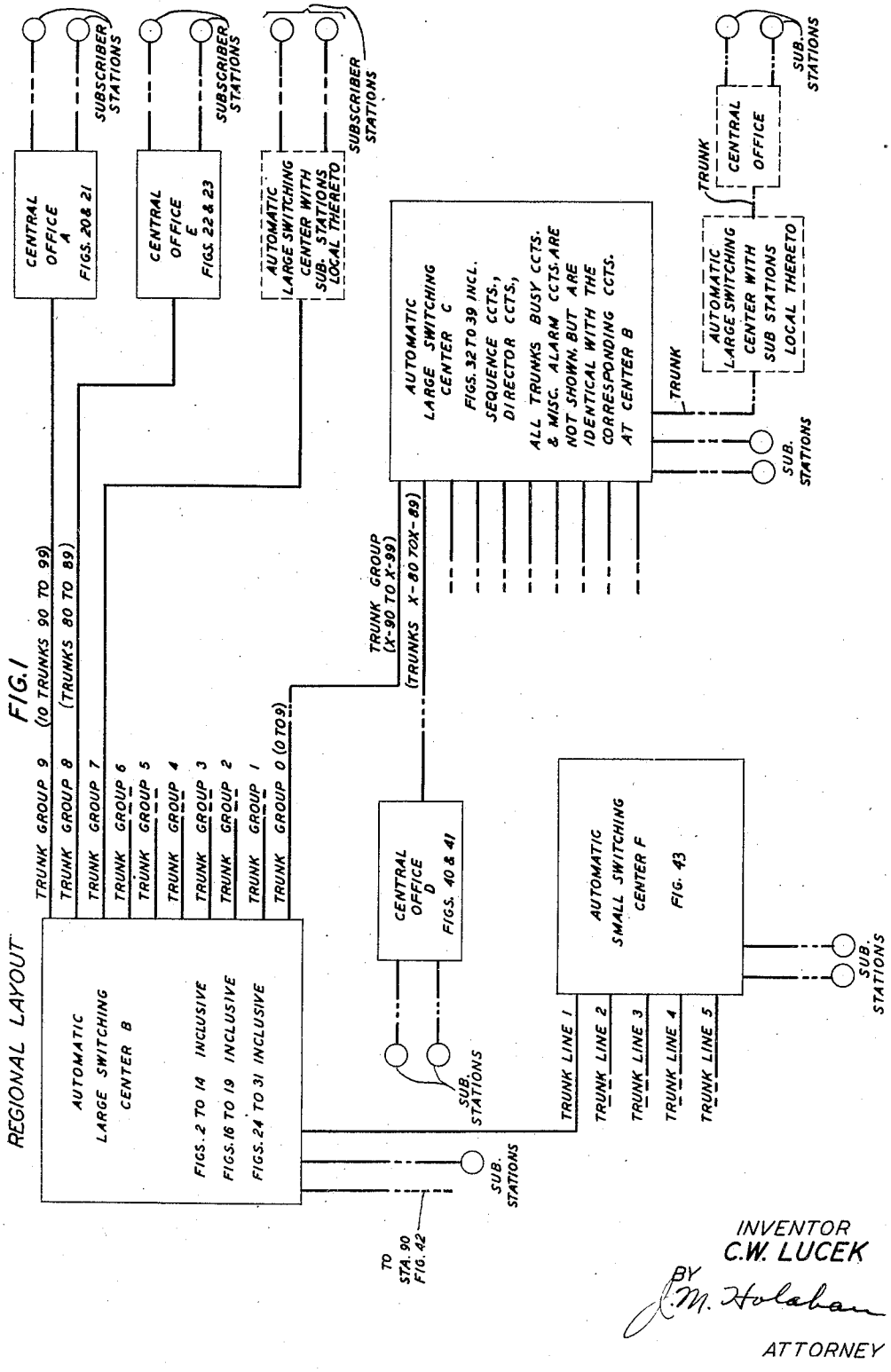
Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 1



INVENTOR
C.W. LUCEK
BY J.M. Holahan
ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 2

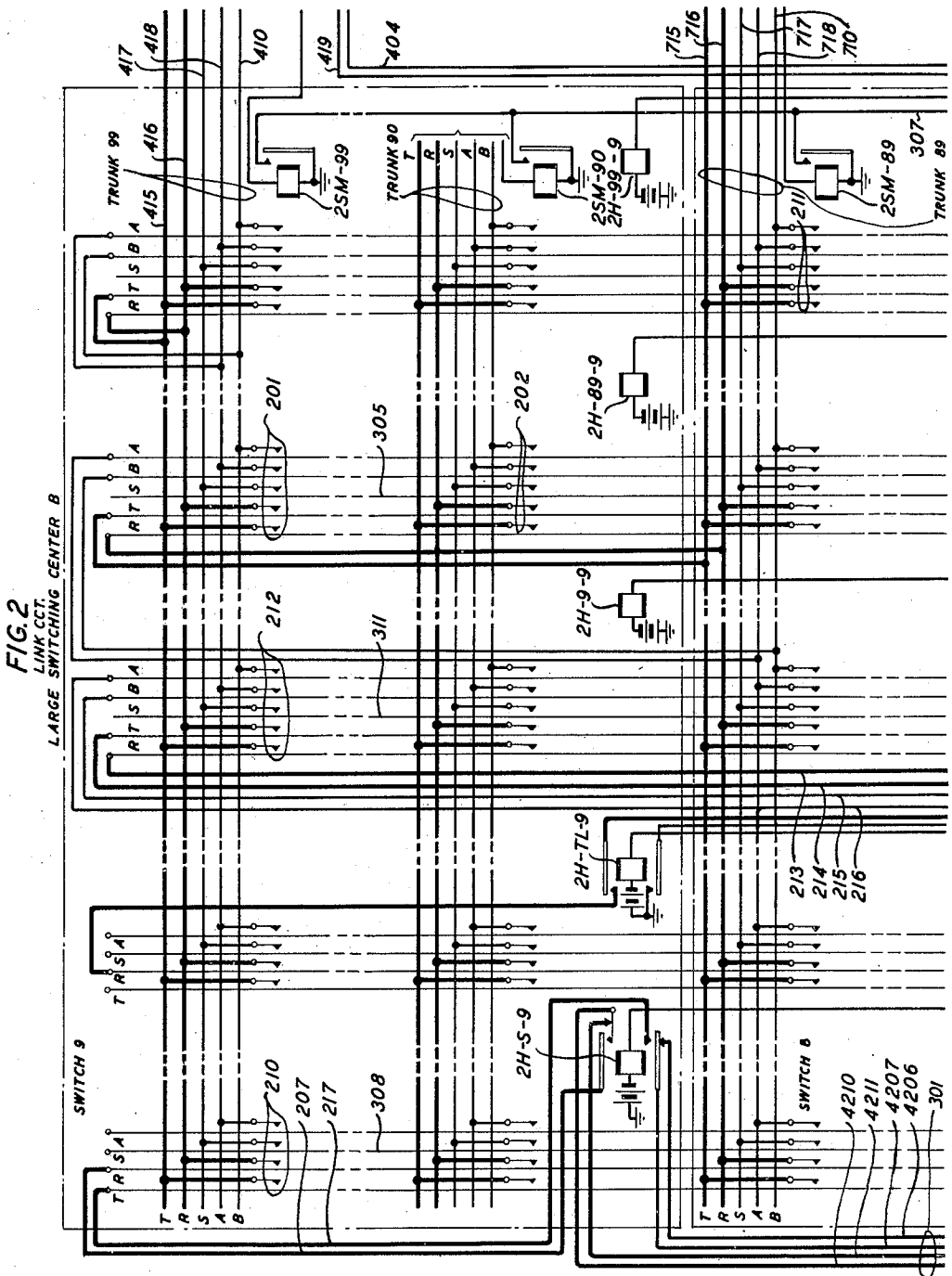


FIG. 2

INVENTOR
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TELETYPEWRITER SWITCHING SYSTEM

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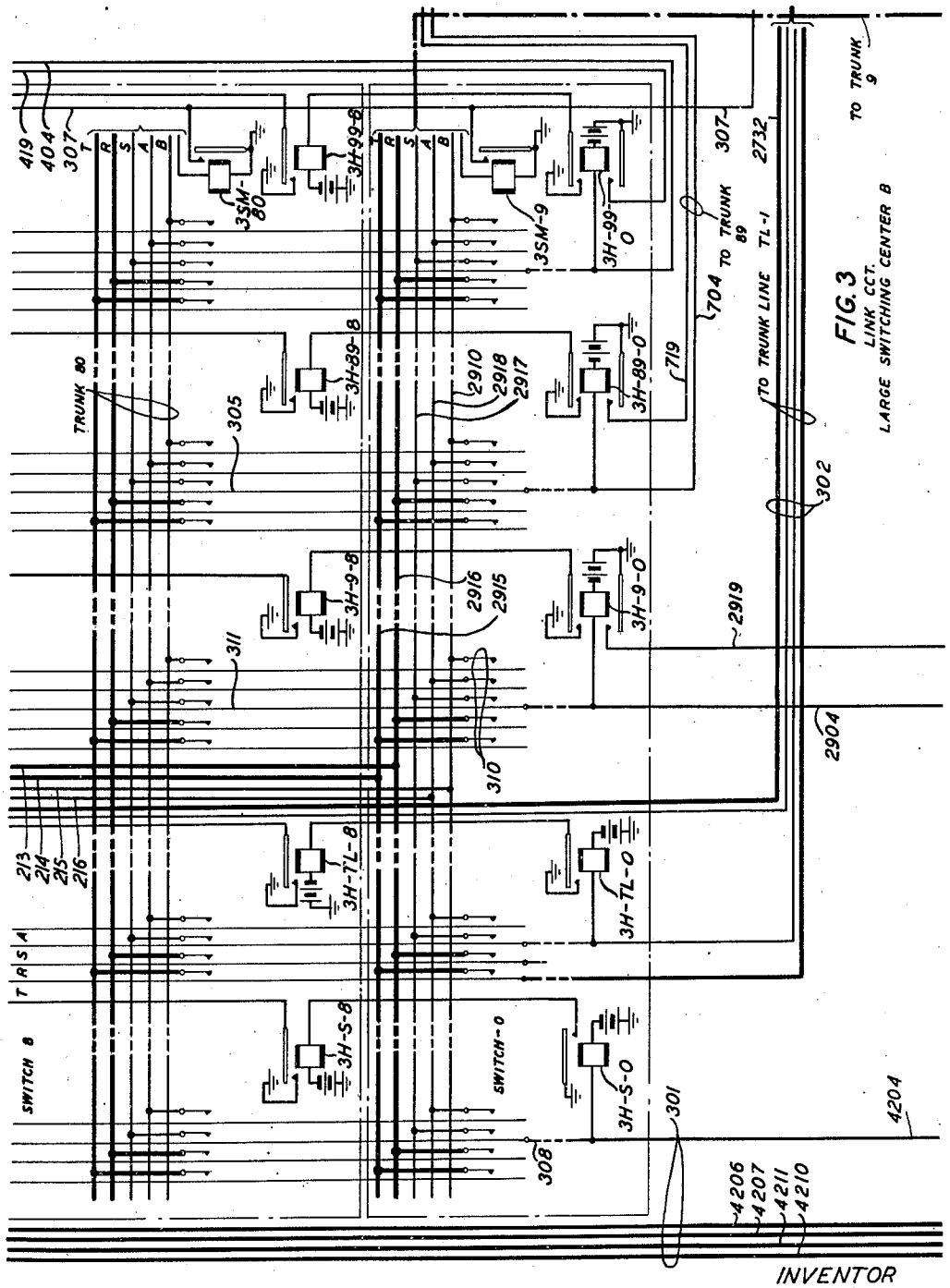

INVENTOR
C.W. LUCEK
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J. M. Holahan
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TELETYPEWRITER SWITCHING SYSTEM

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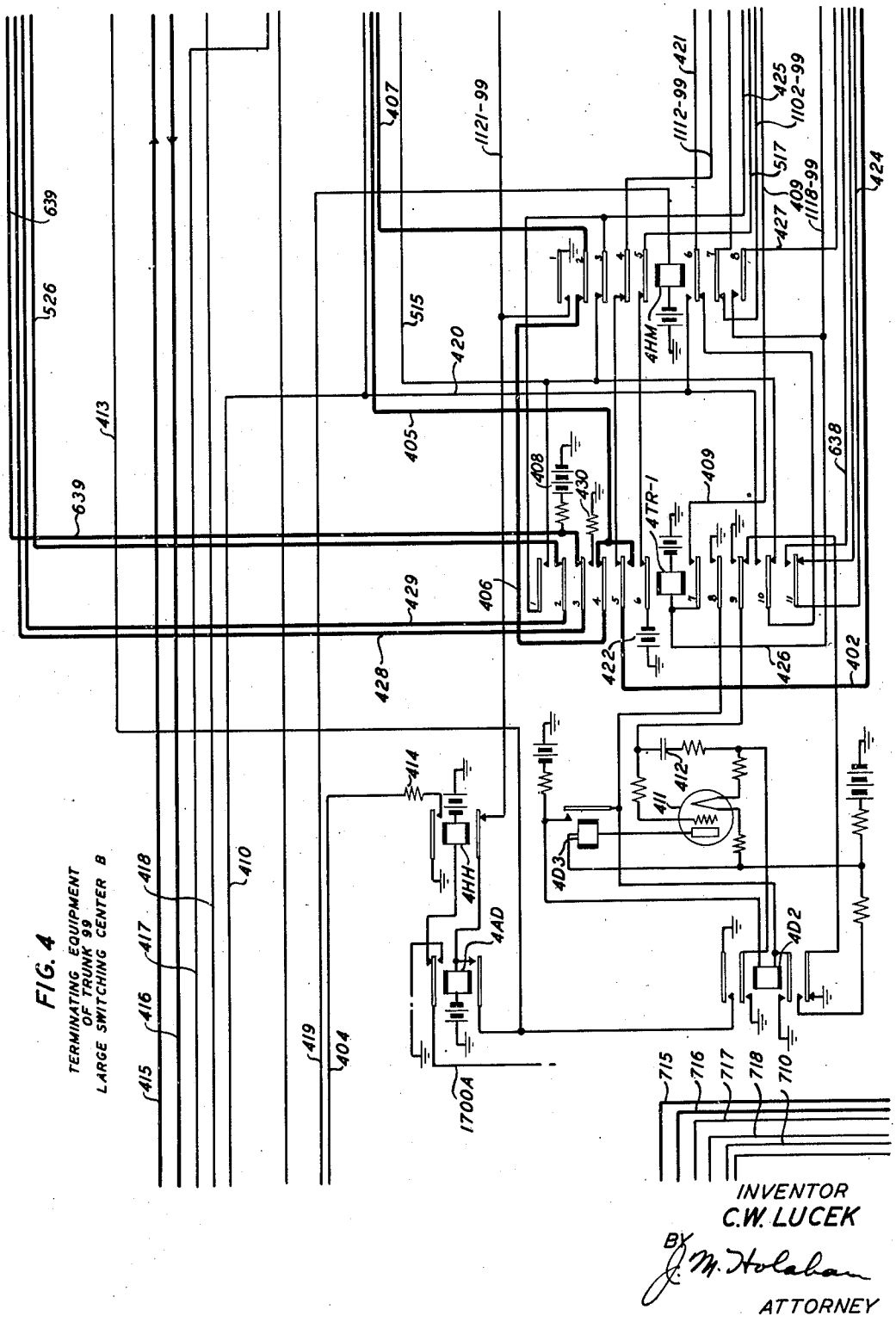

FIG. 4

TERMINATING EQUIPMENT OF TRUNK 99 LARGE SWITCHING CENTER B

INVENTOR
C.W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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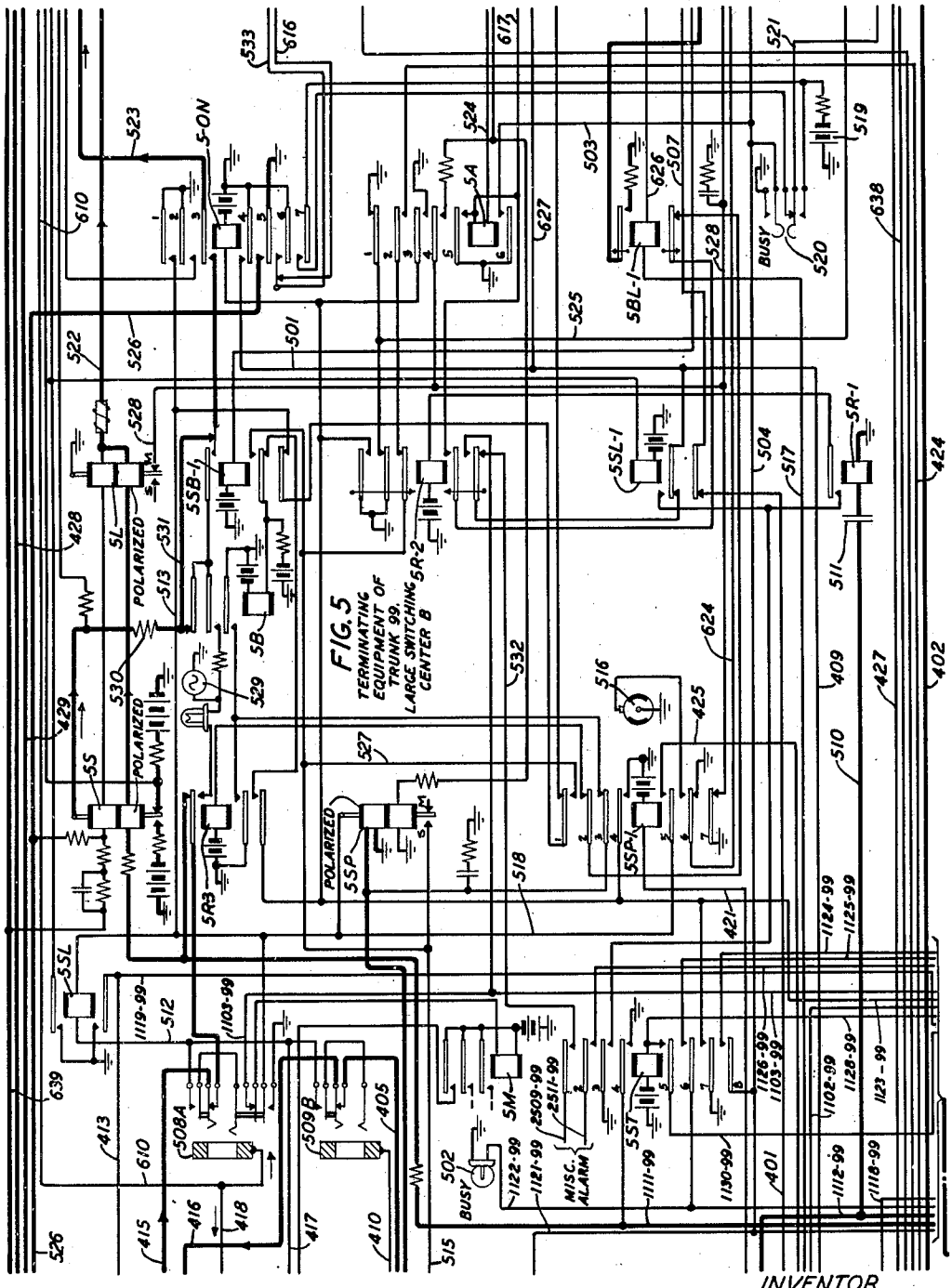

INVENTOR
C. W. LUCEK
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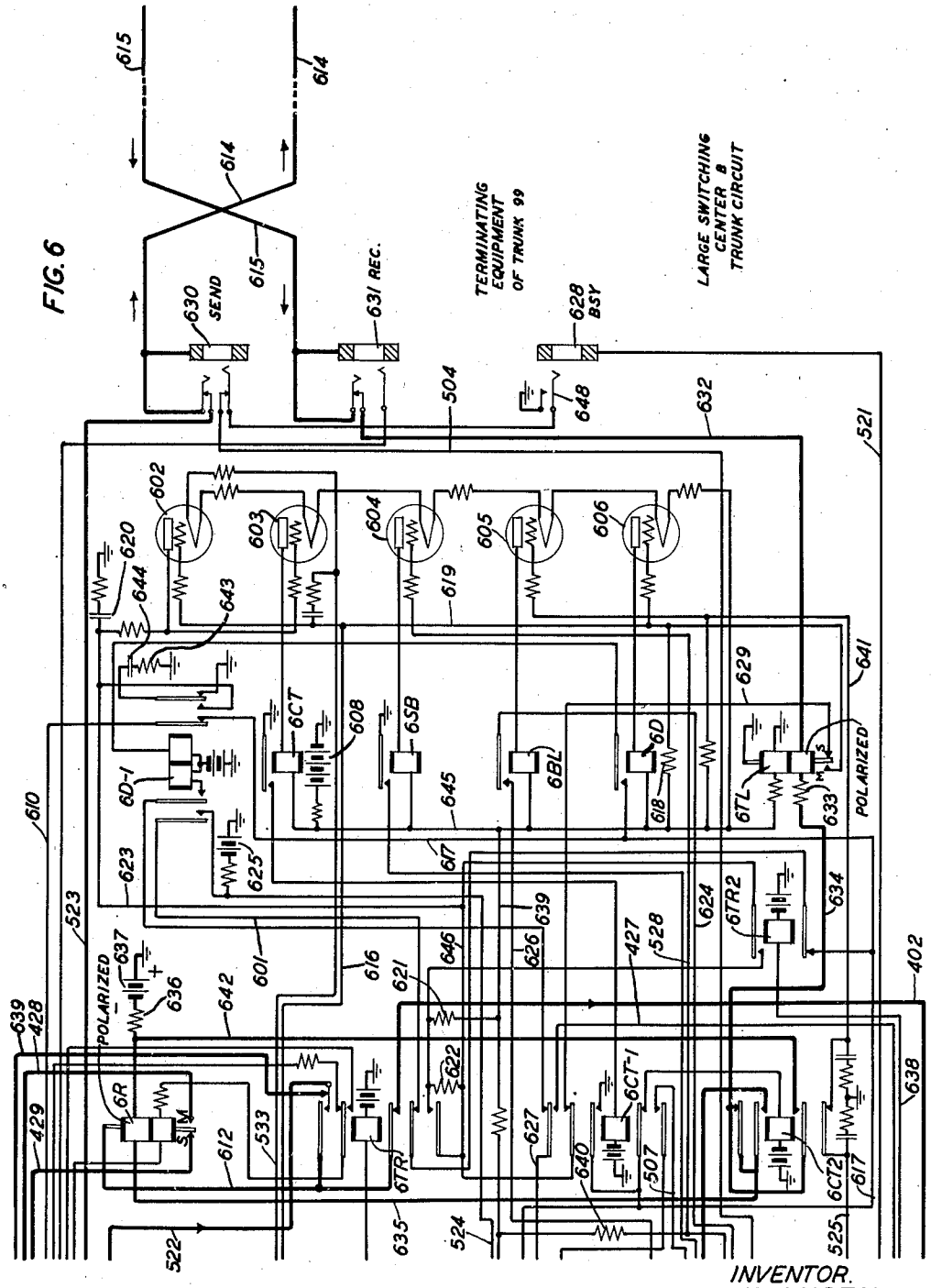
Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 6

FIG. 6



INVENTOR.
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BY J. M. Holahan
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TELETYPEWRITER SWITCHING SYSTEM

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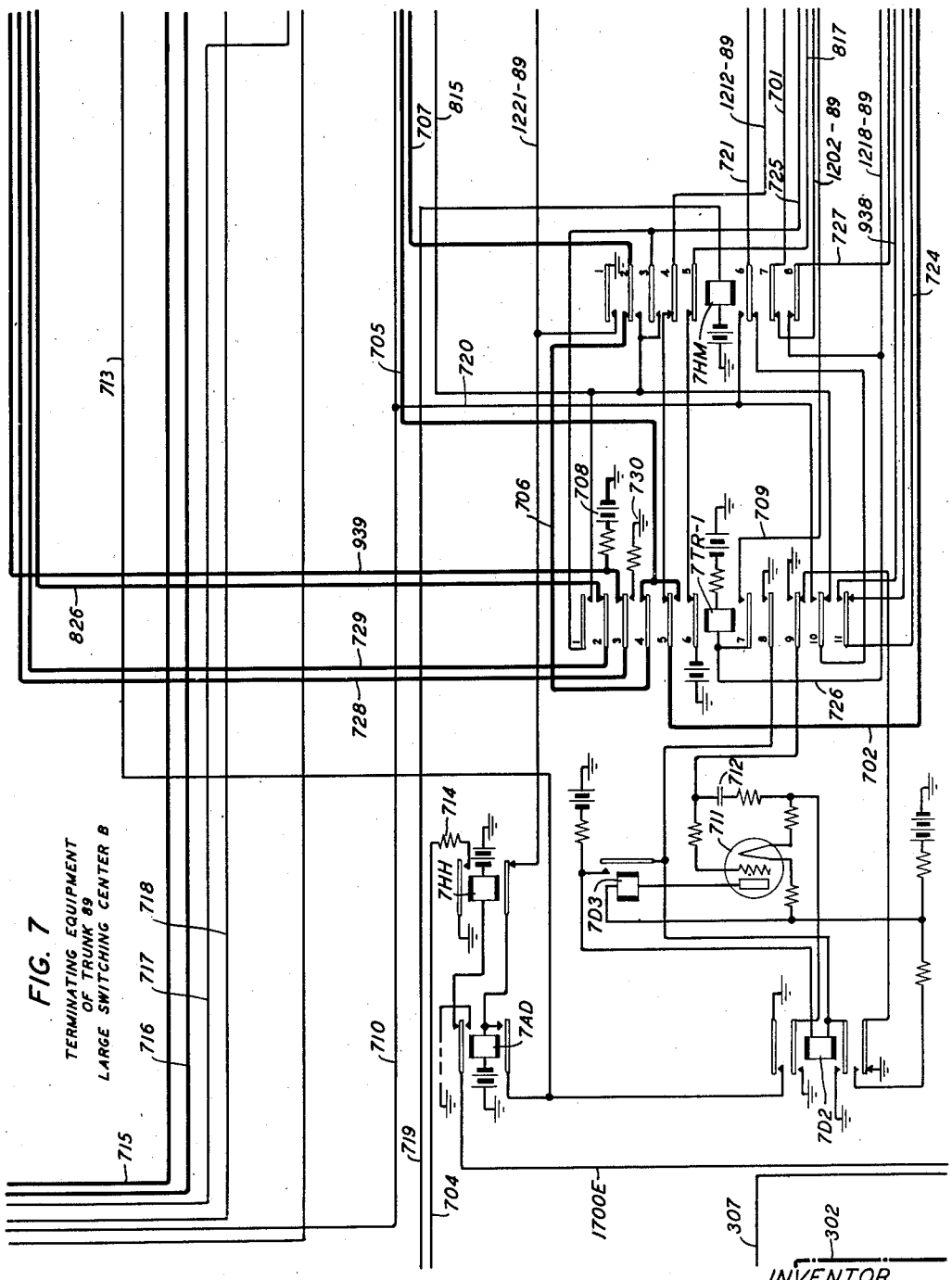

FIG. 7

TERMINATING EQUIPMENT OF TRUNK 89 LARGE SWITCHING CENTER B

INVENTOR
C. W. LUCEK

BY J. M. Holaban

ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

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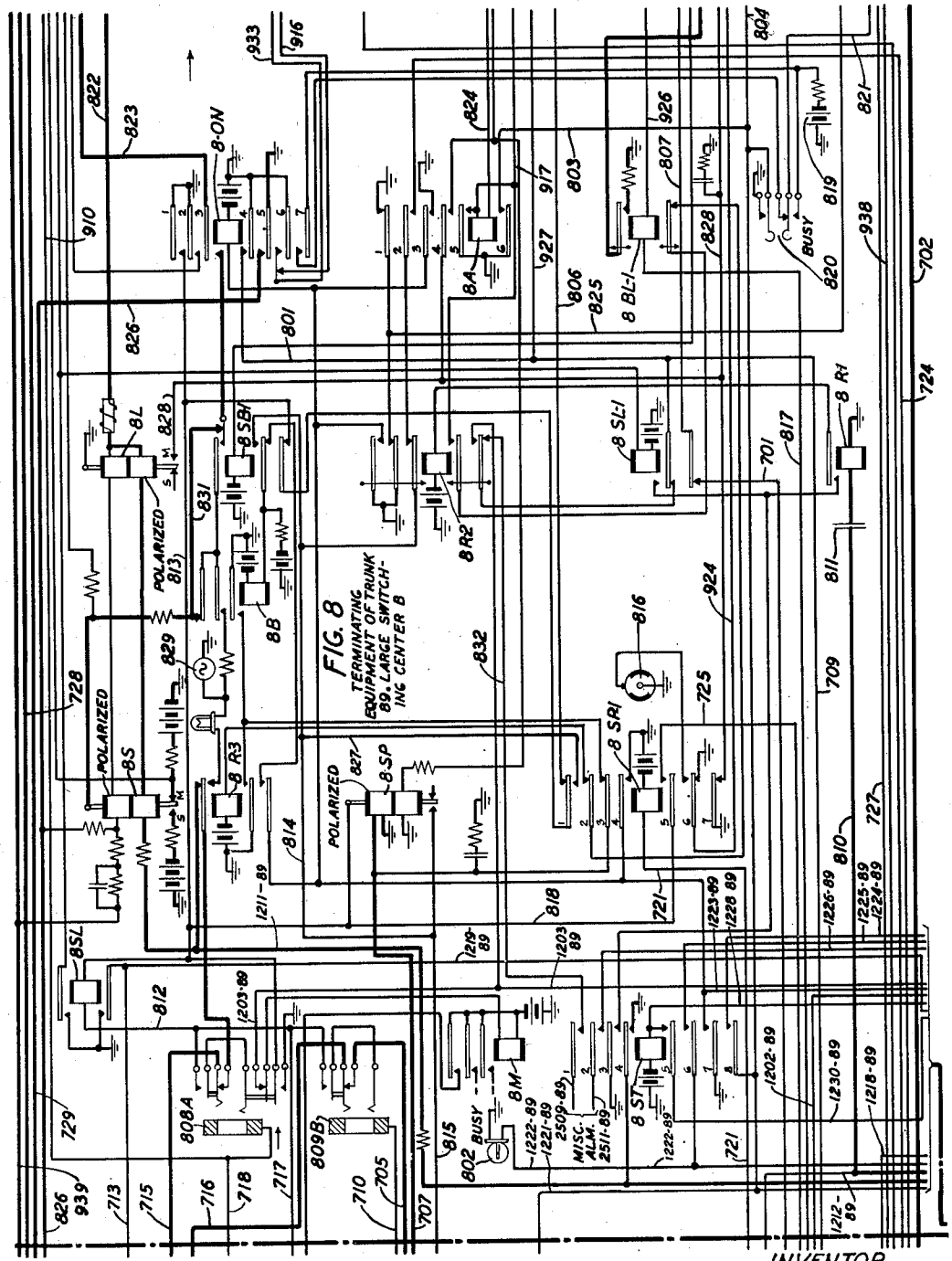
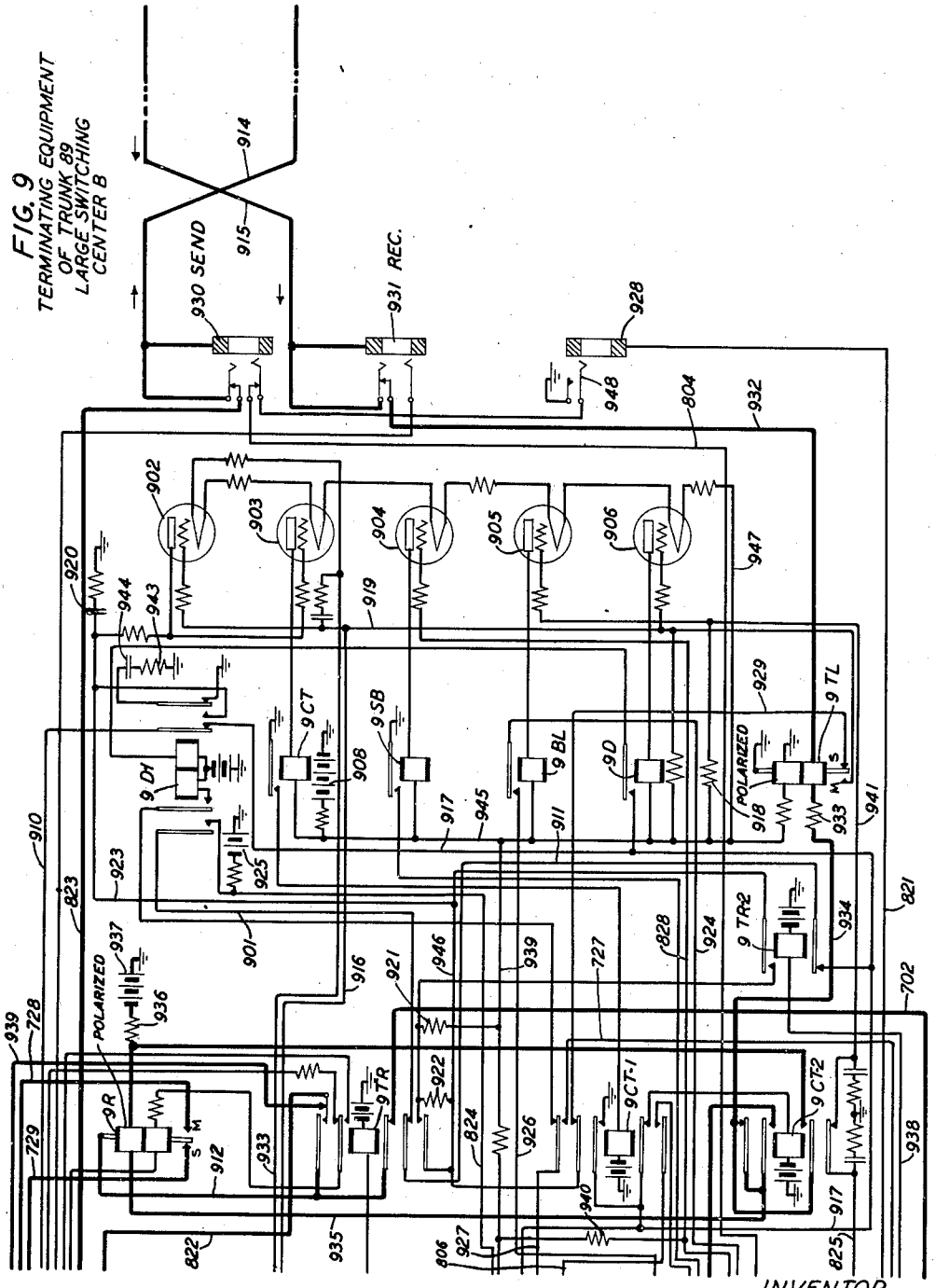


INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 9



INVENTOR
C. W. LUCEK

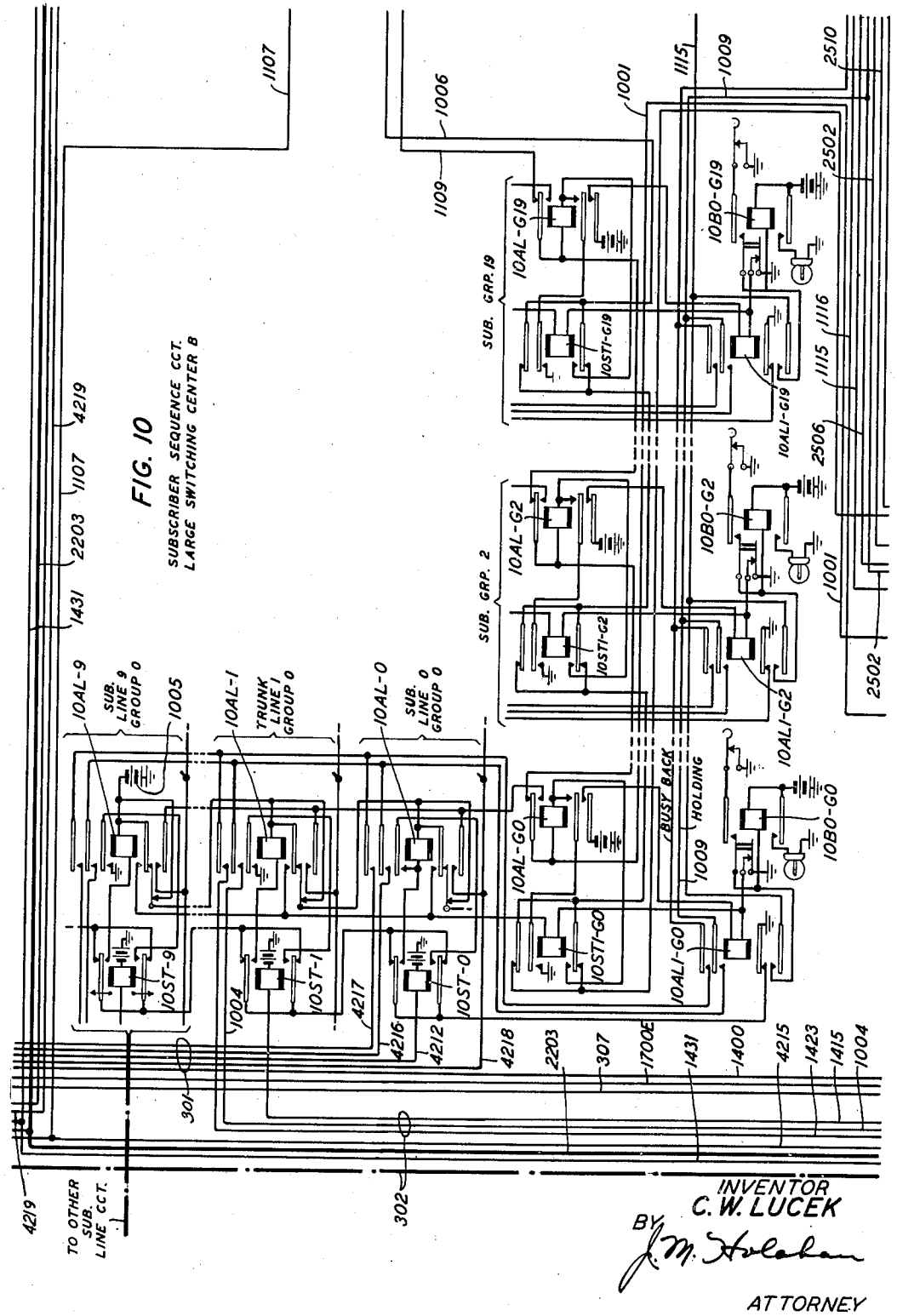
BY
J. M. Holaban

ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 10



INVENTOR
C. W. LUCEK
BY J. M. Hobbs
ATTORNEY

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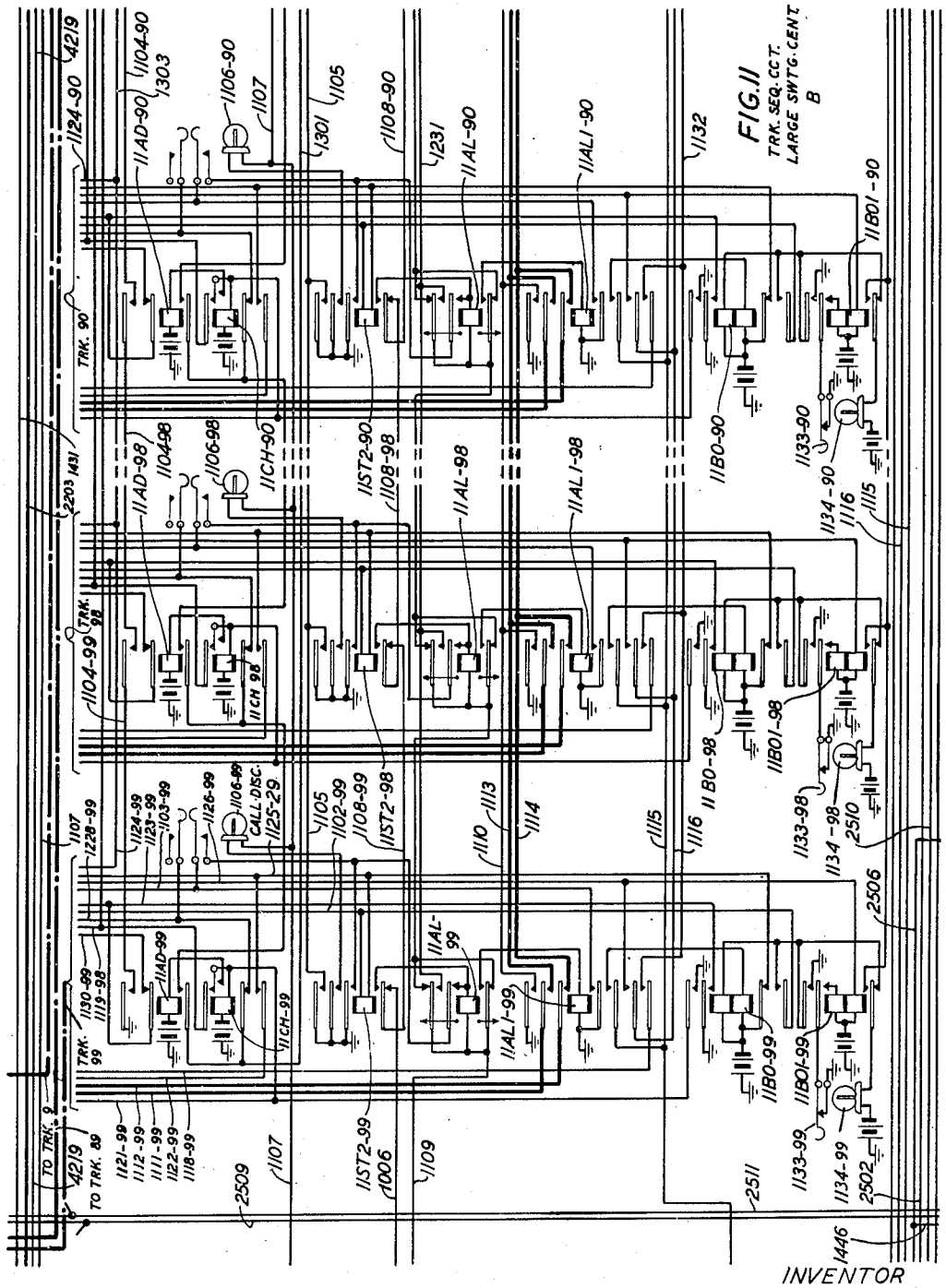
TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 11



INVENTOR
C. W. LUCEK
BY J. M. Holaban
ATTORNEY

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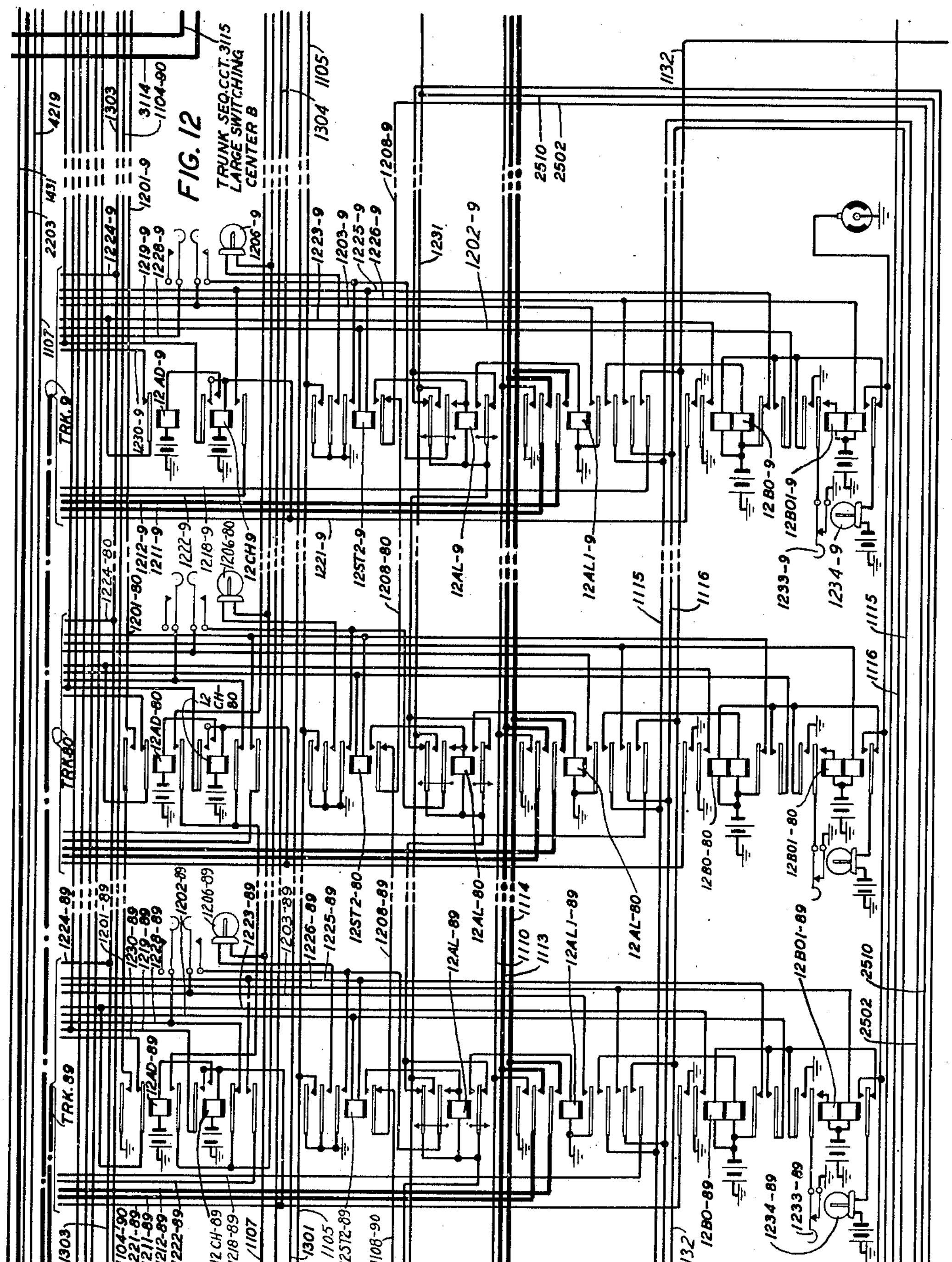
TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 12



INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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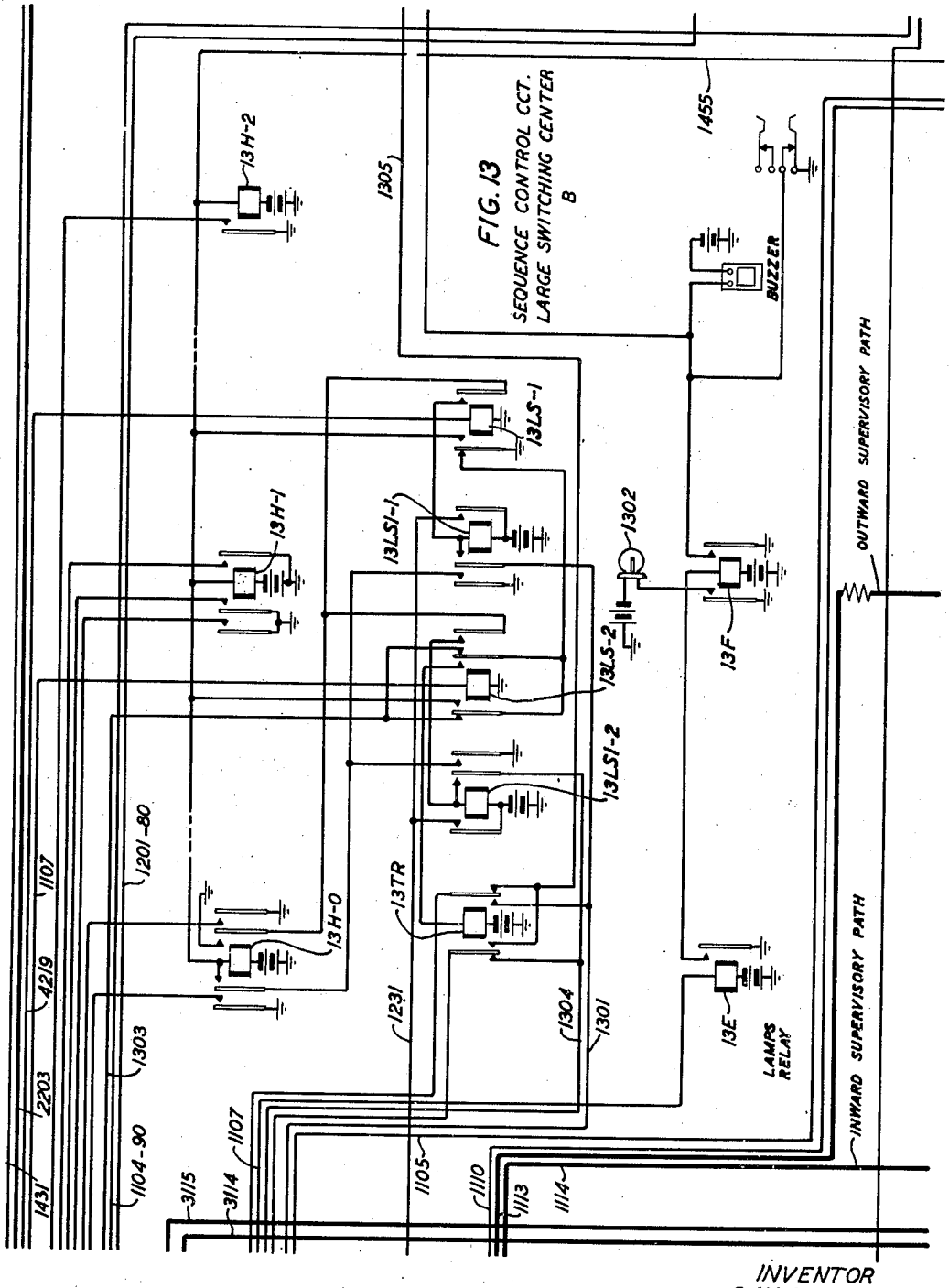
TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 13



INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 14

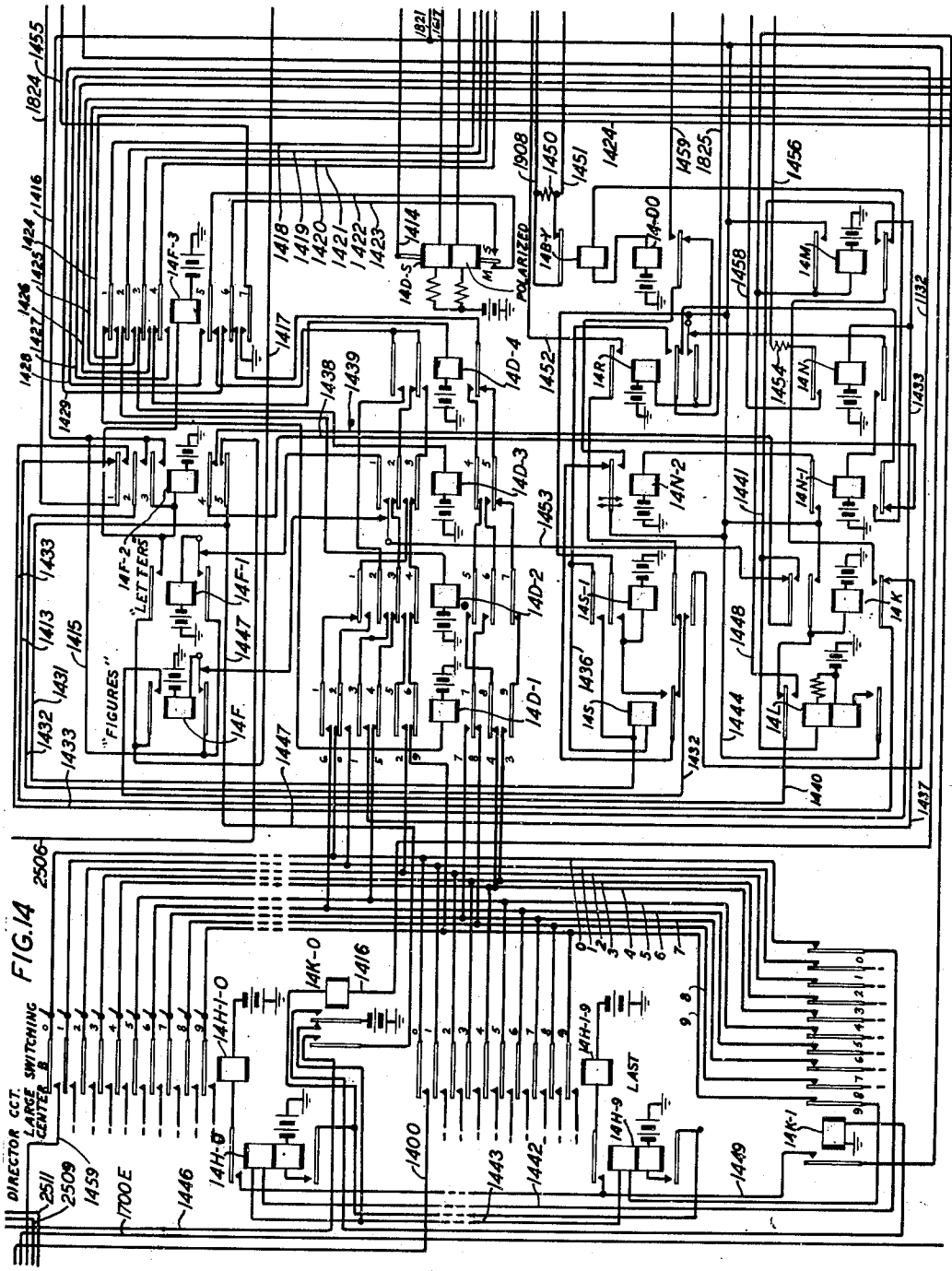

FIG. 14

INVENTOR
C. W. LUCEK
BY
J. M. Holcombe
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TELETYPEWRITER SWITCHING SYSTEM

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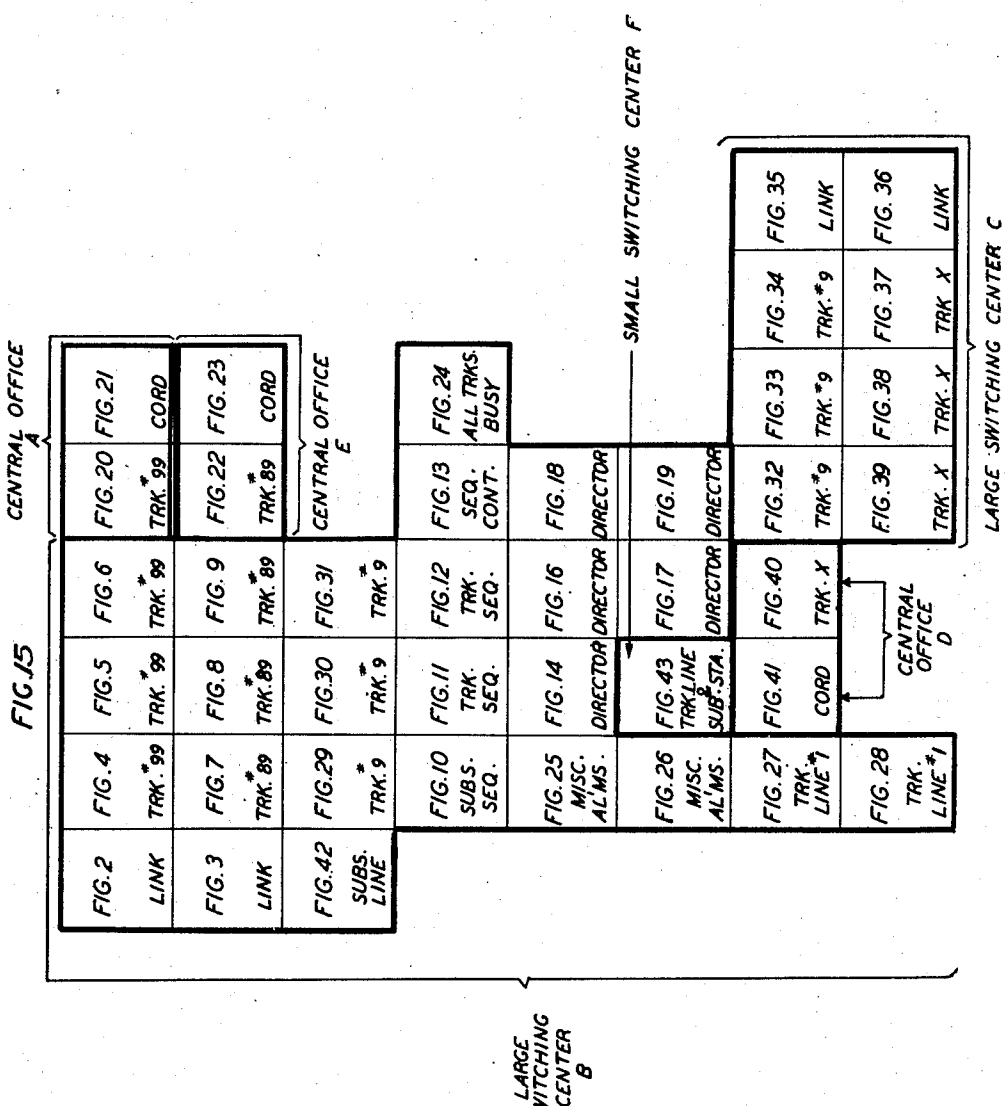

INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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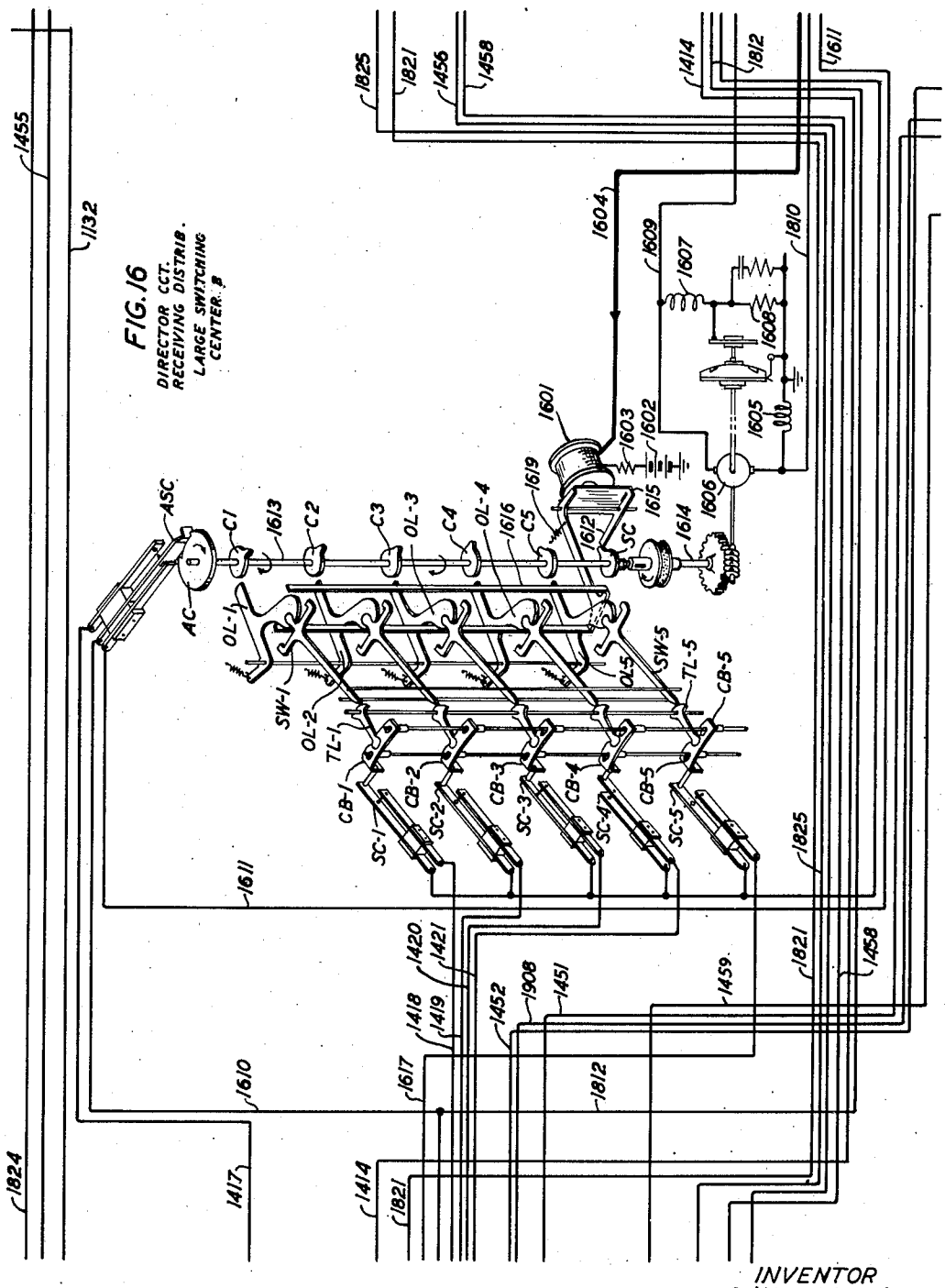

FIG. 16
DIRECTOR CCT. RECEIVING DISTRIB. LARGE SWITCHING CENTER. #

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BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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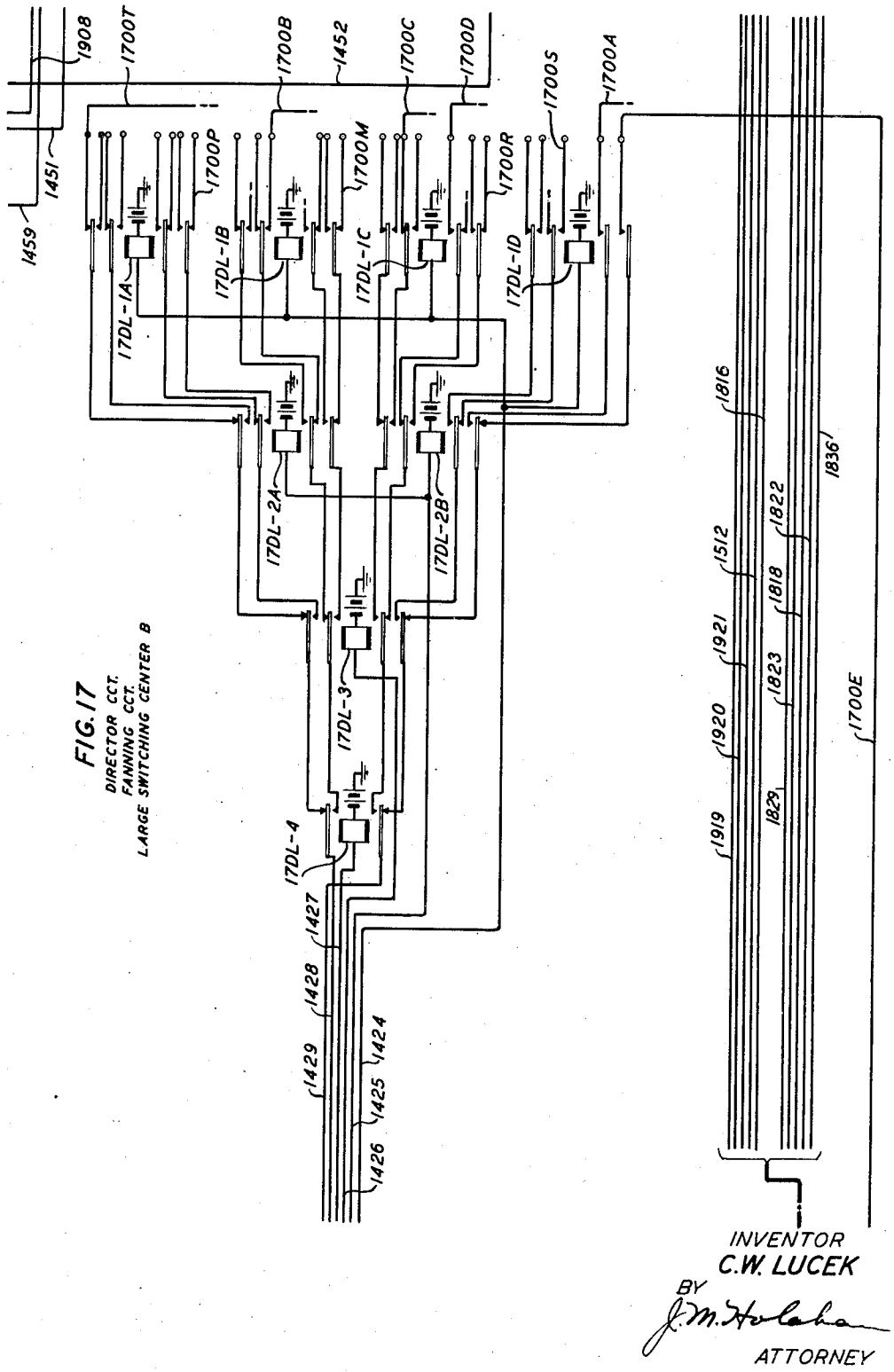

FIG. 17

DIRECTOR CCT.
FANNING CCT.
LARGE SWITCHING CENTER B

INVENTOR
C.W. LUCEK

BY
J.M. Holahan

ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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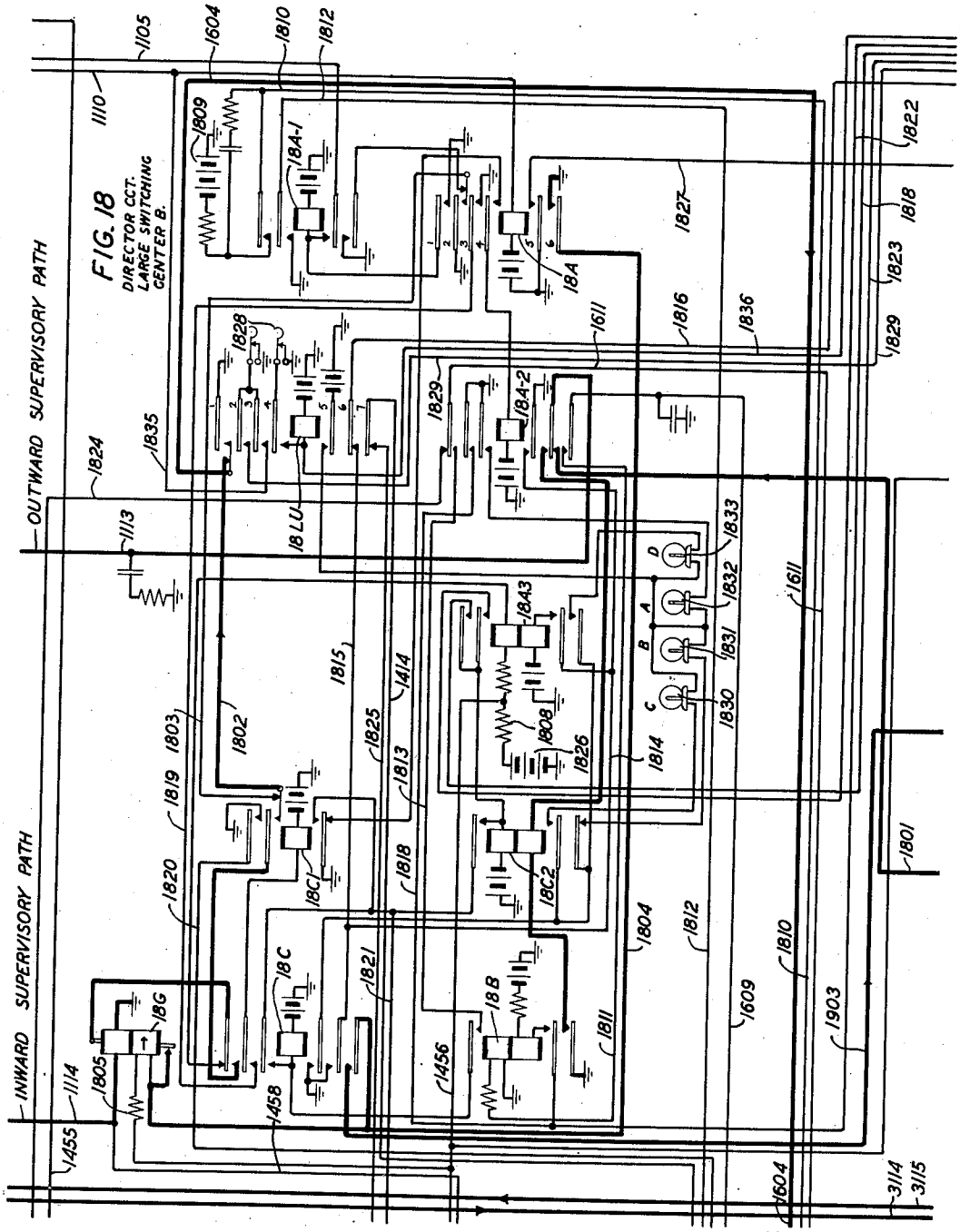

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C. W. LUCEK
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TELETYPEWRITER SWITCHING SYSTEM

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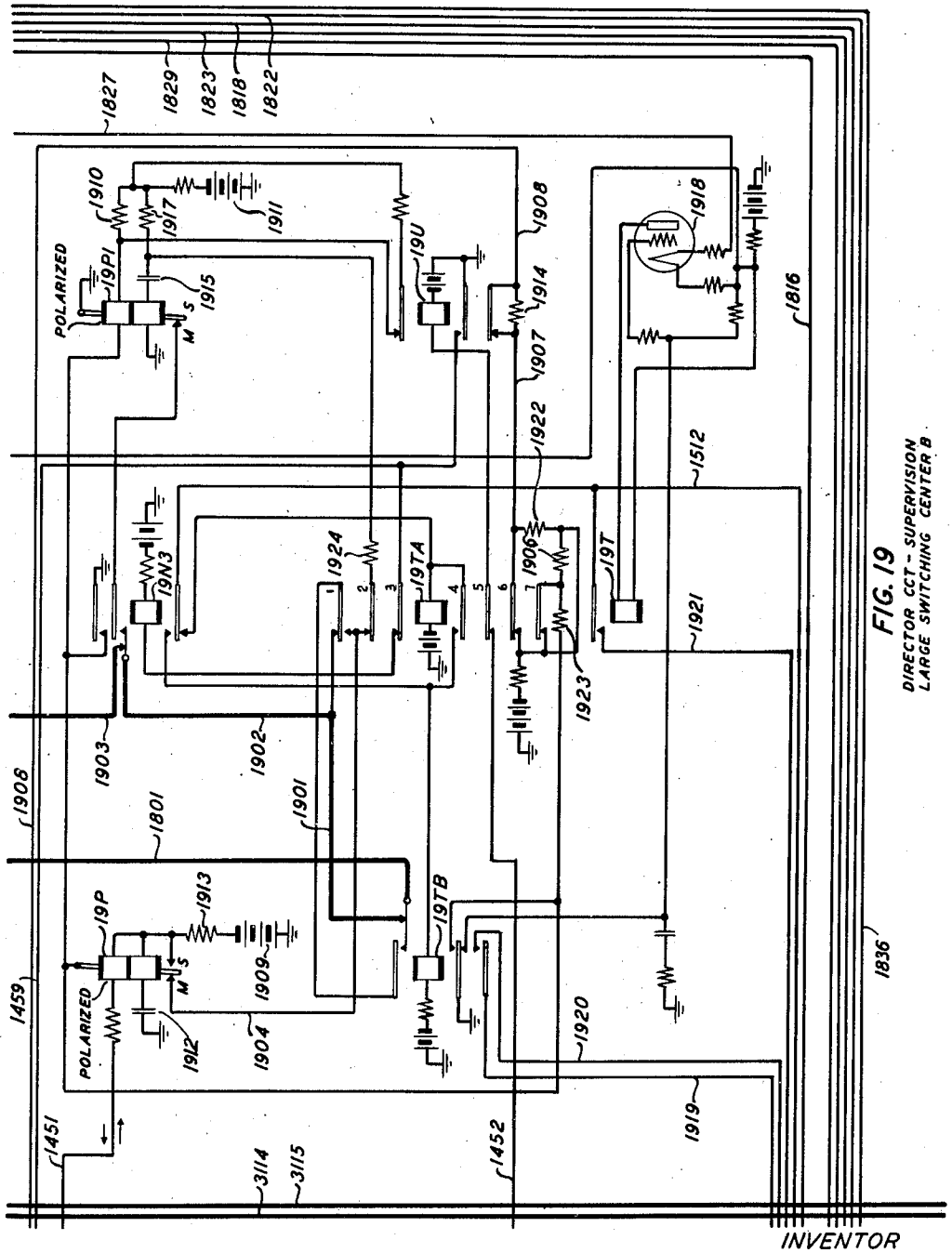

FIG. 19
DIRECTOR CCT - SUPERVISION
LARGE SWITCHING CENTER B

INVENTOR
C. W. LUCEK
BY
J. M. Hallaban
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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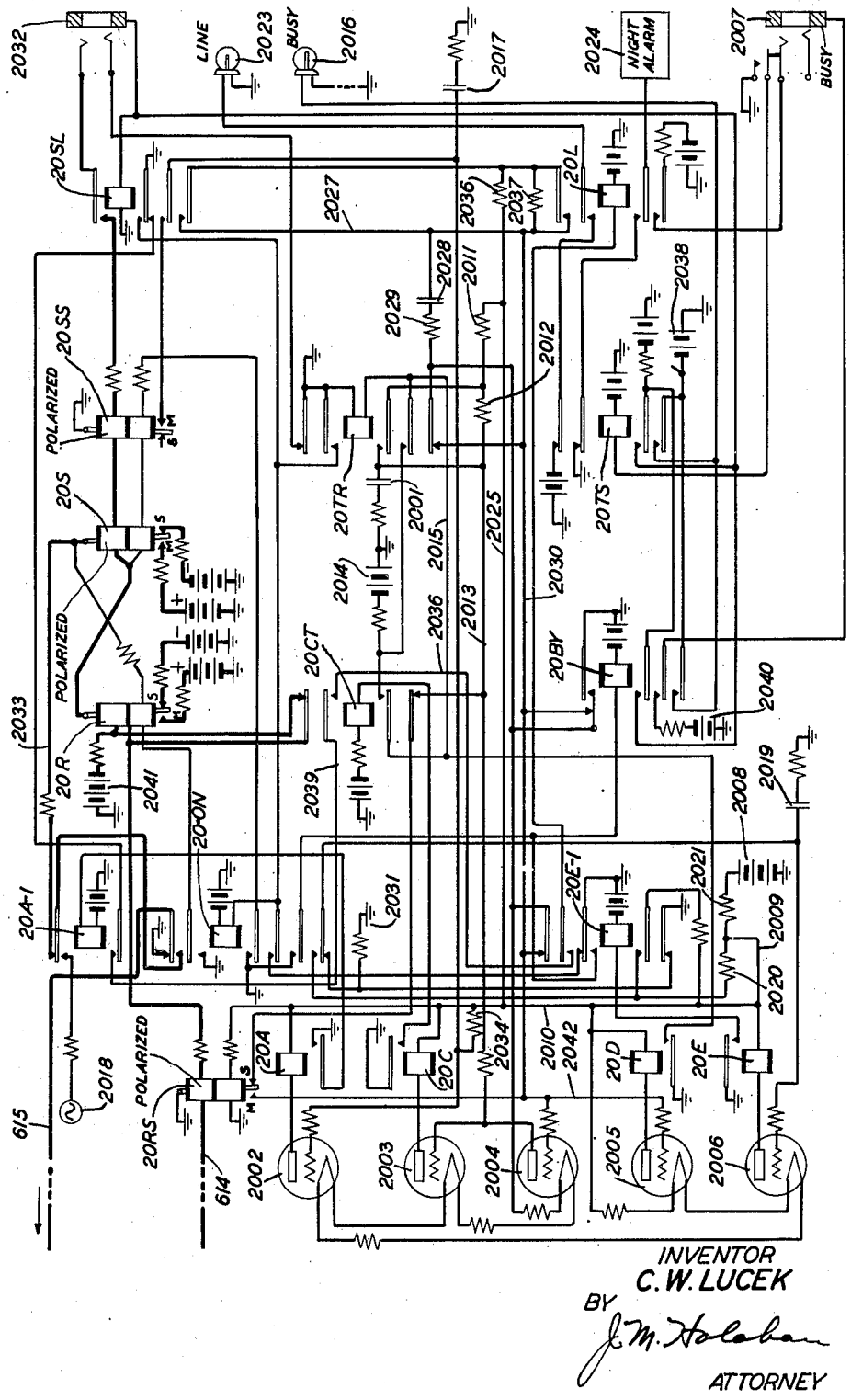

F/G. 20

INVENTOR
C. W. LUCEK
BY
J. M. Hoban
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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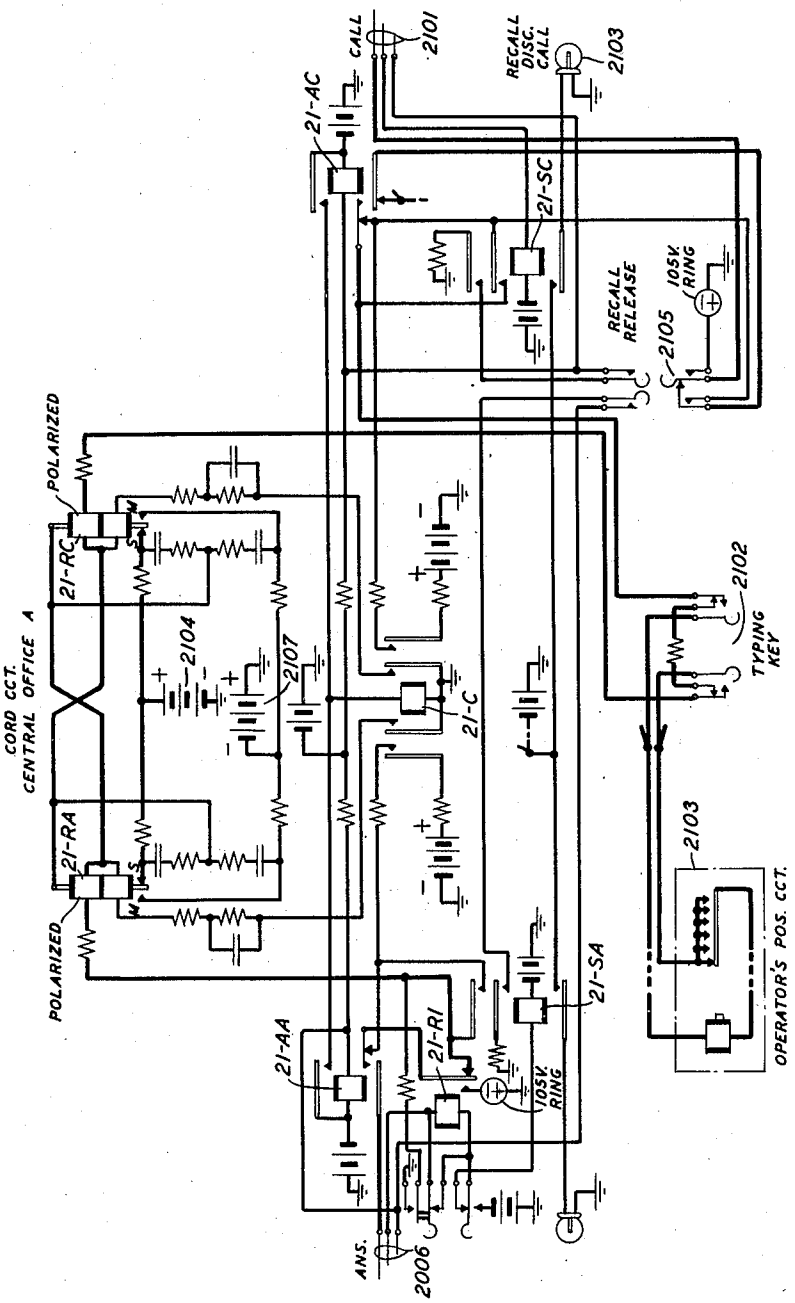

FIG. 21

INVENTOR
C. W. LUCEK
BY
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ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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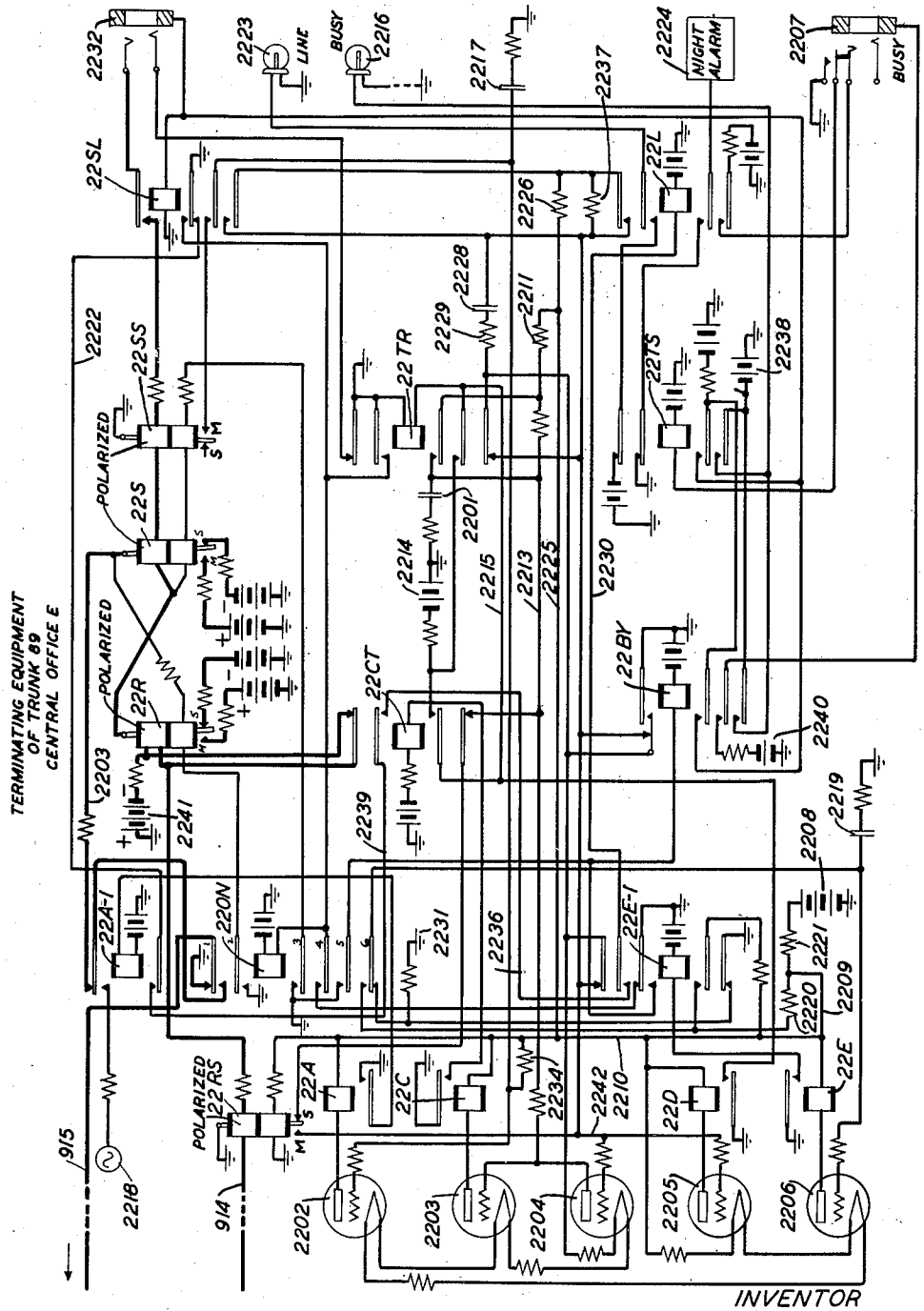

FIG. 22

TERMINATING EQUIPMENT OF TRUNK 89 CENTRAL OFFICE E

INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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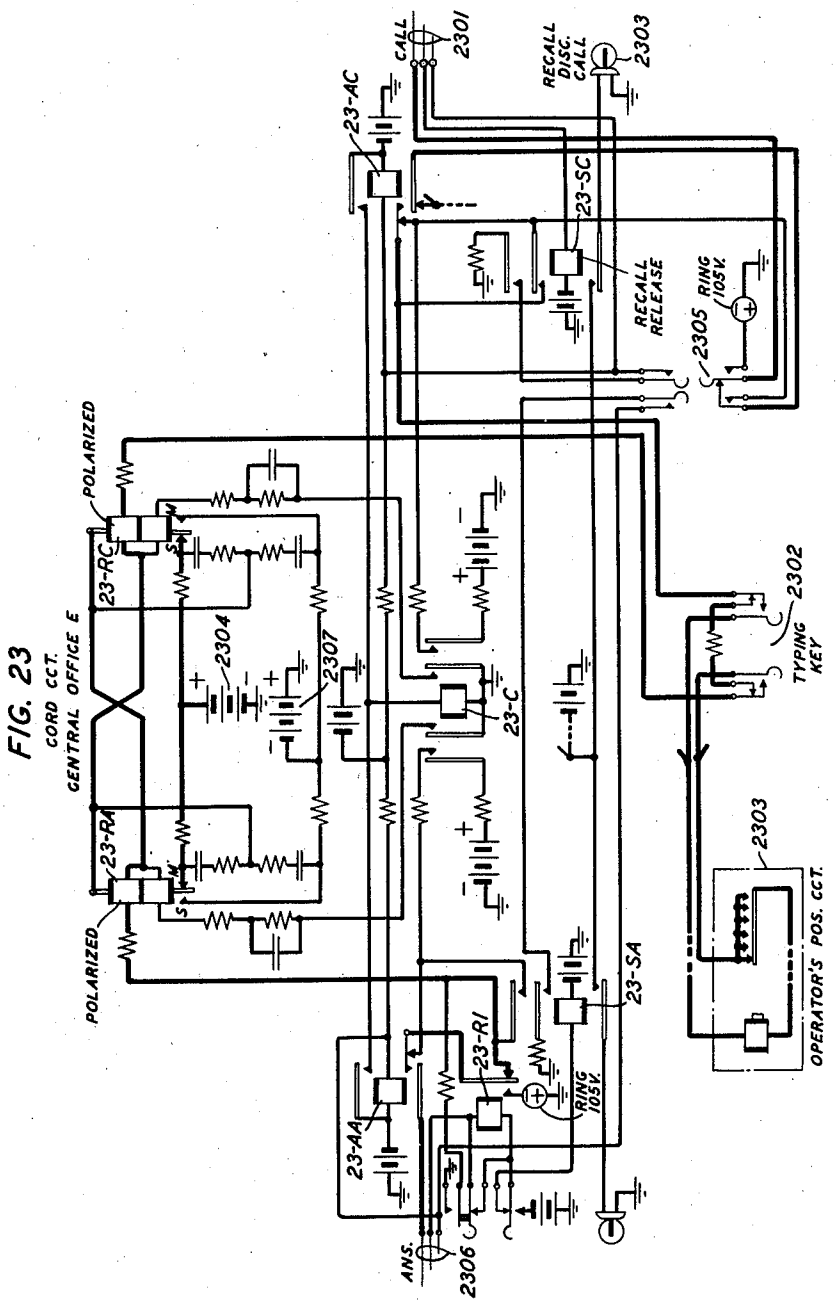

FIG. 23

INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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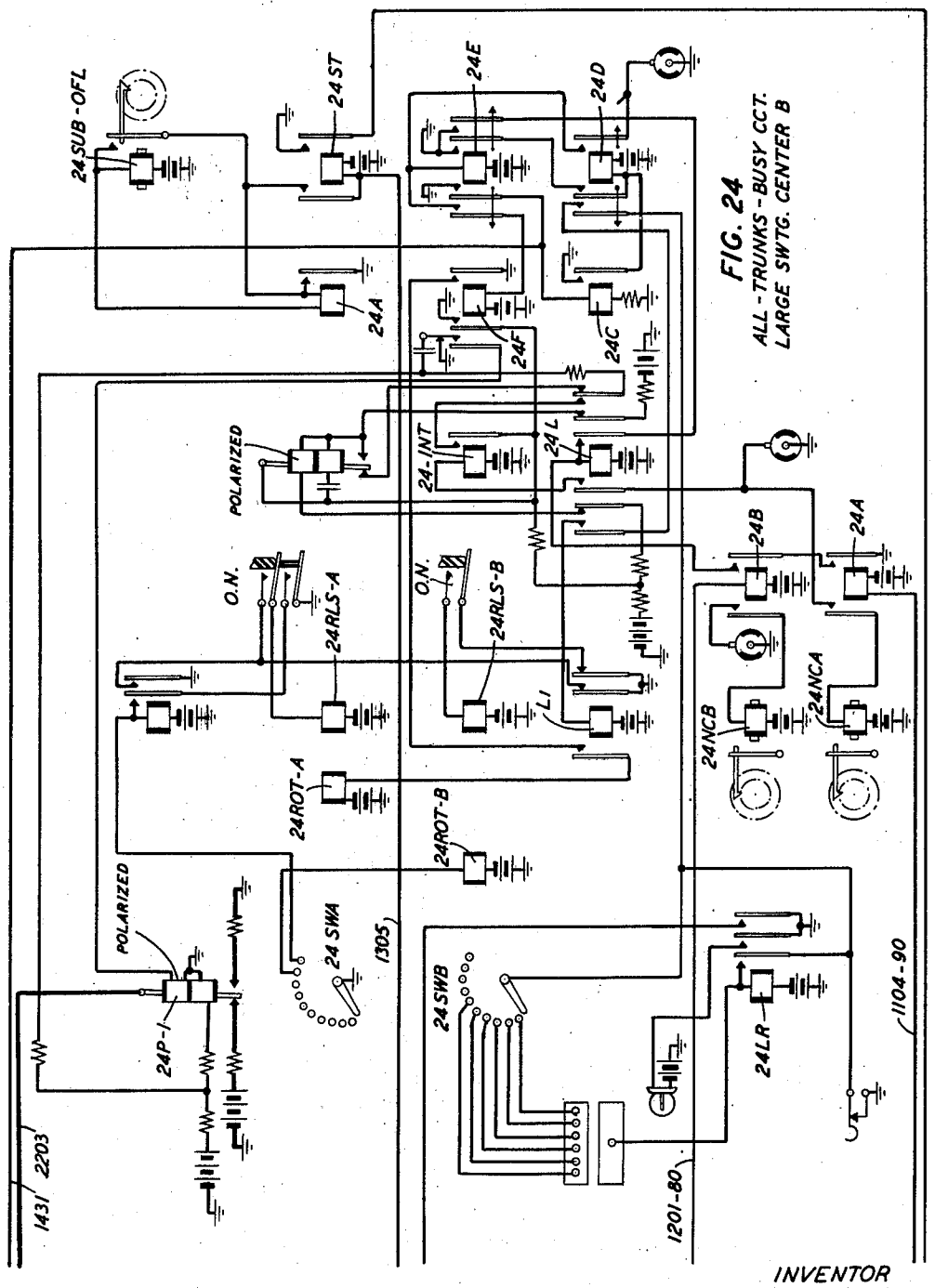

FIG. 24
ALL-TRUNKS-BUSY CCT.
LARGE SWTG. CENTER B

INVENTOR
C.W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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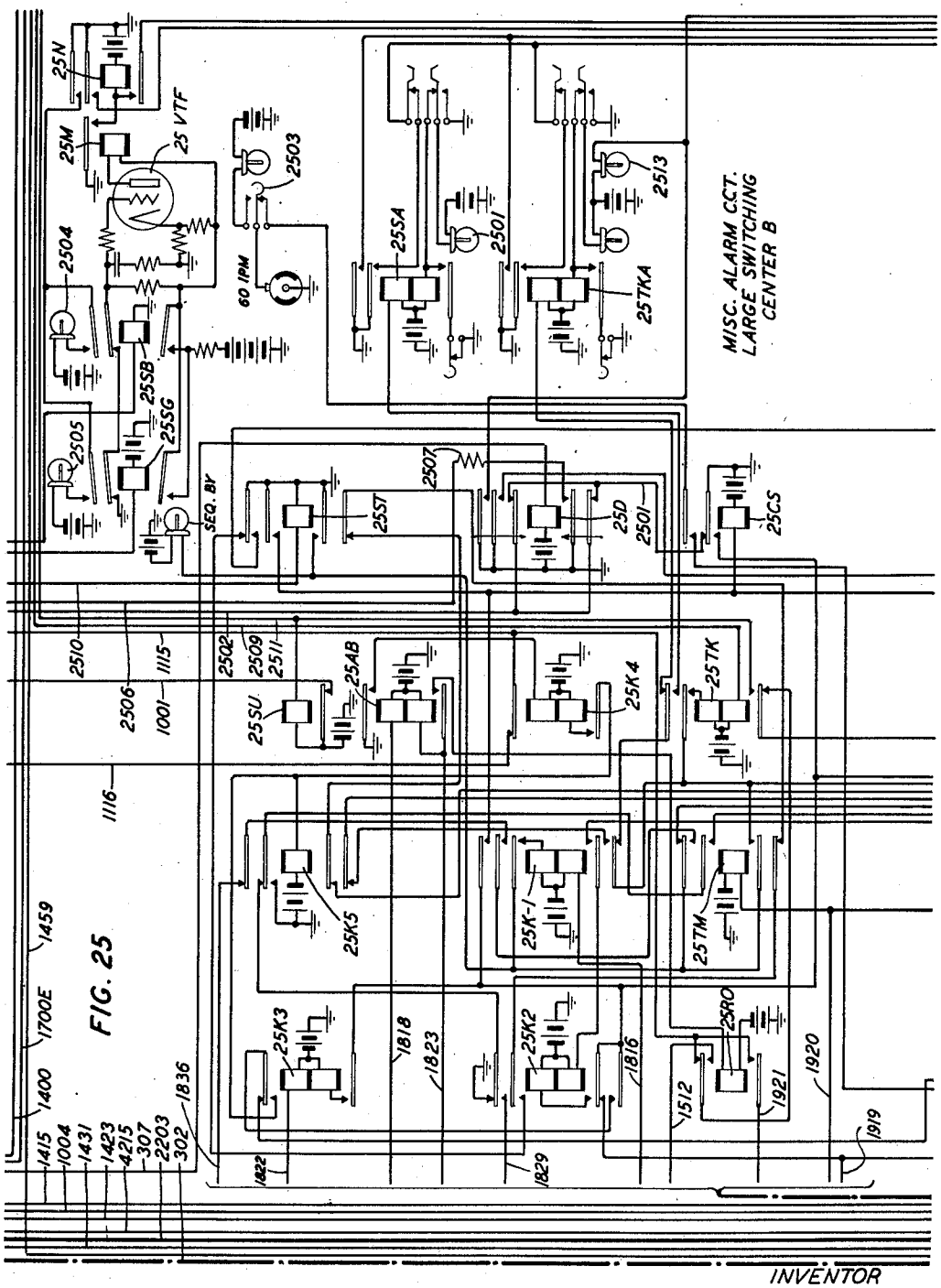

FIG. 25

INVENTOR
C.W. LUCEK
BY
J. M. Halaba
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TELETYPEWRITER SWITCHING SYSTEM

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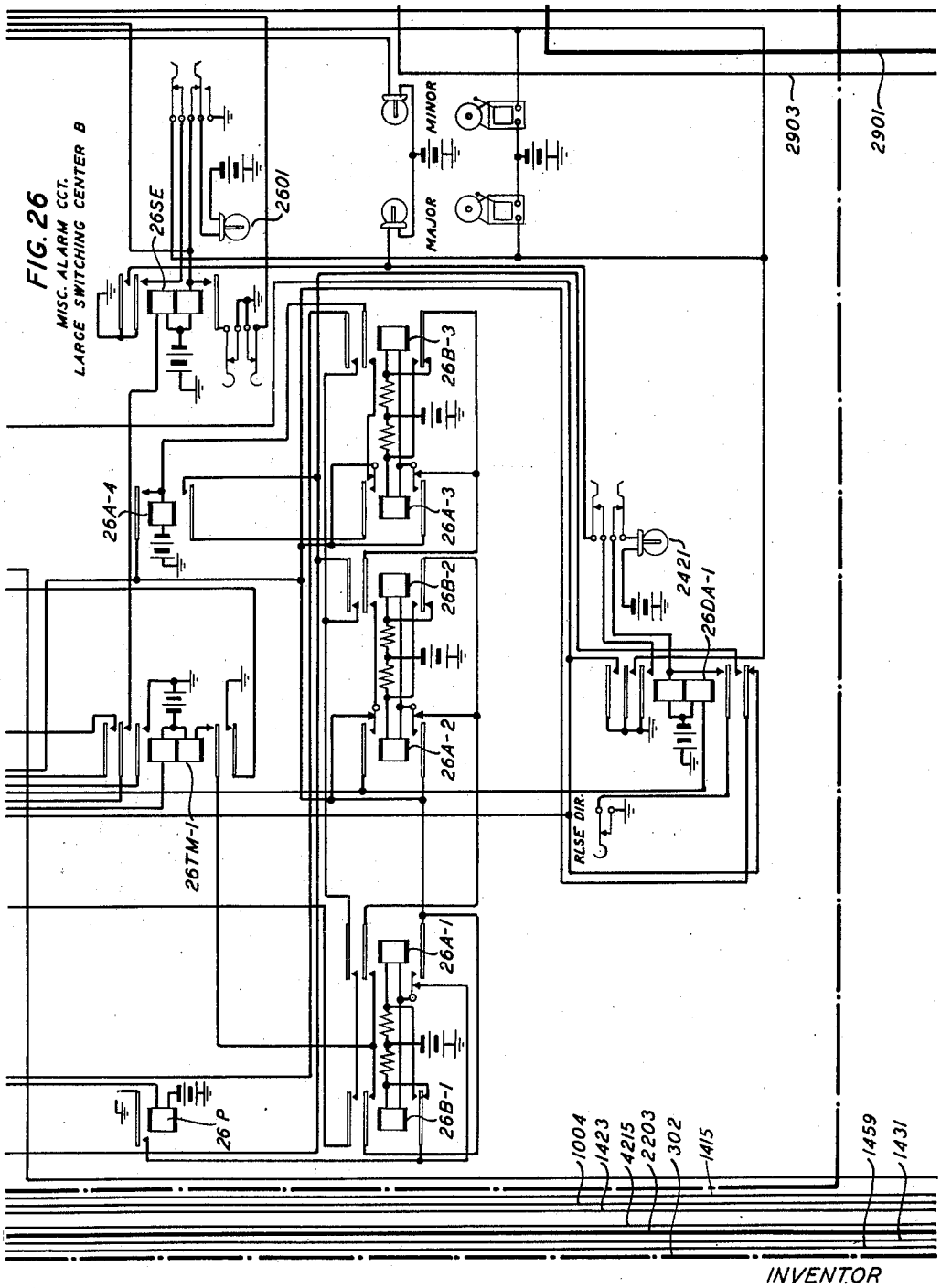

FIG. 26
MISC. ALARM CCT.
LARGE SWITCHING CENTER B

INVENTOR
C.W. LUCEK
BY J.M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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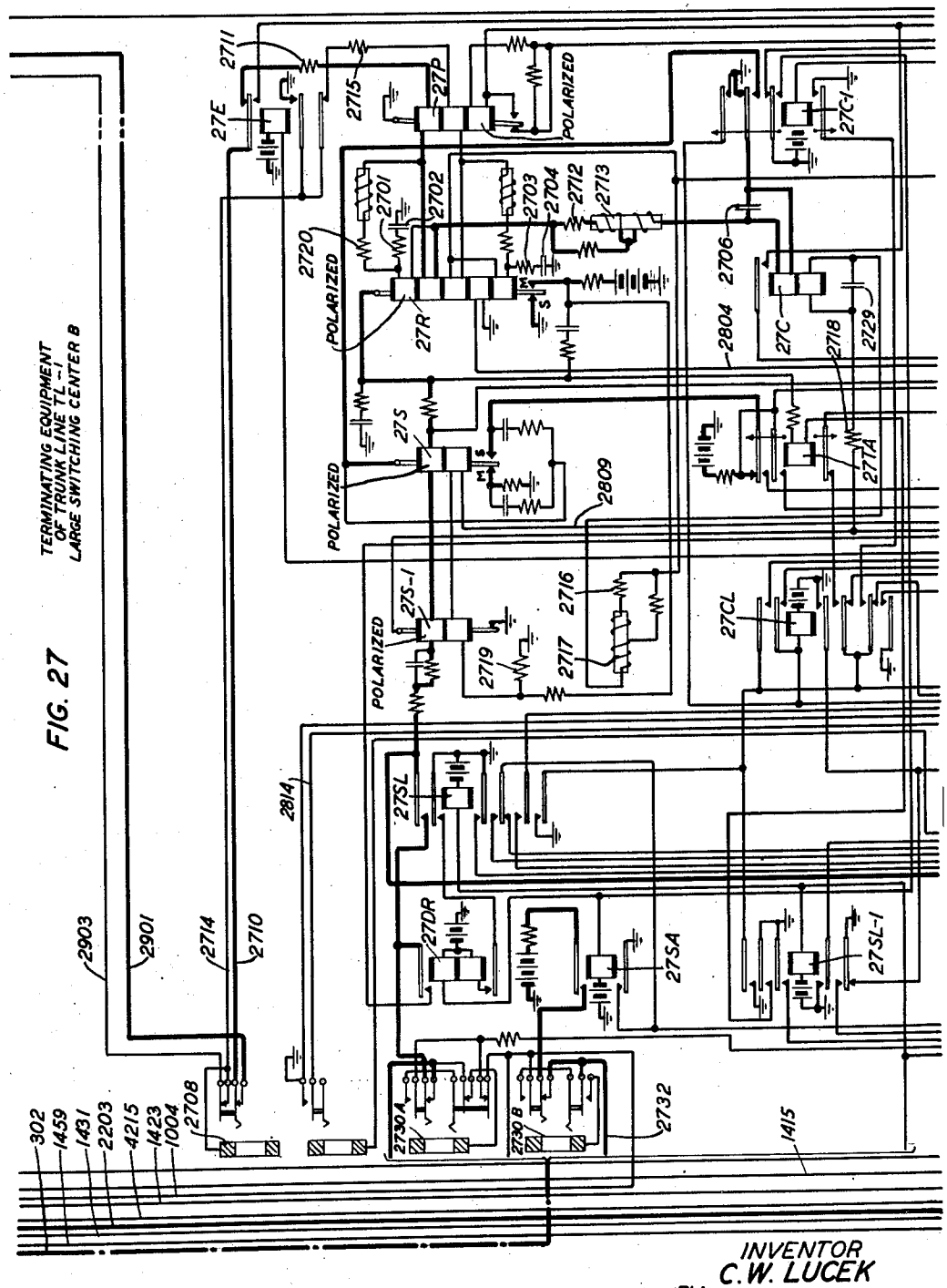

FIG. 27

INVENTOR
C. W. LUCEK
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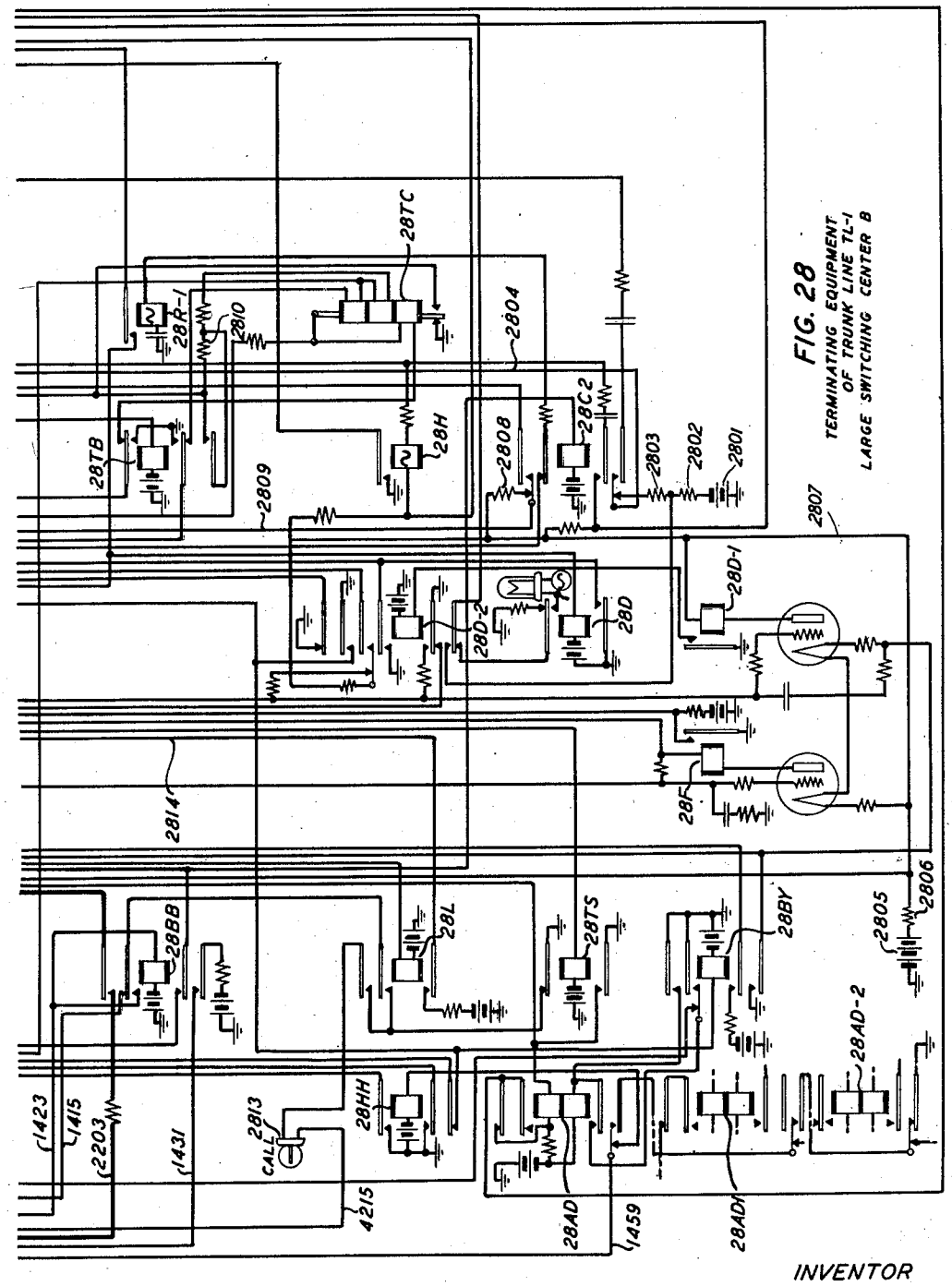

INVENTOR
C.W. LUCEK
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TELETYPEWRITER SWITCHING SYSTEM

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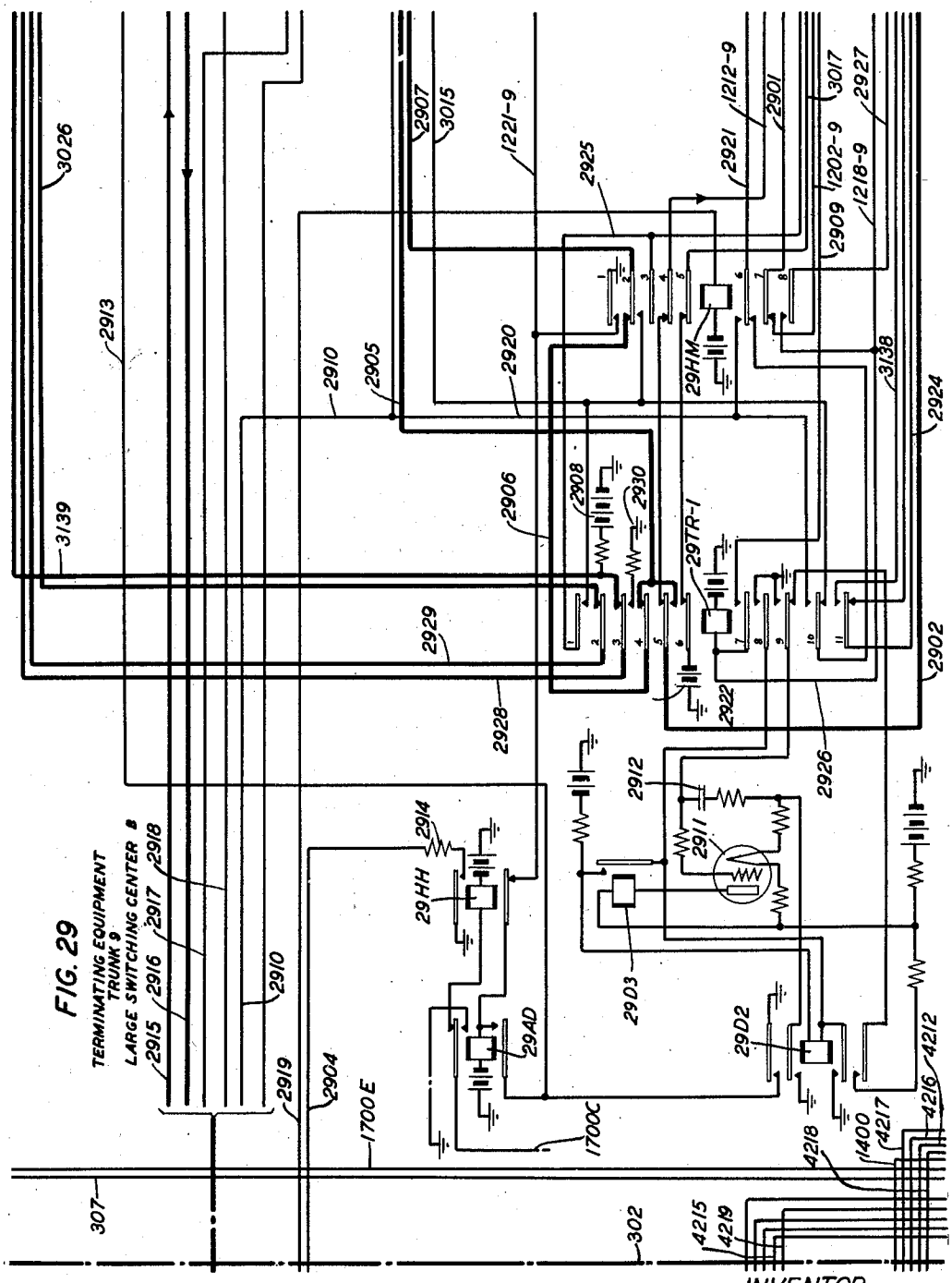

FIG. 29

TERMINATING EQUIPMENT TRUNK 9 LARGE SWITCHING CENTER B

INVENTOR
C. W. LUCEK
BY
J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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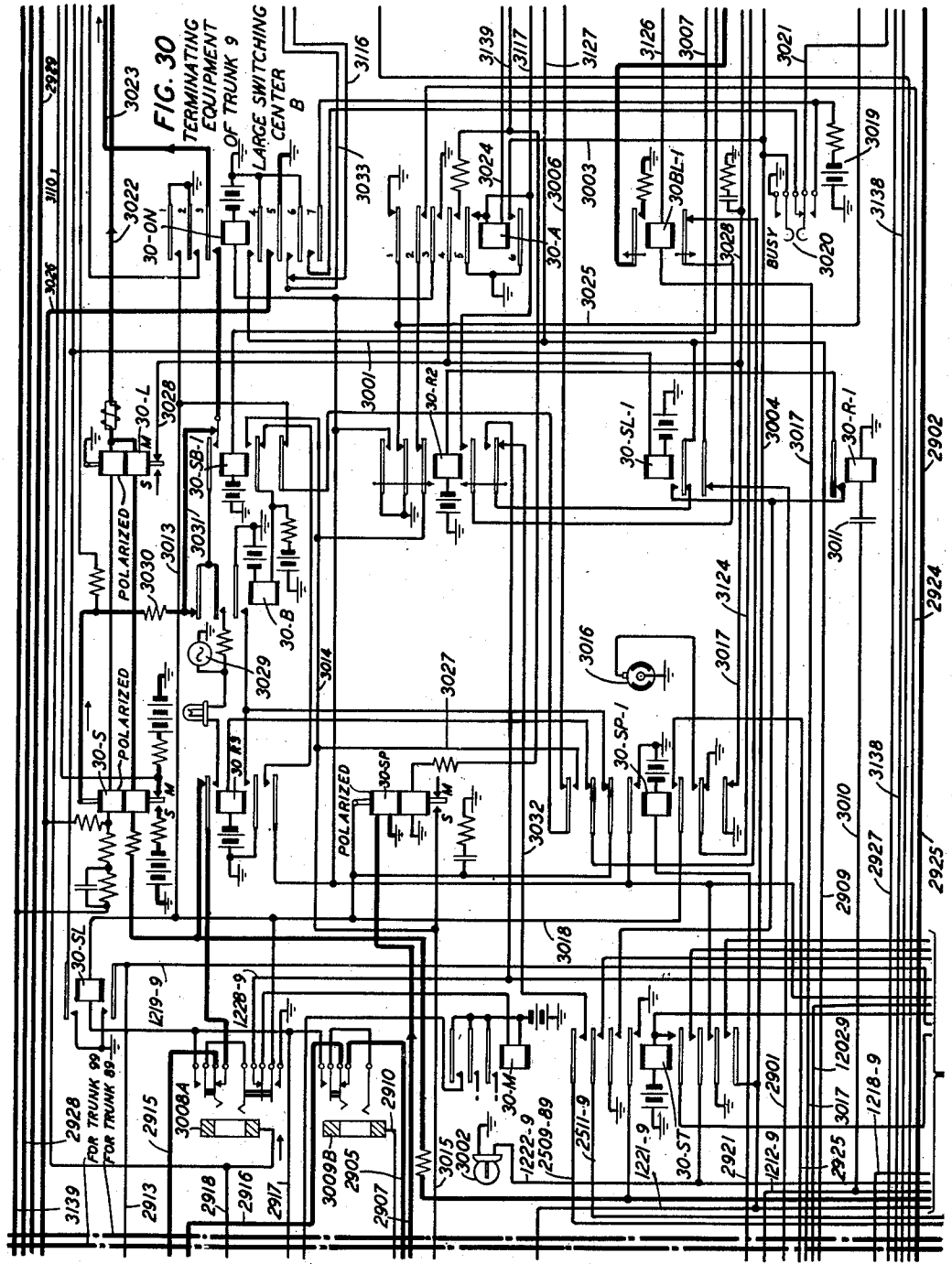

INVENTOR
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BY
J. M. Holahan
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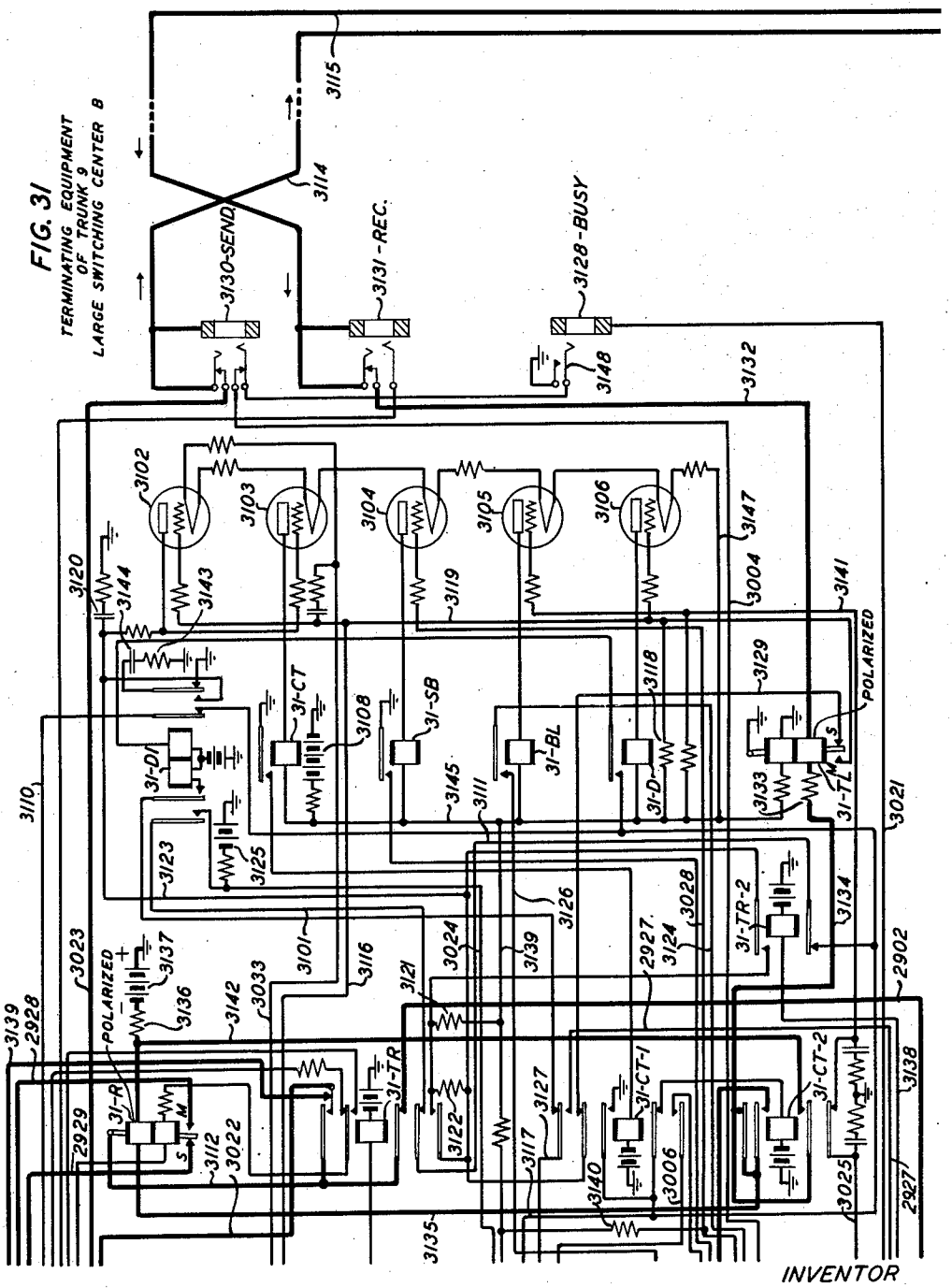
TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 31



INVENTOR
C. W. LUCEK
BY J. M. Holahan
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TELETYPEWRITER SWITCHING SYSTEM

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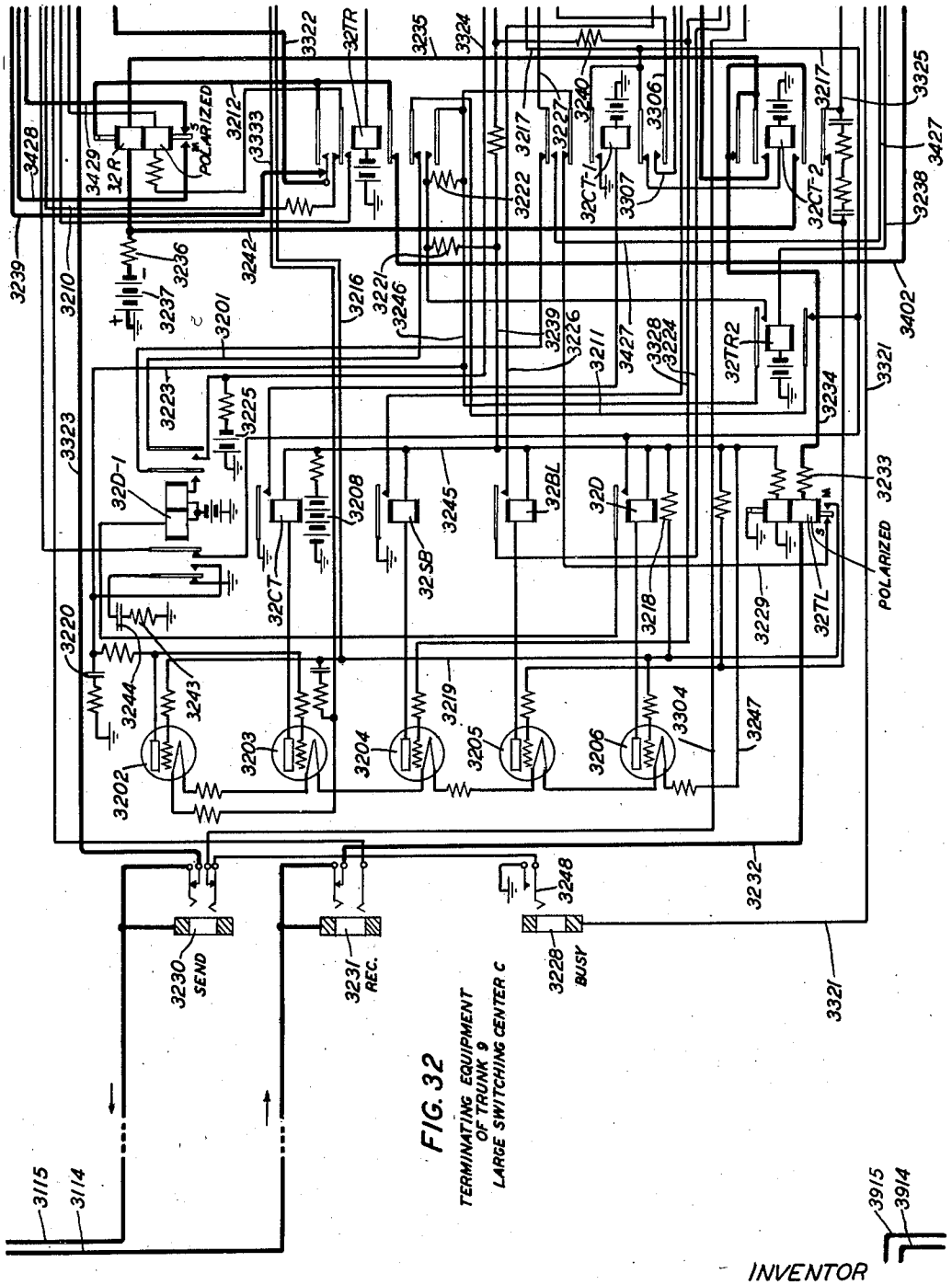

FIG. 32

TERMINATING EQUIPMENT OF TRUNK 9 LARGE SWITCHING CENTER C

INVENTOR
C. W. LUCEK
BY
J. M. Holahan
ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

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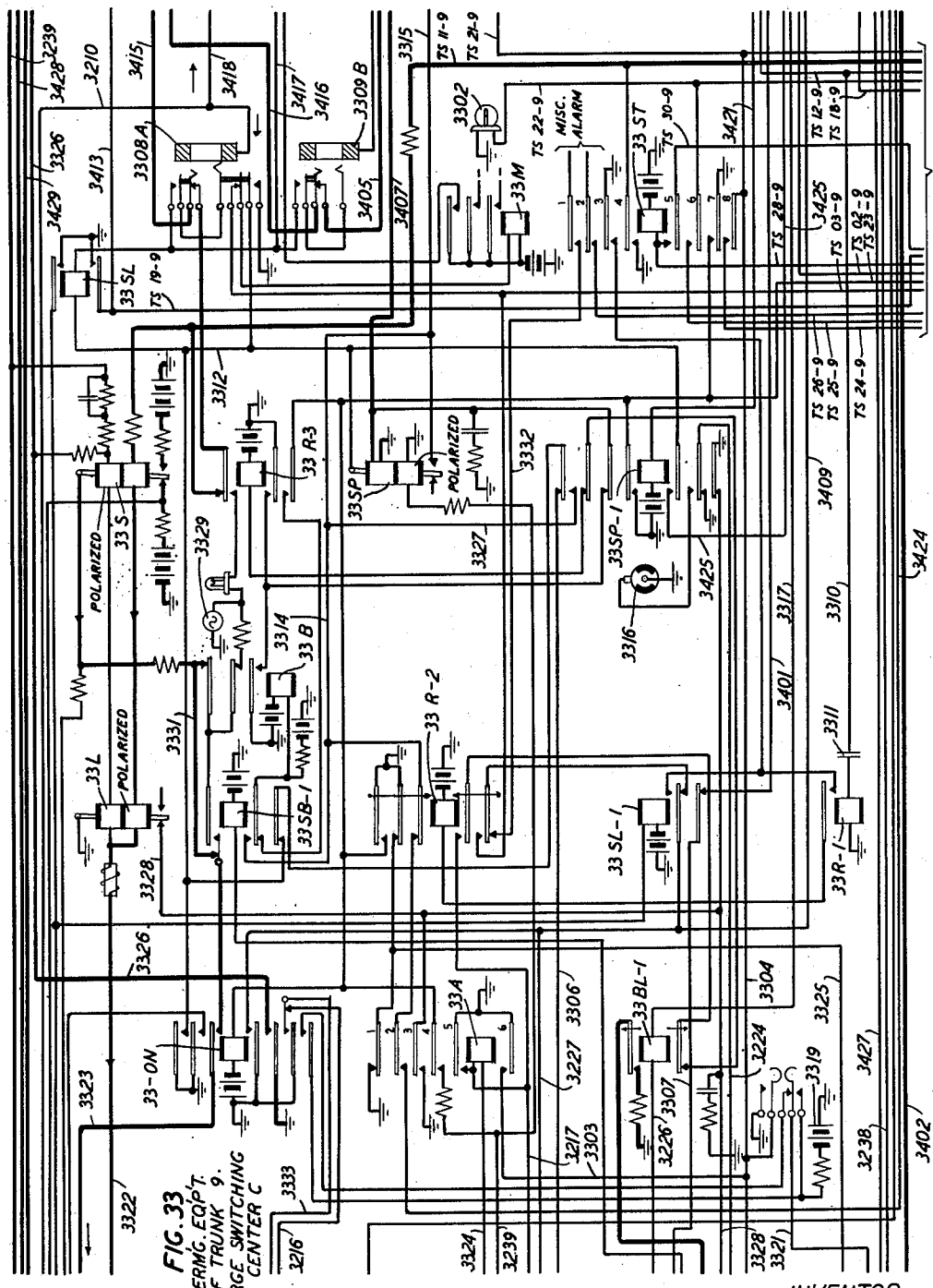

FIG. 33
TERMG. EQP'T. OF TRUNK 9. LARGE SWITCHING CENTER C

INVENTOR
C. W. LUCEK
BY J. M. Holahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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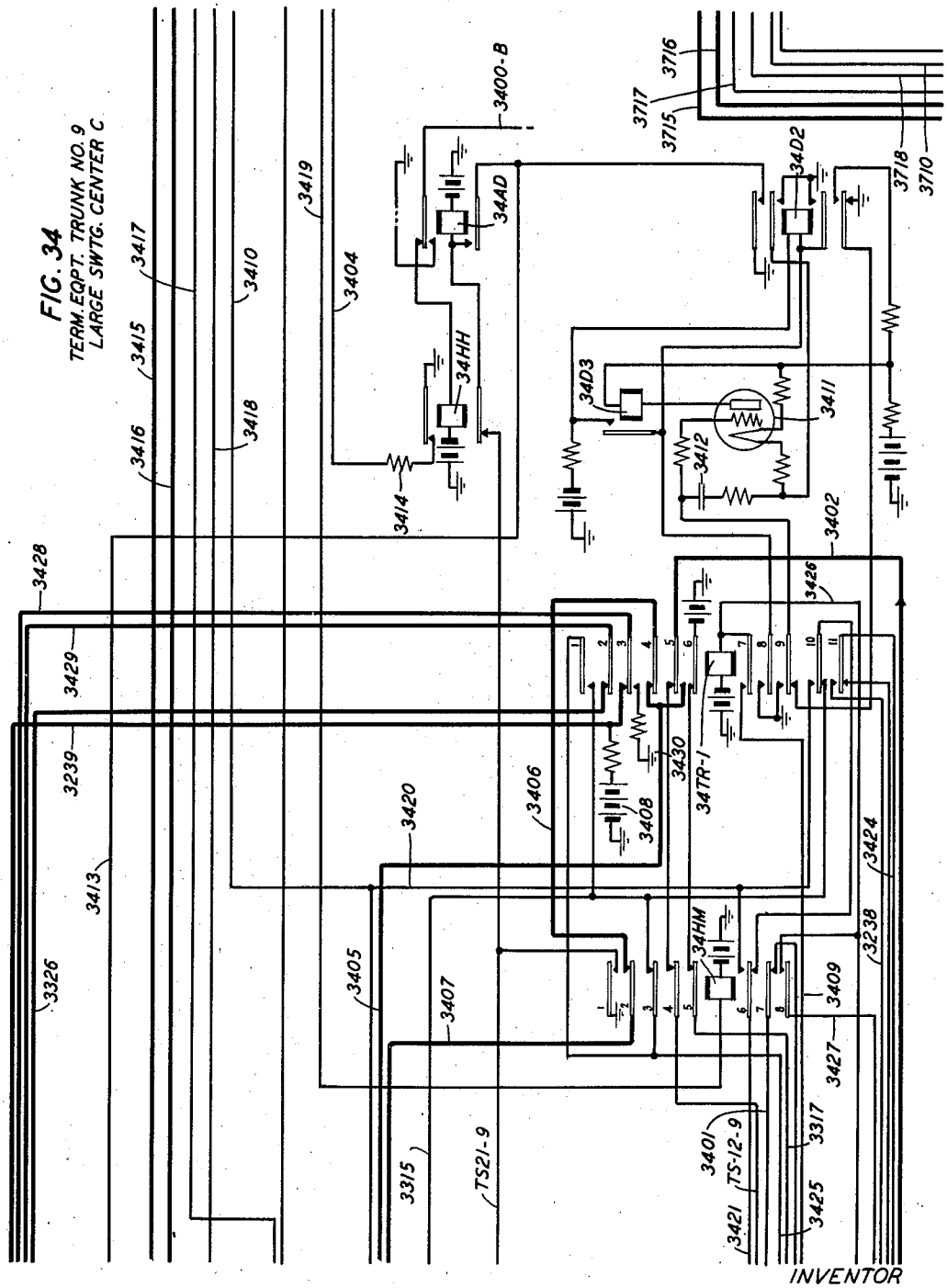

INVENTOR
C. W. LUCEK
BY
J. M. Hahalan
ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

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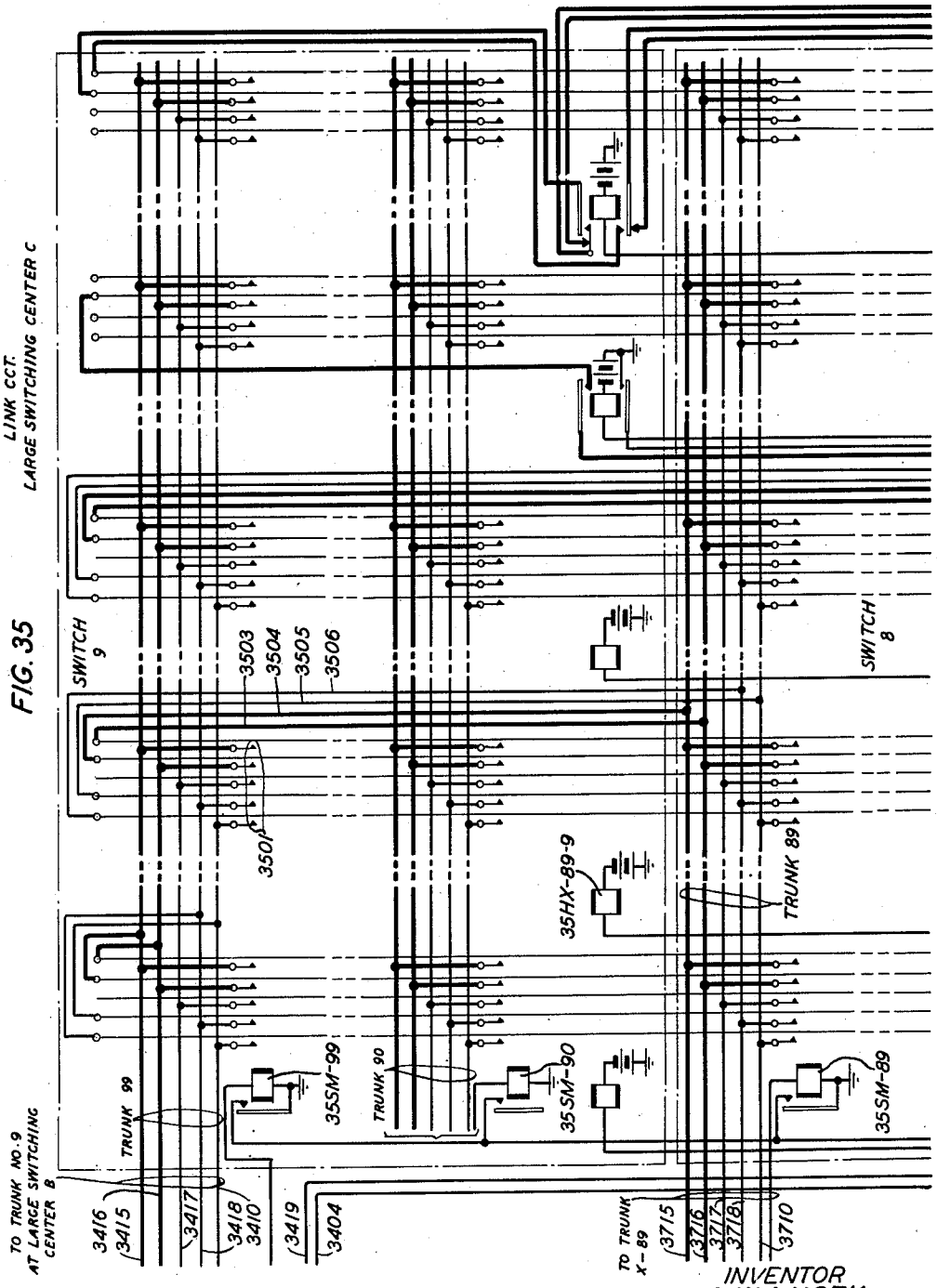

FIG. 35

INVENTOR
C. W. LUCEK
BY
J. M. Halahan
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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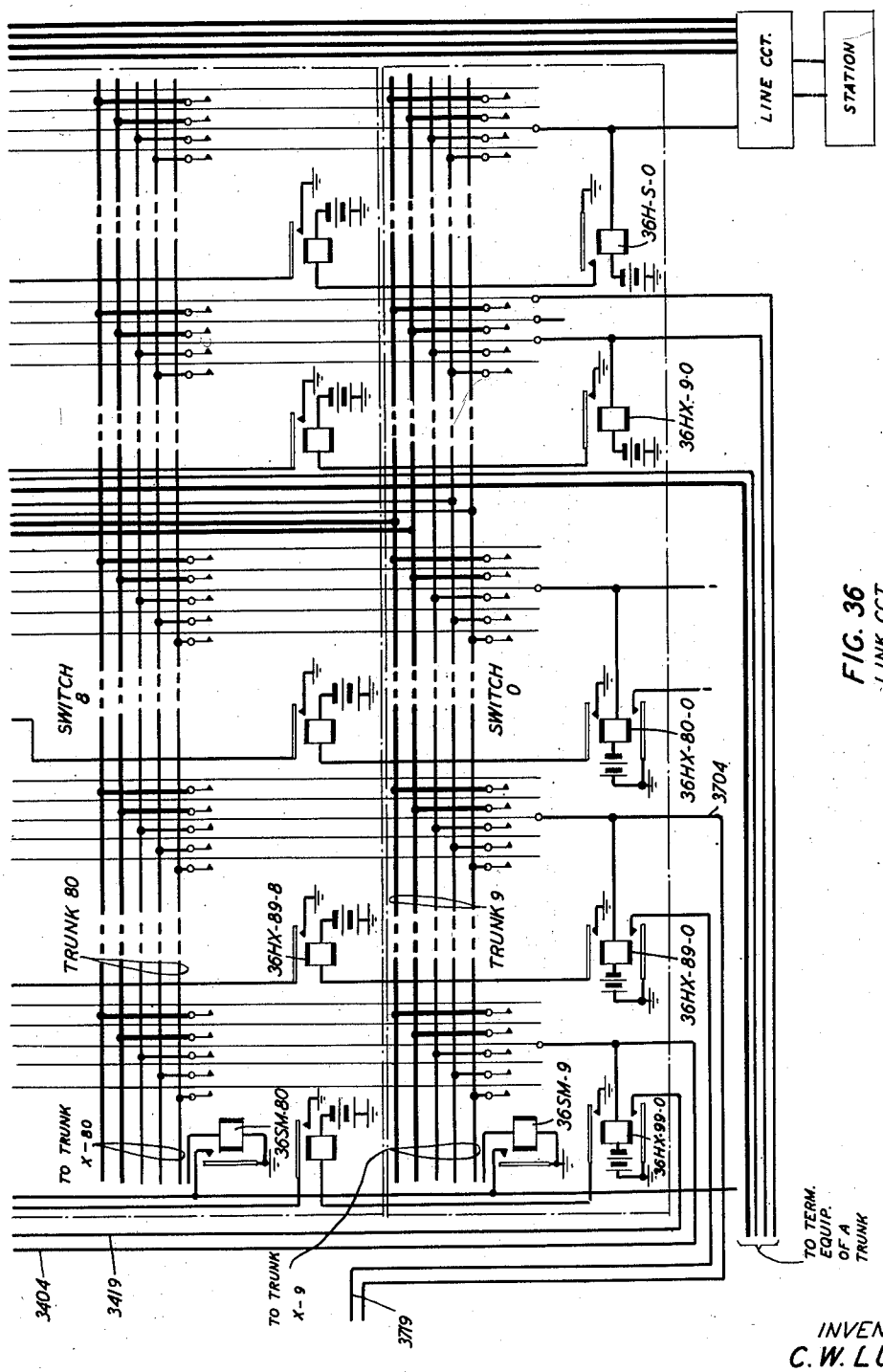

FIG. 36
LINK CCT.
LARGE SWTG. CENTER C

INVENTOR
C. W. LUCEK
BY J. M. Haloban
ATTORNEY

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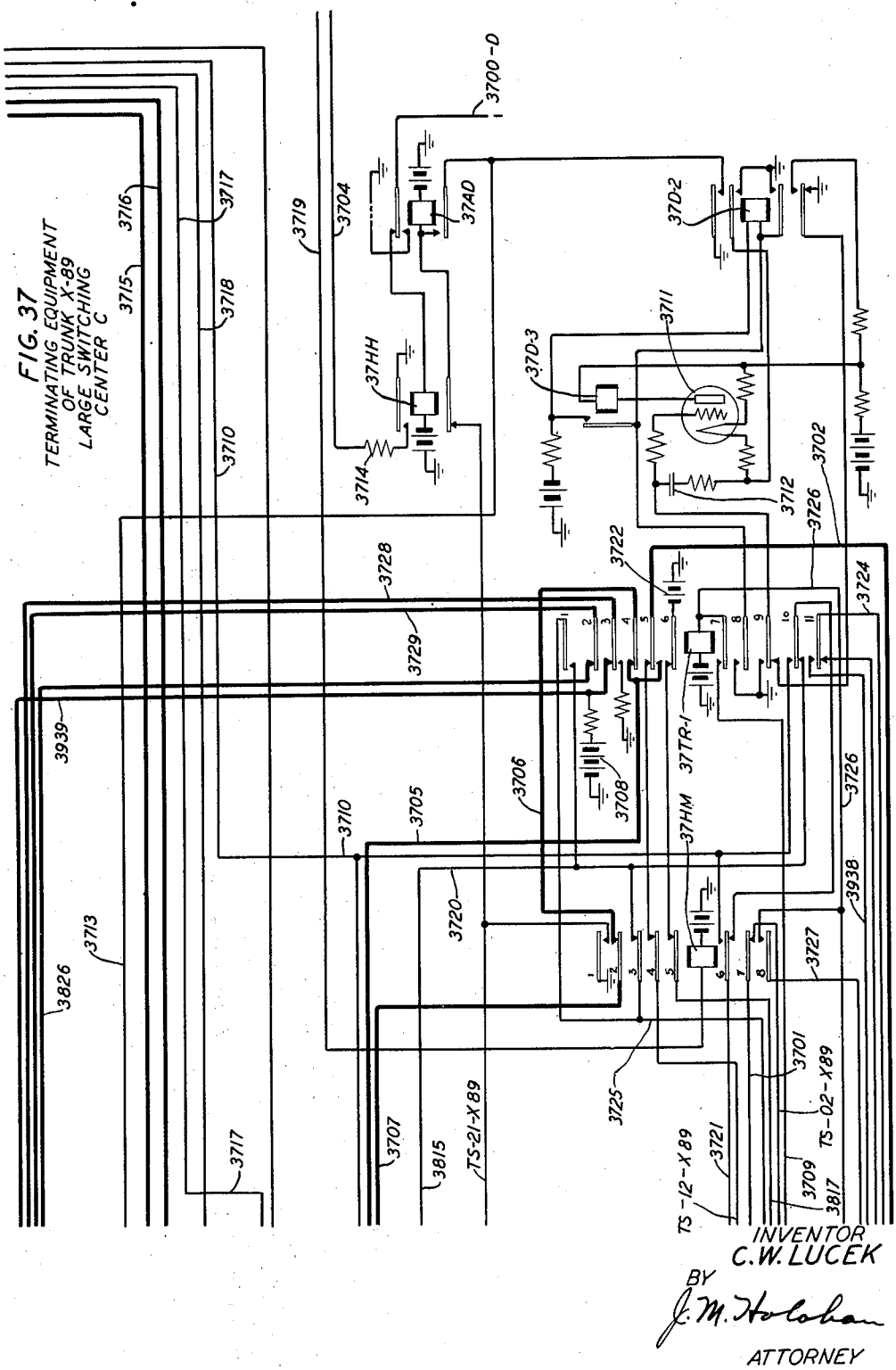
TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 37



INVENTOR
C. W. LUCEK
BY
J. M. Holcombe
ATTORNEY

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TELETYPEWRITER SWITCHING SYSTEM

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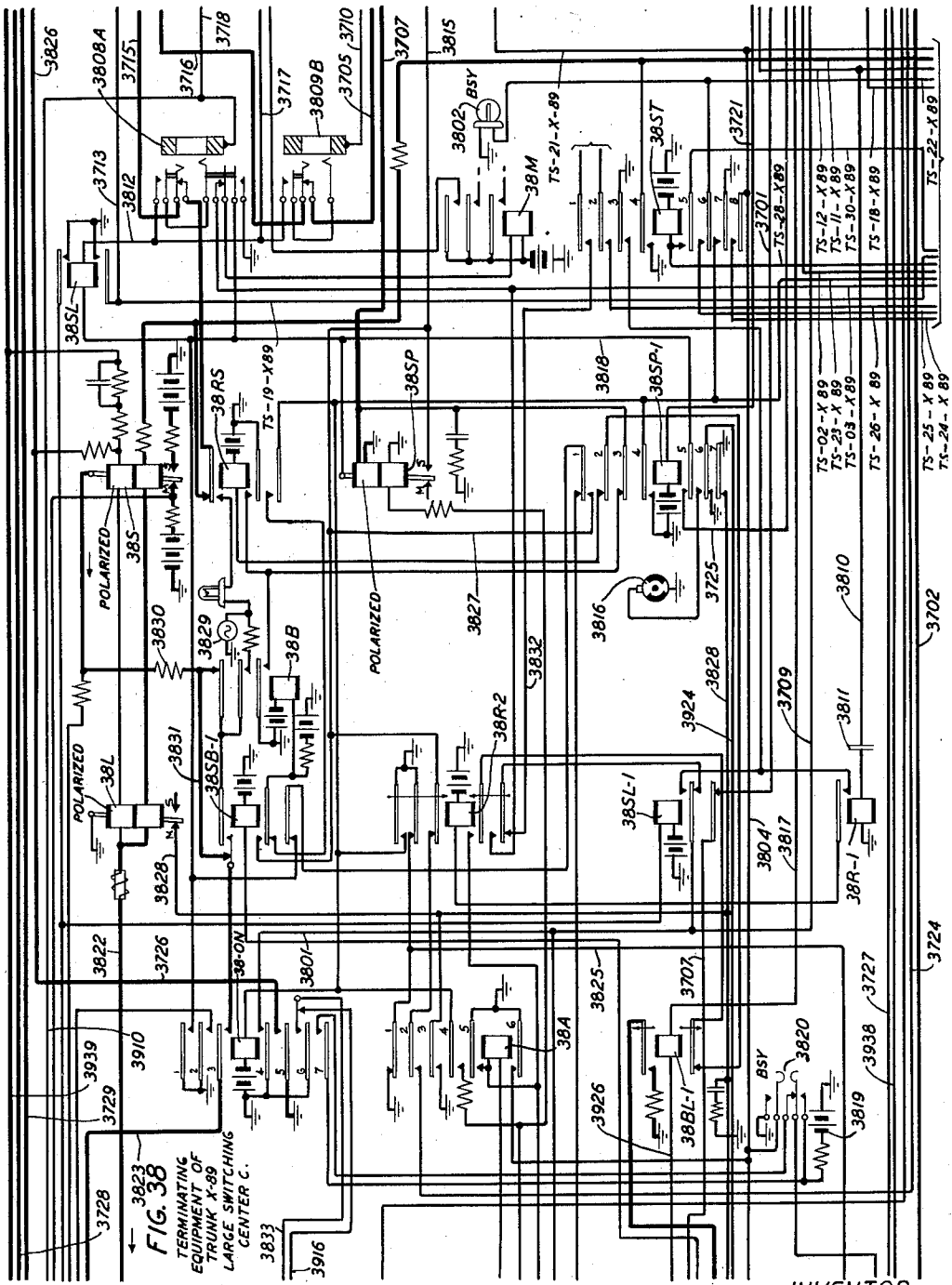

INVENTOR
C. W. LUCEK

BY
J. M. Holahan

ATTORNEY

Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

Filed Aug. 27, 1947 43 Sheets-Sheet 39

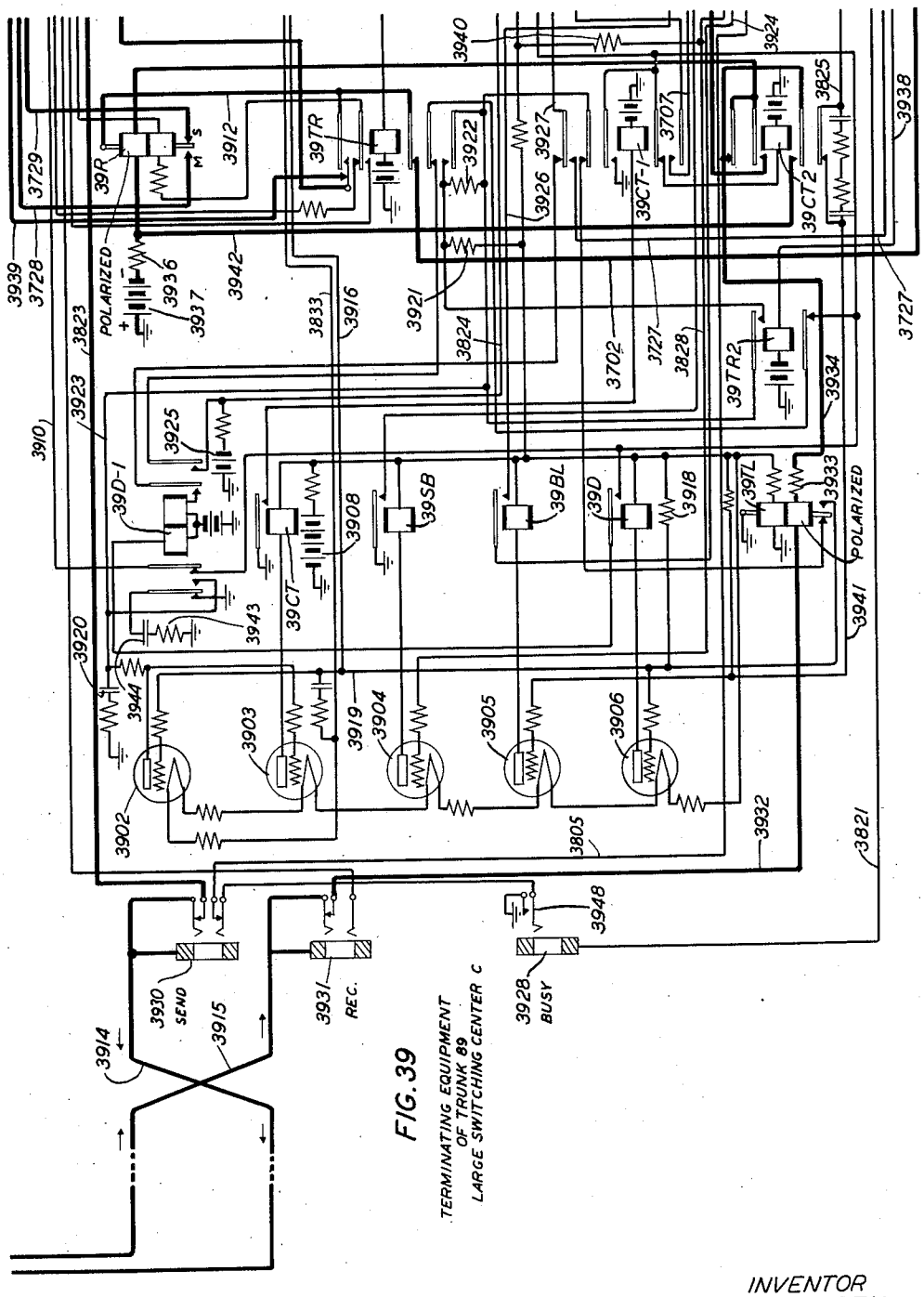

FIG. 39

TERMINATING EQUIPMENT OF TRUNK 89 LARGE SWITCHING CENTER C

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Nov. 29, 1949 C. W. LUCEK 2,489,916

TELETYPEWRITER SWITCHING SYSTEM

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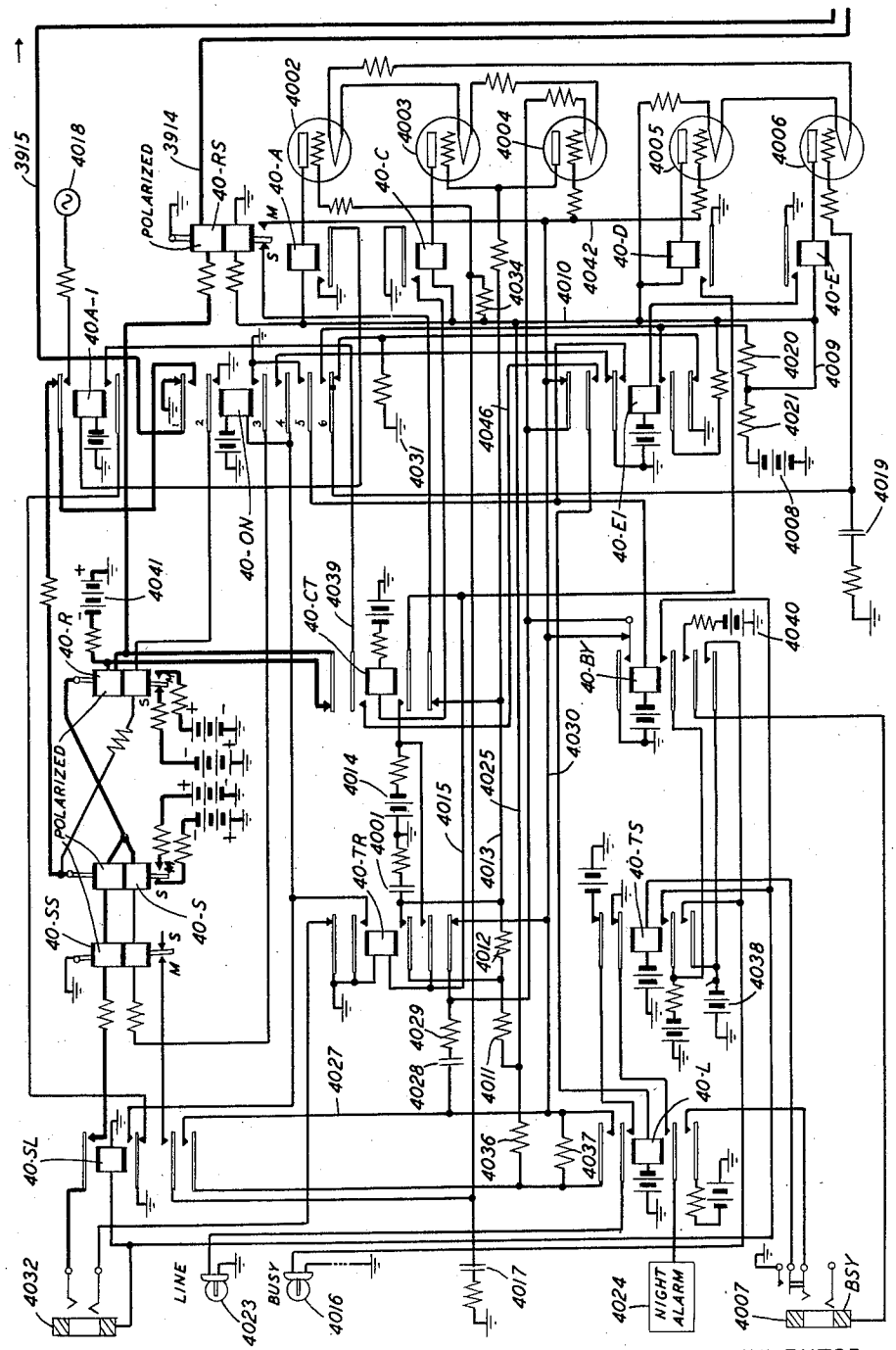

FIG. 40
TERMINATING EQUIP.
OF TRUNK X-89
CENTRAL OFFICE D

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TELETYPEWRITER SWITCHING SYSTEM

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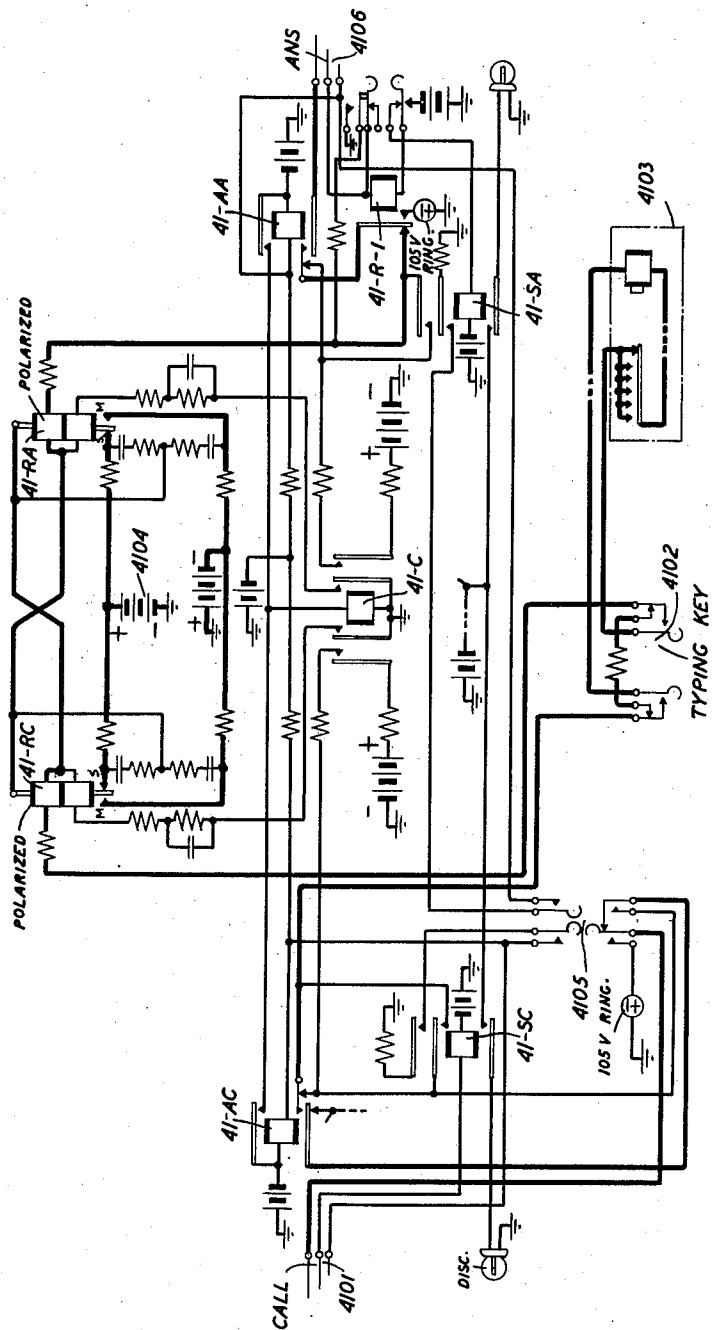

FIG. 41

CORD CIRCUIT
CENTRAL OFFICE D

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TELETYPEWRITER SWITCHING SYSTEM

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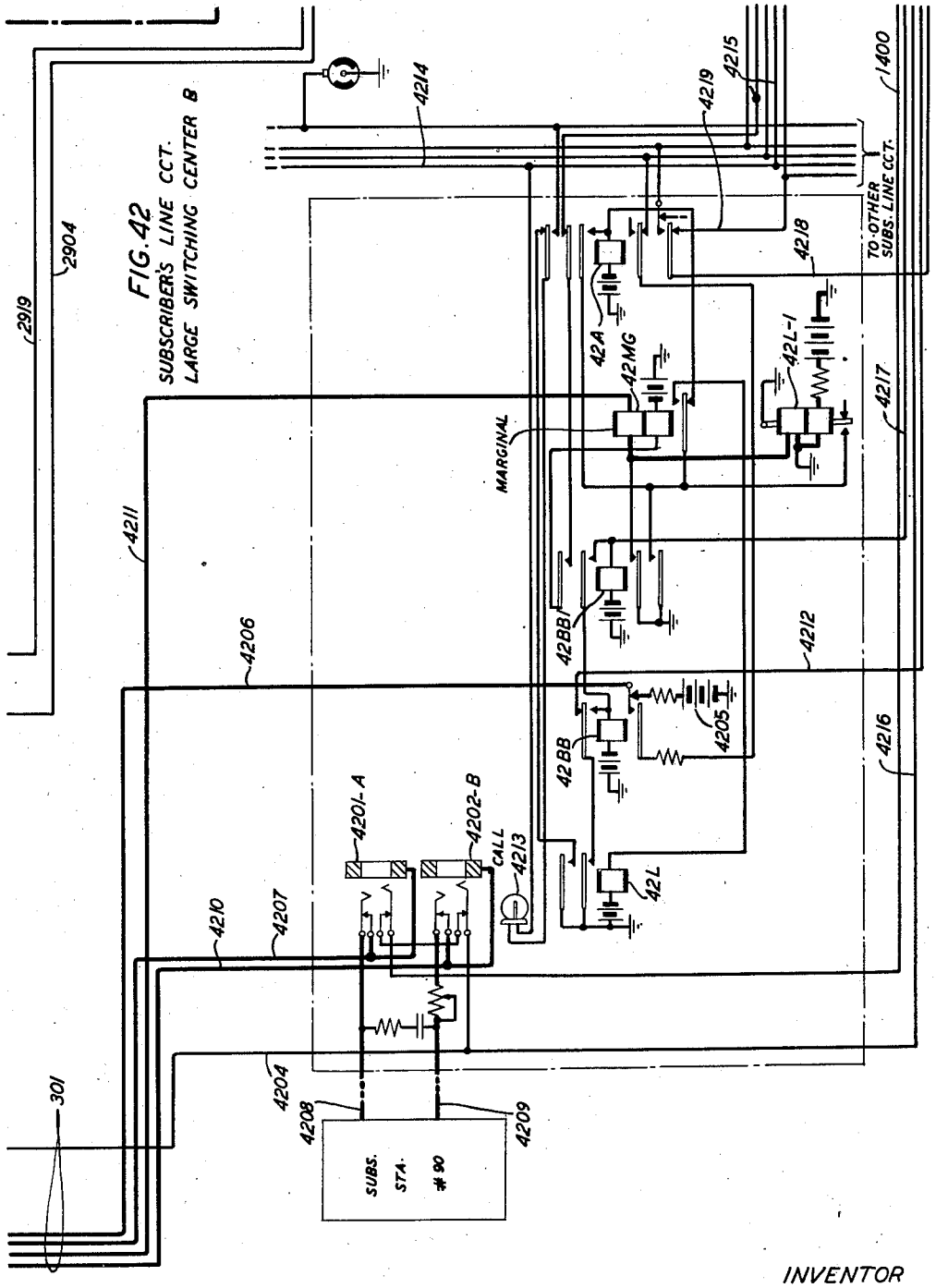

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TELETYPEWRITER SWITCHING SYSTEM

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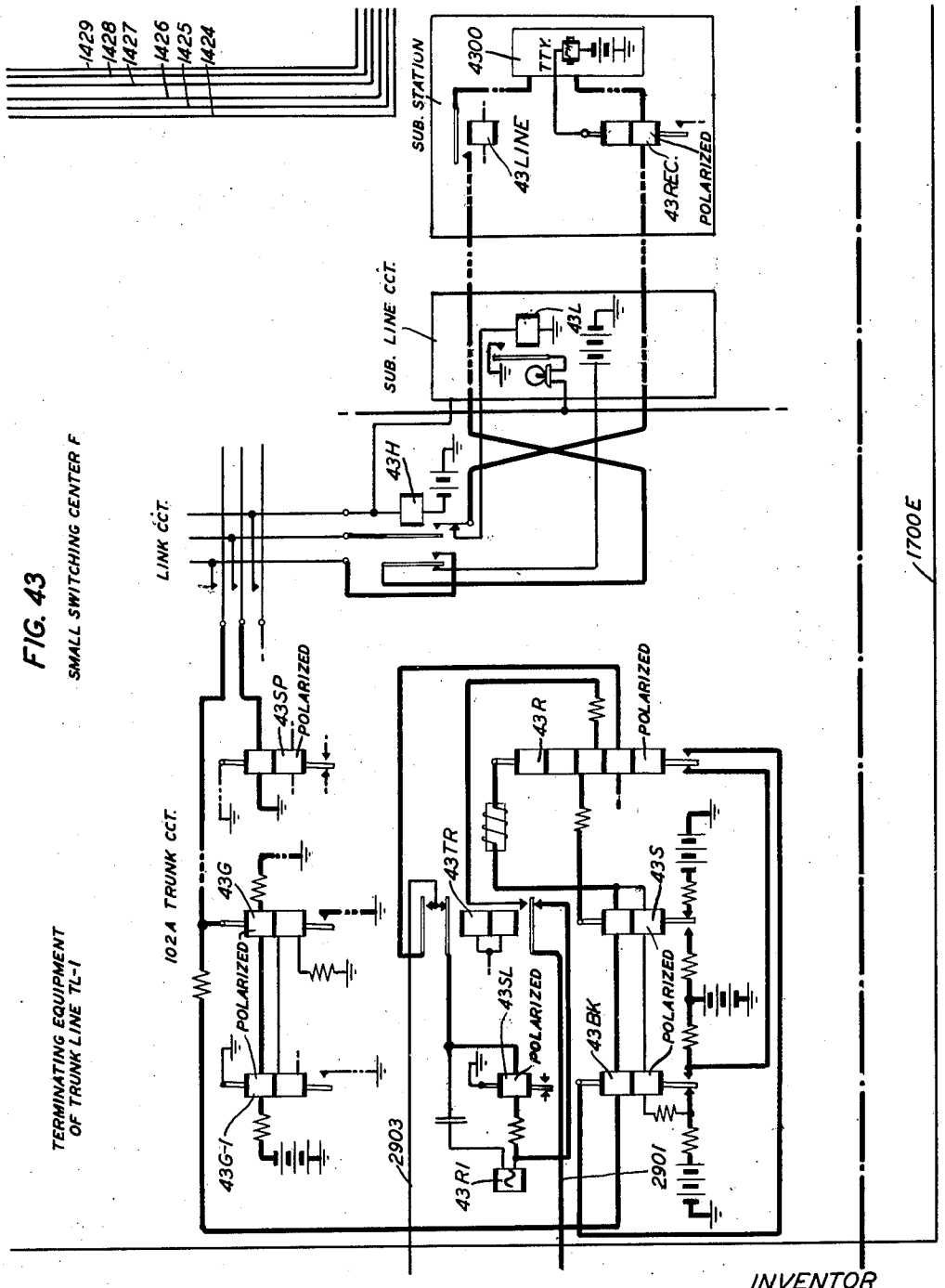

FIG. 43

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UNITED STATES PATENT OFFICE

2,489,916

TELETYPEWRITER SWITCHING SYSTEM

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Application August 27, 1947, Serial No. 773,009

30 Claims. (Cl. 178—4)

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This invention relates to telegraph switching systems and in particular to systems of the type in which central offices are interconnected by one or more trunks arranged for "through" calls through one or more intermediate automatic switching centers, or concentrating units, and in which the communication paths traversed are "through transmission paths."

A prior system is known in which two central offices interconnected by one or more trunks, have subscribers' lines terminating at switchboards of the respective offices and in which an operator at either office may seize the trunk and control the extension of a call to a subscriber line terminating at the other office independently of the operator at the terminating office. Systems of another type are also known in which permutation code is used to control the selection of lines and extensions of paths over said lines to more distant points, but such systems lack the feature of this invention in accordance with which the trunk may be seized from either end and utilized to extend the path selectively at the far end by permutation code.

Other systems are known in which two-way telegraphic trunks terminate in storage devices such as tape reperforators and in which the tape produced by these reperforators control retransmission of the stored signals; such arrangements are not considered to include through transmission paths nor are the lines incoming and outgoing to the reperforator-retransmitter equipment connected to form one transmission path.

Systems according to the present invention are to be distinguished from all such prior systems by the inclusion therein of novel features not previously known.

According to an embodiment of the present invention there is provided a regional layout of teletypewriter exchange offices arranged to automatically establish "through" connections for communication purposes through one or more distant concentrating units, or intermediate primary automatic switching centers, from one central office to another and vice versa, by permutation code signals. Other concentrating units, or automatic switching centers, serving as secondary switching centers, may be connected to the central offices and/or the primary switching centers for establishing communication connections to subscriber stations in outlying locations too remote for direct connection to a central office or a primary switching center.

An object of the present invention is to utilize the numerous advantages of permutation code

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for controlling in either of two opposite directions the automatic switching at intermediate points on a "through" call between widely separated central offices.

A feature of the invention resides in the modification of a system wherein permutation codes may be transmitted from a manually operated switching point and used to automatically control at any intermediate primary switching point or points (1) the selection of trunks and the extension of such trunks through one or more distant intermediate primary switching points to any one of a plurality of terminating switching points, (2) the selection of a trunk line extending to a secondary switching point and (3) the selection of any subscriber line locally connected to any of the intermediate primary switching points or the secondary switching points. Thus a series connection of main trunks for communication purposes is automatically established through one or more intermediate points under the control of permutation code selecting signals. These connections may be established in either of two opposite directions of transmission under the control of allotter, or sequence, circuits and director circuits responsive to different conditioning codes, such as (1) the "Figures" signal followed by a plurality of signals, in permutation code, representing numbers for selecting a subscriber line local to the first intermediate primary switching point or a secondary trunk-line terminating at a secondary switching point, and (2) the "Letters" signal followed by a single letter signal, in code, for selecting at an intermediate primary switching point a main trunk extending to another intermediate or a terminating primary switching point. This use of different preparatory codes for causing subsequent selecting codes to distinguish between selection of different classes of paths is a broadly distinctive feature of the invention.

Another feature of the present invention comprises a system in which two-way trunks may be controlled from either end to automatically extend the call through an intermediate primary switching point to and over a second trunk to another intermediate primary switching point a subscriber's station or to and over a trunk line to a secondary switching point to a subscriber line by means of permutation code controlled selective equipment operated by a permutation code sending instrumentality which in the preferred form comprises an operator's teletypewriter.

A further feature of the invention comprises a tandem arrangement of such trunks whereby an

operator at any one of two or more central offices in a system may seize a trunk extending to another switching point and control equipment at such other switching point to selectively control by means of permutation code the extension of the communication path over another trunk to a third switching point and preferably at such third switching point to control also by means of permutation code the extension of the communication path to a subscriber line.

Still another feature of the invention is a two-way trunking system in which a trunk may be seized at either end and caused to operatively associate with itself at the far end a permutation code selecting mechanism which is used to extend a communication path from the trunk over another line or trunk whereupon the permutation code selective mechanism is released for use in establishing other communication paths upon other calls.

Another feature is the provision of a plurality of automatically operated switching points, a plurality of two-way trunks connecting in series and/or in parallel said automatically operated switching points, two or more manually operated switching points, a plurality of two-way trunks connecting one or more of said manually operated switching points to one or more automatically operated switching points, and subscriber lines connected to each of said automatically operated switching points whereby calls may be automatically established between (1) two manually operated switching points through one or more automatically operated switching points connected in series and (2) any one of said manually operated switching points and a subscriber line connected to any one of said automatically operated switching points, by transmitting from the originating one of said manually operated switching points permutation code signals.

Another feature of the invention resides in the provision of the regional layout of offices wherein the total number of manually operated central offices plus automatic switching centers connected intermediate the central offices and selectable from one of the switching centers by the use of single codes representing letters can be as high as twenty-six and that the total number of other automatic switching centers of comparatively smaller capacities connected in tandem to the intermediate large switching centers only, plus the number of subscriber lines connected to any one intermediate large switching center so connected in tandem cannot exceed one hundred with the use of two-digit code selection as herein disclosed, although it will be obvious that the latter number may be increased to one thousand by the use of three-digit codes. Similarly, it is obvious that by using a two-letter permutation code the arrangement shown herein may be readily changed to increase the total number of central offices and intermediate large switching centers reachable from one of the large switching centers to a total of 676. A regional layout of offices is adapted for connection to other regional layouts and exchange systems.

Another feature is the provision of a two-way trunk circuit arranged to not only connect to a local subscriber's line, but also, when required, to connect to another trunk circuit extending to a distant office on a "through" call basis and to thereby permit proper transmission of supervision signals on the "through" connection. The trunk circuit has the additional feature of permitting selection in either direction by permutation code signals.

Another feature resides in the provision that an indication is furnished to a calling trunk circuit that said trunk circuit is going to be connected to another trunk circuit instead of to a local subscriber's line.

Another feature is the provision for testing over the calling trunk circuit the selected trunk circuit in the trunk group desired and for originating the proper report signals for transmission to the calling operator.

Another feature is the provision of multiple connections of a trunk circuit at both the horizontal and the vertical contact sets of the crossbar switches of a link circuit whereby a "through" connection between any two trunks connected to a crossbar switch may be established in either of two opposite directions.

An embodiment of the invention is comprised in the teletypewriter exchange system herein described and illustrated in the accompanying drawings of which:

Fig. 1 shows a diagrammatic arrangement of the switching points in a teletypewriter exchange system wherein provisions are had for automatically establishing two-way communication connections between a plurality of central offices (offices A and E), through intermediate large switching center B, and between a plurality of central offices (offices A, E and D), through intermediate switching centers B and C connected in tandem. Another switching center F of relatively small capacity is furnished for establishing connections with any of the central offices either directly or through one or more of the large switching centers, or with any one of the large switching centers either directly or through another of the large switching centers. In other words, a connection may be automatically established, in either of two directions, between (1) the operators' teletypewriters at any two central offices interconnected through one or more large switching centers, such as from office A to office E through center B and vice versa, from office A to office D and vice versa and from office E to office D and vice versa; (2) an operator's teletypewriter at a central office and a subscriber's teletypewriter connected locally to a large switching center to which trunks from such central office extend, such as from office A or office E through center B to a subscriber station and from office D through center C to a subscriber station; (3) an operator's teletypewriter at a central office and a subscriber's teletypewriter connected locally to a small switching center, through a large switching center to which trunks from such central office extend, such as from office A or office E through centers B and F to a subscriber station; (4) an operator's teletypewriter at a central office and a subscriber's teletypewriter connected locally to a large switching center through another large switching center to which trunks from such central office extend, such as from office A or office E through centers B and C to a subscriber station and from office D through centers C and B to a subscriber station. A connection between a subscriber's teletypewriter at a station locally connected to a large switching center and a subscriber's teletypewriter at a station locally connected to another large switching center or a small switching center must be established manually by an operator at the central office connected by trunks extending to the large switching center through which the call origi-

nated. An operator's teletypewriter at a central office and a subscriber teletypewriter connected locally to a small switching center may be interconnected for communication purposes through two or more large switching centers in one direction only; a call originating at a subsciber station locally connected to a switching center must be established through the switching center to the central office directly connected to the switching center, such as from a subscriber station through center B to office A or E and from a subscriber station through center C to office D. As hereinbefore stated, a small switching center connected through a large switching center to a central office is provided with means for automatically establishing a connection between a subscriber's teletypewriter locally connected to the small switching center and an operator's teletypewriter at the central office but when two central offices are connected by separate groups of trunks to the large switching center, no means, automatically operated, are provided for connecting the subscriber's teletypewriter to an operator's teletypewriter at the second central office; a connection of the latter type must be established manually by the operator at the first-mentioned central office. By having all calls directed through a central office permits supervision by an operator for determining the necessary service charges that are assessed against the subscribers.

It is obvious that each of the central offices included in the present system has means for being connected to local subscriber stations and to trunks extending to other central offices whereby subscriber stations local thereto may have access by means of an interconnection, to any switching point or subscriber station included in the system.

The system is shown in diagrammatic form in Fig. 1. The circuit schematic is shown in detail in Figs. 2 to 14, inclusive, 16 to 43, inclusive, which are grouped in accordance with their respective locations at the several switching points. The figures are grouped as follows: Figs. 2 to 14, inclusive, 16 to 19, inclusive, and Figs. 24 to 31, inclusive, for large switching center B; Figs. 20 and 21 for central office A; Figs. 22 and 23 for central office E; Figs. 32 to 39, inclusive, for large switching center C; and Figs. 40 and 41 for central office D; Fig. 42 shows a subscriber station and line circuit local to center B; and Fig. 43 shows a circuit schematic in skeletonized form, for small switching center F, which is shown in detail in the Large-Singer Patent 2,372,329, dated March 27, 1945. Fig. 15 shows the relative arrangement of Figs. 2 to 14, inclusive, and 16 to 43, inclusive. The circuit arrangements provided at large switching centers B and C are identical and similar arrangements may be employed in other additional large switching centers that may be provided for the system. Likewise the circuit arrangement provided at small switching center F may serve for other additional small switching centers that may be required in the system.

Figs. 2 and 3 show a link circuit at center B for interconnecting main trunks of groups respectively extending to central offices at A and E, and switching center C. Each main trunk terminates on a horizontal group of contact sets of a crossbar switch, the two uppermost horizontal contact sets being shown as terminating trunks extending to central office A, the next two, or third and fourth from the top, being shown as terminating trunks extending to central office E, the fifth from the top as terminating a trunk extending to large switching center C. Corresponding contact sets of the horizontal groups form vertical groups and each of certain vertical groups terminates a subscriber line local to center B, other vertical groups respectively terminate other lines referred to herein as trunk-lines extending to small switching center F, and still other vertical groups are respectively connected in multiple to the trunks extending to central offices A and E and switching center C, which trunks are mentioned above as also having terminations at their respective horizontal groups of contact sets. In other words, each of the latter trunks is connected in multiple to both a horizontal and a vertical group of contact sets to permit selection in opposite directions by means of permutation code signals. The link circuit shown herein provides for the use of ten crossbar switches Nos. 0 to 9 and each switch is arranged to terminate ten trunks, such as, switch No. 9 terminates trunks Nos. 99 to 90 which extend to central office A, switch No. 8 terminates trunks Nos. 89 to 80 which extend to central office E, switches Nos. 7 to 1, respectively, terminate groups of trunks extending to other central offices or large switching centers other than center C, and switch No. 0 terminates trunks Nos. 9 to 0 which extend to large switching center C, although two or more switches may be readily arranged to terminate two or more groups of ten trunks to any one of the central offices or large switching centers.

Figs. 4, 5 and 6 show, in detail, the termination at center B of a main trunk No. 99 extending to central office A.

Figs. 7, 8 and 9 show, in detail, the termination at center B of a main trunk No. 89 extending to central office E.

Fig. 10 shows, in detail, the subscriber line sequence circuit at center B.

Figs. 11 and 12 show, in detail, the trunk sequence circuit at center B.

Fig. 13 shows, in detail, the control arrangement of the sequence circuit at center B.

Figs. 14, 16, 17, 18 and 19 show, in detail, the director circuit at center B.

Fig. 15 is a diagram which shows the relative arrangements in which Figs. 2 to 14, inclusive, and 16 to 43, inclusive, are to be placed.

Fig. 20 shows at central office A, the termination of the trunk No. 99 whose other termination is shown in Figs. 4, 5 and 6.

Fig. 21 shows an operator's cord circuit at the central office A.

Fig. 22 shows at central office E the termination of the trunk No. 89 whose other termination is shown at Figs. 7, 8 and 9.

Fig. 23 shows an operator's cord circuit at central office E.

Fig. 24 shows the all-trunks-busy circuit at center B.

Figs. 25 and 26 show the miscellaneous alarm circuit at center B.

Figs. 27 and 28 show at center B the termination of a trunk-line TL—1 connected to the vertical group (second from the left) of contacts sent in the link circuit (Figs. 2 and 3), and extending to small switching center F.

Figs. 29, 30 and 31 show, in detail, the termination at center B of a main trunk No. 9 extending to large switching center C.

Figs. 32, 33 and 34 show, in detail, the termination at large switching center C of the main trunk No. 9 whose other termination is shown in Figs. 29, 30 and 31, although at this switching point,

namely, center C, the trunk No. 9 would ordinarily have a different number to correspond to the numbering at the crossbar switch in the link circuit provided at center C.

Figs. 35 and 36 show at large switching center C a link circuit, similar to that shown in Figs. 2 and 3, but arranged to interconnect main trunks, respectively, extending to large switching center B and central office D, the two uppermost horizontal contact sets being shown as terminating trunks extending to center B, the next two, or third or fourth from the top, being shown as terminating trunks extending to central office D.

Figs. 37, 38 and 39 show, in detail, at large switching center C the termination of a main trunk No. X—89 extending to central office D.

Fig. 40 shows at central office D the termination of trunk No. X—89 whose other termination is shown in Figs. 37, 38 and 39.

Fig. 41 shows at central office D an operator's cord circuit which is identical with that shown in Fig. 21 or Fig. 23.

Fig. 42 shows a subscriber line circuit similar to the subscriber line circuit disclosed in Fig. 6 of Krecek Patent 2,368,666, supra, except that the equipment for completing a call to a second choice of trunks in a two-outlet system is omitted.

Fig. 43 shows, in skeletonized form, that part of the system disclosed in Figs. 1 to 9, inclusive, and Figs. 13 to 19, inclusive, of Large-Singer Patent 2,372,329, supra. For an understanding of the apparatus shown in Fig. 43, reference may be made to Figs. 1, 2, 8 and 9 of Patent 2,372,329.

The numbering of the various pieces of apparatus and parts of the circuit shown on the various figures have been kept to a rigid plan. Thus all relays shown in each of the respective figures have reference characters consisting of numerals and letters, the numerals shown as prefixes corresponding in each case to the number of the figure in which the particular relay is located. All other parts or elements in the circuits are designated with numerals only, for instance, those parts of Fig. 2 are designated with numerals between 200 and 299, those in Fig. 3 are designated with numerals between 300 and 399, etc., wherein the hundreds numerals designate in each case the figure in which the particular part is found. In the trunk sequence circuit the equipments respectively allotted to trunks Nos. 99, 98 and 90 are shown in Fig. 11 and those respectively allotted to trunks 89, 80 and 9 are shown in Fig. 12, and the corresponding conductor or elements in each of these trunk equipments are designated with like numerals except that the prefixes and suffixes respectively indicate the figures wherein the respective trunk equipments are located and the trunks to which the equipments are assigned, for example, 11—02—99 is conductor No. 2 of trunk No. 99 in Fig. 11, 12—02—89 is the corresponding conductor No. 2 of trunk 89 in Fig. 12, and 12—02—9 is another corresponding conductor No. 2 but of trunk No. 9 in Fig. 12. At large switching center C the sequence circuits, the miscellaneous alarm circuit and the all-trunks-busy circuit are not shown but are identical, except for the trunk grouping arrangement, with the corresponding circuits shown for large switching center B, and the reference characters for the conductors extending from the sequence circuit to the terminating equipment of trunk No. 9, shown in Figs. 32, 33 and 34, and to the terminating equipment of trunk No. X, shown in Figs. 37, 38 and 39, have prefixes of TS— indicating that they extend to the trunk sequence circuit, not shown.

It is to be understood that any one or more of the switching centers may be a part of the central office to which they are directly connected by trunks, and that any one or more of the small switching centers may be part of the large switching center to which they are directly connected by trunk-lines. This provision is made for various reasons, such as, to shorten the interconnecting trunks and trunk-lines and to utilize available personnel.

GENERAL DESCRIPTION

Reference is made to other patent applications for a complete description of the system shown on the drawings. Only that part of the system that is necessary for a sufficient understanding of the invention is described in detail herein. For example: the parts of the systems which are disclosed in patents of the prior art are shown herein as follows:

(*a*) The terminating equipment of trunk No. 99 and an operator's cord circuit therefor, at central office A are shown in Figs. 20 and 21, respectively;

(*b*) The terminating equipment of trunk No. 89 and an operator's cord circuit therefor, at central office E are shown in Figs. 22 and 23, respectively;

(*c*) The terminating equipment of trunk No. X—89 and an operator's cord circuit therefor, at central office D are shown in Figs. 40 and 41, respectively;

(Large Patent 2,375,856, supra, shows in Fig. 10 the trunk terminating equipment and Large-Singer Patent 2,372,329, supra, shows in Fig. 12 the operator cord circuit, cited under items (*a*), (*b*) and (*c*) listed above. In the present specification the trunk terminating equipments and the operator's cord circuits respectively provided therefor, at central office D are reversed in position with respect to the corresponding equipments and circuits at each of central offices A and E.)

(*d*) The all-trunks-busy circuit shown in Fig. 24 is shown in Fig. 22 of Large Patent 2,375,856, supra;

(*e*) The miscellaneous alarm circuit shown in Figs. 25 and 26 is shown in Figs. 25 and 28, respectively, of Large Patent 2,375,856, supra;

(*f*) The terminating equipment of trunk line TL—1 at large switching center B is shown in Figs. 6 and 14 of Large Patent 2,375,856, supra;

(*g*) The subscriber line circuit terminating at the link circuit located at large switching center B and shown in Fig. 42 is of the attended local subscriber station type and is substantially the same as that shown in Fig. 6 of Krecek Patent 2,368,666, supra, except that the equipment for a second choice of trunks for a two-outlet system is, as hereinbefore stated, omitted;

(The Krecek patent shows the subscriber line circuit adapted for connection to a toll subscriber station unattended and attended, and a local subscriber station attended.)

(*h*) The terminating equipment of trunk line TL—1, the link circuit and the subscriber line circuit at small switching center F, together with a local subscriber station con-

nected to center F are shown skeletonized in Fig. 43 and for a detailed showing reference may be made to Figs. 1, 2, 8 and 9 of Large-Singer Patent 2,372,329, supra.

The remaining parts of the system are more or less novel in order to attain the results desired by the applicant and these parts are as follows:

(*i*) The link circuit at large switching center B, shown in Figs. 2 and 3;

(*j*) The identical main trunk terminating equipments at large switching center B, that of trunk No. 99 being shown in Figs. 4, 5 and 6, that of trunk No. 89 being shown in Figs. 7, 8 and 9, and that of trunk No. 9 being shown in Figs. 29, 30 and 31;

(*k*) The subscriber sequence circuit in Fig. 10, the trunk sequence circuit in Figs. 11 and 12, and the sequence control circuit in Fig. 13, all being at large switching center B;

(Corresponding identical circuits are also provided for large switching center C but are not shown herein.)

(*l*) The director circuit in Figs. 14 and 16 to 19, inclusive, at large switching center B;

(An identical director circuit is also provided at large switching center C but is not shown herein.)

(*m*) The trunk terminating equipments at large switching center C, that of trunk No. 9 being shown in Figs. 32, 33 and 34, and that of trunk No. X—89 being shown in Figs. 37, 38 and 39;

(*n*) The link circuit at large switching center C shown in Figs. 35 and 36 which is the same as that shown in Figs. 2 and 3, except that Figs. 35 and 36 are reversed with respect to Figs. 2 and 3 because in Figs. 35 and 36 the arrangement shows the trunks connected at the left side of the crossbar switches, whereas in Figs. 2 and 3 the trunks are connected at the right side; (the horizontal rows of contact sets on the crossbar switches shown in Figs. 35 and 36 would ordinarily be numbered to correspond to trunks terminating thereat but for illustration purposes the uppermost horizontal row is shown connected to trunk No. 9 in accordance with the numbering scheme used in Figs. 2 and 3);

(The trunk terminating equipments shown in Figs. 32, 33 and 34 and Figs. 39, 38 and 37 are also the same as that of Figs. 4, 5 and 6 except that they are reversed with respect to Figs. 4, 5 and 6.

A miscellaneous alarm circuit and an all-trunks-busy circuit, identical with those shown at large switching center B, are also provided for large switching center C, but are not shown.

The correspondence of figures is tabulated as follows:

This specification:	
Fig. 20	Large Patent 2,375,856, Fig. 10
Fig. 21	Large-Singer Patent 2,372,329, Fig. 12
Fig. 22	Large Patent 2,375,856, Fig. 10
Fig. 23	Large-Singer Patent 2,372,329, Fig. 12
Fig. 24	Large Patent 2,375,856, Fig. 22
Fig. 25	Large Patent 2,375,856, Fig. 25
Fig. 26	Large Patent 2,375,856, Fig. 28
Fig. 27	Large Patent 2,375,856, Fig. 6
Fig. 28	Large Patent 2,375,856, Fig. 14
Fig. 40	Large Patent 2,375,856, Fig. 10
Fig. 41	Large-Singer Patent 2,372,329, Fig. 12
Fig. 42	Krecek Patent 2,368,666, Fig. 6
Fig. 43 (skeletonized)	Large-Singer Patent 2,372,329, Figs. 2, 3, 8 and 9

Should it be desirable to furnish a line hunting arrangement for a group of subscriber lines terminating at a subscriber's premises local to an automatically operated switching center, each line of the group, except the last line, would be modified as shown in Figs. 29 and 30 of Large Patent 2,375,856, supra. This patent together with the patents referred to herein are made a part of this application as if fully included herein.

In some cases in order to avoid the tracing of a plurality of conductors through one or more sheets, these conductors are shown terminated on one sheet in a dot and dash line designated as a single conductor, and the dot and dash line is extended over one or more sheets to a point where the plurality of conductors are again shown.

Reference is made herein to inward and outward calls. An inward call is one that originates at or beyond a central office and terminates at a subscriber station local to a large switching center or a subscriber station connected directly to a small switching center which is connected by trunk-lines to the large switching center. An outward call is one that originates at a subscriber station locally connected to a large switching center and terminates at or beyond a central office, or at a subscriber station locally connected to a small switching center, extends through a large switching center and terminates at a central office.

The complete operation of the system is set forth hereinafter under various headings as follows:

Link circuit at large switching center B

This circuit (Figs. 2 and 3) acts as a selectable connecting medium between trunk circuits extending to central office A, central office E, and large switching center C, and trunk-lines extending to small switching center F and subscriber lines respectively extending to attended local subscriber stations, attended and unattended toll subscriber stations, and groups of subscribers' lines respectively extending to local subscriber premises. It utilizes as its connecting medium a coordinate, or crossbar, switch structure. The subscriber station line circuit, the trunk-line circuit extending to small switching center F and the groups of trunk circuits respectively extending to central offices A and E, and to large switching center C are directly associated with the respective "holding" magnets of the link circuit, these magnets being shown at the bottom of the vertical rows of contact sets. A selecting magnet is provided for each horizontal row of contact sets and these selecting magnets are respectively connected to those trunk circuits which extend to central offices A and E and large switching center C. The link circuit comprises a switching instrumentality well known in the art as a "crossbar switch," certain forms of which are described in United States Patents 2,021,329 and 2,047,383, granted to J. N. Reynolds on November 19, 1935, and July 14, 1936, respectively.

Fundamentally the crossbar switch consists of three major functional parts: (*a*) ten separate vertical circuit paths, (*b*) ten separate horizontal circuit paths, and (*c*) a mechanical means for connecting any one of the ten vertical paths to any one of the ten horizontal circuit paths by operation of electromagnets. Primarily the switch is a multiple relay structure with ten relay-like units, each unit having an operating, or "holding," magnet and ten sets of contacts in a vertical row. The switch arrangement provides a rectangular field of contacts in ten vertical rows and ten horizontal rows or a total of 100 sets of con-

tacts, one set at each "crosspoint." These crosspoint contacts are operated independently of each other by a coordinate operation of the horizontal and vertical bars. The horizontal bars are respectively controlled by the ten horizontal or "selecting," magnets and the vertical bars by ten vertical, or "holding" magnets. Any set of contacts in any vertical row may be operated by first operating the selecting magnet corresponding to the horizontal row in which the set of contacts is located, and then by operating the holding magnet associated with the vertical row. Since the contacts are held operated by the holding magnet alone, the selecting magnet is operated but momentarily and is released as soon as the holding magnet is operated. After the selecting magnet is released, other connections may be established through the switch by the operation of other selecting and holding magnets. It is thus apparent that ten connections can be established through one switch, one for each of the horizontal paths. Ordinarily, in the 100-point crossbar switch each of the ten vertical units or circuit paths, is wired to a subscriber line or a trunk-line which extends to small switching center F and each of ten horizontal circuit paths is connected to a trunk. With such an arrangement, any one of the ten subscriber lines or trunk-lines may be connected to any one of the ten trunks. The number of subscriber lines or trunk-lines, or both, may be increased in multiples of ten by providing an additional switch of 100 points for each multiple with ten different lines or trunk-lines respectively connected to the vertical paths of each additional switch, and by wiring in tandem, the horizontal contact multiple of each additional switch to the horizontal multiple of the first switch and the switches subsequently added thereto. When switches are added to increase the number of subscriber lines and trunk lines each switch is referred to herein as a "bay." The number of trunk circuits may be increased in multiple of ten by providing an additional 100-point switch for each multiple, with ten different trunks respectively connected to the horizontal paths of each additional switch; each switch added to increase the number of trunks has its own ten holding magnets for the ten vertical units thereof, and the holding magnets of each of ten vertical units of one switch are respectively arranged when operated to operate the corresponding holding magnets of the vertical units of the switch immediately above it.

In the system described herein there are provided ten 100-point switches Nos. 0 to 9 for furnishing access to 100 trunks and these ten switches, when so arranged, are referred to herein as one bay. The ten trunks Nos. 90 to 99 of switch No. 9 extend to central office A, the ten trunks Nos. 80 to 89 of switch No. 8 extend to control office E, and the ten trunks Nos. 0 to 9 of switch No. 0 extend to large switching center C; the trunks terminating on each of the seven intermediate switches, not shown, may also extend to office A, office E, center C, and/or any other central offices and switching centers that may be provided. In order to satisfy the purpose of the present invention certain of the vertical units, ordinarily assigned to subscriber lines and trunk-lines as hereinbefore stated, are instead respectively connected in multiple to the trunks of those groups extending to central offices A and E and large switching center C. When a horizontal row of contact sets is prepared by a selecting magnet, and a holding magnet which is associated with one of the vertical rows of contact sets is operated, the contacts at the crosspoint of the row associated with the operated selecting magnet and the row associated with the operated holding magnet are brought into conductive engagement. Immediately thereafter, the selecting magnet may be released as hereinbefore stated, and other contacts of the vertical row wherein the engaged sets are located will not be brought into engagement when other selecting magnets are operated, but the set of contacts already engaged in a connection will remain engaged until the holding magnet which caused them to become engaged, is released. As above stated as one of the features, the trunks extending from central offices A and E and large switching center C which respectively terminate on horizontal rows of contact sets are also connected in multiple to certain vertical rows, respectively, of contact sets, in order to provide for two-way selection in establishing a "through" connection over entire connected main trunk circuits.

Should a call be received over a trunk, such as trunk No. 99, for a local subscriber line shown in Fig. 42 as being connected to the holding magnets associated with the first vertical row of contact sets, the director circuit, as will be hereinafter described, would obtain access to a hunting conductor associated with the called line and connect thereto ground for operating the lowermost of the holding magnets associated with the called line. The holding magnet which is the first one of crossbar switch No. 0, upon operating, causes each of the other holding magnets in the same vertical row associated with the called line but respectively located on the other crossbar switches Nos. 1 to 9, to operate. In the link circuit shown in Figs. 2 and 3 the operated holding magnets are those shown, for example, associated with the first vertical row from the left. The ten holding magnets 3H—S—0 to 3H—S—8 and 2H—S—9 respectively provided in the first vertical row on the ten switches Nos. 0 to 9 are furnished for completing calls to and from the above-mentioned called subscriber line; those associated with the second vertical row are furnished to complete calls to and from a trunk line extending to small switching center F; those associated with the third vertical row are furnished to complete calls to trunk No. 9 extending to large switching center C; those associated with the fourth vertical row are furnished to complete calls to trunk No. 89 extending to central office E; and those associated with the fifth vertical row are furnished to complete calls to trunk No. 99 extending to central office A. An additional vertical row of holding magnets on the same bay or any one of additional bays is understood to be furnished for each of (1) other local subscriber lines (not shown), (2) other trunk-lines (not shown) extending to switching center F, (3) trunk-lines to other small switching centers that may be provided, (4) other trunks to center C and offices A and E and (5) the trunks to other switching centers and central offices (not shown) that may be desired. As hereinbefore stated each of the trunks extending from center B to any one of the central offices or any one of other large switching centers and arranged for "through" connections, is connected in multiple to a vertical and horizontal row of contact sets. For example, trunk No. 99 which is shown connected to the uppermost horizontal row of contact sets is shown also connected to the fifth

vertical row from the left. Each switch bay, such as shown in Figs. 2 and 3, is, therefore, capable of establishing in either direction a call between (1) two main trunks of groups incoming from different central offices or from different switching centers or from a central office and a switching center, (2) any main trunk of any one of the incoming groups and any one of the local subscriber lines, and (3) any of the main trunks of any of the incoming groups and any trunk-line extending a small switching center such as switching center F.

The functions of the link circuits are:

(1) When a selecting magnet, that is, one that is associated with a particular main trunk circuit and a holding magnet are operated in the proper sequence, the particular main trunk circuit with which the operated selecting magnet is associated will be connected to another main trunk circuit or to a trunk-line or to a subscriber station line circuit with which the operated holding magnet is associated.

(2) Off-normal contacts on the selecting magnets insure, upon the establishment of the connection that the magnets are operated in the correct sequence.

(3) When the holding magnet is operated, it will lock under control of the main trunk circuit in order that the operated selecting magnet, or selecting magnets as in the case when multiple switch bays are furnished, may be released.

(4) The holding magnet contacts perform the "cut-off" functions required in the associated subscriber line circuit or its equivalent, upon the establishment of a call.

In an idle condition all magnets are released and the tip and ring conductors of the subscriber lines, trunk-lines extending to switching center F or of a calling main trunk extending to central office A or E or large switching center C will be open, or in a spacing condition, at their respective terminations at the distant offices when such lines and trunks also are in their idle condition.

For a more complete description of the link circuit, reference is made to Large Patent 2,375,856, supra.

Terminating equipment located in large switching center at office B, of main trunk No. 99 extending to central office A

This circuit (Figs. 4, 5 and 6) of trunk No. 99 possesses automatic signaling supervision features, is arranged to terminate at large switching center B a trunk extending from central office A, and may be provided with full-duplex standard toll line facilities shown and described in Krecek Patent 2,368,666, supra. To differentiate from the trunk-line extending to small switching center F, this trunk is referred to herein as one of the main trunks and it differs in another way in that it permits selection in either direction, that is, it is arranged for connection automatically to another main trunk and employs straightforward supervision principles on a full-duplex operation basis.

Main trunk No. 99 functions on a connection to a local subscriber line or to a trunk-line extending to small switching center F in a manner very similar to that disclosed in Large Patent 2,375,856, supra. However, on a call to another main trunk such as trunk No. 89 extending to central office E or trunk No. 9 extending to large switching center C, the function is greatly different in order to permit the satisfactory completion of a connection between main trunks in either direction. Essentially, during the transmission stage, the trunk circuit termination of main trunks Nos. 99, 89 and 9 remains in a full-duplex arrangement on "through" calls and the supervision between any two of these main trunks connected together is handled over separate conductors, such as conductor 1113 of the outward supervisory path and conductor 1114 of the inward supervisory path, also on a full-duplex basis.

On calls to and from a subscriber station, local to large switching center B, and to and from a trunk-line extending to small switching center F the functions of a main trunk circuit at center B are the same, and therefore, a statement setting forth the functions with respect to calls to and from a local subscriber station will suffice for a statement setting forth the functions with respect to calls to and from a trunk-line extending to center F, where the interval required for the routing of the outward call is timed.

On calls from a subscriber station local to large switching center B, to large switching center C or through large switching center C to central office D, the call must first be routed to central office A or E, depending upon which of the two central offices terminates the group of trunks to which the calling subscriber line has access, or whether the two central offices are arranged on a double outlet basis with respect to switching center B, as described in Krecek Patent 2,368,666, supra. Assuming that the first choice group of trunks selected by the calling subscriber, extends to central office A then the call to large switching center C is received by an operator at central office A and the connection therefor is established by the operator in the same manner as a call originating at central office A. Should the subscriber select the second choice group of trunks which will be assumed herein to extend to central office E then the call to large switching center C is received by an operator at central office E and the connection therefor is established as though the call originated at central office E. In this manner the operator at a central office has supervision over all subscriber calls even though they originate at the switching centers.

Each of the main trunks terminating at a large switching center has terminating equipment identical with that shown in Figs. 4, 5 and 6.

Main trunk No. 99 is one of a group arranged for a double outlet at large switching center B.

Functions of the terminating equipment for a main trunk at large switching center B

(1) On an outward call from large switching center B to a central office when an idle main trunk is preselected by the sequence circuit, the terminating equipment sends a continuous "mark," that is, continuous current, to the central office and lights at the switching center B the busy lamp of the selected trunk.

(2) Under condition of paragraph (1) the terminating equipment awaits the reception of "ringing current" from the central office as a trunk verification test that the "mark" was received at the central office, before ordering the link circuit at large switching center B to connect the calling subscriber's line or a calling trunk-line to the seized idle main trunk.

(3) Under the conditions of paragraph (1) the terminating equipment simultaneously with the

sending of the "mark" connects ground to a conductor, such as conductor 2509—99 (Fig. 4) for the terminating equipment of main trunk No. 99, extending to the winding of relay 25TK of the miscellaneous alarm circuit to set up an interval of definite duration required for the routing of the outward call.

(4) If the link circuit at large switching center B has connected a calling subscriber line or a calling trunk-line to one main trunk circuit extending to a central office, the sequence circuit is dismissed and the calling line so connected is held connected to the selected idle main trunk under control of the equipment at the calling station while the selected trunk is made busy to other calling subscriber lines and calling trunk-lines as well as other calling main trunk circuits.

(5) Under the conditions of paragraph (3) if an interval of time as determined by the miscellaneous alarm circuit has been exceeded without the appearance of "ringing" current transmitted from the called central office, the miscellaneous alarm circuit causes the trunk busy lamp at the switching center B to become extinguished and the particular main trunk circuit is removed from service, the subscriber at the calling station being given an opportunity to attempt to place the outward call over the next idle available main trunk circuit while a characteristic trouble signal is sent from the sequence circuit to the main trunk circuit for retransmission to the called office.

(6) While awaiting the answer of the operator at the called office, the subscriber can "flash" the called operator. Under this condition this terminating equipment sends "mark" and "space" signals to the called office in unison with the operation of the power switch or similar means at the calling subscriber station connected locally to large switching center B.

(7) If the calling subscriber abandons an outward call before the operator at the called central office answers, this circuit sends a permanent "space" signal to the called office and when the reception of continuous ringing current ceases, orders the link circuit to disconnect the calling line or trunk-line from the connected main trunk circuit, removing the busy appearance of the main trunk circuit to other calling subscribers and also extinguishing the trunk-busy lamp.

(8) When the operator at the called central office answers the outward call, the continuous ringing current is replaced by a "mark" signal, upon the reception of which this circuit advances to the half duplex transmission stage in which it is capable of distinguishing between normal teletypewriter signals, break signals or disconnect signals from the either end.

(9) When a prolonged "space" signal is received from the calling subscriber station, this circuit transmits a "space" to the called central office and after approximately two-thirds of a second ascertains if the calling subscriber has disconnected. If the subscriber has disconnected this circuit continues to send a "space" signal to the called central office, returns to the full duplex system of transmission but remains in condition to permit the re-ring of the disconnected calling subscriber station. If the "space" signal is a result of a flash from the calling end, the circuit functions as if it had disconnected during the "off" operation of the power, or calling, switch at the calling end and returns to half duplex transmission, transmitting a "mark" as soon as the switch is again turned on. If, however, the "space" signal from the calling subscriber's station resulted from the transmission of a "break" from the calling end, this circuit replaces the "space" signal sent to the called central office by "ringing" for the remainder of the "break" signal received from the calling end, remaining at the same time in the half duplex transmission condition. At the conclusion of the "break" signal this circuit transmits a "mark" to the called central office.

(10) When a prolonged "space" signal is received from the called central office, this circuit continues to send a space signal to the calling end. After two-thirds of a second has elapsed followed by the reception of "ringing" current from the called central office, this circuit remains in the half duplex transmission condition and continues to send a "space" signal to the calling end. After 5.5 seconds of "space" signal to the calling end, this circuit sends periodic mark and space signals to the calling end as long as the reception of "ringing" current from the called central office continues. When a mark signal is received from the called central office, at the end of the "ringing" current period, this circuit sends a mark signal to the calling end.

(11) Under the condition of paragraph 10, if a continuous space signal is not followed by "ringing" current, the circuit acts exactly as described under paragraph 10, provided the calling end's disconnect signal has not been registered in the main trunk. If the calling end's disconnect signal has already been registered, the reception of a space signal of one second duration from the called central office causes this circuit to order the link circuit to disconnect the calling line or calling main trunk from the called main trunk, and returns the called main trunk circuit to normal.

(12) When a main trunk circuit is seized at the distant central office for an inward call, this circuit receives a mark signal which after one-half second has elapsed results in ordering the trunk sequence circuit to connect a director circuit to the main trunk circuit, at the same time marking the main trunk busy to outward calls and lighting the trunk busy lamp.

(13) If the attached director circuit fails to get ready to receive teledirecting pulses, the miscellaneous alarm circuit after an interval of time orders the trunk sequence circuit to manufacture a characteristic trouble signal and transmits it to the main trunk circuit for the retransmission to the calling office, removing the director circuit and extinguishing the trunk busy lamp.

(14) When a director circuit is attached and ready to receive teledirecting pulses, it orders this circuit to send a continuous mark signal to the calling office.

(15) With the director circuit attached if a prolonged space signal is received from the calling office as a result of the operator's disconnect signal, this circuit after one-third second orders the trunk sequence circuit to dismiss the director circuit and after one second returns to normal.

(16) With the director circuit attached, if a two-thirds second space signal followed by "ringing" current is received as a break signal from the operator, this circuit orders the trunk sequence circuit to release the director circuit. If at the conclusion of "ringing" current, a mark signal is received, the trunk sequence circuit is again ordered to connect a director to the main trunk circuit but if at the conclusion of ringing" current, a space signal is received, the main trunk returns to normal.

(17) When the teledirecting pulses are received, they are transmitted to the director circuit which decodes the information and tests the called subscriber's line or the called main trunk extending to another distant switching point, ordering the link circuit to connect the called line or called main trunk to the calling main trunk if the called line or called main trunk is idle.

(18) If the called line or called main trunk is busy, out of order or unassigned, signals characteristic of these conditions are produced in the director circuit, transmitted to the calling main trunk and retransmitted to the calling central office.

(19) When the called line or called main trunk is attached to the calling main trunk, the trunk sequence circuit and the director circuit are dismissed and the called line or called main trunk again sends a space signal to the calling office. If the circuit is not arranged for automatic ringing, the inward operator at the calling central office sends a ringing current signal which in this circuit orders the ringing to be connected to the called line, but not to the called main trunk.

(20) When the subscriber at the called station answers, this circuit during the silent interval disconnects the ringing set, sends a mark signal to the calling office and advances into half duplex transmission stage in which it is capable of distinguishing between normal teletypewriter signals and break or disconnect signals from either end.

(21) If the called subscriber line is to be started on an unattended basis, continuous ringing is received from the calling office causing continuous ringing to be sent to the subscriber's station as described in the Large Patent 2,375,856, supra.

(22) After continuous ringing has exceeded nine seconds in attempt to start an unattended subscriber's station, this circuit sends a permanent mark to the called station. If the subscriber's station has been started, this circuit sends a mark to the calling office and advances to the half duplex transmission stage. If the station has not started after nine seconds, the circuit continues to send a space signal to the calling office and a mark to the subscriber's station until appropriate action is taken by the operator at the calling office.

(24) After a subscriber has disconnected the operator at the calling office can re-ring the subscriber station.

(24) This circuit is provided with jacks, such as jacks **508A** and **509B** for trunk No. **99** or jacks **808A** and **809B** for trunk No. **99**, or jacks **3008A** and **3009B** for trunk No. **9**, each circuit being shown in detail, to permit manual connection of subscribers' lines or trunk lines in case of failure of the automatic equipment.

(25) Jacks such as those designated **508A**, **509B**, **630SEND** and **631REC** or **808A**, **809B**, **930SEND** and **931REC** or **3008A**, **3009B**, **3130SEND** and **3131REC** are also provided to permit the testing and routing of the main trunk circuits by means of the test circuit (not shown herein but disclosed in the Krecek Patent 2,368,666, supra).

Director circuit in large switching center B

This circuit (Figs. 14, 16, 17, 18 and 19) is designed to receive directly the directing teletypewriter pulses sent by the operator at any one of the distant central offices and to decode, or decipher, these pulses thereby causing the selection of the called subscriber line connected to the large switching center or a trunk-line extending to small switching center F or a main trunk extending to one of the other distant switching points. It is, in other words, adapted for selecting "through" trunks to distant switching points as well as selecting subscriber lines and trunk-lines.

Functions of the director circuit are as follows:

(1) This circuit when selected by the trunk sequence circuit on an inward call from one of the central offices starts the receiving distributor motor.

(2) This circuit immediately upon seizure by the trunk sequence circuit tests to detect the reception of a "mark" signal from the calling main trunk circuit.

(3) This circuit immediately upon seizure notifies the miscellaneous alarm circuit that it has been seized and is in the act of bringing the motor of the receiving distributor to a desired speed. The first information is used by the alarm circuit for regulating the timing interval and the second for determining the cause of trouble if an alarm is brought in.

(4) This circuit is arranged to detect when the motor of the receiving distributor attains its desired speed.

(5) This circuit is arranged to send a "director ready" mark signal to the calling main trunk circuit when the up-to-speed condition of the motor has been detected. The main trunk circuit in return retransmits this signal to the distant calling central office as an indication to the operator that a call may be routed through switching center B.

(6) This circuit is arranged to detect the sending of the "director ready" mark to the calling main trunk circuit.

(7) When the rotating distributor cams come to rest and the motor attains its desired speed this circuit is arranged to: (*a*) disconnect the up-to-speed detecting circuit from the motor governor control circuit; (*b*) make the receiving contacts of the distributor effective; (*c*) place the start magnet of the distributor under control of telegraph signals received from the trunk and (*d*) if the director circuit has also detected both the reception of "mark" from the calling main trunk and the transmission of "director ready" signal to the calling main trunk, send a notification to the miscellaneous alarm circuit.

(8) This circuit is arranged following the function set forth in paragraph (7) to separate the telegraph characters received into their dot elements.

(9) This circuit is arranged to disregard all characters received from the distant office until the "Figures" or "Letters" telegraph character is received.

(10) The signal corresponding to the "Figures" or "Letters" teletypewriter character and received from the distant central office will indicate that the operator has recognized the "director ready" signal and will cause this circuit to accept either the next two character signals received after "Figures" as significant characters of the called number, or the next single character signal received after "Letters" as the significant character of the called main trunk group.

(11) This circuit is arranged to distinguish between the preliminary characters "Figures" and "Letters" when either, forming a part of a called number, is received from a distant office. How-

ever, if the preliminary character received is "Letters," this circuit is arranged to ascertain the group of main trunks extending to the office or center desired by the calling operator, and by means of a hunting circuit the first idle trunk of the group is seized for connection to the calling trunk.

(12) This circuit is arranged to test a main trunk in the trunk group desired and to cause to be originated the proper report signals to be transmitted to the calling operator. Certain of these report signals may denote conditions of busy, out-of-order and the like. This circuit also informs the calling main trunk and that it is going to be connected to another main trunk instead of to a local subscriber line or a trunk-line.

(13) Upon receipt of the first significant character, after the preliminary character when such is "Figures," the director circuit will select the group of ten lines which contains the desired local subscriber line or trunk line.

(14) If the first significant character received does not correspond to a group of ten lines that is desired, the circuit will not use the second significant character to reach an undesired group of ten lines or ten trunks.

(15) Upon receipt of the second significant character of the called number, the director circuit will select and test the desired subscriber's line or the desired trunk-line and disregard any additional characters sent to the director.

(16) If the called line or trunk-line or called main trunk has been made "out-of-order," a series of "Q" teletypewriter signals will be transmitted as an indication of this condition to the operator at the calling distant office.

(17) If the called line or trunk-line or called main trunk is busy because of a previously established call or because of busy conditions placed on it by the test circuit, a series of "K" signals will be transmitted to the operator at the distant calling office.

(18) If the operator at the distant calling office has transmitted first and second digits for which no subscriber's line nor trunk-line is assigned or has transmitted an impossible combination of digits, a series of "V" signals will be returned to the operator at the distant calling office.

(19) If the called line or trunk-line or called main trunk is idle, the director circuit wil cause the link circuit to connect the called line or called trunk to the calling main trunk circuit. The director then will be released and restored to the idle condition in preparation for the routing of the next inward call.

(20) The miscellaneous alarm circuit is arranged to allow two seconds for the director to become off-normal, four seconds to complete a self-imposed preliminary test and give satisfactory evidence to the alarm circuit and a total of ten seconds for the director to complete its task in any event.

(21) If the director circuit is not off-normal in two seconds, the miscellaneous alarm circuit removes the calling main trunk from service, but puts the director back into service.

(22) If the director becomes off-normal, but the distributor motor fails to attain its desired speed in four seconds, the director is removed from service, and the calling main trunk is taken out temporarily. A lamp of the director circuit lights and a corresponding minor alarm is sounded.

(23) If the director circuit is not released in ten seconds, a re-order or "T" series of signals will be transmitted to the distant calling office for a period of one second followed by a disconnect condition.

(24) If the "director ready" signal fails to reach the associated loop repeater or a mark from the calling main trunk circuit is not registered in the distributor circuit, both director and the main trunk circuit may be removed from service only under the condition that there is a second director circuit available as disclosed in Krecek Patent 2,368,666, supra, although there is only one shown herein. In this case a minor alarm is sounded and appropriate tell-tale lamps are lighted.

Sequence circuit in large switching center B

This circuit (Figs. 10, 11, 12 and 13) is arranged to permit the routing of only one call at a time in either direction through the large switching center.

The functions of the sequence circuit are as follows:

(1) This circuit is arranged to afford to only one trunk-line or only one subscriber line local to large switching center B at any one time, the privilege of completing a call through the large switching center when no inward call is in the process of completion.

(2) This circuit is arranged to permit only one call at any one time from the distant interconnected offices to seize a director circuit and to be routed and established through large switching center B, provided the routing privilege has not been seized by a local subscriber calling one of the distant interconnected offices.

(3) In case of trouble on an outward call attributed, after a two second interval, by the alarm circuit in general, to the subscriber line terminating circuit or trunk-line to a smaller switching center or the link circuit or any part of this circuit used in an outward call, this circuit is arranged: (*a*) to attempt to free the sequence circuit, (*b*) to remove and lock out of future outward service, under control of the release key, the particular subscriber station and the group containing the particular subscriber station, or the particular trunk-line and the particular group containing the calling trunk-line, and (*c*) to light a lamp indicating the group of trunk-lines or subscriber stations placed out of outward service.

(4) In case of trouble on an outward call in the trunk conductors or parts of the repeater or trunk relay equipment at switching center of the central office as indicated by the alarm circuit after a two second interval, this circuit is arranged: (*a*) to attempt to free the sequence circuit, (*b*) to remove and hold the trunk out of outward service under control of the release key, (*c*) to flash a lamp indicating the trunk removed from outward service. If the outward path to the distant interconnected office is not faulty, the calling subscriber's line or calling trunk-line is connected to the next idle satisfactory trunk available.

(5) This circuit is arranged to allot, in a predetermined order, idle main trunks to subscribers' lines and trunk-lines calling a distant interconnected central office. If the large switching center is arranged for a single outlet or two outlets without overflow provisions between outlets as disclosed in Krecek Patent 2,368,666, supra, this circuit is arranged to hunt for an idle trunk in the trunk group to which the calling subscriber

station is predeterminately connected or to which access is desired and failure to find one to connect to the "all-trunks-busy" circuit associated with that group of trunks. However, the trunk sequence circuit at large switching center B is shown herein as providing for an overflow hunting operation whereby two trunk groups have access to a single all-trunks-busy circuit. The overflow arrangement permits a call directed to a particular trunk group to cause an action similar to a hunting operation in that particular trunk group thereafter to cause an overflow hunting operation in a second group of trunks, and finally to cause the operation of the all-trunks-busy circuit. These trunk groups are sometimes referred to as first and second outlets or choices and each subscriber line may have the first or the second trunk group as its preferred outlet or choice.

(6) This circuit is arranged to cause the selected trunk circuit to repeat a calling signal to the distant interconnected central office when seized by a calling subscriber.

(7) In case all trunks of one or two groups are busy, as mentioned above, this circuit is arranged to cause the "all-trunks-busy" circuit to measure the length of time this condition persists.

(8) In case of a subscriber placing an outward call when all trunks to which he might be connected are busy, this circuit is arranged to connect the calling subscriber's station to the "all-trunks-busy" circuit which manufactures an "all-trunks-busy" signal which is sent to the calling subscriber's station.

(9) This circuit is arranged to advance the trunk chain (Figs. 11 and 12) to the next idle trunk immediately after each calling subscriber has obtained a routing through the large switching center and before the sequence circuit is permitted to handle the next call in either direction.

(10) This circuit is arranged to keep the trunk chain in a "fixed" condition during the entire period that the sequence circuit is attempting to route an outward call through the large switching center.

(11) This circuit is arranged to permit the miscellaneous alarm circuit to function to time the duration required for routing an inward call to the large switching center.

(12) In the case of a failure to complete the routing of an inward call where it has been determined that the trouble may be in the trunk or trunk sequence circuit, the miscellaneous alarm circuit causes this circuit to function to (*a*) remove or hold the trunk out of service under control of a key, at the same time flashing a lamp associated with the trunk circuit, (*b*) attempt to free the sequence circuit and (*c*) send the characteristic re-order signal to the central office if the out-of-order period has exceeded ten seconds.

(13) In case of a failure to complete the routing of an inward call when it has been determined that the trunk or trunk sequence circuit has not caused failure, the miscellaneous alarm circuit causes the sequence circuit to act as described in paragraph No. 12 except that the trunk is removed temporarily under control of a mark signal from the distant interconnected office and the lamp lights steadily instead of flashing.

(14) If one or more trunk calls from a distant interconnected office are awaiting service this circuit is arranged to start and keep the distributor motor at the desired speed.

(15) The calling trunk is provided with means whereby it is warned by the director circuit that it is about to be connected to a "through" trunk and not to a subscriber line or a trunk-line.

The subscriber sequence circuit as shown in Fig. 10 is equipped with an ST and an AL relay, such as relays 10ST—0 and 10AL—0, for each subscriber line or each trunk-line. Relays 10ST—0 and 10AL—0 are assigned to the subscriber line represented by conductors 301 which extends to subscriber No. 90 which is local to large switching center B. Relays 10ST—1 and 10AL—1 are assigned to the trunk-line No. 1 represented by conductors 302 and extending to small switching center F (Fig. 43), which trunk-line with respect to the link circuit on the cross-bar switch, is equivalent to subscriber's line 301. Each group of ten subscriber lines which may include one or more trunk-lines extending to small switching center F, is equipped with an ST1, an AL, an AL—1 and a BO relay, such as relays 10ST1—G0, 10AL—G0, 10AL1—G0 and 10BO—G0 for the first, or zero, group. All these relays of each group are used in routing through an outward call except the BO relay which is used to remove the group from outward service. In general, subscriber lines and/or trunk lines of a group seek the privilege of the use of the subscriber sequence circuit. The subscriber, upon obtaining the privilege, has permission to use the subscriber's group sequence circuit, if permission by the latter circuit and the trunk sequence circuit is given, to route his call through large switching center B.

The trunk sequence circuit, as shown in Figs. 11 and 12, is, for each main trunk to the distant interconnected central offices A and E and large switching center C, equipped with an ST2, an AL and AL1, a BO, a BO1, a CH and an AD relay and one of the "make" contacts on one of the H, H1 and H2 relays, or any one of the additional H relays that may be required for the number of main trunk groups employed. The relays provided in the trunk sequence circuit for main trunk No. 99 are 11ST2—99, 11AL—99, 11AL1—99, 11BO—99, 11BO1—99, 11AD—99 and 11CH—99 relays which are shown in the outermost left-hand vertical column, or set, in Fig. 11. The upper armature of the CH relay in each set is connected to one of the "make" contacts on one of the H relays, such as relays 13H—0, 13H—1 and 13H—2, the number of H relays required, as hereinbefore stated, depending upon the number of trunks provided. For practical reasons a group consists of one to six trunks, although in the present application a group is indicated as consisting of as many as ten trunks. The "make" contact on an H relay holds the trunk chain and advance circuit consisting of the CH and the AD relay of each trunk set in a fixed condition while a call is being routed through large switching center B. In general, the trunk circuit receives normal preference over a subscriber's line or a trunk-line circuit in the sequence circuit chain. When a trunk call obtains permission to be routed through large switching center B the trunk circuit is connected to a director circuit which decodes, or translates, the pulses received from the operator at the distant interconnected central office into the number of the desired subscriber line, or desired trunk-line, or in the case of a "through" connection the incoming pulses are translated into a character representing the desired group of main trunks. As common office equipment the sequence circuit provides relays 13LS—1 and 13LS1—1 as a common start circuit for the first

group of trunks, that is, a group extending to a single outlet, or one distant interconnected central office. Relays 13LS—2, 13LS1—2 and 13TR are supplied as in this case where there is a second trunk group existing at switching center B extending to a second outlet, that is, the same or another distant interconnected central office. Relay 13TR is arranged to change the order of the trunk chain and advance circuit in such a manner that all trunks in the preferred group are tested for busy before a trunk is selected in the other group existing at switching center B although all trunks of both groups are available to a calling line or trunk-line when two groups of trunks are arranged for a double outlet with provision for overflow of calls between the two outlets. The trunk chain and advance circuit (AD and CH relays) of the trunk groups respectively assigned to two outlets herein shown as the trunk groups respectively including trunks Nos. 99 and 88, does not include the AD and CH relays assigned to those trunks, such as trunk No. 9, of the group extending to large switching center C. The group of trunks extending to center C has its own trunk chain and advance circuit.

The subscriber's sequence circuit consists of two parts which are used for outgoing calls at large switching center B. The first part, designated subscriber line sequence circuit, permits any one of ten subscribers or trunk-lines to establish an outward call through the circuit, subsequent calling subscribers in the group being served in accordance with their position in the sequence. The second part, designated subscriber group sequence circuit, permits any subscriber line or trunk-line connected through a subscriber's line sequence circuit to establish an outgoing call at center B through the group sequence circuit, subsequent calls from other subscriber line sequence circuits being served in accordance with their position in the sequence.

On outgoing calls at switching center B, the sequence circuit arranges for the link circuit to connect the calling subscriber line, or calling trunk-line, to the first idle main trunk circuit extending to the called office, or to the all-trunks-busy circuit, if required.

The trunk sequence circuit permits any call from the operator at a calling central office to be served before a call from the subscriber group sequence circuit at switching center B. Subsequent calls from operators at the distant central offices are served in accordance with their position in the sequence.

On incoming calls the sequence circuit at switching center B connects the trunk over which the incoming call is received, to the director circuit. When the director circuit has determined the called subscriber line, or the called group of trunk-lines or the called group of main trunks, the link circuit connects such called line or the first idle trunk of the called group to the calling trunk. The sequence circuit then releases the director circuit and is available for routing a new call. If the called line or called trunk group is busy, out of order, or unassigned, the sequence circuit releases the director circuit when the operator at the distant office disconnects after receiving this information from the director circuit, or at the end of about eleven seconds if the operator does not disconnect. Likewise, when a group of subscriber lines is called hunting operation is required as shown in Fig. 30 of Large United States Patent 2,375,856, supra.

In case trouble is encountered on an outgoing call due to the failure of the subscriber line circuit, trunk line or main trunk, link circuit or sequence circuit, the subscriber group in which the calling line or calling trunk line is included is removed from operation in the sequence circuit and from service, and visual and audible alarms are given. In case trouble is encountered on an outgoing call, due to failure of the main trunk circuit, either at large switching center B or at one of the other offices or switching centers, or between the offices and/or switching centers, the trunk is removed from operation in the sequence circuit and from service, and visual and audible alarms are given.

In case trouble is encountered on an incoming call, due to failure of the trunk or trunk sequence circuit, the trunk is removed from operation in the sequence circuit, and from service, and visual and audible alarms are given.

In case trouble is encountered on an incoming call but not due to failure of the main trunk or trunk sequence circuit, the trunk is removed from service temporarily, as long as a "mark" signal is received from the operator at one of the distant central offices, and is restored to the sequence circuit for future operation as soon as it is released at the distant office.

Miscellaneous alarm circuit at large switching center B

This miscellaneous alarm circuit (Figs. 25 and 26) is arranged primarily to time the interval during which the sequence circuit is in use and is arranged to give appropriate alarms, if a specified time limit is exceeded, giving at the same time an indication of the possible circuit in trouble. The circuit is also arranged to give an alarm when the battery or grounded chain of the sequence circuit remains open.

The functions of the circuit are as follows:

(1) On an outgoing call from a subscriber's station or from a calling trunk line extending from small switching center F the miscellaneous alarm circuit times the interval in which the sequence circuit is used to see that it does not exceed 2.5 seconds.

(2) On an outgoing call when the sequence circuit has been used for more than 2.5 seconds the miscellaneous alarm circuit is arranged to indicate whether the trouble is in the main trunk alone or in any of the other circuits called into use. In case the miscellaneous alarm circuit decides that the main trunk is in trouble it is arranged to give a minor alarm, flash a trunk lamp and to cause the removal of the particular main trunk circuit from service. In case the miscellaneous alarm circuit determines that any of the other circuits in use on the particular call is in trouble, the circuit is arranged to light lamp 2501 and to give a minor alarm, and to cause the removal of the subgroup including the calling subscriber line or calling trunk line.

(3) After removing the particular main trunk or the particular subgroup of subscribers' lines and/or the trunk lines from service, the miscellaneous alarm circuit is arranged to detect the ability of the sequence circuit to return to normal and to light lamp 2601 and bring in a major alarm if it fails to do so within one-half second.

(4) On an incoming call to a local subscriber's line, or a trunk line to small switching center F, or to one of the main trunks to a distant office, the miscellaneous alarm circuit begins timing,

as soon as the incoming call has received preference from the sequence circuit, being arranged to time the interval required to obtain a director circuit and to give an alarm if this period exceeds 2.5 seconds. In this case the miscellaneous alarm circuit is arranged to cause the removal from service of the main trunk in trouble, flash the lamp associated with the main trunk and at the same time light lamp 2501 bringing in a minor alarm. The alarm circuit continues to function as indicated in paragraph 3.

(5) When informed over the conductor 1816 that the director circuit has moved off-normal, the miscellaneous alarm waits a total of four seconds for the director circuit to place ground on conductor 1822. The director circuit places ground on conductor 1822 if the distributor motor has attained the desired speed, if the "director ready" signal reached the associated loop repeater and if a mark signal sent over the calling main trunk from the distant office has been registered in the distributor circuit.

(6) If the miscellaneous circuit times out before conductor 1822 is grounded but after conductor 1816 was grounded, the alarm circuit is arranged: (*a*) to cause the associated director circuit to lock in a "stuck" condition; (*b*) to bring in an audible and visual alarm associated with the director circuit; (*c*) after the director circuit has been locked in a "stuck" condition to remove the calling main trunk from service under control of a key and cause a lamp associated with this trunk to flash or if conductors 1818 and 1823 are connected to ground when the alarm circuit times out to remove the calling main trunk from service temporarily under control of a "mark" signal sent from the distant central office, causing a lamp associated with the calling main trunk to light steadily; (*d*) after allowing approximately one-half second, the director circuit having been locked in a "stuck" condition, the miscellaneous alarm circuit is arranged to test for failure of the sequence circuit to release and to bring in an audible major alarm and light the lamp 2601 if the sequence circuit fails to release; (*e*) if the sequence circuit has been released the miscellaneous alarm is arranged to replace the "stuck" director circuit with another spare director circuit if one is available.

(7) If conductor 1822 is connected to ground the miscellaneous alarm circuit permits the director circuit ten seconds to complete all its functions.

(8) If the miscellaneous alarm circuit times out after ten seconds, the alarm circuit is arranged to function as follows: (*a*) connects a source of signals corresponding to a series of "T" characters to the calling main trunk for one second as a reorder signal and then removes the trunk circuit from service under control of a "mark" signal received from the distant calling end lighting a lamp associated with this trunk circuit but returns the director circuit back to service; (*b*) after approximately one-half second tests for failure of the sequence circuit to release and if the sequence circuit fails to release, brings in an audible major alarm and lights the lamp 2601.

(9) The circuit is arranged to prevent the use of a sequence circuit on a new call for one-half second after the sequence circuit has otherwise returned to normal after timing out.

(10) The circuit is arranged to furnish a time delay between the operation of the selecting magnet of the cross-bar switch and the application of ground for the operation of the holding magnet of the cross-bar switch.

(11) The circuit is provided with a key associated with each type of trouble indicator to permit removal of the audible alarm leaving a lamp to indicate the trouble condition and with a key to release each locked-in trouble indication and also alarm cut-off key 2503 which prevents the alarm circuit from timing out.

(12) This circuit is arranged to light connection lamp 2513 as an indication that a selecting magnet of the link circuit has operated.

(13) This circuit is arranged to prevent the director circuit from interfering with the miscellaneous alarm circuit when both director circuits fail or if the single director circuit fails in a single director circuit switching office.

(14) If the grounded battery or ground chain of the sequence circuit remains open for approximately 45 seconds, this circuit is arranged to give a major alarm and light sequence battery lamp 2504 or sequence ground lamp 2505 to indicate chain is open.

(15) This circuit is arranged to prevent the routing of a call if the selecting magnet of a link circuit is falsely operated and to give an alarm that this condition persists for approximately 45 seconds.

All-trunks-busy circuit at large switching center B

This circuit (Fig. 24) is designed for use in a switching center, such as that located at switching center B, as an originating source of "no circuit" signals and "K" signals sent to the calling subscriber or the trunk line under certain conditions, at the same time providing "no circuit" time integrating registers in addition to subscribers' overflow registers.

The functions of this circuit are as follows:

(1) If all trunks reaching a given office or outlet are busy, this circuit is arranged to measure the length of time this condition persists.

(2) When all circuits associated with this circuit are busy, the circuit is arranged to: (*a*) produce and send to each calling subscriber a "letters," or "no circuit," signal; (*b*) register on the subscriber's overflow registers, the number of attempts the subscriber or the trunk line made during the all-trunks-busy period; (*c*) measure the continuous duration of the production of these "letters" signals giving an audible and visual alarm if the time exceeds a predetermined interval; (*d*) continue to produce the "letters" signal as long as any subscriber or trunk line keeps his loop or trunk line closed.

(3) Whenever a trunk becomes idle, this circuit is arranged to produce "K" signals at a speed of approximately 40 words per minute and send these signals instead of the "letters" to the waiting subscribers' trunk lines.

Two trunk groups at large switching center B are arranged for a double outlet with provision with overflow of outward calls, that is, outward calls which find all the trunks of their respective preferred, or primary, groups busy. Such an outward call upon finding a busy condition on all the trunks of its preferred group is transferred to an available idle trunk in the other, or secondary, group. The operator at the central office whereat the secondary group terminates completes the call over a trunk extending directly to the central office at which the preferred group of trunks terminate or over a "through" trunk of a group, not included in the double outlet ar-

rangement, but extending by the way of large switching center B. The all-trunks-busy circuit is equipped with relays 24A and 24B which are respectively responsive to all-trunks-busy conditions of the two groups of trunks of the double outlet arrangement, as described in detail in Krecek Patent 2,368,666, supra.

Terminating equipment of main trunk No. 99 at central office A

This circuit (Fig. 20) provides a termination having automatic signaling supervisory features at a teletypewriter switchboard at the central office A for the circuit of main trunk No. 99 extending to large switching center B. The termination of main trunk No. 99 is shown in detail at office A. The companion terminating circuit at large switching center B is arranged to operate with 0.020 ampere metallic local subscriber lines or with single conductor transmission trunk-lines extending to small switching center F and arranged for two-way transmission on a half-duplex operation basis or with other main trunk circuits similar to trunk No. 99 but extending to other distant offices such as central office E and large switching center C arranged on a full-duplex basis.

Each of the main trunks terminating at a central office has terminating equipment identical with that shown in Fig. 20.

The functions of this circuit are as follows:

(1) In the idle condition both the incoming and the outgoing transmission paths are in spacing condition.

(2) A call from the large switching center B will be received at office A as a mark signal on the outward path extending from center B. This action will be followed in one-half second by the lighting of the busy lamp, application of a busy test potential to the sleeve multiple and the application of 20 cycle dot signals to the inward path extending to large switching center B. After one-half second additional time, the line lamps will light. Mark signals of less than one second duration will not be registered as calls.

(3) In the "call-before-answer" period, if the subscriber recalls, the disconnect intervals will return the outward path to spacing and will extinguish the line lamps. The resumption of the call will relight the line lamps.

(4) If the subscriber whose station is local to large switching center B abandons the call before the operator at central office A has answered, the outward path from switching center B will return permanently to spacing and the line lamp will be extinguished. The 20 cycle dot signals will be removed from the inward path extending to switching center B after four seconds and the busy condition will be removed after an additional one-and-a-half second.

(5) When the operator at the central office A answers the call, the line lamp will be extinguished and a marking condition will supplant the 20 cycle dot signals on the inward path extending to switching center B. The busy lamps will remain lighted.

(6) During communication, signals from large switching center B toward central office A will be transmitted over the outward path. Signals from the central office A to switching center B will be transmitted over the inward path. Between the trunk termination at central office A and the connected cord circuit signals in both directions will be transmitted over the tip conductor circuit. No supervisory action will take place as a result of the teletypewriter signaling. The ring or supervisory conductor to an operator's cord circuit will therefore remain open during transmission.

(7) A "break" signal from the cord circuit will be repeated to the inward path as a spacing signal which will be supplanted by 20 cycle dot signals after a delay of two-thirds of a second. At the end of the "break" signal, the inward path will return to marking. A "break" signal from the subscriber station will appear as a spacing condition on the outward path followed in two-thirds of a second by 20 cycle dot signals. Throughout the entire "break" interval, however, a spacing condition will be applied toward the cord circuit. No supervisory action will result from "break" signals in either direction.

(8) A disconnect from the switching center B will return the outward path to spacing. After one second ground connection will be applied to the ring conductor of the cord circuit to light the supervisory lamp.

(9) A recall from the subscriber station is the same as a disconnect followed by a new call. When the outward path returns to marking as a result of the new call, the ground connection will be removed from the ring conductor to cause the supervisory lamp in the cord circuit to flash.

(10) When the operator at the central office A connects to the trunk to originate a call, a marking condition will supplant the idle, or spacing, condition of the inward path toward switching center B. Ground connection applied to the ring conductor circuit will light the supervisory lamp of the cord circuit.

(11) When the large switching centers B and C and the small switching center F are, in turn, prepared to receive the signals corresponding to the call telegraph directing characters, the outward path extending from switching center B to central office A will become marking. The action of remotely controlling the directing of a call to a desired line or trunk-line or another main trunk extending to another distant switching point, through the agency of the operator's teletypewriter at central office A and the director circuit at one or more switching centers, will be referred to hereinafter as teledirection. This will permit removal of ground from the ring conductor to extinguish the supervisory lamp.

(12) After the operator at central office A has sent the call directing pulses and the desired subscriber line or desired group of main trunks has been selected as the operator teledirected, the outward path toward central office A will return to the spacing condition to relight the supervisory lamp.

(13) When the called subscriber answers, the outward path will again become marking to extinguish the supervisory lamp. Thereafter the circuit will be conditioned to perform the functions outlined above in paragraphs 6, 7, 8 and 9.

(14) If the desired subscriber line or desired trunk-line or desired group of main trunks is busy, out-of-order or unassigned, the switching centers B, C or F will transmit to the central office A, teletypewriter signals to indicate which of the three conditions exist.

(15) When the operator at central office A abandons the call after receiving the busy, out-of-order busy, or unassigned signal by disconnecting from the main trunk, the equivalent of a break signal will be sent to dismiss the switching center call directing equipment. When this

equipment has been dismissed, the outward path toward central office A will be returned to spacing and this will, after four seconds, cause a spacing condition to supplant the 20 cycle dot signals applied to the inward path. After one-and-one-half additional seconds the busy condition will be removed from the main trunk.

(16) If the operator at the central office A disconnects the calling circuit in error during communication, the circuit will revert to the call-before-answer condition as outlined above in paragraph (3) which may be abandoned by the subscriber as outlined in paragraph (4) if the operator fails to reestablish the connection.

(17) When the operator at the central office disconnects from the trunk at the end of a communication following the subscriber's or distant operator's disconnect, the inward path toward the switching center B will return to the idle, or spacing condition. After a delay of one-and-one-half seconds the busy condition will be removed.

(18) In the idle condition both the inward and outward transmission paths are spacing. No relays or vacuum tubes are energized except the relay 20RS which is held to spacing by the spacing condition of the outward path. Relay 20RS will keep condenser 2001 discharged during the idle condition.

Operator's cord circuit and position circuit at central office A

The operator's cord circuit (Fig. 21) and position circuit may be the same as disclosed in Large and Singer Patent 2,372,329, supra.

Terminating equipment located in large switching center B of main trunk No. 89 extending to central office E

This circuit (Figs. 7, 8 and 9) is identical with the circuit (Figs. 4, 5 and 6) of the terminating equipment of main trunk No. 99 located at switching center B and extending to central office A as hereinbefore described.

Main trunk No. 89 is one of a second group arranged for a double outlet at large switching center B.

Terminating equipment of main trunk No. 89 at central office E

This circuit (Fig. 22) is identical with the circuit (Fig. 20) of the terminating equipment of main trunk No. 99 at central office A as hereinbefore described.

Operator's cord circuit and position circuit at central office E

The operator's cord circuit and position circuit (Fig. 23) are identical to the corresponding circuit (Fig. 21) at central office A and are described in Large and Singer Patent 2,372,329, supra.

Trunk-line interconnecting large switching center B and small switching center F

The terminating equipment for the trunk-line at large switching center B is shown in detail in Figs. 27 and 28 and that terminating the other end of the trunk-line at small switching center F is shown skeletonized at the left-hand side of Fig. 43. At the right-hand side of Fig. 43 are shown, also in skeletonized form, the link circuit and the line circuit of a subscriber station that is connected locally to small switching center F. The trunk-line forms no part of the present invention except that it may be used with main trunks that are adapted for "through" calls originating at central offices, and therefore, no statement of its functions nor description of its operation is furnished herein. For a description of its operation reference may be made to Large Patent 2,375,856, supra, wherein the terminating equipment of a trunk-line at a large switching center is shown in Figs. 6 and 14 and the terminating equipment at the opposite end of the trunk-line, that is, at a small switching center, is shown in Figs. 4 and 5.

Terminating equipment at large switching center B, of main trunk No. 9 extending to large switching center C

The terminating equipment of main trunk No. 9 located at large switching center B and shown in Figs. 29, 30 and 31, is connected in multiple to the horizontal row of contact sets that is third from the top of the link circuit shown in Figs. 2 and 3 and to the vertical row of contact sets that is third from the left. The terminating equipment at the opposite end of main trunk No. 9, that is, at large switching center C, is shown in Figs. 32, 33 and 34, and would, in practice, be identified at this end with a number determined by the position of the trunk on the link circuit shown in Figs. 35 and 36. Trunk No. 9 at center C is connected at the link circuit shown in Figs. 35 and 36, in multiple, to both the uppermost horizontal row of contact sets shown in Fig. 35 and to the first vertical row of contact sets that is first from the left shown in Figs. 35 and 36. The terminating equipments of main trunk No. 9 are identical with those of main trunks Nos. 99 and 89 shown in Figs. 4, 5 and 6 and Figs. 7, 8 and 9, respectively. Main trunk No. 9 is arranged to be selected at large switching center B by means of the vertical row of relays comprising relays 12ST2—9 and 12AL—9 of the trunk sequence circuit shown in Fig. 12 and at large switching center C by another trunk sequence circuit, not shown, but similar to that shown in Figs. 11 and 12. Main trunk No. 9 and all the other main trunks and the subscriber and the trunk-lines that may have a termination at large switching center C, also have associated therewith, in addition to the trunk sequence circuit mentioned above but not shown, a subscriber sequence circuit, a sequence control circuit, a director circuit, an all-trunks-busy circuit and a miscellaneous alarm circuit, but which are similar to their corresponding circuits at large switching center B.

Link circuit at large switching center C

The link circuit (Figs. 35 and 36) at center C is similar to that located at large switching center B, except for a different arrangement of trunks and subscriber lines. For an understanding of this link circuit reference may be had to Figs. 2 and 3 and the description thereof.

Terminating equipment at large switching center C of main trunk No. X—89 extending to central office D

The terminating equipment (Figs. 37, 38 and 39) of main trunk No. X—89 circuit is identical with either of those shown in Figs. 4, 5 and 6 and Figs. 7, 8 and 9 and reference may be had to the description of either Figs. 4, 5 and 6 or Figs. 7, 8 and 9 for an understanding of the operation of this main trunk circuit terminating equipment.

Terminating equipment at central office D of main trunk No. X—89 extending from large switching center C

The terminating equipment (Fig. 40) of main trunk No. X—89 circuit at central office D is identical with either of those shown in Figs. 20 and 22 and reference may be had to the description of the operation of the terminating equipment shown in either Fig. 20 or 22 for an understanding of the terminating equipment shown in Fig. 40.

Operator's cord circuit and position circuit at central office D

These circuits shown in Fig. 41 are identical with the corresponding circuits shown in either Fig. 21 or 23 and reference may be had to the description of the operation of such corresponding circuits for an understanding of the circuits shown in Fig. 41.

DETAILED DESCRIPTION OF OPERATION

Each main trunk having a termination at the operator's switchboard in a central office may be employed in the origination or the termination of a call. The selecting impulses for establishing a connection always originate at a central office and are transmitted over a trunk to a switching center whereat a desired, or called, trunk is selected and connected to the calling trunk in response to selecting impulses. Essentially, during the transmission stage the interconnected main trunks remain on a "through" call in a full duplex arrangement and the supervision between the two trunks connected together is handled over separate conductors also on a full duplex basis.

When the call originates at central office A, selecting impulses are transmitted from the operator's sender or teletypewriter 2103, at the switchboard in central office A to establish connection at any one of the other offices or switching centers connected in the system. For example, the call may be one which terminates in large switching center B, that is, in a subscriber line local to large switching center B. Then again the call may be a "through" call that automatically operates apparatus at center B for extending the call to central office E or to a subscriber or a trunk-line local to large switching center C. In another case, a call from central office A may be extended through large switching center B and small switching center F, in series, to a subscriber line local to small switching center F, the connection being automatically extended from switching center B to switching F over a trunk-line. Then again, the call originating at central office A may be extended through large switching centers B and C, in series, to still another central office such as central office D. Other small switching centers similar to that provided at switching center F may be connected, in tandem, with the large switching center B and with large switching center C and connections to and from subscribers' stations local to such small switching centers may be established as described in the W. V. K. Large Patent 2,375,856, supra.

A call originating at central office E may terminate in a subscriber line or a trunk-line local to large switching center B, or may, for a "through" connection, be extended to central office A, or to a subscriber or a trunk-line local to a second large switching center such as switching center C, or through both large switching centers B and C, in series, to central office D. Likewise, a call originating at center F may be extended through switching center B to either central office A or central office E, providing the double outlet of trunk groups as disclosed in Krecek Patent No. 2,368,666, supra, is employed. A call originating at central office D may terminate in large switching center C or be extended through large switching centers C and B, in series, to either of the central offices A and E, or to small switching center F or to another of the small switching centers, not shown, but connected to switching center C. All main trunks connected to offices A, E and D and passing through either or both of the large switching centers B and C are arranged to transmit selecting impulses toward the switching center whereat a desired, or called, trunk is selected in response to the selecting impulses for extending the connection.

Calls from subscriber stations local to any of the large switching centers B and C must be requested through an operator's switchboard at a central office to which the particular large switching center is directly connected. A call from a subscriber station local to small switching center F is handled in the same manner as a call from a subscriber station local to the large switching center B, that is, to the center to which such small switching center is directly connected. This arrangement permits the operators at the central offices to supervise all calls and to ticket such calls for billing purposes whereby the subscribers are properly charged for such calls.

With reference to a "through" call for which two main trunks are to be interconnected for communication purposes a "director-ready" signal is transmitted from the point of interconnection, say large switching center B over the outward supervisory path such as that including conductor 1113 at center B, to the calling trunk terminating equipment wherein it is retransmitted to the operator at the calling central office, and the operator in response to the "director-ready" signal, types "letters" followed by a teletypewriter coded character representative of the trunk group desired. The pulses representative of the "letters" and the character signal are retransmitted over the calling main trunk to a large switching center, say center B, whereat they are repeated over the inward supervisory path, say that including conductor 1114 at center B, to the director circuit. The director circuit at center B includes relay 18G which repeats the pulses of the "letters" and the character signal to the start magnet 1601 of the receiving distributor and the distributor decodes the teletypewriter signals for routing over a fanning-out circuit to seize a hunting conductor, corresponding to the calling letter, say conductor 1700—E, for letter E of the alphabet. The seized conductor which represents the particular trunk group, is tested for a busy or an idle condition through a chain circuit formed by the AD advance relays, such as relay 7AD provided for main trunk No. 89 of a group of trunks Nos. 80 to 89, one AD relay being provided for each of the ten trunks and all the AD relays of the group being connected by means of their respective upper armatures in the chain circuit.

If a particular trunk of a desired, or called, group is busy on an inward or an outward local

call, or made busy by a busy key, such as busy key 820 for trunk No. 89, or taken out of service by a BO (busy-out) relay, such as relay 12BO—89 for trunk No. 89, in the trunk sequence circuit, or if the trunk circuit on a completed call was prevented from releasing switches associated with it (because of the condition in which it was found during the positioning of the switches), ground will be found on a chain (CH) conductor, such as conductor 1221—89 for trunk No. 89, which will keep the corresponding advance (AD) relay, such as relay 7AD, operated. Similarly, if the trunk is a calling trunk at the time and is busy on a "through" call, ground will be found on its chain (CH) conductor such as conductor 1121—99 for trunk No. 99, and if the trunk is a called trunk at the time and is busy on a "through" call the HM relay, such as relay 7HM for trunk No. 89, will be found operated so that its associated AD relay, such as relay 7AD, will also be found operated. In other words, if a particular trunk of a group is busy for any reason the AD relay for that trunk is operated. The director circuit in testing the trunk group conductor, such as conductor 1700—E, is therefore guided by the AD relay chain to the first idle, available trunk of the group but failing in that, the selected trunk group conductor terminates in ground which the director recognizes as a "busy" condition. The director circuit then functions to manufacture a special signal, such as letter "K," characteristic of this condition, and send a series of such signals over the outward supervisory path such as that including conductor 1113, to the calling trunk terminating equipment which retransmits the series to the calling central office. Upon the reception of this series of signals at the calling central office, the operator thereat sends either a break or a disconnect signal causing the release of the sequence, the director and the trunk circuit. If an idle trunk of the called group has been found by means of the seized trunk group conductor, such as conductor 1700—E, the director circuit furnishes a ground connection in the miscellaneous alarm circuit (relay 25D) for operating an HH relay, such as relay 7HH for trunk No. 89, and almost simultaneously furnishes a ground connection at the inner upper armature and contact of a relay, such as relay 18A—1 in the director circuit for operating in the calling trunk a TR—1 relay, such as relay 4TR—1 in trunk No. 99.

Call originating at the operator's switchboard at central office A for a "through" call to central office E

For the purpose of illustrating a call originating at central office A and extending through large switching center B to central office E, it will be assumed that the operator at office A seizes main trunk No. 99 at the switchboard by means of the cord circuit shown in Fig. 21, and connects to such cord circuit the teletypewriter and position circuit 2103 by operating a typing key, say key 2102, which is individual to the selected cord circuit. The operator, upon selecting trunk No. 99 as the idle trunk extending to the large switching center B and inserting the calling plug, say plug 2101 of the cord circuit into jack 2032 of trunk No. 99, causes to be completed a circuit from grounded battery, through the winding of relay 21—AC, sleeve conductors of plug 2101 and jack 2032, through the winding of sleeve relay 20—SL to ground. Relays 21—AC and 20—SL operate. Relay 21—SC operates in a circuit traceable from grounded battery, through the winding of relay 21—SC, ring conductors of plug 2101 and jack 2032, conductor 2035, to the contact and outer upper armature of relay 20—TR to ground. Relay 21—SC, upon operating, causes call lamp 2103 to light. Call lamp 2103 in addition to furnishing an indication of a call, or busy condition of trunk No. 99, also serves to furnish the disconnect and recall signal. Relay 21—AC, upon operating, (1) closes at its upper armature and contact an operating circuit for relay 21—C which operates and (2) closes at its lower armature and contact a path traceable from grounded negative battery 2104, spacing, or right-hand, contact and armature of relay 21—RA, than over two parallel paths respectively extending through the upper and the lower winding of relay 21—RC, the path of the upper winding extending over operated off-normal, or left-hand, contact of key 2102, through the operator's position circuit 2103, operated off-normal, or right-hand, contact of key 2102, front contact and lower armature of relay 21—AC, normally closed contact of ring key 2105, tip conductors of plug 2101 and jack 2032, upper armature and contact of relay 20—SL, through the upper windings of relay 20—SS and 20—S, in series, armature and spacing, or right-hand, contact of relay 20—R, to grounded positive battery. Relays 21—RC, 20—SS and 20—S are normally held in the positions shown by currents flowing through their respective biasing, or lower, windings, but under the influence of the stronger current flowing in their upper windings, relays 21—RC, 20—SS and 20—S operate to their respective marking positions.

When relay 20—SL operated, it closed at its innermost lower armature and front contact an operating circuit for relay 20—ON which operated. Relay 20—ON, upon operating, closes at its No. 1 armature and front contact the inward transmission path comprising conductor 615 for sending to large switching center B a steady marking current produced at the marking contact and armature of relay 20—S, the circuit for the biasing current being also closed by the operation of relay 20—ON. The inward transmission path extends over the tip spring of receive jack 631—REC, conductor 632, through the lower winding of polarized relay 6TL, resistance 633, conductor 634, back contact and outer upper armature of relay 6CT2, conductor 635, through the upper winding of polarized receive relay 6R, resistance 636, to grounded positive battery 637. At this time the outward transmission path comprising conductor 614 is open at armature No. 3 and contact of relay 5—ON.

The reception of a continuous mark signal at large switching center B is over a circuit traceable from grounded negative battery at the marking contact and armature of polarized relay 20—S, conductor 2033, back contact and upper armature of relay 20—A1, front contact and outer upper armature of relay 20—ON, and as hereinbefore traced over transmission conductor 1615, normally closed tip spring of receive jack 631—REC, conductor 632, through the lower winding of relay 6TL, resistance 633, conductor 634, back contact and outer upper armature of relay 6CT2, conductor 635, through the upper winding of receive relay 6R, resistance 636 to grounded positive battery 637. Relays 6TL and 6R operate to their marking positions. When

relay 6TL operates and ground is thereby removed at its spacing contact, condenser 620 begins to assume a charge over a circuit extending from grounded battery 608, resistances 621 and 622, conductor 623, condenser 620 to ground. After approximately one-half second, condenser 620 assumes a charge having a value sufficient to cause vacuum tube 603 to become conductive thereby causing the operation of cut-through relay 6CT and, in turn, the operation of relay 6CT—1. Relay 6CT—1, upon operating, (1) operates relay 5A and (2) deprives relay 6TL of control of the grid element of vacuum tube 603. Relays 6CT and 6CT—1 remain operated. Relay 6CT—1 also prepares at its outer lower armature and contact, an operating circuit for start relay 11ST2—99 which, with its associated relays in the same vertical set in the trunk sequence circuit, corresponds to main trunk No. 99 selected by the operator at central office A. The operating circuit for start relay 11ST2—99, when completed, will be traceable from grounded battery connected to the inner lower armature and contact of relay 11BO—99, conductor 1125—99, through the winding of relay 11ST2—99, conductor 1102—99, contact and middle lower armature of relay 4HM, conductor 401, contact and outer lower armature of relay 5SL—1, conductor 507, contact and outer lower armature of relay 6CT—1, conductor 506, back contact and armature No. 1 of relay 5SP—1, outer lower armature and contact of relay 5SB—1, armature No. 1 and contact of relay 5—ON, now unoperated, to ground.

Relay 5A, upon operating, (1) closes at its No. 3 armature and contact an operating circuit for relay 5—ON which now operates; (2) removes at its No. 1 armature and contact the ground connection from conductor 525; (3) locks itself at its No. 5 armature, although it is under control of relay 6D—1 which is now unoperated but which, when operated, will close a shunting circuit traceable from grounded battery 625, contact and outer left-hand armature of relay 6D—1, conductor 601, contacts and middle lower armature of relay 6TR, conductor 611, lower armature and contact of relay 6TR2, conductor 617, to the front contact and armature No. 5 of relay 5A, to ground; and (4) connects ground at its No. 6 armature and contact to a circuit traceable over conductors 503, 504 and 1121—99, then over two parallel paths, one extending over back contact and lower armature of relay 4HH, through the winding of relay 4AD, to grounded battery, and the other, extending through the winding of chain relay 11CH—99, to grounded battery. Relays 4AD and 11CH—99 operate to make main trunk No. 99 busy. Relay 11CH—99 upon operating, lights the trunk busy lamp 502 and prevents trunk No. 99 from being selected for another call originating at large switching center B until after the call for which the trunk is engaged is completed. Relay 4AD operates on an inward or an outward call, or by the operation of busy key 648 or by taking the trunk out of service by means of trunk release key 1133—99, or if the trunk on a completed call was prevented from releasing switches associated with it because ground on conductor 1121—99 is connected at the armature and front contact of busy-out relay 11BO—99. But when trunk No. 99 is busy as a called trunk then ground is formed on the front contact and armature No. 1 of relay 4HM which is operated only when trunk No. 99 is the called trunk. Relay 5—ON, upon operating, (1) completes the operating circuit for relay 11ST2—99, previously prepared at the outer lower armature and contact of relay 6CT—1 and relay 11ST2—99 operates in the circuit hereinbefore traced; (2) closes the hereinbefore mentioned outward transmission path extending from the armature of relay 5S, resistance 530, conductor 531, make-before-break contact of relay 5SB—1, contact and armature No. 3 of relay 5—ON, conductor 523, normally closed contacts of the tip spring of send jack 630—SEND, outward transmission conductor 614, through the upper winding of relay 20—RS, outer upper armature and back contact of relay 20—CT, to grounded negative battery, this outward transmission path now being ready for transmission from switching center B to central office A; and (3) connects power to the office repeater and ground to the winding of relay 5SL. Relay 11ST2—99, upon operating, closes at its lower armature and front contact an operating circuit for relay 11AL—99, the circuit being traceable from grounded battery at the armature and contact of relay 25SU in the miscellaneous alarm circuit, conductor 1001, upper armature and front contact of each of relays 10AL—G0 to 10AL—G19, in series, conductor 1109, through the winding of relay 11AL—99, front contact and lower armature of relay 11ST2—99, conductor 1108—99, 1108—98 to 1108—90 of the first group of trunks, conductors 1208—89 to 1208—80 of the second group of trunks, conductor 2502, and back to the miscellaneous alarm circuit where it continues over the outer lower armature and contact of relay 25D, back contact and inner upper armature of common start relay 25CS, to ground. Relay 11AL—99 operates and closes at its lower armature and front contact an operating path for relay 11AL1—99, the path being part of the circuit hereinbefore traced from the grounded battery associated with conductor 1109, lower armature and front contact of relay 11AL—99, through the winding of relay 11AL1—99 to ground, and relay 11AL1—99 operates. When relay 11ST2—99 operates, the trunk sequence circuit is thereby ordered to connect a director circuit to the seized trunk No. 99 for the purpose of receiving teledirecting pulses.

The sequence circuit when it attaches a director circuit to the seized trunk No. 99 connects ground at armature No. 4 and contact of relay 11AL1—99 as will be hereinafter described, to conductor 1103—99, which extends over the normally closed contacts associated with the ring spring of jack 508—A, through the winding of relay 5M, to grounded battery, and relay 5M operates. Relay 5M, upon operating, closes a plurality of circuits each extending through the winding of one of the selecting magnets, such as magnet 2SM—99, of those cross bar switches which have their respective horizontal contact sets connected in multiple. Also, relay 11ST2—99, upon operating, (1) connects ground at its outermost upper armature and contact, through conductor 1105 which extends through one or more trunk sequence groups to the direct circuit wherein it is conected to the inner lower armature and contact of relay 18A—1 which is unoperated at the time, but the path just traced will serve as a locking circuit for relay 18A—1 when the latter relay operates as hereinafter described (relay 18A—1, when operated, is used to keep in speed the director motor associated with the director distributor circuit); (2) connects ground at its middle upper armature and con-

tact to a circuit extending through the call-disconnect lamp 1106—99, conductor 1107, through the winding of relay 13E, to grounded battery, to light the call lamp 1106—99 and operate relay 13E (relay 13E, upon operating, operates relay 13F to light a common call-disconnect lamp 1302); and (3) closes at its lower armature and front contact (assuming that no other ST2 relay in the trunk sequence groups like those shown in Figs. 11 and 12, is operated) a circuit extending from ground at the inner upper armature and back contact of relay 25CS in the miscellaneous alarm circuit, as hereinbefore traced, to operate relay 11AL—99. If another trunk sequence group is in an operated condition and the AL relay, such as relay 11AL—99 in the particular case at hand, will be delayed in operating until it has received a preference accorded to it by the sequence circuit. Relay 11AL—99, upon operating, (1) locks under control of its associated start relay 11ST2—99, (2) causes relay 25ST and relay 25CS in the miscellaneous alarm circuit to operate successively, the operating circuit for relay 25ST being traceable from ground, through the winding of relay 25ST, conductors 2510 and 1231, front contact and outer upper armature of relay 11AL—99, to grounded battery conductor 1109, and when relay 25ST operates an obvious operating circuit for relay 25CS is closed and relay 25CS operates, and (3) closes at its lower armature and front contact an operating circuit for relay 11AL1—99 as hereinbefore described.

Relay 11AL1—99 operates and thereby (1) connects ground at its outmost upper armature and contact to a circuit traceable over conductor 1110, to the director circuit wherein it extends through the winding of relay 18A to grounded battery and relay 18A operates; (2) connects the two transmission conductors 1111—99 and 1112—99 at its middle upper and its innermost upper armature and their respectively associated contacts, to supervisory conductors 1113 and 1114, and selected idle trunk No. 99 shown in Figs. 4, 5 and 6 is now connected to both the director and the sequence control circuit; (3) connects ground at its No. 4 armature and contact as hereinbefore stated, to conductor 1103—99, normally closed contacts of the ring spring of jack 503A, through the winding of relay 5M, to grounded battery, and relay 5M operates to energize the selector magnet 2SM—99 and corresponding selecting magnets on other cross bar switches whose horizontal contact sets are connected in multiple with the corresponding sets shown in Fig. 2; (4) connects the winding of relay 11BO—99 and 11BO1—99 over its Nos. 5 and 6 armatures and their respectively associated front contacts to conductors 1115 and 1116, respectively, the latter conductors being the common busy-out conductors extending to the miscellaneous alarm circuit; and (5) conditions at its No. 7 armature and contact the circuit including conductor 1118—99 which later may be used for serving notice to the main calling trunk No. 99 that it may prepare itself for connection to another main trunk. The operation of relay 25CS in the miscellaneous alarm circuit removes ground from conductor 2501 of the entire office sequence circuit chain.

When main trunk No. 99 is connected to the director circuit, the inward supervisory path from the trunk circuit to the director circuit is in a marking condition and is now extended over conductor 1112—99, armature No. 3 and contact of relay 11AL1—99, conductor 1114, through the upper winding of relay 18G to ground. The outward supervisory path between the trunk circuit and the director circuit is now traceable over conductor 1119—99, armature No. 2 and contact of relay 11AL1—99, conductor 1113, middle lower armature and back contact of relay 18A2, conductor 1801, make-before-break contact of relay 19TB, conductors 1901 and 1902, make-before-break contacts of relay 19N3, conductor 1903, contact and outermost lower armature of relay 18C, then in parallel paths, one extending over the armature and contact of relay 18G and the other, through the lower winding of relay 18G. Relay 18C is unoperated at this time and therefore the outward supervisory path between the trunk and the director circuit is open. The termination of both supervisory paths are at this time in the director circuit.

The operation of relay 18A, as hereinbefore described, is the first function of the director circuit. Relay 18A, upon operating, (1) closes at its No. 1 armature and contact, an obvious operating circuit for relay 18A—1 which operates; (2) closes at its No. 4 armature and contact an operating circuit for relay 18A2, which operates, the operating circuit of relay 18A2 extending to ground at the lower armature and back contact of relay 18C—1 which still is unoperated; (3) closes at its No. 2 armature and front contact an operating circuit for start magnet 1601 of the receiving distributor and the magnet operates, the circuit being traceable from grounded battery 1602, resistance 1603, through the winding of start magnet 1601, conductor 1604, make-before-break contacts of relay 18LU, conductor 1802, make-before-break contacts of relay 18C—1, conductor 1803, to the front contact and armature No. 2 of relay 18A, to ground; (4) connects ground at its No. 6 armature and contact to a circuit for furnishing biasing current to relay 18G, the circuit being traceable over conductor 1804, through the lower winding of relay 18G, resistance 1805, conductors 1806 and 1807, resistance 1808, to grounded battery 1826; and (5) prepares at its No. 3 armature and contact an operating circuit for relay 18C—1. The operation of start magnet 1601 prevents further rotation of the distributor cams AC, C—1 to C—5 and SC, once these cams reach the stop position.

Relay 18A—1 operates and (1) locks under control of conductor 1105 which extends to ground at the outermost upper armature and contact of relay 11ST2—99 in the trunk sequence circuit; (2) closes at its outer armature and contact an operating circuit for the motor of the receiving distributor, the circuit being traceable from grounded battery 1809, contact and outer upper armature of relay 18A—1, conductor 1810, then in parallel paths, one extending through the field winding 1605 to ground, and the other, through the motor armature 1606, low resistance winding 1607, resistance 1608, to ground, and the third, over conductor 1609, outermost lower armature and contact of relay 18A2, conductor 1811, through the upper winding of relay 18B to ground, but relay 18B does not operate at this time, and (3) closes at its inner upper armature and contact an operating path for relay 14D5, the operating path being traceable from ground at the contact and inner upper armature of relay 18A—1, conductor 1812, through the lower winding of relay 14D5, to grounded battery and relay 14D5 operates to its spacing, or right-hand contact. The operating path for relay 14D5 is parallel with the path

extending over conductor 1610, auxiliary spring contacts ASC in their normally closed position, conductor 1611, outer upper armature and front contact of relay 18A2 which at the present time is operated, conductor 1813, to the front contact and upper armature of relay 18B which, at the present time is unoperated.

The connection of ground at the No. 6 armature and contact of relay 18A to the marking, or left-hand, contact of relay 18G as hereinbefore described, will cause the quick operation of relay 18A3, if relay 18G has operated to its marking, or left-hand, contact under the influence of a marking signal received over supervisory conductor 1114 from the trunk circuit No. 99.

Relay 18A2, upon operating, (1) connects the lower winding of relay 18C2 to the outward supervisory conductor 1113 which at this time extends to main trunk circuit No. 99; (2) closes at its innermost lower armature and contact a circuit having two parallel paths, one of which serves as the locking path for relay 18A3 when relay 18A3 operated as hereinbefore described, and the other, for energizing the lower winding of relay 25K—1 of the miscellaneous alarm circuit to indicate that the director circuit is off-normal, the latter path being traceable over conductors 1814 and 1815, contact and No. 6 armature of relay 18LU, conductor 1816, through the lower winding of relay 25K—1, to grounded battery; (3) connects ground at its innermost upper armature and contact to a circuit extending through lamp 1832; (4) connects ground at its middle upper armature and contact to a circuit extending over conductor 1804, through the upper winding of relay 25AB to grounded battery in the miscellaneous alarm circuit, and relay 25AB operates and causes, in turn, the operation of relay 25K4 to prevent the latter circuit from permanently removing the associated trunk circuit No. 99 from service if the allotted time for circuit action has been exceeded; (5) closes at its outermost lower armature and contact the operating circuit for relay 18B, which operates when the motor of the receiving distributor attains the desired speed and thereby causes the vibratory contact member to leave its associated stationary contact member, the separation of contacts being determined by the motor control governor as disclosed in United States Patent 1,860,556, granted to J. H. Sole on May 31, 1932; and (6) closes at its outermost upper armature and contact a path extending from the upper armature and contact of relay 18B, conductor 1813, front contact and outermost upper armature of relay 18A2, conductor 1611, to the normally closed auxiliary spring contacts ASC of the receiving distributor.

Receiving distributor motor attains the desired speed at large switching center B

When the motor of the receiving distributor attains the desired speed, the governor contacts close as described in J. H. Sole's patent, supra, thereby removing a short circuit and permitting relay 18B to become sufficiently energized through its upper winding to operate. Relay 18B, upon operating, (1) locks in a circuit traceable from grounded battery, through the lower winding, contact and inner lower armature of the relay, conductor 1818 to ground at the contact and middle lower armature of relay 18A2; (2) closes at its outer lower armature and contact the circuit traceable from ground, through the winding of relay 18C2, contact and middle lower armature of relay 18A2, conductor 1113 which is an extension of the outward supervisory and transmission conductors 1111—99, 522 and 639, connected in series, of trunk circuit No. 99, and this ground connection furnishes the "director ready" mark signal for transmission to the operator at central office A; and (3) closes at its upper armature and contact, the path extending from the normally closed auxiliary spring contacts ASC of the receiving distributor, conductor 1611, outermost upper armature and front contact of relay 18A2, conductor 1813, contact and upper armature of relay 18B, through the winding of relay 18C, to grounded battery. Trunk circuit No. 99 retransmits this "director ready" signal to the operator at central office A to furnish an indication that the connection is prepared for the call that may be routed through the large switching center at office B. Relay 18C2 will operate if the "director ready" signal is transmitted. If the normally closed auxiliary spring contact ASC of the receiving distributor is closed, as indeed it will be, if the cams have reached the "stop" position, relay 18C will operate.

Relay 18C, upon operating, (1) closes at its outermost lower armature and contact another point in the outward supervisory path between trunk No. 99 and the director circuit, the supervisory path now being traceable from ground at the contact and No. 6 armature of relay 18A, conductor 1804, outermost lower armature and contact of relay 18C, conductor 1903, make-before-break contacts of relay 19N3, conductors 1902 and 1901, make-before-break contacts of relay 19TB, conductor 1801, to the back contact and middle lower armature of relay 18A2 which at this time is in an operated condition; (2) opens at its outermost upper armature and back contact, the operating circuit for relay 18A3, as hereinbefore traced, but if relay 18A3 has already operated because of the operation of relay 18G to its marking contact under the influence of the mark impulse received from trunk circuit No. 99, it is, therefore, at such time, locked in an operated position, (3) connects at its outermost upper armature and front contact the armature of relay 18G, to the inner upper armature of relay 18C—1; (4) prepares at its innermost upper armature and contact a locking circuit for itself under control of relay 18C—1; (5) provides a supplementary ground at its middle lower armature, to the locking circuit of relay 18A3 and also to conductor 1815 which forms part of the operating circuit for relay 25K—1 of the miscellaneous alarm circuit, the operating circuit extending over the contact and middle lower armature of relay 18LU, conductor 1816, through the lower winding of relay 25K—1, to grounded battery; and (6) closes at its middle upper armature and contact an operating circuit for relay 18C—1 which operates in a circuit traceable from grounded battery, through the winding of relay 18C—1, middle upper armature and contact of relay 18C, conductor 1819, No. 3 armature and front contact of relay 18A, to ground. Relay 18C—1, upon operating, (1) opens at its lower armature and back contact, the operating circuit for relay 18A2, which releases; (2) substitutes at its inner upper armature and contact another ground connection in the circuit for operating start magnet 1601 which remains operated under the influence of relay 18G in response to each marking impulse of an incoming signal received from trunk No. 99, the circuit being traceable from ground at armature No. 6 and contact of

relay 18A, conductor 1804, marking, or left-hand, contact and armature of relay 18G, outermost upper armature and front contact of relay 18C, inner upper armature and contact of relay 18C—1, conductor 1802, make-before-break contacts of relay 18LU, conductor 1604, through the winding of start magnet 1601, resistance 1603, to grounded battery 1602; (3) connects ground on its outer upper armature and contact, to conductor 1820 which extends through each of the normally open contacts SC—1 to SC—5, in turn, of the receiving distributor, providing the contact is closed by the marking impulse of an incoming signal received by relay 18G over paths respectively extending through the windings of fanning-out relays 14D—1 to 14D—5, to grounded battery; and (4) at its lower armature and front contact connects ground to the locking circuit for relays 18C and 18C2, if operated, and utilizes this ground for conditioning over conductor 1821, various paths in the director circuit. With relays 18C2 and 18A3 operated, relay 18C—1, upon operating, will place ground over the operated upper armatures of relay 18A3, on conductors 1822 and 1823, respectively, thereby operating relays 25K3 and 25AB, the latter operating relay 25K4 to notify the miscellaneous alarm circuit that the director circuit is ready to function.

Relay 18A2, upon releasing, (1) connects at its middle lower armature and back contact direct ground at armature No. 6 and contact of relay 18A to the outward supervisory conductor 1113, replacing the ground connected to the winding of relay 18C2, thus continuing the "director ready" mark signal, and the circuit thus completed extending from ground and armature No. 6 of relay 18A, conductor 1804, outermost lower armature and contact of relay 18C, conductor 1903, make-before-break contacts of each of relays 19N3 and 19TB, conductor 1801, back contact and middle lower armature of relay 18A2, through the outward supervisory path conductor 1113; (2) removes at its innermost upper armature and contact the ground from lamp 1832 which now becomes extinguished; (3) opens at its outermost lower armature and front contact the operating circuit for relay 18B which is thereby disconnected from the conductor 1609, which is the only one of the paths of the motor governor control circuit of the receiving distributor; (4) removes at its middle upper armature and contact, the ground from conductor 1804 which extends to the miscellaneous alarm circuit, and the removal of the same ground opens the locking circuit for relay 18B, and relay 18B releases; and (5) transfers at its outermost upper armature, conductor 1611 which extends to the normally closed auxiliary spring contacts ASC of the receiving distributor, to conductor 1824 which extends over the outermost upper armature and back contact of relay 14F2, conductor 1413, to the lower armature of relay 14K. Assuming that the "director-ready," or mark, signal has been sent and the mark has been received from the trunk circuit No. 99, the director now awaits the teledirecting telegraph character signals from the operator at central office A.

Reception of teledirecting telegraph character signals at large switching center B

Telegraph signal impulses received over the inward transmission and supervisory path including conductor 1112—99, No. 3 armature and contact of relay 11AL1—99, conductor 1114, through the upper winding of relay 18G to ground, are repeated by the latter relay. Relay 18G is normally held to its marking, or left-hand, position, under the influence of the marking signal normally received over the transmission and supervisory path, just traced, and extending from selected trunk circuit No. 99. Therefore, as soon as the character signal is received, the start, or space impulse of the signal permits relay 18G to operate to its spacing, or right-hand, contact thereby causing selector magnet 1601 of the receiving distributor to release. Selector magnet 1601, in following relay 18G, responds to the impulses of each incoming signal and in response to the start impulse causes its armature to disengage start cam SC and the armature extension 1615 under the influence of the tension of spring 1619, is moved into operative relation with bell crank, or operating, levers OL—1 to OL—5. The receiving distributor is somewhat of the type shown in Fig. 6 of J. M. Desmond's United States Patent 2,190,540, dated February 13, 1940. Relay 18G and selector magnet 1601 respectively correspond to relay 608 and selector magnet 613 of the Desmond patent. Selector magnet 1601 in its normally operated position holds its armature extension 1612 in engagement with start cam SC and in this position prevents the rotatable shaft 1613 from rotating under the influence of driving shaft 1614 driven by the distributor motor, the influence being effected by a friction clutch between the two shafts.

Fixedly mounted on shaft 1613 are cams C—1 to C—5 and an auxiliary cam AC. Integrally formed on each of cams C—1 to C—5 is a projection. The projections are spaced with respect to each other, an angular distance which corresponds to the difference in the time interval between adjacent impulses of an incoming signal. Respectively arranged in engageable relation with projections on cams C—1 to C—5 are bell crank levers OL—1 to OL—5. Each bell crank lever, when operated, initiates a chain movement through a sword member, such as swords SW—1 to SW—5, a T-lever, such as T-levers TL—1 to TL—5, and a code bar, such as code bars CB—1 to CB—5. This chain movement is somewhat similar to that employed in the printer disclosed in United States Patent 1,745,633, granted to S. Morton and H. L. Krum on February 4, 1930. In the particular arrangement shown in Fig. 16, the code bar, being operated to the right or the left position, accordingly closes or opens spring contact sets SC—1 to SC—5 in a combination depending on the impulses of the particular incoming signal that is received from relay 18G. In other words, the second armature extension 1616 is operated into either of two positions, namely, operated and released, by magnet 1601, depending on whether the incoming signal impulse is a mark or a space, and in cooperation, bell crank lever corresponding to the particular selecting impulse of the signal, positions, in turn, the associated sword member, T-lever and finally the associated code bar. The code bars when moved to their 'mark" positions respectively close one or more of spring contact sets SC—1 to SC—5 depending upon the corresponding mark impulses in each incoming signal, the code bars remaining in their "space" positions do not close their corresponding contact sets. The code bars may be provided with detents (not shown) to resist the tension of the spring members of the contact sets SC—1 to SC—5 and therefore remain in their right or left positions until the next signal is received.

For example, if it is assumed that the incoming signal is figure 6 or letter Y, its equivalent signal combination, the selecting impulse combination will be mark, space, mark, space, and mark. Relay 18G, in response to the reception of the "start" impulse which, as hereinbefore stated, is always open, or space, releases magnet 1601 to permit shaft 1613 to rotate. As soon as shaft 1313 begins to rotate the spring member of the auxiliary spring contact set ASC moves from its normal contact to its alternate contact and remains there for the duration of the next five selecting impulses of the incoming signal received by magnet 1601, when it will return to its normal contact at the termination of the fifth selecting impulse, or just before the "stop" impulse, which is always "mark." During the time that magnet 1601 is responding to the five selecting impulses, armature extension 1616 follows the signal impulses.

In the case of the figure 6, or letter Y, for which the selecting impulses are mark, space, mark, space and mark, as stated above the armature extension 1616 alternates its position accordingly as follows: operated, released, operated, released, and operated. In response to the first selecting impulse (mark) armature extension 1616 remains in its operated position and retains bell crank lever DL—1 in engageable relation with cam C—1 and cam C—1, upon rotating with shaft 1613, operates bell crank lever OL—1. In response to the second selecting impulse (space) armature 1616 releases to move bell crank lever OL—2 out of engageable relation with cam C—2 whereby cam C—2, upon rotating, does not operate bell crank lever OL—2. In response to the third selecting impulse (mark) armature 1616 returns to its operated position and retains bell crank lever OL—3 in engageable relation with cam C—2 and cam C—2, upon rotating, operates bell crank lever OL—3. In response to the fourth selecting impulse (space) armature 1616 releases to move bell crank lever OL—4 out of engageable relation with cam C—4 whereby cam C—4, upon rotating, does not operate bell crank lever OL—4. In response to the fifth selecting impulse (mark) armature 1616 returns to its operated position and retains bell crank lever OL—5 in engageable relation with cam C—5 and cam C—5, upon rotating, operates bell crank lever OL—5.

The two groups of fan relays are provided at each of the large switching centers as follows: one, namely the D-relay group, to select a line to a local subscriber's station or a trunk-line, the trunk-line extending to a small switching center, and the other, namely, the DL-relay group, to select a "through" trunk to a central office or to another large switching center. Therefore, the spring contact sets SC—1 to SC—5, will close in a combination corresponding to the mark selecting impulses of the incoming signal to operate one or more relays of the D-relay group or DL relay group to select the desired line or trunk depending on which group is operated. The disengagement of start cam SC with the armature of magnet 1601 permits cam shaft 1613 to rotate through one revolution only. The motor speed and the cutting of the cams are such that at the time the first selecting impulse is due to arrive, the mechanical arrangement is ready if selector magnet 1601 is already operated as it would be, should the first incoming selecting impulse be a mark, to position sword SW—1 which, in turn, causes spring contacts of set SC—1 to close. If perchance, the contact set SC—1 was already closed and the selector magnet was in a released position at this time, sword SW—1 would be operated to position code bar CB—1 to open spring contact set SC—1. Selecting impulses Nos. 2, 3, 4 and 5 are similarly treated. Meanwhile the auxiliary cam AC has caused the auxiliary spring member of the auxiliary contact set ASC to move from its normally closed position at its left-hand terminal to its alternate, or right-hand terminal before selecting impulse No. 1 has been received. Very quickly after the five selecting impulses have been acted upon, the spring member of auxiliary contact set ASC moves back to its normally closed position. Therefore, not only do contacts on contact sets SC—1 to SC—5 accurately interpret the telegraph signals received, but the auxiliary contact set ASC on cam AC also indicates the beginning and the end of the reception of a signal.

Reception of signal preliminary to called number at large switching center B

In the present invention, since it is necessary to discriminate between calls to lines extending to subscriber stations or to trunk-lines extending to a small switching center and calls to a "through" trunk extending to a large switching center or a distance central office, there is transmitted from calling central office A, a preliminary signal prior to the signal or signals corresponding to the called number. When the call is to a subscriber's line or a trunk-line "Figures" is the preliminary signal received at large switching center B and when the call is to a "through" trunk, the preliminary signal is "Letters." Herein for the purpose of illustration two significant character signals corresponding to numerical characters, follow "Figures" and only one significant character signal corresponding to a letter of the alphabet, follows "Letters." The combination of selecting impulses in the "Figures" signal is mark, mark, space, mark, and mark and that in the "Letters" signal is mark, mark, mark and mark, that is, all selecting pulses in the latter signal are all marking. As hereinbefore described under "Reception of teledirecting telegraph character signals" all telegraph character signals received at large switching center B are broken down by the receiving distributor in the director circuit into their five component elements.

Should a "Figures" signal be received, contact sets SC—1, SC—2, SC—4, and SC—5, would close in succession during the rotation of distributor shaft 1613 and thereby close, in turn, the operating circuits for relays 14D—1, 14D—2,, 14D—4 and 14D—5, the operating circuit for relay 14D—5 being connected to the uuper winding of the relay. Therefore, relays 14D—1, 14D—2, 14D—4 will be operated and relay 14D—5 will be operated to its mark, or left-hand, contact. After reception of the fifth impulse, the auxiliary contact ASC controlled by cam AC again becomes normal so that ground at the inner, upper armature and contact of relay 18A—1 is connected to a circuit extending over conductors 1812 and 1610, normal contacts of set ASC of cam AC, conductor 1611, outer upper armature and back contact of relay 18A2, conductor 1824, outermost upper armature and back contact of relay 14F2, conductor 1413, lower armature and back contact of relay 14K, conductor 1437, contacts and armature No. 3 of relay 14D—1, front contact and armature No. 2 of relay 14D—2, contact and outer upper armature of relay 14D—4, back contact and armature No. 5 of relay 14F—3, marking, or left-hand, contact and armature of relay 14D—5, conductor

1414, armature No. 7 and contact of relay 18LU, conductor 1825, inner lower armature and back contact of relay 14R, lower armature and back contact of relay 14N—1, conductor 1438, inner lower armature and contact of relay 14F2, conductor 1439, outer upper armature and back contact of relay 14K, make-before-break contact of relay 14D—3, make-before-break contacts and winding of relay 14F, to grounded battery and relay 14F operates. Any other combination of the 14D relays would have no effect at all at this time. Relay 14F, upon operating, locks in a circuit traceable over conductors 1415, 1416 and 1821 to ground at the front contact and lower armature of relay 18C—1 and prepares at its upper armature for the operation of relay 14K as the subsequent registering of the signals corresponding to the number of the called subscriber line or called trunk-line. The reception of the "Figures" signal, therefore, is a necessary prerequisite to utilization of teledirecting character signals in establishing a call to a subscriber line or trunk-line.

Since the object of the present call is to establish a connection to a "through" trunk, the "Letters" signal is made the preliminary signal sent prior to the signal corresponding to the called number, or designating letter, of the group or trunks extending to the desired large switching center or desired central office. As hereinbefore stated, the selecting impulses constituting the signal combination of "Letters" are all "mark," the contact sets SC—1 to SC—5 will close in succession and thereby operate, in turn, each of the relays 14D—1 to 14D—5, relay 14D—5 operating to its marking, or left-hand, contact. In this case after the reception of the fifth impulse, the auxiliary contacts ASC of cam AC again become normal so that ground on the inner upper armature and front contact of relay 18A—1 is connected to a circuit extending over conductors 1812 and 1610, normal contacts ASC on cam AC, conductor 1611, outermost upper armature and back contact of relay 16A—2, conductor 1824, outermost upper armature and back contact of relay 14F—2, conductor 1413, lower armature and back contact of relay 14K, conductor 1437, contact and armature No. 3 of relay 14D—1, contact and armature No. 2 of relay 14D—2, contact and outer upper armature of relay 14D—4, back contact and armature No. 5 of relay 14F—3, marking, or left-hand, contact and armature of relay 14D—5, conductor 1414, armature No. 7 and contact of relay 18LU, conductor 1825, inner lower armature and back contact of relay 14R, lower armature and back contact of relay 14N—1, conductor 1438, inner lower armature and contact of relay 14F—2, conductor 1439, outer upper armature and back contact of relay 14K, front contact and armature No. 1 of relay 14K, conductor 1453, front contact and armature No. 1 of relay 14D—3, make-before-break contacts and through the winding of relay 14F—1, to grounded battery and in response to the "Letters" signal, relay 14F—1 operates. Relay 14F—1, upon operating, locks in a circuit traceable over its front contact and lower armature, conductors 1415, 1416 and 1821, to the front contact and lower armature of relay 18C—1, to ground. During the reception of the next telegraph character signal, such as a signal for a letter of the alphabet, such letter being used to identify the particular group of "through" trunks desired by the operator at central office A, the director functions as hereinafter described.

Translation of "Letters" and numerical digit code at large switching center B

The following table indicates (1) the condition of relays 17DL—1, 17DL—2, 17DL—3, 17DL—4, and 14D5, resulting from the reception of the five selecting impulses of the signal representing each letter of the alphabet received by the receiving distributor at switching center B for selecting any desired group of trunks extending to a central office or a large switching center, and (2) the condition of relays 14D—1, 14D—2, 14D—3, 14D—4 and 14D—5 resulting from the reception of the five selecting impulses of a signal representing each numerical digit of a number assigned to a subscriber line or group of lines extending to a subcriber's premises. In the following table O, NO, M, and S represent "Operated," "Non-operated," "Mark" and "Space," respectively.

Lower Case	Upper Case	14D-1 17DL-1	14D-2 17DL-2	14D-3 17DL-3	14D-4 17DL-4	14D-5 14D-5
P	0	NO	O	O	NO	M
Q	1	O	O	O	NO	M
W	2	O	O	NO	NO	M
E	3	O	NO	NO	NO	S
R	4	NO	O	NO	O	S
T	5	NO	NO	NO	NO	M
Y	6	O	NO	O	NO	M
U	7	O	O	O	NO	S
I	8	NO	O	O	NO	S
O	9	NO	NO	NO	O	M
A		O	O	NO	NO	S
B		O	NO	NO	O	M
C		NO	O	O	O	S
D		O	NO	NO	O	S
F		O	NO	O	O	S
G		NO	O	NO	O	M
H		NO	NO	O	NO	M
J		O	O	NO	O	S
K		O	O	O	O	S
L		NO	O	NO	NO	M
M		NO	NO	O	O	M
N		NO	NO	O	O	S
S		O	NO	O	NO	M
T		NO	NO	NO	NO	M
V		NO	O	O	O	M
X		O	NO	O	O	M
Z		O	NO	NO	NO	M

Reception and deciphering of first significant character signal of the calling code at large switching center B

Immediately after the reception of the start impulse of the signal of the first significant character, in this case a letter of the alphabet, the signal corresponding to such letter causes to be seized the trunk group desired, and before the reception of the first selecting impulse of such signal, auxiliary spring contact set ASC under the influence of cam AC of the receiving distributor operates to its alternate position whereby grounded conductor 1610 is connected to a circuit including conductor 1417, upper armature and contact of relay 14F—1 and two parallel paths, one extending through the winding of relay 14F2 to grounded battery and the other, through the winding of relay 14F3 to grounded battery. Relays 14F2 and 14F3 operate. Relay 14F3, upon operating, transfers conductors 1418, 1419, 1420, 1421, 1422 and 1423 to their respectively associated conductors 1424 and 1429 for operating in various combinations, depending on the letter used, relays 17DL—1A, 17DL—1B, 17DL—1C, 17DL—1D, 17DL—2A, 17DL—2B, 17DL—3 and 17DL—4.

Relay 14F3, upon operating, also connects ground at its armature No. 7 and contact to conductor 1455 through the windings, in parallel, of relays 13H—0, 13H—1, 13H—2, to grounded battery, in the sequence circuit to establish

a "status quo" condition among the trunks in switching center B thereby preventing any trunks from releasing switches if they are about to do so.

Relay 14F2, upon operating, (1) closes at its No. 3 armature and contact a locking circuit for both itself and relay 14F3, the ground for the locking circuit being had at the lower armature and front contact of relay 18C—1; (2) prepares at its No. 1 armature and front contact an operating circuit for relay 14N; (3) prepares at its No. 5 armature and contact, an operating circuit for relays 14S and 14S—1, the circuit when completed being traceable from ground at the inner lower armature and front contact of slow operating relay 25D which operated a short while after selecting magnet 2SM—99 operated, resistance 2507, conductor 2506, armature No. 5 and contact of relay 14F2, conductor 1431, through the winding of relay 14S, front contact and inner lower armature of relay 14R (now in an unoperated position), conductor 1825, contact and armature No. 7 of relay 18LU, conductor 1414, armature and either contact of relay 14D5, depending on which letter of the alphabet is transmitted from central office A, over the corresponding operated armature of relay 14F3, and the conductor, such as conductor 1428 or 1429, connected to its associated front contact, to the selected path closed by the 17DL relays, to a trunk hunting conductor, assuming that conductor 1709—E corresponding to the signal for letter E, has been selected, then over the upper armature and back contact of relay 7AD, through the winding of relay 7HH, to grounded battery, relays 7AD and 7HH representing the first trunk of group E, which, may be only one of several groups (the other groups being respectively responsive to other letter signals) extending to the desired central office E; (4) connects at its No. 2 armature and contact the series connected ground conductors 1621 and 1416 to a circuit which extends over conductor 1432, contact and outer lower armature of relay 14S—1 (now unoperated), for future connection to conductor 1132, contact and armature No. 7 of relay 11AL1—99, conductor 1118—99 to grounded battery through the winding of relay 4TR—1, to grounded battery for operating relay 4TR—1 as hereinafter described when an idle available trunk in the desired group is found, and (5) removes at its armature No. 1 and back contact the possibility of connecting relay 14F, through the armature of relay 14D5 in the manner hereinbefore described.

The selecting impulses of the signal corresponding to letter E are mark, space, space, space and space and therefore cause contact set SC—1 only to close while contact sets SC—2, SC—3, SC—4 and SC—5 remain open, during one revolution of distributor shaft 1613. Accordingly, relays 17DL—1A, 17DL—1B, 17DL—1C and 17DL—1D operate and relay 14D5 moves to its space or right-hand, position. At the conclusion of the fifth selecting impulse the auxiliary contacts ASC close, causing the rapid operation of relay 14N and, in turn, the operation of relay 14N—1. The operating circuit for relay 14N may be traceable from grounded battery, through the winding of relay 14N, conductor 1433, front contact and armature No. 1 of relay 14F2, conductor 1824, back contact and outermost upper armature of relay 18A2, conductor 1611, normally closed contacts ASC, conductors 1610 and 1812, to ground at the inner upper armature and contact of relay 18A—1. The operating circuit for relay 14N—1 may be traceable over the operated lower armature of relay 14N, make-before-break contacts of relay 14R, conductors 1444, 1416 and 1821 in series, to ground at the front contact and lower armature of relay 18C—1. Relay 14N—1, upon operating, connects at its lower armature and front contact the testing circuit for testing the selected trunk group, the circuit extending from grounded negative battery, through the windings, in series, of relay 14—00 and 14BY, back contact and inner lower armature of relay 14R, conductor 1825, contact and No. 7 armature of relay 18LU, conductor 1414, the space, or right-hand, contact of relay 14D5 and the path extending over conductor 1423, armature No. 6 and front contact of relay 14F3, conductor 1429, lower armature and back contact of relay 17DL—4, outer lower armature and back contact of relay 17DL—3, outer lower armature and back contact of relay 17DL—2B, outer lower armature and front contact of relay 17DL—1D, conductor 1700—E, through the winding of relay 7HH to grounded negative battery. Relay 7HH corresponds to the first trunk, namely, main trunk No. 89, of the desired, or called, group extending to central office E. Should main trunk No. 89 be idle, relays 14—00 and 14BY would not operate because of grounded negative battery is connected to each end of the circuit just traced.

Relay 14N, upon operating, closes at its upper armature and contact a circuit extending from grounded positive conductor 1456, resistance 1454, its upper armature and contact, conductor 1458, through the upper winding of relay 18G to ground, and to conductor 1114 of the inward supervisory path, thereby providing another path extending through the line winding of relay 18G which now locks in its mark, or left-hand, position by not being able to accept any additional telegraph signals incoming from central office A. Relay 14N—1, upon operating, closes at its upper armature and contact an operating circuit for relay 14N2, the circuit traceable over conductors 1444, 1416 and 1821, in series, to ground at the front contact and lower armature of relay 18C—1. Relay 14N2 which is of the type that is both slow-to-release and slow-to-operate, operates after a predetermined interval, to operate relay 14R, the predetermined interval allowing sufficient time to make the necessary test for busy condition of the selected group of trunks, before relay 14R operates.

Testing at large switching center B of the desired group of main trunks extending to central office E for all-busy condition

By means of a chain circuit in the trunks of a group extending to central office E, a trunk hunting path, such as that of conductor 1709—E selected by 17DL fan relays and relay 14D5 in response to the reception of the signal corresponding to letter E, is extended over the upper armature and back contact of relay 7AD, through the winding of relay 7HH to grounded negative battery, providing the first trunk of the group is idle. However, if the first idle trunk of the group is busy trunk hunting conductor 1709—E is extended over the upper armature and front contact of relay 7AD to the next advance AD relay associated with the next trunk of the desired group. If the next trunk of the desired group is busy, trunk hunting conductor 1709—E is extended over the upper armature and front contact of said next advance relay AD to another advance relay AD in the chain and this opera-

tion is continued over the group of trunks until an idle trunk is found or until one of the busy trunks becomes idle.

Should all the trunks of the group controlled by advance relay 7AD be busy, ground would be connected to conductor 1700—E and both relays 14—00 and 14BY would operate, or if a 1900-ohm out-of-order ground, not shown, but located in an out-of-order circuit, is connected to conductor 1700—E, relay 14—00 only operates. In case no ground is available to conductor 1700—E, relays 14—00 and 14BY do not operate as hereinbefore described. This test takes place during the slow operating time of relay 14N2 which, as hereinbefore stated, begins to operate when relay 14N—1 operates. As soon as relay 14N2 operates, the ground at the lower armature and front contact of relay 18C—1 connected to the circuit extending over conductors 1821 and 1444, is now traceable over the armature and front contact of relay 14N2 to the armature of relay 14—00.

First idle trunk of desired group extending from large switching center B to central office E

Assuming that the first trunk, say trunk No. 89, of the desired group is idle, in which case ground is not connected to conductor 1700—E, relay 14—00 will be unoperated and ground connected to the armature of relay 14—00 by relay 14N2 is extending through the winding of relay 14R to grounded battery to cause the operation of relay 14R. Relay 14R, upon operating, (1) removes relays 14—00 and 14BY from the conductor 1700—E of the desired trunk group and replaces them by relay 14S, the replacement path being traceable over the front contact and inner lower armature of relay 14R, through the winding of relay 14S, conductor 1431, outer lower armature and contact of relay 14F2, conductor 2506, to ground at the contact and inner lower armature of relay 25D in the miscellaneous alarm circuit; (2) causes at its make-before-break contacts the opening of the operating circuit for relay 14N—1 which now releases; (3) prepares at its upper armature and contact an operating circuit for relay 19U and (4) locks over its outer lower armature and front contact in a circuit traceable over grounded series-connected conductors 1444, 1416 and 1821, to the front contact and lower armature of relay 18C—1. The release of relay 14N—1 causes relay 14N2 to slowly release. During the time that relays 14N—1 and 14—2 are releasing, ground at the inner lower armature and contact of relay 25D in the miscellaneous alarm circuit is connected to a circuit traceable through low resistance 2507, conductor 2506, outer lower armature and contact of relay 14F2, conductor 1431, through the winding of relay 14S, conductor 1436, front contact and inner lower armature of relay 14R, conductor 1825, contact and outermost lower armature of relay 18LU, conductor 1414, armature and spacing contact of relay 14D5, conductor 1423, No. 6 armature and front contact of relay 14F3, conductor 1429, lower armature and back contact of relay 17DL—4, outer lower armature and back contact of relay 17DL—3, outer lower armature and back contact of relay 17DL—2B, outer lower armature and front contact of relay 17DL—1D, conductor 1700—E to the first idle trunk in the desired group. Under the assumed condition that the first trunk of the group is idle grounded battery connected to conductor 1700—E permits relay 14S to operate, but due to the high resistance of the circuit which at this time includes the windings of relays 14S and 7HH, relay 7HH remains unoperated. Relay 14S, upon operating, opens the operating path of relay 19U and closes a path for operating relay 14S—1, the operable path being traceable from grounded battery, through the winding of relay 14S—1, front contact and armature of relay 14S, back contact and armature of relay 14N2, grounded series-connected conductors 1444, 1416 and 1821, to ground at the front contact and lower armature of relay 18C—1 and relay 14S—1 operates. Relay 14S—1, upon operating, (1) locks to ground on series-connected conductors 1444, 1416 and 1821; (2) short-circuits the winding of relay 14S which now releases; and (3) maintains open at its inner lower armature and contact the operating path for relay 19U. With the winding of relay 14S short-circuited, ground with a low resistance 2507 supplied by the miscellaneous alarm circuit is extended over conductor 2506, front contact and outer lower armature of relay 14F2, conductor 1431, front contact and outer upper armature of relay 14S—1, front contact and inner lower armature of relay 14R, to conductor 1825 and thence, as hereinbefore traced, connected to conductor 1700—E to the first idle trunk of the desired group and relay 7HH operates. Relay 7HH, upon operating, closes at its upper armature and contact a circuit extending over conductor 704, through the winding of "holding" magnet 3H—89—0 to grounded battery. Holding magnet 3H—89—0 operates, and consequently all the other "holding" magnets 3H—89—1 to 2H—89—9, shown in Figs. 2 and 3 as being in the same vertical row, operate. Holding magnets 3H—89—0 to 2H—89—9 are respectively provided for the corresponding vertical rows of contact sets in switches Nos. 0 to 9 of the cross bar switches at large switching center B, the corresponding vertical rows being shown in Figs. 2 and 3 in continuous alignment. One vertical row connected in continuous alignment through switches Nos. 0 to 9 is assigned to each of the main trunks arranged for "through" connections. Likewise, each vertical row of another group is assigned to each trunk line extending to a small switching center, say center F, and each vertical row of still another group is assigned to each subscriber station local to the particular large switching center, in this case, center B. Holding magnet 3H—89—9, upon operating, connects trunk No. 89 to calling trunk No. 99 over the contact set 201 prepared for operation by selecting magnet 2SM—99 as hereinbefore described. The call connection between central offices A and E will, therefore, be established over main trunks No. 99 and No. 89. Also the operated contact set 201 extends conductor 305 over conductors 411 and 512, in series, through the winding of sleeve relay 5SL, conductor 513, to ground on the contact and armature No. 1 of relay 5—ON and relay 5SL operates. The connection to called trunk No. 89 functions to release the sequence circuit when the call for a "through" connection over the trunks becomes established, the function residing in the operation of holding magnet 3H—89—0 whereby ground is connected to conductor 719 of the operating circuit for relay 7HM which operates. Relay 7HM, upon operating, opens at its No. 7 armature and contact the operating circuit for start relay 12ST2—89 of the trunk sequence circuit for called main trunk No. 89, which is prevented from operating and, therefore, cannot be selected for another call at this time.

Functions at large switching center B and central office E, of called trunk No. 89 when selected for interconnection with calling main trunk No. 99

When grounded series-connected conductors 1432, 1416 and 1821 are extended in a path traceable over the front contact and outer lower armature of relay 14S—1, conductor 1132, contact and armature No. 7 of relay 11AL1—99, conductor 1118—99, through the winding of relay 4TR—1 to grounded battery, relay 4TR—1 operates. Relay 4TR—1, upon operating, (1) transfers conductor 405 from armature No. 4 to armature No. 5 and conductor 405 which is a continuation of ring conductor 416 and previously extended through the upper winding of relay 5SP to ground, now extends over a circuit including conductor 402, contact and innermost lower armature of relay 6TR and the armature of receive relay 6R; (2) disconnects at its armature No. 5 and back contact, conductor 402 from the circuit extending over conductor 1112—99 of the inward transmission path extending from trunk No. 99 to the director circuit; (3) opens at its No. 2 armature and back contact the path for connecting ground at armature No. 5 of relay 5—ON to the space, or left-hand, contact of receive relay 6R; (4) substitutes at its No. 3 armature and front contact a resistance ground 430 for the positive potential previously applied to the marking, or right-hand, contact of relay 6R; (5) locks at its No. 7 armature in a circuit extending over conductor 501, to ground at armature No. 4 of relay 5—ON; (6) opens at its No. 11 armature and back contact, the operating circuit for relay 6TR and prepares at the same armature and front contact the operating circuit for relay 6TR2; (7) closes at its No. 10 armature and front contact a point in a path that puts relay 5SP—1 directly under control of conductor 410 which extends to the link circuit; (8) connects at its No. 8 armature and contact a ground connection for operating relay 4D2, which operates and then locks under control of relay 4D3; (9) substitutes at its No. 9 armature and front contact a new ground for the grid of vacuum tube 411 which remains non-conductive; (10) disconnects at its No. 6 armature and contact the battery supply for operating relay 5BL—1; and (11) prepares at its No. 1 armature and contact an operating circuit for relay 5B.

Relay 4D2, upon operating, (1) closes at its inner upper armature and contact a circuit for energizing the filament of vacuum tube 411; (2) prepares at its inner upper and its outer lower armature a charging path for condenser 412; and (3) furnishes at its outer upper armature and contact a locking circuit for operated relay 4AD, and an additional ground for conductor 413 which is connected to conductor 1119—99 of the locking circuit for relays 11CH—99 and 11AD—99. Relay 4AD became operated when relay 5A operated, the operating circuit for relay 4AD being traceable, over the lower armature and contact of relay 4HH, conductors 1121—99, 504 and 503, to ground at armature No. 6 of relay 5A. As hereinbefore stated, relays 11CH—99 and 4AD, upon operating, respectively made main trunk No. 99 busy to any other call from central office A and to any call from any of the other control offices or switching centers.

Turning our attention now to the previously selected called trunk it will be recalled that the director circuit had caused the operation of relay 7HH and that there were operated subsequently thereto holding magnets 3H—89—0, 3H—89—1 (not shown)—3H—89—8 and 2H—89—9, relay 7HM and contact set 201. The connection established between calling trunk No. 99 and called trunk No. 89 at contact set 201 permits conductors 415, 416, 418 and 410 of trunk No. 99 to be respectively connected to conductors 203, 204, 205, and 206 which, in turn, are permanently connected to conductors 715, 716, 710, and 718, respectively, of trunk No. 89, particular notice being given to the fact that the conductors of trunk No. 99 upon being connected to the conductors of trunk No. 89, are reversed. For example, tip conductor 415 of trunk No. 99 is connected to ring conductor 716 of trunk No. 89, ring conductor 416 of trunk No. 99 is connected to tip conductor 715 of trunk No. 89, conductor 418 of trunk No. 99 is connected to conductor 710 of trunk No. 89 and conductor 410 of trunk No. 99 is connected to conductor 718 of trunk No. 89. Also contact set 201, upon establishing the connection, connects the winding of holding magnet 3H—89—0 over conductor 305 to conductor 417 in a circuit traceable over conductor 512, through the winding of relay 5SL, conductor 513, to ground at the contact and No. 1 armature of relay 5—ON as hereinbefore stated. Relay 5SL in the calling trunk No. 99 operates and holding magnet 3H—89—0 is held operated after the sequence circuit and the director circuit are released.

Relay 7HM in the called trunk No. 89, upon operating, (1) connects at its No. 6 armature and front contact, conductor 720 to conductor 721 in order to place relay 8SP—1 under control of conductor 710 which is now connected over the operated contact set 201 to conductor 418 of the calling trunk No. 99 to procure ground in a circuit traceable over conductor 616, inner right-hand armature and contact of relay 6D—1, conductor 617 to the No. 5 armature and contact of relay 5A, thus operating relay 8SP—1 of the called trunk No. 89; (2) removes at its No. 2 armature and back contact relay 8SP from the circuit including conductors 706, 705 and ring conductor 716 which extends to the link circuit; (3) prepares at its No. 8 armature and contact an operating path for relay 7TR—1 of the called trunk No. 89; (4) opens at its No. 7 armature and contact the circuit including conductor 1102—89 which extends through the winding of the start relay 12ST2—89 of the trunk sequence circuit associated with the called trunk No. 89 thus preventing the called trunk from calling for a director circuit; (5) prepares at its No. 1 armature and contact an operating path for relay 7AD of the called trunk No. 89; (6) also places on the No. 1 armature and contact a ground for connecting to conductor 1121—89 of the called sequence trunk circuit for called main trunk No. 89 which ground operates chain relay 12CH—89 and advance relay 12AD—89 to make called trunk No. 89 appear busy if the called trunk was one which could be used for outward service of local subscribers; (7) opens at its No. 4 armature and contact the circuit extending over conductor 702, contact and innermost lower armature of relay 9TR to the armature of receive relay 9R; (8) disconnects battery 722 at its No. 5 armature and contact from the winding of relay 8BL—1; (9) prepares at its No. 2 armature and front contact an operating circuit for relay 8B, the circuit when completed being traceable from

grounded battery, through the winding of relay 8B, inner lower armature and front contact of unoperated relay 8SB—1, conductors 814 and 815, front contact and No. 3 armature of relay 7HM, conductor 725, front contact and No. 5 armature of relay 8SP—1, conductors 818 and 813 to ground on the contact and No. 1 armature of relay 8—ON. Relay 8SP—1, upon operating, (1) causes at its No. 4 armature the operation of relay 8—ON of the called trunk No. 89; (2) opens at its No. 2 armature and contact the operating circuit of relay 8R3 of the called trunk No. 89; (3) removes at its No. 7 armature and contact one of the ground connections from the grid of subscriber break vacuum tube 904; (4) removes at its No. 3 armature and contact the possibility of short-circuiting relay 8SP of the called trunk No. 89, a function which is of no value since the relay 8SP of the called trunk No. 89 is removed from the circuit; (5) connects interrupted ground 816 at its No. 6 armature and front contact to a circuit extending over conductor 924, armature and contact of break limiting relay 9BL (unoperated at this time), conductor 926, through the winding of relay 8BL—1, conductor 817, armature No. 5 and back contact of relay 7HM which is now in an operated position, contacts and armature No. 6 of relay 7TR—1, to grounded battery 722 which circuit performs no function at this time because in addition to relay 9BL having unoperated, relay 7HM is operated; and (6) at its No. 5 armature and contact prepares a path for operating relay 9TR2, the operating circuit for relay 9TR2 being traceable from grounded battery, through the winding of relay 9TR2, conductor 938, front contact and armature No. 11 of unoperated relay 7TR—1, conductor 724, contact and armature No. 2 of unoperated relay 8A, back contact and innermost upper armature of relay 8R2, conductors 814 and 815, contact and armature No. 1 of unoperated relay 7TR—1, conductor 725, front contact and armature No. 5 of relay 8SP—1, conductors 818 and 813, to ground at armature No. 1 and contact of operated relay 8—ON.

Relay 8—ON of the called trunk No. 89, upon operating, (1) closes at its No. 6 armature and front contact a circuit for energizing filaments of vacuum tubes 902, 903, 904, 905 and 906, extending from grounded battery 908; (2) connects power to the repeater relays of the called trunk No. 89; (3) connects at its No. 1 armature and contact ground connection to the operating circuit for relay 8SL which, however, will not operate on this call; (4) connects at its No. 4 armature and contact a locking ground for unoperated relays 7TR—1 and 9D—1; (5) prepares also at its No. 4 armature and contact an operating circuit for relay 7TR—1, the circuit being traceable from grounded battery, through the winding of relay 7TR—1, conductor 726, contact and armature No. 8 of relay 7HM, conductor 727, front contact and outermost upper armature of relay 9CT—1, conductors 927 and 709, to the contact and armature No. 4 of relay 8—ON to ground, and (6) closes at its No. 7 armature and contact a circuit extending from resistance grounded battery 819, over the No. 7 armature and contact of relay 8—ON, normally closed contacts of busy key 820, conductor 821, to the automatic signal trunk jack circuit arranged to be inserted in jack 928. The called trunk No. 89 at this stage therefore has the following relays operated: 7HH, 7HM, 8SP—1 and 8—ON. The condition of the repeater relays will be hereinafter described.

Returning to the calling trunk No. 99 it will be remembered that the holding magnet of the called trunk No. 89 caused the operation of relay 5SL of the calling trunk No. 99. Relay 5SL, upon operating, connects (1) a second ground to conductor 1119—99, and (2) ground at its upper armature and contact to the operating circuit for relay 5SL—1 which operates. Relay 5SL—1, upon operating, (1) prepares at its front contact and inner lower armature an operating circuit for relay 5R2, the circuit when completed being traceable from grounded battery, through the winding of relay 5R2, armature and contact of unoperated relay 5R—1, front contact and inner lower armature of relay 5SL—1, conductor 409, front contact and No. 7 armature of relay 5TR—1, conductor 426, contact and armature No. 8 of relay 4HM, conductor 427, front contact and outermost upper armature of relay 6CT—1, conductor 627, to ground at the contact and armature No. 4 of relay 5—ON, but relay 5R2 will, however, not operate at this time since both conductor 1112—99 and relay 5R—1 have already been disconnected from the armature of receive relay 6R by the operated relay 4TR—1 and (2) opens at its outer lower armature and contact conductor 1102—99 to the director circuit to release relay 11ST2—99 of the trunk sequence circuit for main trunk No. 99 and relay 11ST2—99, upon releasing, causes the disconnection of the director. The release of relay 11ST2—99 also causes the release of relays 11AL—99 and 11AL1—99 whereby the ground on armature No. 6 of relay 18A extended over conductors 1804, 1903, 1902, 1901, 1801, 1113, 1111—99, 522 and 639 of the outward transmission path is therefore disconnected at armature No. 2 of relay 11AL1—99 and relays 5S and 5L operate to their respective spacing, or left-hand, positions. Relay 5S, upon moving into its left-hand position, transmits a spacing signal to the calling central office A. It must be remembered that the tip conductor 415 of the calling trunk No. 99 is already connected to the ring conductor 716 of the called trunk No. 89, but in the called trunk No. 89 the ring conductor 716 is open at relay 7HM so that the space signal continues to be sent to the central office A. A mark signal is still being received from office A so that relays 6TL and 6R are on their marking contacts. Receive relay 6R is therefore connecting a resistance ground at armature No. 3 and front contact of relay 4TR—1, to the circuit extending over conductor 426, marking, or right-hand, contact and armature of relay 6R, innermost lower armature and contact of relay 6TR, conductor 402, armature No. 5 and front contact of relay 4TR—1, conductor 405, normally closed contact of jack 509—B, ring conductor 416, operated contact set 201 of the link circuit, conductor 204, tip conductor 715, normally closed contact at the tip spring of jack 808—A, upper armature and back contact of relay 8R3, through the lower windings, in series, of relays 8S and 8L, conductor 822, make-before-break contacts of relay 9TR, conductor 939, to grounded positive battery 708, it being noted that the marking signal is sent over the ring conductor 416 of the calling trunk No. 99 to the tip conductor 715 of the called trunk No. 89 which signal, of course, operates relays 8S and 8L of the called trunk No. 89 to mark, or their right-hand, positions. Relay 8S, upon operating to its marking position, sends a mark signal from grounded positive battery, over the make-before-break contact of relay 8SB—1, contact and armature No. 3 of relay 8—

ON, conductor 823, to the normally closed contacts at the spring member of jack 930SEND, conductor 914, to the central office E. The distant office E, which in this case is the called office, is, of course, sending back a space signal over conductor 915, normally closed contacts of receive jack 931, conductor 932, through the lower winding of relay 9TL, resistance 933, contact and outer upper armature of relay 9CT2, conductor 935, through the upper winding of receive relay 9R, resistance 936, to grounded negative battery 937, and relays 9TL and 9R are moved to their space positions as shown. With ground removed from the mark, or left-hand, contact of relay 9TL, the grid of disconnect vacuum tube 906 receives a positive potential from grounded battery 903 and tube 906 becomes active after one second time interval, thereby operating relay 9D. Relay 9D—1, however, does not operate at this time since the contact of operated relay 9D has no ground.

The release of the director circuit by the calling trunk No. 99 caused the removal of ground at relay 25D from conductor 1700—E of the called trunk No. 89 thereby releasing relay 7HH and permitting the operation of relay 7AD which, upon operating, makes the called trunk No. 89 busy in its particular called trunk group. The circuit remains therefore awaiting action at the distant central office E and as hereinbefore stated a mark signal is being sent to office E and a space signal to the calling office A. The mark signal to central office E is transmitted over a circuit traceable from grounded positive battery at the mark, or right-hand, contact and armature of relay 8S, conductor 831, make-before-break contacts of relay 8SB—1, contact and armature No. 3 of relay 8—ON, conductor 823, normally closed tip spring of jack 930SEND, conductor 914, through the upper winding of relay 22RS, outer upper armature and contact of relay 22CT, to grounded negative battery. Relay 22RS operates to its mark, or right-hand, position. Relay 22RS in its normal, or space, position keeps condenser 2201 discharged, but when it operates to its marking position condenser 2201 charges over a circuit traceable from grounded positive battery 2208, resistance 2221, conductors 2209, 2210 and 2225, resistances 2211 and 2212, condenser 2201, to ground. Relay 22RS, upon operating to its mark position, also closes a circuit extending from ground, contact and outermost upper armature of relay 22E—1, through the filaments, in series, of vacuum tubes 2204, 2203, 2202, 2206 and 2205, conductors 2210 and 2209, resistance 2221 to grounded battery 2208 and the tubes become energized but not electrically conductive. The removal of ground at the spacing contact and armature of relay 22RS and the substitution therefor of ground at the marking contact for an interval in excess of one-half second permits condenser 2201 to charge sufficiently to allow vacuum tube 2203 to become conductive and relay 22C operates. Relay 22C, upon operating, operates relay 22CT. Relay 22CT, upon operating, opens at its outer lower armature and contact the space contact circuit of relay 22RS so that vacuum tube 2203 will remain conductive during the reception of signals which relay 22RS follows.

Relay 22CT, upon operating, also (1) conditions at its outer upper armature and contact, the upper winding of receive relay 22R for the reception of the signals incoming over conductor 914 of the outward transmission path and (2) closes at its inner lower armature and contact the operating circuit for relay 22TR. Relay 22TR, upon operating, (1) locks at its middle lower armature and contact and (2) closes at its middle upper armature and contact the operating circuit for relay 22—ON. Relay 22—ON, upon operating, closes (1) at its No. 2 armature the power circuit of repeater, or receive, relay 22R, (2) at its No. 3 armature the power circuit for repeater, or send, relay 22S, and (3) at its No. 5 armature the operating circuit for busy relay 22BY. Relay 22BY, upon operating, (1), closes at its outermost lower armature and contact the circuit for lighting busy lamp 2216, (2) at its upper armature and contact a substitute ground for energizing the filament circuit of vacuum tubes 2204, 2203, 2202, 2206 and 2205 independently of the marking contact of relay 22RS, and (3) at its outermost lower armature and contact a path for connecting grounded negative battery 2238 to the sleeve of jack 2232 for testing purposes. Meanwhile, the vacuum tube filaments being energized and a charge being applied to condenser 2217, vacuum tube 2202 becomes conductive prior to the operation of relay 22—ON to operate relay 22A. Relay 22A, upon operating, operates relay 22A—1. Relay 22A—1, upon operating, applies ringing current from source 2218 to conductor 915 after relay 22—ON operates.

The distant called office E is a manually operated office and the terminating circuit of the called trunk at office E sends the ringing current back upon the reception of a mark signal. This will cause relays 9TL and 9R of the called trunk No. 89 to follow the ringing pulses but relay 9TL will not affect the cut-through vacuum tube 903 because the tube in conjunction with condenser 920 requires a one-half second mark signal to become conductive. The operation of relay 9TL in response to the ringing pulses may, though, cause vacuum tube 906 to become unconductive and thereby release relay 9D. Relay 9R, upon following the received ringing pulses, causes no effect since its armature circuit is open by the operated relay 7HM. Hence the circuit continues to wait until a mark signal is received from the distant office E as a result of the operator thereat answering the call. If the distant called end was another large switching center, similar to center B, a space signal would be sent back until the "director ready" signal from the distant called large switching center was transmitted, the "director ready" signal being a mark.

In either case the reception of a mark signal from the called distant end operates both TL and R relays, in this case, relays 9TL and 9R in the called trunk No. 89, to their mark positions resulting in ground being removed from the grid of cut-through vacuum tube 903 for an interval in excess of one-half second whereby condenser 920 receives a sufficient charge from grounded battery 925 to cause the vacuum tube 903 to become active whereby current flowing in vacuum tube 903 operates cut-through relays 9CT and 9CT—1, in turn, of the called trunk No. 89. Relay 9CT—1, upon operating, (1) removes at its outermost upper armature and back contact the locking circuit for relay 9D—1; (2) closes at its outermost upper armature and front contact an operating circuit for relay 7TR—1 which operates, the circuit being traceable from grounded battery, through the winding of relay 7TR—1, contact and armature No. 8 of relay 7HM, conductor 727, front contact and outermost upper armature of relay 9CT—1, conductors 927 and 801, to the contact and armature No. 4 of

relay 8—ON, to ground; (3) closes at its innermost upper armature and contact an operating circuit from ground, conductor 917, through the winding of relay 8A, conductor 824, to grounded battery 925 and relay 8A operates; (4) connects at its innermost upper armature and contact the ground connection to a second path extending over conductor 917, to link circuit conductor 718 of the called trunk No. 9 which, of course, is already connected to the link conductor 419 of the calling trunk No. 99, the circuit in the called trunk No. 89 being traceable from the innermost upper armature of relay 9CT—1, conductor 917, contact and inner right-hand armature of relay 9D—1, conductors 910 and 718 to the cross bar switch of the link circuit; and (5) removes at its middle upper armature and contact the space, or right-hand, contact control of relay 9TL for cut-through vacuum tube 903. Relay 8A of the called trunk No. 89, upon operating, (1) prepares at its No. 2 armature and contact a path for operating relay 9TR2, the path at this time being closed at the back contact and No. 11 armature of relay 7TR—1; (2) furnishes at its No. 3 armature and contact an additional ground for maintaining relay 8—ON operated; (3) changes at its No. 4 armature and contact the timing of subscriber break vacuum tube 904 of the called trunk No. 89; the closure of the contact and No. 4 armature of relay 8A, being effective to shunt resistance 940 which has a value of 1.2 megohms; (4) locks at its No. 5 armature and contact under the control of the outer left-hand armature and contact of relay 9D—1; (5) connects at its No. 6 armature and contact a ground to a path extending over conductors 803 and 804 to the chain conductor 1221—89 of the trunk group of trunk No. 89 whereby a ground in addition to that at armature No. 1 of operated relay 7HM, is furnished for holding relay 7AD operated; (6) removes at its No. 1 armature and contact one of the connections to ground from the grid of break limiting vacuum tube 905, the circuit being traceable over conductor 825, outer lower armature and contact of relay 9CT2, conductor 941, to the grid of vacuum tube 905. Relay 7TR—1, upon operating, (1) opens at its No. 4 armature and contact the operating circuit for the upper winding of relay 8SP, an action which already had begun when relay 7HM operated, thereby disconnecting the upper winding of relay 8SP from ring conductor 705, (2) connects at its No. 5 armature and front contact, ring conductor 705 to the armature of receive relay 9R, the circuit being traceable over conductor 702, contact and innermost lower armature of relay 9TR, to the armature of relay 9R, (3) opens at its No. 2 armature and contact, the path which connects ground to the space, or left-hand, contact of relay 9R, the circuit being traceable from ground, armature No. 5 and contact of relay 8—ON, conductor 826, contact and No. 2 armature of relay 7TR—1, conductor 729, to the space, or left-hand, contact of relay 9R, (4) replaces at its No. 3 armature the potential of grounded battery 708 with a resistance ground on conductor 728 which extends to the mark, or right-hand, contact of relay 9R, (5) locks at its No. 7 armature and contact in a circuit extending over conductor 709 to ground at the contact and No. 4 armature of relay 8—ON (6) prepares at its front contact and armature No. 11 and also at its contact and No. 1 armature an operating circuit for relay 9TR—2 which operates, the circuit being traceable from grounded battery, through the winding of relay 9TR—2, conductor 938, front contact and armature No. 11 of relay 7TR—1, conductor 724, contact and No. 2 armature of relay 8A, contact and innermost upper armature of relay 8R—2, conductors 814 and 815, contact and armature No. 1 of relay 7TR—1, conductor 725, contact and armature No. 5 of relay 8SP—1, conductors 818 and 813 to ground at contact and armature No. 1 of relay 8—ON, (7) closes at its No. 8 armature and contact the operating circuit for relay 7D—2 which operates, (8) places at its No. 9 armature and contact a new ground on condenser 712, (9) disconnects at its No. 6 armature and contact, grounded battery from the operating circuit for relay 8BL—1, and (10) prepares at its No. 1 armature and contact the operating circuit for relay 8B, both of the above-mentioned functions 9 and 10 having already been performed by armatures Nos. 5 and 3, respectively, of relay 7HM. Relay 7D—2, upon operating, (1) closes at its inner upper armature and contact an energizing circuit for vacuum tube 711, (2) closes at its inner lower armature a locking circuit for itself, and (3) closes at its outer upper armature and contact a locking circuit for relay 7AD. Relay 9TR—2, upon operating, changes the timing of vacuum tube 903 by shunting resistance 922, at the contact and upper armature of the relay and opens at its lower armature and back contact the circuit which might have control over relay 8A should such circuit be closed at the outer left-hand armature and contact of relay 9D—1, now in a released position. The connection by means of relay 7TR—1 of the armature of relay 9R to the ring conductor 716 extending to the cross bar switch in the link circuit, which it will be remembered is already connected to the tip conductor 415 of the calling trunk No. 99, transmits a mark signal received by relay 9R of the called trunk No. 89 from the distant called central office E to the calling trunk No. 99.

Turning our attention again to the calling trunk No. 99 it will be remembered that in the previous paragraph it was stated that the called trunk No. 89 as a result of the mark signal received from the distant called office E has first connected ground at the innermost upper armature of relay 9CT—1, through to conductor 419 of the calling trunk No. 99 and then connected a mark condition from the mark, or left-hand, contact and armature of receive relay 9R, through to the tip conductor 415 of the calling trunk No. 99. Ground on the conductor 419 will cause relay 5SP—1 of the calling trunk No. 99 to operate, and relay 5SP—1, upon operating, (1) closes at its No. 1 armature and front contact an operating circuit for relay 6TR—2, the circuit being traceable from grounded battery, through the winding of relay 6TR—2, conductor 638, front contact and armature No. 11 of relay 4TR—1, conductor 424, contact and armature No. 2 of relay 5A, contact and innermost upper armature of relay 5R—2, conductors 514 and 527, front contact and armature No. 1 of relay 5SP—1, outer lower armature and contact of relay 5SB—1 to ground at the No. 1 armature and contact of relay 5—ON, and relay 6TR—2 operates, (2) removes at its No. 7 armature and contact, ground from conductor 528 and the grid of subscriber break vacuum tube 604 which does not become active at this time as hereinafter described, (3) opens at its

No. 2 armature and contact, the operating circuit for relay 5R—3, (4) provides at its No. 4 armature and contact another ground for the operating circuit of relay 5—ON, and (5) connects at its No. 6 armature and contact an interrupted ground 516 to the armature and contact of relay 5BL.

Relay 6TR—2, upon operating, as already described, changes at its upper armature the circuit for timing of vacuum tube 603 and removes at its lower armature the possible control of relay 6D—1, over the operation of relay 5A. The mark signal transmitted to the tip conductor 415 of the calling trunk No. 99 from the ring conductor 716 of the called trunk No. 89 operates relays 5S and 5L to their respective mark contacts whereby relay 5S repeats the mark signal to the distant calling end (office A), and relay 5L again places ground on conductor 528 and the grid of vacuum tube 604 which is held inactive as hereinbefore stated.

At the time that relay 22A—1 operated to apply ringing current from source 2218 to conductor 915 after relay 22—ON operated, relay 22—ON had (1) closed at its No. 4 armature a locking circuit for itself traceable to ground at the innermost upper armature of relay 22E—1, and (2) transferred at its No. 6 armature condenser 2219 from ground at the back contact to grounded positive battery 2208 at the front contact, the latter function serving to charge condenser 2219. When condenser 2219 has charged for a period of one-half second, vacuum tube 2206 became active and operated relay 22E—1. Relay 22E—1, upon operating, closed at its middle upper armature and contact an operating circuit for relay 22L, the circuit being traceable from grounded battery, through the winding of line relay 22L, conductor 2230, middle upper armature and contact of relay 22E—1, conductor 2236, contact and inner upper armature of relay 22CT, conductor 2239, contact and lower armature of relay 22A—1, conductor 2222, to ground at the innermost lower armature and back contact of relay 22SL and relay 22L operates. Relay 22L, upon operating, closes at its inner upper armature and contact an obvious operating circuit for line lamp 2223 and the line lamp lights to indicate to the operator at central office E that a call awaits an answer.

When the operator at central office E answers a call by connecting answering plug 2306 of a cord circuit to trunk jack 2232 a circuit is completed from ground, through the winding of relay 22SL, sleeve conductors of jack 2232 and plug 2306, through the winding relay 23AA, to grounded battery to operate relays 22SL and 23AA and relay 22SL operates. Relay 22SL, upon operating, (1) opens at its innermost lower armature and back contact the operating circuit for line relay 22L which releases and thereby extinguishes line lamp 2223, and (2) shunts at its outermost lower armature and contact, resistance 2237 thereby changing the timing of vacuum tube 2205 so that the vacuum tube will operate relay 22D on subsequent space conditions of the outward transmission path of at least one second duration, as for example, when a disconnect signal is received over the outward path. The operator at central office E before inserting answering plug 2306 operates typing key 2302 which connects into the selected cord circuit teletypewriter 2303. Relay 23AA, upon operating, closed at its upper armature the operating circuit for relay 23C which operates. Relay 23C, upon operating, connects ground at both its inner armatures to the lower windings, respectively, of repeater relays 23RA and 23 RC and connects at both its outer armatures grounded positive battery to the upper windings, respectively, of repeater relays 23 RA and 23RC whereby the repeater relays are operated to their mark positions pending the completion of the connection of the selected cord circuit to a called subscriber line local to central office E.

The connection is now in readiness for message transmission between central office A and central office E. With repeater relay 22R on its mark contact a biasing current will flow through the lower windings, in series, of relays 22S and 22SS, which will follow all signals transmitted from central office E. Relay 22S will repeat the signals to conductor 2203 and relay 22SS will apply ground to condenser 2217 which will discharge during all mark periods wherein vacuum tube 2202 becomes inactive to release relays 22A and 22A—1, in turn. Relay 22A—1, upon releasing, disconnects at its upper armature and front contact source 2218 of ringing current from sending conductor 915, and connects in its stead at its upper armature and front contact conductor 2203.

The inward transmission path from central office E is traceable from grounded positive battery at the mark contact and armature of relay 22S, over conductor 2203, back contact and upper armature of relay 22A—1, front contact and outer upper armature of relay 22—ON, conductor 915, normally closed tip spring of jack 931—REC, conductor 932, through the lower winding of relay 9TL, resistance 933, back contact and outer upper armature of relay 9CT—2, conductor 935, through the upper winding of relay 9R, to grounded negative battery 937. Relay 9R repeats the signals in the inward transmission path from central office E to the outward transmission path extending to central office A, the path over which the signals are repeated may be traced from ground at the front contact and armature No. 3 of relay 7TR—1, conductor 728, mark contact and armature of relay 9R, conductor 912; innermost lower armature and contact of relay 9TR, conductor 702, armature No. 5 and front contact of relay 7TR—1, conductor 705, normally closed tip spring of jack 809B, ring conductor 716, conductor 203, tip contact of contact set 201, tip conductor 415, normally closed tip spring of jack 509A, upper armature and back contact of relay 5R3, through the lower windings, in series, of relays 5S and 5L, conductor 522, make-before-break contacts of relay 6TR, conductor 639, to grounded positive battery 408. Relay 5S repeats the repeatered signals from central office E to central office A in a circuit traceable from grounded positive battery at the mark contact and armature of relays 5S, conductor 531, make-before-break contacts of relay 5SB—1, contact and armature No. 3 of relay 5—ON, conductor 523, normally closed tip spring of jack 630—SEND, conductor 614, through the upper winding of relay 20—RS, outer upper armature and back contact of relay 20—CT, to grounded negative battery 2041, the upper winding of receive relay 20—R being shunted at this time by the unoperated condition of relay 20—CT. Relay 20—RS will follow all signals received over the outward transmission path from large switching center B. During the idle condition, relay 20—RS will keep condenser 2001 discharged by means of ground connected over the space contact and armature of relay 20—RS. Mark signals, upon

operating relay 20—RS to its mark position, permit condenser 2001 to charge and relay 20—RS when thus moved to its mark position closes a substitute circuit for energizing the filaments of vacuum tubes 2005, 2006, 2002, 2003 and 2004, the circuit extending from grounded positive battery 2008, resistance 2031, conductors 2009 and 2010, through the filaments of the vacuum tubes, in series, outermost upper armature and contact of relay 20—E—1, conductor 2042, to ground at the mark contact and armature of relay 20—RS. The first energizing circuit for the vacuum tube was closed when relays 20—ON and 20—BY operated when the call was originated. When a mark signal in excess of one-half second duration, is received by relay 20—RS, condenser 2001 will charge sufficiently to cause vacuum tube 2003 to become conductive and thereby operate relay 20—C which, upon operating, will operate relay 20—CT. Relay 20—CT, upon operating, will (1) open at its outer lower armature and contact the discharge circuit for condenser 2001 and therefore the vacuum tube 2003 will remain conductive, (2) open at its outer upper armature and contact the shunt circuit around the upper winding of relay 20—R which now becomes conditioned to follow the incoming signals following through the lower winding of relay 20—RS, and (3) closes at its inner lower armature and contact an operating circuit for relay 20—TR which operates. Relay 20—TR, upon operating, will (1) close at its inner upper armature a locking circuit for itself, extending to ground at the innermost upper armature and front contact of relay 20—SL, and (2) close at its inner upper armature a holding circuit for relay 20—ON. As hereinbefore stated when relay 20—ON operated at the time the call from central office A first originated, it closes at its armature No. 5 and contact the operating circuit for busy relay 20—BY, which operated to close circuit for energizing the filaments of vacuum tubes 2005, 2006, 2002, 2003 and 2004, and now when relay 20—RS operates to its marking position the circuit closed by relay 20—BY maintains the filament circuit energized independently of the contacts of relay 20—RS. Relay 20—BY, when operated, also applied a busy test potential to the sleeve of jack 2032. Relay 20—RS, upon being conditioned to follow the signals incoming from central office E through large switching center B, operates to its mark position during the idle periods and thereby repeats a mark signal in a circuit traceable from grounded positive battery at the mark contact and armature of relay 20—RS, through the upper windings, in series, of relay 20—S and 20—SS, contact and upper armature of relay 20—SL, tip conductors of jack 2032 and plug 2101, normally closed contacts of ringing key 2105, lower armature and contact of relay 21—AC, right-hand operated contact of typing key 2102, through teletypewriter 2103, left-hand operated contact of typing key 2102, through the upper winding of relay 21—RC, armature and mark contact of relay 21—AC to grounded negative battery 2107.

In the inward transmission path from central office A toward the large switching center B transmission is in the opposite direction to that of the inward transmission path from central office E toward the large switching center B, over the cord circuit at central office A the path is the same for signals incoming and outgoing at central office A, except that for the outgoing signals relays 20—S and 20—SS follow the signals. Relay 20—S repeats the outgoing signals in a circuit traceable from grounded positive battery at its marking contact, conductor 2033, back contact and upper armature of relay 20—A—1, front contact and armature No. 1 of relay 20—ON, conductor 615, normally closed contacts at the tip spring of jack 631—REC, conductor 632, through the lower winding of relay 6TL, contact and outer upper armature of relay 6CT2, conductor 635, through the upper winding of receive relay 6R to grounded negative battery 637. Relay 6R repeats the signals in a circuit traceable from ground at the front contact and armature No. 3 of relay 4TR—1, conductor 426, marking contact and armature of relay 6R, conductor 612, innermost lower armature and contact of relay 6TR, conductor 402, No. 5 armature and front contact of relay 4TR—1, conductor 405, normally closed spring of jack 509B, ring conductor 416, ring contact of contact set 201, conductor 204, tip conductor 715, normally closed tip spring of jack 308A, upper armature and back contact of relay 3R3, through the lower windings, in series, of relays 8S and 8L, conductor 822, make-before-break contacts of relay 9TR, conductor 939, to grounded positive battery 708. Relays 8S and 8L follow the signals from central office A and relay 8S repeats them in a circuit traceable from grounded positive battery at its mark contact and armature, conductor 831, make-before-break contacts of relay 8SB—1, contact and armature No. 3 of relay 8—ON, conductor 823, normally closed tip spring of jack 930—SEND, conductor 914, through the upper winding of relay 22RS, through the upper winding of receive relay 22R to grounded negative battery 2241. Relay 22R repeats the signals from central office A in a circuit traceable from grounded positive battery at its mark contact and armature, through the upper windings, in series, of relays 23S and 22SS, contact and upper armature of relay 22SL, tip conductor of jack 2232 and answer plug 2309, lower armature and front contact of relay 23AA, armature and back contact of ring relay 23R—1, through the upper winding of repeater relay 23RA, armature and mark contact of repeater relay 23RC to grounded negative battery 2307. Relay 23RA repeats the signals from central office A in a circuit traceable from grounded negative battery 2307 at its marked contact and armature, through the upper winding of relay 23RC, left-hand operated contact of typing key 2302, teletypewriter 2303, right-hand operated contact of typing key 2302 to grounded positive battery at the outer right-hand armature and contact of relay 23C.

It will be obvious that transmission from the calling end is retransmitted by the calling trunk over its ring conductor to the tip conductor of the called trunk which in turn retransmits to the distant called end. Similarly, transmission from the called end is retransmitted over the ring conductor by the called trunk to the tip conductor of the calling trunk which in turn transmits to the calling end. If the distant called end is a manually operated office, the operator at the calling end informs the operator at the called end about the details of the called subscriber's number and the operator at the distant called end continues to route the call to its final destination which may be a subscriber station local to the called office or even one that must be reached by going through one or more still further distant manually operated or automatically operated offices. If, however, the distant called office is a large switching center, the calling operator, upon receiving the

second "direct or ready" signal (the first one, of course, was received by the calling operator when sent by the director circuit at large switching center B that had charge of interconnecting thereat the calling trunk to the called trunk) proceeds to type the local subscriber's number or, if necessary, the code of the trunk group reachable from the distant called large switching center.

Call originating at the operator's switchboard at central office E for a "through" connection to central office A

A call originating at the operator's switchboard at central office E for a "through" connection to central office A is substantially the same as a "through" call from central office A to central office E as hereinbefore described and for an understanding of the call originating at central office E reference may be made to the foregoing description.

To complete a "through" connection for a call from central office E to central office A the following differences are important to note with respect to the hereinbefore described call from central office A to central office E:

(1) Contact set 211, instead of contact set 201, at the link circuit operates to complete the interconnection of main trunks Nos. 89 and 99.

(2) Relays 12AD—89, 12CH—89, 12ST2—89, 12AL—89 and 12AL1—89, instead of relays 11AD—99, 11CH—99, 11ST2—99, 11AL—99 and 11AL1—99, of the trunk sequence circuit operate to connect the calling trunk No. 89 to the director circuit.

(3) In response to the teletypewriter code signal received from central office E for selecting the trunk group extending to central office A the receiving distributor selects a conductor corresponding say, to letter A, the code for which is mark, mark, space, space and space to operate relay 14D5 to its spacing position and operate relays 17DL—1A, 17DL—1B, 17DL—1C, 17DL—1D, 17DL—2A and 17DL—2B and the selecting path established by relay 14D5 and the 17DL relays in response to this combination is traceable from the space contact of relay 14D5, conductor 1423, armature No. 6 and front contact of relay 14F3, conductor 1429, lower armature and back contact of relay 17DL—4, outer lower armature and back contact of relay 17DL—3, outer lower armature and front contact of relay 17DL—2B, inner lower armature and front contact of relay 17DL—1D, to conductor 1736—A which extends to the upper armature of relay 4AD, the advance relay of main trunk No. 99 of the desired trunk group extending to central office A.

(4) The remaining functions of the connection so established will be readily understood by referring to the description of a call from central office A to central office E given hereinbefore.

Call originating at the operator's switchboard at central office A for a subscriber line connected to large switching center B

For the purpose of illustrating a call originating at central office A and extending through large switching center B to a subscriber line local thereto, it will be assumed that the operator at office A seizes main trunk No. 99 at the switchboard by means of a cord circuit shown in Fig. 21 and connects to such cord circuit the teletypewriter in position circuit 2103 by operating a typing key, say key 2102 which is individual to the seized cord circuit. The function resulting from the seizure of main trunk No. 99 at the switchboard at central office A are the same as those as hereinbefore described under the caption of a call originating at the operator's switchboard at central office A for a "through" call to station office E, the similarity continuing to a point where the operator transmits the signals preliminary to the called number and such signal is received at large switching center B. Inasmuch as the call now being described is to a subscriber line, the operator at central office A transmits the signal combination corresponding to "Figures" preliminary to the called number of the desired subscriber line. The called number of the desired subscriber line consists of two significant character signals corresponding to numerical digits. The combination of selecting impulses in the "Figures" signal are mark, mark, space, mark and mark, as hereinbefore stated, under "Reception of teledirecting telegraph character signals." All telegraph character signals received at large switching center B are decoded by the receiving distributor in the director circuit, that is, broken down into their five component elements.

When a "Figures" signal is received, contact sets SC—1, SC—2, SC—4 and SC—5 are closed in succession during the rotation of distributor shaft 1613 and thereby close in turn the operating circuits for relays 14D—1, 14D—2, 14D—4 and 14D—5, the operating circuit for relay 14D—5 being connected to the upper winding of the relay. Therefore, relays 14D—1, 14D—2, 14D—4 will be operated and relay 14D—5 will be operated to its mark, or left-hand, contact. After reception of the fifth impulse, the auxiliary contact set ASC or cam AC again becomes normal so that ground at the inner, upper armature and contact of relay 18A—1 is connected to a circuit extending over conductors 1812 and 1610, normal contact and armature of set ASC of cam AC, conductor 1611, outer upper armature and back contact of relay 18A2, conductor 1824, outermost upper armature and back contact of relay 14F—2, conductor 1413, lower armature and back contact of relay 14K, conductor 1437, front contact and armature No. 3 of relay 14D—1, front contact and armature No. 2 of relay 14D—2, front contact and outer upper armature of relay 14D—4, back contact and armature No. 5 of relay 14F—3, conductor 1422, mark, or left-hand, contact and armature of relay 14D—5, conductor 1414, armature No. 7 and contact of relay 18LU, conductor 1825, inner lower armature and back contact of relay 14R, lower armature and back contact of relay 14N—1, conductor 1438, inner lower armature and back contact of relay 14F—2, conductor 1439, outer upper armature and back contact of relay 14K, make-before-break contacts of relay 14D—3, make-before-break contacts and winding of relay 14F, to grounded battery and relay 14F operates. Any other combination of the 14D relays would have no effect at all at this time. Relay 14F, upon operating, locks in a circuit traceable over series connected conductors 1415, 1416 and 1821 to ground at the front contact and lower armature of relay 18C—1 and prepares at its upper armature for the operation of relay 14K and the subsequent registering of the signals corresponding to the number of the called subscriber line.

Reception and deciphering at large switching center B of the first and the second digits of the listed number of the called subscriber line

The first digit of the called subscriber's listed number will be repeated by relay 18G, broken up, pulse by pulse, by the receiving distributor contacts SC—1 to SC—5 and recorded by relay 14D—1, 14D—2, 14D—3, 14D—4 and 14D—5, in much the same manner as the "Figures" character which was previously received. Relay 14D—1 is operated in accordance with the position of relay 18G at the middle of the first impulse, relays 14D—2, according to the second impulse, etc., by means of the receiving distributor shown in Fig. 16.

Assume that the listed number of a called subscriber's station is No. 90, the operation resulting from the reception of the next telegraph character after "Figures," which is the first significant character, in this case the numeral 9, causes each of relays 14D—1, 14D—2, 14D—3, 14D—4 and 14D—5 to assume either of two positions in accordance with the following table wherein O, NO, M, and S represent operated, non-operated, mark and space, respectively:

Lower Case	Upper Case	14D—1	14D—2	14D—3	14D—4	14D—5
P	0	NO	O	O	NO	M
Q	1	O	O	O	NO	M
W	2	O	O	NO	NO	M
E	3	O	NO	NO	NO	S
R	4	NO	O	NO	O	S
T	5	NO	NO	NO	NO	M
Y	6	O	NO	NO	NO	M
U	7	O	O	O	NO	S
Z	8	NO	O	O	NO	S
O	9	NO	NO	NO	O	M

Shortly before the reception of selecting pulse No. 1 the armature of the auxiliary contact set ASC transfers to its alternate contact to close a circuit traceable from grounded negative battery, through the winding of relay 14K, back contact and upper armature of relay 14L, conductor 1440, front contact and upper armature of relay 14F, conductor 1417, alternate contact and armature of auxiliary contact set ASC, conductors 1610 and 1812, upper armature and front contact of relay 18A—1 to ground. Relay 14K operates and locks in a circuit traceable over its inner upper armature and front contact, conductors 1444, 1416 and 1821, to ground at the lower armature and front contact of relay 18C—1.

The signal combination for the first significant character, that is, 9, consists of the start impulse which is always a space, followed by space, space, space, mark and mark and ending with a stop impulse which is always mark. Relay G responds to each of these signal impulses, in turn, and the five selecting impulses by means of the receiving distributor respectively control the operating circuits for relays 14D—1, 14D—2, 14D—3, 14D—4, and 14D—5 and accordingly, relay 14D—1, 14D—2 and 14D—3 remain unoperated, relay 14D—4 operates and relay 14D—5 operates to its mark contact. Shortly after the fifth selecting impulse is acted upon, the armature of the auxiliary contact set ASC again closes to its normal contact to complete a circuit traceable from grounded battery, through the upper winding of relay 14L, conductor 1441, back contact and lower armature of relay 14M, front contact and lower armature of relay 14K, conductor 1413, back contact and armature No. 1 of relay 14F—2, conductor 1824, back contact and outermost upper armature of relay 18A—2, conductor 1611, normal contact and armature of auxiliary contact set ASC, conductors 1610 and 1812, inner upper armature and front contact of relay 18A—1, to ground and relay 14L operates. Relay 14L, upon operating, locks in its operated position in a circuit traceable through its lower winding, front contact and lower armature, conductors 1444, 1416 and 1821 to ground at the front contact and lower armature of relay 18C—1. The ground connected to the operating circuit for relay 14L is also connected to the front contact and outer upper armature of relay 14K, conductor 1439, back contact and inner lower armature of 14F—2, conductor 1438, back contact and lower armature of relay 14N—1, back contact and inner lower armature of relay 14R, conductor 1825, back contact and armature No. 7 of relay 18LU, conductor 1414, armature and marking contact of relay 14D—5, armature No. 5 and back contact of relay 14F—3, inner upper armature and front contact of relay 14D—4, armature No. 3 and back contact of relay 14D—3, armature No. 4 and back contact of relay 14D—2, armature No. 6 and back contact of relay 14D—1, conductor No. 9, back contact and armature No. 9 of relay 14K—1, through the upper winding of relay 14H—9, conductor 1443, back contact and inner armature of relay 14K—0, to grounded negative battery. Relay 14H—9, representative of the tens group of subscriber lines, in which the called line No. 90 is included, operates. Relay 14H—9, upon operating, locks in a circuit traceable from grounded battery, through its lower winding and front contact and lower armature, conductor 1445, through the winding of relay 14K—0, conductors 1416 and 1821, to ground at the front contact and lower armature of relay 18C—1. Relay 14K—0 operates to open the operating circuit for relay 14H—9 and closes an obvious operating circuit for relay 14K—1 which operates. Relay 14K—1, upon operating, disconnects at its right-hand armatures the conductors employed for the tens selection of the called subscriber's listed number and prepares at its left-hand armature and contact a circuit for operating relay 14H—1—9 which, when operated, prepares to make the unit selection of the called subscriber's listed number. The H relays, such as relays 14H—0 to 14H—9 correspond to the digits which represent the tens groups of tens subscribers' lines or subscribers' lines and trunk lines if the latter are combined with the subscribers' lines in the one group. Relay 14L, upon operating, as hereinbefore described, locked to ground on the lower armature of relay 18C—1, opened the operating path for relay 14K which is locked operated and prepared an operating path for relay 14M. Relay 14K—0, upon operating, (1) removes battery from the operating winding of all the H relays, such as relays 14H—0 to 14H—9, thereby preventing the operation of any other of the H relays; and (2) connects its outer left-hand armature and contact, conductor 1447, to a path now open, but extending when closed by relay 14F—2 upon operating in response to a letter signal, over conductors 1446 and 2506, resistance 2507 to ground at the inner lower armature of relay 25D in the miscellaneous alarm circuit.

Upon the reception of the second significant character of the called subscriber's listed number which in this case is 0 or No. 10, relay 14D—1 remains unoperated, relay 14D—2 is operated, 14D—3 is operated, 14D—4 unoperated and 14D—5 is operated to its marking contact. The second significant character upon being received

in the receiving distributor causes to be performed similar functions that were performed when the first significant character was received, that is, the armature of the auxiliary contact set ASC operates to its alternate position to close a circuit for operating relay 14M, the circuit being traceable from grounded negative battery, through the winding of relay 14M, front contact and upper armature of relay 14L, conductor 1440, front contact and upper armature of relay 14F, conductor 1417, alternate contact and armature of auxiliary contact set ASC, conductors 1610 and 1812, to ground at the inner upper armature and front contact of relay 18A—1, and relay 14M operates. Relay 14M, upon operating, (1) locks in a circuit traceable over conductors 1444, 1416 and 1821 to ground at the front contact and lower armature of relay 18C—1, and (2) opens at its lower armature and back contact the operating circuit for relay 14H—9. If, therefore, the first significant character, No. 9 in this case, did not result in the operation of an H relay because, for instance, the first significant character was not a numerical character, no subsequently received character would cause the operation of an H relay.

Shortly after the registration of the fifth selecting impulse of the second significant character by means of the receiving distributor, the armature of the auxiliary contact set ASC is closed to its normal contact thereby causing the quick operation of relay 14N, the circuit being traceable from grounded battery, through the winding of relay 14N, front contact and lower armature of relay 14M, front contact and lower armature of relay 14K, conductor 1413, back contact and armature No. 1 of relay 14F—2, conductor 1824, back contact and outermost upper armature of relay 18A—2, conductor 1611, the armature of auxiliary contact set ASC closed to its normal contact, conductors 1610 and 1812, inner upper armature and front contact of relay 18A—1, to ground. Relay 14N, upon operating, (1) closes at its upper armature and front contact a circuit traceable from ground, through the upper winding of relay 18G, conductor 1458, front contact and upper armature of relay 14N, resistance 1454, conductor 1456, resistance 1808, to grounded positive battery 1826 whereby relay 18G is caused to stay on its marking contact, and therefore, refuses to accept at this time any additional telegraph characters, and (2) closes at its lower armature and front contact an operating circuit for relay 14N—1, the circuit being traceable over the make-before-break contacts of relay 14R, conductors 1444, 1416 and 1821, front contact and lower armature of relay 18C—1, to ground, and relay 14N—1 operates. Relay 14N—1, upon operating, (1) connects grounded battery through the winding of the 14—00 and 14BY to the armature of relay 14D—5 and through the fanning-out circuit to the conductor for selecting the called subscriber's line, the fanning-out circuit closed by the reception of the second significant character being hereinafter described, and (2) closes on its upper armature and front contact an obvious operating circuit for relay 14N—2, which operates.

The selecting impulses for the units digit of the called subscriber's listed number, the units digit being zero, are space, mark, mark, space and mark which are effective to operate relays 14D—2, 14D—3 and to operate 14D—5 to its marking position, relays 14D—1 and 14D—4 remaining unoperated. The fanning-out circuit is therefore traceable from grounded negative battery, through the winding, in series, of relays 14—00 and 14—BY, front contact and lower armature of relay 14N—1, back contact and inner lower armature of relay 14R, conductor 1825, back contact and armature No. 7 of relay 18LU, conductor 1414, armature and mark contact of relay 14D—5, conductor 1422, armature No. 5 and back contact of relay 14F—3, inner upper armature and back contact of relay 14D—4, armature No. 2 and front contact of relay 14D—3, armature No. 1 and front contact of relay 14D—2, armature No. 2 and back contact of relay 14D—1, conductor No. 0, armature No. 0 and front contact of relay 14H—1—9, which operated as hereinbefore described, conductor 1400, normally closed contacts on the ring spring of jack 4201—A, normally closed contacts on the ring spring of jack 4202—B, conductor 1404, through the winding of "holding" magnet 3H—S—0 to grounded negative battery. Relays 14—00 and 14BY and holding magnet 3H—S—0 do not operate because similar batteries are connected to opposite ends of the fanning circuit.

Testing of subscriber's line at large switching center B

The connection of grounded negative battery through the windings, in series, of relays 14—00 and 14BY and to the winding of the holding magnet 3H—S—0, which is assigned to the called subscriber's line, enables these two relays to determine if the conductor 1400 corresponding to the called subscriber's line, is terminated in a direct ground which causes the operation of both relays 14—00 and 14BY, or a 1900-ohm out-of-order ground on the out-of-order circuit, not shown, which results in the operation of relay 14—00 only. The termination in a direct ground, if present, will be found on conductor 308, which extends through an operated contact set of those sets controlled by holding magnet 3H—S—0, such as contact set 210, to the sleeve conductor of the trunk which holds the called subscriber's line busy, the sleeve conductor being connected to ground through the winding of a sleeve relay to the armature of an operated off-normal relay in such trunk. In case no ground is available, neither the 14—00 nor 14BY will operate and this test takes place during the slow-operating time of relay 14N—2 which begins to operate when relay 14N—1 operates. As soon as relay 14N—2 operates, off-normal ground at relay 18C—1 is connected to the armature of relay 14—00. Assuming that the called subscriber's line is idle, in which case ground is not connected to conductor 308, relay 14—00 will remain unoperated and the ground connected to its armature and back contact will complete a circuit extending from grounded negative battery, through the winding of relay 14R, back contact and armature of relay 14—00, front contact and upper armature of relay 14—N2, conductors 1444, 1416 and 1821, to ground at the front contact and lower armature of relay 18C—1 and relay 14R operates. Relay 14R upon operating, (1) removes at its inner lower armature and back contact the operating circuit for relays 14—00 and 14BY, conductor 1400 on the called subscriber's line and replaces it at the same armature now in engagement with its front contact with a path extending through the winding of relay 14S, conductors 1431 and 1447, outer left-hand armature and front contact of relay 14K—0, conductors 1446 and 2506, resistance 2507, to ground, at the inner lower armature and front contact of relay 25D, relay 25D having operated in

a circuit traceable over conductor 307 to ground at the armature and front contact of selecting magnet 3SM—99 which is associated with the calling trunk No. 99, (2) opens at its make-before-break contacts the operating circuit for relay 14N—1 which now releases, (3) prepares at its upper armature and front contact an operating circuit for relay 19U, and (4) locks at its outer lower armature and front contact a circuit traceable over conductors 1444, 1416 and 1821 to ground at the front contact and lower armature of relay 18C—1. Relay 14N—1, upon releasing, causes relay 14N—2 to slowly release. During the time that relays 14N—1 and 14N—2 are releasing, ground connected to the inner lower armature and front contacts of relay 25D in the miscellaneous alarm circuit is connected through the winding of relay 14S to conductor 1400 assigned to the called subscriber's line circuit. Under the assumed condition of the called subscriber's line being idle, grounded negative battery connected to the winding of holding magnet 3H—S—0 permits relay 14S to operate but due to the high resistance of the circuit magnet 3H—S—0 remains unoperated. Relay 14S upon operating opens the operating path of relay 19U and closes a path to operate relay 14S—1. When relay 14N—2 released ground supplied by relay 18C—1 is connected to the armature of relay 14S, which, having operated, causes the operation of the relay 14S—1. Relay 14S—1, upon operating, (1) locks in a circuit extending to ground at the lower armature of relay 18C—1, (2) short-circuits the winding of relay 14S, which now releases; and (3) holds open the operating path to relay 19U. With the winding of relay 14S short-circuited, ground is connected through the low resistance 2507 supplied by the miscellaneous alarm circuit to a circuit extending through the fanning-out 14D relays to the conductor leading to the called subscriber's line. The operating circuit for the holding magnet assigned to the called subscriber's line is traceable from the ground at the inner lower armature and front contact of relay 25D, resistance 2507, conductors 2506 and 1446, front contact and outer right-hand armature of relay 14K—0, conductors 1447 and 1431, front contact and outer upper armature of relay 14S—1, front contact and inner lower armature of relay 14R, conductor 1825, back contact and armature No. 7 of relay 18LU, conductor 1414, armature and marking contact of relay 14D—5, conductor 1422, armature No. 5 and back contact of relay 14F—3, inner upper armature and back contact of relay 14D—4, armature No. 2 and front contact of relay 14D—3, armature No. 1 and front contact of relay 14D—2, armature No. 2 and front contact of relay 14D—1, conductor No. 0, armature No. 0 and front contact of relay 14H—1—9, conductor 1400, normally closed contacts at each of the ring springs of jacks 4201—A and 4202—B, conductor 4204, through the winding of holding magnet 3H—S—0, to grounded battery. In this circuit of lower resistance holding magnet 3H—S—0 operates. Holding magnet 3H—S—0, upon operating, operates holding magnets 3H—S—1 (not shown) to 3H—S—8 and 2H—S—9, and the operation of holding magnet 2H—S—9 causes to be operated contact set 210 which has already been conditioned for operation by the operation of selecting magnet 3SM—99, hereinbefore described, whereby trunk No. 99 becomes connected to the called subscriber's line extending to subscriber's station No. 99. The holding magnets are locked in operated position by a circuit extending over conductor 308, sleeve contacts of contact set 210, conductors 417 and 512, through the winding of sleeve relay 5SL, conductor 513, to ground at the front contact and No. 1 armature of relay 5—ON. Relay 5SL, upon operating, (1) closes at its lower armature and front contact a circuit for locking in operated position chain relays 11CH—99 and 11AD—99 for the duration of the call, and (2) closes at its upper armature and front contact an operating circuit for relay 5SL—1 which operates. Relay 5SL—1, upon operating, opens at its outer lower armature and back contact the operating circuit for relay 11ST2—99 which releases whereby the trunk sequence circuit is released for another call. Relay 11ST2—99, upon releasing, releases relays 11AL—99 and 11ALI—99. Relay 11ALI—99, upon releasing, (1) removes ground from conductor 1110 to cause relay 18A to release, (2) opens up the two transmission paths, respectively, including conductors 1113 and 1114, which serve to direct the signal impulses incoming to and outgoing from the director circuit. Relay 18A, upon releasing, (1) permits the release of relay 18A—1 unless another trunk circuit holds it operated by ground on conductor 1105, (2) causes the release of relay 18C—1, and (3) removes ground from the lower winding of relay 18G and start magnet 1601. The removal of ground from the winding of the start magnet 1601 will cause the cams of the receiving distributor to rotate through, at least, one revolution tending to open contacts SC—1 to SC—5 of the distributor. If relay 18A—1 releases it will remove power from the receiver-distributor motor and ground from the armature of the auxiliary contact set ASC thereby releasing relay 14N. If relay 18A—1 remains operated, the motor of the receiver-distributor will remain at its attained speed and ground will be reconnected to start magnet 1601 when relay 18C—1 releases causing it to finish any revolution that the cams may be engaged in at the time. All or only some of the contacts SC—1 to SC—5 may therefore be operated. Relay 18C—1, upon releasing, removes off-normal ground from all operated relays causing the director circuit to return to normal and be in a position to handle the next call. If relay 18A—1 has remained operated the circuit functions on the next call exactly as described hereinbefore except since the motor has attained its speed and the distributor cams are at rest, no delay in the operation of relays 18B and 18C is encountered.

Inward call to busy or out-of-order subscriber line at large switching center B

The operation of this type of call is exactly the same as hereinbefore described under the caption of "Testing of subscribers' lines" up to the point where the operation of relay 14N—1 connects relays 14—00 and 14BY to conductor 1400 which is assigned to the called subscriber's line circuit. Now, however, conductor 1400 terminates in direct ground, that is, a busy condition, or the 1900-ohm ground which is found in an out-of-order circuit, not shown. In either case, relay 14—00 quickly operates but relay 14BY is marginal and operates only on direct ground. Relay 14—00, upon operating, prevents relay 14R from operating and therefore relay 14N—1 remains operated keeping relays 14—00 and 14BY connected to conductor 3400. Relay 14—00, therefore, remains operated along with relays 14N, 14N—1 and 14N—2 and operates relay 14N3. Relay 14N3, upon operating, (1) applies ground

to start the production of signals corresponding to "K" or "Q" characters, by relays 19P and 19P—1 as described in Krecek Patent 2,368,666, supra; and (2) connects the contact of relay 19P—1 to the outward transmission path extending over conductors 1902, 1901, 1801 and 1113. A brief description of the transmission of the signals corresponding to the "K" or "Q" characters is furnished herein in describing the results of the operation of relay 19N3. Relay 19N3, upon operating, (1) connects ground to a circuit extending from its outer upper armature and front contact, conductor 1905, resistances 1923, 1906 and 1922, conductor 1907, resistance 1914, conductor 1908, resistance 1450 (assuming that the called subscriber's line is busy), conductor 1451, through the upper winding of relay 19P, to grounded negative battery 1909 whereby relay 19P, whose upper winding has a comparatively low resistance value operates to its right-hand position in response to current passing through its upper winding; (2) connects ground at its outer upper armature and contact to a circuit traceable over conductor 1935, through the upper winding of relay 19P—1, resistance 1910, to grounded negative battery 1911. The upper winding of relay 19P—1 has a comparatively low resistance value and the current therethrough operates the relay to its left-hand position to maintain the mark signal on the transmission path, conductor 1113 in a path traceable over ground, armature and left-hand contact of relay 19P—1, inner upper armature and front contact of relay 19N3, conductors 1902 and 1901, make-before-break contact of relay 19TB, conductor 1801, back contact and middle lower armature of relay 18A2, to conductor 1113. When relay 19P, however, operates to its right-hand position the ground connection at the outer upper armature and contact of relay 19N3 is connected over the armature and right-hand contact of relay 19P, to the right-hand end of both the upper and the lower windings of relay 19P. Current through the upper winding of relay 19P is therefore reversed but the discharge of condenser 1912 causes a current to flow through the lower, or comparatively high resistance, winding of relay 19P which maintains the armature on its right-hand contact. When the discharge current of condenser 1912 is sufficiently reduced, the reverse current in the upper winding of relay 19P causes the relay armature to move to its left-hand contact. Again the current in the upper winding reverses but the condenser 1912 now takes a charging current tending to keep the armature of relay 19P on its left-hand contact. When this charging current has sufficiently decreased, the current in the upper winding of relay 19P operates the relay armature to its right-hand contact. Relay 19P continues to pulse in this fashion. The values of condenser 1912 and resistances 1913, 1914, 1906 and 1450 are so proportioned that relay 19P will pulse at about 9 cycles per second if resistance 1450 is in the circuit or 11 cycles per second if resistance 1450 is short-circuited because relay 14BY is not operated when an out-of-order circuit is connected to a jack in the subscriber's line circuit. Each time relay 19P operates to its left-hand position, condenser 1915 is discharged causing a current to flow through the lower, or high resistance, winding of relay 19P—1, which current helps to keep the armature of relay 19P—1 on its left-hand contact. Upon each subsequent opening of the left-hand contact of relay 19P, condenser 1915 charges thereby causing a current flow in the lower winding of relay 19P—1 which operates its armature to its space, or right-hand contact. The charging path has been so chosen that relay 19P—1 leaves its left-hand contact for approximately one pulse length, or 0.022 second. The result of the operation of relays 19P and 19P—1, therefore, is the transmission of a 0.022 second space signal nine or eleven times a second. These signals are sent through the trunk which retransmits to the distant end where they appear on the operator's printer as "K" (9 cycles) signal indicating a busy condition or "Q" (11 cycles) signal indicating an out-of-order condition.

Connection to unassigned or impossible number at large switching center B

If an unassigned number or non-numerical code is received and registered, the circuit functions as hereinbefore described. When, however, the winding of relay 14S is connected to the hunting conductor 1400 of the called subscriber line as hereinbefore described, grounded battery is not available on the conductor and relay 14S fails to operate. When, therefore, relay 14N2 releases, off-normal ground at the lower armature and front contact of relay 18C—1 will be connected over a circuit including conductors 1821, 1416 and 1444, armature and back contact of relay 14N2, armature and back contact of relay 14S, back contact and inner lower armature of relay 14S—1, upper armature and contact of relay 14R, conductor 1452, contact and No. 5 armature of relay 19TA, through the winding of relay 19U, to grounded battery and relay 19U operates. Relay 19U, upon operating, (1) closes at its inner lower armature and contact an operating circuit for relay 19N3, the circuit being traceable over armature No. 3 and contact of relay 19TA, (2) disconnects resistance 1916 which is connected in parallel with resistance 1910. Relay 19N3, upon operating, connects at its outer upper armature and contact a ground connection to two paths, one extending through the upper winding of relay 19P and the other, through the upper winding of relay 19P—1 as hereinbefore described. Resistance 1914 is put into the circuit as the shunt path of the resistance is opened by the operation of relay 19U. Under these conditions, relay 19P operates at approximately 6 cycles per second. When relay 19P operates at its No. 3 contact relay 19P—1 is operated to its space, or right-hand, contact for two pulse lengths, that is, 0.044 second, by charging of condenser 1915. Relay 19P—1, upon returning to its mark, or left-hand, contact, remains in its mark position until relay 19P again operates to its space, or right-hand, position. Thus a "V" character signal is generated and transmitted to the operator at the distant central office. If the miscellaneous alarm circuit times out a ten-second interval while the director circuit is sending "K," "Q" or "V" signals, relay 25ST in the alarm circuit connects the ground at its inner lower armature and front contact to a circuit extending over the inner lower armature and front contact of time measuring relay 25TM, outermost upper armature and front contact of relay 26TM—1, lower armature and back contact of relay 25TK, upper armature and front contact of relay 25R—0, conductor 1512, lower armature and front contact of relay 19N3, through the winding of relay 19TB, to grounded battery, and relay 19TB operates. Relay 19TB, upon oper-

ating, removes at its inner lower armature and back contact the ground connection from the grid of vacuum tube 1918 and interconnects at its outer lower armature and contact, conductors 1919 and 1920 which extend to the miscellaneous alarm circuit wherein relay 25TM is maintained operated in a path extending to ground at the front contact and inner upper armature of common start relay 25CS. The signals produced by the director circuit continue to be manufactured and sent to the trunk circuit extending to the distant calling central office. After approximately one second, relay 19T operates in response to the current flow in vacuum tube 1918 and thereby connects at its armature and contact grounded conductor 1512 to conductor 1921 in a circuit extending over the lower armature and front contact of relay 25R—0 in the miscellaneous alarm circuit, conductor 1115, armature No. 5 and front contact of relay 11ALI—99 in the trunk sequence circuit, through the lower winding of relay 11BO—0, to grounded battery. Relay 11BO—0, upon operating, causes the release of the sequence circuit and therefore the director circuit. The operation just described, therefore, will receive at least one second period of whatever signal the director has manufactured.

Recorder signal at large switching center B

If the miscellaneous alarm circuit times out a ten-second interval and the director circuit is not in the process of sending any signals, the alarm circuit places ground on conductor 1512 causing the operation of relay 19TA. Relay 19TA, upon operating, (1) prevents further operation of either relay 19U or 19N3, (2) opens a short-circuit around resistances 1906 and 1922, (3) prepares at its No. 1 armature and front contact, a connection of the mark, or left-hand, contact of relay 19P to conductor 1801, (4) disconnects at its No. 2 armature and back contact resistance 1924 from the mark contact of relay 19P, (5) closes at its No. 4 armature and contact an operating circuit for relay 19TB which operates. Relay 19TB, upon operating, (1) interconnects conductors 1919 and 1920 which as hereinbefore described extend to the miscellaneous alarm circuit, (2) connects at its upper armature and contact supervision conductor 1801 to the mark, or left-hand, contact of relay 19P, the interconnecting path extending through the front contact and armature No. 1 of relay 19TA, (3) removes at its inner lower armature and back contact ground from the grid of vacuum tube 1918 and (4) connects ground at the inner lower armature and front contact to resistance 1923 and the armature of relay 19P. Relay 19P starts pulsing as hereinbefore described. The resistance change due to the operation of relay 19TA, however, makes relay 19P pulse at approximately 8 cycles per second holding it on its mark contact 0.132 second and on its spacing, or, right-hand, contact 0.110 second. This is equivalent to the telegraph character "T" or "5" signal, which is sent to the trunk circuit extending to the distant calling central office. After the delay of one second, relay 19T operates to place a ground on conductor 1921 which causes the operation of relay 99BO—0 in the trunk sequence circuit and the sequence circuit releases which causes, in turn, the release of the director circuit. A one-second period of "T" signals are therefore sent to the calling operator at the distant central office.

Failure of the director circuit at large switching center B—General

When a trunk circuit on an inward call obtains permission from the sequence circuit to route the call, the miscellaneous alarm circuit begins counting time. Ordinarily the alarm circuit will time-out in two seconds but if the director circuit has grounded the conductor 1816 indicating that it has moved off-normal, the miscellaneous alarm circuit extends timing out to four seconds. Then, if "the director ready" signal is sent as hereinbefore described, relay 18C2, upon operating, connects ground to conductor 1822 to extend the time allowed for handling the call to ten seconds.

Conductors 1818 and 1823 are used to indicate to the miscellaneous alarm circuit whether or not the trunk should be locked up in case of trouble. Ground on either of these conductors prevents the removal of the trunk circuit from service.

Failure to move a director circuit off-normal

After two seconds, if relay 18A2 has not grounded conductor 1816, indicating that the trunk circuit has failed to start a director circuit off-normal, the alarm circuit removes the trunk from service. The removal of the trunk, of course, removes any connection from the director circuit to the trunk circuit, returning the director circuit to normal and permitting it to continue to handle other calls.

Failure of the distributor motor to attain required speed

In this case it is assumed that relay 18A2 has operated and grounded conductors 1816 and 1818 cause the miscellaneous alarm circuit to permit an elapsed time of four seconds but relay 18C—1 fails to operate either because the motor failed to attain speed or the relay arrangement designed to detect the speed fails to function. In this case the alarm circuit after four seconds places a ground on relay 18LU causing relay 18LU to operate. Relay 18LU, upon operating, (1) locks up under control of the release key 1828, (2) places a ground at its No. 3 armature and contact on conductors 1835 and 1110 thereby maintaining the relay 18A operated and the director circuit locks up in a "stuck" condition, (3) places a ground at its No. 2 armature and contact on conductor 1829 to indicate to the miscellaneous alarm circuit that the director circuit is locked up, (4) connects ground at its No. 1 armature and front contact for maintaining the start magnet 1601 of the distributor in an operated condition, (5) connects grounded battery at its No. 5 armature and contact to a circuit for lighting lamps 1830, 1831, 1832 and 1833, (6) disconnects at its No. 6 armature and contact, conductor 1816 from 1815 and (7) opens at its No. 7 armature and contact the common conductor for the fanning-out circuit controlled by relay 14D5. Under this type of trouble, only lamp 1832 lights.

Meanwhile conductor 1818 is grounded. The miscellaneous alarm circuit places the trunk circuit back into service after removing it temporarily, disconnects the trunk circuit from the director circuit which, of course, has no effect on the "stuck" director circuit and then if the sequence circuit has returned to normal, places a ground on conductor 2601 to operate a transfer relay to connect another director circuit. In the case where only one director circuit is provided and such director circuit becomes "stuck," the switching mechanism at the large switching center may be operated manually as described in Krecek Patent

2,368,666, supra. However, two director circuits are usually provided at each switching center so that a transfer from one to the other may be had whenever desired as described in Krecek Patent 2,368,666.

Failure of the "Director ready" signal to reach associated loop repeater or failure of registration of mark signals sent by the trunk circuit to the receiving distributor circuit

In this case it is assumed that the distributor has attained speed and that relay 18C—1 has operated but the circuit by which the "director ready" signal was to be sent was opened somewhere before reaching the associated loop repeater or in any case relay 18C2 fails to operate, or if the incoming transmission conductor to the distributor is opened, it is obvious that directing of the inward call by the connection will be impossible. Such a condition would prevent relay 18A3 from operating. These two troubles could, of course, occur on the same call. In any case after four seconds, the miscellaneous alarm operates the 18LU relay hereinbefore described except that since neither conductor 1818 or 1823 is grounded, the alarm circuit proceeds to lock the trunk circuit as well as the director circuit out of service. Relay LU, upon operating, causes telltale lamps to light as follows. Lamps 1831 and 1832 when lighted indicate "director ready" signal failure. Lamp 1831 when lighted indicates failure to register the incoming mark signal; and lamp 1833 when lighted alone indicates a combination of both types of trouble. The alarm circuit meanwhile proceeds to place the other director circuit, if provided, into service.

Returning previously "stuck" director circuit to service

After the trouble is cleared the director circuit can be made available by momentarily depressing release key 1828 which removes holding ground from relay 18A and locking ground from relay 18LU thereby returning the director circuit to normal.

Call originating at a subscriber station local to large switching center B to central office A

When a subscriber at a station such as station No. 90 which is local to large switching center B originates an outward call by operating the power switch (not shown) to the "on" position, the line circuit shown in Fig. 42 orders the subscriber sequence circuit, shown in Fig. 10, to preselect a trunk circuit. For a description of this operation, reference may be had to the Krecek Patent 2,368,666, supra in which it is shown that a relay in the subscriber line circuit operates to connect ground to a conductor which extends through the winding of the corresponding start relay, such as relay 10ST—0, to the subscriber sequence circuit which operates. The power switch corresponds to start switch 403 in the Krecek Patent 2,368,666, Fig. 4. A point in connection with a subscriber station local to a large switching center is the manner in which a call may be originated from said station. On one hand, the start key, such as key 403, may be operated to close the loop extending to the large switching center whereupon current of marking value will be established which will cause an operation of one kind at the switching, or concentrating, center. On the other hand, a break key corresponding to break key 408, may be first operated and held operated for a short space of time until the start key 403 has been operated. In the latter case current of a reduced value determined by the inclusion of a resistance, such as resistance 407, in the loop will be first established so that an operation of a nature different from that in the former case will take place at the large switching center. From the subscriber point of view the operation may be as follows: Commercial arrangements have been made so that this subscriber will ordinarily be connected with a certain distant central office. Therefore when the subscriber initiates a call by throwing the start key, such as key 403, the call will be automatically directed towards this specific central office. However, there may be occasions when the subscriber wishes to have his call directed towards a different distant central office. In this case he knows by operating a break key, such as key 408, and holding it operated until he has operated a start key, such as key 403, this call will be automatically directed towards his secondary central office. The manner in which his call is directed to one or another central office under these conditions is explained in detail in Krecek Patent 2,368,666, supra.

When the subscriber originates an outward call to the distant central office A, say his first choice office, he does this by merely closing his power, or start, key corresponding to key 403, shown in the Krecek Patent 2,368,666, whereupon both the line relay and the marginal relay in the subscriber's line circuit become operated in a circuit treaceable from grounded positive battery 4205, make-before-break contacts of relay 42BB, conductor 4206, back contact and lower armature of holding magnet 2H—S—9, conductor 4207, tip conductor 4208 of subscriber's loop extending through the calling subscriber's station No. 90, back over the ring conductor 4209, conductor 4210, make-before-break contacts of holding magnet 2H—S—9, conductor 4211 through the upper winding of marginal relay 42MG, through the upper winding of line relay 42L—1, to ground.

Sufficient current will flow in this circuit to cause the operation of line relay 42L—1 and marginal relay 42MG. Thereupon a circuit is closed from ground at the armature of relay 42L—1, armature and front contact of relay 42MG, through the winding of relay 42L, to grounded negative battery and relay 42L operates. Relay 42L, upon operating, places a ground through its inner upper armature and front contact to a circuit extending over the upper armature and back contact of relay 42BB, start conductor 4212, leading to the subscriber's sequence circuit wherein the circuit just traced terminates in the winding of start relay 10—ST—0 in the subscriber sequence circuit, and the start relay operates. Relay 42L, upon operating, also places a steady ground connection on call lamp 4213 in a circuit extending from ground on the outer upper armature and front contact of relay 42L, back contact and outermost upper armature of relay 42A, through call lamp 4213, conductors 4214, 4215 and 1107, through the winding of relay 13E, to grounded negative battery in the master control circuit for the sequence circuit. This will cause the lighting of lamp 4213 steadily. Relay 10—ST—0 is provided for subscriber line No. 90 represented by the block shown in Fig. 42, relay 10—ST—1 is provided for trunk line No. 91 extending to Figs. 29, 28 and 43 and relay 10—ST—9 is provided for another subscriber's line say subscriber's line No.

99 (not shown). Lines Nos. 90 to 99 are in group No. 0 represented by relays 10—ST—1—G0, 10—AL—G0, 10—AL1—G0 and 10—BO—G0. With the start relay 10—ST—0 operated, the chain ground obtained from the inner lower armature and back contact of group relay 10—AL1—G0 is disconnected from all the higher numbered start relays which are respectively connected to other subscriber's lines and/or trunk lines, the latter of which extends to the small switching center F (Figs. 29, 28 and 43). In other words, the circuit connected to the armatures of start relay 10—ST—0 is interrupted so that this ground does not extend to the corresponding armatures of the other start relays 10—ST—1 to 10—ST—9. With relay 10—AL1—G0 normal and no other start relay preceding the operated start relay is operated, then this ground will be extended through the winding of the higher numbered relay associated with the operated start relay which in this case is relay 10—AL—0. Relay 10—AL—0 operates providing no other higher numbered corresponding relay such as relay 10—AL—9, is operated. The circuit being traceable from grounded battery 1005, make-before-break contacts of each of relays 10—AL—9 to 10—AL—1 through the winding of relay 10—AL—0, front contact and upper armature of relay 10—ST—0, to ground on the inner lower armature and back contact of relay 10—AL1—G0. Relay 10—AL—0 locks under control of its associated relay 10—ST—0. The operation of relay 10—AL—0 removes the chain battery 1005 from all lower numbered corresponding 10—AL relays. Thus, when relays 10—ST—0 and 10—AL—0 associated with the calling subscriber line circuit are operated ground and battery chain circuits of the subgroup sequence circuit have been broken preventing the operation of any other 10—AL relays in that group. Relay 10—AL—0, upon operating, in addition to locking up under control of its associated start relay 10—ST—0, connects grounded battery 1005 in the chain circuit hereinbefore traced, then over the inner lower armature and front contact of relay 10—AL—0, through the winding of relay 10—ST1—G0, to ground at the normally closed auxiliary, or make-before-break, contacts of relay 10—BO—G0 and 10—ST1—G0 operates providing this particular subgroup has not been removed from service by the operation of relay 10—BO—G0. Relay 10—A1—0, upon operating, also connects certain common conductors such as conductors 4216, 4217 and 4218 to the subscriber line circuit shown in Fig. 42 through its middle upper and outermost upper armatures and to the sequence control circuit through its outer lower armature. Here also if no other relay, such as relay 10—ST1—G1 to 10—ST1—G19, is operated or if the particular relay 10—ST1—G0 is in a preferential position, and if no relay such as any one of the AL—G1 to AL—G19 relays of the subscriber groups sequence circuit or the AL or ST2 relays of the trunk sequence circuits is in an operated position, the associated ST1—G0 and AL—G0 relays will function in the manner similar to that described for the corresponding relays 10—ST—0 and 10—AL—0 of the subscriber line connected to subscriber line No. 90. The relays such as relays 10—ST1—G0 to 10—ST1—G19, control a chain circuit from grounded battery, armature and contact of relay 25SU in the miscellaneous alarm circuit, conductor 1001, through the winding of relay 10—AL—G0, front contact and lower armature of relay 10—ST1—G0, back contact and outer armatures of each of relays 10—ST1—G1 to 10—ST1—G19, in turn, conductor 1006, back contact and lower armature of each of relays 11ST2—99 to ST2—90, 12ST2—89 to 12ST2—80 and 12ST2—9, conductors 1208—9 and 2502, outer lower armature and back contact of relay 25D, back contact and inner upper armature and contact of relay 25CS, to ground.

When relay 10—ST1—G0 and 10—AL—G0 of the particular subgroup associated with the calling subscriber line No. 90 have operated, permission to route the outward call through the large switching center B has been received. Relay 10—AL—G0, upon operating, causes the operation of relay 10—AL1—G0 and at its upper armature and front contact completes the circuit extending from its grounded battery at the armature and back contact of relay 25SU as connected over a chain circuit extending over conductor 1001, upper armature and front contact of relay 10—AL—G0, outer lower armature and front contact of relay 10—AL—0, conductor 4219 which extends through the winding of relay 13LS—1 to ground. A second LS relay, that is, relay 13LS—2, is provided for cases where there are groups of trunks extending to a second outlet such as another central office or a large switching center. A TR relay, such as relay 13TR, is provided to change the order of the trunk chain and advance circuit such as represented by relay 11CH—99 and 11AD—99 for trunk No. 99 extending to central office A, in such a manner that all trunks in the preferred group are tested for busy before a trunk is selected in the other group terminating at the switching center, although all trunks of both groups may be available to a calling subscriber. An LS relay such as relay 13LS—1 or 13LS—2, upon operating causes the operation of relay 13H—0, 13H—1 and 13H—2 and other H relays required for the trunks that may be provided. The ground at the contact and inner right-hand armature of relay 13H—0 when the relay is operated, is connected in an operating path for relay 13LS1—1 or relay 13LS1—2, depending upon whether the respectively associated relay 13LS—1 or 13LS—2 is operated. Assume that the relay 13LS—2 which is for the double outlet system, operates, then the ground at the back contact and left-hand armature of relay 13LS—1 is connected in an operating circuit for relay 13TR which operates. Relays 13H—0, 13H—1 and 13H—2, in turn, place individual grounds over conductors respectively extending to the trunk chain and advance circuits, each composed of an AD and a CH relay such as relays 11CH—99 and 11AD—99, holding that circuit in a fixed condition during the entire interval that an outward call is being routed through the switching center and therefore not only is the trunk chain circuit placed in a fixed condition by the operation of an H relay, such as one of relays 13H—0, 13H—1 and 13H—2 but if the alternate selection was to have been changed, relay 13TR has accomplished this function before the start conductor to the trunk chain and advance circuit is called into use. The operation of relay 13H—0 permits the operation of an LS—1 relay associated with the particular LS relay that operates first, for example, relay 13LS1—1 associated with relay 13LS—1 and relay 13LS1—2 associated with relay 13LS—2. The LS relay, when operated, closes a circuit extending from

ground at the inner right-hand armature and contact of relay 13R—0, right-hand armature and front contact of the LS relay, front contact and inner armature of the LS1 relay, a start conductor such as conductor 1301 or 1304B, a place in the trunk chain and advance circuit where there is available the first numbered trunk of the group of the trunks associated with either relay 13LS—1 or 13LS—2. The operation of an LS1 relay also results in the operation, in turn, of start relay 25ST and common start relay 25CS in the miscellaneous alarm circuit and furnishes a locking ground for relays 13H—0, 13H—1 and 13H—2, etc. to insure that the trunk chain and advance circuit will be kept in a fixed condition until the routing of the call has been completed. Relay 25CS of the miscellaneous alarm circuit, when operated, removes the main chain ground on conductor 2501 from both the trunk sequence circuit and the subscriber group sequence circuit.

Assume that relay 13LS—1 is operated, then the operation of this relay connects ground in a circuit traceable from ground at the inner right-hand armature of relay 13H—0, right-hand armature and contact of relay 13LS—1, front contact and inner left-hand armature of relay LS1—1, start conductor 1301, inner lower armature and back contact of relay 11CH—99 (providing trunk No. 99 is the first one available in a group extending to central office A,) conductor 1128—99 through the winding of trunk start relay 5ST, to grounded battery and relay 5ST operates. Relay 5ST, upon operating, (1) closes at its No. 4 armature and contact a circuit which causes relays 5S and 5L of the repeater to operate to their marking positions, (2) closes at its No. 7 armature and contact an operating circuit for relay 5—ON, which operates, (3) closes at its front contact and No. 5 armature a locking circuit for itself, the circuit being traceable over conductors 1130—99, back contact and inner upper armature of relay 11AD—99, conductor 1123—99, to ground at its front contact and armature No. 7, (4) closes at its No. 6 armature and front contact a circuit for lighting the trunk No. 99 busy lamp 502, the circuit being traceable over conductor 1125—99, back contact and inner lower armature of relay 11BO—99 to grounded battery, (5) closes, after relay 5—ON operates, a circuit extending from ground at armature No. 4 and front contact of relay 5—ON, conductor 501, inner lower armature and back contact of relay 5SL—1, outer lower armature and back contact of relay 5R2, conductor 532, contact and armature No. 1 of relay 5ST, conductors 2502—99 and 2509 in the miscellaneous alarm circuit, through the lower winding of relay 25TK, to grounded battery and relay 25TK operates to warn the miscellaneous alarm circuit that verification ringing has been required at central office A.

Relay 5—ON, upon operating, (1) closes at its No. 6 armature and front contact a circuit for energizing the filaments of vacuum tubes 602 to 606, inclusive, (2) connects at its No. 2 and No. 5 armatures power to the trunk repeater, (3) prepares at its No. 1 armature and operating circuit for relay 5SL, (4) closes at its No. 3 armature, the outward transmission path for transmitting a mark signal repeated by relay 5S to central office A and (5) supplies at its No. 4 armature the ground hereinbefore mentioned for operating relay 25TK in the miscellaneous alarm circuit in connection with the operation of start relay 5ST. The reception of a mark current at central office A as a calling-in signal causing that end of trunk No. 99 to function to send to large switching center B a 20-cycle ringing current.

The vibration of the armature of relay 6TL in response to the 20-cycle ringing current received from central office A has no effect upon the vacuum tube circuit, but the vibration of the armature of relay 6R causes the operation of relay 5R—1. Relay 5R—1, upon operating, closes a circuit extending from ground at the No. 3 armature of start relay 5ST for operating relay 5R2. Relay 5R2, upon operating, (1) removes at its outer lower armature and back contact the ground connection from conductor 532 which, as hereinbefore stated, extended to the miscellaneous alarm circuit to initiate the warning that a verification signal is requested from central office A, (2) causes the operation of relay 5M. Relay 5M, upon operating, causes all the selecting magnets located on different cross bar switches and associated with trunk No. 99 to operate. Selecting magnet 2SM—99, upon operating, prepares trunk No. 99 for a connection with the line from calling subscriber station No. 90. The selecting magnet connects ground over conductor 307 to grounded battery through the winding of relay 25D and relay 25D operates. Relay 25D which is of the slow-operating type, upon operating, orders the sequence circuit to operate "holding" magnet 3H—S—0 of the link circuit, magnet 3H—S—0 being associated with the line of calling subscriber station No. 90. The operating circuit for magnet 3H—S—0, when subscriber station No. 99 is the calling station, may now be traced over conductors 4204 and 4216, front contact and middle upper armature of relay 10AL—0, conductor 1003, contact and inner upper armature of relay 10AL1—G0, conductors 1009 and 2506, resistance 2507, front contact and inner lower armature of relay 25D to ground.

In the earlier designs of the cross bar switch such as that used in the link circuit, the directing finger actuated by the selecting magnet chatters considerably on being operated. To prevent the holding magnet from functioning while the directing finger is chattering, ground for the operation of the holding magnet is delayed for a short period. The operation of the selecting magnet of the cross bar switch places a ground on the off-normal conductor 307 causing the slow operation of relay 25D. Holding magnet 3H—S—0 operates in response to the operation of magnet 3H—S—0, and connects at the operated contact set 210, trunk No. 99 to the line of subscriber station No. 90, contact set 210, also connecting the winding of holding magnet 3H—S—0 over conductors 308 and 417 through the winding of relay 5SL which now operates in series with holding magnet 3H—S—0. Relay 5SL, upon operating closes at its upper armature and contact an operating circuit for relay 5SL—1 which operates and at its lower armature connects ground to the "holding" chain conductor 1119—99. Relay 5SL—1, upon operating, causes the release of relay 5M which, upon releasing, causes the selecting magnet, such as magnet 2SM—99 to release. In the meanwhile grounded positive battery 493 which terminates a path including conductor 539, make-before-break contacts of relay 6TR, conductor 522, through the lower windings, in series, of relays 5L and 5S, back contact and upper armature of relay 5R3, normally closed contacts of the tip spring of jack 508A, conductor 415, tip

contact of contact set 210, conductor 217, front contact and lower armature of holding magnet 2H—S—9, conductor 4207, normally closed contacts of the tip spring of jack 4201—A, loop conductors 4208 and 4209 of subscriber line No. 90 extending through the subscriber station, normally closed contacts of the tip spring of jack 4202—B conductor 4210, has been applied to a path extending over the front contact and upper armature of magnet 2H—S—9, conductor 207, ring contact of set 219, ring conductor 416, the normally closed contacts of tip spring of jack 509B, conductor 405, contact and No. 4 armature of relay 4TR—1, conductor 406, back contact and No. 2 armature of relay 4HM, conductor 407, through the upper winding of relay 5SP, to ground and relay 5S operates which in turn operates relay 5SP—1. Relay 5SP—1, upon operating, (1) furnishes at its No. 4 armature and contact an additional ground for holding relay 5—ON operated and (2) closes at its No. 1 armature and front contact a locking circuit for itself extending over conductor 424, No. 6 armature and back contact of relay 4HM, No. 10 armature and back contact of relay 4TR—1, conductors 515, 514 and 527, front contact and No. 1 armature of relay 5SP—1, outer lower armature and back contact of relay 5SB—1 to ground at the front contact and No. 1 armature of relay 5—ON.

In the meantime holding magnet 3H—S—O, upon operating, and causing the subsequent operation of holding magnet 2H—S—9, causes at the lower armature and contact of holding magnet 2H—S—9 an opening in the operating circuit for subscriber sequence circuit start relay 10—ST—0 and relay 10—ST—0 releases causing the subsequent release of relay 10—AL—0 as well as the release of relay 10—ST1—G0 and 10—AL—G0. The release of relay 10—AL—0 opens an operating circuit for the operated LS relay such as relay 13LS—1 or 13LS—2. Relay 10—AL—G0, upon releasing, causes the release of relay 10—AL1—G0. The release of relay 10—AL1—G0 disconnects conductor 1009 from the battery source of the winding of holding magnet 3H—S—0, conductor 1009 being included in the circuit which extends over conductor 2506, resistance 2507 to the ground at the contact and inner lower armature of relay 25D in the miscellaneous alarm circuit. The release of relay 13LS—1, Figure 13, connects at its left-hand armature and back contact a ground connection to conductor 1303 in a circuit traceable over advance conductor 1124—99, front contact and No. 8 armature of relay 5ST, conductors 3004 and 1121—99, through the winding of relay 11CH—99, to grounded battery and relay 11CH—99 operates and in turn causes relay 11AD—99 to operate. Both relays 11CH—99 and 11AD—99 close locking circuits for themselves extending over conductor 1119—99 to ground at the lower armature of relay 5SL. Relays 11CH—99 and 11AD—99 remain operated for the duration of the call over trunk No. 99 and prepare over the trunk chain conductor 1301, a circuit for advancing the next call to the next idle trunk. Relay 11AD—99, upon operating, opens at its inner upper armature and back contact, the holding circuit for relay 5ST whereby relay 5ST is released and closes at its outer upper armature and front contact, ground to the conductor 1104—99 in preparation for a path to the all-trunks-busy circuit shown in Fig. 24 which serves to time the interval that the all-trunks-busy condition persists. Relay 11CH—99, upon operating, also (1) removes at its inner lower armature and back contact the holding ground for relay 13LS1—1, thereby causing the release of relay 13LS—1 and (2) closes at its outer lower armature and front contact a circuit extended from grounded battery at the inner lower armature and back contact of relay 11BO—99, conductor 1101—99, front contact and outer lower armature of relay 11CH—99, conductor 1122—99 to the trunk busy lamp 502 and ground and the trunk busy lamp lights. Relay 13LS1—1, upon releasing, opens the operating circuits for relays 13H—0, 13H—1, 13H—2 which also release to remove the individual holding ground to the upper armature of each of the CH relays, such as relays 11CH—99, 11CH—98, 11CH—96 (not shown), etc. of all the trunk circuits thus permitting any CH relay that was in position to release, to do so, thus removing the "fixed" condition of the trunk chain circuit which had been in force throughout the entire routing of the call. The release of the 13LS1—1 relay also causes the release of relay 25CS of the miscellaneous alarm circuit which in turn replaces the ground on the entire office chain which extends over conductor 2502. The trunk sequence and the subscriber sequence circuit have thus been returned to normal and to a condition that will permit the routing of another call in either direction. Upon the completion of the thus established call, the locking ground at the lower armature and front contact of relay 5SL that holds relay 11CH—99 and 11AD—99 operated will be removed permitting their release provided an auxiliary path including conductor 1303 is not being temporarily furnished by relays 13H—0, 13H—1 and 13H—2. Upon removal of any such temporary holding path, relays 11CH—99 and 11AD—99 release, returning the entire sequence circuit to normal. The ground on conductor 1303 also serves to operate relay 4AD over the chain conductor 1121—99. In this stage, the following relays are operated 5—ON, 5R—1, 5R—2, 5SL, 5SL—1, 5SP, 5SP—1, 5S and 5L, relays 5S and 5L operating to their respective marking contacts under control of the subscriber line circuit and relays 6TL and 6R following the ringing current which is being received from central office A while a steady marking is being sent to central office A. For a description of the remainder of the method of operation of establishing a call originating at subscriber station No. 99, reference may be had to Krecek Patent 2,368,666, supra.

A call originating at a subscriber station local to a small switching center F over a trunk-line through large switching center B to central office A

A description of a call over a trunk-line comprising conductors 302, when such call originates at a subscriber station 4300 local to small switching center F and terminates in central office A may be had by reference to Large Patent 2,375,856, supra.

A call originating at central office A and extending through large switching center B to a trunk-line extending to small switching center F and then to a subscriber station local to small switching center F

A description of a call from central office A over a main trunk circuit through large switching center B to a trunk-line extending to small switching center F whereat it is automatically connected in response to additional signals trans-

mitted from central office A and decoded by the receiving distributor at small switching center F to select a hunting conductor, such as conductor 1459, to a subscriber line, say line No. 00, may be had by reference to Large Patent 2,375,856, supra.

Call originating at the operator's switchboard in central office A for a "through" connection through large switching center B to large switching center C

For the purpose of illustrating a call originating at central office A and extending through large switching center B to large switching center C, it will be assumed that the operator at office A selects main trunk No. 99 at the switchboard by means of the cord circuit shown in Fig. 21 and connects to such cord circuit the teletypewriter and position circuit 2103 by operating a typing key, say key 2102, which is individual to the selected cord circuit.

The operation of the terminating equipment of main trunk No. 99 at central office A is identical with that hereinbefore described for a call to central office E. The operation of the terminating equipment of main trunk No. 99 at the large switching center B differs from that for a call to central office E only in that a trunk group selected at switching center B extends to large switching center C.

Like the call from central office A to central office E through large switching center B as hereinbefore described, this call also, from central office A and extending through switching center B but terminating at large switching center C, requires a "through" connection and, therefore, like in the call to central office E, the "Letters" signal is made the preliminary signal sent prior to the significent character, or letter, signal. After the preliminary signal "Letters" is received at switching center B and prior to the reception of the significent character signal, represented by letter C to correspond to a group of trunks extending to switching center C, the following apparatus in the various circuits is in operated condition:

In the cord circuit (Fig. 21) relays 21—AC, 21—SC and 21—C are operated and relay 21—RC is in its marking position. In the terminating equipment (Fig. 20) relays 20—SL and 20—ON are operated and relays 20—SS and 20—S are in their marking positions.

In the terminating equipment (Figs. 4, 5 and 6) relays 6CT, 6CT—1, 5A, 5—ON and 5M are operated, relays 6TL and 6R are in their marking positions and vacuum tube 603 is energized and electrically active.

In the sequence circuit (Figs. 11, 12 and 13) relays 11—CH—99, 11—AD—99, 11—ST2—99, 11—AL—99, 11—AL1—99 and 13E are operated.

In the link circuit (Fig. 2) magnet 2SM—99 is operated.

In the director circuit (Figs. 14 to 19) relays 18A, 18A3, 18C2, 18C, 18C—1, fanning relays 14D1, 14D2, 14D3, 14D4 and 14F—1 are operated; relay 18G and fanning relay 14D5 are operated to marking; relays 18A2 and 18B have operated but are now released.

In the miscellaneous alarm circuit (Fig. 25) relays 25ST, 25CS, 25K—1, 25K3, 25AB, 25K4 and 25D are operated.

Immediately after the reception of the start impulse of the signal corresponding to letter C and before the reception of the first selecting impulse of such signal, auxiliary spring contact set ASC under the influence of cam AC of the receiving distributor operates to its alternate position whereby grounded conductor 1610 is connected to a circuit including conductor 1417, upper armature and front contact of relay 14F—1 and two parallel paths, one extending through the winding of relay 14F2 to grounded battery and the other through the winding of relay 14F3 to grounded battery. Relays 14F2 and 14F3 operate. Relay 14F3, upon operating, transfers conductors 1418, 1419, 1420, 1421, 1422 and 1423 to their respectively associated conductors 1424 to 1429 for operating the 17DL relays in accordance with the teletypewriter code for the letter C as hereinafter described.

Relay 14F3, upon operating, also connects ground at its armature No. 7 and contact to conductor 1455, through the windings, in parallel, of relay 13H—0, 13H—1, 13H—2 to grounded battery in the sequence circuit to establish a "status quo" condition among the trunks in switching center B thereby preventing any trunks from releasing switches if they are about to do so.

Relay 14F2, upon operating (1) closes at its No. 3 armature and contact a locking circuit for both itself and relay 14F3, the ground for the locking circuit being had at the lower armature and front contact of relay 18C—1; (2) prepares at its No. 1 armature and front contact an operating circuit for relay 14N; (3) prepares at its No. 5 armature and contact an operating circuit for relays 14S and 14S—1, the circuit when completed being traceable from ground at the inner lower armature and front contact of slow-release relay 25D which operated a short while after selecting magnet 2SM—99 operated, resistance 2507, conductor 2506, armature No. 5 and contact of relay 14F2, conductor 1431, through the winding of relay 14S, front contact and inner lower armature of relay 14R (now in an unoperated position), conductor 1825, contact and armature No. 7 of relay 18LU, conductor 1414, armature and either contact of relay 14D5 (the spacing contact being closed in accordance with the start impulse of the signal code for letter C), over the corresponding operated armature of relay 14F3 and the conductor, such as conductor 1428 or 1429, connected to its associated front contact, to the selected path closed, by the 17DL relays, to one of the trunk hunting conductors designated 1700, such as conductor 1700—C corresponding to the signal code for letter C, upper armature and back contacts of the AD relay of the first idle available trunk of the called group, such as relay 29AD of main trunk No. 9 through the winding of the corresponding HH relay, such as relay 29HH, also of main trunk No. 9 to grounded battery, it being assumed herein that relays 29AD and 29HH represent the first trunk of group C which, with one or more other groups responsive to other letter signals, may extend to the desired large switching center C; (4) connects at its No. 2 armature and contact the series-connected ground and conductors 1821 and 1416 to a circuit which extends over conductor 1432, front contact and outer lower armature of relay 14S—1 (now unoperated), for future connection to conductor 1132, contact and armature No. 7 of relay 11A1—99, conductor 11—18—99 through the winding of relay 4TR—1 to grounded battery for operating relay 4TR—1 as hereinafter described when an idle available trunk in the desired group is found; (5) removes at its

armature No. 1 and back contact the possibility of connecting relay 14F through the armature of relay 14D5 in the manner hereinbefore described.

The selecting impulses of the signal corresponding to letter C are space, mark, mark, mark, and space and therefore cause contact sets SC—2, SC—3, SC—4 to close and contact sets SC—1 and SC—5 to remain open, during one revolution of distributor shaft 1613. Accordingly, relays 17DL—2A and 17DL—2B, 17DL—3 and 17DL—4 operate and relay 14D5 moves to its space, or right-hand, position. At the conclusion of the fifth selecting impulse the auxiliary contacts ASC close, causing the rapid operation of relay 14N and, in turn, the operation of relay 14N—1. The operating circuit of relay 14N may be traceable from grounded battery, through the winding of relay 14N, conductor 1433, front contact and armature No. 1 of relay 14F2, conductor 1824, back contact and outermost upper armature of relay 18A2, conductor 1611, normally closed contacts ASC, conductors 1810 and 1812, to ground at the inner upper armature and front contact of relay 18A—1. The operating circuit for relay 14N—1 may be traceable over the operated lower armature of relay 14N, make-before-break contacts of relay 14R, conductors 1444, 1416 and 1821, in series, to ground at the front contact and lower armature of relay 18C—1. Relay 14N—1, upon operating, connects at its lower armature and front contact the testing circuit for testing the selected trunk group, the circuit extending from grounded negative battery, through the winding, in series, of relay 14—00 and 14BY, back contact and inner lower armature of relay 14R, conductor 1825, contact and No. 7 armature of relay 18LU, conductor 1414, armature and the space, or right-hand, contact of relay 14D5, and a path extending over conductor 1423, armature No. 6 and front contact of relay 14F3, conductor 1429, lower armature and front contact of relay 17DL—4, inner lower armature and front contact of relay 17DL—3, outer upper armature and front contact of relay 17DL—2B, inner upper armature and back contact of relay 17DL—1C, conductor 1700—C, upper armature and back contact of advance relay 20AD, through the winding of relay 29HH, to grounded negative battery. Relay 29HH which corresponds to the first trunk, namely, main trunk No. 9 of the desired, or called, group extending to large switching center C, operates. Relay 14N, upon operating, closes at its upper armature and contact, a circuit extending from grounded positive battery 1826, conductor 1456, resistance 1454, its upper armature and contact, conductor 1458, through the upper winding of relay 18G to ground, and conductor 1114 of the inward supervisory path, therefore providing another path extending through the line winding of relay 18G which now locks in its mark, or left-hand, position but not being able to accept any additional telegraph signal incoming from central office A. Relay 14N—1, upon operating, closes at its upper armature and contact an operating circuit for relay 14N2, the circuit being traceable over conductors 1444, 1416 and 1821, in series, to ground at the front contact and lower armature of relay 18C—1. Relay 14N—2 which is of the type that is both slow to release and slow to operate, operates after a predetermined interval, to operate relay 14R, the predetermined interval allowing sufficient time to make the necessary tests for busy condition of the selected group of trunks before relay 14R operates.

Testing at large switching center B of the desired group of main trunks extending to large switching center C for busy condition

By means of a chain circuit in the trunks of a group extending to large switching center C, a trunk hunting path such as that of conductor 1700—C selected by fan relays 17DL—4, 17DL—3, 17DL—2 and 14D5 in response to the reception of the signal corresponding to letter C, is extended over the upper armature and back contact of relay 29AD, through the winding of relay 29HH, to grounded negative battery providing the first trunk of the group is idle. However, if the first idle trunk of the group is busy, trunk hunting conductor 1700—C is extended over the upper armature and front contact of relay 29AD to the next advance (AD) relay associated with the next trunk of the desired group. If the next trunk of the desired group is busy, trunk hunting conductor 1700—C is extended over the upper armature and front contact of said next advance (AD) relay to another advance (AD) relay in the chain until an idle trunk is found or until one of the busy trunks becomes idle.

Should all the trunks of the group controlled by advance relay 29AD be busy, ground would be connected to the conductor 1700—C, and both relays 14—00 and 14—BY would operate, or if a 1900-ohm out-of-order ground, not shown, but located in an out-of-order circuit, is connected to conductor 1700—C, relay 14—00 only operates. In case no ground is available to conductor 1700—C relays 14—00 and 14BY do not operate as hereinbefore described. This test takes place during the slow-operating time of relay 14N2 which, as hereinbefore stated, begins to operate when relay 14N1 operates. As relay 14N2 operates, the ground at the lower armature and front contact of relay 18C—1 connected to the circuit extending over conductors 1821, 1416 and 1444, is now traceable over the armature and front contact of relay 14N2 to the armature of relay 14—00.

First idle trunk at large switching center B, of group of main trunks extending to large switching center C

Assuming that the first idle trunk, say trunk No. 9 of the desired group is idle, in which case ground is not connected to conductor 1700—C, relay 14—00 will be unoperated and ground connected to the armature of relay 14—00 by relay 14N—2, is extended through the winding of relay 14R to grounded battery to cause the operation of relay 14R. Relay 14R, upon operating, (1) removes relays 14—00 and 14BY from the conductor 1700—C (conductor 1825) of the desired trunk group and replaces them by relay 14S, the replacement path being traceable over the front contact and inner lower armature of relay 14R, through the winding of relay 14S, conductor 1431, outer lower armature and contact of relay 14F2, conductor 2506, to ground at the contact and inner lower armature of relay 25D in the miscellaneous alarm circuit; (2) causes at its make-before-break contacts the opening of the operating circuit for relay 14N—1 which now releases; (3) prepares at its upper armature and contact, an operating circuit for relay 19U and (4) locks over its outer lower armature and contact in a circuit traceable from grounded series-

connected conductors 1444, 1416 and 1821, to the front contact and lower armature of relay 18C—1. The release of relay 14N—1 causes relay 14N2 to slowly release. During the time that relays 14N—1 and 14N2 are releasing, ground at the inner lower armature and contact of relay 25D in the miscellaneous alarm circuit is connected to a circuit traceable through low resistance 2507, conductor 2506, outer lower armature and contact of relay 14F2, conductor 1431, through the winding of relay 14S, conductor 1436, front contact and inner lower armature of relay 14R, conductor 1825, contact and armature No. 7 of relay 18LU, conductor 1414, armature and spacing contact of relay 14D5, conductor 1423, No. 6 armature and front contact of relay 14F8, conductor 1429, lower armature and front contact of relay 17DL—4, inner lower armature and front contact of relay 17DL—3, outer upper armature and front contact of relay 17DL—2B, inner upper armature and back contact of relay 17DL—1D, conductor 1709—C to the first idle trunk in the desired group. Under the assumed condition that the first trunk of the group is idle, grounded battery connected to conductor 1709—C, permits relay 14S to operate, but due to the high resistance of the circuit which at this time includes the windings of relays 14S and 29HH, relay 29HH remains unoperated. Relay 14S, upon operating, opens the operating path of relay 19U and closes a path for operating relay 14S—1, the operating path being traceable from grounded battery, through the winding of relay 14S—1, front contact and armature of relay 14S, back contact and armature of relay 14N2, grounded series-connected conductors 1444, 1416 and 1821, to ground at the front contact and lower armature of relay 18C—1 and relay 14S—1 operates. Relay 14S—1, upon operating, (1) locks to ground on series-connected conductors 1444, 1416 and 1821; (2) short-circuits the winding of relay 14S which now releases; and (3) maintains open at its inner lower armature and contact, the operating path for relay 19U. With the winding of relay 14S short-circuited, ground from a low resistance 2507 supplied by the miscellaneous alarm circuit is extended over conductor 2506, front contact and outer lower armature of relay 14F2, conductor 1431, front contact and outer upper armature of relay 14S—1, front contact and inner lower armature of relay 14R, to conductor 1825 and thence, as hereinbefore traced, connected to conductor 1709—C to the first idle trunk of the desired group and relay 29HH operates. Relay 29HH, upon operating, closes at its upper armature and contact a circuit extending over conductor 2904, through the winding of holding magnet 3H—9—0 to grounded battery. Holding the magnet 3H—9—0 operates and consequently all the other holding magnets 3H—9—1 to 3H—9—7 (not shown) and holding magnets 3H—9—8 and 2H—9—9, shown in Figs. 2 and 3 operate. Magnets 3H—9—0 to 3H—9—3 and 2H—9—9 are in the same vertical row. Holding magnets 3H—9—0 to 2H—9—9 are respectively provided for the corresponding vertical rows of contact sets in switches Nos. 0 to 9 of the cross bar switches, the corresponding vertical rows being shown in Figs. 1 and 2 in continuous alignment. One vertical row connected in continuous alignment through switches Nos. 0 to 9 is assigned to each of the main trunks arranged for "through" connection. Likewise, each vertical row of another group is assigned to each trunk line extending to a small switching center (not shown but similar to small switching center F) connected to large switching center C, and each vertical row of still another group is assigned to a subscriber station local to the large switching center C. Holding magnet 3H—9—9, upon operating, connects main trunk No. 9 to calling main trunk No. 99 over the contact set 212 prepared for operation by selecting magnet 2SM—99, as hereinbefore described. The call connection between central offices A and large switching center C will, therefore, be established over main trunks Nos. 99 and 9. Also the operated contact set 212 extends conductor 311 over conductors 417 and 512, in series, through the winding of sleeve relay 5SL, conductor 513, to ground on the front contact and armature No. 1 of relay 5—ON and relay 5SL operates. The connection to called trunk No. 9 functions to release the sequence circuit when a call for a "through" connection over the trunk becomes established, the function residing in the operation of holding magnet 3H—9—0 whereby ground is connected to conductor 2919 of the operating circuit for relay 29HM which operates. Relay 29HM, upon operating, opens at its No. 7 armature and contact, the operating circuit for start relay 12ST2—9 of the trunk sequence circuit for called main trunk No. 9 which is prevented from operating and therefore cannot be selected for another call at this time.

Functions at large switching centers B and C of called main trunk No. 9 upon being connected to calling main trunk No. 99

When grounded series-connected conductors 1432, 1416 and 1821 are extended in a path traceable over the front contact and outer lower armature of relay 14S—1, conductor 1132, contact and armature No. 7 of relay 11AL1—99, conductor 1118—99, through the winding of relay 4TR—1 to grounded battery, and relay 4TR—1 operates. Relay 4TR—1, upon operating, (1) transfers conductor 405 from armature No. 4 to armature No. 5 and conductor 405 which as a continuation of ring conductor 416, previously extended through the upper winding of relay 5SP to ground, now extends over a circuit including conductor 402, contact and innermost lower armature of relay 6TR and the armature of receive relay 6R, (2) disconnects at its armature No. 5 and back contact, conductor 402 from the circuit extending over conductor 1112—99 of the inward transmission path extending from trunk No. 99 to the director circuit; (3) opens at its No. 2 armature and back contact, the path for connecting ground at armature No. 5 of relay 5—ON to the space, or left-hand, contact of received relay 6R, (4) substitutes at its No. 3 armature and front contact a resistance ground 439 for the grounded positive battery 408, for connection to the marking, or right-hand, contact of relay 6R; (5) locks at its No. 7 armature in a circuit extending over conductor 409 to ground at armature No. 4 of relay 5—ON; (6) opens at its No. 11 armature and back contact, the operating circuit for relay 6TR; (7) closes at its No. 10 armature and front contact, a point in a path that puts relay 5SP—1 directly under control of conductor 410 which extends to the link circuit; (8) connects at its No. 8 armature and contact a ground connection for operating relay 4D2 which operates and then locks under control of relay 4D3; (9) substitutes at its No. 9 armature and front contact a new ground for the grid of vacuum tube 411 which remains non-conductive; (10) disconnects at its

No. 6 armature and contact the battery supply for operating relay 5BL—1; and (11) prepares at its No. 1 armature and contact an operating circuit for relay 5B.

Relay 4D2, upon operating, (1) closes at its inner upper armature and contact a circuit for energizing the filament of vacuum tube 411, (2) prepares at its inner upper and its outer lower armature a charging path for condenser 412, and (3) furnishes at its outer upper armature and contact a locking circuit for operated relay 4AD, and an additional ground to conductor 413 which is connected to conductor 1119—99 of the locking circuit for chain relays 11CH—99 and 11AD—99. Relay 4AD became operated when relay 5A operated. The operating circuit for relay 4AD being traceable over the lower armature and contact of relay 4HH, conductors 1121—99, 504 and 503, to ground at armature No. 6 of relay 5A. As hereinbefore stated, relays 11CH—99 and 4AD, upon operating respectively made trunk No. 99 busy to any other call from central office A and to any call from any of the other central offices or switching centers.

Turning our attention now to the previously selected called trunk No. 9, it will be recalled that the director circuit has caused the operation of relay 29HH and that there were operated subsequently thereto holding magnet 3H—9—0, 3H—9—1 to 3H—9—7 (not shown), 3H—9—8 and 2H—9—9, relay 29HM and contact set 212. The connection established between calling trunk No. 99 and called trunk No. 9 at contact set 212 permits conductors 415, 416, 418 and 410 of trunk No. 99 to be respectively connected to conductors 213, 214, 215 and 216 which, in turn, are permanently connected to conductors 2916, 2915, 2910 and 2918, respectively, of trunk No. 9, particular notice being given to the fact that the conductors of trunk No. 99 upon being connected to conductors of trunk No. 9, are reversed. For example, the tip conductor 415 of trunk No. 99 is connected to ring conductor 2916 of trunk No. 9, ring conductor 416 of trunk No. 99 is connected to tip conductor 2915 of trunk No. 9, conductor 418 of trunk No. 99 is connected to conductor 2910 of trunk No. 9 and conductor 410 of trunk No. 99 is connected to conductor 2918 of trunk No. 9. Also contact set 212, upon establishing the connection connects the winding of holding magnet 3H—9—0 over conductor 311 to conductor 417 in a circuit traceable over conductor 512, through the winding of relay 5SL, conductor 513 to ground at the contact and No. 1 armature of relay 5—ON as hereinbefore stated. Relay 5SL in the calling trunk No. 99 operates and holding magnet 3H—9—0 is held operated after the sequence circuit and the director circuit at large switching center B are released.

Relay 29HM in the called trunk No. 9, upon operating, (1) connects at its No. 6 armature and front contact, conductor 2920 to conductor 2921 in order to place relay 30SP—1 under control of conductor 2910 which is now connected over the operating contact set 212 to conductor 418 of the calling trunk No. 99 to procure ground in a circuit traceable over conductor 610, inner right-hand armature and back contact of relay 6D—1, conductor 617 to the No. 5 armature and contact of relay 5—A, thus operating relay 30—SP—1 of the called trunk No. 9; (2) removes at its No. 2 armature and back contact, relay 30—SP from the circuit including conductors 2906, 2905 and ring conductor 2916 which extends to the link circuit; (3) prepares at its No. 8 armature and contact an operating path for relay 29TR—1 of the called trunk No. 9; (4) opens at its No. 7 armature and contact the circuit including conductor 1202—9 which extends through the winding of the start relay 12ST2—9 of the trunk sequence circuit associated with the called trunk No. 9 thus preventing the called trunk from calling for a director circuit; (5) prepares at its No. 1 armature and contact, an operating path for relay 29AD of the called trunk No. 9; (6) also places on the No. 1 armature and contact a ground for connecting to conductor 1121—9 of the sequence trunk circuit for called trunk No. 9 which ground operates chain relay 11GH—9 and advance relay 11AD—9 to make called trunks No. 9 appear busy if the called trunk was one which could be used for outward service of local subscribers; (7) opens at its No. 4 armature and contact, a circuit extending over conductor 2902, back contact and innermost lower armature of relay 31—TR to the armature of receive relay 31—R; (8) disconnects battery 2922 at its No. 5 armature and contact from the winding of relay 31—BL—1; (9) prepares at its No. 2 armature and front contact an operating circuit for relay 30—B, the circuit when completed being traceable from grounded battery, through the winding of relay 30—B, inner lower armature and front contact of unoperated relay 31—SB—1, conductors 3014 and 3015, front contact and No. 3 armature of relay 29HM, conductor 2907, through the upper winding of relay 30—SP, to ground. Relay 30—SP—1, upon operating, (1) causes at its No. 4 armature, the operation of relay 30—ON of the called trunk No. 9; (2) opens at its No. 2 armature and contact the operating circuit of relay 30—R3; (3) removes at its No. 7 armature and contact one of the ground connections from the grid of subscriber break vacuum tube 3104; (4) removes at its No. 3 armature and contact the possibility of short-circuiting relay 30—SP, a function which is of no value since the relay 30—SP of the called trunk No. 9 is at this time removed from the circuit; (5) connects interrupted ground 3016 at its No. 6 armature and front contact to a circuit extending over conductor 3124, armature and contact of break limiting relay 9BL, unoperated at this time, conductor 3126 through the winding of relay 30—BL—1, conductor 3017, armature No. 5 and back contact of relay 29HM which is now in an operated position, contacts and armature No. 6 of relay 29TR-1, grounded battery 2922, which circuit performs no function at this time because, in addition to relay 31—BL being unoperated, relay 29HM is operated, and (6) at its No. 5 armature and contact prepares a path for operating relay 31—TR2, the operating circuit for relay 31—TR2 being traceable from grounded battery, through the winding of relay 31—TR2, conductor 3138, front contact and armature No. 11 of unoperated relay 29TR—1, conductor 2924, front contact and armature No. 2 of unoperated relay 30—A, back contact and innermost upper armature of relay 30—R2, conductors 3014 and 3015, contacts and armature No. 1 of unoperated relay 29TR—1, conductor 2925, front contact and armature No. 5 of relay 30—SP—1, conductors 3018 and 3013, to ground at armature No. 1 and contact of operated relay 30—ON.

Relay 30—ON of the called trunk No. 9, upon operating, (1) closes at its No. 6 armature and front contact, a circuit for energizing filaments

of vacuum tubes 3102, 3103, 3104, 3105 and 3106, extending from grounded battery 3108; (2) connects power to the repeater relays of the called trunk No. 9; (3) connects at its No. 1 armature and contact ground connection to the operating circuit for relay 30—SL which, however, will not operate on this call; (4) connects at its No. 4 armature and contact a locking ground for unoperated relays 29TR—1 and 31—D—1; (5) prepares also at its No. 4 armature and contact an operating circuit for relay 29TR—1, the circuit being traceable from grounded battery, through the winding of relay 29TR—1, conductor 2926, contact and armature No. 8 of relay 29HM, conductor 2927, front contact and outermost upper armature of relay 31—CT—1, conductors 3127 and 2909, to the contacts and armature No. 4 of relay 30—ON to ground, and (6) closes at its No. 7 armature and contact a circuit extending from grounded battery 3019, through a resistance, over the No. 7 armature and contact of relay 30—ON, normally closed contacts of busy key 3020, conductor 3021, to the automatic signal trunk jack circuit arranged to be inserted in jack 3128. The called trunk No. 9 at this stage therefore has the following relays operated: 29HH, 29HM, 30—SP—1, and 30—ON. The condition of the repeater relays will be hereinafter described.

Returning to the calling trunk No. 99 it will be remembered that the holding magnet of the called trunk No. 9 caused the operation of relay 5SL of the calling trunk No. 99. Relay 5SL, upon operating, connects (1) a second ground to conductor 1119—99 and (2) ground at its upper armature and contact to the operating circuit for relay 5SL—1 which operates. Relay 5SL—1, upon operating, (1) prepares at its front contact an inner lower armature and operating circuit for relay 5R2, the circuit when completed being traceable from grounded battery, through the winding of relay 5R2, armature and contact of unoperated relay 5R1, front contact and inner lower armature of relay 5SL—1, conductor 409, to ground at the contact and armature No. 4 of relay 5—ON, relay 5R2, however, will not operate at this time since both conductor 1112—99 and relay 5R—1 have already been disconnected from the armature of receive relay 6R by the operated relay 4TR—1 and (2) opens at its outer lower armature and contact conductor 1102—99 to the director circuit to release relay 11ST2—99 of the trunk sequence circuit for main trunk No. 99 and relay 11ST2—99, upon releasing, causes the disconnection of the director. The release of relay 11ST2—99 also causes the release of relay 11AL—99 and 11AL—1—99 and the ground connected at armature No. 6 of relay 18A and extended over conductors 1804, 1903, 1902, 1901, 1801, 1113, 1111—99, 522 and 639 of the outward transmission path, is, therefore, now disconnected at armature No. 2 of relay 11AL—1—99 and relays 5S and 5L operate to their respective space, or left-hand, positions to thereby transmit a space signal to the calling central office A. It must be remembered that the tip conductor 415 of the calling trunk No. 99 is already connected to the ring conductor 2916 of the called trunk No. 9, but in the called trunk No. 9, the ring conductor 2916 is opened at the back contact and armature No. 2 of relay 29HM so that the space signal continues to be sent to the central office A. A mark signal is still being received from office A so that relays 6TL and 6R are on their mark contacts. Receive relay 6R is therefore connecting a resistance ground at armautre No. 3 and front contact of relay 4TR—1 to the circuit extending over conductor 428, mark, or right-hand, contact and armature of relay 6R, innermost lower armature and contact of relay 6TR, conductor 402, armature No. 5 and front contact of relay 4TR—1, conductor 405, normally closed contact of jack 509—B, ring conductor 416, operated contact set 212 of ring circuit, conductor 214, tip conductor 2915, normally closed contact at the tip spring of jack 3008—A, upper armature and back contact of relay 30—R3, through the lower winding, in series, of relays 30—S and 30—L, conductor 3022, make-before-break contact of relay 31—TR, conductor 3139, to grounded positive battery 2908, it being noted that the mark signal is sent over the ring conductor 416 of the calling trunk No. 99 to the tip conductor 2915 of the called trunk No. 9 which signal, of course, operates relays 30—S and 30—L of the called trunk No. 9 to mark, or the right-hand, positions. Relay 30—S, upon operating, to its mark position, sends a mark signal of grounded positive battery over the make-before-break contacts of relay 30—SB—1, contact and armature No. 3 of relay 30—ON, conductor 3023, to the normally closed contacts of the tip spring of jack 3130—SEND, conductor 3114, to large switching center C. The distant switching center C which in this case is the called office, is sending back a space signal over conductor 3115, normally closed contacts of the tip spring of jack 3131—REC, conductor 3132, through the lower winding of relay 31—TL, resistance 3133, conductor 3134, back contact and outer upper armature of relay 31—CT2, conductor 3135, through the upper winding of receive relay 31—R, resistance 3136, to grounded negative battery 3137 and relays 31—TL and 31—R are moved to their space positions as shown. With ground removed from the mark, or left-hand, contact of relay 31—TL, the grid of disconnect vacuum tube 3106 receives a positive potential from grounded battery 3108 and tube 3106 becomes conductive after one second time interval thereby operating relay 31—D. Relay 31—D—1, however, does not operate at this time since the contact of operated relay 31—D at this time has no ground.

The release of the director circuit at large switching center B by the calling trunk No. 99 caused the removal of ground at relay 25D from conductor 1700—C of the called trunk No. 9, thereby releasing relay 29HH and permitting the operation of relay 29AD which, upon operating, makes the called trunk No. 9 busy in its particular trunk group. The circuit remains, therefore, awaiting action at the distant large switching center C which is the called office in this case and, as hereinbefore stated, a mark signal is being sent to large switching center C and a space signal to the calling central office A. The mark signal to large switching center C is transmitted over a circuit, hereinbefore traced, to conductor 3114, which extends over the normally closed contacts of tip spring of jack 3231—REC, conductor 3232, through the lower winding of relay 32TL, resistance 3233, conductor 3234, back contact and outer upper armature of relay 32CT2, conductor 3235, through the upper winding of receive relay 32R, resistance 3236, to grounded negative battery 3237. The space signal to the central office A is transmitted over a circuit hereinbefore traced when relays 5S and 5L operated to their respective space positions immediately subsequent to the release of trunk sequence start relay

11ST2—99, for causing the disconnection of the director circuit.

The mark signal received at large switching center C causes relays 32TL and 32R to operate to their mark positions. When relay 32TL operates to its mark, or right-hand, position, it thereby removes ground from a circuit traceable over its space, or left-hand, contact, conductor 3229, back contact and middle upper armature of relay 32CT1, resistances 3222 and 3221, conductors 3229 and 3245, to grounded positive battery 3208. Current from grounded battery 3208 now flows in a circuit traceable over resistances 3221 and 3222, conductors 3246 and 3223, through the condenser 3220 to ground and the condenser accumulates a charge of positive potential. When relay 32TL operated to its mark contact, the filament circuit of vacuum tubes 3202 to 3206 became energized in a circuit traceable from ground at the mark contact of relay 32TL, conductors 3219 and 3216, make-before-break contacts of relay 32—ON, conductor 3333, filaments of vacuum tubes 3202 to 3206, conductors 3247 and 3245, to grounded positive battery 3208. When the armature of relay 32TL remains off its space contact for approximately one-half second, the positive charge accumulated on condenser 3220 becomes sufficient to cause vacuum tube 3203 to become conductive and relay 32CT operates in a circuit traceable from grounded positive battery 3208, through the winding of relay 32CT, plate to filament of vacuum tube 3203, conductor 3333, make-before-break contacts of relay 33—ON, conductors 3216 and 3219, to ground at the mark contact of relay 32TL. Relay 32CT, upon operating, operates relay 32CT—1. Relays 32CT and 32CT—1 remain operated. Relay 32CT—1, upon operating, prepares at its outer lower armature and front contact, an operating circuit for a start relay in the trunk sequence circuit, not shown, at large switching center C.

At large switching center C, the subscriber sequence, the trunk sequence, the sequence control, the director, the all-trunks-busy and the miscellaneous alarm circuit are not shown and for a description of any one of these circuits, reference may be had to the corresponding circuit hereinbefore described in connection with the operation of the corresponding circuit at large switching center B.

The start relay corresponds to start relay 11ST2—99 shown in the trunk sequence circuit for the calling trunk No. 99 at large switching center B. However, the start relay, not shown, in the trunk sequence circuit at large switching center C was automatically selected when trunk No. 9 was selected as the first idle trunk of a group extending to large switching center C, by conductor 1700—C. For a description of the operating circuit for the particular start relay in the trunk sequence circuit at large switching center C reference may be had to the operating circuit for start relay 11ST2—99, hereinbefore described, up to that portion which is shown in Fig. 32, which portion is assumed herein to be conected to conductor 1102—99 and is traceable over trunk sequence conductor TS—02—9, back contact and No. 7 armature of relay 34HM, conductor 3401, back contact and outer lower armature of relay 32CT—1, conductor 3306, back contact and armature No. 1 of relay 33SP—1, outer lower armature and back contact of relay 33SB—1, armature No. 1 and front contact of relay 33—ON, now unoperated, to ground. Trunk sequence conductor TS—02—9 shown in Fig. 32 corresponds to conductor 1102—99 shown in Fig. 5 as extending into Fig. 11 (the trunk sequence circuit for trunk No. 99) and is not actually connected to conductor 1102—99 as assumed herein.

Relay 32CT—1, upon operating, also closes at its innermost upper armature and contact, an operating circuit for relay 33A, the circuit being traceable over conductor 3217, through the winding of relay 33A, conductor 3324, to grounded negative battery 3225 and relay 33A operates and locks. Relay 33A, upon operating, closes at its No. 3 armature and contact, an operating circuit for relay 33—ON which operates; (2) removes its No. 1 armature and contact, the ground connection from the grid of vacuum tube 3205 over conductor 3325; (3) closes at its No. 5 armature and contact, the locking circuit for itself, although it is under control of relay 32D—1 which is now unoperated, but which, when operated, will close a shunting circuit traceable from grounded battery 3225, contact and outer right armature of relay 32D—1, conductor 3201, back contact and middle lower armature of relay 32TR, conductor 3211, lower armature and back contact of relay 32TR2, conductor 3217, to the front contact and armature No. 5 of relay 33A to ground; (4) connects ground at its No. 6 armature and contact to a circuit traceable over conductors 3305, 3304 and TS21—9, then over two parallel paths, one extending over back contact and lower armature of relay 34HH, through the winding of relay 34AD, to grounded battery and the other extending through the winding of a chain relay corresponding to relay 11CH—99, of the trunk sequence circuit not shown, to grounded battery. Relay 34AD and the chain relay, corresponding to chain relay 11CH—99, at large switching center C operate to make main trunk No. 9 busy. The chain relay for the trunk sequence circuit (not shown) at large switching center C, upon operating, lights the trunk busy lamp 3302 and prevents trunk No. 9 from being selected for another call originating at line switching center C until after the call for which the trunk is engaged is completed. Relay 34AD operates on an inward or an outward call, or by the operation of busy key 3248 or by taking the trunk out of service by means of a trunk release key, corresponding to key 1133—99 shown in the trunk sequence circuit for large switching center B, or if the trunk No. 9 on a completed call was prevented from releasing switches associated with it, because ground at the outer upper armature and front contact of the busy-out relay, corresponding to busy-out relay 11BO—99 at large switching center B, is connected to the conductor, corresponding to conductor 1121—99, but when trunk No. 9 is busy, as a called trunk, then ground is found on the front contact and armature No. 1 of relay 34HM which is operated only when trunk No. 9 is the called trunk.

Relay 33—ON, upon operating, (1) completes the operating circuit for the trunk sequence start relay (ST2—9) corresponding to relay 11ST2—99, previously prepared at the lower armature and contact of relay 32CT—1 and the trunk sequence start relay operates in the circuit traceable from ground at the No. 1 armature and front contact of relay 33—ON, back contact and outer lower armature of relay 33SB—1, armature No. 1 and back contact of relay 33SP—1, conductor 3306, outer lower armature and front contact of relay 32CT—1, conductor 3307, outer lower armature and back contact of relay 33SL—1, conductor

3401, armature No. 7 and back contact of relay 34HM, trunk sequence conductor TS—02—9 which in the trunk sequence circuit, not shown, corresponds to conductor 1102—99 which in the circuit in Fig. 11 is traceable through the winding of relay 11ST2—99, conductor 1125—99, back contact and inner lower armature of relay 11BO—99, to grounded battery; (2) closes the outward transmission path extending from the armature of relay 33S, resistance 3330, conductor 3331, make-before-break contact of relay 33SB—1, contact and armature No. 3 of relay 33—ON, conductor 3323, normally closed contacts of the tip spring of jack 3239—SEND, outward transmission conductor 3115, normally closed contacts of the tip spring of jack 3131—REC, conductor 3132, through the lower winding of relay 31—TL, resistance 3133, conductor 3134, back contact and outer upper armature of relay 31—CT2, conductor 3134, through the upper winding of receive relay 31—R, resistance 3136 to grounded negative battery 3137 and relays 31—TL and 31—R follow any signals in the outward transmission path; (3) connects power to the repeaters at large switching center C and ground to the winding of relay 33SL.

The trunk sequence start relay (ST2—9), corresponding to relay 11ST2—99, upon operating, closes at its lower armature and front contact, an operating circuit for an associated relay (AL—9), corresponding to relay 11AL—99, the circuit being traceable in a manner similar to that for relay 11AL—99 as hereinbefore traced, that is, from grounded battery at the armature and back contact of relay 25SU in the miscellaneous alarm circuit at large switching center B, conductor 1001, upper armature and back contact of each of relays 10AL—G0 to 10AL—G19, in series, conductor 1109, through the winding of relay 11AL—99, front contact and lower armature of relay 11ST2—99, conductors 1108—99, 1108—98 to 1108—90 of the first group of trunks, conductors 1208—89 to 1208—80 in the second group of trunks, conductor 1208—9 in the third group of trunks, conductor 2502, and back to the miscellaneous alarm circuit where it continues over the outer lower armature and back contact of relay 25D, back contact and inner upper armature of common start relay 25CS, to ground. The relay (AL—9), corresponding to relay 11AL—99, operates and closes at its lower armature and front contact an operating path for a relay (AL1—9), corresponding to relay 11AL1—99, the path being similar to that, hereinbefore described, for operating relay 11AL1—99, that is from grounded battery connected to conductor 1109, lower armature and front contact of relay 11AL—99, through the winding of relay 11AL1—99 to ground, and the relay (AL1—9) corresponding to relay 11AL1—99, operates.

When the trunk sequence start relay (ST2—9), corresponding to relay 11ST2—99, operated, as hereinbefore described, the trunk sequence circuit is thereby ordered to connect the director circuit at large switching center C to the selected trunk No. 9 for the purpose of receiving tele-directing pulses. When the sequence circuit, not shown, at the large switching center C attaches its director circuit to selected trunk No. 9 it connects ground at armature No. 4 and contact of the AL1—9 relay, corresponding to relay 11AL1—99, as will be hereinafter described, to a conductor (03—9) corresponding to conductor 1103—99, which extends over conductor TS—03—9 and the normally closed contact at

the contacts of the ring spring of jack 3308A, through the winding of relay 33M, to ground battery. Relay 33M, upon operating, closes a plurality of circuits each extending through the winding of one of the selecting magnets, such as magnet 35SM—9, of each of those cross bar switches which have their respective horizontal contact sets connected in multiple. Also the trunk sequence start relay (ST2—9), corresponding to relay 11ST2—99, upon operating, performs functions similar to those performed by trunk sequence start relay 11ST2—99, as hereinbefore described. Therefore the function of trunk sequence start relay 11ST2—99 will be repeated herein and these functions are (1) connects ground at its outermost upper armature and contact to conductor 1105, which extends through one or more trunk sequence groups to the director circuit wherein it is connected to the inner lower armature of relay 18A—1 which is unoperated at the time, but the path just traced will serve as a locking circuit for relay 18A—1, when the latter relay operates as hereinafter described (relay 18A—1 when operated, is used to keep in speed the motor associated with the director receiving distributor circuit); (2) connects ground at its middle upper armature and contact to a circuit extending through the called-disconnect lamp 1106—99, conductor 1107, through the winding of relay 13E, to grounded battery, to light the called lamp 1106—99 and operate relay 13E (relay 13E, upon operating, operates relay 13F to light a common call-disconnect lamp 1302); and (3) closes at its lower armature and front contact, assuming that no other ST2 relay in the trunk sequence groups like those shown in Figs. 11 and 12, is operated, a circuit extending from ground at the inner upper armature and back contact of relay 25CS in the miscellaneous alarm circuit, as hereinbefore traced, to operate relay 11AL—99. If another trunk sequence group is in an operated condition, the AL relay, such as relay 11AL—99, will be delayed in operating until it has received a preference accorded to it by the sequence circuit.

Assuming that large switching B instead of large switching C is being described, relay 11AL—99, upon operating, (1) locks under control of the associated start relay 11ST2—99; (2) causes relay 25ST and relay 25CS in the miscellaneous alarm circuit to operate successively, the operating circuit for relay 25ST being traceable from ground, through the winding of relay 25ST, conductors 2510 and 1231, front contact and outer upper armature of relay 11AL—99, to grounded battery connected to conductor 1109 and when relay 25ST operates an obvious operating circuit for relay 25CS is closed to thereby operate relay 25CS; (3) closes at its lower armature and front contact an operating circuit for relay 11AL1—99 as hereinbefore described. Relay 11AL1—99 operates and thereby (1) connects ground at its outermost upper armature and contact to a circuit traceable over conductor 1110 to the director circuit wherein the grounded path extends through the winding of relay 18A to grounded battery and relay 18A operates; (2) interconnects at its middle upper armature and contact transmission conductors 1119—99 and 1113 and at its innermost upper armature and contact transmission conductors 1112—99 and 1114 (conductors 1111—99 and 1112—99 respectively correspond to trunk sequence conductors TS—11—9 and TS—12—9 shown in Fig. 33, and the seized idle trunk No. 9 shown in Figs. 29, 30,

31, 32, 33 and 34, is now connected to both the director and the sequence circuit at line switching center C); (3) connects ground at its No. 4 armature and contact, as hereinbefore described, to conductor 1103—99, (trunk sequence conductor TS—03—9, which extends in Fig. 33 to the normally closed contacts of the ring spring of jack 3308A, through the winding of relay 33M, to grounded battery and relay 33M operates to energize the selecting magnet 35M—99 and the selecting magnet on each of the other cross bar switches whose horizontal contact sets are connected in multiple with the corresponding sets shown in Fig. 35); (4) connects at its armature No. 5 and contact the lower winding of relay 11BO—99 to conductor 1115 and at its armature No. 6 and contact the lower winding of relay 11BO1—99 to conductor 1116, conductors 1115 and 1116 being the common busy-out conductors extending to the miscellaneous alarm circuit; and (5) conditions at its No. 7 armature and contact the circuit including conductor 1118—99 which circuit, when energized, operates relay 4TR—1 to serve notice to the main calling trunk No. 99 that it may prepare itself for connection to another main trunk (conductor 1118—99 corresponds to conductor TS—18—9 which is employed for serving notice to main trunk No. 9 that it may prepare itself for connection at large switching center C to another main trunk which in this case may be designated trunk No. X—89). The operation of relay 25CS in the miscellaneous alarm circuit removes ground from conductor 2501 of the entire office sequence circuit chain.

For the purpose of giving a clear understanding of the arrangement of trunks on the cross bar switches Nos. 0 to 9 at large switching center C, trunk No. 9 at large switching center B will be assumed to extend to and into large switching center C whereat it will be connected at the cross bar switch No. 9 to trunk No. X—99 and arranged to be connected, by means of contact set 3501, to trunk No. X—89 which extends to central office D.

Continuing with the description of the sequence circuit at large switching center B as being representative of the sequence circuit at large switching center C, the inward supervisory path from the calling trunk circuit No. 99 (trunk No. 9 at large switching center C) to the director circuit is in a mark condition and is now extended over conductor 1112—99, armature No. 3 and contact of relay 11AL1—99, conductor 1114, through the upper winding to relay 18G to ground. The outward supervisory path between the calling trunk circuit No. 99 (trunk No. 9 at large switching center C) and the director circuit is now traceable over conductor 1111—99, armature No. 2 and contact of relay 11AL1—99, conductor 1113, middle lower armature and back contact of relay 18A2, conductor 1801, make-before-break contacts of relay 19TB, conductors 1901 and 1902, make-before-break contacts of relay 19N3, conductor 1903, contact and outermost lower armature of relay 18C, then in parallel paths one extending over the armature and contact of relay 18G and the other through the lower winding of relay 18G. Relay 18C is unoperated at this time and therefore the outward supervisory path between the trunk and the director circuit is open. Termination of both supervisory paths is at this time in the director circuit. (Conductors 1111—99 and 1112—99 respectively correspond to trunk sequence conductors TS—11—9 and TS—12—9 shown in Fig. 33.) The operation of relay 18A as hereinbefore described, is the first function of the director circuit. Relay 18A, upon operating, (1) closes at its No. 1 armature and contact an obvious operating circuit for relay 18A—1 which operates; (2) closes at its No. 4 armature and contact an operating circuit for relay 18A2 which operates, the operating circuit for relay 18A2 extending to ground at the lower armature and back contact of relay 18C1 which still is unoperated; (3) closes at its No. 2 armature and front contact an operating circuit for start magnet 1601 of the receiving distributor and the magnet operates, the circuit being traceable from grounded battery 1602, resistance 1603, through the winding of start magnet 1601, conductor 1604, make-before-break contacts of relay 18LU, conductor 1802, make-before-break contacts of relay 18C—1, conductor 1803, to the front contact and armature No. 2 of relay 18A, to ground; (4) connects ground at its No. 6 armature and contact to a circuit for furnishing biasing current to relay 18G, the circuit being traceable over conductor 1804, through the lower winding of relay 18G, resistance 1805, conductors 1806 and 1807, resistance 1808 to grounded battery 1826; and (5) prepares at its No. 3 armature and contact an operating circuit for relay 18C—1. The operation of start magnet 1601 prevents further rotation of the distributor cams AC, C—1 to C—5 and SC, once these cams reach the stop position. Relay 18A—1 operates and (1) locks under control of conductor 1105, which extends to ground at the outermost upper armature and contact of relay 11ST2—99 in the trunk sequence circuit; (2) closes at its outer armature and contact an operating circuit for the motor of the receiving distributor, the circuit being traceable from grounded battery 1809, front contact and outer upper armature of relay 18A—1, conductor 1810, then in parallel paths, one extending through the field winding 1605 to ground, another through the motor armature 1606, low resistance winding 1607, resistance 1608 to ground, and the third, over conductor 1609, outermost lower armature and front contact of relay 18A2, conductor 1811, through the upper winding of relay 18B to ground, but relay 18B does not operate at this time; and (3) closes at its inner upper armature and contact, an operating path for relay 14D5, the operating path being traceable from ground at the front contact and inner upper armature of relay 18A—1, conductor 1812, through the biasing, or lower, winding of relay 18D5, to grounded battery and relay 14D5 operates to its space, or right-hand, contact. The operating path for relay 14D5 is parallel with the path extending over conductor 1610, auxiliary spring contact set ASC in its normally closed position, conductor 1611, outer upper armature and front contact of relay 18A2 which at the present time is operated, conductor 1813 to the front contact and upper armature of relay 18B which, at the present time, is unoperated. The connection of ground at the No. 6 armature and contact of relay 18A to the mark, or left-hand, contact of relay 18G as hereinbefore described, will cause the operation of relay 18A3 if relay 18G has already operated to its mark, or left-hand, contact under the influence of a mark signal received over supervisory conductor 1114 from the trunk circuit No. 99. (The supervisory relay, corresponding to relay 18G, at large switch-

ing center C would be operated to its mark contact under the influence of a mark signal received from trunk circuit No. 9 over supervisory conductors TS—12—9. Conductor TS—12—9 in Fig. 33 corresponds to conductor 1112—99 which is assumed herein to be connected to conductor 1114 over armature No. 3 and front contact of relay 11ALI—99.) Relay 18A2, upon operating, (1) connects the lower winding of relay 18C2 to the outward supervisory conductor 1113 which at this time extends to main trunk circuit No. 99 (the outward supervisory conductor, corresponding to conductor 1113, at large switching center C would extend at this time to main trunk circuit No. 9 over conductor TS—11—9, Fig. 33); (2) closes at its innermost lower armature and front contact a circuit having two parallel paths, one of which serves as the locking path for relay 18A3 which operated as hereinbefore described, and the other, for energizing the lower winding for relay 25K—1 of the miscellaneous alarm circuit to indicate that the director circuit is off normal, the latter path being traceable over conductors 1814 and 1815, back contact and No. 6 armature of relay 18LU, conductor 1816, through the lower winding of relay 25K—1, to grounded battery; (3) connects ground at its innermost upper armature and front contact to a circuit extending through lamp 1832; (4) connects ground at its middle upper armature and front contact to a circuit extending over conductor 1804, through the upper winding of relay 25AB, to grounded battery in the miscellaneous alarm circuit and relay 25AB operates and causes in turn, the operation of relay 25K4 to prevent the latter circuit from permanently removing the associated trunk circuit No. 99 from the service if the allotted time for circuit action has been exceeded (the operation of a relay, corresponding to relay 25K4, at large switching center C prevents the permanent removal of the associated trunk No. 9 from service if the allotted time for circuit action has been exceeded); (5) closes at its outermost lower armature and front contact the operating circuit for relay 18B, which operates when the motor of the receiving distributor attains the desired speed and thereby causes its vibratory contact member to leave its associated stationary contact member, the separation of contacts being determined by the motor control governor as disclosed in United States Patent 1,860,556, granted to J. H. Sole on May 31, 1932 and (6) closes at its outermost upper armature and front contact a path extending from the upper armature and contact of relay 18B, conductor 1813, front contact and outermost upper armature of relay 18A2, conductor 1611 to the normal contact of the normally closed auxiliary spring contact set ASC of the receiving distributor.

Receiving distributor motor at large switching center C attains the desired speed

This description is a copy of that hereinbefore given for the receiving distributor motor at large switching center B, and is intended to furnish a clear understanding of the functions of the receiving distributor motor at large switching center C. When the motor of the receiving distributor attains the desired speed, the governor contacts open and close alternately as described in J. H. Sole's patent, supra, thereby controlling a short circuit and permitting relay 18B to become sufficiently energized through its upper winding to operate. Relay 18B, upon operating, (1) locks in a circuit traceable from grounded battery, through the lower winding, contact and inner lower armature of the relay, conductor 1818, to ground at the front contact and middle upper armature of relay 18A2; (2) closes at its outer lower armature and front contact a circuit traceable from ground, through the winding of relay 18C2, front contact and middle lower armature of relay 18A2, conductor 1113, front contact and armature No. 2 of relay 11ALI—99, conductor 1111—99 (the conductor, corresponding to conductor 1111—99 is an extension of the series connected outward supervisory and transmission conductors TS—11—9, 3322 and 3239 of trunk No. 9 at large switching center C, and this ground connection furnishes the "director ready" mark signal for transmission through large switching center B, to the operator at central office A) and relay 18C2 operates; and (3) closes at its upper armature and front contact, the path extending from the normal contact of the normally closed auxiliary spring contact set ASC of the receiving distributor, conductor 1611, outermost upper armature and front contact of relay 18A2, conductor 1813, contact and upper armature of relay 18B, through the winding of relay 18C, to grounded battery. (Trunk circuit No. 9 transmits this "director ready" signal through large switching center B, to the operator at central office A to furnish an indication that the connection thus established is prepared to complete the call to a subscriber line or a trunk line local to the large switching center C, or to seize a main trunk to another large switching center (not shown) or to another central office, such as central office D.) Relay 18C2 will operate if the "director ready" signal is transmitted. If the armature of the normally closed auxiliary spring contact set ASC of the receiving distributor is closed at its normal contact, as it will be if the cams have reached the "stop" position, relay 18C will operate. Relay 18C, upon operating, (1) closes at its outermost lower armature and front contact another point in the outward supervisory path between the calling trunk and the director circuit at the large switching center still assuming that the status of call is at large switching center B and that the supervisory path, if completely closed, would now be traceable from ground at the front contact and No. 6 armature of relay 18A, conductor 1804, outermost lower armature and front contact of relay 18C, conductor 1903, make-before-break contacts of relay 19TB, conductor 1801, back contact and middle lower armature of relay 18A2 which at this time is in an unoperated condition; (2) opens at its outer upper armature and back contact the operating circuit for relay 18A3, as hereinbefore traced, but if relay 18A3 has already operated because of the operation of relay 18G to its marking contact under the influence of the mark impulse received from the calling trunk, it is therefore at this time locked in an operated position; (3) connects at its outermost upper armature and front contact, the armature of relay 18G, to the inner upper armature of relay 18C—1; (4) prepares at its innermost upper armature and front contact a locking circuit for itself under control of relay 18C—1; (5) provides a supplementary ground at its middle lower armature for the locking circuit of relay 18A3 and also for conductor 1815 which forms part of the operating circuit of relay 25K—1 of the miscellaneous alarm circuit, the operating circuit extending over the contact and middle lower ar-

mature of relay 18LU, conductor 1816, through the lower winding of 25K—1, to grounded battery; and (6) closes at its middle upper armature and front contact an operating circuit for relay 18C—1, which operates in a circuit traceable from grounded battery, through the winding of relay 18C—1, middle upper armature and contact of relay 18C, conductor 1819, No. 3 armature and front contact of relay 18A, to ground. Relay 18C—1, upon operating, (1) opens at its lower armature and back contact the operating circuit for relay 18A2, which releases; (2) substitutes at its inner upper armature and contact another ground connection in the circuit for operating start magnet 1601, which remains operated under the influence of relay 18G in response to each mark pulse of an incoming signal received from the calling trunk, the circuit being traceable from ground at the armature No. 6 and contact of relay 18A, conductor 1804, mark contact and armature of relay 18G, outermost upper armature and front contact of relay 18C, inner upper armature and contact of relay 18C—1, conductor 1802, make-before-break contact of relay 18LU, conductor 1604, through the winding of start magnet 1601, resistance 1603, to grounded battery 1602; (3) connects ground on its outer upper armature and front contact to conductor 1820 which extends through each of the normally open contacts SC—1 to SC—5, in turn, of the receiving distributor, providing the contact is closed by the mark impulses of an incoming signal received by relay 18G, over paths respectively extending through the windings of fanning-out relays 14D—1 to 14D—5, to grounded battery; and (4) at its lower armature and front contact connects ground to the locking circuit for relays 18C and 18C2, if operated, and utilizes this ground for conditioning over conductor 1821 various paths in the director circuit. With relays 18C2 and 18A3 operated, relay 18C—1, upon operating, will place ground over the operated upper armature of relay 18A3 on conductors 1822 and 1823, respectively, thereby operating relays 25K3 and 25AB, the latter operating relay 25K4 to notify the miscellaneous alarm circuit that the director circuit at the large switching center is ready to function. Relay 18A2, upon releasing, (1) connects at its middle lower armature and back contact direct ground at armature No. 6 and front contact of relay 18A, to the outward supervisory conductor 1113, replacing the ground connected to the winding of relay 18C2, thus continuing the "director ready" mark signal over the circuit thus completed extending from ground and armature No. 6 of relay 18A, conductor 1804, outermost lower armature and contact of relay 18C, conductor 1903, make-before-break contacts of each of relays 19N3 and 19TB, conductor 1801, back contact and the middle lower armature of relay 18A2, conductor 1113, over the outward supervisory path; (2) removes at its innermost upper armature and front contact, the ground from lamp 1832 which now becomes extinguished; (3) opens at its outermost lower armature and front contact the operating circuit for relay 18B which is thereby disconnected from conductor 1609 which is only one of the paths of the motor governor control circuit of the receiving distributor at the large switching center; (4) removes at its middle upper armature and contact ground from conductor 1804 which extends to the miscellaneous alarm circuit and the removal of the same ground opens the locking circuit for relay 18B, and relay 18B releases; and

(5) transfers at its outermost upper armature, conductor 1611 which extends to the normal contact of the normally closed auxiliary contact set ASC of the receiving distributor, to conductor 1824 which extends over the outermost upper armature and back contact of relay 14F2, conductor 1413, to the lower armature of relay 14K. Assuming that the "director ready" signal has been sent and the mark has been received from the calling trunk, the director circuit at the large switching center now awaits the teledirecting telegraph character signal from the operator at central office A. The teledirecting telegraph signal impulses received over the inward transmission and supervisory path including conductor 1112—9 (trunk sequence conductor TS—12—9 in Fig. 33), No. 3 armature and contact of relay 11AL1—99, conductor 1114, through the upper winding of relay 18G to ground, are repeated by the latter relay. Relay 18G is normally held to its marking position, under the influence of the marking signal normally received from the transmission and supervisory path, just traced. Therefore, as soon as the character signal is received, the start, or open, impulse of the signal permits relay 18G to operate to its space contact thereby causing start magnet 1601, of the receiving distributor to release. The start magnet, in following relay 18G, response to the impulses of each incoming signal and in response to the start impulse causes its armature to disengage the start cam SC and armature extension 1616 under the influence of the tension of spring 1619, is moved out of operative relation with the operating levers OL—1 to OL—5. The receiving distributor at large switching center C is identical with that hereinbefore described as being of the type shown in Fig. 6 of J. M. Desmond's United States Patent 2,190,540, supra, and therefore any further description of its operation at large switching center C is deemed unnecessary.

Reception of signal preliminary to the called number at large switching center C

As hereinbefore stated under the caption of "Reception of signal preliminary to called number at large switching center B," it is necessary to discriminate between calls to lines extending to subscriber stations or to trunk lines extending to a small switching center both of which types of lines may be local to line switching center C, and calls to a "through" trunk extending to another large switching center or to a distant central office. When the call is to a subscriber's line or a trunk line "Figures" is the preliminary signal received in large switching center C and when the call is to a "through" trunk, the preliminary signal is "Letters." Two significant character signals corresponding to numerical digits will follow "Figures" when the incoming call at a large switching center is to a local subscriber line or local trunk line and only one significant character signal corresponding to a letter of the alphabet, will follow "Letters," when the incoming call is to be extended to another large switching center or to a distant central office. As hereinbefore stated the combination of selecting impulses of the "Figures" are mark, mark, space, mark and mark and those in the "Letters" signal are mark, mark, mark, mark and mark, that is, all selecting pulses in the latter signal are mark. All telegraph character signals received at the large switching center C are broken down by the receiving distributor into their five component elements.

Should a "Figures" signal be received at large switching center C, the signal would be broken down into its five component elements by the local receiving distributor in the same manner as the "Figures" signal was translated by the receiving distributor at large switching center B as hereinbefore described.

Establishing a call to a subscriber line or a trunk line local to large switching center C

For a detailed description of a call to a subscriber line local to large switching center C reference may be had to the call from central office A to a subscriber line local to large switching center B, which was hereinbefore described, or to Krecek's Patent 2,368,666, supra, and for a detailed description of a call to a trunk line extending to a small switching center such as switching center F, reference may be had to Large Patent 2,375,856, supra. Inasmuch as these types of calls are established through another large switching center, such as switching center B, they are "through" calls, until they are connected to a main trunk incoming at large switching center C and at switching center C these calls are completed as local calls upon the receipt of signals corresponding to "Figures" and the number of the called line.

Call originating at the operator's switchboard at central office A for a "through" call to central office D

A connection for a call originating at an operator's swtichboard at central office A to central office D is prepared in the same manner as a call to large switching center C hereinbefore described. Should it be desired to extend the connection, hereinbefore described as established at large switching center C, to central office D, the next preliminary signal transmitted from central office A, after the connection is established at large switching center C, would be "Letters" followed by the signal corresponding to letter D, the latter signal being capable of selecting a group of main trunks extending to central office D. As hereinbefore described, the selecting impulses of the signal combination for "Letters" has the corresponding effect on the receiving distributor in the director circuit (not shown) at large switching center C as the signal for the "Letters" signal had on the receiving distributor in the director circuit at large switching center B. At large switching center C the letter D as an incoming signal, is herein the significant character.

Reception and deciphering at large switching center C of the signal combination for letter D

For the purpose of illustration the description herein given, under the present caption, of the sequence and the director circuit (not shown) at large switching center C, reference is again made to the reference characters shown in the sequence and the director circuit shown in Figs. 10 to 14, inclusive, and 16 to 19, inclusive, and used in the description thereof, hereinbefore given, for operations at large switching center B.

Immediately after the reception of the start impulse of the signal combination for the letter which constitutes the significant character at large switching center C, such signal causes to be seized a trunk group extending to a called central office.

Referring to the reference characters hereinbefore used for large switching center B, the armature of the auxiliary spring contact set ASC (Fig. 16), on the receiving distributor in the director circuit, immediately before the reception of the first selecting impulse of the signal corresponding to the significant character operates under the influence of cam AC from its normal contact to its alternate contact whereby grounded conductor 1610 is connected to a circuit including conductor 1417, for operating relays 14F2 and 14F3. Relay 14F3, upon operating, prepares for the operation of the 17DL relays; (2) connects ground at its No. 7 armature and contact to conductor 1455, through the windings, in parallel, of relays 13H—0, 13H—1, 13H—2, to grounded battery, in the sequence circuit to establish a "status quo" condition among the trunks in the switching center thereby preventing any trunk from releasing switches if they are about to do so. Relay 14F2, upon operating, (1) closes at its No. 3 armature and contact a locking circuit for both itself and relay 14F3; (3) prepares at its No. 1 armature and front contact an operating circuit for relay 14N; (3) prepares at its No. 5 armature and contact an operating circuit for relays 14S and 14S—1, the circuit when completed being traceable from ground at the inner lower armature and front contact of slow-operating relay 25D which operated a short while after the selecting magnet 35SM—0 operated, resistance 2507, conductor 2506, armature No. 5 and contact of relay 14F2, conductor 1431, through the winding of relay 14S, front contact and inner lower armature of relay 14R (now in an unoperated position), conductor 1825, contact and armature No. 7 of relay 18LU, conductor 1414, armature and either contact of relay 14D5, depending upon which letter of the alphabet corresponds to the signal transmitted from central office A, over the corresponding operated armatures of relay 14F3, either of two conductors 1428 and 1429, through the selected path closed by the 17DL relays to a trunk hunting conductor corresponding to the signal combination that is transmitted from central office A to establish a "through" connection to a distant called office; (4) connects at its No. 2 armature and contact, the series-connected ground conductors 1321 and 1416 to a circuit which extends over conductor 1432, contact and outer lower armature of relay 14F—1, now unoperated, for future connection to conductor 1132, contact and armature No. 7 of relay 11AL1—99, conductor 1118—99, trunk sequence conductor TS—18—9 (Fig. 33) to grounded battery, through the winding of relay 34TR—1, to grounded battery, for operating relay 34TR—1 as hereinbefore described when an idle available trunk in the desired group is found; and (5) removes at its armature No. 1 and back contact the possibility of connecting relay 14F through the armature of relay 14D5 in the manner hereinbefore described.

The selecting impulses of the signal corresponding to letter D are mark, space, space, mark, space and therefore cause the contact sets SC—1 and SC—4 only, to close while contact sets SC—2, SC—3 and SC—5 remain open during one revolution of shaft 1613 on the receiving distributor. Accordingly, relays 17DL—1A, 17DL—1B, 17DL—1C, 17DL—1D and 17DL—4D operate and the relay corresponding to relay 14D5 moves to its space, or right-hand, position. At the conclusion of the fifth selecting impulse, the armature of the auxiliary contact set ASC closes to its normal contact, causing the rapid operation of relay 14N and, in turn, the operation of relay 14N—1. Relay 14N, upon operating, connects at its lower

armature and front contact the testing circuit for testing the selected trunk group by means of trunk hunting conductor 3700—D which extends through the winding of relay 37HH to grounded negative battery. Relay 37HH corresponds to the first trunk, namely, main trunk No. X—89 of the desired, or called, group extending to central office D.

Testing at large switching center C of the desired group of main trunks extending to central office D for busy condition

By means of a chain circuit in the trunks of a group extending to central office D, a trunk hunting path such as that of trunk hunting conductor 3700—D selected by the fanning relays corresponding to the 17DL relays and relay 14D5, in response to the reception of the signal corresponding to letter D, is extended over the upper armature and back contact of relay 37AD in the chain circuit, through the winding of relay 37HH to grounded negative battery, providing the first trunk of the group is idle. However, if the first idle trunk of the group is busy, trunk hunting conductor 3700—D is extended over the upper armature and front contact of relay 37AD to the next advance AD relay associated with the next trunk of the desired group. If the next trunk of the desired group is busy, trunk hunting conductor 3700—D is extended over the upper armature and front contact of such next advance relay AD to another advance relay AD in the chain and this operation is continued over the group of all trunks until the idle trunk is found or until one of the busy trunks becomes idle.

Should all the trunks of the group controlled by the advance relay 37AD be busy, ground would be connected to conductor 3700—D and the relays corresponding to busy relays 14—00 and 14—BY, would operate. In case no ground is available to trunk hunting conductor 3700—D, the relays corresponding to relay 14—00 and 14B—Y, do not operate as hereinbefore described. This test takes place during the slow operating time of the relay corresponding to relay 14N2, which, as hereinbefore stated, begins to operate when the relay corresponding to relay 14N—1, operates. As soon as the relay corresponding to relay 14N2, operates, the ground at the lower armature and front contact of the relay corresponding to relay 18C—1, connected to the circuit extending over conductors corresponding to conductors 1821, 1416 and 1444, is now traceable over the armature and front contact of the relay corresponding to relay 14N2, to the armature of the relay corresponding to relay 14—00.

First idle trunk at large switching center C of group of main trunks extending to central office D

Assuming that the first trunk, say trunk No. X—89 of the desired group is idle, in which case, ground is not connected to conductor 3700—D, the relay corresponding to busy relay 14—00, will be unoperated and ground connected to the armature of the relay corresponding to relay 14—00, by the relay corresponding to relay 14N2, is extended through the winding of the relay corresponding to relay 14R, to grounded battery to cause the operation of the relay corresponding to relay 14R.

Inasmuch as the director circuit at large switching center C is not shown, the reference characters hereinbefore used in the description of operations in the director circuit at large switching center B, will again be used in the description, immediately following, of the operations in the director circuit at large switching center C. Relay 14R, upon operating (1) removes relays 14—00 and 14—BY from the trunk hunting conductor (2700—D) of the desired trunk group and replaces them by relay 14S, the replacement path being traceable over the front contact and inner lower armature of relay 14R, through a circuit similar to that hereinbefore traced, to ground at the contact and inner lower armature of relay 25D in the miscellaneous alarm circuit; (2) causes at its make-before-break contacts the opening of the operating circuit for relay 14N—1 which now releases; (3) prepares at its upper armature and contact an operating circuit for relay 19U; and (4) locks over its outer lower armature and front contact in a circuit traceable over the grounded series-connected conductors 1444, 1416 and 1821, to the front contact and lower armature of relay 18C—1. The release of relay 14N—1 causes relay 14N—2 to slowly release. During the time that relays 14N—1 and 14N—2 are releasing, ground at the inner lower armature and contact of relay 25D in the miscellaneous alarm circuit is connected to a circuit traceable through low resistance 2507, conductor 2506, outer lower armature and contact of relay 14F2, conductor 1431, through the winding of relay 14S, conductor 1436, front contact and inner lower armature of relay 14R, conductor 1825, contact and outermost lower armature of relay 18LU, conductor 1414, armature and space contact of relay 14D5, conductor 1423, No. 6 armature and front contact of relay 14F3, conductor 1429, lower armature and front contact of relay 17DL—4, inner lower armature and back contact of relay 17DL—3, inner upper armature and back contact of relay 17DL—2B, inner lower armature and front contact of relay 17DL—1C, to a hunting conductor to the first idle trunk in the desired group extending to the terminating office. Under the assumed condition if the first trunk of the group is idle, grounded battery connected to the selected hunting conductor (3700—D) permits relay 14S to operate, but due to the high resistance of the circuit which at this time includes the winding of relay 14S and its associated HH relay which in the case where large switching center B was the terminating office, was relay 7HH, but which in this call is relay 37HH. Relay 37HH, in view of this resistance, remains unoperated at this time.

Relay 14S, upon operating, opens the operating path of relay 19U, and closes a path for operating relay 14S—1, the operable path being traceable from grounded battery, through the winding of relay 14S—1, front contact and armature of relay 14S, back contact and armature of relay 14N2, grounded series-connected conductors 1444, 1416 and 1821, to ground at the front contact and lower armature of relay 18C—1, and relay 14S—1, operates. Relay 14S—1, upon operating (1) locks to ground on the series-connected conductors 1444, 1416 and 1821; (2) short circuits the winding of relay 14S which now releases; and (3) maintains open at its inner lower armature and contact the operating path for relay 19U. With the winding of relay 14S short circuited, ground with the low resistance 2507 supplied by the miscellaneous alarm circuit is extended over conductor 2506, front contact and

outer lower armature of relay 14F2, conductor 1431, front contact and outer upper armature of relay 14S—1, front contact and inner lower armature of relay 14R, to conductor 1825, and thence, as hereinbefore traced, connected to the trunk selecting conductor which, in the present call, is trunk hunting conductor 3700—D, extends to the first idle trunk, namely, trunk No. X—89, of the desired group and relay 37HH operates. Relay 37HH, upon operating, closes as its upper armature and contact, a circuit extending over conductor 3704, through the winding of holding magnet 36HX—89—0, to grounded battery. Holding magnet 36HX—89—0 operates and consequently all the other holding magnets 36HX—89—1 to 36HX—89—8 and 35HX—89—9, shown in Figs. 36 and 35 as being in the same vertical row, operate. Holding magnets 36HX—89—0 to 36HX—89—8 and 35HX and 35HX—89—9 are respectively provided for the corresponding vertical rows of contact sets in switches Nos. 0 to 9 of the crossbar switches provided at large switching center C and represented in Figs. 35 and 36. The corresponding vertical rows in these switches are arranged in continuous alignment. Switches Nos. 0, 8 and 9 only are shown in Figs. 35 and 36 and on these the rows are shown in part only. One vertical row connected in continuous alignment through switches Nos. 0 to 9 is assigned to each of the main trunks arranged for "through" connections. Likewise each vertical row of another group is assigned to each trunk line extending to a small switching center and each vertical row of still another group is assigned to each subscriber's station local to the large switching center C. Holding magnet 35HX—89—9, upon operating, connects trunk X—89 to the calling trunk which in large switching center C is trunk No. 9, the connection being established over contact set 3501 prepared for operation by selecting magnet 35SM—9 as hereinbefore described. The call connection between central office A and central office D will therefore be established over main trunks No. 99, No. 9 and No. X—89. The operated contact set 3501 closes a circuit extending over conductors 3505, 3417 and 3312, connected in series, through the winding of sleeve relay 33SL, conductor 3313, to ground at the contact and armature No. 1 of relay 33—ON and relay 33SL operates. The connection to called trunk No. X—89 functions to release the sequence circuit at the large switching center C when the call for a "through" connection over the trunk becomes established, the function residing in the operation of holding magnet 36HX—89—0 whereby ground is connected to conductor 3719 of the operating circuit for relay 37HM which operates. Relay 37HM, upon operating, opens at its No. 7 armature and contact, the operating circuit for the start relay corresponding to relay 12ST2—89, of the trunk sequence circuit for called main trunk No. X—89, which is prevented from operating and therefore cannot be selected for another call at this time.

Functions at large switching center C and central office D of called main trunk No. X—89 upon being connected to calling main trunk No. 9

When grounded series-connected conductors corresponding to conductors 1432, 1416 and 1821 are extended in a path traceable over the front contact and outer lower armature of the relay corresponding to relay 14S—1, conductors corresponding to conductor 1132, contact and armature No. 7 of the relay corresponding to relay 11AL—1—99, conductor corresponding to conductor 1118—99 which in Fig. 33 is assumed to be trunk sequence conductor TS—18—9, through the winding of relay 34TR—1, to grounded battery and relay 34TR—1 operates. Relay 34TR—1, upon operating, (1) transfers conductor 3405 from armature No. 4 to armature No. 5 and conductor 3405 which is a continuation of ring conductor 3416 and previously extended through the upper winding of relay 33SP, to ground, now extends over a circuit including conductor 3402, contacts and innermost lower armature of relay 32TR and the armature of receive relay 32R; (2) disconnects at its armature No. 5 and back contact, conductor 3402 from the circuit extending over conductor TS—12—9 of the inward transmission path extending from trunk No. 9 to the director circuit; (3) connects at its No. 2 armature and back contact the path for connecting ground and armature No. 5 of relay 33—ON to the space, or right-hand, contact of receive relay 32R; (4) substitutes at its No. 3 armature and front contact a resistance ground 3430 for the positive potential previously applied to the marking, or left-hand, contact of relay 32R; (5) locks at its No. 7 armature in a circuit extending over conductor 3409, to ground at armature No. 4 of relay 33—ON; (6) opens at its No. 11 armature and back contact, the operating circuit for relay 32TR and prepares at the same armature and front contact the operating circuit for relay 32TR2; (7) closes at its No. 10 armature and front contact a point in a path that puts relay 33SP—1 directly under control of conductor 3410 which extends to the link circuit; (8) connects at its No. 8 armature and contact a ground connection for operating relay 34D2, which operates and then locks under control of relay 34D3; (9) substitutes at its No. 9 armature and front contact another ground for connection to the grid of vacuum tube 3411 which remains non-conductive; (10) disconnects at its No. 6 armature and contact, battery supply 3422 for operating relay 33BL—1; and (11) prepares at its No. 1 armature and contact an operating circuit for relay 33B. Relay 34D2, upon operating, (1) closes at its inner upper armature and contact a circuit for energizing the filament of vacuum tube 3411; (2) prepares at its inner upper and its outer lower armature a charging path for condenser 3412 and (3) furnishes at its outer upper armature and contact a locking circuit for operated relay 34AD, and an additional ground for conductor 3413 which is connected to conductor TS—19—9 of the locking circuit for the chain relays corresponding to relay 11CH—99 and 11AD—99, of the trunk sequence circuit at large switching center C. Relay 34AD became operated when relay 33A operated, the operating circuit for relay 34AD being traceable over the lower armature and contact of relay 34HH, trunk sequence conductor TS—21—9 and conductors 3304 and 3303 and to ground at front contact and armature No. 6 of relay 33A. As hereinbefore stated the relays corresponding to relays 11CH—99 and relay 37AD, upon operating, respectively made trunk No. 9 busy to any other call from large switching center C and to any call from any of the other central offices or switching centers.

Turning our attention now to the previously selected called trunk, it will be recalled that the director circuit, not shown, at large switching center C has caused the operation of relay 37HH

and that there were operated subsequently thereto holding magnets 36HX—89—0, 36HX—89—1 . . . 36HX—89—3, 35HX—89—9, relay 37HM and contact set 3501. The connection established between calling trunk No. 9 and called trunk No. X—89 and contact set 3501 permits conductors 3415, 3516, 3418 and 3410 of trunk No. 9 to be respectively connected to conductors 3503, 3504, 3505 and 3506 which, in turn, are permanently connected to conductors 3716, 3715, 3710 and 3718, respectively of trunk No. X—89, particular notice being given to the fact that the conductors of trunk No. 9 upon being connected to the conductors of trunk X—89 are reversed. For example, tip conductor 3415 of trunk No. 9 is connected to ring conductor 3716 of trunk No. X—89, ring conductor 3416 of trunk No. 9 is connected to tip conductor 3715 of trunk No. X—89, conductor 3418 and trunk No. 9 is connected to conductor 3710 of trunk No. X—89 and conductor 3410 of trunk No. 9 is connected to conductor 3718 of trunk No. X—89. Also, contact set 3501, upon establishing the connection connects the winding of holding magnet 36HX—89—0 over conductor 3505, conductor 3417 in a circuit traceable over conductor 3812, through the winding of relay 38SL, conductor 3813, to ground at the contact and No. 1 armature of relay 38—ON as hereinbefore stated. Relay 38SL in the calling trunk No. 9 operates and holding magnet 36HX—89—0 is held operated after the sequence circuit and the director circuit at large switching center C are released.

Relay 37HM in the called trunk No. X—89, upon operating, (1) connects at its No. 6 armature and front contact, conductor 3702 to conductor 3721 in order to place relay 38SP—1 under control of conductor 3710 which is now connected over the operating contact set 3501 to conductor 3418 of the calling trunk No. 9 to procure ground in a circuit traceable over conductor 3210, inner right-hand armature and contact of relay 32G—1, conductor 3217 to the No. 5 armature and contact of relay 33—A thus operating relay 38SP—1 of the called trunk No. X—89—9; (2) removes at its No. 2 armature and back contact relay 38SP from the circuit including conductors 3706 and 3705 and ring conductor 3716 which extends to the link; (3) prepares at its No. 8 armature and contact an operating path for relay 37TR—1 of the called trunk X—89; (4) opens at its No. 7 armature and contact a circuit including conductor TS—02—9 which extends through the winding of the start relay corresponding to start relay 12ST—89, of the trunk sequence circuit associated with the previously called trunk No. 89 thus preventing the called trunk at large switching center C from calling for a director circuit, not shown; (5) prepares at its No. 1 armature and contact an operating path for relay 37AD of the called trunk No. X—89; (6) also places on the No. 1 armature and contact a ground for connecting to conductor TS21—9 of the called sequence trunk circuit (not shown) for called main trunk No. X—89 which ground operates the chain relay corresponding to relay 12—CH—89, and advance relay corresponding to advance relay 12—AD—89, to make called trunk X—89 appear busy if the called trunk was one which could be used for outward service of local subscribers; (7) opens at its No. 4 armature and contact the circuit extending over conductor 3702, contact and innermost lower armature of relay 39TR to the armature of receive relay 39R; (8) disconnects battery 3722 at its No. 5 armature and contact from the winding of relay 38BL—1; (9) prepares at its No. 2 armature and front contact an operating circuit for relay 38B, the circuit when completed being traceable from grounded battery, through the winding of relay 38B, inner lower armature and front contact of unoperated relay 38SB—1, conductors 3814 and 3815, front contact and No. 3 armature of relay 37HM, conductor 3725, front contact and No. 5 armature of relay 38SP—1, conductors 3818 and 3813, to ground on the contact and No. 1 armature of relay 38—ON. Relay 38SP—1, upon operating, (1) causes at its No. 4 armature the operation of relay 38—ON of the called trunk No. X—89; (2) opens at its No. 2 armature and contact the operating circuit of relay 38R3 of the called trunk No. X—89; (3) removes at its No. 7 armature and contact one of the ground connections from the grid of subscriber-break vacuum tube 3904; (4) removes at its No. 3 armature and contact the possibility of short-circuiting relay 38SP of the called trunk No. X—89, a function which is of no value since the relay 38SP of the called trunk number X—89 is removed from the circuit; (5) connects interrupter ground 3816 at its No. 6 armature and front contact to a circuit extending over conductor 3924, armature and contact of break-limiting relay 39BL (unoperated at this time), conductor 3926, through the winding of relay 38BL—1, conductor 3817, armature No. 5 and back contact of relay 37HM which is now in an operated position, contacts and armature No. 6 of relay 37TR—1, to grounded battery 3722, which circuit performs no function at this time because in addition to relay 39BL being unoperated, relay 37HM is operated; and (6) at its No. 5 armature and contact prepares a path for operating relay 39TR2, the operating circuit for relay 39TR2 being traceable from grounded battery, through the winding of relay 39TR2, conductor 3938, front contact and armature No. 11 of unoperated relay 37TR—1, conductor 3724, contact and armature No. 2 of unoperated relay 38A, back contact and innermost upper armature of relay 38R2, conductors 3814 and 3815, contacts and armature No. 1 of unoperated relay 37TR—1, conductor 3725, front contact and armature No. 5 of relay 38SP—1, conductors 3818 and 3813, to ground at armature No. 1 and contact of operated relay 38—ON.

Relay 38—ON of the called trunk No. X—89, upon operating, (1) closes at its No. 6 armature and front contact a circuit for energizing the filaments of vacuum tubes 3902, 3903, 3904, 3905, and 3906, extending from grounded battery 3908; (2) connects power to the repeater relays of the called trunk No. X—89; (3) connects at its No. 1 armature and contact ground connection to the operating circuit for relay 38SL, which, however, will not operate on this call; (4) connects at its No. 4 armature and contact a locking ground for unoperated relays 37TR—1 and 39D—1; (5) prepares also at its No. 4 armature and contact an operating circuit for relay 37TR—1, the circuit being traceable from grounded battery through the winding of relay 37TR—1, conductor 3726, contact and armature No. 3 of relay 37HM, conductor 3727, front contact and outermost upper armature of relay 39CT—1, conductors 3927 and 3909, to the contact and armature No. 4 of relay 38—ON to ground; and (6) closes at its No. 7 armature and contact a circuit extending from resistance, grounded battery 3819, over the No. 7 armature

and contact of relay 38—ON, normally closed contacts of busy key 3620, conductor 3821, to the automatic signal trunk jack circuit arranged to be inserted in jack 3928. The called trunk No. X—89 at this stage therefore has the following relays operated: 37HH, 37HM, 38SP—1, and 38—ON. The condition of the repeater relays will be hereinafter described.

Returning to the calling trunk No. 9 at large switching center C it will be remembered that the holding magnet 36H—89—0 of the called trunk No. X—89 caused the operation of relay 33SL of the calling trunk No. 9. Relay 33SL, upon operating, connects (1) a second ground to trunk sequence conductor TS—19—9 and (2) ground at its upper armature and contact to the operating circuit for relay 33SL—1 which operates. Relay 33SL—1, upon operating (1) prepares at its front contact and inner lower armature an operating circuit for relay 33R2, the circuit when completed being traceable from grounded battery, through the winding of relay 33R2, armature and contact of unoperated relay 33R—1, front contact and inner lower armature of relay 33SL—1, conductor 3409, front contact and No. 7 armature of relay 33TR—1, conductor 3426, contact and armature No. 8 of unoperated relay 34HM, conductor 3427, front contact and outermost upper armature of relay 32CT—1, conductors 3327 and 3409, to ground at the contact and armature No. 4 of relay 33—ON, but relay 33R2 will, however, not operate at this time since both trunk sequence conductor TS—12—9 and relay 33R—1 have already been disconnected from the armature of receive relay 32R by the operated relay 34TR—1, and (2) opens at its outer lower armature and contact trunk sequence conductor TS—02—9 to the director circuit (not shown) to release the start relay corresponding to the start relay 11ST2—99, of the trunk sequence circuit for main trunk No. 9, and the start relay, upon releasing, causes the disconnection of the director circuit at large switching center C. The release of the start relay corresponding to start relay 11ST2—99, also causes the release of its associated relays corresponding to relay 11AL—99 and 11AL1—99, and ground on armature No. 6 of the relay corresponding to relay 18A, extended over conductors corresponding to conductors 1904, 1903, 1902, 1901, 1911, 1113 and 1111—99, then over trunk sequence conductor TS—11—9, and conductors 3322 and 3239 of the outward transmission path is therefore disconnected at the armature No. 2 of the relay corresponding to relay 11AL1—99, and relays 33S and 33L operate to their respective space, or right-hand positions. Relay 33S, upon moving into its right-hand positions transmits a spacing signal to the large switching center B at which station the space signal is repeated to calling central office A. It must be remembered that the tip conductor 3415 of the calling trunk No. 9 is also connected to the ring conductor 3716 of the called trunk X—89, but in the called trunk X—89 the ring conductor 3716 is open at relay 37HM so that the space signal continues to be sent to the large switching center B whereat it is repeated to central office A. A mark signal is still being received from central A through large switching center B so that the relays 39TL and 39R are on their mark contacts. Receive relay 39R is therefore connecting a resistance ground on armature No. 3 and front contact of relay 34TR—1, to the circuit extending over conductor 3428, mark, or right-hand, contact and armature of relay 39R, innermost lower armature and contact of relay 39TR, conductor 3402, armature No. 5 and front contact of relay 34TR—1, conductor 3405, normally closed contacts of jack 3309—B, ring conductor 3416, operating contact set 3501 of the link circuit, conductor 3504, tip conductor 3715, normally closed contact at the tip spring of jack 3808—A, upper armature and back contact of relay 38R3, through the lower winding, in series, of relays 38S and 38L, conductor 3822, make-before-break contacts of relay 39TR, conductor 3939, to grounded positive battery 3708, it being noted that the mark signal is sent over the ring conductor 3416 of the calling trunk No. 9 to the tip conductor 3715 of the called trunk No. X—89, which signal, of course, operates relays 38S and 38L of the called trunk No. X—89 to mark or their left-hand positions. Relay 38S, upon operating to its mark position, sends a mark signal from grounded positive battery, over the make-before-break contact of relay 38SB—1, contact and armature No. 3 of relay 38—ON, conductor 3823, to the normally closed contacts at the spring member of jack 3930—SEND, conductor 3914, to the central office D. The distant central office D, which in this case is the called office, is, of course, sending back a space signal over conductor 3915, normally closed contacts of receive jack 3931, conductor 3932, through the lower winding of relay 39TL, resistance 3933, contact and outer upper armature of relay 39CT2, conductor 3935, through the upper winding of receive relay 39R, resistance 3939, to grounded negative battery 3937, and relays 39TL and 39R are moved to their space positions as shown. With ground removed from the mark, or left-hand, contact of relay 39TL, the grid of disconnect vacuum tube 3906 receives a positive potential from grounded battery 3908 and the tube 3906 becomes conductive after one-second time interval, thereby operating relay 39D. Relay 39D—1, however, does not operate at this time since the contact of operated relay 39D has no ground.

The release of the director circuit at the large switching center C by the calling trunk No. 9 caused the removal of ground at the relay corresponding to relay 25D, from the conductor corresponding to trunk hunting conductor 3700—D, of the called trunk X—89 thereby releasing relay 37HH and permitting the operation of relay 37AD which, upon operating, makes the called trunk No. X—89 busy in its particular called trunk group. The circuit remains therefore awaiting action at the distant central office D and as hereinbefore stated a mark signal is being sent to central office D and a space signal to the calling office A through large switching center B. The mark signal to central office D is transmitted over a circuit traceable from grounded positive battery at the mark, or left-hand, contact and armature of relay 38S, conductor 3831, make-before-break contact of relay 38SB, contact and armature No. 3 of relay 38—ON, conductor 3823, normally closed tip spring of jack 3930—SEND, conductor 3914, through the upper winding of relay 40—RS, outer upper armature and contact of relay 40—CT, to grounded negative battery. Relay 40—RS operates to its mark, or left-hand, position. Relay 40—RS in its normal, or space, position keeps condenser 4001 discharged, but when it operates to its marking position condenser 4001 charges over a circuit traceable from grounded positive battery 4008, resistance 4021, conductors 4009, 4010 and 4025, resistances 4011 and 4012, condenser 4001, to ground. Relay 40—RS, upon

operating, to its mark position, also closes a circuit extending from ground, contact and outermost upper armature of relay 40—E—1, through the filaments, in series, of vacuum tubes 4004, 4003, 4002, 4006 and 4005, conductors 4010 and 4009, resistance 4021 to grounded battery 4008 and the tubes become energized but not electrically conductive. The removal of ground at the space contact and armature of relay 40—RS and the substitution therefore of ground at the mark contact for an interval in excess of one-half second duration, permits condenser 4001 to charge sufficiently to allow vacuum tube 4003 to become conductive and relay 40—C operates. Relay 40—C, upon operating, operates relay 40—CT. Relay 40—CT, upon operating, opens at its outer lower armature and contact the space contact circuit of relay 40—RS so that the vacuum tube will remain conductive during the reception of signals which relay 40—RS follows.

Relay 40—CT, upon operating, also (1) positions at its outer upper armature and contact, the upper winding of receive relay 40—R for the reception of the signals incoming over conductor 3914 of the outward transmission path, and (2) closes at its inner lower armature and contact the operating circuit for relay 40—TR. Relay 40—TR, upon operating, (1) locks at its middle lower armature and contact, and (2) closes at its middle upper armature and contact the operating circuit for relay 40—ON. Relay 40—ON, upon operating, closes (1) at its No. 2 armature the power circuit of repeater, or receive, relay 40—R, (2) closes at its No. 3 armature the power circuit for repeater, or send, relay 40—S, and (3) at its No. 5 armature the operating circuit for busy relay 40—BY. Relay 40—BY, upon operating, (1) closes at its outermost lower armature and contact the circuit for lighting busy lamp 4016 from a current supply at ground negative battery 4038, (2) at its upper armature and contact a substitute ground is connected to energize the filament circuit of vacuum tubes 4004, 4003, 4002, 4006 and 4005 independently of the marking contacts of relay 40—RS, and (3) at its middle lower armature and contact closes a path for connecting grounded negative battery 4040 to the sleeve of jack 4032 for testing purposes. Meanwhile, the vacuum tube filament being energized and a charge being applied to condenser 4017, vacuum tube 4002 becomes conductive prior to the operation of relay 40—ON to operate relay 40—A. Relay 40—A, upon operating, operates relay 40—A—1. Relay 40—A—1, upon operating, applies ringing current from source 4018 to conductor 3915, after relay 40—ON operates.

The distant called central office D is a manually operated office and the terminating circuit of the called trunk at office D sends the ringing current back upon the reception of a mark signal. This will cause relays 39TL and 39R of the called trunk No. X—89 to follow the ringing pulses but relay 39TL will not affect the cut-through vacuum tube 3903 because the tube in conjunction with condenser 3920 requires a one-half second mark signal to become conductive. The operation of relay 39TL in response to the ringing pulses may, though, cause vacuum tube 3906 to become unconductive and thereby release relay 39D. Relay 39R, upon following the received ringing pulses, causes no effect since its armature circuit is opened by the operated relay 37HM. Hence the circuit continues to wait until a mark signal is received from the distant central office D as a result of the operator thereat answering the call.

When the operator at central office D answers a call by connecting answering plug 4106 of a cord circuit to trunk jack 4032, a circuit is completed from ground, through the winding of relay 40—SL, sleeve conductors of jack 4032 and plug 4106, through the winding of relay 41—AA, to grounded battery to operate relays 40—SL and 41—AA, and relay 40—SL operates. Relay 40—SL, upon operating, (1) opens at its innermost lower armature and back contact the operating circuit for line relay 40—L which releases and thereby extinguishes line lamp 4023, and (2) shunts at its outermost lower armature and contact, resistance 4037 thereby changing the timing of vacuum tube 4005 so that the vacuum tube will operate relay 40—D on subsequent spacing conditions of the outward transmission path of at least one second duration as, for example, when a disconnect signal is received over the outward path. The operator at central office D before inserting answering plug 4106 operates typing key 4102 which connects into the selected cord circuit teletypewriter 4103. Relay 41—AA, upon operating, closed (1) at its upper armature the operating circuit for relay 41—C which operates. Relay 41—C, upon operating, connects ground at both its inner armatures through the lower windings, respectively, of repeater relays 41—RA and 41—RC and connects at both its outer armatures grounded positive battery to the upper windings, respectively, of repeater relay 41—RA and 41—RC whereby the repeater relays are operated to their mark positions pending the completion of the connection of the selected cord circuit to a called subscriber line local to central office D.

The connection is now in readiness for message transmission between central office A and central office D. With repeater relay 40—R on its mark contact a biasing current will flow through the lower windings, in series, of relays 40—S and 40—SS, which will follow all signals transmitted from central office D. Relay 40—S will repeat the signals to conductor 4003 and relay 40—SS will apply ground to conductor 4017 which will discharge during all marking periods wherein vacuum tube 4002 becomes unconductive to release relays 40—A and 40—A—1, in turn. Relay 40—A—1, upon releasing, disconnects at its upper armature and front contact source 4018 of ringing current from sending conductor 3915 and connects in its stead at its upper armature and back contact conductor 4003.

The transmission path from central office D through large switching centers C and B, in series, to central office A is traceable from grounded positive battery at the mark contact and armature of relay 40—S, over conductor 4003, back contact and upper armature of relay 40—A—1, front contact and outer upper armature of relay 40—ON, conductor 3915, normally closed tip spring of jack 3931—REC, conductor 3932, through the lower winding of relay 39TL, resistance 3933, conductor 3934, back contact and outer upper armature of relay 39CT2, conductor 3935, through the upper winding of relay 39R, resistance 3936, to grounded negative battery 3937. Relay 39R repeats the signals in the inward transmission path at large switching center C, to the path which may be traced from ground at the front contact and armature No. 3 of relay 37TR—1, conductor 3728, mark contact and armature of relay 39R, conductor 3912, innermost lower armature and contact of relay 39TR, conductor 3702, armature No. 5 and front contact of relay 37TR—1, conductor 3705, normally closed tip

spring of jack 3809B, ring conductor 3716, conductor 3503, tip contact of contact set 3501, tip conductor 3415, normally closed tip spring of jack 3308A, upper armature and back contact of relay 33R3, through the lower windings, in series, of relays 33S and 33L, conductor 3322, make-before-break contacts of relay 32TR, conductor 3239, to grounded positive battery 3408. Relay 33S repeats the signals from large switching center C to large switching center B in a circuit traceable from grounded positive battery at the marking contact and armature of relay 33S, resistance 3330, conductor 3331, make-before-break contacts of relay 33SB—1, contacts and armature No. 3 of relay 33—ON, conductor 3323, normally closed tip spring of jack 3230—SEND, conductor 3115, normally closed tip spring of jack 3131—REC, conductor 3132, through the lower winding of relay 31—TL, conductor 3134, back contact and outer upper armature of relay 31—CT2, conductor 3135, through the upper winding of relay 31—R, resistance 3136 to grounded negative battery 3137. Relay 31—R repeats the repeatered signals incoming from large switching center C to a path extending through large switching center B. The path over which the signals are repeated may be traced from ground at the front contact and armature No. 3 of relay 29TR—1, conductor 2928, mark contact and armature of relay 31R, conductor 3112, innermost lower armature and back contact of relay 31TR, conductor 2902, armature No. 5 and front contact of relay 29TR—1, conductor 2905, normally closed tip spring of jack 3009B, ring conductor 2916, conductor 213, tip contact of contact set 201, tip conductor 415, normally closed tip spring of jack 508A, upper armature and back contact of relay 5R3, through the lower windings, in series, of relays 5S and 5L, conductor 522, make-before-break contact of relay 6TR, conductor 639, to grounded positive battery 408. Relay 5S repeats the repeatered signals from large switching center B to central office A in a circuit traceable from grounded positive battery and from mark contact and armature of relay 5S, resistance 530, conductor 531, make-before-break contacts of relay 5SB—1, front contact and armature No. 3 of relay 5—ON, conductor 523, normally closed tip spring of jack 630—SEND, conductor 614, through the upper winding of relay 20—RS, outer upper armature and back contact of relay 20—CT, to grounded negative battery 2041, the upper winding of receive relay 20—R being shunted at this time by the unoperated condition of relay 20—CT. Relay 20—RS will follow all signals received over the path from large switching center B. From this point on, the completion of the transmission path from central office D to central office A is the same as hereinbefore described for transmission from central office E to central office A.

The transmission path from central office A through the large switching centers B and C, in series, to the central office D, is over the cord circuit at central office A as hereinbefore described when the transmission path from central office A to central office E was traced. In this transmission path relays 20—S and 20—SS follow the signals outgoing from central office A and relay 20—S repeats the outgoing signals in a circuit traceable from grounded positive battery at its marking contact, conductor 2033, back contact and upper armature of relay 20—A—1, front contact and armature No. 1 of relay 20—ON, conductor 615, normally closed contact at the tip spring of jack 631—REC, conductor 632, resistance 633, through the lower winding of relay 6TL, contact and outer upper armature of relay 6CT2, conductor 635, through the upper winding of receive relay 6R, resistance 636, to grounded negative battery 637. Relay 6R repeats the repeatered signals in a circuit traceable from ground at the front contact and armature No. 3 of relay 4TR—1, conductor 428, marking contact and armature of relay 6R, conductor 612, innermost lower armature and back contact of relay 6TR, conductor 402, No. 5 armature and front contact of relay 4TR—1, conductor 405, normally closed contact and tip spring of jack 509B, ring conductor 416, ring contact of contact set 212, conductor 214, tip conductor 2915, normally closed tip spring of jack 3008A, upper armature and back contact of relay 30R3, through the lower windings, in series, of relays 30—S and 30—L, conductor 3022, make-before-break contacts of relay 31—TR, conductor 3139, to grounded positive battery 2908. Relays 30—S and 30—L follow the signals from central office A and relay 30—S repeats them in a circuit traceable from grounded positive battery at its mark contact and armature, resistance 3030, conductor 3031, make-before-break contacts of relay 30—SB—1, front contact and armature No. 3 of relay 30—ON, conductor 3023, normally closed tip spring of jack 3130—SEND, conductor 3114, normally closed contacts at the tip spring of jack 3231—REC, conductor 3232, through the lower winding of relay 32TL, resistance 3233, conductor 3234, back contact and outer upper armature of relay 32CT2, conductor 3235, through the upper winding of relay 32R, resistance 3236, to grounded negative battery 3237. Relay 32R operates to repeat the repeatered signals in a circuit which may be traced from ground at the front contact and armature No. 3 of relay 34TR—1, conductor 3428, mark contact and armature of relay 32R, conductor 3212, innermost lower armature and back contact of relay 32TR, conductor 3402, armature No. 5 and front contact of relay 34TR—1, conductor 3405, normally closed tip spring of jack 3309B, ring conductor 3416, ring contact of contact set 3501, ring conductors 3504 and 3715, normally closed tip spring of jack 3808A, upper armature and back contact of relay 38R3, through the lower windings, in series, of relays 38S and 38L, conductor 3822, make-before-break contacts of relay 39TR, conductor 3939, to grounded positive battery 3708. Relay 38S repeats the repeatered signals at large switching center C to central office D, the circuit through which the signals are repeated being traceable from grounded positive battery at the mark contact and armature of relay 38S, resistance 3830, conductor 3831, make-before-break contact of relay 38SB—1, front contact and armature No. 3 of relay 38—ON, conductor 3823, normally closed contacts at the tip spring of jack 3930—SEND, conductor 3914, through the upper winding of relay 40—RS, outer upper armature and back contact of relay 40—CT, grounded negative battery 4041, the upper winding of receive relay 40—R being shunted at this time by the unoperated condition of relay 40—CT. Relay 40—RS at central office D, as hereinbefore stated, will follow all signals received from large switching center C. During the idle condition, relay 40—RS will keep condenser 4061 discharged by means of ground connected over the space contact and armature of relay 40—RS. Mark signals, upon operating relay 40—RS to its mark posi-

tion, permit condenser 4001 to charge, and relay 40—RS when thus moved to its mark position, closes a substitute circuit for energizing the filament of vacuum tubes 4005, 4006, 4002, 4003 and 4004, the circuit extending from grounded positive battery 4008, resistance 4031, conductors 4009 and 4010, through the filaments of the vacuum tubes, in series, outermost upper armature and contacts of relay 40—E—1, conductor 4042, to ground at the mark contact and armature of relay 40—RS. When a mark signal in excess of one-half second duration, is received by relay 40—RS, condenser 4001 will charge sufficiently to cause vacuum tube 4003 to become conductive and thereby operate relay 40—C which, upon operating, will operate relay 40—CT. Relay 40—CT, upon operating, (1) will open at its outer lower armature and contacts a discharge circuit for condenser 4001 and therefore the vacuum tubes 4003 will remain conductive; (2) open at its outer upper armature and contact a shunt circuit around the upper winding of relay 40—R which now becomes conditioned to follow the incoming signals flowing through the lower winding of relay 40—RS; and (3) closes at its inner lower armature and contacts an operating circuit for relay 40—TR which operates.

Call originating at the operator's switchboard at central office D for a "through" connection to central office A

A call originating at the operator's switchboard at central office D for a "through" connection to central office A is substantially similar to a "through" call to central office A from central office E as hereinbefore described and for an understanding of the call originating at central office D, reference may be made to the foregoing description.

To complete a "through" connection for a call from central office D to central office A, the following differences are important with respect to the hereinbefore described call from central office A to central office D.

At large switching center C:

(1) Contact set 3511, instead of contact set 3501 at the link circuit operates to complete the interconnection of main trunks No. X—89, now the calling trunk, and main trunk No. X—99, now the called trunk, trunk X—99 permanently connected to, or a part of, trunk No. 9 which terminates at the crossbar switches located at large switching center B;

(2) Inasmuch as no trunk sequence circuit is shown at large switching center C, reference may be made to the corresponding relays in the trunk sequence circuit located at large switching center B as shown in Figs. 11 and 12 of the drawing. The relays corresponding to relays 12AD—89, 12CH—89, 12ST2—89, 12AL—89 and 12AL1—89, instead of relays corresponding to relays 11AD—99, 11CH—99, 11ST2—99, 11AL—99 and 11AL1—99 of the trunk sequence circuit operated to connect the calling trunk X—89 to the director circuit (not shown);

(3) In response to the teletypewriter code signal received from the central office D for selecting the trunk group extending to large switching center B, the receiving distributor, not shown, at large switching center C selects a trunk hunting conductor corresponding to, say letter B, the code for which is mark, space, space, mark and mark, to operate the relays corresponding to relays 17DL—1A, 17DL—1B, 17DL—1C, 17DL—1D and 17DL—4, and to operate the relay corresponding to relay 14D5, to its mark position and the selecting path established by the relay corresponding to relay 14D5, and the DL relays corresponding to 17DL relays, in response to the signal combination for the letter B, is traceable from the mark contact of the relay corresponding to relay 14D5, a conductor corresponding to conductor 1422, armature No. 5 and front contact of the relay corresponding to relay 14F3, conductor corresponding to conductor 1428, upper armature and front contact of the relay corresponding to relay 17DL—4, inner upper armature and back contact of the relay corresponding to relay 17DL—3, inner lower armature and back contact of the relay corresponding to relay 17DL—2A, inner upper armature and front contact of relay corresponding to relay 17DL—1B, to the conductor corresponding to conductor 1700—B. The conductor which corresponds to trunk hunting conductor 1700—B, is shown in Figs. 34 wherein it is designated 3400—B which extends to the upper armature of relay 34AD, the advance relay of main trunk No. X—99 on the crossbar switch No. 9 at large switching center C but which is connected to trunk No. 9 of the desired trunk group extending to large switching center B. Trunk No. 9 at this time is regarded at large switching center C as the called trunk;

(4) When trunk No. 9 is selected at large switching center C by the operation of contact set 3511, relays 12AD—9, 12CH—9, 12ST2—9, 12AL—9 and 12AL1—9 of the trunk sequence circuit at large switching center B operate to connect trunk No. 9 to the director circuit, which upon being so connected transmits the "director ready" signal to central office D. Trunk No. 9 is now regarded at large switching center B as the calling trunk;

(5) The operator at central office D then transmits to the director circuit at large switching center B the "letters" signal followed by the signal combination corresponding to the letter A, the code for which is mark, mark, space, space and space to operate relay 14D5 to its spacing position and operate relays 17DL—1A, 17DL—1B, 17DL—1C, 17DL—1D, 17DL—2A and 17DL—2B and the selecting path established by relay 14D5 and the 17DL relays in response to this combination is traceable from the space contact of relay 14D5, conductor 1423, armature No. 6 and front contact of relay 14F3, conductor 1429, lower armature and back contact of relay 17DL—4, outer lower armature and back contact of relay 17DL—3, outer lower armature and front contact of relay 17DL—2B, inner lower armature and front contact of relay 17DL—1D to trunk hunting conductor 1700—A which extends through the upper armature of relay 4AD, the advance relay of main trunk No. 99 of the desired trunk group extending to the central office A, trunk No. 99 being now regarded as the called trunk at large switching center B;

(6) Conductor 1700—A upon being selected causes contact set 212 at the link circuit at large switching center B to operate and thereby complete the interconnection of calling trunk No. 9 and called trunk No. 99, trunk No. 99 being the first idle trunk of the group extending to central office A;

(7) The remaining functions of the connections so established will be readily understood by referring to the description of a call from central office A to central office D given hereinbefore.

Call originating at the operator's switchboard at central office A for a "through" connection to a central office through three or more large switching centers

A call originating at the operator's switchboard at central office A for a "through" connection through three or more large switching centers to a distant central office may be established by transmitting from the operator's teletypewriter at central office A to the first large switching center the permutation code signals corresponding to "Letters" and the letter corresponding to the second large switching center whereby a main trunk is selected at the first large switching center for extending the main trunk selected by the operator at central office A to the second large switching center. The operator at central office A upon receiving a signal indicating that the second main trunk is connected, transmits the signals corresponding to "Letters" and the letter corresponding to the third large switching center whereby a main trunk is selected at the second large switching center for extending the connection so far established, to the third large switching center. The operator upon receiving the signal indicating that the third main trunk is connected transmits the signals corresponding to "Letters" and the letter corresponding to the terminating central office whereby a main trunk is selected at the third large switching center for extending the connection thus far established, to the terminating central office. This connection may be further extended in a like manner through other large switching centers to another terminating central office. It may also be extended to a subscriber line connected to the third or fourth or any additional large switching center by the operator transmitting to the large switching center to which the desired subscriber line is connected, the permutation code signals for "Figures" and the listed number of the subscriber line station.

What is claimed is:

1. In a telegraphic exchange system a plurality of manually operated switching points, a plurality of automatically operated switching points, a plurality of telegraph channels each terminating at one end in one or another of said manually operated switching points and at the other end in one or another of said automatically operated switching points, a plurality of telegraph channels each terminating at opposite ends in any two of said automatically operated points, and selector means at each of said automatically operated points responsive to permutation code signals originating at any one of said manually operated points for successively connecting one or more of said second-mentioned channels in tandem between the first-mentioned channel of said originating point and a like channel of another manually operable point to establish a communication path therebetween.

2. In a telegraphic exchange system, a plurality of manually operable switching stations, an automatically operable switching station, a switching instrumentality in said automatically operable station having terminals invariably assigned for connection of incoming telegraph channels and other terminals invariably assigned for connection of outgoing telegraph channels, telegraph channels extending from each of said manually operable switching stations to said automatically operable switching station and dually connected to said incoming connection terminals and said outgoing connection terminals, and means responsive to telegraph signals incoming over any one of said channels for operating said switching means to connect the incoming connection terminal to any one of said outgoing connection terminals whereby any of said channels has access to any other channel through said switching means.

3. In a telegraphic exchange system, a plurality of manually operable switching stations, an automatically operable switching station, at least one two-way telegraph trunk interconnecting each of said manually operable stations and said automatically operable station, a switching instrumentality in said automatically operable station having terminals invariably assigned for connection of trunks on an incoming basis and other terminals invariably assigned for connection of trunks on an outgoing basis, dual connections for said trunks to both incoming and outgoing terminals of said switching instrumentality, and a call directing circuit available to all of said trunks and responsive to telegraph signals for operating said switching instrumentality to connect any one of said trunks on a calling basis to any other one of said trunks on a called basis.

4. In a telegraphic exchange system, a manually operable switching station, an automatically operable switching station, a telegraph channel interconnecting said stations, a second automatically operable switching station, a telegraph channel interconnecting said automatically operable stations, switching means at said first-mentioned automatically operable switching station responsive to telegraph signals transmitted from said manually operable station for interconnecting said channels, at least one additional automatically operable station, a telegraph channel interconnecting said second and said one additional automatically operable stations and telegraph channels interconnecting any further additional automatically operable stations, and switching means at each such additional station responsive to telegraph signals arriving thereat from said manually operable station over interconnected channels for connecting to said interconnected channels another channel extending to another of said additional stations.

5. A system according to claim 4 in which said second and each of said additional automatically operable stations has at least one telegraph channel extending to a manually operable switching station and connectable to said interconnected channels by the signal responsive switching means at such automatically operable station in lieu of a channel extending to another automatically operable station.

6. A system according to claim 4 in which said second and each of said automatically operable stations has at least one telegraph channel extending to a manually operable switching station and connectable to said interconnected channels by the signal responsive switching means at such automatically operable station in lieu of a channel extending to another automatically operable station, each of said switching means being operable under the control of signals originating at any of said manually operable stations to interconnect said channels progressively toward a remote manually operable station.

7. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, a plurality of communication channels extending from each

of said switching points to certain of said termini, and certain of said other switching points, each of said termini and each of said switching points serving to terminate some of said channels, means at each of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over one of said channels for selecting and connecting to said one channel another of said channels to establish a connection between channels respectively terminating at any two of said termini through one or more of said switching points.

8. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, a plurality of subscriber lines connected to each of said switching termini and each of said switching points, a plurality of communication channels extending from each of said switching points to certain of said termini and certain of said switching points, each of said termini and each of said switching points serving to terminate some of said channels, means at each of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over one of said channels for selecting and connecting to said one channel another of said channels to establish a connection between channels respectively terminating at any two of said termini through one or more of said switching points, and other means included in each of the first-mentioned means arranged to be controlled in one direction only by permutation code signals incoming over one of said channels for selecting and connecting to said one channel one or more other of said channels, in tandem, to prepare a connection between a subscriber line connected to any one of said switching termini and a subscriber line connected to one of said switching points through one or more of said switching points.

9. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, a plurality of communication channels extending from each of said switching points to certain of said termini and certain of said other switching points, each of said termini and said switching points serving to terminate some of said channels, means at each of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over one of said channels from one of said termini, said control means including means for selecting and connecting to one of said channels another channel extending to another of said termini, and means at said switching center for differentiating, in response to said signals of permutation codes incoming over said one channel, between a selection and connection to a channel extending to said other termini and a selection and a connection to a channel extending to another switching point.

10. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, line circuits and subscriber stations therefor connected to each of said switching points, a plurality of communication channels extending from each of said switching points to certain of said termini and certain of the other of said switching points, each of said termini and said switching points serving to terminate some of said channels, means in each of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over one of said channels from one of said termini for selecting a desired line extending to a subscriber's station or a desired channel extending to another of said termini or another of said switching points for establishing a connection for communication purposes, other means at said switching center for differentiating, in response to other signals of permutation code incoming over said one channel, between calls for an established connection to a subscriber's station local to said switching center and an established connection to another channel extending to another of said termini or another said switching points, and signaling means in said controlled means for sending to the termini originating a call, a signal indicating whether the call is being completed to a subscriber station or to a trunk extending to said other termini or said other switching point.

11. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, line circuits and subscriber stations therefor connected to each of said switching points, a plurality of communication trunk groups extending from each of said switching points to certain of said termini and certain of the other of said switching points, means at each of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over the trunk of one of said groups extending from one of said termini to select a line circuit extending to a desired subscriber station, or a trunk of a desired trunk group extending to another termini, a sequence circuit for permitting, only one at a time, a trunk or a subscriber line circuit of those connected to a switching point, to seize said controlled means for establishing a connection to another trunk, and means for giving said one calling trunk the preference over said one calling subscriber line.

12. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, a plurality of communication trunk groups extending from each of said switching points and terminating at each of said termini, means at each of said termini for seizing a trunk of one of said groups, means at one of said switching points in response to permutation code signals incoming over said seized trunk for associating said seized, or first-mentioned trunk, with a trunk of another group extending to another of said termini, said associating means including means for interconnecting the two trunks in the reversed order when the permutation code signals are incoming over the second-mentioned trunk instead of said first-mentioned trunk.

13. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, trunk groups extending from each of said switching points to certain of the other of said switching points and certain of said termini to form a complete network of trunk groups between said switching points and said termini, means at each of said switching points responsive to permutation code signals incoming over any one trunk of any one of said groups connected to one of said switching points for associating said one trunk of said one group with a trunk of any desired one of the other of said groups and means in said responsive means for testing the trunks of said other groups for an idle trunk, and other means

in said responsive means for reporting back on the trunk over which the signals were received, the condition of the trunk in the desired group.

14. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically switching points, a plurality of communication trunk groups extending from each of said switching points to certain of the other of said switching points and certain of said termini to form a complete network of trunk groups between said switching points and said termini, and a coordinate switching circuit at each of said switching points for arranging trunk groups terminating thereat so that each trunk of a group may be arranged to complete a connection to a trunk of another group either as a calling or a called trunk in the connection.

15. In a telegraphic exchange system, a plurality of switching termini, a plurality of automatically operated switching points, a plurality of smaller automatically operated switching points, line circuits and subscriber stations therefor connected to each of said switching points, a plurality of main trunk groups extending from each of said switching points to certain of said termini and certain of the other of said switching points, a plurality of secondary trunks, or trunk lines, extending from one or more of said switching points to one or more of said smaller switching points, means at certain of said switching points arranged to be controlled in either of two opposite directions by permutation code signals incoming over a trunk of any one of said groups for associating the trunk of one group with the trunk of another group to establish a communication connection (1) between any one of said termini and one or more of said switching points in tandem, and (2) any two termini through one or more of said switching points, and means included in each of said control means and responsive to permutation code signals incoming from any one of said termini and in one direction only, for establishing a communication connection between (1) one of said termini and a subscriber station local to one of said switching points, (2) one of said termini and a subscriber's station local to a switching point through two or more other of said switching points, and (3) between one of said termini and a subscriber's station local to one of said smaller switching points either directly or through one or the other of said switching points.

16. In a telegraphic exchange system having a plurality of paths arranged for interconnection to establish telegraphic communications paths, one or more of said paths comprising a plurality of switching termini, a plurality of automatically operated switching points in each of said paths, a plurality of line circuits and subscriber stations therefor connected to each of said switching points, a plurality of telegraphic channels extending from each of said switching points, certain of said channels extending to one or more of said termini, and others extending to one or more of the other of said switching points, means at each of said switching points responsive to signals of permutation code incoming over any one of the channels extending to any one of said termini for selecting and connecting to any of the other of said channels extending to another of said termini or another of said switching points in any one of said paths to establish a connection between a calling one of said termini and a called one of said termini either directly or through two or more of said switching points in the same or a different path or to a subscriber's station connected to one of said switching points either directly to or through one or more of the other of said switching points, and means in said responsive means for establishing the connection in either of two opposite directions through one or more of the other of said switching points in the same or different paths.

17. In a telegraphic exchange system having a plurality of paths arranged for interconnection to establish telegraphic communications, one or more of said paths comprising a plurality of switching termini, a plurality of automatically operated switching points in each of said paths, a plurality of telegraphic trunks arranged in groups respectively interconnecting said termini and said switching points in each of said paths and each of said switching points and other of said switching points in the same or different paths, each of said trunks being operated on a full duplex basis, switching instrumentality at each of said switching points having terminals assigned for connection of certain of said trunks on an incoming basis and other terminals assigned for connection of certain other of said trunks on an outgoing basis, dual connections for said trunk to both incoming and outgoing terminals of said switching instrumentality, a call directing circuit available to all of said trunks at each of said switching points and responsive to telegraph signals of permutation codes transmitted from any one of said termini for operating said switching instrumentality to connect at the switching point any one of the trunks terminating locally at the switching point and prepared for connection thereto on a calling basis to any one of the other local trunks selected on a called basis through one or more other switching points in the same or different paths, and supervisory means operated on a full duplex basis at each of said switching points arranged for connection to each of said switching points in the same or different paths arranged for connection to each of said local trunks extending therefrom for furnishing at any one of said termini supervision on an established connection between said one terminus and the switching point or between said one and any of the other of said termini through the switching point or two or more of said switching points connected in tandem in the same or different paths.

18. In combination, a telegraphic trunk having a terminus and a switching point, means in said terminus for seizing said trunk, a plurality of telegraphic channels leading away from said switching point, means at said switching point actuatable selectively under control of and in accordance with signals in permutation codes proceeding over said trunk, said terminus to select one of said plurality of telegraphic channels and extend a communication path over said trunk and said selected channel, in tandem, in combination with another trunk having a separate terminus and a separate switching point, means at said separate terminus for seizing said other trunk, a plurality of telegraphic channels including said selected one channel, leading away from said separate switching point, means at said separate switching point actuatable selectively under control of and in accordance with signals in permutation codes proceeding over said other trunk from said separate terminus to select said one channel of the second-mentioned plurality of said telegraphic channels, and extend a communication path over said separate trunk and said one chan-

nel of the second-mentioned plurality of telegraphic channels, in tandem.

19. In combination, a telegraphic trunk having a terminus and a switching point, means at said terminus for seizing said trunk, a plurality of telegraphic channels leading away from said switching point, means at said switching point actuatable selectively under control of and in accordance with signals in permutation codes proceeding over said trunk from said terminus to select one of said plurality of telegraphic channels, and extend a communication path over said trunk and said selected channel, in tandem, in combination with another trunk having a separate terminus and a separate switching point, means at said separate terminus for seizing said other trunk, a plurality of telegraph channels including said selected one channel, leading away from said separate switching point, means at said separate switching point actuatable selectively under control of and in accordance with signals in permutation code proceeding over said other trunk from said separate terminus to select said one channel of the second-mentioned plurality of telegraphic channels and extend a communication path over said separate trunk and said one channel of the second-mentioned plurality of telegraphic channels, in further combination with busy means operable by seizure of said trunk at either of said termini rendering it unavailable at both termini so long as it remains seized.

20. A channel of telegraphic communication extending from a first station to a second station, a plurality of classes of paths of telegraphic communication extending away from said second station, means for sending one or another of a plurality of preparatory permutation codes followed by path selecting codes over said channel from said first station to said second station, means operable by each preparatory code for restricting subsequent selecting codes to selection of certain classes of paths whereby, dependent upon the preparatory code used, the same selecting code may be available to select paths of said certain different classes and means operable under control of said selecting codes to select one of the other of said paths of another class and connect it to said channel as a "through" telegraphic communication path.

21. A channel of telegraphic communication, leading from the first station to a second station, means for sending telegraphic permutation codes over said channel from a first station to a second remote station, lines and trunks proceeding away from said second station, means included in the first mentioned means for sending selecting permutation codes preceded by a case shifting codes to select said lines or trunks, and means respectively actuated by either of said case shifting codes whereby subsequent selecting codes are limited to selection of lines or trunks depending upon the nature of the preceding case shifting code.

22. Line selecting system comprising a code sending source, means for selecting individual local lines, means for selecting individual trunks, means operated by a "Letters" code followed by a selecting code from said course for selecting a trunk identified by said selecting code, and means operated by a "Figures" code followed by a selecting code from said source for selecting a local line characteristic of that selecting code.

23. A system comprising a first switching terminus, a first switching point, a second switching terminus, a second switching point, trunks

extending from the first switching point to each of said switching termini, trunk lines extending from said first switching point to said second switching point, local lines extending from each of said switching points, a permutation code sending source at each of said termini, selecting means at said first switching point, including means responsive to a "Letters" code followed by a selecting code from either of said sources for selecting a trunk extending to the terminus of the other of said sources and identified by the selecting code and other means responsive to a "Figures" code followed by a selecting code from either of said sources for selecting a local line or a trunk line characteristic of the selecting code, and means at said second switching point responsive to a "Figures" code followed by a selecting code from either of said sources for selecting at said second switching point a local line, characteristic of its selecting code.

24. A selecting system comprising switching termini, two or more switching points, local lines connected to each of said switching points, trunks interconnecting each of said termini and one of said switching points, other trunks connecting said two or more switching points in tandem, a signal sending source at each of said termini, means controlling said source at any one of said termini for selecting at one of said switching points one of said local lines locally connected thereto, other means controlling said source at said one termini for selecting at said one of said switching points individual trunks extending to another of said termini or to another of said switching points, relay means at said one switching point operated by a "Letters" code followed by a selecting code from said one source for selecting a trunk identified by said selecting code, other relay means operated by a "Figures" code followed by a selecting code from said one source for selecting a local line characteristic of said selecting code another relay means at a second of said switching points, operable in case of a selection of a trunk interconnecting said one and said second switching points, responsive to other groups of codes comprising "Letters" or "Figure" followed by selecting codes transmitted from said one source for selecting one of the trunks connected to either another of said termini or a third switching point, or to a local line locally connected to said second switching point.

25. In combination, a plurality of telegraphic channels extending from one terminus to a switching point and a second plurality of channels extending from another terminus to said switching point, means at said terminus for seizing one of the first-mentioned plurality of channels, means at said switching point actuatable selectively under control of and in accordance with permutation code signals proceeding over said seized channel from said one terminus to select one out of said second plurality of telegraphic channels and extend a communication path over said seized and said selected channel, in tandem, to said second terminus, in combination with means at said second terminus for seizing one of said second plurality of channels, means at said switching point actuatable selectively under control of and in accordance with permutation code signals proceeding over said seized channel of said second plurality to select one out of said first-mentioned plurality of telegraphic channels and to extend a communication path over said seized channel of said second plu-

rality and said selected channel of the first-mentioned plurality in tandem to said one terminus.

26. A system of telegraphic trunk groups, one extending between a terminus A and a switching point B and the other extending between a terminus E and said switching point B, means at terminus A for seizing a trunk of said one group, means at switching point B responsive to said seizure to seek and temporarily connect trunk directive equipment including a permutation code signal selector usable in common by all of said trunks, means for transmitting to terminus A in response to said seizure a signal indicative of the readiness of said selector to receive permutation code selecting impulses, means at terminus A for transmitting said impulses to control said selector, means at switching point B responsive to said impulses for extending a channel of communication including the seized trunk selectively beyond switching point B, in combination with means at terminus E for seizing a trunk of said other group, means at switching point B responsive to said seizure of the trunk of said other group and associate the second seized trunk with said permutation code selector, means at switching point B responsive to said seizure of said second seized trunk to send to terminus E a signal indicating the readiness of said selector to receive permutation code selecting impulses, means at terminus E to relay such impulses to switching point B and means at switching point B responsive to said impulses to extend a channel of communication including said trunk seized at terminus E beyond switching point B as a channel of communication.

27. A telegraph system including a first and a second switching office interconnected over a trunk, means at each office operable to seize said trunk, if idle, by connection thereto of a link circuit, means operative as a result of said seizure to seize at the other office and attach to said trunk and prepare for operation a permutation code selector, a sender of the teletypewriter type associated with said trunk through said link circuit to control said selector by codes ordinarily usable for message communication in said system, means controlled by said selector incident to the operation thereof by said codes for extending a path over said trunk alternatively to a local station or to a third switching office over another trunk, and a channel selecting permutation code selector at said third office seizable incident to said extension and operable by further permutation codes over said trunks in tandem to select a path of telegraphic transmission and extend the tandem paths of said trunks thereover.

28. A telegraph system including a channel of transmission terminating at a first switching point, one or more local telegraph channels from said point to local stations, one for each such

local channel, one or more trunks extending to a further switching point or points, selective means at said first switching point controlled by permutatively coded impulses arriving at said first switching point, means cooperating with said selective means whereby different preparatory codes condition said selective means to select a local line only or a trunk only, and means included in said selective means whereby codes following said preparatory code select a local line or a trunk as the case may be.

29. A telegraph system comprising a channel of telegraphic transmission extending from a station A to a station B, lines to local offices and trunks to switching offices extending from station B to local offices and switching offices respectively, selective equipment at station B including a permutation code selector operable by telegraphic codes proceeding over the channel from station A to station B, said selective equipment including a first element conditioned by a code assigned as one case in the system and another element conditioned by a code assigned as another case in the system, means operable by one or more subsequent codes following the conditioning of said first element to select a line to a local office and extend the channel from station A to station B communicatively thereover, and means operably by one or more subsequent codes following the conditioning of said other element to select a trunk to a switching office and extend the channel from station A to station B communicatively thereover.

30. In a telegraphic exchange system, a switching terminus, a second switching terminus remote therefrom, a plurality of automatically operated switching stations geographically and systematically intermediate said termini, trunks connecting each of said termini to at least one of said automatically operated switching stations, other trunks connecting each of said automatically operated switching stations to at least one other automatically operated switching station, and automatic switching means at said automatically operated switching stations responsive to signals originating at either of said termini for interconnecting two trunks in tandem at each automatically operated switching station to establish a communication path to the other terminus.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,228,279	Lucek	Jan. 14, 1941
2,345,317	Bailey	Mar. 28, 1944
2,372,329	Large et al.	Mar. 27, 1945