(No Model.) 4 Sheets—Sheet 1.

# W. DECKER.

## AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

No. 537,603. Patented Apr. 16, 1895.

Fig. 1.

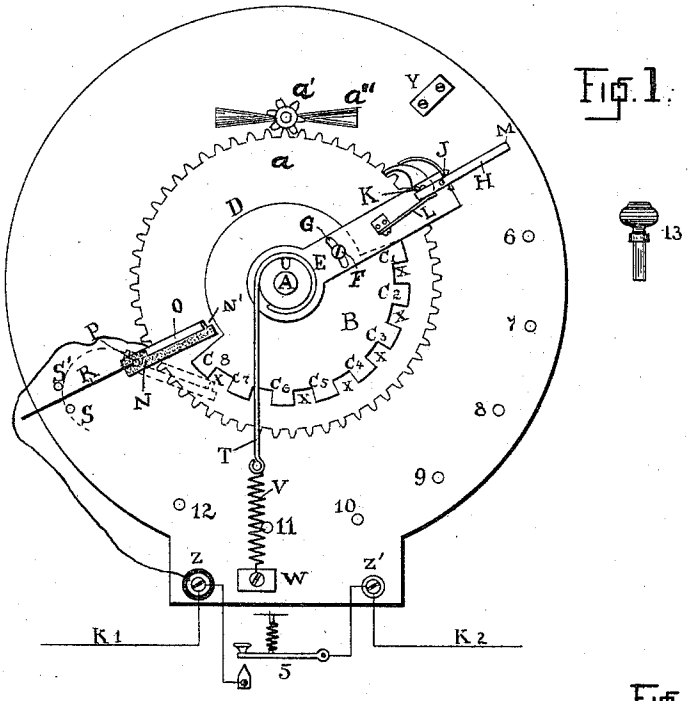
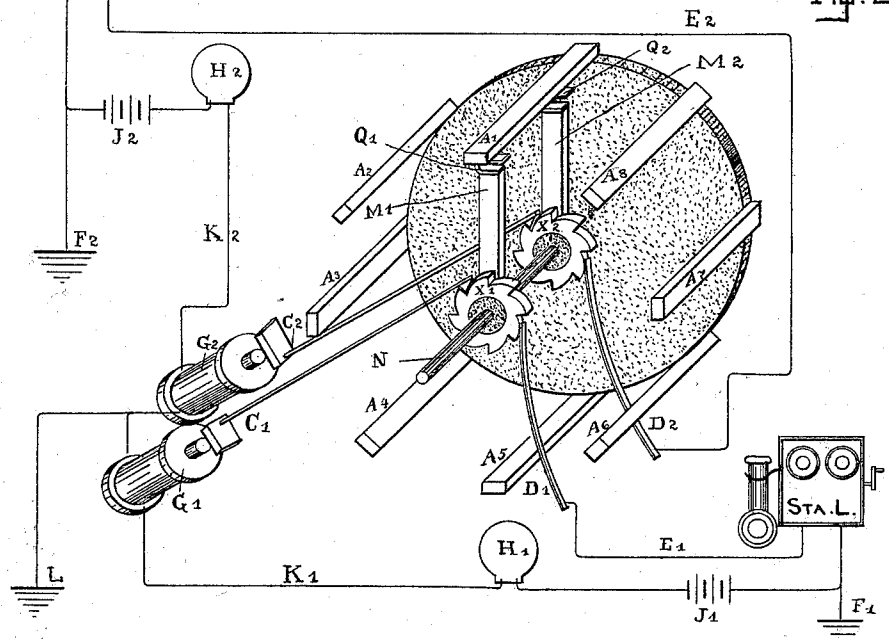



Fig. 2.

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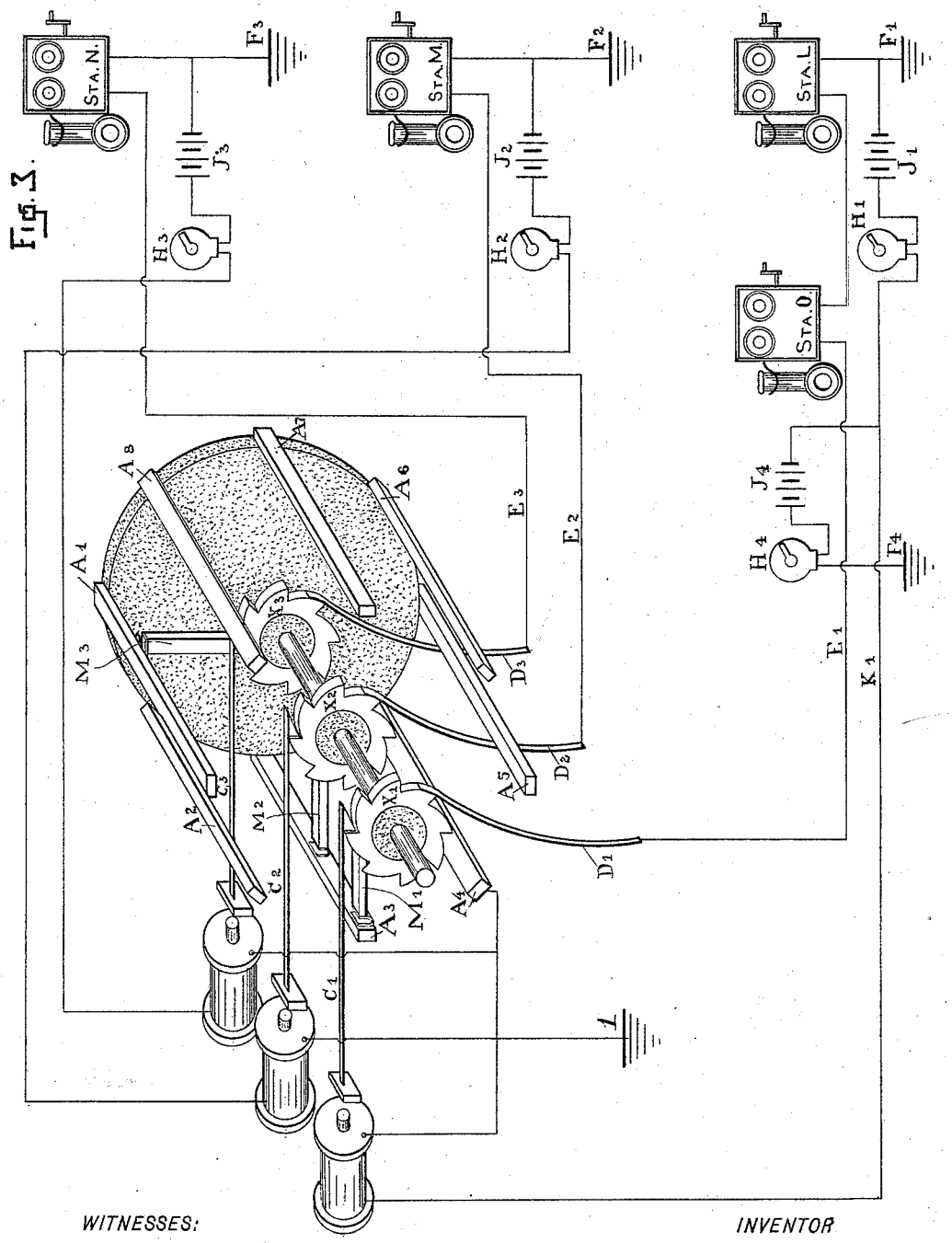
# W. DECKER.

## AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

No. 537,603. Patented Apr. 16, 1895.

Fig. 3.

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## AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

No. 537,603. Patented Apr. 16, 1895.

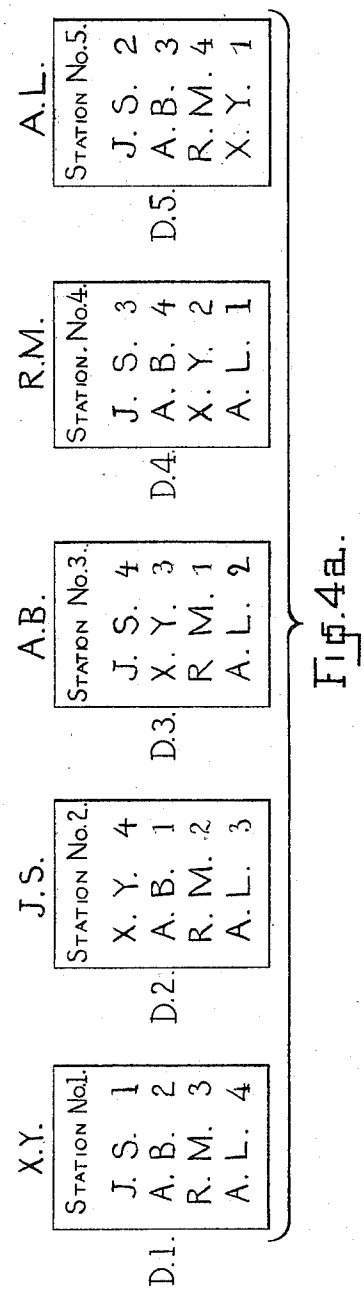


Fig. 4a.

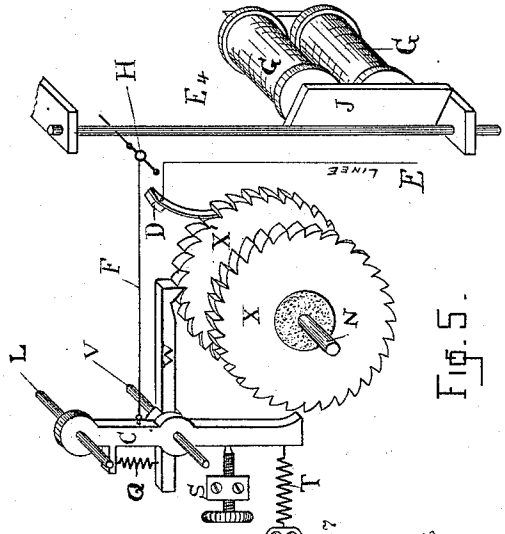


Fig. 5.

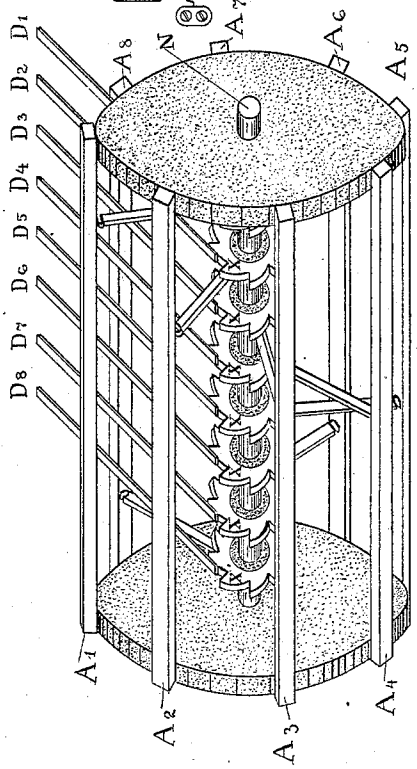


Fig. 4.

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(No Model.)

4 Sheets—Sheet 4.

# W. DECKER.

## AUTOMATIC TELEPHONE EXCHANGE SYSTEM.

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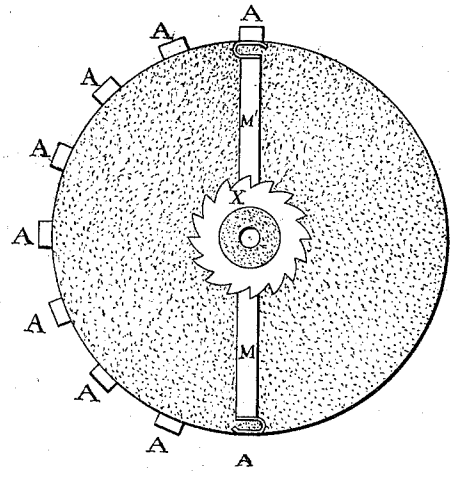


Fig. 6.

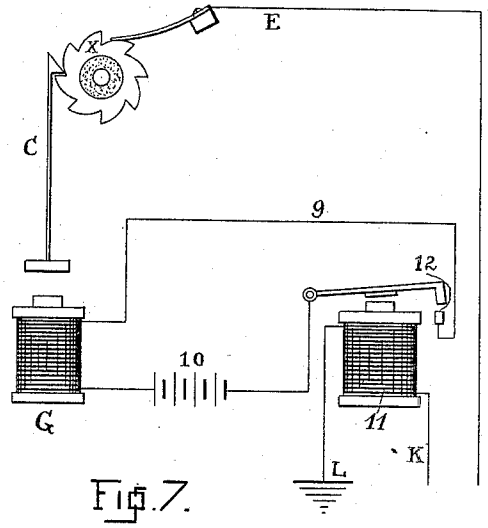


Fig. 7.

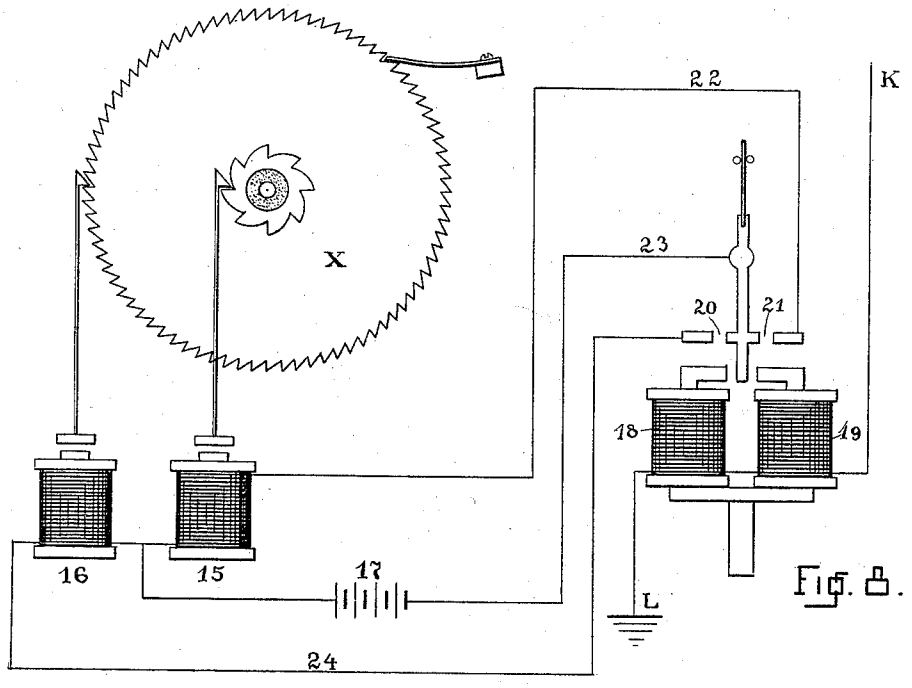


Fig. 8.

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# UNITED STATES PATENT OFFICE.

WARD DECKER, OF OWEGO, NEW YORK.

## AUTOMATIC TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 537,603, dated April 16, 1895.

Application filed May 14, 1894. Serial No. 511,085. (No model.)

*To all whom it may concern:*

Be it known that I, WARD DECKER, a citizen of the United States of America, and a resident of Owego, in the county of Tioga and State of New York, have invented certain new and useful Improvements in Automatic Telephone-Exchange Systems, (Case No. 5,) of which the following is a specification.

My invention relates to an automatic telephone exchange system and apparatus. Its object is to do away with the use of employés and managers at the central station, and therefore, to reduce the operating expenses. The special object of the invention is to simplify and otherwise improve the present systems having a similar object.

By "telephone lines" in the following description I mean those lines which are to be connected by the automatic central exchange device. They may be used also to connect circuits in telegraph systems; or in systems of seeing by electricity. It is applicable to any system in which apparatus at one sub-station is to be placed in electrical communication with apparatus at another sub-station, through a device located at an intermediate station.

I find it convenient to use the words "calling lines" to indicate those lines which are used for operating the switch board. Sometimes I employ for the central station switch board merely the words "the central station," and the outlying stations I call either "subscribers" or "sub-stations."

All the details of the invention are represented in the accompanying drawings.

Generally stated, the figures show the invention mostly in diagram, so as to bring out more clearly the individual elements which comprise the invention as a whole.

Figure 1 is an elevation of the apparatus employed at the sub-stations for operating the central station device, which may be called the switch board, while the device shown in Fig. 1, may be called a switch board transmitter. Fig. 2 is intended to represent the electric circuits from one sub-station to another sub-station through the central station switch board, which is represented as to its necessary elements in perspective. The transmitter in Fig. 1, is represented twice in Fig. 2, but only as to the mere outline of one or two of its elements. The switch board shown is adapted to put eight subscribers into electrical communication. Fig. 3 is a similar view to that shown in Fig. 2 for illustrating how two subscribers on one line may be connected to one subscriber on another line. In Fig. 2 only a portion of the switch board is shown; but in Fig. 4 there is a perspective view of all the connecting bars, ratchet wheels, and switches, as they stand at rest on an eight subscriber exchange. Fig. 4ª shows the system of cards at the sub-stations. Fig. 5 shows a modification of means for operating the ratchet wheels. It is a perspective view. Fig. 6 is a modification of an eight subscriber switch board in end view. The ratchet wheel has twice the number of teeth, and has two contact arms. All the contact bars can therefore, be arranged on one side of a circle. Fig. 7 illustrates the application of a relay for the operation of the switch board, so that the currents passing over the main line between the several stations need not be very much, because the local current which is operated by the relay may be caused to do all the work. Fig. 8 shows a modification of the arrangement shown in Fig. 7, whereby a polarized relay is employed, and whereby the number of sub-stations may be multiplied without materially increasing the intricacy of the central station switch board.

I will first describe the invention by particular reference to Fig. 1.

A, is a shaft capable of rotation in either direction and rigidly mounted thereon is the segmental wheel B, with eight raised surfaces $C'$, $C^2$, $C^3$, $C^4$, $C^5$, $C^6$, $C^7$, and $C^8$, and on one side the depression D, is considerably more in depth than the notches X, on the opposite side.

E, is an arm held in position on the wheel B, by the screw F, and is adjustable sidewise by the screw F, and slot G.

H, is an arm pivoted at J, and held against the stop K, by the spring L, so that the outer end M, is movable only to the left, as viewed from the center or shaft A.

N, is an arm of insulating material, while O, is a strip of conducting substance mortised into the side. The arm N, is pivoted at P,

and is held normally in position as shown, pointing toward shaft A, by the flexible strip or spring R, working between the two pins S, and S'.

T, is a cord or chain, one end fastened around the drum U, which is fastened rigidly on the shaft A, and the other end fastened to the spring V, which is fastened to the frame work at W, the tendency of the spring being to always bring the arm H, against the stop Y.

Z, is a binding post connected to the conducting strip O, and Z', another binding post connected through the frame work to the teeth C', $C^2$, &c.

The point 5 is simply a normally open contact point, whose use will be explained later.

6, 7, 8, 9, 10, 11, and 12, are holes of the proper size to hold the plug 13.

The shaft A carries the gear wheel *a*, engaging with the pinion *a'*, having a fan wheel *a''*, all so arranged in such a manner as to cause the shaft A when revolved by the action of the spring V, and chain T, to move at a comparatively slow rate of speed. Also, rigidly attached to shaft A, but not shown, is a crank, by the action of which shaft A, is turned by hand in a direction contrary to the pull of the chain and spring. When normally at rest, arm H, rests against stop Y, and arm N, points directly toward shaft A, as represented in the drawings. On revolving shaft A, together with its wheel and arm attached, in a direction to the right, as seen in looking at the drawings, arm N, is forced backward, and when arm H, passes the hole 6, arm N, drops into the first notch X, and by its end resting against $C^8$, prevents wheel B, from turning backward. This action continues on all the notches, until the last one C', has passed, when the arm N, drops into the depression D, and once more points directly toward the shaft A. While said arm N, has been making engagement with the wheel teeth, it has been touching said teeth only by its insulated side. The wheel B in its first movement is carried around so far that the arm N can entirely escape from the teeth and assume its radial position in reference to the center A, in order to be ready for the reverse movement of the wheel B, which will throw the arm N into the position shown dotted. Of course the wheel B need not be turned around in its first or forward movement any farther than simply to let the arm N drop into its radial position after the teeth have all passed it. Now, if shaft A, is released, it starts to travel back slowly by action of spring V, and retarding wheels, and arm N, is thrown in the opposite direction, as shown by the dotted lines in the drawings. The teeth on wheel B, one after the other, strike, first upon the conducting strip O, and then upon the insulating body of arm N, causing, by these alternate makes and breaks, successive impulses to travel over the lines attached to the binding posts Z, and Z'. Always suppose a battery or other source of electricity in circuit with said lines. Supposing, that before operating the transmitter, plug 13 to have been placed in some one of the holes, for example, in hole 10. In turning by hand in the direction toward the right, arm H, would spring past the plug 13 in hole 10, but on returning, going in the opposite direction, arm H, would not spring by, but would cause the entire stoppage of all the moving parts. Three impulses would have gone over the circuit. This circuit is attached to an operating magnet at the central station, and these impulses cause a switch at said central station, connected by another wire, to a telephone or other communicating instrument, located at the same substation as the transmitter, to have moved three contacts in advance, as will be explained hereinafter, and come incontact with a contact bar occupied by a switch from another sub-station, thus putting the two sub-stations in electrical connection with each other, and this connection will be maintained until plug 13, is removed from hole 10. During the stoppage of the moving parts by the plug 13, in the hole 10, communication may be carried on telephonically with a distant station until the two parties have finished their conversation. Then the plug 13 may be removed from the hole 10. When that occurs, wheel B, continues its rotation, making five more contacts with the conducting plate O, and by so doing makes its switch at the central station complete an entire revolution, and come to rest at the starting point. The whole system is now ready for use for the purpose of communicating again with the same or a different station and the operation if repeated would be substantially the same as above described, except that the plug 13 would be put into the proper hole according to instructions conveyed by the cards shown in Fig. $4^a$, hereinafter described. Further, in order to understand the above mere outline of communicating with a distant sub station, the reader is referred to matter stated hereinafter, where the remaining elements of the central station named in the operation are indicated by reference letters. In the last direction that wheel B, moves, the arm N, also makes engagement with the teeth C, and prevents backward motion, so that in operating, nothing but the complete number of impulses can be sent, as arm E, must be moved past all the holes before it can return, and when started back, must come to the starting point before another call can be made.

If, from accident, the subscriber's switch at the central station should come to rest on the wrong bar, for instance, five in advance of his own, he, ascertaining by calling the said fifth subscriber, the number he is on, and finding it five, and knowing that three more complete the cycle of eight, sends three impulses over the calling line by the key 5, and brings his switch at the central station to the proper position. It is evident that any subscriber on any size exchange, can re-set his switch, if disturbed, in the same manner.

The insulated pawl N, has a notch N'. If it were not for this notch, the same object would be accomplished only by having the teeth on wheel B in contact with the extreme end of the insulated portion of the pawl N, and by so doing, it could be moved backward far enough to send a wrong impulse before the pawl would strike against the next tooth; also, by the use of this notch, the arm H, on striking the plug 13, will bring a tooth on the wheel B, in such a position that the notch N', in the end of the pawl N, will prevent backward movement and will also prevent the conducting strip O, from making contact with the next tooth. This also prevents the battery from being maintained in circuit during the operation of the telephone or other instrument.

In Fig. 2, representing two subscriber's connections on an eight subscriber exchange, A', $A^2$, $A^3$, $A^4$, $A^5$, $A^6$, $A^7$, and $A^8$, are stationary contact rods or bars. X' and $X^2$ are ratchet wheels with eight teeth apiece, into which the pawls C', and $C^2$, play. The wheel's backward motion is prevented by the springs D' and $D^2$, engaging with said teeth. The springs D' and $D^2$ serve as conductors from the wheels X', and $X^2$, to the telephone lines E' and $E^2$, attached to sub-stations L, and M, respectively. M' and $M^2$, are arms with spring contact ends Q' and $Q^2$, and they are rigidly attached to, and in electrical connection with X', and $X^2$, which revolve on, but are insulated from the shaft N. Each ratchet wheel and arm is insulated from the other ratchet-wheels and arms. The other end of the circuits E', and $E^2$, are grounded at F', and $F^2$, respectively. G' and $G^2$, are electro-magnets controlled by transmitters H', and $H^2$, and batteries J' and $J^2$, over the lines K' and $K^2$, respectively. G' and $G^2$, are also connected to the common ground L. Batteries J' and $J^2$ are connected to ground at F' and $F^2$, respectively. Contact ends Q' and $Q^2$, are adapted to make contact, one after the other, with each stationary contact-bar in the A series. When normally at rest, contact-end Q', lies in contact with contact-rod $A^2$, while contact-end $Q^2$, is in contact with contact-rod A'. As shown in the drawings, sub-station L, has connected itself to sub-station M. Consequently both arms are in contact with rod A'.

Fig. 3, shows the same general connections, and is designated by the same letters as in Fig. 2, with the exception that one of the stationary bars $A^4$, is permanently connected to the common ground 1, and two sub-stations O, and L, are shown connected on the same line.

Fig. 4, as before explained, shows in perspective, all the contact arms of an eight subscriber exchange at rest in a spiral row, each in contact with a separate bar.

In Fig. 5, C represents an arm pivoted or journaled at L, and held when at rest, against the stop S, by the spring T. Pivoted on the arm C, at V, is another arm W, held in contact with the wheel X', by the spring Q. D is a spring pawl, which serves as a conductor from wire K, to wheels X and X'. G is an electro-magnet by whose action, through the armature, J, rocking shaft $E^4$, arm H, and rod F, the pawl W, and stop C, are operated. In operation a current is sent through the electro-magnet G, thereby attracting its armature J, and, through the action of the rocking shaft $E^4$ and arm H and rod F, pulls the pawl W, and stop C, forward. As W, moves forward, it turns wheel X', toward the right, but only as far as is determined by the stop C, for when the wheel X', has been turned to the required distance, the stop C, has engaged with the wheel X, thereby locking both the wheels, which are rigidly connected together and insulated from the shaft. Wheels X, and X', are duplicates, but are mounted on the shaft in such a manner that the teeth occupy reversed directions. The wheels, by this method, are prevented from turning farther than they should at one movement.

In Fig. 6, which shows a different arrangement of an eight subscriber exchange, the bars A, are all located on one side of the center, and the ratchet-wheel X, has twice the number of teeth, or sixteen, and has two arms M, and M', and makes but one half of a revolution at one operation. It is obvious that this construction can be modified still more by having three or more arms, and causing it to make one third or less of a revolution at each operation.

In the operation of this exchange, suppose, in Fig. 2, that arm M', instead of standing on connecting bar A', stands on its own, or $A^2$. Now if the sub-station L, wishes to call or put himself in communication with another sub-station, for instance, the sub-station M, he finds from a card with list of subscribers thereon, the proper number to call, which in this case is 7, as M's switch is seven in advance of his own. The subscriber then puts plug 13, Fig. 1, in the hole 6, and turns the shaft A, to the right as far as it will go. On releasing it, the mechanism travels back, as before described, and after sending seven impulses, stops, by reason of the arm H, striking the plug 13, in hole 6. Referring again to Fig. 2, it will be seen that the transmitter H', which is the one operated, has made and broken the circuit, beginning with the ground F', through the battery J', transmitter H' line K', magnet G' and ground L, seven times. This has caused magnet G' to attract and release its armature the same number of times and caused the ratchet C', to move the ratchet-wheel X', and arm attached, seven bars in advance, or in other words, to rest, as shown on bar A'. It will be seen that now station L, is in direct communication with the station M. The telephone circuit can be traced beginning with ground F', through the magneto calling apparatus, line E', spring D', ratchet wheel X', arm M', contact end Q', connecting bar A', contact end $Q^2$, arm $M^2$, ratchet-wheel $X^2$,

spring $D^2$, line $E^2$, magneto calling apparatus, terminating at ground $F^2$. The subscriber L, calls M, by a magneto or other suitable means, and maintains connection with him as long as desired. Referring to Fig. 1, it will be noticed that the wheel B, has been, during this time, in contact with the insulated notched end of arm N. On wishing to terminate the above described connection, the subscriber L, removes the plug 13, from the hole 6, releasing the mechanism and allowing it to finish its movement. In so doing it sends one more impulse over the line K′, and causes the magnet G′, to turn the wheel X′, and arm M′, one more notch, bringing the contact end Q′, in contact with the starting point, or bar $A^2$.

It is evident that suitable switches may be located at the various sub-stations so that a metallic return, a ground return, or both, may be used for telephoning purposes only. By metallic return, in this case I mean the use of the calling lines, as shown at K′ and $K^2$, Fig. 2; and it is evident that the calling lines and ground may both be used at the same time for the return telephone circuit. No signal or call that would disturb the electro-magnets G, should be sent.

It will be noticed that I locate batteries for connecting purposes at subscriber's end, instead of at the central station. This is because the mechanism would be more apt to be disturbed by lines becoming accidentally grounded, or otherwise disturbed, if batteries were located at the central station.

In Fig. 3, O and L, are two sub-stations connected on the same line. As they are normally in an open circuit to call each other, they must have their switch M′, at the central station grounded. This is accomplished by having one bar, as shown at $A^4$, permanently grounded. Station L, is known to station O, as No. 1, for one impulse is needed to place their switch on the grounded bar. Also station O, is known as No. 1, to station L, for the same reason, but in calling each other, one must be designated by a particular, individual signal, otherwise, these stations are operated in the same manner as the others. Two or more stations may be connected on any line or lines, but in these cases, individual signals, such as two rings, three rings, &c., each differing from the other, must be used by each subscriber on the telephone lines.

Fig. 3, shows station M, connected to lines E′, and $E^2$, so that by using an individual signal, either station O, or station L, may be called.

As will have been seen from the preceding description, each subscriber will have a list of all the other subscribers, with a proper calling number attached to each name. As shown in Fig. 4, each arm attached to the ratchet-wheel is connected through the ratchet-wheel to a spring; thus, the first arm is connected to the spring D′, the second to the spring $D^2$, and so on. As each subscriber is connected to one of these springs, for convenience I will call D′ and all the other D's "subscribers," and omitting the D, will simply designate them by numbers. At No. 1, is located a card containing the other seven subscribers' names. To call No. 2 from No. 1, would require one impulse, for that is the number needed to place No. 1's arm on $A^2$ with No. 2's arm. To call No. 3, two would be needed, for No. 4, three, and so on; but at No. 2's station the operation would be different. For No. 2, to call No. 3, would only require one impulse instead of two, as in the case of No. 1. For No. 2 to call No. 4 would need two instead of three at No. 1, and so on. At every station of the series it would require one less impulse than at the preceding station, that is, taking them as numbered in Fig. 4,—No. 1, No. 2, No. 3, &c. Therefore, for calling purposes, each subscriber bears a different number on each card located at the different stations. For example No. 3 is known as No. 3 to No. 8, as No. 2 to No. 1, as No. 1 to No. 2, and as No 7 to No. 4, and so on.

In Fig. 7, 11 is the relay magnet operated by impulses from the sub-station over the line K, to the ground L. 12 are the contacts operated by relay magnet 11, controlling the circuit through the local battery 10, operating the magnet G, over line 9. This is the preferable mode of using the exchange.

Fig. 8, shows an arrangement whereby, in a large exchange, eighty for example, ten bars or contacts may be moved over at one time, thereby reducing the time occupied in operating. 18 and 19 are the the coils of a polarized relay through which the line K, is directly connected to the ground L. 20, and 21 are its local contacts. 15, and 16, are the local operating magnets, and 17, the local battery. By sending impulses of one polarity, 16 will operate the wheel X, one tooth at a time. By sending impulses of the opposite polarity, 15 will operate and draw wheel X ten teeth at one time. In calling 79, 15 would be caused to act seven times, then 16 nine times, or vice versa, the transmitter at the subscriber's end being so arranged as to always send seven impulses in the direction to operate 15, and ten in the direction to operate 16, thus bringing the switch at the central station, back to the starting point after each operation. The transmitter may be two like Fig. 1, one arranged to send seven impulses, the other ten, of opposite polarities, and simple means can be used to operate one after the other, the batteries being suitably arranged.

Some of the changes obtained by my invention over the state of the art, are as follows:—First, each line is connected to a traveling switch, and permanently to nothing else, all the switches being hung on, and insulated from a common shaft, and capable of being rotated in one direction only, independently; second, each switch, at every complete oper-

ation at its connecting sub-station, travels over, in one direction, the entire series of bars, by doing which, all the contacts are always kept bright and clean; third, these bars are not connected to any line or circuit only as a switch rests on one; fourth, when normally at rest, the switches stand on and in contact with different bars, preferably one in advance of the preceding one, or in other words, in a spiral row; fifth, by so standing in contact, each bar serves the purpose of a terminal for that line whose switch is in contact with it; sixth, by moving (preferably by ratchet-wheel attached to switch and operated by independent line from sub-station) a switch from its own bar, to contact with another bar, two switches come in contact with this latter bar, and are therefore, connected, in the most simple manner; seventh, at the completion of the operation at the sub-station, (which may be interrupted for any length of time) the switch continues in the same direction and goes over all the bars and stops in contact with the original or starting bar, in readiness to call or be called again; eighth, in this system in necessary cases, two or more subscribers, or sub-stations, may be connected on the same line, a very important object sometimes, and although on a normally open circuit, (open at the central station) are enabled to call and communicate with each other on the same line and be connected with no other line; ninth, in case of accidental disturbance by reason of a partial ground, contact with electrically charged wires, or any other cause in which the normal resting point of any switch is disturbed or changed to a wrong bar, the switch at the central station can be righted or re-set to its proper position by simple means at the sub-station.

Referring to Fig. 4ª, representing cards used in a five station exchange: XY in order to call JS, sends one impulse; to call AB, two impulses; to call RM, three impulses; to call AL, four impulses. JS, to call XY, must send four impulses; to call AB, one impulse; to call RM, two impulses; to call AL, three impulses. AB, to call JS, must send four impulses; to call XY, three impulses; to call RM, one impulse; to call AL, two impulses, &c.

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.

In the claims I allude to electrical intercommunication, meaning not only telephonic communication, but other kinds, for example, transmission of visual images.

I claim as my invention—

1. In an automatic telephone exchange system, the combination of a backward and forward moving intermittent circuit closer for producing intermissions of currents during its backward movement only, means for stopping the circuit closer at any one of several predetermined positions during its backward movement, and a stop located at the normal position of the circuit closer for stopping said circuit closer at the end of its backward movement.

2. In an automatic telephone exchange system, a transmitter for operating the central station transfer instrument, consisting of the combination of a central axle, a notched disk forming an electric terminal, and rotary about the axle, a yielding electric terminal lying in the path of the projections formed by the notches, means for retracting the notched disk, and a plug for stopping the disk at any one of a given number of positions, said yielding terminal being insulated from the disk terminal during its former motion.

3. In an automatic telephone exchange system a transmitter for operating a central station transfer instrument, consisting of the combination of a backward and forward moving intermittent circuit closer, for producing intermissions of currents during its backward movement only and means for stopping the circuit closer at any one of several predetermined positions during its backward movement.

4. A system of electrical intercommunication consisting of a set of electrical conductors extending from sub-stations to a central station in which each conductor terminates in a switch only, a series of stationary "dead" bars $A'$, $A^2$, $A^3$, &c., arranged in the paths of the switches or terminals; a second set of electrical conductors from the sub-stations and connected at the central station through magnets to a return circuit and mechanisms at the respective sub-stations and central station whereby two or more terminals of the first set of conductors, may by means of the magnets in circuit with the second set, be automatically placed in electrical connection with each other through one of the dead bars.

5. An automatic switch board for a central station in a system of electrical intercommunication, consisting of the combination of stationary conducting bars, terminals, connected with the telephone lines for making contact therewith, and independently movable from the sub-stations, and means for automatically bringing two or more of the movable terminals into electric contact with one of the stationary bars.

6. An automatic telephone exchange system, consisting of the combination of parallel stationary conducting rods insulated from one another and arranged circularly, rotary electric terminals connected in circuit with telephones at different sub-stations and adapted to come in contact with any one of the said rods; and electro mechanical means located in circuit with intermittent circuit closers at the sub-stations for bringing two or more rotary terminals in contact with the same rod to complete the electric circuit between the sub-stations.

7. An automatic telephone exchange switch board, consisting of the combination of parallel conducting rods and radial arms, ratchet wheels carrying each one of the radial arms which are of such a length as to come in contact with the conducting rods, and the ratchet wheels being independently rotary upon an insulated rod, and electro mechanical devices for operating the respective ratchet wheels for the purpose of bringing two or more of the radial arms in connection with one rod.

8. An automatic telephone exchange switch board, consisting of the combination of stationary parallel conducting rods and radial arms, ratchet wheels carrying each one of the radial arms which are of such length as to come in contact with the rods, and the ratchet wheels being independently rotary upon and insulated from a rod, and electro mechanical devices for operating the respective ratchet wheels to bring two or more of the radial arms in contact with one rod, the said ratchet wheels being rotary in one direction only.

9. In a system of electrical intercommunication, a group of switches or contacts, each switch or contact being capable of rotation in one direction only, and when normally at rest in contact with a connecting rod or bar, by such contact making said rod or bar the terminal of the line or circuit attached to said switch or contact, said rods or bars being arranged in a circular row in the paths of all the switches or contacts.

10. In a system of electrical intercommunication conducting bars arranged in a circular row, a system of switches located, when normally at rest, in a spiral row and insulated from one another in such a manner that each switch is in electrical contact with its own independent stationary switch bar, thereby making such bar the terminal of the line or circuit attached to said switch or contact.

11. In a system of electrical intercommunication employing circuits normally open at the central station, of a contact A′ permanently connected to ground or other return circuit, and situated in the path of a movable terminal of a line which includes telephones in series with each other for furnishing a circuit for the said line, which is attached to said terminal when on said contact, independently of connecting said line with any other of the said terminals.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 7th day of May, 1894.

WARD DECKER. [L. S.]

Witnesses:
S. S. WALLIS,
E. A. HINCKLEY.