Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 1

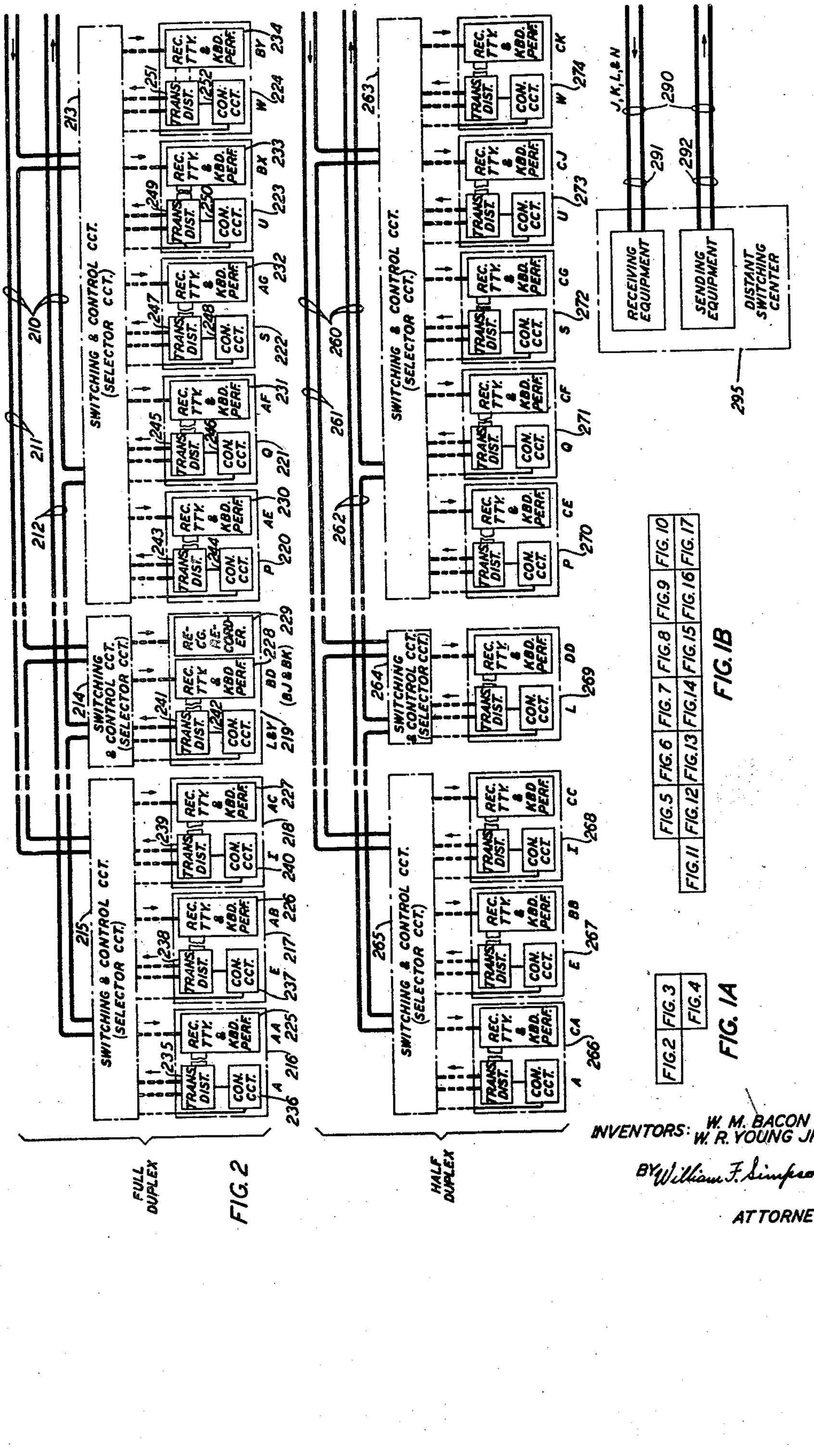

FIG. 2

FIG. 1A

FIG.11	FIG.12	FIG.13	FIG.14	FIG.15	FIG.16	FIG.17	
FIG.5	FIG.6	FIG.7	FIG.8	FIG.9	FIG.10		
				FIG.2	FIG.3		
					FIG.4		

FIG. 1B

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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 2

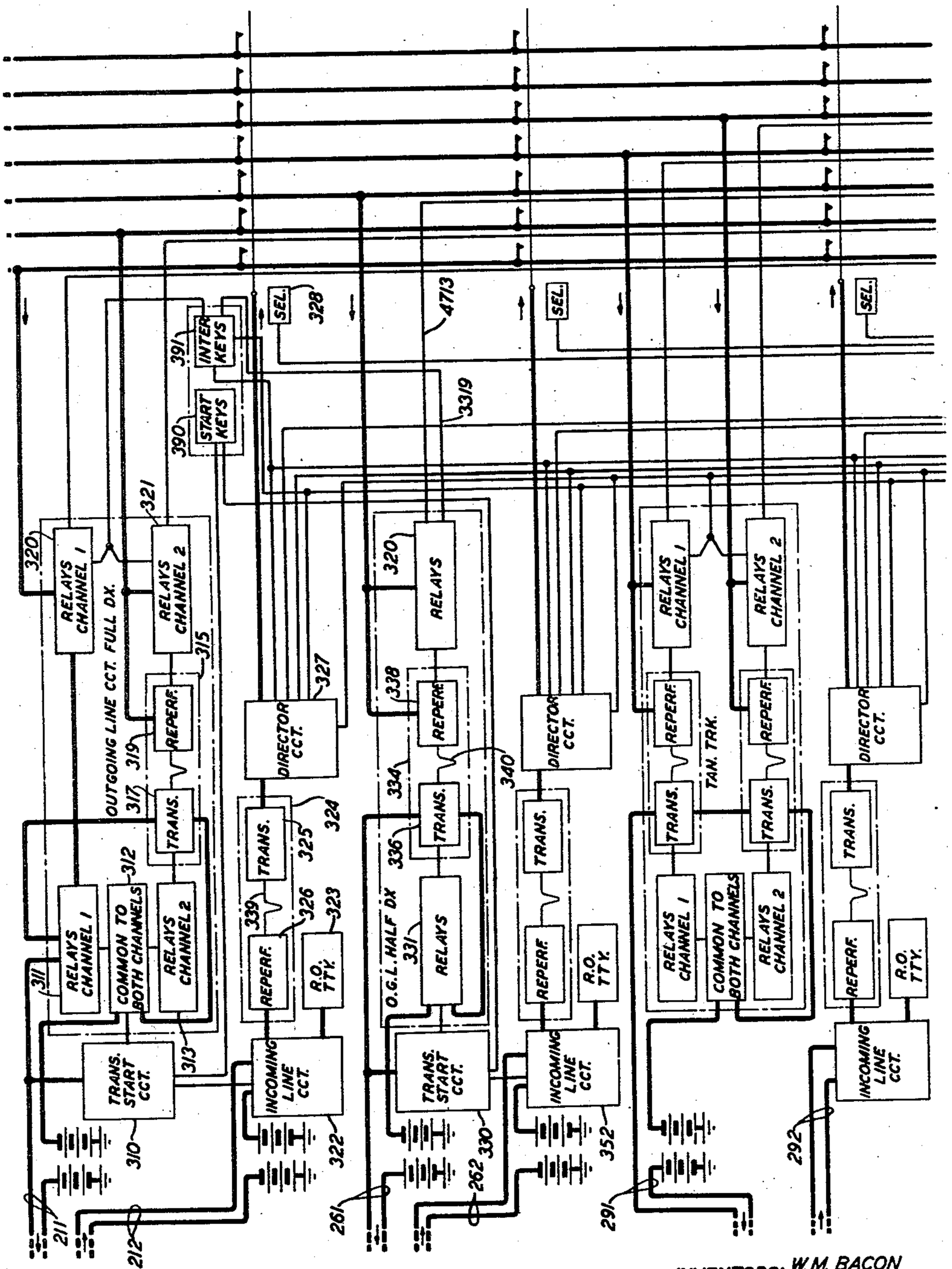

FIG. 3

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TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 3

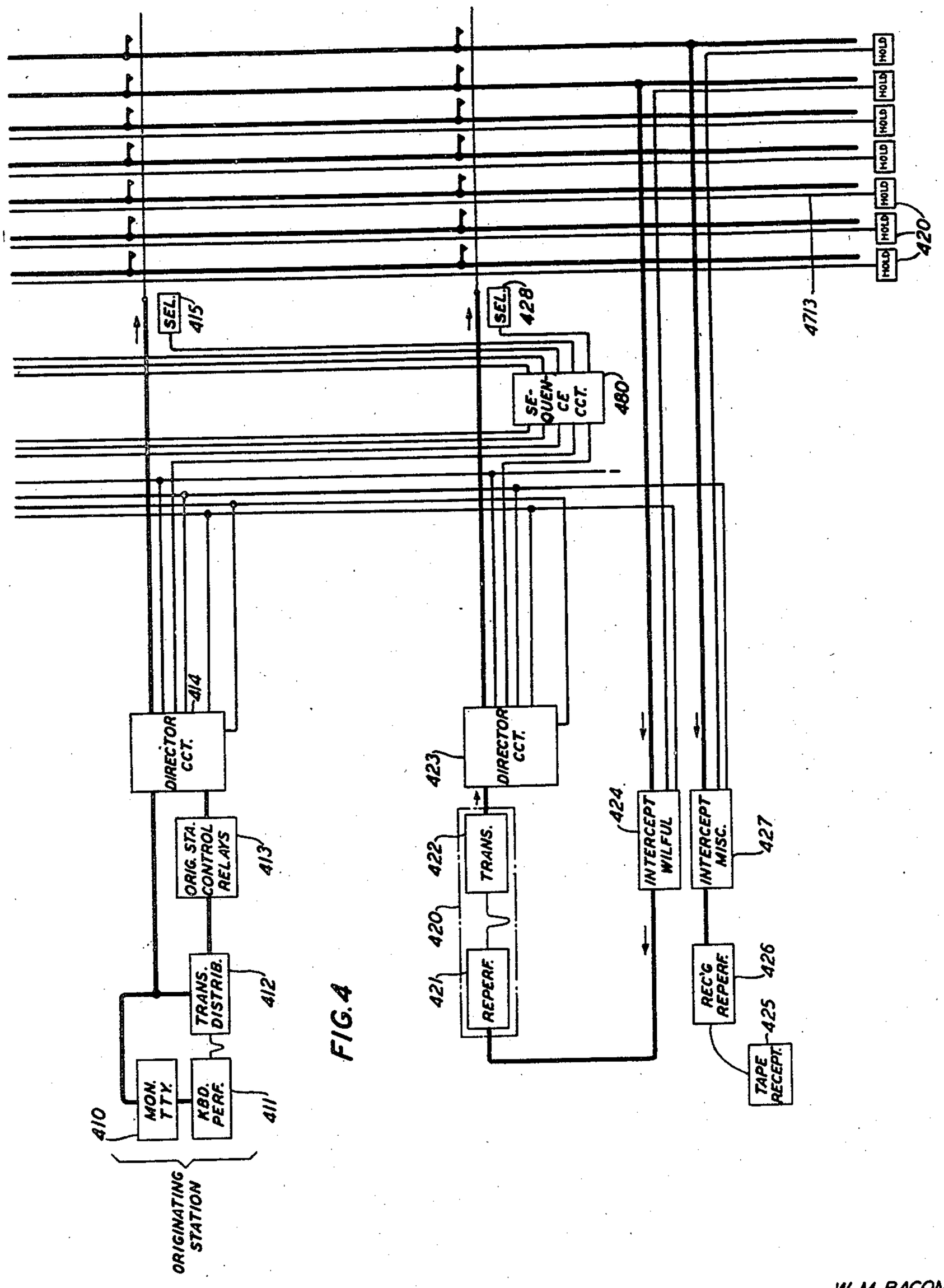

FIG. 4

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Dec. 24, 1946. W. M. BACON ET AL. 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 4

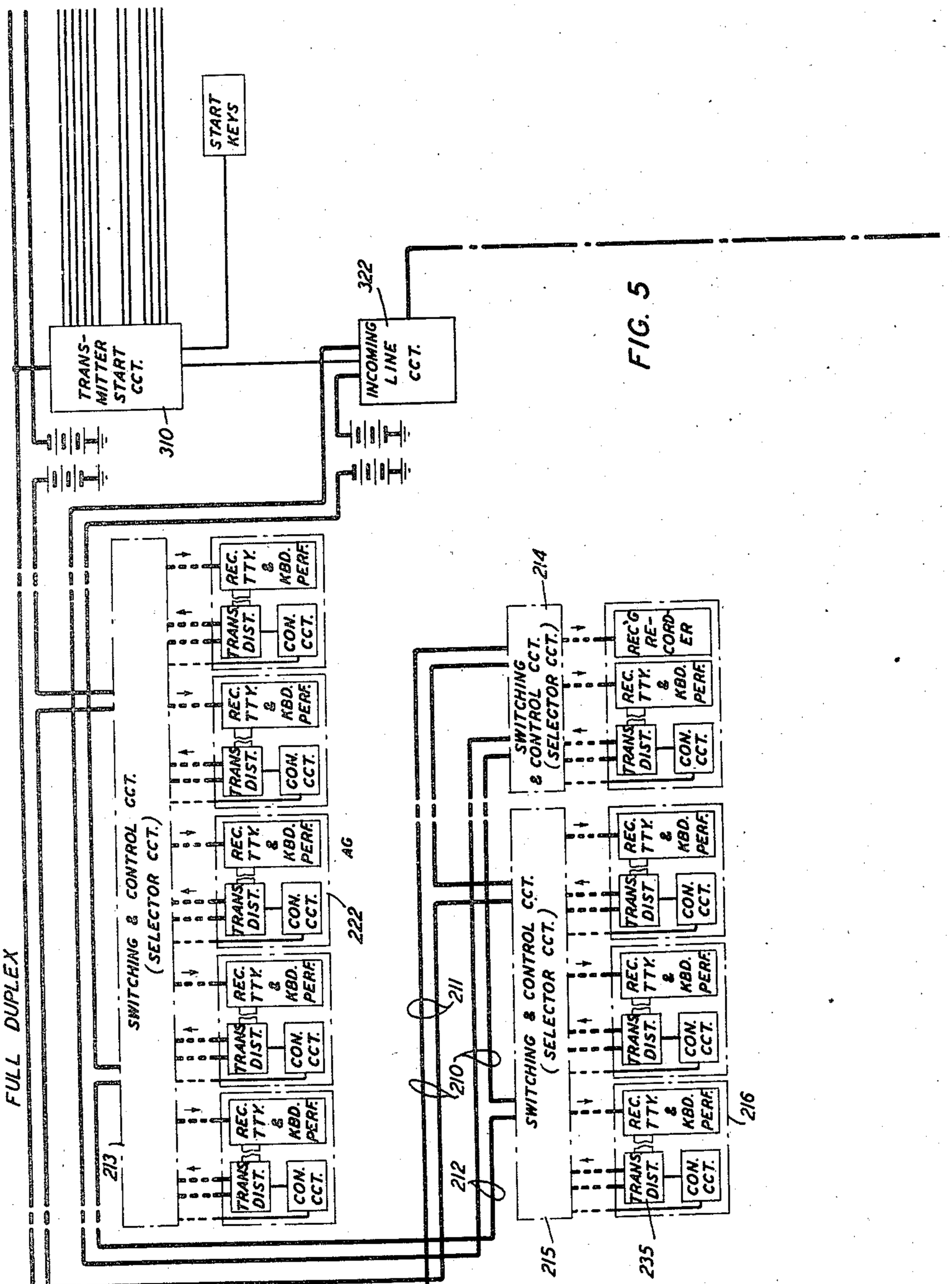

FIG. 5

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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 5

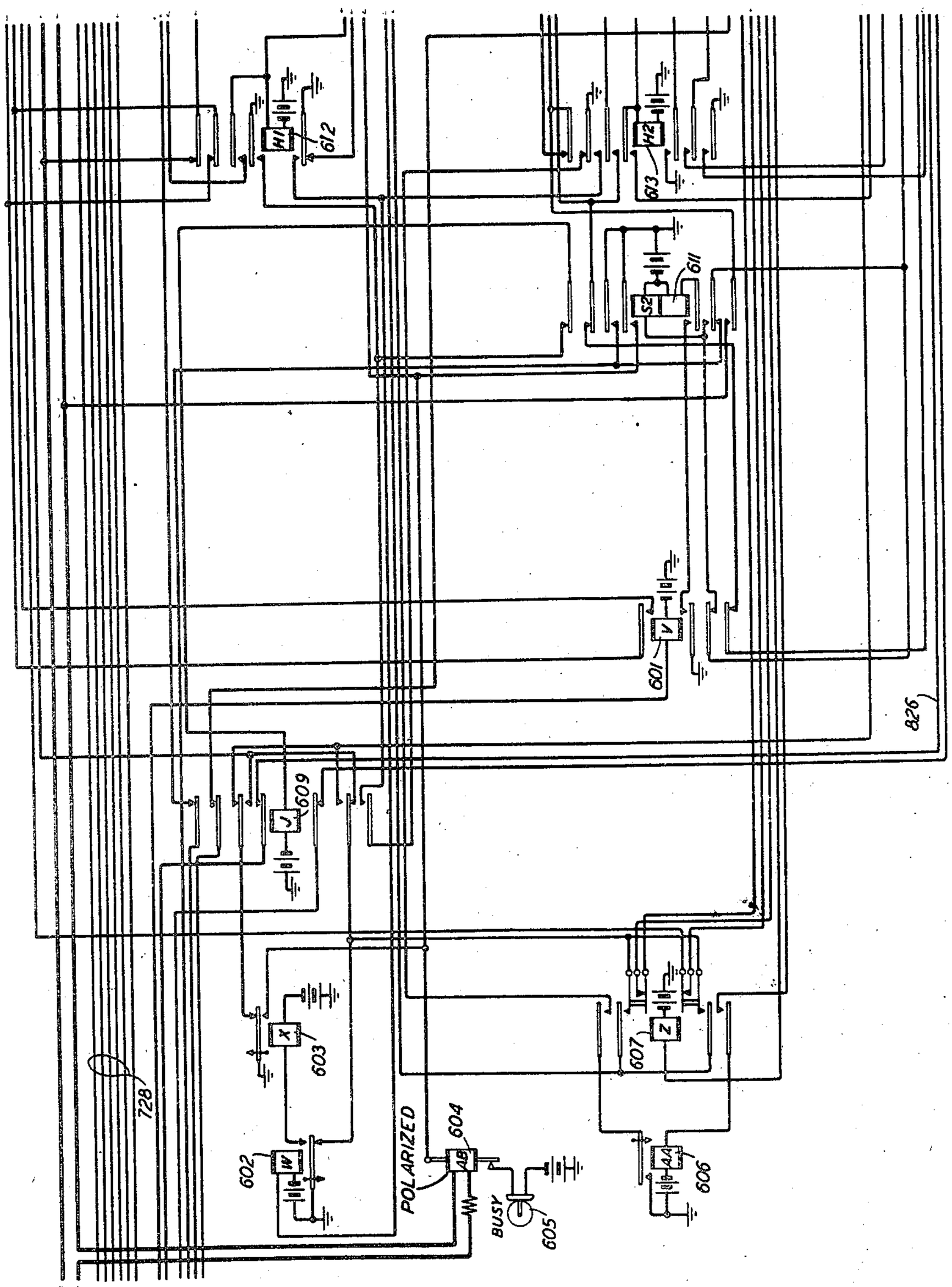

FIG. 6

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TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 6

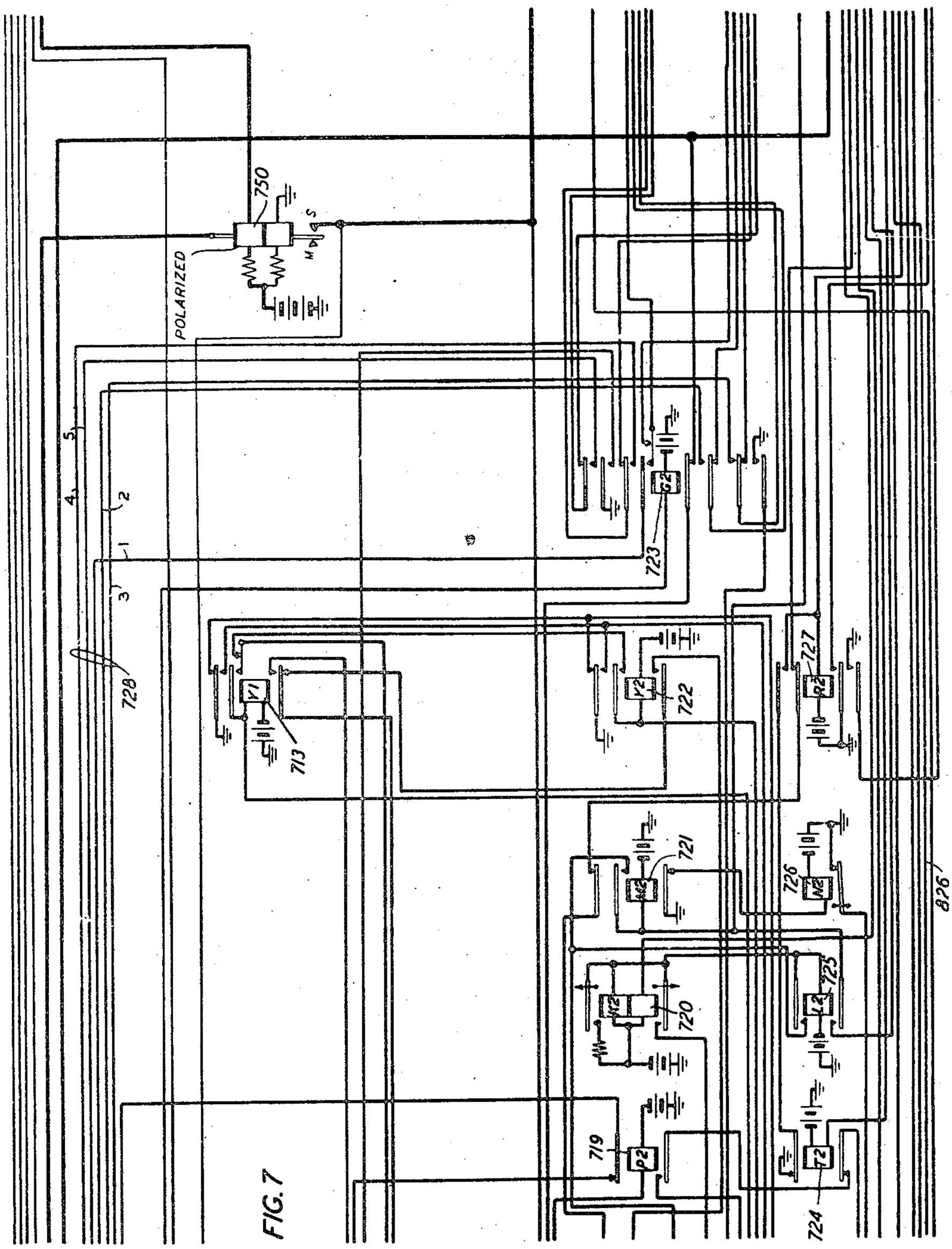

FIG. 7

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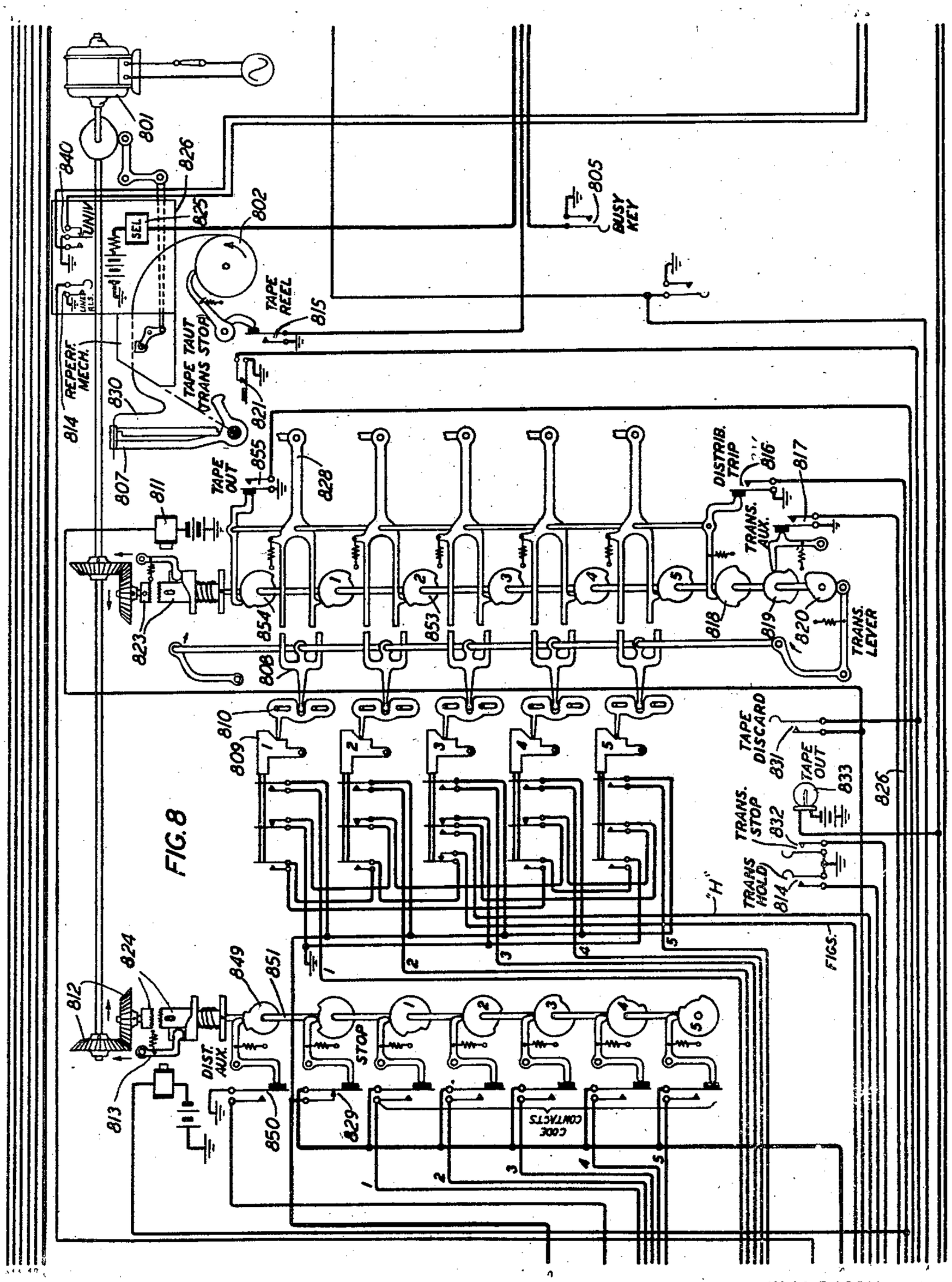
Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 7



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TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 8

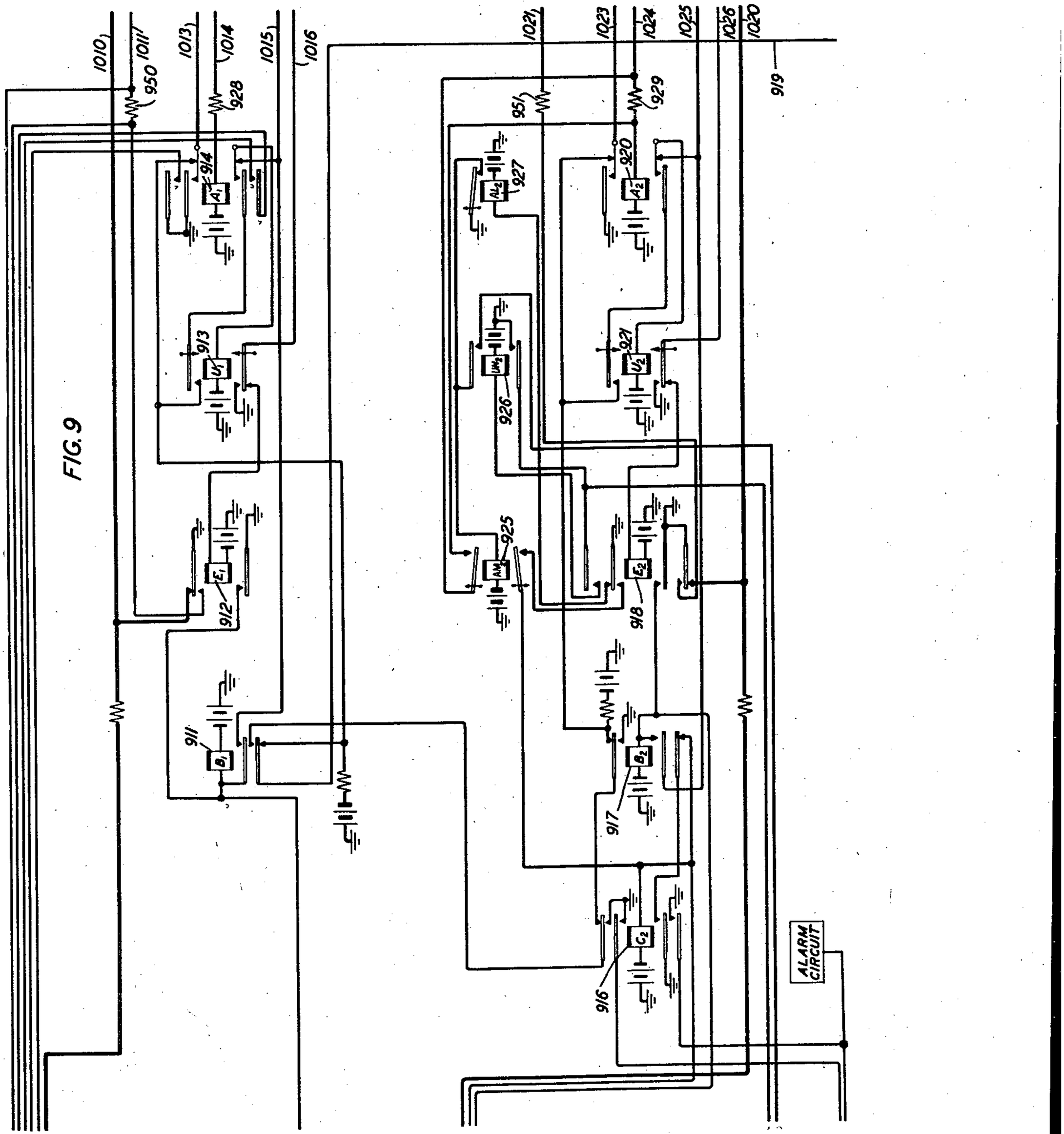

FIG. 9

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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 10, 1943 16 Sheets-Sheet 9

FIG. 10

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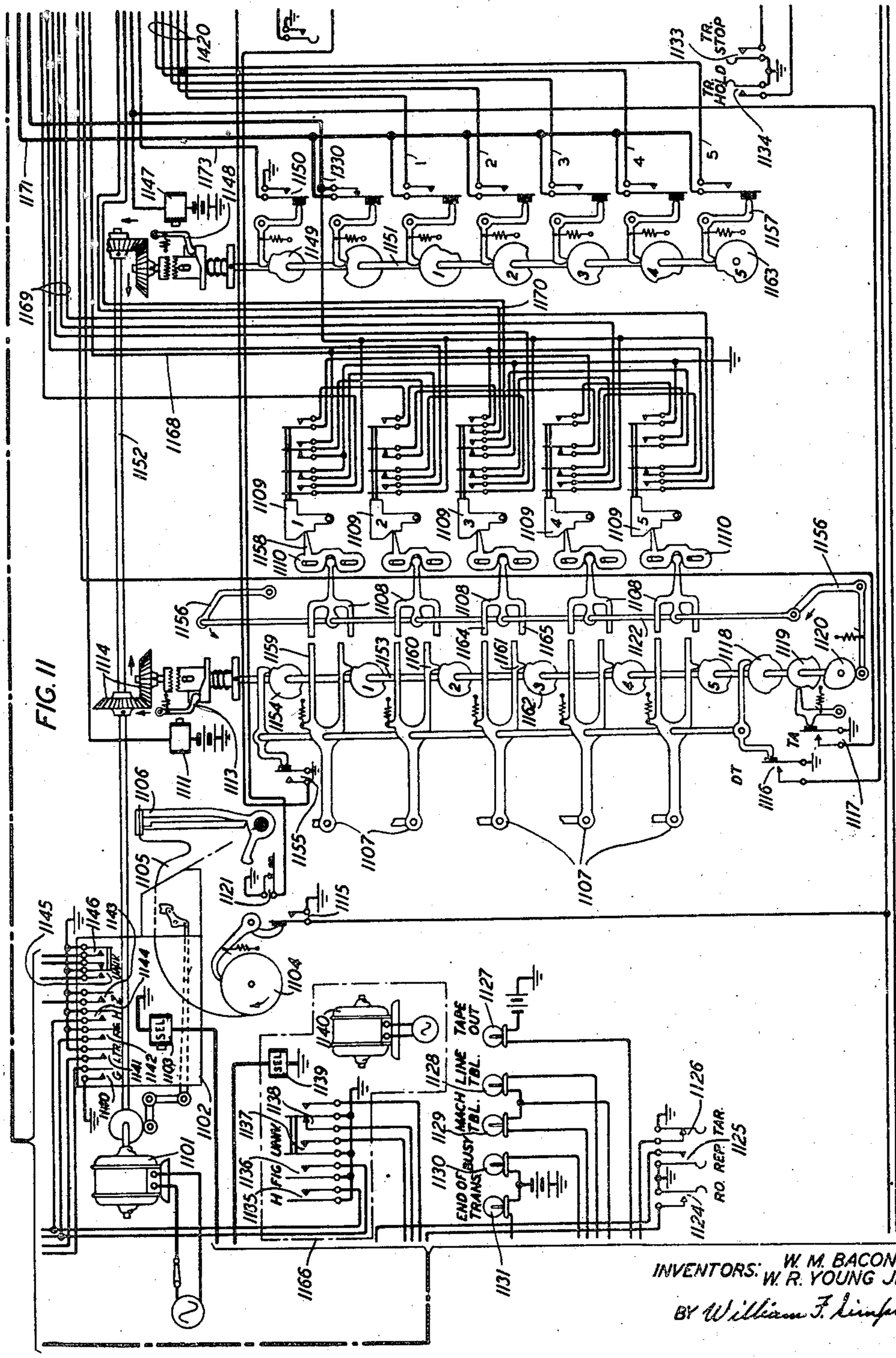
Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 10

FIG. 11



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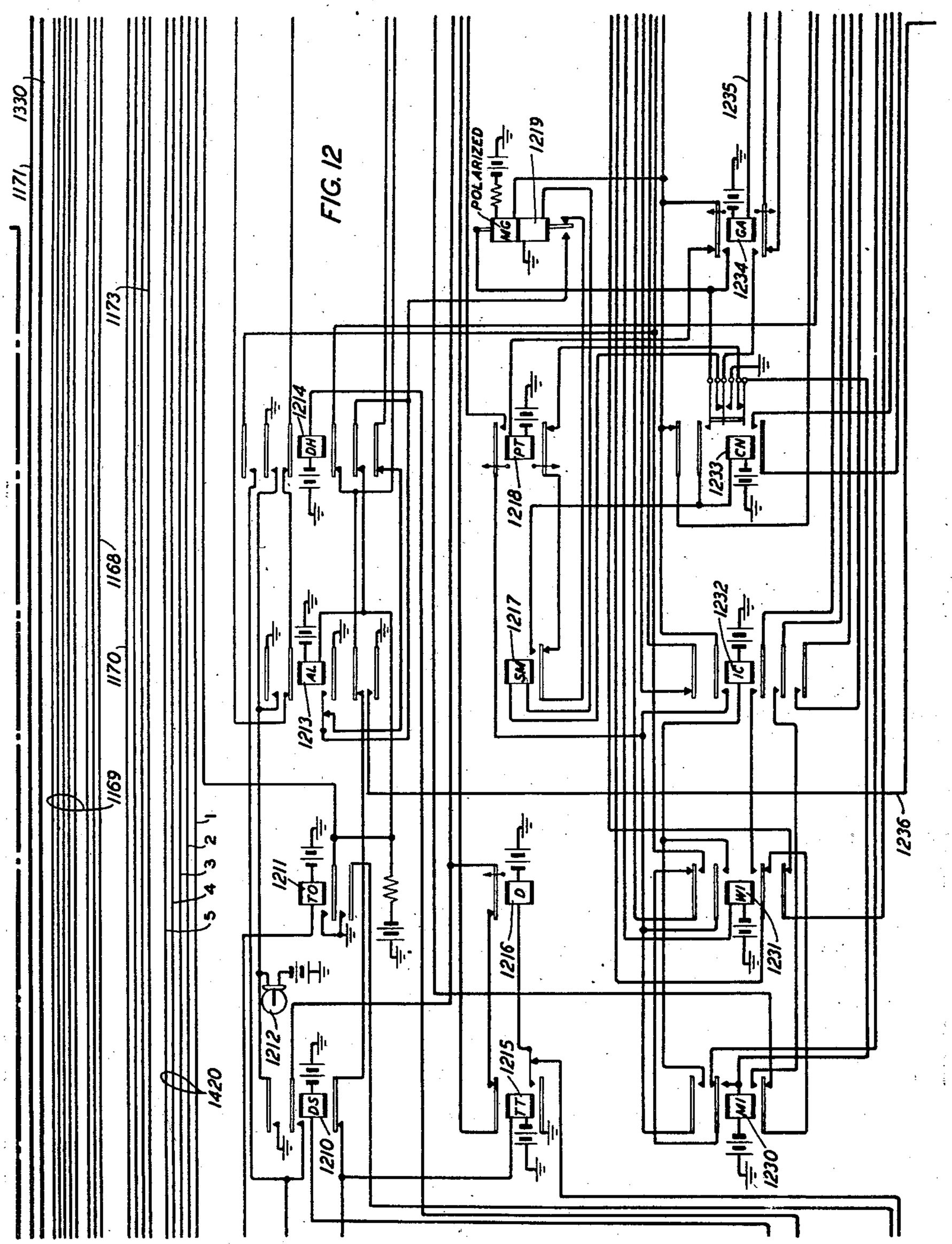
Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 11

FIG. 12



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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 12

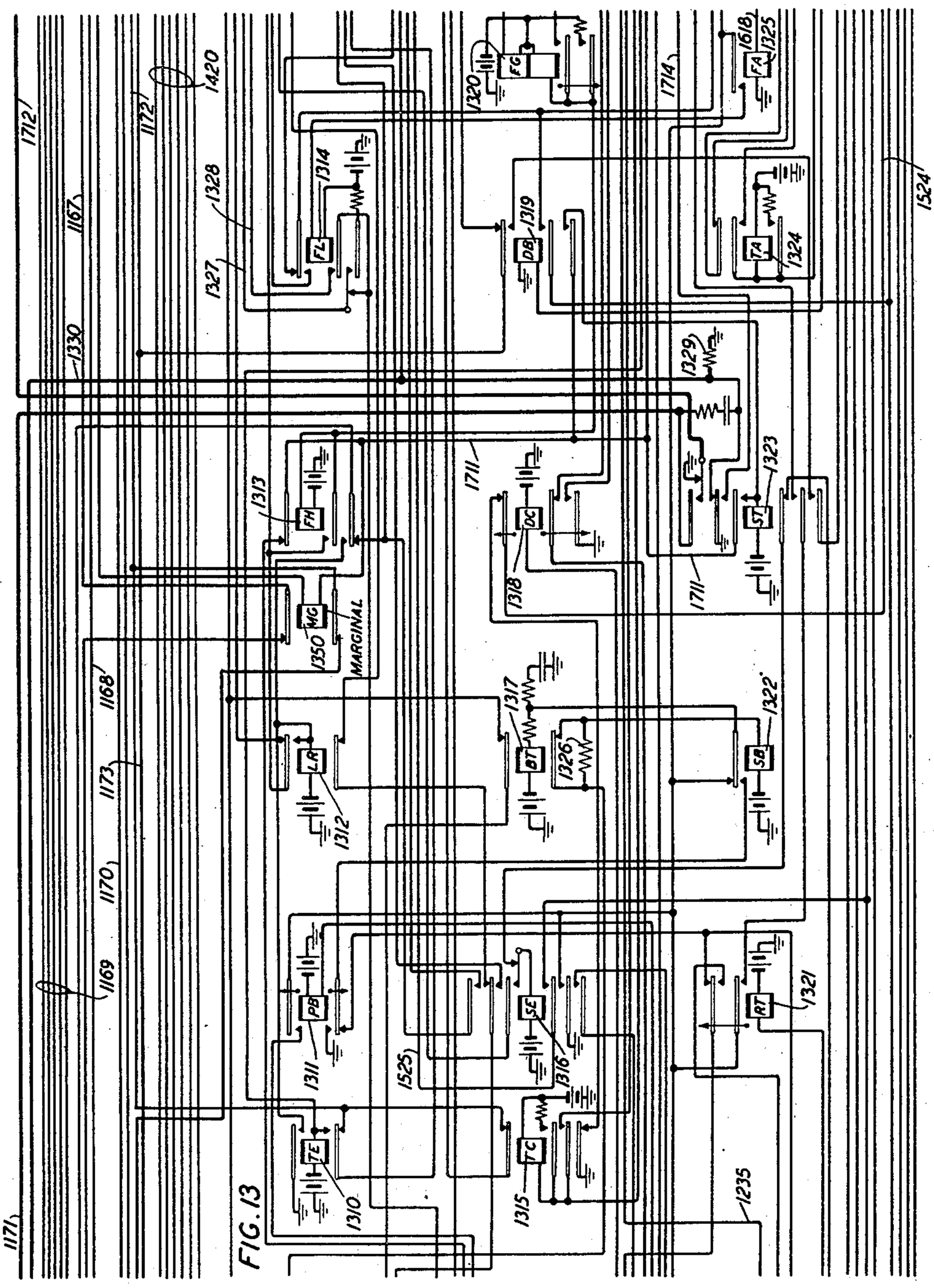

FIG. 13

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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 13

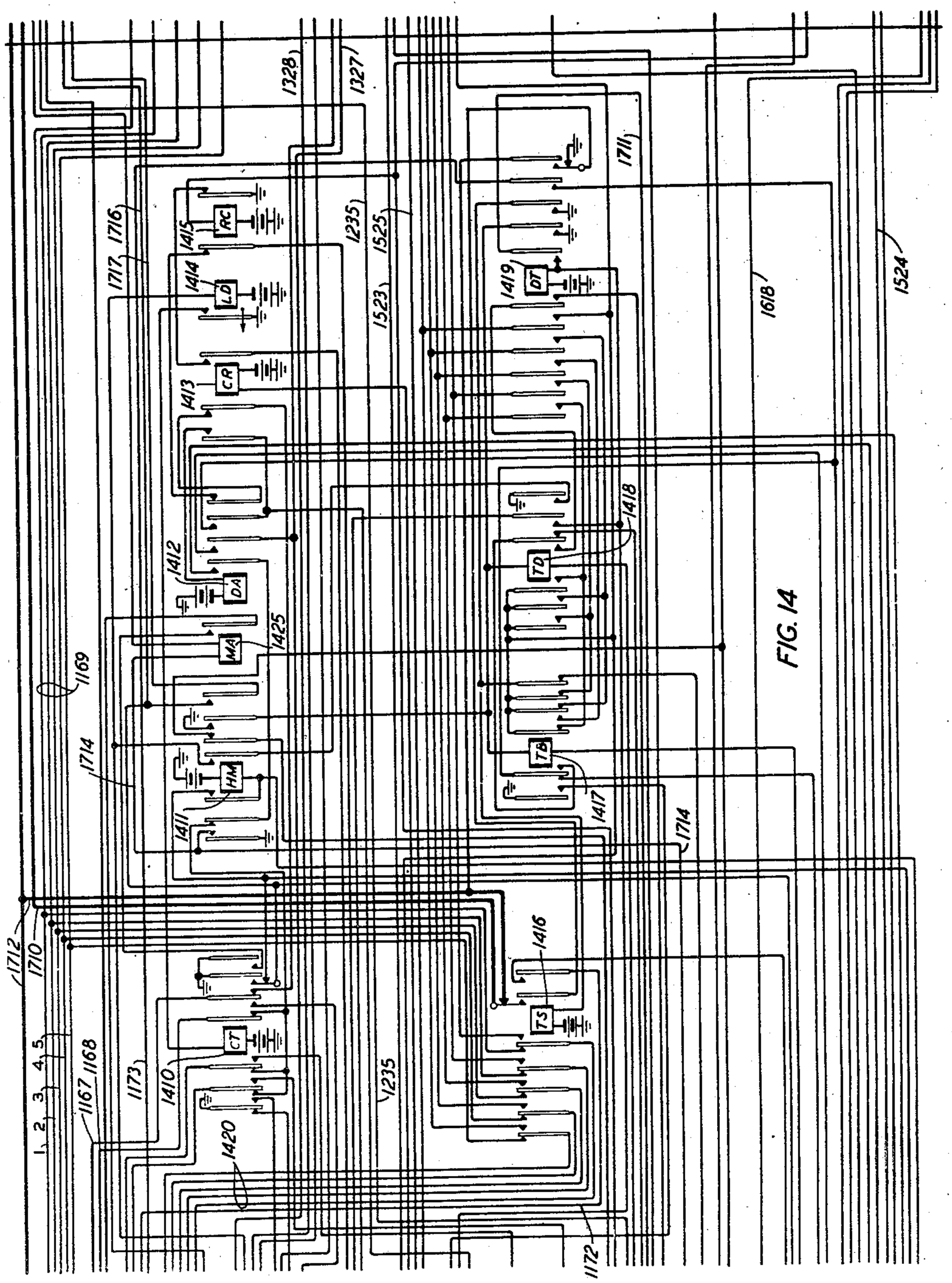

FIG. 14

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TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 14

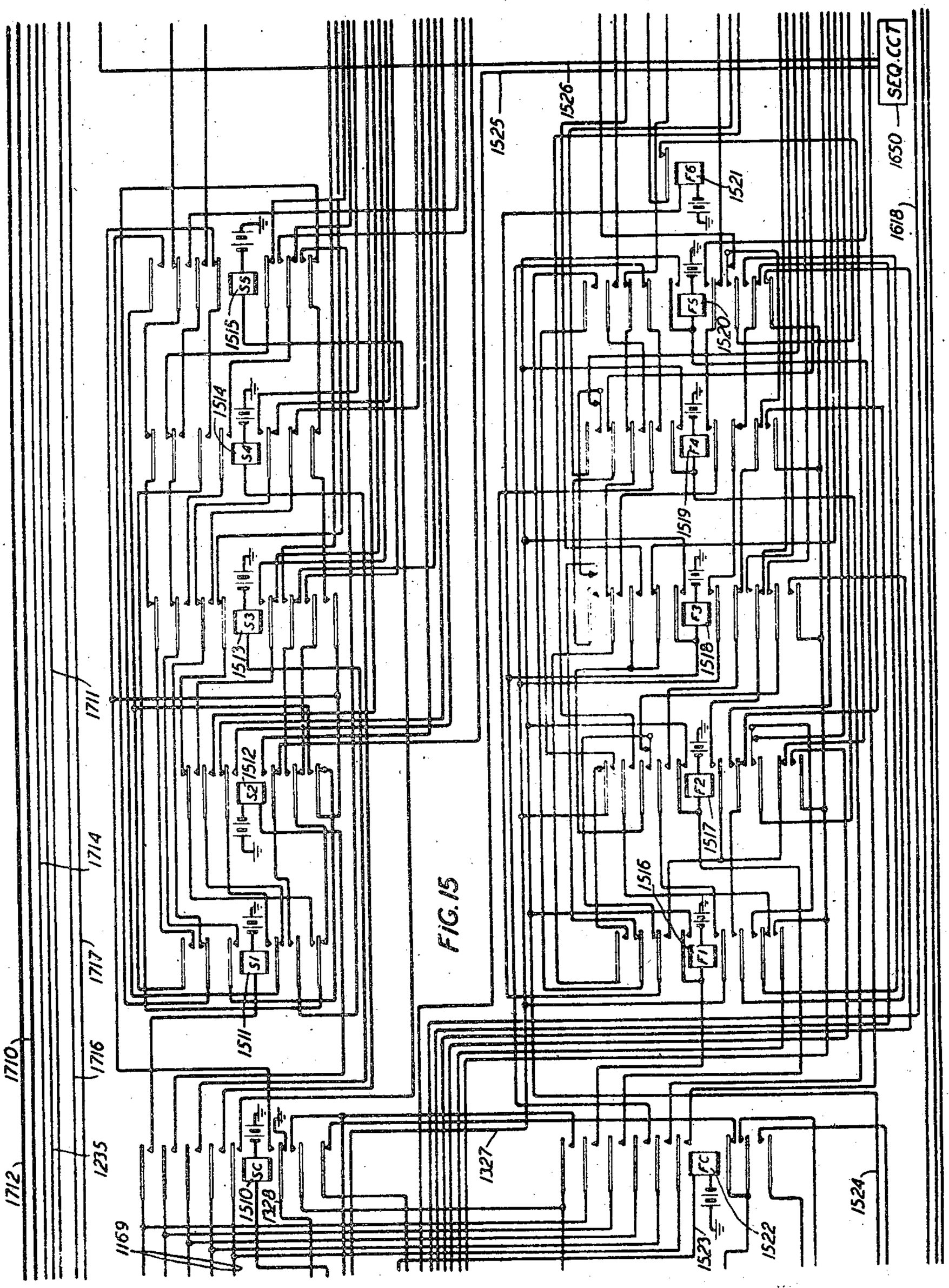

FIG. 15

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Dec. 24, 1946. W. M. BACON ET AL 2,412,955

TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 15

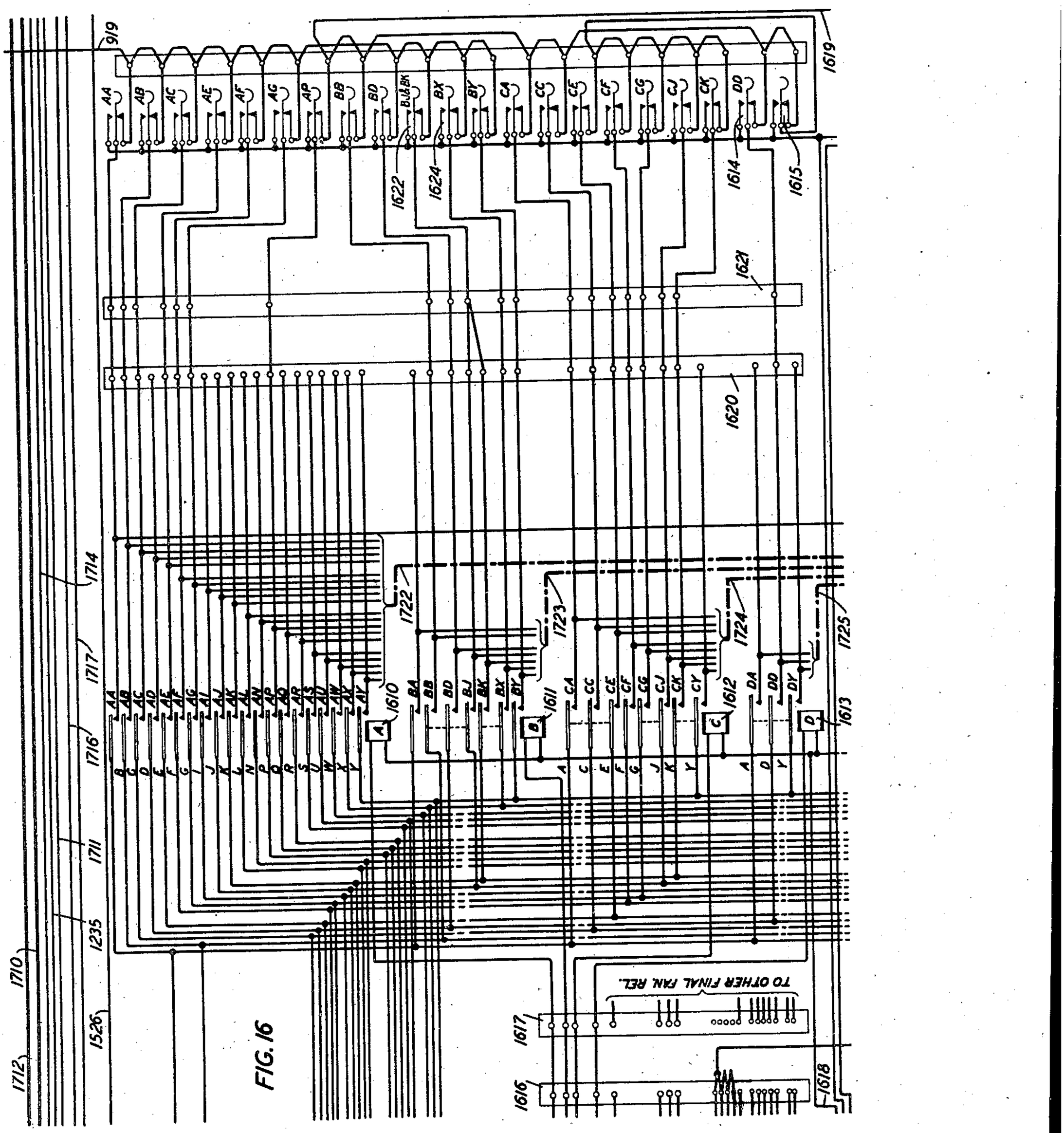

FIG. 16

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TELEGRAPH SWITCHING SYSTEM

Filed Sept. 18, 1943 16 Sheets-Sheet 16

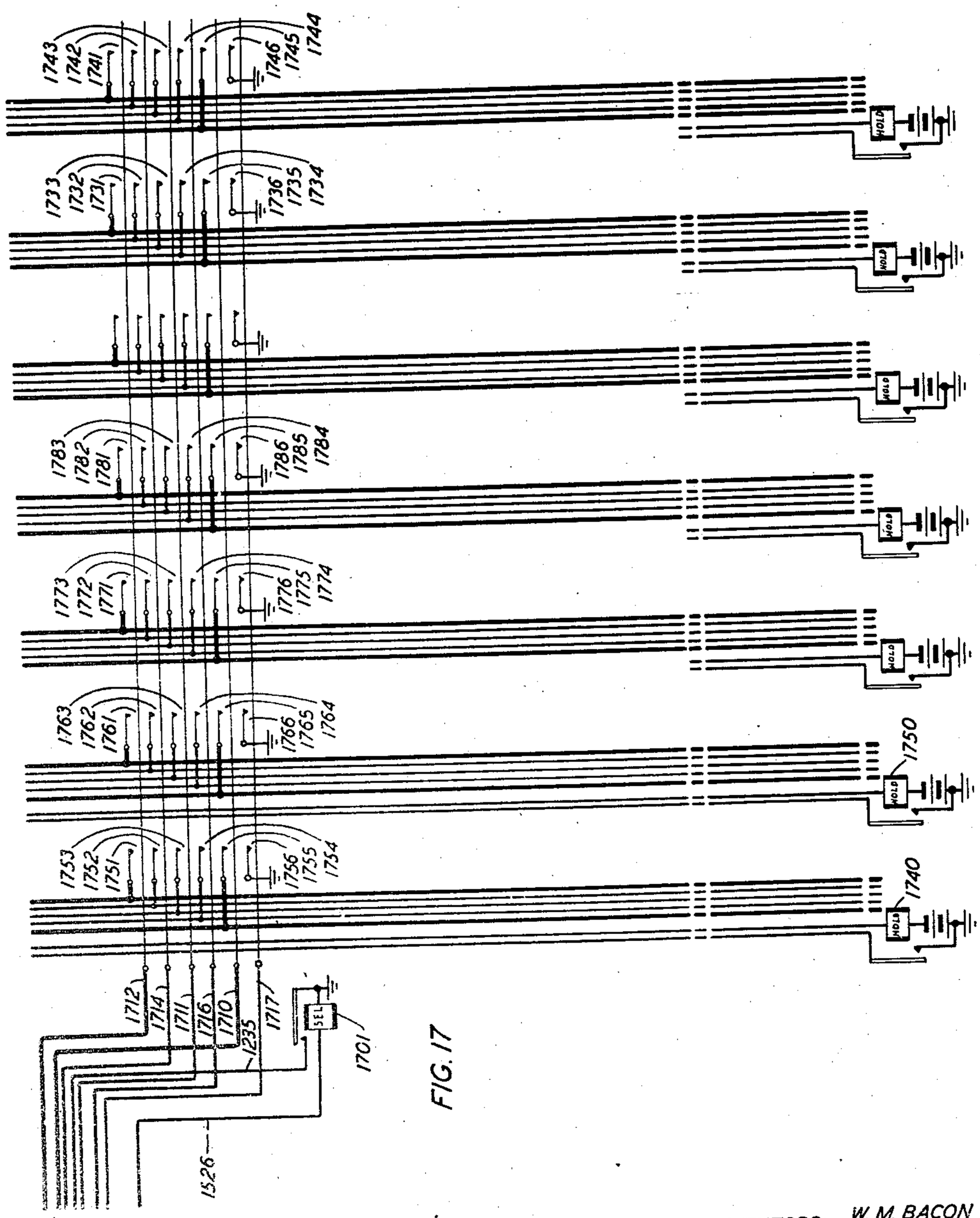

FIG. 17

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Patented Dec. 24, 1946 2,412,955

UNITED STATES PATENT OFFICE

2,412,955

TELEGRAPH SWITCHING SYSTEM

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Application September 18, 1943, Serial No. 502,944

17 Claims. (Cl. 178—4)

1

This invention relates to communication systems and more particularly to automatic telegraph switching systems in which messages are automatically directed and routed to stations of ultimate destination under control of certain predetermined signals or code combinations usually preceding each message.

The object of the present invention is to provide an improved telegraph system employing less apparatus than comparable systems of the prior art and at the same time expediting the transmission of messages through the system.

In accordance with an exemplary embodiment of the invention, the system disclosed in United States patent application of Branson et al., Serial No. 448,878, filed June 27, 1942, has been improved in order to expedite the transmission of messages through the system and at the same time require less apparatus and hence less sources of trouble and less equipment to maintain, thus improving the service and at the same time reducing the cost per message. In accordance with the system disclosed in said Branson et al. application, messages are transmitted from outlying stations to a central switching station. At the central switching station the messages intended for other outlying stations are stored in a tape by means of a reperforator. The tape then controls the transmitter which transmits the message through selective switching equipment to a second reperforator associated with a line extending towards the station of ultimate destination of the message. Thereafter the second tape controls a transmitter which transmits the message over the line extending towards the station of ultimate destination.

In accordance with the present invention the second storage of the message is dispensed with except when the line extending towards the station of ultimate destination is employed for the transmission of another message over that line. Hence during periods of light traffic the messages are not stored a second time. Instead the messages are immediately transmitted over the line extending towards their stations of ultimate destination. However, when the traffic over the line becomes heavier many messages will be directed to a storage device associated with said line. Thus during a considerable portion of the time the second storage of the message is dispensed with as well as the equipment necessary for accomplishing this second storage. However, when the line becomes more heavily loaded as is usual during certain hours of the day many of the messages will be stored a second time and await their turn for

2

transmission over the outgoing line to which they have been directed.

A feature of this invention relates to switching circuits and apparatus which will select an outgoing line if that line is idle and alternatively and automatically select a storage device and transmit messages thereto if the line had been previously selected by the selecting equipment and a message is in the process of being transmitted thereover.

In addition, the system is arranged to provide numerous other tests, alarm, and other features as disclosed in said above-identified application of Branson et al., all these being incidental to message transmission and in the nature of auxiliary apparatus.

The foregoing objects and features of the present invention, the novel features of which are specifically set forth in the claims appended hereto, may be more readily understood from the following description when read with reference to the attached drawings in which:

Fig. 1A shows the manner in which Figs. 2, 3 and 4 should be arranged adjacent one another to show in outline form the various circuits and equipment of an exemplary system in accordance with the present invention as well as illustrate the routes of messages through the system;

Fig. 1B shows the manner in which Figs. 5 through 17, inclusive, should be arranged adjacent one another to show the circuit arrangements in detail of one exemplary form of the invention;

Figs. 2, 3 and 4 show in outline form a typical system embodying the present invention; and

Figs. 5 through 17, inclusive, when arranged as shown in Fig. 1B, show in detail the various circuits and equipment comprising and cooperating with the present invention.

Referring now to Figs. 2, 3 and 4 when arranged as shown in Fig. 1A, Fig. 2 shows two typical party lines and the station and control equipment associated therewith. One party line is designated **210** which comprises a receiving channel **211** and a transmitting channel **212**. Similarly, party line **260** comprises a receiving channel **261** and a transmitting channel **262**. Both transmitting and receiving channels are illustrated in Fig. 2 and also Fig. 3 by means of telegraph lines or conductors. It is to be understood, however, that these lines or channels may include any type of telegraph transmission equipment normally employed for the transmission of telegraph signaling pulses or code combinations of pulses. These lines or channels may, for example, include

open wire lines, cable lines, channels of voice frequency or high frequency carrier current systems, radio systems, time division multiplex systems or telegraph channels of composite telephone and telegraph transmission systems or of any other type of pulse transmission channels or systems suitable for the transmission of signaling pulses such as employed in telegraph systems. The various party lines and channels thereof may include or comprise any or all of the foregoing types of transmission systems or any or all combinations of such types of transmission systems.

The transmission systems of the various types comprising the party lines operate in their usual and well-understood manner so a description of the operation thereof need not be included herein because it would serve no useful purpose and only tend to obscure the other elements and features of the present invention.

Each of the party lines shown in Fig. 2 extends to a plurality of outlying subscriber or way stations. It is to be understood also that it is within the scope of this invention to extend lines individually from one or more of the outlying stations to the central switching exchange. In this case certain of the control equipment associated with each of the party lines need not be provided as will be readily apparent to those skilled in the art.

Each of the lines which extends to more than one outlying station is provided with control equipment located at or near the outlying stations of the party line. Control equipment may be provided which is individual to each of the outlying or way stations in case the way stations are rather widely separated or the control equipment may be provided common to a group of outlying stations which are located more closely together. In addition, certain of the control equipment may be individual to certain outlying stations, while other control equipment provided for the same party line may be common to a plurality of the outlying stations.

As shown in Fig. 2, three separate and distinct sets of switching and controlling circuits, sometimes referred to as a secondary switching center, are associated with each of the party lines. For example, party line **210** extends to the switching and control circuits or secondary switching centers **213**, **214** and **215**. The control equipment **214** is individual to station **219**. Control equipment **215** is common to stations **216**, **217** and **218**, while control equipment **213** is common to stations **220** to **224**, inclusive. Each of the outlying stations is provided with a receiving instrument, transmitting equipment, and control equipment. In the specific system described herein, the transmitting equipment comprises a keyboard perforator for perforating paper tape in accordance with the signals to be transmitted and a tape controlled transmitter for transmitting signals in accordance with the perforations in the tape. For example, at station **216** the receiving instrument and the keyboard perforator is illustrated diagrammatically and designated **225** in Fig. 2, the transmitting distributor is designated **235**, while the control equipment is designated **236**. Similar equipment is provided at the other stations. In addition, station **219** is provided with a receiving recorder or reperforator for again perforating tape in accordance with messages received from the system. This reperforator is provided at those stations at which other telegraph lines or circuits terminate so that the messages intended

for stations connected to these other lines may be recorded at station **219** and later automatically transmitted over the proper line without requiring the time of an operator to retransmit the message.

In order to transmit messages over this system, the attendant or subscriber at the outlying or way stations perforates messages in paper tapes for later transmission over the system. Preceding each message, an address or group of switching signals is perforated in the tape and following each message an end-of-message or disconnect signal is also perforated in the tape. Following the end-of-message signal the subscriber may perforate any address signal followed by another message intended for the station designated by the address. Following this message and each of the messages, the operator will then perforate a disconnect signal in the tape. Furthermore, the operator or attendant will usually perforate an end-of-transmission signal in the tape after the disconnect signal following the last message available for transmission from the station then transmitting.

The attendant or operator at the outlying station will then insert a tape in the transmitter for transmission over the system. At a later time the transmitter is started under the control of an operator or switching circuits at the central switching station. Thereafter the messages are transmitted to the central switching station and recorded thereat.

The circuits at the central switching station are illustrated in Figs. 3 and 4. Fig. 4 shows the originating position at the central switching station comprising a keyboard perforator **411**, a monitoring receiving instrument **410**, transmitter and transmitting distributor **412**, control relays **413** and a director circuit **414**. Fig. 4 also shows a miscellaneous intercept circuit **427** and a receiving reperforator **426** and a tape receptacle **425**. A willful intercept circuit **424** is also shown. This intercept circuit is provided with a repeating instrument **420** comprising a recorder or reperforator **421** and a transmitting device **422**. A director **423** is also associated with the willful intercept circuit.

Each of the party lines terminating at the switching office or center is provided with an incoming line circuit **322** and a receiving only machine **323**, a storage repeater **324** and associated transmitter **325**. Incoming line circuit **322** causes the messages intended for the central switching station to be recorded on the receiving only receiver **323** and causes the messages intended for other stations of the system to be recorded by the reperforator **326**. Director circuit **327** is associated with the transmitter **325** and serves to connect the transmitter **325** selectively to any of the lines terminating at the central switching station under control of the address characters preceding each message.

Each of the party lines is also provided with transmitter start circuits, such as **310**, and outgoing line circuits and equipment for transmitting messages over the party line. The outgoing line circuit associated with party line **210** incorporates control circuits and equipment in accordance with the present invention as will be described hereinafter. Briefly, messages directed to stations of party line **211** are transmitted either directly over the party line or to storage repeaters associated with line **211** under control of the director circuits individual to the lines upon

which the messages originate for later transmission over the outgoing lines.

Figs. 2 and 3 also show a trunk circuit **290** comprising two transmission channels **291** and **292** extending to a distant switching center **295**. The terminal equipment associated with the trunk circuits is similar to the terminal equipment associated with each of the party lines as described above.

The operation of the various circuits referred to above is described in detail in the above-identified copending patent application of Branson et al. Since the respective circuits referred to above forming parts of the systems referred to herein operate in substantially the same manner as described above in said patent application of Branson et al., which patent application has been made a part hereof as if fully included herein, an elaborated description has therefore not been repeated here.

Reference will now be made to Figs. 5 through 17, inclusive, when arranged as shown in Fig. 1B. Fig. 5 shows the subscribers' stations and control equipment associated with party line **210**. The subscribers' stations and control equipment associated with party line **210** are shown in substantially the same form as shown in Fig. 2. In addition, the same reference numerals have been employed to designate stations and equipment. Details of typical party lines of this type are described in the above copending application of Branson et al. and also in a patent application of Krecek et al., Serial No. 408,406, filed August 28, 1941, which was issued on January 9, 1945 as Patent 2,366,733, the disclosures of which are hereby made a part of this specification as if fully included herein. Inasmuch as the equipment in the circuits at the subscribers' stations as well as the control circuits therefor operates in substantially the same manner as described in the above-identified copending applications, detailed operation of these circuits will not be repeated here.

Fig. 5 also shows transmitter start circuit **310** as well as the incoming line circuit **322**. As described above, incoming messages intended for the central switching center are directed to the receiving only machine **1166**, while messages intended for other stations of the system are recorded by the reperforator **1102**.

Inasmuch as the circuits and equipment at the outlying stations and the control thereof in the exemplary system disclosed herein operate in the same manner as described in the above-identified applications of Branson et al. and Krecek et al., they have been shown only in outline form and a detailed description of their operation will not be repeated here. Likewise the transmitter start circuit **310** as well as the incoming line circuit **322** has been shown only in outline form since these circuits operate in substantially the same manner and cooperate with the other circuits in a similar manner to the manner described in said Branson et al. application. Consequently the detailed description of the operation of these circuits need not be repeated since this information may be obtained by reference to the applications above identified and incorporated herein. However, inasmuch as the director circuit cooperates with the outgoing line circuit in a novel manner and inasmuch as the outgoing line circuit has been materially modified, an exemplary form of these circuits is shown in detail in Figs. 5 through 17, inclusive, and the operation of these circuits will be described in greater detail in order that the operation of the improved circuits as well as the manner of cooperation between the various circuits may be more readily understood.

In the exemplary system shown in Figs. 2, 3 and 4 only one line of each of the different types of lines disclosed in the above-identified application of Branson et al. is indicated. It is to be understood, however, that any number of the various types of lines and their associated equipment may be provided as are required by any one or more of a number of different conditions and requirements encountered in any specific installation. Likewise equipment associated with only one of the lines is shown modified in accordance with the present invention in Figs. 2 through 4, inclusive. It will be readily apparent to those skilled in the art, however, that the equipment associated with any one or more of the lines may readily be modified in accordance with the present invention. The amount of equipment and the number of lines and the features provided on each line will vary depending upon the circumstances of each installation. However, lines equipped in accordance with the present invention will cooperate with all the other lines of such an exemplary system.

Likewise Figs. 5 through 17, inclusive, show in detail the circuits associated with only one of these lines. It will be readily appreciated by persons skilled in the art, however, that the equipment disclosed in these figures may be duplicated for additional lines and it may be incorporated without involving invention in any of the other types of line circuits disclosed in said copending applications.

Assuming now by way of example that it is desired to transmit a message from station **216** to station **222**. The attendant at station **216** will perforate the address or switching codes AG one or more times in the tape preceding the message. The attendant will then perforate the message in the tape after which a disconnect or end-of-message signal comprising a figures signal is followed by an H signal and this in turn is followed by a letters signal. The attendant may perforate additional messages in the tape each preceded by proper address code or signals and each followed by an end-of-message group of code combinations. After a predetermined number of messages have been perforated in the tape the attendant will perforate an end-of-transmission group of codes in the tape. Thereafter the tape will be inserted in transmitter **235**.

At a somewhat later time the transmitter will be started into operation in response to the operation of the transmitter start circuit **310** at the central switching station. Transmitter **235** will then transmit the address codes followed by the message over the transmitting channel **212** of party line **210**.

The operation of the equipment at the central station including the incoming line circuit **322** in cooperation with the receiving printer **1166** and the reperforator **1102** and the associated circuits in response to the address codes AG preceding the message causes the message to be directed to the selector magnet **1103** of the reperforator **1102**. Magnet **1103** in turn causes the message to be printed upon and perforated in tape **1105**. The reperforator **1102** is arranged to cooperate with the transmitting instrument shown in Fig. 11 so that the transmitting equipment shown in Fig. 11 will transmit the last character recorded in the tape **1105**. The details of such a transmitter and reperforator are shown and described

in the above-identified application of Branson et al. incorporated herein and therefore need not be repeated here.

Upon the reception of the address codes A and G by the reperforator 1102 the increase in supply of tape between the reperforator and the sensing head 1106 of the transmitter will cause the sensing head 1106 to be rotated in a clockwise direction as seen in Fig. 11 thus permitting contacts 1121 to close. The closing of contacts 1121 completes a circuit for the operation of relay 1316. Relay 1316 in turn completes circuits for the operation of relays 1311, 1317, 1321 and 1218. The operation of relay 1316 also completes a circuit for the operation of the transmitter magnet 1111. The circuits for the operation of the above relays and magnet are traced in detail in the above-identified application of Branson et al. and need not be repeated here. Similarly the circuits for the operation of various of the other relays to be described hereinafter are likewise set forth in detail in said Branson et al. application so that this information will not be repeated at this point.

The operation of magnet 1111 withdraws stop latch 1113 and permits shaft 1153 to rotate through one revolution. Near the beginning of this revolution the tape is advanced through the sensing head 1106 so that the feeler pins will be below the next set of perforations in the tape 1105. That is, they will be below the first set of perforations received by the printing reperforator 1102. Thereafter arms 1107 are released and permit the feeler pins to sense the tape to determine the perforations therein. The pins which encounter perforations above them will rise further as viewed in Fig. 11 than those which do not find perforations above them. At a later time after the arms 1107 have been fully positioned in accordance with the perforations in tape 1105 the transfer cam 1120 will cause the transfer members 1108 to be moved to the left as viewed in Fig. 11 and engage either the upper or lower bifurcated end of the arm 1107 and thus cause the members 1108 to be positioned in accordance with the perforations in tape 1105. The transfer members 1108 control intermediate members 1110 having a projection 1158 which engages a switch control member 1109 which in turn causes the contacts controlled thereby to be positioned in accordance with the perforations in tape 1105.

During the revolution of shaft 1153 cam 1119 will cause contacts 1117 to be momentarily closed. The momentary closing of contacts 1117 completes a circuit for the operation of relay 1413 which relay operates and completes a circuit for maintaining itself operated under control of relay 1415. Relay 1413 in operating interrupts the operating circuit of release magnet 1111, thus insuring that magnet 1111 will release and cause shaft 1153 to stop at the end of one revolution.

After the contact members 1109 have had ample time to position the contacts controlled by them in accordance with the perforations in the tape 1105 contacts 1116 are closed in response to the rotation of cam 1118 on shaft 1153. Closure of contacts 1116 completes a circuit for the operation of the distributor release magnet 1147. Magnet 1147 releases a distributor shaft 1151 for rotation through one revolution.

During this revolution the transmitting contacts 1 to 5 are closed in sequence for transmitting a signal code combination in accordance with

the setting of the contacts controlled by members 1109. However, since the contacts 1 to 5 of the distributor are not connected to any transmission circuit at this time, this signal is not transmitting during the revolution of shaft 1151. Near the beginning of the revolution of the shaft 1151 cam 1149 causes contacts 1150 to close. The closure of contacts 1150 completes a circuit for the operation of relay 1142.

Under certain circumstances the first characters received by the reperforator 1102 may be switching characters which have already performed their function, may be disconnect characters and certain other characters which are normally discarded by the switching equipment. The contacts controlled by members 1109 are arranged to complete circuits through them from ground in response to each of the discard characters. As described in the above-identified application of Branson et al., these discard characters include the figures, H, letters and Z code combinations or signals. Upon the operation of relay 1412 if the code combination above the sensing pins is one of the discard characters, relay 1318 is operated. Near the completion of the revolution of the distributor shaft 1151 contacts 1150 reopen at which time relay 1319 operates and locks operated in series with relay 1412.

The operation of relay 1318 in response to a discard character as described above completes a circuit for the operation of relay 1415. Relay 1415 in operating interrupts the locking circuit of relay 1413 and relay 1413 releases. Relay 1413 in releasing interrupts the locking circuit of relays 1319 and 1412 and permits these relays to release which relays in turn cause the slow release relay 1318 to release. After a short interval of time relay 1318 will release and cause relay 1415 to release. The release of relay 1415 will again complete a circuit from the transmitter release magnet 1111 and the above cycle of operation is repeated as long as discard characters are presented over the feeler pins of the transmitter.

Following the discard signals recorded in tape 1105 the address code of the succeeding message will usually be recorded. As assumed above this address code is AG. When the letter A code combination appears above the sensing pins relay 1318 will not be operated upon the operation of relay 1412 as described above. Near the end of the revolution of the distributor shaft 1151 contacts 1150 reopen as described above and permit relay 1319 to operate and lock operated in series with relay 1412. With relay 1318 released and relay 1319 operated a circuit is completed for the operation of relay 1522.

Relay 1522 in operating interrupts the operating of the slow release relay 1311. This relay does not, however, immediately release since it is a slow release relay and allows time for certain of the other relays to function before it releases. The operation of relay 1522 connects the first group of fan or coding relays 1516 to 1521 to the contacts controlled by members 1109 thus positioning the relays in accordance with the code combination recorded in tape 1105. Under the assumed conditions these relays will be positioned in accordance with the letter A signal.

The operation of relay 1522 completes a circuit for the operation of relay 1415 which relay operates and in turn causes the release of relays 1413 and 1412 and 1319. The operation of relay 1515 extends a circuit from the winding of relay 1322 to a sequence circuit 1650. When the

sequence circuit is idle relay 1322 will operate. Upon the operation of relay 1322 and the release of relay 1311 as described above the battery through the winding of relay 1317 extends through numerous relay contacts including the contacts of the first group of fan relays 1516 to 1521, the winding of one of the selective switching relays which under the assumed conditions will be relay 1610 to ground through the winding of relay 1325. The characteristics of the various relays and resistances of the circuit are such that relay 1317 remains operated at this time and relay 1325 operates. Relay 1610, however, does not operate at this time. Operation of relay 1325 completes a circuit for the operation of relay 1314. Relay 1314 in operating increases the current flowing through the winding of relay 1610 and thus causes the operation of relay 1610 and at the same time maintains relay 1325 operated.

Operation of relay 1314 causes the release of relay 1522 which release in turn causes the release of relays 1322, 1415, 1413, 1412 and 1319 as well as the reoperation of relay 1311.

The release of the foregoing relays again completes a circuit to the transmitter magnet 1111 which causes the transmitting mechanism to advance and test the succeeding code combination stored in the tape 1105. Under the assumed conditions this code combination will represent the letter G. As before, during the revolution of the transmitter shaft 1153 contacts 1117 close and complete a circuit for the operation of relay 1413. Contacts 1116 also close and complete a circuit for the operation of the distributor magnet 1147, thus releasing shaft 1151 for rotation through another revolution. During this revolution contacts 1150 are closed and complete a circuit for the operation of relay 1412. Inasmuch as the second character in tape 1105 is assumed to be a character other than one of the discard characters, relay 1318 does not operate at this time. When contacts 1150 open relay 1319 again operates and completes a circuit for the operation of relay 1510. The operation of relay 1510 connects the windings of the relays of the second group of fan or coding relays 1511 through 1515, inclusive, to the contacts controlled by members 1109 and thus positions or sets the relays 1511 through 1515 in accordance with the second address code combination recorded in tape 1105. The operation of relay 1510 again interrupts the circuit of relay 1311 thus permitting this relay to start to release. Operation of relay 1510 also again extends the circuit of relay 1322 to the sequence circuit 1650. When the sequence circuit is idle and relay 1311 is released, the circuit of the winding in the busy test relay 1317 extends through the contacts of the second set of fan relays and the contacts of the relay operated by the first set of fan relays, i. e., relay 1610, and over a selected lead associated with a line extending towards the station of ultimate address of the message, viz., the line 210 extending towards the station 222. This lead is designated 919 in Figs. 9 and 16. If the paths or channels extending through the cross bar switch to this line are busy ground will be connected to lead 919 due to the operation of relays 911 and 916 in which case relay 1317 remains operated.

When both the sequence circuit and one or more of the paths to line 210 are idle relay 1317 releases and short-circuits resistance 1326. The release of relay 1317 also connects an alarm or test relay 1213 to the busy test lead as described in said copending application of Branson et al.,

The short-circuiting of resistance 1326 will cause the sequence circuit to be seized and set into operation. The sequence circuit will then cause the operation of the cross bar selector magnet 1701. The operation of the sequence circuit is described in detail in the above-identified Branson et al. application incorporated herein and need not be repeated here. It is to be noted, however, that the sequence circuit is provided so that only one connection may be established at a time through the cross bar switch. However, once a connection has been established through the switch the established connection or connections may be maintained independently of the establishment of any other connection through the switch. The sequence circuit merely insures that a single connection will be established at a time through the cross bar switch so that there will be no chance for false or cross-connections through the switch.

The operation of magnet 1701 completes a circuit for the operation of relay 1234. The operation of relay 1234 connects the windings of relays 1219 and 1217 to the selected lead 919. If only a single cross bar holding magnet is connected to this lead relay 1217 will operate and relay 1219 will not operate. If, however, the lead is open neither relay 1217 nor 1219 will operate. On the other hand, if lead 1219 becomes connected to two hold magnets or in some other manner becomes connected to battery through a low impedance both relays 1217 and 1219 will operate. The operation of the circuits under abnormal conditions when relays 1219 and 1217 are either both operated or neither operated is substantially the same as described in the above-identified Branson et al. application incorporated herein and consequently need not be repeated at this time.

With relay 1217 operated and relay 1219 released, which is the normal manner of operation of the system, a circuit is completed for the operation of relay 1233 which relay operates and connects ground to the lead 919 thus operating the selected hold magnet 1740 of the cross bar switch, it being assumed that both of the outgoing line circuit channels to party line 210 are idle, in which case lead 1919 extends through the break contacts of relays 911 and 914 to the windings of hold magnets 1740. The operation of the hold magnet 1740 during the time the selector magnet 1701 is operated causes the contacts at the cross-points, that is, 1751 through 1756, inclusive, to close.

The structure of an exemplary cross bar switch as well as its mode of operation and manner of control by operation of the selector and hold magnets is set forth in greater detail in United States Patent 2,021,329 granted to Reynolds, November 19, 1935, the disclosure of which is hereby made a part of the present application as if fully included herein.

Operation of the hold magnet 1740 also completes a circuit for the operation of relay 913. Operation of relay 913 in turn causes the operation of relay 1411. The operation of relay 1411 completes a circuit for the operation of relay 914. Relay 914 in operating transfers the operating circuit of relay 913 from the contacts of the hold magnet 1740 to lead 919. Consequently relay 913 will remain operated as long as ground is maintained on lead 919 by relays of the director circuit.

The operation of relay 1411 also interrupts the operating circuit of relay 1510 thus permitting

relay 1510 to release. The release of relay 1510 in turn interrupts the operating circuit of relay 1322 and dismisses the sequence circuit thus causing the sequence circuit to be restored to its normal condition. The restoration of the sequence circuit permits the selector magnet 1701 to release as well as relays 1234 and 1233. The release of relay 1233 in turn again completes a circuit for the operation of relay 1321.

The release of the selector magnet 1701 does not in any way cause the cross-point contacts 1751 through 1756, inclusive, to open. These contacts of the cross bar switch are maintained closed independently of the operation or release of the selector magnet 1701 or any other of the selector magnets of the cross bar switch. As described in the above-identified patent to Reynolds, the structure of the cross bar switch is such that it requires the operation of one selector magnet and one hold magnet to cause any set of contacts to close. Once the contacts are closed, however, they are maintained closed by the hold magnet independently of the operation or release of any of the selector magnets.

The release of relay 1510 interrupts the locking or holding circuits of relay 913 by removing ground from lead 919 extending through the director circuit to the outgoing line circuit shown in Fig. 9 as described above. The release of relay 913 at this time causes relay 912 to operate. The operation of relay 912 completes a circuit for the operation of relay 911 which relay operates and transfers the busy test and switching lead 919 from the first channel of the outgoing line circuit shown in Fig. 9 to the second channel thereof. Consequently if another message is awaiting transmission over line 210 the second channel of the outgoing line circuit will be set into operation. Relay 911 in operating locks operated under control of the hold magnet 1740 thus insuring that relay 911 will be maintained operated so long as the hold magnet 1740 is operated.

The operation of relay 912 removes ground from the transmission path of the first channel of the outgoing line circuit shown in Fig. 9 and thus conditions the repeating relay 750 associated with this channel for repeating signals from the transmitter shown in Fig. 11 over the outgoing or receiving channel of party line 210 extending toward station 222.

The operation of relay 912 in addition completes a circuit for the operation of relay 1323 which relay operates and locks operated under control of relay 912.

The circuit for the operation of relay 1323 extends through the winding of the marginal relay 1350. Inasmuch as resistance 950 is short-circuited at this time by the second set of break contacts from the top of relay 612, relay 1350 will operate and open the circuits of the transmitter and distributor release magnets 1111 and 1149 and thus prevent the operation of these magnets at this time. The operation of relay 1323 also completes a circuit for the operation of relay 1416. Relay 1416 in operating connects the distributor contacts 1 through 5 to contacts of the first group of fan relays 1516 through 1521, inclusive.

Thereafter the director circuit is maintained in the condition described until the receiving channel of the party line 210 is available for transmission.

The operation of relay 914 as described above

at least partially prepares the circuit for the operation of relay 713.

If and when the receiving channel 211 of party line 210 becomes idle relays 602 and 603 will release, as will be described hereinafter. With relays 602 and 603 released and relay 914 operated a circuit is completed for the operation of relay 713.

Assuming, for the purpose of illustration, that both relays 602 and 603 are released due to an idle condition of the receiving channel 211 of party line 210 at the time relay 914 operates. Under these circumstances the operation of relay 914 completes a circuit for the operation of relay 713. Assuming that there are no messages awaiting transmission from the transmitter shown in Fig. 8 the operation of relay 713 completes a circuit for the operation of relay 706. Upon the operation of relay 706 and with relay 722 released, a circuit is completed for the operation of relay 606 which relay in turn completes a circuit for the operation of relay 612. Relay 612 in operating completes a circuit for maintaining itself operated under control of relay 914.

Relay 612 in operating also completes a circuit for operating relay 609 which relay operates and completes a circuit for maintaining itself operated under control of relay 613. Operation of relay 612 also completes a circuit for the operation of relay 602 and this relay in turn completes a circuit for the operation of relay 603. Relay 603 connects ground to the armature of relay 604 thus permitting busy lamp 605 to follow the signals to be transmitted over the outgoing channel of party line 210. The operation of relays 602 and 603 also prevents the operation of relay 722 during the time the message is being repeated by relay 750.

The operation of relay 612 removes the short-circuit from around the contacts of the repeating relay 750 thus permitting this relay to repeat to the receiving channel of party line 210 any signals received by it.

The operation of relay 612 in addition to performing the functions described above also removes the short-circuit from around the resistance 950 thus causing the release of the marginal relay 1350. The release of the marginal relay 1350 completes a circuit for the operation of distributor magnet 1147 which magnet operates and permits the distributor shaft 1151 to rotate through one revolution. Near the beginning of this revolution contacts 1150 close and complete a circuit for the operation of relay 1324. Thereafter during the remainder of the revolution of shaft 1151 the code combination stored upon the first group of fan relays 1516 through 1521 will be transmitted by the distributor shown in Fig. 11. However, this code combination is transmitted over lead 1712 but not over lead 1710 due to the fact that relay 1416 is operated. Consequently this code combination is not transmitted over the receiving channel of party line 210. It will be recalled that the first code combination, viz., the letter A under the assumed conditions, is not transmitted over a local line terminating at any of the switching centers but is only transmitted when it is necessary to transmit the message either to one of the intercept positions or over a trunk circuit to a distant main or central switching center.

Near the end of the revolution of shaft 1151 contacts 1150 open and permit relay 1417 to operate and lock operated in series with relay

1324. The operation of relay 1417 interrupts the operating circuit of relay 1416 and thus permits this relay to release. The release of relay 1416 connects the cam controlled contacts of the distributor to the contacts controlled by members 1109. The contacts controlled by members 1109 were previously positioned in accordance with the second of the two address codes as described above and have remained in this position ever since.

The operation of relay 1417 again completes a circuit for the operation of the distributor magnet 1147 which magnet in operating again permits shaft 1151 to rotate through one revolution. Near the beginning of this revolution contacts 1150 will close to complete a circuit for the operation of relay 1315 which relay in operating interrupts the locking or holding circuits of relays 1516 through 1521. The release of these last-mentioned relays permits the release of relays 1314, 1325 and 1610 thus restoring the fan circuit to its original condition.

During the remainder of the revolution of the cam shaft 1151 the second of the address codes, viz., the letter G, will be transmitted over the receiving channel of party line 210. Near the end of the revolution of shaft 1151 contacts 1150 will open and permit relay 1418 to operate and lock in series with relay 1315. The operation of relay 1418 completes a circuit for the operation of relay 1414 which relay in turn completes a circuit for the operation of relay 1410. Relay 1410 interrupts the operating circuit of relay 1411 the release of which relay in turn permits the release of relays 1315, 1324, 1417 and 1418. The operation of relay 1410 also permits the release of relay 1316 which relay in releasing in turn causes the release of relays 1311, 1317, 1321 and 1218.

The release of relay 1316 also causes the release of relays 1412, 1413 and 1319.

The release of relay 1316 also completes a circuit for the operation of transmitter start magnet 1111 under control of contacts 1121. Consequently, so long as a supply of tape is available for transmission the transmitter magnet 1111 will operate and remain operated thus permitting shaft 1153 to rotate and initiate operation of the distributor shaft 1151. Each of these shafts makes one revolution for each character to be transmitted and the characters are transmitted over the transmission paths through the repeating relay 750 over the receiving channel of party line 210.

When the letter G signal which was the second of the address codes is transmitted over the receiving channel of party line 210 it will condition the secondary switching equipment associated with line 210 so that the succeeding message will be directed to station 222. In other words, the switching and control circuits 214 and 215 in responding to the letter G signal will prevent the transmission of the message to any of the stations associated with them. However, the switching and control circuit 213 will cause the immediately following message to be directed to the receiving instrument at station 222.

If it is desired at any time during the transmission of this message to send transmitter start signals over the receiving channel of the party line 210 the transmitter start circuit 310 is set into operation. The operation of the transmitter start circuit is substantially the same as described in the above-identified application of Branson et al.; consequently the detailed description of its operation need not be repeated.

The operation of this transmitter start signal causes relay 601 to be operated. The operation of relay 601 will again short-circuit resistance 950 and cause marginal relay 1350 to reoperate. The reoperation of relay 1350 at this time interrupts the operating circuit of the transmitter start magnet 1111 and thus interrupts the transmission of the message over the receiving channel of party line 210. During the remainder of the operation of the transmitter start circuit 310 the distributor shown in Fig. 8 is employed to transmit the transmitter start signals. At the end of the operation of the transmitter start circuit relay 601 is again released and the short-circuit removed from around resistance 950 thus causing relay 1350 to release whereupon the transmission of the message stored in tape 1105 is resumed.

As was the case in the above-identified application of Branson et al. the circuits associated with the party line as well as at the central switching station are so arranged that the message is interrupted and the transmitter start signals transmitted, then the transmission of the message resumed, without the addition, subtraction or mutilation of any characters of the message. Furthermore, none of the transmitter start signals are recorded by the receiving instrument at station 222.

When a figures signal is transmitted over the system during the transmission of a message the contacts controlled by members 1109 will complete a circuit for the operation of relay 1320. Relay 1320 is a slow to release relay and will remain operated for a short interval of time during at least a portion of the next code combination transmitted over the system by the transmitter shown in Fig. 11.

If the code combination immediately following the figures signal is another figures signal, relay 1320 will remain operated during at least a portion of the next succeeding code combination. If the code combination following the last figures code combination transmitted by transmitter shown in Fig. 11 is some code combination other than a figures or the H code combination, relay 1320 will release and the transmission of the subsequent portion of the message continued in the usual manner.

However, if the subsequent code combination is an H code combination, then the relay 1320 will be maintained operated and relay 1313 operated and both relays 1313 and 1320 locked operated. As pointed out above, the group of code combinations comprising a figures code combination followed by an H code combination, and these in turn followed by any other code combination, preferably a letters code combination, will constitute a disconnect signal and end-of-message signal and cause the circuits previously established for the transmission of the message to be interrupted and restored to their idle condition awaiting transmission of a subsequent message. Following the transmission of the H code combination, the transmitter will send the succeeding letters code combinations stored in tape 1105. Near the beginning of revolution of shaft 1153 during which the letters code combination is sent, contacts 1117 close and cause the operation of relay 1312. Relay 1312 when operating interrupts the operating circuit of the transmitter start magnet 1111, thus permitting this magnet to release and insure that the transmitter will stop after the letters code combination has been sent. Likewise the distributor magnet 1147 will not be reoperated so that the distributor shaft 1151 will be stopped

after the letters code combination has been fully transmitted.

The operation of relay 1312 interrupts the holding circuit of relay 1414. Relay 1414, however, is a slow to release relay and will not release until after the letters code combination has been fully transmitted. Release of relay 1414 interrupts the operating circuit of relay 1410 and permits this relay to release. Release of relay 1410 in turn interrupts the operating and locking circuits of relays 1313, 1320 and 1312, thus permitting these relays to release.

Release of relay 1410 also interrupts the holding circuit of relay 912 and permits relay 912 to release. Release of relay 912 applies ground to the transmission circuit extending to the repeating relay 750 and thus prevents further operation. Release of relay 912 also interrupts the holding circuit of relay 1323 and permits relay 1323 to release. The release of relay 1323 interrupts the operating circuit of relay 914 which relay in turn interrupts the current through the winding of the holding magnet 1740 of the cross bar switch. Release of holding magnet 1740 causes the switch contacts 1751 to 1756, inclusive, to open and the opening of these contacts together with the release of the various relays enumerated above restores the system to its idle condition.

If additional messages have been stored in tape 1105, contacts 1121 remain closed. Consequently, relay 1316 will reoperate and the above cycle of operations repeated for succeeding messages.

The release of relay 914 as described above causes the release of relay 612, which relay in turn permits the release of relays 602 and 603 in sequence. Relay 609, however, does not release at this time since it is locked operated under control of relay 613.

Assume, now for purposes of illustration, that during the transmission of the message described above, another message directed to line 210 is received by some other equipment at the central switching office, or that it is desired to initiate such a message in the central switching office. If this other message arrives at the transmitting position of the associated storage controlled transmitter during the time line 210 is busy transmitting the message, conductor 919 will extend to the relays and equipment in the lower half of Fig. 9 which are associated with the second channel adapted to receive messages intended for line 210. The operation of the system and circuits during the transmission of the message to the second channel is substantially the same as described in the above-identified Branson et al. application, the message being transmitted to the storage repeating equipment shown in Fig. 8. If other messages are received for stations associated with party line 210 during the time of transmission of both of these messages, they will await transmission to either one of the channels depending upon which one becomes idle first. If the second channel having a storage repeater shown in Fig. 8 associated with it becomes idle first, messages will be transmitted to the storage repeater as soon as it becomes idle. However, if the first channel, that is the channel having no storage repeater associated with it becomes idle first, this channel will be seized by the equipment having a message directed to some station of party line 210. However, the message will not be transmitted over party line 210 at once unless the receiving channel of the party line becomes idle.

Assume by way of example that during the time the first message is being transmitted over

the party line, a second message is received by the second channel and stored in tape 830 by the storage equipment shown in Fig. 8. Then when the end-of-message signal is transmitted as described above relay 612 releases and in turn causes to release relay 602. The release of relay 602 at this time, assuming a message is awaiting transmission from tape 830, will complete a circuit by the operation of relay 722 and this in turn will cause the operation of other relays of the outgoing line circuit to establish a transmission path from a transmitter shown in Fig. 8 so that the second message will be transmitted over the outgoing line circuit. Incident to the transmission of this message, relay 613 operates and interrupts the locking circuit of relay 609. Relay 609 will thereupon release and at the end of the message being transmitted from tape 830 preference will be given to any message awaiting transmission from the first channel of the outgoing line circuit, that is the channel having no second storage equipment associated with it. If a message is awaiting transmission from one of the director transmitters similar to that shown in Fig. 11 at this time, relay 914 will be operated and upon release of relay 602, relay 612 will operate and complete the establishment of transmission circuits from that transmitter to the receiving channel over party line 210 whereupon that message will be transmitted over the party line.

Thus during busy periods messages are transmitted to the receiving channel of the party line, first from the channel having no repeating equipment associated with it and then from the channel having repeating equipment associated with it. This cycle of transmission alternately from each of the two channels over the receiving channel of the party line is repeated so long as messages are awaiting transmission over the party line from either of these channels.

As indicated above during periods of light traffic, the channel of the outgoing line circuit which has no storage equipment associated with it will be selected unless it is busy. Hence during periods of light traffic, messages are transmitted from the director transmitters directly to the outgoing channel of the respective party lines and are not stored in a second storage device associated with that line. However, during periods of heavy traffic to any given line, many of the messages are transmitted directly over the line without being stored in any storage equipment individual to that line, while many other messages are stored a second time in storage equipment individual to that line. Thus the storage equipment associated with any of the outgoing lines is employed only during times of heavy traffic in order to handle the load. At other times, the messages are transmitted directly over the outgoing line without any delay incident to the second storage of the message.

It should be noted that during the transmission of messages from any of the director circuits to the storage equipment associated with the second channel of the outgoing line circuit resistance 951 never becomes short-circuited. Consequently relay 1350 will not operate and the remaining circuits and equipment operate in the manner described in the above-identified application, Branson et al. Likewise during the transmission of messages over the first channel of the outgoing line circuit, which has no storage equipment associated with it, resistance 928 is never short-circuited. Relay 1425, therefore, is not op-

erated so that the operation of the transmitter shown in Fig. 11 was not interrupted due to failure of any subsequent storage apparatus. In other words, when the messages are stored a second time in the switching center, the system operates as described in said Branson et al. application, whereas when the messages are transmitted directly to an outgoing line circuit, the system operates as described herein and all of the features provided in the system described in said Branson et al. application are also provided in the present system and cooperate with the improved outgoing line circuit having no storage equipment associated therewith without any interference between any of the circuits of said Branson et al. application and the improved outgoing line circuit described herein.

What is claimed is:

1. A telegraph system in which messages are automatically directed by directing code combinations at the head end thereof, a plurality of sources of such messages including directing code combinations, a line selectable by any of said sources for transmission of the message thereover when the line is idle, a storage device, and means for selecting said storage device by any of said sources and for the transmission of a message thereto when said line is busy.

2. A telegraph system in which messages including directing code combinations at the head end thereof are transmitted selectively to a plurality of stations, a plurality of sources of such messages including directing code combinations, a line selectable by any of said sources for the transmission of a message thereover when the line is idle, a storage device individual to said line, means for causing the selection of said storage device and the transmission of a message thereto when said line is busy, and means operating automatically for thereafter transmitting the message from said storage device to said line when said line becomes idle.

3. A telegraph system in which messages are automatically directed by directing code combinations at the head end thereof, a plurality of sources of such messages including directing code combinations, a line selectable in accordance with said directing code combinations by said source for transmission of messages thereover when said line is idle, a storage device, and means for causing the selection of said storage device by any of said sources and transmission of the messages thereto when selected and means whereby messages are transmitted from said storage device to said line as soon as said line becomes idle.

4. An automatic switching system comprising a signaling channel, a selectable path extending towards said channel, a storage device individual to said channel, automatic switching equipment for selecting said path, and other automatic switching equipment for selecting said storage device when said path is busy.

5. An automatic switching system comprising a signaling channel, a selectable path extending towards said channel, a storage device individual to said channel, automatic switching equipment for selecting said path, other automatic switching equipment for selecting said storage device when said path is busy, and apparatus for thereafter transmitting messages stored in said storage device over said signaling channel.

6. In an automatic telegraph system, a plurality of storage controlled telegraph transmitters, a plurality of telegraph lines extending from said transmitter, a selectable path extending directly to each of said lines, a storage device individual to each of said lines, selective switching apparatus controlled by stored signals for selecting said path when it is idle, and other equipment controlled by the same stored signals for automatically selecting a storage device individual to a selected line when the path extending directly thereto is busy.

7. In a telegraph switching system in which messages are automatically and selectively transmitted to outgoing channels under control of telegraph signals comprising a direct transmission path extending to said channel, means for directing all messages to said channel over said path when said path is idle, an auxiliary transmission path separate from said direct path extending to said channel and including a storage device, and apparatus for selecting said storage device when said first chosen path is busy.

8. In a telegraph switching system in which messages are automatically and selectively transmitted to outgoing channels under control of telegraph signals comprising a direct transmission path extending to said channel and means for directing all messages to said channel over said path when said path is idle, and an auxiliary transmission path separate from said direct path extending to said channel and including a storage device, apparatus for selecting said storage device when said first path is busy, and apparatus for subsequently transmitting messages from said storage device to said outgoing channel.

9. In a telegraph switching system in which messages are automatically and selectively transmitted to outgoing channels under control of telegraph signals comprising a direct transmission path extending to said channel, means for directing all messages to said channel over said path when said path is idle, an auxiliary transmission path extending to said channel and including a storage device, apparatus for selecting said storage device when said direct path is busy, and apparatus for transmitting messages to said channel alternately from said direct path and said storage device.

10. In a telegraph system, a source of message groups of telegraph signals each group of which is preceded by an address group of telegraph signals, automatic switching apparatus controlled by said address groups of signals, a first choice direct transmission path for the instantaneous and continuous transmission of telegraph signals thereover, apparatus for selecting said path by a predetermined address group of signals when it is free, a second choice delayed transmission path paralleling said first path including a storage repeater, and apparatus controlled by said predetermined address group of signals for selecting said second choice path when it is free and said first path is busy.

11. In a telegraph system, stations of address, a source of message groups of telegraph signals each group of which is preceded by an address group of telegraph signals designating a station of address, a plurality of transmission paths individual to and extending toward stations of address, automatic switching apparatus controlled by said address groups of signals for selecting and connecting said sources with said transmission paths extending toward such stations of address, storage devices associated with and individual to each of a plurality of said transmission paths, apparatus controlled by a busy condition of each of said paths for altering said switching

apparatus for directing messages intended for said transmission path to said storage equipment individual thereto, and equipment for later transmitting stored messages over said path from said storage device when said path becomes idle.

12. A telegraph system in which messages including directing code combinations at the head end thereof are transmitted selectively between stations, a plurality of sources of such messages including directing code combinations, a line selectable by any of said sources for transmission of a message thereover when said line is idle, a storage device, means for causing a selection of said storage device and the transmission of a message thereto by any one of said sources when said line is busy, and switching equipment jointly responsive to a message in said storage device and the non-busy condition of said line for automatically connecting said storage device to said line for the transmission of said message thereover.

13. A telegraph switching system in which messages are automatically and selectively transmitted to an outgoing channel under control of telegraph signals comprising, a direct transmission path extending to such channel for the substantially instantaneous conveyance of message signals to said channel, selecting means for directing all messages for said channel over said direct transmission path when said channel is idle, a storage device individual to said channel, apparatus responsive to a busy condition of said channel for causing messages for said channel to be directed to and stored by said storage device, apparatus responsive to a message stored in said storage device and the idle condition of said channel for automatically extending a transmission path from said storage device to said channel for transmission of the stored message over said channel.

14. A telegraph switching system in which messages are automatically transmitted to outgoing channels under control of telegraph signals comprising a direct transmission path extending to said channel, means for directing all messages for said channel over said direct transmission path when said channel is idle, an auxiliary transmission path extending to said channel, a storage device individual to said channel and connected in said auxiliary transmission path, apparatus for selecting said auxiliary transmission path and storing messages in said storage device when said channel is busy, apparatus operative under control of a message stored in such storage device and by the idle condition of said channel for automatically establishing a transmission path from said storage device to said channel when said channel becomes idle.

15. In a telegraph system, a telegraph code impulse transmitter, a plurality of channels of transmission, means operable to attempt to operably associate said transmitter selectively with one out of several of said channels, means conditioned by an idle condition of said one channel upon said attempted association for completing said association and initiating transmission of a message from said transmitter over said channel, code storage means, means conditioned by a busy condition of said one channel upon said attempted association to initiate and include transmission of said message from said transmitter into said storage means, and automatically operating means other than said transmitter operable if and when said channel becomes thereafter idle to transmit said message over said channel under control of said code storage means.

16. In a system according to claim 15, in the case of transmission from said transmitter over said channel, means operable under control of an end-of-message signal code or codes to dissociate said transmitter from said channel at the end of the message over said channel.

17. In a telegraph system, a telegraph code impulse transmitter, a plurality of channels of transmission, means operable to attempt to operably associate said transmitter selectively with one out of several of said channels, means conditioned by an idle condition of said one channel upon said attempted association for completing said association, to seize said storage means, and initiating transmission of a message from said transmitter over said channel, code storage means, means conditioned by a busy condition of said one channel upon said attempted association to initiate and conclude transmission of said message from said transmitter into said storage means, automatically operating means other than said transmitter operable if and when said channel becomes thereafter idle to transmit said message over said channel under control of said code storage means, and, in the case of transmission from said transmitter into said storage means, means operable under control of an end-of-message signal code or codes to dissociate said transmitter from said storage means at the end transmission of the message into said storage means.

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