91, make contacts 106A-CE0 to the winding of relay 91-PG0 to operate it. The operation of relay 133-GC0 also completes the following path to operate relay 158-TCA0 in the key-control position-control circuit: ground on terminal 102 of FIG. 158, break contacts 115-TDC, make contacts 133-GC0, and conductor TCA0 to the winding of relay 158-TCA0 to operate it.

The position control circuit is disclosed on FIGS. 162 through 204, and 222. An individual one of these circuits is provided for each operator position circuit. Referring to FIG. 163, the position control circuit provides a set of idle test leads designated P-, RT-, and DCT- in the lower right-hand corner of the figure, which leads indicate the availability of the individual positions in the following manner: (a) A negative voltage is placed on the P- lead by the position control circuit when the associated operator is available and more than one operator loop is idle. (b) A negative voltage is placed on the RT- lead by the position control circuit when the associated operator is available and one or more of the operator loops is idle. (c) A negative voltage is placed on the DCT- lead by the position control circuit when the associated operator requests connection to a "delayed call" trunk, as is described in detail hereinafter.

When relay 154-GA0 operated, thereby indicating that position group "0" had been seized by the controller, the corresponding 133-GC0 relay operated. This relay, in turn, performs the following functions: (a) It operates the corresponding relay 91-PG0 in the link and connector circuit, which connects the controller to the sleeve lead of the linkages between the secondary and tertiary cross-bar switches which can be used to connect to the chosen position group. The controller will then subsequently test for a "busy" on these leads, as is described in detail hereinafter. (b) It operates a relay in the key-control position-control circuit which serves to connect the individual position control circuit busy test leads associated with the proper position group to the controller as follows: relay 133-GC0, in operating, causes the operation of the associated relay 158-G0D if the current call were a request from a "delayed call" trunk. Also, the operation of re-

lay 133-GC0 causes the operation of relay 158-TCA0 if the current request is from any other type of trunk, such as, for example, the present call, in which event relay 158-TCA0 is operated over the circuits hereinabove described. In addition, relay 133-GC0 operates relay 158-RT0 in the key-control position-control circuit if this is a "reserve test" call. The operation of relay 158-RT0, in turn, connects the correspondingly numbered P- and RT- leads of the position control circuit, and of the proper group, together (FIG. 161). This is described in greater detail hereinafter. (c) If the -TP- relay (on FIG. 152 or 153) associated with the chosen position group is operated, relay 133-GC-, in operating, will complete a connection from negative voltage (FIG. 161), through the key-control position-control circuit and back to the controller, over the proper P- lead, to indicate that this position is idle. The reason for connecting this lead back to the key-control position-control circuit is that the key-control position-control circuit must provide a set of cross-connections to associate the several TP- leads with their respective proper position "units" within the associated group.

At this point, there will be a brief digression from the description of the call currently being described to permit the discussion of certain features of the key-control position-control circuit shown on FIGS. 158 through 161, all of which features are not utilized on each and every call.

The key-control position-control circuit is used to permit placement of calls of specified classes only, under key control, to a maximum of five positions of an operator position group for transmitting purposes.

In each of the five first subgroups of ten operator positions, one position may be used as a controlled traffic position. This circuit provides five sets of keys, each set being associated with one of the controlled traffic positions. Each key represents a class of call that an operator may be required to handle. Operation of a key permits only calls of that class to be connected to the controlled traffic position. In this way, an operator in training may learn an operating procedure without being bothered by other classes of calls which may require different operating procedures. As the training of the operator progresses, more keys may be operated to permit additional classes of calls to be connected to the trainee's position. Thus, the circuit selectively limits the particular classes of calls which may be connected to a controlled traffic position.

Since these operators may not be available to serve all classes of calls, "position busy" information is sent to the traffic regulator circuit on a class basis. Another feature incorporated in this circuit is a "position group unavailable" (GU) indication. The GU indication enables a controller to select the most-preferred available position group. This method of operation makes it unnecessary for a controller to wait if another controller should have previously seized its most-preferred group.

Referring to FIG. 159, the keys AK1 through AK7 are associated with a controlled traffic position in controller position group "0." In a like manner, the keys BK-, CK-, DK- and EK- are associated with controlled traffic positions in operator position groups "1," "2," "3" and "4," respectively. The operation of any one of these keys causes the operation of the one of the relays 159-TPA through 159-TPE respectively associated therewith, and the lighting of the respectively associated, and like-designated, lamp. The function of these relays is to intercept the idle indicating leads and to transmit idle indications to the controller, depending on which of the keys is operated. The functions of the TP- lamps, which are located on the key cabinet, is to indicate in the operating room that the traffic offered to the associated positions is being controlled. No provision is made for controlling traffic to any positions in groups "5" or "6."

Referring to FIG. 160, the position grounds the RTG- and PG- leads and, referring to FIG. 161, places battery



on the P- and RT- leads when more than one of the operator loops are available and the position is idle. When only one operator loop is available and the position is idle, only the RTG- and RT- leads have the signals. When no loops are available, or the position is busy, the signals are removed from all leads. The operation of the TP- relay on FIG. 159, say for example, relay 159-TPA, which is associated with operator group "0," opens the PGG0 lead on FIG. 160 to the controller and connects the PG- lead from the position control circuit associated with operator group "0" to the winding of relay 160-PGA. Relay 160-PGA will operate whenever two or three operator loops are available and the position is idle, because of the potentials put on the PG- lead by the associated position control circuit. Since it is not desirable to have a training operator handle more than two calls at a time, the RTG- lead from the position control circuit extending to the controller, via the RTG0 lead for position "00," is opened at break contacts 159-TPA. The opening of this path prevents the application of that potential to conductor RTG0 which would normally be there when only two of the operator loops are busy, and would thereby enable a call to be served to the third loop. However, the opening of the RTG- lead makes it appear to the controller that all three loops are busy and, therefore, no further calls will be offered to this position. The removal of ground from the PG- lead from the position control circuit, as a consequence of two loops being busy, causes the release of relay 160-PGA and indicates that the training position is either busy or that two operator loops are unavailable. This is true because the position applies ground to the PG- lead when two or more of the operator loops are available and the position is idle. Therefore, the removal of the ground from this lead indicates that not more than one loop is available.

Referring to FIG. 160, respectively connectable to each of the leads RTG0 through RTG6 from the controller is a corresponding one of the relays 160-RTG0 through 160-RTG6. The operation of relay 160-RTG0, for example, informs the traffic regulator circuit that the corresponding position group has at least one regular position serving all classes of calls. The particular circuit over which this relay operates is described in greater detail hereinafter. Briefly, however, it operates due to the following considerations. First of all, the RTG- lead of each position which is not a training position is not connected to the key-control position-control circuit but, instead, is run directly from the position control circuit to the controller. The controller, in turn, by means of circuitry internal to it, returns the RTG- lead for the nontraining positions to the RTG- lead on FIG. 160. Thus, referring only to operator position group "0," the nine positions of this group which are not training positions will have their respective RTG- leads connected in common and run through the controller, and then back on the RTG0 lead from the controller to relay 160-RTG0.

The above-mentioned indication to the traffic regulator circuit that the corresponding position has at least one regular position serving all classes of calls is provided by the circuitry on the right-hand side of FIG. 159. This indicating circuitry comprises leads PCA0 through PCA5, make contacts of relays 160-RTG0 through 160-RTG6, and make contacts of relays 158-TC00 through -TC05, -TC10 through -TC15, -TC20 through -TC25 . . . -TC40 through -TC45. Thus, it may be seen that the operation of any relay 160-RTG-, grounds all of the conductors PCA0 through PCA5, thereby indicating to the traffic regulator circuit that all types of traffic may be served; while in the event that none of the relays 160-RTG- are operated (as would be the case for the condition when all regular operators are unavailable or busy), the grounds on conductors PCA0 through PCA5 will be dependent upon the type of traffic, if any, that the associated training position may serve. Thus, referring to group "0," assume that on FIG. 158 the keys AK2 and AK7 are operated,

thereby operating relays 158-TC00 and 158-TC05, respectively. Referring again to FIG. 159, the operation of relay 158-TC00 applies a ground to conductor PCA0, thereby indicating that type "0" traffic may be served; while the operation of one of the relays 158-TC05 through 158-TC45 applies a ground to conductor PCA5, thereby indicating that type "5" traffic may be served. Referring now to FIG. 158, ground is closed through all operated keys of a set and through the make contacts of the associated operated relays 160-PG-, to the windings of the respectively associated relays 158-TC-. The operation of one of the 158-TC- relays, say relay 158-TC00, for example, grounds conductor TC00 (FIG. 152) extending back to the controller. When a controller registers that a particular class of trunk requests a connection to a position, it connects one of its -TP- relays on FIGS. 152 and 153, such as for example, relay 152-TP0, through make contacts of one of the relays 115-TC0 through 115-TC5 (which represents the class of the incoming call), to a TC- lead in each position group in the key-control position-control circuit, such as leads TC00 through TC05. If this particular TC- lead is grounded, the -TP- relay (FIGS. 152 and 153) will operate, thereby indicating that the control traffic position of that group can receive the class of call currently being served.

After having ascertained what position groups have idle positions, the controller, as hereinbefore described, selects one of these groups; and for the present call it was assumed that operator group "0" was selected. The controller, it will be remembered, then operated group relay 158-TCA0, which relay is associated with selected group "0." Referring to FIG. 161, at the same time, the controller relay 152-TP0, which is associated with selected group "0," if operated, extends negative battery on FIG. 161 from terminal 161-101, through the TP resistor, make contacts 133-GC0, 152-TP0, conductor TP0, and transfer make contacts 159-TPA, to terminal 161-PAA. Since any one of the ten positions of any of the first five operator position groups can be designated as a controlled traffic position, a cross-connection field is provided. Referring to FIG. 161, the P- leads from the 66 positions are respectively connected to the 66 terminals P00 through P65; thus, for example, lead P00 (in cable P) from position "00" is connected to terminal P00 on FIG. 161. The P- terminal associated with the controlled traffic position in its group is cross-connected to the PA terminal if it is in group "0," to the PB terminal if it is in group "1," to the PC terminal if it is in group "2," to the PD terminal if it is in group "3," and to the PE terminal if it is in group "4." Thus, assuming position "00" to be a training position, its lead P00 is connected to terminal P00 which, in turn, is cross-connected to terminal PA. Assuming, also, that position 65 is a training position, its lead P65 is connected to terminal P65 which, in turn, is cross-connected to terminal PE, since position 65 is in group "4."

All P- terminals (FIG. 161) associated with positions which are not training positions are cross-connected directly to the associated P-A terminal on the left-hand side of FIG. 161. Thus, for example, terminal P- on the right-hand side of FIG. 161 is cross-connected directly to terminal P-A on the left-hand side of the same figure. The PAA terminal on the left-hand side of FIG. 161 is cross-connected to the P-A terminal (in this case, terminal P00A), associated with a controlled traffic position in group "0." In a like manner, the PBA, PCA, PDA, and PEA terminals (as exemplified by PEA) are cross-connected to the P-A terminals associated with the controlled traffic positions in groups "1," "2," "3" and "4," respectively.

The operation of one of the relays TAC0 through TAC6 on FIG. 158, such as for example, relay 158-TCA0 for group "0," closes ten P- leads to the controller. For group "0" the ten leads would be designated P00 through P09 if the operator positions in the group are



in numerically sequential order. Nine of the leads P00 to P09 have battery connected from the position circuit when it is idle. The controlled traffic position for group "0" is position "00" and, therefore, the corresponding P-- lead therefrom is P00. The lead P00 is opened by the transfer break contacts of relay 159-TPA on FIG. 161, and battery is supplied to lead P00 by the controller relay 152-TP0, as hereinbefore described. These P-- leads complete paths to operate P- relays in the controller. The controller selects one of these positions and proceeds to connect the trunk to the selected position. It can be seen that an idle controlled traffic position capable of serving a particular class of calls received by the controller still competes with other idle positions of its group to serve the call.

Referring to FIG. 159, the operation of the keys AK1, BK1, CK1, DK1 and EK1 causes the operation of the respective associated relays TPA, TPB, TPC, TPD and TPE relays, as hereinabove described. The operation of a -K1 key, such as for example 159-AK1, has the further effect of disconnecting the ground on terminals 159-101 from conductors CAEX in cable CA extending through FIGS. 159, 161, 152, 153, and 163 to the relay 163-CAEX in the associated controlled position. This prevents the operation of a -CAEX relay in the position control circuit and permits the controlled traffic position to serve CAMA calls.

When a controller tests for an idle group of operator positions and finds that all operators are busy, or that more than one of the operator loops are busy, as indicated by the absence of a ground on the associated PG-- lead of FIGS. 152 and 153, it operates relay 152-RT. The operation of relay 152-RT connects each RTG- lead to its respectively associated group idle (GI-) relay. Thus, for example, on FIG. 152, lead RTG0 is now connected by means of make contacts of relay 152-RT, and through other hereinbefore-described circuitry to the winding of group idle relay 152-GI0. The presence of ground on an RTG- lead indicates that at least one of the ten positions in the group is idle and has a third operator loop available. The controller then selects a group with an idle position and, as hereinbefore described, operates the associated RT- relay on FIG. 158. The operated RT- relay, in a manner hereinabove described, connects the ten RT-- leads on FIG. 161 to their respective corresponding P-- leads, and those P-- leads (in bracket on left-hand side of FIG. 161) that have battery connected to them are connected through cross-connections, transfer break contacts 159-T-, other cross-connections, make contacts 158-TC--, cable P' extending through FIGS. 161, 152, 148, 142, 136, 137, 131, and 125, make contacts 133-GC-, and break contacts 137-PGTA to the windings of the respectively associated P- relays of FIG. 125 in the controller, to operate them. The controller then selects one of these positions and proceeds to connect the trunk to the selected position. A controlled traffic position would not indicate that it is idle under this condition since the RTG- and the P- leads are opened by the operation of the associated TP- relay of the controlled position.

When an operator desires to set up a connection on a delayed call basis, the position must, first, be made to appear "busy" to incoming calls at the link appearances. To do this the operator operates the make busy key in that position (FIG. 205). This key in the position causes the operation of relays 168-MBA and -MBB which, in turn, causes the opening of its associated P-- and RT-- leads the operation of relay 168-MBA releases relay 163-PGT, which, in turn, causes the opening of its associated leads PG- and RTG-. The opening of these associated leads prevents any other class of call from being connected to this position. Next, the operator must operate an access key (ACS- on FIG. 216) on an idle operator loop. This key operation sends a seizure signal to the "delayed call" trunk allotter circuit which selects an idle "delayed call" trunk. The seized trunk initiates a "start"

signal to the position link connector, as any other trunk does, and it is eventually associated with a controller. The controller is apprised that this is a delayed class call, thereby operating the 115-TDC relay, in a manner explained in detail hereinafter. The operation of relay 115-TDC transfers the "group idle" (GI-) relays of FIGS. 152 and 153 from their respective PGG- leads to their respective DCTG- leads. Only a position having the ACS key operated has a ground on its DCTG- lead, the presence of which ground forces the controller to select the group associated with this position. The controller then causes the operation of a G-D relay, such as for example, relay 158-G0D which, by the closure of its make contacts on FIG. 161, connects the corresponding one of the ten position DCT-- leads of the selected group to the corresponding P-- lead in the controller. Thus, for example, the operation of relay 158-G0D would close a path through make contacts 158-G0D on FIG. 161 to interconnect the conductor P00 to conductor DCT00. Only the position in which an ACS- key was operated has battery on its DCT-- lead. The presence of battery on the lead DCT-- causes the operation of the associated relay 125-P0, FIG. 125, in the controller. The controller proceeds to connect the "delayed call" trunk to this position.

The operation of an RTG- relay on FIG. 160 indicates that at least one position in the associated position group, other than the controlled traffic position, if any, is idle and available. The operation of the TC-- relay, such as for example, TC00 of FIG. 158, as hereinbefore described, indicates whether or not an operator at a controlled traffic position can handle a particular class of call. A contact of each relay 160-RTG- is connected in multiple with contacts of the relays 158-TC--, and ground is extended therethrough to the traffic regulator circuit over the leads PCA0 through PCA5 in the bracket on the right-hand side of FIG. 159. Ground on any of these leads indicates that at least one position is idle and available which can handle a call of the indicated class.

Whenever a controller position group is seized by a controller, the controller grounds the associated GU- lead to operate the associated one of the relays 159-GU0 through 159-GU6. Thus, for example, relay 159-GU0 would be operated in the event that a controller has seized operator position group "0." This relay, in operating, in turn passes information back to the other traffic service position controllers, via the contacts 159-GU0 through 159-GU6 shown on FIG. 151 of the controller, thus causing these controllers to skip the position group which has been made "busy" when making a group selection. This concludes the detailed description of the key-control position-control circuit.

It will now be described how an indication of the available positions of the selected group is registered in the controller. Referring now to FIG. 125, the operation of relay 133-GC0 connects the ten position "units" "busy test" leads, corresponding to the ten positions which comprise the selected group, to the windings of relays 125-P0 through 125-P9. A negative potential will now be found on the leads corresponding to those positions within the group which are available to serve the offered traffic, thereby causing the operation of the associated relay 125-P-. For example, let it be assumed that positions "00," "01," and "09" of operator group "0" are all currently available to serve calls. This being the case, the circuitry of FIG. 161 will cause negative battery to be applied, via cable P', to conductors P00, P01 and P09 on FIG. 125, thereby operating relays 125-P0, -P1, and -P9 through make contacts of relay 133-GC0. The controller distributes calls to positions by means of a descending-order closed-ring preference arrangement. Therefore, the controller now attempts to pick a position whose "units" designation is numerically equal to or lower than the preferred "units" designation. If the "units" number of any one of the available positions is numerically



equal to or lower than the "units" preferred, the parallel-connected position gate relays 137-PGT and 137-PGTA will operate. Referring to FIG. 137, the contacts of relays 128-PP0 through 128-PP9 are associated with a position-preference circuit whose operation is hereinafter described in detail. The essential facts to be understood at this point are that one of these relays is always operated and that the operated relay signifies the preferred position for receiving a call. Let it be assumed, for the time being, that relay 128-PP0 is operated, thereby indicating that position "00" is preferred. Since, as has hereinbefore been discussed, the controller has already indicated a preference and has preliminarily connected itself to position group "0," the operation of position preference relay 128-PP0 thereby signifies that position "00" is currently preferred. Also, it has been assumed that relays 125-P0, -P1, and -P9 are currently operated, thereby indicating that positions "00," "01," and "09" of group "0" are currently available for the serving of calls. By means of circuit operations which have hereinabove been described, the ground on terminal 101 of FIG. 137 may now be extended through break contacts 126-RS, make contacts 115-TCK and break contacts 128-PKA to terminal 137-104. The ground on terminal 137-104 may now be extended through make contacts 125-P0, since position "00" is currently available for the serving of calls, make contacts 128-PP0 (since position "00" is currently preferred), and break contacts 137-APS, to the parallel-connected windings of relays 137-PGT and 137-PGTA, thereby operating them.

The ground on terminal 137-104 may also be extended through make contacts 125-P1 and 125-P9, since positions "01" and "09" in group "0" are also currently available. The grounds extended through the latter two contacts cannot be extended to the right beyond transfer break contacts 128-PP0 which are currently open. However, the ground extended through make contacts 125-P1 may now be extended leftwards through series-connected transfer break contacts of the 128-PP- and 125-P- relays, but the circuit is opened at transfer break contacts 125-P9. Similarly, the ground extended through make contacts 125-P9 may now be extended leftward through transfer break contacts 128-PP9 and 137-CAP, break contacts 137-PGT, and transfer break contacts 157-FAP, to the winding of relay 137-APS, in an attempt to operate it before the time that relay 137-PGT operates. Thus, it may be seen that, with relays 125-P0, -P1, and -P9 operated and with relay 128-PP0 operated, the ground on terminal 137-104 is extended through the make contacts of relays 125-P1 and 125-P9 in an attempt to operate relay 137-APS, while the ground on the same terminal is simultaneously extended through the make contacts of relays 125-P0 and 128-PP0 and through the break contacts of relay 137-APS in an attempt to operate parallel-connected relays 137-PGT and 137-PGTA. Relays 137-PGT and 137-PGTA operate much faster than relay 137-APS; and, therefore, even though circuit paths exist simultaneously to operate the relays 137-PGT, 137-PGTA, and 137-APS, relays 137-PGT and 137-PGTA operate (concurrently) first, and, by means of break contacts 137-PGT in the operating with relay 137-APS, opens the circuit for relay 137-APS and thereby prevents its operation.

From the foregoing, it may be seen that the circuitry provides a means whereby relays 137-PGT and 137-PGTA may be operated, provided a position is currently available whose "units" designation is numerically equal to or lower than the numerical designation of the preference relay. On the other hand, if no such position is available, and if the only position available is one having a "units" designation numerically higher than the numerical designation of the operated preference relay, relay 137-APS will operate and, in operating, will open the operating path of relays 137-PGT and 137-PGTA and will cause the controller to attempt to connect to a new operator

group, as determined by the following considerations. On FIG. 151, the break contacts of operated relay 137-APS will open the path interconnecting the ground on terminal 151-101 with terminal 151-102, thereby disconnecting ground from the secondary windings of relays 151-GR0 through 151-GR6 which, in turn, will release the operated one of the relays 151-GR0 through 151-GR6. Referring now to FIG. 127, relay 137-APS, operated, extends the ground on terminal 127-101 through make contacts 137-APS to the group preference circuit comprising relays 127-GP0 through 127-GP6, thereby preparing a path whereby the preference circuit may advance by releasing the currently operated 127-GP- relay and operating a different one of the 127-GP- relays. Relay 137-APS ultimately releases, thereby permitting the circuitry of FIG. 151 to operate a different one of the relays 151-GR0 through 151-GR6 in accordance with the newly shifted group preference, as determined by the transfer make contacts of the newly operated 127-GP- relay.

The operation of relay 137-PGTA opens break contacts 137-PGTA of FIG. 125 to open the operating circuits for relays 125-P0, 125-P1, and 125-P9. Relays 125-P1 and 125-P9 release, but relay 125-P0 remains operated over the following circuit: ground through relay winding 125-P0, transfer make contacts 125-P0, make contacts 128-PP0, break contacts 128-PK and 157-PBT in parallel, make contacts 136-ATK, through the winding of relay 125-P to negative battery. Relay 125-P0 remains operated over this circuit and, in addition, causes relay 125-P to operate. The circuitry on FIG. 125, involving the contacts of relays 125-P0 through -P9, and 128-PP0 through -PP0, enables an operated P- relay, such as 125-P0, to remain operated in series with relay 125-P, provided its numerical designation is equal to or lower than the numerical designation of the operated 128-PP- relay, such as for example, 128-PP0. Thus, referring to the circuit conditions hereinbefore assumed, whereby relays 125-P0, 125-P1, and 125-P9 are operated while relay 128-PP0 is operated, it may be observed from a study of the circuitry on FIG. 125 that only relay 125-P0 remains operated in series with relay 125-P, since its numerical designation is equal to that of the relay 128-PP0; while relays 125-P1 and 125-P9 release, since their respective numerical designations are higher than that of relay 125-P0.

The controller now proceeds with the operation of seizing an operator position. The operation of relay 137-PGT, and the subsequent release of all but the selected one of relays 125-P0 through -P9, closes the following circuit on FIG. 157 to operate relay 157-P0K: ground on terminal 157-101, make contacts 113-ON, through the 1-out-of-10 symmetric circuit comprising the make and break contacts of relays 125-P0 through -P9, indicated by rectangle PK, and thence (in the event that one, and only one, of these ten relays is operated) the circuit is completed via the upcheck lead UK and transfer make contacts 137-PGT to the winding of relay 157-P0K, to operate it. The operation of relay 157-P0K closes the following circuit on FIG. 125 to operate relays 125-P0B and 125-P0A: ground on terminal 125-102, make contacts 157-P0K, 125-P0, to the respective windings of relays 125-P0A and 125-P0B, thereby operating them. The operation of relay 125-P0A, in turn, closes the following path to operate relay 125-P0C: ground on terminal 101 of FIG. 125, make contacts 125-P0A, to the winding of relay 125-P0C to operate it.

Referring now to FIG. 148, the operation of relay 133-GC0, as hereinbefore described, closes the following path to operate relay 148-CL3: ground on terminal 101, make contacts 133-GC0, to the winding of relay 148-CL3 to operate it.

The operation of relay 137-PGT, as hereinabove described, closes the following downcheck circuit involving the link channel relays to operate relay 144-CDK: ground on terminal 144-101 of FIG. 144, through make contacts



113-ON, 137-PGT, transfer break contacts 144-NCM, terminal 144-102, upwards to terminal 144-103, leftwards through the series-connected transfer break contacts of the various channel relays 144-C-- shown at the top of FIG. 144, to terminal 144-104, to terminal 143-101 of FIG. 143, leftwards through the series-connected transfer break contacts of the channel relays 143-C-- shown at the top of this figure, to terminal 143-102, to terminal 142-101 of FIG. 142, through the series-connected transfer break contacts of the channel relays 142-C-- shown at the top of this figure, terminal 142-102, downwards to terminal 142-103, terminal 142-104, to terminal 143-103 on FIG. 143, to terminal 144-105 on FIG. 144, through the transfer break contacts 144-CDK, and through break contacts 142-CHA, to the winding of relay 144-CDK to operate it. Relay 144-CDK, in operating, closes an obvious holding circuit for itself to ground on terminal 102 of FIG. 144.

FIG. 157 discloses a connector circuit whereby connections from the winding of relay 157-PS, the winding of relay 157-PBT, and the battery potential on terminal 157-102 may be extended to any of the 66 operator position control circuits, each of which control circuits is individually and exclusively associated with one of the operator position circuits. Thus, since there are assumed to be 66 operator position circuits in the present disclosure, there are, similarly, 66 position control circuits, with the position control circuit for position "00" being shown on FIGS. 162 through 204 and 222 of the drawings. The 65 remaining position control circuits respectively associated with the remaining 65 operator position circuits are not shown, for reasons of economy in presentation. The operator position that is to serve the next call may be uniquely defined by the operation of one of the relays 133-GC0 through 133-GC6 such as for example, relay 133-GC0, and the operation of one of the relays 125-P-A or 125-P-B, such as for example, relay 125-P0A. The operation of the 133-GC- relay indicates the number of the operator group, while the operation of the relay 125-P-A or 125-P-B indicates the number of the selected operator position within the group. Thus, since it has been assumed, for example, that operator position "00" will serve the present call, it has also been hereinbefore described how, for example, relays 133-GC0 and 125-P0A are operated to prepare the circuit for extending the call to operator position "00." The battery potential on terminal 102 of FIG. 157 may be extended through resistor R and make contacts 157-P0K to terminal 157-103. Terminal 157-103 is connectable by means of make contacts of the relays 133-GC0 through 133-GC6 to the make contacts of the 125-P-A and 125-P-B relays. The contacts of these relays are, in turn, connected to the PC-conductors extending to the various position control circuits, of which only the position control circuit for position "00" is shown. Thus, negative battery on terminal 157-103, with relay 133-GC6 operated, may be extended to one side of the make contacts of the indicated 125-PP-B relays, the other side of which make contacts are connected to the eight PC- leads extending to the eight position control circuits comprising group "6." These eight PC- leads are all represented by a single conductor, and the eight contacts of the eight 125-P-B relays are all represented by a single contact, for economy of disclosure. With relay 133-GC0 operated, as hereinbefore described, negative battery on terminal 157-103 may be extended through make contacts 133-GC0 to the make contacts of relays 125-P0A, 125-P1A, and the remaining 125-P2A through 125-P9A relays. The other side of these make contacts are connected to the PC- leads extending to the ten operator positions comprising the "0" group. It has been assumed that relay 125-P0A is operated, since the call is to be extended to operator position "00" and, therefore, the negative battery on terminal 157-103 may be extended through the series-connected

make contacts 133-GC0 and 125-P0A to conductor PC- in cable PCC extending through FIGS. 157, 167, 166, 165, 164, and 163 to terminal 163-101 of FIG. 163 of the position control circuit for operator position "00." The battery potential on terminal 163-101 may then be extended through transfer break contacts 195-CCW, 169-T, 167-PBB, 167-PBA, 167-TBB, 167-TBA, 168-MBA, 197-ACS, 176-PDA, and transfer make contacts 168-P0 to the winding of relay 163-PLC to operate it. Relay 163-PLC, in operating, closes an obvious circuit to operate relay 163-PLCA. The operation of relay 163-PLCA extends the ground on terminal 102 of FIG. 163 through make contacts 163-PLCA, conductor NBY- in cable PCC extending to FIG. 157 of the controller, make contacts 133-GC0, break contacts 157-PBT to the winding of relay 157-PS to operate it and thereby indicate to the controller that the position control circuit was idle and has now been seized. If the position control circuit had become busy after the operation of relay 125-P, the subsequent operation of one of the relays 169-T, 167-PBA, 167-PBB, 167-TBA, 167-TBB, 197-ACS, or 176-PDA, at the transfer make contacts thereof, would have transferred the negative potential on terminal 163-101 to lead PBY-, in cable PCC, which potential would then be extended over obvious circuitry on FIG. 157 to operate relay 157-PBT. The manner in which relay 157-PBT would operate and the circuit operations ensuing therefrom are described in detail hereinafter.

The operation of relay 157-PS resets the position "group" and "units" preference circuits of the controller, as described hereinafter, and completes a circuit on FIG. 125 to lock relay 125-P in series with the winding of relay 125-P0, over circuitry excluding the contacts of the preference relays 128-PP0 through 128-PP9, and including the transfer make contacts of relay 125-P0, the series-connected transfer break contacts of relays 125-P1 through 125-P9, make contacts 167-PBT, 137-CAP, 157-PS, 125-P, and 136-ATK.

If the operator position is found to be busy for any reason at the time that a negative voltage is connected to the PC- lead to the position control circuit, that circuit will then place a negative voltage on the PBY- lead instead of the NBY- lead to the controller, thereby causing the controller relay 157-PBT to operate instead of relay 157-PS. Relay 157-PBT, operated, causes the position "units" preference order to be lowered by one digit less than the position "units" just selected. This starts a sequence resulting in: (a) the release of all relays associated with the selected positions "units"; (b) a second busy test to determine which positions within the group other than the one previously selected are available, followed by position selection and seizure in the normal manner, as already described.

The operation of relay 157-PS, as a consequence of the seizure of the position control circuit, also closes the following circuit on FIG. 133 to operate relay 133-GCA0: ground on terminal 133-108, make contacts 157-PS, make contacts 133-GC0, to the winding of relay 133-GCA0 to operate it. The operation of relay 133-GCA0 assists in the transmission of the trunk connector number to the position control circuit, as hereinafter explained with reference to FIG. 150.

Trunks which are served by operators are divided into ten groups, on an office basis, and are referred to as trunk groups. These trunk groups are numbered from "0" through "9." There are ten trunk groups on any link frame, each of which groups is assigned a trunk connector number which corresponds to the trunk group number. For example, all trunks in trunk group "4" are served by trunk connector "4." Similarly, all trunks in group "0" are served by trunk connector "0." When the controller is in the process of setting up a trunk-to-operator-position connection, it transmits the trunk connector number to the position. The trunk connector number for the present



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call is "0," since the calling trunk is in trunk group "0." It will be recalled that relay 130-AGA0 operated as a consequence of the selection of group "0." The circuit on FIG. 150 translates a 1-out-of-10 code indication of relays 130-AGA0 through 124-AGA9 to a 2-out-of-5 code indication for transmitting the trunk connector number to the position control circuit. Thus, with the operation of relay 130-AGA0, the ground on terminal 101 of FIG. 150 may be extended through the make contacts of this relay, the break contacts 115-TDCA, and make contacts 133-GCA0 to conductors DGN4 and DGN7 in cable DGN, thereby signifying a "0" in the conventional 2-out-of-5 code. The grounds on these conductors in cable DGN are extended through FIGS. 150, 154, and 164, through make contacts 163-PLCA, and through make contacts 169-T0B, -T1B or -T2B, to the windings of relays 164-0DN4 and 164-0DN7, or 164-1DN0 and 164-1DN7, or 164-2DN4 and 164-2DN7, respectively, of the position control circuit, thereby registering a trunk connector number of "0" in 2-out-of-5 code form in the position control circuit.

In ensuing paragraphs, it will be described how the controller establishes and checks an available channel through the link connector frame. The controller, having selected a position to serve the calling trunk, must now set up a connection through the crossbar switches on the link frame to connect the calling trunk and the selected operator position. Each link frame is composed of primary, secondary, and tertiary crossbar switch groups. The linkages connecting the primary and secondary switches are arbitrarily designated as the "A" links, while the linkages connecting the secondary and the tertiary switches are designated the "B" links. The primary switches are divided into "A" and "B" groups, with each group providing four of the linkages available to serve the selected trunk. Therefore, the trunk to be served may use any of the eight "A" links which it shares with all other trunks having the same "units" designation.

When the trunks "units" to be served is chosen, the link frame connects the sleeve leads of the eight "A" links associated with this trunk to the controller for test purposes. Referring now to FIG. 118, the sleeve leads of the four "A" links associated with the "A" group of primary switches are designated AL0A, AL1A, AL2A, and AL3A; while the sleeve leads of the four "A" links associated with the "B" group of primary switches are designated AL0B, AL1B, AL2B, and AL3B. The controller provides one correspondingly designated relay respectively associated with each lead for testing. The "A" link test relays operate if a ground appears on their respectively associated leads. The operation of any such relay on a test is an indication that the associated "A" link is part of an existing busy channel and is, therefore, not available to serve the present call.

On FIG. 118, the eight relays 118-AL0A, -AL1A, -AL2A, -AL3A, -AL0B, -AL1B, -AL2B, and -AL3B are connected over obvious circuits, comprising for the most part, break contacts of relays on FIGS. 142, 143, and 144, to conductors 118-AL0A, -AL1A, -AL2A, -AL3A, -AL0B, -AL1B, -AL2B, and -AL3B, respectively. These eight conductors in cable AL extend through FIGS. 118, 112, 113, 107C, 100, 99, 98, and 97 and to FIG. 96 of the link connector circuit. In FIG. 96, the four conductors AL0B, AL1B, AL2B, and AL3B are connected to the primary "B" switches, represented only by the rectangle "B"; and the four conductors AL0A, AL1A, AL2A, and AL3A are connected, by means of make contacts 106A-CG0 and 106A-TU0 on FIGS. 96 and 97, to the windings of the hold magnets for the first four columns of the crossbar switches on FIGS. 86, 96, 87, and 97 which, together with FIGS. 98 and 88 comprise the hold magnets for the primary and secondary "A" switches. Thus, the four test leads, AL0A, AL1A, AL2A, and AL3A, from FIG. 118, are respectively connected to the hold magnets 86-PH0-0, -1, and -2, 86-PH1-0, -1,

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and -2, 87-PH2-0, -1, and -2, and 87-PH3-0, -1, and -2, which magnets serve the first four columns of the primary switching stage and, additionally, are respectively connected to the hold magnets 96-SH0-0, -1, and -2, 96-SH5-0, -1, and -2, 97-SH10-0, -1, and -2, and 97-SH15-0, -1, and -2, which serve the 0, 5th, 10th, and 15th columns of the secondary switching stage. The rectangle "B," extending across FIGS. 96, 97, and 98, and to which the conductors AL0B, AL1B, AL2B, and AL3B are connected, diagrammatically indicates circuitry for the primary and secondary "B" switch hold magnets. This circuitry is substantially the same as for the above-described primary and secondary "A" switch hold magnets.

It should be borne in mind that it is these hold magnets, and only these hold magnets, which serve the correspondingly designated columns of their respective switching stages, and which can extend a connection from trunk "00" to a position. Thus, the horizontal to which trunk "00" is connected is served by only the first four columns of the primary switching stage and, therefore, only the hold magnets for the first four columns of the primary "A" and "B" switches need be examined at the current time in ascertaining which path is available to serve the present call. Also, as may be seen from FIGS. 73B, 74 and 75, the "A" links extending from the first four columns of the "A" and "B" primary switching stages are connected to the 0, 5th, 10th, and 15th columns of the secondary switching stage and, therefore, only the hold magnets for these columns need be examined in determining which circuit paths are available for the present call.

If any of the eight "A" links under test are currently busy in the serving of another call, they will have a ground thereon from the position circuit serving the other call. This ground will be extended over the associated one of the AL-- conductors on FIG. 96 in cable AL, and through series-connected transfer break contacts of relays -C--, to operate the associated AL-- relay on FIG. 118.

The 40 "B" links interconnecting the horizontals of the secondary switches and the verticals of the tertiary switches are divided into four groups, each group consisting of the conductors from ten secondary switch horizontals. It would appear that there are a maximum of 16 "B" links available for use by any position group. Actually, however, for any given position, the number of links is limited to 12; and never are more than 12 test relays interrogated for a selected position. When the position group of which the selected operator position is a member is chosen, the link connector frame connects the sleeve leads of the "B" links that may be associated with that position group to the controller for test purposes.

As shown on FIGS. 119 and 120 of the controller, the 16 test leads designated BL00, -10, -20, -30, BL01, -11, -21, -31, BL02, -12, -22, -32, and BL03, -13, -23, and -33, are arranged in four groups, each group of leads being associated with a group of four links. The controller contains one correspondingly designated relay for each of these test leads (FIGS. 119 and 120). These relays are called the "B" link test relays, and any one of them will operate if a ground appears on its correspondingly designated lead. The operation of a test relay is an indication that the associated "B" link is part of a busy channel and is not currently available for the serving of a call.

The circuitry of FIGS. 89 through 91, and 99 through 101, together illustrate the following: (1) the manner in which the hold magnets for each column of the tertiary "A" and "B" switches are interconnected with each other; (2) the manner in which the interconnected hold magnets for each column of the tertiary "A" and "B" switches are connected to a respective corresponding tertiary vertical sleeve conductor accessible through a set of cross-point tertiary switch contacts to the sleeve conductor of one of the groups of 17 leads extended through from a trunk to a position; and (3) the manner in which the



tertiary vertical sleeve conductors, the tertiary hold magnets, and the "B" link test leads (BL- -) extending from FIGS. 119 and 120 in cable BL are interconnected.

Referring to FIGS. 89 and 99, the three hold magnets 89-TH0-0A, -TH0-2A, and -TH0-4A for column "0" of the tertiary "A" switches "0," "2," and "4" are connected in parallel with each other. This is done because each crossbar switch crosspoint closes through a maximum of six contacts and, therefore, it is essential that three switches be concurrently operated to concurrently close through the 17 contacts required in the system of the present disclosure. Likewise, the three hold magnets 99-TH0-0B, -TH0-2B, and -TH0-4B for column "0" of the tertiary "B" switches "0," "2," and "4" are also connected in parallel with each other, and are also connected in parallel with the three above-mentioned hold magnets for the "0" column of the tertiary "A" switches "0," "2," and "4," since the "0" column of all the "tertiary B switches" is connected to and serves the same circuits as do the "0" verticals of the "tertiary A switches." Each such parallel-connected group consisting of three tertiary "A" hold magnets and three tertiary "B" hold magnets on FIGS. 89, 90, and 91, and 99, 100, and 101 is respectively connected to a set of make contacts, such as for example, 89-TCP00 (enclosed in broken rectangle 89-TA0), which set of contacts comprises one of the 18 sets of crosspoint contacts closed each time the group of three tertiary "A" hold magnets operates, to close through a circuit in their respective crossbar switches. This set of contacts (e.g., 89-TCP00) effects a connection to the sleeve lead which is extended to the position circuit. Enclosed within broken rectangle 89-TA0 is a representation of the sleeve conductors of the tertiary "A" horizontal group "0" (FIG. 76) and the crosspoints affording access thereto. Similarly, rectangles 90-TA1, 90-TA2, 90-TA3, and 91-TA4, respectively, are related to tertiary "A" horizontal groups "1," "2," "3," and "4." In like manner, the solid rectangles 89-TB0, 90-TB1, 90-TB2, 90-TB3, and 91-TB4, respectively, represent the sleeve conductors of the tertiary "B" horizontal groups "0," "1," "2," "3," and "4," the crosspoints respectively affording access thereto, and their respective connections to the hold magnets for the "A" and "B" switches. Reference is made to the previous description of the circuitry of FIGS. 86 through 88, and 96 through 98, which description sets forth in detail the same concept of how the crosspoint contact sets shown thereon actually comprise one set of contacts of the 18 sets of contacts closed upon the concurrent operation of the corresponding hold magnets for the three primary "A" switches and the corresponding hold magnets for the three secondary "A" switches, such as for example, primary "A" switches "0," "1," and "2," and secondary "A" switches "0," "1," and "2." Referring to FIGS. 76 through 78, 82 through 84, and 92 through 94, it may be seen that the verticals of the tertiary crossbar switches comprise the inputs, and these verticals are connected to the horizontals of the secondary switches. The horizontals of the tertiary switches may be considered to be the outputs, and conductors extended to the right therefrom are terminated in brackets on FIGS. 78, 84 and 94, and from which, in turn, cables are extended, via loops to the position control circuit, to the various operator positions. A connection comprising 18 wires may be extended from the output of the secondary switches to an operator position by operating, for example, either tertiary "A" switches "0," "2," and "4," or tertiary "A" switches "1," "3," and "5," depending upon the particular output of the secondary switches that is to be extended. For example, referring to FIG. 75, the output of the secondary "A" switch comprising horizontal L9 intersecting vertical V19 may be extended through the tertiary "A" switches only by operating the tertiary "A" hold magnets associated with vertical 19 of the tertiary "A" switches "1," "3," and "5"; while referring to FIG. 74, horizontal L0 intersecting vertical V4 (the output of the secondary

switch) may be extended through the tertiary "A" switch network only by operating the tertiary "A" hold magnets associated with vertical "0" of the tertiary "A" switches "0," "2," and "4."

Any particular operator position within the selected position group can be connected to a calling trunk by three of the four groups of "B" links, thereby making a total of 12 available links.

A trunk may be connected to a position by one of three operator loops at the position. The controller provides four relays on FIGS. 148 and 149, 149-CL0, 149-CL1, 148-CL2, and 148-CL3, to test the operator loops for a busy condition. The three operator loops provided will be connected to three of the four -CL0 through -CL3 relays. If one or more of the -CL0 through -CL3 relays are operated, it is an indication that the respectively associated operator loops are busy. In addition, the controller operates one of the -CL- relays, so that only the proper three of the four groups of "B" links are associated with the selected position.

Referring more specifically now to the details of FIGS. 148 and 149, the four test relays comprise relays CL0 and CL1 on FIG. 149 and relays CL2 and CL3 on FIG. 148. These relays are connectable by means of a switching network comprising make contacts of relays 133-GC0 through 133-GC6 and relays 125-P0B through 125-P9B to the three loop test relays of the position control circuit associated with the position selected by the controller to serve the call. The make contacts of the operated one of the relays in the series 133-GC0 through 133-GC6 connect the windings of the -CL0 through -CL3 relays to a set of contacts on each of the ten relays 125-P0B through 125-P9B. The particular 133-GC- relay and the particular 125-P-B relay that are operated depend upon the position group selected and upon the position "units" selected. Thus, for example, referring to terminal 101 on FIG. 149, which terminal is connected to one side of the winding of relay 149-CL0, this terminal may be connected to terminal 149-102 in the event that relay 133-GC1 were operated incident to the selection of operator position group "1." Terminal 149-102 is, in turn, connected to a set of contacts on each of the ten relays 125-P0B through 125-P9B. The operation of one of these ten relays incident to the selection of an operator position "units" digit will, in turn, extend the potential on terminal 149-102 to the BY- lead extending to the selected position control circuit.

It was assumed in connection with the present call that operator position "00" has been selected. This being the case, relay 133-GC0 is now operated, as hereinbefore described, and, therefore, the potential on terminal 149-101 may be extended through make contacts of relay 133-GC0 to terminal 149-103. The contacts of the ten relays 125-P0B through 125-P9B to which terminal 149-103 is connected are shown in expanded form over the comparable circuit associated with the other 133-GC-relays in order to facilitate the description of the present call. Thus, on FIGS. 149 and 148, the make contacts of relays 125-P0B and 125-P1B associated via make contacts 133-GC0 with relays -CL0, -CL1, and -CL2, respectively, are separately shown; and in addition, the make contacts of the remaining eight relays 125-P2B through 125-P9B associated via make contacts 133-GC0 with relays -CL0, -CL1, and -CL2, respectively, are symbolically shown as a single contact. Relay 125-P0B is already operated, since position "00" has been selected and, therefore, the potential on terminal 149-103 may be extended through make contacts 125-P0B and over the BY0 lead extending through FIGS. 149, 153, 152, and to FIG. 162 of the position control circuit for operator position "00." By means of comparable circuitry, the windings of relays 149-CL1 and 148-CL2 may be extended over the BY1 and BY2 leads, respectively, to FIG. 162. The operation of the circuitry on FIG. 162 which applies the appropriate test potentials to conductors BY0,



BY1, and BY2 is explained hereinafter in connection with a separate description of the position control circuit.

Relay 148-CL3 is not needed for test purposes on the present call, since the three operator loops from the position control circuit for operator position "00" are connected to the windings of relays 149-CL0, 149-CL1, and 148-CL2. However, relay 248-CL3, as well as the remaining -CL- relays, is an active test relay insofar as the controller is concerned on each and every call and, therefore, it is necessary that this relay be operated on the present call so that it will appear to the controller that the circuitry associated with this relay is not available for the serving of calls. Therefore, it may be seen that an obvious path is closed to operate relay 148-CL3 from ground on terminal 148-101 through the make contacts of relays 133-GC0 through 133-GC3 whenever a call is extended to an operator position in any one of these groups. Also, it may be seen that a comparable circuit is closed to operate relay 148-CL3 by the controller whenever position "0," "1," "2," "4," "5," "6," "7," or "9" of group "5" have been selected. Similarly, each of the remaining -CL- relays has a comparable circuit whereby it may be operated directly by the controller incident to the selection of a certain position and a certain group. The foregoing arrangement permits the four test relays -CL0 through -CL3 to be used in the extending of the three test leads BY0, BY1, and BY2 to the various position control circuits.

The circuitry associated with the selection of a channel through the link connector is shown on FIGS. 142, 143 and 144. The link frame provides 24 channels over which a particular trunk may be connected to a particular operator position. The operation of relay 157-PS, incident to the seizure of a position, initiates the selection of one of the 24 possible channels by closing a circuit through contacts of the "A" link relays of FIG. 118, the "B" link relays of FIGS. 119 and 120, and the operator loop busy-test relays of FIGS. 148 and 149 to effect the operation of a channel relay.

Referring now to FIGS. 142, 143, and 144, the controller provides four groups of eight channel relays per group. The first group consists of relays 142-C00A through 142-C30A and 142-C00B through 142-C30B; the second group consists of relays 142-C01A through 143-C31A, and 142-C01B through 143-C31B; the third group consists of relays 143-C02A through 144-C32A and 143-C02B through 144-C32B; and the fourth group consists of relays 144-C03A through 144-C33A and 144-C03B through 144-C33B. A particular position is associated with three of the four groups of channel relays, thereby making a total of 24 channel relays associated with each position. The operation of one of the channel relays is an indication that all of the links associated with that channel are idle and that the controller can proceed to operate the appropriate crossbar switch "select" and "hold" magnets associated with this channel.

After the controller has determined the linkages which are idle, it selects the one preferred channel through which to connect the bidding trunk to the selected position. The preference of channel selection is permanent and nonrotating, as it has been found that a higher grade of service with less delay due to no channel being available is given at peak traffic when the connecting path channels are selected in a definite, nonrotating, and permanent order.

The original order of preference of the selection of the connection path is inherent from relay 142-C00A being the most preferred, to relay 144-C33B being the least preferred. This order of preference exists when the following cross-connections are made as shown on FIGS. 143 and 144:

- (a) Terminal 143-S is cross-connected to terminal 143-INX;
- (b) Terminal 143-M is cross-connected to terminal 143-OTX;

- (c) Terminal 143-M1 is cross-connected to terminal 143-INY; and (d) terminal 144-E is cross-connected to terminal 144-OTY.

To equalize the life of the switching equipment, the original order of preference of selection of the channel relays can be changed periodically so that the preference will then be from the C02A relay of FIG. 143 being the most preferred, to the C31B relay of FIG. 143 being the least preferred. This new order of preference will exist when the following cross connections are made: (a) terminal 143-S is cross-connected to terminal 143-INY; (b) terminal 143-M is cross-connected to terminal 144-OTY; (c) terminal 143-M1 is cross-connected to terminal 143-INX; and (d) terminal 144-E is cross-connected to terminal 143-OTX.

Assuming that all the "A" link test relays of FIG. 118, and all the "B" link test relays of FIGS. 119 and 120, as well as the operator loop test relays CL0, CL1, and CL2 of FIGS. 148 and 149 are normal, the following path may now be traced to operate relay 142-C00A: ground on terminal 101 of FIG. 144, make contacts 113-ON, 137-PGT, break contacts 144-NCM, terminal 144-102, upwards to terminal 144-103, leftwards through an obvious series of transfer break contacts to terminal 104 of FIG. 144, terminal 101 of FIG. 143, leftwards through an obvious series of transfer break contacts to terminal 143-102, terminal 101 of FIG. 142, leftwards through an obvious series of transfer break contacts to terminal 142-102, downwards to terminal 142-103, towards the right to terminal 142-104, terminal 103 of FIG. 143, break contacts 118-SLK, make contacts 144-CDK, make contacts 157-PS, terminal 143-S, the cross-connection to terminal 143-INX, transfer break contacts 131-TTFA, terminal 142-105, series-connected transfer break contacts 149-CL0, 119-BL00, and 118-AL0A, to the winding of relay 142-C00A to operate it. Relay 142-C00A, in operating, closes its transfer make contacts which bypasses a portion of its operating circuit, and completes a holding path for itself through the break contacts of the channel relays to the right on FIG. 142 to terminal 142-101.

It may be appreciated that the foregoing circuit for operating relay 142-C00A is dependent upon the following relays being in their normal (i.e., unoperated) condition: link test relay 118-AL0A, link test relay 119-BL00, and operator loop test relay 149-CL0.

Referring now to FIG. 142 and to that portion of the operating circuit for relay 142-C00A as hereinabove described, in the vicinity of terminal 142-105, it may be seen that if relay 149-CL0 had been operated (instead of released), thereby indicating that the first operator loop associated with position "00" is not currently available, terminal 142-105 would no longer be interconnected with terminal 142-106 but, instead, would be interconnected via transfer make contacts 149-CL0 to terminal 142-107. This being the case, it may be seen that extending the connection to the right to terminal 142-109, relay 142-C01A would now be the first preferred and would be operated in the event that all of the relays 149-CL1, 119-BL01, and 118-AL0A were normal.

Referring now to terminal 106 of FIG. 142, it may be seen that its interconnection with terminal 142-110 in the operating path of relay 142-C00A is dependent upon the normal condition of "B" link test relay 119-BL00. If relay 119-BL00 were operated (instead of released), terminal 142-106 would then be interconnected via the transfer make contacts 119-BL00 with terminal 142-108. The first channel relay preferred in this event then would be relay 142-C10A, and it would be operated in the event that both of the relays 119-BL10 and 118-AL1A were normal.

Referring now to that portion of the operating circuit for relay 142-C00A including terminal 142-110, it may be seen that the operation of relay 142-C00A depends upon the normal condition of the "A" link test re-



lay 118-AL0A. In the event that this relay 118-AL0A were operated (rather than released), terminal 142-110 would be connected over make contacts 118-AL0A and, in the event that relay 118-AL0B is released, thence to the winding of channel relay 142-C00B to operate it.

Assuming, for example, that the controller has selected group "4," position "1," and that this position has loops "0" and "1" busy, the least-preferred channel relay, 144-C33B, would be operated under the following conditions: ground on terminal 142-105, extended through the transfer make contacts of relay 149-CL0 operated, to terminal 142-107, and, thence, to terminal 142-109, through the transfer make contacts of the loop test relay 149-CL1 operated, terminal OTX of FIG. 143, the cross-connection, terminal 143-M, to terminal 143-M1, the cross-connection, terminal 143-INY, through transfer make contacts 148-CL2 of this test relay operated, terminal 143-105 to terminal 143-104, to terminal 144-105, through transfer break contacts 148-CL3 of this test relay normal on FIG. 144, through transfer make contacts of relay 120-BL03 operated, transfer break contacts of relay 120-BL13 normal, transfer make contacts of relay 118-AL1A operated, transfer make contacts of relay 118-AL1B operated, transfer make contacts of relay 120-BL23 operated, transfer break contacts of relay 120-BL33 normal, transfer make contacts of relay 118-AL3A operated, and transfer break contacts of relay 118-AL3B normal, to the winding of relay 144-C33B. Thus, by means of circuitry similar to that already described, any of the channel relays available for serving the present call may be operated, depending upon the specific combination of "A" link, "B" link, and of the operator loop test relays that are currently operated.

In order to simplify the description of the present call, let it be assumed that circuit conditions are such at the time the channel selection test is made that relay 142-C00A operates as above described, and locks up to ground on terminal 144-103.

The operation of channel relay 142-C00A, as hereinbefore described, closes a path on FIG. 142 to operate check relay 142-CHA. Relay 142-CHA operates from ground on terminal 142-111 extended through the 1-out-of-32 symmetric circuit, indicated by rectangle CUC, in the event that one, and only one, of the 32 channel relays whose contacts comprise the 1-out-of-32 symmetric circuit is operated. This condition should now be satisfied, since only relay 142-C00A of all the channel relays is operated, and, therefore, the path is now complete to operate relay 142-CHA.

If the controller should find that there is no combination of an idle "A" link and an idle "B" link, together with an operator loop which can connect the selected trunk and position through the link frame crossbar switches, it will then operate relay 144-NCM over circuitry similar to that hereinabove described. Although there are many different possible combinations of an "A" link, a "B" link, and operator loop test relay operations which could operate relay 144-NCM, one possible operating circuit would be as follows: ground on terminal 104 of FIG. 143 as above described, terminal 105 of FIG. 144, transfer break contacts 148-CL3, transfer make contacts 120-BL03, transfer break contacts 120-BL13, transfer make contacts 118-AL1A, 118-AL1B, and 120-BL23, transfer break contacts 120-BL33, transfer make contacts 118-AL3A, and transfer make contacts of relay 118-AL3B (operated), to terminal 144-OTY, over the cross connection to terminal 144-E, to the winding of relay 144-NCM, causing it to operate and lock up to ground on terminal 144-101. If the call is of the nonpriority type, the operation of relay 144-NCM initiates the following circuit operation which eventuates in the operation of relays 115-GDN and -GDNA: ground on terminal 107 of FIG. 151 is extended through make contacts 113-ON, break contacts 139-SNG, make contacts 144-NCM, to the left-hand winding of relay 152-GD, causing it to op-

erate. With relays 144-NCM and 152-GD operated, ground is extended from terminal 101 on FIG. 126, through make contacts 113-ON, 137-PGT, 144-NCM, and 152-GD, to the winding of relay 126-RS, causing it to operate and lock up to ground over the path just described. With relay 152-GD operated, ground is extended from terminal 102 on FIG. 115, through make contacts 152-GD, and terminal 115-104, to the winding of relay 115-GDNA and, at the same time, ground is extended through break contacts 115-RC to the winding of relay 115-GDN, causing relays 115-GDN and -GDNA to operate. If the call is of the priority type, relays 115-GDN and 115-GDNA operate as above described and, additionally, relays 115-GDP and 115-GDPB operate over the following path: the ground extended to terminal 104 of FIG. 115, the make contacts of the operated one of the relays 145-G0P through 145-G9P, to the winding of relay 115-GDP; and, at the same time, ground is extended through break contact 115-PC to the winding of relay 115-GDPB, causing relays 115-GDP and -GDPB to operate. Relay 115-GDP, in operating, closes a holding path for itself to ground on terminal 115-104. The operation of either relay 115-GDN or 115-GDP serves to disconnect the trunk group being served. The controller will then select the group of trunks next highest in the order of preference for service. This mode of operation results in more efficient controller usage. The trunk being served, to which no idle channel could be found, can be disconnected without penalty because the link frame trunk-class-gating system will prevent registration of any other nonpriority requests of this class until the disconnected trunk is either served, or until it removes its bid for service from the system.

#### Select magnet operation

The following describes the select magnet operation in the trouble-cross-detection circuitry. Having selected an idle channel, the controller proceeds to operate the proper select magnets on the link frame crossbar switches.

Referring now to FIG. 127, the operation of relay 157-PS, as a consequence of the seizure of the position, closes its make contacts on FIG. 127 to extend ground from terminal 127-105, thereby preparing a circuit for advancing the group order of preference one position. Relay 127-GK releases during the preference advance, and then reoperates when the 127-GP- relay representing the newly preferred group is operated. The detailed discussion of the manner in which the group preference circuit advances is hereinafter described. On FIG. 128, the operation of relay 157-PS also closes its make contacts to extend ground from terminal 128-101, thereby advancing the position preference circuit. Relay 128-PK releases and then reoperates as a consequence of the operation of the 128-PP- relay representing the newly preferred position. This circuit is hereinafter also described in more detail.

Referring to FIG. 147, the operation of relay 142-C00A closes an obvious path over its make contacts to operate relay 147-C0A from ground on terminal 147-101. The operation of relay 142-C00A also closes a similar circuit on FIG. 147 to operate relay 147-C0 from ground on terminal 147-105.

Referring now to FIGS. 103 and 109 of the link connector circuit, the left-hand portions thereof disclose the circuitry associated with the select magnets of the primary stage of the crossbar switches. There are 20 sets of select magnets associated with the primary stage of the crossbar switches, each set consisting of three select magnets connected in parallel. Ten of the 20 sets are associated with the "A" group of primary switches "0," "1," and "2," as shown on the left side of FIG. 103; and the other ten sets are associated with the "B" group of primary switches "0," "1," and "2," as diagrammatically shown on the left side of FIG. 109. The 20 sets of select magnets are connected to the controller via leads PS0A



through PS9A (FIG. 103), and PS0B through PS9B (FIG. 109), the numerical portion of the designation of the leads corresponding to the primary switch levels of horizontals of the "A" or "B" switch groups. The selected trunk connector number corresponds to the switch level, and the operated channel relay determines whether the channel will use the "A" or "B" group of primary switches.

Referring still to FIGS. 103 and 109, in the right-hand portions thereof, it may be seen that there are 20 sets of secondary select magnets arranged into "A" and "B" groups, in a manner analogous to that shown for the primary switches. In this case, the operation of the proper set of select magnets depends on the position group selected and the particular channel chosen.

Referring now to FIGS. 104 and 110, there are 40 sets of select magnets associated with the tertiary switches, each set consisting of three select magnets connected in parallel. Twenty of the 40 sets are associated with the "A" group of switches (FIG. 104) and the other 20 sets are associated with the "B" group of switches (FIG. 110). The "B" group of tertiary switches is a "buildout," which increases, from 33 to 66, the number of operator positions to which the links may have access. In this case, the choice of the select magnets to be operated depends on the individual position which has been selected and which of its three operator loops the controller has selected for connection.

The controller provides three low-resistance cross-detecting relays, 147-PSX, 141-SSX, and 134-TSX, which, respectively, are associated with the primary, secondary and tertiary select magnets. These relays act as low-resistance shunts across the associated select magnets if a "trouble cross" exists, thereby preventing the operation of any of the select magnets. The operation of any of the cross-detecting relays will cause the controller to request connection to the trouble recorder circuit thereby, to record automatically the existence of the trouble condition.

Referring to FIGS. 73A and 73B, it will be recalled that the calling trunk for the present call is assumed, for example, to be trunk "00," which is served by level "0" of the primary "A" switches. Under this condition it will, therefore, be necessary to operate the select magnets for the "0" level or horizontal of these switches. This being the case, the following path may now be traced to operate the select magnets for the "0" level of the primary "A" switches of FIG. 103: battery on terminal 101 of FIG. 146 through resistance PA, break contacts 126-PSL, 126-RS, terminal 146-102, make contacts 142-C00A, 130-AG0, conductor PS0A in cable PSA extending through FIGS. 146, 147, 141, 135, 129, 123, 117, 110, 109, and 103, through make contacts 106A-CE0, to the parallel-connected windings of the select magnets in level "0" of primary "A" switches "0," "1," and "2," thereby operating them.

The particular combination of relays currently operated in the controller, as a consequence of the controller extending a call from calling trunk "00" to operator position "00," results in the operation of the select magnets for the "0" level of the secondary "A" switches "0," "1," and "2." The path to operate these select magnets may be traced as follows: battery on terminal 101 of FIG. 141, resistance SA, break contacts 126-PSL, 126-RS, terminal 141-102, terminal 101 on FIG. 140, transfer make contacts 154-PG0 (which are closed as a consequence of the selection of operator position group "0"), transfer make contacts 147-C0A (which are closed as a consequence of the operation of channel relay 124-C00A), conductor SS0A in cable SSA extending through FIGS. 140, 141, 135, 129, 123, 117, 110, 109, and 103, make contacts 106A-CC0 (FIG. 103), to the parallel-connected windings of the select magnets for the "0" level of the secondary "A" switches "0," "1," and "2," thereby operating them.

The set of tertiary select magnets that are now operated is dependent upon the combination of 147-C-, 154-PG- and 125-P- relays that are currently operated. Recalling that relays 147-C0, 154-PG0 and 125-P0 are now operated, the following path may be traced to operate select magnets on the tertiary switches: battery on terminal 101 of FIG. 135, through resistance TA, break contacts 126-PSL, 126-RS, make contacts 142-CHA, terminal 135-102, leftward to terminal 102 on FIG. 134, through transfer make contacts 154-PG0, transfer break contacts 154-PG2, terminal 134-103, transfer make contacts 125-P0, conductor T0AX in cable TAX extending through FIGS. 134, 135, 129, 123, 117, 110, and 104, through make contacts 106A-CC0 (FIG. 104 of the link connector), to the winding of select magnet 104-TS0A in tertiary switch "0," as well as to the parallel-connected corresponding select magnets for level "0" of tertiary "A" switches "2," and "4," thereby operating them.

#### Hold magnet operation

The following describes the hold magnet operation. Where there is an absence of a ground on the sleeve conductors of the linkages which comprise a channel, the controller recognizes this as an idle linkage indication and may select any such idle channel. The controller does not know how long a selected channel has been idle and, therefore, the channel may be selected just after it has become idle from a previous connection but before the hold magnets and select fingers have had time to release. To ensure against trying to reoperate a hold magnet before that magnet and the select fingers are released from a previous connection, the relay 120-SMK introduces a delay interval by waiting until all nine select magnets have operated. The delay interval, thus introduced, is sufficient to allow time for the hold magnets and select fingers to release from a previous connection. The release time of a hold magnet is determined by the time required to release the armature and crosspoints; while the release time of the select finger is determined by the time required for the vibration of the select finger to become damped out after it has released from the crosspoint trap. False operation of crosspoints might occur if the hold magnet were to be reoperated before the vibration of the select finger has ceased.

During the interval transpiring between the application of current to the select magnets and until the operation of relay 120-SMK, the controller performs a number of checks and functions. First, on FIG. 156, when relay 142-CHA operates, it extends the very low negative potential from the junction of voltage divider resistors PTA and PTB through the winding of relay 156-PDCT, through make contacts 142-CHA, 147-C0, 133-GCA0, and 125-P0A, to position sleeve conductor S0 in cable S0-2, extending through FIGS. 155, 165, 164, 163, and 162, through the winding of relay 162-S0, in the position control circuit associated with the selected operator loop, to negative 48 volts, thereby causing relays 156-PDCT and 162-S0 to operate in series, and in that order. If the particular operator loop chosen were already busy, ground on sleeve conductor S0 would, effectively, shunt relay 156-PDCT down, because of the very low negative potential on its winding, thus preventing relay 156-PDCT from operating, thereby blocking the progress of the controller. The controller would then time out and request connection to a trouble recorder to record this trouble.

Second, referring to FIGS. 118 and 119, during the hold magnet timing interval the controller also connects the 118-ALKC and 119-BLKC relays to the "A" and "B" sleeve linkages, respectively, through a high impedance circuit to check the AL-- and BL-- leads for continuity. Relays 118-ALKC and 119-BLKC both operate if negative potential is found on the linkages. This test is necessary to prevent falsely connecting into busy linkages associated with other channels. This can occur



because the link-busy test relays associated with discontinuous test leads to a link frame will not operate, thereby making the associated linkage appear to be idle whether it is busy or not.

Referring now to FIG. 118, relay 118-ALKC is connected in series with transistor T1, and operates from the collector current thereof. The collector current of the transistor is, in turn, controlled by the bias applied to the base thereof. The normal biasing of the base is such that the resulting collector current is negligible, thereby maintaining relay 118-ALKC nonoperated. The transistor T1 conducts only when the base has a sufficiently large negative potential applied thereto, thereby increasing the collector current and operating relay 118-ALKC. This negative base potential is obtained from the hold magnet of the linkage to which the test circuit is currently connected. This circuit may be traced as follows: the base of transistor T1, terminal 101 of FIG. 118, resistance AK4, break contacts 126-DCT, transfer make contacts 142-CHA, transfer break contacts 126-HMT1, inductance A, transfer make contacts 142-C00A, conductor AL0A in cable AL extending to FIG. 96, make contacts 106A-CG0, 106A-TU0, to one side of the three parallel-connected hold magnets for the primary "0," "1," and "2" "A" switches on FIG. 86, and to one side of the parallel-connected hold magnets for the secondary "0," "1," and "2" "A" switches on FIG. 96, and through the windings of these hold magnets to negative battery. The potential of this battery is sufficient to apply the required bias to the base of transistor T1 on FIG. 18, thereby increasing its collector current and operating relay 118-ALKC.

The operating circuit for relay 119-BLKC is similar to that for relay 118-ALKC and, therefore, it operates as the collector current for transistor T2 on FIG. 119 increases to the required amount. Similarly, the collector current for transistor T2 is controlled by the potential applied to the base thereof. The required negative potential to increase the collector current of transistor T2 and to operate relay 119-BLKC is obtained from the hold magnets to which the "B" link test leads are currently connected. The circuit to apply negative potential to the base of transistor T2 may be traced as follows: the base of transistor T2, terminal 119-101, resistor R1, break contacts 126-DCT, transfer make contacts 142-CHA, transfer break contacts 126-HMT1, inductance B, transfer make contacts 142-C00A, conductor BL00 in cable BL extending to FIG. 99, make contacts 106A-CF0, make contacts 91-PG0 (FIG. 89), terminal 101 on FIG. 89, to the three parallel-connected hold magnets for column "0" of tertiary "A" switches "0," "2," and "4," as well as to the corresponding parallel-connected hold magnets of tertiary "B" switches "0," "2," and "4" (on FIG. 99), and through the windings of these six hold magnets to negative 48-volts potential. This potential increases the collector current of transistor T2 to operate relay 119-BLKC.

Third, referring now to FIG. 126, after the operation of relays 118-ALKC and 119-BLKC, the following circuit is now closed to operate relay 126-DCT: ground on terminal 101 of FIG. 126, make contacts 113-ON, 136-ATK, transfer make contacts 156-PDCT, break contacts 118-SLK, make contacts 119-BLKC, 118-ALKC, break contacts 126-HMT2, to the winding of relay 126-DCT, causing it to operate as a check that this sequence has been completed satisfactorily. Relay 26-DCT, in operating, closes a holding path for itself over its own make contacts to ground on terminal 126-107. The operation of relay 126-DCT opens its break contacts on FIG. 118 to remove the negative potential from the base of transistor T1 and, at the same time, opens its break contacts on FIG. 119 to remove the negative potential from the base of transistor T2. The removal of the negative potential from the bases of these transistors re-

duces their collector currents, thereby causing relays 118-ALKC and 119-BLKC to release.

A checking network composed of contacts of the select magnets causes relay 120-SMK in the controller to operate as a check that all of the select magnets associated with the selected channel on the link frame have operated. The operation of relay 120-SMK ensures the complete release of the hold magnet and select fingers. The path to operate this relay may now be traced as follows: starting on the right-hand winding terminal of the relay on FIG. 120, conductor SMK extending from FIG. 120 through FIGS. 114, 108A, 108B, 109, 110, and 111, to FIG. 105, through make contacts 106A-CD0, terminal 105-101, through the make contacts on the select magnets for level "0" of primary "A" switches "0," "1," and "2," which are designated PS0A on each of the "A" switches "0," "1," and "2," to terminal 105-102, through the make contacts of the three select magnets serving level "0" for secondary "A" switches "0," "1," and "2" to terminal 105-103, through the make contacts of the three select magnets for level "0" of tertiary "A" switches "0," "2," and "4," to ground on terminal 105-104.

At the completion of the hold-magnet timing interval, the operation of relay 120-SMK closes the following path to operate relay 126-HMT1: ground on terminal 101 of FIG. 126, make contacts 113-ON, 136-ATK, transfer make contacts 156-PDCT, make contacts 120-SMK, 126-DCT, break contacts 139-TAC, 129-TR, and 126-HMT2, and through the winding of the holding magnet timing relay 126-HMT1 to negative battery, causing it to operate. Relay 126-HMT1, in operating, closes a locking path through make contacts 126-HMT1 and break contacts 126-PSL to ground on terminal 126-107. The operation of relay 126-HMT1 extends ground on terminal 126-104, through make contacts 126-HMT1, through the winding of relay 126-HMT2 to negative battery, causing it to operate. Relay 126-HMT2, in operating, closes a locking path through make contacts 126-HMT2 and 136-ATK to ground on terminal 126-105.

The operation of relay 126-HMT1, subsequent to the operation of relays 142-CHA, 118-ALKC and 119-BLKC, completes the circuit over which the controller operates the hold magnets in the link connector circuit. To decrease the time of operation of the crossbar switch hold magnet, as well as to decrease the controller holding time, the hold magnets are operated by the use of a momentarily applied total voltage of 178 volts rather than the customary 48 volts. In this case, when a hold magnet is to be operated, the controller will apply momentarily a voltage of +130 volts to the hold magnet windings. Since the other end of the hold magnet winding is connected to -48 volts, this gives a total operating voltage of 178, which operates the hold magnets in a much shorter time than would be required for -48 volt operation.

Referring to FIG. 118, which discloses the circuit for operating the primary and secondary switch hold magnets, the positive 130-volt battery on terminal 118-102 charges capacitor AH0 to positive 130 volts during the hold magnet timing interval which is terminated by the operation of relay 126-HMT1. Diode AHS does not conduct, since it is reverse biased when capacitor AH0 is charged. When the hold magnets are to be operated, the positive 130-volt charge on the capacitor is extended from the controller, via transfer make contacts 126-HMT1, inductance A, transfer make contacts 142-C00A, over conductor AL0A in cable AL extending from FIG. 118 to FIG. 96, as hereinbefore described. In FIG. 96, conductor AL0A is connected to the same hold magnets hereinbefore described in connection with the continuity test of these leads, and which resulted in the operation of relay 118-ALKC. The positive 130-volt charge on capacitor AH0 (FIG. 118) is discharged through the winding of the connected hold magnets. The



capacitor discharge operates the hold magnets far more quickly than would be possible with the negative 48-volt potential alone. The capacitor continues to discharge as the hold magnet operates and, finally, when the potential across the capacitor drops to approximately one-half volt, diode AHS is no longer reverse biased and it becomes, conducting, thereby supplying the steady-state current necessary to hold the hold magnets operated.

The circuit for operating the tertiary switch hold magnets is shown on FIGS. 119 and 120. By circuitry similar to FIG. 99, as hereinbefore described. In FIG. 99, con-volt potential on terminal 102 of FIG. 119 charges capacitor BH0 to 130 volts and, as a consequence of the operation of relay 126-HMT1, the charge on this capacitor is connected via transfer make contacts 126-HMT1, inductance B, transfer make contacts 142-C00A, conductor BL00 in cable BL extending from FIG. 119 to FIG. 99, as hereinbefore described. In FIG. 99, conductor BL00 is connected to the same hold magnets of the tertiary switch hereinbefore described in connection with the continuity test of these leads, and which resulted in the operation of relay 119-BLKC. These tertiary magnets, when operated, will extend the necessary connection for the present call. The capacitor BH0 discharges over this path to operate the hold magnets and, as the charge in the capacitor decreases, diode BHS becomes conductive and supplies the steady-state current necessary to maintain the hold magnets operated.

The hereinabove-described operation of relay 126-HMT2 closes the following path to operate relays 113-HG and 113-HGP: ground on terminal 102 of FIG. 113, break contacts 126-RS, 144-NCM, make contacts 126-HMT2 to the parallel-connected windings of relays 113-HG and 113-HGP to operate them. Also, the hereinbefore-described operation of relay 162-S0 in the position control circuit completes the following path to operate relay 149-CL0 in the controller, thereby indicating the busy condition of loop "0": ground on terminal 101 of FIG. 162, transfer make contacts 162-S0, conductor BY0 extending from FIG. 162 to FIG. 149, make contacts 133-GC0, terminal 149-101, to the winding of relay 149-CL0 to operate it.

The following combination of select and hold magnets is operated as shown in the following table. In this table the designations PS, SS, and TS, represent primary select magnets, secondary select magnets, and tertiary select magnets, respectively. The designations PH, SH, and TH represent primary hold magnets, secondary hold magnets, and tertiary hold magnets, respectively. The designations PS0A-0, -1, and -2, as examples, represent primary select magnets "0" for "A" switches "0," "1," and "2," respectively. Similarly, for the primary switches "A" the designations PH0-0, -1, and -2, as examples, represent the primary hold magnets "0" for the switches "0," "1," and "2," respectively.

|        | Primary    |      | Secondary  |      | Tertiary   |           |
|--------|------------|------|------------|------|------------|-----------|
|        | "A"        | "B"  | "A"        | "B"  | "A"        | "B"       |
| Select | 103-PS0A-0 | None | 103-SS0A-0 | None | 104-TS0A-0 | None      |
|        | 103-PS0A-1 | do   | 103-SS0A-1 | do   | 104-TS0A-1 | Do        |
|        | 103-PS0A-2 | do   | 103-SS0A-2 | do   | 104-TS0A-2 | Do        |
| Hold   | 86-PH0-0   | do   | 96-SH0-0   | do   | 89-TH0-0A  | 99-TH0-0B |
|        | 86-PH0-1   | do   | 96-SH0-1   | do   | 89-TH0-1A  | 99-TH0-1B |
|        | 86-PH0-2   | do   | 96-SH0-2   | do   | 89-TH0-2A  | 99-TH0-2B |
|        |            |      |            |      | 89-TH0-3A  | 99-TH0-3B |

Keeping in mind the above combination of select and hold magnets that are currently operated, the following path may now be traced through the switching network from the incoming appearance of trunk "00," as shown on FIG. 73B. The following path is described only with respect to the operation of a single crossbar switch in each stage. As described hereinbefore, it is to be understood

that the cutting through of a connection requires the cutting through of 18 wires and, since a single crossbar switch crosspoint has a maximum of six contacts, three such switches must be concurrently closed to extend a circuit comprising 18 wires. However, as above stated, the operation is described only with respect to a single switch, since the paths through the other two crossbar switches in each stage which would also be operated is precisely the same. A path may now be extended from the trunk "00," connected via cable L00, to FIG. 73A, through the crosspoints comprising level L0 and vertical V0 on FIG. 73B of "primary A switch 0," since its hold magnet 86-PH0-0 and its select magnet 103-PS0A-0 are both operated. The several crosspoints are represented by crosses, but the crosspoints controlled by the joint energization of hold magnet 86-PH0-0 and select magnet 103-PS0A-0 are of hold magnet 86-PH0-0 and select magnet 103-PS0A-0 are represented on FIG. 73B by a cross which is somewhat larger than that for the other crosspoints. Continuing via the conductors serving vertical V0 of this crosspoint, the path may now be extended to vertical V0 of the "secondary A switch 0" on FIG. 74, indicated by an enlarged crosspoint. The hold magnet 96-SH0-0 and the select magnet 103-SS0A-0 for the "secondary A switch 0" are both operated and, therefore, the path may be extended from vertical V0 of the switch, through the enlarged crosspoint, and thence, via the conductors serving level L0 of the switch to the conductors serving the vertical V0 of the tertiary "A" switch "0" on FIG. 76. The hold magnet 89-TH0-0A and the select magnet 104-TS0A-0 for the tertiary "A" switch "0" are both operated and, therefore, the path may now be extended over the enlarged crosspoint to the conductors L0 which are included within a cable designated group "0," and which extend to the top of FIG. 84 where cable group "0" once again fans out to ten conductor groups, designated L0 through L9. The conductor group L0 represents the extension of trunk "00" through the switching network as a consequence of the above-mentioned select and hold magnets of the link connector being currently operated by the controller. Conductors L0 comprise the individually designated six conductors shown on the drawing which extend to loop "0" for the position control circuit, which loop connection, together with connections to loops "1" and "2," are shown on FIG. 94. Specifically, the conductors comprising loop "0" extend to FIG. 165. The specific connection representing this extension is not connected to a cable on FIG. 94 in order to minimize the complexity of the drawings. Instead, the termination of the conductors for loop "0" on FIG. 94 is merely stated to extend to FIG. 165. Correspondingly, the extension of these conductors on FIG. 165 is stated as coming from FIG. 94. Similarly, the circuits representing the loops "1" and "2" of the same position are connected to the indicated switch positions

shown on FIGS. 76, 82, and 92, and similarly connect to FIG. 165.

The sets of "A" and "B" tertiary switch hold magnets on FIGS. 89 through 91, and 99 through 101, are respectively connected to vertical conductors of the tertiary switches which, by the closure of the operated one of the associated tertiary switch crosspoints, extend a connection



to the horizontal tertiary conductor intersected by the vertical tertiary conductor. The horizontal conductors which are connected to the same contact set of each crosspoint, to which is also connected the hold magnet windings via the tertiary vertical conductor connected to the same contact set are, in turn, connected to the sleeve conductor designated S0 on FIG. 89 which, it will be noted, is a part of FIG. 76. Conductor S0 is cut through from the trunk circuit to the position circuit by the crossbar switch field. Thus, the closure of the crosspoints defined by vertical V0 and horizontal L0 on FIG. 76, at make contacts 89-TCP00, connects the "0" hold magnets of the indicated "A" and "B" switches to the S0 lead. Referring to this same crosspoint, by means of the make contacts 89-TCP00 shown on FIG. 89 comprising a portion of the crosspoint shown in enlarged form on tertiary "A" switch "0," the S0 lead on FIG. 89 is connected on the vertical side of the crosspoint on FIG. 76 to the S0 conductor extended from the trunk "00" for the present call. The trunk "00" S0 conductor, as hereinbefore described, is further extended by the closure of make contacts 89-TPC00 of the above-discussed crosspoint on FIG. 76 to the output of the switch field, and thence further to FIG. 165.

The closure of the crosspoints extends ground to the S- leads, via the circuitry of FIG. 89, as hereinbefore described. The ground for the circuitry of FIG. 89 is supplied originally over the following circuit path, as hereinbefore described: ground on terminal 105 on FIG. 119, through diode BHS, to terminals 119-106 and 119-103, through transfer make contacts 126-HMT1, inductance B, transfer make contacts 142-C00A, lead BL00 in cable BL extending to FIG. 99, make contacts 106A-CF0 and 91-PG0 to terminal 89-101, and through make contacts 89-TCP00 to conductor S0. Similarly, the ground for the circuitry of FIG. 86 is supplied originally over the following circuit path: ground on terminal 103 on FIG. 118, through diode AHS, to terminals 118-104 and 118-105, through transfer make contacts 126-HMT1, inductance A, transfer make contacts 142-C00A, lead AL0A in cable AL extending to FIG. 96, make contacts 106A-CG0, 106A-TU0, and 86-CP100 to lead V0 to FIG. 73B. Lead V0 also extends ground through the crosspoints of the switching train to conductor S0. Both of the diodes 118-AHS and 119-BHS are forward-biased at this time to supply the holding current for the associated hold magnets. However, the ground on the sleeve lead S0 is extended to terminal 101 of FIG. 165, which is the circuit interconnecting relay 156-PDCT with relay 162-S0, and thereby initiates a reverse current flow through the winding of relay 156-PDCT, since it was previously operated from the very low negative potential on one side of its winding connected in series with negative 48 volts supplied through the winding of relay 162-S0. The current now flows between the ground on terminal 101 on FIG. 165 and the very low negative potential supplied at the junction of voltage divider resistances PTA and PTB on FIG. 156. This reversal of current through relay 156-PDCT causes it to release.

With the release of relay 156-PDCT, and with relay 126-HMT2 operated, the operation of relay 120-SMK closes the following path to operate relay 126-PSL: ground on terminal 101 of FIG. 126, make contacts 113-ON, 136-ATK, terminal 126-106, break contacts 156-PDCT, make contacts 126-HMT2, and 120-SMK, to the winding of relay 126-PSL to operate it. Relay 126-PSL, in operating, closes a holding path over its own make contacts in series with break contacts 126-RS, to ground on terminal 126-106. The operation of relay 126-PSL opens its break contacts on FIG. 146 to isolate the battery on terminal 146-101 from terminal 146-102, thereby opening the primary select magnet operating circuit via conductor PS0A, and thereby causing the operated primary select magnets 103-PS0A-0, -PS0A-1, and -PS0A-2 to release. The operation of relay 126-PSL also

opens its break contacts on FIG. 141 to isolate battery on terminal 101 of FIG. 141 from terminal 141-102, thereby opening the secondary switch select magnet operating circuit via conductor SS0A on FIG. 140, and thereby causing the operated secondary select magnets 103-SS0A-0, -SS0A-1, and -SS0A-2 to release. Similarly, the operation of relay 126-PSL opens its break contacts on FIG. 135 to isolate the battery on terminal 135-101 from terminal 135-102, thereby opening the tertiary switch select magnet operating circuit via conductor T0AX on FIG. 134, and thereby causing the operated tertiary select magnets 104-TS0A-0, -TS0A-2, and -TS0A-4 to release.

Referring now to FIG. 126, with relay 156-PDCT released, the operation of relay 126-PSL, at its break contacts, also opens the locking circuit for relay 126-HMT1, causing it to release. Referring to FIG. 119, the release of relay 126-HMT1 opens its transfer make contacts and closes its transfer break contacts common to terminal 104 of FIG. 119, thereby removing the ground extended through diode BHS from inductance B in the tertiary hold magnet holding path and transferring the circuit so that ground is now supplied from terminal 119-107, through make contacts 126-PSL, break contacts 139-PAK, resistance U, and transfer break contacts 126-HMT1 to terminal 119-104 and, thence, over the hereinbefore-described hold magnet operating circuit, to the windings of the hold magnets. The current flow through the windings of the hold magnets from the ground supplied through resistance U supplements that supplied through the voltage divider resistors and the winding of relay 156-PDCT, via the position control circuit, so that the operated hold magnets will not be held by the current through the winding of relay 156-PDCT alone. Referring to FIG. 118, the release of relay 126-HMT1 also performs a similar function with respect to the primary and secondary switch hold magnets so that holding ground therefor is no longer supplied through the AHS diode but, instead, is supplied from ground on terminal 118-107, through make contacts 126-PSL, break contacts 139-PAK, resistance V, and transfer break contacts 126-HMT1 to terminal 118-106 and, thence, over the hereinbefore described primary and secondary hold magnets operating circuit to the windings of the hold magnets. As was true for the tertiary hold magnets, the current supplied by ground through resistance V of this circuit for the primary and secondary hold magnets constitutes only a portion of the required holding current, the rest being supplied through the winding of relay 156-PDCT.

The operated hold magnets and the position circuit relay 162-S0 now hold in series with the winding of relay 156-PDCT. The current flowing through the winding of relay 156-PDCT at this time is sufficient to reoperate it. If a double connection obtains, the direct ground from the other connection would maintain the reverse direction of current flow in the winding of relay 156-PDCT and would prevent it from operating. Referring now to FIG. 126, the reoperation of relay 156-PDCT closes the following path to operate relay 126-OK: ground on terminal 126-101, make contacts 113-ON, 136-ATK, transfer make contacts 156-PDCT, make contacts 126-PSL, and break contacts 126-HMT1, to the winding of relay 126-OK to operate it. Relay 126-OK, in operating, closes a holding path for itself through transfer break contacts 126-RS to ground on terminal 126-106. The operating ground on the left-hand winding terminal of relay 126-OK may be extended through make contacts 133-GC0 and over conductor OK0 in cable OK extending through FIGS. 126, 125, 131, 137, 136, 142, 152, 162, 163, and 164, through make contacts 163-PLCA, 169-TOA, transfer break contacts 164-OK0, make contacts 162-S0, to the winding of relay 164-OK0 to operate it. The operation of relay 164-OK0 informs the position control circuit that it has been connected to a trunk and that it must now ground the associated S- lead to take control of the connection.



Referring now to FIG. 165, the S-lead sleeve connection for the present connection through the link connector circuit enters the position control circuit on FIG. 165 over conductor S0 and is connected to terminal 165-101. The operation of relay 164-OK0 closes the following circuit to apply a direct ground to conductor S0 on FIG. 165: ground on terminal 104 of FIG. 162, break contacts 176-PD, make contacts 164-OK0, 162-S0, conductor S0 in cable S0-2 extending through FIGS. 162, 163, 164, and 165 to terminal 165-101. This solid ground on the S0 lead holds up the connection when the controller subsequently releases, and also again reverses the current through relay 156-PDCT, thereby causing it to again release.

The operation of relay 164-OK0 in the position control circuit constitutes a signal to it that a position is connected to a trunk. The operation of relay 164-OK0 closes its make contacts on FIG. 164 to extend ground from terminal 164-101, through make contacts 164-OK0, to conductor PA0 in cable PA0-2 extending to FIG. 165 and, thence, to the output of the link connector switching field (FIG. 94), through the link connector to FIG. 73A, to the PA lead of the calling trunk circuit on FIG. 15 and to the winding of relay 13-PA to operate it. The operation of relay 13-PA constitutes a signal to it that a position is attached. The operation of relay 13-PA opens its break contacts on FIG. 15 to disconnect the ground on terminal 15-102 from the "start" lead ST- to the link connector. The "start" lead of this trunk, as hereinbefore described, is connected to conductor ST00 of FIG. 85A. Conductor ST00, in turn, is connected by means of the specific combination of relays currently operated to conductor T0 in the upper right-hand portion of FIG. 85A, which conductor extends, via cable T to FIG. 115, through break contacts 145-PTC to the winding of relay 115-T0 in the controller. Therefore, the release of ground from the "start" lead ST- by the calling trunk circuit causes the controller relay 115-T0 to release. Referring now to FIG. 139, the release of relay 115-T0 closes the following path to operate relay 139-PAK: ground on terminal 139-101, make contacts 113-ON, 136-ATK, 136-AT0, break contacts 115-T0, transfer make contacts 126-HMT2, and make contacts 126-OK, to the winding of relay 139-PAK to operate it. The operation of relay 139-PAK informs the controller that the position has been satisfactorily attached to the trunk.

The removal of ground potential from lead ST- of the calling trunk, as it operates its relay 13-PA, removes the ground potential from conductor ST00 on FIG. 85A, as hereinabove described, to release relay 85A-M00. The release of relay 85A-M00 opens make contacts 85A-M00 on FIG. 107A which, in turn, releases relay 107A-ST0.

Reviewing the circuit action just described, it may be seen that when the position control circuit is informed that it is connected to a trunk, it sends a signal over its PA lead through the crossbar switch crosspoints and over the interconnections to the trunk as an indication to the trunk that a position is attached. This signal operated relay 13-PA in the trunk. The trunk responded by opening its "start" lead, which released relays 85A-M00 and 107A-ST0 in the link connector and, in addition, released relay 115-T0 in the controller, relay 115-T0 being associated with this trunk. The release of relay 115-T0, in turn, operated the position-attached check relay 139-PAK.

Referring now to FIG. 118, the controller, recognizing that the position-attached check signal has been sent to the trunk, now reconnects relay winding 118-SLK through make contacts 139-PAK, conductor S0, via cable S, to the sleeve lead on the primary side of the link frame crossbar switch on FIG. 86. Relay 118-SLK operates at this time from the ground on the sleeve lead. The operation of relay 118-SLK serves as a check of the validity of the sleeve crosspoints and that the position control circuit has actually taken control of the connection by placing a

ground on the sleeve lead, as hereinabove described. On FIG. 105, the release of the link connector select magnets removes ground from conductor 105-SMK, thereby releasing relay 120-SMK.

Assuming that the foregoing checks are completed satisfactorily, the controller will recycle and, if it has registered the bids of other trunks within the attached trunk group, it will select the trunk having the next highest order of preference and will attempt to connect it to an available position. If, on the other hand, the trunk served was the only calling trunk in its group, and if the controller had initially registered other trunk groups with calling trunks, the controller would now recycle and select the group having the highest order of preference of the remaining registered group and would attempt to serve the calling trunks within the most-preferred groups.

If there are no other trunk groups on the link frame which have calls waiting, the controller will proceed in the manner now described to release both itself and the link connector from the connection, with the exception, of course, of the closed crosspoints.

Referring now to FIG. 113, the operation of relay 139-PAK and the release of relay 115-T0 now close the following circuit to operate relay 113-DR: ground on terminal 113-102, break contacts 126-RS, 144-NCM, make contacts 126-HMT2, 139-PAK, transfer break contacts 113-DR, series-connected make contacts 115-T0 through 115-T4, to the winding of relay 113-DR to operate it. The operation of relay 113-DR opens break contacts 113-DR on FIG. 114 to disconnect the battery supplied at terminal 114-102 from terminal 114-103, thereby, in turn, removing holding battery from the circuit extending through transfer make contacts 130-AG0, transfer break contacts 145-G0P, lead D0 in cable D, extending to FIG. 106A, and make contacts 106A-CH0, to the winding of relay 106A-D0 in the link connector to cause relay 106A-D0 to release. The release of relay 106A-D0, in turn, opens its make contacts on FIG. 106B to open the circuit for relay 115-TC0 in the controller, thereby causing relay 115-TC0 to release. The release of relay 115-TC0 opens symmetric check circuit TCK and releases relay 115-TCK.

At this time, the satisfactory completion by the controller of the hereinbefore-described checks closes through the following circuit to operate relay 126-RS: ground on terminal 101 of FIG. 126, make contacts 113-ON, 136-ATK, transfer break contacts 156-PDCT, break contacts 129-TR, 120-SMK, make contacts 128-PK, 127-GK, 139-PAK, 118-SLK, and 126-OK, to the winding of relay 126-RS to operate it. The operation of relay 126-RS initiates the release of the controller relays involved in this connection. If the controller has registered the bids of any other trunks within the attached trunk group, it will select the trunk having the next highest order of preference with respect to the trunk just served and will attempt to connect it to an available position. If the trunk just served was the only bidding trunk of the group, the release, at this time, of the associated group relay, with all of the 115-T- relays released, will cause relay 139-SNG to operate. If there are other trunk groups which have bidding trunks, the controller with the 139-SNG relay operated will select the trunk group having the next highest order of preference with respect to the group just served and will attempt to serve the bidding trunks within that group.

If relay 139-SNG is operated, and if there are no other trunk groups registered as having calls waiting, the controller-release relay 131-RL will operate. When relay 131-RL in the controller operates, ground on terminal 131-102 is connected through make contacts 131-RL to lead RL extending through make contacts 106A-CD0, to the winding of relay 106B-RL in the link and connector frame (FIG. 106B), which, in operating, will allow the frame to release itself from the controller connection. The controller relay 131-RL, operated, will also advance



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the frame preference relay circuit within the controller as described in detail hereinafter. On FIG. 151, the operation of relay 126-RS opens its break contacts, thereby disconnecting the ground supplied at terminal 151-101 from terminal 151-102, thereby releasing relay 151-GR0. On FIG. 126, the operation of relay 126-RS, at transfer break contacts 126-RS, also opens the locking circuit for relay 126-PSL, causing it to release. The operation of relay 126-RS also opens the locking circuit for relay 126-OK, causing it to release. The operation of relay 126-RS also opens the locking circuit for relay 126-DCT, causing it to release. On FIG. 136, the operation of relay 126-RS, at break contacts 126-RS, also opens the locking circuit for relay 136-AT0, causing it to release. The release of relay 136-AT0, in turn, opens the circuit through symmetric check circuit ATCK, causing relay 136-ATK to release. On FIG. 126, the release of relay 136-ATK opens the locking circuit for relay 126-HMT2, causing it to release. On FIG. 139, the release of relay 126-HMT2, at transfer make contacts 126-HMT2, opens the circuit for relay 139-PAK, causing it to release. On FIG. 151, the operation of relay 126-RS opens an obvious circuit to release relay 151-GADK. On FIG. 113, the operation of relay 126-RS also opens an obvious circuit to release relay 113-HG. The release of relay 113-HG, in turn, releases relay 113-G0. On FIG. 139, the release of relay 113-G0, at its transfer break contacts, closes the circuit from ground on terminal 139-101, through make contacts 113-ON, 113-DR, 130-AG0, transfer break contacts 113-G0, 145-G0P, break contacts 131-TTFA, and series-connected transfer break contacts 115-T0 through 115-T4, to the winding of relay 139-SNG to operate it. On FIG. 113, the operation of relay 126-RS, at its break contacts, opens the circuit for relays 113-HG and 113-HGP, causing them to release. The operation of relay 139-SNG also releases relay 113-DR. On FIG. 136, the operation of relay 139-SNG, at its break contacts, opens the circuit for relays 130-AG0 and 130-AGA0, causing them to release. The release of relay 130-AG0, in turn, opens the symmetric checking circuit CK, causing relays 130-AGK and 130-AGKA to release. On FIG. 118, the release of relay 130-AG0, at its make contacts, also releases relay 118-SLK.

Referring now to FIG. 131, the operation of relay 139-SNG closes the following path to operate relay 131-RL: ground on terminal 131-101, series-connected break contacts 145-G0P through 145-G9P, series connected break contacts 113-G0 through -G9, series-connected transfer break contacts 121-G0T through -G9T, make contacts 139-SNG, and break contacts 129-TR, to the winding of relay 131-RL to operate it.

The operation of relay 131-RL extends the ground on terminal 131-101 to advance the frame-preference circuit, as is hereinafter described. Thus, if relay 131-FP0 had initially been operated, the advance of this preference circuit would operate relay 131-FP1, thereby permitting the release of relay 131-FP0. Relay 131-FPK releases during the period of time that the frame-preference circuit is advancing, since it is a one-out-of- $n$  check relay, where  $n$  is the number of relays in the preference chain, and operates only when one, and only one, of the frame-preference relays is operated. On FIG. 113, the release of relay 131-FPK removes the ground from terminal 113-103 from the winding of relay 113-GE, causing it to release.

The release of relay 151-GR0, as hereinbefore described, with all of the other 151-GR- relays released, thereby completes a path through the 0-out-of-7 symmetric downcheck circuit indicated by rectangle CK on FIG. 145 and causes the operation of downcheck relay 145-GRDK. On FIG. 154, the release of relay 151-GR0 also releases relay 154-PG0 which, in turn, releases relay 154-GA0. On FIG. 133, the release of relay 154-GA0 releases relay 133-GC0 which, in turn, releases relay 133-GCA0. On FIG. 149, the release of relay 133-GC0

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also releases relay 149-CL0. On FIG. 157, the release of relay 133-GC0 also releases relay 157-PS. On FIG. 125, the release of relay 157-PS releases relay 125-P. The release of relay 157-PS also opens the series connection between the windings of relays 125-P and 125-P0, thereby releasing them. The release of relay 157-PS also releases relay 128-PK. On FIG. 127, the release of relay 154-GA0 disconnects ground from the 1-out-of-7 symmetric upcheck circuit, indicated by rectangle GPK, to release the upcheck relay 127-GK.

On FIG. 137, the release of relay 115-TCK releases relays 137-PGT and 137-PGTA. On FIG. 126, the release of relays 136-ATK and 137-PGT releases relay 126-RS. On FIG. 151, the release of relay 126-RS extends the ground on terminal 151-101 to terminal 151-102 and, thence, through the series-connected transfer break contacts of all the relays 154-GA6 through 155-GA0, released, to the winding of relay 151-GADK to operate it. On FIG. 144, the release of relay 137-PGT opens a holding circuit for relay 144-CDK, causing it to release. On FIG. 157, the release of relay 137-PGT opens the path through the 1-out-of-10 symmetric upcheck circuit, indicated by rectangle PK, to release relay 157-P0K. The release of relay 157-P0K, in turn, opens circuitry on FIG. 125 to release relays 125-P0A, 125-P0B, and 125-P0C.

On FIG. 144, the release of relay 137-PGT opens its make contacts, thereby opening the locking circuit for relay 142-C00A, causing it to release. The release of relay 142-C00A, in turn, opens the 1-out-of-32 symmetric upcheck circuit on FIG. 142, indicated by rectangle CUC, to release relay 142-CHA. The release of relay 142-C00A also opens circuitry on FIG. 147 to release relays 147-C0 and 147-C0A.

On FIG. 136, the release of relay 136-AT0 opens circuitry to release relay 106A-TU0 in the link connector. On FIG. 96, the release of relay 106A-TU0 opens circuits to release relays 118-AL0A and 118-AL0B.

On FIG. 152, the release of relay 154-GA0 opens a circuit to release relay 150-GU0 in the key-control position-control circuit. On FIG. 158, relay 133-GC0, in releasing, also opens a circuit to release relay 158-TCA0 in the key-control position-control circuit. On FIG. 157, the release of relay 133-GC0 also opens a circuit to release relay 163-PLC which, in turn, releases relay 163-PLCA. The release of relay 133-GC0 in the controller also opens a circuit, beginning on FIG. 133, to disconnect negative battery from lead PG0, in cable PG to FIG. 91, to release relay 91-PG0 in the link connector. The release of relay 91-PG0, in turn, opens a circuit on FIG. 89, to conductor BL00 in cable BL to FIG. 119, to release relay 119-BL00 in the controller.

The operation of relay 131-RL in the controller, in the manner hereinbefore discussed, now closes the following path to operate relay 106B-RL in the link connector: ground on terminal 102 of FIG. 131, make contacts 131-RL, over conductor 131-RL extending to FIG. 106B, and make contacts 106A-CD0, to the winding of relay 106B-RL to operate it. The operation of relay 106B-RL, in turn, releases relay 102-CSA. The release of relay 102-CSA, in turn, opens a circuit, beginning on FIG. 108B, to disconnect negative battery from lead CS0 to release relay 112-CS0 in the controller. The release of relay 112-CS0 opens a circuit, starting on FIG. 116, to open lead CB0, to release relay 102-CBT0. The release of relay 112-CS0 also opens a circuit, beginning on FIG. 112, to disconnect negative battery from lead CA0, to release relay 106A-CA0. The release of relay 106A-CA0, in turn, disconnects ground from the following relays on FIG. 106A: 106A-CB0, -CC0, -CD0, -CE0, -CF0, -CG0, and -CH0, thereby causing their release. The release of relay 106A-CA0 also disconnects ground from relay 106A-LCC, thereby causing its release. The release of relay 106A-LCC, in turn, releases relay 106A-LCCA.



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On FIG. 106B, the release of relay 106A-CD0 opens a circuit to release relay 106B-RL. On FIG. 108B, the release of relay 106B-RL also releases relay 108B-CCP. The release of relay 108B-CCP, in turn, advances the "WXZ" walking circuit one step.

On FIG. 106A, the release of relay 106A-CE0 opens a circuit to disconnect the ground on terminal 106A-109 from the conductor "ON" extending to "off-normal" relay 113-ON in the controller, causing relay 113-ON to release. The release of relay 113-ON, in turn, opens the circuits for relays 139-SNG, 151-GADK, and 145-GRDK, causing them to release. The release of relay 139-SNG releases relay 145-PTC. On FIG. 131, the release of relay 113-ON opens the locking circuit for relay 131-RL, causing it, also, to release. The release of relay 131-RL advances the frame-preference circuit on FIG. 131 one step. When the circuit is so advanced frame-preference-check relay 131-FPK operates from ground over the symmetric check circuit shown on FIG. 131. The operation of relay 131-FPK closes a path on FIG. 112, from ground on terminal 112-101, through the relay contacts of the frame-preference circuit, to operate relay 112-DA1. Relay 131-FPK, operated, also connects battery on terminal 112-102, through the frame-preference circuitry, to operate relay 112-DA2. The operation of relay 131-FPK, as a consequence of the advance of the frame-preference circuit, opens the holding path for relay 116-MB, causing it to release.

Referring now to FIG. 116, the leads designated CB0 through CB9, which extend to the various link connector frames, are used to tell the link connector frames when the controller is busy and when it is idle. During a seizure of the link controller, all link frames which have not successfully seized the controller have their respectively associated 112-CS- relays released while relay 116-MB in the controller is operated. This being the case, a path may be closed on FIG. 116 to extend ground through make contacts 116-MB, through the transfer break contacts of the respectively associated 112-CS- relay, to the respective CB- leads leading to the link connectors which have not seized the controller. Thus, assuming, for example, that link connector frame "1" did not seize the controller, a path would now be closed to extend ground on terminal 116-102, through make contacts 116-MB and transfer break contacts 112-CS1, to lead CB1 which connects to the link connector frame "1." The same would be true for all other CB- leads associated with link connector frames which did not seize the controller. However, assuming that frame "0" had successfully seized the controller, a ground would not be extended to lead CB0 since relay 12-CS0 would be operated at this time and, therefore, its break contacts on FIG. 116 would isolate lead CB0 from the ground on terminal 116-103 extended through make contacts 116-MB. The release of relay 116-MB, at the termination of release of the controller, removes the grounds from these CB- leads, thereby releasing their associated 112-CBT- relays in the link connector, which are shown on FIG. 102 for controller "0."

Reviewing the circuit action just described, it may be seen that when the controller has satisfactorily completed the trunk-to-position connection, it makes a final check to determine whether the new position group in the "units" order of preference has been set properly. If this check is satisfactory, the relay 126-RS is operated as hereinbefore described. The operation of relay 126-RS initiates the release of the controller relays involved in the connection. If the controller has registered the bids of any other trunks within the attached trunk group, it will select the trunk having the next highest order of preference with respect to the trunk just served and will attempt to connect it to an available position. If the trunk served is the only bidding trunk of the group, then the associated group relay releasing at this time, with all of the relays 115-T0 through 115-T4 released,

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will operate relay 139-SNG. If there are other trunk groups which have bidding trunks, the controller having its relay 139-SNG operated will select the group having the highest order of preference with respect to the group just served and will attempt to serve the bidding trunks within the group. If relay 139-SNG is operated and there are no other trunk groups registered as having calls waiting, the controller-release relay 131-RL will operate. When relay 131-RL operates, the controller places a ground potential on the RL lead extending to the link and connector frame, which ground allows the frame to release itself from the controller connection. Relay 131-RL, operated, will also advance the frame-preference relay circuit in the controller. Also, the release of relay 131-RL in the controller releases relay 112-CS0 which, in turn, as hereinbefore described, operates relay 102-CBT0 in the link connector frame which just served the present call, thereby making this link frame "busy" to the controller which, in turn, forces the link frame to bid for another controller on an immediate subsequent call, if any such calls are waiting on the frame. After the controller releases its relay 131-RL, it then releases all the multicontact connector relays associated with the frame-to-controller connection that is now being broken down. At this stage of the release, the frame advances its controller-preference circuit, consisting of relays 108B-W, 108B-X, and 108B-Z, one step by releasing relay 108B-CCP which drives the controller-preference circuit. The advance of the controller-preference circuit partially closes the operate path for relay 102-CSA. The idle link frame is now able to initiate another bid for a controller to serve any calls which may be waiting at this time, or when it recognizes subsequent requests for a connection.

The following describes the frame-preference circuitry shown on FIGS. 112 and 131. In the controller, one 131-FP- relay (frame preference) is provided for each link frame to which it can be connected. The 131-FP- relays are arranged in a chain in such a manner that, in its normal state, only one of the preference relays will be operated. An operated 131-FP- relay will place one of the link frame circuits in a preferred position in the controller-start circuit on FIG. 112. The controller-start circuit consists of an endless chain composed of interspersed transfer contacts of the -CS- and -FP- relays, the entry point of which is set by the operated -FP- relay. At the end of each controller usage, relay 131-RL operates, as hereinabove explained, and advances the frame-preference chain one step as follows: an operated -FP- relay, such as for example, 131-FP0, partially closes a circuit to the succeeding -FP- relay, such as 131-FP1, through a chain comprising the transfer break contacts of all the preceding -FP- relays. When relay 131-RL operates, this circuit is completed and the succeeding frame-preference relay operates and locks itself to ground through a chain of transfer break contacts of all succeeding frame-preference relays. The operation of the succeeding -FP- relay, in addition, transfers the locking path of the previously-operated -FP- relay to ground through the make contacts 131-RL which control this circuit, thus ensuring that the previously-operated -FP- relay will remain operated until relay 131-RL is released.

On FIG. 131, with two -FP- (frame-preference) relays operated, the frame-preference-check relay 131-FPK will release, thereby opening the controller-start circuit of FIG. 112, thus making the controller unavailable for service during the time required by the frame-preference-advance sequence. The release of relay 131-FPK opens a locking path of relay 131-RL. This path is provided to ensure that relay 131-RL is operated a sufficient length of time to advance the frame-preference circuit. If the last preference relay is operated when relay 131-RL operates, the reset-frame-preference relay 131-RSF will be permitted to operate. Relay 131-RSF serves to reset



the frame-preference circuit by causing relay 131-FP0 to operate next.

If for any reason there is no -FP- relay operated, such as might be the case when power is first applied to the circuit, ground is extended through transfer break contacts 131-RSF, 131-FP0, 131-FP1, transfer break contacts of the remaining -FP- relays, and the primary winding of the frame-preference-alarm relay 131-FPAL, thereby causing it to operate. Relay 131-FPAL, operated, in turn, operates trouble recorder relay 129-TR, thereby causing the controller to request connection to a trouble recorder circuit to record the fact that the frame-preference circuit has been momentarily lost. Relay 129-TR, operated, operates the trouble-recorder-busy relay 117-TRB. The operation of relay 117-TRB, which signals the completion of the trouble record, extends ground through an -FP- downcheck chain circuit, causing relay 131-FP0 to operate. Relay 117-TRB, operated, also operates relay 131-RL which, in turn, operates relay 131-FP1. The release of relay 117-TRB releases relay 131-RL which, in turn, releases relay 131-FP0, thereby leaving the controller-preference circuit primed with relay 131-FP1 operated. The controller is now returned to normal service.

If the frame-preference circuit fails to advance when relay 131-RL is operated, relay 131-FPAL will operate from ground extended through make contacts 131-RL and 131-FPK to its secondary winding. Relay 131-FPAL is "slow acting" to give the preference circuit sufficient time to advance normally. If relay 131-FPAL operates, the controller will request a connection to the trouble recorder circuit as hereinbefore described. The controller will, in this case, ground the FPAF lead (FIG. 123) to the recorder, so that the associated perforation will be punched on the trouble record card, thereby alerting the maintenance personnel to the fact that the preference circuit does not advance. The completion of the recording does not advance the circuit in this case, and, therefore, trouble cards will be generated on each succeeding call until the trouble is corrected.

The following describes the trunk-preference circuitry shown on FIGS. 132, 133, 124 and 130: the 50 trunks served by each link frame are divided into ten groups of five trunks each. In the controller, one preference relay is provided for each of the five trunk "units" within a group. The preference relays are arranged in a contact chain which constrains the circuit so that in the quiescent state only one preference relay will be operated. The operated preference relay places the trunk "units" having the numerical designation corresponding thereto in the highest order of preference in the closed ring selection circuit by selecting the proper entry point to that circuit.

When the frame-preference circuit has undergone one complete rotation, relay 131-RSF is operated, as hereinabove described. Relay 131-RSF, in operating, advances the trunk-units-preference by one step as follows: the operated trunk-units-preference relay 133-TUP- on the right-hand side of FIG. 133 partially completes a circuit to the succeeding 133-TUP- relay. Relay 131-RSF, in operating completes the circuit to the succeeding -TUP- relay, which operates and locks through the break contacts of the two -TUP- relays succeeding it. The just operated -TUP- relay transfers the locking path of the previously-operated -TUP- relay to ground through the 131-RSF make contacts which control this circuit, thereby holding the previously-operated -TUP- relay operated until relay 131-RSF releases.

With two trunk-units-preference relays operated, the trunk-group-preference-one upcheck relay 132-TUPK releases. The release of relay 132-TUPK opens an auxiliary locking path on FIG. 131 to relay 131-RSF. This auxiliary locking path ensures that relay 131-RSF will remain operated until the trunk-group-preference circuit advances. When the trunk-units-preference circuit subsequently restores to normal, relay 132-TUPK reoperates and partially completes this circuit for the trunk "units" selection.

The circuit is arranged to function in a closed ring with relay 133-TUP0 following relay 133-TUP4. Therefore, no end relay is required to reset this preference circuit. If there is a loss of trunk "units" preference, relay 131-FPAL will be operated on its primary winding, through a chain of transfer break contacts of all of the trunk-units-preference relays. The operation of relay 131-FPAL causes the controller to request a connection to the trouble recorder, thereby generating a trouble recorder card as hereinabove described in connection with the frame-preference circuit.

If the trunk-units-preference circuit fails to advance when relay 131-RSF is operated, relay 133-TAF2 will operate. Relay 133-TAF2 is slow in operating in order to give the preference circuit enough time to advance normally. If relay 133-TAF2 operates, the controller will request a connection to the trouble recorder circuit, and will function as hereinabove discussed except that, in this case, ground on FIG. 123 will be extended through make contacts 117-TCB and 133-TAF2 to the TUA lead to the trouble recorder circuit.

In the controller, one trunk-group-preference relay is provided for each of the ten trunk groups, designated -TGP0 through -TGP9 on FIGS. 132 and 133. The trunk-group-preference circuit is completely analogous in its operation to the trunk-units-preference circuit just described and, hence, will not be described in detail. The trunk-group-preference circuit is advanced one step at the end of each complete rotation of the trunk-units-preference circuit.

The following describes the "position-group" and "units" preference circuit: the controller has the ability to connect a bidding trunk to any one of a maximum of 66 operator positions. The 66 positions are divided into 7 groups. In distributing traffic, the controller places calls with positions as if the entire group of 66 operators were an entity, with the positions numbered from "00" to "65." The controller attempts to distribute calls equally among all of the positions by allotting calls to available positions in descending numerical order in a closed ring arrangement. In the controller, a set of seven relays, designated -GP0 through -GP6, on FIG. 127, is provided, also, a set of ten relays, designated -PP0 through -PP9, on FIG. 128, is provided. These two sets of relays afford the preference feature for the "position-group" and "units," respectively. Each set of relays is arranged in a chain in such a manner that only one relay in each set will normally be operated. The relays function to record the identity of the position which will be preferred when the next connection is to be set up. For example, if relays 127-GP3 and 128-PP5 are operated, the controller will attempt to select position "5" in group "3" (position "35") to serve the next bidding trunk; or, if this position is unavailable, the controller will select the first available position by hunting in a descending numerical order. If, for example, position "28" is seized, relays 154-GA2 and 125-P8A are operated. When relay 157-PS operates, the controller will reset the preference to position "27," with relay 154-GA2, operated, directing ground on terminal 127-105, through make contacts 157-PS, and transfer break contacts 125-P0, to the primary winding of relay 127-GP2 and, similarly, with relay 125-P8A, operated, directing ground on terminal 128-101, through make contacts 157-PS, and 125-P8A, to the winding of relay 128-PP7. If on any call, the position "units" chosen is "0," the preference will then be reset to the "9th" position of the group, numerically one digit lower than the group just selected. When a relay 127-GP- or a relay 128-PP- is thus operated, on its primary winding, any other relay in the same chain loses its locking circuit for its secondary winding and, hence, releases. When only one relay in each of the -GP- and -PP- chains is operated, the operate path is extended through the symmetric check circuits 127-GPK and 128-PPK, respectively, to the winding of check relays 127-GK and 128-PK for the "group"



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and "units" preference circuits, respectively, which then operate as a check that one and only one preference relay in its respectively associated chain is operated. If either of the check relays 127-GK and 128-PK fails to operate, relay 126-RS will be prevented from operating, thereby causing the circuit to time out and request connection to the trouble recorder circuit, to record the details of the position preference failure. At the conclusion of the recording 117-TRB operates, resetting the position preference to relays 127-GP6 and 128-PP9.

The controller, in selecting a position, seizes the most-preferred group having positions available to serve the waiting call. If all of the available positions in the selected group are higher in numerical designation than the preferred "units," the controller will select none of them, since this would be contrary to the call distribution pattern, but would, instead, operate the advance preference and selection relay 137-APS. The operation of relay 137-APS resets the preference to the "9th" position of the next lower group. Relay 137-APS, operated, also releases the previously-operated relay 151-GR- associated with the selected group, in turn, releasing the associated -PG-, -GA-, -GC-, and -P- relays. Relay 137-APS then releases, initiating the "start" of a second position selection in the normal manner. Should the controller recognize, prior to the operation of relay 137-APS, that there are no other groups which have idle positions, it will operate the cancel-advance-of-preference relay 137-CAP to cancel the advance of preference. The controller in this case hunts for the first idle position within the seized group, in numerically descending order, starting with the "9th" position in the group.

If the controller selects a position group with only one position available, and if for any reason the position which was available then becomes busy prior to the operation of relay 137-PGT, the position will remove the negative potential from its idle indicating lead, thereby causing the associated -P- relay to release. The release of the associated -P- relay closes a path through symmetric check circuit 157-PK, operating relay 157-FAP. Relay 157-FAP, operated, operates relay 137-APS, which functions as hereinabove described.

The serving of the presently described call has progressed to the point where, in response to a request from the trunk circuit for connection to an operator position, the link connector and the link controller have extended a connection from the calling trunk circuit (FIGS. 10 through 15) to the position control circuit (FIGS. 162 through 204, and 222) which is individually associated with and serves the operator position circuit shown on FIGS. 205 through 221, and 223.

It has hereinbefore been described that the presently disclosed system includes 66 operator positions, each of which has its own individual position control circuit. Therefore, the physical embodiment of the disclosed system would contain 66 operator position circuits identical to the one shown in FIGS. 205 through 221, and 223, and 66 position control circuits identical to the one shown in FIGS. 162 through 204, and 222. For reasons of economy of disclosure, only one position control and position circuit are shown on the present drawings, and it is assumed that these particular circuits serve the present call.

The position and position control circuits are arranged so that, at the time a position is not occupied by an operator, the various leads interconnecting the position control circuit with the link controller have potentials applied to them to make the position and position control circuits appear busy to the link controller. Upon occupation of a position by an operator, the operator's headset plugs are inserted into jacks C and D on FIG. 221. This completes the transmission circuit for the operator, as is hereinafter described, and, in addition, closes the C jack contact on FIG. 221 to operate the relay 221-P0 over the following circuit: ground on terminal 221-101, make

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contacts of the C jack, to the winding of relay 221-P0 to operate it. The operation of relay 221-P0 closes an obvious circuit, on FIG. 168, to operate relay 168-P0 in the position control circuit. The operation of relay 168-P0, in turn, closes a circuit, on FIG. 167, to operate relay 167-P0A. The operation of relay 167-P0A completes the following circuit to operate relay 163-PGT: ground on terminal 103 of FIG. 163, make contact 167-P0A, break contacts 176-PDA, 169-T, 197-ACS, 168-MBB, 181-PRA2, 165-S5, 167-PBA, 167-TBA, 167-TBB, 167-PBB, and 168-MBA, to the winding of relay 163-PGT to operate it. As a consequence of the operation of relay 163-PGT, the ground on terminal 104 of FIG. 163 is extendible, through various break contacts of relays 162-S0 through 162-S2, in various combinations and under varying conditions, to conductors PG- and RTG- extending, respectively, to terminals P0 and R0 on FIG. 152 of the link controller, and, thence, via conductors PGG0 and RTG0, respectively, in cable PRG, to FIG. 160 of the key-control-position-control circuit. These leads are arranged in accordance with operator groups in the link controller, and the potentials on them enable the controller to ascertain whether any position in the associated group is currently available for service. Conductor PG- has a ground extended to it from terminal 163-104 whenever two or more loops are idle as a consequence of two or more of the relays 162-S0 through 162-S2 being released, while lead RTG- has a ground extended to it from terminal 163-104 as a consequence of any one of the relays 162-S0 through 162-S2 being released. As hereinbefore described, the controller in attempting to extend a connection to a position, first looks at the PG- leads to find a position having two or more loops idle and, in the event that no such position can be found, then looks at the RTG- leads to find a position having one loop idle.

Thus, the absence or presence of ground potential on conductors PG- and RTG- enables the controller to select the operator group that will serve the present call. Next, as hereinbefore described, the controller looks at the P00 and RT00 leads to ascertain the number of loops available in the various positions of the group to serve the call. Referring to FIG. 163, the battery on terminal 163-105 is extendible through a contact network to conductors P00 and RT00 in cable P, extending to FIG. 161 of the key-control-position-control circuit, the completion of this path depending mainly upon the number of relays 162-S0 through 162-S2 which are currently released. Conductor P00 has battery extended to it in the event that two or more loops are idle as a consequence of two or more of the relays 162-S0 through 162-S2 being released, while conductor RT00 has battery extended to it whenever a single loop is available, as indicated by the released condition of one of the relays 162-S0 through 162-S2. Conductors P00 and RT00 extend from FIG. 163 to FIG. 161 of the key-control-position-control circuit where, by means of terminal 161-P00, which is strapped to terminal 161-PA, the circuit may be extended through transfer break contacts 159-TPA, and through various other circuits, to conductor P00 in cable P', extending to FIG. 125 of the link controller, and terminates on the specific 125-P- relay associated with the particular position circuit shown in detail on the present drawings.

The controller has now, after ascertaining the operator group that will serve the present call, tentatively selected a particular position and must determine which loop of the position is available, as manifested by the potentials on conductors BY0 through BY2 of FIG. 162. The presence of ground on any of these leads indicates that the associated loop is busy. When the position is unoccupied, relay 168-P0 is released and the ground on terminal 162-105 is extended by break contacts 168-P0, and transfer break contacts 191-OG-, and 162-S-, to all of conductors BY0 through BY2, to make their associated loops



busy to the link controller. However, the operation of relay 168-P0 removes the ground on terminal 162-105 from conductors BY0 through BY2, thereby, for the present, making all of their associated loops available. From now on, as long as the position is occupied, a ground will be on one of these conductors only when its associated loop is busy, as manifested by the operated condition of relays 162-S0 through 162-S2. As hereinbefore described, three of the four relays -CL0 through -CL3, on FIGS. 149 and 148 of the controller, are now connected to conductors BY0 through BY2 of FIG. 162 to determine the loop that will serve the present call. In this connection, it was earlier assumed that relay 149-CL0 did not operate. Therefore, relay 149-CL0, normal, allowed the controller to attempt to extend the call to loop "0" of this position.

The operation of relay 168-P0 closes its transfer make contacts on FIG. 163 of the position control circuit in series with the operating circuit of relay 163-PLC, so that it may condition this circuit to enable the controller to operate relay 163-PLC in an attempt to extend a call to this position control circuit.

It has hereinbefore been described how, in extending a call to the disclosed position control circuit, relay 125-P0 operates in series with the resistance battery connected to terminal 105 of FIG. 163. The controller next attempts to operate relay 163-PLC in connection with the extension of this call to this circuit. It was hereinbefore described that relay 163-PLC was operated without any difficulty, and that the call was successfully extended to this position. Although it has not yet been described, the operator performs a plurality of functions, some of which are initiated on the operator's own accord, which functions may effect the availability of the operator's position for service. The contacts associated with the various functions are shown connected intermediate terminals 106 and 101 on FIG. 163, and it may be seen that the operation of any of their associated relays will be effective to disconnect the winding of relay 163-PLC from terminal 163-101 and the PC lead connected thereto, and thereby prevent the controller from operating relay 163-PLC. The operation of any of these transfer contacts, such as for example, 169-T, disconnects the battery extended from the controller, via lead PC, from the circuit to operate relay 163-PLC and, instead, returns it through transfer make contacts 169-T, and break contacts 163-PLCA via lead PBY, in cable PCC, extending back to the controller to operate relay 157-PBT in the controller, thereby informing it that this position is currently unavailable. The operation of relay 157-PBT causes the controller to recycle and attempt to select a different position, as hereinbefore described. It has hereinbefore been described how in serving this call the controller found positions "0," "1," and "9" of group "0" available as a consequence of the operation of its relays 125-P0, -P1, and -P9. It was then described that position "0" was the preferred position, and that as a consequence, relays 125-P1 through 125-P9 released. It was also described how relays 137-PGT and 137-PGTA operated, along with relays 157-P0K, 125-P0A, 125-P0B, and 125-P0C in the controller. It was further described how relays 163-PLC and 163-PLCA were operated in extending this call to this position control circuit. It was then described how the position control circuit acknowledged its seizure by extending a ground from the make contacts of relay 163-PLCA to operate relay 157-PS in the link controller. It was also hereinbefore described how the operation of relay 157-PS operated relay 133-GCA0 to transmit a trunk connector number of "0" to the position control circuit by operating its relays 164-ODN4 and 164-ODN7. The trunk connector number is stored by the position control circuit until the call progresses to the point where the operator has no further need for this information.

The following circuit actions have also been hereinbefore described: (1) How the operation of relay 157-PS

operates relay 142-C00A which is associated with the selection of a particular link. (2) How relay 162-S0 was operated as a consequence of the seizure of the "0" loop of this position. The operation of relay 162-S0 completes the following circuit to operate relay 169-T0: ground on terminal 101 of FIG. 169, make contacts 167-P0A, break contacts 167-LMT, 173-RMT, 165-S5, 169-T5, 169-T2, 169-T1, 173-HD0, and make contacts 162-S0, to the winding of relay 169-T0 to operate it. The operation of relay 169-T0 completes an obvious circuit to operate relay 169-T. On FIG. 162 the operation of relay 169-T0 also connects ground through transfer make contacts 169-T0, via conductor T0, in cable TA, to the winding of relay 169-T0A, causing it to operate. The operation of relays 169-T0, -T0A, and -T serves to condition the traffic service position so that the active loop just selected is converted to the talking condition. The operator telephone circuit and some of the switchboard keys are effective only when associated with the currently active loop.

The operation of relay 169-T completes the following path to operate relay 181-TTMG: ground on terminal 102 of FIG. 182, make contacts 169-T, break contacts 191-OG, make contacts 163-PLCA, break contacts 198-10T, 175-TRW, 172-STMA, to the primary winding of relay 181-TTMG to operate it. Relay 181-TTMG, in operating, partially completes the seizure path for the data transfer circuit. Relay 181-TTMG has its secondary winding short-circuited through resistor TTMG and its own make contact, thus making it slow to release, to ensure that the data transfer seizure signal will be provided within a measured time interval determined by the release time of relay 181-TTMG.

The operation of relay 169-T closes the following circuit on FIG. 169 to operate relay 169-TNT: ground on terminal 169-102, break contacts 176-PDA, make contacts 167-P0A, terminal 169-103, make contacts 169-T, break contacts 197-ACS, make contacts 169-T, make contacts 163-PLCA, to the primary winding of relay 169-TNT to operate it. Relay 169-TNT, in operating, completes a holding path for itself through break contacts 169-TN, its own make contacts, make contacts 167-P0A, and break contacts 176-PDA, to ground on terminal 169-102. The secondary winding of relay 169-TNT is short-circuited through its own make contact to provide a controlled slow release. This slow-release feature is used later in the operation to provide a timed delay interval which directly controls the duration of the "zip" tone signal spurt to the operator, which alerts the operator that a call has been placed actively in that position.

Reviewing briefly, the following circuit actions were hereinbefore described: (1) How relay 142-CHA operated in connection with a channel check operation. (2) How relay 156-PDCT operated in connection with a test of loop "0" of the currently connected position control circuit. (3) How relay 126-DCT operated as a double-connection test to ensure that only one controller is attempting to connect this link to this position. (4) How relays 126-HMT1 and 126-HMT2 operated to provide the necessary timing for the double-connection test. (5) How the hold magnets in the link connector operated and, as a consequence thereof, how the associated crosspoints closed. (6) How relay 156-PDCT releases following the closure of the crosspoints. (7) How relay 126-HMT1 then releases. (8) How relay 156-PDCT reoperates following the release of relay 126-HMT1. (9) How relay 126-PSL operated. (10) How relays 126-OK in the link controller and 164-OK0 in the position control circuit operated, thereby constituting a "connection OK" signal to the position control circuit signifying that the link controller has satisfactorily completed its functions in connecting the trunk to the selected position. This "OK" signal is received in the position control circuit and registered on relay 164-OK0. (11) How relay 156-PDCT released subsequent to the operation of relays 126-OK and 164-OK0. (12) How relay 13-PA operated in the trunk to inform



the trunk that it is now attached to a position. (13) The operation of relays 139-PAK and 126-RS, and the release of relays 151-GR0, 154-PG0, 154-GA0, and 113-GC0.

The release of relay 133-GC0 opens its make contact, on FIG. 157, which is in the operate circuit for relay 163-PLC, thereby causing it to release. The release of relay 163-PLC, in turn, releases relay 163-PLCA. The release of relay 163-PLCA closes the following path to operate relay 181-DTST: ground on terminal 102 of FIG. 182, make contacts 169-T, break contacts 191-OG, 163-PLCA, 169-TE, 197-ACS, 170-PR, 187-RRL, 182-CIF, 175-TRA, 182-DTOK, 182-TIF, 175-TRBY, 182-DTBL, make contacts 181-TTMG, to the winding of relay 181-DTST to operate it. The operation of relay 181-DTST causes the closure of obvious paths on FIG. 181 to operate relays 181-PRA, 181-PRA1, and 181-PRA2. Relay 181-PRA, in operating, closes a holding circuit for itself and, in turn, causes the holding of relays 181-PRA1 and 181-PRA2. Relays 181-PRA1 and 181-PRA2 serve to provide an off-normal ground supply to all registration relays in the position control circuit which will be associated with the active call connected to loop "0" at this time. These relays remain operated to provide for retaining the memory of the call detail information until such time as the operator has no further need for it. Referring now to FIG. 224, the operation of relay 181-DTST applies battery through its make contacts, shown in FIG. 224 to conductor STDT extending to the data transfer circuit. The battery on this conductor represents a bid by position "0" for a connection to the data transfer circuit.

#### *Data transfer circuit operations*

The following describes how the data transfer circuit functions in connection with the serving of the present call. The broader functions and operations of this circuit have been priorly described in connection with FIGS. 2A through 2D, and 3A through 3K, in the general portion of the description. The discussion set forth therein need not be repeated, and it is believed sufficient at this point to state, merely, that the over-all function of the data transfer circuit is to interconnect one or more circuits during the serving of calls in order to facilitate the interchange of whatever data between these circuits is required for the successful serving of calls.

Basically, for this disclosure, the data transfer circuit comprises four conductor groups called channels, each of which channels comprises a large number of individual conductors. The various circuits to which the data transfer circuit must be connected are themselves divided into groups, each group of which is associated with a connector, which connector also comprises a portion of the data transfer circuit. Two circuits desiring interconnection are interconnected by assigning each circuit the use of its associated connector, by then assigning one of the four data channels to serve the interconnection, and finally, by completing the necessary contact closures to connect each circuit to its connector, as well as to connect each connector to the data channel assigned to serve the interconnection.

The data channels and connectors are shown on FIGS. 2A through 2D, and 3A through 3K, in coordinate or matrix form, wherever possible, for ease of understanding, with the data channels extending horizontally on a drawing, or between sheets of drawings, and with the connectors being shown vertically and intersecting the channels. Thus, the data transfer circuit may, to an extent, be analogized to a crossbar switch having four horizontals and a large number of verticals. Each of the four horizontals of such a switch may be considered to be analogous to one of the four data channels, and each of the verticals may be considered to be analogous to one of the connectors.

The circuit details of the data transfer circuit are shown on FIGS. 224 through 298. The matrix or coordinate form of presentation used on FIGS. 2A through 2D, and 3A through 3K, is also used on FIGS. 224 through 298 when-

ever possible. Also, for ease of understanding, the data transfer circuitry has been subdivided into groups of drawings in accordance with the function of each group. Further, relay windings, relay contacts, conductors, and entire circuits have multiple designations where they represent multiple circuits or elements which differ from each other only in their designations and where they are otherwise similar to each other in every respect. For example, referring to FIG. 280, it may be seen that relay DAR0 for channel "0" may be operated by a large number of make contacts. Rather than show each of these contacts separately, each with its own individual designation, a number of the contacts are provided with multiple designations, and each such designation is to be understood to represent a separate, individual, and different contact. It may be appreciated that this expedient considerably reduces the size of the drawings required to disclose the data transfer circuit.

Also, the complexity of the data transfer circuit drawings is greatly reduced by disclosing only one circuit in those instances where the same circuit is repeated a number of times in the over-all data transfer circuit. Thus, referring again to FIG. 280, the complete details of the path over which relay DAR0 operates for channel "0" are shown. Each of the remaining three channels also has a relay DAR- which may be operated over a circuit identical to that shown for channel "0"; however, the equivalent circuitry for each of the remaining channels is shown only diagrammatically by the rectangles respectively designated channel "1," channel "2," and channel "3," immediately below the large rectangle designated channel "0" which contains the circuit details for channel "0." Similar expedients are used profusely throughout the data transfer circuit drawings in order to minimize their size and complexity.

Each channel of the data transfer circuit comprises a vast quantity of individual conductors. Some of these conductors are interconnectable, via the connectors, to any circuit having access to the data transfer circuit. Others of the conductors, on the other hand, are connectable to some, but not to all, of the different types of circuits served by and having access to the data transfer circuit. For example, one conductor in a channel, or one group of conductors in a channel, may not be connectable to the trunks and, therefore, these conductors serve no function on interconnections involving only a sender and a trunk.

As hereinabove stated, the plurality of conductors comprising each channel are shown in matrix form on the present drawings. The channel conductors are shown horizontally and the connector conductors are arranged vertically. However, due to the vast quantity of conductors comprising each channel, no single figure of the drawing, and no single matrix display, discloses all the conductors together as an entity. Instead, a plurality of matrix displays is utilized, each such matrix display disclosing only the conductors which are a part of or are associated with the specific subcircuit shown on the display. Thus, FIGS. 259 and 261 comprise two different matrix displays, each of which discloses the position circuits and certain control circuitry within the data transfer circuit. The matrix display on FIG. 261 has multiple designations and displays the circuitry interconnected by conductors ST0P and PT0S. Multiple designations are used in this instance since identically designated relay contacts are used to interconnect these conductors with their associated relays in the data transfer circuit and with their associated equipments in the positions. FIG. 259, on the other hand, comprises a matrix display of only the circuitry associated with the single conductor 0TR. This display on FIG. 259 could not be combined with that on FIG. 261 since contacts of different relays are used to interconnect the positions with their connectors and their connectors with the data channels. Thus, referring to FIG. 259, the contacts interconnecting position "00" with po-



sition connector "0" are designated 224-PE00, while on FIG. 261 the connecting contacts are 224-PF00.

The function of the data transfer circuit on the present call is to interconnect trunk "00," position "00" and sender "00." All of these three circuits are already interconnected via other circuitry in the office. However, a supplemental interconnection of these circuits via a connector of large contact capacity and of short duration is desired at this time in order that these three circuits may interchange the vast amount of data required for the successful serving of the call. The interconnection may be said to be under control of the position since it is this circuit which first initiates a bid for service to the data transfer circuit and, once having secured a connection to a data channel, it is this circuit which instructs the data channel to interconnect itself with trunk "00" and sender "00." Thus, the description of operation of the data transfer circuit for the present call begins with the circuitry which interconnects the bidding position with an available data channel.

#### POSITION AND REGISTER CONNECTORS

The circuitry relating to the details of how a position first bids for, and is then connected to an idle channel of the data transfer circuit, is shown on FIGS. 224 through 235. Recalling the relationship of elements hereinbefore-described in that portion of the specification entitled "General Description," in connection with FIGS. 2 and 3, FIGS. 224 and 227 disclose the selection, preference, and connection circuitry of the six position connectors, each of which connectors is enclosed within a rectangle designated "B" in its upper left-hand corner. These six connectors serve the 66 operator positions. Only the circuit details of position connector "0" are disclosed, while the remaining connectors are shown only diagrammatically. Associated with each position connector is a plurality of rectangles designated "C" in the upper left-hand corner, each of which rectangles is associated with one of the position circuits served by its associated connector, and each of which rectangles contains the circuitry of the position control circuit responsible for the transmission of a "start" signal to the data transfer circuit when its respective position is to be connected to one of the data channels. The details of the position control circuit associated with position "00" are shown in its associated rectangle "C," while the position control circuits for the remaining positions are shown only diagrammatically in their respectively associated "C" rectangles.

FIGS. 230 and 233 disclose the selection, preference, and connection circuitry of the register connectors, each of which connectors is enclosed within a rectangle designated "D." Also disclosed thereon, in rectangles "F," is as much of the circuitry of the registers respectively associated with the register connectors as is responsible for the transmission of a "start" signal to the register connector as the register attempts a connection thereto.

FIGS. 225, 226, 228, 229, 231, 232, 234 and 235 disclose the data channel selection, preference, and connection circuitry for the position and register connectors. The circuitry individual to a channel is shown column-wise on these figures. That circuitry individual to data channel "0" is disclosed in detail on FIG. 225 and those figures thereunder, while the circuitry associated with the remaining three channels is shown column-wise on FIG. 226 and those figures thereunder. The access circuitry for the data channels comprises a two-dimensional preference and lockout circuit which arranges the four channels in a preferred order of seizure with respect to a single register or position connector and, secondly, arranges the connectors in a preference circuit per channel in order to provide for attempted simultaneous seizures of a single data channel by a plurality of bidding connectors.

Proceeding now with the circuit operation, it was hereinbefore described how relay 181-DTST operated in position circuit "00" shown on FIGS. 162 through 204, and FIG. 222. Referring now to FIG. 224, the operation

of relay 181-DTST closes the circuit path in position control circuit "00" shown in the leftmost box designated "C." The following path is now closed to operate relay 224-PP00: negative battery on terminal 224-101 of the position control circuit "00," break contacts 182-TIF, 182-DTBL, 182-CIF, make contacts 181-TTMG, break contacts 182-DTOK, make contacts 181-DTST, conductor STDT, to terminal 224-102, and to the winding of relay 224-PP00 to operate it. Relay 224-PP00 is individually associated with the position control circuit for position "00," and is connected in a preference circuit in conjunction with relays 224-PP01 through 224-PP09, each of which, respectively, is also individually associated with one of the position control circuits "01" through "09."

FIG. 224 discloses the circuitry for position connector "0" which serves the 10 position control circuits for positions "00" through "09." The 10 relays 224-PP00 through 224-PP09 in this connector are arranged in a preference circuit which permits the relay 224-PP00, for position "00," to be the most preferred, and relay 224-PP09, for position "09," to be the least preferred, in the event of simultaneous seizures. This relationship exists since the right-hand winding terminal of relay 224-PP00 is connected directly to ground, while the respective right-hand winding terminals of the remaining -P- relays may obtain a ground only through the transfer break contacts of all preceding -P- relays in the chain. In view of the foregoing arrangement, relay 224-PP00 for position "00" will operate any time battery is applied to terminal 224-102, while the -PP- relay for any other position, such as, for example, relay 224-PP09, for position "09," can operate in response to battery extended to terminal 224-104 only in the event that all the other -PP- relays in the same position connector are released.

The operation of relay 224-PP00 closes the following circuit to operate relays 224-PE00 and 224-PF00: battery extended to terminal 224-102, through the windings of relays 224-PE00 and 224-PF00, through transfer make contacts 224-PP00 to terminal 224-106, thence to the right through the series-connected transfer break contacts of all remaining -PP- relays in the connector, to ground on terminal 224-105. Obviously, with this arrangement, relays 224-PE00 and 224-PF00 can operate only in the event that the -PP- relays for all of positions "01" through position "09" are released. The operation of relays 224-PE00 and 224-PF00 close obvious circuits to operate the primary cut-in relays 224-PA00, -PB00, -PC00 and -PD00. All relays within each rectangle designated "A" on FIG. 224 respectively represent the primary cut-in relays for each associated position. Each connector serves ten positions, and therefore, there are ten rectangles designated "A" associated with position connector "0."

The remaining position connectors are shown diagrammatically on FIG. 227. Each of these connectors also includes a plurality of sets of cut-in relays, each set of which is respectively represented by an "A" rectangle for each position served thereby. Also respectively associated with each connector is a "C" equipment rectangle for each position. This "C" rectangle is identical to the "C" rectangle shown on FIG. 224 for position "00" and contains the circuitry within the associated position control circuit to transmit a "bid" signal to its connector.

Each register connector, as shown on FIGS. 230 and 233, includes a set of primary cut-in relays within an "E" rectangle for each register served by the connector. The "F" equipment rectangles on these figures respectively represent the circuitry within each register which transmits a "bid" signal to its connector.

From the foregoing, it may be seen that the preference and cut-in relay control circuit for each connector includes one preference relay 224-PP- for each position in a position connector, and one preference relay 230-RP- for each register in a register connector. These preference relays control the selection and the order in which wait-



ing positions and registers are to be served in a connector. Each connector also contains a set of primary multicontact cut-in relays for each circuit served by the connector, for connecting the leads from these circuits to the connector multiple. These relays are designated 224-PA— through 224-PF— for the positions, and 230-RA— through 230-RC— for the registers. Only one set of cut-in relays at a time can be selected and operated by the preference relays within a connector, thereby ensuring that only one circuit can be cut through to the associated connector multiple at a time.

Referring now to FIGS. 224 and 230, when a position or register is ready to use the services of the data transfer circuit, it places a 48-volt battery potential on its data transfer "start" lead STDT to its associated connector. The associated preference relay 224-PP— or 230-RP— is operated, thereby, in turn, operating the multicontact cut-in relays 224-PE— and 224-PF—, or 230-RB— and 230-RC—, of the individual circuit requesting connection to the data transfer circuit. The data leads from the bidding circuit are then connected to the connector multiple awaiting connection to a data channel, once its associated primary cut-in relays are operated. Thus, since it has been assumed on FIG. 224 that relay 224-PP00 and the primary cut-in relays for position "00," namely, relays 224-PA00 through 224-PF00 operated, it may be seen by reference to the disclosure of FIGS. 2 and 3 that the plurality of leads from the position control circuit for position "00" are now connected to the plurality of conductors comprising position connector "0."

If more than one position or register circuit associated with a single connector requests service simultaneously, their preference relays may or may not operate, depending upon their relative positions in their connector preference chain with respect to the preference relay of the other bidding circuit. The same situation exists in the event that a new circuit requests service while its associated connector is in use. The circuit requesting service, in this case, must wait until the connector is free and the preference and cut-in relays of the circuit currently engaging the connector are released before a new connection with the connector multiple can be made. The preference relays operate through the transfer break contacts on all preceding relays in the preference chain, or through the transfer make contact on the last succeeding relay operated. Thus, if the last relay in the chain were the first to operate, it is possible for all relays in the chain to operate if their requests are placed in the proper order or sequence. The preference relay for the circuit which is assigned as first choice in the preference chain is connected directly to ground. Thus, the right-hand winding terminal of relay 224-PP00 is shown connected directly to ground. Any preference relay other than the first may operate if all the relays preceding it in the chain, including the first, are released, or if any succeeding relay in the chain is operated.

As each preference relay operates, such as for example, relay 224-PP00, it locks and awaits the closure of the associated multicontact cut-in relay circuit. This circuit starts at the contacts of the last -PP— relay in the chain, namely, terminal 105 on FIG. 224, and progresses towards the first relay. Thus, the operated preference relay nearest the start of the multicontact relay circuit chain will operate its primary cut-in relays. Other preference relays which may be operated must wait until the preferred relay has released before operating their primary cut-in relays. This arrangement prevents any one circuit from monopolizing the connector, since the preference relays at the end of the operating chain cannot operate, once they release, until the relays at the start of the chain are served and released.

CONNECTION TO IDLE CHANNEL, POSITION CONNECTOR "0" BIDS FOR AN IDLE CHANNEL

The circuit operation described, so far, for the data transfer circuit explains how a bidding register or posi-

tion may obtain a connection to the multiple of its associated connector. In particular, it has been described how position "00" bid for and obtained a connection to the multiple of position connector "0." It is now described how the connector, in turn, bids for and obtains a connection to an idle data channel. The circuitry associated with this operation is shown on FIG. 225 together with the three figures immediately therebelow, and on FIG. 226 together with the three figures immediately therebelow. The circuitry associated with channel "0" is shown in detail, while that for channels "1," "2," and "3" is shown diagrammatically for the most part.

The control circuit for the selection and allocation of a data channel for use by a connector is shown, generally, within the "G" and "J" rectangles and comprises a selector relay -PS— for each position connector (225-0PS0 for data channel "0," position connector "0"), a register-select-preference relay -RS— for each register connector (231-0RS0 for data channel "0," register connector "0"), a connector busy relay -PCB— for each position connector (225-0PCB0 for data channel "0," position connector "0"), one register-connector-busy-in-data-channel relay -RCB— for each register connector (231-0RCB0 for data channel "0," register connector "0"), and a pair of channel busy relays -CHB— and -CHB1 which, for channel "0," are 225-CHB and 225-CHB1, shown in the "H" rectangle in the upper right-hand corner of FIG. 225. Similar corresponding relay equipment is provided in each of the other channels.

The operation of a set of connector primary cut-in relays extends the battery potential supplied via the STDT lead to the associated selector relay -PS— for the positions, and the associated register-selector-preference relay -RS— for the registers, one of the first idle data channel. This path includes the respectively associated -PF— or -RC— make contacts, -PP— or -PR— resistance lamp, conductor STDT', break contacts of a 283-PGT and 283-PGT1, or 283-RGT and 283-RGT1 gate relay and the transfer contacts of a -PCB— or -RCB— connector-busy relay. The purpose of the resistance lamp is to prevent blowing the fuse of every circuit gaining access to a data channel if the common STDT lead is grounded on trouble. Thus, referring to FIG. 224, the battery extended to terminal 102 may be extended through make contacts 224-PF00, resistance lamp PP00, over conductor STDT' extending to FIG. 225, break contacts 283-PGT and 283-PGT1, terminal 225-101 on FIG. 225, rightwards to terminal b, through break contacts 225-0PCB0, to one side of the winding of relay 225-0PS0. The other side of the winding of relay 225-0PS0 is connected in a chain circuit similar to that described for the -PP— relays of FIG. 224. This chain circuit begins with a ground on terminal D at the bottom of FIG. 234, and extends upwards through the series-connected break contacts of the various -RS— relays in the register connectors, and the various -PS— relays in the position connectors, to the right-hand winding terminal of relay 225-0PS0 on FIG. 225. This circuit arranges the -PS— and -RS— relays in a predetermined order of preference to provide for simultaneous bids for a connection to channel "0" by a plurality of connectors. With the specific arrangement just described, relay 234-0RS9 for register connector "9" is the first preferred, since it is directly connected to ground, while relay 225-0PS0 for position connector "0" is the last preferred in the chain.

The first selector relay in the chain is in the block of connectors which has the particular data channel for first choice, and all other connectors, block-by-block, are in a fixed order in the chain. The connectors, in turn, in each block are in a fixed order. A request for connection to a data channel, originating in another connector, may also operate its selector relay for the same data channel when its relay is in a preferred position in the selector relay chain. With the data channel idle, its channel relays



will be normal (i.e., released), and so will all its associated connector-busy relays in each connector.

In view of the foregoing, the hereinabove described circuit, which extended battery from a bidding connector to the left-hand winding terminal of relay 225-0PS0, may now be extended through the relay to its right-hand winding terminal, then down through the preference circuit comprising the break contacts of relays 228-0PS1 through 228-0PS6, and 231-0RS0 through 234-0RS9, to ground on terminal D of FIG. 234. Relay 225-0PS0 operates provided that none of the -RS-, or none of the remaining -PS- relays are operated at this time. Relay 225-0PS0, in operating, closes an obvious holding circuit for itself over its own make contacts to ground. The operation of selector relay 225-0PS0 opens its break contacts on FIG. 225 to open the circuits for relays 225-DCA1 and 234-DCA2, thereby causing them to release. These two relays are normally held operated via a check circuit during the normal circuit condition of channel "0." The circuit holding relay 225-DCA1 operated, during such times, begins with ground on terminal D of FIG. 234 and extends upward, via the hereinabove described preference circuit, to FIG. 225, terminal 225-D of box "G" on FIG. 225, and break contacts 225-0PS0, to the winding of relay 225-DCA1. This circuit checks the integrity of the preference circuit. Relay 234-DCA2 is held operated by an analogous circuit which begins with ground on terminal 225-H of box "G" on FIG. 225 and extends downward through break contacts 225-0PS0, through the break contacts of the remaining -PS- relays and the break contacts of the -RS- relays, to the winding of relay 234-DCA2.

On FIG. 225, the operation of relay 225-0PS0 also closes a set of its make contacts to extend the ground on terminal 225-H to the winding of relay 225-0PRF0 to operate it. Relay 225-0PRF0 comprises one of the secondary cut-in relays for position connector "0." Each position connector has a corresponding relay (i.e., 228-0PRF6 for position connector "6"), and each register connector also has a corresponding relay (i.e., 231-0RRC0 for register connector "0"). All of these relays are in a preference circuit, beginning with the ground on terminal 225-H of box "G" on FIG. 225, whereby relay 225-0PRF0 is the first preferred and relay 234-0RRC9 is the last preferred. Thus, for the present call, relay 225-0PRF0 is the most preferred, operates regardless of the operated or nonoperated conditions of any of the other -0PRF- or -0RRC- relays in the preference chain. The operation of relays 225-0PS0 and 225-0PRF0 together operate relays 225-0PRC0 and 225-0PRD0 both of which, along with relay 225-0PRF0, comprise part of the secondary cut-in relays of data channel "0," position connector "0." The operation of relay 225-0PS0 closes the following circuit to operate relay 225-0PSA0: ground on terminal 109 of FIG. 225, make contacts 231-ST0P and 297-DTMB0 in parallel, make contacts 225-0PS0 and 225-0PRF0, to the winding of relay 225-0PSA0 to operate it. The following circuit paths are now closed on FIG. 225 to operate relays 225-0PSB0 and 225-0PSE0: ground on terminal 225-110, make contacts 261-ST0P and 297-DTMB0 in parallel, make contacts 225-0PS0 and 225-0PRF0, to the windings of relays 225-0PSB0 and 225-0PSE0, thereby operating them. Make contacts 297-DTMB0 are operated at this time in order to complete the circuit paths just described. Relay 225-0PSA0, 225-0PSB0, and 225-0PSE0 comprise the remainder of the secondary cut-in relays of data channel "0," position connector "0."

Referring to FIG. 297, relay 297-DTMB0 is operated from ground on terminal 297-101, through transfer break contacts 297-DTM0 and break contacts 234-DCA2, to the winding of relay DTMB0 to operate it. Relay 297-DTMB0 operates as a consequence of the release of relay 234-DCA2, as hereinbefore described. Relay 261-ST0P is currently operated upon operation of the connector secondary relays, since the flow of information via

the data transfer circuit for the present connection will be from the sender to the position. Relay 261-ST0P is operated over the following circuit: battery on terminal 101 of FIG. 188 in the position control circuit for position "00," through the resistor DTST, make contacts 181-DTST, transfer break contacts 175-TRZ, 179-SAF, 169-TE, conductor "ST0P" extending from FIG. 188 to FIG. 261, and in particular to the position "00" rectangle on FIG. 261, conductor "ST0P," make contacts 224-PF00 (which are the primary cut-in relays for position "00"), make contacts 225-0PRF0 (which are the secondary cut-in relay contacts for position connector "0"), and data channel "0," to the winding of relay 261-ST0P to operate it.

The operation of the primary cut-in relays for position "00" on FIG. 224 and the operation of the secondary cut-in relays on FIG. 225, together, complete all the necessary connections between bidding position "00" and the data channel "0."

#### CHANNEL MADE BUSY TO OTHER CALLS

The operation of relay 225-0PRD0 closes its make contacts to extend a ground from terminal 102 on FIG. 225 through make contacts 225-0PRD0, to the windings of relays 225-CHB, and 225-CHB1, thereby operating them. These two relays are enclosed within the rectangle designated "H" on FIG. 225 and comprise the channel-busy relays for channel "0." Each of the remaining three channels have similar channel-busy relays contained within their "H" rectangles on FIG. 226. The operation of relay 225-CHB closes make contacts 225-CHB to extend the ground on terminal 225-103 to the winding of relay 225-0PCB0 to operate it. Each remaining position connector contains a similar -PCB- relay for channel "0" which is operated as a consequence of the operation of the 225-CHB relay. Also, as may be seen on FIG. 231, each register connector contains an -RCB- relay for channel "0" which is also operated by the operation of relay 225-CHB.

The -0PCB- relay on each position connector for channel "0," and the -0RCB- for the same channel in each register connector, when operated by the operation of relay 225-CHB or 225-CHB1, opens the circuit of its associated selector relay and causes it, if operated, to release unless its associated secondary cut-in relays are also operated. Thus, referring to FIG. 225, the operation of relay 225-0PCB0 opens its transfer break contacts to disconnect relay 225-0PS0 from the "start" battery extended to terminal 225-101. The operation of the remaining -0PCB0- or -0RCB- relays for channel "0" opens their break contacts to open the "start" lead of their respectively associated selector relays. Relay 225-0PS0 does not release when relay 225-0PCB0 operates, since the prior operation of the secondary cut-in relay 225-0PRF0 closes a supplementary path to maintain the interconnection between the battery on terminal 225-101 and the left-hand winding terminal of relay 225-0PS0. However, it may be appreciated that since the secondary cut-in relays of the remaining position and register connectors associated with channel "0" are not operated at this time, any operated selector relay will now release. For example, assuming that relay 231-0RS0 was operated, the operation of relay 231-0RCB0 would release relay 231-0RS0, since its associated secondary relays are not operated, and consequently, the supplementary holding path comprising make contacts 231-0RRC0 would not be closed to maintain relay 231-0RS0 operated.

The -PCB- and -RCB- relays of channel "0," in operating, also advance the "start" leads from the associated connectors to the -PCB- and -RCB- relays for the next choice data channels in the same connector. For example, assume that register connector "0" transmitted a bid signal to terminal 101 of FIG. 231 a short time after a similar signal was received from position connector "0." In this case, the operation of relay 231-0RCB0 extends the ground on terminal 101 of FIG. 231 through transfer



make contacts 231-ORCB0, and through break contacts 231-ORS0 to terminal b1 in the lower-right-hand corner of the "J" rectangle on FIG. 231. Terminal b1 is interconnected to the input terminal b of a corresponding "J" rectangle in channel "1" on FIG. 232. The b terminal in the "J" rectangle of FIG. 232 is interconnected with a selector relay therein by means of circuitry identical to that for the "J" rectangle of FIG. 231 for channel "0." This being the case, the ground on terminal 101 of FIG. 231 is extended to place a bid for connection to channel "1." The success of this bid in obtaining a connection for its register connector to channel "1" depends upon whether it is the only connector currently bidding, or whether it is the preferred connector of a plurality of bidding connectors. If successful, it will be connected to channel "1"; and if unsuccessful, the bidding potential on the b terminal of the "J" rectangle for channel "1" will be extended to its b1 terminal, and thence to the b terminal of the "J" rectangle for channel "2." By means of the same circuit arrangement, an attempt will now be made to connect its connector to channel "2," and if unsuccessful in this attempt, to channel "3."

As soon as a connector is seized, all the -PCB- or -RCB- relays in the connectors associated with busy data channels are locked operated until the connector is released. Thus, referring to FIG. 225, the operation of relay 225-OPSO closes make contacts 225-OPSO to interconnect terminals 225-104 and 225-105. This interconnects conductors LGB1 and LGB, which conductors extend through similar circuitry in the corresponding "G" rectangles for each remaining channel on FIG. 226. Also, at the same time, the -PE- relay associated with the bidding position in position connector "0" closes its make contacts, which relay for the present call is 224-PE00, to extend ground on terminal 225-107, through make contacts 224-PE00, to terminal 225-106 which is connected, via conductor LGB, to terminal 225-105 which, in turn is currently connected, via make contacts 225-OPSO, to terminal 225-104. Thus, both conductors LGB and LGB1 are grounded as long as any position circuit served by the connector is bidding. If at this time the -PGB0 relay in a different channel, say, for example, 226-1PCB0 for channel "1," should be operated by the operation of the -CHB or -CHB1 relay in the "H" rectangle for that channel as a consequence of a bid signal received by a selector relay for channel "1" from one of the other register or position connectors, it may be seen that a path may be closed from the LGB1 conductor through the 226-1PCB0 make contact, the PCB resistor, the PCB diode, to the winding of the 226-1PCB0 relay for channel "1." This circuit will hold the 226-1PCB0 relay of channel "1" operated, as well as the corresponding relay in any other busy channel, until ground is removed from terminal 106 on FIG. 225 by the release of the 224-PE- relay associated with the bidding position.

All register connectors contain circuitry, similar to that hereinbefore described, for operating and for holding operated the relays corresponding to relay 231-ORCB0 for register connector "0" in all busy data channels when the relay corresponding to relay 231-ORS0 is operated in response to a bid from its associated connector circuit. The locking of the operated -PCB- or -RCB- relays, as hereinabove described, prevents a connector which has started to seize a data channel of other than its first choice from abandoning that data channel and reverting to a more preferred channel if it becomes idle at the critical time. The transfer break contacts of relay 225-OPCB0, connected to terminal 108 on FIG. 225, and the similar contacts in other channels are used to prevent a permanent lock of all the -PCB- relays in a connector, in the event that they should be operated at the time that the connector is seized.

A data channel, when seized by a connector, is guarded against intrusion by the selector relay chain comprising the -PS- and -RS- relays. A busy data channel is further

guarded against intrusion, and requests for service which would normally go to it are passed to other data channels, by the operation of the -PCB- or -RCB- relays. The "start" lead of a connector which has seized a data channel, however, holds its selector relay operated and is not transferred forward by the operation of its -PCB- or -RCB- relay. Such an extension is prevented by the break contacts of the operated selector relay. Thus, the bidding potential extended to terminal 101 on FIG. 225 is prevented from being extended to terminal b1 of the "G" rectangle on FIG. 225 by break contacts of operated relay 225-OPSO. The -PCB- and -RCB- relays are operated, or held operated, whenever the associated connector primary or secondary relays are operated, and they are also held when the data channel encounters trouble.

The release of relay 225-DCA1 closes the following circuit on FIG. 279 to operate relay 279-CONN: ground on terminal 104, through break contacts 225-DCA1 and 280-DAR0, to the winding of relay 279-CONN to operate it. Relay 279-CONN, in operating, closes a holding path over its own make contacts to parallel the break contacts 280-DAR0. The operation of relay 279-CONN also closes obvious circuits over its make contacts to operate relays 279-CONA, 279-CON1, 279-CON2, and 279-CON3.

Relays 225-DCA1 and 234-DCA2 are operated during the normal or idle conditions of a data channel, as hereinabove explained. The operation of these relays closes obvious circuits on FIG. 248 to maintain relays 248-TST1 through 248-TST6 operated in the data channel associated with the operated 225-DCA1 and 234-DCA2 relays. The release of relays 225-DCA1 and 234-DCA2 as a channel is seized, and in particular on the present call as channel "0" is seized, breaks the path holding relays 248-TST1 through TST6, thereby causing them to release. As is hereinafter described in greater detail, these relays are maintained operated during the idle condition of a channel in order to test for the presence of unwanted shorts and grounds on any of the conductors comprising the channel.

Referring to FIG. 225, the operation of relays 224-PE00 and 225-OPRC0 complete two separate paths from ground on terminals 275-101 and 275-102, respectively, over their make contacts, to operate relay 275-PGRA.

Referring to FIG. 283, the operation of relay 225-OPRC0 also completes an obvious circuit, via its make contacts, to operate relay 283-PGT within the position gate for position connector "0." The operation of relay 283-PGT closes an obvious circuit to operate relay 283-PGT1.

#### SELECTION OF TRUNK CONNECTOR, DATA CHANNEL "0" SEIZES TRUNK CONNECTOR "0"

The first function of a data channel, once it is seized by a position connector for the presently described type of call, is to connect itself to the trunk circuit, which is currently connected by means of the position link with the same position that is currently connected via the position connector to the data channel. Referring now to the present call, the first function of data channel "0," once it is seized by position connector "0," is to connect itself to trunk circuit "00," which trunk circuit is already connected via the position link to position "00" which, in turn, is currently connected via position connector "0" to data channel "0."

#### IDENTIFYING TRUNK CONNECTOR NUMBER

Before the data channel can connect itself to the trunk "00," it must first determine the trunk connector which must be seized in order to gain access to trunk "00." The identity of the trunk connector serving trunk "00" is established by the trunk connector number assigned to it. This number is stored in the position circuit, as hereinbefore described, and is passed to the data transfer circuit over the circuitry shown on FIGS. 236 through 240. FIGS. 236 and 237 disclose 66 position control circuits,



100 register circuits, the four data channels "0" through "3" of the data transfer circuit, together with position and register connectors for connecting the position control circuit of a bidding position, or a register circuit, to an idle one of the four data channels.

Each position control circuit and each register circuit has five wires extending therefrom designated DGN0, -1, -2, -4, and -7. These five wires extend from each position and register into a cable which functionally represents the vast number of wires comprising the connector multiples and the data channel multiples. Each position and each register may apply ground potentials to various combinations of these conductors in order to signify, in 2-out-of-5 code form, the trunk connector number for the trunk connector associated with the trunk currently serving the call to which the register or position is currently connected by means of either the register link or the position link, as the case may be. FIG. 239 discloses four sets of five relays, the relays of each set being designated -DG0, -1, -2, -4, and -7, the designations of which correspond to the similarly designated conductors extending from the position control and the register circuits. Each of the four sets of -DG- relays is respectively associated with a different data channel as indicated by its prefixed digit, and is connected thereto by means of the cables extending between FIGS. 237 and 239. Each set of -DG- relays registers the trunk connector number information transmitted thereto by the position control or register circuits, via the associated connector, upon its seizure of the data channel on a call.

Trunk "00" serving the present call is, in turn, served by trunk connector "0." It has been hereinbefore described how a trunk connector identification digit of "0" is stored in 2-out-of-5 code form in the position control circuit. On FIG. 236, the closure of contacts 224-PF00 and 225-0PRF0, as position "00" seizes position connector "0" which, in turn, seizes data channel "0," completes the following circuit to operate relays 239-0DG4 and 239-0DG7 for channel "0," thereby causing a trunk connector identification digit of "0" to be registered in 2-out-of-5 code form in the relay register circuit of FIG. 239: ground on terminal 101 of FIG. 236, break contacts 175-TRZ, over both make contacts 164-DGN4 and 164-DGN7, to both of conductors DGN4 and DGN7 in the cable associated with position control "00," make contacts 224-PF00, secondary contacts 225-0PRF0, over channel "0" cable, out of the cable on conductors DGN4 and DGN7 on FIG. 239, to operate relays 239-0DG4 and 239-0DG7 for channel "0."

Each set of -DG- relays on FIG. 239 has a "K" equipment rectangle respectively associated therewith. The "K" rectangle for the -DG- relays of channel "0" is shown in detail on the bottom of FIG. 239, while the respective "K" rectangles for the remaining channels are shown on the bottom of FIG. 240. Each "K" rectangle includes a symmetric upcheck circuit and a 2-out-of-5 to 1-out-of-10 translator. The symmetric upcheck circuit produces an output on the 2-out-of-5 upcheck lead in the event that 2-out-of-5 of its associated -DG- relays are operated during a registration. This is the desired condition of operation. Each symmetric upcheck circuit also contains an additional lead designated 0URA which provides an error output signal in the event of a registration which operates either 1-out-of-5 or 3-out-of-5 of its -DG- relays. Either of these latter two conditions represents a trouble condition. The 2-out-of-5 to 1-out-of-10 translator comprises circuitry associated with the contacts of its -DG- relays and translates the 2-out-of-5 registration of its -DG- relays to a 1-out-of-10 indication which is applied to its output conductors DGN0 through DGN9 in accordance with the value of the registered translated digit.

The circuitry of FIGS. 238 and 240 comprises the seizure circuitry for the ten trunk connectors and is similar in function to the seizure circuitry of the position con-

nectors and register connectors shown on FIGS. 224, 227, 230, and 233. The seizure circuit of FIGS. 238 and 240 is mainly composed of equipment subdivided into "L" rectangles which are arranged in rows and columns. The "L" rectangles included in each row are associated with a particular trunk connector, while the "L" rectangles included in each column are associated with a particular one of the four data channels. Thus, the "L" rectangles included in the top row on FIG. 238 are associated with trunk connector "0," while the leftmost column of "L" rectangles on FIGS. 238 and 240 is associated with channel "0."

The DGN0 through DGN9 output conductors of each "K" rectangles on FIGS. 239 and 240 are respectively connected to the various "L" rectangles of that column which is associated with the same channel as is the "K" rectangle. Thus, the DGN0 through DGN9 output conductors of the "K" rectangle for channel "0," on the bottom of FIG. 239, are respectively connected to the "L" rectangles of the first column, with the digit indicating the trunk connector number matching the final digit of the designation for each DGN- lead. A similar relationship exists between the "K" rectangles for the other channels and the column of "L" rectangles associated therewith.

The DGN0 through DGN9 leads associated with each data channel serve as the "start" leads, one to each of the ten trunk connectors. Each such lead terminates at a -DCS- (data-channel-select) preference relay, of which there is one for every "L" rectangle. There is a -DCS- relay and an associated trunk secondary multicontact cut-in-relay designated -TS- and -TSS- for each channel serving a given connector. The -DCS- relays common to a connector are connected in a preference chain which controls the selection and order in which waiting data channels are to be admitted thereto and served by a trunk connector. Only one set of the trunk secondary cut-in relays -TS- and -TSS- can be selected and operated by the preference relay chain, thereby ensuring that only one data channel can be connected to the trunk connector multiple at a time. When the data channel translator in the "K" rectangle places a potential on one of its DGN- output leads, it operates a -DCS- relay associated with that channel in the data-channel-selection preference chain of the trunk connector which is identified by the last digit of the lead number.

Recalling that a trunk connector digit of "0" is currently registered in 2-out-of-5 code form in the 239-DG- relays for channel "0," the following circuit may now be completed to operate relay 238-0DCS0: battery on terminal 101 of FIG. 239, break contacts 293-RCI, 293-TIB0, through the symmetric upcheck circuit DGK, out on its 2-out-of-5 upcheck lead to terminal 239-102, through the 2-out-of-5 to 1-out-of-10 translator DGT, to its output conductor DGN0, thence to terminal 101 on FIG. 238, and through the winding of relay 238-0DCS0 to ground on terminal 238-102. Relay 238-0DCS0 operates any time it receives an output signal from the translator DGT in the "K" rectangle for channel "0," since relay 238-0DCS0 is in a preference chain in which it is the first preferred. Each of the remaining 238-DCS0 relays for this trunk connector can operate only in the event that all of the preceding similarly designated, but lower numbered, relays are released. Thus, relays 238-3DCS0 can operate in response to a signal from its associated "K" rectangle, to ground on terminal 102 of FIG. 238, only in the event that all of the preceding 238-DCS- relays are released.

The operation of relay 238-0DCS0 permits the battery extended to terminal 101 of FIG. 238 to be extended through the winding of relay 238-0TS0, through transfer make contacts 238-0DCS0, to terminal 238-103. The battery may be further extended from terminal 238-103, through the series-connected transfer break contacts of all the succeeding 238-DCS0 relays (i.e., in the same trunk connector), to ground on terminal 238-104. Obviously



with this arrangement, each -TS- relay can operate only in the event that the -DCS- relays associated with all higher numbered channels are released. Thus, the -TS- relay (e.g., 238-0TS0 for channel "0" can operate only in the event that the -DCS- relays for all remaining channels are released. Let it be assumed that all such -DCS- relays are released and, therefore, relay 238-0TS0 for channel "0" now operates. As hereinbefore described, the seizure of a channel causes normally-operated relay 234-DCA2 to release, eventuating in the operation of relay 297-DTMB0. This being the case, an obvious path is closed on FIG. 238, through make contacts 297-DTMB0, to operate relay 238-0TSS0 in the same "L" equipment rectangle.

It should be recalled at this point, in connection with the embodiment shown on FIGS. 3A through 3K, that it has been described how the data transfer circuit receives and translates the trunk connector number and then applies a positive 130-volt potential back through the established connection to operate relays in the trunk and sender, to facilitate the connection of these two circuits to the data channel serving the call. Specifically, referring to FIG. 3J, it was hereinbefore described how upon the operation of relay 238-0TS0 as a consequence of the registration of the trunk connector number "0" in the translator for channel "0," the positive 130-volt potential is extended through the make contacts of relay 238-0TS0, via conductor PC, through make contacts 225-0PRF0, conductor PC, make contacts 224-PA00, through position "00" (where conductor PC is also designated "KPR"), conductor KPR in cable P00 extending through the link connector to operate relay 13-TP00 in trunk "00" on FIG. 3B, and also, via sender link conductor S00, ultimately, to operate relay 243-SE00 associated with sender "00" on FIG. 3G. It was then described how the operation of relays 243-SE00 and 13-TP00 facilitated the interconnection of sender "00" and trunk "00" with data channel "0."

The detailed circuitry associated with the extension of a positive 130-volt potential from the data transfer circuit to relays in the trunk and sender, in order to interconnect these two circuits with the proper channel of the data transfer circuit, is shown on FIGS. 241 through 244. Referring to FIG. 242, the four positive 130-volt terminals, 105 through 108, are individually associated with channels "0" through "3," respectively. Each such terminal is connected to a -PC resistor which, in turn, is connected to a -PC inductance parallel-connected to a -PC diode. The -PC diode and -PC inductance for each channel is connected to its respective terminal. The terminal for channel "0" is designated 109 and the terminals for channels "1" through "3" are designated 110 through 112, respectively. Each of the terminals 242-109 through 242-112, for channels "0" through "3," respectively, is, in turn, respectively connected to a set of ten parallel-connected contacts; 238-0TS0 through 240-0TS9 for channel "0," 238-1TS0 through 240-1TS9 for channel "1," 238-2TS0 through 240-2TS9 for channel "2," and 238-3TS0 through 240-3TS9 for channel "3." These relays comprise the secondary cut-in relays for the trunk connectors shown on FIGS. 238 and 240. The same relays, as well as their contacts, are shown on FIG. 3J.

Channel "0" of the data transfer circuit is serving the present call; and since calling trunk "00" is served by trunk connector "0," this trunk connector must be utilized by the data transfer circuit in connecting trunk "00" to data channel "0." To this end, the data transfer circuit has utilized the trunk connector information received from the position to seize trunk connector "0" and, in accordance therewith, has, up to this point, operated relays 238-0DCS0, 238-0TS0, and 238-0TSS0, all of which are individually common to channel "0" and trunk connector "0." This being the case, the positive 130-volt battery on terminal 105 of FIG. 242 may now be extended through the 0PC resistor and the 0PC inductance to terminal 242-109. From terminal 242-109, the potential may

be extended through make contacts 238-0TS0 to terminal 242-101. Terminal 242-101 is connected to channel "0," by which means it is connectible to any register via its associated register connector, or with any position via its associated position connector. Similarly, terminals 242-102 through 242-104 of channels "1" through "3," respectively, are connectible by means of their respectively associated channels and the various register connectors or position connectors to any register or position.

Channel "0" is currently connected to position "00" and, therefore, the potential extended to terminal 101 on FIG. 242 may be extended through make contacts 225-0PRF0 and 224-PF00, via the PC lead, to FIG. 241. From FIG. 241, the circuit may be continued via the PC lead extending to the position control circuit "00" for position "0" (FIG. 185). The circuit now follows a circuitous path which takes it through the position control circuit, the position link circuit, the trunk circuit, the sender link circuit, and the sender circuit, and, finally, back to the data transfer circuit, via conductor SP from the sender circuit (FIG. 48), as shown on FIG. 241. For the reader's convenience and to facilitate understanding of the above-cited circuitous path, the same is shown in condensed form in the rectangle PCSP interconnecting terminal 101 on the left-hand side of FIG. 241 with terminal 102 on the right-hand side of the same figure. Within rectangle PCSP are shown smaller rectangles diagrammatically indicating all the circuits through which this path follows, as well as the detailed circuit elements within each such small rectangle. One may, if he desires, by this expedient, trace the entirety of this circuit on FIG. 241 itself rather than laboriously trace it through the many sheets of drawings on which are disclosed the different individual circuits. However, the detailed circuit drawings include all such circuitry in the event that one desires to trace this circuit in greater detail. In this event, the connection will be traced from the data transfer circuit drawings, via the PC lead on FIG. 241, and, in lieu of rectangle PCSP, to the position control circuit on FIG. 185 and, thence, through the path as shown in detail on other drawing figures, via the SP lead from the sender on FIG. 48, to the SP lead on FIG. 241.

The condensed version of the circuit shown in rectangle PCSP will be described in this specification in order to conserve space. Therefore, beginning with terminal 101 on FIG. 241, the circuit may be extended to the right over the PC lead, through make contacts 181-DTST and 169-T0A in the position control circuit for position "00," over the KPR0 lead to the position link circuit, over the KPR lead to trunk circuit "00," where the potential operates relay 13-TP00. The circuit may be further extended over make contacts 10-SA in the trunk circuit, over the SPI lead to the sender link, over the SPI lead, through make contacts 24-SPL and 51-RGCB, through the parallel-connected combination of make contacts 64-SSP and break contacts 65-DTCK of sender "00," over the SP lead, to terminal 102 on FIG. 241. The circuit may be further extended over the SP conductor to the winding of relay 243-SS00, thereby operating it.

The operation of relay 13-TP in the trunk circuit closes the primary cut-in relay contacts to connect the trunk conductors with the conductors comprising the portion of trunk connector "0" served by the subgroup relay associated with trunk "00." In addition, the operation of relay 13-TP00 operates its associated subgroup relay, thereby completing the interconnection between the conductors of this trunk and those of trunk connector "0." The foregoing operations may be better understood when considered along with FIG. 13 of the incoming trunk circuit, and FIGS. 3A through 3K. Relay 13-TP00, shown as part of the incoming trunk circuit, is also shown on FIG. 3B where the elements of the incoming trunk circuits are shown which are necessary for an understanding of the overall principles of operation of the data transfer circuit. In the upper right-hand corner of FIG. 3B, the trunk cir-



cuit identified as "00" is the same circuit the details of which are shown on FIGS. 10 through 15. Relay 13-TP00 on FIG. 3B is the same relay which is shown on FIG. 241 in the condensed circuitry, shown interconnecting terminals 241-101 and 241-102. Referring now to FIG. 3B, it may be seen that the operation of relay 13-TP00 closes its make contacts 13-TP00 on the right-hand side of the rectangle representing trunk "00," thereby interconnecting conductors of trunk "00" with the conductor multiple connected to terminals 3B-101 and 3B-102 and common to trunks "00" through "09." The operation of relay 13-TP00 also closes its make contacts on FIG. 3B to complete an obvious circuit from ground on terminal 3B-103 to operate relay 263-0TSG0, which relay is the subgroup relay serving trunks "00" through "09." Relay 263-0TSG0, in operating, closes its make contacts to interconnect the conductors of trunk "00," via terminals 3B-101 and 3B-102, with the conductor multiple of trunk connector "0." The conductors of trunk connector "0," in turn, are interconnected with those of data channel "0" at this time, since relay 238-0TSG0 has been operated as hereinbefore described as a consequence of the registration of a trunk connector digit of "0" in channel "0" of the data transfer circuit. Position "00" and trunk "00" are now both connected to each other, since they are both connected at this time to data channel "0." Referring now to FIG. 266, the following circuit is now closed to operate relay 266-0TP0, thereby signifying that channel "0" is successfully interconnected with a trunk connector: ground on terminal 101 of FIG. 266, through make contacts 263-0TSG0, 238-0TSG0, to the winding of relay 266-0TP0 to operate it.

Referring now to FIG. 242, the -PC inductor and diode network protect the contacts of the various -TS- relays from the high currents which would otherwise flow from the positive 130-volt potential, and through the capacity of the connector multiple, to ground on the closure of the contacts. The inductor prevents the development of the high current surges, and the diode is used to limit the inductive voltage rise across the inductor when the contacts open.

#### SEIZING SENDER CONNECTOR, CONNECTION OF SENDER "00" TO DATA CHANNEL "0"

A sender connector will be seized and connections will be established between the sender and other associated circuits on all usages of the data transfer circuit if the sender is attached to the trunk. The potential on the PC lead, which is used to operate the trunk primary cut-in relay 13-TP00 as hereinabove described, is extended through the sender link as a "start" potential on the SPI lead, to operate the sender-preference-select relay 243-SS00, as hereinabove described.

Referring to FIGS. 243 and 244, the preference and cut-in control circuitry for each sender connector includes a preference relay -SS- for each sender accessible to a sender connector. These preference relays control the selection and the order of preference in which waiting senders are to be served by a connector.

The preference circuitry for sender connector "0" is shown in detail on FIG. 243, while the corresponding circuitry for sender connectors "1" through "9" is shown only diagrammatically on FIG. 244. Referring to FIG. 243, the ten relays 243-SS00 through 243-SS09 are arranged in a preference circuit in which, for bidding, relay 243-SS00 is the most preferred and in which relay 243-SS09 is the least preferred. Also, the primary cut-in relays, 243-SA00 through 243-SE00, through 243-SA09, through 243-SE09, are arranged in a reverse order of preference, in which, for cutting in, relays 243-SA00, etc., are the most preferred, and in which relays 243-SA09, etc., are the least preferred. These two preference circuits together are similar to those already described for the position connector seizure circuitry on FIG. 224 and, therefore, need not be described again in detail.

The circuitry comprising each sender connector is

respectively enclosed within a rectangle designated "M" on FIGS. 243 and 244, while the circuitry within each "M" rectangle and which is respectively individual to a sender is designated "N." Thus, the "M" rectangle on FIG. 243 contains a plurality of rectangles designated "N," one for each of the senders served by this sender connector. Also, each "M" rectangle includes circuitry enclosed within a rectangle designated "P," the purpose of which is hereinafter explained. Each connector contains a set of primary multi-contact cut-in relays, namely -SA- to -SE-, for connecting the leads from each sender to the connector multiple. Only one set of these relays per connector can be selected and operated by the preference relays at a time, thereby ensuring that only one sender served by a connector can be cut through to the common connector multiple at a time.

The operation of preference relay 243-SS00, for the present call, results in the operation of the multi-contact secondary cut-in relays 243-SA00 through 243-SE00. Referring now to FIG. 64, the operation of relay 243-SS00 also extends ground through make contacts 243-SS00 in rectangle DTC, via lead SSP, to relay 64-SSP in the sender, causing it to operate as an indication that the associated preference relay was operated.

If one or more requests for the connection of senders to a data channel occur while their connector is in use, the preference relays for these senders may operate, depending upon their relative position in the connector-preference-chain with respect to the preference relay of the sender using the connector. Requests for the service of the connector must wait until the connector is free and the preference and cut-in relays of the sender engaging the connector are released before a new connection to another sender can be established. The circuitry of these connectors is identical to that previously described for the position and other connectors and, therefore, need not be reviewed in complete detail.

#### TRANSLATING TRUNK CONNECTOR NUMBER

The circuitry associated with the translation of the trunk connector number by the sender is shown on FIGS. 245 through 247. Before the sender can make a connection to a data channel, it must first ascertain the identity of the data channel which has been reserved to handle this particular connection; that is, the sender must ascertain the identity of the trunk connector used on the present call, as well as the identity of the data channel to which this trunk connector is currently connected. The identity of the trunk connector serving the present call is established by the trunk connector number assigned to the calling trunk and registered in the sender. This number is stored in the sender and is transmitted therefrom to its associated sender connector in the data transfer circuit, as a consequence of the seizure of the sender connector, as shown in connection with FIGS. 241 through 244. Referring to FIG. 245, the trunk connector number has previously been registered in sender "00," in 2-out-of-5 code form, by the operation of two of the relays 66-DG0, -DG1, -DG2, -DG4, and -DG7, as hereinbefore described. The subsequent interconnection of sender "00" with sender connector "0" closes make contacts 243-SE00, as hereinabove discussed, thereby extending ground from terminal 245-101 in sender "00," through the closed make contacts 66-DG4 and 66-DG7, for a sender connector number of "0," through make contacts 243-SE00, to operate relays 245-DGN4 and 245-DGN7 in the "Q" rectangle of sender connector "0."

#### OPERATION OF SENDER CONNECTOR SECONDARY CUT-IN RELAYS

The circuitry shown on FIGS. 246 and 247 controls the operation of the sender connector secondary cut-in relays for connection of the connector to a data channel. The circuitry of FIG. 246 controls the operation of the sender connector secondary receive cut-in relays 246-0SRE0, -1SRE0, -2SRE0, and -3SRE0; while the cir-



cuitry on FIG. 247 controls the operation of the sender connector secondary send cut-in relays 247-0SSA0 through 247-3SSD9 for connection of the connector to the desired channel. Referring to FIG. 246, the circuitry associated with the operation of the -SRE- secondary cut-in relays for sender connector "0" is shown in detail, while the circuitry for the remaining sender connectors is shown only diagrammatically, since it is merely a duplicate of that for sender connector "0."

Each "R" equipment rectangle is individual to a sender connector and includes a symmetric check circuit 100 comprising the contacts of the 245-DGN- relays shown in the "Q" rectangle on FIG. 245 for the same sender connector. The input to the symmetric check circuit 100 comprises battery on terminal 246-101. The battery is extended through circuit 100 to an output on terminal 246-102 to provide a 2-out-of-5 upcheck whenever two of the five associated relays are operated. This is the normal condition of operation. The input battery may be extended to terminal 246-103 as an error signal in the event that either one or three of the five associated relays are operated. The potential extended to terminal 246-103 operates relay 246-0UR as an alarm indication. The operation of relay 246-0UR, in turn, closes its make contacts to light the correspondingly designated lamp in the upper right-hand corner of the same "R" equipment rectangle.

The desired condition of operation of the symmetric check circuit 100 occurs when the battery on terminal 246-101 is extended to the 2-out-of-5 upcheck terminal 246-102, and thence to terminal 246-105 of a 2-out-of-5 to 1-out-of-10 translator 104. The necessary translation functions are performed by the 245-DGN- relays, and an output potential on one of conductors 0SG through 9SG is obtained, depending upon the trunk connector number registered in the 245-DGN- relays. A trunk connector number of "0" is presently registered in the 245-DGN- relays of the "Q" equipment rectangle for sender connector "0" and, therefore, the battery on terminal 101 of FIG. 246 is now extended through the symmetric check circuit 100, and through the 2-out-of-5 to 1-out-of-10 translator 104, to output conductor 0SG.

The ten output conductors 0SG through 9SG from translator 104 on FIG. 246 for each sender connector correspond, respectively, to the output conductors "0" to "9" for each sender connector shown on FIG. 3K. Just as on FIG. 3K, each translator output conductor is connectable by a set of four make contacts --0TS- through --3TS- to four relays 246-0SRE- through 246-3SRE-. In the instant example, for sender connector "0" on FIG. 246, so is each output conductor interconnectable, via a set of four make contacts to the same relays 246-0SRE0, 246-1SRE1, 246-2SRE2, and 246-3SRE3, which are part of the secondary cut-in relays which, in turn, operate the remainder of the sender connector secondary cut-in relays shown on FIG. 247. The relays on FIG. 247 correspond to those shown on FIG. 3K. The main distinction between the showing of FIG. 3K and that of FIGS. 246 and 247, other, of course, than that the latter figures are more detailed, is the fact that the output conductors on FIG. 3K, from the translator for each sender connector, are directly connectable to the secondary cut-in relays to operate them, while on FIG. 247 the intermediately connected relays 246-0SRE0 through 246-3SRE0, etc., are provided as drive relays to operate the main or secondary cut-in relays (247-0SSA0, etc.) shown on FIG. 247. Also, each secondary cut-in relay on FIG. 3K, such as, for example, relay 246-0SRE0 actually comprises the intermediate cut-in relay 246-0SRE0 shown on FIG. 246, and the main or secondary cut-in relays 247-0SSA0, -0SSB0, -0SSC0, and -0SSD0 shown on FIG. 247. These five relays are required in order to close the large number of contacts required.

Returning now to FIG. 246, the battery potential on terminal 246-106 of output conductor 0SG is interconnectable, through make contacts 238-0ST0 through 238-3ST0, with relays 246-0SRE0 through 246-3SRE0, respectively. The particular one of these relays with which a translator output conductor is connected on a call is dependent upon the number of the trunk connector to which the channel serving the call is currently connected. An output potential on conductor 0SG for sender connector "0," in essence, tells the data transfer circuit that sender connector "0" desires interconnection with trunk connector "0" over the data channel currently connected to trunk connector "0." Of the four make contacts connected to terminal 246-106, namely, 238-0TS0, 238-1TS0, 238-2TS0, and 238-3TS0, one of these contacts must currently be closed. It having been previously operated to connect trunk connector "0" to one of the data channels. The initial digit following the -- for the designation of these contacts represents the associated channel number, while the final digit represents the trunk connector number. Thus, make contacts 238-0TS0 would be closed if trunk connector "0" were connected to channel "0," while contacts 238-3TS0 would be operated if trunk connector "0" were connected to channel "3." Terminal 246-106 would be connected to relay 246-0SRE0 for the first of these conditions, and to relay 246-3SRE0 for the second of these conditions. The same relationship exists with respect to terminal 246-107 on output conductor 9SG since it is connectable, via contacts 240-0TS9, 240-1TS9, 240-2TS9, and 240-3TS9 of the relays comprising the secondary cut-in relays for trunk connector "9," to relays 246-0SRE0 through 246-3SRE0. A similar relationship exists between the remaining eight output conductors and these latter relays. However, the specific contact circuitry associated therewith is not shown in detail.

It has been assumed in connection with the present call that trunk connector "0" is currently connected to channel "0" by the operation of the secondary cut-in relays for the trunk connector, namely, 238-0TS0, as hereinbefore described. This being the case, the potential on terminal 246-106 of FIG. 246 may now be extended through make contacts 238-0TS0 to operate relay 246-0SRE0.

Referring now to FIG. 247, and remembering that relay 297-DTMB0 is already operated, a path may now be extended from ground on terminal 101 of FIG. 247, through make contacts 297-DTMB0 and 246-0SRE0, to the winding of the four secondary sender connector cut-in relays 247-0SSA0, -0SSB0, -0SSC0, and -0SSD0. These four relays correspond to the relay 246-0SRE0 on FIG. 3K and, referring to FIG. 3G, it may be seen how the closure of the make contacts of relay 246-0SRE0 completes the interconnection of sender "00" with data channel "0." Both position "00" and trunk "00" have been previously connected to data channel "0." Therefore, the connection of sender "00" completes the interconnection of the necessary circuits, via data channel "0," for the serving of this call.

FIG. 247 discloses the sender connector secondary cut-in relay circuitry in a matrix manner, insofar as possible, with the circuitry individual to each channel being shown row-wise, or horizontally, while that circuitry individual to each sender connector is shown column-wise, or vertically.

#### CHANNEL CONTROL AND CHECK CIRCUITRY

The following discusses the data channel control and check circuitry. Each data transmission and control lead in the data channel is continuously monitored in the idle state of the channel to detect possible trouble conditions. As previously noted, the data-channel-preference-chain guard relays 225-DCA1 and 234-DCA2 are operated during the idle state of a channel. The operation of relays 225-DCA1 and 234-DCA2 at such time completes obvi-



ous paths on FIG. 248 to operate relays 248-TST1 through 248-TST6.

The operation of relays 248-TST1 through 248-TST6 closes circuits which test for the presence of unwanted grounds on the various data-transmitting leads of each channel during the idle condition of the channel. Each data-transmitting lead is connected to a relay at this time and if any lead is then grounded, due to a circuit trouble such as a short circuit or a false ground, the relay will operate and call in an alarm. The data-transmitting leads, together with the check circuitry therefor, are shown on FIGS. 249 through 258, 264 and 265, 269 through 272, and 274 through 278.

Referring to FIGS. 249 and 250, which together disclose the A- through F- data conductors together with the check circuitry therefor, it may be seen on FIG. 250 that an "S" equipment rectangle is associated with each channel and that within each such "S" rectangle is a relay individual to each conductor. Make contacts 248-TST1 are operated during the idle condition of each channel, thereby connecting each conductor to the winding of its associated relay. With this arrangement, a ground on any conductor at this time operates its associated relay to call in an alarm. For example, a ground on the A0 conductor for channel "0" would be transmitted through the make contacts of the 248-TST1 relay for channel "0" to the winding of relay 250-A0, thereby operating it. Relay 250-A0, in operating, closes an obvious locking path for itself to ground through break contacts 279-CON1. The check relays for the conductors A0 through F0 of channel "0" are shown on FIG. 250 within a rectangle designated "S," while the check relays for the corresponding conductors of the other three channels are shown only diagrammatically by an "S" rectangle individual to each channel. The relationship between each of the remaining data-transmitting leads and their check relays on the other figures is similar to that just described for the conductors on FIGS. 249 and 250.

#### STANDING GROUND TEST ON THE CONTROL AND DATA LEADS DURING IDLE INTERVAL

Referring now to FIGS. 274, 276, and 277, the control leads DTOK, DTBL, CIF, and AMAE are respectively connected to the trouble check relays 276-DOK0, 276-DTBL0, 276-0DCS- or 276-DAE0 by the operation of relay TST6, and a trouble ground on these leads will operate a corresponding relay. A battery cross on the instruction leads, or a trouble ground on the leads to various control relays, will operate them directly.

Referring to FIG. 280, the false operation of any of the data check, control lead check, instruction, or control relays during the idle period of the data channel will ground the circuit to the 280-DAR0 data-alarm relay for channel "0," thereby operating it from ground through break contacts 279-CONN and 297-TM00, and make contacts 225-DCA1. Referring now to FIG. 293, the operation of relay 280-DAR0, with relay 279-CONN released, extends ground through make contacts 280-DAR0 and break contacts 279-CONN to operate relay 293-TBL0. Relay 293-TBL0, in operating, closes an obvious holding path for itself to ground, via the break contacts of relay 293-TIB0. Referring to FIG. 297, the operation of the 293-TBL0 relay extends ground through make contacts 293-TBL0 and 280-DAR0 to operate the 297-ALM0 relay and, additionally, on FIG. 225, operates relays 225-CHB and 225-CHB1 or the similarly designated relays in the other channels as shown on FIG. 226 in the "H" equipment rectangles for those channels. The operation of these relays makes their associated channels busy, as hereinbefore described, to all requests for service until the trouble is cleared by the maintenance personnel. The operation of the 297-ALM0 relay energizes the 297-DCA0 lamp which provides the necessary visual alarm indication. In addition, means are provided on FIGS. 293 to 295, under the control of the operation of the 293-TBL0

relay, to call in and connect to a trouble recorder circuit for recording the condition of all check and control relays on punched cards.

The ground test for the conductors of the data transfer circuit is removed immediately upon seizure of the data channel. The release of relays 225-DCA1 and 234-DCA2 releases relays 248-TST1 through 248-TST6 on FIG. 248, thereby removing the check relays from their associated data and control leads. The release of relay 225-DCA1 releases relay 280-DAR0. The release of relays 225-DCA1 and 280-DAR0 operates relay 279-CONN. Relay 279-CONN, operated, in turn, operates relays 279-CON1, 279-CON2, 279-CON3, and 279-CONA, thereby removing the locking grounds from the check relays on FIGS. 250, 252, etc.

#### TRANSMISSION OF DATA SIGNALS

The data bits are transmitted over the data channel leads by means of ground signals in definite code patterns which can be subjected to parity checks. These ground signals are transmitted from the sending to the receiving circuits as soon as the various connectors cut through the data leads to the required circuits. The grounds on the data leads result in operating and locking up the data relays in the receiving circuits, with the locking ground in the receiving circuit being returned to the data lead as an indication that the receiving relay has operated and locked to ground.

The particular circuits interconnected, and the data transmitted on any given use of the data transfer circuit, depends upon the type and condition of the call in progress. The data channel must, therefore, be given instructions as to the directions of data flow since the leads are capable of transmitting in either direction. Thus, on some calls, the information may be transmitted from the position to the sender via the data transfer circuit, while on other calls the information may be transmitted from the sender to the position. Also, the data channel must be furnished instructions concerning the exact data which must be checked for each usage of the channel. The primary instructions are given in the form of battery signals from the register or from the position control circuit as they are connected to a data channel. The primary instructions are given by operating one of the following relays: 261-ST0P for a sender-to-position indication, 261-PT0S for a position-to-sender indication, and 260-RT0S for a register-to-sender indication. The operation of one of these three instruction relays indicates the direction of data transmission. Thus, for example, on the present call the data is to be transmitted from the sender to the position and, therefore, relay 261-ST0P is operated over the following circuit, starting (on FIG. 261) with the winding of relay 261-ST0P and extending towards the operating battery as follows: battery on terminal 101 of FIG. 188 in the position control circuit for position "00," through resistor DTST, make contacts 181-DTST, transfer break contacts 175-TRZ, 179-SAF, and 169-TE, conductor "ST0P" extending from FIG. 188 to FIG. 261, where it appears within the rectangle representing position "00," make contacts 224-PF00, 225-OPRF0, to the winding of relay 261-ST0P to operate it.

In addition to the primary instructions associated with the foregoing relays, the data channel utilizes certain data check relays to obtain additional instructions for modifying, in accordance with call conditions, the checking pattern set up by the primary instructions. The check relays used for this purpose and which characterize the call in progress are: relay 273-NSA (which represents a no-sender-attached indication), relays 258-ND3 through 258-ND11 (which represent the number of digits to be transmitted), relay 262-NCN (which represents a no-called-number-to-be-transmitted indication), relay 264-OMA (which represents an operator identification for a non-ANI call), relay 256-IF (for an identification failure), relay 264-OI (which represents an operator iden-



tification signal), and relay 269-NIT (for a number identification failure in the tandem office). In addition, the relays 266-0PT0 through 266-3PT0 furnish information that the trunk connector has successfully cut through to the trunk.

The foregoing set of call setup data is utilized by each data channel to modify and control the logical check pattern which the incoming data will be subjected by the data channel.

It should be recalled that it is assumed for the call currently being described that the calling party is served by trunk "00" which is served by trunk connector "0"; that the calling party directory number is 582-4106; that the called party is in area 212; and that the called party directory number is 243-1000. This being the case, the following data conductors on the following figures will now be energized by sender "00" in order to transmit this and other call information to position "00": on FIGS. 249 and 250, conductors A0, A2, B0, B1, C0, C2, D0, D2, E0, E4, F1, and F2; on FIGS. 251 and 252, conductors G0, G1, H4, H7, J4, J7, K4, K7, DA1, and DA4; on FIGS. 253 and 254, conductors DB1, DB7, DC0, DC2, DTH0, DTH4, DH0, and DH1; on FIGS. 255 and 256, conductors RN0, RN1, RN13, CNM, AI, NAC, CS0 and CS1; on FIGS. 257 and 258, conductors DT4, DT7, DU4 and DU2; and on FIGS. 271 and 272, conductors SPT and OA0.

The grounded A- through K- conductors represent the called number digits, 212-243-1000. The grounded DA-, DB-, DC-, DTH-, DH-, DT- and DU- conductors represent the digits of the calling directory number, 582-4106. The grounds on conductors RN0, RN1 and RN13, together, represent a recorder number of 14. Ground on conductor CNM represents a cancel-number-match indication. Ground on conductor AI represents an automatic identification signal informing the operator that the calling number has been automatically identified. Ground on conductor NAC signifies that a national area code is involved in the called number digits. Ground on conductors CS0 and CS1, together, represent a class-of-service number of 11. Ground on conductor SPT signifies that the present call is of the special toll type, while ground on conductor OA0 signifies that the calling party is in originating area "0."

The called-area code and directory-number registers of the sender are shown on FIGS. 69 and 70. These registers comprise 11 sets of relays, designated A- through H-, and J-, K-, and L-, which store in 2-out-of-5 code form the digits comprising the called-area code, if any, the directory number and the party digit, if any. Of these 11 sets of relays, only the A- through G- registers would be used for seven-digit calls, and the A- through H-, and J- and K- registers for ten-digit area code calls. All of the A- through H-, and J-, K-, and L- registers would be used for area code calls to subscribers on party lines for which the dialing of a party digit is required.

Once the called digits have been registered by these relays, as hereinbefore described, the relays remain locked to ground over their own make contacts and the make contacts of relay 42-ON3. The locking ground for the A-, B-, C-, J-, K-, and L- registers is supplied from terminal 101 on FIG. 69, while the locking ground for the D-, E-, F-, G-, and H- registers is supplied from terminal 69-102. Each of these register relays has a correspondingly designated conductor extending to the data transfer circuit. These conductors are shown as leaving the sender circuit and extending to the data transfer circuit on FIG. 69. Each conductor is connected to the same side of the winding of its associated register relay to which the holding ground is applied when the relay is locked operated. Thus, each conductor is grounded whenever its respective register relay is locked operated for the registration of a digit.

Recalling that the called-area code for the present call is 212, the following relays have been previously operated

on FIG. 69 of the sender, and the identically designated leads extending to the data transfer circuit are now grounded: A0, A2, B0, B1, C0, and C2. Since the called station number is 243-1000, the D0 and D2 relays on FIG. 69 are now operated, thereby grounding the identically designated leads to the data transfer circuit. Also, the following relays on FIG. 70 are now operated, and the identically designated leads to the data transfer circuit are grounded: E0, E4, F1, F2, G0, G1, H4, H7, J4, J7, K4, and K7. No relays in the L- register are operated and none of the L- leads are grounded, since the dialing of a party identification digit is not required on the present call. Conductors A- through F- extend from FIG. 69 to the sender "00" rectangle on FIG. 250 of the data transfer circuit, while conductors G-, H-, J-, K-, and L- extend from FIG. 69 to the sender "00" rectangle on FIG. 252.

The calling station number of 582-4106 has been previously registered in the sender by the operation and locking of relays 43-DA1 and 43-DA4, 43-DB1 and 43-DB7, and by the operation and locking of the following relays on FIG. 44: DC0 and DC2, DTH0 and DTH4, DH0 and DH1, DT4 and DT7, and DU2 and DU4. The operation of relays 43-DA1 and 43-DA4 closes their make contacts (shown within sender "00" rectangle on FIG. 252) to apply grounds to conductors DA1 and DA4 of the data transfer circuit. The operation of the 43-DB- relays, as well as the DC-, DTH- and DH- relays on FIG. 44, closes their contacts (shown within the sender "00" rectangle on FIG. 253), thereby grounding the correspondingly designated conductors extending via the data transfer circuit to position "00." The operation of the above-mentioned DT- and DU- relays on FIG. 44 closes their make contacts (shown within the rectangle for sender "00" on FIG. 258), thereby grounding the correspondingly designated conductors extending for this call, via the data transfer circuit, to position "00."

Referring to FIG. 255, the grounds supplied to conductors RN0, RN1, RN13, CNM, AI, NAC, CS0 and CS1 at this time are supplied from FIGS. 39 and 45 of the sender. Conductors RN0, RN1, and RN13 are grounded by virtue of the closure of make contacts on FIG. 39 of relays 60-RN0, 60-RN1, and 60-RN13, respectively. Conductor AI is grounded by virtue of the operation of make contacts 51-AI and the nonoperation of break contact 51-AIT on FIG. 39. Conductors CS0 and CS1 are grounded by virtue of the operation of make contacts 60-CS0 and 60-CS1, respectively of FIG. 39. Conductor NAC is grounded by the circuit shown on FIG. 45 beginning with ground on terminal 45-101, break contacts 24-OPT, 60-AS0, and transfer make contacts 28-AC. Conductor CNM is grounded by the following circuit on FIG. 45: ground on terminal 45-102, break contacts 24-OPT, 27-OEZ, transfer break contacts 51-AIT, transfer make contacts 51-AI, 43-DI7, to conductor CNM. Conductors SPT and OA0 on FIGS. 271 and 272 are grounded by trunk "00" and not by the sender. Referring to FIG. 14 of the trunk circuit, both of these conductors are grounded over an obvious circuit including make contacts of relay 13-TP00. Only one of the OA0, OA1, and OA2 conductors on any one trunk circuit is used, since only one of the correspondingly designated terminals is cross-connected to a terminal for relay 13-TP00. The cross-connection is in accordance with the originating area traffic served by the particular trunk circuit. Thus, the trunk circuit shown on FIGS. 10 through 15 is wired so as to serve only traffic from originating area "0." Other trunk circuits would be provided to serve the traffic from the other originating areas, and their OA-terminals would be cross-connected in accordance with the originating area they serve. Position "00," sender "00," and trunk "00" are all interconnected at this time via data channel "0." The grounds applied to the aforementioned conductors by the sender and the trunk, representing call data that is to be transmitted to the position,



are transmitted over data channel "0" and received by the correspondingly designated conductors of position "00," since the necessary primary and secondary relays of the data transfer circuit have by now been operated to effect the desired interconnections. The specific circuit paths within the data transfer circuit will not be traced in detail of conductors involved, and also due to the fact that the for each of the foregoing conductors due to the quantity relay contact designations comprising the paths for some conductors are different from those of the others. However, a study of the figures involving the circuitry within the data transfer circuit on which any of the foregoing conductors are shown, together with a study of the relay contacts which must be closed in order to effect the required interconnection of the sender, the position, and the trunk will show that all such relays have been operated at this time as hereinbefore described.

The called number, plus the area code, is received by the position control circuit and registered in 2-out-of-5 code form by the relays shown on FIGS. 196 and 202. The relays TA0, etc., indicated by a rectangle of FIG. 202, register the first digit dialed, the 196-TB- relays register the second digit dialed, etc. Whereas, as hereinbefore described, 11 digits are dialed for the instant call, the first digit or "0" prefix is a "special service directing code"; therefore, only ten digits are required for the called number on the present call, and these ten digits are stored in the relays 202-TA- through 196-TH-, and 202-TJ- and 196-TK-. The grounds for operating these relays are supplied from the data transfer circuit via the conductors A- through H-, and J- and K-, shown on the bottom of FIG. 202, extending to FIGS. 249 and 251 of the data transfer circuit. Recalling that the called digits are 212-243-1000, the following relays on FIGS. 196 and 202 are now operated: 202-TA0 and -TA2, 196-TB0 and -TB1, 202-TC0 and -TC2, 196-TD0 and -TD2, 196-TE0 and -TE4, 202-TF1 and -TF2, 196-TG0 and -TG1, 196-TH4- and -TH7, 202-TJ4 and JT7, 196-TK4 and -TK7. All of these relays, in operating, close an obvious holding path for themselves over a set of their own make contacts, through break contacts 204-RLTR and make contacts 181-PRA1, to ground on terminal 196-101 for relays 202-TA- through 196-TE-, and terminal 196-102 for relays 202-TF- through 196-TH-, and 202-TJ- and 196-TK-.

The calling number is received by the position control circuit and registered in 2-out-of-5 code form on the sets of relays shown on FIG. 194. The grounds to operate each relay are supplied over the correspondingly designated conductors extending from the bottom of FIG. 200 to FIGS. 251, 253, and 257 of the data transfer circuit. Recalling that the calling number is 582-4106, the following relays on FIG. 194 are now operated: DA1 and DA4, DB1 and DB7, DC0 and DC2, DTH0 and DTH4, DH0 and DH1, DT4 and DT7, and DU2 and DU4. Most of the remaining information transmitted to the position for the present call is registered and stored by the relays shown on the bottom portion of FIG. 193. Each of these relays, respectively, has a lead connected to one side of its winding which is designated to correspond to the relay and runs to the indicated figure number of the data transfer circuit. The other side of each winding is connected directly to battery. Thus, when any lead is grounded, its relay is operated and, in so doing, it closes an obvious holding path for itself to ground on either terminals 101 or 102 of FIG. 193 through break contacts 182-TIF and make contacts 181-PRA. Thus, referring to FIG. 193, grounds on conductors RN0, RN1, RN13, CNM, AI, CS0 and CS1 operate and lock relays: 193-R0, -R1, -R13, -CNM, -SOI, -CS0, and -CS1, respectively.

The ground on conductor NAC extending from FIG. 255 of the data transfer circuit, and entering the position control circuit on FIG. 204, is extended to the winding of relay 204-NAC to operate it. Relay 204-NAC, in operating, closes an obvious holding path for itself over

its own make contacts, through break contacts 182-TIF, 204-RLTR, and make contacts 181-PRA1, to ground on terminal 101 of FIG. 204. The grounds on conductors SPT and OA0 extending from position "00," via FIG. 271 of the data transfer circuit, enter the position control circuit on FIG. 193 and operate and lock relays 193-SPT and 193-OA0.

The entry of the calling and called number information into the position control circuit, as described, and the operation of the above-enumerated miscellaneous relays on FIGS. 193 and 203, complete the transmission of information to the position control circuit from the sender and from the trunk.

#### DATA TIMING INTERVAL

As soon as the data channel has been assured that all the required circuits have been interconnected, it provides a minimum timing interval during which the connected circuits may interchange the data required, and during which interval the channel must check that the data transmitted to the receiving circuit has been registered and locked therein. This timing interval begins, for the present call, with the operation of the secondary cut-in relay 247-OSSD0 for sender connector "0," on FIG. 247. The operation of relay 247-OSSD0 closes its make contacts on FIG. 297, thereby closing the following path to operate relay 297-SDTM0: ground on terminal 297-102, make contacts 247-OSSD0, transfer break contacts 273-NSA, to the winding of relay 297-SDTM0 to operate it. Relay 297-SDTM0, in operating, closes an obvious path over its make contacts to operate relay 297-DTM0. Relay 297-DTM0 is slow to operate so as to provide ample time for the circuitry within the receiving circuit to register the data transmitted thereto.

#### OPENING SENDING GROUND CIRCUITS

The operation of relay 297-DTM0 opens an obvious path to release relay 297-DTMB0. The operation of relay 297-DTM0 also closes an obvious circuit from ground on terminal 297-101 to operate relay 297-DTMF0.

The release of relay 297-DTMB0 opens its make contacts on FIG. 247 and, with neither relay 261-PTOS0 nor 260-RTOS0 operated (since this is a "STOP" call), breaks the operating circuit for the secondary cut-in relays 247-OSSA0, -OSSB0, -OSSC0, and -OSSD0 for sender connector "0" for channel "0," thereby causing them to release. Similarly, the release of relay 297-DTMB0 opens its make contacts on FIG. 238 and breaks the operating circuit for the secondary cut-in relay 238-OTSS0 for trunk connector "0," thereby causing it to release. The release of relays 247-OSSA0, etc., breaks the interconnection between the sender and the position, and the release of relay 238-OTSS0 breaks the interconnection between the trunk and the position for all conductors over which the sender or trunk transmitted data to the position. If the call were such that the transmission of data was from the register or position to the sender, either relay 260-RTOS0 or 261-PTOS0 would have been operated, and the sender connector secondary cut-in relays would not have released. However, the register or the position connector secondary cut-in relays would have released, and the data registered in the sender would have been checked instead. The only grounds appearing on these transmission conductors after the release of these cut-in relays will, therefore, be the grounds returned by the locking circuits of those data receiving relays in the position control circuit which have successfully operated and locked.

#### CHECKING DATA AS LOCKED IN AT THE RECEIVING CIRCUITS

The operation of relay 297-DTMF0 closes an obvious path on FIG. 248 to operate relays 248-TST1 through 248-TST6 for channel "0." The operation of these relays reconnects a data check relay back onto each data conductor over which the data was transmitted from the



sender to the position. The data check relays for all conductors which are grounded by the locking circuits of the receiving register relays in the position will now operate; while those check relays associated with ungrounded data conductors will remain unoperated. Thus, for example, referring to FIGS. 249 and 250, the data check relays for channel "0" are shown within the "S" equipment rectangle connected to channel "0" on the right-hand side of FIG. 250. A relay is provided for each data check lead, and, therefore, recalling that the first six digits of the called number transmitted from the sender to the position were 212-243, the following data conductors will be grounded by the locking ground returned from the register relays in the position, and, in so doing, will operate their corresponding data check relays in the "S" equipment rectangle for channel "0": 250-A0 and -A2, -B0 and -B1, -C0 and -C2, -D0 and -D2, -E0 and -E4, and -F1 and -F2. In a similar manner, the other data check conductors over which data is transmitted from the sender and trunk to the position will be grounded at this time, providing that the proper register relays operated in the position, and, accordingly, their associated data check relays will now be operated.

The operation of the data check relays energizes checking circuitry for the channel, which ascertains that a logical set of data was transmitted from the sender to the position and was successfully registered in the position. This checking is accomplished by wiring the contacts of the data check relays into logical circuits which cut through a ground from their input to their output upon the successful registration of a logical set of data for a call.

FIGS. 286 through 292 disclose in detail the check patterns used to verify and check the data transmitted over the data channel under various call conditions, in accordance with the instructions given to the data channel.

#### PARITY CHECKS TROUBLE CONDITIONS

All data transmitted is in the form of codes which are subject to parity checks. An "under" or "over" registration for any data item results in the operation of one of the following data error detecting relays indicative of the group of data containing the error: relay 239-OU10 for relay 293-OU0, both for call setup data, relay 287-TDE0 for the trunk data, relay 289-CNE0 for called number data error, relay 292-AMAE0 for automatic message accounting data error. The operation of one of these error detecting relays results in the grounding of certain trouble indicating leads to the register, position, and sender, as described below, and in the operation of relay 293-TBL0. The operation of relay 293-TBL0, in turn, results in the release of the attached circuits and a request for a trouble record.

Referring now to FIG. 276, the operation of the 292-AMAE0 relay grounds the lead AMAE to the position circuit only. The grounding of lead AMAE to the position circuit, as an indication of error in the AMA information, allows the operator to salvage the call by obtaining the AMA details from the subscriber orally. The detailed circuitry for terminating lead AMAE is shown on FIGS. 188 and 182 of the position control circuit. No trouble indication was given to the sender circuit under these conditions and it processes the call in the normal manner. Under all other data error conditions, the DTBL leads, both to the position circuit and to the sender circuit, are also grounded, thereby blocking the further progress of the call. This function is hereinafter explained in detail.

#### SATISFACTORY CHECK CONDITIONS

Again referring to FIG. 276, a satisfactory check of the data pattern results in the grounding of the DTOK leads to the position control circuit, the register circuit, and the sender circuit, if attached. The position control

circuit, or the register circuit, on receiving the DTOK signal, opens "start" leads to the data transfer circuit to release it.

Referring now to FIGS. 286 through 292, the energizing ground potential for the check circuits is supplied by the circuitry of FIG. 286, which shows the four data channels, the ten register connectors, and the seven position connectors, together with their associated contacts, in coordinate form. Although the 224-PF-- and the 230-RC-- contacts, together with the grounds supplied thereto, are internal to the data transfer circuit, they are shown in coordinate form in order to facilitate an understanding of the circuit.

#### CHECKING THE DATA TRANSMITTED

Referring to FIG. 286, it has been assumed that position "00" serves the present call and, therefore, contacts 224-PF00 and 225-OPRC0 on FIG. 286 are now closed. The closure of these contacts permits the ground on terminal 101 of FIG. 286 to be extended therethrough to terminal 102 of the same figure. Relays 248-TST3 and 297-DTMF0 are also operated at this time and, therefore, the ground on terminal 286-102 may be extended through make contacts 248-TST3 and 297-DTMF0 to terminal 101 of FIG. 287.

Looking now at the circuitry of FIG. 287, it is evident that the ground extended to terminal 287-101 will be extended to terminal 287-103 in the event that relay 260-RTOS or 261-PTOS is operated. Relay 260-RTOS represents a register-to-sender direction of data flow, while relay 261-PTOS represents a position-to-sender direction of data flow. If neither relay 260-RTOS nor relay 261-PTOS is operated, the ground on terminal 287-101 will be extended through their series-connected transfer break contacts to terminal 287-102. From terminal 287-102, the ground may be extended through break contacts 271-SPT to terminal 287-104 if relay 271-SPT is not operated, or through make contacts 271-SPT to terminal 287-105 if relay 271-SPT is operated. Relay 271-SPT represents a special toll call. If relay 271-SPT were operated, thereby extending the ground on terminal 287-102 to terminal 287-105, the input ground could then be further extended to terminals 287-106, -107, or -108, depending upon whether none of, one of, or both of relays 271-ZCN and 271-ZNC are operated. Only one of these relays should ever be operated during a call, and, therefore, the desired mode of operation is for a ground on terminal 287-104 to be extended to terminal 287-107 on the 1-out-of-2 output of this matrix. Terminals 287-106 and -108, representing the 2-out-of-2 and the 0-out-of-2 outputs, are connected to the winding of relay 287-TDE0 to operate it and signify trunk data error. If relay 271-SPT is operated, thereby extending the ground on terminal 287-102 to terminal 287-105, ground may be then further extended to either terminal 287-108 and the winding of relay 287-TDE0 in the event that either of the relays 271-ZCN or 271-ZNC is operated, or, as is the intended mode of operation, the ground on terminal 287-105 may be extended to terminal 287-109 in the event that either of these two relays is operated. The ground on terminal 287-109 may be further extended to terminal 287-112 and the winding of relay 287-TDE0 as an error signal in the event that either of the relays 271-RCL or 263-NZRC is operated, or, alternatively, ground may be extended to terminal 287-110 in the event that neither of these two relays is operated. The ground extended to terminal 287-107 may be further extended to terminal 287-112 and the winding of relay 287-TDE0 in the event that neither of the relays 271-RCL or 263-NZRC is operated, and, similarly, ground may be extended to terminal 287-112, via terminal 287-111, in the event that both of these relays are operated. The desired mode of operation for a call having a ground extended to terminal 287-107 is for only one of these two relays to be operated, thereby extending the input ground



to terminal 287-110. The ground extended to terminal 287-110 may be further extended via terminal 287-113, to the winding of relay 287-TDE0 as an error signal in the event that two of the three relays 271-OA0, -OA1, and -OA2 are operated, or via terminal 287-115 in the event that none of them are operated. The desired mode of operation is for one of these three relays to be operated, in which case ground will be extended to terminal 287-114 and to terminal 287-103, thereby indicating that the trunk data is okay.

Relay 271-SPT is operated, since the present call is of the special toll type, and, therefore, the ground extended to terminal 287-102 is further extended, initially, to terminal 287-105. Neither of the relays 271-ZCN or 271-ZNC is currently operated and, therefore, the ground may be further extended through their series-connected transfer break contacts to terminal 287-109. Neither of the relays 271-RCL or 263-NZRC is operated and, therefore, ground may be further extended through their series-connected transfer break contacts to terminal 287-110. Only relay 271-OA0 is currently operated and, therefore, the ground extended to terminal 287-110 may now be further extended to terminal 287-114, and thence to terminal 287-103.

Relay 273-NSA is operated in the event that a sender is not attached during the serving of a call. In this event, with relay 273-NSA operated, the ground extended to terminal 287-103 may be further extended to terminal 287-117 through the make contacts of relay 273-NSA and thence, over conductor NSA, to terminal 101 on FIG. 292. A sender is attached during the serving of the presently described call and, consequently, relay 273-NSA is unoperated, thereby further extending the ground on terminal 287-103 through its transfer break contacts to terminal 287-116.

Relay 262-NCN is normal in the event that the called number is to be transmitted via the data transfer circuit from the register or from the position to the sender, or from the sender to the position, and is operated whenever the called number is not to be transmitted to the position. The -NCN relay will not be operated for the present call, its nonoperation indicating that the called number is to be transmitted to the position since, as hereinbefore described, this information was previously received by the sender via the incoming trunk from the preceding office and is required by the position operator for charging purposes, etc.

Therefore, for the present call, the ground extended to terminal 287-116 may be further extended through transfer break contacts 262-NCN to terminal 287-125. Relay 261-STOP is operated whenever the called number information is transmitted from the sender to the position. For the instant call, with relay 261-STOP operated, the ground extended to terminal 287-125 may be further extended through its transfer make contacts to terminal 287-118, and thence to terminal 287-120. However, relay 261-STOP will not be operated on calls for which the called number information is to be transmitted to the sender. On such calls the ground extended to terminal 287-125 may, therefore, be further extended through transfer break contacts 261-STOP to terminal 287-119 which constitutes the input of a symmetric check circuit comprising the contacts of the indicated relays. One, and only one, of these relays should be operated on a call, to indicate to the sender the number of digits in the called number, in order that the steering relays of the sender may be set in a manner necessary to receive the called number. Assuming that one, and only one, of the nine indicated relays is operated, the ground extended to terminal 287-119 will be further extended to the 1-out-of-9 upcheck output on terminal 287-120. Terminal 287-126 constitutes the 0-out-of-9, and the 2 (or more)-out-of-9, output of this symmetric check circuit and, in the event that the relays of this symmetric check circuit fail to operate in the desired manner, the ground ex-

tended to terminal 287-119 will be further extended to terminal 287-126, and thence to the winding of relay 289-CNE0 to operate it, thereby indicating an error in the called number information.

Terminal 120 on FIG. 287 also constitutes the input of the called number check circuit which, in turn, comprises a plurality of symmetric circuits connected in cascade, one such circuit for each digit of the called number, as shown on FIGS. 287, 288, and 289. Each digit of the called number is received in 2-out-of-5 code form, and the check circuit for each digit of the called number comprises a symmetric check circuit whose 2-out-of-5 upcheck output conductor is interconnected to the input conductor of the next succeeding digital symmetric check circuit for the desired mode of operation, and whose other output conductor (indicative of 0-out-of-5, 1 out-of-5, 3-out-of-5, 4-out-of-5, and 5-out-of-5 trouble conditions) is connected to the common "error" conductor, and thence to the winding of relay 289-CNE0.

The symmetric check circuits are shown in diagrammatic form to conserve drawing space, and the drawings show each such symmetric check circuit to have an input conductor, a 2-out-of-5 output conductor (representing the desired mode of operation), and an error output conductor (for trouble conditions). Thus, referring to the symmetric check circuit for the "A" digit of the called number as shown on FIG. 287, its input is connected to terminal 287-120, its error signal output is connected to terminal 287-127, and its 2-out-of-5 upcheck output (representing the desired mode of operation) is connected to terminal 287-122.

The ground on terminal 287-120 may be extended through the cascade-connected symmetric check circuits for the "A," "B," and "C" digits to terminal 287-124, provided that the relays of these three symmetric check circuits are operated in the desired 2-out-of-5 code form. Any symmetric check circuit having an improper number of relays operated therein, less or more than two, will extend the ground on its respective input terminal to its respective error signal output conductor, and thence to relay 289-CNE0 to operate the relay and thereby to signify an error in the called number information.

Assuming that there are no errors in the "A," "B," or "C" digits, the ground extended to terminal 124 of FIG. 287 is further extended to terminal 103 on FIG. 288. FIG. 288 contains seven symmetric check circuits, one such circuit for each of the digits "D" through "H," and "J" and "K" of the called number. Each of these symmetric check circuits is similar to those previously described for the "A," "B," and "C" digits on FIG. 287 and, accordingly, each has an input terminal, an error output conductor, and a 2-out-of-5 upcheck output conductor. The error output conductor of each symmetric check circuit on FIG. 288 is connected to terminals 112 and 113 which, in turn, are connected to the winding of relay 289-CNE0. This permits an improper registration in any symmetric check circuit to extend the ground signal on its input terminal to its error signal output conductor, thereby, in turn, operating relay 289-CNE0. The 2-out-of-5 upcheck output conductor of each symmetric check circuit is respectively connectable, by means of a transfer break contact on a 258-ND- relay, to the input conductor of the symmetric check circuit for the next succeeding digit of the called number. With this arrangement and with all of relays 258-ND3 through 258-ND10 released, a ground on terminal 288-103 will be further extended through the seven cascade-connected symmetric check circuits to terminal 288-111.

The number of digits in the called number is not fixed, but, on the contrary, varies for different calls. Therefore, a steering circuit comprising a set of transfer contacts on each of the relays 258-ND3 through -ND10 is employed to interconnect the input and output conductors of the symmetric check circuits on FIG. 288, in order to bypass any symmetric check circuit not needed for checking the



number of digits in the called number on any particular call. For example, relay 258-ND3 will be operated in the event that only three digits of a called number are transmitted over the data transfer circuit to the sender. In this event, the ground extended to terminal 288-103 will be further extended through transfer make contacts 258-ND3 to terminal 288-101, to terminal 288-102, to terminals 102 and 103 on FIG. 289, and thence, over the circuitry hereinabove discussed, to the input conductor of the check circuit for the calling number. Similarly, if there are only four digits in the called number information transmitted via the data transfer circuit on a call, relay 258-ND4 will be operated, thereby further extending the ground extended to terminal 288-104 to terminal 288-102, and thence to the input conductor of the calling number check circuit on FIG. 289. Similarly, the 258-ND- relay transfer contacts respectively connected to the output conductor of each remaining symmetric check circuit is operated in the event that the 2-out-of-5 upcheck output conductor of that particular symmetric check circuit represents the termination of the checking operation needed to ensure a valid 2-out-of-5 registration for each called number digit. The operation of that particular -ND- relay, in turn, extends ground from the output conductor of its respective symmetric check circuit to the input conductor of the calling number check circuit.

Relays 258-ND3 through -ND11 are operated only for calls on which the called number is to be transmitted from the register or position, via the data transfer circuit, to the sender. However, there are other types of calls where this is not the case and where, yet, it is still desirable to terminate the check of the called number information having a predetermined number of digits. Thus, relay 256-LAC, which represents a local area code call, i.e., one not having a prefixed national area code, is provided, and is operated for every seven-digit call. The transfer make contacts of relay 256-LAC operated, the break contacts of which are connected to the input conductor of the "H" digit symmetric check circuit on FIG. 288, connect the 2-out-of-5 upcheck output conductor of the "G" digit symmetric check circuit, through transfer break contacts 258-ND7, to terminal 288-114, thereby bypassing the symmetric check circuits for the "H," "J," and "K" digits on FIG. 288, together with the symmetric check circuit for the "L" digit on FIG. 289. Similarly, relay 256-NAC is provided, and is operated for all calls having a prefixed national area code, i.e., ten-digit calls. The transfer break contacts 256-NAC connected to the input conductor of the "L" digit symmetric check circuit on FIG. 289, when operated, bypass this symmetric check circuit, via transfer make contacts 256-NAC, for such calls by connecting the output conductor of the "K" digit symmetric check circuit to terminal 288-114. All 11 symmetric check circuits, i.e., for digits "A" through "H," and "J" through "L" are used for eleven-digit calls, and for which relay 258-ND11 is operated, thereby further extending the ground check signal through the "L" digit symmetric check circuits, and through make contacts 258-ND11, to terminal 104 on FIG. 289.

On dial "0" calls to the position operator, for which calls the calling number is automatically identified at the originating office, the sender is called in on its initial seizure merely to obtain the calling number from the originating office and to then transmit this number over the data transfer circuit to the position associated with the trunk. When serving this type of call, the 262-NCN (no-called number) and the 261-STOP (sender-to-position direction of data flow) instruction relays are operated by a signal from the sender and position. Thus for this type of call, the ground extended to terminal 116 on FIG. 287 may now be further extended through transfer make contacts 262-NCN to terminal 101 on FIG. 288, thence to terminal 288-102, and thence to terminal 102 on FIG. 289, terminal 289-103, transfer break contacts 260-RT0S, 261-PT0S, 264-OI, 264-OMA, 256-IF, and

269-NIT to terminal 289-104 which constitutes the input to the symmetric check circuit for the calling number information transmitted from the sender to the position.

Referring back to terminal 116 on FIG. 287, the transfer make contacts 262-NCN are operated since no check will be made of called number information and since the sender does not transmit the information to the position for this type of call. Therefore, the ground extended to terminal 287-116 may be further extended to terminal 104 on FIG. 289, as above described.

Terminal 104 on FIG. 289 constitutes the input to a calling number check circuit which, in turn, comprises a plurality of symmetric check circuits, similar to those hereinabove described for the called number, which checks to ensure that the calling number relay registers are operated in the proper 2-out-of-5 code form. An individual symmetric check circuit is provided for each digit of the calling number, and the contacts comprising each symmetric check circuit are respectively on the register relays comprising the register for the digit represented by each such symmetric check circuit. The seven digits of the calling number are registered in the sets of relays 252-DA-, 254-DB-, 254-DC-, 254-DTH-, 254-DH-, 258-DT- and 258-DU- and, accordingly, the symmetric check circuit for each digit respectively comprises the contacts of one set of these relays.

The ground extended to terminal 104 of FIG. 289 is further extended through the cascade-connected symmetric check circuits to terminal 101 on FIG. 291 in the event that all calling number registers are operated in the desired 2-out-of-5 code form. In the event that an "over" or "under" registration has occurred in any register, the ground extended to its input conductor is extended out over its "error" output conductor to terminal 102 on FIG. 291, rather than out over its 2-out-of-5 upcheck output conductor to the input conductor of the next succeeding symmetric check circuit. A ground extended to terminal 202 of FIG. 291 is further extended to the winding of relay 292-AMAE0 to operate it, and to thereby indicate an automatic message accounting error.

Terminal 101 on FIG. 291 is connected to the input conductor of a three-relay symmetric check circuit having a 1-out-of-3 upcheck output conductor, and an "error" output conductor indicative of 0-out-of-3 or 2-out-of-3. One, and only one, of the three relays, 256-CMN, 256-S0, or 256-NS0 should be operated on every call, thereby extending the ground on terminal 291-101 to terminal 291-103. The designations of these three relays respectively signify "cancel no match," "service observing," and "no service observing."

If relay 262-NCN is operated to indicate that there is no called number to be transmitted via the data transfer circuit on this call, the ground extended to terminal 103 of FIG. 291 is further extended through transfer make contacts 262-NCN, to terminal 291-104. If relay 262-NCN is unoperated, the ground extended to terminal 291-103 is further extended to terminal 291-104 via the 1-out-of-2 upcheck output conductor of the area information symmetric check circuit, comprising the contacts of relays 256-LAC and 256-NAC, which relay designations respectively signify "local area code," and "national area code." The 1-out-of-2 upcheck output conductor for the area information symmetric check circuit is connected to a plurality of symmetric circuits, shown on FIG. 292 which perform the indicated logic checks on the recorder number information, class-of-service information, and call identification information. If the proper number of relays are operated in each register, as indicated by the designation on the upcheck output conductor for each, the ground on terminal 102 of FIG. 292 is further extended, through the cascade-connected symmetric check circuits, to terminal 292-105, which constitutes the output of the call identification symmetric check circuitry. If an improper number of relays are operated in any of the registers, the ground extended to the input conductor of



its respective symmetric check circuit is not extended to its upcheck output conductor but, instead, is connected to its "error" output conductor which, in turn, is connected to the winding of relay 292-AMAE0 to operate it and thereby indicate an automatic message accounting error.

Referring to FIG. 289, the transfer make contacts of relay 260-RTOS, for interconnecting terminals 289-101 and 289-103, are provided so that when relay 260-RTOS is operated (thereby indicating that information is to be transmitted from the register via the data transfer circuit to the sender), the symmetric check circuitry associated with the calling number, together with the rest of the symmetric check circuitry on FIGS. 290 and 291, is bypassed, so that the ground extended to terminal 289-103 is extended to terminal 105 on FIG. 292 and to the winding of relay 292-DOK20, causing it to operate. The make contacts 261-PT0S on FIG. 289 similarly provide for bypassing selected portions of the check circuitry for different types of calls.

Referring again to FIG. 289, it may be seen that the winding of relay 289-DOK10 is connected to terminal 289-102, which terminal has ground extended thereto in the event that the called number registers are operated in the proper code combination form.

Referring now to FIG. 292, relay 292-DOK20 is connected to terminal 292-105, which terminal is grounded in the event that the calling number information is registered properly in code combination form, or if the calling number check circuitry is bypassed. Referring to FIGS. 289, 292 and 267 jointly, the operation of relay 289-DOK10 serves no useful purpose on most calls since the ground on terminal 101 in rectangle "DD," on FIG. 267, and connected through make contacts 289-DOK10, is opened at the make contacts of relay 292-AMAE0, which relay operates only in the event of certain trouble conditions. The operation of relay 292-DOK20 extends the ground from terminals 267-102 and 276-102, on both FIGS. 267 and 276, through its make contacts, through break contacts of relay 293-TBL0 and 292-AMAE0, over the data transfer circuit, as shown, to conductor DTOK of position control "00" on FIG. 274, and over the like designated conductor to sender "00" on FIG. 267.

There are certain calls for which erroneous calling number information may be transmitted via the data transfer circuit while, at the same time, the called number information is good. In this event, relay 292-AMAE0 operates, relay 292-DOK20 does not operate, but relay 289-DOK10 does operate since the called number information is good. In such event, since the called number information is good, it is desired to have the call completed even though the calling number information is defective. Therefore, the concurrent operation of relays 289-DOK10 and 292-AMAE0 close their series-connected make contacts on FIG. 267 to extend a ground over conductor DTOK from terminal 267-101 to sender "00," thereby sending it the same signal as it receives for normal calls, in order that it may proceed with its functions of establishing the desired connection. However, referring to FIG. 276, the failure of relay 292-DOK20 to operate prevents the ground on terminal 276-102 from being extended over the DTOK lead to the position "00," so that, under this condition, the position does not receive the same signal as it does for normal calls. By means explained elsewhere in this description, the operation of relay 292-AMAE0 effects the transmission of a trouble condition to the operator, thereby indicating that the connection is to be established but that it will be necessary to obtain the calling number information orally and to manually ticket the call.

#### RELEASE OF DATA CHANNEL

As hereinafter described, when the position circuit receives a data transfer "okay" check signal from the data transfer circuit upon the satisfactory transfer of data

through the channel, it removes battery potential from its "start" leads, thereby causing the data transfer circuit to release and free the channel for the serving of subsequent calls. Referring to FIG. 224, the reception of the data transfer "okay" check signal by position "00" operates relay 182-DTOK, as hereinbefore described, thereby removing the negative battery potential from the conductor STDT extending from the position control for position "00," via make contacts 224-PF00, resistor PP00, and conductor STDT', to position connector "0." The removal of this potential releases relays PP00, PE00, and PF00 on FIG. 224. The release of relay 224-PF00, in turn, releases relays PA00 through PD00 on the same figure. The removal of battery from conductor STDT by the position control for position "00" also releases relay 225-OPS0. The release of relay 225-OPS0, in turn, releases relays OPSA0, OPSB0, and OPSE0 on the same figure. The release of relay 225-OPS0 also releases relays OPRC0, OPRD0, and OPRF0 on the same figure.

The release of the aforementioned relays on FIGS. 224 and 225 opens the primary and secondary cut-in relay contacts of position connector "0" in order that the connector may serve subsequent calls. The release of these relays also re-establishes the chain circuit for relays 225-DCA1 and 234-DCA2, thereby permitting them to reoperate in the event that all of the position connector and register connector secondary cut-in relays for channel "0" are currently idle.

Referring now to FIG. 297, the operation of relay 234-DCA2 releases relay 297-DTMF0 which, in turn, will permit the release of relays 297-SDTM0 and 297-DTM0 after relay 247-OSSD0 shall have released as hereinafter described. Referring to FIG. 248, the release of relay 297-DTMF0 also releases the relays 248-TST1 through -TST6. Referring to FIG. 279, the operation of relay 225-DCA1 releases relay 279-CONN which, in turn, releases relays 279-CON1 through -CON3, and -CONA. Relay 279-CONN is of the slow-release variety and, therefore, remains operated a brief interval after its operating circuit is open. The release of these relays, together with the operation of relays 225-DCA1 and 234-DCA2, recloses the circuit paths to reoperate relays 248-TST1 through -TST6. The reoperation of the relays 248-TST1 through -TST6 recloses the ground test circuits to the data channel conductors during the idle period of the data channel.

Referring to FIG. 283, the release of relay 225-OPRC0 releases relay 283-PGT which, in turn, releases relay 283-PGT1 for position connector "0." Referring to FIG. 275, the release of relays 224-PE00 and 225-OPRC0 releases relay 275-PGRA. Referring to FIG. 261, the release of relay 224-PF00 opens a circuit to release relay 261-ST0P for channel "0." Referring to FIG. 236, the release of relay 224-PF00 opens its make contacts to release relays 239-ODG4 and -ODG7. The release of these relays, in turn, releases relays 238-ODCS0 and -OTS0 which, in turn, releases relay 266-0TP0. Relay 238-0TSS0 previously released when relay 297-DTMB0 released. The release of relay 238-OTS0 opens a circuit on FIG. 246 to release relay 246-0SRE0.

Referring now to FIG. 242, the concurrent release of relays 224-PF00 and 238-OTS0 opens a circuit which removes the negative 130-volt battery potential from the PC conductor, extending via the circuitry of FIG. 241, to the SP conductor of FIG. 243. The removal of this battery potential from the circuit of FIG. 243 releases relay 243-SS00 which, in turn, releases relays 243-SE00, -SA00, -SB00, SC00, and -SD00. The release of these relays, in turn, releases relays 245-DGN4 and -DGN7.

Referring to FIG. 242, the release of relay 224-PF00 removes battery from conductor PC on FIG. 241 which, in turn, releases relay 13-TP00 in the trunk. Referring to FIG. 263, the release of relay 13-TP00 opens a circuit to release trunk subgroup relay 263-0TSG0.



Referring to FIG. 225, the release of relays 225-OPRD0, 238-OTS0, 297-SDTM0 and 246-OSRE0 causes relays 225-CHB and -CHB1 to release at this time, thereby indicating that channel "0" is once again available for the serving of subsequent calls. The release of the above-mentioned relays, in turn, releases relay 225-OPCB0 as a further indication that channel "0" is now idle.

The release of the above-described relays effected the release of all relays on FIGS. 286 through 292, so that at this time all the circuitry comprising channel "0" is rendered idle after having served the currently described call.

#### CONNECTOR SEQUENCE GATE CONTROL AND GATE ALARM CIRCUITRY

In periods of heavy traffic the position connector or register connector may encounter delays in seizing data channels, due to the lack of an idle channel. In order to equalize the delays among the various connectors at such times, a sequence or "gating" feature is provided. This feature locks out of service any position connector or register connector which has seized a data channel until all other waiting position connectors and register connectors have each served one call. The "QQ" rectangles on FIG. 283 respectively disclose gating equipment individual to each position connector, while the "RR" rectangles respectively disclose gating equipment individual to each register connector. The circuits for position connector "0" and register connector "0" are respectively shown in detail in the appropriate "QQ" and "RR" rectangles, while the circuits for the other position connectors and register connectors, represented by the other "QQ" and "RR" rectangles, are not shown in detail, since these circuits are identical to those shown for position connector "0" and register connector "0."

Referring to FIG. 283, when a connector gains access to a data channel, the operation of its --PRC- or --RRC- cut-in relay places a ground on the winding of its respectively associated 283-PGT or -RGT relay to operate it and, in turn, its related 283-PGT1 or -RGT1 auxiliary relay. For the present call, the operation of relay 225-OPRC0 extends ground over an obvious circuit to one side of the primary winding of relay 283-PGT for position connector "0" to operate it, since the other side of the winding is connected via break contacts GTM to battery in the trouble recorder frame in rectangle TRF. The operation of relay 283-PGT completes an obvious circuit to operate relay 283-PGT1 for the same position connector. When the connector is released, relay 225-OPRC0 releases and removes the operating ground from relay 283-PGT. However, if some other connector is waiting for a data channel, its respective --PE- or --RC- relay is operated and the 283-PGT relay of position connector "0" is held operated as follows: The operation of the associated 283-PGT1 relay on the present call closes a path for the secondary winding of relay 283-PGT to conductor 101 on the bottom of FIG. 283. This conductor is common to all position connectors and register connectors and is connected to the circuitry therein via the *b* terminal of each "QQ" and "RR" rectangle. The operated --PE- or --RC- relay in the connectors waiting to be served extend a ground to conductor 101, which ground maintains relay 283-PGT in position connector "0" operated, via transfer make contacts 283-PGT and 283-PGT1. For example, if register connector "0" is waiting to be served while the position connector "0" serves the present call, ground will be applied to conductor 101 to maintain relay 283-PGT in position connector "0" operated over the following circuit: make contacts 230-RC00 (above the "RR" rectangle for register connector "0"), via terminal *a*, break contacts 283-RGT1, transfer break contacts 283-RGT, via the *b* terminal of this rectangle, to conductor 101. Any other connector waiting for service would similarly apply ground to conductor 101 over an analogous circuit.

In view of the foregoing circuit description, it may be

seen that the ground extended to conductor 101 will remain as long as a position connector or a register connector is waiting for a connection to an idle data channel, and that each waiting connector when served removes the ground extended by it to conductor 101 immediately upon the operation of its 283-PGT or 283-RGT relay.

Referring to FIGS. 225 and 231, it may be seen that the "start" lead STDT for each connector includes parallel-connected break contacts of its 283-PGT and 283-PGT1 relays for the position connectors, and parallel-connected break contacts of its 283-RGT and 283-RGT1 relays for the register connectors. These break contacts prevent a "start" ground from being applied to their respective connector whenever relays 283-PGT and 283-PGT1 or 283-RGT and 283-RGT1 are operated. Thus, as long as these relays remain locked operated, the "start" lead for the related connector remains open, so that those connectors which have been served cannot be served again until all waiting connectors have been served. Each connector waiting to be served takes its turn in this manner and is connected to a data channel as it becomes available.

The specific order in which waiting connectors become connected to a data channel as it becomes available is determined by the preference circuitry hereinbefore described in connection with FIGS. 224 through 235. Each connector, when served, becomes locked out from further service until all other waiting connectors are served. When all waiting connectors finally have been served, the last 283-PGT or -RGT relay, in operating, removes ground from conductor 101, thereby releasing the "gate" relays and all connectors which were held operated by the ground extended to conductor 101. When the "gate" relays release, the "start" lead is reclosed to the data channel preference circuit.

Referring to FIG. 285, if a 283-PGT or -RGT relay is operated and a data channel is not seized when available, the timing circuit shown on this figure is activated by the removal of ground from terminal GT which, in turn, after a predetermined time interval, permits capacitor GT1 to charge from positive 130-volt battery, fire the gas tube GTM, and operate relay 285-GTM to bring in an alarm. Relay 285-GTM, in operating, opens its break contacts shown within the upper rectangle TRF on FIG. 283, thereby releasing all operated 283-PGT or -RGT relays and making the circuit "gate" ineffective until the DAR key on FIG. 285 is operated to disable the alarm circuit.

#### ALARM CIRCUITS

##### STANDING GROUND TESTS OF THE DTOK, DTBL, CIF AND AMAE CONTROL LEADS OF THE POSITION, REGISTER AND SENDER CONNECTORS

A standing ground test is provided in all position, register, and sender connectors to monitor the DTOK, DTBL, CIF and AMAE control leads of these connectors for false grounds at all times when the connectors are idle. If any of these leads should become falsely grounded in a connector, the associated circuit served by the connector would be released prematurely. Referring to FIGS. 275, 278 and 268, a trouble ground appearing on any of these leads in the idle state of any connector will operate its respective 275-PGR, 278-RGR or 268-GRS ground alarm relay. The operation of ground alarm relay 275-PGR lights lamps PCGR and PCA; the operation of relay 278-RGR lights lamps RCGR and RCA; and the operation of relay 268-GRS lights lamp SCA. The lamp PCA is for position connectors; the RCA lamp is for register connectors; and the SCA lamp is for sender connectors. A 275-PGR, 278-RGR, or 268-GRS relay locks once it is operated, and an alarm condition will persist until the trouble is cleared and the associated alarm release key is operated.

The winding of each test relay is connected to the multiples of its associated connector, via break contacts of an associated test cut-off relay which, for position connector "0," for example, is designated 275-PGRA. The operation



of a connector primary cut-in relay operates its associated test cut-off relay, thereby removing the ground test relay from the control leads and freeing the connector for service. Thus, on the present call, the operation of relay 224-PE00 operates relay 275-PGRA which, at its break contacts, opens the circuit to disconnect the winding of ground test relay 275-PGR from the multiples of position connector "0."

#### CONNECTOR GROUND CHAIN ALARM FOR POSITION, REGISTER AND SENDER CONNECTORS

The preference ground chains of all the connectors are continuously monitored for false grounds or opens in the chain leads. Referring to FIGS. 224, 230, and 243, this is accomplished by a 224-PCH, a 230-RCH, or a 243-SCH relay arranged as a detector and a balanced resistance bridge circuit. This relay, for position connector "0," is designated 224-PCH, for register connector "0," 230-RCH, and for sender connector "0," 243-SCH. An unbalance in the resistance bridge, due to an open or a falsely grounded chain circuit, will result in the operation of the 224-PCH, 230-RCH, or 243-SCH relay. The operation of one of these relays operates its associated 275-PGR, 278-RGR, or 268-GRS relay, thereby energizing an alarm as described under the standing-ground-test of the connector multiples. For example, the operation of relay 224-PCH in the event of a defect in its chain circuit closes a path to operate relay 275-PGR.

#### TRUNK CONNECTOR PREFERENCE SELECTOR CHAIN ALARM

The trunk connector circuitry on FIGS. 238 and 240 contains relays which detect an "open" in the connector chain circuit and which operate in a manner similar to that already described for the position, register, and the sender chain alarm circuits. Thus, the operation of relay 238-DCH in the event of a chain circuit defect for trunk connector "0," through its make contacts on FIG. 238, energizes the DG lamp shown immediately thereabove, which lamp remains energized until the trouble is cleared by an attendant.

#### CONNECTOR TIME-OUT ALARM

The position connectors and the register connectors are each provided with a time-out alarm circuit shown on FIGS. 281 and 282 which supplies an alarm in the event that the connector does not perform its indicated functions within a predetermined time interval, which interval may be adjusted as desired, say from one to two and one-half seconds.

The operation of a preference relay, such as, for example, a relay -PP-- in a position connector, or a relay -RP-- in a register connector, removes a shunt ground from its associated PTM or RTM timing capacitor, thereby allowing it to start charging to a 130-volt positive potential. The capacitor continues charging until a secondary cut-in relay, such as, for example, a relay --PRC- of the position connector or a relay --RRC- in a register connector, operates, thereby placing a shunting ground back on the condenser to cause it to discharge. Thus, referring to position connector "0" on FIG. 281, the operation of primary cut-in relay 224-PP00 permits the capacitor PTM to start charging, and the operation of secondary cut-in relay 225-OPRC0 terminates the charging interval and discharges the capacitor. By this means, under normal service conditions, no operation of the timer takes place.

On trouble conditions wherein no secondary cut-in relay operates to complete the connector function, the PTM or RTM capacitor charges to the firing potential of the associated PTMC or RTMC tube, thereby causing it to conduct and operate its associated 281-PTMC or 282-RTMC relay. This associated relay, upon operating, locks to ground through the associated alarm release key 281-AR1 or 282-AR3 and grounds out the associated timing capacitor and tube to return the timing circuit to normal. The operation of the 281-PTMC or 282-RTMC relay

lights its related PCA or RCA lamp on FIG. 275 or 278. The alarm persists until the associated alarm release key 281-AR1 or 282-AR3 is operated by an attendant.

#### TRUNK CONNECTOR NUMBER REGISTRATION ERROR ALARM

The trunk connector number is passed from a position or register circuit to a data channel, and is additionally passed from a sender to its sender connector. This number is registered in 2-out-of-5 code form in the data channel on the various -DG- relays of FIG. 239, and is registered in the sender connector by the various DGN-relays of FIG. 245. An "over" or "under" registration in either of these registers results in the operation of relay 239-OU10 for the channel registers, and 246-OUR for the sender connector registers.

The operation of relay 239-OU10, for example, on an erroneous trunk connector number registration in channel "0," operates relay 293-OU0 which, in turn, operates relay 293-TBL0 and grounds the OURA lead to the trouble recorder on FIG. 293. Relay 293-OU0 locks to ground through the make contacts of relay 279-CONA operated, and releases upon the release of the data channel. Relay 293-TBL0 releases upon the release of the data channel and the completion of the trouble recording operation, as the trouble recorder sends back a ground on conductor TIB0 to operate relay 293-TIB0. The DTBL leads to both the position control circuit and the sender circuit (FIG. 276) are grounded under this condition, upon which the position control circuit withdraws its "start" lead ground to the data transfer circuit, thereby causing it to release.

The operation of relay 246-OUR, for a trunk connector number registration error in the sender connector lights lamp 246-OUR and, additionally, extends the ground from key 268-AR5 which operates relay 268-GRS which, in turn, lights lamp 268-SCA which functions as an alarm, as hereinabove described.

#### DATA CHANNEL TIME-OUT ALARMS

Two time-out alarm circuits are provided for each data channel. The alarm circuit for channel "0" is shown on FIG. 297, and the alarm circuits for the remaining three channels, "1," "2," and "3," are shown on FIG. 298. One timing circuit times the normal circuit functions, and its time-out period may be varied and recycled from function to function. The other timing circuit is an overall emergency timer which will time out in the event that the normal timer fails, or in the event that trouble is encountered in taking the trouble record after a normal timeout. In either event, the data channel fails to get a TIB indication from the trouble recorder circuit and thus fails to progress to its release cycle. The overall timer is used to release it from this "stuck" condition.

One interval timed by this timer is the time elapsing from the channel seizure to the seizure of a trunk connector. The release of relay 234-DCA2, upon the seizure of the data channel, removes the shunting ground from the TM00 capacitor on FIG. 297, thereby allowing it to charge towards the positive 130-volt potential. The operation of a relay 238-OTS-, upon the seizure of the trunk connector, places the shunting ground back across the capacitor network, thereby causing capacitor TM00 to discharge. Should the time required to secure the services of a trunk connector be excessive, the potential on the capacitor will build up to the firing potential of tube TM00, thereby causing it to break down and conduct. In this case, relay 297-TM00 operates through break contacts of relay 293-TBL0, normal, and locks through make contacts of relay 279-CONN, operated. The operation of the relay 297-TM00 places a shunting ground back across the capacitor network, discharging the capacitor and, in addition, operating relay 293-TBL0.

Another interval timed by this timer is that beginning with the seizure of the trunk connector and terminating with the start of the data timing. The operation of relay



297-RCTM0, as a consequence of the operation of a relay 238-OTS-, removes the shunting ground from the TM00 capacitor resistive network, thereby allowing capacitor TM00 to charge. The operation of relay 297-SDTM0 replaces the shunt ground on the TM00 capacitor network, thereby discharging capacitor TM00. Should the time required to start the data timing be excessive, the potential on the TM00 capacitor will build up to the level required to fire tube TM00 which, in turn, will operate relay 297-TM00, as hereinabove described.

Another interval timed by this circuit is that which begins with the completion of the data timing operation and which terminates in the release of the data channel. The timing cycle is restarted upon the release of relay 297DTMB0 and the operation of relay 297-DTMF0, upon the completion of data timing. The release of relay 297-DTMB0 removes the shunt ground from the TM00 capacitor resistor network and, with the operation of relay 297-DTMF0, changes the timing period by substituting the PTM10 potentiometer and associated TMO40 resistor in place of the PTM0 potentiometer and TMO20 resistor. The subsequent operation of relay 234-DCA2, upon the release of the data channel, replaces the shunting ground across the TM00 capacitor, to discharge it. Should the time required for the data channel to complete its functions and release prove excessive, the charge on capacitor TM00 will become sufficient to break down tube TM00 and operate relay 297-TM00, as hereinabove described.

The TM00 timer is recycled and prevented from further timing during the period that the data channel is seeking access to a trunk connector, which connector is busy handling a call from another data channel at the time. Referring to FIG. 296, a busy trunk connector places ground on its -DG- leads by the operation of its -TS- trunk secondary cut-in relay in the associated data channel. These grounds are routed to all the other three data channels as a trunk connector busy indication. If another data channel is seeking connection to the same trunk connector, the ground on the trunk connector group lead will be extended to the STM- "stop-timing" lead by the operated -DG- relays bearing the same channel number indication as the grounded lead. Ground on lead STM0, for example, extending from FIG. 296 to FIG. 297, shunts the TM00 capacitor-resistance network, thereby discharging the capacitor and blocking further timing until the ground is removed from the lead STM0 by the release of the busy connector.

Referring to FIG. 297, tube OTM0, together with its associated circuitry, comprises the "overall" timer. A long period "overall" timer is provided to function in the event of the failure of the normal TM00 timer, or in the event of a failure to receive the TIB0 release signal from the trouble recording equipment, following a request for a trouble record upon the operation of the TM00 timer.

The release of relay 225-DCA1, upon the seizure of the data channel, removes the shunting ground from the OTM0 timer, thereby allowing the OTM0 capacitor to charge. The reoperation of relay 225-DCA1, upon the release of the channel, restores the shunting ground and discharges capacitor OTM0. Should the data channel be held for an excessive period of time, the potential charge on the OTM10 capacitor will rise to the firing potential of tube OTM0, thereby causing it to conduct and operate relay 297-OTM0. The operation of relay 297-OTM0, in turn, operates relay 297-ALM0, and locks itself to ground through make contacts of relay 279-CONN, and replaces the shunt ground on the OTM0 capacitor-resistance network, thereby discharging capacitor OTM0 and extinguishing tube OTM0. The operation of relay 297-ALM0 lights lamp 297-DCA0 to indicate an alarm. The 297-OTM0 relay, operated, also grounds the AMAE and DTBL leads (FIG. 276) to the associated circuits as a

trouble release indication. The alarm persists until the alarm release key is operated by an attendant.

#### DATA CHANNEL PREFERENCE CHAIN ALARM

The data-channel-preference-chain is continuously monitored for trouble "grounds" or "opens" by the guard relays 225-DCA1 and 234-DCA2. Any false "grounds" or "opens" in the chain associated with these relays results in a false operation or release of one of these relays; and they then will not all be operated or released simultaneously, as they normally should be. Should any one of these relays be out of step with the others, relay 297-CGA0 will operate and light lamp 297-CGA0 to indicate an alarm. The alarm indication will persist until the trouble is cleared.

#### Operation of position and position control circuits

Referring now to FIG. 204, on each of the register relays 202-TA0, -1, -2, -4, and -7, a set of make contacts is respectively connected to the "swinger" or common point of one of five sets of transfer contacts on relay 204-TRON1. The five transfer break contacts of relay 204-TRON1 are all strapped together and are connected to the winding of relay 204-TRON.

The operation of register relays 202-TA0 and -TA2 completes a path from ground on terminal 102 on FIG. 204, through their respective make contacts and their respective associated transfer break contacts 204-TRON1, to operate relay 204-TRON which, in operating, completes a holding path for itself over its own make contacts, break contacts 182-TIF, make contacts 204-NAC, and make contacts 203-LSM to ground (i.e., the ground holding relay 204-NAC operated at this time). The operation of relay 204-TRON closes a circuit to operate relay 204-TRON1.

Referring to FIG. 192, the operation of register relays 194-DU2 and -DU4 completes the following circuit to operate relay 192-ORON: ground on terminal 101 of FIG. 192, make contacts 194-DU2 and -DU4, transfer break contacts 192-ORON1, to the winding of relay 192-ORON to operate it. Relay 192-ORON, in operating, completes a holding path for itself over its own make contacts, through break contacts 192-RLOR and make contacts 181-PRA1 to ground. The operation of relay 192-ORON closes a circuit to operate relay 192-ORON1.

Assuming that the data check relays for channel "0" determine that the proper data is transmitted to and locked up in the position control circuit, relays 289-DOK10 and 292-DOK20 operate as hereinbefore described in connection with FIGS. 286 through 292. Referring to FIG. 276, the operation of relay 292-DOK20 extends ground on terminal 276-102 through its make contacts, through break contacts 293-TBL0 to terminal 276-103. From terminal 276-103 the ground may be further extended over make contacts 248-TST6 and break contacts 276-CONN to operate relay 276-DOK0 for channel "0." The ground extended to terminal 276-103 may also be further extended through break contacts 292-AMEO and over conductor DTOK extending to the position control circuit "00" rectangle on FIG. 274. Referring to FIG. 267, the operation of relay 289-DOK10 closes its make contact to extend ground from terminal 267-101 in rectangle "DD" for channel "0," over make contacts 292-AMAE0, and thence over conductor DTOK extending to the sender "00" rectangle on FIG. 267. The ground on the DTOK conductor to the sender, and on the same lead to the position control circuit, FIG. 274, informs both circuits that the transferred information has been successfully registered and checked in the position control circuit.

The ground on conductor DTOK to the position control circuit enters the position control circuit from the data transfer circuit on FIG. 188 and extends to FIG. 182 to operate relay 182-DTOK. Relay 182-DTOK, in operating, closes a holding path for itself over its own make



contacts and through resistor DTL and the relay contact network to ground on terminal 101 of FIG. 182. The operation of relay 182-DTOK opens its break contacts (shown in rectangle "C" on FIG. 224), thereby removing battery from conductor STDT extending to the data transfer circuit. This causes the data transfer circuit to release, as hereinbefore described. Relay 182-DTOK also opens its break contacts on FIG. 181, to release relay 181-DTST.

Referring now to FIG. 169, the operation of relay 182-DTOK completes the following circuit to operate relay 169-TN: ground on terminal 169-102, break contacts 176-PDA, make contacts 167-POA and 169-T, transfer break contacts 197-ACS, make contacts 169-T, transfer break contacts 163-PLCA, make contacts 182-DTOK, break contacts 198-FC, 198-10T, and 197-TEA, to the winding of relay 169-TN to operate it. The operation of relay 169-TN opens a holding path for relay 169-TNT. However, this latter relay is slow releasing. Referring to FIG. 189, the operation of relay 169-TN also closes its make contacts to connect the tone supply to the primary winding of transformer TN. The secondary winding of transformer TN is at this time closed through transfer make contacts of relay 169-TN, via the circuitry of FIG. 190 and cable TL, to the operator telephone circuit in FIG. 221. This arrangement provides a tone to the operator so long as relay 197-TEA remains unoperated. Slow-release relay 169-TNT releases a brief interval time after its holding circuit is opened. Relay 169-TNT, in releasing, further extends the ground extended to terminal 104 of FIG. 169, through its transfer break contacts and make contacts 169-TN, to the winding of relay 169-TE to operate it. Referring to FIG. 197, the operation of relay 169-TE closes an obvious circuit to operate relay 197-TEA. The operation of relay 197-TEA, at its transfer break contacts on FIG. 189, causes the tone to the operator to be removed. The operation of relay 197-TEA also opens an obvious circuit on FIG. 169 to release relay 169-TN.

Referring now to FIG. 197, the operation of relay 169-TE closes the following circuit to operate relay 216-T0 in the operator position circuit: ground on terminal 197-101 in the position control circuit, transfer break contacts 187-TBFL, make contacts 169-TE, transfer make contacts 169-T0, transfer make contacts 164-OK0 on FIG. 191, break contacts 163-PLC, 176-PDA, 191-OG0, 173-RMT, 167-LMT, out over the conductor ASC0 in cable S0 extending from FIG. 191 to FIG. 216, to the winding of relay 216-T0 to operate it. Relay 216-T0, in operating, closes an obvious circuit on the same figure to light access lamp ASC0. The illumination of this lamp indicates to the operator that a call has been connected to the "0" loop.

Referring to FIG. 181, the operation of relay 169-TE also closes an obvious circuit to operate relay 181-LL. The operation of relay 181-LL closes a number of circuits to light various lamps in the operator position circuit. The presently described call assumes that the called number information was automatically obtained, via ANI, from the originating office. If this had not been the case, and if it was the operator's duty to perform the function of identifying the calling party, the lamp designated KEY-CLG- on FIG. 219 would be illuminated, thereby indicating that it was the operator's function to "key" into the circuit the calling station identification. The present call is assumed to be a special toll type and, therefore, lamp SPL-TOLL on FIG. 219 will now be lighted over the following circuit: ground on terminal 101 of FIG. 219, make contacts 181-LL, break contacts 195-OVLP, make contacts 193-SPT, through resistor SPT, to the lamp SPT-TOLL to light it.

The operator headset circuitry is shown on FIG. 221. This circuitry is connected at this time by means of conductors T, R, T1, and R1 in cable TL extending from FIG. 221 to the circuitry of FIGS. 189 and 190. This cir-

cuitry, in turn, connects the operator, via conductors T0-2 and R0-2, for the present call, to FIG. 165 of the position control circuit, extending to the link connector circuit. The position control circuit, in turn, is connected by the link connector to the calling incoming trunk. The operator may now converse with and orally ascertain from the calling party the nature of the special services desired on the call. Let it be assumed, for example, that the calling party desires person-to-person service and informs the operator of this fact. Referring now to FIG. 218, the operator now depresses the PERSON PAID key. This completes the following circuit to operate relay 183-PP in the position control circuit: ground on terminal 218-101, break contacts 213-KGR, make contacts 216-T0, break contacts 220-OUT, make contacts of the PERSON PAID key, conductor PP in cable KL extending from FIG. 218 to FIG. 183, transfer break contacts 183-CLKA, to the winding of relay 183-PP to operate it. Relay 183-PP, in operating, closes a circuit through its make contacts, the break contacts 183-RLS, the winding of relay 183-CLK, and make contacts 181-PRA to ground. The subsequent release of the PERSON PAID key by the operator removes the direct ground from the one side of the winding of relay 183-PP, thereby allowing check relay 183-CLK to operate in series with the winding of relay 183-PP, and to supply a holding ground for relay 183-PP. The operation of relay 183-CLK closes an obvious circuit to operate relay 183-CLKA.

Referring to FIG. 215, the operation of relay 183-PP extends the ground from terminal 215-102 over its make contacts and conductor PPL to light the PERSON PAID lamp. The operation of relay 183-CLK closes its transfer make contacts on FIG. 183 connected together and through break contacts 172-TVR and 172-TVA to the winding of relay 183-RLS, thereby transferring all of the conductors PP, PC, PS, SPD, SC, SS, NC and SE from their associated relays to the winding of relay 183-RLS. If, subsequently, the customer should change his mind concerning the class of billing desired the operator may operate a different class of billing key. This key operation will apply ground to the appropriate conductor on FIG. 183 and operate relay 183-RLS. Relay 183-RLS, in operating, will open the circuit holding relays 183-CLK and 183-PP operated, thereby releasing the entire registration and operating the relay associated with the new class of service desired.

In the meantime, while the presently described circuit operations are occurring, the sender, as is hereinafter described, after it receives a DTOK signal from the data transfer circuit, proceeds with its functions of controlling the establishment of a connection to the called station. Once the called station answers, since the present call is of the person-to-person type, the operator orally ascertains whether the wanted party is available at the called station. The operator, having been satisfied that this party is on the connection, next depresses the ST-TMG key on FIG. 213. The operation of this key extends the ground on terminal 101 of FIG. 213 over break contacts 213-KGR, make contacts 216-T0, make contacts of the ST-TMG key, over conductor STM extending from FIG. 213 to FIG. 178, break contacts 173-HPR, transfer break contacts 172-STMF, break contacts 183-NCH, transfer break contacts 172-TCMB, 181-TIFM, 198-COP, 204-LAC, transfer make contacts 204-NAC, 183-CLKA, 204-TRON, transfer make contacts 192-ORON, break contacts 172-STMA (FIG. 172), transfer break contacts 183-SS, and 183-SP, make contacts 169-T0, break contacts 176-TS0, terminal 103 of FIG. 172, up through the remainder of the contact network shown on this sheet to the winding of relay 172-STM to operate it. Relay 172-STM, in operating, closes a holding path for itself over its own make contacts to ground on terminal 101 of the same figure. Also, it closes an obvious circuit to operate relay 172-STMA. The operation of relay 172-STMA, in turn, closes a circuit over its make contacts to



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extend the battery on terminal 102 of FIG. 172 to conductors STV and CBS to the transverter connector, which battery constitutes a "start" signal thereto. In response to this "start" signal, the transverter connector circuit, as is more fully described in the aforementioned Breed et al. patent, seizes a transverter which, in turn, seizes a recorder. The recorder then makes an AMA entry, recording all items of information necessary for the billing of the call. After the AMA entry has been made, a ground is applied by the transverter, via the transverter connector, to conductor TVR on FIG. 172, thereby operating relay 172-TVR. Relay 172-TVR is operated by the transverter for the duration of time that the transverter is connected to the position control circuit. The operation of relay 172-TVR closes its make contacts on FIG. 172, thereby shunting make contacts 172-STMA and assuring that the "start" signal to the transverter will not be interrupted. The operation of relay 172-TVR also opens its break contacts to release relay 172-STM.

Referring now to FIG. 213, the operation of relay 172-TVR closes the following circuit to light the lamp ST-TMG on FIG. 213: ground on terminal 213-102, over the contact network shown to conductor STML, resistor STM, to the lamp ST-TMG. The lighting of this lamp signifies to the operator that the AMA entry has been completed and that the connection may now be released.

The contact network on FIG. 178 is associated with the data registration relays which have been operated by the data transfer circuit. If the registration of any data is improper, the ground on conductor STM from the START TIMING key (FIG. 213) will not be cut through to operate relay 172-STM but, instead, will be cut through, via transfer break contacts 192-ORON, to operate relay 172-STMF. Referring now to FIG. 213, the operation of relay 172-STMF, in turn, will cut through an interrupted ground from terminal 213-103 to the ST-TMG lamp to flash it. The operator, upon seeing this, may then check the registered call information and correct an improper registration in the class of service, the calling number, or the called number data. The operator will then depress the START TIMING key and, assuming that everything is "okay" at this time, the circuit actions will proceed as hereinbefore described.

Referring now to FIG. 205, the operator having ascertained that all of the operator services required in connection with the call have been completed, operates the POSITION RELEASE key to release the position from the connection. The operation of this key completes the following circuit to operate relay 170-PR: ground on terminal 205-101, out over a contact network including that of the POSITION RELEASE key, to conductor PR extending from FIG. 205 to FIG. 170, over the break contact network shown on FIG. 170, to the winding of relay 170-PR to operate it. Relay 170-PR, in operating, closes a locking path for itself over its own make contacts, and through the contact network shown, to ground on terminals 101, 104, 105, 106 and 107 on FIG. 170. Multiple grounds are used on this holding circuit in order to ensure the release of each and every one of the associated relays before relay 170-PR may release.

The operation of relay 170-PR closes an obvious circuit to operate relay 176-PDA. The operation of relay 176-PDA closes the following circuit to operate relay 170-PDB: ground on terminal 103 of FIG. 170, make contacts 176-PDA, transfer break contacts 173-HPR, transfer make contacts 181-PRA2, transfer break contacts 188-DTSF, transfer break contacts 183-NCH, make contacts 172-TVR, to the winding of relay 170-PDB to operate it. The operation of relay 176-PDA opens its break contacts to effect the release of relays 169-TE, 197-TEA, and 216-T0. The release of this last relay, in turn, extinguishes the access lamp ACS0 for loop "0" (FIG. 216). The operation of relay 170-PDB also opens its break contacts on FIG. 164, thereby releasing relays 164-ODN4 and -ODN7 which registered the trunk con-

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ductor number information received from the trunk via the link connector. The operation of relay 170-PDB also opens its break contacts on FIG. 181, thereby releasing relay 181-PRA. Relay 181-PRA, in releasing, releases its slave relays 181-PRA1 and 181-PRA2. These last three relays, in releasing, open the ground supply which holds the register relays which operated at the time the position control circuit received information from the data transfer circuit. All of these relays now release. Included in these relays is relay 182-DTOK.

The operation of relay 170-PDB closes its make contacts on FIG. 170 to extend a ground from terminal 108, through its make contacts, transfer break contacts 191-OG and makes contacts 169-T0A to the winding of relay 170-PD0 to operate it. The operation of relay 170-PD0, in turn, completes an obvious circuit to operate relay 176-PD. The operation of relay 176-PD opens its break contacts on FIG. 162, thereby removing ground on terminal 162-104 from relay 162-S0 to release it. The operation of relay 176-PD, at its same break contacts, also removes ground from conductor S0 in cable S0-2 extending from FIGS. 162 to 165, from where it extends to the link connector. This conductor in the link connector is connected to the hold magnets holding up the connection in the link; and, therefore, the removal of this ground releases these hold magnets and drops the connection between this position and the trunk.

The release of relay 162-S0 opens its make contacts (FIG. 169) to release relay 169-T0. Relay 169-T0, in releasing, in turn releases its auxiliary relay 169-T0A. The release of relay 162-S0 also opens its make contacts to release relay 164-OK0.

Relay 169-T0, in releasing, also releases relay 169-T. Relay 169-T0A, in releasing, releases relay 170-PD0. Relay 170-PD0, in releasing, releases relay 176-PD.

The release of all the registered data information received from the data transfer circuit releases relay 170-PDB by disconnecting it from the holding grounds immediately therebelow on FIG. 176. The concurrent release of relays 176-PD and 170-PDB releases relay 170-PR. The release of relay 170-PR, in turn, releases relay 176-PDA. Relay 176-PDA, in releasing, extends the necessary grounds and batteries to the link circuit to make it appear idle, thereby indicating that it is available for serving subsequent calls.

#### *Miscellaneous features of the position circuit and position control circuit*

The loop timers shown on FIG. 212 of the position circuit are primarily intended for use with dial "0" coin class calls. In case the customer desires to be notified at the end of the initial conversation period, this timer can be used for this purpose. The timer operation and sequence of operation is as follows: the operator will position the INTERVAL SELECT switch to select a desired one out of the several intervals, which intervals range from one minute to five minutes. After positioning the INTERVAL SELECT switch to select the time period desired, the SEL. TIMER key will program the timer for start of timing. The TIMER lamp for the particular loop being used will light when the timer is set to start timing. The timer starts functioning when the ST TMG key is depressed by the operator to initiate AMA tape entry, and the ST TMG key also starts the loop timer functioning. At six seconds prior to the end of the selected interval, the associated TIMER lamp will start flashing at 120 i.p.m. The lamp will continue flashing for a duration of 12 seconds after the interval has elapsed, at which time it will change to a steady lighted condition. The flashing TIMER lamp indicates to the operator that the pre-selected time interval is about to be completed, and the operator will at this time notify the customer that his initial conversation period has ended.

There are on the position console ten indicator tubes which are used to display digital information to the op-



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erator when requested. These are shown on FIGS. 207 and 208. If the operator desires to display the called number, the DISPLAY CLD NO key on FIG. 223 will be operated. Operation of this key transmits a ground signal, via conductor DTN in cable DN extending to FIG. 186 of the position control circuit, and through transfer make contacts 204-NAC, to operate relay 180-TR0 of the position control circuit. Relay 180-TR0, operated, in turn, operates relay 180-TR1. These two relays, operated, close contacts to cut in the information stored in the called number registration circuit shown in FIGS. 196 and 202 of the position control circuit. These contacts of relays 180-TR0 and 180-TR1 are shown on FIG. 200. The information from the called number register is used on a 2-out-of-5 basis to operate corresponding relays on a 2-out-of-5 basis on FIGS. 199 and 200. These relays are designated 199-A- through 199-F-, 200-G-, 200-H-, 200-J-, and 200-K-. The contacts of these 199-A- through 199-F-, 200-G-, -H-, -J-, and -K- relays are shown on FIGS. 210 and 211. The combination of 2-out-of-5 relays operated in each relay group completes a circuit network shown on FIGS. 210 and 211 to the corresponding one of the indicator tubes shown on FIGS. 207 and 208, to display the numerical information stored in the called number register. This information remains displayed on the indicator tubes for the duration that the operator holds the DISPLAY CLD NO key operated. Upon release of the key, the 180-TR0 and 180-TR1 relays are released and, in turn, release the A- through K- translator relays shown on FIGS. 199 and 200. The translator relays, in releasing, extinguish the display tubes on FIGS. 207 and 208.

In a similar manner, if the operator desires to display the calling number, the DISPLAY CLG NO key on FIG. 223 will be operated. Operation of this key extends a ground via conductor DON in cable DN extending to FIG. 186 in the position control circuit, and through make contacts 192-ORON and break contacts 182-TIF, to operate relay 186-OR0 which, in turn, operates relay 186-OR1. Relays 186-OR0 and 186-OR1 close circuitry between the calling number register on FIG. 194 and the above-mentioned display translator relays A- through K- on FIGS. 199 and 200. Again, 2-out-of-5 relays in each group operate in combination respectively corresponding to the relays operated in the calling number register of FIG. 194. The display translator relays, in operating, again close the contact network on FIGS. 210 and 211, to display, on the indicator tubes of FIGS. 207 and 208, the numerical information stored in the calling number register. Upon release of the DISPLAY CLG NO key by the operator, the 186-OR0 and 186-OR1 relays release and, in turn, release the A- through K- relays on FIGS. 199 and 200, thereby extinguishing the display on the indicator tubes.

If a dial "0" call has been connected to the position circuit, it is then the operator's job to "key" in both the calling and called numbers. The operator obtains this information orally from the calling subscriber. Assuming that the operator first "keys" in the seven digit calling number, the sequence will be as follows: the operator operates the KP BACK key on FIG. 220. This key, operated, extends ground over conductors KPB and RS, in cable KP, to FIG. 184 to operate relays 184-RS and 184-KPB and, in turn, relays 177-KPI and 192-RLOR. The function of relays 184-RS and 192-RLOR is to release any information that has been previously stored in the calling number register on FIG. 194, and also to release any operated one of the digit-steering relays 174-AS through 174-MS on FIG. 174 of the position control circuit. Referring to FIG. 174, upon release of any operated steering relay, a path is completed from ground on terminal 174-101, through transfer make contacts of relay 184-RS, through transfer break contacts of relay 174-RS1, through transfer break contacts of all the steering relays normal, and through break contacts 174-MS1 to operate the 174-RS1 relay. Referring to FIG. 177, the 184-KPB relay, in operating, closes a path in conjunction

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with the 174-RS1 relay, operated, to operate the 177-KPI relay which, in turn, operates relay 177-KPB1. Referring to FIG. 174, ground is extended through make contacts 174-RS1, break contacts 169-T5, transfer break contacts 177-KPR1, and transfer make contacts 177-KPB1 to operate the steering relay 174-ES. Upon the operation of the 177-KPI relay, the 174-ES relay locks and opens the locking circuit for relay 184-RS, causing it to release. Relay 184-RS, in releasing completes a path from ground on FIG. 222, through transfer break contacts 174-PE, break contacts 184-RS, and make contacts on the 184-KPB relay, via the KPBL conductor to the position circuit, and through break contacts 220-KP0 to light the KP BACK lamp on FIG. 223. The KP BACK lamp, in lighting at the position, indicates to the operator that the circuitry has been programmed to receive the calling number information. The operator then proceeds to "key" in the calling number on the keyset on FIG. 209. Operation of any one of the ten keys 0 through 9 in the keyset operates corresponding pairs of the relays 209-0, -1, -2, -4, and -7, in a 2-out-of-5 code combination, to represent the digit "keyed." These relays, operated, in turn, operate relays 217-R0, -R1, -R2, -R4, and -R7 on a 2-out-of-5 code combination basis which, in turn, send out ground signals on the conductors 0, 1, 2, 4, and 7 in cable PR, extending from FIG. 217 to the position control circuit on FIG. 175. These leads then continue from FIG. 175 in the position control circuit, via cable PR', to FIG. 201, where they enter the steering chain circuit of relays 174-AS through 174-LS. It is to be understood that whereas the steering circuitry of FIG. 201 shows a single chain circuit, comprising the series-connected transfer break contacts of relays 174-AS, 174-BS, etc., the single chain circuit shown is intended to represent five such chains, one such chain being provided for each of the conductors 0, 1, 2, 4, and 7 in cable PR'. Grounds, representing the first digit in 2-out-of-5 code form, are extended through the series-connected transfer break contacts of relays 174-AS through 174-DS, the transfer make contacts of relay 174-ES, and the transfer make contacts of relay 177-KPB1, into the 194-DA0, -1, -2, -4, and -7 register set, to operate two out of the five relays of this group, corresponding to the digit keyed. The succeeding digits "keyed" are, in turn, steered through the 177-FS, -GS, -HS, -JS, -KS, -LS, -BS, and -CS through the -GS steering relay contacts, and through the transfer make contacts of relays 177-KPB2 and 177-KPB3 into the calling number digit registers on FIG. 194.

Upon completion of "keying" of the seventh digit of the calling number, the operator operates the ST key on FIG. 205. Operation of this key operates the 205-ST relay. Referring to FIG. 184, the operation of relay 205-ST extends a ground through its make contacts on FIG. 184 to operate the 184-ST relay in the position control circuit. The 184-ST relay, operated, locks to ground through make contacts of the 177-KPI relay on FIG. 184. The 184-ST relay, in operating, opens the locking path for the 184-KPB relay. The 184-KPB relay, in releasing, opens the locking path for the 177-KPI relay which, in releasing, opens the locking path for the 184-ST relay. Referring to FIG. 222, the release of the 184-KPB relay removes the ground from the KPBL conductor extending to FIG. 223 of the position circuit, thereby extinguishing the KP BACK lamp. The KP BACK lamp being extinguished indicates to the operator the completion of the registration of the calling number in order that the operator may next initiate registration of the called number.

Referring now to FIG. 220, the operator next operates the KP FWD key. In a similar manner to that described for the operation of the KP BACK key, the relay 184-KPF operates, which, in turn, operates relay 177-KPI. The steering circuit on FIG. 174 is also reset, with the 174-ES steering operated in a similar manner as was described for the calling number "keying" function. Referring to FIG. 222, when the steering circuit has been reset



and the 184-KPF relay operated, a ground is extended through transfer break contacts 174-PE, transfer make contacts 184-KPF, over the KPFL lead to FIG. 223, through break contacts 220-KP0, and resistor KPF in the position circuit, to light the KP FWD lamp. Lighting of the KP FWD lamp indicates to the operator that the position control circuit is ready to receive the called number information. The operator then "key" the called number on the keyset on FIG. 209. The digit "keying" functions are carried on in a similar manner to that described for the calling number. Referring to FIG. 175, the grounds on the conductors 0, 1, 2, 4 and 7, in cable PR', are extended to FIG. 201, through the transfer contacts of the steering relays 174-A, 174-B, etc., and the transfer break contacts of relays 177-KPB1, -KPB2, and -KPB3 on FIG. 201, and enter the 202-TA- through 196-TL- relays of the called number registration circuitry of FIGS. 202 and 196. The relays in the called number registration circuitry are operated on a 2-out-of-5 basis, corresponding to the digits "keyed" by the operator.

The called number normally contains either seven or ten digits. Assuming that this is a ten-digit registration, upon completion of "keying" of the ten digits, the operator operates the 205-ST key which operates relay 205-ST. The 205-ST relay, operated, extends ground through its make contacts to operate the 184-ST relay. Referring to FIG. 179, the operation of relay 184-ST completes a path to operate relay 179-STF. The 179-STF relay, operated, in turn, extends ground through break contacts 179-SAF, transfer make contacts 179-STF, conductor RFO to FIG. 165, through the link connector, to the trunk circuit to indicate a sender request signal to the trunk. The trunk then requests a sender. Upon seizure of a sender, a signal is sent via the link connector and over the SAO lead to the position control circuit to operate relay 179-SAF. The 179-SAF relay, in operating, closes its make contacts on FIG. 182 and completes a path to operate the 181-DTST relay. Referring to the "C" rectangle on FIG. 224, relay 181-DTST, operated, in turn, sends a "start" signal, via conductor STDT of the data transfer circuit, whose functions have been previously described. The called number is then sent to the sender via the data transfer circuit. Upon checking of the information transferred to the sender from the position, a DTOK signal is received, via conductor DTOK from FIG. 274, by the position control circuit on FIG. 182. The sender then sets up the connection to the called number from the information received from the position control circuit. When the connection has been established, the operator then proceeds with the normal functions previously described. These functions consist of orally determining the billing class desired by the customer, operating the proper billing class key, and then operating the ST TMG key on FIG. 212 to initiate AMA tape entry. The operator may then disconnect from the call by operating the POS RLS key on FIG. 205.

Provision is also made in the position circuit to allow the operator of one position console to transfer the headset of that position, to permit the completion of calls originally placed on "hold" on an adjacent position. This function is accomplished by operating either the POS TRFR (R) or POS TRFR (L) key shown on FIG. 205. Operation of either of these key transfers the operator telephone set on FIG. 221 to either the left adjacent or the right adjacent position, respectively. The operator then proceeds to serve any call remaining on one of the loops in the "hold" position, completes the functions required, and then disconnects the call from the loop. The operator then returns to the home position by reoperation of the key that was initially operated (either the POS TRFR (R) or the POS TRFR (L) key). For example, assuming that the operator has operated the POS TRFR (L) key, a ground is extended from FIG. 205, over the LM lead, to FIG. 168 to operate the 168-LM relay. Relay 168-LM, in turn, completes a circuit to operate the 167-LMT relay. Referring to FIG. 190,

operation of relay 167-LMT transfers the tip-and-ring circuit for the operator telephone circuit on FIG. 189 from the "hold" position to the left adjacent position. Operation of relay 168-LM also extends a ground to operate the 167-TBA relay which is half of a "WZ" relay combination. When the operator releases the POS TRFR (L) key, the 167-TBB relay in this combination operates.

After the operator has completed functions required on the left adjacent position, the operator then returns to the home position by operating the POS TRFR (L) key a second time. Operation of this key again extends ground on the LM lead to the position control circuit to operate the 168-LM relay. Operation of the 168-LM relay again extends the ground to the 167-TBA relay but, in this case, it shunts down the 167-TBA relay and, upon removal of the ground from the LM lead by release of the POS TRFR (L) key, the 167-TBB relay releases. Release of the relays 167-TBA and 167-TBB removes the locking path for the 167-LMT relay. Release of the 167-LMT relay restores the tip-and-ring circuitry of FIG. 189 to connect the operator telephone circuit to the home position tip-and-ring network shown on FIG. 189.

In connection with the previously-described special toll call, a further feature of the position is its ability to retry the called number in case the initial connection established by the sender encounters an "overflow" or "reorder" condition. The circuit and operator functions in such an event are as follows: A "reorder" or "overflow" condition is indicated by an audible tone in the operator telephone set and, also, a flashing called "supervisory lamp" (in this case, CLD0 on FIG. 216). Upon hearing this audible tone and seeing the flashing lamp, the operator operates the RLS FWD key on FIG. 205. The operation of this key extends ground over the RLF lead in cable RT, extending to FIG. 179, to operate the 179-RLF relay in the position control circuit. The 179-RLF relay, in turn, locks up through its own contacts to a ground through make contacts of the 169-T relay. Operation of the 179-RLF relay applies a battery signal on FIG. 179 to the RLF0 lead extending to FIG. 165, and thence through the link and connector circuit to the trunk circuit to operate the 13-RLF relay in the trunk circuit. Operation of the 13-RLF in the trunk circuit accomplishes the release of the forward connection. This is indicated to the operator by removal of the audible "overflow" or "reorder" tone in the operator headset and by the changing of the flashing called supervisory lamp CLD0, -1, or -2, on FIG. 216, to a steady indication. The operator then proceeds to retry the initial called number stored in the called number register on FIGS. 196 and FIG. 202. This retrial function is accomplished by the operator depressing the ST key on FIG. 205. Operation of the ST key operates the 205-ST relay. Referring to FIG. 184, operation of the 205-ST relay extends a ground over the ST lead to the position control circuit to operate the 184-ST relay. The 184-ST relay, in turn, locks through its own make contacts to the make contacts of the 179-RLF relay to ground. With the 184-ST relay operated and the 179-RLF relay operated, as well as the 181-PRA and 204-TRON relays, a path is completed to operate the 179-STF relay. The 179-STF relay, operated, then sends a ground signal from FIG. 179 on the RF0 lead through the link and connector circuit to the trunk circuit, to request a sender. The circuit action requesting a sender, and subsequent data transfer seizure, will proceed as previously described. Upon establishment of a connection to the called number, the operator proceeds with the normal operator functions required for the call and then disconnects the position from the connection by operation of the POS RLS key, as hereinbefore described.

The purpose of the RFL lead (FIGS. 187, 193 and 216), connecting the position circuit with the position control circuit, is to enable the operator to drop either the 193-RCL recall relay or the 187-TBFL trouble flash relay which initially provided the position with a flashing



lamp signal to indicate either a trouble or a recall from an existing call in operation. The access ACS0, -1, or -2 lead, between the position circuit and the control circuit, FIGS. 191 and 216, is used to operate the talk relay 216-T0, -T1, or -T2 of the particular loop which has been selected by the link circuit to attach the operator to a particular trunk circuit. The talk relay, 216-T-, operated, lights the access lamp ACS0, -1, or -2 of the correct loop with which the operator headset should be associated. The talk relays are designated 216-T0 to -T2 and, depending on which loop is serving a call, the associated talk relay will be operated.

Referring to FIG. 216, the OS0 to OS2 leads from the position control circuit are the originating supervision leads and are used to indicate the "on-hook" or "off-hook" condition of the subscriber telephone subset. The CLG0 to CLG2 calling supervisory lamps are lighted if the originating subscriber handset is "on-hook" and conversely, they are extinguished if the handset is "off-hook." On the OS0 to OS2 leads, provision is made in the control circuit to enable a switchhook flash to be recognized by flashing the CLG0 to CLG2 lamps to indicate that the originating subscriber desires the assistance of the operator. Similarly, the TS0 to TS2 leads from the position control circuit are terminating supervision leads and are used to light the CLD0 through CLD2 lamps associated with the particular loops at the position. The HD0 through HD2 leads (FIG. 216) from the position control circuit. (FIG. 173) indicate a "hold" condition on a particular loop. If the operator has depressed a HOLD key, the HOLD 0, -1, or -2 lamp, respectively associated with the loop on which the "hold" key was depressed, is lighted to indicate that this loop is on "hold." While the loop is on "hold," the connection between the trunk and the operator position is held up, but the operator headset is freed and can be utilized by any of the other two loops not in the "hold" condition. The HD lead (FIGS. 166 and 216) between the position and position control circuit is the "hold" lead by means of which, when any one of the three hold keys HOLD 0, -1, or -2, is operated by the position operator, the associated "hold" relay in the control circuit is operated. When the "hold" relay is operated, it lights the "hold" lamp at the position.

FIGS. 216 and 219 of the position circuit contain lamps to indicate the class of call and other information for each call connected to the position. The key calling lamp, KEY CLG, indicates that the originating subscriber number must be orally obtained by the operator. The lamp is lighted steadily to indicate an operator-identified class of call, and flashes to indicate that there has been an automatic number identification failure in the switching equipment and, therefore, the operator will have to orally identify the originating subscriber number. The NFY lamp (notify) indicates a coin class call for which the position operator must notify the customer that the initial interval is up. The charges-due (CHG DUE) lamp is lighted when a coin call is connected to the position for which charges need to be collected by the position operator. The charges required will be displayed on the indicator tubes at the position circuit.

This billing class registration circuitry of FIGS. 215 and 218 is used by the operator to register the particular type of billing class requested by the calling customer. The class of billing selected by the position operator is indicated by a corresponding billing class lamp associated with the billing class keys. The position operator orally asks the calling subscriber what type of billing he wants for each call. The various types of billing are station enterprise, station paid, station collect, station special, person paid, person collect, person special, and no charge.

FIG. 205 contains equipment for generating control signals to the trunk circuit and position control circuit, for processing the call connected to the position. The RLB lead is associated with the RELEASE BACK key. The function of this key is to send a signal to the trunk

to release the connection back or, in other words, the originating end of the connection. The TRCB lead is used in conjunction with the TRFR key to transfer a call to a cordboard. The need to transfer a call to a cordboard sometimes arises if the calling customer desires to make a special class of call, such as for example, a marine call, or other special type.

The RLF lead is associated with the RLS FWD key. This functions to send a signal to the trunk circuit to release the connection forward to the terminating end. This key is used when the forward connection is requested to be changed by the originating subscriber due to a change in destination of the terminating call. The MAKE BUSY key is used by the operator to make the position appear busy on all link appearances of the position. This key is used prior to operation of the access key, for purposes of making a delayed call. The lamps appearing on FIG. 205 are normally associated with the similarly designated keys, and each lights after its associated key is operated. In addition, the position release (POS RLS) lamp will flash if, prior to operating the POS RLC key, the operator puts a loop on "hold" and then fails to operate the POS RLS key. Also, the MAKE BUSY lamp will flash if the position control circuit encounters a data-transfer-start-failure, to indicate that the switchboard operator should operate the MAKE BUSY key and take that position out of service.

FIGS. 206 and 209 show the pulsing control and digit check circuitry. The ten-button keyset is used to operate a 2-out-of-5 relay combination of the relays 209-0, -1, etc., for each digit. After two out of the five digit relays 209-0, -1, etc., operate, check relay 206-CKN operates. Relay 206-CKN, in operating, causes the capacitor timed 206-PT relay to operate. The 206-PT relay, in operating, removes the locking path for the 2-out-of-5 digit relays 209-0, -1, -2, -4, and -7. These digit relays then release, awaiting the next digit to be "keyed" in by the operator. Ground extended from the position circuit, via the SA lead on FIG. 174, is used to advance the steering circuit each time a new digit has been "keyed" in by the operator.

FIGS. 214 and 217 disclose the MF and direct-current pulsing paths associated with the position. The KPT and KPR leads, extending from FIG. 214 of the position circuit to FIG. 185 of the position control circuit are the MF pulsing leads. This MF pulsing path is used on "delayed" calls. A "delayed" call is noted by the "out" relay, 220-OUT, being operated. The 0, 1, 2, 4 and 7 leads, in cable PR, extending from FIG. 217 to FIG. 175, are used for direct-current pulsing. These leads are used by the operator to "key" information into the position control digit registers on which the digit information is then stored and, at a later time in the sequence of the call, upon seizure of the data transfer channel, this stored digit information will be passed directly to the sender in one complete digit group, rather than on a digit-by-digit basis, as is normally done in digit pulsing.

FIG. 213 shows some other keys which are used to send control signals to the trunk, and also to the position control circuit, for the processing of a call connected to the position. The "key ground removed" relay, 213-KGR, is used to indicate that the position control circuit is functioning with the data transfer circuit. Relay 213-KGR is used to disable all nonessential keys on the position at this time, so that no information will be changed to interfere with the data transfer check circuitry. The ST TMG key is used to send a signal to the position control circuit to call in the transverter circuit to start AMA timing of the call connected to the position. The start timing lamp, ST TMG, indicates that a proper initial entry has been put on the AMA tape for this particular call. A flashing start timing lamp indicates a failure to complete an initial entry on the AMA tape. The operator, upon seeing a flashing start timing lamp, will then see if the trouble can be corrected and will try again for a new



AMA initial entry. The cancel timing key, CNL TMG, is used to signal the trunk to put a "cancel entry" on the AMA tape, so that the AMA accounting center will disregard the previously-entered initial entry. The purpose of the break contacts on the RING BACK, RING FWD, COIN RET, and COIN COL keys is to prevent a dual signal being sent to the trunk in case the position operator accidentally operates any two of these keys in error. With this circuit arrangement, if two keys are hit, no signal will be sent to the trunk, thereby preventing possible trouble in the trunk circuit. The CAMA CW key is used by the position operator to admit one CAMA call, on an overlap basis, to that position.

The 220-OUT and 220-STP relays are used in conjunction with the making of "delayed" calls. The 220-OUT relay indicates that a call of the "delayed" class is being made, and the 220-STP relay indicates that it is permissible to start pulsing into the sender by the position operator. The KP FWD key (FIG. 220) sends a signal to the control circuit to program the terminating digit registers to receive the terminating number "keyed" in by the position operator. Similarly, the KP BACK key sends a signal to the control circuit to program the originating digit registers to receive the originating number "keyed" in by the position operator, and, in like manner, the KP RATE key sends a signal to the control circuit to program the "rate treatment" digit registers to receive a three-digit "rate treatment" "keyed" in by the position operator. The parallel-connected combination of KP FWD, KP BACK and KP RATE make contacts connected to the RS lead in cable KP (FIG. 220) is used to operate the 184-RS relay in the position control circuit, to reset the steering relays in the position control circuit for reception of the digits "keyed" by the operator.

The DISPLAY CLD NO and DISPLAY CLG NO keys on FIG. 223 are used by the position operator to display either the calling number or the called number. The display tubes (FIGS. 207 and 208) will display the desired information for the duration that the key is held operated. When the key is released, the display is extinguished. The KP BACK, KP FWD, and KP TRBL lamps (FIG. 223) light to indicate to the position operator that the circuitry is preset for reception of digits to be "keyed" by the operator.

#### *Recapitulation of sender operation*

Returning now to the circuit actions of the sender in connection with the remainder of the call, it will be recalled that the trunk circuit receives a signal when a position is attached to the connection. This signal comprises a ground extended via conductor PA (FIG. 15) of the trunk circuit, and for the current call it operates relay 13-PA. The operation of this relay closes the following circuit on FIG. 12 to apply ground to conductor FR extending from the trunk via the sender link to the sender: ground on terminal 105 of FIG. 12, break contacts 13-SR, make contacts 13-PA, break contacts 11-OP, transfer break contacts 10-FA, transfer make contacts 10-SA, to conductor FR. The ground extended on conductor FR is then further extended from the illustrated trunk circuit, via the sender link, to FIG. 24 of the sender circuit. The ground on conductor FR on FIG. 24 may then be further extended through transfer make contacts 64-SCW, to the winding of the relay 24-SPA to operate it. The operation of relay 24-SPA opens its break contacts on FIG. 64 to release relay 64-SCW.

While this operation is going on in the sender, the data transfer circuit is seized by the position control circuit and is instructed to interconnect this position control circuit, the sender circuit, and the trunk circuit serving this call, via one of its data channels. As a consequence of this instruction, and as hereinbefore described in connection with the detailed description of the data transfer circuit, the data transfer circuit on FIG. 242 extends a positive 130-volt potential, via its data chan-

nel "0," its position connector "0," and position circuit "0," all as shown on FIG. 242, to the PC lead on FIG. 241. The potential on lead PC may then be further extended through the position control circuit, through the position link on its KPR lead, through the make contacts 10-SA in the trunk circuit, through the sender link on its SPI lead to the sender, via its SPI lead. Referring both to FIG. 241 of the data transfer circuit and to FIG. 48 of the sender, it may be seen that the positive 130-volt potential extended to conductor SPI is further extended through make contacts 24-SPL, 51-RGCB, break contacts 64-DTCK, and out on conductor SP back to FIG. 241, whence the SP conductor extends to FIG. 243, and to the winding of relay 243-SS00 to operate it. The operation of relay 243-SS00 closes its make contacts shown on FIG. 64 to extend a ground to the winding of relay 64-SSP to operate it. The operation of relay 64-SSP informs the sender that it is currently connected to its sender connector.

As hereinbefore described in connection with the data transfer circuit, the sender, once it is connected via its sender connector to the data transfer circuit, passes the various items of information stored in its registers to the data transfer circuit. These items include the called number, the calling number, the recorder number, the class of service, and the trunk connector number, together with other bits of information discussed in detail in connection with the data transfer circuit. The data transfer circuit registers and checks this information. If it is found to be correct, the data transfer circuit applies a ground to its DTOK lead in rectangle "DD" on FIG. 267, which ground is then extended to lead DTOK on FIG. 69 of the sender circuit. The ground on conductor DTOK is then extended to FIG. 64, where it may be further extended through break contacts 64-SA, to the winding of relay 64-DTOK to operate it. Relay 64-DTOK, in operating, closes a holding path for itself over its own make contacts to ground via make contacts 42-ON.

The data transfer circuit subsequently transfers to the position circuit some of the information received from the sender. The position circuit registers and checks this information and, if found to be correct, sends back a data "okay" signal to the data transfer circuit which, in response thereto, as hereinbefore described, releases the sender from the connection by releasing relay 243-SS00. The release of relay 243-SS00 opens its make contacts on FIG. 64 to release relay 64-SSP. The data transfer circuit then on its own, as hereinbefore described, performs the rest of the circuit operations required to disconnect it from the sender. The release of relay 64-SSP notifies the sender that it is no longer connected to the data transfer circuit. With the operation of relay 64-DTOK and the release of relay 64-SSP, relay 64-DTCK is operated. Relay 64-DTCK, in operating, closes a holding path for itself over its own make contacts via make contacts 42-ON3.

#### *Synopsis of sender communication with a marker*

When the required number of digits is received by the sender, an idle marker is seized via the marker connector and the necessary digits of the trunk link frame number and the class of service are sent by the sender to the marker. The marker decodes the called number and returns to the sender, via the marker connector, all the information necessary for completing the call. This information, for the most part, comprises the type of outpulsing required, together with the number of digits to be outpulsed. The marker then releases the marker connector but maintains communication with the sender by way of the trunk link, trunk, and sender link, back to the sender, over a connection established through the trunk and office link frames. The sender may disregard all information received from the marker and seize another marker for a second or third trial. This would occur if the previous marker trial encountered trouble in any of its func-



tions, if the sender encounters an overflow condition in making selections beyond, if trouble is encountered during AMA functions, or if the sender "times out" due to a trouble condition.

#### *Sender seizes a marker*

The release of relay 64-SSP terminates the sender's communication with the data transfer circuit on this call, and initiates the sender circuit actions required for the sender to interconnect itself, via a marker connector, with a marker. Specifically, the release of relay 64-SSP closes the following circuit to operate relay 41-DST: ground on terminal 101 of FIG. 40, make contacts 42-ON2, transfer break contacts 60-NGP, make contacts 64-DTCK, transfer break contacts 60-DP, make contacts 72-RGC2, break contacts 60-AS0, 59-TR1, 65-TR3, 28-CA6, 40-MR, 65-TRL, 48-DC, 33ROP, 27-TVS, and 64-SSP, to the winding of relay 41-DST to operate it.

The operation of relay 41-DST closes the following circuit path to operate relay 41-SP in the marker connector: battery on terminal 103 of FIG. 41, make contacts 42-ON, transfer break contacts 46-RS1, make contacts 41-DST, transfer break contacts 20-RVT, break contacts 38-LR1, 28-CA6, 40-MR, 28-DRL, 46-CP, conductor ST extending to the marker connector, and to the winding of relay 41-SP therein to operate it. The operation of relay 41-SP in the marker connector causes it, in a manner well known in the art and described in the aforementioned Breed et al. patent, to seize an idle marker and operate multicontact connector relays, thereby closing a large number of leads between the sender and the marker. Office, or toll code, and other information passes from the sender to the marker over some of these leads and, after decoding by the marker, selection information passes from the marker to the sender over others of these leads.

The operation of relay 41-SP in the marker connector closes its make contacts to operate relay 41-SCB in the marker connector which, in turn, operates relay 41-SCA therein. Both of these latter relays operate from the battery applied to the CBS lead extending from the sender on FIG. 41. The operation of relay 41-DST also closes an obvious circuit on FIG. 28 to operate relay 28-ATR, and on FIG. 26 relay 41-DST closes an obvious circuit to operate relay 26-DKP.

#### *Marker operation*

The marker, after decoding the received information, seizes the office and link frame connectors required for completing the call, and then grounds the DC conductor extending from the marker back to the sender. This lead enters the sender on FIG. 54, via cable SM from the marker connector, and from there it extends to FIG. 48 and continues through transfer break contacts 65-RS2 and break contacts 40-MR to the winding of relay 48-DC to operate it. Relay 48-DC, in operating, extends the operating ground, applied to one side of its winding, through its own make contacts and transfer break contacts 65-RS2 to the DC conductor, which conductor extends via the sender link to the trunk circuit. Conductor DC enters the trunk circuit on FIG. 12, whence it may be extended through transfer break contacts 15-D1 to the winding of relay 12-F to operate it. Relay 12-F, in operating, extends its operating ground through its own make contacts to conductor LC, extending from FIG. 12 of the trunk circuit to the trunk link circuit. The trunk link circuit, in turn, extends this connection to another point in the marker, where another ground is supplied to it. This marker ground holds relay 48-DC locked up for a time after the direct connection between the sender and the marker is broken by the release of the marker connector.

The marker, at the same time the aforementioned operations are taking place, sends completing information to the sender which instructs the sender how to complete

the call, including the type of outpulsing required, the number of digits to be outpulsed, whether code conversion is necessary, etc., all depending upon the nature of the call and the path over which it is to be completed to the distant office. For the present call, the following instruction relays in the sender might be operated from the marker via the sender link: relay 53-RBS (which indicates reverse battery start), relays 63-MFA and MFB (which indicate the multifrequency class of outpulsing, possibly relay 53-SSA (which represents a dial pulsing loop "A" indication), together with two of the 47-CR1, -CR2, -CR4 or -CR5 relays on FIG. 47 to indicate the compensating resistance to be inserted in the output loop, together with the code converted "C" digit register to be used.

After the marker completes the transmission of the call setup data to the sender and has operated relay 48-DC, it grounds the RL lead on FIG. 28, which extends via the marker connector to the sender as shown. The ground may further be extended through break contacts 65-RS2 and transfer break contacts 59-R0 to the windings of relays 28-DRL and 28-DRL1 to operate them. These relays, in operating, close a holding circuit for themselves over the make contacts of relay 28-DRL to ground in series with the make contacts of relay 41-DST. Thus, relays 28-DRL and 28-DRL1 remain operated as long as does relay 41-DST, which is for the duration of the sender usage unless a second seizure of the marker should be required.

On FIG. 41, relay 28-DRL, in operating, opens its break contacts, thereby removing battery from the "start" lead ST, thereby, in turn, releasing the marker connector and breaking all direct connections between the sender and the marker.

The sender is still in indirect communication with the marker over the DC and D leads of the sender (FIG. 48), which leads extend through what may be termed a "backdoor" path, via the sender link, the trunk circuit, and the trunk link, back to the marker. When the marker has completed its work, and has established a path through the trunk and office link frames, it removes ground from the DC lead, thereby releasing relay 48-DC in the sender and, in turn, relay 12-F in the trunk circuit. The release of relay 12-F is a signal to the sender that a path through the tandem office has been set up and that the sender may proceed with the remainder of its required action.

#### *Sender-to-marker information*

In the meantime, further circuit action within the sender is taking place. The operation of relays 28-DRL and 41-DST, together, closes the following path to operate relays 50-CCC1 and 50-CCC2: ground on terminal 101 of FIG. 50, make contacts 28-DRL, 41-DST, 47-CR4 and 47-CR2, transfer break contacts 47-SK3, to the winding of relays 50-CCC1 and 50-CCC2 to operate them. The following path is now closed on FIG. 53 to operate relay 53-SSMF: ground on terminal 101 of FIG. 53, make contacts 28-DRL, transfer make contacts 53-SSA and 53-MFA, to the winding of relay 53-SSMF to operate it. The operation of relay 53-SSMF closes the following path on FIG. 57 to operate relay 57-S1: ground on terminal 101 of FIG. 57, make contacts 28-DRL, 48-DC, 53-SSMF, transfer break contacts 47-IG5, 47-S0, 47-PF, 47-SK3, 28-TX, to the winding of relay 57-S1 to operate it. The operation of relay 53-SSMF also closes the following circuit to operate relay 23-P: ground on terminal 102 of FIG. 23, make contacts 53-SSMF, break contacts 26-SP, to the winding of relay 23-P to operate it.

The operation of the marker connector, as hereinbefore described, attached an idle marker to the sender by a multiplicity of leads, over some of which leads the sender passes information required by the marker to select the proper outgoing trunk, to determine the type of outpulsing to be used.



The following is a discussion of the leads involved, and the information transmitted thereover, from the sender to the marker. Referring to FIG. 54, the trunk link frame number information is passed to the marker by conductors F0, F1, F2, F3, F4, F00, F10. This informs the marker on which trunk link frame the incoming trunk for the present call appears. Also on FIG. 54, the class-of-service information is transmitted to the marker over conductors CS0 through CS6.

Referring to FIGS. 29 and 35, the first six digits of the called number are transmitted, in 2-out-of-5 code form, to the marker over conductors CA0, -1, -2, -4, and -7, CB0, -1, -2, -4, and -7, through CF0, -1, -2, -4, and -7. These six digits represent the three digits of the national area code plus the three digits of the called office code. Conductors EA and LA, on FIG. 29, represent TX or non-TX call information, respectively.

Referring to FIG. 59, conductors TR1, TR2, OF, and ANI indicate to the marker whether a first, second, or third announcement trial is being made. The conductor OF signifies that the call is to be set to an overflow trunk. The conductor ANI indicates that the call is to be set up to an announcement trunk. Conductor MFM, on FIG. 41, indicates that this sender is capable of multifrequency outputting or dial pulsing, with the office code pulsed as received or code converted, and outputting TX or service codes as received, including the "1-1" prefix. Conductor 2/5, on FIG. 41, indicates that the sender used the 2/5 code signaling system. Conductor MF, on FIG. 41, indicates that this is a multifrequency sender. The STA and STB leads, on the same figure, provide a preference indication for the foreign area translator that is to be used. Conductor OPT, on FIG. 59, indicates that the call has been rerouted.

#### Marker-to-sender information

The marker, after having received the aforementioned information from the sender pertaining to the call, selected a route relay corresponding to the code digits received from the sender. This selection is made with the assistance of a foreign area translator on A0X and A1X area code calls if the area is one of the five six-digit translation areas and if foreign area code translation is provided. Cross-connections from route relay contacts to marker transmitting relays caused grounds to be transmitted over marker-to-sender information leads in various combinations. Route relay cross-connections are also used to select the proper outgoing trunk group.

When the marker has transmitted completing information to the sender and selected an idle outgoing trunk, a signal is sent to the sender, indicating that the completing information may be locked up and that the marker connector is to be released. The marker retained control of the sender over a "backdoor" path comprising the trunk link, the trunk, and the sender link, until a channel was established between the incoming and outgoing trunks. Marker-to-sender information is not locked in prior to selection of an outgoing idle trunk, as the marker may recycle several times while advancing to different trunk groups, which may require new completing instructions. These information leads may be grouped into four categories: class of call, outsteering code conversion, miscellaneous digit registration, and trunk data.

Referring to FIGS. 47 and 53, class-of-call information is transmitted to the sender over conductors IG5, SSA, SSB, MFA, RBS, and OD. The information received on any of these leads applies grounds to relays having the same designation, on FIGS. 47 and 53. Resistance battery is also supplied over lead TCI, on FIG. 47, to satisfy a marker transmitting lead check circuit.

The marker signals the sender regarding which digit to start the DP or MF outputting with, as the case may be, via conductors PF, SK3, IG5, and S0, on FIG. 47. It may further signal cancel-code-conversion instruction by applying grounds to conductors CR2 and CR4 on the

same figure, and may indicate that a TX code, which may be either 115-EX or 115-X, is to be outputted with the initial "1-1" prefix, or that a service code is to be outputted as received by applying grounds to conductors OB5 and IG5. The sender starts outputting, beginning with the digit indicated, and continues pulsing until all subsequent digits are outputted. The outputted digits are preceded by a KP pulse and are followed by a "start" pulse on MF calls. Prefixed digits are always arbitrary digits supplied by the marker and have their main use with seven-digit codes where the best route to a terminating office (in the same area, as the tandem office) is through an office in an adjacent area.

#### General description of outputting selections and completion of connection

##### Outsteering and recapture circuit

The marker provides the sender with information indicating the class of call, outsteering start information, arbitrary code converted or prefix digits, if any, and trunk information, as hereinabove described.

The outsteering circuit, used in connection with the outputting operation, is shown on FIGS. 57 and 58. This outsteering circuit is similar to the steering circuits used elsewhere, and which have been hereinbefore described, such as for example, the insteering circuit hereinbefore described in connection with the reception of the calling number by the sender. Action in the outsteering circuit is initiated when the decoding functions of the marker have been completed, as indicated by the operation of relay 28-DRL. The initial steering relay to be operated is controlled by information received from the marker. The steering relay operated initially indicates the digit with which outputting is to begin. All steering relays subsequent to the initial steering relay operate in sequence, under control of the outputting class relays, until outputting is completed.

When the initial steering relay is preoperated prior to the start of outputting, it is locked, through a chain of series-connected break contacts on the succeeding steering relays, to ground through make contacts of relay 28-DRL. Locking the circuit in this manner permits the steering relay to be reset if relay 28-DRL is released when making another marker trial. With one steering relay operated, the application of a steering advance ground causes the succeeding steering relay to operate and lock, through a chain of series-connected break contacts of all its successive steering relays, to the 28-DRL ground on terminal 57-101. At the same time, the holding ground of the previously-operated steering relay is transferred to the steering advance ground, the relay releasing when the ground is removed, thus completing the advance of the steering circuit to the next digit. Subsequent steering relays are operated and released in a similar manner by the application of the steering advance ground under control of the outputting class relays. This action allows the sender outputting circuit to progress, digit-by-digit, until outputting is completed.

Referring now to FIGS. 49 and 50, associated directly with the outsteering circuit are the recapture relays 49-RR0, -1, -2, -4, and -7. These relays connect the various called number registers containing digits to be outputted, or to the relay register contacts 47-CR1, -CR2, -CR4, and -CR5, or 47-OG1, -OG2, -OG4, and -OG5, or 47-OB1, -OB2, -OB4, and -OB5 on FIG. 49, if necessary for code conversion or prefixing under control of the outsteering circuit. Normally, the operation of relay 57-S1 connects the recapture relays to the "A" digit register contacts on FIG. 29; the operation of steering relay 57-S2 connects the recapture relays to the "B" digit register on FIG. 29; and so on through steering relay 58-S11, the operation of which connects the recapture relay to the "L" digit register on FIG. 34. This relationship can be changed to permit registered digits to be code con-



verted, or terminating area codes to be outpulsed before other digits.

The recapture relays function to check that 2-out-of-5 register relays of each digit to be outpulsed are operated, and also function to perform any translation required to outpulse a digit, depending on the class of outpulsing to be used.

#### Trunk testing

In preparation for outpulsing, the first action of the sender is to make a trunk test which constitutes, in part, a continuity test of the outgoing tip-and-ring leads, called the fundamental tip-and-ring leads to distinguish them from the incoming tip-and-ring leads, through the sender link, the tandem trunk, through the trunk link frame and the office link frame, to the battery and ground in the outgoing trunk. The fundamental circuit is closed for "trunk test" by the operation of relay 21-STG. The operation of this relay depends upon the following conditions: (a) Relay 48-DC must be released to signify that the marker has completed a connection to the outgoing trunk. (b) Relay 47-OD must be nonoperated in senders not arranged for "trunk test" on straightforward calls. (c) Relay 31-TTE, which is controlled by relay 31-TTD, must be released. Relays 31-TTE and 31-TTD are slow-release relays used to provide a brief delay (advantageously from 400 to 825 milliseconds) before closing a bridge on a trunk to a step-by-step selector, to allow said selector to restore to normal in case it is seized by the marker immediately after its release on a previous call. Relays 31-TTD and 31-TTE are operated only on one-way trunks to step-by-step selectors, and their timed release begins when relay 48-DC is released by the marker. (d) Relay 22-FO2 must be released. The relays 22-FO1, -FO2, and -FO3 are selection-progress-synchronizing relays. Relay 22-FO1, operated, operates relay 22-FO2 and is used to withhold "trunk test" until various conditions are met, depending upon the class of outpulsing utilized.

On ANI calls to senders where an operator is required, operation of relay 21-STG is delayed until the operator has registered the "A" digit of the calling number, thereby operating relay 18-DNB1. This reduces the possibility of terminating sender time-out. On ANI calls to senders where no operator is required, the operation of relay 21-STG is delayed until the "start" pulse following the called number is completed. Relay 18-DNB1 operates only when operators are attached.

Referring to FIG. 24, the operation of relay 21-STG, at its make contacts, closes the fundamental tip and ring conductors, FT and FR, respectively, from the trunk to the 25-TG relay winding, causing it to operate. The operation of relay 25-TG operates slow-release relay 31-TG1. The operation of relay 31-TG1, in turn, operates relay 31-TG2. Relay 31-TG2, operated, then operates relay 21-MFTT on an MF call. To provide maximum loop range for the "trunk test," the winding of the 25-TG relay is shunted by a TGS resistor on MF calls.

#### Pulse generator

Referring to FIG. 23, for multifrequency or dial pulse outpulsing, the timing of the pulses is controlled by the pulse generator circuit comprising the pulse generator relay 23-PG, the pulsing relay 23-P, the timing capacitor PG, and a resistor network for both types of pulsing. Relay 23-PG is a double-wound polar relay and comprises a set of transfer contacts. When the circuit is completed for pulsing, the relays 23-P and -PG constitute a self-interrupting pulsing circuit, the timing of the pulse being controlled by the capacitor PG and the various combinations of resistors PG1 to PG14 that are utilized.

The upper winding of relay 23-PG is connected at both ends to battery through the network resistors. The negative terminal of the lower winding of relay 23-PG is connected to the positive terminal of the upper winding,

and the positive terminal of the lower winding is connected to the PG capacitor. The lower and upper windings are connected in opposition to each other. Thus, with relay 23-P normal, ground on the armature thereof is connected through its control contacts, and current is applied to the upper winding of relay 23-PG in a direction tending to operate relay 23-PG, but the current flowing in the lower winding to charge the capacitor PG opposes the operation of relay 23-PG. As the capacitor PG becomes charged, the lower winding current decreases until the upper winding ampere turns exceed the ampere turns of the lower winding, and relay 23-PG operates. The operation of relay 23-PG operates relay 23-P which, in effect, transposes the battery and ground connections to both windings of relay 23-PG. The current in the upper winding of relay 23-P is now in a direction tending to cause its armature to return to its break contacts, but since the capacitor PG will charge in the reverse direction, which in this case is the direction to hold the armature of relay 23-PG on its make contacts, the relay armature action is delayed until the upper winding ampere turns exceed the ampere turns of the lower winding, and relay 23-PG releases, thereby releasing relay 23-P. When this occurs, the closure of ground through the break contacts of relay 23-P restores the initial condition in which the current in the upper winding of relay 23-PG is again in the direction tending to operate relay 23-PG to close its make contacts, while the current in the lower winding opposes its operation. The pulsing, therefore, continues. The duration of the closure of the contacts of relay 23-PG, in either direction, depends upon the value of the resistors used, which resistor values determine the pulsing speed.

#### Type of outpulsing selection

The circuitry of the disclosed sender provides for the transmission of direct-current dial pulses, compensated loop dial pulses, or battery and ground pulses to terminating step-by-step selectors, or DP senders. The marker indicates the type of pulsing to be used by the operation of either or both of the relays 53-SSA and/or 53-SSB, and if the call is to a sender or register type of office, by the operation of relay 53-RBS. Following "trunk test," the fundamental circuit is connected to the dial pulse generator circuit and the required number of digits may be transmitted to the terminating equipment. This sender has the ability to outpulse one to fourteen digits on both dial pulse and MF outpulsing. The sender then cuts the tandem trunk through to the outgoing trunk and restores to normal.

For multifrequency outpulsing, the marker operates the relays 53-MFA, 53-SSA and 53-RBS in the sender. Referring to FIGS. 24 and 25, the fundamental circuit, via transfer make contacts 53-MFA, is then connected through the secondary windings of an output repeating coil T through other 53-MFA make contacts to the series-connected primary winding of relay 25-OF and the winding of relay 25-TG. The primary winding of the repeating coil T is connected to the MF pulse control circuit. From one to fourteen digits, preceded by a KIP pulse and followed by a start pulse, may be transmitted to the terminating equipment. The sender then cuts the tandem incoming trunk through to the outgoing trunk and releases.

#### Outpulsing steering, code conversion and prefixing

The digit with which pulsing is to begin is determined by the relays operated by the marker. The marker in this manner instructs the sender as to whether code conversion is necessary, whether prefixing is necessary, and with what digit to start outpulsing. Having started outpulsing with the digit associated with the particular steering relay, the required code digits, if any, and as many numerical digits as are registered are then outpulsed.



When outpulsing starts with any of the "A," "B," or "C" digits, they may be sent as registered or they may be converted to any other arbitrary digits or sets of digits. In the latter case, the converted digits are set up by the marker on the relays 47-OB-, 47-OG-, and 47-CR- for the "A," "B," and "C" digits, respectively. When the digits are to be sent as originally registered, the marker causes the cancel-code-conversion relays 50-CCC1 and 50-CCC2 to be operated through a break contact of relay 47-SK3 by the operation of relays 47-CR2 and 47-CR4. Relays 50-CCC3 and 50-CCC4 are operated through break contacts of relays 47-SK3 and 28-TXA, so that the "D," "E," and "F" digits are sent as registered.

#### *Start pulsing*

On DP or MF calls to sender or register type offices, a reverse-battery "start" signal must be received by the tandem sender before outpulsing may begin. This "start" signal indicates that the terminating equipment is attached and prepared to receive pulsing. This signal consists of a fundamental tip-and-ring reversal from an off-hook to an on-hook condition. In the case of a delayed dial "start" signal, the trunk is seized in an off-hook condition and is held off-hook by the terminating office incoming trunk and sender circuits until the sender is prepared to receive pulsing. With a "wink-start" signal, the trunk is seized in the on-hook condition, is reversed to an off-hook condition when the terminating sender is seized, and then returned to the normal on-hook polarity when the terminating sender is prepared to receive pulsing. For both delay dial and "wink-start" pulsing signals it is the reversal from an off-hook to an on-hook condition that the sender recognizes as a "start" signal.

The marker informs the sender, by operating relay 53-RBS, that a reverse-battery "start" signal is to be expected from the next office. Relay 26-SP is the start-pulsing relay and it operates when the "trunk test" has been completed, as indicated by the operation of relay 21-MFTT on MF calls when, on calls to sender or register type offices, the proper start-pulsing has been received. The operation of relay 26-SP allows the pulse generator to function. When the "stop" of the "stop-go" signal is received, relay 26-SP releases and then reoperates when "go" is received, thus stopping and starting the pulse generator. On MF calls, relay 21-MFTT, in operating, connects the 24-MG capacitor between the secondary or low side coils of transformer T<sub>1</sub> of FIG. 24, to provide a low impedance for MF signals in preparation for outpulsing. The 24-MG capacitor is not inserted in the fundamental circuit until "trunk test" is completed, to prevent false operation of the "A" relay on the outgoing trunk due to a possible charged capacitor at the time the marker closes the channel through to the outgoing trunk, prior to test by the sender.

#### *Multifrequency pulsing and advance to release*

Referring to FIG. 23, when relay 26-SP operates, as a result of the start-pulsing signal from the originating office, relay 23-P is released, thereby starting the pulse generator circuit. A pulse consisting of two audio frequency signals is sent during each interval that relay 23-P is released. The relay 23-P is released for approximately 100 to 150 milliseconds during the first pulse; and at the end of the first pulse, relay 23-FO7 is operated to switch out resistors PG2 and PG3 to change the pulse interval to approximately 50 to 80 milliseconds. Referring to FIG. 30, the audio signals are supplied by the MF current supply circuit over six leads designated 0, 1, 2, 4, 7, and 10, which may be associated advantageously with the frequencies 700, 900, 1100, 1300, 1500, and 1700 cycles per second, respectively. These leads are connected to the MF transformer by recapture relay contacts 49-RR- in such a manner that contact failure will not allow only a single frequency pulse to be transmitted. The digits "1," "2," "3" through "9," and "0" are registered in the 49-

RR- relays in conventional 2-out-of-5 code form, as determined by the numerical portion of each 49-RR- relay's designation. A "start" pulse is transmitted by MF supply leads 7 and 10, with relays 49-RR7 and 23-FO7 operated. A KP pulse is transmitted, via MF leads 2 and 10, with relay 23-FO7 normal.

The first pulse transmitted is the KP pulse and it should be, advantageously, of at least 100 milliseconds duration. This is a gate-opener pulse, preparing the MF receiver associated with the terminating sender or register in the next office for reception of the called number digits. The digits to be outpulsed are transferred to the recapture relays during the interval that relay 23-P is operated, the steering circuit being advanced by the relay 23-P. Delay synchronization is in effect during outpulsing to assure that two, and only two, of the recapture relays are operated and that registration of the succeeding digit to be outpulsed has begun. When the last digit registered is sent, operation of relay 23-P advances the steering chain, and relay 32-MFS operates to cancel the 2-out-of-5 check of the recapture relays, and the "start" pulse consisting of the frequencies 7 and 10 is transmitted when relay 23-P releases. The advance of the steering circuit, when relay 23-P operates, closes a path to operate relay 32-AV1, which stops the pulse generator and causes the trunk to be cut through and the sender to be released.

#### *Trunk cut through and sender release*

The operation of relay 32-AV1 indicates completion of the pulsing function and that the incoming trunk can now be connected through the tandem office of the outgoing trunk for the talking connection. On "AS0" calls, the operation of relay 32-AV1 indicates the calling number has been received and checked by the data transfer circuit. The operation of relay 32-AV1 follows the operation of relay 38-LR1 which operated through make contacts of relays 60-AS0 and 64-DTCK. Relay 32-AV1, in operating, operates a cut-through relay in the trunk, over the "D" lead on FIG. 48, except on "AS0" calls, where the sender times out as an abandoned call. The trunk returns a ground over the DC lead on FIG. 48, operating relay 48-CK1 which, in turn, operates relay 48-CK2 in the sender. Relay 48-CK2, in operating, opens the C0 lead (FIG. 42), disconnecting ground therefrom, and effectively placing a resistance battery on the C0 lead, thus releasing the cut-off relay in the trunk. The trunk then removes ground from the DC lead to release relay 48-CK1, thereby resulting in the release of relay 48-CK4 and the operation of relay 38-AV4. Relay 48-AV4, in operating, releases the off-normal relays and the sender link hold magnets. The sender busy relay in the sender link and controller is held operated until the off-normal relay is released. However, the locking ground returned to the sender over the BS lead (FIG. 42) is removed by the release of relay 66-SR when relay 32-AV1 operates. The release of relay 48-CK4 is sufficiently slow to allow the operation of relay 11-A in the trunk, which indicates transfer of the supervision back to the trunk circuit. The release of the off-normal relays allows relay 17C-SB in the sender link to release and return the sender to normal.

#### *Continuation of detailed description of the present call*

Recalling the hereinbefore-described operation of steering relay 57-S1, the recapture relays on FIG. 49 are now connected, via the transfer make contacts of relay 57-S1, to the A0, A1, A2, A4, and A7 output leads in cable A-C of the "A" digit register, comprising the contacts (on FIG. 29) of relays 69-A0, -A1, -A2, -A4 and -A7. Recalling that the called number digits are 212-243-1000, the "A" digit of "2" is stored in the "A" digit register on FIG. 69 by the operation of relays 69-A0 and 69-A2. The circuit on FIG. 29, therefore, grounds conductors A0 and A2 extending in cable A-C back to the steering circuit on FIG. 49, through the transfer make contacts of steering relay 57-S1, to operate relays 49-RR0 and 49-



RR2. Referring to FIG. 22, the operation of the foregoing recapture relays opens the check circuit and releases relay 22-F01 which, in turn, releases relay 22-F02. Relay 22-F01, immediately prior to its release, is held operated from the ground supplied from terminal 101 on FIG. 22. Included in the circuit path intermediate terminal 2-101 and the winding of relay 22-F01 is what is commonly termed a negative 2-out-of-5 check circuit, comprising the contacts of the recapture relays on FIG. 49. This check circuit is effective to maintain continuity from its input to its output at all times except when any two out of the five recapture relays are operated. Continuity is broken whenever two such relays are operated. Thus, referring to the foregoing circuit operation, relay 22-F01 is maintained operated from ground on terminal 22-101 prior to the time that two out of the five recapture relays are operated. When two such relays are operated, continuity is broken within the negative 2-out-of-5 check circuit, thereby removing ground from relay 22-F01 and causing it to release.

Referring to FIGS. 48 and 54, the marker connector at this point has removed ground from conductor DC, thereby releasing relay 48-DC. The release of relay 48-DC is a signal to the sender that a path through the tandem office has been set up by a marker and that the sender may now proceed with the remainder of its required action on the call. Relay 20-RVT is released at this time. Referring to FIG. 21, the following path is now closed to operate relay 21-STG: ground on terminal 21-101, make contacts 28-DRL, 51-AI, 51-EOP, break contacts 51-AIT, transfer make contacts 60-NGP, and through break contacts 22-FO2, plus the remainder of the break contact chain shown, to the winding of relay 21-STG to operate it. The release of relay 22-FO2 completes an obvious circuit to operate relay 22-FO3. Referring to FIGS. 24 and 25, the operation of relay 21-STG cuts through the fundamental circuit for a trunk test and connects relays 25-TG and 25-OF in series with the fundamental tip and ring conductors (FT and FR), thereby causing them to operate from the potentials applied via the fundamental circuit. The battery and ground potentials applied to the fundamental tip-and-ring circuit to operate relays 25-OF and 25-TG are supplied by the outgoing trunk circuit in the tandem office. This is connected to the sender at this time by the connections established by the marker between the incoming and outgoing trunks, so that this potential is applied also to the incoming trunk, and thence, via the sender link, to the sender. The operation of relay 25-TG, in turn, operates relay 31-TG1 which, in turn, operates relay 31-TG2. The operation of relay 26-OF closes a circuit on FIG. 26, from ground on terminal 26-101, to operate relay 26-ROF. Relay 26-ROF is operated over the following circuit: ground on terminal 26-101, transfer make contacts 26-OF, break contacts 26-COF, transfer break contacts 23-FO7, transfer make contacts 53-RBS, transfer break contacts 26-ROF, and break contacts 23-FO7, to the winding of relay 26-ROF to operate it. Referring to FIG. 21, the operation of relay 31-TG2 closes the following circuit to operate relay 21-MFTT: ground on terminal 21-102, make contacts 28-DRL, 31-TG2, and transfer make contacts 53-MFA, to the winding of relay 21-MFTT to operate it.

Referring to FIGS. 25 and 26, next, the potentials on the fundamental tip and fundamental ring conductors are altered sufficiently to cause the release of relay 25-OF. The release of relay 25-OF, in turn, removes the ground formerly supplied from terminal 26-101, to release relay 26-DKP.

#### *Outpulsing by sender*

The following circuit is now closed to energize the start-outpulsing relay 26-SP: ground on terminal 101 of FIG. 26, transfer break contacts 26-OF, break contacts 26-DKP, make contacts 21-MFTT, 26-ROF, 22-FO3, break contacts 62-FOA, and 32-AV1, to the winding of relay 26-SP to operate it.

The operation of relay 26-SP opens its break contacts on FIG. 23 to release relay 23-P by disconnecting it from the ground on terminal 102 of FIG. 23. The release of relay 23-P closes the following circuit to operate relay 23-FO6: ground on terminal 103 of FIG. 23, transfer break contacts 23-P, transfer make contacts 21-MFTT, transfer break contacts 58-S11A, break contacts 58-S10A, make contacts 53-MFB, transfer break contacts 23-FO6, to the winding of relay 23-FO6 to operate it.

The release of relay 23-P, together with the circuit actions just described, initiates the outpulsing of the called number by the sender. The rate at which the outpulsing takes place is controlled, by and large, by the pulse generator comprising relays 23-PG and 23-P. These two relays, together, constitute a self-interrupter, which operates at a controlled rate, to control the rate at which the outpulsing takes place together with the time duration of each pulse. The operation of the pulse generator itself has been hereinbefore described in connection with the general comments on the sender.

Referring to transformer T, on FIG. 24, its secondary windings are connected to the fundamental tip-and-ring circuit (conductors FT and FR), while the primary windings are connected to the tone oscillators of FIG. 30, which are used in connection with MF outpulsing. These oscillators are connectable to the windings of transformer T by a contact network including the contacts of the various recapture relays on FIG. 49, as well as by the break contacts of relay 23-P and the make contacts of relay 21-MFTT. With this arrangement, and with make contacts 26-SP and 21-MFTT closed, it may be seen that two of the MF frequencies will be impressed upon the fundamental tip-and-ring circuit, in accordance with the particular pair of recapture relays operated. Relay 23-FO7 is normal at this time and, therefore, a KP signal comprising frequencies 1100 and 1700 c.p.s. are now impressed on the primary windings of transformer T. The KP pulse is terminated as relay 23-PG operates, followed by the operation of relay 23-P. Next, relay 23-FO7 is operated from the ground supplied by terminal 103 of FIG. 23 as a consequence of the operation of relays 23-P and 23-FO6. The operation of relay 23-FO7 alters the timing of the outpulsing operation and releases relay 26-ROF.

Next, relays 23-PG and 23-P release, thereby initiating the outpulsing of the "A" digit. Recalling that the called number is 212-243-1000 and that the "A" digit is "2," the recapture relays 49-RR0 and 49-RR2 are operated, thereby applying MF frequencies 700 and 1100 to the fundamental tip and ring. Referring now to FIGS. 57 and 58, the release of relays 23-PG and 23-P also closes the following circuit to operate steering relay 57-S2: ground on terminal 101 of FIG. 58, through the contact network shown, including the break contacts of relay 23-P to terminal 102 on FIG. 58, leftwards to terminal 102 on FIG. 57, down to terminal 103 on the same figure, leftwards and then down to terminal 104 on FIG. 57, rightwards, through the series-connected transfer break contacts shown, to terminal 105, through transfer make contacts 57-S1, transfer break contacts 57-S2, to the winding of relay 57-S2 to operate it. Relay 57-S2 comprises the steering relay for the "B" digit. The "B" digit is "1" and was registered in the "B" digit register by the operation of relays 69-B0 and 69-B1. The operation of steering relay 57-S2 prepares a path to interconnect the recapture relays 49-RR- on FIG. 49, via conductors B0, B1, B2, B4, and B7 in cable A-C, with the contact network of the "B" digit register relays on FIG. 29, and thereby operate recapture relays 49-RR0 and 49-RR1.

Next, relays 23-PG and 23-P reoperate to terminate the transmission of the "A" digit. Steering relay 57-S2 has operated by now, as described. Steering relay 57-S1 now releases as a consequence of the operation of steering relay 57-S2. The release of steering relay 57-S1 and the operation of steering relay 57-S2 releases the two previously-op-



erated recapture relays and operates two new ones, in accordance with the value of the "B" digit of "1" which is now fed to the recapture relays, via the contacts of steering relay 57-S2.

Next, relays 23-PG and 23-P release, thereby connecting the MF oscillators of FIG. 30 to the fundamental tip-and-ring circuit to begin the transmission of the "B" digit of "1." Recapture relays 49-RR0 and 49-RR1, operated at this time, connect the frequencies 700 and 900 c.p.s. to the fundamental circuit. Steering relays 57-S3 and 57-S3A operate during the transmission of the "B" digit. Next, relays 23-P and 23-PG reoperate to terminate the transmission of the "B" digit. The reoperation of relays 23-P and 23-PG releases steering relay 57-S2 and recaptures relays 49-RR0 and 49-RR1. The recapture relays are now connected, via cable A-C, to the output of the "C" digit register, and since the "C" digit for the present call is "2," recapture relays 49-RR0 and 49-RR2 are operated.

Next, relays 23-PG and 23-P release, thereby initiating the transmission of the "C" digit of "2." Steering relays 57-S4 and 57-S4A operate while the "C" digit is being transmitted. Next, relays 23-P and 23-PG reoperate to terminate transmission of the "C" digit. Following this, steering relays 57-S3 and 57-S3A release. The release of these steering relays releases the previously-operated recapture relays and reoperates a new pair of recapture relays, via conductors D0, D1, D2, D4, and D7 in cable D-L extending from the contacts of the register relays on FIG. 34, in accordance with the value of the "D" digit to be transmitted. The "D" digit is "2" and, therefore, recapture relays 49-RR0 and 49-RR2 are now operated. Relays 23-P and 23-PG now release to initiate the transmission of the "D" digit of "2." Steering relays 57-S5 and 57-S5A operate while this digit is being transmitted. The release of relays 23-P and 23-PG terminates the transmission of the "D" digit. Steering relays 57-S4 and 57-S4A now release. The release of these relays releases the previously-operated recapture relays and operates recapture relays 49-RR0 and 49-RR4 for an "E" digit of "4."

Next, relays 23-P and 23-PG release and then reoperate to transmit the "E" digit of "4." At this time, steering relays 58-S6 and 58-S6A operate. Steering relays 57-S5 and 57-S5A release following the transmission of the "E" digit. Following this, the previously-operated recapture relays release, and since the "F" digit on the present call is a "3," recapture relays 49-RR1 and 49-RR2 now operate. Next, pulsing relays 23-P and 23-PG release and reoperate to transmit the "F" digit of "3." Steering relays 58-S7 and 58-S7A operate during the transmission of this digit. Next, steering relays 58-S6 and 58-S6A release, followed by the release of the previously-operated recapture relays. Recapture relays 49-RR0 and 49-RR1 now operate to prepare for the transmission of the "G" digit of "1." Next, pulsing relays 23-P and 23-PG release and then reoperate to transmit the "G" digit of "1." While this action is taking place, steering relays 58-S8 and 58-S8A operate. Next, steering relays 58-S7 and 58-S7A release. The previously-operated recapture relays now release, and recapture relays 49-RR4 and 49-RR7 are operated for an "H" digit of "0." Next, pulsing relays 23-P and 23-PG release and then reoperate for the transmission of the "H" digit of "0." Steering relays 58-S9 and 58-S9A operate during the transmission of the "H" digit. Next, steering relays 58-S8 and 58-S8A release. Following this, the previously-operated recapture relays release, and recapture relays 49-RR4 and 49-RR7 operate preparatory to the transmission of a "J" digit of "0." Next, pulsing relays 23-P and 23-PG release and then reoperate for the transmission of the "J" digit of "0." Steering relays 58-S10 and 58-S10A operate during the transmission of the "J" digit. Steering relays 58-S9 and 58-S9A then release, followed by the release of the previously-operated recapture relays. Next, recapture relays 49-RR4 and 49-RR7 operate for the transmission of the "K" digit and "0." Following this, pulsing relays 23-P and 23-PG release

and then reoperate for the transmission of the "K" digit of "0." During this time, steering relays 58-S11 and 58-S11A operate. Following this, steering relays 58-S10 and 58-S10A release. The previously-operated recapture relays now release and no further recapture relays operate, since the outpulsing of the called number digits is completed.

Referring to FIG. 23, next, pulsing relays 23-P and 23-PG operate and then release to outpulse the "start" pulse. Relay 23-W operates at this time over the following path: ground on terminal 23-106, break contacts 32-AV1, 23-P, make contacts 53-SSA, 26-SP, 53-MFB, break contacts 58-S10A, transfer make contacts 58-S11A, transfer break contacts 23-Z, to the winding of relay 23-W to operate it. Relays 58-S11 and 58-S11A release upon the termination of the transmission of the "start" pulse. Referring to FIG. 32, relay 32-AV1 now operates over the following path: ground on terminal 32-102, make contacts 42-ON3, 72-RGC, terminal 32-103, make contacts 67-LS, transfer make contacts 23-W, terminal 32-104, rightwards through the series-connected transfer break contacts of the various steering relays, and break contacts 57-S4A to terminal 32-105, make contacts 32-MFS, transfer make contacts 53-MFB, make contacts 53-SSMF, and break contacts 46-CP, to the winding of relay 32-AV1 to operate it.

The operation of relay 32-AV1 indicates the completion of the pulsing functions and that the incoming trunk may now be connected through the tandem office for the talking connection. As hereinbefore described, relay 32-AV1 now operates a cut-through relay in the trunk over the D lead, makes certain checks that the proper potentials are on the various leads, and then releases itself from the connection.

The succeeding switching center which received the MF pulses representing the called number now takes the necessary steps to extend the connection to the called party. The operator at the special position remains on the connection while ringing takes place, and as soon as the call is answered at the called station, the operator then performs whatever functions may be required in connection with the call. Assuming, for example, that person-to-person service is requested, the operator ascertains that the individual specified by the calling party is available, and that such individual actually answers the phone, before depressing the necessary keys at that position to initiate the recording of the charges for the call and to disconnect the operator equipment from the connection. The specific manner in which the operator performs these functions has been previously described in connection with the details of the position and position control circuit. Suffice it to say that, once the operator is satisfied that the functions required for serving the call have been performed, the operator initiates the recording of the necessary charges for the call, if applicable, and then depresses a key at that position to release the operator equipment from the connection. The operation of this key, as hereinbefore described, releases the circuits in the position and position control circuits which were serving the call and, further, removes ground from the sleeves of the circuitry through the link connector, so that the hold magnets serving this connection release, thereby disconnecting the incoming trunk from the operator position.

The call at this time is completely under control of the calling and called parties, and the connection will remain established through the tandem office as long as the parties' subsets remain in an off-hook condition.

This completes the description of the present call, which call was served by an incoming MF-ANI trunk.

#### General description of a dial pulse call

This portion of the specification describes the manner in which the system of the present invention serves a special service call incoming on a dial pulse (DP) trunk at tandem.



A substantial portion of the system operations for the serving of a DP call are analogous, similar, or identical to those of the previously described MF call. Therefore, in order to reduce the size of the specification, only those system and circuit operations for a DP call which are different from those of an MF call are described in detail. Those operations which are similar are mentioned only briefly, along with a statement indicating that the corresponding operations have been previously described in detail for the MF call.

When a calling subscriber in a step-by-step office originates a special service call which is to be served by the tandem office, an incoming DP trunk at tandem is seized after the subscriber has dialed the special service prefix digit, and after the local office has completed a path there-through, to the incoming DP tandem trunk. In the interdigital time between the subscriber dialing of the special service prefix digit, or the last digit of the directing code, if any, and the first digit of the office or area code, the incoming DP trunk connects itself to a ten-digit register through its associated register link circuit. This register must be attached during the interdigital time if no digits are to be lost. The incoming trunk then receives the incoming loop pulses from the local office as the subscriber continues dialing, and repeats these pulses to the registers for storage.

The register initiates a request for an MF sender to be attached to the trunk after it has received and registered the called number digits. This request is passed through the trunk circuit to its associated sender link, which seizes an idle sender. The sender, after it is attached and ready to receive the called number digits, signals the DP trunk circuit, which passes this signal on to the register. The register then requests the services of a data transfer circuit, which connects itself to the register and to the sender and transfers the called number digits from the register to the sender. The register then releases the data transfer circuit, and both circuits return to normal.

At the same time, if the calling office is arranged for automatic number identification (ANI), the tandem sender returns off-hook supervision to the originating office as a request for the calling number. After the calling and called numbers are received by the sender, or after the called number is received, if the calling office is not arranged for automatic number identification, the sender signals the trunk circuit to connect itself to an operator position via the position link and connector circuit.

When an idle position has been attached to the trunk circuit, the position requests the services of the data transfer circuit which now interconnects the trunk, the sender, and the position now serving the call, and transfers call data to the position circuit. The operator is connected to the transmission circuit of the trunk for talking to the calling subscriber while the sender calls a marker to set up a path to an outgoing trunk. The DP trunk circuit assists in setting up this connection by identifying itself to the marker, by closing the first crosspoints in the trunk link frame, and by supplying means for maintaining the connection through the trunk and office link frames for the duration of the call.

The marker disconnects after the above connections have been completed, and the sender then outpulses the called number forward to complete a connection to the called station. The DP trunk circuit is cut through, the sender releases, and the operator is bridged on the connection.

The DP trunk now waits for called party answer supervision, which is timed by the trunk to distinguish between "busy," "back" or "overflow" signals and a true called-party-answer. This is termed the charge delay interval. When it has been determined that the call was actually answered, the trunk is prepared to make the answer entry, provided the initial entry has been made.

The operator controls the perforation of the initial AMA tape entry, which may be made before the called

station answers if it is a paid station-to-station call, or after answer on calls such as person-to-person, where it is necessary to ascertain that the desired parties are connected before timing can be started. In either case, the operator's request for the initial entry associates a transverter with the position circuit. The position circuit provides to the transverter the call information necessary to determine the initial entry to be perforated on the AMA tape by a recorder. Near the end of the initial entry, the trunk circuit identifies itself to the recorder through the call identity indexer. When the initial entry is completed, information to that effect is registered in the trunk circuit.

The trunk now requests the start-timing entry if the call has already been answered, or the entry request is held up until the completion of the charge delay interval when the answer signal is received. The trunk now calls in the AMA recorder, through the call identity indexer, and indicates that an AMA timing entry should be perforated. Upon completion of the timing entry, the recorder signals the trunk to remove the entry request.

After the operator receives a signal that the initial entry has been made, the operator's services are no longer required on a normal call and the operator releases the position link connection to the calling trunk circuit. The trunk now controls the established connection and there is no further action until a disconnect signal is received. As soon as the calling party disconnects, the trunk circuit partially restores to normal and releases the connection through the trunk link and office link frames. Simultaneously, a request is made for the recorder to perforate the AMA disconnect entry. When the disconnect time entry has been perforated, the trunk circuit restores to normal.

In summary, one of the main distinctions, insofar as the present invention is concerned, between the manner in which the MF call previously described is served and that in which a DP call is served is that the data transfer circuit is used twice on DP calls in order to perform the interconnecting functions required. The first use of the data transfer circuit occurs after the called number has been entered in the register, which then requests the data transfer circuit to interconnect it with the same sender to which the calling DP trunk is currently connected via the sender link, in order that the register may transfer the called number to the sender. This information is transmitted to the sender after the data transfer circuit establishes the desired connection, whereupon the data transfer circuit is released and the call progresses to the point where the sender requests the trunk to establish a connection via the link connector to a position circuit.

The second interconnection is, broadly, similar to that of the MF call, namely, on the second use of the data transfer circuit, the position requests the data transfer circuit to interconnect the position with the trunk circuit to which the position is already connected, via the link connector, and with the same sender with which the trunk circuit is currently connected via the sender link.

#### *Detailed description of DP call*

##### SEIZURE OF TRUNK

The incoming DP trunk circuit that is assumed to serve the present call is shown on FIGS. 299 through 306. This trunk circuit circuit is further assumed to be the trunk circuit designated 900 and shown on FIGS. 2B, 3B, and 307.

Referring to FIG. 299, the call is initiated as the calling party 200 lifts his handset and dials the special service prefix digit, plus the called station digits, including the area code, if any. The originating office 202 responds to this dialing operation and establishes a connection therethrough to the incoming special service DP trunk at tandem, shown on FIGS. 299 through 306. The associated outgoing trunk at the originating office closes a dry loop across the tip-and-ring conductors (T and R) 203, as a consequence of the seizure, thereby completing a path to operate relay 299-A over a circuit including the tip-and-



ring conductors, transfer break contacts of relays 304-T and 306-RV, through the windings of relay 299-A to ground and battery. The particular combinations of polarities now on the tip-and-ring, namely, ground on the tip and negative battery on the ring, indicate a seizure condition to the originating office.

Referring to FIG. 300, the operation of relay 299-A closes an obvious path to operate relay 300-A1 which, in turn, operates relay 300-A2. The operation of relay 299-A also completes the following path to apply ground to conductor ST00, extending to FIG. 309 of the register link circuit: battery on terminal 300-101, make contacts 299-A, terminal 300-103, transfer break contacts 300-RA, break contacts 306-RVR, 301-TC, 300-OF, 305-PA, 305-RLF, and 303-D. The battery on lead ST00 causes the register link to connect the trunk to a register, as subsequently described. Negative battery extended to terminal 300-103 is also extended through transfer break contacts 304-T and resistance P to conductor R extending to FIG. 317 of the register link. Conductor R is used in the pulsing operation, as subsequently described. The operation of relay 229-A operates relay 300-B over the following circuit: battery on terminal 300-101, make contacts 299-A, transfer break contacts 300-RA, the winding of relay 300-B, and make contacts 299-A, to ground on terminal 300-104. Relay 300-B, in operating, closes an obvious holding path for itself.

#### *Operation of the register link*

##### GENERAL DESCRIPTION

The register link circuit, which is shown diagrammatically on FIG. 307, and in detail on FIGS. 308 through 321, functions to interconnect calling DP trunks with idle registers. Each connection to a register is completed in the interdigital interval between the dialing of the special service prefix digit, or the last digit of the directing code, if any, and the first digit of the called station number. Because of the high speed with which this connection is established, dialing may be completed without hesitation by the calling party. The high speed closure to the register is obtained through the use of a bylink, a temporary pulsing path completed by the operation of a few fast relays controlling the establishment of a crossbar switch connection, which is the ultimate linkage. The parallel bylink connection is opened under control of the register circuit when the crosspoints have been closed and checked.

Referring to FIG. 307, the crosspoint connection is via a single stage link utilizing 200-point crossbar switches in the present specification. Ten such switches may be provided per incoming register link frame to serve 200 trunks and 20 registers. Two hundred DP trunks, designated 900 through 1099, are shown on FIG. 307, as well as on the remainder of the drawings for the register link. Of these 200 trunks, only DP trunks 900 through 999 are shown on FIGS. 2B, 3B and 3H, and on these figures these trunks are shown to be served by trunk connector 9. DP trunks 1000 through 1099, shown on the register link drawings, are not shown on FIGS. 2B, 3B or 3H. If desired, this second group of 100 trunks could be served by any of trunk connectors 1 through 8, whose details are not shown, or, alternatively, the present invention is not limited to the specific details of the disclosed embodiment, and, therefore, additional trunk connectors other than the ten disclosed could be provided, with trunks 1000 through 1099 being served by one of these additional connectors, such as for example, connector 10 (the eleventh connector).

Trunks appear on the verticals of the crossbar switches, and the 20 registers appear on the horizontals of the 10 switches in a random slip multiple. Each of the 20 trunks on each switch has access to 10 registers, and each register is available to the trunks on five switches. Relays associated with the trunk and register appearances on each switch are arranged in order of preference, and in busy chains, and provide the dialing paths and crossbar switch control paths.

##### TRUNK START AND PREFERENCE CIRCUITS

The trunk preference circuitry of the register link is shown on FIGS. 308 and 309, with the circuitry for switch "A" being shown in detail in rectangle "A" on FIG. 309 and with the circuitry for the remaining switches being shown diagrammatically in rectangle "A" on FIG. 308. Switch "A" serves the 20 DP trunks numbered 900 through 919, and each trunk has its "start" lead connected to a preference circuit comprising relays TP00 through TP19 on FIG. 309, with the "start" lead ST100 of trunk 900 being connected to the winding of relay 309-TP00 and with the "start" lead ST- of trunk 919 being connected to the winding of relay 309-TP19. The windings of these relays are connectable to ground on terminal 101 of FIG. 309, via contacts on the same relays, in such a manner so as to give functional preference to the highest numbered relay, i.e., 309-TP19, which is directly grounded. However, other contacts of these same relays interconnect the LK and RA leads of the registers with the LK and RA lead of each trunk, via a preference circuit which gives functional preference to the lowest numbered relay. The remaining switches are equipped with circuitry similar to that of switch "A."

Recalling that trunk 900 applies a negative battery to its "start" lead as a consequence of its seizure by the originating office, a path on FIG. 309 is now closed to operate relay 309-TP00 from the negative battery on the ST00 lead of trunk 900, through the winding of relay 309-TP00, and through the series-connected break contacts of the higher numbered TP- relays, to ground on terminal 101 of FIG. 309, assuming that all higher numbered TP- relays are unoperated.

##### REGISTER SELECTION AND SWITCH PREFERENCE CIRCUITRY

FIGS. 313 and 314, together, disclose the circuitry which controls and selects the register that is to be seized on each usage of the register link. FIG. 313 discloses a plurality of "C" equipment rectangles, one for each of the ten switches "A" through "H", and "J" and "K", with each such rectangle including a register-busy preference chain which determines the order in which each switch attempts to seize an idle register. FIG. 314 discloses a plurality of "B" equipment rectangles, one for each of the 20 registers, with each such rectangle including a register preference circuit which determines the order in which each register, when subject to simultaneous bids, will give preference to the various switches. Only the register preference circuitry for register 00 is shown in detail, and it includes the five relays 314-RPA0, -RPK0, -RPJ0, -RPH0, and -RPG0.

On FIG. 313, the circuitry within each "C" equipment rectangle for each switch includes the parallel-connected make contacts of the 20 TP- relays associated with a switch, followed by a preference circuit comprising the series-connected transfer make contacts of the register-busy relays associated with this switch. Thus, the register-busy relays associated with switch "A" are designated 318-RBA0 to -RBA9, where the "A" portion of the designation identifies the switch, and where the numerical portion of the designation identifies the register whose busy condition operates the register busy relay associated with the contacts.

The break contacts of each register-busy (RB-) relay extend to a register preference relay in the "B" rectangle (FIG. 314) of the register associated with the register-busy relay. Thus, referring to the "C" rectangle for switch "A," the conductor A0, extending from the break contacts of register-busy relay 318-RBA0, extends to the winding of the register preference relay 314-RPA0 in the "B" equipment rectangle for register 00. Similarly, the conductors associated with the remaining break contacts of the register-busy relays of switch "A" extend to register preference relays within the "B" equipment rectangles for registers 01 through 09, which are not shown in detail.



Also, the winding connections for the remaining register preference relays within the "B" equipment rectangle for register 00 respectively extend to the indicated output conductors of the register-busy preference circuits for switches "G," "H," "J," and "K," as indicated. Also, the winding connections for the register-preference relays within the "B" rectangle for the nineteenth register extend to the register-busy preference chain of the various switches, in the manner indicated on FIGS. 313 and 314.

Switch "A" is connectable to registers 00 through 09, and the register-busy preference circuit controls the order of seizure, so that register 00 is first preferred by switch "A," while register 09 is last preferred. Similarly, the register preference circuit in rectangle "B" for register 00 arranges the various switches so that a bid from switch "G" will have first preference, while a bid from switch "A" has the least preference.

Recalling the previously-described operation of relay 309-TP00, and assuming an otherwise idle condition of the register link, the following path may now be closed to operate relay 314-RPA0 within the "B" equipment rectangle for register 00: ground on terminal 101 of FIG. 313, make contacts 309-TP00, transfer break contacts 318-RBA0, conductor A0 extending to relay 314-RPA0, through the winding of relay 314-RPA0, through the series-connected transfer break contacts of the remaining register preference relays within this rectangle, to a resistance negative battery within register 00.

In the foregoing description it is assumed that register 00 was idle at the time that switch "A" bid for the services of a register. Each register-busy relay operates when its associated register becomes busy, as subsequently described. Thus, if register 00 were busy rather than idle at this time, the ground from terminal 101 on FIG. 313 would have been extended through make contacts 309-TP00, through transfer make contacts 318-RBA0, since register 00 is busy, and out via the transfer break contacts of the first RB-- relay associated with an idle register. Thus, if register 01 were idle at this time, this ground would be extended through transfer break contacts of relay 318-RBA1, and conductor A1, to a register preference relay in the "B" rectangle associated with register 01, whose details are not shown. This arrangement provides that the preference for registers on each switch is varied in order to distribute calls as evenly as practicable among all registers of the frame.

Recalling the circuit actions in the register link, to date, it may be seen that the operation of relay 309-TP00 by trunk 900 closes a ground on FIG. 313 to the register-busy preference chain associated with switch "A," thereby operating the register preference relay associated with the most-preferred idle register which, in its case, is relay 314-RPA0 for register 00.

Each register appears on five switches in the present embodiment and, therefore, it is possible that more than one switch will select the same register simultaneously. Thus, the register preference circuit comprising the relays RP-- within each "B" rectangle on FIG. 314 is provided, and is arranged in a chain, to assign a relative preference to each switch having access to the register. This preference is illustrated in detail for registers 00 and 19.

The RP-- relay chain makes effective only the contacts of its most-preferred operated RP-- relay in the event of simultaneous bids, and prevents the subsequent operation of a less-preferred relay. A call on a switch simultaneously operating a less-preferred RP-- relay in the chain will be momentarily delayed until the selected register operates its RB-- relays for the switch, thereby advancing the preference circuit of the waiting switch to the next choice register.

FIG. 318 discloses the register busy and lockout circuitry. The "D" equipment rectangles on this figure disclose that portion of each register associated with the register busy and lockout function, while the "E" equipment rectangles disclose the register link circuitry as-

sociated with this function. By means subsequently described in connection with a detailed discussion of the register circuit, the register circuit at this time closes its 322-RB contacts shown within the rectangle "D" on FIG. 318, thereby extending battery from terminal 318-103 in series with common resistor MB and branch resistors RB0 through RB4 to the windings of the RB-- relays in the "E" equipment rectangle associated with the register. Thus, for register 00 a resistance battery is now extended to the upper windings of relays 318-RBA0, -RBK0, -RBJ0, -RBH0, and -RBG0. The register at this time also extends ground from terminal 101 of FIG. 326, through transfer make contacts 322-RB, 330-ON1, break contacts 322-DCK, terminal 326-103, and conductor L0, to terminal 318-102 of the "E" equipment rectangle associated with the register 00. Terminal 318-102 constitutes the input of a preference circuit comprising the contacts of the register preference relays associated with register 00, which relays are shown on FIG. 314. This preference network further extends the ground extended to terminal 318-102 through the make contacts of the one operated register preference relay to the winding of the register-busy relay associated with the switch which, on FIG. 313, has been successful in operating the register preference relay of FIG. 314. Thus, for the current call, the ground extended to terminal 102 on FIG. 318 is now further extended, through make contacts 314-RPA0, to the upper winding of relay 318-RBA0, thereby short-circuiting the resistance battery currently applied thereto from terminal 318-103. The remaining RB-- relays in this "E" equipment rectangle now operate, since the resistance battery now applied thereto is not short-circuited by a ground from conductor L0 of the register.

Each RB-- relay in an "E" equipment rectangle is associated with one of the five switches served by the associated register. Thus, referring to the "E" rectangle associated with register 00, the five RB-- relays are associated with switches "A," "J," "K," "H" and "G," respectively as indicated by their designations. The operation of the four RB-- relays associated with the four switches which have not seized the register close their contacts on FIG. 313, so that subsequent calls incoming on these four switches will not attempt to seize register 00.

All RB-- relays on FIG. 318 are provided with a locking path to prevent a releasing register from stealing a call from a less-preferred register by releasing its RB-- relays and switching the RP-- relay operating path. Of course, if all registers available to a switch have operated their RB-- relays, no register selection can be in progress. The circuit is arranged to open the locking path of all RB-- relays associated with the switch upon the occurrence of this condition and to send the call to "overflow."

#### BYLINK HOLDING AND PULSING PATHS

Referring to FIG. 317, the operation of relays 309-TP00 and 314-RPA0, together, close a bylink pulsing path to interconnect terminals 317-101 and 317-102, and, in turn, to connect the circuitry for trunk 900 within the "F" equipment rectangle with the circuitry for register 00 within the "G" equipment rectangle. Register relays 327-ON and 330-L operate at this time, in the manner subsequently described. Also, referring to FIGS. 309 and 312, the operation of trunk preference relay 309-TP00 and register preference relay 314-RPA0 close their series-connected transfer make contacts to interconnect conductors LK and RA from the "H" equipment rectangle of trunk 900 on FIG. 309 to the like designated conductors of the "J" equipment rectangle for register 00 on FIG. 312, thereby operating trunk relay 300-RA when register relays 327-ON and 330-L operate, as subsequently described. The operation of trunk relay 300-RA places relay 309-TP00, and consequently relay 314-RPA0 under control of the register, via the LK lead, to maintain the bylink connection. During this time the register supplies resistance battery to the LK lead, which is extended



through the trunk circuit and reappears on the ST00 lead, whence it is applied to the winding of relay 309-TP00 to hold it operated under control of the register.

Referring to FIG. 300, the operation of trunk relay 300-RA marks the point at which the register is attached and is ready to receive dial pulses. Pulsing is relayed to the register (FIG. 330), via the lead R (FIG. 300), by the relay 299-A in the trunk, by the register link circuit of FIG. 317. Arrival of a pulse prior to the operation of relay 300-RA in the trunk results in the operation of trunk relay 300-OF when relay 299-A releases. Relay 300-OF, operated, will return overflow tone to the customer and will withdraw the "start" signal to the register link, thereby releasing the link and the register.

FIGS. 316 and 317, together, disclose the manner in which the various registers may be interconnected to the trunks to which they have access, via the bylink circuitry, initially, and then subsequently by the closure of the associated crossbar switch crosspoints. The "F" equipment rectangles, respectively representing trunks 900 and 919, are shown as having access to switch "A" on FIG. 317, while switch "G" on FIG. 316 is similarly shown as associated with another 20 trunks. The "G" rectangle for register circuit 00 on FIG. 317 is shown as having access to switch "A" via its 314-RPA0 contacts, and to switch "G" via its 314-RPG0 contacts. Also, the "G" rectangle for register circuit 09 on FIG. 316 is shown as having access to switch "A" via its -RPA9 contacts.

#### SELECT AND HOLD MAGNET OPERATION AND CROSS-POINT HOLDING AND PULSING PATHS

The select magnet operating circuit is shown on FIG. 319, where the "L" equipment rectangles respectively represent the circuitry of the various registers pertaining to the operation of the select magnets; while each "K" rectangle respectively contains the select magnets of the five switches to which its corresponding register has access. Referring to the "K" rectangle associated with register 00, it contains select magnets on switches "A," "K," "J," "H," and "G," as indicated by the select magnet designations. The numerical portion of each such designation indicates the level of the crossbar switch served by the select magnet. Relay 314-RPA0 is operated for the present call, and, therefore, an obvious circuit is extended to supply resistance battery from register 00, which is extended through transfer make contacts of relay 314-RPA0 to the winding of select magnet "0" (i.e., 319-SMA0) of switch "A" to operate it.

The circuitry associated with the operation of the hold magnets is shown on FIG. 321. The "P" equipment rectangles respectively represent the trunk circuitry associated with this function; the "Q" rectangles respectively represent the register link circuitry associated with this function; and the "R" equipment rectangles respectively represent the register circuitry pertaining to this function. Of the five switches having access to register 00, only switches "A" and "G" are shown, and the circuit details of switch "A" only are shown. Also, only hold magnet "0" associated with the first vertical (V0) of switch "A" and hold magnet 19 associated with the last vertical (V19) of switch "A" are shown. Remembering that the trunk appearances are on the verticals, and that, therefore, each hold magnet is individually associated with a particular trunk, a trunk hold magnet is operated through the transfer make contacts of its 309-TP-- relay and the contacts of the selected off-normal springs, to ground in the register, via lead OH. Thus, for the present call, hold magnet 321-HM0 for trunk 900 is operated from the negative battery supplied within trunk 900, through make contacts 300-RA of the trunk, via conductor "B," through the winding of hold magnet 321-HM0, transfer make contacts 309-TP00, make contacts of select magnet 319-SMA0, over conductor OH, to ground within register 00. The previously-described operation of select magnet 319-SMA0 and hold magnet 321-HM0 on FIG. 321 closes

the crosspoints defined by level "0" and vertical "0" of the "A" switch, thereby extending the ground from conductor OH in the register, through the crosspoints, and back to the register on conductor S. The closure of these crosspoints completes interconnection paths between trunk 900 and register 00 for conductors H and R on FIG. 317, conductors SR, SA, and PC on FIG. 320, as well as between the B lead of the trunk and the S lead of the register on FIG. 321.

The circuitry of FIG. 320 of the register link now transmits the trunk connector number of calling trunk 900 to the register. This trunk connector number is indicated by a combination of positive and/or negative potentials cross-connected to contacts of the 309-TP-- relays, and is transmitted to the register via conductors SR, SA and PC. This circuitry is described subsequently in further detail in connection with the description of the register circuit.

Referring to FIG. 321, the hold magnet operating ground is extended through the crosspoints to lead S, extending to FIG. 326, and thence to FIG. 322, to operate register relay 322-HD which, in operating, at its break contacts (FIG. 321) opens the select and hold magnet operating paths and, at its transfer make contacts (FIG. 322), locks the hold magnet via lead S to ground through the lower winding of register relay 322-DCK, thereby starting a double-connection test, as subsequently described. If the double-connection test is satisfactory, register relay 322-DCK operates and, at its make contacts (FIG. 322), applies a solid ground to conductor S, and, at its break contacts (FIG. 326), opens lead L0 on FIG. 318, thereby permitting the shunted register busy relay, namely, 318-RBA0, to operate. Relay 318-RBA0, in operating, releases preference relay 314-RPA0, which, in turn, releases relay 309-TP00, thereby making the bylink available for another call.

FIGS. 309 and 315, together, disclose the circuitry by means of which class mark information pertaining to a calling trunk is transmitted to the register serving the call. The right-hand side of FIG. 309 contains two class relays, 309-C1A and 309-C2A. Each of these relays is selectively cross-connected to make contacts of the various 309-TP-- relays associated with the same switch. FIG. 309, for switch "A," shows make contacts of relay 309-TP00 connected to the winding of relay 309-C2A, while the make contacts of relay 309-TP19 are connected to the winding of relay 309-C1A. The make contacts of the other 309-TP-- relays on the same switch may be cross-connected to either relay 309-C1A or 309-C2A in whatever manner may be desired, depending upon the traffic requirements applicable to the trunks. The "A" rectangles for the remaining switches each include a -C1- and a -C2- relay individual to each "A" rectangle, with the windings of each relay being selectively cross-connected to the make contacts of the -TP-- relays associated with the other switches.

With the foregoing arrangement, the trunk that is successful in seizing the switch, as manifested by the operation of its associated -TP-- relay, also closes a circuit from ground, over the make contacts of its associated -TP-- relay, to operate the class relay representing the class of service associated with the trunk. Thus, for the present call, the seizure of switch "A" by trunk 900 operates its 309-TP00 relay which, in turn, extends a ground from terminal 309-102, through its transfer make contacts, to the winding of class relay 309-C2A to operate it.

Each "N" rectangle on FIG. 315 discloses the circuitry individual to a register by means of which the register receives class information; each "M" rectangle of FIG. 315 is individually associated with a register and contains a preference circuit comprising the contacts of the register preference relays associated with the register, and, additionally, contains make contacts of the class relays associated with the switches served by the register. The contacts of the register preference relays serve to extend ground from terminal 315-101 to one of terminals 315-



102 through 315-106, depending upon the register preference relay currently operated. This ground is then further extended through the make contacts of the operated class relay and transmitted to the register over either lead ONB or ONA, depending upon which class relay is operated. Thus, for the present call, the ground on terminal 315-101 is extended through transfer make contacts 314-RPA0 (since register 00 is currently serving switch "A"), make contacts 309-C2A (since class relay C-2 of the "A" switch is currently operated), over conductor ONA, and transfer make contacts 322-HD, to operate relay 327-CLA in the register.

The aforementioned class information (generation, and transmitting) circuit provides an efficient and expedient method of transmitting class information from a bidding circuit to a serving circuit. Although, in the present embodiment, only two class relays are associated with each switch, it may be appreciated that as many class relays as desired, up to and including 20, could be provided, so that each trunk, when successful in seizing a switch, could operate its class relay, which class relay would then, by means of make contacts on FIG. 315, in conjunction with the preference relay contacts associated with the register, extend the desired class information to the register.

#### *General description of register*

The following describes the functions of the register in connection with the serving of a DP call. The register circuit stores the called station digits on a DP call; bids for the services of a data transfer circuit after the called number registration is completed; controls the establishment of an interconnection, via the data transfer circuit, between itself and the sender serving the call; and, finally, transmits the called station information to the sender, via the data transfer circuit, and releases both itself and the data transfer circuit from the connection.

Pulsing may begin after a bylink path is established between the DP trunk and the register, via the register link, as hereinbefore described. After checks have been made in the register that the bylink pulsing path is properly connected, the register link crosspoints are closed, as hereinabove described, and after a check for a double connection, the control relays of the link are dismissed. Other trunks served by this link switch can then be connected to registers which are not busy. The register makes itself busy to all other switches immediately upon seizure from one switch.

Make contacts of the trunk-preference relays in the register link are cross-connected to sources of positive and negative battery to correspond to the trunk connector number of the calling DP trunk. This trunk connector number is required by the data transfer circuit to provide a channel match, so that the sender may be connected to the same data transfer circuit channel as is the register after it has seized the data transfer circuit. The trunk connector number is passed to the register in a 2-out-of-6 code over three leads, upon the closure of the link hold magnet. The subsequent release of the trunk-preference relays disconnects the trunk connector number battery source and connects the leads back into the trunk for a subsequent use.

The incoming trunk repeats the pulses received from the originating office. These repeated pulses, in turn, are passed to the register as ground pulses over a single lead, and a relay in the register follows the pulsing relay in the trunk. The pulses are counted by a five-relay counting circuit. The end of each digit is recognized by the release of a slow-release relay which operates at the beginning of each digit and holds up between pulses. The release of this relay, except for the tenth digit, causes the count registered on the counting relays to be transferred into a digit register, on a 2-out-of-5 basis, where the digit is stored for the rest of the register holding time.

The counting relays are locked into their final position to register the tenth digit.

Once a registration is completed, the register requests the trunk to seize a sender by sending a signal to the sender link through the register link and the trunk. When a sender is finally attached, it returns a signal which causes the register to start for a data transfer circuit connection. The register competes with other registers in its register connector group for operation of its data transfer primary cut-in relay. Once it succeeds in operating its primary cut-in relay, this primary cut-in relay competes with other primary cut-in relays for the control of a data channel. After it succeeds in obtaining a connection to a data channel, the trunk connector number is transmitted to the relays associated with this channel. Once the register has control of the data channel, the data transfer circuit returns a signal to the sender through the register, the register link, the trunk, and the sender link, to operate the primary cut-in relays of the sender. The sender, too, has by this time received the trunk group number from the trunk. The sender forwards this number to the channel matching circuit of the data transfer circuit, which, in turn, closes the sender's secondary cut-in relay, to interconnect the sender with the particular channel to which the register is finally connected.

On the closure of the sender's secondary cut-in relay, the called number is transmitted to the data transfer circuit and to the sender in 2-out-of-5 code form. Signals are also transmitted to the data transfer circuit, indicating the number of digits sent, so that the 2-out-of-5 code check may be made on the proper number of digits. When the called number digits have been received correctly by the sender, the data transfer circuit is advised of this and, in turn, signals the register to release.

The release of the register may be initiated from the data transfer circuit, from the incoming trunk, or from the register itself. In normal operation, the register releases following receipt of a signal from the data transfer circuit that the digits have been passed successfully to the sender. The incoming trunk circuit may initiate a register release under three conditions first, if a dial pulse is received before a register has signaled its readiness to receive it; second, if a customer abandons a call; or third, if advised by the originating office that the call has been misrouted.

The sender may initiate its own release if it recognizes a trouble, or if for some other reason it cannot complete its function. Overflow tone is returned to the subscriber in all of these cases.

#### *Detailed description of register operation*

##### REGISTER SEIZURE

FIGS. 324, 328, and 332 disclose the nine individual digit registers, each of which registers, in 2-out-of-5 code form, the "A" through "H," and "J" digits of the called number. The "A" and "B" digit registers are shown in detail on FIG. 324, in rectangles "C" and "F," respectively, while those for the "C" through "H," and "J" digits are shown only diagrammatically in FIGS. 328 and 332. Digit "C" is represented by rectangle "F." The remaining digits are respectively represented by rectangles "C." However, the conductors extending into the rectangles representing these registers are designated in the same manner as are those for the "A" and "B" digits, in order to indicate the relationships between each such conductor and the internal circuitry of the register associated therewith.

Recalling the hereinabove described operation of the register link, the following path is now closed to operate relay 332-J1 to check that lead L0 is connected to the low-resistance winding of a register-busy relay in the register link: battery on terminal 101 of FIG. 332 (associated with the "J" digit register) to one side of the winding of relay J1 within this register ("J" digit "C" rectangle), terminal J1 connected to the other side of the wind-



ing of relay J1, conductor JC extending from FIG. 332 to FIG. 326, transfer break contacts 332-RB, make contacts 330-ON1, break contacts 322-DCK, conductor L0 extending from FIG. 326 of the register to the "D" rectangle for register 00 on FIG. 318 of the link, conductor L0 extending from the "D" rectangle to the "E" rectangle, terminal 318-102, transfer make contacts 314-RAP0, and through the upper winding of register-busy relay 318-RBA0 to ground. The operation of relay 332-J1 thereby verifies the presence of the low-resistance ground through the winding of relay 318-RBA0 on conductor L0 of the register.

Relay 327-ON is now operated over the following path in order to check the H lead bylink path and to indicate a seizure to the register: negative battery on conductor H of the trunk circuit (FIGS. 300 and 317) is supplied thereto over an obvious circuit including the winding of relay 300-OFF in the trunk, transfer make contacts 309-TP00 on FIG. 317, transfer make contacts 314-RPA0, conductor H extending to FIG. 326 of the register, and thence to the left-hand side of the middle winding of relay 327-ON, through the middle and upper windings of relay 327-ON, resistance ON, transfer break contacts 322-HD, conductor ONA extending from FIG. 326 to FIG. 315 of the link, make contacts 309-C2A, terminal 315-106, transfer make contacts 314-RPA0, to ground on terminal 101 of FIG. 315. The operation of relay 327-ON closes an obvious circuit on FIG. 330 to operate relay 330-ON1. The following circuit is now completed to operate relay 332-J2: battery on terminal 101 of FIG. 332, the winding of relay J2 within the "J" digit register, terminal J2 of the "J" register "C" rectangle, transfer break contacts 332-ON2, conductor ON extending from FIG. 332 to FIG. 327, terminal 101 on FIG. 327, transfer break contacts of relay 322-HD, conductor ONA extending to FIG. 315 of the register link, makes contacts 309-C2A, terminal 315-106, and transfer make contacts 314-RPA0, to terminal 315-101.

Relay 330-L is now operated over the following circuit to check the validity of the bylink pulsing path: ground on terminal 101 of FIG. 330, through the secondary winding of relay 330-L, conductor R extending from FIG. 330, and as shown in the "G" equipment rectangle for register 00 on FIG. 317, transfer make contacts 314-RPA0 and 309-TP00, over conductor R, as shown in the "F" equipment rectangle for trunk 900, to FIG. 300 of the trunk circuit, conductor R on FIG. 300, resistance P, transfer break contacts 304-T, make contacts 299-A, battery on terminal 300-101.

The hereinbefore-described ground extended to conductor ON on FIG. 332 is further extended through transfer break contacts 322-ON2, terminal J2 of the "J" register, through the locking make contacts of relays J2 and J1, out on terminal J1 of the "J" register, conductor JC extending from FIG. 332 to FIG. 326, transfer break contacts of relay 322-RB, make contacts 326-ON1, break contacts 322-DCK, conductor L0 extending from FIG. 326 to the equipment rectangle "D" for register 00 on FIG. 318, terminal 102 in the "E" equipment rectangle, transfer make contacts 314-RPA0, to the right-hand winding terminal of relay 318-RBA0, thereby grounding it and preventing relay 318-RBA0 from operating, in the manner hereinbefore described in connection with the link circuit.

The following circuit is now closed to operate relay 322-RB: ground on terminal 101 of FIG. 322, transfer break contacts 322-HD, series-connected make contacts 332-J2 and -J1, transfer break contacts 322-ON2, to the winding of relay 322-RB to operate it. The operation of relay 322-RB closes its make contacts, shown within the "D" equipment rectangle for register 00 on FIG. 318, to extend battery from terminal 318-103, through the common resistor MB, and through individual resistors RB1 through RB4, respectively, to operate relays 318-RBK0, -RBJ0, -RBH0, and -RBG0 within the "E" equivalent rec-

tangle associated with register 00. This operation was described in detail in connection with the description of the link circuit.

The operation of relays 327-ON and 330-L, together, close the following circuit to operate relay 332-J0: ground on terminal 102 of FIG. 330, make contacts 327-ON, transfer break contacts 322-ON2, make contacts 330-L, terminal 105 of FIG. 330, terminal 101 of FIG. 331, break contacts 322-HD, conductor JD, terminal J0 of the "J" register, to the winding of relay J0 therein to operate it. The following circuit is also closed at this time to operate relay 300-RA in the trunk: ground on terminal 330-102, make contacts 327-ON, transfer break contacts 322-ON2, make contacts 330-L, conductor RA extending to the "J" equipment rectangle on FIG. 312, conductor RA00, transfer make contacts 314-RPA0, conductor RA-1 to FIG. 309, transfer make contacts 309-TP00 on FIG. 309, conductor RA00 extending from the "H" rectangle for trunk 900 on FIG. 309 to FIG. 300 of the trunk circuit, the winding of relay 300-RA, transfer break contacts 300-RA, break contacts 300-OFF, conductor LK00 extending through rectangle "H" back to FIG. 309 of the register link, back over a path corresponding to that for conductor RA, extending through the trunk-preference relays and the register-preference relays, to conductor LK00 within the "J" equipment rectangle for register 00 on FIG. 312, break contacts 322-DCK, to resistance battery on FIG. 327.

The above-described operation of relay 332-J0 closes its make contacts, in the "C" equipment rectangle for register 00 on FIG. 332, to extend ground over conductor JD to FIG. 331, and over conductor RA from FIG. 330 to the "J" rectangle in FIG. 12, to maintain relay 300-RA operated in the trunk, even if an early pulse causes the release of relay 330-L. Relay 300-RA, in operating, closes a locking path for itself over its own make contacts, make contacts 300-B, and break contacts 303-D, to battery on terminal 300-106. The operation of trunk relay 300-RA opens its transfer break contacts and closes its transfer make contacts common to terminal 107 on FIG. 300, so that the battery formerly supplied to terminal 107 from terminal 300-101 is now supplied by conductor LK00 extending to FIG. 309, which conductor receives its battery for the present call from terminal 102 of the "J" equipment rectangle for register 00 on FIG. 312. Conductor ST00 extending from FIG. 300 to FIG. 309, is connected to one side of the winding of relay 309-TP00, and, therefore, the operation of relay 300-RA places the trunk preference relay 309-TP00 under control of the battery originating on conductor LK00 in register 00.

Relays 332-J0, -J1, and -J2 are later released by the operation of the 334-AS steering relay, so that they may be used for the ninth digit registration.

#### OPERATION OF CROSSPOINTS

Referring to FIG. 322, the operation of register relays 332-J0 and -J2, and of relays 322-RB and 330-ON1, together, prepare the following path to operate relay 322-ON2: ground on terminal 101 of FIG. 322, transfer break contacts 322-HD, make contacts 332-J2, 332-J0, 322-RB, transfer break contacts 322-HD, make contacts 330-ON1, to the winding of relay 322-ON2 to operate it. Referring to FIG. 321, the operation of relay 322-ON2 closes the following previously described path to operate hold magnet 321-HM0: ground on terminal 101 within the "R" rectangle for register 00, make contacts 322-ON2 and break contacts 322-HD, conductor OH, select magnet make contacts 319-SMA0, transfer make contacts 309-TP00, to the winding of hold magnet 321-HM0 to operate it from the battery supplied over the B conductor from the trunk, by the make contacts of relay 300-RA, as shown within the "P" equipment rectangle for trunk 900 on FIG. 321. The operation of the hold magnet 321-HM0 establishes the crosspoint path for conductors H, R (FIG.



317), SR, SA, and PC (FIG. 320), as hereinbefore described in connection with the register link. The operation of hold magnet 321-HM0 also closes its crosspoint, shown on FIG. 321, to interconnect the right-hand side of its winding to conductor S extending to FIG. 326 of the register, as indicated in the "R" rectangle for register 00. The link at this time thereby grounds conductor S, via the closed crosspoints, from the same operating ground that operated hold magnet 321-HM0. This ground, extended to conductor S on FIG. 326, completes the following circuit to operate relay 322-HD: conductor S, extending from FIGS. 326 to 322, make contacts 322-ON2, 330-ON1, to the winding of relay 322-HD to operate it. The operation of relay 322-HD closes the following circuit to provide a holding path for itself, as well as to maintain a low-resistance ground on conductor S: ground on terminal 102 of FIG. 322, make contacts 322-ON2, transfer make contacts 322-HD, terminal 322-103, the low-resistance lower winding of relay 322-DCK, make contacts 330-ON1, terminal 322-104, make contacts 330-ON1 to the winding of relay 322-HD. The ground extended to terminal 322-104 is further extended through make contacts 322-ON2 to conductor S leading to FIG. 321. This ground extended through the low-resistance winding of relay 322-DCK holds both relay 322-HD and the hold magnet 321-HM0 operated.

Referring to FIG. 321, the operation of relay 322-HD also opens an obvious circuit, shown within the "R" equipment rectangle for register 00 on FIG. 321, to open the operating circuit for hold magnet 321-HM0. Referring to FIG. 319, the operation of relay 322-HD also opens an obvious circuit, shown within the "L" rectangle for register 00 on FIG. 319, to release the operated select magnet 319-SMA0. Referring to FIG. 322, relay 322-DCK, operated by virtue of the current through its lower winding, closes a circuit from ground extended to terminal 322-103 through its own make contacts to its upper winding as a holding circuit for itself, and short circuits its lower winding from ground extended to terminal 322-103, through its own make contacts, to terminal 322-106, through another set of its make contacts and make contacts of relay 330-ON1, to terminal 322-105, which terminal is electrically connected to the right-hand side of its lower winding at this time.

DOUBLE CONNECTION CHECK

The operation of relay 322-DCK checks that no double connection exists at a crosspoint. If there had been such a double connection, a ground on the S lead from the other register circuit would have been connected to the hold magnet 321-HM0 and to the S lead of register 00, so that the lower winding of relay 322-DCK would have been short-circuited after relay 322-HD operated, and relay 322-DCK would not have operated. The operation of relay 322-DCK opens its break contacts on FIG. 326 to isolate the ground on terminal 326-101 from terminal 326-103, thereby removing ground from conductor L0 extending to FIG. 318 of the link circuit. The removal of ground from conductor L0 removes the shunting ground from the right-hand side of the upper winding of relay 318-RBA0, to permit the operation of relay 318-RBA0, thereby making register 00 unavailable to any subsequently bidding trunk served by switch A.

TRUNK CONNECTOR NUMBER REGISTRATION

The register link is arranged so that a trunk connector number may be assigned to each trunk by making appropriate cross connections on FIG. 320. The special service trunks in the tandem office of the disclosed embodiment of the invention are divided into ten groups, each of which groups is individual to one of the trunk connectors of the data transfer circuit, as shown on FIGS. 2B and 2D, and 3B and 3H. Only three trunk connector number data leads are available through the register link to transmit this information to the register, and, therefore, combinations of positive or negative signals are

transmitted over the SR, SA and PC leads to the register, with only two of the three leads being energized for any single trunk connector number.

The three leads SR, SA, and PC in the "U" rectangle for register 00 on FIG. 320 extend to FIG. 333 of the register. It may be seen from a study of the circuit on FIG. 333 that the relays 330-0, -1, -2, -4, -7, and -X are connected to these three leads in pairs through diodes, and the connections are so arranged that relays 330-0, -2, and -7 respond only to positive battery, and so that relays 333-1, -4, -X, and -XA respond only to negative battery. The numerical coding of the trunk group number used is the same as the standard 2-out-of-5 code, except for the following: 1=0+X, and 6=2+X. This difference occurs because it is impossible to operate two relays simultaneously fed by the same lead from the link, such as for example, relays 333-0 and -1. Also, two possible cross-connections in the register link are not used: (1) a negative signal on the SR lead and a negative signal on the PC lead for a 333-1+333-X relay combination, and (2) a negative signal on the SA lead and a negative signal on the PC lead for a 333-4+333-X relay combination. Relay 333-XA is an auxiliary to relay 333-X and is operated in parallel therewith. A summary of the coding of the trunk group number register is shown in the table below:

| Number sent to Data Transfer CKT | Lead from Reg LK CKT | Signal | Relays Operated | Leads Grounded to Data Transfer CKT |
|----------------------------------|----------------------|--------|-----------------|-------------------------------------|
| 0.....                           | SA<br>PC             | -<br>+ | 4<br>7          | 4, 7                                |
| 1.....                           | SR<br>PC             | +<br>- | 0<br>X, XA      | 0, 1                                |
| 2.....                           | SR<br>SA             | +<br>+ | 0<br>2          | 0, 2                                |
| 3.....                           | SR<br>SA             | -<br>+ | 1<br>2          | 1, 2                                |
| 4.....                           | SR<br>SA             | +<br>- | 0<br>4          | 0, 4                                |
| 5.....                           | SR<br>SA             | -<br>+ | 1<br>4          | 1, 4                                |
| 6.....                           | SA<br>PC             | +<br>- | 4<br>2          | 2, 4                                |
| 7.....                           | SR<br>PC             | +<br>+ | 0<br>7          | 0, 7                                |
| 8.....                           | SR<br>PC             | -<br>+ | 1<br>7          | 1, 7                                |
| 9.....                           | SA<br>PC             | +<br>+ | 2<br>7          | 2, 7                                |

Relay XA is an auxiliary X relay and is operated in parallel with it.

Referring to FIG. 320, the hereinbefore described operation of relay 309-TP00 in the link opens its transfer break contacts and closes its transfer make contacts to disassociate the SR, SA and PC lead of trunk 900 in rectangle "S" from the circuitry of FIG. 320, in order to prevent any false operations. The closure of the crossbar switch crosspoints closes the SR, SA and PC leads of the crossbar switch to the rectangle "U" of the register 00 on FIG. 333. Vertical 0 of switch A applies positive battery to conductors SA and PC and no potential to conductor SR. This combination of potentials, extends to FIG. 333, causes relays 333-2 and 333-7 to operate, thereby entering a trunk connector number of "9" (from trunk 900) in a register.

Relays 333-2 and -7, in operating close holding paths for themselves to a battery of the same polarity as that of the operating signal. With the aid of the work contacts of the 333-X and 333-XA relays, the trunk connector number currently registered in 2-out-of-6 code form is subsequently translated into a 2-out-of-5 code form for later transmission to the data transfer circuit.

DISMISSAL OF THE LINK CONTROL RELAYS

Referring to FIG. 312, the previously described operation of relay 322-DCK opens its break contacts within the "J" equipment rectangle for register 00 to remove the resistance battery from conductor LK00, thereby releas-



ing relay 309-TP00. The release of relay 309-TP00, in turn, releases relay 314-RPA0. The register link is now free to serve other trunks desiring service on the same link switch.

## REGISTER TIMING

The register timing circuits are shown on FIGS. 335 and 337. Referring now to the timing circuit of FIG. 337, it might be said to constitute two separate subtiming circuits, with one subtiming circuit timing the interdigital intervals before registration, the interval after registration required for sender attachment, the interval required for data circuit operation, and the interval required for register release. The second subtiming circuit guards the recycling time of the first subtiming circuit and times the interval required for the pulses comprising any digit to be received. The first subtiming circuit comprises capacitor TM2, together with resistors TM2A and TM2B. These resistors provide a path to charge capacitor TM2 from the positive 130-volt battery. Resistor TM2C also constitutes a portion of the first subtimer, as do the contact networks interconnecting resistor TM2C with the other two resistors, as well as capacitor TM2. This contact network is selectively operable so as to vary the resistance in series with capacitor TM2 and the 130-volt battery, and thereby, in turn, vary the time required for the capacitor TM2 to charge up to the level required to fire tube TM. The second subtimer comprises resistor TM1 and capacitor TM1 in series.

The operation of the timer on FIG. 337 starts with the operation of relay 322-DCK. The release of relay 331-RA1 at the beginning of impulsing of the first digit, through transfer break contacts 331-RA1, discharges capacitor TM2, if charged, and starts the timing of the interval required for the reception of the pulses comprising a digit by charging capacitor TM1. The interdigital timing is started again at the end of impulsing of a digit, and is recycled as each succeeding digit is received. The operation of relay 336-RC, at the end of impulsing of the last digit, decreases the interdigital timing interval by a range of seven to twelve seconds by closing its make contacts on FIG. 337, thereby short-circuiting resistor TM2A and decreasing the resistance of the charging path for capacitor TM2.

Relay 327-CLA will be operated for class "A" calls and will be released for class "B" calls. Its timing contacts on FIG. 337 also control the charging time of capacitor TM2. If relay 327-CLA is operated, thereby closing its transfer make contacts, the charging path of capacitor TM2 includes resistor TM2C, whose resistance value is less than that of resistors TM2A and TM2B in series. On the other hand, if relay 327-CLA is released, the charging path of the capacitor is through transfer break contacts 327-CLA and resistors TM2A and TM2B in series, thereby providing a higher resistance in the charging path of capacitor TM2.

Relay 337-TM on FIG. 337 operates whenever tube TM fires. The operation of relay 337-TM, in turn, operates relay 336-RC. The operation of relays 336-RC and 337-TM, together, discharges capacitor TM2, and also releases relay 337-TM. Relay 336-RC, operated, and relay 337-TM, released, cause the operation of relay 334-TM1, thereby permitting the TM2 capacitor to charge again, this time through the TM2B resistor. The operation of relay 336-RC forwards the call to a sender as described.

The operation of relay 337-TM, in connection with the measurement of an interdigital interval, operates relay 336-RC which, in turn, as is subsequently described, causes the trunk to bid for connection to a sender. The operation of relay 337-TM, as a consequence of measuring any other time interval, operates relay 327-TRL which, in turn, reduces the resistance of the H conductor going back, via FIG. 317, to the trunk, to operate relay 300-OFF in the trunk, which operation clears the trunk

out, releases the register, and returns an "overflow" signal to the subscriber.

## LINK ALARM TIMING

Referring to FIG. 335, link alarm timing starts with the opening of the LT lead (extending from FIG. 335, via FIG. 330, to FIG. 319A), by an associated 314-RP-- relay in the register link, and ends when all associated 318-RB-- relays are operated at the end of the link-connecting function. The completion of the link-connecting function within the allotted time recloses ground on the LT lead, which ground discharges the LA capacitor on FIG. 335.

When ground is removed from the LT lead at the start of the connector function, the LA capacitor charges up during the predetermined time, i.e., from 150 to 300 milliseconds, thereby firing the LA tube to operate relay 335-LA. The 335-LA relay locks through resistor LA3, thereby placing a shunt around the tube LA to extinguish it. The 335-LA relay also operates the 327-TRL relay, to initiate a trouble release, and the 327-TRL relay, operated, further opens the LT lead. Relays 335-LA and 327-TRL remain operated when the cancel timing key is closed.

The reconnection of ground to the LT lead, when the 314-RP-- and the 318-RB-- relay chain circuit is restored and the 327-TRL relay is released, shunts down the 335-LA relay. The 130-volt positive battery is protected by the resistor LA5 until the 327-LA relay opens the shunting ground. The self-restoring feature of the timer is provided to permit maintenance operations on the link relays 314-RP-- and 318-RB-- without inadvertently leaving the link alarm off-normal.

The operation of the 327-TRL relay as a result of a function time-out also opens the LT lead to start the LA timer for timing the trouble release. A successful trouble release will release the 327-TRL relay to halt the timer. If it times out, the 327-TRL relay, operated, will keep relay 335-LA operated until the register is released.

## PULSE COUNTING AND REGISTRATION

Referring to FIG. 300, the pulsing received from the originating station is repeated by the 299-A relay of the trunk, over the R lead (extending from FIG. 300 of the trunk, through FIG. 317 of the register link), to the R lead on FIG. 330 of the register, where the circuit terminates on terminal 330-103 and the secondary winding of relay 330-L. The 330-L relay is a magnetically biased and polarized relay with four windings. The secondary (S) winding, as above described, is connected via the R lead of the register link to the trunk and controls the pulsing of the called number. The tertiary (T) winding is used as a pulse-help winding and is wired in series with the pulse-help capacitor PH, and transfer make contacts 322-ON2, to the terminal 330-104, which terminal represents one-half of a set of make contacts on the 330-L relay. Terminal 330-104 is also connected, via transfer make contacts of relay 322-ON2, to resistor L1. When relay 330-L operates and closes ground to terminal 330-104, which ground is supplied thereto over a circuit beginning on terminal 330-106, the PH capacitor charges through the tertiary winding, and the current flow is in a direction to hold the relay 330-L operated. This current is reduced to zero as the capacitor PH charges, and the secondary winding finally resumes control. The subsequent release of relay 330-L, upon the termination of a pulse, removes ground from terminal 330-104. The PH capacitor then discharges through the L2 resistor, and the current flow in the 330-L relay tertiary winding is in a direction to hold relay 330-L released. This pulse-help feature thus acts to ensure that, once the 330-L relay operates, it will remain operated for a definite minimum interval, and that, once it is released, it will remain released for a definite minimum interval.



The Q winding of relay 330-L is used for slightly altering the sensitivity of the 330-L relay as it operates and releases. This Q winding is also connected to terminal 330-104 and is so poled that its ampere turns exceed those of the secondary winding when the relay 330-L is operated. This has the effect of making relay 330-L, once it has operated, slightly "stiffer" or easier to release, and when it releases, slightly "weaker" or easier to operate. The value of the L1 resistor is chosen to give the maximum benefit from this winding. The pulse-help feature is unused until the operation of relay 322-ON2. This is to permit the half of the 330-L relay make contacts attached to terminal 330-104 to be used for the early check of lead R.

The dial pulse counting circuit counts the number of pulses in each digit and, when the dialing of the digit is completed, transfers its count to the appropriate digit register. It then recycles to make itself ready for the reception of the next digit. The last digit is locked in the counting relays to save one digit register. Relays 331-RA and -RA1 recognize the start and the completion of pulse trains for each digit and control the digit registration and the progress of the digit insteering circuit, as subsequently described.

#### PULSE COUNTING

The pulses of each digit, as indicated by the release and the reoperation of relay 330-L, are counted on relays 330-P1, 330-P2, 331-P3, 331-P4, and 331-P5, as shown on FIGS. 330 and 331. The 330-P1 and 330-P2 relays are wired as a pulse divider, and the contacts on these relays control relays 331-P3, -4, and -5. These latter three relays lock as required, under control of relays 331-RA and -RA1, to ground extended through make contacts of relay 322-ON2 from terminal 330-106 of FIG. 330. A distinct combination of these five relays remains operated at the end of each digit. The sequence of operation for the reception of specific digits is subsequently described.

If, due to a trouble condition, the counting circuit counts more than ten pulses, only lead 0 is grounded, and this will later be detected as a "trouble" by the 2-out-of-5 check circuit in the data transfer circuit.

#### REGISTER ADVANCE RELAYS

Referring to FIG. 331, relay 331-RA is a fast-operate slow-release relay which operates during the first pulse of each digit, remains operated during pulsing, and then releases during the interdigital interval. This relay has two windings; the primary winding is used to energize the relay under the control of the 330-L relay, and the secondary winding is used to delay the release of the relay when the primary winding is de-energized. Relay 331-RA operates at the start of the pulse train for each digit to provide a locking circuit for the relays 330-P1 and 330-P2 on FIG. 330 and relays 331-P3, 331-P4, and 331-P5 on FIG. 331, and releases at the end of the digit pulse train to transfer the register count from the counting relays to the digit register. Relay 331-RA1 operates whenever relay 331-RA is normal between digits and releases when relay 331-RA is operated during the reception of the pulses for a digit. Relay 331-RA1 aids in holding the counting relays and in transferring the digits to the digit registers, and controls the insteering advance.

#### DIGIT STEERING

Referring now to FIGS. 334 and 336, the steering relays are designated 334-AS through 334-ES, 336-FS through 336-HS, 336-JS, 336-KS, and 336-RC. The contacts on the steering relays -AS to -JS, inclusive, steer the digit registration temporarily stored in the contacts of the counting relays to the proper digit register. The K, or tenth digit, remains locked in the counting relays.

Relay 334-AS operates after the first pulse is received when counting relay 330-P2 operates. This guarantees that relay 331-RA1 will have time to operate and thus prevent false registration in the "A" digit register.

During the first digit, after relay 330-P2 has operated, relay 334-AS operates and then holds through its own transfer make contacts, and through the 334-BS transfer break contacts, to ground on terminal 101 of FIG. 336, via make contacts of relay 322-ON2. When relay 331-RA1 operates at the end of impulsing of the first digit, relay 334-BS operates through transfer make contacts of relay 334-AS, transfer break contacts of relay 336-RC, make contacts of relay 331-RA1, make contacts 322-ON2, to the previously-described ground on terminal 336-101. The operation of relay 334-BS transfers a holding path for relay 334-AS, thereby putting it under control of the same 331-RA1 make contacts. When relay 331-RA1 releases during the impulsing of the second digit, relay 334-AS releases. Relay 334-BS holds up over a path similar to that described previously for relay 334-AS.

The remaining insteering relays are operated and released in the same manner during the reception of the subsequent digits. The last steering relay, operated, and relay 336-RC, operated, remain locked through make contacts 322-ON2, to ground on terminal 336-101.

If a time-out of the TM timer occurs after any digit, relay 336-RC will operate, via make contacts 337-TM. This will indicate a complete call, regardless of the number of digits dialed. Any subsequent operation of the TM timer will be on a "trouble," and so will cause the operation of relay 327-TRL.

#### DIGIT REGISTRATION

The digit registers are shown on FIGS. 324, 328 and 332. Each register comprises five relays having two contacts each. One of the contacts is used for locking purposes and is shown immediately adjacent to its associated relay winding, while the other contacts are used for data read out purposes to the data transfer circuit and are shown on FIGS. 325 and 329.

Relay 331-RA operates and relay 331-RA1 releases at the receipt of the first pulse of the first digit. Relay 331-RA operates from the ground on terminal 106 of FIG. 330 at this time. When the last pulse of the first digit is received, the number of pulses in the first digit are registered on contacts of the counting relays 331-P1 and 331-P2, and 332-P3 through 332-P5. When relay 331-RA releases, but before relay 331-RA1 operates, paths on FIGS. 323 and 324 are closed to operate two out of the five relays in the "A" digit register through break contacts 331-RA and 331-RA1, a translating network on the counting relays (331-P1, etc.), and transfer make contacts on relay 334-AS. The operation of relay 331-RA1 opens leads 0, 1, 2, 4, and 7 from the translating network to the digit registers and restores the counting relays to normal. The register relays must, therefore, be capable of operating during the minimum operating time of relay 331-RA1. The registration of digits "B" through "H," and "J" proceeds in the same manner as described for the first digit.

The tenth digit is not transferred into a digit register but is locked in the counting relays by make contacts on relay 336-KS, and by break contacts on relay 336-JS. The operation of relay 336-RC at the end of impulsing of the last digit locks the 330-L relay operated, to avoid changing the registration of the last digit.

#### NUMBER OF DIGITS ACCEPTED

The register will accept any number of digits, up to ten. At the end of each digit, except the tenth, the TM timer is recycled and times for a predetermined interval, such as for example, from 17 to 25 seconds. Time-out after any digit will cause relay 337-TM to operate relay 336-RC. The register calls for a sender and proceeds to transfer the digits received. After the receipt of ten digits, relay 336-RC operates independently of the timer circuit and causes the trunk to bid for a sender, as hereinbefore described.



DETAILED DESCRIPTION OF PULSE  
COUNTING CIRCUIT

The following describes the detailed circuit actions of the pulse-counting circuit for the reception of a "0" digit comprising ten pulses, in order to describe the entirety of the circuit. It is to be understood that a "0" would rarely, if ever, be the first digit received at tandem for a normal call; therefore, the circuit actions associated with the reception of a "0" digit are described at this time, and only in order to describe the circuitry of the pulse-counting relays for the reception of all possible digits.

Relay 331-RA1, it will be remembered, operated from ground on terminal 106 of FIG. 330, upon the operation of relay 322-ON2. Trunk relay 299-A releases upon the first opening of the line by the reception of the first pulse of the first digit, and removes ground from conductor R (FIG. 300) extending, via FIG. 317, to FIG. 330, to release register relay 330-L. The release of relay 330-L closes a circuit on FIG. 330 to operate relay 330-P1 from the ground on terminal 330-106. The same ground is extended to FIG. 331, to operate relay 331-RA and to release relay 331-RA1. The end of the first pulse operates trunk relay 299-A, which, in turn, operates register relay 330-L, to operate counting relay 330-P2 from ground on terminal 106 of FIG. 330, over the circuit including terminal 330-107, make contacts 331-RA, and terminal 330-108.

The following circuit is now closed to operate steering relay 334-AS: negative 48-volt battery, through the winding of relay 334-AS, terminal 334-101, transfer break contacts 336-RC, transfer break contacts of the steering relays, terminal 334-102, make contacts 330-P2, transfer break contacts of steering relay 334-BS, terminal 334-103, transfer break contacts of steering relays 334-CS through 336-KS, make contacts 322-ON2, to ground on terminal 101 of FIG. 336. The operation of relay 334-AS opens its break contacts on FIG. 332, to open the locking circuit to release relays 332-J0, -J1, -J2, -J4, and -J7. On FIG. 327, the operation of steering relay 334-AS also opens its transfer break contacts, and closes its transfer make contacts, to disconnect ground on terminal 102 from the winding of relay 327-CLA, causing it to release and to connect ground to operate relay 327-CLB. This causes a shift in the timing of the register timer.

Relay 330-P2, in operating, closes a holding path for itself over its own transfer make contacts, over transfer make contacts 330-P1 and make contacts 331-RA, to terminal 101 on FIG. 331 which, in turn, is connected through make contacts 322-ON2 to ground on terminal 106 of FIG. 330. No further circuit action occurs until the reception of the second pulse. At this time, trunk relay 299-A and register relay 330-L release, as before. The release of relay 330-L removes ground from terminals 107 and 108 of FIG. 330, thereby releasing relay 330-P1. The release of relay 331-P1 closes the following circuit to operate counting relay 331-P3: negative 48-volt battery, through the winding of relay 331-P3, transfer break contacts 331-P4, and 331-P5, terminal 331-101. Relay 330-L reoperates upon the termination of the second pulse and, in turn, releases relay 330-P2.

Relay 330-L releases upon the line opening for the third pulse and, in turn, reoperates relay 330-P1. Relay 330-L reoperates upon the termination of the third pulse and, in turn, closes the previously-described path to operate relay 330-P2 and, additionally, operates relay 331-P4 over the following circuit: negative 48-volt battery, through the winding of relay 331-P4, break contacts 331-P5, make contacts 331-P3, transfer make contacts 330-P1 and 330-P2, and make contacts 331-RA to ground on terminal 331-101.

Relay 330-L releases upon the line opening for the fourth pulse and, in turn, releases relay 330-P1. Relay 330-L reoperates and, in turn, releases relay 330-P2 upon the termination of the fourth pulse. Relay 330-L releases

upon the fifth pulse line opening and, in turn, reoperates relay 330-P1 and releases relay 331-P3. Relay 330-L reoperates upon the termination of the fifth pulse and, in turn, reoperates relay 330-P2. Relay 330-L releases upon the beginning of the sixth pulse and, in turn, releases relay 330-P1. The subsequent reoperation of relay 330-L upon the termination of the sixth pulse, in turn, releases relay 330-P2 and closes the following circuit to operate relay 331-P5: negative 48-volt battery, through the winding of relay 331-P5, make contacts 331-P4, break contacts 331-P3, 330-P1, transfer break contacts 330-P2, make contacts 331-RA, to ground on terminal 331-101. Relay 330-L releases at the beginning of the seventh pulse and, in turn, operates relay 330-P1. Relay 330-L reoperates at the end of the seventh pulse and, in turn, operates relay 330-P2.

Relay 330-L releases at the beginning of the eighth pulse and, in turn, releases relay 330-P1, and, in addition, closes the previously-described path to operate relay 331-P3. Relay 330-L reoperates at the end of the eighth pulse and, in turn, releases relay 330-P2. Relay 330-L releases at the beginning of the ninth pulse, to operate relay 330-P1, and reoperates at the end of the ninth pulse, to operate relay 330-P2 and release relay 331-P4. Relay 330-L releases at the beginning of the tenth pulse and, in turn, releases relay 330-P1. Relay 330-L reoperates at the end of the tenth pulse, to release relays 330-P1 and 330-P2.

Relay 331-RA releases shortly after the termination of pulsing, and relay 331-RA1 reoperates. It should be noted that counting relays 331-P3 and 331-P5 remain operated following the reception of the tenth pulse. The translating contacts of the pulse-counting relays are shown on FIG. 323. These contacts translate and enter into the appropriate digit register the count remaining on the counting relays on the termination of the pulses representing each digit. This occurs after relay 331-RA releases, but before 331-RA1 operates, at the end of each digit. With relays 331-P3 and 331-P5 operated, the circuitry of FIG. 323 operates relays 324-A4 and 324-A7, to enter the digit "0" in 2-out-of-5 code form in the "A" digit register. The circuit to operate relay 324-A7 is as follows: ground on terminal 101 of FIG. 323, make contacts 322-ON2, break contacts 331-RA, transfer make contacts 331-P5, terminal 332-102, make contacts 331-P3, terminal 323-103, terminal 323-104, break contacts 331-RA1, conductor 7, and transfer make contacts of steering relay 334-AS, to the winding of register relay 324-A7 to operate it. The circuit for relay 324-A4 is as follows: ground on terminal 101 of FIG. 323, make contacts 322-ON2, break contacts 331-RA, transfer break contacts 330-P2, terminal 323-105, transfer break contacts 331-P4, terminal 323-106, transfer make contacts 331-P5, terminal 323-107, transfer make contacts 331-P3, terminal 323-108, break contacts 331-RA1, conductor 4, transfer make contacts 334-AS, to the winding of register relay 324-A4 to operate it. Both register relays, in operating, close holding paths for themselves to the ground supplied by the make contacts of relay 330-ON1 connected to terminal 101 on FIG. 328.

The subsequent operation of relay 331-RA1 releases all the pulse-counting relays and operates steering relay 334-BS. The operation of steering relay 334-BS transfers the holding path for relay 334-AS, thereby putting the 334-AS relay under control of the 331-RA1 relay make contacts. When relay 331-RA1 releases during the impulsing of the second digit, relay 334-AS releases, thereby disassociating the contact network of FIG. 323 from the "A" digit registers and associating it with the "B" digit registers.

Let it be assumed, for example, that the called number on the present call is 212-243-1000. This being the case, these digits are successively stored in the "A" through "H," and "J" registers, and in the counting relays themselves, in the manner similar to that hereinabove described



for the reception of the digit of "0" and for its entry into the "A" digit register.

The release of relay 331-RA1 at the termination of the registration of the tenth digit operates relay 336-RC, over a circuit analogous to that of the steering relays 334-AS 5 through 336-KS.

#### *Sender request and seizure*

Referring to FIG. 330, the operation of relay 336-RC, as a consequence of the registration of the tenth digit, applies battery, through resistor L3, to terminal 330-103, to lock relay 330-L operated so as to prevent the receipt of further pulses and a possible change in the number registered. Relay 336-RC, operated, also disconnects the trunk connector number registers on FIG. 333 (relays 333-0, -1, -2, -4, -7, -X) from the SR, SA and PC conductors in order to prevent possible false operations. Relay 336-RC, operated, also causes the interval of the TM timer on FIG. 337 to decrease its timing interval by eight to twelve seconds.

Referring to FIG. 333, the operation of relay 336-RC closes its transfer make contacts, to extend ground from terminal 333-101 to conductor SR. The ground on conductor SR is then transmitted, via the register link on FIG. 320, to conductor SR of the DP trunk circuit in rectangle "S" on FIG. 300. The trunk circuit extends this ground, via conductor SR, from FIG. 300 to FIG. 304, where the designation of the conductor SR changes to ST, whence it extends to the sender link and controller of FIG. 16C. The ground on conductor ST causes the sender link to associate the calling trunk circuit with an idle sender, in the same manner as hereinbefore described for the MF call. The only distinction that might be pointed out at this time, in connection with the sender link, is that a different combination of relays operates within the sender link, so as to transmit the proper class information pertaining to the calling DP trunk to the sender. The trunk also grounds conductor FR, extending to the sender, as an indication that it is to be used for receiving digits dialed by a calling subscriber, rather than by an operator.

When the sender has been attached to the DP trunk, it grounds its lead C0 on FIG. 42 and this ground is then extended, via the sender link, to trunk conductor C0 on FIG. 304 to operate trunk relay 304-SA. Subsequently, when the sender is ready to receive the called number, it grounds its conductor FR from terminal 102 on FIG. 24, which ground is then extended to the trunk circuit on FIG. 304, whence it passes through transfer make contacts 304-SA and transfer break contacts 304-FA, to conductor SA extending, via FIG. 320, to FIG. 333 of the register, where the ground is then further extended over an obvious circuit to operate relay 333-SA, thereby informing the register that the sender is now attached and is ready to receive the called number. Relay 333-SA, in operating, closes its make contacts, shown within the "F" equipment rectangle for register 00 on FIG. 230, to extend the battery on terminal 101 within the "F" rectangle to conductors STDT and STDT1, which extend to the seizure and preference circuitry of register connector "0," as hereinafter described.

After the sender link has completed its seizure of the sender, the initial operation of the sender is essentially identical to that of the previously-described MF call. Specifically, relays 42-SC1, -SC2, and -SC3 operate in the same manner as before. Class information is then passed to the sender by the sender link in the same manner, with one exception. The exception is that, on the MF call, relay 60-MF is operated as an indication to the sender that it will receive information in MF form; while for the present DP call, relay 60-DP is operated as an indication that the impulsing from the originating office will be in DP form. Also, referring to FIG. 42, the path over which relay 42-ON1 operates is different in this manner only: it passes through a transfer break contact on the 60-MF relay and a transfer make contact on the 60-

DP relay, which latter relay is now operated. On the MF call, this path was through the transfer make contact of the 60-MF relay and through the transfer break contact of the 60-DP relay. Also, steering relay 68-AS is not operated on the present call. Referring to FIG. 68, it will be recalled that on the MF call, it was operated from the ground on terminal 68-101, via make contacts 60-MF and 42-SC2. It is desired not to have steering relay 68-AS operated at this stage of the call, since steering information is transmitted to the sender from the register, indicating the number of digits that will be received from the register via the data transfer circuit. Relay 66-SR operates as before.

Once the sender is seized by the sender link, it grounds conductor C0 on FIG. 42, as previously mentioned, which ground is further extended, via the sender link, to trunk conductor C0 on FIG. 304 and to the winding of relay 304-SA, causing it to operate. The operation of relay 304-SA, in turn, closes an obvious circuit from ground on terminal 101 of FIG. 303 to operate relay 304-T. The operation of relay 304-T operates its transfer contacts on FIG. 299 to disconnect the incoming tip and ring conductors T and R from the battery and ground potentials supplied through the windings of relay 299-A, and to connect them, via conductors T and R, respectively, to on-hook polarity in the sender. Relay 304-T, operated, in turn, also operates relay 306-RV and releases relay 299-A which, in turn, releases relay 300-A1 and provides a holding circuit to maintain relay 300-A2 operated.

Relay 42-ON3 in the sender operates as before. Referring to FIG. 36, the operation of relay 42-ON3 closes its make contacts to connect the T and R conductors from the trunk with the remainder of the circuitry on FIG. 36, including battery and ground through the windings of relay 36-L.

A brief comment is in order, at this point, concerning the polarity reversals of the incoming tip-and-ring conductors, as seen by the originating office throughout different stages of various calls. It will be recalled that for the MF call, the incoming trunk is seized in an on-hook condition, and that the tip-and-ring polarity was reversed to an off-hook condition when the sender was seized. The 60-MF relay, in operating, caused the off-hook condition seizure of the sender. Next, the sender operated its relay 20-RV to restore the polarity condition to on-hook as a signal to the originating office that the sender was ready for the reception of the called station digits. This reversal of polarity, from on-hook to off-hook and back to on-hook, is commonly referred to as a "wink" signal to the originating office. Next, after the termination of the reception of the called station digits, the sender reversed the polarity condition to off-hook as a signal that it is ready for the receipt of the ANI information. Thus, in summary for MF calls, the incoming trunk recognizes the polarities on-hook, off-hook, on-hook and then off-hook, in that order.

The incoming DP trunk is similarly seized in an on-hook condition. However, the sender 60-MF relay is not operated and, therefore, the sender is seized in an on-hook rather than an off-hook condition. The sender then, as a consequence of its seizure, transmits a signal, via the trunk, to the register, signifying that it is ready for the reception of the called station digits, and also operates the 20-RV relay as a signal to the originating office that the sender is now ready for the ANI information. Thus, the incoming DP trunk recognizes the polarity conditions on-hook, on-hook, and off-hook, in that order.

Referring to FIG. 36, the operation of relay 42-ON3 closes its make contacts to interconnect the tip-and-ring conductors of the trunk with the remainder of the circuitry within the sender. Relay 60-MF operates for an MF call and operates its transfer contacts to provide a reversal of the polarities applied to the tip-and-ring conductors by the windings of relay 36-L. Also, relay 20-RV



is subsequently operated on MF calls to provide a polarity reversal when a sender is ready to receive the called number via MF pulsing from the local office. The situation is different for the presently described DP call, since the 60-MF relay is not operated and, therefore, the condition of the tip-and-ring conductors at the time the 42-ON3 relay operates is the same as that supplied by the trunk, i.e., an on-hook condition.

Relay 42-ON3, together with relay 72-RGC1, controls the time at which the five leads from the MF receiver are associated with the calling or the called number registers. Referring to FIG. 72, on a dial pulse call, the operation of relay 42-ON3 immediately closes an obvious circuit from ground on terminal 72-101 to operate relay 72-RGC1 through a transfer break contact of the 60-MF relay. This is not the case on the MF call, where relay 72-RGC1 is operated normally only after the called number has been received. On a DP call, relay 72-RGC1 must be operated prior to the receipt of the called number from the register, via the data transfer circuit, to transfer the five leads of the MF receiver from the called to the calling number registers, in order to prepare the sender for the receipt of the ANI information from the originating office.

Referring to FIG. 51, relay 20-RVT subsequently operates and, in turn, operates relays 51-RGCB and 51-RGCA. Referring now to FIG. 20, the operation of relay 51-RGCA operates relay 20-RV from the ground on terminal 20-106. The operation of relay 20-RV operates its transfer contacts shown on FIG. 36, which reverse the polarity condition of the tip and ring to an off-hook condition. This off-hook signal is a request for the calling number from the originating office, and the circuit operations associated with this operation are exactly the same as for the reception of the calling number in the MF call.

Referring to FIG. 64, the operation of relay 51-RGCB operates relay 64-SA over the circuit including make contacts 51-RGCB and 60-DP. The operation of relay 64-SA closes its transfer make contacts shown on FIG. 24 to pass ground back over the FR conductor, through the trunk circuit (FIG. 304), and via conductor SA to FIG. 320, thence to the ten-digit register on FIG. 333, to operate relay 333-SA, indicating that the sender is attached and ready to receive the called number via the data transfer circuit. This operating path for relay 333-SA begins with ground on terminal 102 of FIG. 24, extends through break contacts 32-AV1, make contacts 36-L, break contacts 64-DTCK, 65-TR4, 52-TM1, 64-RCK, transfer make contacts 64-SA, to conductor FR extending via the sender link to the trunk circuit on FIG. 304, transfer make contacts 304-SA, transfer break contacts 304-FA, to conductor SA, which extends through FIG. 300, via FIG. 320 of the register link, to the register circuit on FIG. 333, to operate relay 333-SA, thereby indicating to the register that the sender is now attached and is ready to receive the called station information via the data transfer circuit. The operation of register relay 333-SA, as is hereinbefore described in detail, causes the register to bid for the services of the data transfer circuit.

The preceding circuit description of the sender in connection with its seizure by the trunk and the sender link on a DP call, in response to which seizure it prepares itself for the reception of the called station digits and so informs the register of this fact, is similar in many respects to that of the previously-described MF call. Therefore, the preceding description has described only those actions of the sender which are different for the DP call than they are for the MF call. The relays whose circuit actions have not been described, since they are similar to that of the MF call, are as follows: 42-ON3, 17C-SB, 42-ON2, 17C-RA, 42-ON, 36-L, 54-TFA5, 48-AV3, 48-CK4, 38-RD, 27-TVR, 53-PR1, 53-PR2, 22-FO1, 23-P, 32-AVA, and 59-TG3.

### Data transfer circuit—General comments

Further detailed comments concerning the general operation of the data transfer circuit on a dial pulse call are believed to be unnecessary since this operation has already been covered in connection with the description of the dial pulse trunk, the register link, and the register. Suffice it to say that the data transfer circuit is used twice on a dial pulse call, the function of the first usage being to interconnect the register with the sender in order that the register may transmit the called number via the data transfer circuit to the sender, and the function of the second usage being similar to that of the already described MF call, on which the position circuit, the trunk, and the sender are all interconnected via the data transfer circuit.

Many portions of the operation of the data transfer circuit on its first usage as it interconnects a register with a sender are identical, similar, or analogous to corresponding operations hereinbefore described for the MF call. Therefore, only those circuit operations are described in detail in this section which are different from those previously described. All relay operations are mentioned in order to ensure the completeness of the description; however, only the detailed circuit paths are described for those relay operations which could not be readily understood from the knowledge obtained from a thorough understanding of the data transfer operations for the previously-described MF call.

### Detailed circuit description

#### DATA TRANSFER CIRCUIT—SEIZURE OF A REGISTER CONNECTOR

Operation of register relay 333-SA, as hereinbefore described, applies a battery potential to its "start" conductors STDT and STDT1, which constitutes a service-request signal to the data transfer circuit from the register. These conductors are shown within the "F" rectangle for register 00 on FIG. 230. The register connector preference and control circuitry of the data transfer circuit is shown on FIGS. 230 and 233 and is similar, in most respects, to that of the previously described position connector preference circuitry shown on FIGS. 224 and 227. FIGS. 230 and 233 disclose ten register connectors, respectively designated "0" through "9," with registers 00 through 09 being served by register connector "0" and with registers 10 through 19 being served by register connector "1." The remaining register connectors may serve registers associated with additional register link frames.

Each "F" equipment rectangle on FIGS. 230 and 233 discloses the data transfer "start" circuitry internal to the registers, while each "D" equipment rectangle discloses the preference circuitry for each register connector. The "start" circuitry for register 00 is shown in detail on FIG. 230, and from this it may be seen that the operation of register relay 333-SA closes an obvious path to extend the battery from terminal 230-101, over the STDT lead, to operate relay 230-RP00. The operation of relay 230-RP00 constitutes a bid for the services of register connector "0" by register 00. Assuming that register 00 is successful in obtaining the services of register connector "0," primary cut-in relays 230-RA00, -RB00, and -RC00 now operate to connect the conductors of the register to those of its register connector. The operation of these relays, in turn, operates relay 278-RGRA.

Next, the register connector extends the battery potential from the "F" equipment rectangle for register 00, via conductor SDT1, to the circuitry of FIGS. 231 and 232, to cause register connector "0" to bid for the services of an idle data channel. Let it be assumed that register connector "0" is successful in obtaining the services of data channel "0." The battery potential on conductor SDT1 is now extended, via make contacts 230-RC00, resistor 230-RP00, and conductor STDT', to operate relay 231-ORS0 which, in turn, operates relay 231-ORRC0. Normally operated relays 225-DCA1 and 234-



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DCA2 now release as a consequence of the operation of relay 231-ORS0. The release of relay 234-DCA2, in turn, operates relay 297-DTMB0. The operation of this relay, in turn, operates secondary cut-in relays 231-ORSA0 and -ORSB0.

The release of relays 225-DCA1 and 234-DCA2 respectively open obvious circuits on FIG. 248 to release the channel test relays 248-TST1 to -TST6. Referring to FIG. 279, the release of relay 225-DCA1 releases relay 279-CONN which, in turn, releases relays 279-CONA, -CON1, -CON2, and -CON3.

The operation of relay 231-ORS0 operates secondary cut-in relay 231-ORRC0, as already mentioned. The operation of relay 231-ORRC0, in turn, operates relay 283-RGT which, in turn, operates relay 283-RGT1. The operation of relay 231-ORRC0 also operates relay 260-RTOS. The operation of relay 231-ORRC0 also operates relays 225-CHB and -CHB1 to indicate a channel-busy condition. The operation of these latter two relays, in turn, operates the -PCB- relay in each position connector for channel "0," and the -RCB- relay in each register connector for channel "0." These relays are designated 225-OPCB0 and 231-ORCB0 for position and register connectors "0," respectively.

Register 00 is now connected to data channel "0" as a consequence of the operation of the primary cut-in relays common to register connector "0" and register 00, and the operation of the secondary cut-in relays common to register connector "0" and data channel "0."

#### SEIZING OF TRUNK CONNECTOR

The first function of the data channel, apart from its seizure by a register, is to make a connection with the trunk circuit to which the register is currently connected via the register link. Before the data channel can make a connection to the trunk, it must determine the trunk connector that will have to be used on the connection. This information is obtained from the trunk connector number, which number is currently stored in the register circuit (FIG. 333) and is now passed to that data channel, in a 2-out-of-5 numerical code, over conductors DGN0, -1, -2, -4, and -7, extending from register circuit FIG. 333 to FIG. 237 of the data transfer circuit. A trunk connector number of "9" is currently stored in register 00, since the calling trunk is served by trunk connector "9" and, therefore, register 00 (FIG. 333) now applies grounds to conductors DGN2 and DGN7 to operate relays 239-ODG2 and -ODG7. The operation of these two relays informs channel "0" that it will have to establish a connection to the calling trunk via trunk connector "9."

The circuitry within the "K" equipment rectangle on FIG. 239 for channel "0" checks and translates the trunk connector number of "9" now stored in its trunk connector number register (its -DG- relays) and extends the battery on terminal 101 of FIG. 239 through the symmetric check circuit DGK, and through the 2-out-of-5 to 1-out-of-10 translator DGT, to output conductor DGN9, which extends to the "L" equipment rectangle on FIG. 240 for trunk connector "9." Assuming that trunk connector "9" is currently idle, the potential extended via conductor DGN9 causes relay 240-ODCS9 to operate, in a manner comparable to that in which relay 238-ODCS0 operated for the previously described MF call. The operation of relay 240-ODCS9 operates the secondary cut-in relays common to channel "0" and trunk connector "9," which relays are designated 240-OTS9 and 240-OTSS9. The closure of these secondary cut-in relays interconnects the conductors of data channel "0" and those of trunk connector "9."

#### OPERATION OF TRUNK CONNECTOR PRIMARY CUT-IN RELAYS

Referring to FIG. 242, the operation of relay 240-OTS9 closes the following circuit to apply battery to

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conductor PC extending to register 00, and thence to operate relay 305-TP900 in the calling trunk: battery on terminal 242-105, resistor OPC, inductance OPC, terminal 242-109, make contacts 240-OTS9, terminal 242-101, make contacts 231-ORRC0, upwards on the PC conductor of register connector "0," make contacts 230-RC00, conductors PC extending from FIG. 242 of the data transfer circuit to FIG. 333 of the register circuit, through transfer make contacts 336-RC on FIG. 333, break contacts 327-DTOK, the PC conductor extending from FIG. 333 of the register to FIG. 320 (rectangle "U") of the register link, through the cross bar switch contacts shown in FIG. 320 to conductor PC on FIG. 300 of the trunk (rectangle "S"), conductor PC continues as conductor SPI, through make contacts 304-SA on FIG. 305, to the winding of relay 305-TP900 to operate it. The operation of relay 305-TP900, in turn, closes an obvious circuit on FIG. 263 to operate relay 263-9TSG0, which is the subgroup primary cut-in relay serving trunks 900 through 909. The operation of this relay (FIGS. 263 and 270) closes its contacts to interconnect the conductors of trunk 900 with those of trunk connector "9." The operation of this relay also closes an obvious circuit on FIG. 266 to operate relay 266-OTP0, via make contacts of the operated trunk subgroup primary cut-in relays and those of the trunk secondary cut-in relays.

#### SEIZURE OF SENDER CONNECTOR "0"

Referring to FIG. 300, the ground extended to conductor PC of the trunk circuit is further extended to FIG. 304, where the conductor designation PC changes to SPI, and whence the conductor SPI extends via the sender link to the sender circuit. The battery potential on conductor SPI is further extended through the sender circuit in the same manner and over the same circuit as described previously for the MF call and as shown in simplified form on FIG. 241. The sender passes this battery potential back to the data transfer on its conductor SP extending from FIG. 241 to FIG. 243, to operate relay 243-SS00. The operation of relay 243-SS00 constitutes a bid by the sender for the services of its sender connector. Assuming that the sender connector is otherwise idle, the operation of this relay, in turn, operates the primary cut-in relay 243-SE00 which, in turn, operates the four relays 243-SA00 through 243-SD00. These latter four relays are also primary cut-in relays. The operation of relay 243-SS00 closes a circuit shown on FIG. 64 (rectangle "DTC") to operate relay 64-SSP in the sender as an indication that preference has been granted to it for the use of its sender connector.

The sender now transmits the trunk connector number to the data transfer circuit in order that the data transfer circuit can determine to which of the four data channels this particular sender should now be connected. The trunk connector number of "9," stored in the sender "00," is transmitted to the data transfer circuit over an obvious path shown on FIG. 245, to operate relays 245-DGN2 and -DGN7. Recalling that relay 238-OTS0 is now operated, the circuit of FIG. 246 extends the battery on terminal 246-101, through the symmetric check circuit 100, through the 2-out-of-5 to 1-out-of-10 translator 104 for the trunk connector number, to output conductor 9SG, thereby indicating a trunk connector number of "9." The battery on conductor 9SG is extended to terminal 246-107, and thence through make contacts 240-OTS9 to operate relay 246-OSRE0, which is the sender connector secondary cut-in relay. The operation of relay 246-OSRE0 closes its make contacts on FIG. 258 to interconnect the multiples of sender connector "0" with those of data channel "0." The connection between the sender and the register is now completed, since both of these circuits are connected to channel "0" of the data transfer circuit.



The data channel "0" now provides a measured time interval, during which time the data stored in the register must be transferred to and locked into the called number receiving relays of the sender. Following this, the data transfer circuit disconnects the conductors from the register over which the data transmitting grounds were applied and, in turn, connects a test relay to each of these conductors of the data channel in order to check for the presence of the locking grounds which should be supplied to these conductors at this time by the sender.

The aforementioned timing interval provided by channel "0" of the data transfer circuit is initiated as a consequence of the operation of relay 246-OSRE0 which, in turn, operates relay 247-OSSD0 which, in turn, closes an obvious circuit to operate relay 297-SDTM0. The operation of relay 247-OSSD0 constitutes the beginning of the timing interval. Thus, following the operation of this relay, the register now has a prescribed time interval in which it must transmit its data via the data transfer circuit to the sender. The interval subsequently terminates with the operation of relays 248-TST1 to -TST6. The operation of relay 297-SDTM0, in turn, operates relay 297-DTM0 which, in turn, releases relay 297-DTMB0 which, in its turn, releases relays 240-OTSS0, 231-ORSA0, -ORSB0. The operation of relay 297-DTM0 also operates relay 297-DTMF0. The operation of relay 297-DTMF0, in turn, operates test relays 248-TST1 through -TST6.

The following paragraphs describe how the register transmits information, via the data transfer circuit to the sender, during the time interval between the operation of relays 247-OSSD0 and 248-TST1 through 248-TST6, as above described. The register now transmits information to the data transfer circuit. Included in this information is the called station digits, together with an indication to the sender of the number of digits to be received by it. Assuming that the called station digits are 212-243-1000, the register now applies ground potential to the following A- through H-, and J- and K- conductors on FIGS. 325 and 329 to transmit these digits via the data transfer circuit to the sender in 2-out-of-5 code form: conductors A0 and A2 for an "A" digit of "2," conductors B0 and B1 for a "B" digit of "1," conductors C0 and C2 for a "B" digit of "2," conductors D0 and D2 for a "D" digit of "2," conductors E0 and E4 for an "E" digit of "4," conductors F1 and F2 for an "F" digit of "3," conductors G0 and G1 for a "G" digit of "1," and conductors H4 and H7, J4 and J7, and K4 and K7 for the "H," "J," and "K" digits of "0," respectively.

Referring to FIGS. 334 and 336, the following circuit is now closed in the register to apply ground to conductor LS: ground on terminal 336-101, make contacts 322-ON2, 331-RA1, transfer make contacts 336-KS, the series-connected transfer break contacts of all of relays 336-JS through 334-BS, make contacts 330-P2 on FIG. 334, terminal 334-102, series-connected transfer break contacts of relays 336-JS through 336-GS, and transfer make contacts 336-KS to conductor LS extending from register FIG. 334 to register FIG. 333, and thence to data transfer circuit FIG. 257.

Referring to FIGS. 249 through 252, the ground applied to the A- through K- conductors by register 00 is transmitted over the primary and secondary cut-in relays of register connector "00," over data channel "0," over the primary and secondary relays for sender connector "0," to the similarly designated conductors on FIG. 69 of the sender. FIGS. 69 and 70 of the sender contain a set of called station digit registers similar to those of the register circuit, and each A- through K- conductor on FIG. 69 is connected to a correspondingly designated relay in one of the registers on FIGS. 69 or 70.

Each of the A- through K- leads currently grounded by the register, via the data transfer circuit, now operates

its associated relay, so that the following relays now operate in the sender: 69-A0 and -A2, 69-B0 and -B1, 69-C0 and -C2, 69-D0 and -D2, 70-E0 and -E4, 70-F1 and -F2, 70-G0 and -G1, 70-H4 and -H7, 70-J4 and -J7, and 70-K4 and -K7. Each relay, in operating, closes an obvious locking path for itself over its own make contacts to ground on either terminal 101 or terminal 102 of FIG. 69. Also, ground on conductor LS from FIG. 333 of the register, via FIGS. 257, and 258, operates sender relay 67-LS.

Toward the end of the timing interval allowed by the data transfer circuit for information to be passed from the register to the sender, relay 297-DTM0 operates, as previously described. The operation of relay 297-DTM0 releases relay 297-DTMB0 which, in turn, releases secondary cut-in relays 231-ORSA0 and -ORSB0. Secondary cut-in relay 231-ORRC0 remains operated at this time, however. Referring now to FIGS. 249, 251 and 257, the release of secondary cut-in relays 231-ORSA0 and -ORSB0 disconnects the multiples shown on FIGS. 249, 251 and 257 of register connector "0" from those of channel "0." This disconnection removes the transmitting grounds applied by the register to the A- through K- and the LS channel conductors to transmit the called station information and steering information to the sender.

Subsequently, relay 297-DTMF0 operates and, in turn, operates relays 248-TST1 through -TST6. The operation of relays 248-TST1 and -TST2 connects the test relays, shown within the "S" and "T" equipment rectangles on FIGS. 250 and 252, to the corresponding data conductors of channel "0." Each sender relay on FIGS. 69 and 70, which operated as a consequence of the reception of the called number from the register, locks over its own make contacts to ground and, in so doing, extends the locking ground back to the conductors on FIGS. 250 and 252 of the data transfer circuit. Each test relay in rectangles "S" and "T" now connected to one of these conductors which is grounded from the holding grounds applied thereto by the sender now operates and closes a locking path to ground for itself over its own make contacts and break contacts 279-CON1.

The test relays within the "S" and "T" equipment rectangles on FIGS. 250 and 252 should now be operated in 2-out-of-5 code form, since this is the manner in which the called number was transmitted to the sender by the register. Contacts on these relays are arranged into symmetric circuits, which are interconnected in the manner shown on FIGS. 286 through 292, in order to provide a 2-out-of-5 check on each group of these relays.

Referring now to FIGS. 286 through 292, a circuit is now closed to extend ground from make contacts 230-RC00 on FIG. 286, through make contacts 231-ORRC0, terminal 286-102, make contacts 248-TST3 on FIG. 287, make contacts 297-DTMF0, to terminal 287-101, through transfer make contacts 260-RT0S, to terminal 287-103. The ground on terminal 287-103 may be further extended through transfer break contacts 273-NSA, 262-NCN, 261-ST0P, to terminal 287-119, which is the input of the symmetric check circuit of the nine relays indicated within the confines of the rectangle. By means similar to that described on these figures for the MF call, the ground on terminal 287-119 is further extended through the 1-out-of-9 symmetric check circuit comprising the contacts of the ND- relays, to terminal 287-120, and thence is further extended through the symmetric check circuits comprising the contacts of the A- through J- relays on FIGS. 287 and 288, to provide a check on the 2-out-of-5 code registration in each of these registers. This check ground is further extended to terminal 110 on FIG. 288 if all of the A- through K- registers are operated properly, and thence the ground is further extended through transfer make contacts 258-ND10 to the winding of relay 289-DOK10 on FIG. 289 to operate it. The same ground is further extended,



via terminals 102 and 103 on FIG. 289, through transfer make contacts 260-RT0S, to terminal 289-101, and to the winding of relay DOK20 on FIG. 292 to operate it.

Referring to FIG. 276, the operation of relay 292-DOK20 closes the following circuit to apply ground to conductor DTOK extending to the register circuit: ground on terminal 276-102, make contacts 292-DOK20, break contacts 293-TBL0, transfer break contacts 292-AME0, conductor DTOK extending from FIGS. 276 to 277, make contacts 231-ORRC0, 230-RC00, to conductor DTOK extending to FIG. 329 of the register. The ground on conductor DTOK in the register is further extended from FIG. 329 to FIG. 327, to operate relay 327-DTOK as a signal to the register that the sender has satisfactorily received the information transmitted thereto, via the data transfer circuit, from the register.

Referring to FIG. 267, the following circuit is now closed to apply a ground to conductor DTOK of the sender circuit: ground to terminal 267-102 within the "DD" equipment rectangle, make contacts 292-DOK20, break contacts 293-TBL0, transfer break contacts 292-AMAE0, conductor DTOK of channel "0," make contacts 246-OSRE0, 243-SE00, conductor DTOK, extending from FIG. 267 of the data transfer circuit to FIG. 69 of the senior circuit, and thence to FIG. 64, through a circuit comprising transfer make contacts 64-SA and 60-DP, and break contacts 64-RCK, to the winding of relay 64-RCKA to operate it. With the release of relay 64-SSP, the operation of relay 64-RCKA, in turn, operates relay 64-RCK. The operation of relay 64-RCK, in turn, operates relay 72-RGC.

Relay 327-DTOK, operated, locks to ground supplied by make contacts 322-RB. The operating ground for relay 327-DTOK, on conductor DTOK, is also applied to the right-hand side of the secondary winding of relay 327-ON to energize it in a direction opposite to that required for its operation. The ampere turns on the secondary winding exceed those of the other two windings combined and, therefore, the reverse energization of the secondary winding at this time releases relay 327-ON and, in turn, releases relay 330-ON1.

Referring to FIG. 230, register 00 in rectangle "F," the operation of relay 327-DTOK removes the battery potential from conductors STDT and STDT1 to register connector "0" of the data transfer circuit, to cause relay 230-RP00 to release, thereby initiating the release of the entire data transfer circuit, in a manner similar to that for the previously-described MF call. The release of relays 327-ON and 330-ON1 in the register opens the holding grounds for the various relays now operated therein, thereby causing them to release and, in turn, to release the register, as well as the associated hold magnet on the switch "A" of the register link. Both register 00 and data channel "0" are now free to serve other calls.

#### *Partial summary of dial pulse call*

Summarizing the progress of the DP call through the tandem office, the incoming DP trunk, in response to its seizure by the originating office, first seized a DP register via the register link. Following that, the called station digits were received from the originating office by the trunk and relayed to the register, where they were stored in 2-out-of-5 code form. Next, after the received digits were stored in the register, the register instructed the trunk to bid, via the sender link, for a sender. The sender was then attached and, after having received the necessary class mark and other call setup information, reversed the tip-and-ring polarity back to the originating office as a signal that it was ready to receive the ANI information. The sender, at the same time, instructed the register, via the sender link, the trunk, and the register link, to bid for the services of the data transfer circuit in order to transfer the called station registration in the register to the sender. The register next bid for and obtained the services of data channel "0," which then interconnected regis-

ter 00 with sender "00." Following this, the register transmitted, via the data transfer circuit to the sender, the called station digits, together with an indication of the number of digits to be received. The data transfer circuit then checked the validity of the information transmitted to and registered in the sender and, at the conclusion of this check, transmitted a "data OK" signal to both the sender and the register, which register then, in turn, initiated the circuit actions required to release both itself and the data transfer circuit.

The current condition of the call is that the DP trunk has now been released from the register and the register link and is connected only to the sender via the sender link. The sender is now currently progressing with the remainder of its circuit operations in connection with the serving of the call.

#### *Sender operation—Receipt of calling and called numbers*

It has hereinbefore been explained how the operation of relay 51-RGCA in the sender operated relay 20-RV which, in turn, reversed the polarity condition of the tip-and-ring conductors to an off-hook condition, thereby signaling a request for the calling number, via ANI from the originating office, via MF pulsing. It will also be recalled how the operation of relays 51-RGCB and 64-SA control the circuit actions by which the sender requests the register to transmit the called station digits thereto via the data transfer circuit. The circuit action by which the sender requests the calling number, and the circuit action by which it requests the called number, occur simultaneously, and the operations respectively associated with each of these functions proceed somewhat independently of the other. Therefore, the called and calling numbers are sent to the sender simultaneously, in that the called number is received from the register via the data transfer circuit at the same time that the calling number is being received via the tip-and-ring conductors from the originating office by means of MF pulsing.

#### *Sender instructs trunk to bid for a position*

Once the sender ascertains that it has completed the storage of the calling and called numbers, it is then ready to request a connection to an operator position in exactly the same manner as for the previously-discussed MF call. Thus, the sender extends ground, via conductor FT on FIG. 24, through the sender link circuit, to FIG. 304 of the trunk circuit, through transfer make contacts 304-SA, transfer break contacts 304-FA, and make contacts 304-T, to the winding of relay 304-PR to operate it. At the same time, the sender connects ringing tone to the transmission circuit, as a signal to the calling subscriber that the call is being handled. Relay 304-PR, operated, connects ground to conductor ST on FIG. 305 extending to the position link and connector circuit link group 1 (FIG. 7) which, in the same manner as already described for the MF call, establishes a connection between this trunk circuit and an idle operator position. Once a position is attached, ground extended from the position circuit, via conductor PA, operates relay 305-PA which, in turn, releases relay 304-T. The release of relay 304-T at its transfer break contacts on FIG. 299 restores the incoming loop conductors to battery and ground through the windings of the 299-A relay, with off-hook polarity, since relay 306-RV is now operated. The tip-and-ring leads T and R (FIG. 304) to the sender are kept closed through resistor C (FIG. 299) to prevent the sender release at this time. The operation of relay 305-PA also grounds conductor FR (FIG. 304) extending to the sender as a position-attach signal. The release of relay 304-T re-operates relay 299-A which, in turn, operates relay 300-A1.

#### *Connection of position, trunk, and sender to a data channel*

At the same time that the trunk circuit receives the position-attach signal, the selected position bids for and



connects itself to an idle channel of the data transfer circuit, as hereinbefore described for the MF call. Battery is subsequently connected by FIG. 320, rectangle "U" of the data transfer circuit, to trunk conductor PC on FIG. 300 to operate relay 305-TP900. Relay 305-TP900, operated, closes the leads extended from FIG. 306, via FIG. 272, to the selected data channel for transferring the information to the position. The battery extended to FIG. 300 from FIG. 320, via the PC conductor, is extended on conductor SPI to FIG. 304, via the sender link, to the sender, which controls the connection of the sender to the data channel, as hereinbefore described for the register usage of the data transfer circuit.

The remainder of the circuit actions associated with the data transfer circuit operations are identical to those for the MF call, on which the trunk, the position, and the sender are similarly all interconnected by a channel of the data transfer circuit. Therefore, these operations will not be discussed in further detail in this portion of the specification. Suffice it to say that the trunk, the position, and the sender now interchange information as required. Included in this information interchange is the transmission of the calling and called station information from the sender to the position, and the transfer of originating area information from FIG. 306 of the DP trunk circuit, via FIG. 272 of the data transfer circuit, to the position for charging purposes.

When the call data is transferred to the position, trunk relay 305-TP900 and the sender data channels are released, the operator is given a signal indicating that the operator position is connected to a call which is being established, and the sender proceeds to set up the call forward, as described for the MF call.

The operation of relay 64-RCK, as previously described, releases relay 64-SA and removes the sender-attached indication extended over the FT conductor on FIG. 24, via the sender link circuit, to the register circuit, thereby removing the sender-attached indication to the register.

Also, the operation of relay 64-SCW on a dial pulse call varies slightly from that of the MF call. Specifically, its operate path is through a make contact on the 60-DP relay, instead of through a make contact on the 60-MF relay. Since the calling and called numbers are being received simultaneously, relay 64-SCW does not operate until both the calling and called number information is received, and this condition is manifested in the operate path of the 64-SCW relay by the closure of a make contact of relay 51-EOP, which contact closure indicates that the ANI information is complete, and by the closure of a make contact of relay 72-RGC2, which indicates that the called number is complete. The 72-RGC2 relay will operate under the control of the 72-RGC relay, as described for the MF call.

#### Connection to the outgoing trunk

The sender now calls in the marker to set up a connection to an outgoing trunk to the desired terminating office. The marker determines that there is an idle trunk available, identifies the location of the incoming trunk on the trunk link frame, and sets up a connection between the incoming and outgoing trunks. In establishing the location of the incoming trunk circuit, the marker causes the sender to ground the lead DC extending, via the sender link circuit, to FIG. 304 of the trunk circuit which, in turn, operates relay 303-F and, in turn, relay 304-FA. Relay 303-F, operated, extends ground over the LC lead (FIG. 303) to a link connector relay in the trunk link frame, which trunk link relay now operates and returns ground to the marker through a marker connector. Relay 303-F, operated, also supplies ground for operating the trunk link primary select magnets associated with this ground circuit. Relay 303-F, operated, at its transfer make contacts on FIG. 303, also connects the S lead to the SL lead over which the marker supplies the sleeve

ground while setting up the connection between the trunk and office link frames. When the marker has checked the connection to the outgoing trunk, relay 303-F is released. The release of relay 303-F transfer the sleeve ground supply to the trunk circuit, which now controls the hold magnet. The marker checks for this control ground and if detected then releases, or if not detected gives a trouble indication.

The sender is now connected to the outgoing tip-and-ring leads over the FT and FR leads, via the sender link, and outputs the digits required for completing the connection. After outputting is completed, the sender grounds lead D (FIG. 48), thereby extending ground, via the sender link, to FIG. 304, causing relay 303-D to operate, which, in turn, operates relay 302-D1, which, at its transfer make contacts on FIG. 303, bridges the operator onto the outgoing connection. The sender is now released and the operator awaits the called party answer.

#### Called party answer

Called-party-answer is indicated by a reversal of the polarity on the tip-and-ring conductors from the called office, thereby operating polarized relay 299-CS. Since "busyback" and "overflow" signals are intermittent reversals from the called office, and since the call may be abandoned just as it is answered, relays 300-A1 and 299-CS must remain operated for a minimum of two to five seconds for the trunk circuit to recognize a legitimate called-party-answer. This interval is controlled by relays from a charge-delay interrupter and culminates in the operation of relays 301-IN and 301-CH. The trunk circuit is now conditioned to control the making of timing entries on the AMA tape. The momentary release of either relay 300-A1 or 299-CS before completion of the timing interval, as indicated by the operation of relay 301-CH, results in the release of relay 301-IN, which relay, released, recycles the timing.

The remainder of the call, including the perforation of the initial entry in the position release, the perforation of the answer entry, as well as the perforation of the disconnect entry, are all similar to those described for the MF incoming trunk and, therefore, need not be further discussed in detail. Suffice it to say, at this point, that when the calling party disconnects, relays 299-A and 300-A1 release; and with the position link released, as indicated by the release of relay 305-PA, trunk relays 303-D, 302-D1, and 302-D2 release to release the trunk connection, both forward and back, and to control the perforation of the disconnect entry. Relay 302-D1, releasing, opens the loop forward to release the connection to the called party. Relay 302-D2, releasing, removes the ground from the sleeve lead to release the hold magnets of the trunk and office link frames, and closes the path between the CH and DJ conductors on FIG. 302 to request a disconnect entry. The disconnect entry is handled in the same way as the answer entry. When the call identity indexer RC lead on FIG. 30 is grounded at this time, relay 301-CH is shunted down. The release of relay 301-CH opens the lead RC as a signal to the recorder, and the path between leads CH and DJ is opened to disconnect the recorder. Relay 301-CH, released, also releases relays 301-IN and 301-TC. Relay 301-TC, in releasing, releases relay 306-RV, which, in releasing, at its transfer contacts on FIG. 299, reverses the polarity to the originating office to re-establish the connection therein. At this point, the circuits serving the DP call have been restored to normal and are free to serve other calls.

#### Dial pulse—nonANI call

The following paragraphs describe the operation of the system comprising the present invention during the serving of an incoming call on a dial pulse trunk where the originating office is not equipped for automatically identifying the calling station digits and transmitting them to the tandem sender. The preponderance of the circuit



operations associated with the serving of this type of call are identical in every respect to those for the serving of a DP-ANI call, as previously described, and, therefore, the following paragraphs describe only such circuit operations for a DP nonANI call as differ from those of the DP-ANI call.

First of all, the call will be received at the tandem office on a DP trunk circuit similar to that disclosed in detail on FIGS. 299 through 306 for the DP-ANI call. However, the DP nonANI trunk will be in a different trunk group, so that the sender link will recognize it as serving DP nonANI calls. The sender link also replaces the ANI indication to the sender by an AMA indication. This AMA indication is stored in the sender by the operation of relay 60-AMA, which indicates to the sender that no calling number will be forthcoming from the local office.

A further distinction characterizing the DP nonANI call is that the operation of relay 20-RVT does not operate relay 51-RGCA, since relay 60-ANI is normal. Also, relay 20-RV does not operate, since relay 60-MF is normal. With relay 20-RV not operating, the tip-and-ring conductors to the originating office do not go from an on-hook to an off-hook condition, but always remain in an on-hook condition. Also, the sender is not required, on this type of call, to wait for any calling number information; therefore, when the sender has received the called number information from the register via the data transfer circuit, as a consequence of which relay 72-RGC2 is operated, the sender immediately operates relay 64-SCW. The operation of relay 64-SCW initiates the circuit action which causes the trunk to bid for a connection to an operator position. Once the operator position is attached to the connection, the sender transmits an indication to the position instructing the operator that it is necessary to orally ascertain the identity of the calling station and to key these digits into registers at that operator position. The facilities within the position for performing this function were previously described in the section covering the MF call; and such facilities were specifically described in the section containing a comprehensive detailed discussion of the various facilities of the operator positions. The remainder of the circuit operations associated with a DP nonANI call are identical to those for the DP-ANI call, and need not be discussed further.

#### *Dial 0 call*

##### *General description of dial 0 call*

This portion of the specification describes the circuit actions associated with the serving of dial 0 ANI and non-ANI calls. A dial 0 call in the system of the present invention is one for which the calling party at the originating office dials only the digit "0," or some other special operator code, in order to obtain a connection to an operator at a tandem office, which operator then converses with the calling party in order to determine the nature of the service desired. The operator's duties in connection with this type of call vary, depending upon the nature of the services required by the calling party, together with the destination of the call. A dial 0 call may be of an emergency nature, where the calling party desires to be connected with the police, the fire department, or some other similar emergency service. In this case, the operator dispenses with all other call details and proceeds to establish the connection as quickly as possible. A dial 0 call may also be of a nonemergency nature, such as for example, where the calling party is not familiar with the necessary dialing procedure to reach a certain called station, and, instead, merely dials the digit "0" and then requests the operator to perform the remainder of the dialing functions. The operator in this case dials the called number, and also orally ascertains and enters the calling station digits into her position register if the originating office is not equipped for ANI operation.

When a customer making a dial 0 call dials the digit "0," or the required operator code if not a "0," an outgoing trunk circuit is seized in the originating office. This outgoing trunk circuit is directly associated with a dial 0 trunk at tandem, and the seizure signal is sent forward to the associated tandem dial 0 trunk. The tandem trunk recognizes the seizure signal and, if the local office has ANI operation, an MF tandem sender is seized. The attached sender calls for the ANI information and, when its registration is complete, a position request signal is passed from the sender to the dial 0 trunk. If the local office is not equipped for ANI operation, the trunk originates a position request immediately upon its seizure.

The position link finds an idle operator position in response to the trunk request and connects it to the dial 0 trunk. The position next bids for the data transfer circuit and, once connected thereto, receives through it the subscriber class information from the trunk, and, for ANI, also receives the calling number from the sender at this time. After receiving such call details, the position places itself in condition so that conversation may take place between the calling customer and the operator. The operator orally ascertains and then registers the calling number for nonANI operation.

The customer informs the operator of the called station desired and whether the call is to be person-to-person, station-to-station, station paid, collect, or special; and the operator then "keys" this information into the position register. When the operator is ready to complete the call, a sender request signal is given by the operator to the trunk, via the position link. The position waits for a sender-attached signal from the trunk and then calls in the data transfer circuit, which data transfer circuit now interconnects the position, the trunk, and the sender. The called number stored in the position register is passed through the data transfer circuit and recorded in the sender. On receipt of this information, the sender calls for a marker, and a channel is set up to an outgoing trunk. This trunk maintains the connected channel when the marker releases, and the sender now completes outputting. The sender sets this trunk in a cut-through condition for transmission, after outputting, and then releases. The operator is now bridged on the established through connection to the called station.

The operator controls the making of the initial entry on dial 0 calls in essentially the same manner as for the previously described MF and DP calls.

This circuit can also serve calls having irregular and special calling conditions. One such condition is known as "operation recall." After a complete connection has been established, the operator usually releases. The calling subscriber may recall an operator for additional service by flashing the switchhook. This trunk circuit functions to reconnect an operator to the connection and indicates to the operator that this is a "recall" seizure.

Another special condition is known as "cord board" transfer. There are a few types of calls which the presently disclosed operator positions will not complete. These are: overseas calls, marine operator calls, conference calls, mobile telephone calls, and sequence calls. In these cases, an operator will institute a transfer operation, by means of which the trunk starts a trunk finder which causes a cord-type toll-board operator to take up the call. The presently disclosed operator positions are bridged on the transfer connection and pass the call details to the toll-board operator. The position operator then releases the position, thereby leaving the transferred connection under the joint control of the calling subscriber and the cord-type toll-switchboard operator.

This trunk has facilities whereby, when an operator wishes to ring the calling station, a signal is sent to the trunk. The trunk, in turn, signals the local office outgoing trunk, which applies a signal to the calling subscriber line. The present trunk also contains ring-forward facilities. If the operator wishes to recall an inward operator, the op-



erator signals the trunk to ring forward. The trunk signals the trunk circuit outgoing from tandem, and it signals forward for the "recall." The trunk also contains release-forward facilities whereby if, on completing a call, the operator determines that the termination is not the proper one, the operator may release the connection. A release-forward signal is sent to the trunk, which releases the tandem outgoing trunk, and which, in turn, releases the intertoll and terminating equipment. The operator may put through another call in the same manner as the first, after releasing forward.

#### *Detailed description of dial 0 calls*

Dial 0 calls are similar in many respects to the DP and MF calls previously described. Therefore, the following description discusses only the distinctions between dial 0 calls and those previously described. Also, specific circuit paths are traced only for circuit operations which are not identical, analogous, or similar to those of MF or DP calls. Most of the circuit operations which distinguish a dial 0 from an MF or DP call are centered around either the incoming trunk or sender circuit, and therefore a majority of the following description pertains to either the trunk or the sender.

Dial 0 calls, for the purpose of this specification, may be divided into two types, namely, ANI and nonANI, depending upon whether or not the originating office automatically supplies the calling number information to the tandem office. The incoming dial 0 trunks at tandem may similarly be divided into two types, namely ANI and nonANI, depending upon whether or not they serve originating offices having ANI facilities. The circuitry of the ANI dial 0 trunk is slightly different from that of the nonANI dial 0 trunk. The main differences center around the fact that the ANI dial 0 trunk causes a sender to be seized immediately upon the receipt of an incoming call; while the nonANI trunk bypasses the first sender seizure and, instead, immediately bids for an idle operator position. A typical ANI dial 0 incoming trunk is shown on FIGS. 338 through 347; while its nonANI dial 0 counterpart is shown on FIGS. 338A through 347A. It is assumed in the following description that these two trunk circuits serve the described ANI and nonANI dial 0 calls, respectively.

It is pertinent to mention, at this point, that separate showings of ANI and nonANI MF trunks, as well as ANI and nonANI DP trunks, are not required, since the only difference between the ANI and the nonANI versions resides not in the internal circuitry of the trunk, as is the case for the dial 0 trunk, but, instead, resides in the cross connections which transmit the class mark or call setup information to the sender. Thus, in describing the differences between the ANI and nonANI MF calls, it was sufficient to point out the different types of class information that would be transmitted to the sender for the two types of calls. It was not necessary to supply a separate set of drawings for the two types of trunks where the only differences therebetween would be a single cross-connection on the sender link.

#### **INCOMING TRUNK SEIZURE**

After the calling party at the originating office dials the digit "0," or whatever the necessary directing code for a dial 0 call may be, the originating office establishes an interconnection between the calling line and an outgoing trunk which is connected to one of the dial 0 trunks at tandem. The outgoing trunk at the originating office may, in turn, seize the specific dial 0 trunk shown on FIGS. 338 through 347 if the originating office is of the ANI type, or, alternatively, may seize the specific dial 0 trunk shown on FIGS. 338A through 347A if the associated originating office is of the nonANI type.

The following description, except where otherwise noted, is directed to the circuit of the ANI trunk of FIGS. 338 through 347. Similar circuits may be found on the

nonANI trunk circuit of FIGS. 338A through 347A, the only differences being that the letter "A" follows the figure number prefix designation of each relay. As previously stated, in instances where the circuitry of the ANI trunk is different from that of the nonANI trunk, both circuits are described in detail, separately.

When the associated outgoing trunk at the originating office is seized, it places a low-resistance shunt across the tip-and-ring leads T and R shown on FIG. 338, which, in turn, operates relay 338-A from the battery and ground potentials connected to its windings. The particular polarity condition now applied through the windings of relay 338-A to the tip-and-ring conductors are such that the originating office construes this as an on-hook condition. The operation of relay 338-A, in turn, operates relay 344-A1 which, operated, connects ground on FIG. 338 to the A lead of the service observing circuit, as a busy indication.

#### **SENDER REQUEST—ANI OPERATION ONLY**

Relay 338-A, operated, grounds the ST lead on FIG. 344 to the sender link which acts to associate the trunk with an idle sender. This ground is supplied from terminal 101 on FIG. 344. The trunk also extends ground from terminal 102 on FIG. 344 to the FT lead on FIG. 344 extending to the sender link, to inform the sender that it is to be used for receiving digits from a calling subscriber, rather than from an operator.

#### **SENDER ATTACHED AND POSITION REQUEST—ANI OPERATION ONLY**

The "class" information provided by the sender link on the dial 0 call is exactly the same as for the dial pulse call, except that relay 60-AS0 is operated in the sender, instead of relay 60-DP, as was the case with the DP call. The function of the operated 60-AS0 relay is to instruct the sender that it will receive no called number and is to receive only the ANI digits from the local office. The ANI mark is passed from the sender link to operate relay 60-ANI, thereby indicating that the sender is now serving an ANI type trunk.

The sender grounds the C0 lead on FIG. 42, causing ground to be extended, via the sender link circuit, to conductor C0 on FIG. 344, thereby operating relay 344-T. Relay 344-T, operated, transfers the incoming T and R leads (FIG. 338) from battery and ground through the windings of relay 338-A, to the T and R leads to the sender link. The C0 lead from the sender link is also extended, via the SA lead, to the service observing circuit. The operated 344-T relay releases relay 338-A. Relay 344-T, operated, in turn, operates relay 344-RVR, removes ground from the ST lead (FIG. 344) to the sender link, and operates relay 344-T1 which, in turn, operates relay 339-RV. Relay 344-T1, operated, closes a holding circuit for relay 344-A1.

As previously described for the DP call, the operation of relay 20-RVT operates relay 51-RGCA. The operation of relay 51-RGCA, in turn, operates relay 20-RV which, at its transfer contacts on FIG. 36, changes the tip-and-ring condition from on-hook to off-hook, thereby indicating that the sender is ready for the receipt of the ANI information from the originating office. This ANI information is then received and registered in the sender, in exactly the same manner as hereinbefore described in detail for the MF call. Upon the completion of the reception and registration of the ANI information, the sender operates relay 51-EOP, as previously described which, in turn, operates relay 64-SCW. The operation of relay 64-SCW signals the trunk to request a connection to an operator position by grounding lead FT (FIG. 24), which ground operates relay 344-PR. In the meanwhile, audible ringing tone is being sent from the sender to the originating office, so that the calling party will know that the call is being served in the event that there is a delay in an operator being attached. Relay 344-PR, operated, extends the ground on terminal 101 of FIG. 340 to con-



ductor ST (FIG. 340) extending to the position link, via FIG. 346, as a request signal for the position link to interconnect this trunk circuit with an idle operator position. The ground on conductor ST is also extended on FIG. 346, via conductor PR, to the service observing circuit. Ground from terminal 101 of FIG. 340 is also extended, via the make contacts of relay 344-PR, to conductor ATR on FIG. 340 extending to the answer time recorder circuit.

#### POSITION REQUEST—NonANI OPERATION

For nonANI operation, the operation of relay 338A-A operates relay 344A-PR directly, without calling for a sender connection. Audible ringing tone to the subscriber is now supplied from the trunk circuit through make contacts of relay 344A-PR (FIG. 342), instead of from the sender as in the case for ANI operation.

#### POSITION ATTACHED

The operation of relay 344-PR (or 344A-PR) in the trunk grounds conductor ST (FIG. 340 or 340A) extending to the position link, both for ANI and nonANI operation. The link, in turn, functions to interconnect the bidding trunk circuit with an idle operator position.

Upon connection of the operator position, the position control circuit passes ground to the PA lead (FIG. 346), to operate relay 341-PA. The operation of relay 341-PA removes ground from the ST lead to the position link on FIG. 346, and from the ATR lead to the answer time recorder circuit of FIG. 340, and, in turn, operates relay 340-PA1 which releases relay 344-PR.

For nonANI operation, the operation of relay 341A-PA also, in turn, operates relays 339A-RV and 344A-RVR. Relay 339A-RV, operated, at its contacts on FIG. 338A, sends an off-hook signal to the originating office and grounds the S lead to the service observing circuit.

For ANI operation, the operation of relay 341-PA also grounds the sender FR lead on FIG. 344, momentarily, as a sender-attached signal, connects resistor 338-SH across the T and R leads to the sender to prevent sender release, and reconnects the windings of relay 338-A to the incoming loop. Relay 338-A now operates.

At the same time that the trunk circuit receives the position-attached signal, i.e., operation of relay 341-PA, the selected position circuit bids for and connects itself to an idle channel of the data transfer circuit. The selected position places a 130-volt potential on the KPR lead of FIG. 346, to operate relay 341-TP90 for ANI operation, and 341A-TP80 for nonANI operation. This is in keeping with the assumption that the dial 0 ANI trunk shown on FIGS. 338 through 347 is trunk 90 shown on the block diagrams of FIGS. 2 and 3, and that the DP nonANI trunk shown on FIGS. 338A through 347A is trunk 80 shown on the block diagram figures. The operation of this TP— relay closes leads on FIG. 347 (or FIG. 347A) to the selected data channel, for transferring trunk class information to the position.

#### DATA TRANSFER—ANI OPERATION

The position potential extended to lead KPR (FIG. 346) from the position link and connector is further extended for ANI calls, via lead SP and make contacts 344-T1, to the sender on the SPI lead (FIG. 344) which connects the sender to the data channel for registering call data, including the calling number, in the position. Once the call data has been transferred to the position and has been checked, the sender data relays are released, followed by the release of relay 341-TP90. A signal is then given to inform the operator that the position is connected to the call being established.

Upon completion of the data transfer checking features, the sender conductor DTOK is grounded by the data transfer circuit, thereby operating relay 64-DTOK which, in turn, operates relay 64-DCTK. The operation of relay 64-DCTK on the dial 0 call causes the sender to manufacture a simulated abandonment to allow itself

to release from the connection. Prior to its disconnection from the data transfer circuit and prior to the data checking operation within the data transfer circuit, the sender transmits an NCN mark via conductor NCN (FIG. 45) to the data transfer circuit (FIG. 262), to operate relay 262-NCN therein, thereby indicating that no called number will be transmitted to the position from the sender. This was not the case for DP and MF calls where called number information was transmitted from the sender to the position via the data transfer circuit. The circuit within the sender which manufactures the simulated abandonment indication to allow the sender to time out in a normal manner is as follows: ground on terminal 110 on FIG. 38, make contacts 60-AS0, transfer make contacts 64-DTCK, break contacts 64-SSP and 65-RS2, to the windings of relays 38-LR, -LR1, and -LR2 to operate them. The function of the relays 38-LR, -LR1, and -LR2 is to recognize an abandonment and to allow the sender to time out in a normal manner. The 38-LR1 relay, operated, operates relay 32-AV1; and the release of the circuit after the operation of relay 32-AV1 is the same as is described in the normal release of the sender on the MF call.

A further difference between the dial 0 call and the MF and DP types is that, on the first usage of the sender, there is no marker communication or function involved. In other words, the marker is never brought in on the first usage of the sender on this type of call. The sender now releases, once it has transmitted the call data to the position; and the sender, in releasing, in turn, removes ground from its C0 lead (FIG. 42) to release relay 344-T. The release of relay 344-T, in turn, releases slow-release relay 344-T1.

#### DATA TRANSFER—NonANI OPERATION

As previously described, the selected position operates relay 341A-PA and, at the same time, bids for and connects itself to an idle data channel of the data transfer circuit. With the 341A-TP80 relay operated, the first usage of the data transfer circuit for nonANI calls is similar to that of the described ANI call, except that no sender usage is involved. Therefore, the data transfer circuit at this time interconnects only the nonANI dial 0 trunk and the position, in order that the trunk may transmit call setup information to the position. The data transfer circuit releases after the data is satisfactorily registered and checked in the position.

#### POSITION CONTROL CIRCUIT OPERATION—ANI CALL

The data transfer circuit releases after transferring the necessary data from the trunk and sender to the position circuit. This information includes class mark and other call setup information from the trunk and the sender, as well as the calling number from the sender. The operator now answers the call, and in so doing causes the call information, including the calling number, to be displayed at the position. The operator is apprised by this information that this call is from a dial 0 trunk and that the calling customer requires some type of service. The operator orally ascertains the called number from the calling party, along with the type of service desired, and "keys" the called number information into storage registers at the position. The sender was released as hereinbefore described, after transmitting the calling number information to the position.

On-hook, or "flashing," signals are repeated to the operator from a calling or called subscriber by grounds extended via the OS or TS leads on FIG. 346 to the operator position circuit. The operator may re-establish a talking connection by depressing the access key for that link, if the link has been put in a hold condition.

#### POSITION CONTROL CIRCUIT OPERATION—NonANI CALL

If the originating office is not equipped for ANI operation, the nonANI dial 0 trunk, immediately upon its seizure by the originating office, bids for an operator position without first connecting to a sender. The operator posi-



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tion is then connected and bids for a data transfer circuit usage to interconnect the trunk with the position, in order that the trunk may pass information to the operator, among which information is included an indication that this is a dial 0 nonANI call. The data transfer circuit, after being connected, checks and transfers the information transmitted from the trunk to the position and then releases. The operator then challenges the subscriber, not only for the called number information, but for the complete calling number information as well. Once the operator has obtained these and entered them into the storage registers at the position, the operator then bids for connection to a sender and completes the remainder of the call in the same manner as previously described.

## SENDER OPERATION

Referring to FIG. 205, the operator next depresses the ST (start) key, causing relay 205-ST to operate. Relay 205-ST, operated, extends ground through its make contacts on FIG. 184, causing relay 184-ST to operate. Referring now to FIG. 179, relay 184-ST, operated, extends ground through its make contacts to operate relay 179-STF. Relay 179-STF, operated, extends ground through its transfer make contacts, via the RF- lead from FIG. 73A of the position link, to FIG. 346 of the trunk, which operates relay 341-SR. Relay 341-SR, in operating, extends ground on the ST and FR leads of FIG. 344 to the sender link which connects the trunk to a sender. The grounded FR lead has the same effect in the sender as a "rerouted" call, so that this first completion of a dial 0 call is handled by the sender as previously described for a "rerouted" call. Ground on the C0 lead from the sender link is now passed on the SA lead to the service observing circuit of FIG. 344. The ground received over the C0 lead from the sender link operates the 344-T relay, the operation of which opens the ST lead to the sender link and operates relay 344-T1. The 344-T1 relay, operated, places a ground on the S lead of FIG. 343 to the trunk link. When the sender is ready to receive information, ground received from the sender link over the FR lead of FIG. 344 is passed to the position control circuit on the SA lead. The circuit interconnecting the FR conductor of FIG. 344 with the SA conductor of FIG. 346 may be traced as follows: conductor FR, transfer make contacts of relay 344-T, transfer break contacts of relay 339-FA, transfer make contacts of relay 341-SR and relay 344-T, to conductor SA of FIG. 346, to the link and connector circuit. For this use of a sender on a dial 0 call (the first use if nonANI, or the second use if ANI), the trunk circuit notifies the sender of such operator usage by grounding the FR lead (FIG. 344), via the sender link, to FIG. 24, to operate sender relay 24-OPT rather than 24-SPL. Sender relay 24-SPL is operated for first use of the sender on a dial 0 ANI call, or for other calls, such as the described MF call, if the FT lead to the sender link is grounded in the trunk circuit instead of the FR lead. This operation of relay 24-OPT instructs the sender to disregard any of the class information coming from the sender link, i.e., such as whether the trunk originally has registered an MF mark, a DP mark, or an AS0 mark. (The validity of the ANI or AMA marks would still be checked before relay 42-ONI operates.) This, in turn, instructs the sender that there is no calling number function on this call, since an operator has control of the connection, and that it is to give only a sender-attached signal back to the position for the data transfer seizure, followed by the passage to the sender, via the data transfer circuit, of the called number information. The sender, upon receiving this information from the position, requests a marker usage and, once the connection is set up forward, it will output the call and release from the connection.

The SPL and OPT marks are actually controlled within the trunk circuit itself. If the trunk does not have its relay 341-SR operated at the time the sender is seized, its conductor FT will be grounded through transfer break

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contacts of relays 341-SR and 344-T in the trunk, which ground will be passed over conductor FT, through the sender link, to operate relay 24-SPL in the sender. If relay 341-SR is operated in the trunk at the time a sender is seized, the trunk, through a transfer make contact of its 341-SR relay and a transfer break contact on its 344-T relay, applies ground over conductor FR, through the sender link, to the sender, to operate relay 24-OPT. The necessity for having the trunk circuit control the class mark information in the sender is due to the fact that dial 0 ANI trunks sometimes serve customer-dialed calls which require the calling number functions of the sender, and at other times the dial 0 ANI trunks serve operator positions with relay 24-OPT operated, where no calling number function must be performed by the sender. It must not reverse the tip-and-ring polarities into an off-hook condition for an operator usage, since this would cause a false charging condition in the local office.

In response to the sender-attached signal on the SA lead, the position control circuit removes ground from the RF lead, thereby releasing relay 341-SR, the release of which keeps lead SA grounded through transfer make contacts on FIG. 340 of relay 344-T operated.

## SECOND SEIZURE OF DATA TRANSFER CIRCUIT

The position control circuit now seizes the data transfer circuit and connects a positive 130-volt potential to the position link lead KPR (FIG. 346). This positive potential operates relay 341-TP90 for ANI calls and relay 341A-TP80 for nonANI calls. The same potential is extended, via conductor SP and make contacts 344-T1, to the sender over sender link lead SPI to connect the sender to the data channel, as hereinbefore described. Relay 341-TP90, operated, closes the data information leads of FIG. 347 to the data transfer circuit, which, after checking, then passes the information to the sender, along with the called station digits now stored in the position. When all information has been satisfactorily passed to the sender, the data transfer circuit releases, thereby removing the positive 130-volt potential from the KPR lead, which, in turn, releases relay 341-TP90 or 341A-TP80.

## SENDER AND MARKER OPERATION

The sender, after it has received the called number information, calls in a marker to set up a connection to the terminating office. The marker selects an idle outgoing trunk leading to the terminating office, selects idle linkage between the incoming trunk and the selected outgoing trunk, and closes the linkage to set up the connection.

The marker causes ground to be applied, via the sender and the sender link and controller circuit, to lead DC on FIG. 344, thereby operating relay 344-F, in order to establish the location of this incoming trunk circuit appearance on the trunk link frame. Relay 344-F, operated, in turn, operates relay 339-FA. Relay 344-F, operated, extends its operating ground through its make contacts on FIG. 343, and over the LC lead of FIG. 343 to an LC relay in the trunk link frame. That LC relay operates and extends the ground back to the marker from the trunk link and connector. A marker relay operates and grounds the LC lead (FIG. 343) to lock operated the LC relay in the trunk link frame and the 344-F relay in the trunk. By keeping relay 344-F operated, the marker maintains a channel of common communication through the trunk link, over the TRL lead, and through make contacts of the 344-F relay, to the sender, via the D lead, after the release of the marker connector has opened the direct channel between the marker and the sender.

The 344-F relay, operated, also supplies grounds for operating the trunk link primary select magnet associated with this trunk circuit. It connects the S lead of FIG. 343, through its transfer make contacts, to the SL lead over which the marker supplies the sleeve lead ground while setting up the connection through the trunk and office link frames. When the marker has checked the connection to



the outgoing trunk, it removes ground from the LC lead, to release the 344-F relay. The release of relay 344-F connects ground extended through the make contact of the 344-T1 relay, through transfer break contacts 344-F, to the operated hold magnets on the S lead of FIG. 343, thereby transferring control of the connection, through the tandem office, from the marker to the sender. The marker checks for this ground before releasing, and gives a trouble indication if it is not present.

The sender FT and FR leads (FIG. 24) are now connected, via the sender link and controller circuit, through transfer make contacts of the 339-FA relay, to the outgoing tip-and-ring leads (FIG. 343) to the trunk link. The sender then outpulses the called number.

After outpulsing, but before releasing the 344-T relay, the sender prepares the incoming trunk circuit to hold the connection, to repeat the supervisory signals from the terminating office, and to provide a transmission path. First, the sender grounds the D lead (FIG. 48) to operate the 339-D relay, which, in turn, operates the 345-D1 relay, which, in its turn, operates relay 346-D2. Make contacts on FIG. 343 of the 345-D1 and 346-D2 relays ground the S lead (FIG. 343) to hold the connection to the trunk link after the sender is released. Transfer make contacts of the 345-D1 relay close through the T and R leads (FIG. 343) to the trunk link for transmission. The loop from the outgoing T lead to the outgoing R lead includes the winding of the 343-CS polarized relay. This relay provides means for recognizing supervisory signals from the terminating office. It also supplies trunk closure, to give the incoming trunk control of the outgoing trunk.

When relay 346-D2 operates, it connects a ground to the DC lead (FIG. 344) to the sender link. The sender checks for this ground, as an indication that the trunk closure is completed, and then opens the CO lead (FIG. 344) to release the 344-T relay. The sender also checks for removal of ground from the DC lead (FIG. 344). Relays 344-T1 and 339-FA release after the release of relay 344-T, and the sender link and the sender are then released.

The operator is now bridged on the established connection through the trunk circuit and waits for an answer from the called party. While the 341-PA relay remains operated under control of the position operator, relay 339-RV is held operated, so that the originating office circuit cannot be disconnected.

#### CALLED PARTY ANSWERS

Called party answer is indicated by a reversal of polarity on the T and R leads (FIG. 343) from the called office, which operates the 343-CS polarized relay. Since busy-back and overflow signals are intermittent reversals from the called office, and since the call may be abandoned just as it is answered, relays 344-A1 and 343-CS must remain operated for a minimum of two to five seconds in order for the trunk circuit to recognize a legitimate called-party-answer. This interval is controlled by relays from a charge-delay interrupter, and results in the operation of relays 345-IN and 345-CH. Referring to FIG. 342, the interrupter contacts CH, in the lower righthand corner, operate and release relays 342-F1 and 342-B1 continuously at a predetermined frequency. The frequency is such that ground can be supplied by a 342-F1 relay make contact not less than two seconds and not more than five seconds after ground is supplied by a 342-B1 relay make contact. The operation of relay 342-B1 closes the following path to operate relay 345-IN: ground on terminal 101 on FIG. 345, transfer make contacts of relay 343-CS, make contacts 344-A1, transfer break contacts of relay 345-CH, break contacts 341-CTM, transfer make contacts of relay 346-D2, and make contacts 342-B1, to the winding of relay 345-IN, which operates from battery through the A resistor. The 345-IN relay locks to the same ground on terminal 101 through the 343-CS relay transfer make contacts. When relay 342-F1 operates, with

relay 345-IN operated, relay 345-CH operates over the following circuit: ground on terminal 102 on FIG. 345, make contacts of relay 345-IN, another set of make contacts of relay 345-IN, make contacts of relay 342-F1, transfer make contacts 346-D2, to the winding of relay 345-CH to operate it from battery through the A resistor. The 345-IN relay is now locked under control of the 345-CH relay operated. Note that the 345-IN relay will release if either the 344-A1 or the 343-CS relay should release before the 345-CH relay is operated, i.e., within two to five seconds after relay 345-IN is first operated. In this event, the timing cycle may begin again if the circuit is not disconnected. The trunk circuit is now conditioned to control the making of timing entries on AMA tape, provided, of course, that an initial entry has already been made. The operation of the 343-CS relay removes the ground from the TS lead (FIG. 346) to the position link, to provide called-end supervision to the operator.

#### PERFORATION OF INITIAL ENTRY AND POSITION RELEASE

Since, on the majority of calls, it is necessary for an operator to determine when the desired connection has been established, the initial entry on the AMA tape is under the operator's control. All of the data required for the initial entry is registered at the operator position, and when the operator requests that an entry be made, a transverter is associated with the position and it determines the initial entry to be perforated for this call.

The IC lead (FIG. 346) to the position link and the DJ lead to the call identity indexer on FIG. 345 are checked for false grounds and for continuity during the perforation of the initial entry. The checking of the IC and DJ leads is performed under control of the transverter, which, at this time, forms a loop circuit out of the IC and DJ leads, with the loop running through all the circuits of the office associated with the perforation of the initial entry at this time. Upon checking for the loop continuity, the transverter causes the DJ and IC leads to be grounded, thereby causing the operation of the call identity indexer, to initiate the recording of the trunk number. The OT lead (FIG. 345) to the call identity indexer is also checked for an open at this time. The RC lead (FIG. 345) to the call identity indexer is checked for the presence of ground, and the TC lead to the same circuit is checked for battery through the winding of relay 345-TC. These checks of the OT, the RC, and the TC leads are controlled by the recorder to prevent any false charging. Any check failure results in a transverter trouble indication.

If the initial entry fails, the operator may make another attempt at any entry, or may "ticket" the call. For a non-charge call, an initial entry is not made. When the initial entry has been made, the operator receives an entry-completed signal and can then release the link connection from the trunk circuit. While the operator is connected, the operator is in control of the connection. The operator receives continuous supervision from both ends of the connection over the OS and TS leads of FIG. 346, and may talk to both subscribers over the T and R lead (FIG. 346) bridge. After the initial entry, the operator, on normal calls, releases the position link and the 341-PA relay. With relay 341-PA released, the trunk circuit is in control of the connection.

#### PERFORATION OF THE ANSWER ENTRY

Depending upon the type of call, the operator may make the initial entry either before or after the answer by the called party. In either case, the answer entry will not be made until completion of both the initial entry and the answer-delay cycle. When this occurs, the path between the CH lead of FIG. 346 to the recorder and lead DJ of FIG. 345 to the call identity indexer is closed. When a recorder is available for this trunk, the CH lead will be grounded, and this ground will be extended over



the DJ lead to the call identity indexer, to cause the call identity indexer once again to transmit the calling trunk number to the recorder. This signal results in leads OT, TC, and RC being connected through to the recorder. Lead OT is checked for the presence of battery, and lead RC is checked for partial battery potential by the recorder. When answer-entry is recorded, ground is connected to lead RC by the recorder, which shunts down the 345-IN relay. The release of relay 345-IN opens the lead RC as a signal to the recorder, and the path between the CH and DJ leads is opened to disconnect the recorder. There will usually be no further action in the circuit after the 345-IN relay is released during the answer entry or, if no initial entry had been made, after the relay 345-CH has been operated, until the called or calling party disconnects. However, the calling party may recall the position if it is not connected; and, if the operator holds the trunk circuit connected to the traffic service position link, either the called or the calling party may signal the operator for assistance.

#### CALLING PARTY DISCONNECTS

The release of relay 339-D, after the release of relay 338-A for disconnection of the call, is under control of the calling subscriber, unless after cut-through the circuit has been connected to a position link. The link may be kept locked to the trunk circuit after cut-through if supervision by the operator is required. In this event, the 341-PA and 340-PA1 relays are kept operated, and relay 339-D cannot release to initiate disconnection until the operator releases the locked link.

When the originating subscriber disconnects, the T and R loop is changed to high resistance, thereby causing the release of relays 338-A and 344-A1. With the position link released, timer tube 339-TM begins its timing cycle. Capacitor TM now charges through resistor TM, thereby raising the cathode-to-anode potential of the timer tube. The charging continues until—at some critical potential—the starter arc from electrode 2 to electrode 4 is transferred to the main gap comprising electrodes 2 and 1. The tube completely ionizes and passes a large current, which flows through the primary winding of the operated 339-D relay. The magnetic field now produced by the tube current flowing in the primary winding cancels the magnetic field produced by the current flowing in the secondary winding to release relay 339-D. This release occurs from 500 to 800 milliseconds after the release of the 338-A and the 340-PA1 relays. The release of relay 339-D opens the tube charging circuit, thereby causing the arc to extinguish. Relay 345-D1 now releases, followed by release of relay 346-D2. The T and R leads (FIG. 343) to the terminating office are opened by relay 345-D1 releasing. The opening of the T and R leads releases the 343-CS relay, if operated, and allows the terminating office circuits to restore to normal. The energized hold magnets on the trunk and office link frames are released when the opening of the make contacts of the slow-releasing 346-D2 relay removes ground from the S lead (FIG. 343) to the trunk link circuit. If a "charge" condition was established, the release of relay 346-D2, at its break contacts on FIG. 346, connects a ground from the recorder circuit on the CH lead to the DJ lead to the call identity indexer, as a start signal.

The disconnect entry is handled in the same manner as the answer entry; however, when the RC lead is grounded by the recorder, this time relay 345-CH is shunted down. The release of relay 345-CH opens the RC lead, as a signal to the recorder. Relay 345-CH, released, opens the path between the CH and DJ leads, and releases the 345-TC relay and relay 345-IN, if operated. The 339-RV relay is released by the release of relay 345-TC; however, if no initial entry is made, the release of relay 339-RV follows the release of relay 345-D1. Relay 339-RV, released in turn, de-energizes relay 344-RVR. Relay 339-RV, released, at its contacts on FIG. 338, also

sends a steady on-hook signal, which releases the originating office circuit. The trunk circuit is now restored to normal.

#### IRREGULAR CALLS—NONCHARGE CALLS

On certain calls, such as those completed to free numbers, or calls which must be timed and manually ticketed by the operator, the operator does not make an initial entry. Also, the 345-TC relay is not operated in this case, because no initial entry has been made. There are no requests for answer or disconnect entries. When the subscriber disconnects, with the switchboard link also released, the connection is released, as previously described. The release of relay 345-D1 results in the release of relay 339-RV, and, subsequently, in the release of relay 344-RVR, thereby restoring the trunk to normal.

#### Call encountering busy or overflow conditions

When a line-busy condition is encountered, there may be polarity reversals from the called office to alternately operate and release relay 343-CS. This "flashing" condition is not mistaken for an "answer," since relay 343-CS does not remain operated for a predetermined interval of time, such as for example, two seconds. Relay 343-CS, operating and releasing, connects intermittent ground to the position link lead TS (FIG. 346) to "flash" the operator supervisory lamp, which indicates a "busy" condition. Interrupted tone from the called office will be returned to the calling subscriber, and the operator can inform the calling subscriber of the busy condition. The connection may be released, or a new connection may be set up forward at this time, if the calling party so desires.

If an all-trunks-busy condition is encountered at an intermediate link, in setting up the connection, a recorded announcement is returned to the operator and to the calling subscriber. Alternately, as a busy signal, intermittent tone, with or without "flashes," is returned to the operator. In either case, the connection is handled by the operator in the same manner as for a line-busy condition.

If an all-trunks-busy condition is encountered in the tandem office, the sender requests the marker to set up the connection to an overflow trunk. The connection is cut through to the overflow trunk, which returns an announcement or recorder tone, with or without "flashes," to the operator and to the calling subscriber. The operator then releases the connection, or sets up a new call forward, as on a line-busy condition.

#### Abandoned calls

The calling subscriber may abandon a call at any time before completion of the charge-delay cycle, which indicates a legitimate answer. The release of the connection, as previously described, varies somewhat, depending upon when the abandoned-call signal is recognized during the process of setting up the connection. In all cases, however, no charging entries are made on the AMA tape.

If the call is abandoned before the position link is closed, the sender is released, if attached, and the trunk circuit restores to normal without signaling the operator. If it is abandoned after the operator is connected, the release of the 344-A1 relay connects ground to the OS lead of FIG. 346, as a disconnect signal to the operator. The operator then releases the link connection and the trunk circuit restores to normal.

If the call is abandoned after the position link is released but before the called party answers, the connection is released and the trunk circuit restores to normal as on a regular call, except that no timing entries are made on the AMA tape.

#### Sender time-out

If the sender should time out while requesting a position, after having received ANI information, ground is removed from the sender link lead FT (FIG. 344), thereby releasing relay 344-PR to remove the position request, and the registered ANI information will be released.



The sender advances "out" and removes ground from lead C0 (FIG. 344) to release relay 344-T and the slow-releasing relay 344-T1. Relay 344-T, released, closes the loop to relay 338-A, which now operates. Relay 344-PR now reoperates and originates a new position request, which causes the position link to reconnect this trunk circuit with an idle operator position. Relay 344-PR, operated, also holds relay 339-RV operated and re-applies ringing tone to the transmission circuit, as an indication to the calling subscriber that the call is now being served.

When an idle position has been selected, relay 341-PA operates (thereby removing ground from the ST lead of FIG. 346 to the operator position), holds relay 339-RV operated, and operates relay 340-PA1. Relay 340-PA1, operated, releases relay 344-PR, and the audible ringing ceases. The position control circuit seizes the data transfer circuit, and the 341-TP90 relay is operated from the KPR lead of FIG. 346. The trunk information is checked and transferred by the data transfer circuit to the operator position. Part of the information to the data transfer circuit includes the ground on the ZTO lead of FIG. 347, to inform the operator that the calling number must be obtained from the calling subscriber.

The call may be abandoned at any point, in which case the sequence is the same as previously described.

#### *Second trial by marker*

If the marker encounters trouble in setting up the connection, it can ground the trunk link lead TRL of FIG. 343, which, via the D lead of FIG. 344 and the sender link and controller circuit, will signal the sender to make another trial. After the second unsuccessful trial, the sender will route the call to overflow.

#### *Calling party does not disconnect—Timed release*

The calling subscriber is normally in control of the connection after the operator has released the position link. He is not, however, permitted to hold up the connection to the called party indefinitely if the called party hangs up. Normally, both subscribers hang up within a few seconds of each other and no special action is taken.

If the calling subscriber has not hung up when the called subscriber hangs up, relay 343-CS releases and energizes the thermal type relay 345-RL. If the calling party does not disconnect within 15 to 25 seconds, relay 345-RL operates and releases relay 345-D1. The sequence of operation following the release of relay 345-D1 is the same as that previously described for normal operation. When the disconnect entry is made, if required, ground on the OT lead informs the recorder that the disconnect was caused by a timed release. This results in a special mark being perforated on the AMA tape, so that the accounting sender can compensate for the timed disconnect in computing the elapsed time of the call.

If the call was a noncharge call, the timed release functions the same as on a charge call, with the exception that no AMA entry is then made and the OT lead is not grounded.

#### *Special features—Trunk circuit held through lock link*

Referring to FIG. 216, by operating a HOLD key at a position, the operator can keep the trunk circuit connected through the position link to the position control circuit. With the HOLD key operated, ground is extended via conductor HD to operate relay 166-HB. Relay 166-HB, operated, extends a ground to operate one of the relays 173-HD0, -HD1, or -HD2. The operated 173-HD-relay extends ground to operate a corresponding one of the relays 169-T0, -T1, or -T2. The operated one of the 169-T-relays extends a ground to operate a corresponding one of the relays 169-T0A, -T1A, or T2A, to hold the registration. The operator keeps control of the trunk circuit connection while attending to other calls. The 341-PA and 340-PA1 relays in the trunk are held operated.

The 339-RV relay is held operated by the 341-PA relay. The position talking circuit is not associated with the connection unless the operator reoperates the access key ACS—associated with the link, but supervisory signals from either the calling or the called subscriber are repeated to the position since the OS and TS leads (FIG. 346) from the trunk are closed through to the position. The operator can now effect the required operator functions.

#### *Cancel timing*

After the initial entry has been made under operator control, it may be desirable to change the entry due to a change in a called classification, or because the entry was made too soon. Referring now to FIG. 213, if the position register still contains the call data required for the initial entry, the operator can initiate a cancel timing request by operating key CNL TMG. With the CNL TMG key operated, ground is extended via conductor CTM to operate relay 179-CTM. Relay 179-CTM, operated, extends negative 48 volts, through resistor CTM, to conductor RFO on FIG. 179; thence through a previously described path, through the operator loop, and through the link and connector circuit, to the RF lead on FIG. 346 of the trunk circuit. If the call has not yet been answered, relay 341-CTM operates and, in turn, operates relay 340-CD. Relay 340-CD, operated, releases relay 345-TC. Relay 345-TC, released at its break contacts on FIG. 340, connects ground to the position link lead SA on FIG. 346. This ground is used to inform the operator that the initial entry signal in the trunk circuit has been canceled. Since only the initial entry will be found by the accounting center, no charge will be made. With the SA lead grounded, the position control circuit removes battery from lead RF on FIG. 346, causing relay 341-CTM to release. The release of relay 341-CTM causes relay 340-CD to release.

If a call been answered before the cancel timing request is made, it is necessary to make a special disconnect entry in addition to restoring the trunk circuit to the no-entry condition. As previously described, the operation of relay 341-CTM operates relay 340-CD, which then releases relay 346-D2. Relay 346-D2, released, causes a request for a disconnect entry. A positive 130-volt potential from FIG. 339 is then applied, via lead HV2, to the OT lead of FIG. 345. When the disconnect entry is made, the high voltage on the OT lead informs the recorder that the entry is made because of a cancel-timing request. This results in a special mark being perforated on the AMA tape, which mark the accounting center will recognize and then disregard the call timing entries, and will make no charge for the call. Ground from the recorder circuit, on the RC lead of FIG. 345, shunts the 345-CH relay when the cancel timing entry is recorded. Relay 345-CH releases, followed by the release of relay 345-TC, and relay 345-IN if operated. Relay 345-CH, released, also reoperates relay 346-D2. Relay 345-TC, released, at its break contacts on FIG. 340, grounds the SA lead on FIG. 346. The position control circuit releases the 341-CTM relay which, in turn, releases relay 340-CD. The recorder circuit and the call identity indexer release after the 345-CH relay is shunted down.

The purpose of the circuit functions associated with the operator's depressing the cancel-timing key CNL TMG is: (1) to cause a cancel timing entry to be made if a prior timing entry has already been made and, (2) to release relay 345-TC. The description in the preceding paragraph assumed that a timing entry had already been made. However, if this is not the case, relay 345-TC releases when the cancel-timing key CNL TMG is operated, and no cancel-timing entry is perforated.

If the cancel-timing disconnect entry is not made within two to five seconds, the 345-TC relay is shunted down as previously described. Battery connected by the trunk circuit to the position link lead SA of FIG. 346 informs the operator that the cancel-timing entry was not made.



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The operator must then manually "ticket" the call for the proper charging information. Relay 341-CTM is released when, after timing for five to eight seconds from the connection of battery on the RF lead of FIG. 346, the position control circuit removes the battery. Relay 341-CTM, released, reoperates relay 346-D2 and releases the 345-CH and 340-CD relays. Thus, the trunk circuit is returned to the no-entry condition.

*Releasing forward*

The operator may release the forward connection without losing the trunk circuit connection to the calling subscriber. The release-forward signal originates from a manually operated key, RLS FWD (FIG. 205) at the operator position. With the RLS FWD key operated, ground is extended via conductor RLF, in cable RT, to operate relay 179-RLF. Relay 179-RLF, operated, extends negative 48 volts, through resistor RLF, conductor RLF0, and through the link and connector circuit, to conductor RLF on FIG. 346 of the trunk circuit. This battery operates relay 340-RLF. If the sender is connected, the T and R leads to the sender link are now opened. The sender may then be abandoned, thereby releasing the terminating office circuits. The sender advances and ground is removed from the C0 lead of FIG. 344. The removal of this ground causes the 344-T relay, and, in turn, the 339-FA relay, if operated, to release. The release of the 344-T relay releases relay 344-T1, which, released, removes ground from the S lead of FIG. 343, thereby releasing the trunk link, if operated. If no initial entry was made, relay 344-T, released, also releases relay 340-RLF. If upon operation of the 340-RLF relay, the sender is not attached and the call has been completed forward, the 339-D relay is released and, in turn, relay 345-D1. If no initial entry was made, relay 339-D, releasing, releases the 340-RLF relay. Relay 345-D1, releasing, at its transfer make contacts on FIG. 343, also opens the T and R leads forward and, at its make contacts on FIG. 346, releases the 346-D2 relay. Relay 346-D2, released, removes ground from the S lead on FIG. 343 to release the trunk link.

The remainder of the sequence depends upon the supervisory and the AMA entry condition at the time. If the called party has not answered, or if the trunk circuit is in a no-entry condition (the forward connection being released), there is no charging for the previously established connection. If the connection being released forward has been answered, and if the trunk circuit condition shows that the initial and start-timing entries have been made, a disconnect entry is made on the AMA tape when the forward connection is released. In this case, the call is charged for up to the time of releasing forward.

The operator may now either set up a new connection forward or may disconnect the position circuit. If an initial entry was made, the 340-RLF relay is locked operated under control of the operated 345-TC relay. The 345-TC relay is released, either by the release of relay 340-PA1 following the position disconnect or by the operation of relay 340-CD when a new forward connection is attempted. The 340-RLF and 340-CD relays then release.

*Operator establishes a connection forward*

After a connection has been released as just described, the operator can establish a new connection to a called subscriber. When the position circuits are ready to set up a new connection forward, ground on the position link lead RF (FIG. 346) operates relay 341-SR. Ground extended to the sender, via the sender link lead ST (FIG. 344), connects a sender to the trunk; and ground extended to the sender, via the sender link lead FR (FIG. 344) informs the sender that this is an operator request rather than a subscriber request. When the sender is attached, ground extended from the sender, via the CO lead from the sender link (FIG. 344), operates relay 344-T. The

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sender holding bridge on the T and R leads is closed through resistor 338-SH. When the sender is ready to receive pulses, it connects ground to the sender link lead FR (FIG. 344), and this ground is extended to the switchboard position over position link lead SA (FIG. 346). The position then removes ground from the RF lead (FIG. 346), which releases the 341-SR relay. At the same time, the position control circuit requests a data transfer channel and connects battery to the position link lead KPR (FIG. 346). This battery operates relay 341-TP90, and is extended, via lead SP, and through make contacts 344-T1, to the sender over sender link lead SPI (FIG. 344), to connect the sender to the data channel, as previously described. The called number digits and the class information are transferred to the sender, after which the data transfer circuit is released and battery is removed from the KPR lead, thereby releasing relay 341-TP90. The sender then proceeds to set up the desired call forward, as previously described for a normal call.

*Ringback*

Referring to FIG. 213, when a connected operator wishes to ring back on a connection to recall an originating subscriber, a RINGBACK key is depressed at the operator position. This causes a ground to be connected, via the position link and connector, to the position link lead RB (FIG. 346), thereby operating relay 341-RB. Relay 341-RB, operated, applies +130 volts through resistance lamp 339-HV, via conductors HV1 and HV3, and -48 volts through resistance lamp 340-LV, via conductor LV1 to the T and R leads, with on-hook polarity, back to the originating office, as a ringback signal. Upon release of the RINGBACK key at the operator position, ground is removed from the RB lead and the 341-RB relay releases, to terminate the ringback signal and to re-establish an off-hook T and R lead connection towards the originating office.

*Ring forward*

Referring to FIG. 213, when a connected operator wishes to ring forward on a connection to recall a called subscriber, this is done by operating the RING FWD key. With the RING FWD key operated, ground is extended, via the link and connector circuit, to the RF lead (FIG. 346). This ground operates the 341-RF relay, which, in turn, operates relay 340-RFC. When the RING FWD key is released, relay 341-RF releases and, in turn, releases relay 340-RFC. Relay 341-RF, released, connects +130 volts, through resistance lamp 339-RV, and via conductors HV1 and HV3, to the forward T and R leads, through simplex resistor RF, for the duration of the release time of relay 340-RFC. Relay 340-RFC releases in 100 to 200 milliseconds, and this timed application of simplex battery causes the called office circuits to apply a ringing signal to the called line.

*Cordboard transfer*

When the position operator receives a request for a special call, such as a mobile, foreign, or conference call, it must be transferred to a cord switchboard operator for proper handling. In this event, the position operator operates the transfer key TRFR (FIG. 205) at the position, thereby operating relay 179-TRCB. Relay 179-TRCB, operated, extends ground, via the link and connector circuit, to the position link lead RLF (FIG. 346) to operate relay 340-CBST. Relay 340-CBST, in operating, connects ground over leads ST, and A, and battery over lead S on FIG. 342 to the trunk finder circuit. Ground connected on lead ST starts a trunk finder, associated with an idle switchboard transfer circuit, hunting for this circuit. The finder level on which this trunk circuit appears is identified by a ground connected on lead A, and its appearance on the level is identified by battery extended through the 342-CB relay winding, to lead S.



When the finder has stepped to the appearance of this trunk circuit, ground on lead S (FIG. 342) operates relay 342-CB, which holds to the S lead, and releases relay 340-CBST. Control leads are now closed through, the relay 342-CB holds relay 339-RV operated and, at its transfer make contacts on FIG. 342, closes the T and R leads, including the winding of the 343-CS relay bridge, to the connected circuit which functions to maintain ground on lead S (FIG. 342), to signal the cordboard operator. When the cordboard operator answers, the T and R lead (FIG. 343) polarity is reversed, thereby operating polarized relay 343-CS, which, at its transfer break contacts on FIG. 345, removes ground from the position lead TS (FIG. 346), as an answer signal. The position operator may now communicate with the cordboard operator. After passing the necessary information, the position operator may then release the position from the call, thereby releasing the position link and relays 341-PA and 340-PA1. The connection is then under the joint control of the cordboard operator and the calling party.

If all the trunk finders in the group are busy or out of service when relay 340-CBST is operated, the position operator will be informed of this fact, since transfer make contacts on FIG. 346 of relay 340-CBST connect the TS lead (FIG. 346) to the operator position circuit to a TS lead (FIG. 342) to alarm relays in the trunk finder circuit.

When the calling customer disconnects, the 338-A relay is released, followed by the release of relay 344-A1. Ground is removed from the A lead (FIG. 338) to the service observing circuit, and the T and R loop (FIG. 342) to the switchboard trunk circuit is opened, thereby causing a disconnect signal to appear at the cordboard. The cordboard connection is then taken down manually. Ground is then removed from the S lead (FIG. 342), thereby causing the release of the transfer trunk, the trunk finder, and the 342-CB relay. Relay 339-RV now releases, thereby reversing the incoming T and R lead polarity to release the originating office circuit; and relay 344-RVR releases, thereby returning this trunk circuit to normal.

#### *Recalling position*

With the trunk circuit cut through and with no position link attached, a momentary on-hook ("flashing") signal by the calling subscriber will connect an operator for further assistance to the trunk via the position link.

The switchhook "flash" momentarily releases relays 338-A and 344-A1, and the reclosure of the line loop then reoperates relay 338-A. The reclosure of the line loop incident to the "flashing" signal should occur before relay 339-D is released. Under this condition, ground is extended from terminal 101 in FIG. 344, through transfer break contacts 341-SR, make contacts 338-A, transfer make contacts 339-RV, transfer break contacts 344-A1, make contacts 345-D1, and break contacts 340-PA1, and through the winding of relay 344-PR, causing it to operate. Relay 344-PR, operated, grounds the PS lead (FIG. 346), as a "start" signal to the position link and connector circuit. The position is connected as previously described. A ground on the RCL lead (FIG. 347) to the data transfer circuit serves to inform the operator that the position was connected on a recall operation. The operator now talks to the subscriber and provides whatever assistance is required.

It is to be understood that the above-described arrangements are but illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a telephone switching system, trunk circuits, a first and a second group of other circuits, means responsive to the receipt of a call by one of said trunk circuits for interconnecting it with one circuit in each of said

groups, a data transfer circuit, further means responsive to the receipt of said call for causing said one trunk circuit to effect the transmission of a service request signal to said data transfer circuit, and means responsive to the receipt of said signal by said data transfer circuit for causing it to establish a data transmission path interconnecting said one trunk circuit with said one circuit in each of said groups.

2. In a switching system, a plurality of incoming trunk circuits, a group of sender circuits, a group of position circuits, a first switching means responsive to the receipt of an incoming call by one of said trunk circuits for interconnecting said one trunk circuit with one circuit in each of said groups, and additional switching means responsive to said interconnection for effecting a second interconnection between said one trunk circuit and the said one circuit in each group.

3. The invention of claim 2 in combination with means responsive to said second interconnection for causing call data to be transmitted thereover between the circuits inter-connected by said additional switching means.

4. In a switching system, a plurality of incoming trunk circuits, a group of sender circuits, a group of position circuits, switching means responsive to the receipt of a call by one of said trunk circuits for interconnecting it with one circuit in each of said groups, a multichanneled interconnecting means, means in said one circuit of said position group and responsive to its interconnection with said calling trunk circuit for applying a service request signal to said multichanneled interconnecting means, means responsive to said signal for interconnecting said one position circuit with one channel of said interconnecting means, and means responsive to said last interconnection for connecting said one channel to said calling trunk circuit and to the circuit in said sender group currently interconnected with said calling trunk circuit.

5. A switching system having a plurality of incoming trunk circuits together with a first and a second group of other circuits wherein a trunk circuit receiving an incoming call is interconnected via a first switching means with a circuit in each of said groups, characterized in that the system further comprises additional switching means associable with any of said trunk circuits and with any of the circuits of said first and second groups and responsive to a signal from a circuit in said first group upon its interconnection with said calling trunk circuit for connecting said calling trunk circuit to the particular circuit in each of said groups with which said calling trunk circuit is currently interconnected via said first switching means.

6. A switching system having a plurality of incoming trunk circuits together with a first and a second group of other circuits wherein a trunk circuit receiving an incoming call is interconnected via a first switching means with a circuit in each of said groups, characterized in that the system further comprises additional switching means connectable with any of said trunk circuits and with any of the circuits of said first and second groups, means for transmitting a signal to said additional switching means from a circuit in said first group upon its interconnection with said calling trunk circuit signifying the identity of said calling trunk circuit, and means in said additional switching means responsive to the reception of said signal for connecting said calling trunk circuit to the particular circuit in each of said groups with which said calling trunk circuit is currently interconnected via said first switching means.

7. A switching system comprising a plurality of incoming trunk circuits and a first and a second group of other circuits wherein a trunk circuit receiving an incoming call is interconnected via a first switching means with one circuit in each of said groups, characterized in that the system further comprises a second switching means connectable with any of the trunk circuits and with any of the circuits of said first and second groups for connecting



a calling trunk circuit to the particular circuit in each of said groups with which said trunk circuit is currently interconnected via said first switching means, means for transmitting information to said second switching means on each call identifying the calling trunk circuit and said circuits currently connected thereto via said first switching means, and means including said second switching means responsive to the receipt of said information for interconnecting said calling trunk circuit to said one circuit in each of said groups.

8. In a switching system, a plurality of incoming trunk circuits, a plurality of senders and registers, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting said calling trunk circuit with one of said senders and one of said registers, means in said sender for registering calling station information received via said calling trunk circuit from a preceding office, means in said register for registering called station information received via said calling trunk circuit from said preceding office, and switching means responsive to said last registration for transmitting the called station information from said register to said sender while said sender is receiving said calling station information.

9. In a switching system, a plurality of incoming trunk circuits, a plurality of senders and registers, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting said calling trunk circuit with one of said senders and one of said registers, means in said sender for registering calling station information received via said calling trunk circuit from an originating office, means in said register for registering called station information received via said calling trunk circuit from said originating office, a data transfer circuit, means responsive to said registration by said register for connecting said register to said data transfer circuit, and means responsive to said connection for transmitting the called station information from said register to said sender while said sender is receiving said calling station information.

10. In a switching system, a plurality of incoming trunk circuits, a plurality of senders and registers, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting said calling trunk circuit with one of said registers, means in said register for registering called station information received via said calling trunk circuit from said originating office, means responsive to said registration by said register for connecting said calling trunk circuit to one of said senders, means in said sender for registering calling station information received via said calling trunk circuit from an originating office, a data transfer circuit, means responsive to said registration by said register for connecting said register to said data transfer circuit, means responsive to said connection for causing said data transfer circuit to interconnect said register and said sender, and means responsive to said last interconnection for transmitting the called station information from said register to said sender simultaneously with the reception of said calling station information by said sender.

11. In a tandem telephone switching system, incoming trunk circuits for serving calls incoming from originating offices, outgoing trunks extending to called offices, means responsive to the receipt of a call by one of said incoming trunk circuits for establishing a connection to one of said outgoing trunks, operator positions, further means responsive to a call on one of said incoming trunk circuits for establishing an interconnection between the said incoming calling trunk circuit and one of said operator positions, additional circuits, other means responsive to a call on one of said incoming trunk circuits for establishing an interconnection between said calling trunk circuit and said additional circuits, a data transfer circuit, means responsive to the interconnection of said incoming trunk circuit and said operator position for causing said data transfer circuit to interconnect said operator position

with a plurality of said additional circuits, and means responsive to said last interconnection for causing said additional circuits to transmit call data to said operator position via said data transfer circuit.

12. The invention of claim 11 in combination with call recording equipment, and means operable under control of an operator for causing said recording equipment to record charge data for said call.

13. In a telephone switching system, incoming trunk circuits for serving calls from originating offices, outgoing trunks extending to called offices, operator positions, further means responsive to the receipt of a call by one of said incoming trunk circuits for establishing an interconnection between the said incoming calling trunk circuit and one of a plurality of operator positions, additional circuits, means responsive to a call on one of said incoming trunk circuits for establishing an interconnection between said calling trunk circuit and said additional circuits, a data transfer circuit, means responsive to the interconnection of said incoming trunk circuit and said operator position for causing said data transfer circuit to interconnect said operator position with a plurality of said additional circuits, means responsive to said last interconnection for enabling said operator position to transmit call data via said data transfer circuit to one of said additional circuits, and means responsive to the receipt of said call data for establishing a connection through said office to one of said outgoing trunks.

14. The invention of claim 13 in combination with means operable under control of an operator for recording charge data for said call.

15. In a switching system, a control circuit, an incoming trunk circuit, an operator's position circuit, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position and said trunk circuit for establishing a data channel interconnecting said position circuit with said control circuit and with said trunk circuit, and means responsive to the establishment of said data channel for causing said control circuit and said trunk circuit to transmit call data over said channel to said position circuit.

16. The invention of claim 15 in combination with circuit responsive to said call on said incoming trunk circuit for establishing a connection from said incoming trunk circuit to an outgoing circuit extending to a terminating office.

17. The combination recited in claim 16 together with means operable under control of an operator at said position circuit for recording data pertaining to said call.

18. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office, a control circuit, an incoming trunk circuit, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said trunk circuit with said control circuit, means in said control circuit for registering call information received over said trunk circuit, switching equipment responsive to said registration for establishing a connection from said incoming trunk circuit to an outgoing circuit extending to a terminating office circuit, an operator's position circuit, means responsive to said registration for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position and said trunk circuit for establishing a data channel interconnecting said position circuit with said control circuit and with said trunk circuit, means responsive to the establishment of said data channel for causing said control circuit and said trunk circuit to transmit over said channel to said position circuit information pertaining to the call currently served by said incoming trunk circuit, and means operable under control of an operator at said position circuit for recording data pertaining to said call.



19. In a switching system, a plurality of senders, a plurality of incoming trunk circuits, means responsive to the receipt of a call by one of said trunk circuits for interconnecting said one trunk circuit with one of said senders, means in said one sender for registering call information received over said trunk circuit, a plurality of operator position circuits, means responsive to said registration in said sender for interconnecting said trunk circuit and one of said one position circuits, means responsive to said interconnection of said one position circuit and said trunk circuit for establishing a data channel interconnecting said position circuit with said sender and with said trunk circuit, and means responsive to the establishment of said data channel for causing said sender and said trunk circuit to transmit over said channel to said position circuit information pertaining to call currently served by said trunk circuit.

20. The invention recited in claim 19 in combination with means operable under control of an operator at said one position circuit for recording data pertaining to said call.

21. The invention of claim 19 in combination with switching equipment responsive to said registration in said sender for establishing a connection from said trunk circuit to an outgoing circuit extending to a subsequent switching center.

22. The invention of claim 21 in combination with means in said sender responsive to the establishment of said connection to said outgoing circuit for transmitting called station information to said subsequent switching center.

23. The invention recited in claim 22 in combination with means at said position circuit operable under control of an operator thereat for releasing said connection from said trunk circuit to said sender and to said outgoing circuit.

24. The invention recited in claim 23 in combination with further means at said position circuit operable under control of an operator thereat for registering new called station information, means responsive to the registration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

25. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office, a control circuit, an incoming trunk circuit, an operator's position circuit, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position and said trunk circuit for establishing a data channel interconnecting said position circuit with said control circuit and with said trunk circuit, means responsive to the establishment of said data channel for causing said control circuit and said trunk circuit to transmit over said channel to said position circuit information pertaining to the call currently served by said incoming trunk circuit, means effective when said position circuit is interconnected with said trunk circuit for establishing a speech circuit between said position circuit and the calling and called stations for said call, means operable under control of an operator at said position circuit for recording data pertaining to said call, and means responsive to said call on said incoming trunk circuit for establishing a connection from

said incoming trunk circuit to an outgoing circuit extending to said terminating office.

26. In a switching system, a sender, an incoming trunk circuit, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said trunk circuit with said sender, means in said sender for registering calling and called station information received over said trunk circuit, an operator's position circuit, switching equipment responsive to said termination of said registration in said sender for establishing a connection from said incoming trunk circuit to an outgoing circuit extending to a terminating office, means in said sender responsive to the establishment of said connection for transmitting called station information to said terminating office, further means responsive to said registration in said sender for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position and said trunk circuit for establishing a data channel interconnecting said position circuit with said sender and with said trunk circuit, means responsive to the establishment of said data channel for causing said sender and said trunk circuit to transmit over said channel to said position circuit information including said calling and called station information pertaining to the call currently served by said incoming trunk circuit, means effective when said position circuit is interconnected with said calling trunk circuit for establishing a speech circuit between said position circuit and the calling and called stations for said call, and means operable under control of an operator at said position circuit for recording data pertaining to said call.

27. In a switching system for interconnecting a calling incoming trunk circuit with an outgoing circuit extending to a called line at a terminating office, a control circuit, an operator's position circuit, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position and said trunk circuit for establishing a data channel interconnecting said position circuit with said control circuit and with said trunk circuit, means responsive to said establishment for causing said control circuit and said trunk circuit to transmit call information over said channel to said position circuit, and means at said position circuit operable under control of an operator thereat for registering calling station information.

28. The invention recited in claim 27 in combination with means at said position circuit operable under control of an operator thereat for recording data pertaining to said call.

29. The invention of claim 27 in combination with means including said control circuit responsive to said call on said incoming trunk for establishing a connection from said incoming trunk to an outgoing circuit extending to a terminating office.

30. In a switching system for interconnecting a calling incoming trunk circuit with an outgoing circuit extending to a called line at a terminating office, a sender, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said trunk circuit with said sender, means in said sender responsive to said interconnection for registering call information, an operator position circuit, means responsive to said registration by said sender for interconnecting said calling trunk circuit and said position circuit, means responsive to said interconnection of said position circuit and said trunk circuit for establishing a data channel interconnecting said position circuit with said sender and with said trunk circuit, means responsive to said establishment for causing said sender and said trunk circuit to transmit call information over said channel to said position circuit, means effective when said position circuit is interconnected with said calling trunk for establishing a speech circuit between said position circuit and the calling and called stations for said call, and means at said position circuit operable under



control of an operator thereat for registering calling station information.

31. The invention of claim 30 in combination with switching equipment responsive to the completion of said registration in said sender for establishing a connection from said incoming trunk to an outgoing circuit extending to a terminating office, and means in said sender responsive to the establishment of said connection for transmitting called station information to said terminating office.

32. The invention recited in claim 31 in combination with means at said position circuit operable under control of said operator for recording data pertaining to said call.

33. In a switching center for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office, a plurality of registers, an incoming trunk circuit responsive to the receipt of a call thereon for seizing one of said registers, means in said one register for registering called station information received over said calling trunk circuit, a plurality of senders, means in said one register responsive to the registration of said called station information for causing said calling trunk circuit to seize one of said senders, a data transfer circuit, means in said one register responsive to the registration of said called station information for causing said data transfer circuit to interconnect said one register with said one sender, means in said one register for transmitting said called station information over said data transfer circuit to said one sender for registration therein, means responsive to said last registration for releasing said one register and said data transfer circuit, means in said one sender for recording calling station information received over said calling trunk circuit, a plurality of operator position circuits, means responsive to the registration of said calling and called station information by said one sender for interconnecting said calling trunk circuit and one of said position circuits, means including said data transfer circuit responsive to said interconnection of said one position circuit and said calling trunk circuit for establishing a data channel interconnecting said one position circuit with said one sender and with said calling trunk circuit, and means responsive to the establishment of said data channel whereby said one sender and said calling trunk circuit transmit over said channel to said one position circuit information pertaining to the call currently served by said calling trunk circuit.

34. The invention of claim 33 in combination with means including said one sender responsive to said registration in said one sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to said terminating office.

35. The invention recited in claim 34 in combination with means in said sender responsive to the establishment of said connection from said incoming trunk circuit to said outgoing circuit extending to said terminating office for transmitting called station information to said terminating office.

36. The invention recited in claim 35 in combination with means in said position circuit for connecting speech-wise an operator at said position with the calling and called stations on said call.

37. The invention recited in claim 36 in combination with recording means and means at said position circuit operable under control of an operator thereat for controlling the recording of data pertaining to said call.

38. The invention recited in claim 35 in combination with means at said one position circuit operable under control of an operator thereat for releasing said established connection from said calling trunk circuit to said outgoing circuit.

39. The invention recited in claim 38 in combination with further means at said one position circuit operable under control of an operator thereat for registering new called station information, means responsive to the regis-

tration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

40. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a called line at a terminating office, a plurality of registers, a plurality of incoming trunk circuits, means responsive to the receipt of a call by one of said trunk circuits for seizing one of said registers, means in said one register for registering called station information received over said calling trunk circuit, a plurality of senders, means in said one register responsive to the registration of said called station information for causing said calling trunk circuit to seize one of said senders, a data transfer circuit, means in said one register responsive to the registration of said called station information for causing said data transfer circuit to interconnect said one register with said one sender, means in said one register for transmitting the called station information through said data transfer circuit to said one sender for registration therein, means responsive to said registration for releasing said one register and said data transfer circuit, a plurality of operator position circuits, means responsive to the termination of registration of said called station information by said one sender for interconnecting said calling trunk circuit and one of said position circuits, means including said data transfer circuit responsive to said interconnection of said one position circuit and said calling trunk circuit for establishing a data channel interconnecting said one position circuit with said one sender and said calling trunk circuit, means responsive to the establishment of said data channel whereby said one sender and said calling trunk circuit transmit over said channel to said one position circuit information pertaining to the call currently served by said calling trunk circuit, and means operable under control of an operator at said one position circuit for registering calling station information.

41. The invention recited in claim 40 in combination with recording means and means at said position circuit operable under control of an operator thereat for controlling the recording of data pertaining to said call.

42. The invention of claim 40 in combination with switching equipment responsive to said registration in said one sender for establishing a connection from said calling trunk circuit to said outgoing circuit extending to a terminating office.

43. The invention of claim 42 in combination with means in said sender responsive to the establishment of said connection from said incoming trunk circuit to said outgoing circuit extending to said terminating office for transmitting called station information to said terminating office.

44. The invention recited in claim 43 in combination with means effective when said one position circuit is interconnected with said calling trunk circuit for establishing a speech circuit between said one position circuit and the calling and called stations for said call.

45. The invention recited in claim 43 in combination with means at said one position circuit operable under control of an operator thereat for releasing said established connection from said calling trunk circuit to said outgoing circuit.

46. The invention recited in claim 45 in combination with further means at said one position circuit operable



under control of an operator thereat for registering new called station information, means responsive to the registration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

47. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office under control of a sender circuit, a plurality of groups of incoming trunk circuits with each trunk group having an identifying group number individual thereto, a plurality of groups of sender circuits and position circuits, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting it with one of said sender circuits and with one of said positions circuits, means responsive to said interconnection for transmitting the group number of said calling trunk circuit to both said one sender circuit and said one position circuit, a data transfer circuit, means responsive to said interconnection for transmitting said calling trunk circuit group number to said data transfer circuit, and means responsive to the reception by said data transfer circuit of said calling trunk circuit group number for establishing a supplemental interconnection path between said calling trunk circuit and said one sender circuit and said one position circuit.

48. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office under control of a sender circuit, a plurality of groups of incoming trunk circuits with each trunk circuit group having an identifying group number individual thereto, a plurality of groups of sender circuits, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting one of said senders with said incoming calling trunk circuit, means responsive to said interconnection for transmitting call information to said one sender with said information including the group number of said calling trunk circuit, a plurality of groups of operator position circuits, means responsive to the registration of said information in said sender for interconnecting said calling trunk circuit with one of said operator position circuits, means responsive to the interconnection of said calling trunk circuit and said one position circuit for transmitting to said one position circuit call information including the group number of said calling trunk circuit, a data transfer circuit having a plurality of data channels, a trunk circuit group number translator for each data channel, means responsive to the interconnection of said calling trunk circuit and said one position circuit for interconnecting said position circuit with one of said data channels, means responsive to the interconnection of said one operator position circuit with said one data channel for transmitting to said data channel the group number of said calling trunk circuit, means operable for connecting any one of said incoming trunk circuits to any one of said data channels, said last-named means including trunk circuit subgroup relays for each trunk circuit group and a trunk circuit secondary relay for each data channel of each trunk circuit group, all trunk circuits of a group being connectable to each data channel by one of said trunk circuit subgroup relays and by a trunk circuit secondary relay common to the trunk circuit group and the data channel, means including said trunk circuit group number translator responsive to the receipt of said trunk circuit group number by said one

data channel for operating the trunk circuit secondary relay common to said one data channel and the trunk circuit group containing said calling trunk circuit, further means responsive to the reception by said one data channel of said trunk circuit group number for operating the trunk circuit subgroup relay serving said calling incoming trunk circuit thereby interconnecting said calling incoming trunk circuit with said one operator position circuit via said one data channel, means operable for interconnecting any one of said senders with any one of said data channels, said last-named means including a sender primary relay individual to each sender and a set of sender secondary relays for each channel of each sender group, each group of senders having a secondary relay for each channel, further means responsive to the receipt of said trunk circuit group number information by said data channel for operating the sender primary relay of the sender currently connected to the said calling incoming trunk circuit, a translator control circuit for each group of senders, means responsive to the operation of the primary relay in said one sender for transmitting the group number of said calling trunk circuit from said one sender to said translator control circuit for the group containing said calling sender, means in said translator control circuit serving said calling sender for translating the group number of said calling trunk circuit, means for supplying to said translator control circuit information signifying the operation of each trunk circuit secondary relay associated with the trunk circuit group containing said calling trunk circuit, and means responsive to said last-named means for operating the sender connector secondary relay for the calling sender and said one data channel, thereby interconnecting said sender via said one data channel with said calling trunk circuit and with said operator position circuit.

49. The invention recited in claim 48 in combination with means responsive to said last-named interconnection for causing said calling trunk circuit and said sender circuit to transmit call information to said operator position circuit.

50. The invention recited in claim 49 in combination with means including a data check circuit responsive to the reception of said information by said position circuit for releasing said data channel.

51. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office under control of a sender circuit, a plurality of groups of incoming trunk circuits with each trunk circuit group having an identifying group number individual thereto, a plurality of groups of sender circuits, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting one of said senders with said incoming calling trunk circuit, means responsive to said interconnection for transmitting call information to said one sender with said information including the group number of said calling trunk circuit, a plurality of groups of operator position circuits, means responsive to the registration of said information in said sender for interconnecting said calling trunk circuit with one of said operator position circuits, means responsive to the interconnection of said calling trunk circuit and said one position circuit for transmitting to said one position circuit call information including the group number of said calling trunk circuit, a data transfer circuit having a plurality of data channels, a trunk circuit group number translator for each data channel, means responsive to the interconnection of said calling trunk circuit and said one position circuit for interconnecting said position circuit with one of said data channels, means responsive to the interconnection of said one operator position circuit with said one data channel for transmitting to said data channel the group number of said calling trunk circuit, trunk circuit connecting means operable for connecting any one of said incoming trunk circuits to any one of said



data channels, means including said translator responsive to the reception by said one data channel of said trunk circuit group number for operating the trunk circuit connecting means, thereby interconnecting said calling incoming trunk circuit with said one operator position circuit via said one data channel, sender connecting means operable for interconnecting any one of said senders with any one of said data channels, and means responsive to the operation of said last-named means for operating said sender connecting means, thereby interconnecting said sender via said one data channel with said calling trunk circuit and with said operator position circuit.

52. In a switching system, a first, a second, and a third group of circuits, means for interconnecting one circuit of each group during the serving of a call by said office, a data transfer circuit, a plurality of connector circuits operable to interconnect said data transfer circuit with circuits in said first, second, and third groups, means responsive to the receipt of a call by said system for causing a circuit in said first group to interconnect itself with said data transfer circuit, means responsive to said connection for transmitting to said data transfer circuit the identity of the connector having access to the circuit in said second group to which the circuit in said first group is currently connected, means in said data transfer circuit for registering said information, and means in said data transfer circuit operable in response to the reception and registration of said information for establishing a supplementary interconnecting path between the priorly connected circuits in said first, second, and third groups.

53. In a switching system for interconnecting a calling incoming trunk circuit with an outgoing circuit extending to a terminating office, a plurality of senders, means responsive to the receipt of a call by said incoming trunk circuit for interconnecting said trunk circuit with one of said senders, means in said one sender responsive to said interconnection for registering call information, switching equipment responsive to said completion of said registration in said one sender for establishing a connection from said incoming trunk circuit to an outgoing circuit extending to said terminating office, a plurality of operator position circuits, further means responsive to said registration by said one sender for interconnecting said calling trunk circuit and one of said position circuits, means responsive to said interconnection of said one position circuit and said trunk circuit for establishing a data channel interconnecting said one position circuit with said one sender and with said calling trunk circuit, means responsive to said establishment whereby said one sender circuit and said trunk circuit transmit call information over said channel to said one position circuit, and means at said one position circuit operable under control of an operator thereat for registering calling station information.

54. The invention recited in claim 53 in combination with means at said one position circuit operable under control of an operator thereat for releasing said established connection from said calling trunk circuit to said outgoing circuit.

55. The invention recited in claim 54 in combination with further means at said one position circuit operable under control of an operator thereat for registering new called station information, means responsive to the registration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said sender for establishing a connection from said

calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

56. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office, a plurality of incoming trunk circuits, a plurality of senders, means responsive to the receipt of a call by one of said incoming trunk circuits for interconnecting said calling trunk circuit with one of said senders, means in said one sender for registering calling station information received over said calling trunk circuit, a plurality of position circuits, means responsive to the registration of said calling station information in said one sender for interconnecting said calling trunk circuit with one of said position circuits, a data transfer circuit, means responsive to the registration of said calling station information in said one sender for causing said one position circuit to seize said data transfer circuit, means responsive to the seizure of said data transfer circuit for causing said data transfer circuit to establish a data channel interconnecting said calling trunk circuit with said one position circuit and with said one sender, means responsive to said interconnection by said data channel for controlling said calling trunk circuit and said one sender to transmit calling station information via said data channel to said one position circuit for registration therein, means responsive to said last-named registration whereby said data transfer circuit and said one sender release, means at said one position circuit for registering called station information under control of an operator thereat, means operative subsequent to said called station information registration at said one position circuit for interconnecting said calling trunk circuit with any one of said senders, means responsive to said interconnection of said calling trunk circuit and said one sender for causing said one position circuit to seize said data transfer circuit, means responsive to said seizure for causing said data transfer circuit to establish a data channel interconnecting said calling trunk circuit with said one sender as well as with said one position circuit, means responsive to said last-named interconnection by said data channel for transmitting called station information from said calling trunk circuit and said one position circuit over said data channel to said one sender for registration therein, means responsive to said last-named registration by said one sender for releasing said data transfer circuit, and means including said one sender responsive to the registration of said called station information therein for establishing a connection from said incoming trunk circuit to an outgoing circuit extending to a terminating office.

57. The invention recited in claim 56 in combination with means in said sender responsive to the establishment of said connection from said incoming trunk circuit to said outgoing circuit extending to said terminating office for transmitting called station information to said terminating office.

58. The invention recited in claim 57 in combination with means at said one position circuit operable under control of an operator thereat for releasing said established connection from said calling trunk circuit to said outgoing circuit.

59. The invention recited in claim 58 in combination with further means at said one position circuit operable under control of an operator thereat for registering new called station information, means responsive to the registration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said



sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

60. The invention recited in claim 57 in combination with means effective when said one position circuit is interconnected with said calling trunk circuit for establishing a speech circuit between said one position circuit and the calling and called stations for said call.

61. The invention recited in claim 60 in combination with means for recording call information under control of said operator.

62. In a switching system for interconnecting an incoming calling trunk circuit from an originating office with an outgoing circuit extending to a terminating office, a plurality of incoming trunk circuits, a plurality of position circuits, means responsive to the receipt of a call by one of said incoming circuits for interconnecting said calling trunk circuit with one of said position circuits, means in said one position circuit for registering calling and called station information under control of an operator thereat, a plurality of senders, means responsive to said information registration in said one position circuit for interconnecting said calling trunk circuit with one of said senders, a data transfer circuit, means responsive to said interconnection of said calling trunk circuit and said one sender for causing said one position circuit to seize said data transfer circuit, means responsive to said seizure for causing said data transfer circuit to establish a data channel interconnecting said calling trunk circuit with said one sender as well as with said one position circuit, means responsive to said last-named interconnection by said data channel for transmitting called station information from said one position circuit over said data channel to said one sender for registration therein, means responsive to said last-named registration by said one sender for releasing said data transfer circuit, and means including said one sender responsive to the registration of said called station information therein for establishing a connection from said calling trunk circuit to an outgoing circuit extending to a terminating office.

63. The invention recited in claim 62 in combination with means in said sender responsive to the establishment of said connection from said incoming trunk circuit to

said outgoing circuit extending to said terminating office for transmitting called station information to said terminating office.

64. The invention recited in claim 63 in combination with means at said one position circuit operable under control of an operator thereat for releasing said established connection from said calling trunk circuit to said outgoing circuit.

65. The invention recited in claim 64 in combination with further means at said one position circuit operable under control of an operator thereat for registering new called station information, means responsive to the registration of said new called station information for interconnecting said calling trunk circuit with any one of said senders, means including said data transfer circuit responsive to said last interconnection for establishing a data channel between said one position circuit and said one sender, means responsive to the establishment of said last data channel for transmitting said new called station information from said one position circuit to said one sender for registration therein, and means responsive to the registration of said new called station information in said sender for establishing a connection from said calling trunk circuit to an outgoing circuit extending to the terminating office serving said new called station.

66. The invention recited in claim 63 in combination with means effective when said one position circuit is interconnected with said calling trunk circuit for establishing a speech circuit between said one position circuit and the calling and called stations for said call.

67. The invention recited in claim 66 in combination with means for recording all data in response to the operation of said operator-controlled means.

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