

S. H. BROWNE,
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED DEC. 19, 1904.

1,125,954.

Patented Jan. 26, 1915.

5 SHEETS—SHEET 1.

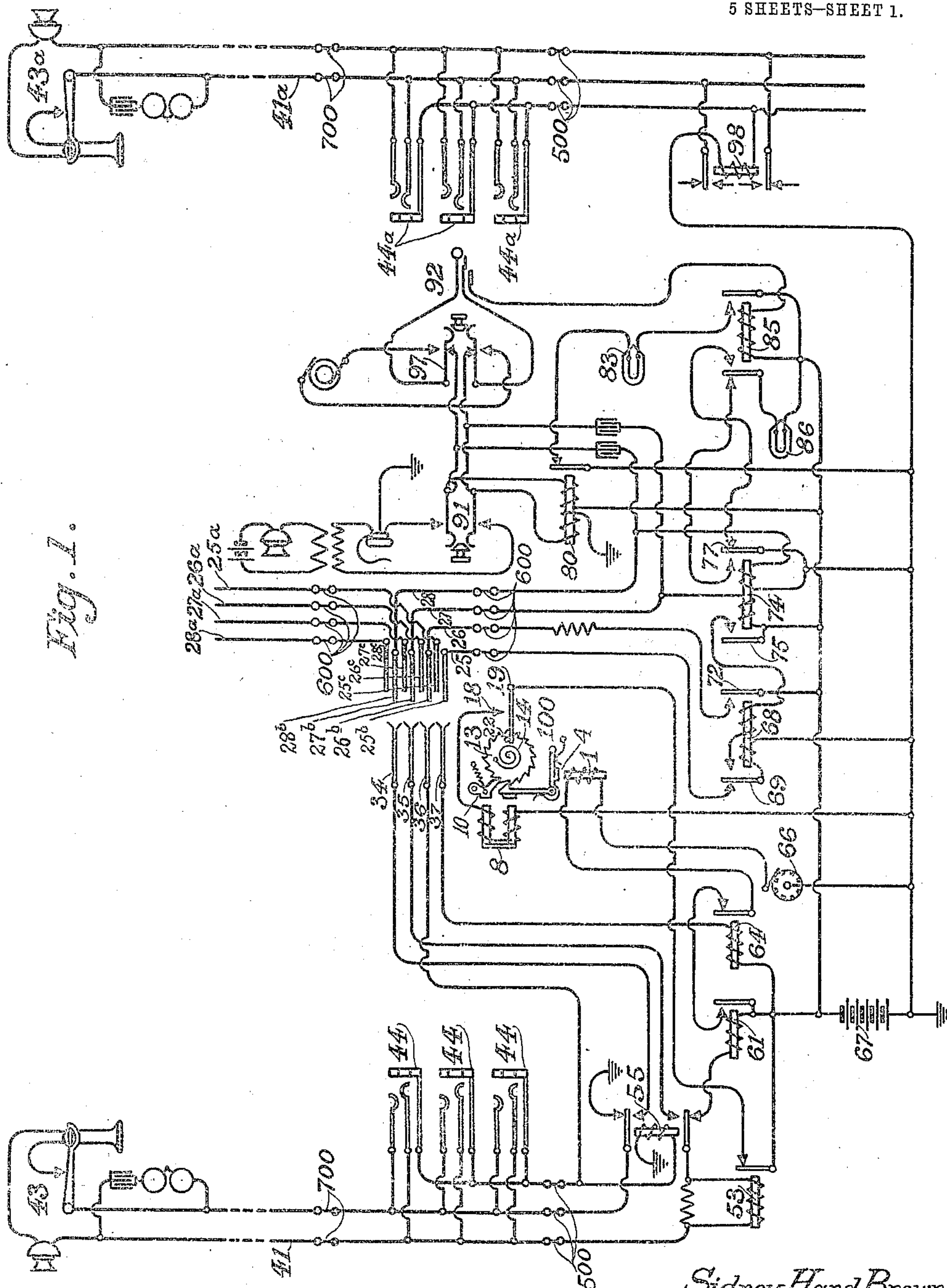


Fig. 1.

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David S. Hulfish

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5 SHEETS—SHEET 2.



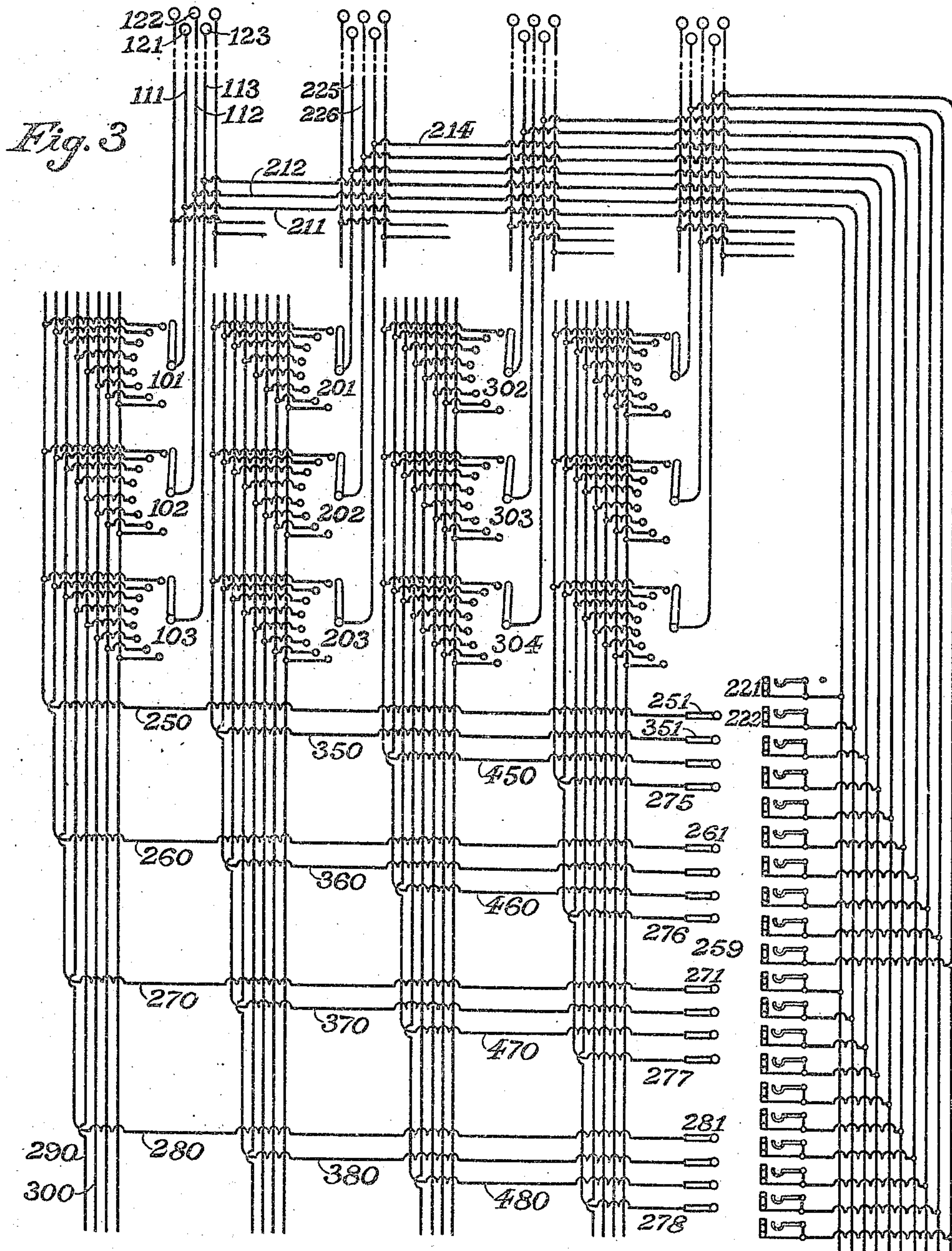
by Kempster B. Miller,
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5 SHEETS—SHEET 4.

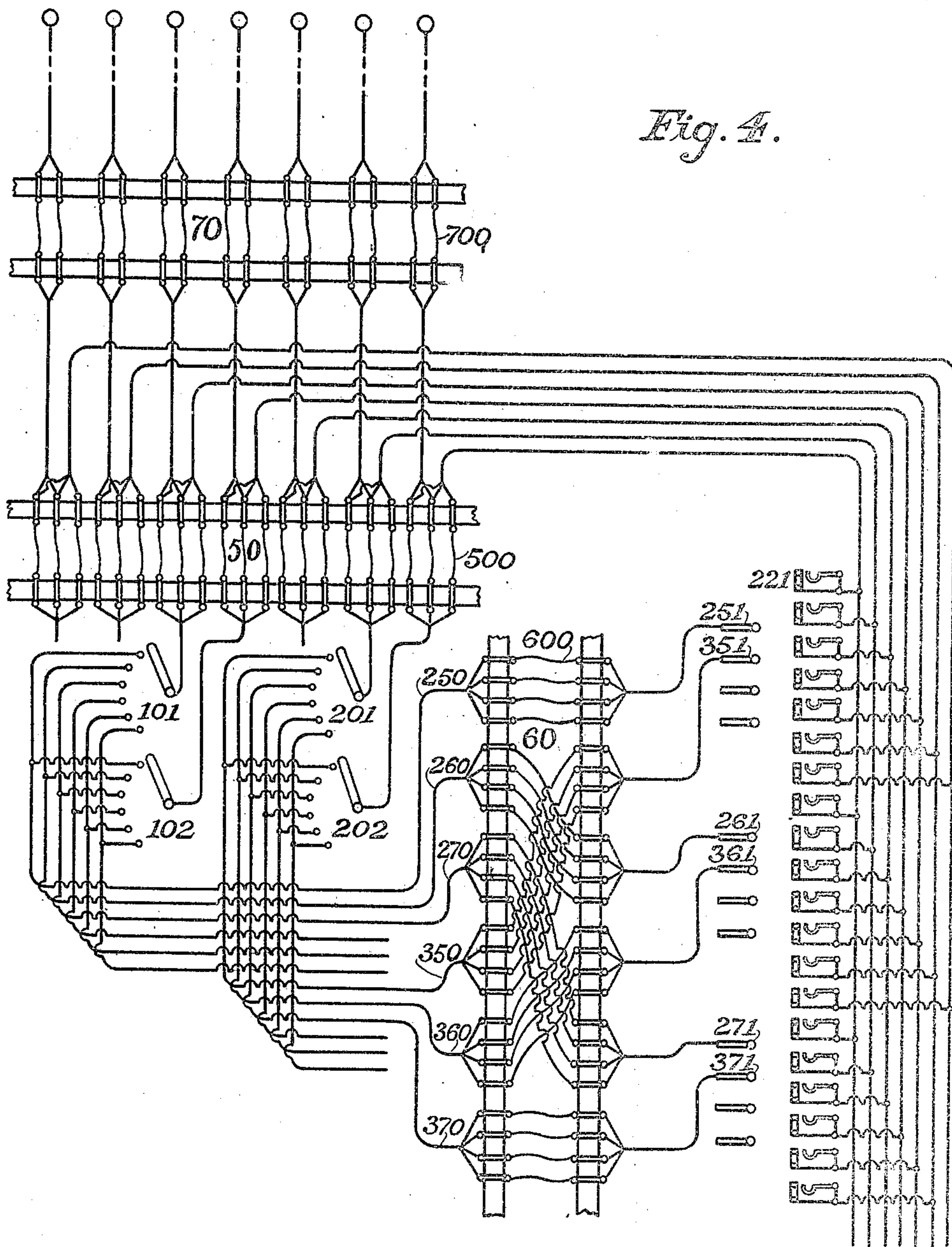


Fig. 4.

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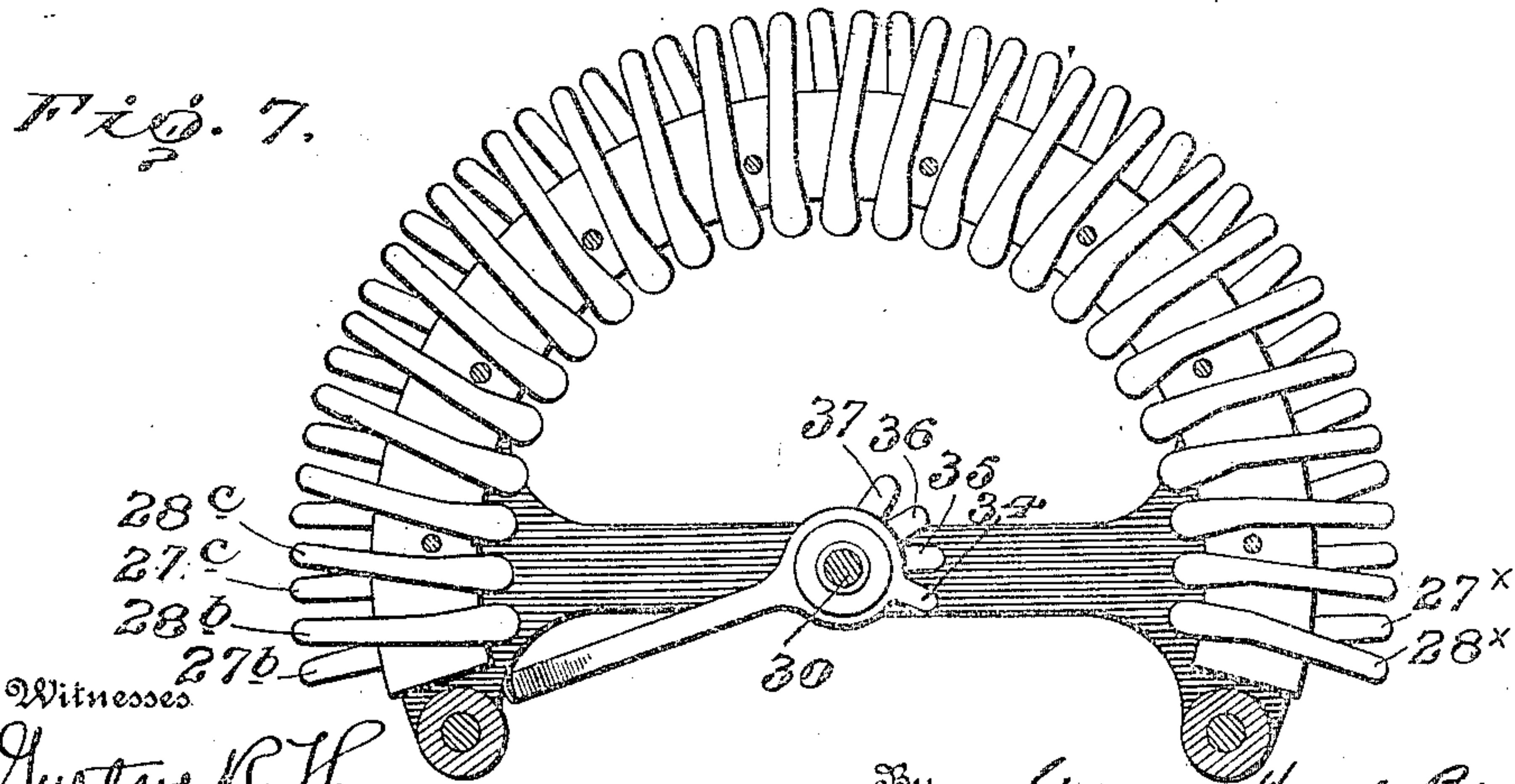
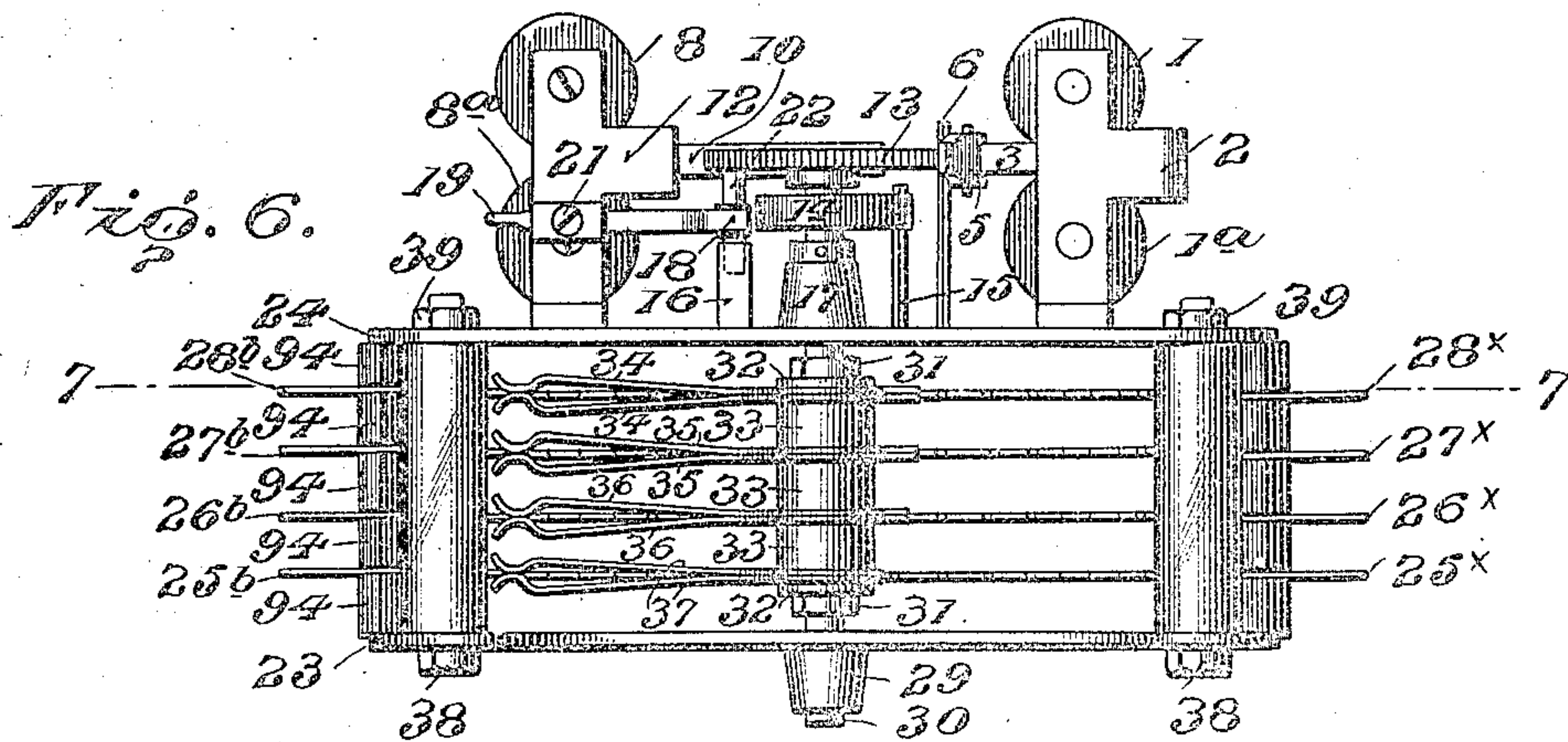
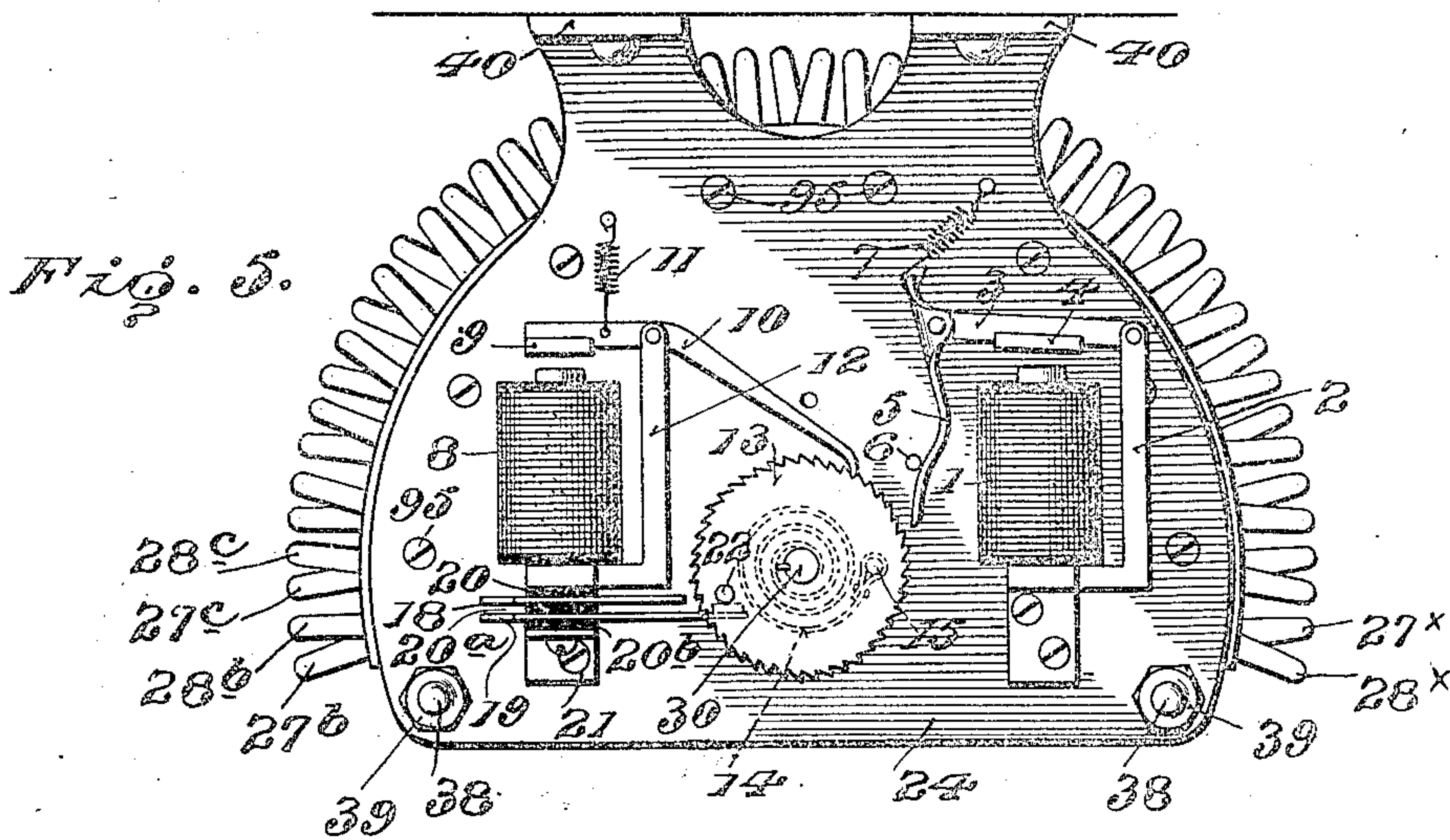
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5 SHEETS—SHEET 5.



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

1,125,954.

Specification of Letters Patent.

Patented Jan. 26, 1915.

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To all whom it may concern:

Be it known that I, SIDNEY HAND BROWNE, a citizen of the United States of America, and resident of Pittsburgh, county of Allegheny, and State of Pennsylvania, have invented a new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to improvements in telephone exchange systems, and has for its object the quickening of telephone service and a lowering of the cost thereof by decreasing the number of operators, or the number of hours of their work, or both.

The invention relates more particularly to an improved system of receiving and distributing incoming calls whereby such calls are grouped upon receipt and forwarded to the attendant telephone operators in such manner as to be most advantageously and economically handled by the operators.

In telephone exchanges of the most general use, which therefore may be termed of the most modern accepted type, a line signal is associated at the central station with each telephone line, for the purpose of indicating the calls coming in over such line from the substation or substations thereof; so that whenever a substation of any particular line transmits a call, the particular line signal device associated therewith is operated to attract the attention of the operator, and to notify her that her services are desired. In large offices, or in offices sufficiently large to employ two or more operators during the busy hours, these line signals, being in number one for each line entering the exchange, are distributed among the different parts or divisions of the switchboard, and are thereby made visible or accessible to a number of operators who likewise are distributed among the different parts or divisions of the switchboard. The distribution therefore becomes such that certain line signals are said to belong to a certain operator's position, and all calls originating upon the lines connected with those line signals are received upon that operator's position of the switchboard and require to be answered from that position. As different lines will show differing amounts of business during the day, an inequality of the distribution of

work among operators will naturally result, and this inequality will result from two variations: first, the differing amounts of business or number of calls from one line or group of lines as compared with other lines or groups of lines, and, second, the differing amounts of business or number of calls from any line or group of lines during one period of time as compared with the business or number of calls received from the same line or group of lines during an equal period of time at some other hour of the day or night. The duties of an operator sitting before a group of line signals therefore vary considerably, and these variations have been contended with separately in the prior and present state of the art.

To overcome the unequal distribution of labor among operators by reason of one position having a large number of busy lines while another position has a small number of comparatively idle lines, the intermediate distributing frame has been invented and used generally, by means of which it is possible to change any line on the switchboard to the service of any operator on the switchboard, and thus to give to each operator her due proportion of the busy lines and also her due proportion of the idle lines, that all operators may have equal duties; or to give to one operator a small number of very busy lines and to another a comparatively large number of comparatively idle lines, thus equalizing their duties; and also when opportune to distribute the entire duties of the exchange upon a smaller number of operators, thus reducing the operating force and working economy in operating. But in all of these distributions by means of the intermediate distributing frame the load of the busiest hour must be considered and provided for that no operator may be overburdened at that time to the detriment of the service given to any particular call. This distribution by means of the intermediate distributing frame therefore utilizes 100 per cent. of an operator's ability during the hours of heavy traffic of the day, but necessarily entails occupying her during the remaining hours of her daily service with less labor than she could handle efficiently and economically.

To overcome the unequal distribution of the calls throughout the day and night, it is the common practice to provide uniform equipment throughout the switchboard for all lines and for all operators, and to place the operators' positions near each other so that the tools with which any operator works may be used to answer calls upon the position on either side of her as well as upon her own. This permits relieving one-half of the operators when the traffic falls below 50 per cent. of each operator's capacity, and permits relieving two-thirds of the operators when the traffic falls below 33 1/3 per cent. of each operator's capacity, but beyond this limit the plan is ineffectual, as with the present practice in telephone switchboards an operator sitting at her position cannot reach more than three positions including her own. Even with this arrangement of economy in number of operators working, the loss in operating efficiency is large during such hours as will give to each operator duties between 50 and 100 per cent. of her capacity or between 33 1/3 and 50 per cent., or less than 33 1/3 per cent.

At night, in a large exchange, when the operating load falls to less than one per cent. of the heaviest day load, one operator should handle 100 operators' positions; but this is rendered difficult by the fact that the calls still continue to come in upon line signals distributed all over the extent of the switchboard and the operator necessarily would have to walk to each line signal to answer that call. The loss of time to the operator and the delay to each call may be so great as to justify the employment of two or even more operators for a task which lies well within the capacity of one operator, could the calls be efficiently and economically brought to her. It is with this double problem of the distribution of operating load upon operators that my invention deals. It is the theory of my invention to receive all calls upon automatic apparatus or switches connected permanently with the lines and grouped in one group or in two or more closely related groups; to forward from these automatic apparatus or switches to the first operator on duty as many calls as she can handle efficiently; if a surplus of calls over the first operator's capacity exists, then to forward to the second operator on duty as many calls as she can handle efficiently; and thus to continue with successive operators, sending all calls received promptly and directly to the switchboard, and sending each call received to a line signal located before a waiting operator, whether the traffic of the exchange at that moment be occupying the efforts of only one operator or of a very large number of operators.

In Patent No. 1,073,589 issued September 23, 1913, upon my prior application, No.

222,645, filed August 29, 1904, I have shown details of circuit and apparatus for the construction of trunks such as are suitable for utilization in the system of my present invention, which latter deals more particularly with the arrangement of the trunks among themselves, with the arrangement of the trunk terminals upon the switchboard, and with the arrangement of the trunk terminals at the automatic switches which belong to the telephone lines.

My said prior application, as filed, contained in its description a disclosure of the subject-matter of many of the claims herein.

In the drawings—

Figure 1 shows diagrammatically the circuits and apparatus of a trunk such as described and illustrated in my application above mentioned. Fig. 2 shows the method of distribution of calling elements in an office requiring but one set of automatic switches with one group of trunks, there being shown only a limited number of telephone lines and associated trunking elements. Fig. 3 shows the method of distribution of calling elements in an office too large to handle all business over one group of trunks. Both Fig. 2 and Fig. 3 show the elements in ultimate simplicity. Fig. 4 shows the method of distribution of calling elements in an office with distributing frames lending convenience and flexibility to the system. Fig. 5 is a plan view, Fig. 6, an elevation, and Fig. 7 a horizontal section, on line 7—7 of Fig. 6, of an automatic switch suitable for connection with each telephone line.

Fig. 1 shows two telephone lines, 41 and 41^a, with their substation telephones 43 and 43^a, and their connected multiple jacks, 44—44 and 44^a—44^a. Each line is assumed to be equipped fully with an automatic call-distributing device, which is indicated only at 98 for line 41^a, but is shown in full diagrammatically for line 41. 100 is an automatic switch, consisting of fixed and rotary parts carrying fixed and rotary contact points, respectively. It is the duty of the automatic switch to move the set of rotary contacts over the fixed contacts, successively, until a suitable set of fixed contacts is found; then to permit the rotary contacts to remain upon that set of fixed contacts until disconnection is desired. Because of this action of the rotary contacts moving forward to select specific fixed contacts, the rotary contacts are hereafter designated selecting contacts, or wipers, and the fixed contacts, waiting for the selecting contacts to approach them, are hereafter called waiting contacts. The rotary contacts are one set of four, shown in Fig. 1 at 34, 35, 36 and 37. The waiting contacts are in many sets of four each, one set 28^b, 27^b, 26^b, 25^b being shown near the selecting

contacts and connected to conductors 28, 27, 26 and 25 respectively, and another set 28^c, 27^c, 26^c, 25^c being shown slightly farther away from the selecting contacts and connected to conductors 28^a, 27^a, 26^a and 25^a respectively; these two sets of waiting contacts are typical of the many sets of such contacts carried by the automatic switch 100, the equipment of each set being complete as shown here for set 28^b, 27^b, 26^b and 25^b. The magnet 1 with its armature 4 and ratchet wheel 13 is designed to propel said rotary part of said automatic switch, and thereby to propel said selecting contacts which stand normally disconnected from any waiting contacts. Upon the first energization of magnet 1, said selecting contacts are propelled into contact with set 28^b, 27^b, 26^b, 25^b of the waiting contacts; then at the next energization of magnet 1 from the preceding set and into contact with set 28^c, 27^c, 26^c and 25^c, etc. Magnet 8 is designed to release the rotary part of said switch, whereupon, by the action of the spiral spring 14 shown connected with ratchet wheel 13, the entire rotary part of the automatic switch is returned to its position of rest and the selecting wipers thus disconnected from any waiting contacts.

A suitable automatic switch, such as that referred to above, is illustrated more in detail in Figs. 5, 6 and 7. The plates 23 and 24, having the lugs 40, 40 formed from them for convenience in mounting the switch, are clamped together by the bolts 38 and the nuts 39. Contact pieces 25^b, 26^b, 27^b, 28^b constituting one group, 25^c, 26^c, 27^c, 28^c another group, 25^a, 26^a, 27^a and 28^a another group, and so on,—are arranged in four horizontal circular arcs between the plates 23 and 24; in the form of switch which I have here shown, there are twenty-five contact pieces in each arc, and each piece is brought out at the periphery of the circular portion of the switch so that a wire may be attached to it. Between each row of contact pieces and the neighboring row, between the upper row and the top plate 24, and between the lower row and the bottom plate 23, insulating material 94, such as hard rubber or fiber, is clamped by the bolts 38, and the screws 95. This serves the double purpose of insulating the contact pieces from each other and from the framework, and holding all of them securely in position.

Plates 23 and 24 have thereon bearing studs 17 and 29 respectively, which guide and support the vertical shaft 30 carrying at its upper end the ratchet wheel 13, adapted to be held in or returned to normal position by the action of the spiral spring 14, attached to the shaft 30 at one end, and to the pin 15 at its other end. The pin 15 is carried by the top plate 24. When the ratchet wheel 13 is in its normal position the

pin 22 engages the post 16, and also engages the contact spring 19, bending the latter out of engagement with the contact piece 18. The spring 19 carries on its end an insulation to prevent electrical contact with the pin 22. Spring 19 and the piece 18 are separated from electrical contact with each other and with the conducting part of the switch structure, by the insulating pieces 20, 20^a and 20^b, of rubber or other suitable material; they are bound to place by a screw 21, bushed from contact with the spring and contact piece in a familiar manner, and entering the bracket 12. The bracket 12 serves the double purpose of supporting the magnet coils 8 and 8^a, and of forming a part of the magnetic circuit of those coils. A retaining pawl 10 for the ratchet wheel 13 is pivoted to the bracket. Helical spring 11 holds the pawl 10 in engagement with a tooth of the ratchet wheel 13, except when the cores of the coils 8 and 8^a are sufficiently energized to attract the iron armature 9.

The magnet formed of the coils 1 and 1^a is of very similar construction, having the bracket 2, the iron armature 4, the lever 3—the latter in this instance carrying a ratchet 5—and a helical retractile spring 7 which tends not only normally to hold the arm and armature 3 and 4 respectively, away from the cores of the coils 1 and 1^a, but to keep the free end of the arm 5 in engagement with the post 6 carried by the top plate 24. Unless the coils are energized, the free tip of the arm 5 will be out of engagement with the teeth of the ratchet wheel 13; but if the coils are energized, attracting the armature 4, the motion of the arm 5 will enable it, while still sliding in contact with the post 6, to engage a tooth of the ratchet wheel 13 and advance the wheel one step, the wheel being held in its advanced position by pawl 10. When the cores 1 and 1^a are deenergized, the tip of the arm 5 will again pass out of engagement with the ratchet wheel 13; hence successive impulses of current will advance the ratchet wheel step by step, carrying with it the shaft 30. The relation between the teeth of the ratchet wheel and the successive contact pieces 25, 25^b, 25^c, etc., in one row and similar contact pieces in the other three rows, is such that for each advance of the ratchet wheel one step, the contact wipers corresponding to each row will be moved from one contact into engagement with the next succeeding contact. The contact wipers 34 to 37 inclusive, are in pairs, the two members of each pair being in electrical contact, but each pair being insulated from the shaft and other conducting parts of the structure by insulating bushings 32, 33, adapted not only to bind and to space the contact wipers, but also to center them in a well-known manner. The ends of the

contact wipers which do not engage the contact pieces, are adapted to receive flexible conductors making continual connection with the contact wipers during a movement through the whole arc.

In their normal position, the contact wipers are out of engagement with the contact pieces, as heretofore stated; the first step of the ratchet wheel 13 causes the wipers to make contact respectively with the first group of contact pieces, and so on. Energization of the magnet coils 8 and 8^a at any time, will release the ratchet wheel 13, unless the magnet coils 1 and 1^a are also energized. Upon such release of wheel 13, the contact wipers return to normal position, out of engagement with any contact pieces, and the contact between the spring 19 and the contact piece 18, which remains established so long as the wipers are out of their normal position, is broken.

The operation of the circuit and devices shown in Fig. 1 is briefly as follows: Assuming that a subscriber at substation telephone 43 desires to make a call, he takes his telephone from the hook, closing the circuit through the substation telephone, thus by current from battery 67 energizing relays 61 and 53. Armature and contact of relay 61 now permit current from battery 67 to flow through armature and contact of relay 64 and thence through magnet 1 and interrupter 66, thus energizing magnet 1 and stepping the set of selecting contacts into connection with the first set of waiting contacts, 28^b, 27^b, 26^b, 25^b; current from battery 67 through relay 64, energizes relay 64, opens the circuit previously existing through magnet 1 and also energizes relay 68; armature 72 of relay 68 gives current from battery 67 through wiper 36 and relay 55, energizing relay 55, which then by its armatures and contacts interrupts the current through relay 61 and connects the two limbs of the line 41 to the conductors leading to wipers 35 and 34 which now are connected through the waiting contacts to conductors 27 and 28 which in turn are connected through the windings of relay 74 to the two poles of the battery 67; current therefore flows from battery 67 through the relay 74 to the substation telephone 43, and return, and relay 75 is energized; armature 75 of relay 74 closes path for current from battery 67 through winding, contact and armature 69 of relay 68, holding relay 68 energized and leaving open the circuit from battery 67 through relay 64 which originally energized relay 68. Armature 77 of relay 74 now gives current to lamp 86, located adjacent to plug 92 and before a telephone operator. Responding to the call indicated by the lamp 86, the operator listens upon the trunk 28—27 by the use of her key 91, takes the subscriber's order, lifts plug 92,

tests the multiple jack of the line called for, inserts the plug 92 into a jack of the line called for, as jack 44^a, and rings with her ringing key 97. By the insertion of the plug 92, relays 85 and 98 have been energized; relay 98 has by attracting its armatures cut off from the called line all its automatic calling equipment (not shown); and relay 85 has extinguished lamp 86 and lighted lamp 83. By the answering of the called subscriber, relay 80 is energized and lamp 83 is extinguished, indicating to the operator that the called party is at his telephone.

When the called station replaces its receiver upon the switch-hook, relay 80 is released and lamp 83 is lighted to indicate a disconnect signal; on similar action at the calling station, relay 74 is released and lamp 86 is lighted, also to serve as a disconnect signal; both lamps thus giving signals to the operator for withdrawal of the trunk-switch plug. Moreover, when the receiver at the calling station 43 is thus replaced, relay 53 also is released, and its armature and contact give path for current from battery 67, through contact of 19 and 18 and magnet 8; relay 53 has been energized continuously from the closure of the substation telephone circuit, and contact 19—18 is an off-normal contact pair which was closed by the first motion of the rotary part of automatic switch 100; the circuit now closed by the replacement of the telephone receiver energizes magnet 8 and releases the rotary part of the automatic switch 100; the spiral spring 14 shown on ratchet wheel 13 (Fig. 1) restores the rotary part of the switch to normal, opening contact 19—18 and releasing magnet 8. All parts are now in their original condition of rest, and are ready for another call. However, if the trunk connected to the first set of waiting contacts 28^b, 27^b, 26^b, 25^b had been in use by another subscriber, relay 68 would have been found energized, and current would not have passed from battery 67 through relay 64, wiper 37, waiting contact 25^b, conductor 25, and contact and armature 69 back to battery; then rotary interrupter 66 would have continually released and energized magnet 1 until in the progress of the rotary part of the switch the selecting contacts had come into contact with a non-busy set of waiting contacts, as until such time circuit through relay 64 could not be completed and magnet 1 could not be permanently released. When such non-busy trunk was encountered relay 64 would be energized and magnet 1 would be permanently released; therefore the motion of the rotary part of the automatic switch must progress until the first non-busy trunk is encountered, and must be arrested there, connecting the calling line to that trunk, and lighting the calling signal

before the operator handling the calls for that trunk.

Thus it will be understood that the mechanism explained above, when connected to a telephone line and a group of trunks, will remain inactive when said telephone line is not active in a call originated by itself; will immediately select the first idle trunk from said group of trunks when said telephone line originates a call, connecting the telephone line to that trunk and setting the calling signal for the operator handling the traffic of that trunk; and further will disconnect immediately upon the replacement of the receiver upon that line, releasing the trunk from that line.

In Fig. 2 is shown diagrammatically the arrangement of a complete exchange for seven telephone lines, six trunks and three operators, the number of each unit being made small to simplify the drawing; to simplify the drawing further, only the essential features of the apparatus are shown, and only one line is used to indicate the complete circuits of the element, although it is understood that the telephone lines may be metallic circuits, the plugs and multiple jacks may have three conductors, and the trunks may have four conductors, all as shown in Fig. 1. The apparatus of the trunk also is included in the simple line shown. Automatic switches are represented at 101, 102, 103, 104, etc., connected telephone lines are represented by 111, 112, 113, 114, etc., and connected substation telephones are represented by 121, 122, 123, 124, etc. The set of selecting contacts is represented by 131, 132, etc., and the sets of waiting contacts by 151, 161, 171, 152, 162, 172, etc. Branch conductors 211, 212, 213, etc. extend from the telephone lines, from a point within the central office to the multiple jacks of the switchboard which is designated as a whole 259. Trunks 250, 260, 270, etc., connect the automatic switches with the switchboard, terminating in plugs at the switchboard end and terminating at the other end in the waiting contacts of the automatic switches, each trunk being multiplied through corresponding contacts of all the switches. The switchboard is divided also into three divisions, assumed to be adapted to be occupied by three operators, and designated 267, 268, and 269.

The operation of the system is as follows: The first call, say from substation telephone 123, operates automatic switch 103, moving selecting contacts 133 into connection with waiting contacts 153, and trunk 250 thus is selected, switching the call to plug 251, upon operator 267. Before disconnection of this call, another call, say from substation telephone 122, over line 112, actuating switch 102, would move selecting contacts 132 into connection with waiting contacts 152, but

as the trunk connected therewith is already in use, by the design of the switch 102 the selecting contacts 132 would be passed one step farther, to waiting contacts 162, and would stop there, connecting the calling line to trunk 260, whose plug 261 is before operator 267. A third call, originated before the disconnection of either of the two calls described in detail, would find trunks 250 and 260 both busy and therefore would be switched to trunk 270, before operator 268; but were the first call disconnected before the third call was originated, said third call would find trunk 250 idle and would be switched to operator 267. It is seen therefore that with this system of trunking incoming calls, all calls are assigned to the first position, 267, of the switchboard, until all the trunks upon that position are busy, and that any calls in excess of the trunk capacity of the first position are switched to the second position of the switchboard, but that should any trunk or trunks on the first position become idle the next calls are placed upon those idle trunks. Therefore it is impossible to switch a call to the second position of the switchboard except upon the condition of all trunks to the first position being busy; to interpret this statement into other words, no business is sent to the second operator until the first operator is working to her full efficiency and capacity, it being assumed that the first operator has been given a number of trunks which, from observation, will keep her efficiently busy, and no more. It will be seen also from the diagram that no call will be switched to the third position of the switchboard until such time as all trunks to both the first and second positions are busy, and that therefore as long as the entire traffic of the exchange can be handled by two operators, all calls will be automatically switched to those two positions, regardless of how many additional positions may be equipped upon that switchboard.

In the mechanical design of the automatic switches, economy requires that the parts be as few and as simple as possible, and this in turn limits the number of sets of waiting contacts which are placed upon each automatic switch. Twenty-five sets seem, from a general study of the present art, to be a desirable number. This limitation provides for an office laid out on the basis of Fig. 2 to be extended until the number of trunks reaches twenty-five, and until the telephone lines, unlimited numerically, produce such an amount of traffic as cannot be handled over the twenty-five trunks; at this point it is possible to increase the number of trunks by either of two methods: first, to substitute larger switches, each accommodating a larger number of sets of waiting trunk contacts; second, to install additional switches

similar to the first, but connected with a separate group of trunks. The second plan is illustrated diagrammatically in Fig. 3.

In Fig. 3, automatic switches 101, 102, etc., represent the switches serving the first group of trunks, 250, 260, etc., the individual switches of the group belonging individually to the telephone lines 111, 112, etc., serving telephone substations 121, 122, etc.; another group of trunks is represented by 350, 360, etc., served by automatic switches 201, 202, etc., belonging to lines 225, 226, etc. A third group of trunks is represented by 450, 460, etc., served by automatic switches 302, 303, etc., belonging to lines and serving substations as diagrammatically represented. Branch conductors 211, 212, 214, etc., connect the telephone lines with multiple jacks 221, 222, etc., on a multiple switchboard designated as a whole 259. Upon multiple switchboard 259 are located also groups 275, 276, etc. of plugs 251, 261, 351, etc., belonging to the individual trunks of the trunk groups, as diagrammatically shown. Trunk 250 is the first trunk of its group and terminates upon a plug 251 of plug group 275; trunk 350 is the first trunk of its trunk group and terminates upon a plug 351 of plug group 275; it is seen also that all of the first trunks of all the trunk groups terminate in plug group 275. Likewise, trunk 260, the second of its trunk group, terminates upon a plug 261, in plug group 276; it is seen also that all of the second trunks of all of the trunk groups terminate in plug group 276, which therefore may be termed the second plug group. Likewise, the third trunks of all groups terminate in plug group 277, the third plug group, and so throughout the switchboard. As the number of trunks in each trunk group is limited by the mechanical construction of the automatic switch to twenty-five, it follows that there will be twenty-five plug groups 275, 276, etc.; these plug groups will occupy the entire switchboard 259, regardless of the extent of said switchboard or of the number of operators to be accommodated by it.

The first call from any group of substations will be switched to the first trunk of the trunk group serving those substations, and therefore will be switched to plug group 275, the first plug group. Further, all calls from all trunk groups will be switched to said first plug group until such time as two calls exist simultaneously in the same trunk group, when the existence of the prior call in that trunk group will cause the second trunk of the group to be selected by the later call and thus the second of the two simultaneous calls will be switched to the second plug group 276. In like manner, the first two plug groups will receive all calls until the traffic of the switchboard becomes so great that three simultaneous calls exist

in one trunk group, when the last of the calls will be switched to the third trunk of that trunk group and therefore to the third plug group. Thus in Fig. 3, as in Fig. 2, the traffic of the entire exchange is automatically switched to the first plug group until the traffic exceeds the capacity of that plug group, when the surplus is sent to the second plug group, the traffic being then sent to those two plug groups until it exceeds their capacity, when the surplus is sent to the third plug group, and so on until in the periods of maximum traffic of the exchange the entire switchboard is assumed to be utilized.

In the arrangement of parts shown in Fig. 3, the number of plug groups 275, 276, etc., is twenty-five by limitation of automatic switch construction, but the number of plugs in each group is unlimited, being governed only by the size of the telephone exchange. The distribution of the plug groups among operators therefore becomes a feature to be considered. In a small exchange, say 100 trunks, four plugs in each plug group, the first operator on duty could handle probably ten trunks, being the first two plug groups and two plugs of the next plug group; the second operator on duty would handle the remaining two plugs of the third plug group and also the fourth and fifth plug groups, etc. In an exchange of 250 trunks, 10 trunk groups, 10 plugs in each plug group, each plug group probably would be equal to an operator's capacity, but if nine trunks were the capacity of the first operator on duty, she would be given nine plugs from the first plug group, the second operator on duty would be given the remaining plug of the first group and eight plugs from the second plug group, the third operator on duty would be given the remaining two plugs from the second plug group and seven plugs from the next plug group, etc. It is seen therefore that each operator can be given just enough work to utilize her capacity economically and efficiently, and that all surplus traffic will be shifted to the next operator in order, regardless of whether in such disposition of traffic the first operator handles several plug groups or the first plug group requires several operators.

In the description relating to Fig. 3, it is assumed that the traffic arising in the many substations will be distributed equally, or approximately so, among the several trunk groups; to secure and maintain such distribution, the first intermediate distributing frame, 50, is shown in Fig. 4. In the construction of the switchboard, a fixed number of plugs is given to each operator's position, which fixed number by design should be as great as the number of trunks ever required to be terminated for that operator's use; in

placing the switchboard in service, the number of active trunks required by the operator to utilize her capacity efficiently, may not coincide with the number of trunk plugs provided when building the switchboard, may vary with the individuality of the operator, and may vary from time to time with some variation in the nature of the traffic. To secure economical, convenient and flexible distribution of the active trunks among the operators' positions, the second intermediate distributing frame is provided at 60 in Fig. 4, which distributing board also provides facilities for the new grouping of trunks and plugs necessary to follow implicitly the plan shown in Fig. 3, when by the growth of the exchange it is necessary to install an additional trunk group and thus to include an additional plug in each plug group; by means of the second distributing frame it is possible also to connect upon one plug two or more sets of conductors from the waiting contacts of the automatic switches. The main distributing board 70, is an adjunct of every modern telephone exchange, and is for that reason included in Fig. 4. Each line, trunk, or other circuit in Fig. 4, is represented as a unit by a single line, except that in the distributing frame jumpers the conductors are separated to show the number of conductors involved and also that by reference to similar numbers of Fig. 1, the parts of the circuits may be more readily identified. Main distributing frame jumpers are numbered 700; first intermediate jumpers 500; second intermediate jumpers 600. These intermediate distributing frames serve the further purpose of permitting the isolation of any part of the apparatus which may become defective.

To recapitulate the system of selection and distributing frame connection: All calls are switched to selected trunks, certain trunks being so placed in the automatic switches as to receive the calls in precedence over other trunks, and thus a relation is established between the trunks of any group which may for convenience be termed an order of precedence. In each group, those trunks having priority over others in the matter of receiving calls may be referred to as being of a higher order of precedence. Calls received by trunks are carried to plug groups on the multiple switchboard in a method of distribution governed by the second intermediate distributing frame 60, and in this distribution the earlier calls are collected to one of the plug groups, and thus the plug groups may be said also to have an order of precedence. Plug groups are located adjacent to each other in their order of precedence, and thus the object is accomplished of having all calls concentrated upon one portion of the switchboard and

there distributed among only so many operators as may be required to handle them efficiently.

Having thus described my invention, what I claim as new and desire to secure by Letters-Patent is:

1. In a telephone system, the combination of telephone lines and substation telephones; automatic switches connected with said telephone lines; waiting contacts in said automatic switches; multiple jacks connected with said telephone lines; plugs adapted to connect with said multiple jacks; and trunks each connected at one end with one of said plugs and at its other end with homologous waiting contacts in all of said automatic switches, said trunks having among themselves an order of precedence in receiving calls and a grouping of their said plugs adapted to terminate in one group those trunks having the highest order of precedence in receiving calls and in other plug groups those trunks having other orders of precedence; substantially as described.

2. In a telephone system, the combination of telephone lines and substation telephones; automatic switches connected with said telephone lines; multiple jacks connected with said telephone lines; plugs adapted to connect with said multiple jacks; and trunks connecting said plugs with said automatic switches, said trunks being so arranged that certain trunks have precedence over others in receiving calls, and the plugs being so grouped as to terminate in one plug group those trunks having the highest order of precedence; substantially as described.

3. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for and connected with each of said telephone lines; waiting contacts in said automatic switches; multiple jacks connected with said telephone lines; plugs adapted to connect with said multiple jacks; and trunks forming a plurality of groups each group having a group of automatic switches pertaining thereto, each trunk being connected at one end with one of the plugs and at its other end with all homologous waiting contacts of the automatic switches pertaining to its trunk group, the trunks of each group being arranged so that they will have among themselves an order of precedence in receiving calls, and said plugs being so grouped as to terminate in one plug group those trunks in all of the trunk groups which have the highest order of precedence and in other plug groups those trunks of other orders of precedence; substantially as described.

4. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for and connected with each of said telephone lines; multiple jacks connected with said telephone lines; plugs

adapted to connect with said multiple jacks and forming a plurality of plug groups; and trunks forming a plurality of trunk groups and connecting said plugs with said automatic switches, the trunks of each group being so arranged that they will have among themselves an order of precedence in receiving calls, and the plugs being so grouped as to terminate in one plug group those trunks in all of the trunk groups which have the highest order of precedence and in other plug groups those trunks of other orders of precedence; substantially as described.

5. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for each of said telephone lines; a distributing frame; terminals on said distributing frame connected to said lines; terminals on said distributing frame connected to said automatic switches; jumpers in said distributing frame adapted to connect together the terminals of any line and the terminals of any automatic switch; multiple jacks connected to said telephone lines; plugs adapted to connect with said multiple jacks; and trunks connecting said multiple jacks with said automatic switches; substantially as described.

6. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for and connected with each of said telephone lines; multiple jacks connected with said telephone lines; plugs adapted to connect with said multiple jacks; a distributing frame; terminals on said distributing frame connected with said plugs; terminals on said distributing frame connected with said automatic switches; and jumpers in said distributing frame adapted to connect together the terminals of any plug and the terminals of any automatic switch; substantially as described.

7. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for each of said telephone lines; a distributing frame; terminals on said distributing frame connected to said lines; terminals on said distributing frame connected to said automatic switches; jumpers in said distributing frame adapted to connect together the terminals of any line and the terminals of any automatic switch; multiple jacks connected to said lines; plugs adapted to connect with said multiple jacks; another distributing frame; terminals on said latter distributing frame connected with said plugs; terminals on said latter distributing frame connected with said automatic switches; and jumpers in said latter distributing frame adapted to connect together the terminals of any plug and the terminals of any automatic switch; substantially as described.

8. In a telephone system, the combination

of telephone lines and substation telephones; automatic switches connected with said telephone lines; waiting contacts in said automatic switches; other lines; multiple jacks connected with said other lines; plugs adapted to connect with said multiple jacks; and trunks each connected at one end with one of said plugs and at the other end with homologous waiting contacts in all of its corresponding automatic switches, said trunks having among themselves an order of precedence in receiving calls and a grouping of said plugs adapted to terminate in one group those trunks having the highest order of precedence in receiving calls, and in other plug groups those trunks having other orders of precedence.

9. In a telephone system, the combination of telephone lines and substation telephones; automatic switches connected with said telephone lines; other lines; multiple jacks connected with said other lines; plugs adapted to connect with said multiple jacks; and trunks connecting said plugs with said automatic switches, said trunks being so arranged that certain trunks have precedence over others in receiving calls, and the plugs being so grouped as to terminate in one plug group those trunks having the highest order of precedence; substantially as described.

10. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for and connected with each of said telephone lines; waiting contacts in said automatic switches; other lines; multiple jacks connected with said other lines; plugs adapted to be connected with said multiple jacks; and trunks forming a plurality of groups, each group having a group of automatic switches pertaining thereto, each trunk being connected at one end with one of the plugs and at its other end with all homologous waiting contacts of the automatic switches pertaining to its trunk group, the trunks of each group being arranged so that they will have among themselves an order of precedence in receiving calls, and said plugs being so grouped as to terminate in one plug group those trunks in all of the trunk groups which have the highest order of precedence and in other plug groups those trunks of other orders of precedence; substantially as described.

11. In a telephone system, the combination of telephone lines and substation telephones; an automatic switch for and connected with each of said telephone lines; other lines; multiple jacks connected with said other lines; plugs adapted to connect with said multiple jacks and forming a plurality of plug groups; and trunks forming a plurality of trunk groups and connecting said plugs with said automatic switches, the trunks of each group being so arranged that

they will have among themselves an order of precedence in receiving calls and the plugs being so grouped as to terminate in one plug group those trunks in all of the 5 trunk groups which have the highest order of precedence and in other plug groups those trunks of other orders of precedence; substantially as described.

Signed by me at Pittsburgh, county of Allegheny, and State of Pennsylvania, in 10 the presence of two witnesses.

SIDNEY HAND BROWNE.

Witnesses:

A. H. MORAWECH,
B. H. SHRYOCK.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."