(No Model.) 4 Sheets—Sheet 1.

A. S. McCASKEY.

AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

No. 498,291. Patented May 30, 1893.

FIG. I.

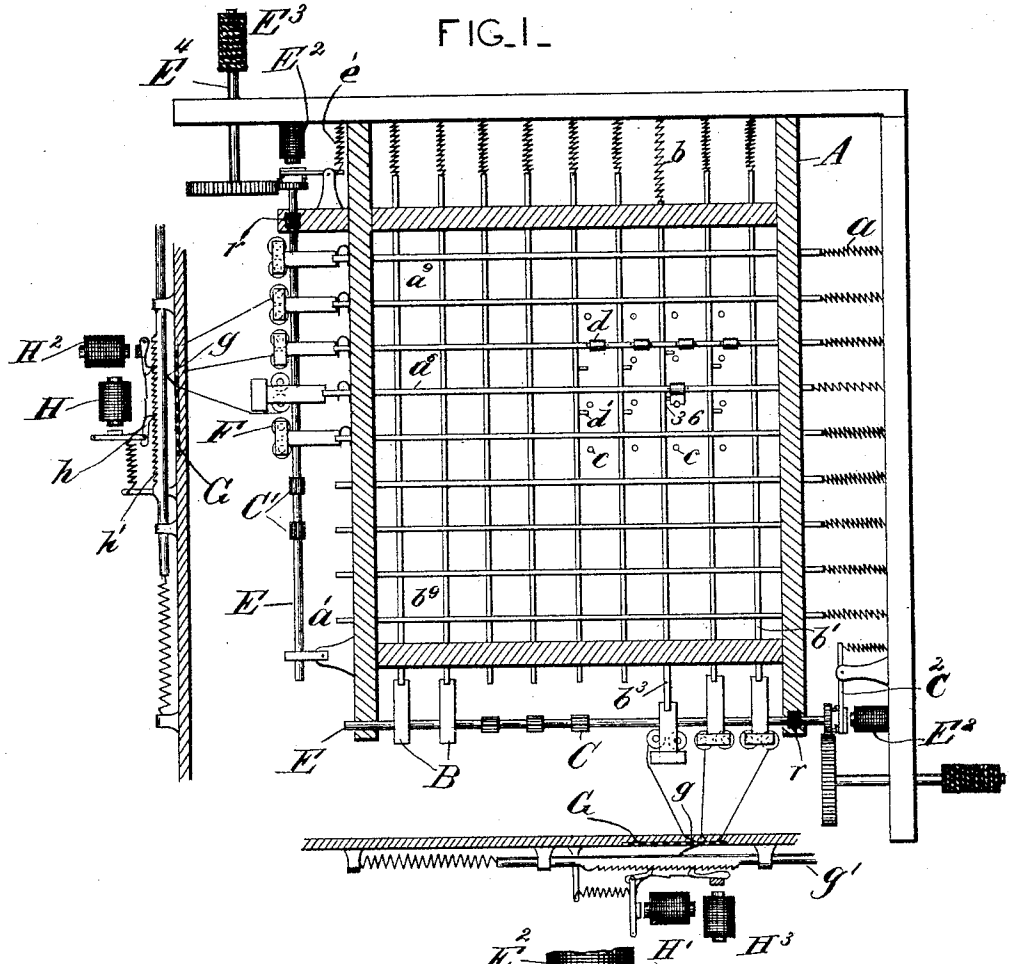
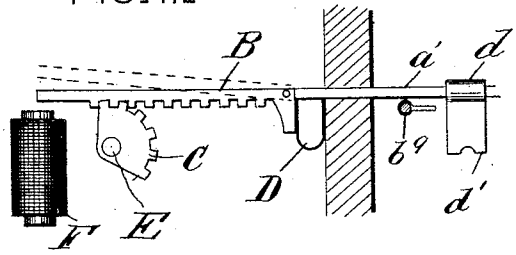


FIG. II.



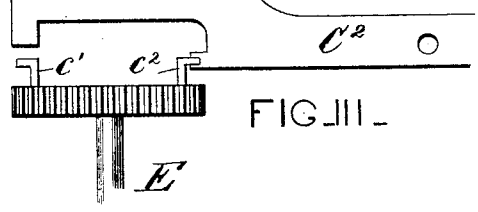


FIG. III.

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(No Model.) 4 Sheets—Sheet 2.

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AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

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FIG. IV.

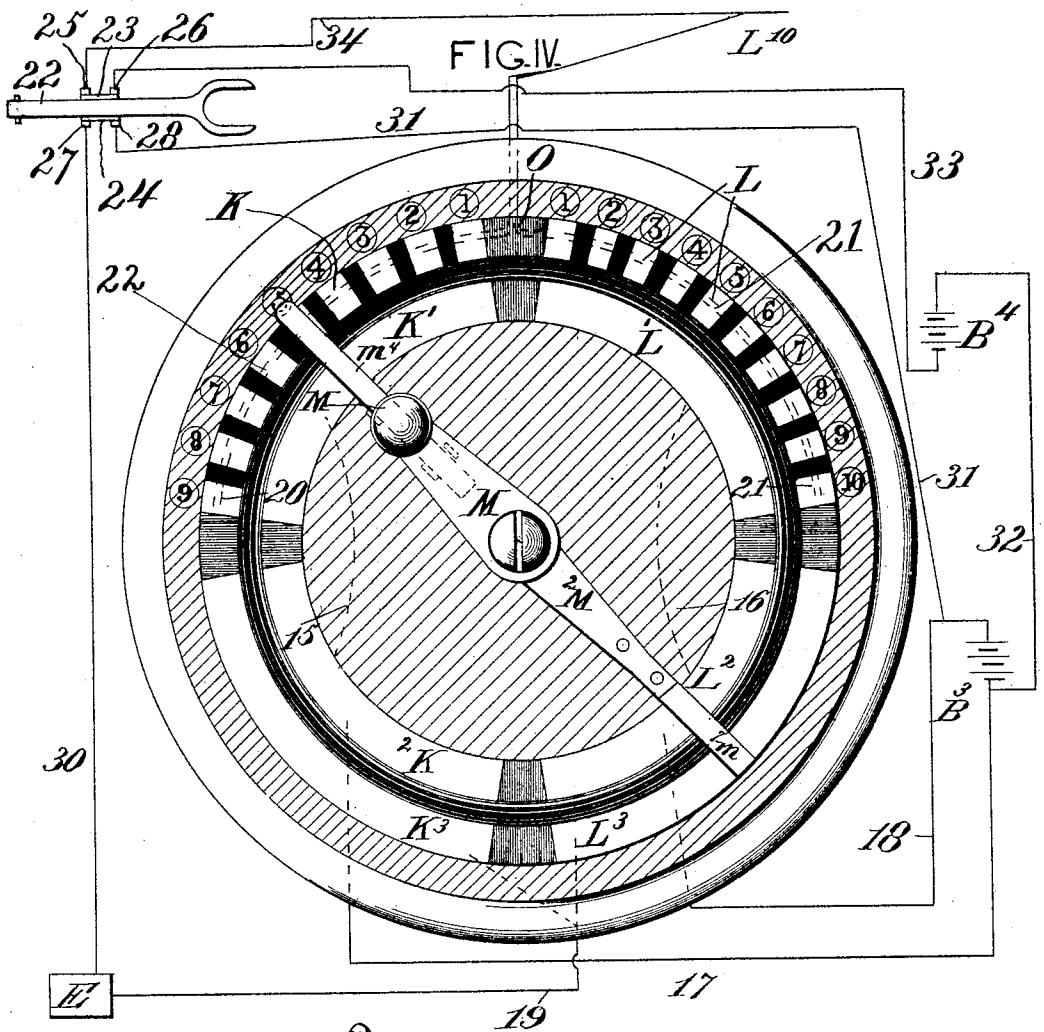


FIG. V.

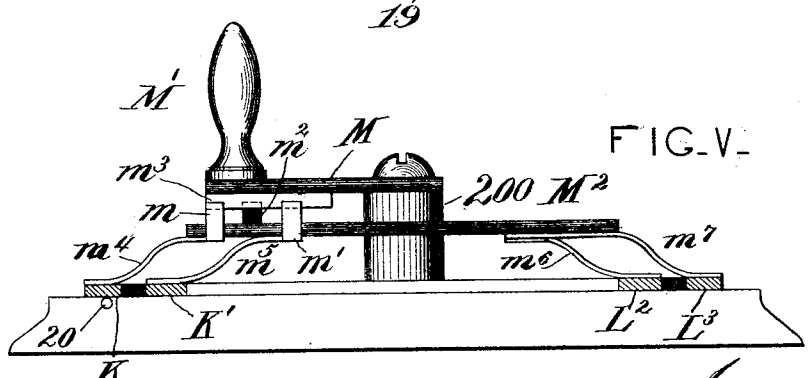
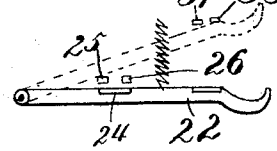


FIG. VI.



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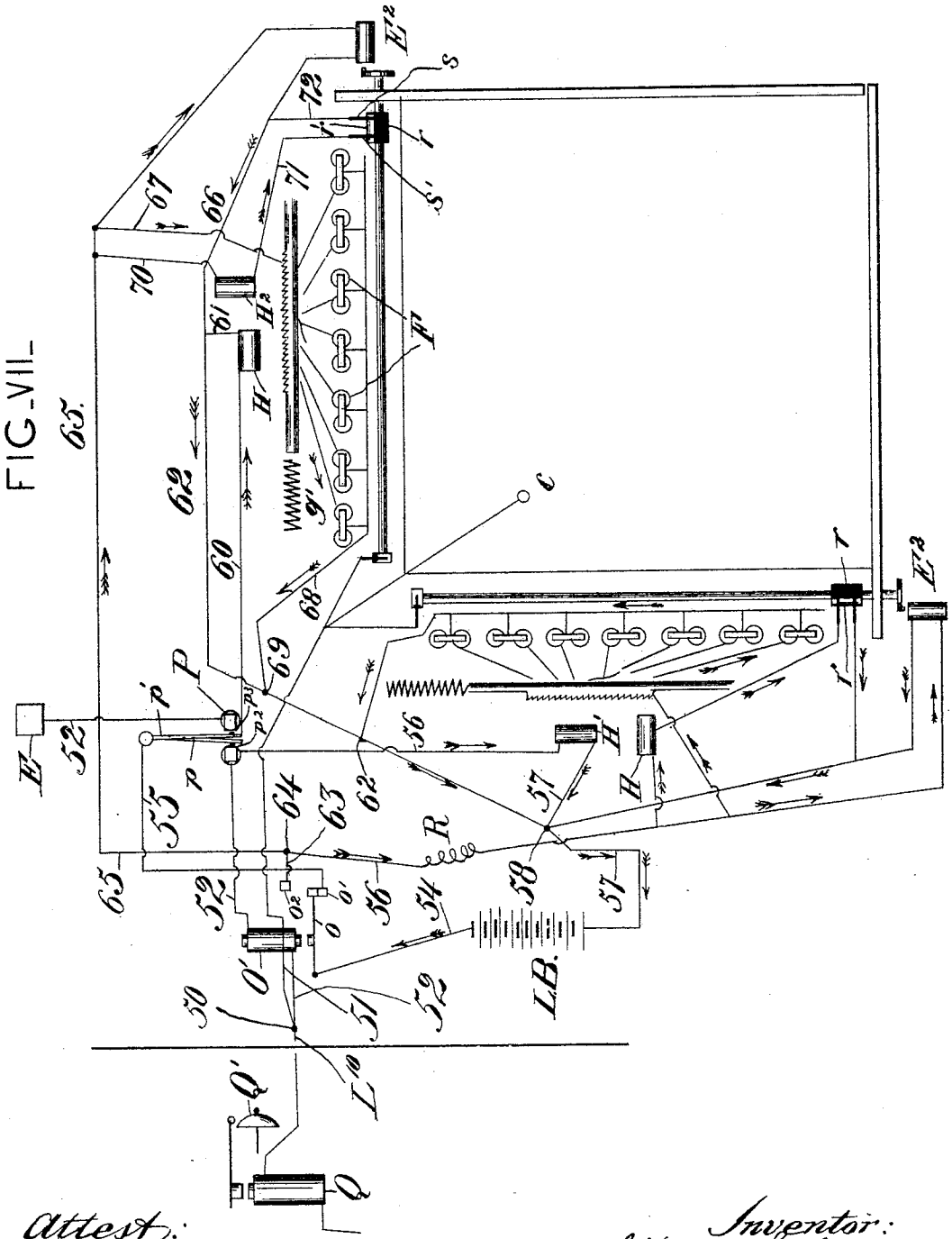
AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

No. 498,291. Patented May 30, 1893.

FIG. VII.



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AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

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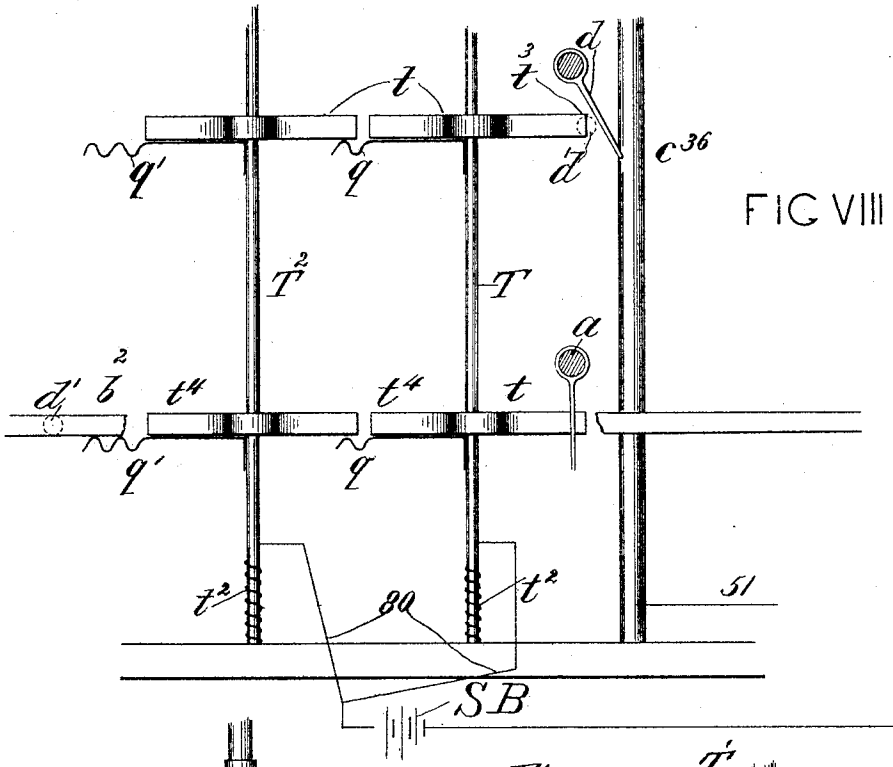

FIG VIII

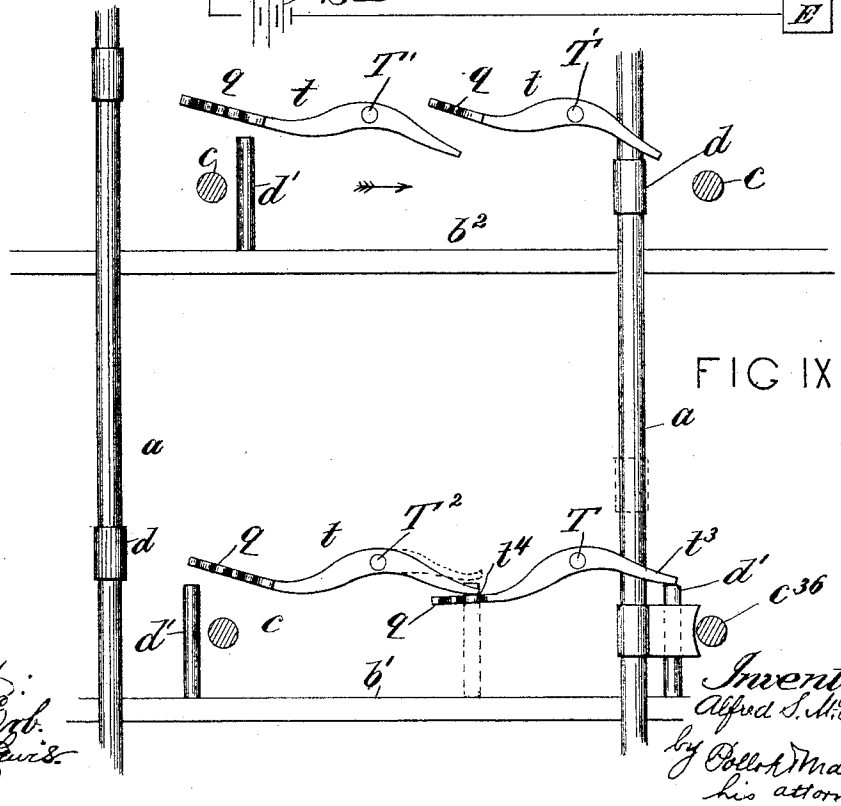

FIG IX

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UNITED STATES PATENT OFFICE.

ALFRED S. McCASKEY, OF CHICAGO, ILLINOIS.

AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 498,291, dated May 30, 1893.

Application filed August 25, 1892. Serial No. 444,100. (No model.)

To all whom it may concern:

Be it known that I, ALFRED SAMUEL MCCASKEY, of Chicago, Illinois, have invented a new and useful Improvement in Automatic Telephone-Exchange Systems, which is fully set forth in the following specification.

This invention has reference to telephone exchange systems, comprising a central office and subscribers' stations connected therewith, and apparatus whereby any subscriber can connect his wire for talking purposes with the line of any other subscriber.

Many systems of this general character have been heretofore devised, but have gone into use to a very limited extent, such systems having been found to be adapted only to exchanges where the number of subscribers is small, and to involve too great complexity or too much uncertainty in operation to be efficient for city exchanges.

The object of my invention is to produce an automatic exchange system which is capable, without sacrifice of reasonable simplicity and certainty, of employment for a large number of subscribers, and it consists in a novel form of central office switch-board or connecting mechanism, combined with local station apparatus of a simple character for selecting and making connection with any desired line of the system.

The present invention utilizes the principle of combinations of the connecting elements, to obtain with a relatively small number of connecting elements a relatively large number of connections. Thus, if the connecting elements are so arranged as to require the motion of a pair of such elements for each connection, the total number of connections that can be made will be equal to the square of half the number of connecting elements (*e. g.*, twenty elements can effect one hundred connections) while the subscriber's actuating mechanism will only have to select and act upon two out of a relatively small number of elements.

Apparatus based on this principle may be constructed in a variety of ways, but that form which is deemed the simplest and readiest of application, comprises connecting elements in the form of intersecting wires, as will be fully explained hereinafter. Each line entering the exchange terminates in a rod or wire, these terminals being arranged in group, say vertically. Each subscriber has also under his control a system of connecting wires composed of two series, one series being at right angles to, or intersecting the other. The plane of the connecting wires is transverse to the line terminals, being horizontal, if the latter stand vertically, as hereinafter described and shown. The planes of connecting wires are arranged one above the other, (or it might be one alongside of the other) so that the connecting mechanism presents a structure having three series of wires running in three directions, each wire being normally out of contact with all the others. The two series of horizontal wires constituting a subscriber's connection system, form a number of intersections equal to the product of the number of longitudinal wires multiplied by that of the cross-wires. If there be ten in each row, there will be one hundred intersections. The vertical terminal wires stand adjacent to these intersections, and the horizontal or connecting wires are provided with contact devices so arranged that a slight movement of any longitudinal wire and any cross wire will establish an electrical connection with that vertical wire which stands at the intersection of these two connecting wires. The subscriber's station has a selecting device adapted to send signals of a sufficient number of impulses of either polarity, so as to select and operate that longitudinal wire and that cross-wire at whose intersection stands the line terminal with which connection is desired.

This part of the invention may be carried out in various ways. That which is at present regarded as the simplest and most efficient is as follows: The selector is a pivoted arm which on turning one way from its normal resting point makes successive contact with a series of terminals with which the plus pole of the signaling battery is connected, and on turning the opposite way makes contact with terminals of the minus pole of the battery. The subscriber can thus send any desired number of impulses, followed by any desired number of impulses of the opposite polarity. At the central office is a circuit-maker having electro-magnetic operating mechanism for moving it step by step, and at each step it completes a circuit for the controlling mag-

net of one of the longitudinal wires. The operating magnet is in a local circuit controlled by a polarized relay, so as to be closed by say positive impulses from the signaling station. Thus the circuit-maker can be moved to make connection with any magnet of the series controlling the longitudinal connecting wires. A similar circuit-maker and operating magnet are provided for the cross-wires being closed by currents of opposite polarity to those which influence the first operating magnet. The subscriber thus brings under control the two connecting wires which intersect at the line terminal with which he wishes to communicate. He now, by a suitable signal (which may be by a double strength current) moves the two connecting wires, making the desired contact and establishing a talking circuit with the desired line. When the conversation is finished a disconnecting signal (which may be a repetition of the connecting signal) releases the connecting wires, which are restored by springs to their normal positions. To prevent confusion, one of the connecting wires in its movement sets a guard mechanism, which prevents any other connecting wire from approaching the terminal wire. This guard mechanism may be, and preferably is, combined with indicating devices, which, by ringing a bell at the subscriber's station, shows that the line with which he has attempted to connect himself is busy. The number of strokes of the bell will indicate whether one or more subscribers is or are ahead of him in connecting or attempting to connect with that particular line.

The system is of course complete and operative without the guard mechanism, which may be used or disused as desired.

It will not of course, in practice, be necessary to provide a connection plane of intersecting wires for each subscriber, but it will suffice if the number of planes be large enough to provide for the maximum number of connections likely to be required at any one time.

The invention includes many details of construction and combinations and arrangements of parts, as will be hereinafter explained.

The accompanying drawings, which form part of this specification illustrate a system constructed and arranged in accordance with the invention.

Figure I, is a sectional plan view of the central office connecting apparatus, showing the horizontal connecting wires of one subscriber, and the position of certain of the vertical line terminals. Fig. II, is a detail in elevation showing the operating mechanism of one connecting wire. Fig. III, is a detail of the escapement mechanism. Fig. IV, is a plan view, partly diagrammetric, of the subscriber's selecting device. Fig. V, is a sectional elevation thereof. Fig. VI, is a detail of an automatic switch. Fig. VII, is a diagram illustrating the electrical connections of the switch board mechanism. Fig. VIII is an enlarged detail in elevation of parts of the system of connection-wires, illustrating particularly the guard mechanism, and Fig. IX, is a similar enlarged detail in plan.

In Fig. I, the guard mechanism is not shown, because it could not be clearly indicated upon the scale of that figure. Moreover, for the sake of greater clearness I have shown only a few of the vertical terminal wires, contact makers and connection-magnets.

In Fig. I, A, represents a frame work having dimensions sufficiently large to accommodate the connecting wires or elements required for the system. This frame supports a series of longitudinal wires lettered from a' to a^9 and a series of intersecting cross-wires lettered from b' to b^9, the wires being capable of sliding lengthwise, and being all normally held by retractile springs a b. These wires form eighty-one intersections, and adjacent to each intersection stands a vertical wire c, constituting a line terminal. It will be understood that there are a number of planes of intersecting wires aranged one above the other, and as shown in Fig. II, wires b' are a little below and out of contact with wires a'. The latter carry a number of contact makers d, which hang vertically by their own weight but can turn easily on the supporting wire. Cross-wires b' have each a series of projecting pins d'. The relative positions of these pins and contact-makers will be readily understood from Figs. I and II, and it will be seen that if any wire, as a^6 be drawn against its spring, all its contact makers will be brought into line with pins on the intersecting wires b'. If now, any cross-wire say b^3 be drawn out, one of its pins will engage and lift the adjacent contact maker at its intersection with a^6, and make a connection at the intersection 36 with the line terminal c at that point, which will be the line terminal of subscriber 36. Thus it requires the movement of both wires forming an intersection to make a connection with the vertical wire at that point.

A simple form of mechanism for moving the connection wires is shown in the drawings. Each wire has at its end a pivoted rack B overlying a segmental pinion C the latter being carried by a shaft E. Racks B are normally out of engagement with pinions C, being tilted up into the position shown in dotted lines Fig. II by a light spring D., but when the circuit of a magnet F is closed, the rack B controlled by that magnet is attracted, and if shaft E be rotated the wire attached to that particular rack will be drawn out, all the others remaining stationary. The circuits of these connection magnets are normally open at a terminal plate G. A brush g carried by a slide g' is adapted to make contact successively with the several terminals of these circuits. There are two of these contact making appliances, one for the longitudinal wires a, and the other for the cross-wires b'. Each

has a selecting magnet H or H′, and a release magnet H^2 or H^3. The selecting magnet of each appliance moves its slide g' step by step, through a pawl h and ratchet bar h', and each of these movements carries the brush g from one terminal to the next, thus selecting the desired connecting wire. One of these magnets is adapted to act upon positive impulses being sent to line from a sub-station, and the other upon negative impulses; so that a subscriber to connect his line with any other, say No. 36, will send three plus impulses, followed by three minus impulses, and thus close the circuits of the connection magnets corresponding to wires b^3 and a^6. He will then send the proper signal to rotate the shafts E, as presently described, and thus bring wire a^6 into electrical connection with vertical wire c at intersection 36, as already pointed out. Shaft E has on its end two projections c', c^2 controlled by an escapement lever C^2, (Fig. III) the latter being moved in one direction by an escapement magnet E^2, and in the other by a spring e', so that at each vibration of lever C^2 shaft E can make a half revolution. Shaft E when released by the lever C^2 is rotated by a weight whose cord E^3 is wound upon a drive shaft E^4, or by other suitable means. Escapement magnet E^2 is operated when a double strength impulse comes from the subscriber's station, so that it does not respond when ordinary signals are sent to operate the selecting-magnets. When it is desired to restore the parts to their normal positions, a second double-strength impulse will again release shaft E, and it will then complete its revolution; but during this part of its movement the pinion C is out of engagement with rack B, and the wire attached thereto is accordingly drawn back by its spring (a or b). When completely retracted the rack B is again tilted up by spring D.

The electrical connections of this automatic switch-board mechanism will now be explained in connection with the diagram (Fig. VII).

Line wire L^{10} enters the central office branches at the point 50. One branch 51, goes to the two shafts E, and also to the subscriber's vertical terminal rod c. This may be called the talking branch. The other branch 52 goes first to the extra strength magnet O′, then to the polarized relay P, and then to earth. These are all the line circuits, the other circuits on the diagram belonging to the local battery L B. In tracing these circuits we will follow an operation of making a connection. The subscriber first sends positive impulses to connect with the proper magnet of the series of cross-wires b'. These impulses pass without affecting magnet O′, and in passing relay magnet P draw tongue p to contact point p^2 and close a local circuit through the selecting magnet H′ as follows: from battery L B by wire 54, armature lever o of magnet O′, wire 55, tongue p, contact p^2, wire 56, magnet H′ and wire 57 back to battery L B. At each of these impulses magnet H′ moves its contact making slide g' one step as already explained. When negative impulses come from the subscriber's station tongue p' closes against contact p^3, energizing selecting magnet H, the circuit being as traced above to tongue p', thence to contact p^3, wire 60, magnet H, wires 61, 62, the latter joining the return wire 57 at point 58. The subscriber next sends an extra-strength impulse, to which switch-magnet O′ responds, attracting its armature o, breaking the circuit of the selecting-magnets H, H′ at contact o', and closing another local circuit at o^2. This is the circuit of the escapement magnets E^2, as follows: wire 63 which branches at 64 to the two escapement magnets. Following that branch which leads to the magnet of the longitudinal connection wires a', the circuit proceeds by wire 65 to magnet E^2, and by wire 66, which joins the return wire 62, and proceeds by the path already traced to the battery. The circuit of the other escapement magnet is identical, except that it includes a retarding resistance R, the object being that the wire a' shall move its contact-makers d into the range of the pins d' before wire b' moves the latter. The wire 65 has a branch wire 67 leading to the contact making slide g' and its brush g, and thence to the connection magnet F which is for the time being in circuit with brush g. All the magnets F are connected to a common return wire 68, which joins wire 62 at point 69. Thus a current passes to energize the proper connection-magnets, and bring the two selected connection wires into engagement by their racks B with the pinions C on the shaft E. Each shaft E carries a collar, part of which is of insulating material r and part of conducting material r'. Brushes s s' rest on the collars, normally on the insulating portion. These collars constitute the circuit controllers of the release-magnets H^2, H^3. At the first extra-strength impulse the circuits of the release magnets are open at the collars, but when shaft E has made a half-revolution and comes to rest, the brushes s, s' rest upon the conducting portion r' of the collar. At the conclusion of the conversation, the subscriber sends another extra-strength impulse, closing the circuit of escapement magnets E^2 as before, so that shafts E make another half-revolution and resume their normal positions. But at this time the circuit of the release magnets is closed, as follows: from the wire 65 by branch wire 70 to release magnet H^2, by wire 71 to brush s', conducting strip r', brush s, and wire 72 to return wire 66. Release-magnet thereupon acts as already explained, and slide g' is drawn back by its spring to its normal position.

It has already been pointed out that the subscriber's line wire branches to its vertical terminal c, and to shafts E. At both points the circuit is normally open; but when a rack

B is in engagement with a pinion C, a talking circuit is made from the signaling subscriber's line to shaft E, pinion C, rack B, connection wire a', contact maker d and the terminal wire c of the subscriber with whom communication is desired.

The subscriber's signaling mechanism comprises a device for sending the selecting impulses, and the operating impulses to which the polarized relay magnet and the extra-strength magnet respectively respond. One form of such mechanism is shown in Figs. IV, V and VI. The apparatus which may be termed the selector, comprises a dial, around the edge of which on opposite sides of the zero point O are arranged two series of contact plates K, L which may be numbered to correspond with the longitudinal and cross-connection wires. Those to the left of the zero point correspond with the connection wires a', and those to the right with the wires b'. Within the contact plates K, L are conducting strips K′, L′, connected respectively by wires 15, 16, with two similar strips K^2 L^2. The former connects by wire 17 with the positive terminal of a battery B^3 and the latter by wire 18 with the negative terminal of the same battery. Alongside of strip K^2 is an earth contact strip K^3, and another earth contact strip L^3 is adjacent to strip L^2. These strips K^3 L^3 are connected to earth at E by a wire 19.

Pivoted on a stud 200 in the center of the dial is an arm M having a handle M′, and on the same stud is pivoted a flat bar M^2. Arm M has a rib m^3 which lies between stops m, m', m^2 on the bar M^2, so that the movement of arm M will carry bar M^2 with it; but the former has a slight play between the stops m m' on one side and m^2 on the other. Stops m m' are of conducting material (as is rib m^3) and connect with springs m^4 m^5, attached to the insulating bar M^2. Spring m^4 is arranged to slide over the contact plates K, L and spring m^5 to slide over strips K′ L′. Plates K all connect with a conductor 20 and plates L with a conductor 21, and both of these conductors connect with the line wire L^{10}, leading to the central office. Insulating bar M^2 also carries two springs m^6 m^7, which are electrically connected and are adapted to slide over strips K^2 L^2 and K^3 L^3 respectively. If the subscriber wishes to connect his wire with that of subscriber No. 36 he turns handle M′ to the right until it rests on line contact No. 3 of the series L. During this movement rib m^3 bears against stop m^2 which has no electrical connection, and consequently no current goes to line. He then moves it to the left, and consequently rib m^3 closes the battery circuit across stops m, m' and at each of line plates L a positive impulse is sent to the central station, the circuit being from the earth at E by wire 19, earth plate K^3, brushes m^7, m^6, plate K^2 and wire 17 to the negative pole of battery B^3, and thence by wire 18, plate L^2, wire 16, plate L′, brush m^5, stop m', rib m^3, stop m, brush m^4, line plates L, and conductor 21 to the line L^{10}. Thus when arm M reaches the zero point three positive impulses will have been sent, and by continuing the movement to the line plate No. 6 of the series K, six negative impulses will follow. The subscriber then returns arm M to its resting position, and during this return movement no current flows, for the reason that rib m^3 breaks contact with brushes m, m'. The operator has now to send an impulse of sufficient strength to operate the magnet O′. This may be conveniently effected by bringing in an auxiliary battery B^4, by means of a switch or push button; or as indicated in Figs. IV and VI, the movement of the hook 22, on which the receiving telephone usually hangs may be utilized to bring in this battery, with battery B^3. As shown, the hook carries two connecting strips 23, 24. The former brushes past and connects the terminal points (which are preferably springs) 25, 26, while the latter is simultaneously making contact with the terminals 27, 28. This contact, made as the arm 22 moves upward, sends a current from both batteries to line by the following path: from earth at E by wire 30, terminal 27, plate 24, terminal 28, wire 31, battery B^3, wire 32, battery B^4, wire 33, terminal 26, plate 23, terminal 25, and wire 34, connecting with line wire L^{10}. This actuates the magnet O′ closing the circuit of the escapement-magnets already explained, and when the conversation is concluded, and the telephone again hung on its arm 22, the latter in descending causes another like impulse to go to line, again actuating the escapement magnets, permitting the shafts E to return to their normal positions.

The points 37, 38, indicate the terminals of the usual local telephone circuit, closed when the arm 22 reaches the limit of its upward movement.

I have not deemed it necessary to indicate the telephones and call mechanism of the station, as these appliances may be of any usual or suitable construction, and arrangement.

It is often desirable to prevent a subscriber from connecting his line with another already in use, and thus interfering with the conversation. To this end I have devised a guard mechanism illustrated in detail in Figs. VIII and IX.

In the open spaces between the intersecting wires a' b', is placed a series of upright shafts T, T′ T^2. As shown there are two of these guard shafts for each terminal c. It will suffice to show and describe the guard-mechanism for one vertical wire c, as the arrangement is identical for each. Each shaft T, T′, &c., has a transverse guard wing t at each connection plane, the wings being at the same vertical level as the connection pin d' on cross-wire b'. The guard shafts T′, in the upper part of Fig. IX, adjacent to connection wire b^2, are shown in their normal positions, in which they are held by springs t^2 (Fig. VIII),

and it will be seen that the pin d' in moving in the direction of the arrow will pass the two guard wings, tilting each in passing and will come to rest at the extremity t^3 of the second guard wing. This is the position of the parts connected with connection wire b'. The end t^4 of the guard wing nearest the vertical wire c^{36} is thus thrown into the path of any pin seeking to approach that wire, and this is the position of every wing on guard shaft T. The position of such a pin is shown in dotted lines. If a pin were in that position it would in like manner displace the second guard shaft T^2, so that another subscriber seeking to connect with terminal c^{36} would find the guards of shaft T^2 in the way, and could not reach that terminal until both the subscriber in actual connection therewith, and the one seeking such connection, had restored their apparatus to the normal positions. A busy signal may be given in the following way: A local signaling battery S B (Fig. VIII) has connection by wires 80 to each guard shaft, and the latter are electrically connected with contact springs q q'. The springs on the first guard shaft T have one bend or corrugation, while those on shaft T^2 have two bends or corrugations. Looking at Fig. IX, it will be seen that in the normal position of the guard shafts these contact springs are out of the range of the pins d'; but when a shaft T is displaced during a connection, the springs q all come into range of the pins on wires b', so that any wire b' moving toward terminal c^{36} will brush over spring q, and make a single contact. This completes a circuit from the local battery S B to the cross-wire b', and as the latter is at this moment in electrical connection with shaft E, the circuit is completed through to the station of the subscriber attempting to connect with line terminal c^{36}. If now a suitable bell-magnet Q be included in the subscriber's circuit (as indicated in Fig. VII) a single stroke will be given on bell Q'. If another subscriber is already attempting to connect with the terminal c^{36}, the pin would brush over spring q', of shaft T^2, and send back two impulses, indicating that two persons are ahead of the subscriber for purposes of communicating with line 36.

In conclusion I desire it to be understood that my invention is not limited to particular details of construction and combinations of parts as herein set forth; but that modifications may be made therein without departing from the spirit of the invention, which includes as well the different elements individually, where these are susceptible of separate use, as the system as a whole, comprising all the elements combined, or substantial equivalents thereof. For example, the switch-board mechanism is susceptible of use in an ordinary telephone exchange, the connection elements or wires being operated by hand instead of automatically; and the selecting device at the subscriber's station is susceptible of use with other forms of connecting apparatus controlled by different combinations of impulses.

Having now fully described my invention, what I claim is—

1. In an automatic telephone exchange system the combination with the line terminals, of subscriber's connection-elements, such as wires arranged in groups or rows as specified with respect to said line terminals, the movement of a combination of connection elements being necessary to make a connection with a line terminal, each different combination making a different connection, substantially as described.

2. In a telephone exchange system, a central office switch-board or connecting apparatus, comprising line terminals, and connection-elements or wires arranged in two series transversely to each other, and in planes at right angles to said line terminals, one series being also branch line terminals, and contact-makers and actuating mechanism whereby the movement of any two intersecting wires makes connection with one of the line terminals, substantially as described.

3. In a telephone exchange system, a central office switch-board or connection apparatus, comprising line terminals arranged in one direction, connection systems comprising each two sets of wires intersecting each other, and arranged in planes at right angles to the said line terminals, there being a line terminal adjacent to each intersection, contact making devices carried by the connection wires, and means for moving any two connection-wires to make a connection with the line terminal at their intersection, substantially as described.

4. In an automatic telephone exchange system, the combination of a series of subscriber's line terminals arranged in parallel lines at the central office, a series of connection systems comprising each two sets of wires arranged transversely to each other and at right angles to said line terminals, the latter being each adjacent to an intersection of two connection wires, line wires extending from substations to the central office and branching to said line terminals and to one set of connection wires, electro-magnetic actuating mechanism for said connection wires, and a signaling or selecting device at each subscriber's station for actuating any two intersecting connection wires, and there by connecting his line with that whose terminal is at the intersection of said two wires, substantially as described.

5. The combination of the connection-wires arranged in two series intersecting each other, the line terminals intersecting the planes of all the connection wires, the latter being movable lengthwise so that the movement of any intersecting pair will make a contact with a particular line terminal, connection-magnets for the several connecting wires, a circuit-closer, for each series of magnets moving step by step, a local battery circuit-closer, se-

lecting-magnets therein for said circuit-closers, a polarized relay closing the circuit of one selecting magnet when influenced by plus currents, and of the other when influenced by minus currents, a signaling device for sending to line selecting impulses of either polarity, whereby the user can gain control of any intersecting pair of connection wires, an escapement magnet for effecting the movement of the connection wires, and an extra-strength magnet, controlling the circuit of the escapement-magnet, substantially as described.

6. The combination of the two intersecting series of connection wires, the transverse line terminals adjacent to the intersections, the connection-magnets for the several wires arranged in multiple arc branches of a common local circuit, a sliding step-by-step circuit-closer for each series of magnets, a selecting-magnet and a release magnet for each series, each selecting magnet being in a separate local circuit, a polarized switch operating to close one or the other of these circuits, according to the direction of the impulse in its circuit, a line wire including said polarized relay, mechanism as specified for moving the selected pair of connection wires, an escapement magnet, for actuating such mechanism, and operating also to close the circuits of said release magnets, a switch magnet controlling the circuit of the escapement magnet and irresponsive to impulses which actuate said polarized relay, said switch magnet being also in the main line circuit, and appliances at the subscriber's station for sending the proper impulses to line, substantially as described.

7. A subscriber's signaling device comprising in combination a line battery, a pivoted contact making arm, terminals on one side of the normal resting point of said arm connected with the positive pole of said battery, and other terminals on the opposite side connected with the negative pole of said battery, and line and earth contacts also controlled by said arm, substantially as described.

8. In an automatic exchange, the combination with central office switch-board mechanism comprising two sets of connection elements, and operating mechanism for each set responsive to currents of a definite direction, of a substation signaling or selecting device comprising a contact-making arm, two series of contacts arranged respectively on opposite sides of the zero point of said arm, a battery having its positive pole adapted to be connected by the movement of said arm with one series of contacts and its negative pole to be in like manner connected with the other series, and ground and line contacts controlled by said arm, whereby its movement in one direction sends to line a succession of positive impulses, and in the other direction a succession of negative impulses, substantially as and for the purpose set forth.

9. The combination with central office switch-board or connection mechanism operative by impulses of different polarity, of a subscriber's signaling device comprising a battery, two sets of terminal contact plates with which the two poles of the battery are adapted to be respectively connected, a trailing arm carrying brushes for making contact with said terminal plates, a handle having a slight play upon said arm and constituting a circuit-breaker, so that the circuit is closed when the arm is moved by said handle in one direction, and broken when moved in the opposite direction, substantially as described.

10. The combination with the switch-board or connection mechanism having two sets of connection elements, an independent selecting magnet for each set, each in a separate circuit, a polarized relay or switch adapted to close each of said circuits when influenced by a current of the proper direction, a main line circuit including said polarized relay, a connection-operating or escapement magnet in a separate local circuit for making a connection after the proper connection elements have been selected, a switch magnet controlling the last named circuit and irresponsive to the impulses that actuate said polarized relay, but responsive to currents of different strength, and subscriber's signaling mechanism, comprising line batteries, a selector for sending a succession of any number of normal impulses of either direction, to operate said polarized relay, and means for sending the extra-strength impulses to actuate said switch-magnet, substantially as described.

11. The combination with the line terminals, and the connection-wires adapted to be moved into contact therewith, of guard-mechanism, comprising stops or guards adapted to be displaced, by the movement of a connection-wire into contact with a line terminal, into position to arrest any other connection wire before reaching such line terminal, substantially as described.

12. The combination with a series of line terminals and connection wires arranged in planes at right angles to said line terminals, and with mechanism for actuating said connection wires to make contact with any of said terminals, of guard mechanism for each terminal wire, comprising guards or stops which are displaced by the movement of any of the connection wires in the other planes, substantially as described.

13. The combination with a series of line terminals and connection wires arranged in planes at right angles thereto, and with mechanism for actuating said connection wires, as set forth, of line circuits extending from subscribers' stations and terminating each at one of said terminals and also at one set of connection wires, guard-mechanism, comprising a series of guards for each terminal wire which are displaced by the movement of a connection wire into contact with a terminal wire, and so interposed between that terminal and other connection wires, a contact spring carried by each guard and forming the normally open terminal of the signaling circuit, said spring being

brought, when the guard is displaced into the path of a contact-maker on the connection wire adjacent thereto, so that a circuit will be closed by the movement of such connection wire, and a signal-giving device at the subscriber's station connected with said connection wire, whereby a busy-signal may be given, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ALFRED S. McCASKEY.

Witnesses:
PHILIP MAURO,
REEVE LEWIS.