Oct. 25, 1949. A. C. REID ET AL 2,485,986

AUTOMATIC TELEPHONE SYSTEM

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FIG. 1

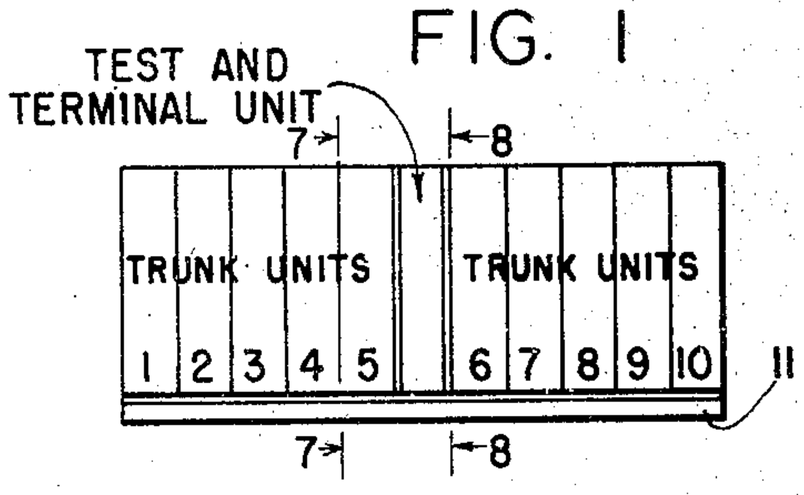
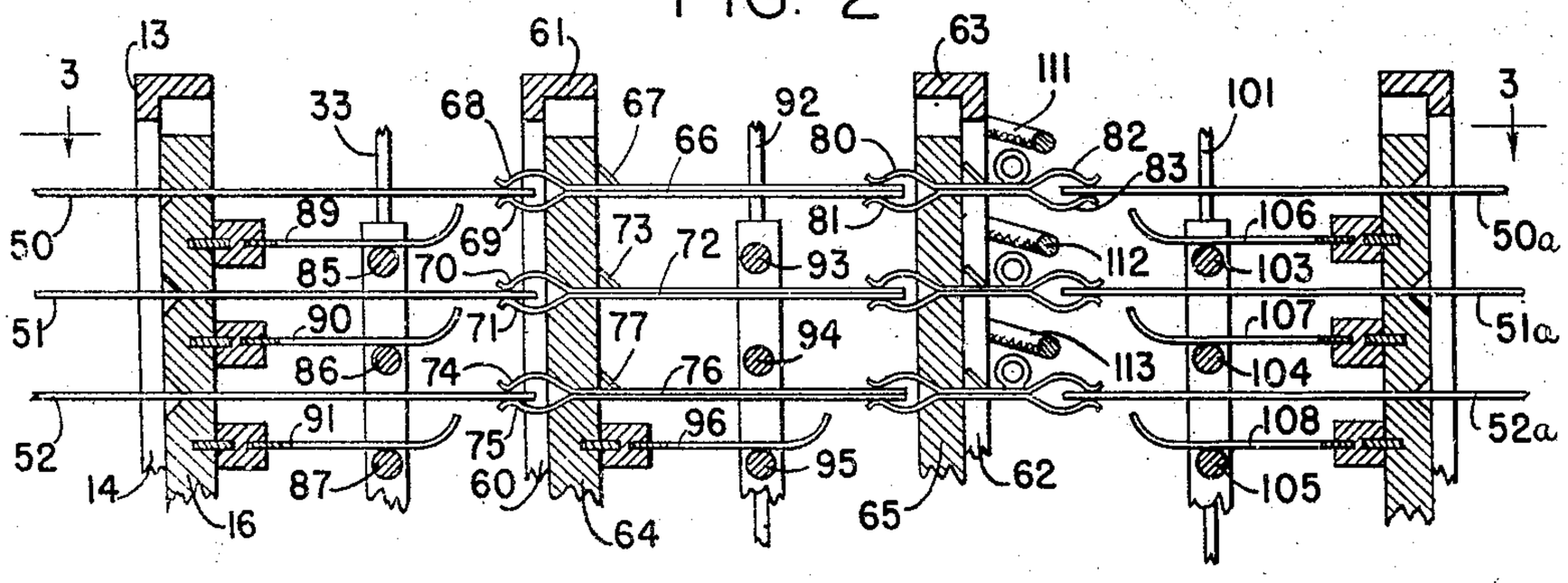


FIG. 2



TRUNK UNIT NO.5 TEST & TERMINAL UNIT TRUNK UNIT NO. 6

FIG. 3

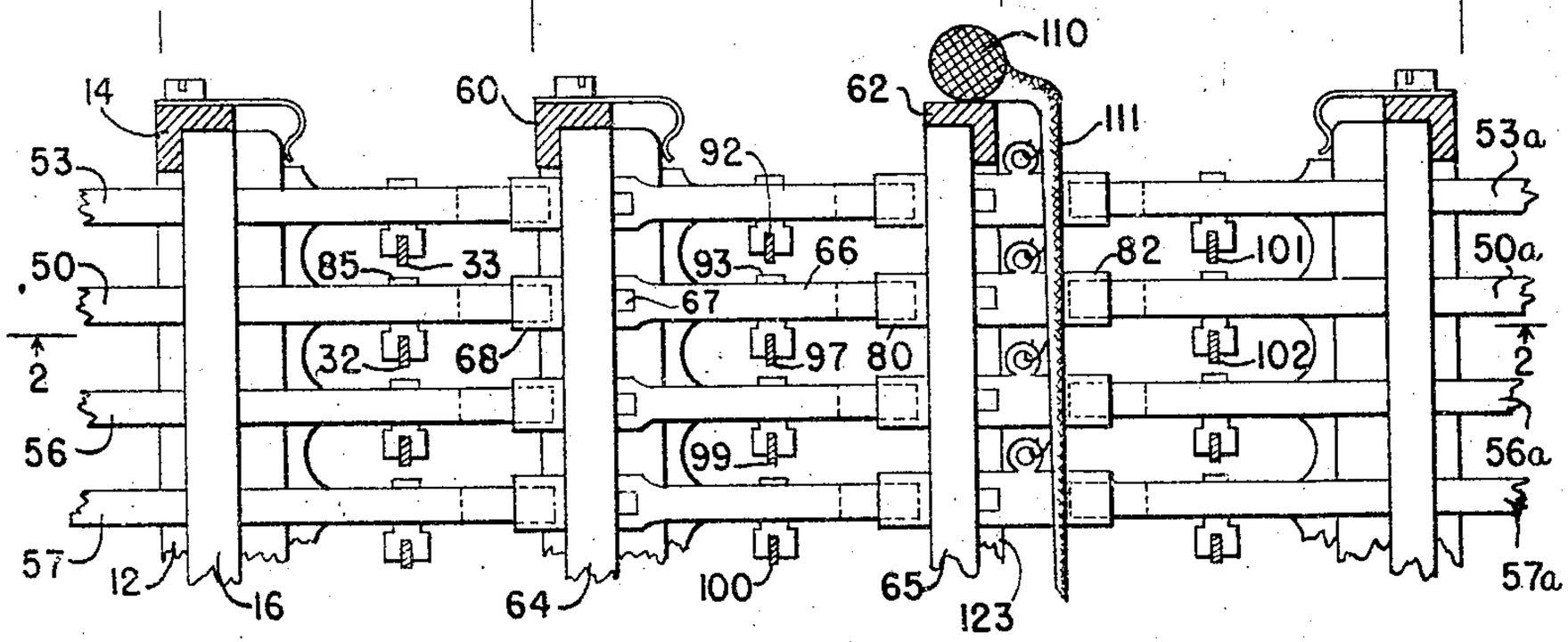


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FIG. 4

FIG. 5

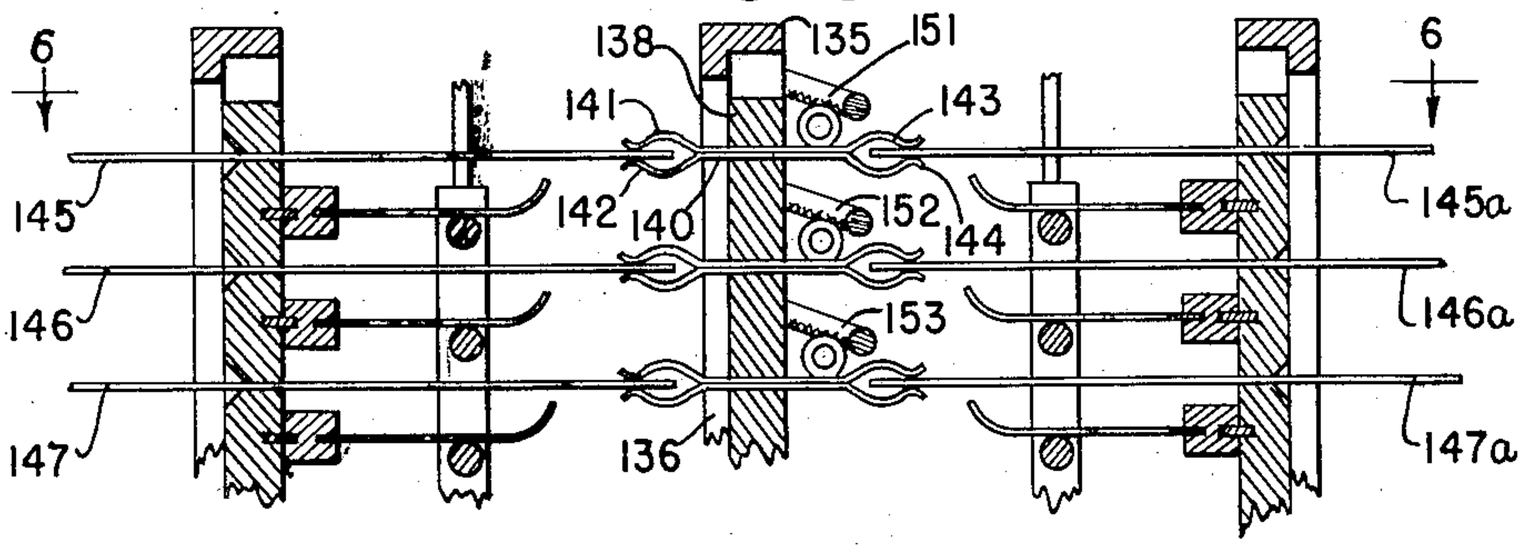

FIG. 6

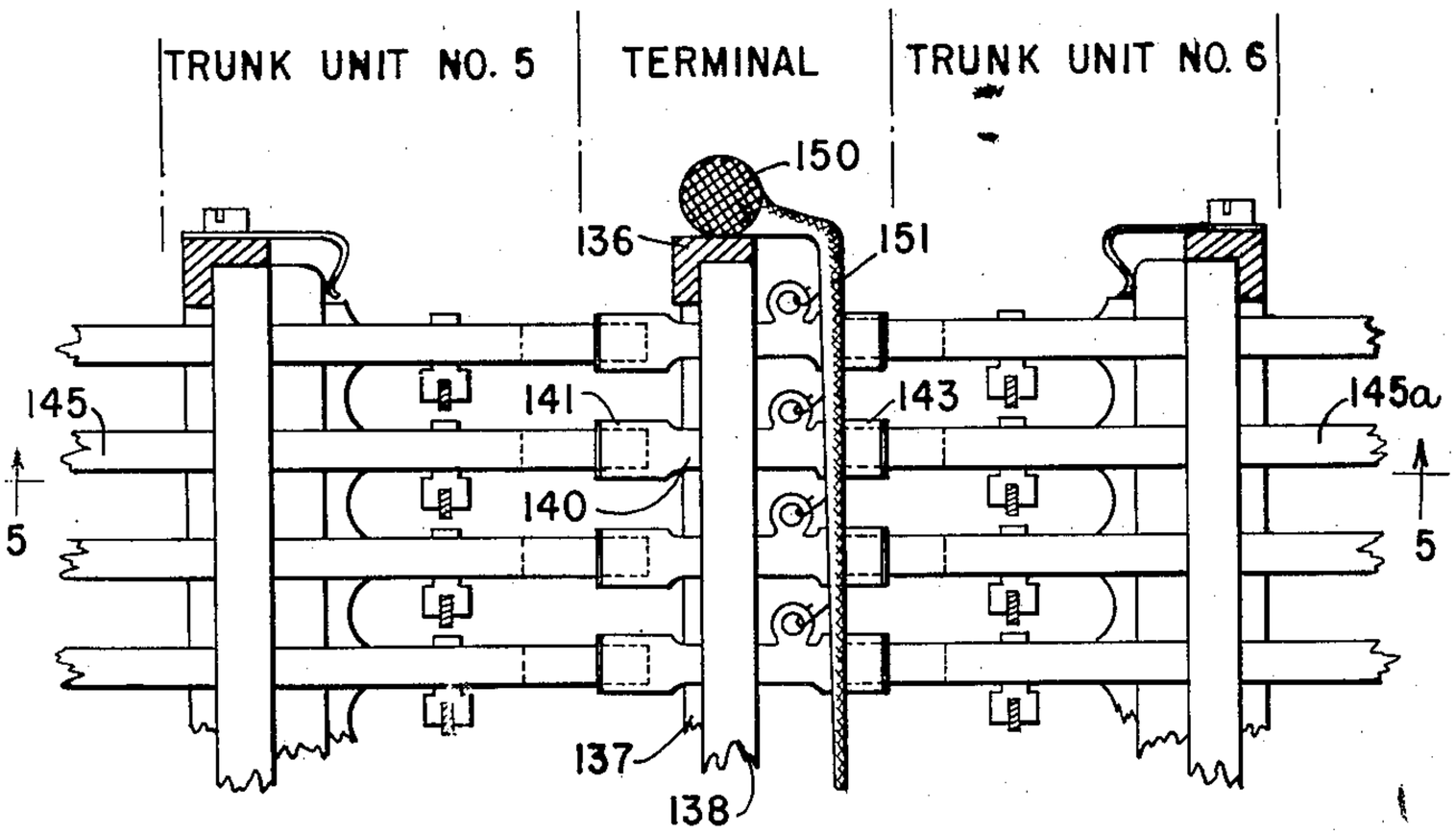

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FIG. 7

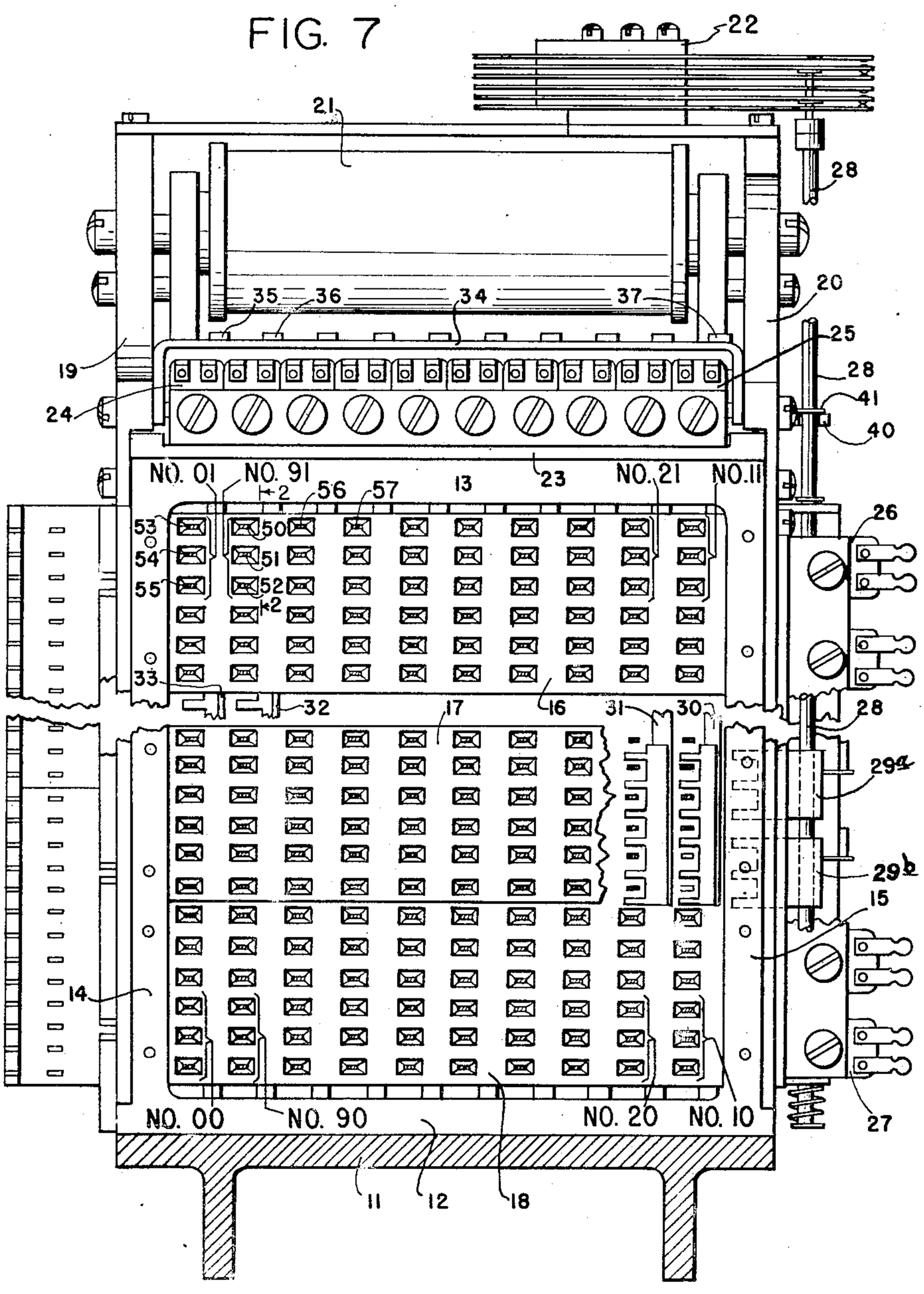

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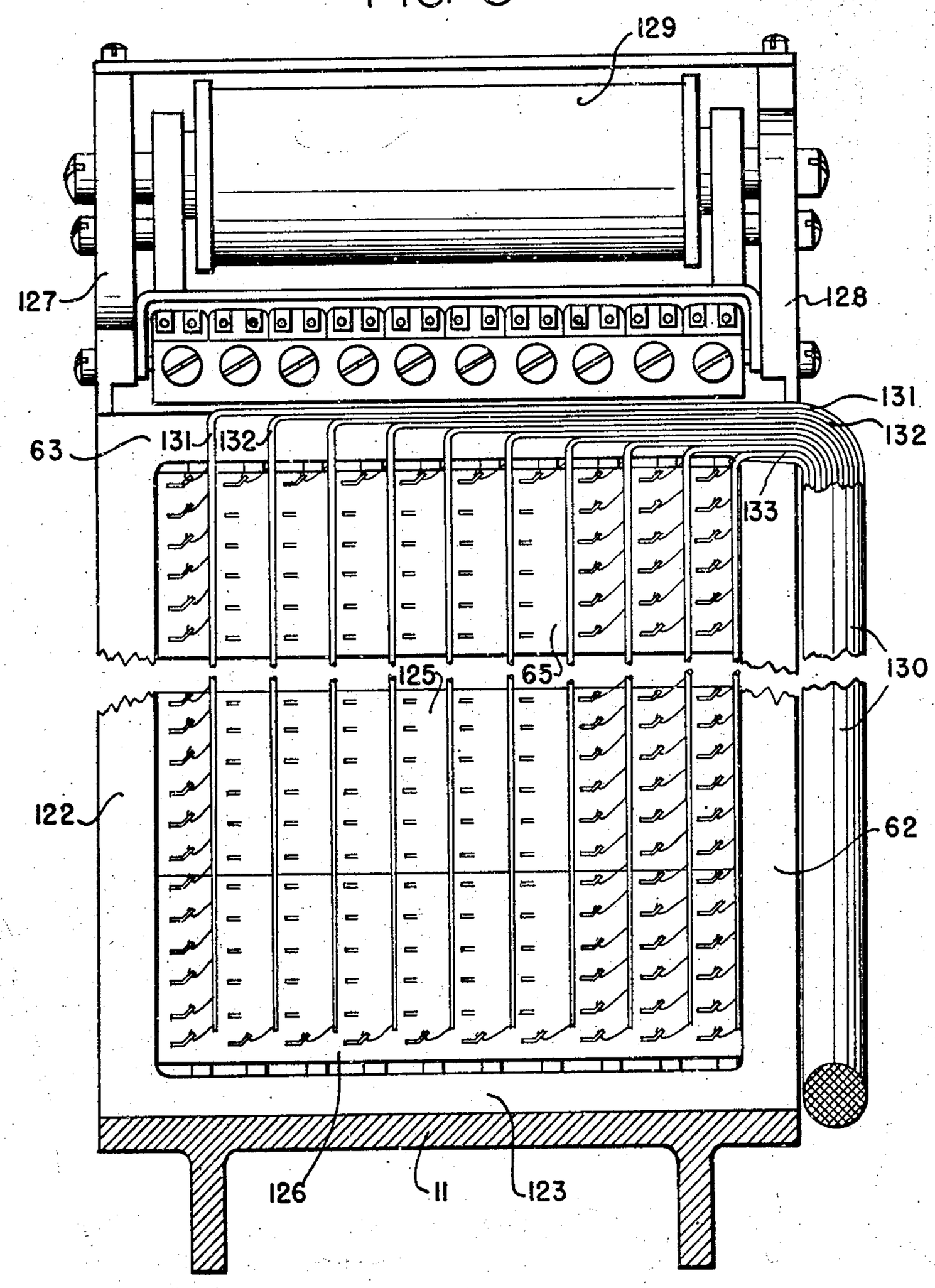
FIG. 8



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UNITED STATES PATENT OFFICE

2,485,986

AUTOMATIC TELEPHONE SYSTEM

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Application June 11, 1945, Serial No. 598,694

5 Claims. (Cl. 179—22)

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This invention relates to signalling systems, for example, automatic telephone systems, of the general type disclosed in U. S. Patents Nos. 2,307,757 and 2,396,077, and in co-pending application Ser. No. 583,567, which may be referred to, for the sake of convenience, as coordinate or crossbar switching systems.

A brief description of the salient features of the apparatus disclosed in the co-pending application Ser. No. 583,567 is presented below in order to furnish a basis for understanding the invention which will presently be discussed in detail.

The line and test conductors of the prior apparatus are bare strip or bar-like members disposed in groups in a plurality of parallel rows forming a bank of cross-sectionally rectangular outline. These members may be referred to as bars. Assuming that the apparatus is used, for example, as a line finder in a 100-line system and that there are in the exchange equipment two line conductors and one test conductor for each subscribers' line, the bank of the switching mechanism will contain 100 sets of bars, each set comprising two line and one test bar and representing a subscribers' line. There are therefore 200 line bars and 100 test bars, or a total of 300 bars. These bars are arranged in ten vertically extending subscribers' subgroups disposed in parallel, each subgroup having ten lines or a total of thirty bars. The arrangement of the line and test bars in the ten vertical subgroups therefore forms thirty vertically superposed horizontally extending rows of bars, each row comprising ten bars. A group of three vertically successive horizontal rows of bars constitutes a switching or selection level and there are, therefore, ten vertically superposed horizontally extending switching or selection levels each comprising three rows of ten bars each, or a total of thirty bars representing ten subscribers' lines, one line for each of the ten vertical subgroups.

It will be understood from the foregoing that the group or tens digit selection is determined by the placement of the bars in the ten vertically extending subgroups and that the units digit selection within all of the ten subscribers' subgroups is determined in accordance with the ten vertical switching levels of the bank.

A desired number of trunk lines may be provided, each having two line conductors and one test conductor. These trunk lines give access to equipment for completing calls. Each trunk line with its three conductors terminates in an individual trunk or switching unit which is disposed

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transversely of the bank of line and test bars. Each trunk unit contains the switching means for selectively connecting any one set of three bars representing the three conductors of any one of the 100 subscribers' lines with the three conductors of the trunk line served by the trunk unit. The three conductors of the trunk line of each trunk unit are for this purpose multipled to ten sets of extensions, each set having three extensions, forming in this manner in each trunk unit ten sets of stationary intermediate trunk contacts, each set comprising three contacts, or thirty stationary intermediate trunk contacts altogether. These trunk contacts are vertically superposed in a row extending alongside one edge of the trunk or bank unit of which they are a part. The vertical placement of each set of intermediate trunk contacts coincides with the placement of the line and test bars in the corresponding switching or selection level of the bank.

The switching means comprises in each trunk or bank unit ten intermediate trunk elements for each conductor of the trunk line, or a total of thirty intermediate trunk elements. Each intermediate trunk element is associated with one of the stationary trunk contacts but is normally out of engagement therewith. These trunk elements are disposed transversely of the bank of line and test bars in vertically superposed relationship, one trunk element for each of the thirty superposed rows of line and test bars. Each trunk element forms ten resilient contact fingers for engagement with its associated line or test bars and an eleventh contact finger for engagement with its associated intermediate trunk contact. A group of three such intermediate trunk elements is thus individual to each switching or selection level and is adapted to extend any one of ten sets of line and test bars in such level to the line and test conductors of the trunk line by way of the corresponding set of stationary intermediate trunk contacts.

The connection of any one calling subscribers' line with the trunk line therefore depends, first, on the actuation, in any switching or selection level, of three vertically superposed resilient contact fingers of three intermediate trunk elements into engagement with the three bars representing the line and test bars of the calling line and, second, on the actuation of the eleventh resilient contact fingers of these three intermediate trunk elements into engagement with the associated stationary intermediate trunk contacts of the trunk line disposed on a level which coincides

with the switching level of the three intermediate trunk elements. The first operation corresponds to the group or tens digit selection, and the second operation corresponds to the units digit selection within the selected group.

The above described operations are controlled by so-called tens and units actuators. There are tens actuators, one for each vertically disposed subscribers' subgroup, each having thirty projections for actuating the associated resilient contact fingers of the thirty intermediate trunk elements into engagement with the line and test bars in the corresponding sub-group and ten units actuators, one for each of the ten sets of intermediate trunk contacts, each having three projections for actuating the eleventh contact fingers of the associated intermediate trunk elements into engagement with the corresponding stationary intermediate trunk contacts.

The operation of the tens and units actuators is selectively prepared or "selected" by certain electromagnetically operated clutch or coupling means adapted to couple selected actuators with operating means controlled by a common gate magnet.

If the mechanism serves as a finder switch, as assumed before, it may be provided with a test or control unit which is structurally similar to the trunk units but is equipped only with tens actuators for operating the resilient contact fingers of intermediate trunk elements into engagement with associated test bars. The test unit aids in the control of the operation of the units actuators in all the trunk units.

The connection between a calling line and the trunk line is completed in each trunk unit by the energization of the gate magnet which displaces the operating means and the actuators coupled therewith.

A desired number of trunk or switching units may be provided, each having switching means for connecting any one of the 100 sets of line and test bars with the trunk line terminating therein, as briefly described above. It is understood, of course, that the mechanism may be used in the manner of a finder switch for connecting calling subscribers' lines with trunk lines leading to selectors; or in the manner of a selector switch for extending a trunk from a finder to a further switching stage or to a connector; or in the manner of a connector for extending a call to a called line so as to complete desired connections. The test or control unit which may be provided when the switching mechanism is used as a finder switch, may be dispensed with in the case of selectors and connectors. The trunk or switching units are in either case arranged side by side transversely of and in intersecting relationship with the bank of line and test bars. In other words, the line and test bars which represent subscribers' lines in the case of finders and connectors, or trunks in the case of selectors, extend through all the trunk or switching units, and in the case of finder switches also through the test or control unit provided therefor. The line and test bars are therefore common to the trunk units and to the control unit provided in a given switching mechanism, whether it be a finder or a selector or connector.

The line and test bars are removable; that is, each bar is inserted from one end of the mechanism through certain guide and mounting means in the various trunk or switching units and into removable engagement with terminal means disposed at one end of the mechanism.

Addition of a new trunk or switching unit for the purpose of providing an added terminal facility, or removal of a unit for repair, adjustment, checking, or for any other purpose, requires withdrawal of all the line and test bars from their terminals. Consequently, the entire switching mechanism is withdrawn from service. No calls can be handled until the necessary work is completed and all units are in place and the line and test conductors restored in proper position. Repairs or adjustments requiring such temporary removal or disconnection of the line and test bars is therefore, in the prior mechanism, usually carried out at night when service can be suspended without inconvenience to the subscribers.

In order to overcome this drawback and shortcoming, the invention proposes to divide the trunk units, forming the switching mechanism, into a plurality of groups, for example, into two groups, and to provide individual line and test bars for each group of trunk units. Corresponding line and test bars of such groups are interconnected by suitable means forming a multiple. Thus, if the mechanism is used as a finder switch, any one of the subscribers' lines is represented by two line bars and by one test bar in each group of trunk units, and the bars serving one group of trunk units are interconnected with or multipled to corresponding bars serving the other group of trunk units. Putting it in other words, the line and test bars of the switching mechanism are divided into two sections, each section serving a number of trunk units. The interconnection or multiple maintains the conductive continuity between the two sections of any one line or test bar.

The invention, therefore, permits withdrawal of the line and test bar sections in either group from operative engagement with their associated trunk units without altering the operative engagement of the corresponding line and test bar sections in the remaining group of trunk units. Any one of the trunk units in either group can thus be removed for repair or adjustment, and service can be maintained over the trunk units of the undisturbed group. Likewise, either one of the groups of trunk units may be withdrawn from service, by removing its associated line and test bars, e. g., for the purpose of adding a new trunk unit to the group, and service can be maintained over the trunk units of the undisturbed group.

A preferred embodiment of the invention provides a control or terminal unit and arranges a group of trunk or switching units at the left and a group of such units at the right thereof. The line and test bars, as previously explained, are made in two sections, one section for each group of trunk units, and means are provided in the terminal unit for removably interconnecting the sections of the bars serving the groups of trunk units on either side thereof. The conductive continuity of the line and test bars is therefore preserved throughout the entire mechanism.

Details of the invention will be described with reference to the accompanying drawings, showing certain embodiments. In these drawings,

Fig. 1 shows in diagrammatic representation a complete crossbar switching mechanism constructed in accordance with the invention for use, e. g., as a finder switch, having two groups of trunk units and a test and terminal unit disposed intermediate of these groups;

Fig. 2 represents in diagrammatic manner a

section through parts of trunk units Nos. 5 and 6 provided in the mechanism shown in Fig. 1, and a corresponding section through part of the new test and terminal unit disposed between these trunk units, showing also one manner of wiring conductors to the soldering tabs in the terminal unit;

Fig. 3 illustrates the parts as seen along lines 3—3 in Fig. 2;

Fig. 4 is a diagrammatic representation of a switching mechanism of the crossbar or coordinate type constructed in accordance with the invention, showing the principal parts of which the mechanism is composed for use, e. g., as a selector or as a connector switch, having two groups of trunk or switching units and a terminal unit intermediate thereof;

Figs. 5 and 6 are diagrammatic sectional views through trunk units Nos. 5 and 6 and through the new terminal unit provided in Fig. 4, in a showing analogous to Figs. 2 and 3, the section Fig. 5 being taken approximately along lines 5—5 in Fig. 6 and the section Fig. 6 representing the corresponding parts approximately along lines 6—6 in Fig. 5;

Fig. 7 is a side view of a trunk or switching unit; and

Fig. 8 shows the test and terminal unit indicated in Figs. 1, 2 and 3, and an alternate manner of wiring the conductors to the soldering tabs of the line and test bar terminals.

Like parts are indicated by like reference numerals throughout the drawings. Details and elements of the trunk or switching units disclosed in the previously mentioned patent and co-pending applications will be described only to the extent required for an understanding of the invention. The drawings are not to scale, and are intended only for descriptive and illustrative purposes.

The mechanism shown in Fig. 1 may be a finder switch comprising ten trunk units disposed in two separate groups, one on either side of the new test and terminal unit. All these units are mounted on a base 11. The trunk units 1–5, of one group, are disposed at the left of the test and terminal unit, and trunk units 6–10, of the other group, are disposed at the right thereof.

The trunk units are alike. Each may be made, for example, in accordance with the disclosure in the co-pending application Ser. No. 583,567. For the sake of convenience, a side view of a trunk unit is shown in Fig. 7. The figure may represent any one of the trunk units at the left of the terminal unit, for example, the trunk unit No. 5 as seen from the left along lines 7—7 in Fig. 1. Since all the trunk units are constructed alike, Fig. 7 is also representative of any one of the trunk units on the right of the test and terminal unit shown in Fig. 1, except that the parts shown in Fig. 7 must be visualized as being transposed by 180°.

A brief description of the trunk unit is included below solely for the purpose of identifying its principal parts to the extent required for understanding the present invention.

The trunk unit is mounted on the base 11, which is shown in Fig. 7 in section. The unit comprises a rectangular lower frame defined by the bottom portion 12, top portion 13 and side walls 14 and 15. Mounted in this frame are five mounting plates made of insulating material. Three of these plates are shown at 16, 17 and 18. Each of the plates is provided with six vertically superposed rows of ten holes each, or a total of sixty holes. The five mounting plates thus provide a total of 300 holes for the reception of the 300 line and test bars. The holes are tapered, as shown in Fig. 7 and, as will also be clear from other figures yet to be described, the taper in the mounting plates provided in each of the trunk units 1–5, inclusive, being directed with the large side of each opening pointing to the left and the taper in the trunk units 6–10, inclusive, being directed with the large side of each opening pointing to the right of the structure, as shown in Fig. 1. The 300 line and test bars are inserted through the successive tapered holes in the mounting plates. The bars are shown in Fig. 7 in cross-section.

On top of the lower rectangular frame of each trunk unit, which is defined by the bottom wall 12, top 13 and the side walls 14 and 15, are mounted upwardly projecting extensions 19 and 20, forming an upper frame. This upper frame carries a master or gate magnet 21 and sets of contacts indicated at 22. At the juncture between the legs or extensions 19 and 20 and the top 13 of the lower frame is provided a shelf-like member 23 which carries certain control parts and ten solenoids. The first in the row of these solenoids is indicated by numeral 24 and the last, by numeral 25. These solenoids constitute the tens selection means of the structure. Each solenoid is adapted to couple an associated tens actuator with an operating member controlled by the gate magnet 21.

At the front of each trunk unit are provided ten units selection solenoids in a vertical row, the units solenoid on top being indicated by the numeral 26 and the bottom solenoid being indicated by numeral 27. Each of these units solenoids is adapted to couple an associated units actuator with the units lifting rod 28. Two such units actuators are indicated at 29*a* and 29*b*. The units lifting rod 28 is also controlled by the gate magnet 21.

An intermediate trunk element made of a strip of conductive material having eleven resilient contact fingers is disposed below each of the thirty vertically superposed horizontally extending rows of line and test bars. As previously mentioned, the line and test bars are arranged in vertically extending subscribers' subgroups. The first subgroup contains the subscribers' lines Nos. 11—10, the second subgroup, in Fig. 7 at the left of the first, contains subscribers' lines Nos. 21—20, etc., until we come to the last vertically disposed subscribers' subgroup at the left of the structure containing subscribers' lines Nos. 01—00. A tens actuator is provided for each of these subgroups. The tens actuator is a rod or bar carrying thirty projections disposed under the corresponding resilient contact fingers below the associated line and test bars. Thus, the tens actuator 30 serves the first subscribers' subgroup containing lines Nos. 11—10; the actuator 31 serves the second subscribers' subgroup containing lines Nos. 21—20; the ninth tens actuator 32 serves the ninth subscribers' subgroup containing lines Nos. 91—90; and the tens actuator 33 serves the tenth subscribers' subgroup containing lines Nos. 01—00. The tens actuating rods extend upwardly and each is provided with a clutch mechanism, as described in the previously mentioned co-pending application. Each of these clutch mechanisms is in turn controlled by an associated tens selection solenoid such as 24—25. When one of these solenoids operates, it couples the corresponding tens actuator with a lifting pin projecting through the

armature 34 which is operated by the gate magnet 21. Each lifting pin is provided with a head holding it on top of the armature 34. Thus, the tens actuator rod 33 projects upwardly for coupling engagement with the lifting pin having the head 35 lying on top of the armature 34. The coupling is responsive to the actuation of the tens selection solenoid 24. The tens actuator rod 32 likewise projects upwardly into coupling engagement with a lifting pin having a head 36 lying on top of the armature 34. The coupling is responsive to the actuation of the tens selection solenoid disposed at the right of solenoid 24. All other tens actuator rods are arranged similarly. The tens actuator rod 30 projects upwardly for coupling engagement with a pin having a head 37 lying on armature 34, and the coupling is accomplished by operation of the tens selection solenoid 25.

It will be seen from the above description that any one of the tens actuators may be selected; that is, it may be coupled with its associated lifting pin by the operation of the corresponding tens selection solenoid. The coupled or selected tens actuator may be lifted by the operation of the armature 34 responsive to energization of the gate magnet 21; that is, the armature is displaced upwardly, lifting all the lifting pins such as 35, 36, 37 upwardly; but only that tens actuator is upwardly displaced which has been coupled to its associated lifting pin by the operation of the corresponding tens selection solenoid.

The armature 34 is provided with a slotted extension 40 which surrounds the units lifting rod 28, below a bead 41, as shown in Fig. 7. Accordingly, when the gate magnet 21 operates it also lifts the units actuator rod 28, and therewith that units actuator, such as 29*a*—29*b*, which has been coupled with the units lifting rod by the energization of its associated units selection solenoid such as indicated at 26—27.

It is believed that the above general description of the trunk or bank unit will be sufficient for an understanding of the mechanism. Details of the structure and operation of the trunk unit may be had from consulting the co-pending application Ser. No. 583,567.

The test unit is constructed generally just like the trunk unit, but is provided only with tens actuators which aid in the operation of the units selection as described in detail in the co-pending application.

In the prior structure the test unit is arranged at one end of the trunk units, that is to say, the trunk units 1–10, each of which is constructed like the unit shown in Fig. 7, or such number of trunk units as may be provided, are arranged side by side on the base 11 with the taper of the holes for the line and test bars pointing in one direction, and at the end of the mechanism is arranged the test unit. The prior structure is also equipped with a terminal plate for receiving the ends of the 300 line and test bars which extend serially through all the trunk units and through the test unit. Assuming, for example, that the test unit and the terminal means are provided in the prior structure at the right and adjacent to trunk unit No. 10, then the 300 line and test bars are pushed in place from the left serially through all the units into engagement with terminal prongs in the terminal plate which may be mounted with the test unit.

Any repairs or adjustment that may necessitate removal of a trunk unit requires, in such prior mechanism, withdrawal of the 300 line and test bars to such extent that these bars clear the trunk unit that has to be removed. The withdrawal of the line and test bars disengages the bars from their terminals and, therefore, withdraws the entire mechanism from service. No calls can be handled so long as the line and test bars are disengaged. While the servicing may take only a short time, the withdrawal from service of the entire switching mechanism, with all its trunks, is an inconvenience that may be seriously felt and may inconvenience some subscribers.

The present invention therefore provides the new test and terminal unit, as indicated in Fig. 1 and as shown more in detail in Figs. 2 and 3. This test and terminal unit is arranged intermediate or midway between the trunk units 5 and 6, or at any convenient intermediate point. The trunk units are thus disposed in groups and in the present instance, which is assumed for illustrative purposes, the first group comprises the trunk units 1–5 and the second group comprises the trunk units 6–10. All the units, however, operate as an integral switching mechanism, in this case as a finder switching mechanism. The number of trunk units on either side of the new test and terminal unit may be more or less than indicated. The number of trunks will be determined by service requirements in any given case.

The line and test bars are made in sections, one section for the group of trunk units Nos. 1–5, and another section for the group of trunk units Nos. 6–10.

The new structure may be explained particularly with reference to Figs. 2 and 3. Fig. 2 is a partial section taken through the trunk units 5 and 6, and also through the new test and terminal unit along lines 2—2 in Fig. 7.

Referring now to Figs. 1, 2 and 3, the trunk unit No. 5 comprises the lower rectangular frame, parts of which are shown in Figs. 2 and 3 at 12, 13 and 14. 12 is the bottom portion of the frame of trunk unit No. 5, 13 is its top portion, and 14 is its left side wall, identified by like numerals in Fig. 7. In this frame is mounted the insulating, mounting and supporting plate 16, also shown in Fig. 7. This mounting plate is provided with the tapering holes for supporting the line and test bars. The large side of the taper points to the left. Three bars are shown in Fig. 2, namely, sections of the bars 50—51—52, serving trunk units 1–5, on top of the ninth subscribers' sub-group containing the lines Nos. 91—90. Numerals 50 and 51 indicate the line bars, and 52 indicates the test bar of subscribers' line No. 91. Line No. 01, which is in the next or last subgroup at the left of line No. 91, as shown in Fig. 7, is represented by similar line bars 53—54 and by the test bar 55. The corresponding section of the line bar 53 is also shown in Fig. 3. The corresponding section of the line bar of line No. 81, at the right of line bar 50, is indicated by numeral 56. Similarly, numeral 57 indicates the section of the line bar of subscribers' line 71 in the group of trunk units Nos. 1–5.

The sections of the line bars 50, 51, 52 of subscribers' line No. 91, serving trunk units Nos. 1–5, extend serially from the left through all the trunk units Nos. 1–4 and also through trunk unit No. 5, as shown in Figs. 2 and 3. Each bar section is inserted into the mechanism, first, into its corresponding tapering hole in a mounting member such as 16 in the trunk unit No. 1, and then

successively through its corresponding tapering holes in the corresponding mounting members provided in the trunk units 2, 3 and 4, and, finally, into its tapering hole in the mounting member 16 in the trunk unit 5, as shown in Fig. 2.

Each of the trunk units 6–10 is constructed just like the trunk units 1–5. The line and test bar sections serving the trunk units 6–10 are inserted serially from the right through the trunk units 10–6, inclusive. The right section of line bar 50 is indicated in Figs. 2 and 3 by numeral 50*a*; the right section of line bar 51 is indicated by numeral 51*a*; and the right section of the test bar 52 is indicated by numeral 52*a*. Similarly, the right sections of line bars 53, 56 and 57, shown in Fig. 3, are indicated by the numerals 53*a*, 56*a* and 57*a*. The two sections of each of the 300 bars are in longitudinal alignment throughout the mechanism and are interconnected by certain coupling means in the test and terminal unit.

Referring now to Figs. 2, 3 and 8, the new test unit comprises two frames, one at the left and one at the right. Each frame may be a rectangular structure just like the lower rectangular frame of the trunk unit shown in Fig. 7. The left frame of the test and terminal unit shown in Fig. 2 or 3 comprises the side wall 60 and the top 61; the right frame, also appearing in Fig. 8, comprises the side walls 62 and 122, the bottom 123 and the top 63. Mounted in each of these frames are again insulating, mounting and supporting plates such as 64—65, Figs. 2 and 3, each of which may be similar to the mounting plate 16 shown in Figs. 2, 3 and 7. The top plate 65 in the rectangular frame at the right in Figs. 2 and 3 is also shown in Fig. 8. The mounting plate 64 in the left frame is provided with tapered holes and inserted into each of these tapered holes is a connector member comprising a flat strip 66 carrying prongs 68—69, the strip projecting to the right of the mounting plate 64. This strip is provided with an angularly extending projection or ear 67 which catches on one side of the mounting plate 64, holding it in place. The inner end of the left section of the line bar 50 is gripped between the prongs 68 and 69, and is thus conductively extended into the test unit by way of the strip 66 which is longitudinally aligned therewith. The left section of line bar 51 of subscribers' line No. 91 is similarly extended into the test and terminal unit by means of the conductive strip 72 having the prongs 70 and 71 and the ear 73 which holds it in place. The left section of the test bar 52 of line No. 91 is likewise extended into the test and terminal unit by means of the strip 76 having the prongs 74 and 75 and the ear 77 which holds it in place. Each and every one of the remaining left sections of the line and test bars serving the trunk units Nos. 1–5 is similarly extended into the test and terminal unit shown in Figs. 1–3.

At the right of the test and terminal unit is provided the frame having the side walls 62, 122 and the top and bottom sections 63, 123. Mounted in this frame (see also Fig. 8) are again insulating, mounting and supporting plates such as 65, 125 and 126, corresponding to the plates 16, 17 and 18 shown in Fig. 7. There are five such mounting and supporting plates, and each is provided with 60 connectors each having a pair of oppositely disposed prongs, totalling 300 connectors for interconnecting the 300 sections of the line and test bars serving the group of trunk

units Nos. 6–10 with the 300 sections of the corresponding bars serving the group of trunk units Nos. 1–5. A single terminal plate may be provided for supporting all the 300 connectors. The connector shown in Fig. 2 in the mounting plate 65 on top thereof carries on the left the prongs 80—81 and on the right the prongs 82—83. The prongs 80—81 are engaged by the strip 66 which represents within the test unit the line bar 51, and the prongs 82—83 engage the right section 50*a* of the line bar serving the second group of trunk units Nos. 6–10. Similar connectors or coupling means are provided for the line bar sections 51—51*a*, also for the test bar sections 52—52*a*, and for each of the remaining line and test bar sections in the structure.

Numeral 33 in Figs. 2 and 3 indicates the tens actuator bar for the subscribers' subgroup containing lines Nos. 01—00 which is indicated by like reference numeral in Fig. 7. Numerals 85, 86, 87, in Fig. 2, indicate three projections on the tens actuator bar 32 (see Fig. 7) which serves the subscribers' sub-group containing the lines Nos. 91—90. The projection 85 of the tens actuator 32 engages the resilient contact finger 89 of the intermediate trunk element provided just underneath the horizontal top row of line bars, as shown in Fig. 7; the projection 86 is provided for operating the resilient contact finger 90 of the intermediate trunk element disposed underneath the second horizontal row of line bars; and the projection 87 on the tens actuator rod 32 operates the resilient contact finger 91 which is part of the intermediate trunk element just underneath the horizontal row third from the top of Fig. 7 of the test conductors, which includes the test conductors 55 and 52.

The test unit is provided with tens actuators just like the tens actuators 30, 31, 32, 33 shown in Fig. 7. These tens actuators operate contact fingers disposed in each switching level just underneath the corresponding test bars. Thus, the tens actuator provided with the projection 95 in Fig. 2 actuates the resilient contact finger 96 provided underneath the strip 76 which constitutes the test bar within the test unit. Projections 93 and 94 of the tens actuator have no function in the test unit. Similar tens actuators are provided in each vertically extending subgroup of line and test conductors in a test unit, as indicated in Fig. 3 at 92, 99, 100. The actuator bar 101 in the trunk unit No. 6, in Figs. 2 and 3, is the tens actuator bar corresponding to bar 33 in trunk unit 5. Similarly, tens actuator bar 102 in trunk unit 6 corresponds to tens actuator bar 32 in trunk unit 5. The tens actuator bar 102 in trunk unit 6 carries the projections 103, 104, 105 for actuating the resilient contact fingers 106, 107, 108, respectively, into engagement with the right sections of the line and test conductors 50*a*, 51*a*, 52*a*, serving the trunk unit No. 6 as well as the trunk units Nos. 7–10, inclusive.

Numeral 129 in Fig. 8 indicates the gate magnet provided in the test unit for operating the tens actuators such as the actuators 92, 97, 99 and 100 shown in Figs. 2 and 3. This gate magnet is mounted between the extensions 127—128 which project from the lower rectangular frame indicated in Figs. 2 and 3 by numerals 60—61. The remaining equipment in the test unit includes tens selection solenoids corresponding to the solenoids 24—25 shown in Fig. 7.

The circuit conductors required in the system are wired to the line and test bars, either in accordance with the scheme shown in Figs. 2 and

3 or in accordance with the scheme shown in Fig. 8.

As shown in Figs. 2 and 3, numeral 110 (130 in Fig. 8) is a common cable containing the circuit conductors which are to be connected to the various line and test bars. The cable may be provided in the rear of the test and terminal unit adjacent to the frame wall 62, as shown. Bundles of conductors branch off laterally from the cable 110, as indicated in Figs. 2 and 3 at 111—112—113. The branch 111 is carried on top and across the top row of the connector or coupling means for the corresponding line bars; the branch 112 radiates from the common cable 110 similarly, just underneath the top row of line bars carrying the circuit conductors for line bars such as bars 51 and 51*a*; the third branch from the top, numbered 113, radiates from the common cable, carrying the circuit conductors for the test bars such as bars 52—52*a* in the topmost switching level of the structure. Similar branches radiate from the common cable to the line and test bars in the downwardly successive switching levels.

The wiring scheme shown in Fig. 8 comprises the cable 130, (corresponding to the cable 110 in Fig. 3) carrying all the circuit conductors for the line and test bars in the various subscribers' subgroups. The scheme distinguishes from the wiring explained in connection with Figs. 2 and 3 by carrying the wires from the cable 130 to the line and test bars in accordance with the subgroups of subscribers' lines instead of in accordance with the switching levels of the structure. Thus, a branch 131 radiates from the cable 130, carrying all the circuit conductors for the first subgroup of subscribers' lines containing the lines Nos. 11—10, inclusive. Branch 132 carries the conductors for the second subgroup of lines containing Nos. 21—20; similar branches radiate from the cable to the line and test bars of the remaining subgroups of lines. The branch 133 radiates from the cable 130 to the terminals provided for the last subgroup of lines containing lines Nos. 01—00. Each circuit conductor is connected with its corresponding line or test bars through the medium of a suitable soldering tab extending from the corresponding connector or coupling means, as shown in Figs. 2 and 3.

Fig. 4 shows a switching mechanism comprising a group of trunk units 1–5 arranged on the left of a terminal unit and a group of trunk units 6–10 arranged on the right thereof. Each of the trunk units may again be of the general type shown in Fig. 7. The various trunk units and the terminal unit are mounted on the base 11*a* which corresponds to the base 11 of the previously discussed structure. This switching mechanism may not require a test unit such as described in connection with Figs. 1, 2 and 3 and may serve, for example, as a connector or selector.

The terminal unit may comprise a simple rectangular frame defined by side and top walls, as discussed in connection with the previously described frames, the top wall being shown in Fig. 5 at 135, one of the side walls at 136, and the bottom at 137. Provided in this frame are again a number of supporting and mounting plates, one such plate being indicated in Figs. 5 and 6 at 138. This plate may correspond to plate 65 in Figs. 2, 3 and 8. The plate carries 60 terminal members, all constructed alike and being similar to the terminal members shown in Figs. 2 and 3. There are five such plates carrying a total of 300 terminal members. A single insulating plate carrying the 300 terminal members may be provided in place of the five sectional mounting plates. The topmost terminal member in Fig. 5 comprises a strip 140 having a pair of prongs 141—142 at the left and a pair of prongs 143—144 at the right end. The terminal members are thus similar to those discussed in connection with the previous embodiment. They may be attached and assembled with the mounting and supporting plate 138, as previously discussed, or they may be molded integrally with the plate; that is, the plate may be molded around these terminal members in a suitable jig. The terminal member 140 serves as a means for interconnecting the line bar sections 145 and 145*a* serving the left and right groups of trunk units, respectively. Similar terminal members connect the line bar sections 146—146*a* and also the test bar sections 147—147*a*. Bar sections 145, 146, 147 correspond to bar sections 50, 51, 52, and sections 145*a*, 146*a*, 147*a* correspond to sections 50*a*, 51*a*, 52*a* in the previous embodiment. All the remaining line and test bar sections in the structure Figs. 5 and 6 are interconnected in longitudinal alignment just like the sections 145 and 145*a*.

The circuit conductors may be connected to the various line and test bars, either in accordance with the scheme indicated in Figs. 2 and 3, also shown in Figs. 5 and 6, or in accordance with the scheme shown in Fig. 8. Numeral 150 in Figs. 5 and 6 is the cable containing the circuit conductors for the line and test bars, and numerals 151, 152, 153 are branches radiating from the cable to the line and test bars in the various switching levels.

Changes may be made within the scope and spirit of the appended claims.

We claim:

1. In a telephone system of the crossbar type, switching apparatus comprising a terminal device, a plurality of sets of connector means carried by said terminal device, conductors representing an incoming line terminating in each set of connector means, a plurality of switching units each having access to an outgoing line arranged on either side of said terminal device, and a plurality of sets of conductor bars individual to each group of switching units, said sets of conductor bars extending through all the switching units of the associated group into removable connection with corresponding sets of connector means in said terminal devices, whereby each set of conductors representing a line may be connected with a trunk line through the medium of any one of said switching units in either group independently of the switching units in the other group.

2. In a telephone system of the crossbar type, switching apparatus comprising a terminal device, sets of connecting means in said terminal device each comprising a plurality of connectors, sets of incoming line conductors each comprising a plurality of conductors associated with each set of terminal connectors and respectively terminating therein, a group of switching devices each comprising a plurality of individual switching units disposed on either side of said terminal device, and sets of conductor bars individual to each group of switching units and extending therethrough for removable engagement with corresponding sets of said terminal connectors.

3. In a telephone system of the crossbar type, switching apparatus comprising a terminal de-

vice, sets of connecting means in said terminal device each comprising a plurality of connectors, sets of incoming line conductors each comprising a plurality of conductors associated with each set of terminal connectors and respectively terminating therein, a group of switching devices each comprising a plurality of individual switching units disposed on either side of said terminal device, and sets of conductor bars individual to each group of switching units and extending therethrough for removable engagement with corresponding sets of said terminal connectors whereby said sets of incoming line conductors may be extended by way of each switching unit on each side of said terminal device, and whereby the switching units of each group may be withdrawn from service independently of the switching units of the other group by removal of the conductor bars associated therewith.

4. In a telephone switching apparatus of the crossbar type, a terminal device comprising two spaced terminal panels extending in parallel relationship, a plurality of similarly positioned sets of connector means carried by each panel, means for removably interconnecting the connector means of each set carried by one panel with the connector means of a correspondingly positioned set carried by the other panel, conductors representing an incoming line terminating in each interconnected set of connector means, a plurality of switching units each having access to an outgoing line arranged on either side of said terminal device and extending in a group side by side from the corresponding terminal panel thereof, and a plurality of sets of bare conductor bars individual to each group of switching units, said sets of conductor bars extending through all the switching units of the associated group into removable connection with corresponding sets of connector means in the corresponding terminal plate of said terminal device, whereby each set of conductors representing an incoming line may be connected with an outgoing line

through the medium of any one of said switching units in either group independently of the switching units in the other group.

5. In a telephone system of the crossbar type, switching apparatus comprising a terminal device, sets of connector means carried by said terminal device and extending from each side thereof, conductors representing an incoming line terminating in each set of connector means, a first group of switching units including a plurality of identical units disposed side by side on one side of said terminal device, a second group of switching units including a plurality of identical units disposed side by side on the other side of said terminal device, each switching unit having access to an outgoing line, and a plurality of sets of conductor bars individual to each group of switching units, the sets of conductor bars of each group of switching units being identically arranged and extending through all the switching units of the associated group into removable connection with corresponding sets of connector means extending from the corresponding side of said terminal device, whereby each incoming line may be connected with an outgoing line through the medium of any one of said switching units in either group independently of the switching units in the other group.

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