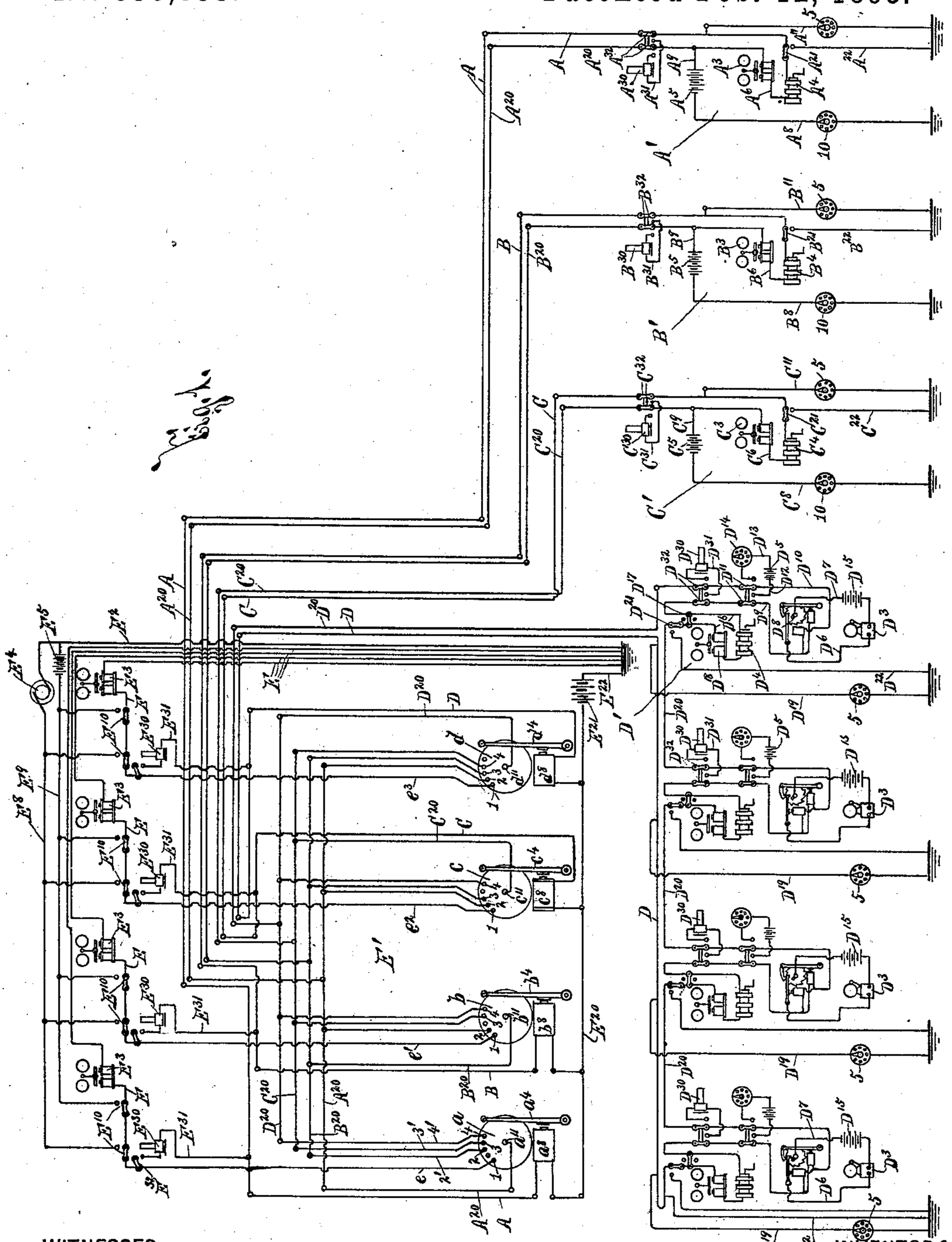
(No Model.) 3 Sheets—Sheet 1.

G. W. HEY & A. E. PARSONS.

ELECTRICAL EXCHANGE SYSTEM.

No. 533,893. Patented Feb. 12, 1895.



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(No Model.) 3 Sheets—Sheet 2.

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ELECTRICAL EXCHANGE SYSTEM.

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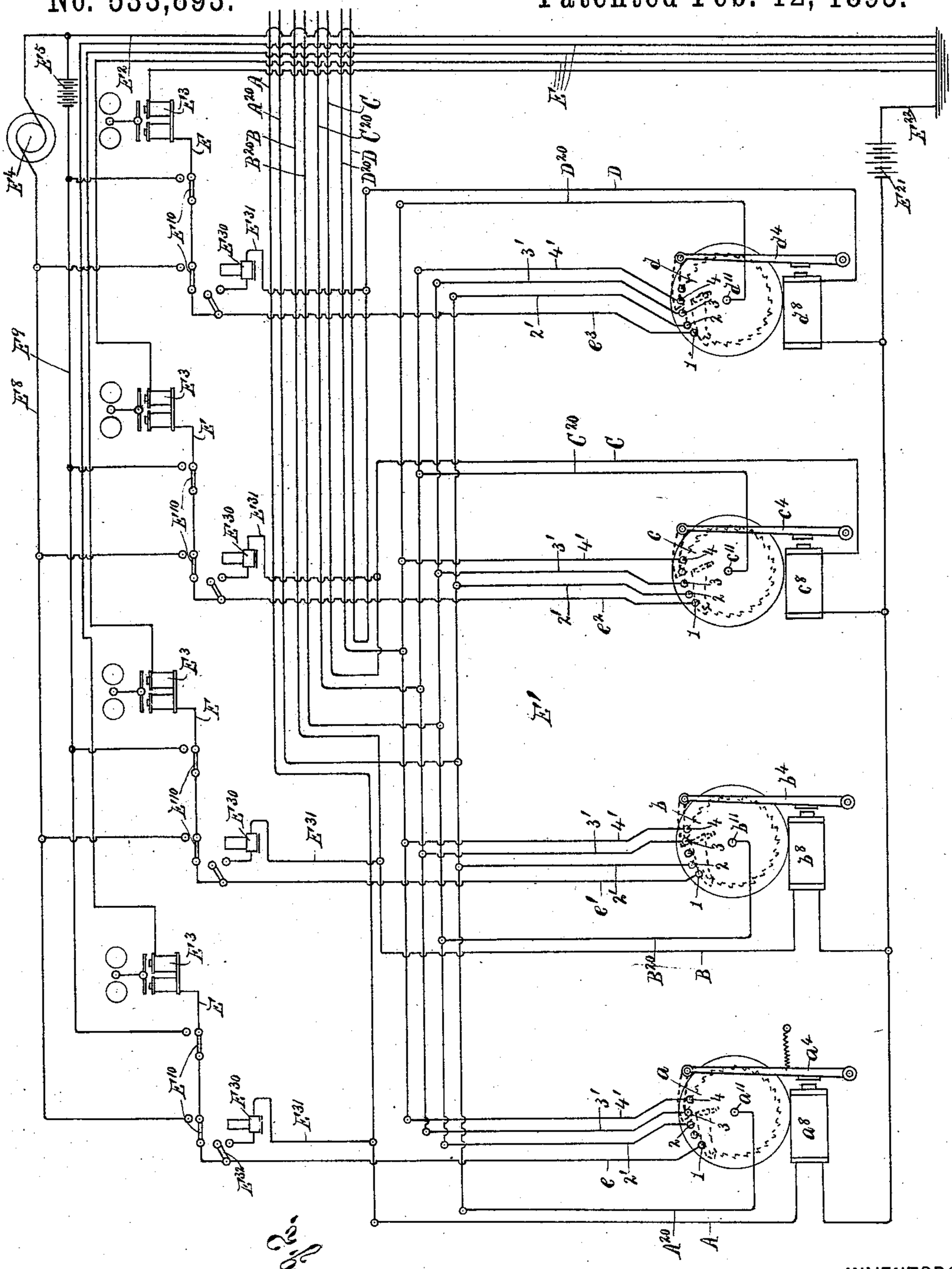

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ELECTRICAL EXCHANGE SYSTEM.

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Fig. 3.

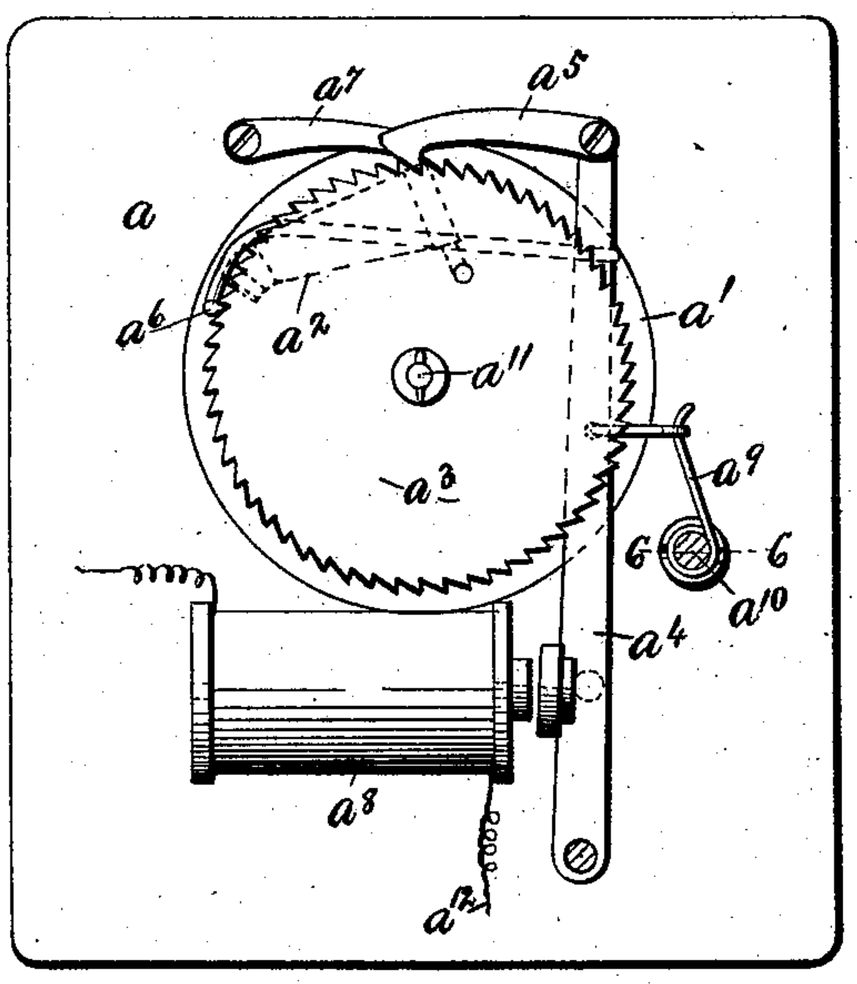


Fig. 4.

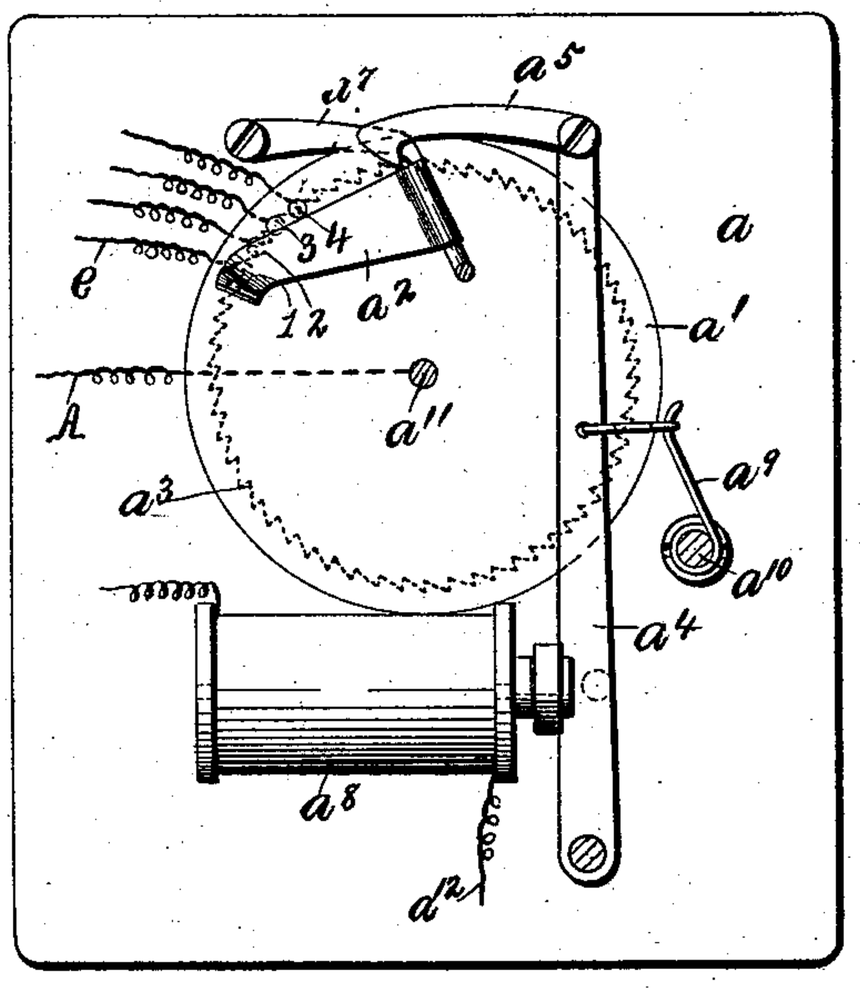


Fig. 5.

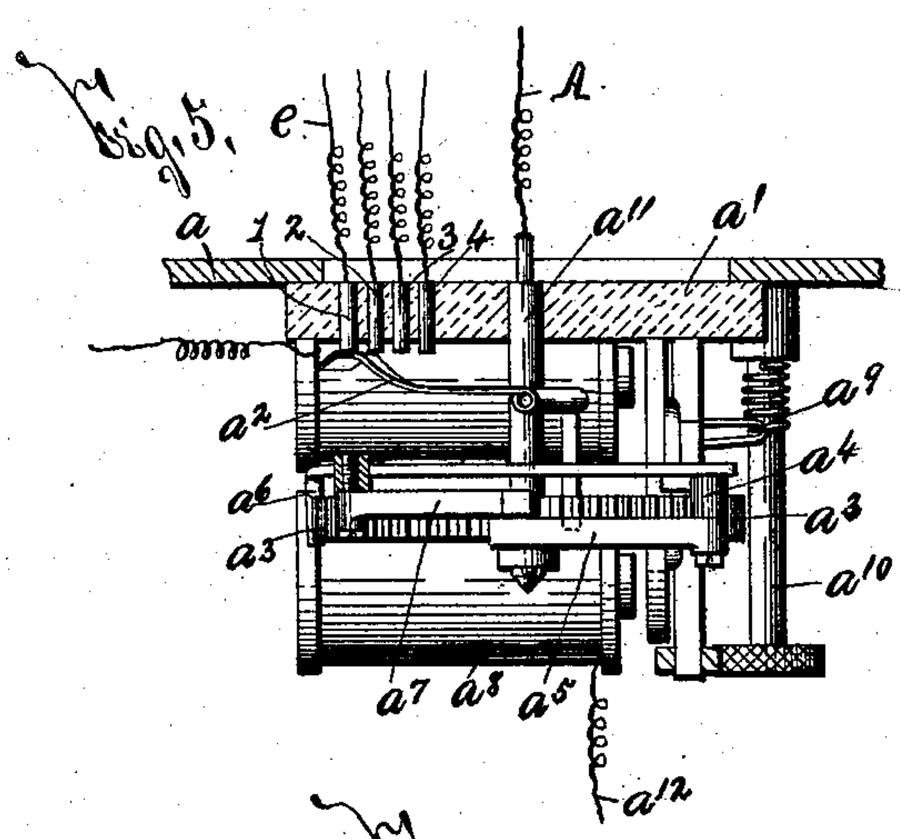
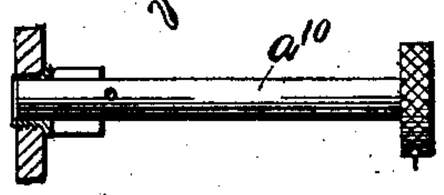


Fig. 6.



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UNITED STATES PATENT OFFICE.

GEORGE W. HEY AND ARTHUR E. PARSONS, OF SYRACUSE, NEW YORK.

ELECTRICAL EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 533,893, dated February 12, 1895.

Application filed March 30, 1893. Serial No. 468,374. (No model.)

To all whom it may concern:

Be it known that we, GEORGE W. HEY and ARTHUR E. PARSONS, of Syracuse, in the county of Onondaga, in the State of New York, have invented new and useful Improvements in Electrical Exchange Systems, of which the following, taken in connection with the accompanying drawings, is a full, clear, and exact description.

Our invention relates to improvements in electrical exchange systems for permitting communication between different metallic circuits as telephonic, telegraphic, &c., and has for its object the production of a simple, practical, and effective apparatus for accomplishing the desired result; and to this end it consists, essentially, all as hereinafter more fully described and pointed out in the claims.

In describing this invention, reference is had to the accompanying drawings, forming a part of this specification, in which like letters and numerals indicate corresponding parts in all the views.

Figure 1 is a diagrammatic view, illustrating the general construction and arrangement of an apparatus embodying our improved system. Fig. 2 is an enlarged diagrammatic view of the main station. Fig. 3 is an elevation of one of the detached switching devices. Fig. 4 is a similar elevation, the movable support for the movable terminal being removed and shown by dotted lines. Fig. 5 is a top plan view of the switching device shown at Fig. 2, the support for the terminals connected to the separate wires being shown in section, and Fig. 6 is a detail sectional view, taken on line 6—6—, Fig. 3.

A A^{20}, B B^{20}, C C^{20}, D D^{20}, represent the wires or conductors of a series of separate metallic circuits; *a*, *b*, *c*, *d*, automatic switching devices connected to the ends of the conductors A A^{20}, B B^{20}, C C^{20}, D D^{20}, and E a series of ground wires having branches *e e'*, e^2 e^3 connected respectively to the switching devices *a*, *b*, *c*, *d*. The wires E and the switching devices *a*, *b*, *c*, *d*, are preferably arranged at a main or common station E', and the wires A A^{20}, B B^{20}, C C^{20}, D D^{20} extend from the main station E' to a series of subscribers' stations A' B' C' D' D' D' D'.

As clearly seen at Fig. 1 we have illustrated a number of the stations D' arranged one after the other for forming sub-stations for the wires D D^{20}. The extreme outer end of the wire D is connected by a branch D^2 to the ground, and the inner ends of the wires A^{20}, B^{20} C^{20} D^{20} are, as presently described, normally connected to the ground wires E of the common or main station.

When our invention is used as a telephonic electrical exchange system the stations A' B' C' D' D' D' D' are provided with telephones A^{30} B^{30} C^{30} D^{30} D^{30} D^{30} D^{30} connected to loops A^{31} B^{31} C^{31} D^{31} D^{31} D^{31} D^{31}, which are connected by switches A^{32} B^{32} C^{32} D^{32} D^{32} D^{32} D^{32} to the metallic circuits leading from said stations, but it is unnecessary to illustrate or describe said telephones in detail, as their construction forms no essential feature of our present invention.

The stations A' B' C' D' D' D' D' E' are respectively provided with a series of signals A^3 B^3 C^3 D^3 D^3 D^3 D^3 E^3 and with a series of current generators A^4 A^5, B^4 B^5, C^4 C^5, D^4 D^4 D^4 D^4, D^5 D^5 D^5 D^5, E^4 E^5, for effecting the operation of said signals, all of which parts may be of any desirable form, size, and construction.

The signals A^3 B^3 C^3 consist of magneto-electric bells, and the current generators A^4 B^4 C^4 D^4 D^4 D^4 D^4 E^4 for operating said bells preferably consist of alternating-current generators, the generator E^4 being a dynamo electric machine for producing an alternating current and the other generators being magneto-electric machines.

The signals D^3 D^3 D^3 D^3 preferably consist of automatic electric bells, and the generators A^5 B^5 C^5, D^5 D^5 D^5 D^5 E^5 for effecting the action of said signals consist of direct current generators, which are here indicated as batteries, although it is evident that the generator E^5, and, if desired, any of the other generators may consist of a dynamo-electric machine for producing a direct current.

The signals A^3 B^3 C^3 are connected to the wires A^{20} B^{20} C^{20}, and are connected by short wires A^6 B^6 C^6 to the generators A^4 B^4 C^4, and the wires A B C are connected to said generators, and to the outer ends of ground wires A^{11} B^{11} C^{11}.

The generators A^5 B^5 C^5 are connected to the ground by short wires A^8 B^8 C^8 provided with suitable calls 10, and are connected by

wires A^9 B^9 C^9 to the wires A^{20} B^{20} C^{20}. The calls 10 normally break the circuits from the generators or batteries A^5 B^5 C^5 to the ground, and, when operating, permit the passage of a series of consecutive current pulsations from said generators through the wires A^8 B^8 C^8 to the ground and also through the wires, A^{20} B^{20} C^{20} to the switching devices *a*, *b*, *c*, *d*, and thence, as presently described, to the wire D^{20} and to the ground through the ground wire D^2.

The signals D^3 D^3 D^3 D^3 of the sub-stations D′ D′ D′ D′, which, as previously stated, preferably consist of automatic electric bells, are each connected by positive and negative wires D^6 D^7 to local generators or batteries D^{15} D^{15} D^{15} D^{15}, and each pair of said wires D^6 D^7 is connected to a circuit closer D^8 for normally breaking the circuit through said wires and preventing the operation of the corresponding signals D^3.

The circuit closers D^8 D^8 D^8 D^8 are each connected by wires D^9 D^{10} to the line wire D^{20}, and are so constructed as to be automatically operated by the passage through said line wire of predetermined current pulsations from the generators or batteries A^5 B^5 C^5, D^5 D^5 D^5 D^5 E^5. These circuit closers may be of any desired construction, providing they are so arranged as to be operated independently by predetermined current pulsations in order that any one circuit closer may be operated to close the local circuit from the battery D^{15} without effecting the similar operation of the others. Consequently by the passage of a predetermined number of current pulsations through the wire D^{20} any one of the circuit closers D^8 D^8 D^8 D^8 is operated at will to close a local circuit for actuating the signal D^3 of the station provided with said circuit closer, and the signals of no two of the stations D′ D′ D′ D′ are operated simultaneously.

In the pending applications, Serial Nos. 430,274 and 432,284, of George W. Hey there are shown circuit closers capable of being independently actuated, as described, by the passage of predetermined current pulsations through the line wire connected therewith, and consequently we do not deem it necessary to herein further illustrate and describe said circuit closers, since the circuit closers described in said applications may be used if desired.

The wires D^9 D^{10} of each station D′ D′ D′ D′ are provided with a switch D^{11}, and the generators D^5 D^5 D^5 D^5 are connected to the corresponding switches D^{11} D^{11} D^{11} D^{11} by wires D^{12} D^{13}, D^{12} D^{13}, D^{12} D^{13}, D^{12} D^{13}. Each of said switches D^{11} D^{11} D^{11} D^{11} is so constructed as to normally pass the current through the wires D^9 D^{10} from the wire D^{20} to the corresponding circuit closer, or to pass the current at will from the generator D^5 through the wires D^{12} D^{13} to the line wire D^{20}. A suitable call D^{14} is connected to each of the wires D^{13} for normally breaking the circuit through said wire and controlling the current pulsations passed therethrough from the corresponding generator D^5 to the line wire D^{20}.

The current generators D^4, as previously stated, preferably consist of magneto-electric machines, and are each connected to the line wire D^{20} by branch wires D^{16} having their upper ends provided with a switch D^{17} for normally connecting said upper ends and permitting the ready passage through the line wire D^{20} of current pulsations from the generators A^5 B^5 C^5, D^5 D^5 D^5 D^5 E^5, and preventing the retardment of the transmission of sound by the generators D^4 D^4 D^4 D^4, and the signals as magneto-electric bells D^{18} D^{18} D^{18} D^{18} in circuit with said generators.

The signals E^3 of the main station E′ are in circuit with the wires E, and these signals, although illustrated as magneto-electric bells, may consist of visual signals in order that the attendant may readily and conveniently receive the signal.

In practice, as presently described, each of the line wires A^{20} B^{20} C^{20} is connected normally to one of the wires of the main or common station E′.

The generators E^4 E^5 of the main station are connected to separate branches of a grounded wire E^2, and are also connected to wires E^8 E^9, which terminate at switches E^{10} upon the wires E connected to the branch wires *e e′*, e^2 e^3 leading from the switching devices *a*, *b*, *c*, *d*. These switches E^{10} are so constructed as to normally permit the passage of the current from the generators A^4 B^4 C^4 D^4 D^4 D^4 D^4, line wires A^{20} B^{20} C^{20} D^{20}, and switching devices *a b c d* through the branch wires *e e′*, e^2 e^3, to the signals of the wires E, and to also prevent the passage of a current through said wires E when desired to pass the current from either of the wires E^8 E^9 through said branch wires to the signals A^3 B^3 C^3 D^3 D^3 D^3 D^3 of the metallic circuits connected therewith.

The main station E′ is provided with one or more telephones E^{30} connected to loops E^{31} having corresponding ends terminated at switches E^{32} for connecting the same to the branch wires *e e′*, e^2 e^3, and having their opposite ends connected to the wires A, B, C, D. The wires E of the main or common station are independently grounded at the main station, as previously stated, and the line wires A^{20} B^{20} C^{20} D^{20} are provided with switches A^{21} B^{21} C^{21}, D^{21} D^{21} D^{21} D^{21} in proximity to the generators A^4 B^4 C^4 D^4 D^4 D^4 D^4 connected thereto. These switches form normally a part of the metallic circuit extending from the stations A′ B′ C′ D′, and normally permit the passage of the current through the wires A A^{20}, B B^{20}, C C^{20}, D D^{20}, but said switches may be connected to the adjacent ends of local ground wires A^{22} B^{22} C^{22} D^{22} D^{22} D^{22} D^{22} at the stations A′ B′ C′ D′ D′ D′ D′ for grounding the generators A^4 B^4 C^4 D^4 D^4 D^4 D^4 at said stations.

When the subscriber at one of the stations A′ B′ C′ D′ D′ D′ D′ desires to signal the main station he connects to the aforesaid local

ground wire of his station the generator at said station adapted to actuate the corresponding signal of the main station, and connected thereto by one of the line wires. He then readily actuates the signal of said main station by the operation of said generator, using the local ground wire, said line wire, and the wire E as the circuit.

As soon as a signal of the main station is actuated, as previously described, by any one of the current generators A^4 B^4 C^4, D^4 D^4 D^4 D^4 of the stations A' B' C' D' D' D' D' the person at the subscriber's station breaks the local ground connection by means of the switch therefor, as just described, and the attendant at the main station in charge of said signal, and the person at the subscriber's station immediately connect into circuit the telephones at said stations. On the contrary, if it is desired without the aid or even without the knowledge of the central station to operate by the current generator of one of the stations A' B' C' D' D' D' D' the signal at another of said stations, the switching device at the main station connected to the wires forming the metallic circuit leading from said station is operated, as presently described, to connect said circuit with the metallic circuit leading from the station provided with the signal that it is desired to operate, and said current generator is then in circuit with and free to actuate said signal. It will be understood, however, that, if it is desired, to operate the signal of one of the sub-stations D' D' D' D' by the subscriber at one of the stations A' B' C' that the direct current producing generator of the subscriber's station is connected to the corresponding line wire of the metallic circuit leading therefrom by the corresponding switching device at the main station for effecting said result, and that, by means of the call 10 connected to the ground wire of said generator, the necessary current pulsations are passed through said line wire, and its corresponding switching device to the line wire D^{20} and through the circuit closers D^8 D^8 D^8 D^8, whereupon the circuit closer connected to the signal, which it is desired to operate, is actuated to permit the passage of the local current to said signal, and the desired local signal is operated without bringing into action any of the signals of the other stations D'.

In order that our invention may be more thoroughly understood let it be supposed that the attendant at the station A' desires to actuate the signal B^3, the switching device *a* is operated, as presently described, to connect the wires A A^{20}, B B^{20}, and upon the action of the magneto-electric machine or other current generator A^4 at said station A', the signal B^3 normally in circuit with the wires B B^{20} is immediately operated. The persons at said station then connect the telephones A^{30} B^{30} into circuit by means of the switches A^{32} B^{32}, and said telephones are then connected together by a complete metallic circuit. Let it also be supposed that the subscriber at station A' desires to operate the signal D^3 at one of the stations D'. The wire A^{20} is connected to the wire D^{20} by the switching device *a*, current pulsations from the generator A^5 are passed through the wire A^{20} by means of the call 10, and are then passed through the switching device *a* and the wire D^{20} for operating the circuit closer D^8 connected to said signal D^3, and immediately said signal is actuated by the local current generator D^{15}. The telephones A^{30} D^{30} are then connected by the switches A^{32} D^{32} to the metallic circuits leading from said stations A' D'.

As the wires A^{20} B^{20} C^{20} D^{20} are normally in circuit with the corresponding wire E, as previously described, the attendants at the main station E' are able to call any of the stations A' B' C' by operating the switches E^{10} to connect the current generator E^4 into circuit with the branch wires *e e' e²* extending to the switching devices *a b c* connected to the circuits leading from said main station, and said attendants are also enabled to call any of the substations D' D' D' D' by similarly connecting the generator E^5 to the branch wire e^3 extending to the switching device *d* connected to the line wire D^{20} of the metallic circuit extending to the stations D' D' D' D' and by passing through said line wire D^{20} the required current pulsations for operating the circuit closer at the station which it is desired to call.

At Figs. 3 to 6 inclusive we have fully illustrated the switching device *a*, which is similar to the remaining switching devices *b c d*, and is only indicated in the previous figures. This switching device consists of a support *a'* preferably formed of insulating material, a series of terminals 1, 2, 3, 4, mounted on said support, a movable terminal a^2 for making contact with the terminals 1, 2, 3, 4, a movable support a^3 for moving the terminal a^2, and an armature lever a^4 connected to actuate the terminal support a^3.

The terminals 1, 2, 3, 4, of the switching device *a*, are clearly indicated at Figs. 1 and 2, and, as seen therein, and at Figs. 4 and 5, the terminal 1 is connected by the branch wire *e* to the corresponding wire E, and the terminals 2, 3, 4, are respectively connected by comparatively short branch wires 2' 3' 4' at the main station to the wires B^{20} C^{20} D^{20}. The armature lever a^4 of the switching device *a* is provided with a suitable feeding dog a^5 which engages a series of teeth in the edge of the movable support a^3, and said lever is provided with a stop dog a^6 for engaging the teeth of said support a^3 and preventing the feeding of said support more than a tooth at a time. A suitable stop dog as a^7 prevents the retrograde movement of the support a^3.

The lever a^4 is drawn forwardly by a magnet a^8, presently described, and, as the current is broken which energizes said magnet, a suitable retractor as a spring a^9 returns the armature lever to its normal position. The movable terminal support a^3, the armature

lever a^4, and the dogs a^5 a^6 a^7 are so arranged that the action of the magnet a^8 only draws the feeding dog a^5 into operative position, and the action of the retractor a^9 restores the feeding dog to its normal position and feeds the disk a tooth at a time. This is a particularly practical and effective construction of step by step movement, since the same is not in the least dependent upon the strength of the current energizing the magnet a^8, providing said current is sufficiently strong to enable the magnet to draw the armature lever a^4 to operative position, and consequently the feeding of the disk is very uniform and accurate. It is desirable, however, to provide an adjuster a^{10} for the spring a^9, and since this may be of any desirable form, size, and construction, we have shown the same as consisting of a revoluble pin for supporting one end of the spring a^9.

The wire A^{20} is connected to the shaft a^{11} of the movable support a^3 of the switching device a, and one end of the movable terminal a^2 of said switching device is connected by the movable support a^3 to said shaft a^{11}, and the opposite end of the terminal a^2 normally makes contact with or engages the terminal 1, thereby normally connecting the wires A^{20} E.

As the support a^3 is moved or rotated by the oscillatory movement of the armature lever a^4 occasioned by the action of the magnet a^8, presently described, the free end of the terminal a^2 makes contact successively with the terminals 2, 3, and 4, and by means of the branch wires 2′ 3′ 4′ extending from said terminals the wire A^{20} is successively connected to the wires B^{20} C^{20} D^{20}. It will be readily understood that the support a' may be provided with a greater number of terminals than illustrated, and that the wire A^{20} may be connected successively by the switching device a to all of the wires connected to the terminals of said support a.

The switching devices a, b, c, d, are all of similar construction, and consequently it is unnecessary to illustrate in detail the remaining switching devices b, c, d. We have, however, indicated at Figs. 1 and 2 the terminals 1, 2, 3, 4 of the switches b, c, d, and, as clearly shown at said figures, the branch wires e' e^2 e^3 connect the corresponding wires E to the terminals 1 of the switching devices b, c, d.

The terminals 2, 3, 4 of the switching device b are connected by the respective wires 2′ 3′ 4′ to the wires C^{20} D^{20} A^{20}. The similar terminals of the switching device c are connected by the branch wires 2′ 3′ 4′ to the wires D^{20} A^{20} B^{20}, and the terminals 2, 3, 4 of the switching device d are connected by the branch wires 2′ 3′ 4′ to the wires A^{20} B^{20} C^{20}. We have also illustrated at said Figs. 1 and 2 the armatures and shafts b^4 c^4 d^4, b^{11} c^{11} d^{11} of the switching devices b c d, and, as clearly seen at said figures, the wires B^{20} C^{20} D^{20} are respectively connected to said shafts, and we have indicated in said figures the actuating magnets b^8 c^8 d^8 for said switching devices. In order to facilitate securement of the branch wires 2′ 3′ 4′ of the switching devices a, b, c, d, to the wires A^{20} B^{20} C^{20} D^{20}, said wires, A^{20} B^{20} C^{20} D^{20} are provided at the station E′ with laterally extending branches only one of which is connected to the corresponding switching device. It will thus be readily understood that the initial or zero terminal 1 of each of the switching devices a b c d is normally connected to one of the line wires of the metallic circuit for the subscriber's station corresponding to said switching devices and to the corresponding wire E at the main or common station, and that the remaining terminals of each of said switching devices are connected respectively to the corresponding line wires of the separate metallic circuits extending from the main station.

The ends of the wires A B C D at the main station E are connected to the actuating magnets a^8 b^8 c^8 d^8 for controlling the operation of the switching devices, and are also connected to a common wire E^{20} having one end extended to a battery E^{21} grounded by a wire E^{22}.

In order that the action of said switching devices may be entirely under the control of the persons at the stations of the branch wires, a call 5 is connected to each of the ground wires A^{11} B^{11} C^{11} previously mentioned, and to local ground wires D^{19} D^{19} D^{19} D^{19} at the stations D′ D′ D′ D′ connected to the wire D, and, when said calls 5 are actuated, a series of current pulsations are passed from the battery E^{21} through the wires A B C D to the ground, and serve to energize the magnets a^8 b^8 c^8 d^8 and rotate the movable terminals a^2 b^2 c^2 d^2 of the switches a b c d. It will be understood, however, that each of these calls 5 operates independently, and that consequently each magnet a^8 b^8 c^8 d^8 is operated independently. These switching devices and calls are so relatively constructed that the complete action of the call causes the movable terminal a^2 of the switching device connected to said call to make a complete revolution, and said calls are also so constructed that, after one has rotated the movable terminal of the switching device connected thereto into engagement with the predetermined terminal of the switching device, the movable parts of said call are temporarily restrained from movement by a suitable stop pin or other device not necessary to herein illustrate or further describe. Said movable terminal then remains in this position until the movable parts of said call are again permitted to continue their movement and the movable terminal then completes its revolution and normally connects to the corresponding wire E, the line wire provided with said call. We have not deemed it necessary, however, to more than indicate the calls 5 at Figs. 1 and 2, since their detail construction and arrangement form no part of our present invention, and since it is well known to those skilled in the

art that a call may be operated to send through a line connected thereto any determined number of pulsations, and may in its movement be temporarily restrained, and will then continue its revolution or full movement at the termination of said restraint.

The construction of the various switches A^{32} B^{32} C^{32} D^{32}, D^{11} D^{11} D^{11}, D^{17} D^{17} D^{17} D^{17}, E^{10} E^{32}, A^{21} B^{21} C^{21} D^{21}, D^{21} D^{21} D^{21}, D^{32} D^{32} D^{32} D^{32} is evident to one skilled in the art, and, as the detail construction thereof forms no part of our present invention, it is unnecessary to further illustrate or describe the same.

It will thus be readily understood that the subscriber upon any of the wires A B C D is normally connected with the corresponding line E of the main station E′, and can either signal said station directly for any purpose whatever as to secure connection to an out of town line, or can at will by means of his automatic switching device, automatically connect himself with any of the other lines connected to his automatic switching device, and call the attention of the attendant at the subscribers' station of any of said wires by operating his magneto electric machine in the ordinary manner, and can effect this operation without the aid, or indeed without the knowledge of the attendants at the central station or the knowledge or inconvenience of the subscribers of the other line wires.

The normal connection of the wires E of the main station to all of the line wires leading from the main station enables the attendants at the main station to test the line wires in the usual manner.

The feature of great advantage of our system is that when the subscribers on any of the line wires are connected either to the central station or to the other line wires for talking therewith that complete metallic circuits connect the telephones at said stations, and, in order that these circuits may be more readily apparent, we will now proceed to briefly describe the same.

Let it be supposed that the subscriber at station A′ has signaled one of the attendants at the main station, and that said subscriber and the attendant have placed the switches A^{32} E^{32} so as to connect the telephone A^{30} to the wires A A^{20} and the telephone E^{30} to the branch wire *e* and the loop E^{31}. The metallic circuit connecting the telephones A^{30} E^{30} consists of the wire A^{20}, movable terminal a^2, normal terminal 1 of the switching device *a*, branch wire *e* connected by the switch E^{32} to the loop E^{31} provided with a telephone E^{30}, and the wire A connected to the loop A^{31} provided with a telephone A^{30}. On the other hand if the subscriber at station A′ has signaled the subscriber at one of the sub-stations D′ D′, and said subscribers have placed their switches A^{32} D^{32} so as to connect the telephones A^{30} D^{30} to the wires A A^{20} D D^{20}; the metallic circuit connecting said telephones consists of the wire A^{20}, movable terminal a^2 of the switching device *a*, fixed terminal 4 of said switching device, branch wire 4′, wire D^{20}, loop D^{31} connected to the wire D^{20} and provided with the telephone D^{30}, wire D, main station wire E^{20}, wire A, and the loop A^{31} provided with a telephone A^{30}.

It is thus apparent from the foregoing description that the telephones of our exchange are connected together by metallic circuits when in use; that corresponding wires of each circuit are normally connected together by the main station wire E^{20}, and that the opposite wires of said circuits are normally connected to grounded wires at the main station, and are automatically connected together by the corresponding switching devices.

It will also be evident that each station upon the line wires is provided with a ground wire adapted to be connected to one of the wires of the metallic circuit leading therefrom for operating the signal at the main station, and is also provided with an additional ground wire provided with a call and connected to the other wire of said metallic circuit for operating the corresponding switching device at the main station, which is controlled by a magnet connected to said wire.

Our invention will be readily understood upon reference to the foregoing description and the accompanying drawings, and it will be evident to one skilled in the art that it is particularly simple, practical, and effective and possesses features of great advantage and merit.

The switching devices at the main station connected to the various metallic circuits leading from said station, and the exact arrangement of wiring at the main and subscribers' stations may be considerably changed or varied without departing from the spirit of our invention, and hence we do not herein specifically limit ourselves to the exact detail, construction and arrangement of said parts.

Having thus fully described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. An electrical exchange system, the same consisting of a series of metallic circuits, and an automatic switching device suitably connected in said circuits and provided with means operated by electric currents passed over one of the wires of said circuits, whereby, one of said circuits is connected to any of the others, substantially as and for the purpose described.

2. An automatic electrical exchange system comprising a series of metallic circuits, each circuit being provided with an automatic switching device connected in one conductor thereof and each switching device being provided with connections to corresponding conductors of the remaining circuits, and a movable member connected to said conductor of each metallic circuit, and means operated by electric currents passed over one of the wires of the metallic circuit connected with said switching device for connecting said movable member to said connections, whereby one cir-

cuit is connected to any of the others, substantially as specified.

3. An automatic electrical exchange system comprising a main station, a series of metallic circuits converging at said main station and having corresponding conductors connected together, each circuit being provided with an automatic switching device connected in the other conductor thereof and each switching device being provided with connections to corresponding conductors of the remaining circuits, a movable member connected to the other conductor of the metallic circuit connected with said switching device, and means operated by electric currents passed over one of the wires of said metallic circuit for connecting said movable member to said connections, whereby one circuit is connected to any of the others, substantially as and for the purpose described.

4. In an electrical exchange system, the combination of a series of metallic circuits, each provided with a suitable transmitter and receiver, and an automatic switching device suitably connected in said circuits and provided with means operated by electric currents passed over one of the wires of said circuits, whereby one of said circuits is connected to any of the others, substantially as and for the purpose set forth.

5. An automatic electrical exchange, the same comprising a series of metallic circuits, sub-stations for one of said circuits, an automatic switching device connected in the circuit provided with the sub-stations and connected to the other circuits, and provided with means operated by electric currents passed over one of the wires of said circuit whereby said circuit is independently connected to the other circuits, and means at each sub-station for controlling the action of said automatic switching device, substantially as and for the purpose specified.

6. In an electrical exchange system, the combination of a series of metallic circuits each provided with transmitting, receiving, and signaling devices, and an automatic switching device connected to said circuits and provided with means operated by electric currents and connected to one of said circuits; whereby the operations of said switching device and said devices of the circuits connected by said switching device are effected by electric currents passed over said metallic circuits, substantially as set forth.

7. An electrical exchange system, the same comprising metallic circuits having corresponding wires normally connected together and their opposite wires normally disconnected, and an automatic switching device operated by current pulsations passed over one of the wires of said circuits for connecting said opposite wires together, substantially as and for the purpose specified.

8. An electrical exchange system, the same comprising metallic circuits having corresponding wires normally connected together and their opposite wires normally disconnected, wires as E normally connected to the disconnected wires of the metallic circuits, an automatic switching device connected to said metallic circuits and operated by electric current pulsations passed over the wires of said circuits for connecting and disconnecting the normally disconnected wires thereof, substantially as and for the purpose set forth.

9. An electrical exchange system, the same comprising a series of metallic circuits, an automatic switching device suitably connected to said circuits and operated by current pulsations passed over one of the wires of the circuits for connecting one of said circuits to any one of the others, and a call for controlling the action of said switching device substantially as and for the purpose set forth.

10. An electrical exchange system, the same comprising a series of metallic circuits, an automatic switching device connected in one of said circuits and operated by current pulsations passed over one of the wires of said circuits and connected to the other circuits, whereby said one of the circuits is automatically connected to the other circuits, a signal normally in circuit in one of said circuits, and means connected to another of the circuits for operating said signal, substantially as and for the purpose set forth.

11. The combination in an electrical exchange; of a series of metallic circuits, a series of telephones connected to the circuits, an automatic switching device connected in one of said circuits and operated by current pulsations passed over one of the wires of said circuits and independently connected to the other circuits, whereby the telephone connected to said one of the circuits is automatically connected to the other circuits, a signal in one of said circuits, and means connected to another of the circuits for operating said signal, substantially as and for the purpose described.

12. The combination in an automatic switching device; of a series of fixed terminals connected to a series of line wires of independent metallic circuits, and a pair of line wires forming a metallic circuit, one wire of said pair being connected to a movable terminal of said switching device and the other wire being connected to actuate said movable terminal, whereby the metallic circuit formed by said pair of wires may be connected to any one of the other independent metallic circuits through the medium of currents passed over the other wire of said pair, substantially as and for the purpose described.

13. The combination in an automatic switching device connected to a metallic circuit; of a series of fixed terminals and one movable terminal, an electro-magnet connected to one of the wires of said metallic circuit, mechanism connected to the movable terminal and operated by said magnet for connecting the movable terminal with any one of the fixed terminals, and a series of wires of independ-

ent metallic circuits connected to said fixed terminals whereby the metallic circuit connected to said switching device is automatically connected by said switching device to said series of metallic circuits, substantially as and for the purpose described.

14. In an automatic electrical exchange system, the combination of a main station having one or more signals, a series of metallic circuits leading to the main station, one wire of each circuit being normally connected to a signal at the main station, ground connections for the opposite ends of said wires, a series of switching devices at the main station for connecting the former wires to each other at the main station, magnets at the main station, connected to the latter wires and to said switching devices for operating the same, and mechanism at the opposite ends of the latter wires for controlling the action of said magnets, substantially as and for the purpose described.

15. The combination of the wires of a pair of metallic circuits; with an automatic switching device connected to one of said wires and provided with means for connecting said metallic circuits, ground connections for the wire connected to the switching device, whereby one conductor of the metallic circuit is utilized for passing the electric current necessary to actuate the switching device for connecting the metallic circuits, substantially as specified.

In testimony whereof we have hereunto signed our names, in the presence of two attesting witnesses, at Syracuse, in the county of Onondaga, in the State of New York, this 16th day of March, 1893.

GEORGE W. HEY.
ARTHUR E. PARSONS.

Witnesses:
CLARK H. NORTON,
E. A. WEISBURG.