May 21, 1946. J. I. BELLAMY 2,400,530

SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 1

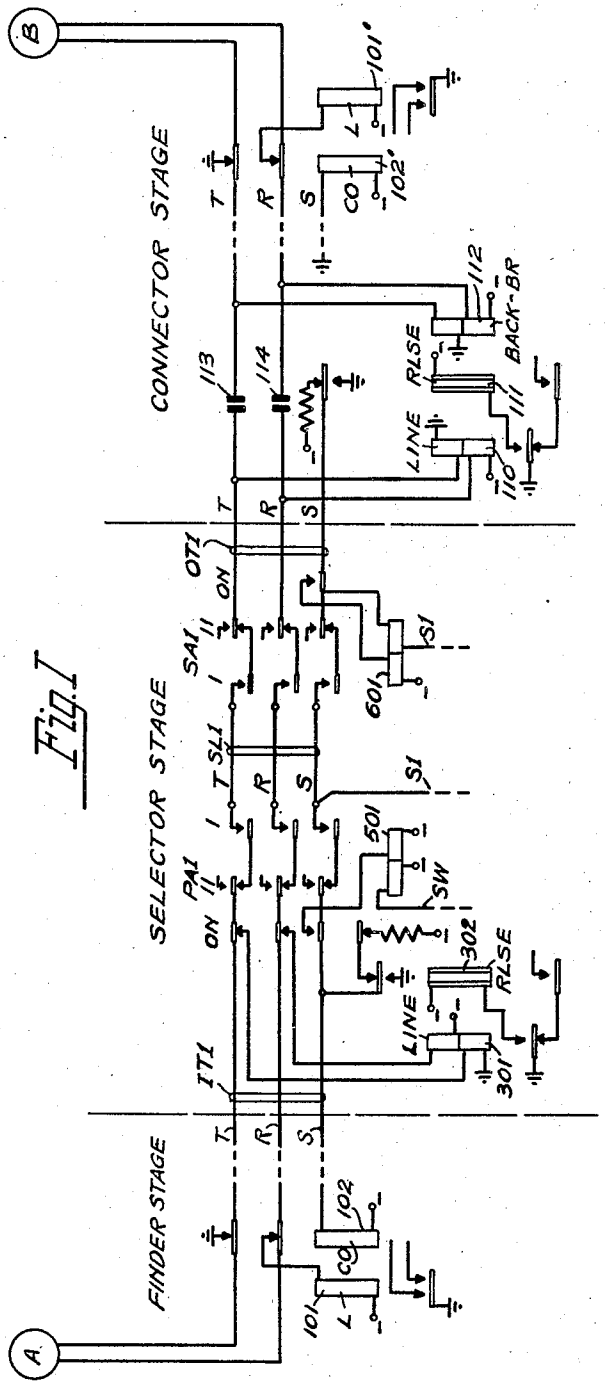

Fig. 1

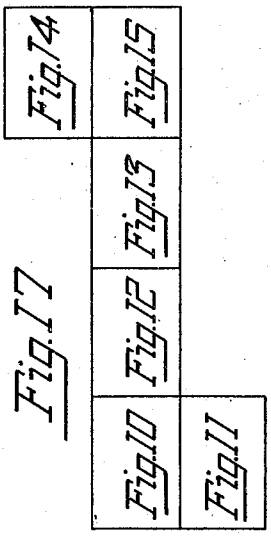

Fig. 17

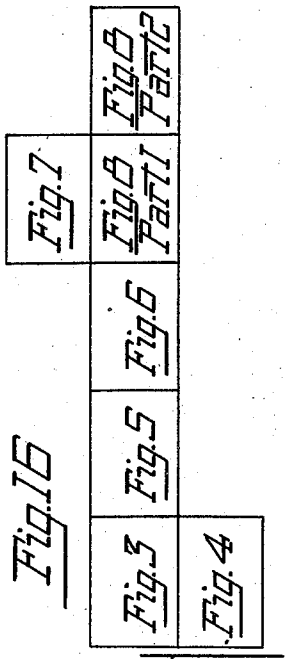

Fig. 16

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SELECTOR SWITCHING SYSTEM

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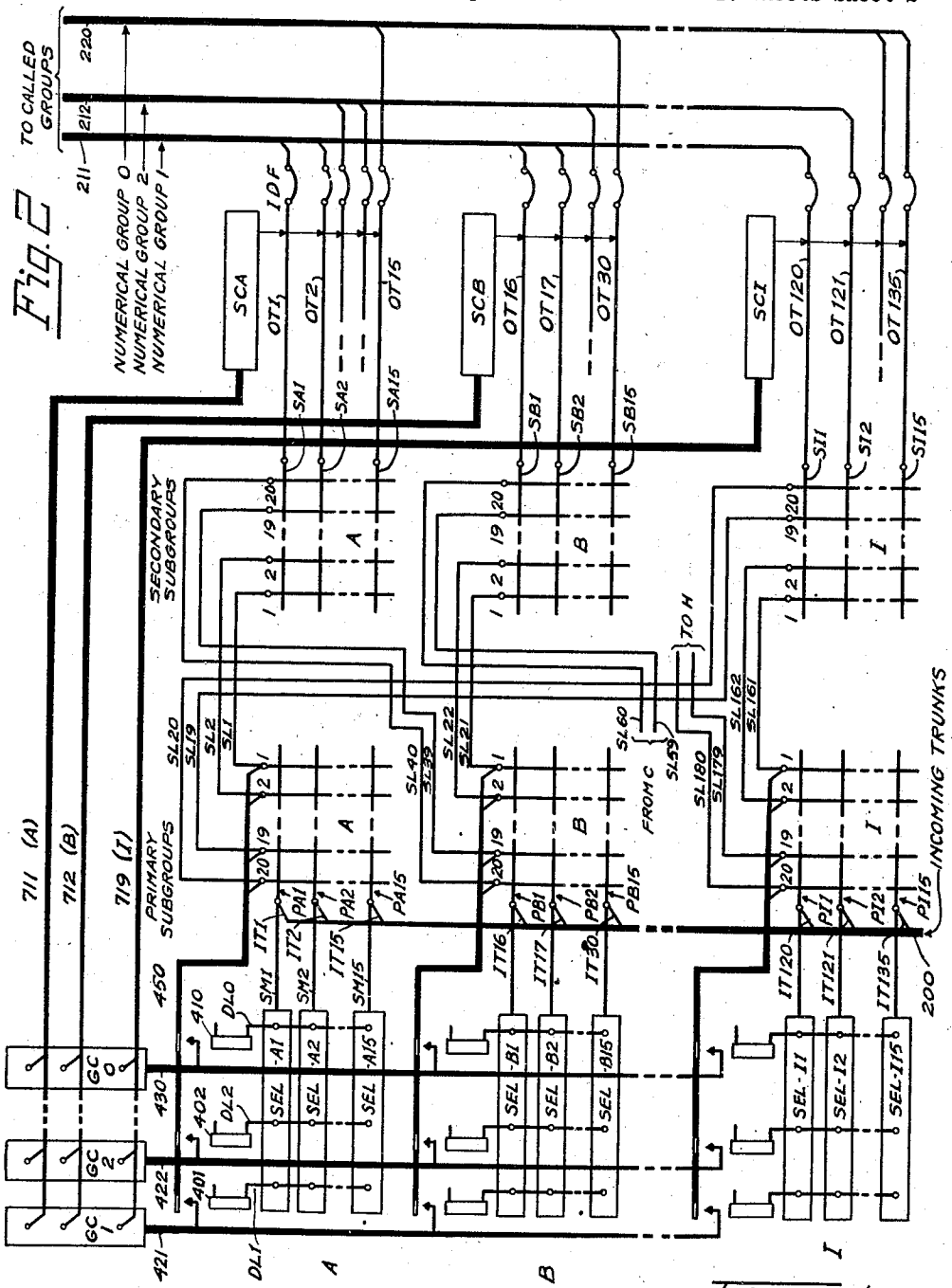

Fig. 2

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SELECTOR SWITCHING SYSTEM

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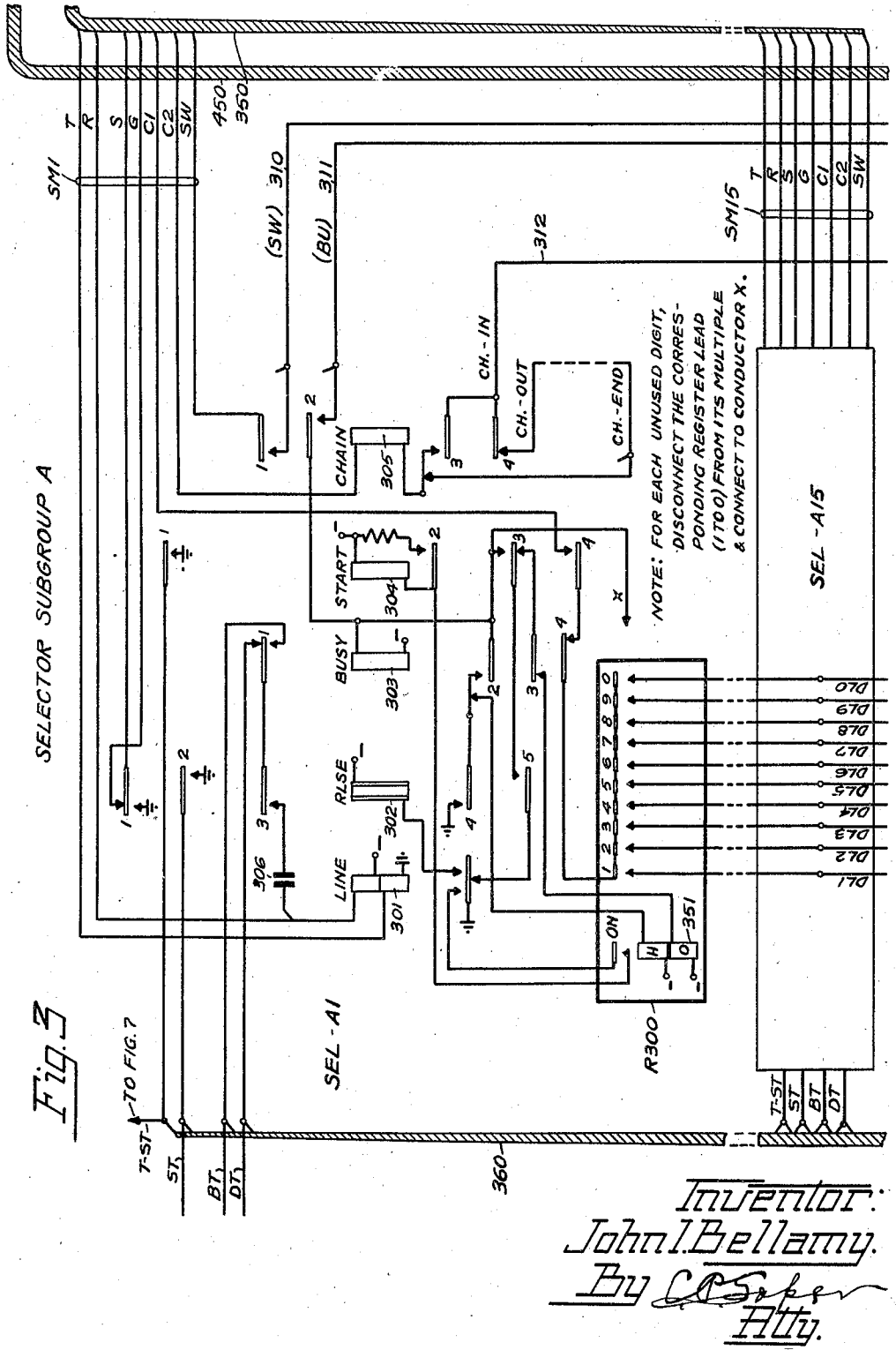

Fig. 3

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May 21, 1946. J. I. BELLAMY 2,400,530

SELECTOR SWITCHING SYSTEM

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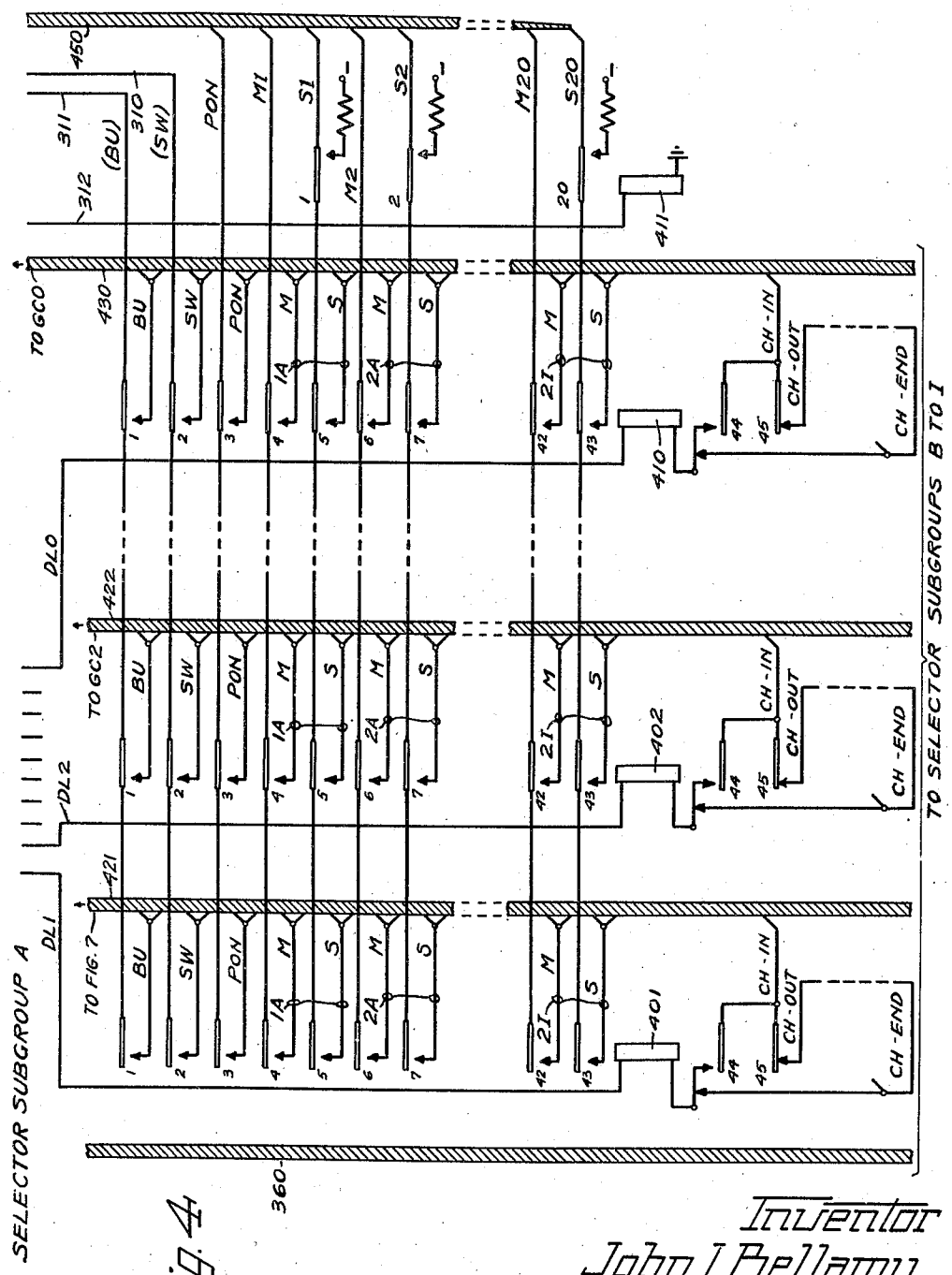

Fig. 4

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May 21, 1946. J. I. BELLAMY 2,400,530

SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 5

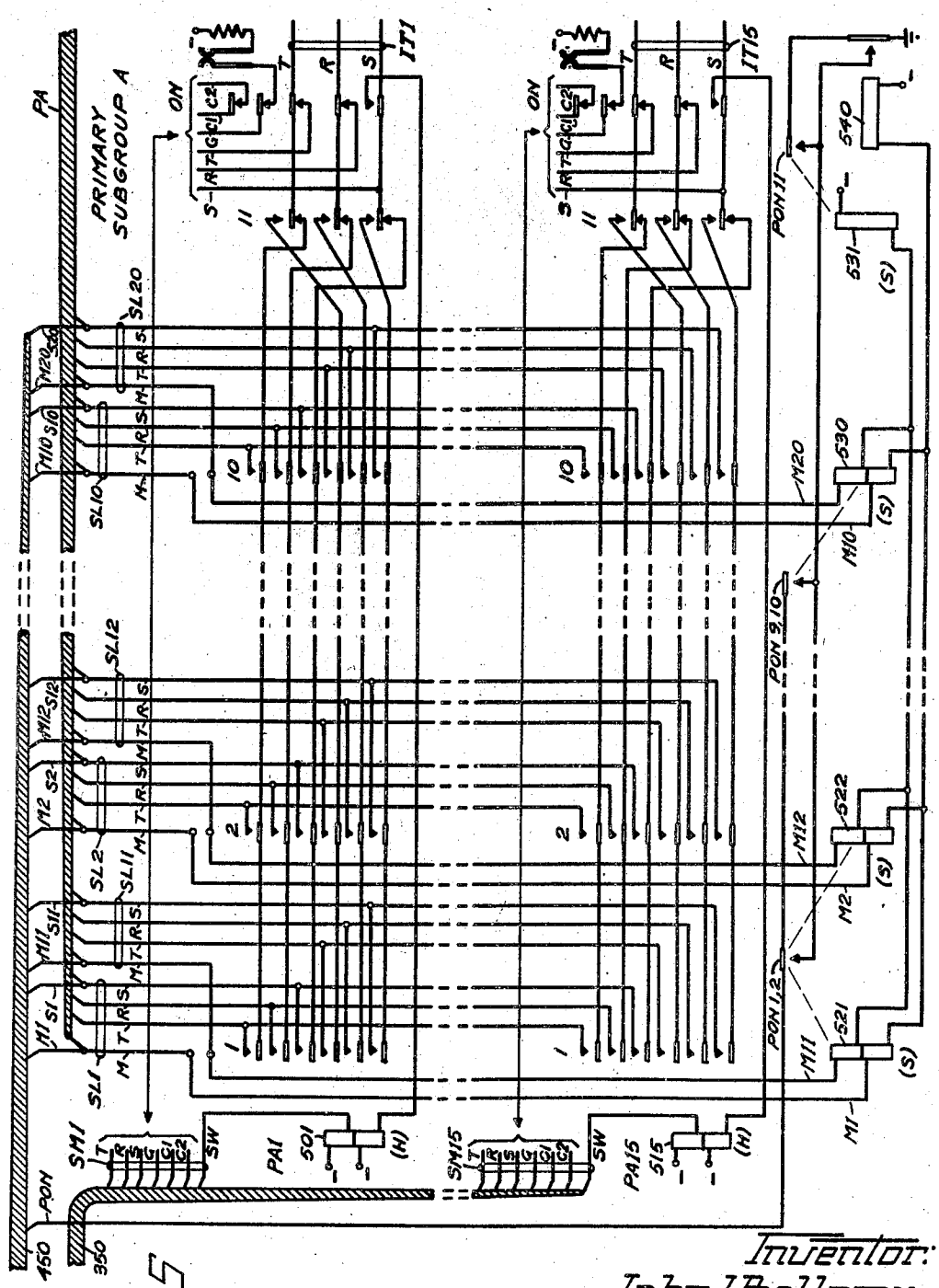

Fig. 5

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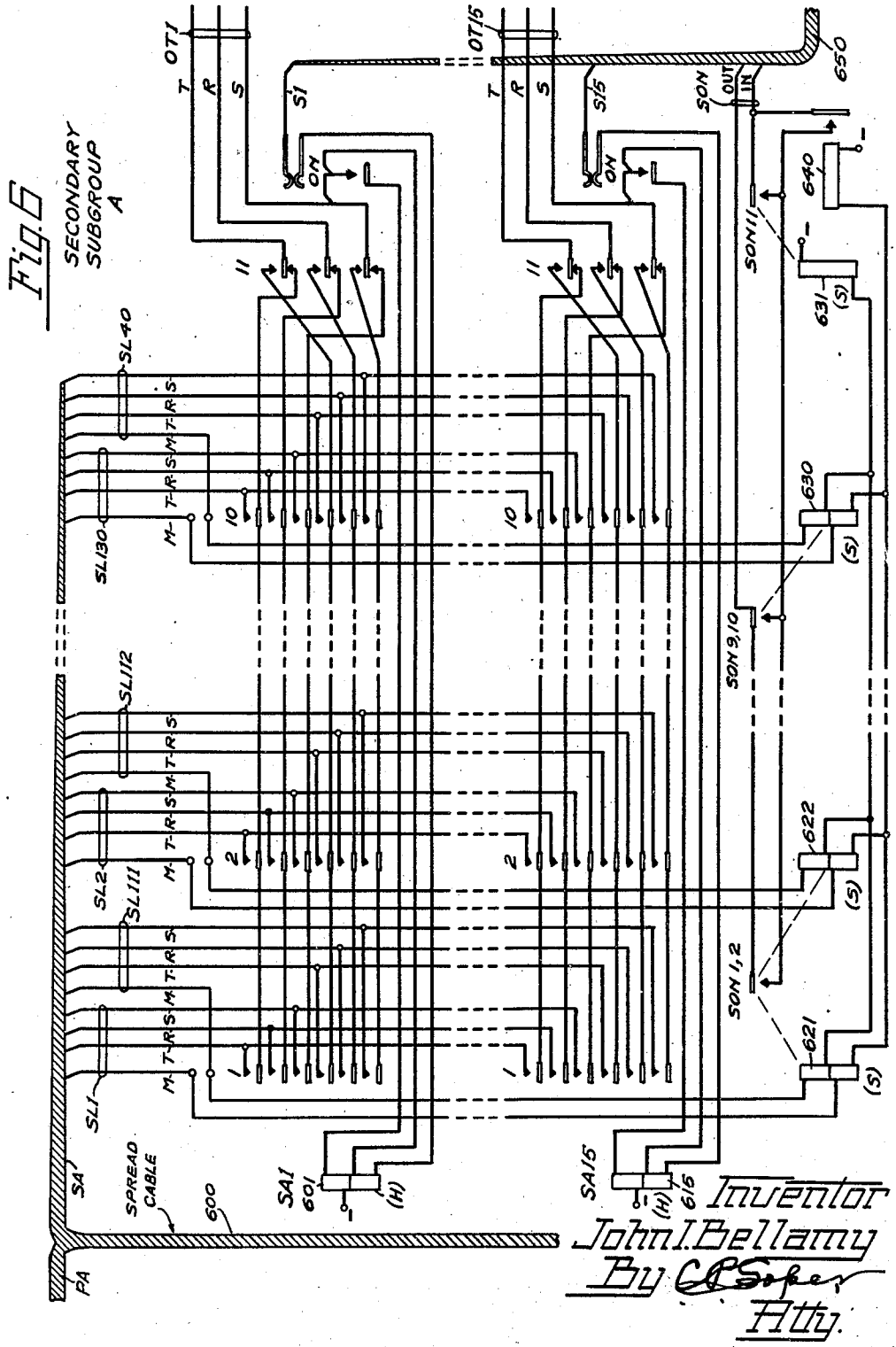
May 21, 1946. J. I. BELLAMY 2,400,530

SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 6



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SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 7

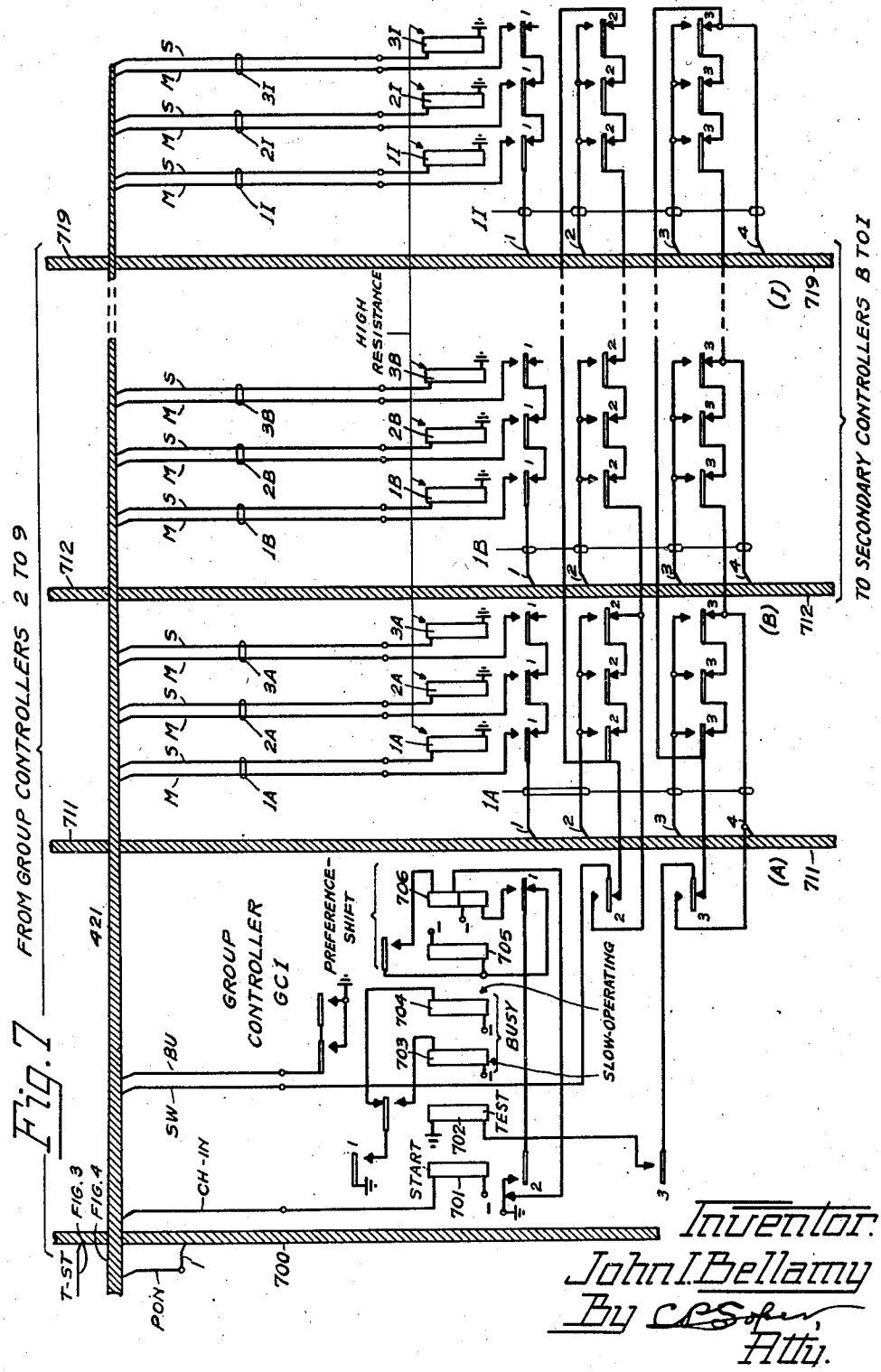

Fig. 7

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SELECTOR SWITCHING SYSTEM

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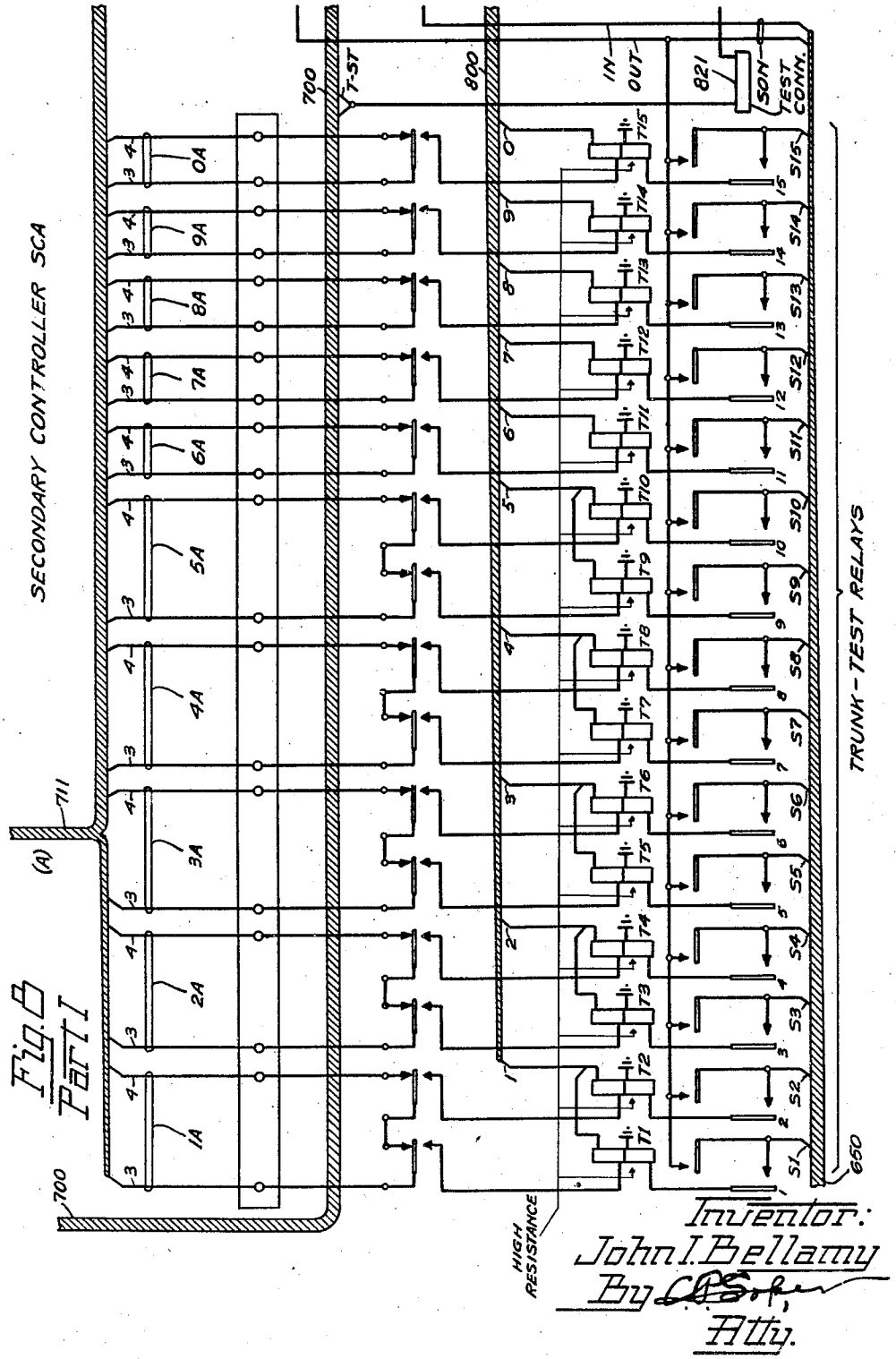

Fig. 8 Part I

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SELECTOR SWITCHING SYSTEM

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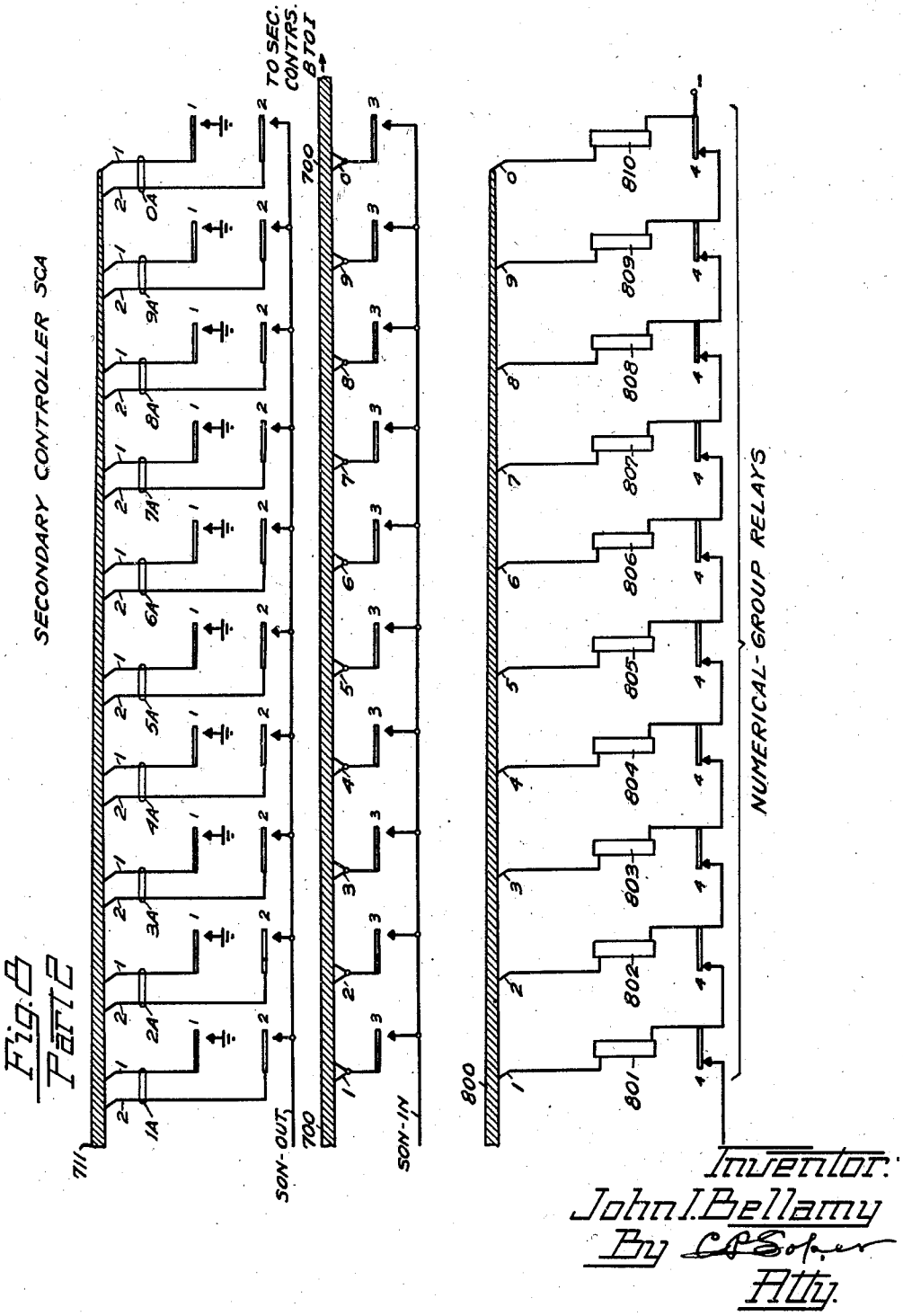

Fig. 8 Part 2

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SELECTOR SWITCHING SYSTEM

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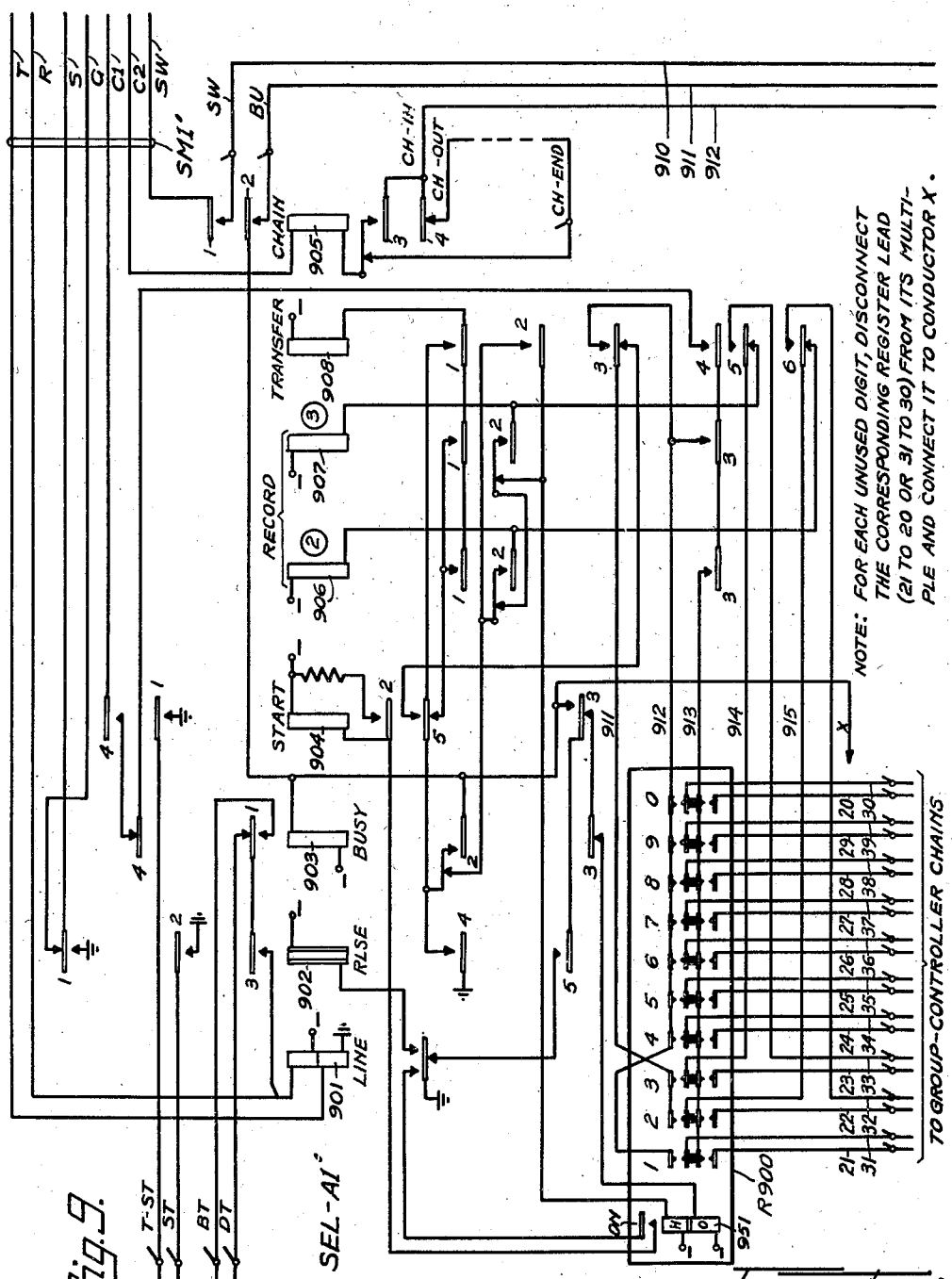

Fig. 9.

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SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 11

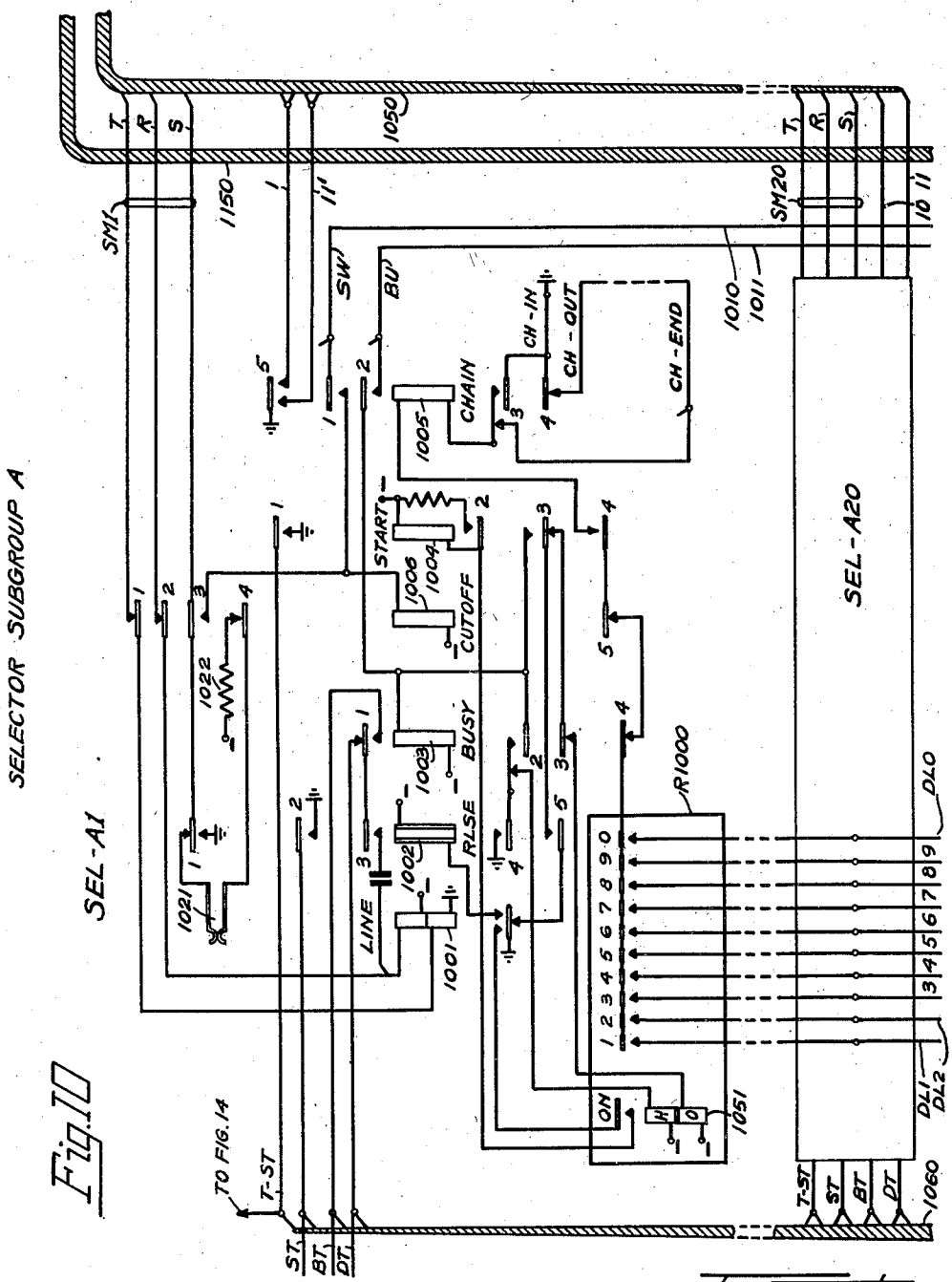

Fig. 10

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SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 12

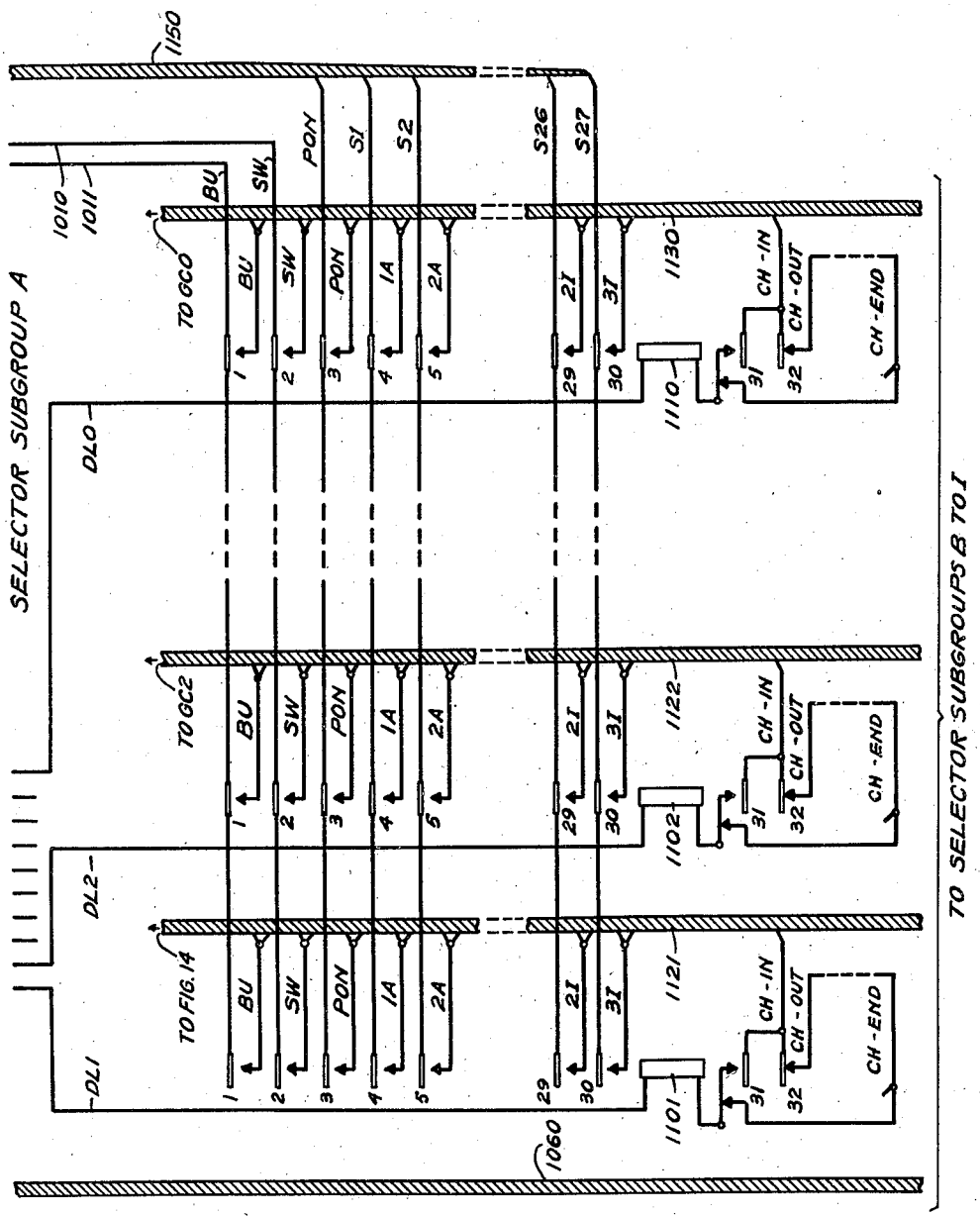

Fig. 11

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SELECTOR SWITCHING SYSTEM

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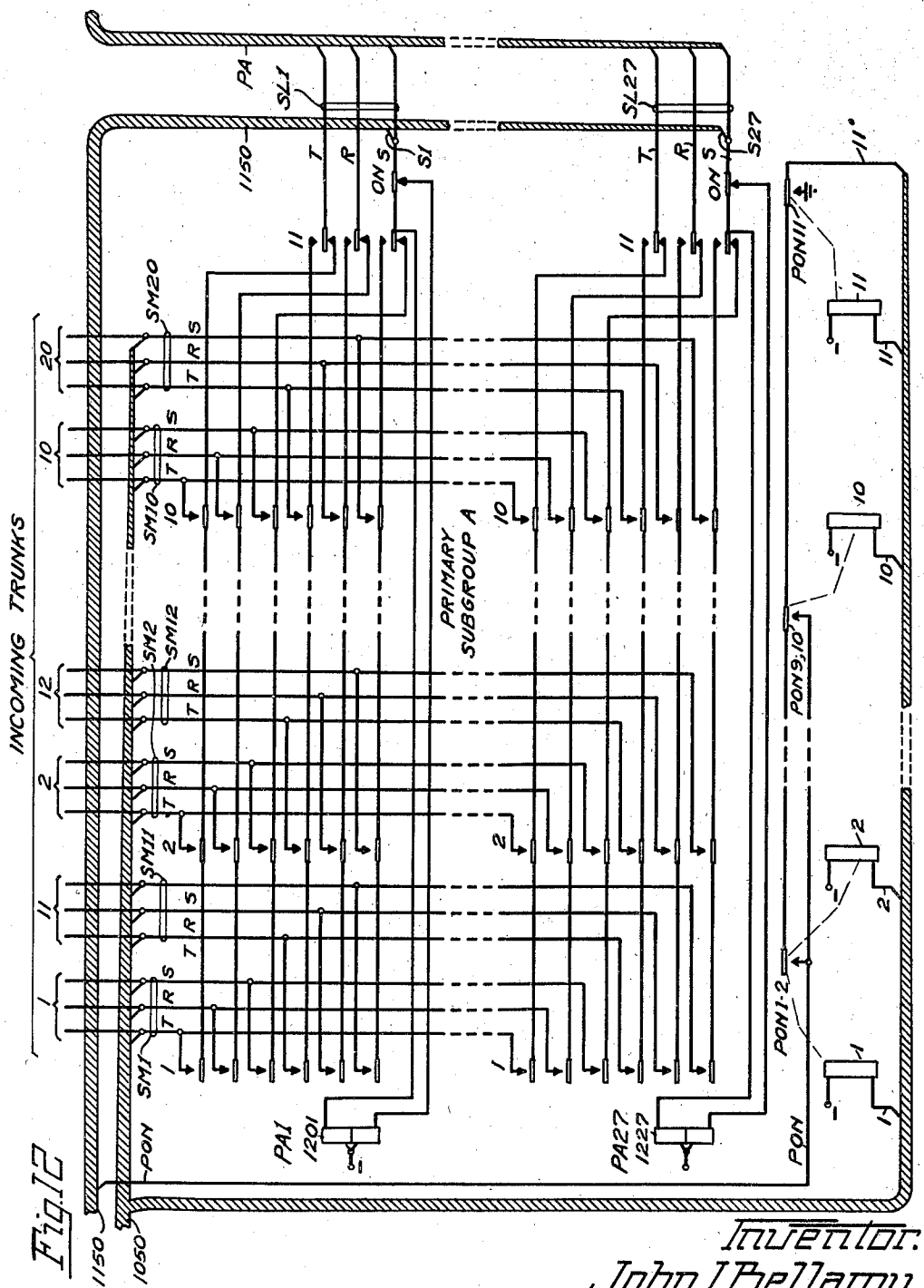

Fig. 12

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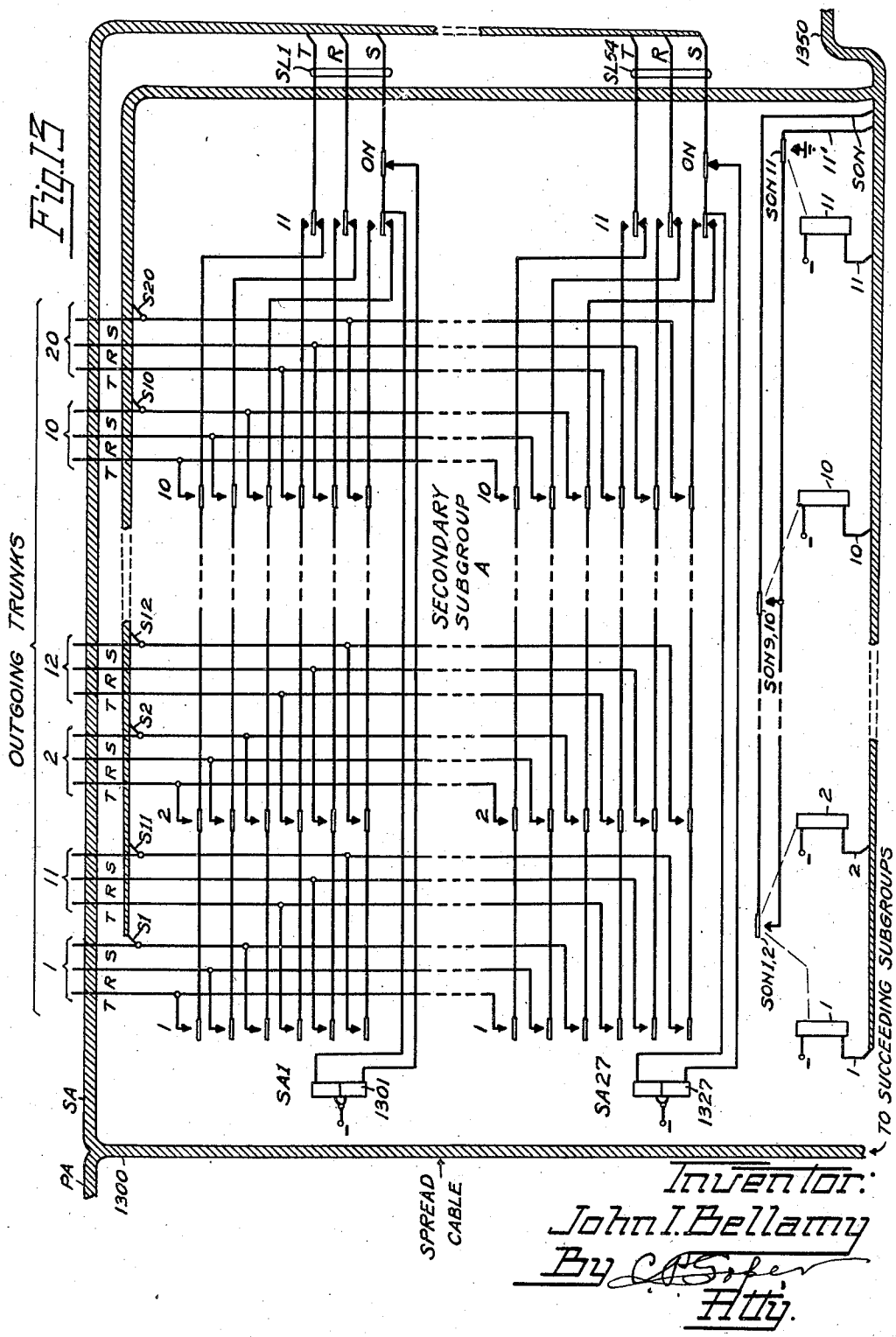
SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 14



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SELECTOR SWITCHING SYSTEM

Filed April 20, 1944 16 Sheets-Sheet 15

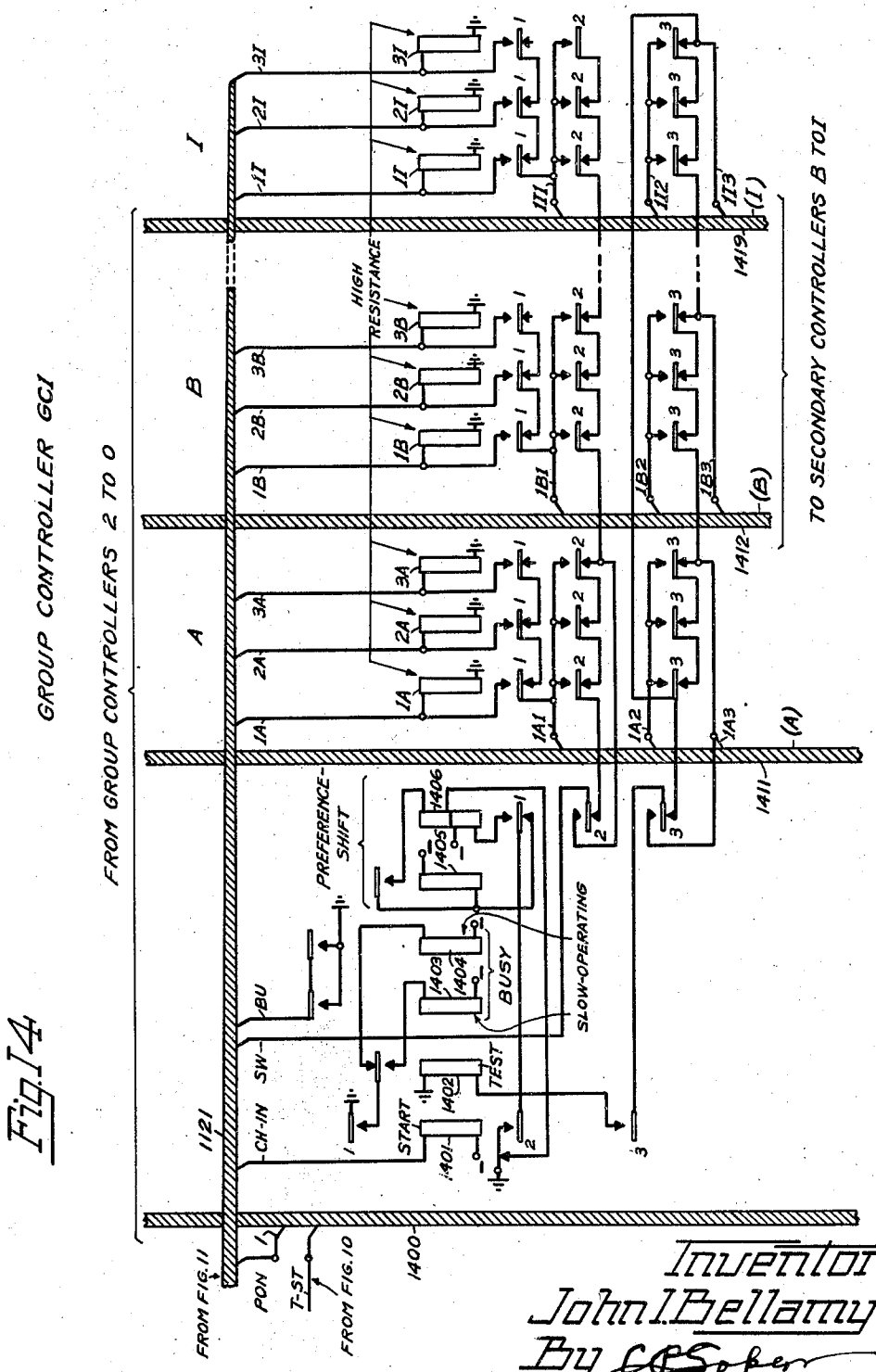

Fig. 14

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SELECTOR SWITCHING SYSTEM

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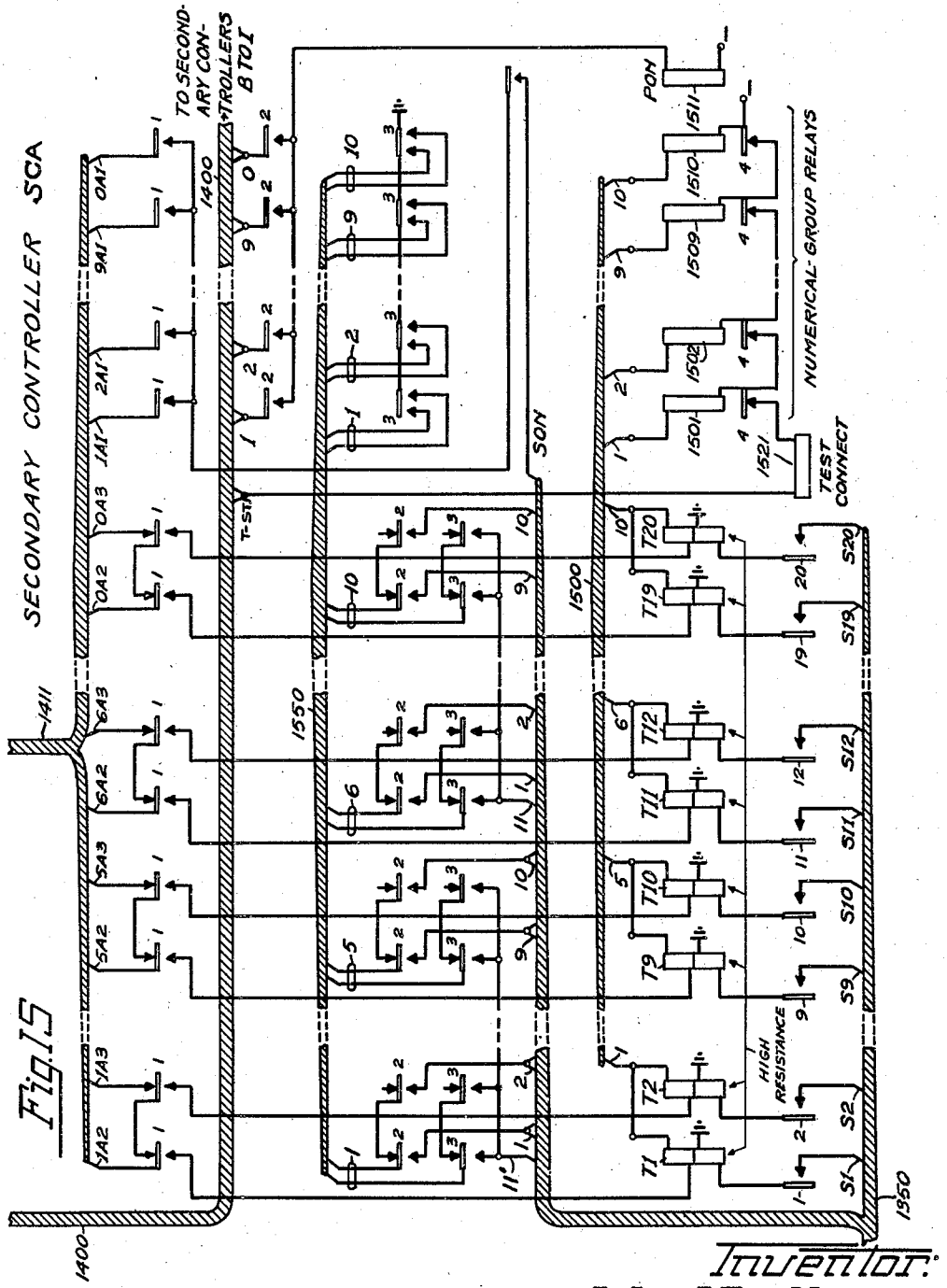

Fig. 15

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Patented May 21, 1946 2,400,530

UNITED STATES PATENT OFFICE

2,400,530

SELECTOR SWITCHING SYSTEM

John I. Bellamy, Brookfield, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a corporation of Illinois

Application April 20, 1944, Serial No. 531,949

41 Claims. (Cl. 179—18)

This invention relates to selector switching systems, being concerned more particularly with selector switching systems employed at selector switching stages in automatic telephone systems and the like to interconnect any calling incoming trunk with an idle outgoing trunk in any called numerical group.

The general object of the invention is to provide an improved selector switching system of the type employing a group of tandem-related subgrouped primary and secondary switches.

GENERAL DESCRIPTION

This invention is an improvement on the switching system employed at the selector switching stage disclosed in my prior application for Automatic telephone switches and systems, Serial Number 451,565, filed July 20, 1942, now Patent No. 2,354,660, granted August 1, 1944. The principal feature of improvement over the said prior application is that the primary and secondary switches at a selector stage are more efficiently and flexibly employed, in that they comprise a single non-numerical group, rather than being divided into separate numerical groups. That is, in the improved system, no primary nor secondary subgroup has any numerical significance, and any trunk outgoing from any secondary subgroup can be assigned to any outgoing numerical group of trunks.

A special object of the invention is to provide an efficient selector system of the foregoing character in which a number of calls may proceed simultaneously through the primary-secondary group without mutual interference.

A corresponding feature of the invention is that the act of establishing a connection from a calling incoming trunk to an idle outgoing trunk in a called numerical group, while temporarily monopolizing the primary subgroup at which the calling incoming trunk terminates, and the secondary subgroup at which the said idle outgoing trunk terminates, leaves all other primary and secondary subgroups free to handle other calls.

THE DRAWINGS

Other objects and features of the invention, for the most part subordinate to those enumerated, will appear upon a further perusal of the specification in connection with the accompanying drawings comprising Figs. 1 to 17, wherein;

Fig. 1 is a call-through diagram showing a connection completed from the calling line to a called line by way of a selector stage employing a selector system according to the invention;

Fig. 2 is a schematic trunking diagram illustrating the general arrangement of one embodiment of the improved selector system;

Figs. 3 to 8 are circuit drawings of portions of the equipment indicated in Fig. 2;

Fig. 9 is a modification of the selector illustrated in Fig. 3;

Figs. 10 to 15 are drawings similar to Figs. 3 to 8 respectively, but illustrating modified circuit arrangements for use with a modified arrangement of the switching mechanism at the selector stage;

Fig. 16 shows the way Figs. 3 to 8 are intended to be assembled; and

Fig. 17 shows the way Figs. 10 to 15 are intended to be assembled.

The primary and secondary switches employed in the selector system as disclosed herein may be of the general type disclosed in my prior application hereinbefore referred to, but are illustrated as of the twenty-point, three-wire, enlarged-capacity type disclosed in my application for Automatic telephone switches, Serial No. 524,816, filed March 1, 1944.

THE PRIMARY-SECONDARY ARRANGEMENT

In the modification shown in Figs. 1 to 8, the primary and secondary switches are arranged "face-to-face" at the selector stage, and interconnected by selector links. That is, each primary switch serves as the terminal point for an incoming trunk, and has access (in common with other switches of the same primary subgroup) to twenty selector links, and each secondary switch serves as the beginning point of an outgoing trunk and has access (in common with the other switches of the same secondary subgroup) to twenty selector links. This arrangement is illustrated best in Fig. 2 wherein nine primary subgroups of switches, A to I, are indicated and nine secondary subgroups of switches A to I, are indicated. Primary subgroups C to H and secondary subgroups C to H are omitted from the drawing for the sake of simplicity and to conserve drawing space. Since each subgroup of primary or secondary switches may have access to twenty selector links, the number of selector links is twenty times the number of primary or secondary subgroups. In the illustrative example, the nine primary and nine secondary subgroups (A to I) provide for a total of 180 selector links. In this arrangement, the number of selector links may vary from forty to four hundred, according to the traffic to be carried by the primary-secondary group of switches, for the number of subgroups can vary from two to twenty.

The number of primary or secondary switches in a subgroup has more or less arbitrarily been set at fifteen. By this arrangement, only fifteen of the twenty selector links served by a primary or a secondary subgroup can be in use at the same time, whereby the selector links are operated at a very low traffic density and a consequently low lost-call rate, which is in keeping with their comparative low cost.

In Fig. 2, the primary switches are represented by horizontal lines PA1 to PA15 for primary subgroup A, PB1 to PB15 for primary subgroup B, and PI1 to PI15 for primary subgroup I. The secondary switches are represented by horizontal lines SA1 to SA15 for secondary subgroup A, SB1 to SB15 for secondary subgroup B, and SI1 to SI15 for secondary subgroup I. The vertical lines extending across a subgroup represent the twenty link outlets of the subgroup by way of the twenty contact sets of any switch in such subgroup. The common outlet (or inlet) terminals of a subgroup are shown at the top, numbered 1 to 20. A few of the 180 selector links are shown interconnecting primary-subgroup terminals with secondary-subgroup terminals.

The nine primary subgroups, A to I, of Fig. 2, with fifteen primary trunks each serve as terminating points for 135 incoming trunks IT1 to IT135. Similarly, the nine secondary subgroups serve as starting points for 135 outgoing trunks OT1 to OT135. The selector links are "spread" between the primary and secondary subgroups on the basis of each primary subgroup having access to at least one link extending to each secondary subgroup, and vice-versa. When only two primary and two secondary subgroups are required, half the links from any primary subgroup extend to one secondary subgroup, the remaining half to the other. When twenty primary and twenty secondary subgroups are required, the twenty links from any primary subgroup extend respectively to the twenty secondary subgroups. For each intermediate number of primary and secondary subgroups, a separate spreading arrangement may be employed, as will be readily understood. For nine primary and nine secondary subgroups, as assumed herein, each primary subgroup has access to three links extending to each of two of the secondary subgroups, and two links extending to each of the other seven secondary subgroups.

The following table shows the general spread arrangement for each number of primary and secondary subgroups from two to twenty:

TABLE NO. 1

No. of subgroups	No. of links from any primary subgroup to the secondary subgroups
2	10 to each.
3	7 each to two; 6 to one.
4	5 to each.
5	4 to each.
6	4 each to two; 3 each to four.
7	3 each to six; 2 to one.
8	3 each to four; 2 each to four.
9	3 each to two; 2 each to seven.
10	2 to each.
11	2 each to nine; 1 each to two.
12	2 each to eight; 1 each to four.
13	2 each to seven; 1 each to six.
14	2 each to six; 1 each to eight.
15	2 each to five; 1 each to ten.
16	2 each to four; 1 each to twelve.
17	2 each to three; 1 each to fourteen.
18	2 each to two; 1 each to sixteen.
19	2 to one; 1 each to eighteen.
20	1 to each.

In carrying out any of the general spread arrangements indicated in Table No. 1, an orderly specific arrangement may be adopted wherein the selector link extending from any primary subgroup terminal extends to the correspondingly numbered (1 to 20) terminal in the desired secondary subgroup, and wherein the spread of selector links extending from any primary subgroup begins with the corresponding secondary subgroup.

The following table gives the specific arrangement chosen and considered preferable for the system of Fig. 2, wherein 180 selector links interconnect nine primary and secondary subgroups A to I.

TABLE NO. 2

Sel. link	From pri. term.	To sec. term.	Sel. link	From pri. term.	To sec. term.	Sel. link	From pri. term.	To sec. term.
1	A1	A1	21	B1	B1	41	C1	C1
2	A2	A2	22	B2	B2	42	C2	C2
3	A3	*A3*	23	B3	*B3*	43	C3	*C3*
4	A4	B4	24	B4	C4	44	C4	D4
5	A5	B5	25	B5	C5	45	C5	D5
6	A6	*B6*	26	B6	*C6*	46	C6	*D6*
7	A7	C7	27	B7	D7	47	C7	E7
8	A8	*C8*	28	B8	*D8*	48	C8	*E8*
9	A9	D9	29	B9	E9	49	C9	F9
10	A10	*D10*	30	B10	*E10*	50	C10	*F10*
11	A11	E11	31	B11	F11	51	C11	G11
12	A12	*E12*	32	B12	*F12*	52	C12	*G12*
13	A13	F13	33	B13	G13	53	C13	H13
14	A14	*F14*	34	B14	*G14*	54	C14	*H14*
15	A15	G15	35	B15	H15	55	C15	I15
16	A16	*G16*	36	B16	*H16*	56	C16	*I16*
17	A17	H17	37	B17	I17	57	C17	A17
18	A18	*H18*	38	B18	*I18*	58	C18	*A18*
19	A19	I19	39	B19	A19	59	C19	B19
20	A20	*I20*	40	B20	*A20*	60	C20	*B20*
61	D1	D1	81	E1	E1	101	F1	F1
62	D2	D2	82	E2	E2	102	F2	F2
63	D3	*D3*	83	E3	*E3*	103	F3	*F3*
64	D4	E4	84	E4	F4	104	F4	G4
65	D5	E5	85	E5	F5	105	F5	G5
66	D6	*E6*	86	E6	*F6*	106	F6	*G6*
67	D7	F7	87	E7	G7	107	F7	H7
68	D8	*F8*	88	E8	*G8*	108	F8	*H8*
69	D9	G9	89	E9	H9	109	F9	I9
70	D10	*G10*	90	E10	*H10*	110	F10	*I10*
71	D11	H11	91	E11	I11	111	F11	A11
72	D12	*H12*	92	E12	*I12*	112	F12	*A12*
73	D13	I13	93	E13	A13	113	F13	B13
74	D14	*I14*	94	E14	*A14*	114	F14	*B14*
75	D15	A15	95	E15	B15	115	F15	C15
76	D16	*A16*	96	E16	*B16*	116	F16	*C16*
77	D17	B17	97	E17	C17	117	F17	D17
78	D18	*B18*	98	E18	*C18*	118	F18	*D18*
79	D19	C19	99	E19	D19	119	F19	E19
80	D20	*C20*	100	E20	*D20*	120	F20	*E20*
121	G1	G1	141	H1	H1	161	I1	I1
122	G2	G2	142	H2	H2	162	I2	I2
123	G3	*G3*	143	H3	*H3*	163	I3	*I3*
124	G4	H4	144	H4	I4	164	I4	A4
125	G5	H5	145	H5	I5	165	I5	A5
126	G6	*H6*	146	H6	*I6*	166	I6	*A6*
127	G7	I7	147	H7	A7	167	I7	B7
128	G8	*I8*	148	H8	*A8*	168	I8	*B8*
129	G9	A9	149	H9	B9	169	I9	C9
130	G10	*A10*	150	H10	*B10*	170	I10	*C10*
131	G11	B11	151	H11	C11	171	I11	D11
132	G12	*B12*	152	H12	*C12*	172	I12	*D12*
133	G13	C13	153	H13	D13	173	I13	E13
134	G14	*C14*	154	H14	*D14*	174	I14	*E14*
135	G15	D15	155	H15	E15	175	I15	F15
136	G16	*D16*	156	H16	*E16*	176	I16	*F16*
137	G17	E17	157	H17	F17	177	I17	G17
138	G18	*E18*	158	H18	*F18*	178	I18	*G18*
139	G19	F19	159	H19	G19	179	I19	H19
140	G20	*F20*	160	H20	*G20*	180	I20	*H20*

Numerical Grouping of Outgoing Trunks

The outgoing trunks OT1 to OT135 of Fig. 2 may be divided into as many separately numbered groups as desired, each trunk group leading to a separate destination, usually a separate group of called lines. Each such separate group of outgoing trunks may be designated a numerical group, in that each group bears a separate number, or digit, designation. It is assumed that the outgoing trunks indicated in Fig. 2 are divided into ten numerical groups, of which groups

1, 2 and 0 are represented respectively by cables 211, 212, and 220.

For convenience in grouping, the outgoing trunks OT1 to OT135 may be passed through an intermediate distributing frame indicated at IDF, across which each trunk may be carried by a separate jumper connection. The preferred assignment of outgoing trunks to the numerical groups is such that each numerical group contains as nearly as possible the same number of trunks from each secondary subgroup, an ideal rarely obtaining in practice.

The 135 outgoing trunks OT1 to OT135 provide an average of thirteen and one-half trunks for each of the ten outgoing numerical groups 1 to 0. Some numerical groups may contain only ten trunks, or fewer, while other numerical groups may contain twenty trunks or more, all depending upon the traffic requirements.

The Group-Control Arrangement

In the arrangement shown in Fig. 2, ten group controllers, GC1 to GC0, correspond respectively to the ten numerical groups of outgoing trunks. Each group controller is arranged to direct any primary switch in any subgroup to extend a connection to any outgoing trunk in the corresponding numerical group, by way of a selector link and the concerned secondary switch. Any operating group controller is assisted in selection of an idle outgoing trunk by one or another of the nine secondary controllers SCA to SCI, according to the secondary subgroup through which connection with an idle trunk in the called numerical group is located. The secondary controllers are connected with the group controllers through the nine cables 711 to 719. Since each secondary subgroup has its own secondary controller, each secondary subgroup is able to act as a unit independent of the others.

The Selectors

As shown in Fig. 2, selectors SEL—A1 to SEL—A115 are individual respectively to the primary switches PA1 to PI15. These selectors are divided into subgroups A to I, fifteen selectors to a subgroup, in accordance with the division of the primary switches into subgroups. The selectors of any subgroup are connected with the respective switches of the corresponding primary subgroup by way of selector multiples, such as SM1 to SM15 for selector subgroup A. Each selector includes an arrangement of control relays (Fig. 3) for performing the necessary control functions, and for transmitting impulses to a register device, through which selection is made of one or another of ten so-called dial leads, one for each separate digit value employed to direct a call through the selector stage. A separate one of ten digit values is employed for each of the ten numerical groups 1 to 0 of outgoing trunks.

Each subgroup of selectors is provided with ten connecting relays, such as relays 401 to 410 of subgroup A, in which the dial leads DL1 to DL0 of that selector subgroup terminate. Through the selection and operation of one or another of the relays 401 to 410, connection is made with the corresponding one of the group controllers GC1 to GC0, by way of a local cable such as 450 and the concerned group cable 421 to 430, whereby the requisite number of connections is made to the group controller to enable the latter to control the extension of the connection to an idle trunk in the called numerical group. Since each selector subgroup A to I is provided with its own set of dial leads such as DL1 to DL0, its own group of ten connecting relays such as 401 to 410, and its own local cable such as 450, each selector subgroup, together with its associated primary subgroup of switches, is able to act as a unit independent of the others.

The Circuit Drawings

The circuit drawings of Figs. 3 to 8 will now be explained briefly. Fig. 3 shows in full the circuits of selector SEL—A1 and indicates the fifteenth selector SEL—A15 by means of a rectangle. These two selectors, together with thirteen intermediate selectors, form selector subgroup A of Fig. 2. Cable 350 contains the fifteen selector multiples SM1 to SM15, which interconnect the selectors of selector subgroup A with the respective corresponding switches of primary subgroup A, the first and last of these multiples being shown in Figs. 3 and 5. Fig. 3 also shows dial leads DL1 to DL0 which are multiply connected to the contacts of the registers such as R300, a separate such register being provided for each selector.

Fig. 4 shows three of the ten connecting relays 401 to 410 to which the dial leads DL1 to DL0 of selector subgroup A respectively extend. Each such relay, when operated over its associated dial lead from any selector in selector subgroup A, operates to interconnect conductors 310, 311, and the conductors in subgroup-A cable 450, to conductors in the associated one of the cables 421 to 430 extending respectively to the ten group controllers GC1 to GC0.

Fig. 5 shows the circuit arrangement of primary subgroup A of Fig. 2, primary switches PA1 and PA15 being shown. The intermediate primary switches of this subgroup are omitted to conserve drawing space. Primary switch PA1, for example, contains eleven selective stackups of contacts 1 to 11 (stackups 3 to 9 are omitted to conserve drawing space) and an off-normal stackup ON. The arrangement for selecting and operating the stackups of contacts may be as shown and described in the second of my previously identified prior applications. That is, eleven select magnets are provided, one for each of the stackups of contacts 1 to 11. The select magnets for stackups 1, 2, 10, and 11 are magnets 521, 522, 530, and 531. Select magnet 531, associated with stackup 11 of any primary switch of the subgroup, is operated or not (along with one of the magnets 521 to 530) depending upon whether the lower contact set or the upper contact set of an operated stackup 1 to 10 is to be effective.

For the operation, and maintenance, of the selected combination of stackups, each switch is provided with a hold magnet (501 for switch PA1, and 515 for switch PA15).

The off-normal stackup ON of any of the switches is not a selective stackup, being operated each time the corresponding hold magnet, such as 501, is energized, irrespective of what stackup selection has been accomplished.

Each primary and each secondary subgroup of switches is provided with its own set of select magnets 521 to 531, and with its own set of selecting shafts (not shown), whereby each subgroup is capable of operating as a unit independent of the other subgroups.

Fig. 6 is a drawing corresponding generally to Fig. 5, but showing secondary subgroup A instead of primary subgroup A. Here again, only the first and fifteenth switches are shown, and stack-

ups 3 to 9 are omitted. Magnets 621 to 631 correspond respectively to magnets 521 to 531; and hold magnets 601 to 615 correspond respectively to magnets 501 to 515.

Fig. 5 shows the three-conductor incoming trunks IT1 and IT15 terminating respectively in primary switches PA1 and PA15, and Fig. 6 shows the three-conductor outgoing trunks OT1 and OT15 extending respectively from secondary switches SA1 and SA15.

Assuming the primary and secondary subgroups to be mounted in superposed relation as indicated in Fig. 2, spread cable 600 extends vertically between them and has lateral branches for the respective primary and secondary subgroups. Branches PA and SA are the lateral branches for primary subgroup A and secondary subgroup A. This spread cable contains conductor sets comprising the selector links interconnecting the subgroups of primary and secondary switches according to Table No. 2, appearing hereinbefore. Each selector link (such as SL1 to SL20 extending from primary subgroup A) includes four conductors, a magnet conductor M, and the usual tip, ring, and sleeve conductors T, R, and S. The magnet conductor M in any selector link is the conductor over which the one of the ten select magnets such as 621 to 630 is operated in the secondary subgroup to which such link extends, with or without operation of the associated eleventh select magnet such as 631.

The six contact pairs in stackups 1 to 10 of any switch comprise an upper set of three and a lower set of three, each switch having ten upper sets and ten lower sets. The upper sets represent terminals 1 to 10, respectively, of the subgroup, while the lower sets represent terminals 11 to 20, respectively. Stackup 11 of any switch is operable to render sets 11 to 20 effective in place of sets 1 to 10.

Fig. 7 shows the circuit arrangement at group controller GC1 of Fig. 2, the circuit arrangement at each of the other group controllers being similar.

Group controller GC1 includes start and test relays 701 and 702, a pair of busy relays 703 and 704, a pair of preference-shift relays 705 and 706, and twenty-seven link-test relays 1A to 3I. The link-test relays are assigned in subgroups of three to test the links extending from a calling primary subgroup to the respective secondary subgroups. This is in accordance with Table No. 2, wherein it will be noted that not more than three selector links extend from any primary subgroup to any secondary subgroup. Relays 1A to 3A are assigned to links extending from a calling primary subgroup to secondary subgroup A; relays 1B to 3B are assigned to links extending to secondary subgroup B; and so on, to relays 1I to 3I, which are assigned to links extending from a calling primary subgroup to secondary subgroup I.

Group controller GC1 is connected with selector subgroups A to I by the conductors in cable 421 incoming to Fig. 7 from Fig. 4. Group controller GC1 is also interconnected with the nine secondary controllers (SCA to SCI), by conductor sets 1A, 1B, and so forth, to 1I, lying respectively in cables 711 to 719. These cables carry similar conductor sets to the secondary controllers from the other group controllers. These other conductor sets (not shown in Fig. 7) may be similarly labeled 2A to 2I, 3A to 3I, and so forth, to 0A to 0I, according to the group controller at which they originate.

Fig. 8, comprising parts 1 and 2, shows secondary controller SCA of Fig. 2, the other secondary controllers being similar. Relays T1 to T15 are test relays corresponding respectively to the fifteen trunks, OT1 to OT15, outgoing from the associated secondary subgroup A. The interconnection between the outgoing trunks and relays T1 to T15 is through conductors S1 to S15 in cable 650, and by way of contacts of connecting relay 821, when operated.

Relays 801 to 810 are numerical-group relays assigned respectively to numerical groups 1 to 0 of outgoing trunks. Each such numerical-group relay is controllable only from the corresponding group controller, and then only if the secondary controller is idle. Upon the operation of any numerical-group relay, operations occur to mark the secondary controller busy to the remaining group controllers, as will appear subsequently, and to initiate the operation of the switching apparatus to complete the connection.

DETAILED DESCRIPTION

The invention having been described generally, a detailed description will now be given. The operation will first be described with reference to Fig. 1.

A. FIGURE 1

Referring now particularly to Fig. 1, the general operations involved in setting up a connection from a calling substation A to a called substation B will now be described.

When the receiver (not shown) is removed at substation A, a direct-current bridge is established across the tip and ring conductors of the associated line, operating line relay 101 through contacts of cutoff relay 102 to cause finder action to occur at the associated finder stage. As a result of this finder action, the tip, ring, and sleeve conductors of the calling line are extended in any desired manner to an idle trunk line such as trunk line IT1 incoming to the selector stage. IT1, it may be pointed out, is shown also in Fig. 5, incoming to the primary switch PA1. The trunk line IT1 is normally marked idle by an idle-indicating battery potential applied to the sleeve conductor S thereof by way of contacts of release relay 302 and contacts in stackup ON of the associated primary switch PA1, the connection being made by way of the illustrated current-limiting resistor.

When the finder-stage extension has been made, line relay 301 associated with trunk IT1 (being a relay of selector SEL—A1, Fig. 3) operates over the calling line, causing operation of the associated release relay 302. Relay 302 disconnects the normally applied idle-indicating battery potential and substitutes ground potential to maintain in the usual manner the connection established through the finder stage, closing an operating circuit for cutoff relay 102. Relay 102 thereupon operates to disconnect the line-relay bridge, whereupon line relay 101 restores.

The calling subscriber may now dial the first digit in the number assigned to the line of substation B, causing the usual series of interruptions to be produced in the bridge across the calling line by the usual form of calling device. The resulting series of momentary restorations of line relay 301 causes a selecting operation to occur in a manner to be explained subsequently in connection with Fig. 3. Upon the termination of the dialing of this digit, operations occur to test the selector links such as SL1 accessible to pri-

mary switch PA1 and to test the trunks extending from the secondary switches such as SA1 to the connector stage group containing the desired called line. The testing of sleeve conductor S of selector link SL1 occurs over the illustrated downward extension S1 thereof, while the testing of outgoing trunk OT1 is performed over its sleeve conductor S, over the indicated downward extension S1, connected therewith through the operating winding of hold magnet 601 of the associated secondary switch SA1.

Assuming that the testing operation determines that selector link SL1 and outgoing trunk OT1 are both idle, and are to be used for the connection, selecting operations occur as will be subsequently described to cause selector link SL1 to be selected by mechanism common to the primary switch PA1 and other switches in the same primary subgroup. Similar selecting operations occur in the mechanism common to secondary switch SA1 and other switches in the same secondary subgroup. When these selecting operations have been performed, the conductor labeled SW, and extending downwardly from the left-hand winding of hold magnet 501, is temporarily grounded, causing magnet 501 to operate to close the associated stackup 1 of contacts, thereby extending the tip, ring, and sleeve conductors of incoming trunk IT1 respectively to the corresponding conductors of selector link SL1. At the same time, ground potential is temporarily applied to the lead S1 extending downwardly from the right-hand winding of hold magnet 601, thereby closing an operating circuit for this magnet over the sleeve conductor of trunk OT1, to battery through contacts of release relay 111 and the associated current-limiting resistor. Magnet 601 thereupon operates to close its selected stackup 1, further extending the connection to the tip, ring, and sleeve conductors of outgoing trunk OT1. Thereupon, line relay 110 (being a portion of the connector-stage equipment to which trunk OT1 extends) operates over the calling line and causes release relay 111 to operate. The latter relay disconnects the normally applied source of idle-indicating battery potential from sleeve conductor S of trunk OT1 and substitutes a holding ground potential.

Stackups ON in switches PA1 and SA1 are actuated by the said operation of their respective magnets 501 and 601. Ground potential on the sleeve conductor of the extended connection is effective to energize the hold winding of magnet 601 through the associated off-normal contacts. Similarly, the hold winding of magnet 501 is energized through its associated off-normal contacts over the sleeve conductor. The off-normal stackup ON of switch PA1 also disconnects the associated line relay 301, following which relays 301 and 302 restore. The holding ground potential is subsequently maintained by release relay 111, through which magnets 601 and 501 and cutoff relay 102 are maintained operated, along with any holding magnets or relays (not shown) required at the finder stage.

The temporary circuits closed to select and operate magnet 501 are shortly opened, leaving the connection maintained by the above-noted holding ground potential on the sleeve conductor thereof. The lower pair of contacts in stackup ON of switch PA1 prevents reapplication of the normally applied source of idle-indicating battery potential, upon the restoration of release relay 302, thereby avoiding unnecessary current drain.

Following the described extension of the connection to the outgoing trunk OT1, the calling subscriber may dial the remaining digits in the desired number to cause the connection to be completed to the called line in the usual manner, line relay 110 responding to the further dialing to deliver the required local series of impulses.

When the connection is completed to the called line, ground potential is applied to the sleeve conductor thereof, operating cutoff relay 102' to disconnect the associated line-relay bridge.

After the called subscriber has been signalled in the usual manner and has answered, the talking connection is completed as indicated by the dotted connections. Talking current is supplied to the called line through back bridge relay 112, being supplied to the calling line through the windings of line relay 110. The voice currents pass through the usual talking condensers 113 and 114.

When the conversation has been completed, the replacing of the receiver at the calling substation permits line relay 110 to restore, followed shortly by the restoration of release relay 111. When the latter relay restores, it removes the holding ground potential from the sleeve conductor of the established connection, whereupon magnets 601 and 501 and cutoff relay 102 restore, along with any holding magnets or cut-off relays at the finder stage, immediately clearing out the connection between the calling line and trunk OT1.

B. Figures 3 to 8

B1. *Seizure of incoming trunk IT1*

Referring now to Figs. 3 to 8, the operations involved in extending a connection through the selector switching system at the selector stage of Fig. 2 will be further given in detail.

When incoming trunk IT1 (Fig. 5) is idle, an idle-indicating battery potential is impressed on its sleeve conductor S as follows: from the ungrounded pole of the exchange battery, through the illustrated current-limiting resistor and normally closed make-busy contacts associated with off-normal stackup ON of switch PA1, a pair of normally closed contacts in the said stackup, guard conductor G in selector multiple SM1, back contact of armature 1 of release relay 302 of selector SEL—A1, and thence, over conductor S in selector multiple SM1, to sleeve conductor S of incoming trunk IT1.

Upon seizure of incoming trunk IT1, the bridging of the calling line across the tip and ring conductors T and R thereof closes an energizing circuit, through normally closed contacts in the associated stackup ON, and conductors T and R of SM1, for the windings of line relay 301. Line relay 301 thereupon operates, followed by the operation of slow-restoring release relay 302. At its armature 1, relay 302 disconnects the incoming sleeve conductor from the normally connected source of idle-indicating potential and substitutes a holding ground potential therefor, through which the partially established connection is temporarily maintained. At armature 4, relay 302 closes a circuit, through contacts of busy relay 303, for hold winding H of magnet 351 of register 300; at armature 5, it prepares an impulse circuit for operating winding O of register 300; at its armature 2, it applies ground potential to the common start lead ST to start the common tone apparatus (not shown); and, at armature 3, it closes a connection between the associated ring conductor R and the common dial-tone lead DT, by way of condenser 306. A dial-tone signal is thereby transmitted back to the calling substa-

tion to inform the calling subscriber that he may begin to dial the digits in the desired number.

B2. *Dialing*

At this point, it should be noted that the register R300 is of the construction and operation disclosed in my prior application, Serial No. 493,312, filed July 2, 1943. Briefly, the construction is such that energization of hold winding H of magnet 351 produces no immediate effect; transmission of the first impulse to winding O of magnet 351 causes simultaneous closure of off-normal contacts ON and contacts 1 of the register; transmission of the second impulse causes separation of contacts 1 and the closure of contacts 2; transmission of the third impulse causes separation of contacts 2 and the closure of contacts 3, and so forth.

Upon the dialing of the first digit in the desired number, line relay 301 is momentarily restored a number of times corresponding to the digit value (1 to 0) thereof. Upon each restoration of line relay 301, release relay 302 is open-circuited. Being slow-restoring, release relay 302 remains operated notwithstanding.

Upon each momentary restoration of line relay 301, an impulse is transmitted to winding O of magnet 351. As above noted, contacts ON and 1 of register R300 close responsive to this impulse. Off-normal contacts ON remain closed thereafter, but delivery of a second impulse causes contacts 1 to open and contacts 2 to close. Each succeeding impulse causes the last closed pair of contacts to open and the next succeeding pair to close.

At the termination of the series of impulses, the one of contact pairs 1 to 0 which corresponds to the value of the dialed digit is in closed condition, the others being open.

In the present example, it may be assumed that the first digit dialed is the digit 1, in which case contacts ON and 1 of the register R300 are in closed condition at the termination of the dialing of the digit.

B3. *Termination of dialing*

Following closure of off-normal contacts ON of register 300, each reoperation of line relay 301 completes a circuit for start relay 304. Relay 304 is so designed and adjusted that it does not operate responsive to the momentary impulses it receives during the remaining portion of the dialing of the digit.

When line relay 301 comes to rest in an operated condition at the end of the dialing of the digit, start relay 304 operates fairly promptly. At its armature 3, relay 304 disconnects the impulse lead from the lower winding of magnet 351 and transfers it to busy relay 303, whereby the latter relay is operated in the event that, for any reason, the call does not clear through the selector stage before the calling subscriber starts to dial the next digit.

B4. *Preconditioning the secondary controllers*

At its armature 4, start relay 304 closes a point in the double-chain circuit (to be subsequently traced) to initiate the selecting and testing operations necessary to clear the call through the selector stage. At its armature 1, start relay 304 grounds the associated common test-start conductor T—ST. This conductor is grounded by the start relay of any selector in any subgroup. Conductor T—ST extends to Fig. 7, where it enters cable 700, and extends through this cable to each of the secondary controllers. Grounding of this conductor causes each idle secondary controller to test all associated outgoing trunks in preparation for the extension of a connection over an idle one thereof.

If the secondary controller SCA (Fig. 8) is idle, all its numerical-group relays 801 to 810 are in restored condition. In this event, the grounding of conductor T—ST closes a circuit through the winding of test-connecting relay 821, by way of the back contacts 4 of relay 801 to 810 in series. Relay 821 thereupon operates, and connects the test conductors S1 to S15 in cable 650 respectively to ground through the high resistance test windings of relay T1 to T15.

As is shown in Fig. 1, the sleeve conductor S of each idle outgoing trunk is connected to an idle-indicating battery potential at the switching apparatus to which such trunk extends. Accordingly, the high-resistance lower winding of each of the relays T1 to T15 which corresponds to an idle outgoing trunk is energized, operating the concerned test relay. When outgoing trunk OT1 is idle, the operating circuit of relay T1 is as follows: from ground through the high resistance lower winding of relay T1, contacts of the operated test-connecting relay 821, conductor S1 in cable 650, normally closed make-busy contacts associated with off-normal contacts ON of secondary switch SA1, the operating winding of hold magnet 601, and thence over sleeve conductor S of the outgoing trunk OT1 to the above-noted source of idle-indicating battery potential. Magnet 601 is not effectively energized by the closure of this circuit because of the above-noted high resistance of the lower winding of relay T1.

From the above, it will be seen that all idle secondary controllers are placed in active waiting condition immediately upon the operation of the start relay (such as 304) in any selector upon the completion of the dialing of the digit at the selector stage.

B5. *The selector-subgroup chain*

Since the primary switches PA1 to PA15 with which the selectors SEL—A1 to SEL—A15 are respectively associated are controlled by the common selecting magnets 521 to 531, the common selecting magnets must be placed under control of calling selectors only one at a time in order to avoid confusion. To this end, each selector is provided with a chain relay such as 305, and the chain relays of the fifteen selectors in a subgroup are interconnected in a local subgroup chain. Assuming the selector-subgroup-A chain to be idle (none of the chain relays such as 305 energized) at the time start relay 304 operates as previously described, the closure of contacts 4 of the latter relay extends ground potential, through contacts 4 of busy relay 303, to the common input conductor of register R300 by way of the following circuit path: from ground through the winding of relay 411, chain-in conductor 312, back contact 4 of chain relay 305, the associated chain-out conductor CH—OUT, through the corresponding chain contacts of the succeeding chain relays such as 305, the associated chain-end conductor CH—END (being the chain-out conductor at the final selector SEL—A15 of the subgroup), normally closed contacts controlled by armature 3 of chain relay 305, conductor C2 in selector multiple SM1, normally closed contacts of stack-up ON of switch PA1, conductor C1 in selector multiple SM1, and thence, by way of contacts 4 of

relays 304 and 303, to the input conductor common to contact pairs 1 to 0 of the register R300.

The further extension of the above-noted ground potential at the moment depends upon whether the group controller (GC1, Fig. 7) associated with the called numerical group of trunks is busy or idle. If this group controller is busy, the ground potential in question is not operatively extended until the group controller becomes idle.

B6. *The group-controller chain*

The disclosed arrangement is such that a group controller can be associated with only one primary subgroup at a time in order to avoid confusion in the completion of connections. For this purpose, all relays such as 401 associated with the same group controller are included in a chain opened by any operated one to indicate that the group controller is busy.

Assuming that group controller GC1 is in idle condition at the moment, the above-noted extension of ground potential (by way of the windings of relays 411 and 305), to the input conductor common to contacts 1 to 0 of register R300 of the calling selector SA1, results in the closure of the following double-chain start circuit: from ground as previously traced to the common input conductor of register R300, and thence through the closed contacts 1 of such register, over the selected dial lead DL1 (common to selectors SEL—A1 to SEL—A15), the winding of relay 401, normally closed contacts controlled by armature 44 of relay 401, the associated common conductor CH—END (being the end of the group controller chain), through series contacts of relays such as 401 associated with the succeeding selector subgroups, chain-out conductor CH—OUT of relay 401, chain contacts 45 of relay 401, chain-in conductor CH—IN in cable 421, and thence through the winding of start relay 701 to battery. Relays 411, 305, 401, and 701 all operate in series over the above-traced circuit.

B7. *Conditioning the selector links*

Relay 411, at its armatures 1 to 20, applies an idle-indicating battery potential to each of the conductors S1 to S20 in local cable 450, being the sleeve conductors S of the twenty selector links SL1 to SL20 respectively, extending from the associated primary subgroup A to the several secondary subgroups.

B8. *Individualizing the subgroup with the selector*

Relay 305, at its armature 3, locks itself to conductor 312, at the same time disconnecting its winding from the associated conductor CH—END. At its armature 4, relay 305 disconnects conductor 312 from conductor CH—END (common to the fifteen selectors of the subgroup), thereby precluding operation of any further chain relays of the selector subgroup for the time being. That is, the subgroup chain is now busied to the remaining fourteen selectors. At its armatures 1 and 2, relay 305 connects the associated switching conductor 310 and busy conductor 311 respectively to the operate winding of hold magnet 501 and the winding of busy relay 303.

B9. *Individualizing the group controller with the subgroup*

Relay 401, at its armature 44 locks itself to the associated chain-in conductor CH—IN, at the same time disconnecting its winding from the associated conductor CH—END (common to relays 401 in all selector subgroups). At its armature 45, relay 401 opens the chain circuit between conductors CH—IN and CH—END thereof, thereby precluding operation for the time being of any further chain relays such as 401 associated with the same group controller. At its armatures 1 and 2, relay 401 connects the subgroup busy and switching conductors 311 and 310 to conductors BU and SW of cable 421, extending to group controller GC1 (Fig. 7); at its armature 3, it connects primary off-normal lead PON in cable 450 with primary off-normal lead PON in cable 421; while at its armatures 4 to 43, it connects the remaining conductors (M1 to S20) in local cable 450 to respective conductors in cable 421, extending to group controller GC1.

Conductors M1 to S20 of cable 450 comprise twenty pairs, each pair being associated with a separate one of the twenty links extending from the associated primary subgroup A to the several secondary subgroups. Conductors M1 and S1 comprise the first pair (associated with the first link); M2 and S2 comprise the second pair; and so forth, to M20 and S20, which comprise the twentieth pair (associated with the twentieth link). It should be noted further that cable 421 (and the same is true for each of the similar cables 422 to 430) contains twenty-seven pairs of conductors 1A, 2A, and so forth, to 3I (Fig. 7), each pair extending to a separate one of the twenty-seven link-test relays 1A to 3I. A separate combination of twenty of these test relays is used for each primary subgroup. The particular combination used for any primary subgroup is that combination which corresponds to the selector-link spread from that primary subgroup to the secondary subgroups, as given in Table No. 2, supra. Accordingly, at each selector subgroup only twenty of the above-noted twenty-seven pairs of conductors 1A to 3I in cable 421 are brought out to the contacts of the concerned connecting relay such as 401. Table No. 3, below, shows the particular combination of the twenty-seven pairs of conductors in cable 421 which appears at the contacts of any relay such as 401:

TABLE No. 3

Pairs	A	B	C	D	E	F	G	H	I
1A	1st	19th	17th	15th	13th	11th	9th	7th	4th
2A	2nd	20th	18th	16th	14th	12th	10th	8th	5th
3A	3rd								6th
1B	4th	1st	19th	17th	15th	13th	11th	9th	7th
2B	5th	2nd	20th	18th	16th	14th	12th	10th	8th
3B	6th	3rd							
1C	7th	4th	1st	19th	17th	15th	13th	11th	9th
2C	8th	5th	2nd	20th	18th	16th	14th	12th	10th
3C		6th	3rd						
1D	9th	7th	4th	1st	19th	17th	15th	13th	11th
2D	10th	8th	5th	2nd	20th	18th	16th	14th	12th
3D			6th	3rd					
1E	11th	9th	7th	4th	1st	19th	17th	15th	13th
2E	12th	10th	8th	5th	2nd	20th	18th	16th	14th
3E				6th	3rd				
1F	13th	11th	9th	7th	4th	1st	19th	17th	15th
2F	14th	12th	10th	8th	5th	2nd	20th	18th	16th
3F					6th	3rd			
1G	15th	13th	11th	9th	7th	4th	1st	19th	17th
2G	16th	14th	12th	10th	8th	5th	2nd	20th	18th
3G						6th	3rd		
1H	17th	15th	13th	11th	9th	7th	4th	1st	19th
2H	18th	16th	14th	12th	10th	8th	5th	2nd	20th
3H							6th	3rd	
1I	19th	17th	15th	13th	11th	9th	7th	4th	1st
2I	20th	18th	16th	14th	12th	10th	8th	5th	2nd
3I								6th	3rd

The above table shows that pair 1A is the 1st pair at selector subgroup A; is the 19th pair at selector subgroup B; the 17th at C; and so on. The table further shows that conductor pair 2A in cable 421 is the 2nd conductor pair at selector subgroup A; the 20th at B; the 18th at C; and so on. Each of the columns headed A to I shows

what conductor 1A to 3I appear at the corresponding selector subgroup, and in what order.

B10. *Preparing the group controller*

In group controller GC1 (Fig. 7), when start relay 701 operates as previously noted (in series with relays 411, 305, and 401), it prepares a test circuit at armature 3; at armature 1, it closes a circuit through contacts of test relay 702 for busy relay 704. Relays 703 and 704 are both so designed and adjusted that neither has time to operate during the brief normal operation of the group controller. The intended operation of relays 703 and 704 will be described subsequently.

Assuming preference shift relays 705 and 706 to be both in restored condition, relay 701 closes a circuit, through the back contact of armature 1 of relay 706, for relay 705. Relay 705 thereupon operates and prepares a locking circuit through the upper winding of relay 706. The circuit arrangement of the preference shift relays 705 and 706 is such that the relay 706 operates following odd-numbered operations of group controller GC1, and restores following even-numbered operations of the group controller to shift the preference alternately between two secondary subgroups, subgroups A and B in the illustrated example.

B11. *Setting the link-test relays*

As a result of the connecting up of the sleeve conductors S in the twenty pairs of conductors in cable 421 which appear in contacts of relay 401, in accordance with column A of the above Table No. 3, each concerned one of the link-test relays 1A to 3I of the group controller GC1 operates, subject to the selector link with which it is currently associated being idle. For example, if the first selector link SL1 extending from the concerned primary subgroup A, Fig. 5, is idle, there is no ground potential on the sleeve conductor thereof. Consequently, conductor S1 in cable 450 is ungrounded. In this event, the battery potential placed on this conductor through the resistor associated with the front contact of armature 1 of relay 411 passes effectively through the front contact of this armature to the said conductor and extends thence, through the operated armature 5 of relay 401, and over conductor S in group 1A of cable 421, to the upper terminal of the winding of link-test relay 1A in group controller GC1, providing an operating circuit for the said relay 1A whose lower terminal is grounded. On the other hand, if the selector link in question is in use, a holding (and guarding) ground potential is maintained on the sleeve conductor S thereof, effectively neutralizing the above-noted idle-indicating battery potential, in which event the said relay 1A remains unoperated.

As will be seen from column A of Table No. 3, the twenty test relays of group controller GC1 which are effective in the present call (involving selector subgroup A and primary subgroup A) are relays 1A to 3A, relays 1B to 3B, relays 1C and 2C (not shown), and so on, to relays 1I and 2I. Each such relay is operated, or not (by a test connection similar to that for relay 1A), depending upon whether the selector link with which the relay is currently associated is idle or busy.

If relay 1A operates (indicating that the link with which it is currently associated is idle), at its armature 1, it disconnects conductor 1 in cable 711 from the corresponding armatures of the associated relays 2A and 3A and transfers it to conductor M in conductor group 1A in cable 421, being the magnet conductor of the selector link with which the relay is currently associated. This is merely a preparatory operation, becoming effective only in case the link in question is selected, depending in turn upon whether there is an idle outgoing trunk assigned to the called numerical group in secondary subgroup A, with which relays 1A to 3A of the group controller are associated.

B12. *Bath selection*

At its armature 2, relay 1A prepares to ground switching conductor SW in cable 421, and at its armature 3 it connects the free terminal of the ground-connected test relay 702 to conductor 3 in group 1A of cable 711. This latter operation constitutes the testing operation determinative of which currently idle secondary subgroup in the order from A to I is the first subgroup containing the idle outgoing trunk assigned to the called numerical group. Conductor 3 in group 1A of cable 711 extends to the upper armature of test relay T1 in secondary controller SCA, for relay T1 is associated with trunk OT1 (Figs. 2 and 6) outgoing from secondary subgroup A and assigned to the called numerical group 1. In the illustrative wiring of secondary controller SCA, the first two trunks outgoing from secondary subgroup A are assigned to the first numerical group, the second two trunks to the second numerical group, and so on, to the fifth pair of trunks which are assigned to the fifth numerical group, the remaining five trunks outgoing from this secondary subgroup being assigned respectively to numerical groups 6 to 0.

If the two outgoing trunks in secondary subgroup A assigned to the currently called numerical group 1 are both in use, trunk-test relays T1 and T2 are both in restored condition, as hereinbefore explained. In this event, the ground potential applied (by way of the winding of test relay 702 and contacts of relays 701, 706, and 1A) to conductor 3 in group 1A in cable 711, is extended, through back contacts of the upper armatures of relays T1 and T2, and thence over the associated conductor 4, to armature 3 of relay 1B, whereby secondary subgroup A is by-passed and the control over trunk selection is transferred to secondary subgroup B, through which it may be transferred in a similar manner to any one of the succeeding secondary subgroups, to become effective at the first point where there is an idle selector link outgoing from the calling primary subgroup to an idle secondary subgroup containing an idle trunk assigned to the called numerical group.

B12*a*. *Selecting secondary controller SCA*

With link-test relay 1A operated as assumed, if either of test relays T1 and T2 is in operated condition (indicating an idle outgoing trunk leading from secondary subgroup A, to the called numerical group), incoming conductor 3 in group 1A is disconnected from outgoing conductor 4 of the same group and a selecting circuit is completed locally in the secondary subgroup A through the upper winding of one or another of the relays T1 and T2.

If relay T1 is energized (by its high-resistance lower winding), the previously described operation of relay 1A completes the following selecting circuit: from ground through the winding of test relay 702, contacts 3 of start relay 701, back contact of armature 3 of relay 706, front contact of armature 3 of relay 1A, conductor 3 in group 1A of cable 711, front contact of the upper arma-

ture of trunk-test relay T1, the upper winding of relay T1, conductor 1 in cable 800, numerical group relay 801, and thence to battery through the contact chain including the back contacts of the lower armatures 4 of relays 802 to 810. The closure of this circuit establishes a holding current through the upper winding of relay T1, and an operating current for test relay 702 and numerical group relay 801. Test relay 702 disconnects busy relay 704, and substitutes busy relay 703 for a purpose to be subsequently made clear.

B13. *Individualizing the secondary controller with the group controller*

Relay 801 opens the chain circuit of test-connecting relay 821 at its lower contacts 4. When this occurs, relay 821 restores and open-circuits the lower windings of the fifteen trunk-test relays T1 to T15, whereupon any operated one of these relays restores, with the exception of relay T1 which is held by current flow through its upper winding over the above-traced circuit. Restoration of relays T3 to T15 operates to mark the secondary controller SCA (and consequently the corresponding secondary subgroup A of switches) as busy to the remaining secondary group controllers 2 to 9. This is done by joining incoming test conductor 3 to outgoing test conductor 4 in each of the groups 2A to 0A in cable 711. Secondary controller SCA is now individualized with group controller GC1. As a further result of its operation, relay 801 causes connection to be made between the calling incoming trunk and the now-selected outgoing trunk OT1 by operation of its armatures 1 to 3. Its armature 1 closes the prepared select-magnet circuits to be subsequently traced; its armature 3 interconnects the subgroup off-normal circuit of the calling primary subgroup in series with that of the called secondary subgroup; and its armature 2 prepares for operation of the hold magnet of the calling primary switch over conductor SW in cable 421.

B14. *Select-magnet operation*

With relays 801 and T1 operated in secondary controller SCA, and with relay 1A operated in group controller GC1, the following operating circuit is established for causing stackup selection to occur in the concerned primary and secondary subgroups: from ground through contacts 1 of numerical group relay 801, conductor 1 in group 1A of cable 711, front contact of armature 1 of link-test relay 1A of the group controller, conductor M in group 1A in cable 421, contact pair 4 of relay 401, conductor M1 in cable 450, lower winding of the No. 1 select magnet 521 of primary subgroup A, and thence through the winding of relay 540 to battery. A branch of this circuit extends from ground as previously traced to conductor M1 in cable 450, and thence, by way of conductor M in selector link SL1 (extending by way of branches PA and SA of spread cable 600), lower winding of No. 1 select magnet 621 of secondary subgroup A, Fig. 6, and thence to battery through relay 640. Accordingly, relays 540 and 640 and select magnets 521 and 621 are operated responsive to the described operation of relay 801. Relays 540 and 640 close points in the respective primary and secondary subgroup off-normal circuits, while magnets 521 and 621 actuate the associated selecting shafts (not shown) to cause selection of selective stackup 1 in primary subgroup A and secondary subgroup A.

B15. *Hold-magnet operation*

When the two relays 540 and 640, and the two select magnets 521 and 621 have operated to perform their set functions, the following circuit is completed for operating the hold magnets of the concerned primary and secondary switches PA1 and SA1: from ground through contacts of relay 540, primary off-normal contacts PON1, 2 (associated with select magnets 521 and 522) conductor PON in cable 450, contacts 3 of relay 401, conductor PON in cable 421, conductor 1 in cable 700 (extending in multiple to all relays such as 801 in the several secondary controllers), contacts 3 of numerical group relay 801, conductor IN in group SON in cable 650, contacts of relay 640, secondary off-normal contacts SON1, 2, conductor OUT in group SON in cable 650, the lower contacts of the held-operated trunk-test relay T1, conductor S1 in cable 650, normally closed make-busy contacts associated with off-normal stackup ON of secondary switch SA1, the lower, or operating, winding of hold magnet 601, and thence to battery over the sleeve conductor S of the outgoing trunk OT1, the battery connection being as shown in Fig. 1. Magnet 601 operates over this circuit. At its off-normal stackup ON, it connects its upper, or holding, winding to the sleeve conductor of the outgoing trunk to maintain the magnet operated (by ground potential to be placed on this sleeve conductor) after the operating circuit is opened. The operation of magnet 601 also closes its selected stackup 1, thereby connecting the tip, ring, and sleeve conductors of the secondary end of the selector link SL1 respectively to the tip, ring, and sleeve conductors of outgoing trunk OT1, by way of normally closed contacts in stackup 11 of the switch.

A branch of the above-traced operating circuit is simultaneously effective to operate primary switch PA1, the operating circuit for the latter being as follows: from ground, as previously traced, to conductor OUT in group SON of cable 650, and thence through contacts 2 of relay 801, conductor 2 of group 1A in cable 711, front contact of armature 2 of relay 1A, back contact of armature 2 of relay 706, switching conductor SW in cable 421, contacts 2 of relay 401, local switching conductor 310 (common to all selectors in subgroup A), contacts 1 of chain relay 305, conductor SW in selector multiple SM1, and thence to battery through the upper, or operating, winding of magnet 501 of primary switch PA1. Upon operating, magnet 501 closes the associated selected stackup 1, thereby connecting the tip, ring, and sleeve conductors at the primary end of selector link SL1 respectively with the tip, ring, and sleeve conductors of the incoming trunk IT1, by way of normally closed contacts of the associated stackup 11. Since the sleeve conductor S of incoming trunk IT1 is currently maintained grounded at the front contact of armature 1 of release relay 302, the said closure of the contacts in stackup 1 of switch PA1 extends a holding ground potential immediately over the sleeve conductor of the selector link SL1, to the sleeve conductor of the now-connected outgoing trunk OT1, thereby immediately completing a holding circuit for the upper winding of hold magnet 601 of selector SA1, through the off-normal stackup ON of the latter switch. At the same time, the off-normal stackup ON of switch PA1 is actuated, and the lower contact pair of this stackup closes a holding circuit to the sleeve conductor of the incoming trunk for magnet 501.

It will be noted that the described operation of primary switch PA1, by connecting ground potential to the sleeve conductor of selector link SL1, short-circuits the winding of the currently associated link-test relay 1A of group controller GC1. Relay 1A, however, does not restore immediately responsive to this operation, for a short-circuited relay is slow-restoring as is well known.

B16. *Holding ground returned*

Responsive to the described extension of the connection through the selector stage from incoming trunk IT1 by way of selector link SL1 to the outgoing trunk OT1, line relay 110, Fig. 1, operates over the calling line, followed by the operation of release relay 111, to disconnect the normal source of idle-indicating potential and to transfer the incoming sleeve conductor S to ground, providing a source of holding and guarding potential.

B17. *Clearing out the selector subgroup*

Clearing out of the common equipment temporarily individualized with the incoming trunk IT1 is initiated by separation of the upper pair of contacts in stackup ON of switch PA1, Fig. 5, open-circuiting and restoring relays 411, 305, 401, and 701.

The selector subgroup chain is cleared out responsive to the restoration of chain relay 305. The associated chain-in conductor 312 is thereby again extended to conductor CH—END (common to all relays such as 305) through the chain contacts of the succeeding relays in the selector subgroup chain. At the same time, relay 411 restores, disconnecting the associated resistors from sleeve conductors S1 to S20 in cable 450.

B18. *Clearing out the group controller*

Relay 401 returns the associated circuit connections to normal condition, again connecting chain-in conductor CH—IN in cable 421 to the associated chain-end conductor CH—END (common to relay 401 and the other similar relays in the group controller chain), placing the chain in its normal idle condition. Contacts 2 of relay 401 open the operating circuit of the now-locked hold magnet 501, while contacts 4 of relay 401 open-circuit magnets 521 and 621, and relays 540 and 640, clearing out the selecting apparatus at the primary and secondary subgroups.

In the group controller GC1, Fig. 7, start relay 701, at its armature 3, opens the previously traced test circuit, thereby initiating the clearing out of secondary controller SCA. At about the same time, all operated ones of the link-test relays 1A to 3I restore responsive to the restoration of relays 411 and 401.

At its armature 2 and associated contacts, relay 701 opens the initial circuit of the operated relay 705, and closes a new circuit for relays 705 and 706 in series: from ground, through the normally closed contacts controlled by armature 2 of relay 701, through the upper winding of relay 706, contacts of relay 705, and thence to battery through the winding of relay 705. Relay 706 operates, and relay 705 remains locked operated in this circuit. At its armature 1, relay 706 opens a further point in the initial circuit of relay 705, and prepares a holding circuit for the lower winding of relay 706. At its armatures 2 and 3, relay 706 shifts the preference from secondary subgroup A to secondary subgroup B by disconnecting armatures 2 and 3 of the relay 1A and substituting armatures 2 and 3 of relay 1B. The preference has thus been shifted from one subgroup to another to insure that successive calls do not take the same secondary subgroup as first choice. This arrangement is of some utility in periods of light traffic, when otherwise calls made one at a time to the same numerical group of trunks might always take the same outgoing trunk, which may possibly be defective at one time or another.

On the next use of group controller GC1, the consequent operation of start relay 701 completes a locking circuit for the lower winding of preference shift relay 706, by way of armatures 2 and 1 of relays 701 and 706, respectively, at the same time opening the series circuit for relays 706 and 705, permitting relay 705 to restore. Relay 706 holds operated, to maintain the preference shifted, so long as relay 701 remains operated, restoring responsive to the restoration of relay 701. Relays 705 and 706 are thus again restored after each even-numbered use of the group controller, returning the preference from subgroup B to subgroup A.

B19. *Clearing out the secondary controller*

Responsive to the opening, at contacts 3 of relay 701, of the previously traced test circuit through the upper winding of relay T1 and the winding of relay 801, relays T1 and 801 restore, clearing out the secondary controller SCA.

Upon the restoration of numerical-group relay 801, the battery supply chain to the right-hand terminal of the winding of test-connecting relay 821 is again completed, permitting this relay to operate again immediately, to again complete test circuits for the lower windings of relays T1 to T15 subject to the continued grounded condition of the associated test-start lead T—ST, common to all selectors. Accordingly, if a start relay such as 304 is energized in any other selector (indicating that dialing has been completed in such selector), the secondary controller is again placed in readiness to assist in setting up the desired connection in a manner similar to that hereinbefore described.

B20. *Clearing out the selector*

A further result of the operation of off-normal stackup ON of primary switch PA1 is that the windings of line relay 301 of selector SEL—A1 are disconnected from in bridge of the tip and ring conductors of incoming trunk IT1 (being what may be described as a cut-off relay operation); the guard conductor G in selector multiple SM1 is opened to avoid current drain through the associated resistor after the selector has cleared out.

In the selector SEL—A1, line relay 301 restores responsive to being disconnected at contacts of off-normal stackup ON of the associated primary switch PA1. Upon so doing, it open-circuits release relay 302 and start relay 304. Being slow-restoring, release relay 302 retmains operated for an interval sufficient to permit the previously described operation of relays 110 and 111 (Fig. 1) to occur.

Start relay 304 is rendered slightly slow in restoring by the resistance shunt placed around its winding at its contacts 2. Busy relay 303 is accordingly operated, through back contacts of line relay 301 and front contacts 5 and 3 of relays 302 and 304. Upon operating, relay 303 closes a self-locking circuit through its front contact 2, and contacts 4 of release relay 302, at the same time opening the holding winding H of register magnet 351, clearing out the register. The opera-

tion of busy relay 303 however is merely incidental at this time, for the call has gone through successfully.

Start relay 304 restores a moment after busy relay 303 operates, leaving busy relay 303 locked operated. Still later, slow-restoring release relay 302 restores, unlocking and restoring busy relay 303, finally completing the clearing out of the selector SEL—A1.

B21. *Clearing out the established connection*

When the connection is to be cleared out, the replacing of the receiver at the called substation results shortly in the removal of holding ground potential from the sleeve conductor S of the established connection (by restoration of relays 110 and 111, Fig. 1), thereby open-circuiting the holding windings of magnets 601 and 501. These magnets consequently deenergize, clearing out primary switch PA1 and secondary switch SA1.

B22. *Selecting other selector links*

Considering primary subgroup A as shown in Fig. 5, if any one of the second to tenth (SL2 to SL10) selector links accessible to this subgroup is to be connected with by one or another of the primary switches therein, one or another of the leads M2 to M10 in cable 450 becomes grounded in the manner pointed out hereinbefore for lead M1, causing energization of one or another of the select magnets 522 to 530 through its lower winding, in series with relay 540. The upper contact set is thereby selected in the corresponding one of the stackup 2 to 10 of the primary switches. Relay 540 cooperates with the concerned pair of primary off-normal contacts (PON1, 2, and so forth, to PON9, 10) to ground primary off-normal conductor PON in cable 450 for the previously explained purpose.

When any one of the eleventh to twentieth (SL11 to SL20) selector links accessible to this subgroup is to be connected with by one or another of the switches therein, the corresponding one of magnet conductors M11 to M20 in cable 450 becomes grounded, closing a circuit for the upper winding of the concerned one of magnets 521 to 530, in series with the eleventh select magnet 531. Accordingly, the eleventh select magnet 531 is energized in addition to one of the preceding ten. As a result, the eleventh stackup of contacts is actuated in the concerned primary switch, along with one or another of stackups 1 to 10 thereof. As a result, the concerned incoming trunk is interconnected, through the lower set of contacts in the closed stackup 1 to 10, with the concerned one of the selector links SL11 to SL20. In this event, relay 540 is not operated, wherefore ground potential is not extended to conductor PON in cable 450 until select magnet 531 has closed primary off-normal contacts PON11, and the concerned one of the magnets 521 to 530 has closed its associated pair of primary off-normal contacts.

In the secondary subgroup A, Fig. 6, the arrangement is similar to that just described. That is, the in and out conductors of group SON in cable 650 are joined through the cooperation of one or another of the secondary off-normal contact pairs SON1, 2 to SON9, 10 with either the contacts of relay 640 or with secondary off-normal contacts SON11 (controlled by the eleventh select magnet 631).

By the foregoing simple arrangement, the off-normal circuit path at a primary or secondary subgroup is closed only responsive to the operation of two select magnets when two are to operate, and is closed responsive to the operation of a single select magnet when one select magnet is to operate, a relay such as 540 or 640 acting to by-pass the off-normal contacts controlled by the eleventh select magnet when such select magnet is not to be operated.

B23. *Changing trunk assignments*

It will be clear from the foregoing description that any outgoing trunk can be assigned initially to any numerical group. The way in which any outgoing trunk can be later shifted from one numerical group to another will now be described with reference to outgoing trunk OT1 (Figs. 2 and 6). If, for example, outgoing trunk OT1 is to be removed from numerical group 1 and assigned to numerical group 0, the following steps may be taken: (1) trunk OT1 may first be marked busy to the common control apparatus by separating the make-busy contacts associated with off-normal stackup ON of switch SA1 (Fig. 6), preventing subsequent energization of the lower winding of the corresponding trunk-test relay T1 (Fig. 8) therethrough; (2) the indicated jumper connection at the intermediate distributing frame IDF (Fig. 2) may be changed to transfer outgoing trunk OT1 from a trunk path in cable 211 to a trunk path in cable 220 (numerical group 0); (3) the upper terminal of the upper winding of trunk-test relay T1 may now be disconnected from conductor 1 in cable 800 and transferred into connection with conductor 0 in this cable, thereby serially relating the upper winding of relay T1 with the winding of numerical group relay 810, associated with numerical group 0 of outgoing trunks; (4) conductor 3 in group 1A of cable 711 may be transferred from in connection with the upper armature of relay T1 into connection with the upper armature of relay T2, and the connection between the back contact of the upper armature of relay T1 and the upper armature of relay T2 may be severed; and (5) conductor 3 in group OA of cable 711 may be removed from in connection with the upper armature of trunk-test relay T15 and transferred into connection with the upper armature of relay T1, and the back contact of the latter armature may be connected with the upper armature of relay T15.

When the foregoing connection changes have been made, relays T1 and T15 are interrelated with conductors 3 and 4 of group OA in cable 711 in the same way that relays T1 and T2 are shown interrelated with conductors 3 and 4 in group 1A of the said cable, and relays T1 and T15 are jointly in circuit with relay 810 in the same way that relays T1 and T2 are shown jointly in circuit with relay 801.

When the foregoing changes have been made, the make-busy contacts associated with stackup ON of the concerned switch SA1 (Fig. 6) may be reclosed to render the concerned trunk OT1 again idle to the common switching apparatus. Henceforth, this trunk handles calls to numerical group 0, to which it has been newly assigned.

B24. *Traffic equalization*

The offered traffic is preferably more or less equalized among the several secondary subgroups by arranging the group controllers to take the secondary subgroups for use in various choice combinations. In the illustrative example, there are ten group controllers (one for each of the ten numerical groups of trunks leading from the se-

lector stage), but only nine secondary subgroups. Accordingly, two of the group controllers are arranged to take the same secondary subgroup as first choice. The following table shows one arrangement for traffic equalization by preference distribution wherein secondary subgroup A is first choice to group controllers 1 and 2, and the secondary subgroups B to I are first choice respectively to the remaining group controllers 3 to 0:

TABLE No. 4

G. C.	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
1, 2	A	B	C	D	E	F	G	H	I
3	B	C	D	E	F	G	H	I	A
4	C	D	E	F	G	H	I	A	B
5	D	E	F	G	H	I	A	B	C
6	E	F	G	H	I	A	B	C	D
7	F	G	H	I	A	B	C	D	E
8	G	H	I	A	B	C	D	E	F
9	H	I	A	B	C	D	E	F	G
0	I	A	B	C	D	E	F	G	H

In the above Table No. 4, the numbers in the first column (under the heading G. C.) represent the group controllers 1 to 0. The letters in the succeeding columns represent the secondary nine subgroups A to I. Reading horizontally, the table shows that secondary subgroup A is first choice to group controllers 1 and 2; secondary subgroup B is second choice to these group controllers; secondary subgroup C is third choice; and so on, to secondary subgroup I, which is ninth choice to group controllers 1 and 2. The next horizontal line in the table shows that the subgroup choice for the third group controller begins with secondary subgroup B, and extends through the secondary subgroups in regular order to secondary subgroup I (eighth choice), and ending with secondary subgroup A (ninth choice). The bottom line in the table shows that group controller 0 starts with secondary subgroup I as first choice, and follows with secondary subgroups A to H, second to ninth choices respectively.

In the above Table No. 4, no account is taken of the previously described arrangement in group controller GC1 (and the same is true for each other group controller) for shifting the actual preference at that group controller alternately between the nominal first choice secondary subgroup and the nominal second choice.

In carrying out the preference distribution according to the foregoing Table No. 4, the back and front contacts of armatures 2 and 3 of preference-shaft relay 706 in the second group controller are connected respectively to armatures of link-select relays 1A and 1B of such group controller (as shown in Fig. 7 for group controller GC1); in the third group controller these conductors are shifted to the armatures of link-select relays 1B and 1C therein respectively; and so on, for the various group controllers.

B25. *Goup-busy signalling*

As previously noted, each selector contains a busy relay such as busy relay 303. This busy relay is operable from the group controller associated with the called numerical group to return a group-busy signal to the calling line when, for any reason, connection cannot be completed to an idle trunk in the called numerical group. It may be assumed that the selector SEL-A1 (following the dialing of the digit 1) is individualized with the group controller GC1 of Fig. 7 as hereinbefore described, and that no path is available between the calling primary subgroup A and the desired called numerical group 1. In this event, no circuit is completed for test relay 702, wherefore the circuit of busy relay 704 remains established for a longer than normal interval. Slow-operating relay 704 accordingly has time to operate. Upon so doing, it applies ground potential to busy lead BU in cable 421, closing a circuit for busy relay 303 of selector SEL—A1, by way of contacts 1 of relay 401, and contacts 2 of relay 305. Relay 303 thereupon operates. At its armature 1, it disconnects dial-tone lead DT and substitutes busy-tone lead BT, whereby a busy signal is transmitted back to the calling substation to inform the calling subscriber of the busy condition. At its armature 4, busy relay 303 opens the previously traced chain circuit, immediately initiating the clearing out of the subgroup and group controller chains. At its armature 3, relay 303 opens the operating circuit for the lower winding of magnet 351 to avoid transmitting further impulses to the said magnet in the event that the calling subscriber again operates his calling device in disregard of the busy signal. At its armature 2, busy relay 303 closes a self-locking circuit to ground through contacts 4 of release relay 302, at the same time open-circuiting the hold winding of register R300, clearing out the register.

When the calling subscriber subsequently replaces his receiver, line relay 301 restores, followed shortly by the restoration of release relay 302. At its armature 4, relay 302 open circuits and restores busy relay 303, while at armature 1 it disconnects conductor S in selector multiple SM1 from its source of holding ground potential, thereby removing ground potential from sleeve conductor S of the associated incoming trunk IT1. The partially established connection clears out in the usual manner responsive to this operation.

As previously noted, when test relay 702 operates it disconnects slow-operating busy relay 704, as an indication that an idle path has been located from the calling primary subgroup, by way of an idle selector link, to an idle trunk line assigned to the called numerical group in one or another of the secondary subgroups. It may happen occasionally that a mechanical or circuit defect intervenes to prevent the establishment of a connection by way of the selected path. For example, it will be clear from the foregoing description that the desired connection cannot be completed until off-normal contacts have closed in the concerned primary and secondary subgroups. Accordingly, test relay 702 closes a circuit for slow-operating relay 703 when it disconnects slow-operating busy relay 704. If the selected connection is not completed promptly, relay 703 has time to operate before the group controller clears out. In this event, busy lead BU in cable 421 is grounded, causing busy relay 303 to operate as hereinbefore explained.

It should be noted that relays 703 and 704 can be replaced by a single relay, but two separate relays are considered preferable in that each can be accurately adjusted to allow just time enough for the concerned portion of the operation to occur and then promptly operate the busy relay of the calling selector when the concerned time limit is exceeded. This arrangement minimizes the time during which a subgroup chain, a group controller, and a secondary controller are monopolized by a call which cannot be completed.

B26. *Unused digits*

As previously noted, the arrangement of Figs. 2 to 8 provides for a maximum of ten numerical groups, one for each of the indexing digits

1 to 0 appearing on the dial of the usual automatic-telephone calling device. It frequently happens that a lesser number of numerical groups are in use. Then, one or more selector-stage digits are unused.

Fig. 3 indicates a simple arrangement for halting further progress of the connection and transmitting a busy signal back to the calling substation in the event that a calling subscriber dials an unused (or unassigned selector-stage digit when the numerical groups in use are fewer than ten.

As is indicated by the note appearing in Fig. 3, for each unused (or unassigned) digit the corresponding contacts such as R300 are not multipled together vertically (as by the dial leads DL1 and DL0), but remain as individual contacts in each register such as R300. All such unmultipled individual contacts in register R300 are connected to lead X, extending to the winding of busy relay 303. The dialing of an unused digit results in the closure of the following circuit: from ground through the winding of relay 411, conductor 312, contacts 4 of chain relay 305 and the similar chain relays, conductor CH-END, contacts controlled by armature 3 of relay 305, conductors C2 and C1 in series (by way of off-normal contacts of switch PA1), contacts 4 of start and busy relays 304 and 303, the currently closed one of pairs 1 to 0 of the register R300, the associated lead X, and thence to battery through the winding of busy relay 303. Busy relay 303 is preferably of such high resistance that neither of the relays 411 and 305 operates in series therewith. Upon operating, relay 303 locks itself to ground through contacts 4 of release relay 302; closes a busy-tone circuit at the front contact of its armature 1; and opens the above-traced chain circuit at its contacts 4. Busy relay 303 restores as hereinbefore described, following the successive restoration of relays 301 and 302, when the calling subscriber replaces his receiver.

B27. *Premature dialing*

In the event that the calling subscriber begins to dial the next digit in the desired number before the selector-stage operations have been completed, the first momentary restoration of line relay 301 open-circuits start relay 304 and completes an energizing circuit for busy relay 303, through front contacts 5 and 3 of relays 302 and 303. Upon operating, busy relay 303 closes a self-locking circuit at its armature 2, at the same time clearing out the register R300. Contacts 4 of relay 303 immediately open the series chain circuits to initiate relinquishment of the common equipment. At the front contact of its armature 1, relay 303 returns a busy signal from busy-tone lead BT. Start relay 304 restores after a slight interval (being slowed by the resistance shunt connected by its contacts 2) and does not reoperate as register R300 is cleared out.

The selector and the partially established connection are cleared out as previously described when the calling subscrber replaces his receiver in response to the returned busy-tone signal.

C. Figure 9

Fig. 9 shows selector SEL—A1', a modification of the selector SEL—A1 of Fig. 3. The two selectors are similar in operation except that SEL—A1' is a two-digit selector arranged to select any one of twenty numerical groups, whereas the selector of Fig. 3 is a single-digit selector, having a selective capacity of ten numerical groups, as hereinbefore explained. In a system employing selectors according to Fig. 9, there may be as many as twenty numerical groups outgoing from the selector stage instead of the ten numerical groups indicated in Fig. 2. Accordingly, the ten group controllers indicated in Fig. 2 may be increased to twenty, one for each outgoing numerical group of trunks.

The circuit arrangement at the selector SEL—A1', it will be observed, is exactly similar to the circuit arrangement at the selector SEL—A1, except for a limited number of additions and changes having to do with the increase in selective capacity from ten to twenty. More in particular, relays 901 to 905 of the selector SEL—A1' correspond respectively to relays 301 to 305 of the selector SEL—A1, Fig. 3; recording relays 906 and 907 and transfer relay 908 are added relays; selector multiple SM1' corresponds exactly to selector multiple SM1; conductors 910 to 912 correspond exactly to conductors 310 to 312; and register R900 corresponds to register R300, except that each of the contact pairs 1 to 0 of the register R300 is replaced in the register R900 by a set of contacts, each such set of contacts comprising two contact pairs.

It may be noted that contacts 4 of busy and start relays 903 and 904 are shown at the top of the drawing instead of at the bottom as in Fig. 3, and that the start relay 904 is provided with an additional armature (5) having contacts for controlling the added relays 906 to 908.

The arrangement in the selector is such that the register R900 responds twice. It is operated to record the first digit (a 2 or a 3); it is cleared out by the operation of either of the recording relays 906 and 907; transfer relay 908 is operated; and register R900 operates again, responsive to the second digit.

When the selector of Fig. 9 is seized, line and release relays 901 and 902 thereof operate (as described for the selector of Fig. 3) to prepare the selector for operation. Hold winding H of magnet 951 is energized through contacts 4 of release relay 902, by way of the normally closed contacts controlled by armatures 2 of relays 903, 906, and 907.

When the first selector digit is dialed (either a 2 or a 3), impulses are transmitted to operate winding O of magnet 951, through back contacts of line relay 901, contacts 5 of release relay 902, and back contacts 3 of relays 904 and 903. The recording contact sets 1 to 0 of the register R900 are actuated progressively in a wave-like action, each closed set opening before the next succeeding set closes. If the digit has a value of 2, the two contact pairs in set 2 of the register are in closed condition at the end thereof, but if the first digit has a value of 3, the third set of contacts is the one closed.

Start relay 904 operates at the end of the dialing of the first digit, as explained in connection with start relay 304 of Fig. 3. The circuit of relay 904 includes front contacts of relay 901 and contacts ON of the register R900. Upon operating, start relay 904 closes a circuit as follows for one or another of the relays 906 and 907: from ground through contacts 4 of release relay 902, front contact of armature 5 of start relay 904, back contact of armature 3 of transfer relay 908, conductor 911, upper contact pair of set 2 or set 3 of the register R900, conductor 910 or 911, back contact 5 or back contact 6 of relay 908, and thence to battery through the wind-

ing of either relay 906 or 907. The concerned one of the relays 906 and 907 now operates. At its armature 1, it prepares a circuit for transfer relay 908; at its armature 2, it closes a self-locking circuit, at the same time opening the circuit of hold winding H of magnet 951, clearing out the register R900; and at its armature 3, it connects up conductor 913 in the case of relay 906, or conductor 912 in the case of relay 907.

When the register R900 clears out, the contacts thereof return to their illustrated normal condition. Upon the opening of off-normal contacts ON, start relay 904 restores. Start relay 904, at the back contact of its armature 5 (grounded at contacts 4 of release relay 902), operates transfer relay 908, through contacts 1 of relay 906 or 907. At its armature 1, relay 908 locks itself directly to the grounded front contact 4 of release relay 902; at its contacts 2, it recloses the circuit of hold winding H of magnet 951 in by-pass of the contacts controlled by armatures 2 of relays 906 and 907; at its armature 3, it disconnects conductor 911 from the front contact of armature 5 of start relay 904 and joins it to conductor 912, common to the upper contact pairs in stackups 1 to 0; at its contacts 4, it closes a point that has been held open in the series conductor for joining the subgroup chain with one or another of the group-controller chains; and at its armatures 5 and 6, it disconnects conductors 914 and 915 from the windings of relays 906 and 907, and extends them respectively to dial leads 33 and 32. The operated one of the recording relays 906 and 907, and transfer relay 908, remain operated until release relay 902 subsequently restores to clear out the selector.

The register R900 having been cleared out, start relay 904 having been restored, and the holding circuit for the register R900 having been reestablished, the calling subscriber may now dial the second selector digit. As previously noted, this second selector digit may have any value of from 1 to 0. When this digit is dialed, from one to ten impulses are transmitted by line relay 101 to the operate winding O of register R900. At the end of the dialing of this digit, one or another of the sets of contacts 1 to 0 of the register R900 is in closed condition, the other sets being open. Start relay 904 operates again at the end of the second digit, responsive to line relay 901 coming to rest in operated condition, with off-normal contacts ON closed. A double chain circuit, similar to the one previously described in connection with the selector of Fig. 3, is thereupon closed at contacts 4 of start relay 904, as follows: from ground by way of a relay such as 411, thence over conductor 912, contacts 4 of relay 905 and the remaining relays in the selector-subgroup chain, the associated conductor CH—END, contacts controlled by armature 3 of relay 905, winding of relay 905, conductor C2 in selector multiple SM1', a pair of off-normal contacts in the associated primary switch (see Fig. 5), conductor C1 in the selector multiple, contacts 4 of relays 904, 903, and 908, contacts 3 of the operated one of the relays 907 and 906, upper common conductor 912 or the lower common conductor 913, one or another of the dial leads 21 to 20, or 31 to 30, and thence to battery through a group controller chain including a relay such as 401 (Fig. 4). Relay 905 and the other relays in the above chain circuit operate with results exactly similar to those described in connection with Figs. 3 to 8.

When path selection has been accomplished and the selecting magnets in the concerned primary and secondary subgroups have been set, a circuit is closed over switching conductor 910, contacts 1 of relay 905, and thence over conductor SW in selector multiple SM1', for the hold magnet, such as 501, of the associated primary switch, which occurs along with the operation of the hold magnet of a secondary switch. The off-normal contacts of the primary switch thereupon disconnect conductors C1 and C2, opening the above-traced circuit through chain relay 905 and over the selected dial lead, initiating the clearing out and return to common use of the common equipment. At the same time, line relay 901 is disconnected by the off-normal contacts and consequently restores. The restoration of line relay 901 is followed by the temporary operation of busy relay 903, followed in turn by the successive restoration of relays 904, 902, and 903, as explained hereinbefore for the relays 301 to 304, Fig. 3.

Selector SEL—A1', having been used to direct the extension of a connection, has now cleared out and remains in this condition until the established connection has been cleared out and the associated incoming trunk (such as IT1, Fig. 5) has been seized again in another call.

In respects not mentioned, the selector SEL—A1' operates as hereinbefore described for the selector SEL—A1, Fig. 3.

D. Figures 10 to 15

Figs. 10 to 15 correspond respectively to Figs. 3 to 8. They show modified interconnections and control circuits for use in a second embodiment of the system, wherein the primary and secondary switches are interconnected in what may be described as a back-to-back arrangement. In the modified arrangement, each primary subgroup of switches has access to twenty incoming trunks; each secondary subgroup has access to twenty outgoing trunks; and selector links interconnect the primary switches individually with respective secondary switches. Each of the two modifications presents its own special advantages. For example, the modification shown in Figs. 2 to 8 presents the advantage that the selectors are individual respectively to the primary switches, wherefore the off-normal contacts of any primary switch serves to disconnect the selector when the connection is extended. Among the special advantages of the modification shown in Figs. 10 to 15 is that the group is expandable to include a larger number of incoming and outgoing trunks, and the select-magnet circuits are controlled locally at the primary and secondary subgroups, reducing the number of conductors required to be carried through the individualizing chain relays.

It will be recalled that, in the first embodiment, the more or less arbitrary ratio of incoming or outgoing trunks to selector links is 15 to 20, or 3 to 4. In the embodiment of Figs. 10 to 15, the number of trunks incoming to or outgoing from a subgroup is twenty. The number of selector links leading from or to such subgroup has accordingly been fixed at twenty-seven, for the ratio of 20 to 27 is approximately the above-noted more or less arbitrary ratio of 3 to 4. In both embodiments, the reason for the increased number of selector links is to render it comparatively rare that a call is lost solely because of a busy selector-link condition.

In the modification of Figs. 10 to 15, while the ultimate number of primary and secondary subgroups is twenty-seven (with each such subgroup containing twenty-seven switches, serving as terminal points for twenty-seven selector links), it has been chosen to illustrate the arrangement as applied specifically to nine primary and secondary subgroups A to I to enable a more ready comparison to be made with the first embodiment, combining nine primary and secondary subgroups.

Referring now particularly to Fig. 12, the first primary subgroup A is shown therein. This subgroup includes twenty-seven primary switches PA1 to PA27, switches PA2 to PA26 being omitted from the drawings. The hold magnets for the illustrated switches are shown at 120 and 127. The first, second, tenth and eleventh select magnets for primary subgroup A are shown at 1, 2, 10, and 11, respectively. Six of the twenty trunks incoming to the primary subgroup are shown bracketed and numbered 1, 2, 10, 11, 12, and 20. The second to ninth trunks incoming to this primary subgroup have been omitted from the drawings, along to the thirteenth to nineteenth ones and the corresponding stackups of the illustrated primary switches, to conserve drawing space.

Each of the twenty trunks incoming to primary subgroup A of Fig. 12 is connected to an associated selector by a three-conductor multiple in cable 1050. These multiples are labeled SM1 to SM20, the first and last of these multiples being shown in Fig. 10 wherein the first selector SEL—A1 is shown in full and the last selector SEL—A20 of the same selector subgroup is shown as a rectangle.

Selector SEL—A1 of Fig. 10 is similar to selector SEL—A1 of Fig. 3. That is, relays 1001 to 1005 and register R1000 correspond respectively to relays 301 to 305 and register R300. Cutoff relay 1006 in the selector SEL—A1 of Fig. 10 has been provided to accomplish the cutoff function accomplished for the selector SEL—A1 of Fig. 3 by the off-normal stackup ON of switch PA1 of Fig. 5. Additionally, chain relay 1005 is provided with an armature 5 which has the illustrated pair of front contacts connected to a pair of conductors for controlling trunk selection at the associated primary subgroup.

Relays 1101 to 1110 correspond respectively to relays 401 to 410, except that each of the relays of Fig. 11 requires fewer contact pairs (in spite of the fact that it individualizes twenty-seven selector links with a group controller instead of twenty) because select-magnet conductors are not required to be closed through the relays of Fig. 11.

Fig. 13 shows secondary subgroup A including twenty-seven secondary switches of which the first and last (SA1 and SA27) are shown. Of the twenty trunks outgoing from this subgroup, Nos. 1, 2, 10, 11, 12, and 20 are shown. Nos. 1, 2, 10, and 11 of the eleven select magnets of the secondary subgroup are shown at the bottom of the sheet. Magnets 130 and 1327 are the hold magnets for the switches SA1 and SA27, respectively.

Fig. 14 shows the first group controller GC1 of the modified arrangement. In this group controller, relays 1401 to 1406 correspond exactly in arrangement and operation to relays 701 to 706 hereinbefore described. Additionally, the group controller of Fig. 14 comprises twenty-seven link-test relays 1A to 3I, corresponding exactly in function, and generally in their contact arrangement, to the correspondingly designated relays of Fig. 7.

Fig. 15 shows secondary controller SCA of the modified arrangement. This secondary controller includes twenty test relays T1 to T20 (relays T3 to T9 and T13 to 18 are omitted to conserve drawing space), one for each of the twenty trunks outgoing from the associated secondary subgroup A, Fig. 13. Test-connect relay 1521 corresponds exactly to test-connect relay 821, except that it has twenty pairs of contacts instead of fifteen. The secondary controller also includes ten numerical-group relays 1501 to 1510, corresponding in function to relays 801 to 810. Relays 1503 to 1508 are omitted to conserve drawing space.

In Fig. 15, armatures 1 and their back contacts of relays T1 to T20 are connected together in pairs and joined to conductors in cable 1411 so as to assign the twenty associated outgoing trunks in pairs to the ten numerical groups 1 to 0. Similarly, the upper windings of relays T1 to T20 are interconnected in ten pairs, connected to numerical-group relays 1501 to 1510 respectively, through conductors 1 to 10 in cable 1500. Cable 1500 corresponds exactly to cable 800, while cable 1550 contains ten pairs of conductors not represented in the secondary controller of Fig. 8. These conductors are employed to control trunk selection in the associated secondary subgroup A as will subsequently appear.

The operation of the modified arrangement in extending a connection will now be described in detail. Preliminarily, it may be pointed out that the sleeve conductor S of each incoming trunk is normally supplied with an idle-indicating battery potential. For example, sleeve conductor S of trunk 1 incoming to primary subgroup A of Fig. 12 is normally supplied with battery potential by way of current-limiting resistor 1022, contacts 4 of cutoff relay 1006, normally closed make-busy contacts 1021, back contact 1 of release relay 1002, and thence, by way of sleeve conductor S in the associated selector multiple SM1, to the sleeve conductor of the attached incoming trunk 1 (Fig. 12).

D1. *Seizure of incoming trunk*

Upon the seizure of incoming trunk 1 (Fig. 12), the bridging of the tip and ring conductors thereof closes a circuit over the tip and ring conductors in selector multiple SM1, and through contacts 1 and 2 of cutoff relay 1006, for line relay 1001 of the selector SEL—A1 (Fig. 10). Thereupon, line and release relays 1001 and 1002 operate successively, performing operations as described in connection with Fig. 3. Armature 1 of relay 1002 disconnects the normally applied idle-indicating potential and substitutes holding ground potential on the associated sleeve conductor, to maintain the partially established connection.

D2. *Dialing*

When the first digit in the desired number is dialed, line relay 1001 responds as previously described for the line relay 301 to transmit impulses to the operate winding O of magnet 1051 of register 1000, causing off-normal contacts ON of the register to close and causing closure of contacts 1 to 0 successively in the manner previously described for the register R300. It may be assumed that the digit dialed is the digit 1, in which case contacts 1 of the register are in closed condition at the termination of the dialing operation, contacts 2 to 0 being open.

D3. *Termination of dialing*

When line relay 1001 comes to rest in an operated condition at the end of dialing, slow-operating start relay 1004 operates through off-normal contacts ON of the register R1000, performing operations as described for start relay 304.

D4. *Preconditioning the secondary controllers*

Test-start conductor T—ST (common to all selectors) is grounded at contacts 1 of start relay 1004. Conductor T—ST enters cable 1400, through which it is distributed to all secondary controllers. In the secondary controller SCA of Fig. 5, provided none of the numerical group relays 1501 to 1510 is energized, the grounding of conductor T—ST closes an operating circuit for test-connect relay 1521. Relay 1521 connects the high-resistance lower windings of trunk-test relays T1 to T20, respectively to the sleeve conductors of the twenty trunks outgoing from the associated secondary subgroup A (Fig. 13) by way of conductors S1 to S20 in cable 1350. When this occurs, each relay T1 to T20 operates, subject to the associated outgoing trunk being idle. The sleeve conductor of each outgoing trunk is normally supplied with an idle-indicating battery potential as described hereinbefore in connection with Fig. 2. It is this potential which, when present on the sleeve conductors, operates relays T1 to T20. Similar operations occur in the secondary controllers at the remaining idle secondary subgroups.

D5. *Individualizing the subgroup with the selector*

The selector-subgroup chain of Fig. 10 is similar to that of Fig. 3, except that ground potential is applied directly to the chain-in conductor CH—IN associated with the first relay 1005 in the chain, because this modification does not require a relay such as 411 of the previously described modification. Accordingly, if the chain at selector subgroup A is idle at the moment, start relay 1004, at its contacts 4, extends the local branch of the chain, by way of contacts 5 and 4 of relays 1006 and 1003, to the conductor common to contact pairs 1 to 0 of register R1000. With contacts 1 closed, this ground potential is further extended over dial lead DL1 to relay 1101 of the chain associated with group controller GC1 (Fig. 14). This chain is similar to the chain associated with relay 401, and is supplied with battery potential by way of chain-in conductor CH—IN in cable 1121, by way of start relay 1401.

If the subgroup chain and the group-controller chain are both idle when start relay 1004 operates, relays 1005, 1101, and 1401 operate in series over the two serially related chains. Chain relay 1005 locks itself to the associated chain-in conductor and opens the chain to preclude operation for the time being of the corresponding relays in the other selectors of the subgroup. At its armatures 1 and 2, relay 1005 connects subgroup conductors 1010 and 1011 respectively to the windings of relays 1006 and 1003.

D6. *Primary select-magnet operation*

At the front contacts of its armature 5, relay 1005 grounds conductors 1 and 11' in cable 1050 to cause selection of the associated incoming trunk 1 (Fig. 12) to occur.

As a result of the grounding of conductor 1 in cable 1050, select magnet 1 of primary subgroup A (Fig. 12) is energized to select stackup 1 in all switches of the subgroup, and the grounding of conductor 11' in cable 1050 extends ground potential directly to the five pairs of off-normal contacts PON1, 2 to PON9, 10 so as to prepare for the grounding of conductor PON in cable 1150 without waiting for the operation of off-normal contacts PON11. It should be noted that front contacts 5 of chain relays 1005 in selectors 1 to 10 of the subgroup are arranged to ground conductors 1 to 10 respectively (2 to 9 not shown) in cable 1050 to cause energization of select magnets 1 to 10 respectively (Fig. 12), and that conductor 11' is grounded by each of these chain relays, for select magnet 11 of Fig. 12 is not required to be operated from any of the first ten selectors. Selectors 11 to 20 of the subgroup also ground conductor 1 to 10 respectively. Additionally, each of the selectors 11 to 20 grounds conductor 11 in cable 1050, in place of conductor 11', to thereby cause select magnet 11 of Fig. 12 to operate to pre-select stackup 11 in each of the associated primary switches pursuant to making connection with one or another of the incoming trunks 11 to 20. In this event, since conductor 11' in cable 1050 is not grounded, ground potential can be extended to conductor PON in cable 1150 only by the joint action of primary off-normal contacts PON11 and one or another of the pairs of off-normal contacts associated with select magnets 1 to 10.

D7. *Individualizing the group controller with the subgroup*

When group controller relay 1101 operates, it locks itself to the associated chain-in conductor, at the same time opening the chain to preclude operation for the time being of any further relays therein. At its armature 1, relay 1101 connects subgroup busy conductor 1011 to busy conductor BU in cable 1121; at its armature 2, it connects the subgroup switching conductor 1110 to switching conductor SW in cable 1121; at its armature 3, it connects conductor PON in cable 1150 to conductor PON in cable 1121; and at its armatures 4 to 30, it connects conductors S1 to S27 in cable 1150 (being the sleeve conductors of the associated selector links SL1 to SL27) respectively to the twenty-seven conductors 1A to 3I in cable 1121, extending respectively to relays 1A to 3I (Fig. 14).

In the specifically illustrated embodiment of the second modification, since there are twenty-seven selector links outgoing from or incoming to each primary or secondary subgroup, and since there are nine primary and nine secondary subgroups, the selector links extending from any primary subgroup are divided evenly amongst the secondary subgroups, three to each. Following the general arrangement hereinbefore discussed, in connection with the first modification, links 1, 2, and 3 from any primary subgroup are links 1, 2, and 3 at the corresponding secondary subgroup; links 4, 5 and 6 from the same primary subgroup are links 4, 5 and 6 at the next succeeding secondary subgroup; links 7, 8, and 9 from the same primary subgroup are links 7, 8, and 9 at the secondary subgroup next succeeding the one last mentioned; and so forth.

In accordance with the above-described selector-link spread, the twenty-seven conductors 1A to 3I in cable 1121 appear in front contacts of the twenty-seven armatures 4 to 30 of relay 1101 and the corresponding chain relays of the succeeding selector subgroups as shown in the following Table No. 5:

TABLE NO. 5

Cond.	A	B	C	D	E	F	G	H	I
1A	1st	25th	22nd	19th	16th	13th	10th	7th	4th
2A	2nd	26th	23rd	20th	17th	14th	11th	8th	5th
3A	3rd	27th	24th	21st	18th	15th	12th	9th	6th
1B	4th	1st	25th	22nd	19th	16th	13th	10th	7th
2B	5th	2nd	26th	23rd	20th	17th	14th	11th	8th
3B	6th	3rd	27th	24th	21st	18th	15th	12th	9th
1C	7th	4th	1st	25th	22nd	19th	16th	13th	10th
2C	8th	5th	2nd	26th	23rd	20th	17th	14th	11th
3C	9th	6th	3rd	27th	24th	21st	18th	15th	12th
1D	10th	7th	4th	1st	25th	22nd	19th	16th	13th
2D	11th	8th	5th	2nd	26th	23rd	20th	17th	14th
3D	12th	9th	6th	3rd	27th	24th	21st	18th	15th
1E	13th	10th	7th	4th	1st	25th	22nd	19th	16th
2E	14th	11th	8th	5th	2nd	26th	23rd	20th	17th
3E	15th	12th	9th	6th	3rd	27th	24th	21st	18th
1F	16th	13th	10th	7th	4th	1st	25th	22nd	19th
2F	17th	14th	11th	8th	5th	2nd	26th	23rd	20th
3F	18th	15th	12th	9th	6th	3rd	27th	24th	21st
1G	19th	16th	13th	10th	7th	4th	1st	25th	22nd
2G	20th	17th	14th	11th	8th	5th	2nd	26th	23rd
3G	21st	18th	15th	12th	9th	6th	3rd	27th	24th
1H	22nd	19th	16th	13th	10th	7th	4th	1st	25th
2H	23rd	20th	17th	14th	11th	8th	5th	2nd	26th
3H	24th	21st	18th	15th	12th	9th	6th	3rd	27th
1I	25th	22nd	19th	16th	13th	10th	7th	4th	1st
2I	26th	23rd	20th	17th	14th	11th	8th	5th	2nd
3I	27th	24th	21st	18th	15th	12th	9th	6th	3rd

In the above table, the twenty-seven conductors 1A to 3I are listed in regular order in the first column. Column A lists the order number, from 1st to 27th, in which the conductors appear in the contacts of the group-controller chain relay 1101 in selector subgroup A. Column B shows that conductor 1B appears in the first position at the contacts of the chain relay of selector subgroup B, followed in regular order by conductors 2B, 3B, and so forth, and ending with conductor 3A, occupying the 27th position. Each of the succeeding columns C to I shows the order, from 1st to 27th, in which the conductors listed in the first column appear in the contacts of the group-controller chain relays at the respective selector subgroups. The arrangement is such that, in each case, the sleeve conductor of a selector link is extended to a link-test relay of Fig. 14 assigned to the secondary subgroup to which such selector link extends.

D8. *Setting the link-test relays*

Each of the link-test relays 1A to 3I of Fig. 14 now operates, subject to the selector link with which it is currently associated being idle. If selector link SL1 is idle, there is no ground potential on the sleeve conductor thereof, and the following circuit exists for relay 1A, Fig. 14: from battery through the upper winding of each of the magnets 1201 and 1301 to sleeve conductor S of link SL1 (extending from primary switch PA1, by way of branches PA and SA in spread cable 1300, to secondary switch SA1), and through the lower windings of magnets 1201 and 1301 and the associated off-normal contacts to the said sleeve conductor S of selector link SL1, conductor S1 in cable 1150, contacts 4 of relay 1101, conductor 1A in cable 1121, and thence to ground through the winding of relay 1A, Fig. 14. The high resistance of the winding of relay 1A keeps the test current below the operating value for magnets 1201 and 1301.

D9. *Path selection*

With the idle secondary controllers having been preconditioned as described, the setting of the link-test relays of Fig. 14 selects a path for the extension of the connection as described in connection with the first embodiment.

D9a. *Selecting secondary controller SCA*

Assuming that preference-shift relay 1406 is restored (as it is during completion of odd-numbered calls); that link-test relay 1A operates to show that selector link SL1 of Figs. 12 and 13 is idle; and that trunk-test relay T1 (Fig. 15) is operated to show that outgoing trunk 1 of Fig. 13 (assigned to the called numerical group 1) is idle, the following test circuit is established: from ground through test relay 1402, contacts 3 of start relay 1501, back contact 3 of preference-shift relay 1406, front contact 3 of link-test relay 1A, conductor 1A2 in cable 1411, front contact 1 of relay T1 (Fig. 15), upper winding of relay T1, conductor 1 in cable 1500, numerical-group relay 1501, and thence to battery through chain contacts 4 of relays 1502 to 1510. Current flow over the above-traced circuit serves to hold relay T1 operated and to operate relays 1402 and 1501.

D10. *Individualizing the secondary controller with the group controller*

At its contacts 4, relay 1501 open-circuits and restores test-connect relay 1521, and the latter opens the test circuits of relays T1 to T20. Each operated one of these relays restores, except the held-operated relay T1, thereby marking the secondary controller SCA busy to the other group controllers by rejoining the pairs of conductors controlled by armatures 1 of the relays succeeding relay T2, as explained hereinbefore in connection with the first modification.

D11. *Secondary select-magnet operation*

At the front contacts of its armature 3, numerical-group relay 1501 grounds the conductors comprising pair 1 in cable 1550. With trunk-test relay T1 held operated over its above-traced circuit, the grounding of conductor-pair 1 in cable 1550 extends ground potential through front contacts 2 and 3 of relay T1 to conductors 1 and 11' of cable 1350. The grounding of conductor 11' in cable 1350 extends ground in by-pass of primary off-normal contacts PON11 of Fig. 13 to the preceding primary off-normal contacts, while the grounding of conductor 1 in the said cable establishes an operating circuit for select magnet 1 of Fig. 13. By the operation of this magnet, stack-up 1 is selected in each of the secondary switches SA1 to SA27.

D12. *Hold-magnet operation*

It will be recalled that select-magnet operation was initiated in primary subgroup A (Fig. 12) responsive to the grounding of conductors 1 and 11' in cable 1050 at the front contacts of armature 5 of chain relay 1005. Assuming that this operation has been completed (as is normally the case), by the time numerical-group relay 1501 has operated as described, contacts 2 of relay 1501 complete a circuit for primary off-normal relay 1511, as follows: from ground potential on conductor 11' in cable 1050 (applied by the concerned front contact of armature 5 of relay 1005), primary off-normal contacts PON1, 2 of Fig. 12, conductor PON in cable 1150, contacts 3 of relay 1101, conductor PON in cable 1121, conductor 1 in cable 1400, contacts 2 of relay 1501, and thence to battery through the winding of primary off-normal relay 1511. Relay 1511 accordingly operates to prepare operating circuits for the hold magnets of the primary and secondary switches between which the now-selected selector link (SL1) extends, subject to the completion of the secondary select-magnet operation initiated as

described at the front contacts of armature 5 of relay 1501.

As soon as the secondary select-magnet operation is completed, the following circuit for the primary and secondary hold magnets is established: from ground on armature 3 of relay T1, Fig. 15 (applied over the conductor of pair 1 of cable 1550 and a front contact of armature 3 of relay 1501), front contact of the said armature 3 of relay T1, conductor 11' in cable 1350, secondary off-normal contacts SON1, 2 (Fig. 13), conductor SON in cable 1350, contacts of primary off-normal relay 1511, contacts 1 of numerical-group relay 1501, conductor 1A1 in cable 1411, front contact 1 of relay 1A (Fig. 14), conductor 1A in cable 1121, contacts 4 of relay 1101, conductor S1 in cable 1150, sleeve conductor S of selector link SL1, and thence to battery through the two windings of hold magnet 1201 of primary switch PA1 and the two windings of hold magnet 1301 of switch SA1, in parallel. By the resulting operation of magnets 1201 and 1301, incoming trunk 1 of Fig. 12 is interconnected with outgoing trunk 1 of Fig. 13, by way of the upper three contact pairs of stackup 1 of the primary switch PA1, normally closed contacts in stackup 11 of the said primary switch, selector link SL1, normally closed contacts in stackup 11 of secondary switch SA1, and the upper three contact pairs in stackup 1 of the said secondary switch. By the opening of the off-normal contacts ON of the said primary and secondary switches, the lower winding of each of the hold magnets 1201 and 1301 is disconnected to reduce the comparatively heavy flow of operating current to an efficient holding value.

It will be noted that the establishment of the above-traced circuit for the hold magnets short-circuits the winding of link-test relay 1A, but relay 1A does not restore immediately because of the well-known slow-restoring action of a short-circuited relay.

Since the sleeve conductor S of incoming trunk 1 of Fig. 12 is grounded (over sleeve conductor S of selector multiple SM1 and front contact 1 of release relay 1002), hold magnets 1201 and 1301 are immediately locked operated to the sleeve conductor of the connection. Upon the described extension of incoming trunk 1 of Fig. 12, by way of selector link SL1, to outgoing trunk 1 of Fig. 13, the usual line and release relay operations may occur over the outgoing trunk to cause a holding ground potential to be returned over the sleeve conductor to maintain magnets 1201 and 1301 operated after release relay 1002 of selector SEL—A1 (Fig. 10) has restored, as it shortly does.

The same operation which closes the above-traced circuit for hold magnets 1201 and 1301 closes a circuit for cutoff relay 1306 in the selector of Fig. 10, as follows: from ground as previously traced to conductor 1A1 in cable 1411, and thence by way of front contact 2 of link-test relay 1A (Fig. 14), back contact 2 of relay 1406, conductor SW in cable 1121, contacts 2 of relay 1101, subgroup switching conductor 1010, contacts 1 of relay 1005, and thence to battery through the winding of cutoff relay 1006.

At its contacts 3, relay 1006 locks itself to the associated sleeve conductor, so as to remain operated thereover until the established connection is subsequently cleared out; at its contacts 4, it disconnects the current-limiting resistor 1022 from back contact 1 of release relay 1002 to prevent unnecessary current drain through this resistor after release relay 1002 is restored; at armatures 1 and 2, it disconnects line relay 1001 to permit the selector SEL—A1 to clear out as described hereinbefore for the selector of Fig. 3.

At its contacts 5, cutoff relay 1006 opens the previously traced circuit including the local subgroup chain and the chain of the first group controller in series, immediately initiating clearing out of the common equipment. Relays 1005, 1101, and 1401 restore directly responsive to the opening of these contacts. Care should be exercised in selecting a winding for cutoff relay 1006, and in setting the operating adjustment, to the end that the clearing-out operation is not initiated so quickly at its contacts 5 that the selected primary and secondary switches (PA1, Fig. 12, and SA1, Fig. 13) do not have time to operate fully and lock, as described, before their described operating circuit is interrupted by the clearing-out operation.

D13. *Clearing out the selector subgroup*

When chain relay 1005 restores, it clears out the selector chain by reclosing its contacts 4. At its contacts 5, it ungrounds conductors 1 and 11' in cable 1050. The ungrounding of conductor 11' open-circuits primary off-normal relay 1511, which thereupon restores.

A further point in the circuit of relay 1511 is simultaneously opened at contacts 3 of relay 1101. The ungrounding of conductor 1 in cable 1050 open-circuits and restores select magnet 1 of primary subgroup A to terminate the temporary selection of the associated stackups 1 of the several primary switches.

D14. *Clearing out the group controller*

Responsive to the registration of chain relay 1101, the test circuits for link-test relays 1A and 3I of Fig. 14 are opened by relay 1101 when the latter relay restores to return the group-controller chain to normal condition. Each operated one of the said relays 1A to 3I thereupon restores. It may be pointed out that conductor 1A1 in cable 1411 becomes ungrounded responsive to the restoration of primary off-normal relay 1511, removing the short-circuit from around the winding of relay 1A to permit this relay to restore promptly along with the other link test relays.

D15. *Clearing out the secondary controller*

Start relay 1401 of the group controller, at its contacts 3, open-circuits and restores the associated test relay 1402, as well as the operated relays T1 and 1501 of the secondary controller SCA (Fig. 15). The restoration of relays T1 and 1501 clears out the secondary controller. Secondary select magnet 1 of Fig. 13 is thereupon deenergized.

D16. *Clearing out the established connection*

When ground potential is subsequently removed from the sleeve conductor S of outgoing trunk 1 (Fig. 13), the holding circuits of magnets 1301 and 1201 are thereby opened. Switches SA1 and PA1 restore responsive to the consequent deenergization of the hold magnets, clearing out the established connection. At the same time, cutoff relay 1006 (Fig. 10) restores preparing the selector for further use.

D17. *Changing trunk assignments*

Referring again to trunk-test relays T2 to T20 of Fig. 15, it will be recalled that relays T1 to T10

are associated respectively with outgoing trunks T1 to T10 (Fig. 13), accessible through the upper three contact pairs of stackups 1 to 10 of the secondary switches of Fig. 13. Accordingly, each of the relays T1 to T10 is arranged, when selected, to secure operation of the corresponding one of select magnets 1 to 10 (Fig. 13) without causing operation of select magnet 11 of Fig. 13. Select-magnet conductors 1 to 10 in cable 1350 are connected to front contacts 2 of test relays T1 to T10 respectively. Conductor 11' in cable 1350 (used to by-pass secondary off-normal contacts SON11 of Fig. 13) is connected in multiple to front contacts 3 of each of the relays T1 to T10.

Since relays T11 to T20 are associated respectively with outgoing trunks 11 to 20 of Fig. 13, accessible through the three lower contact pairs in stackups 1 to 10 respectively of the subgroup shown in Fig. 13, the front contacts 2 of relays T11 to T20 are connected respectively to select-magnet conductors 1 to 10 in cable 1350, whereby each such relay (when selected) secures the energization of the corresponding one of the said select magnets 1 to 10. The concerned trunks being reached through the lower (alternate) set of three contact pairs in the stackups of the switches, the operation of stackup 11 of any switch of Fig. 13 is required to enable connection to be made with any selected one of outgoing trunks 11 to 20. Accordingly, select-magnet conductor 11 of cable 1350 is connected in multiple to the front contacts 3 of trunk-test relays T11 to T20.

The foregoing connections to front contacts 2 and 3 of relays T1 to T20, along with the connections to front contacts 1 of these relays may be made permanently, and have no specific relation to the assignment of outgoing trunks to numerical groups. The connections, however, to armatures 2 and 3 of relays T1 to T20 must be made in accordance with the numerical groups to which the respective corresponding outgoing trunks are assigned, as is true with respect to armatures 1 of these relays and the back contacts thereof, and the connections between the upper terminals of the upper windings of the test relays and conductors 1 to 10 in cable 1500.

Suppose, for example, that outgoing trunk 2 of Fig. 13 (corresponding to relay T2 of Fig. 15) is to be reassigned from numerical group 2 to numerical group 0. Following the physical transfer of the conductors of the outgoing trunk from a trunk of group 2 to a trunk of group 0 (as by a jumper change as hereinbefore described in connection with the first embodiment), conductor 1A3 is transferred from the back contact of armature 1 of relay T2 to the back contact of armature 1 of relay T1; armature 1 of relay T2 is disconnected from the back contact of armature 1 of relay T1; conductor OA3 is disconnected from the back contact of armature 1 of relay T20 and is transferred into connection with the back contact of armature 1 of relay T2; the back contact of armature 1 of relay T20 is connected to armature 1 of relay T2; the upper terminal of the upper winding of relay T2 is disconnected from conductor 1 in cable 1500 and is transferred to conductor 10; the back contacts of armatures 2 and 3 of relay T1 are disconnected from armatures 2 and 3 of relay T2; and armatures 2 and 3 of relay T2 are connected to the back contacts of armatures 2 and 3 respectively of relay T20. When the foregoing changes have been made, trunk-test relay T1 remains as the sole trunk-test relay in the secondary controller associated with the first numerical group, and trunk-test relays T19, T20, and T2 are related, in the preference order named, with numerical group 0.

Reference is made to my application for Selector switching systems, Serial No. 649,595, filed February 23, 1946, a continuation in part of this application, wherein certain features described herein are claimed.

I claim:

1. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means being operable to cause such extension of a plurality of calling trunks to occur contemporaneously, each such extension being over a separate idle path.

2. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means being operable to cause such extension of a plurality of calling trunks to occur contemporaneously, each con-

temporaneously effected extension being through a separate primary subgroup, a separate secondary subgroup, and to a separate numerical group.

3. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups; and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; means responsive to such selection for rendering the primary subgroup containing the calling incoming trunk, and the selected numerical group of outgoing trunk lines, temporarily individual to each other, while leaving the remaining numerical groups and the remaining primary subgroups free to become similarly individualized; means for selecting an idle trunk outgoing to the selected numerical group from a secondary subgroup containing an idle selector link extending thereto from the individualized primary subgroup; means for temporarily individualizing the last-named secondary subgroup with the called numerical group and with the individualized primary subgroup, while leaving the remaining secondary subgroups free to become similarly individualized with other numerical groups and primary subgroups; and means for operating a switch in the individualized primary subgroup and a switch in the individualized secondary subgroup to interconnect the calling incoming trunk with the selected outgoing trunk by way of an idle selector link extending between the individualized subgroups.

4. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; means responsive to such selection for rendering the primary subgroup containing the calling incoming trunk, and the selected numerical group of outgoing trunk lines, temporarily individual to each other, while leaving the remaining numerical groups and the remaining primary subgroups free to become similarly individualized; means for selecting a secondary subgroup containing an idle trunk in the selected numerical group, and containing an idle selector link extending thereto from the individualized primary subgroup; means for temporarily individualizing the selected secondary subgroup with the called numerical group and with the individualized primary subgroup, while leaving the remaining secondary subgroups free to become similarly individualized with other numerical groups and primary subgroups; means for selecting an idle trunk outgoing from the individualized secondary subgroup to the selected numerical group; and means for operating a switch in the individualized primary subgroup, and a switch in the individualized secondary subgroup, to interconnect the calling incoming trunk with the selected outgoing trunk by way of an idle selector link extending between the individualized subgroups.

5. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; means responsive to such selection for rendering the primary subgroup containing the calling incoming trunk, and the selected numerical group of outgoing trunk lines, temporarily individual to each other, while leaving the remaining numerical groups and the remaining primary subgroups free to become similarly individualized; means for selecting an idle path for extending the calling incoming trunk, said path including an idle selector link serially related with an idle trunk in the selected numerical group through an idle secondary subgroup; means responsive thereto for individualizing such secondary subgroup with the called numerical group and with the individualized primary subgroup, while leaving the remaining secondary subgroups free to become similarly

individualized with other numerical groups and primary subgroups; and means for operating a switch in the individualized primary subgroup and a switch in the individualized secondary subgroup to extend the calling incoming trunk over said selected path.

6. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; group controllers corresponding respectively to said numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group, means responsive thereto for associating the calling trunk, and the primary subgroup containing it, individually with the corresponding group controller; and means controlled by said group controller for operating a primary switch in the calling primary subgroup and a secondary switch in one or another of the secondary subgroups to extend the calling trunk, by way of an idle selector link, to an idle outgoing trunk in the selected numerical group.

7. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; group controllers corresponding respectively to the numerical groups; secondary controllers corresponding respectively to the secondary subgroups; means controlled over any calling incoming trunk for selecting any desired numerical group, means responsive thereto for associating the calling trunks, and the primary subgroup containing it, individually with the corresponding group controller; means controlled by said group controller for selecting a secondary controller associated with a secondary subgroup containing an idle trunk in the called numerical group, and having an idle selector link extending thereto from the calling primary subgroup; and means controlled jointly by said group controller and the selected secondary controller for operating a primary switch in the calling primary subgroup and a secondary switch in the concerned secondary subgroup to extend the calling trunk, by way of said idle selector link, to said idle outgoing trunk.

8. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selectors links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; group controllers corresponding respectively to the numerical groups; secondary controllers connected respectively to the secondary subgroups; control conductors extending to each group controller from all primary subgroups; control conductors interconnecting each group controller with each secondary controller; means controlled over calling incoming trunks for selecting the respective desired numerical groups by selecting the respectively corresponding group controllers; and means controlled over said control conductors by said group controllers and secondary controllers for selecting idle selector links and idle outgoing trunks in the respectively selected numerical groups, and for operating the concerned primary and secondary switches to extend the calling incoming trunks.

9. In a switching system, lines, a group of first and second trunk sections over which calling ones of said lines may be extended; said group comprising subgroups each including a first section and a second trunk section, some subgroups including a plurality of first trunk sections each; first switching devices operable to interconnect any one of said lines with any first trunk section; second switching devices operable to connect any first trunk section to any second trunk section in the same subgroup; contact sets corresponding respectively to said trunk sections; means for positioning each of said contact sets in one or another of two positions, depending upon whether the corresponding trunk section is busy or idle; means controlled through said contact sets when one of said lines is calling, and dependent upon the respective positions occupied by concerned ones of them, for selecting any subgroup containing an idle first trunk section and an idle second trunk section, and for selecting an idle

first trunk section and an idle second trunk section in the selected subgroup; and means for operating a first switching device and a second switching device to extend the calling line by way of the selected first trunk section to the selected second trunk section.

10. In a switching system, lines, a group of first and second trunk sections over which calling ones of said lines may be extended; said group comprising subgroups each including a first trunk section and a second trunk section, some subgroups each including a plurality of first trunk sections, and some subgroups each including a plurality of second trunk sections; first switching devices operable to interconnect any one of said lines with any first trunk section; second switching devices operable to connect any first trunk section to any second trunk section in the same subgroup; contact sets corresponding respectively to said trunk sections; means for positioning each of said contact sets in one or another of two positions, depending upon whether the corresponding trunk section is busy or idle; means controlled through said contact sets when one of said lines is calling, and dependent upon the respective positions occupied by concerned ones of them, for selecting any subgroup containing an idle first trunk section and an idle second trunk section, and for selecting an idle first trunk section and an idle second trunk section in the selected subgroup; and means for operating a first switching device and a second switching device to extend the calling line by way of the selected first trunk section to the selected second trunk section.

11. In a switching system, lines, a group of first and second trunk sections over which calling ones of said lines may be extended, said group comprising subgroups each containing at least one first trunk section and at least one second trunk section, at least one of said subgroups including a plurality of first trunk sections, at least one of said subgroups containing a plurality of second trunk sections; first switching devices operable to interconnect any one of said lines with any first trunk section; second switching devices operable to interconnect any first trunk section to any second trunk section in the same subgroup; contact sets corresponding respectively to said trunk sections, means for positioning each of said contact sets in one or another of two positions depending on whether the corresponding trunk section is busy or idle; conductors interconnecting the contact sets of the first trunk sections in a main chain extending through the subgroups sequentially; conductors interconnecting the contact set or sets associated with the second trunk section or trunk sections of a subgroup in a branch chain leading to the conductor of the main chain extending from such subgroup to the next succeeding one, said branch chains having alternate paths corresponding respectively to said second trunk sections; the said first-section contact sets serving to interrupt the main chain at the first subgroup containing an idle first trunk section and to transfer it to the input conductor of the associated branch chain; the said second-section contact sets serving to interrupt each branch chain at the first idle second trunk section included therein and to transfer it to the associated alternate path; and means effective when any one of said lines is calling, responsive to the transfer of the main chain to the associated branch chain, and to the transfer of the branch chain to an associated alternate path, in the first subgroup containing an idle first trunk section and an idle second trunk section, for operating a first switching device and a second switching device to extend the calling line by way of an idle first trunk section in the concerned subgroup to an idle second trunk section therein.

12. In a switching system, lines; a group of first and second trunk sections over which calling ones of said lines may be extended, said group comprising subgroups each containing at least one first trunk section and at least one second trunk section, at least one of said subgroups including a plurality of first trunk sections, at least one of said subgroups containing a plurality of second trunk sections; switching devices operable to interconnect any first trunk section to any second trunk section in the same subgroup and to interconnect any such interconnected pair of sections with any line; contact sets corresponding respectively to said trunk sections, means for positioning each of said contact sets in one or another of two positions depending on whether the corresponding trunk section is busy or idle; conductors interconnecting the contact sets of the first trunk sections in a main chain extending through the subgroups sequentially; conductors interconnecting the contact set or sets associated with the second trunk section or trunk sections of a subgroup in a branch chain leading to the conductor of the main chain extending from such subgroup to the next succeeding one, said branch chains having alternate paths corresponding respectively to said second trunk sections; the said first-section contact sets serving to interrupt the main chain at the first subgroup containing an idle first trunk section and to transfer it to the input conductor of the associated branch chain; the said second-section contact sets serving to interrupt each branch chain at the first idle second trunk section included therein and to transfer it to the associated alternate path; and means effective when any one of said lines is calling, responsive to the transfer of the main chain to the associated branch chain, and to the transfer of the branch chain to an associated alternate path, in the first subgroup containing an idle first trunk section and an idle second trunk section, for operating a first switching device and a second switching device to extend the calling line by way of an idle first trunk section in the concerned subgroup to an idle second trunk section therein, and for operating another switching device to interconnect the calling line with one of the interconnected trunk sections.

13. In a switching system, lines; a group of first and second trunk sections over which calling ones of said lines may be extended, said group comprising subgroups each containing at least one first trunk and at least one second trunk section, at least one of said subgroups including a plurality of first trunk sections; first switching devices operable to interconnect any one of said lines with any first trunk section; second switching devices operable to interconnect any first trunk section to any second trunk section in the same subgroup; contact sets corresponding respectively to said trunk sections, means for positioning each of said contact sets in one or another of two positions depending on whether the corresponding trunk section is busy or idle; conductors interconnecting the contact sets of the first trunk sections in a main chain extending through the subgroups sequentially; conductors interconnecting the contact sets associated with the second trunk sections in branch chains, one for each subgroup, each branch chain leading to

the conductor of the main chain extending from such subgroup to the next succeeding one, said branch chains having alternate paths corresponding respectively to said second trunk sections; the said first-section contact sets serving to interrupt the main chain at the first subgroup containing an idle first trunk section and to transfer it to the input conductor of the associated branch chain; each second-section contact set serving to interrupt the associated branch chain, subject to the concerned trunk section being idle, and to transfer it to the associated alternate path; and means effective when any one of said lines is calling, responsive to the transfer of the main chain to the associated branch chain, and to the transfer of the branch chain to an associated alternate path in the first subgroup containing an idle first trunk section and an idle second trunk section, for operating a first switching device and a second switching device to extend the line by way of an idle first trunk section in the concerned subgroup to an idle second trunk section therein.

14. In a switching system, lines; a group of first and second trunk sections over which calling ones of said lines may be extended, said group comprising subgroups each containing at least one first trunk section and at least one second trunk section, at least one of said subgroups including a plurality of first trunk sections; switching devices operable to interconnect any first trunk section to any second trunk section in the same subgroup and to interconnect any such interconnected pair of sections with any line; contact sets corresponding respectively to said trunk sections, means for positioning each of said contact sets in one or another of two positions depending on whether the corresponding trunk section is busy or idle; conductors interconnecting the contact sets of the first trunk sections in a main chain extending through the subgroups sequentially; conductors interconnecting the contact set or sets associated with the second trunk section or trunk sections of a subgroup in a branch chain leading to the conductor of the main chain extending from such subgroup to the next succeeding one, said branch chain having alternate paths corresponding respectively to said second trunk sections; the said first-section contact sets serving to interrupt the main chain at the first subgroup containing an idle first trunk section and to transfer it to the input conductor of the associated branch chain; the said second-section contact sets serving to interrupt each branch chain at the first idle second trunk section included therein and to transfer it to the associated alternate path; and means effective when any one of said lines is calling, responsive to the transfer of the main chain to the associated branch chain, and to the transfer of the branch chain to an associated alternate path in the first subgroup containing an idle first trunk section and an idle second trunk section, for operating one of said switching devices to interconnect an idle first trunk section in such subgroup with an idle second trunk section therein, and for operating another switching device to interconnect the calling line with one of the interconnected trunk sections.

15. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means including a separate group of assignment terminals and interconnecting conductors at each secondary subgroup; each such group including terminals individual to the respective numerical groups, terminals individual to the respective outgoing trunks, and conductors interconnecting the trunk terminals with the group terminals according to the trunk assignment desired at the concerned secondary subgroup, independent of the trunk assignment at any other secondary subgroup.

16. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; the trunks outgoing from any secondary subgroup being assignable to each of said numerical groups in any desired combination irrespective of the trunk assignment at any other secondary subgroup, said control means including separate means local to the secondary subgroups respectively for directing connections thereat according to the local assignment combination.

17. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means including secondary controllers assigned respectively to said secondary subgroups, each secondary controller including relays corresponding respectively to the numerical groups and trunk relays corresponding respectively to the associated outgoing trunks; means controlled by said trunk relays for rendering a secondary controller seizable on a call to any numerical group subject to the associated secondary subgroup containing an idle outgoing trunk assigned to such numerical group; and circuit connections effective on seizure of a group controller for causing a trunk relay associated with an idle outgoing trunk assigned to the called group to cooperate with the concerned group relay in directing the connection through the subgroup to the last-named idle trunk.

18. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means including means for localizing any secondary subgroup temporarily with any called numerical group; group relays at each secondary subgroup corresponding respectively to the numerical groups; and means for operating the concerned group relay to mark the numerical group with which the secondary subgroup is localized.

19. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into operationally separate primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into operationally separate secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; means controlled over any calling incoming trunk for selecting any desired numerical group of outgoing trunks; and control means responsive to any such selection for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group; said control means including trunk relays associated respectively with the outgoing trunks, each outgoing trunk and associated relay being assigned to any desired numerical group, means operative on a call to any numerical group for operating each trunk relay subject to the associated trunk being idle, said control means including means controlled by the operated trunk relays for seizing a secondary subgroup containing an idle selector link extending thereto from the calling primary subgroup and containing an idle outgoing trunk assigned to the called numerical group, means thereupon operable for restoring all operated trunk relays in the seized subgroup except the one associated with the last-named idle trunk, and means controlled by the unrestored relay for directing the said extension of the calling line.

20. In a switching system, lines divided into pairs, a group of selective switches having common access to said lines, select magnets corresponding respectively to said pairs of lines, each select magnet having windings corresponding respectively to the lines of the corresponding pair, means for closing an energizing circuit for any one of said windings, means including the concerned select magnet responsive to such closure for selecting the corresponding line in all idle switches without the cooperation of any other select magnet, subject to such corresponding line being a first line of its said pair, means including the concerned select magnet and an additional select magnet responsive to such closure for cooperatively selecting the corresponding line in all

idle switches, subject to such corresponding line being the second line of its said pair, means for operating any idle switch, and means responsive thereto for making connection between the operated switch and the selected line.

21. In a switching system, lines divided into pairs, a group of selective switches having common access to said lines, pair-select magnets corresponding respectively to said pairs of lines, a line-select magnet corresponding to the second line of a pair, each pair-select magnet having first and second windings corresponding respectively to the first and second lines of the corresponding pair, said line-select magnet having a winding included in circuit with the second winding of each pair-select magnet and excluded from the circuit of each of the first windings, means for closing an energizing circuit for any one of said windings of the pair-select magnets, means responsive to such closure subject to such corresponding line being the first line of its said pair, for selecting the corresponding line in all idle switches, said selecting means comprising the concerned pair-select magnet acting without the cooperation of any other select magnet of the said group of switches, means for operating any idle switch, and means responsive thereto for making connection between the operated switch and the selected line.

22. In a switching system, lines divided into pairs, a group of selective switches having common access to said lines, pair-select magnets corresponding respectively to said pairs of lines, a line-select magnet corresponding to the second line of any pair, each pair-select magnet having first and second windings corresponding respectively to the first and second lines of the corresponding pair, a relay having a winding included in circuit with each first winding, said line-select magnet having a winding included in circuit with each second winding, means for closing an energizing circuit for any one of said windings of the pair-select magnets, means responsive to such closure, and including the concerned select magnet or select magnets, for selecting the corresponding line in all idle switches, first off-normal contacts controlled by any one of the pair-select magnets, second off-normal contacts controlled by the line-select magnet and by said relay, means controlled jointly by said first and second off-normal contacts for operating any idle switch, and means responsive thereto for making connection between the operated switch and the selected line.

23. In a switching system, lines divided into pairs, a group of selective switches having common access to said lines, pair-select magnets corresponding respectively to said pairs of lines, a relay corresponding to the first line of any pair, a line-select magnet corresponding to the second line of any pair, means for operating any pair-select magnet, without operating the line-select magnet, to select the first line of the corresponding pair, means for operating any pair-select magnet and the line-select magnet to select the second line of the corresponding pair, means for operating said relay along with any pair-select magnet when the line select magnet is not operated, first off-normal contacts controlled by any one of the pair-select magnets, second off-normal contacts controlled by the line-select magnet and by said relay, means controlled jointly by said first and second off-normal contacts for operating any idle switch, and means responsive thereto for making connection between the operated switch and the selected line.

24. In a switching system, a group of selective switches, first lines and second lines accessible to all said switches, line-select magnets corresponding respectively to the first lines and corresponding respectively to the second lines, a group-select magnet, means for operating any line-select magnet alone to select the corresponding first line and for operating any line-select magnet and the group-select magnet to select the corresponding second line, first off-normal contacts controlled by the line-select magnets, second off-normal contacts controlled by the group-select magnet, an off-normal circuit controlled by said first and second off-normal contacts jointly when a second line is selected, means effective when a first line is selected for enabling the first off-normal contacts to control the off-normal circuit without the cooperation of the second off-normal contacts, and means controlled over said off-normal circuit in either case for operating any idle one of said switches to make connection with the selected line.

25. In a switching system, a group of selective switches, first lines and second lines accessible to all said switches, line-select magnets corresponding respectively to the first lines and corresponding respectively to the second lines, a group-select magnet corresponding to the second lines, relays corresponding respectively to said lines, means for operating any relay when connection is to be made with the corresponding line, means responsive thereto for operating the corresponding line-select magnet, without the cooperation of any other select magnet of the said group of switches, to select the corresponding line provided it is a first line and for operating the corresponding line-select magnet and the group-select magnet to select the corresponding line provided it is a second line, and means for operating any idle one of said switches to make connection with the selected line.

26. In a switching system, a group of selective switches, first lines and second lines accessible thereto, line-select magnets corresponding respectively to said first lines and corresponding respectively to said second lines, a group-select magnet corresponding to the second lines, first off-normal contacts controlled by the line-select magnets, second off-normal contacts controlled by the group-select magnet, operate conductors for said select magnets respectively, a by-pass conductor for said second off-normal contacts, relays corresponding respectively to said lines, means for operating any desired relay, each relay including contact means for energizing the operate conductor of the corresponding line-select magnet, each relay corresponding to a first line also including means for energizing said by-pass conductor, each relay associated with a first line also including means for energizing the operate conductor for the group-select magnet, an off-normal circuit closed jointly by the first and second off-normal contacts when a first line is selected and closed jointly over the first off-normal contacts and the energized by-pass conductor when a first line is selected, and means responsive to closure of said off-normal circuit for operating any idle one of said switches to make connection with the selected line.

27. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and groups of trunks outgoing therefrom; primary switches for interconnecting said incoming trunks with selector links, secondary switches for interconnecting said selector links

with said outgoing trunks; said incoming trunks, said primary switches, and the primary end of said selector links, being divided into primary subgroups; the secondary end of said selector links, said secondary switches, and each of said groups of outgoing trunks, being divided into secondary subgroups; group chains associated respectively with the groups of outgoing trunks, each such chain having subgroup branches associated respectively with the primary subgroups, subgroup relays included in the subgroup branches respectively; subgroup chains associated respectively with the primary subgroups, each subgroup chain having trunk branches associated respectively with the trunks incoming to the associated primary subgroup, trunk relays included in the trunk branches respectively; means controlled over any calling incoming trunk for selecting any desired called group of outgoing trunks, means responsive thereto for interconnecting the local subgroup chain in series with the group chain associated with the called group, by way of the associated trunk branch of the calling-subgroup chain and the associated subgroup branch of the called-group chain, the trunk and subgroup relays included in the last-named branches thereupon operating subject to both concerned chains being closed by way of said branches in series; means controlled by the operated trunk relay for opening all other branches of the subgroup chain to preclude operation for the time being of any further trunk relays in the same subgroup chain and for individualizing the calling trunk with the associated primary subgroup; means controlled by the operated subgroup relay for individualizing the calling primary subgroup with the called group of trunks and for opening all other branches of the group chain to preclude operation for the time being of any further subgroup relays in the same group chain; means responsive to the said operation of a trunk relay and a subgroup relay for selecting an idle trunk in the called group, which is in a secondary subgroup containing an idle selector link extending thereto from the calling primary subgroup; and means controlled by the operated trunk and subgroup relays for operating a primary switch in the calling primary subgroup and a secondary switch in the last-named secondary subgroup, to interconnect the calling trunk with the selected outgoing trunk by way of said idle selector link.

28. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and groups of trunks outgoing therefrom; primary switches for interconnecting said incoming trunks with selector links, secondary switches for interconnecting said selector links with said outgoing trunks; said incoming trunks, said primary switches, and the primary end of said selector links, being divided into primary subgroups; the secondary end of said selector links, said secondary switches, and each of said groups of outgoing trunks, being divided into secondary subgroups; each outgoing group including subgroup relays associated respectively with the primary subgroups; each primary subgroup including trunk relays associated respectively with the trunks incoming to such subgroup; means controlled over any calling incoming trunk for selecting any desired called group of outgoing trunks, means responsive thereto for operating the concerned associated trunk and subgroup relays, means responsive to the said relay operation for selecting an idle trunk in the called group, which is in a secondary subgroup containing an idle selector link extending thereto from the calling primary subgroup; and means controlled by the operated trunk and subgroup relays for operating a primary switch in the calling primary subgroup and a secondary switch in the last-named secondary subgroup, to interconnect the calling trunk with the selected outgoing trunk by way of said idle selector link.

29. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and groups of trunks outgoing therefrom; primary switches for interconnecting said incoming trunks with selector links, secondary switches for interconnecting said selector links with said outgoing trunks; said incoming trunks, said primary switches, and the primary end of said selector links, being divided into primary subgroups; the secondary end of said selector links, said secondary switches, and each of said groups of outgoing trunks, being divided into secondary subgroups; each outgoing group including primary-subgroup relays associated respectively with the primary subgroups and secondary-subgroup relays associated respectively with the secondary subgroups; each primary subgroup including incoming-trunk relays associated respectively with the trunks incoming to such subgroup, and each secondary subgroup including outgoing-trunk relays associated respectively with the trunks outgoing from such subgroup; means controlled over any calling incoming trunk for selecting any desired called group of outgoing trunks; means responsive thereto for operating the incoming-trunk relay associated with the calling trunk, for operating the primary-subgroup relay in the called group associated with the calling primary subgroup, for operating the outgoing-trunk relay associated with an idle trunk in the called group outgoing from a secondary subgroup containing an idle selector link extending thereto from the calling primary subgroup, and for operating the secondary-subgroup relay of the called group associated with such secondary subgroup; and means controlled jointly by the said operated relays from operating a primary switch in the calling primary subgroup and a secondary switch in the last-named secondary subgroup to interconnect the calling trunk with the said idle outgoing trunk by way of said idle selector link.

30. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into secondary subgroups; the selector links being so spread amongst the primary and secondary subgroups that each primary subgroup contains selector links extending respectively to the secondary subgroups, and each secondary subgroup contains selector links incoming respectively from the primary subgroups; the outgoing trunks being divided into numerical groups, each numerical group containing trunks outgoing from a plurality of secondary subgroups, and each secondary subgroup containing trunks outgoing to a plurality of numerical groups; groups of link-test relays, said groups being associated respectively with said numerical groups of outgoing

trunks; means controlled over any calling incoming trunk for selecting any desired numerical group, means responsive thereto for associating the selector links outgoing from the concerned primary subgroup respectively with link-test relays in the group associated with the selected numerical group; and control means including the last-named link-test relays for operating a primary switch and a secondary switch to extend the calling trunk by way of an idle selector link to an idle trunk in the selected numerical group.

31. In a switching stage having a group of lines incoming thereto, links thereat, and a group of lines outgoing therefrom; primary switches for interconnecting the incoming lines with the links, secondary switches for interconnecting the links with the outgoing lines; the incoming lines, the primary switches, and the primary end of the links being divided into primary subgroups; the outgoing lines, the secondary switches, and the secondary end of the links, being divided into secondary subgroups; the links being so spread amongst the primary and secondary subgroups that each primary subgroup contains links extending respectively to the secondary subgroups, and each secondary subgroup contains links incoming respectively from the primary subgroups, the order in which the links outgoing from a primary subgroup to the secondary subgroup are spread varying amongst the primary subgroups; a group of link-test relays assigned to the secondary subgroups, there being as many assigned to any secondary subgroup as there are links incoming to such subgroup from any primary subgroup; means controlled over any calling line in any primary subgroup for connecting the links outgoing from such primary subgroup respectively to relays of said link-test group in accordance with the assignment of the link-test relays to the secondary subgroups, and in accordance with the order in which the last-named links are spread amongst the secondary subgroups; and control means including the connected link-test relays for selecting an idle link extending from the calling primary subgroup to a subgroup containing an idle outgoing line, and for operating a primary switch and a secondary switch for extending the calling line to said idle outgoing line by way of said idle link.

32. In a selector switching stage having a group of trunks incoming thereto, selector links thereat, and a group of trunks outgoing therefrom; primary switches for interconnecting the incoming trunks with the selector links, secondary switches for interconnecting the selector links with the outgoing trunks; the incoming trunks, the primary switches, and the primary end of the selector links being divided into primary subgroups; the outgoing trunks, the secondary switches, and the secondary end of the selector links, being divided into secondary subgroups; each of said numerical groups having a separate two-digit number assigned thereto, means for taking any incoming trunk for use and for transmitting the two digits of any said assigned number thereover; and control means responsive to such transmission for operating a primary switch and a secondary switch to extend the calling trunk, by way of an idle selector link, to an idle trunk in the numerical group to which the transmitted number is assigned.

33. In combination, a plurality of selectors, means for taking any one of said selectors for use and for transmitting any one of a plurality of two-digit numbers thereto, control conductors multipled to all said selectors and corresponding respectively to said numbers, means in any selector responsive to the transmission thereto of any of said numbers for selecting the corresponding control conductor, each selector including connecting means operable to make a control connection with the selected control conductor, and means responsive to the operation of said connecting means in any said selector for preventing operation thereof in any other said selector.

34. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; group controllers corresponding respectively to said numerical groups; means controlled over any calling first-order trunk for selecting any desired numerical group, means responsive thereto for associating the calling trunk individually with the corresponding group controller irrespective of whether or not other calling trunks are contemporaneously similarly associated with other group controllers; and means controlled by said corresponding group controller for operating the concerned switches to extend the calling trunk, by way of an idle selector link, to an idle trunk in any subgroup of second order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group.

35. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; group controllers corresponding respectively to said numerical groups, means controlled over any calling first-order trunk for selecting any desired numerical group, means responsive thereto for associating the calling trunk individually with the corresponding group controller; test relays individual respectively to all said second-order trunks; and means controlled by said corresponding group controller, in cooperation with concerned ones of said test relays, for operating the concerned switches to extend the calling trunk, by way of an idle selector link, to an idle trunk in any subgroup of second-order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group.

36. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; group controllers corresponding respectively to said numerical groups, each group controller having test connections therefrom to the trunks in the corresponding numerical group, such test connections for any group controller being individual thereto, means controlled over any calling first-order trunk for selecting any desired numerical group, means responsive thereto for associating the calling trunk individually with the corresponding group controller; and means controlled by said group controller for operating the concerned switches to extend the calling trunk, by way of an idle selector link, to an idle trunk in any subgroup of second-order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group.

37. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; means controlled over any calling first-order trunk for selecting any desired numerical group, means responsive thereto for operating the concerned switches to extend the calling trunk, by way of an idle selector link, to an idle trunk in any subgroup of second-order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group; and means enabling the trunks in any second-order subgroup to be assigned to the numerical groups in any desired order and proportion irrespective of the order and proportion in which the trunks in the other second-order subgroups are assigned to the numerical groups.

38. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; means controlled over any calling first-order trunk for selecting any desired numerical group, means responsive thereto for operating the concerned switches to extend the calling trunk, by way of an idle selector link, to an idle trunk in any subgroup of second-order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group; and means enabling all second-order trunks to be assigned to any desired number of numerical groups and to be assigned in any desired order and proportion.

39. In a selector switching stage having first-order trunks incoming thereto and divided into subgroups, selector links thereat, and second-order trunks outgoing therefrom and divided into subgroups; switches for interconnecting the incoming trunks with the selector links, and for interconnecting the selector links with the outgoing trunks; selector links assigned to any subgroup of one order of trunks having common access, through concerned ones of said switches, to the trunks comprising such subgroup, and having access individually, through concerned ones of said switches, to separate ones of said subgroups of the other order of trunks; the second-order trunks being further divided into numerical groups each containing trunks outgoing from a plurality of said subgroups of such trunks; means for selecting any desired numerical group and for identifying a first-order trunk, means responsive thereto for operating the concerned switches to extend the identified first-order trunk, by way of an idle selector link, to an idle trunk in any subgroup of second-order trunks, subject to any such second-order trunk being one which is outgoing to the selected numerical group, and means enabling all second-order trunks to be assigned to any desired number of numerical groups and to be assigned in any desired order and proportion.

40. In a switching stage having first-order lines terminating thereat and divided into subgroups, second-order lines terminating thereat and divided into subgroups, and links thereat in excess of the number of lines of either order; switching mechanism for interconnecting the first-order lines with the links, and for interconnecting the links with the second-order lines; links being assigned to any said subgroup in excess of the number of lines comprising such subgroup; all links assigned to any said subgroup having common access, through said mechanism, to the lines comprising such subgroup, each such link having access through said mechanism, to one of said subgroups of the other order of lines; and at least one link assigned to any said subgroup having access, through said mechanism, to any said subgroup of the other order of lines.

41. In a switching system, lines divided into pairs, a group of selective switches having common access to said lines, first selective means common to all said switches for physically selecting any pair of lines in all idle ones of said switches, second selective means for physically selecting either said line to the exclusion of the other in the pair selected in any switch, said second selective means having first and second positions corresponding respectively to the first

line and the second line of any said pair, restoring-spring means normally maintaining said second selective means in its said first position, electromagnet means operable to overcome said restoring-spring means to move said second selective means from its first position to its second position, means for predetermining the respective settings of the first and second selective means in accordance with the line to be selected, and means including electrical contacts controlled by the first and second selective means for operating an idle switch to connect with the selected line.

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