No. 646,675. Patented Apr. 3, 1900.

E. E. CLEMENT.

TELEPHONE EXCHANGE SYSTEM.

(Application filed June 16, 1898.)

(No Model.) 3 Sheets—Sheet 1.

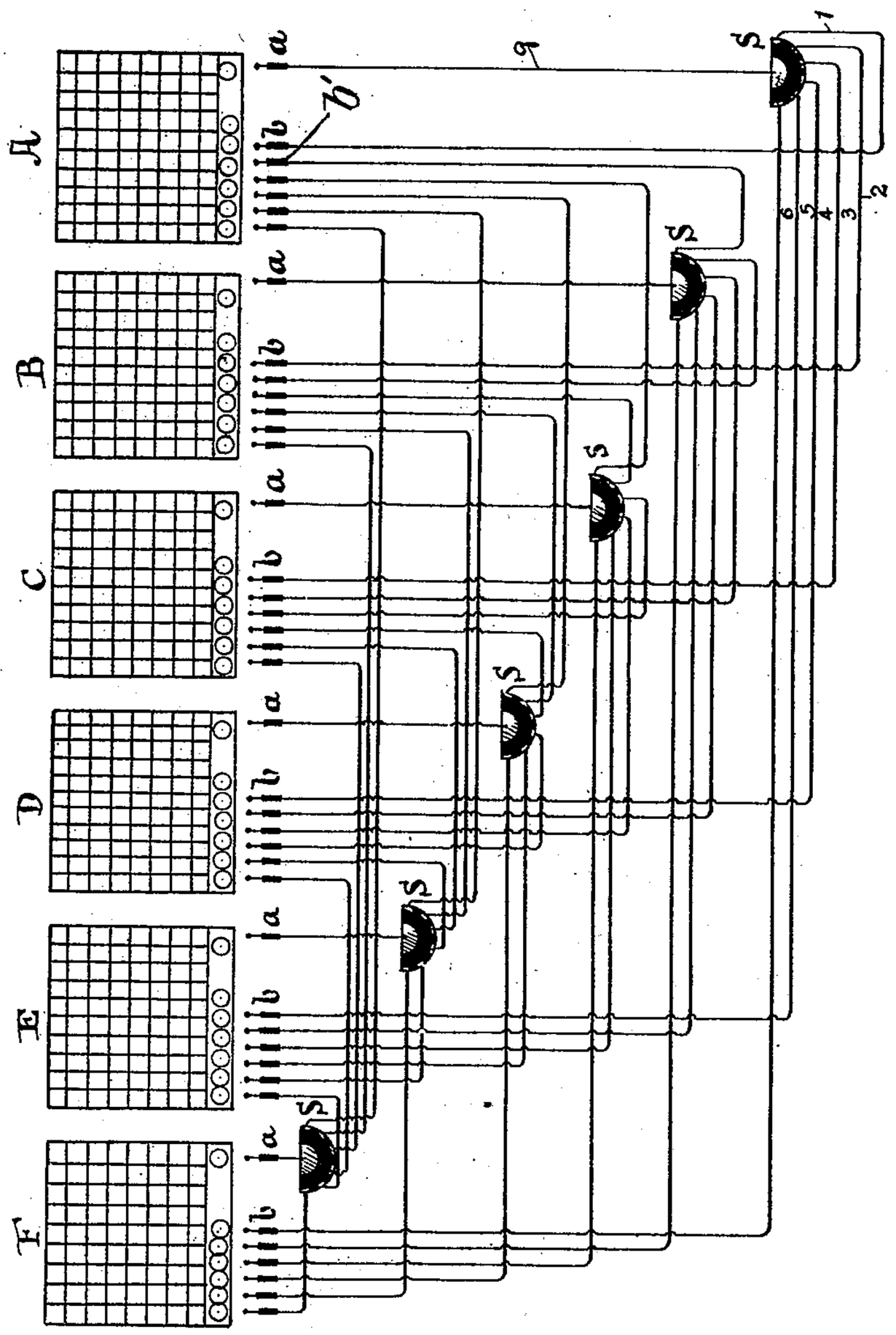

Fig. 1.

Witnesses:
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Inventor:
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3 Sheets—Sheet 2.

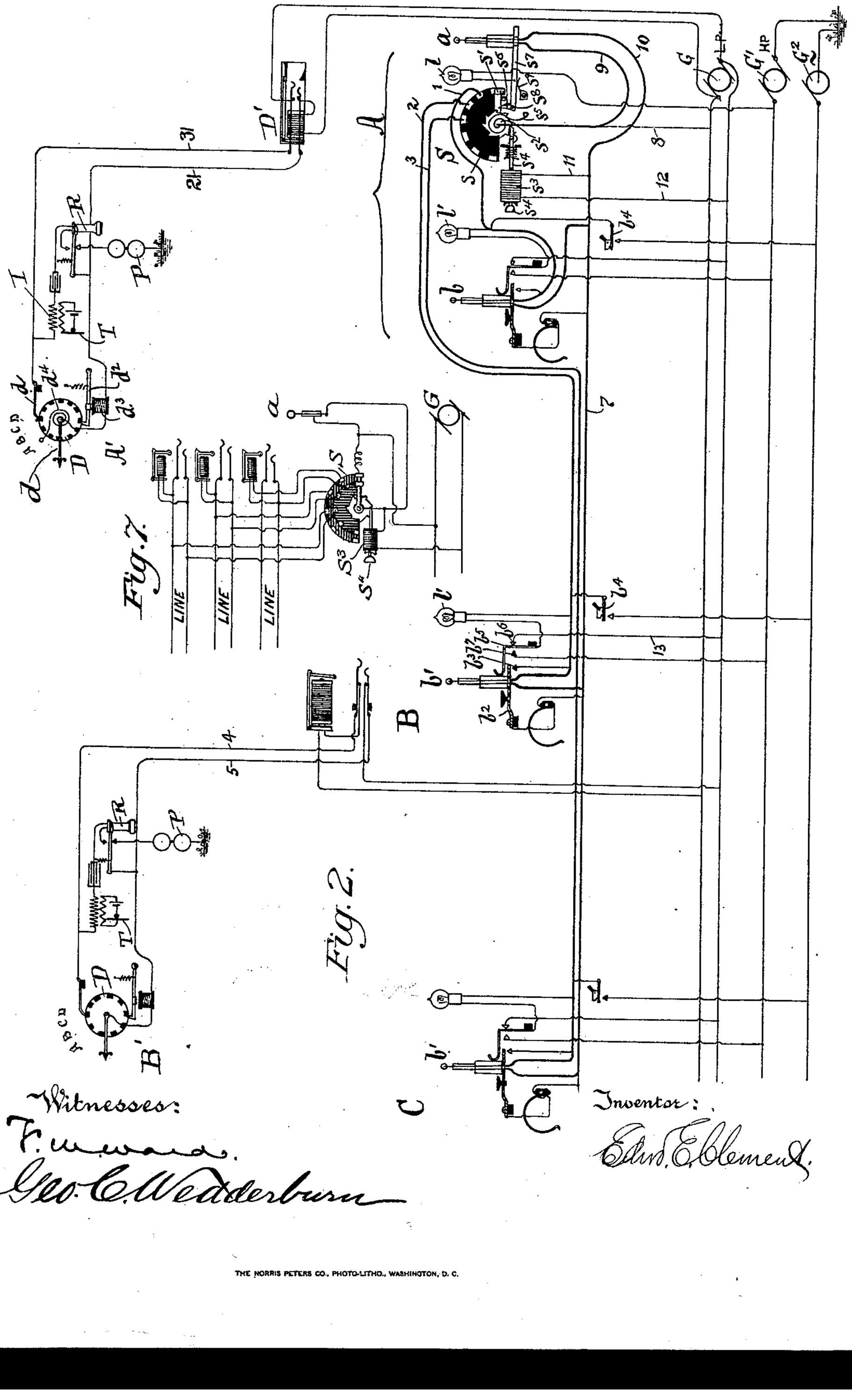

Fig. 1.

Fig. 2.

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3 Sheets—Sheet 3.

Fig. 3.

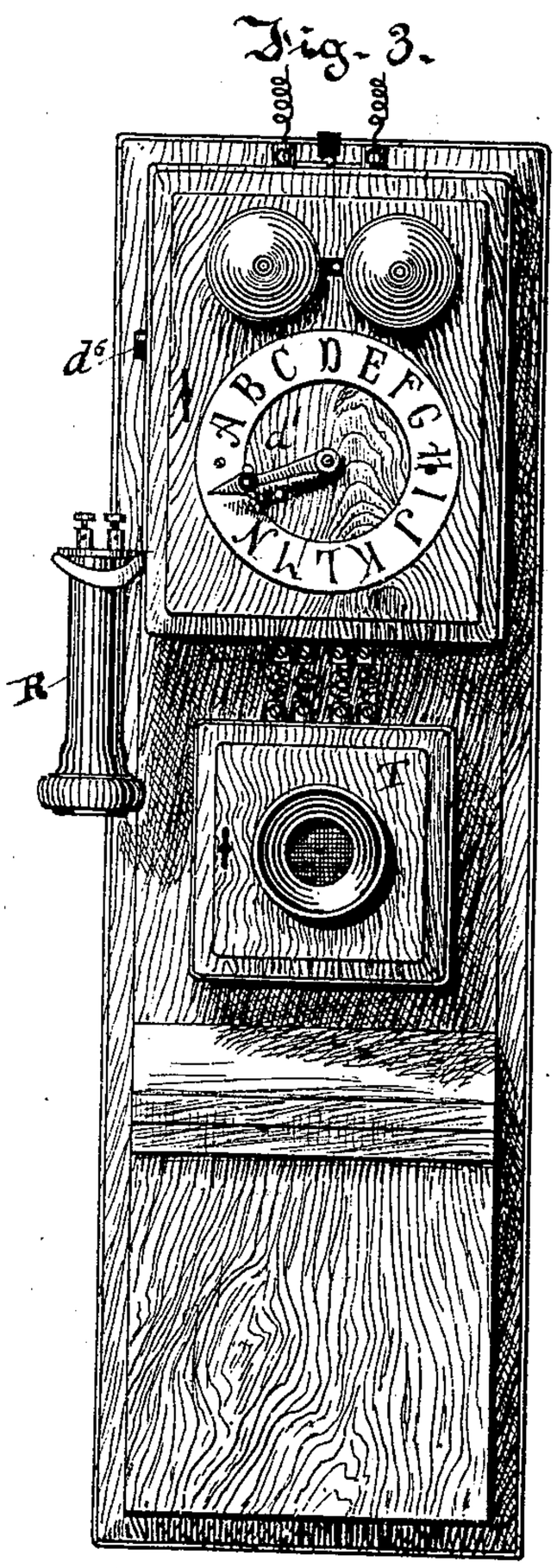


Fig. 4.

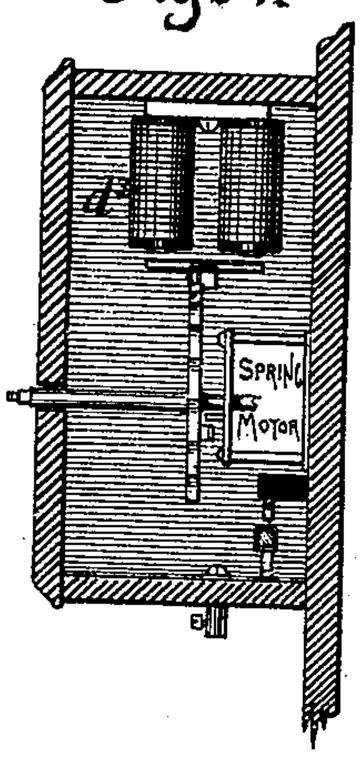


Fig. 5.

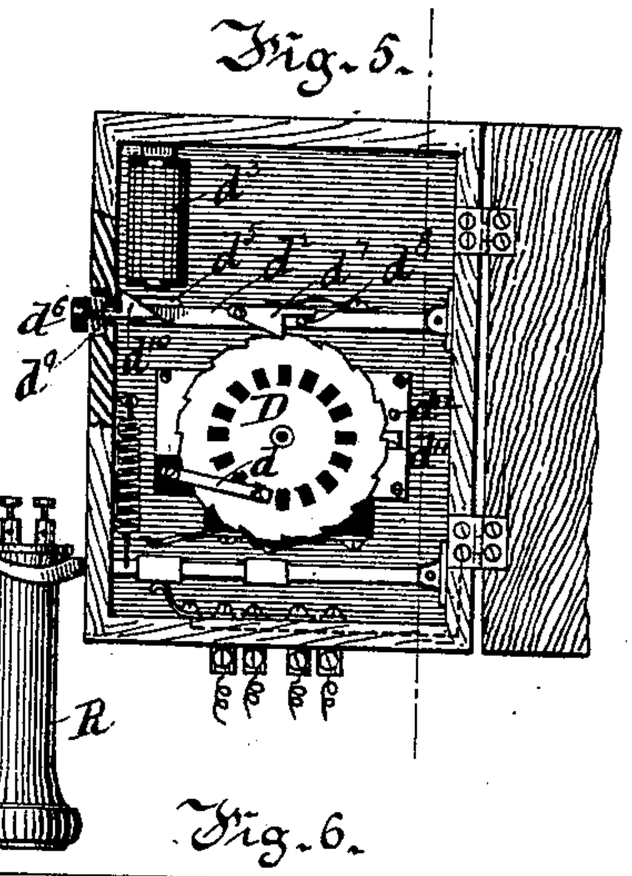
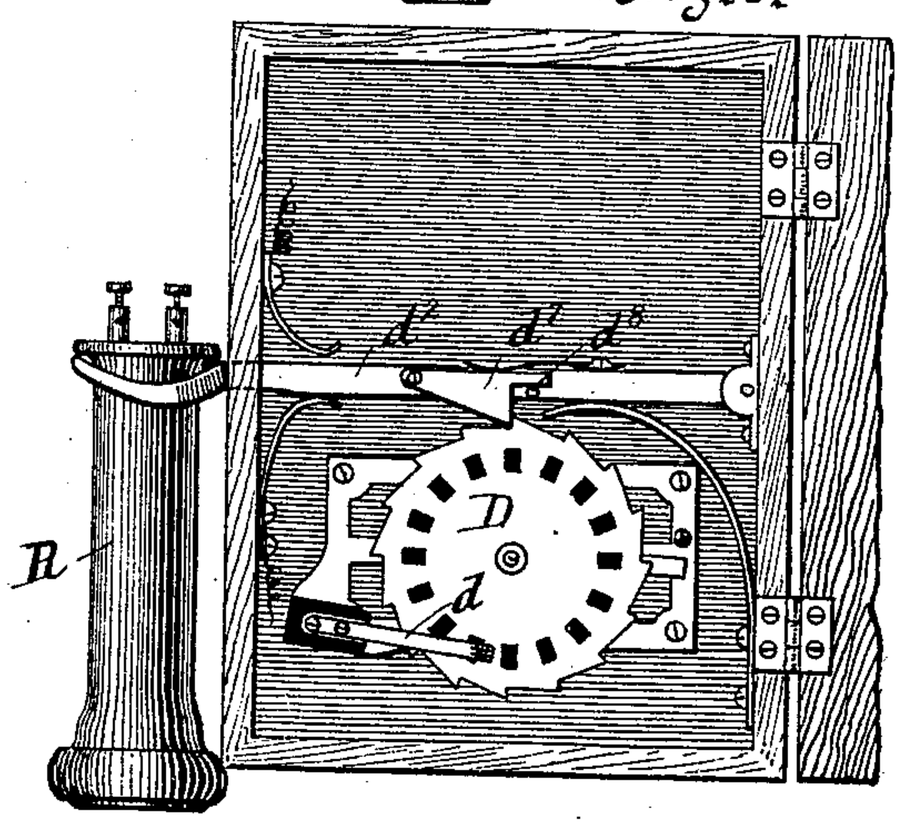


Fig. 6.



Witnesses:
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UNITED STATES PATENT OFFICE.

EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO THE SUN ELECTRIC MANUFACTURING COMPANY, OF NEW JERSEY.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 646,675, dated April 3, 1900.

Application filed June 16, 1898. Serial No. 683,652. (No model.)

To all whom it may concern:

Be it known that I, EDWARD E. CLEMENT, a citizen of the United States, residing in the city of Washington, in the District of Columbia, have invented a new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification.

My invention relates to the connective means employed in telephone-exchange systems and includes of necessity not only the central-office apparatus, but a portion of the apparatus at subscribers' stations.

My invention has for its object the simplification of the switchboard apparatus now required in large exchanges and the provision of means whereby all exchange work, regardless of the size of the exchange, may be expedited.

The invention is applicable to exchange systems having any number of subscribers over five hundred. With less than that number it could be used, but would probably not be economical.

The whole end and aim of a telephone central station is to enable any given subscriber to secure connection with any other subscriber with whom he may desire to converse and to disconnect the lines when the conversation has been finished. All the various methods which have been proposed and used from time to time to attain this connection and disconnection at will are divisible into two main classes—viz., manual and automatic—that is, those in which the operators manually perform the work incident to connection and disconnection and those in which all the work is done by a machine or machines under the control of the subscribers. Each of these classes has its advantages and disadvantages. The manual systems, speaking generally, have obtained better repute and are in general use because of their certainty of operation and their lower cost in the first instance. Automatic systems, so far as I know, have never been brought to such a state of perfection that they could be entirely relied upon, and in the few instances in which they have been installed it has been found that not only was their first cost high, but that the cost of maintenance actually approached, if it did not exceed, that of a manual exchange. Manual systems, so far as they are at present developed, are almost as gravely handicapped as the automatic systems, however. The enormous increase in the number of telephone users at the present day, which bids fair to be continuous, renders it necessary to furnish interconnection on a scale, especially in large cities, which positively prohibits reliance being placed upon any single exchange center. This means that the system of today to be successful must be divided in such a way that there will be independent connection centers, each serving the class of people who are most intimately related to each other in their business dealings and all interconnected by common lines, usually designated as "trunk-lines," through which subscribers connected to one center or local exchange may secure connection with those of another. Where all the lines of an exchange system not exceeding a few thousand subscribers are centered upon a single board, the so-called "multiple" switchboard has proved the most economical means for handling the business; but the trunk idea referred to above has been so convenient, particularly in the ease both of its extension and of its adaptability to new conditions, that it is only a question of a short time when the multiple board will give way entirely to trunking arrangements within the exchange operating-room itself. Theoretically speaking, the trunking system or, as it is sometimes called, the "divided central scheme" constitutes a perfect solution of the problem of interconnection first above stated. Practically, however, there are numerous conditions connected with the operation of any trunking system which must be overcome before its efficiency will be equal to the more limited multiple-board arrangement. Both the scheme and the difficulties in its practical execution are those always inherent in the subdivision method of handling large numbers. In any given case where a certain unit out of many is to be selected the most logical way to proceed is by a series of subdivisions. The difficulties involved in any case are the indirectness of the process and its consequent lack of speed. In order to

appreciate the importance of these points, it is only necessary to remember that the number of calls per day possible to be handled directly determines the earning capacity of an exchange, and consequently the size to which it can profitably be extended—that is, when the expenses of operation increase in a greater ratio than the receipts that can be expected to accrue the limit of size has been reached. The present invention relates entirely to divided central systems, and the leading assumption upon which it depends is that with any call received by the proper operator at any central station the subsequent amount of work in subdividing will be constant, depending only upon the number of subdivisions. Changes in apparatus at central can have but little effect upon the time required for the subdivisions, for the number of selections must always remain constant as long as those selections are performed entirely within the exchange. The leading feature of my invention is the provision of means whereby a subscriber performs his part of the necessary subdivision without inconvenience to himself, and that when a call is received upon the proper switchboard-section of the central office to which said subscriber is connected exercise of a mental process is required of one operator only who is called on to perform the last step in the subdivision. The invention even contemplates the removal of the necessity for this last mental act on the operator's part; but for reasons which will appear when the invention is fully disclosed such a development is problematic in its value.

I attain the objects and satisfy the requirements enumerated above by using a system which is part manual and part automatic, striving so far as may be to combine the speed and high theoretical efficiency of the automatic system with the certainty and low cost of maintenance of the manual system.

In all automatic systems, so far as I know, there is more or less selective apparatus connected directly to each subscriber's line and belonging exclusively thereto in the central office. In addition there must be, even in the best systems of the kind, a large amount of apparatus common to all the lines. It may be safely assumed that the main objection to which such a system is liable is not on account of the nature of the apparatus itself, but because of the quantity thereof and the ratio between any increase of such apparatus and the corresponding increase in the number of subscribers. There must be a multitude of contacts every one of which is liable to derangement, consequently requiring attention. Every subscriber's terminal selector must have a certain number of contacts and movable parts, dependent upon the number of subscribers which he is enabled to reach therewith. The number of these terminal selectors of course increases with the number of subscribers. Thus the increase in component elements or of selectors is as the square of the increase in the number of subscribers, for that same factor enters into the problem twice. This state of facts prohibits the use, in a successful system, of individual selective apparatus.

In manual systems requiring subdivisions—that is, the selection, through trunk-lines, of a particular group of subscribers' or other trunk lines and then the selection of a particular one of those subscribers' or trunk lines, and so on—one of two things is necessary. Either the operators conducting the successive steps in the subdivision and selection must communicate through the trunk-lines or over separate instruction-circuits or the subscriber must repeat to each successive operator with whom he is connected, as the selection proceeds, the instructions he originally gave to the answering operator. Both of these are objectionable. The first because it takes time which the operators could profitably employ in the active work of making and breaking connections for passing orders from one to another, and, moreover, an element of uncertainty is involved, because of the liability of a message or a number which is repeated several times to be erroneously changed. The second course is out of the question. In a system having many thousand subscribers where perhaps three steps would be required for the selection of a particular subscriber three repetitions by the calling subscriber would be necessary. No system could hope to give even the smallest degree of satisfaction to its users which involved such inconvenience.

In designing my system I have succeeded in arranging automatic selecting mechanism which is independent of the subscribers' lines which only increases in direct ratio to the increase in subscribers. In other words, I provide connective means in number bearing a percentage relation to the number of lines connected to the exchange that experience has shown to be necessary, and connected with each connective means, as a plug-and-cord circuit or trunk-line, I provide a selective device which performs automatically a part or all of the subdivision required. At each subscriber's station I provide a transmitter which is adapted to affect the said selective device when the latter has been brought into operative relation to the particular line with which the former is connected. I believe that I am the first to do this. I am aware that in the early days of the telephone art schemes were proposed whereby subscribers could select the particular switchboard upon which they desired connection; but, so far as I know, all such schemes required selective means for each line, which rendered them manifestly impracticable. I am not aware that it has ever been proposed to place such selective means within the cord-circuits or trunk-line circuits in exchanges themselves and only connect them to the lines in answering calls, and that manu-

ally. It will be seen at a glance that this not only enormously reduces the amount of selective apparatus and the attention it will require, but also permits the alternative old-fashioned manual work to go on side by side with the automatic, thereby affording an instant substitute for the latter in case of its failure to operate satisfactorily.

My invention is described and illustrated in connection with certain apparatus in the present application. Various other forms of apparatus embodying the same broad idea form the subject-matter of other applications filed and to be filed in the Patent Office. See the following: Serial No. 683,654, for a telephone-exchange system, filed June 16, 1898, and Serial No. 713,833, for a telephone-exchange system, filed April 21, 1899.

My invention is fully described in the following specification and the accompanying drawings, wherein the same letters and figures refer to the same parts throughout.

Referring to said drawings, Figure 1 is a diagram of an arrangement of switchboard-sections and plug-circuits at a central office embodying my invention. Fig. 2 is a more specific diagram showing all of the apparatus at two subrcribers' stations and throughout one cord or trunk circuit. Fig. 3 is a face view of one form of subscribers' apparatus constructed in accordance with my invention. Fig. 4 is a side view, and Fig. 5 is a face view, parts being in section in both views, of one form of a subscriber's impulse-transmitter. Fig. 6 is a front view of a modification thereof. Fig. 7 is a diagram of a modification.

Referring to Fig. 1, A, B, C, D, E, and F are sections of a switchboard in the central station. Upon each section a certain number of subscribers' lines terminate and are there provided with spring-jacks and annunciators. The spacing of the line-terminals is roughly represented by squares upon these sections. For the purposes of description I will assume that there is but one operator at each of these sections and that the board contains, say, one hundred drops. In practice the arrangement will be different, as it is possible with my apparatus to greatly increase the number of lines which one operator can care for and at the same time place more operators at one board, thus reducing the number of board-sections for any given number of subscribers. Proceeding, then, upon this assumption, it will be observed that each operator has upon her right hand an answering-plug *a* and at her left hand a number of connecting-plugs *b b'*, &c. Leading from the plug *a* in each case is a cord-circuit 9. Connected to this cord-circuit is a selective device S, to be hereinafter described. When it is operated, the circuit 9 may be connected to any one of the circuits 2, 3, 4, 5, or 6, leading, as shown, each to a plug *b* upon one of the other board-sections—that is to say, the answering-plug *a* at each board-section is represented by a connecting-plug *b* at each section. Each plug, whether *a* or *b*, is provided with a signal. The operation of the construction thus far described is as follows: When a subscriber calls, his line-annunciator exhibits its signal. The operator at the particular section upon which his line terminates inserts the answering-plug *a* in his jack. A series of changes are then caused in the circuit by the subscriber, which affect the selective device S in such a way as to cause it connect the circuit 9 of the answering-plug with the circuit 2, 3, 4, 5, or 6, leading to the particular section upon which the line-terminal of the subscriber with whom he wishes to communicate is located. A complete circuit then exists between the *a* plug and the calling-subscriber's line and a certain *b* plug. The signal of the *b* plug is thereupon displayed, and the operator upon that section commuicates with the subscriber and ascertains the number of the subscriber wanted. Having obtained this, she finishes the connection by inserting the *b* plug in the proper jack. It will be observed that the operator who answers the call does nothing but insert an answering-plug in the jack of the line calling. She pays no further attention to the matter until she sees the signal pertaining to that plug exhibited, which indicates to her that the conversation on that line is finished. She thereupon withdraws the plug. In the meantime, upon the insertion of the *b* plug in the called subscriber's jack, the signal pertaining to that plug became extinguished, and upon the completion of the conversation it relights, indicating to the operator at that section also that the conversation is finished, whereupon she withdraws the *b* plug.

Fig. 2 shows, diagrammatically, the elements of the apparatus required for the operation outlined above. A′ is a subscriber's station whose line terminates in connective means located on the A section of the switchboard. B′ is another subscriber's station whose line terminates in connective means located upon the B section. A, B, and C represent three sections with a plug-circuit therebetween. At each subscriber's station I locate the usual transmitter T, receiver R, polarized bell P, and induction-coil I. Their arrangement is a matter not germane to the present invention, but varying with the nature and requirements of the service. The bell P in Fig. 2 is represented as connected when the receiver is on the hook from one of the line-wires to ground, while the talking set when the receiver is off the hook is supposed to be bridged across the metallic circuit.

In addition to the ordinary apparatus at each subscriber's station I provide an impulse-transmitter or circuit-changer D, provided with a pen *d*, connected to one line-wire, a setting-hand d', a detent d^2, controlled by a magnet d^3, included in the other line-wire, and a restoring-spring d^4. The arrangement of this circuit-changer, as shown in Fig. 2, is such that when the setting-hand d' is at zero—

that is, unset—the pen d rests upon a break in the wheel, which may be, as is well understood in connection with transmitting-wheels of this character, a portion of insulation or an indentation in the wheel. Further, the relation between the insulating or cut-away portion of the wheel and the teeth which cooperate with the detent d^2 is such that when the pen is upon a conducting-tooth of the wheel the detent is in position to engage with a stop-tooth; but when the pen d is over the insulating or cut-away portion of the wheel the detent is not in position to stop the mechanism. This is to prevent the magnet from stopping the wheel when it is running down. The same end may be attained by making the armature of the magnet very sluggish in its action. The subscriber's station A′ is connected by line-wires 21 31 to an annunciator and spring-jack D′ upon the switchboard-section A. Current is constantly supplied through the spring-jack and annunciator D′ to the line-wires 21 31, and, in fact, to all the line-wires in the exchange by a common generator G. Normally this current has no effect to operate the annunciators, because while there is a difference of potential between the sides of the line they are normally open at the telephone hook-switch and at the transmitter. When, however, a subscriber has set his impulse-transmitter to select a particular switchboard-section, a circuit is closed across the line-wires through the said impulse-transmitter. Under these circumstances the annunciator D′ exhibits its signal; but the subscriber's transmitter remains set for the reason that the magnet d^3 is of very low resistance in comparison with the annunciator-magnet, and consequently insufficient current is allowed to pass to actuate the former. When the operator perceives the signal, she lifts the plug a from its seat and inserts it in the jack at D′. The jack-springs are thereupon raised off their anvils and the resistance of the annunciator removed from the circuit, leaving the magnet d^3 free to retract the armature d^2 and release the impulse-transmitter D. The impulses sent over the line directly affect certain apparatus in the plug-cord circuit, which I will now describe.

S is a step-by-step mechanism consisting of an insulating-disk s, upon which are located a number of terminal contacts, one for each section of the switchboard, including the one at which it is placed. Pivoted at the center of the disk and adapted to be moved around over these contacts successively is a traveling arm s', actuated through a toothed wheel s^2 by a magnet s^3 acting upon an armature and connecting pawl-carrying link s^4. In order to return the traveling arm to zero at the close of an operation, I provide a spiral spring s^5, attached at one end to the arm of the device and at the other to the shaft of the toothed wheel, this shaft being fixed and the toothed wheel being loosely journaled thereon. In order to hold the arm in any position to which it may be stepped, I provide a detent s^6, carried upon a lever s^7, pivoted at s^8, and normally forced upward by a spring s^9. The lever s^7 is normally depressed by the weight of the plug a, beneath whose seat it extends. Connected at one end to the lever s^7 and at the other end to one pole of a grounded generator G′ is a circuit containing a lamp or other signal l. Leading from the terminal contacts on the periphery of the disk s are wires 1 2 3, &c., each of which forms one side of the circuit of a plug b at one of the board-sections. The very first terminal contact on the disk, however, is not connected to any operator's board-section, but is connected to a trouble or complaint operator, who thus has a direct connection with all of the cord-circuits in the exchange. The second terminal contact is connected by wire 1 with the plug b on the A board-section, the third terminal contact is connected by wire 2 to the plug b' on the B section, and the fourth terminal contact by the wire 3 to the plug b' on the C section, and so on. A common return is provided which goes to all these plugs and the common plug a. The apparatus at each of these connecting-plugs b is the same. It consists of listening-in and calling means of any ordinary type. I have shown the listening-in means as a contact-arm b^2 and contact b^3, and the ringing means as a key b^4, adapted to complete connection from the individual line to the circuit of a grounded alternating-current generator G^2. Each plug is provided with a lamp or other signal l', one side of whose circuit is permanently connected to individual wire 1, 2, or 3 and the other side to a spring b^5, which extends into the plug-seat and is adapted to be engaged by the plug while in its seat and forced into contact with the anvil b^6. When the b plug is removed from its seat, spring b^5, which is already under tension, moves over, leaving the anvil b^6 and making connection with the anvil b^7, which is connected to the circuit of a grounded direct-current generator G′. The further operation after the insertion of the plug a into a calling subscriber's jack will now be understood. Current from the generator G passes through the wire 8, the cord-circuit 9, the tip of the a plug, the spring-jack at D′, line-wire 21, magnet d^3, impulse-transmitter D, pen d, line-wire 31, spring jack and sleeve of the a plug, cord-circuit 10, wire 11, magnet s^3, wire 12, and back to the generator G. The magnets s^3 and d^3 being approximately of the same resistance, both being low, will both operate, the latter to release the impulse-transmitter D and start it revolving and the former to step around the wheel s^2 in consonance with the makes and breaks in the circuit. If the setting-hand d' has been set to the letter B, there will be a sufficient number of makes and breaks to move the traveling arm s' around until it rests upon the contact-terminal connected to plug b' on the B board. When this has been

accomplished, the impulse-transmitter will have again reached zero and the pen d will rest upon the spot of insulation. A new circuit will have been formed from the generator G through the wire 8, traveling arm s', contact-terminal, and wire 2, the lamp-circuit on board B, to and through the lamp l' to the spring b^5, to the contact b^6, wire 13, and back to the generator. This will cause the lamp l' to become incandescent, and the operator at the B board is made aware that some one is calling upon the trunk-line connected with that plug. She thereupon depresses the plug, which brings the spring-arm b^2 into contact with the anvil b^3, and bridges her telephone set across the trunk-line. Having ascertained the number required, she lifts the plug from its seat and inserts it in the proper jack, immediately afterward depressing the ringing-key b^4, by which a current passes from the grounded alternating-current generator G^2 to and through the ringing-key b^4 at board-section B to the circuit-wire 2, to the tip of the plug b', to the spring-jack of the subscriber wanted, to his line-wire 5, to and through his telephone hook-switch and the bell to ground. When the plug b was removed from its seat, the spring b^5 was allowed to move away from the anvil b^6 and engage with the anvil b^7, thereby changing the circuit of the lamp l', so that in order to complete that circuit it is now necessary that there should be a ground upon the wire b^5, which, it will be perceived, will not again occur until the subscriber hangs up his telephone and cuts in his bell. The subscribers are now enabled to converse over a complete metallic circuit consisting of their line-wires, plug a, the wire 2, the common return 7, the plug b, and line-wires 4 5. When the subscribers have finished their conversation, they hang up their receivers. This completes the ground-circuits through both lamps $l\,l'$, the former of which was put into condition to receive this signal when the plug a was lifted from its seat by contact of the detent s^6 with the wheel s^2. The operators thereupon withdraw the plugs. The plug a by its weight forces the detent away from the toothed wheel s^2, allowing the spring s^5 to return it to zero, and the plug b presses the spring b^5 away from the anvil b^7 and again in contact with the anvil b^6, the entire cord-circuit being thus restored to its normal condition of disuse.

One form of apparatus at the subscriber's station which will serve to accomplish the results hereinbefore set forth is shown in Figs. 3 to 6, inclusive.

In Fig. 3 it will be perceived that although a telephone set of ordinary appearance is employed (shown, for the purpose of illustration, as having a backboard, bell-box, and a Blake transmitter) no hand-generator is provided; but instead thereof the setting-hand d' is provided upon the face of the bell-box, said setting-hand being adapted to sweep around and indicate letters or numbers corresponding to those designating the different board-sections at central.

Figs. 4 and 5 show the interior of the bell-box. Mounted upon the top of the box is a magnet d^3, in position to lift the armature d^5, attached to the detent-lever d^2. Pivoted upon the lever d^2 is a pawl d^7, normally resting against a stop-pin d^8, upon which it is held, if required, by a spring. Projecting through the side of the box is a resetting-button d^6, carried on a rod d^9, surrounded by a spring, which normally tends to force the button outward, and provided upon its inner end with a cam-surface d^{10}. The end of the armature-lever d^2 is provided with an inclined face which normally rests upon this cam-face in such a position that the pawl d^7 will properly engage the teeth of the wheel D. The wheel D is provided with a stop arm or projection d^{11}, which normally engages with a stop-pin d^{12}, and when in such position the contact-spring d is adjusted to rest upon an insulated spot on the wheel. In the position shown, however, in Fig. 5 the wheel has been set a single step, the pen resting between two insulated portions and the pawl engaging one of the teeth. It will be observed that the teeth upon the wheel D in this figure are provided with flattened crowns, the relation between these crowns and the insulated spots being such that the pawl d^7 will always be right upon a flattened tooth-crown when the pen d is passing over an insulated spot. When, however, the pawl reaches the face of a tooth and would, if not otherwise withheld, engage therewith, the pen is always upon the conducting-face of the wheel, and the magnet, having its circuit closed thereby, is energized to hold the armature up.

If in setting the signal the subscriber moves the hand too far, it is only necessary to press the button d^6 to lift the lever d^2 and the pawl d^7, whereby the wheel is released and may be reset.

It is understood, of course, that the wheel D is carried upon an arbor adapted to be rotated by the hand d^8 in the setting direction and to be returned when released by a proper spring-motor, which forms no part of the present invention.

In the modification of the transmitter shown in Fig. 6, on a somewhat-enlarged scale, no magnet is employed to release the signal. In this case the lever d^2 is the hook-switch lever which opens and closes the bell and talking circuits and being actuated by the receiver R. The pawl d^7 is pivoted and normally rests upon a stop-pin d^8 in the proper position to engage with the teeth of the wheel D; but the signal is retained until the subscriber removes his telephone-receiver from the hook, which he does only upon hearing a single stroke on his bell, which results from the operator having plugged into his line-jack, thereby connecting a grounded direct-current generator G′ thereto. If he desires to reset

his signal, he momentarily lifts the receiver and then allows it again to hang upon the hook.

I wish it to be distinctly understood that my invention is not limited to the use of the apparatus herein described, but contemplates many forms of such apparatus, some of which, together with valuable modifications and developments of the system itself, are illustrated and described in other applications of mine now pending or to be filed. It should also be understood that while I have described the invention as applied to connections in a system where the subscribers have terminals located upon divided boards, it may be used upon single boards for the purpose of enabling any given subscriber, when a plug has been inserted in his spring-jack, to connect himself with any subscriber upon the board. In this case the only change that would be required in the circuits shown in Fig. 2 would be the connection of the lines 1, 2, 3, &c., to subscribers' line-wires direct instead of to the plugs *b'*. This is indicated in diagram in Fig. 7, wherein *a* is an answering-plug, S is the switch controlled by magnet s^3, and the switch-contacts are shown connected to the lines back of the spring-jacks.

Having described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a telephone-exchange system, a switchboard carrying line-terminals, subscribers' lines connected thereto, and provided with selective apparatus at the subscribers' stations, operators' connective means, adapted to cooperate with said line-terminals, and a selective device connected with each operator's connective means, and adapted to continue the circuit to any one of a number of given points, as previously determined by the subscriber's instrument, substantially as described.

2. In a telephone-exchange system, a switchboard, line-terminals thereon, subscribers' lines connected thereto, and provided at the subscribers' stations, with selective transmitters; answering-plugs and cord-circuits at the switchboard, and mechanism connected with said cord-circuits adapted, when the said plugs are inserted in the line-terminals, to respond to the subscriber's transmitter, and connect the answering-plug with any desired one of a series of circuits, substantially as described.

3. In a telephone-exchange system, a switchboard, subscribers' line-terminals thereon, an answering-plug, calling-plugs, and circuits between said plugs, the calling-plugs being disposed upon different parts of the switchboard; and a selective mechanism connected with the answering-plug and adapted to be controlled by a subscriber, to connect answering-plug with any of the calling-plugs, substantially as described.

4. In a telephone-exchange system, a switchboard divided into sections, subscribers' lines having terminals grouped upon said sections, answering-plugs and calling-plugs at each section, and circuits leading therebetween, magnetic selective apparatus adapted, when actuated, to automatically connect an answering-plug with any desired calling-plug, and means whereby said selective apparatus is placed under the control of a subscriber in answering a call, substantially as described.

5. In a telephone-exchange system, a series of subscribers' lines, provided with connective terminals and signals, and means whereby a connection in response to a signal, is manually initiated by an operator, and thereafter, automatically controlled from the subscriber's station, substantially as described.

6. In a telephone system, a central office or exchange, a series of subscribers' lines terminating therein, each provided at the subscriber's station with automatic controlling means, and a number of automatic line connectors at the central office less than the number of subscribers' lines, each adapted to be manually connected to any subscriber's line, and thereafter controlled by the subscriber, substantially as described.

7. In a telephone-exchange system, a switchboard, subscribers' lines provided with terminals upon said switchboard, and a normally-disconnected selective device at the subscriber's station, means, whereby the setting of the subscriber's selective device, displays a signal upon the switchboard, and automatic connecting means adapted to be placed, by the operator, under control of the subscriber in response to said signal, substantially as described.

8. In a telephone system, a central office, subscribers' lines radiating therefrom, each provided, at the subscriber's station, with a normally-open selective transmitting-circuit, and a normally-closed signal-receiving circuit, and at the central office with a normally-closed signal-circuit; means whereby the subscriber may close his selective signal-circuit, and thereby operate the central-office signal, and automatic connecting devices at the central office adapted to be connected to the subscriber's line while disconnecting the central-office signal therefrom, substantially as described.

9. In a telephone system, two or more switchboards or board-sections, each provided with line-terminals, and lines leading from said terminals to different localities; connective means at each one of said boards, and circuits therebetween, and automatic selective means connected with certain of the connective means, and adapted, when the same are placed in connection with line-terminals, to be controlled through the lines, to complete connection through the boards, substantially as described.

10. In a telephone system, a subscriber's line, provided at the subscriber's station, with telephonic apparatus normally disconnected therefrom, a signal normally connected thereto, an impulse-transmitter and a magnet con-

trolling the same, in a circuit normally connected to the line, but broken at said transmitter, a signal for the line at the central office, a magnet for controlling the same, and a generator, both normally connected to the line, the generator-current being of a proper character to operate the signal-magnet, but not the transmitter-magnet at the subscriber's station, when said transmitter is set thereby closing its own circuit, operators' connective means at the central office, adapted to be connected to the line-wires while disconnecting the signal-magnet therefrom, a responsive circuit-controlling device in the circuit of said connective means, and suitable connections whereby the character of the current upon the line is so changed in the act of making connection therewith, that the subscriber's transmitter-magnet is operated, and the circuit-controlling device affected in response thereto, substantially as described.

11. In a telephone-exchange system, a series of boards or board-sections, subscribers' line-terminals grouped thereon, answering and calling plugs at each board, circuits leading from each answering-plug at one board to calling-plugs at two or more boards, and automatic means in the answering-plug circuit, adapted to be controlled by any subscriber with whose line it is connected, to complete a circuit from said plug to any one of its associated calling-plugs, substantially as described.

12. In a telephone system, a subscriber's circuit containing telephonic instruments in a normally-open bridge, and an impulse-transmitter or circuit-changer in another normally-open bridge, containing also a low-resistance transmitter-controlling magnet, a signal at the central office, and a magnet therefor, of high resistance, normally connected to the line and to a suitable generator of electricity, together with plugs and cord-circuits and automatic selectors connected thereto, whereby, when the subscriber's transmitter is set, the signal at the central office alone is operated, and when a plug is connected with the line-circuit, the signal-magnet is disconnected therefrom and the automatic selector connected in its place, to respond to the subscriber's transmitter, substantially as described.

13. In a telephone-exchange system, a series of switchboards or board-sections, subscribers' lines connected to terminals grouped thereon, answering and connecting plugs at each section, one terminal of each answering-plug being connected by a continuous line with the corresponding side of a number of connecting-plugs, the other terminal of the answering-plug being connected to a selecting device consisting of a movable conducting-arm, adapted to coöperate with a series of terminals, from each of which, a wire leads to the corresponding terminal of each of the connecting-plugs before mentioned, and a magnet for said selecting device connected to the plug-circuit, and adapted to be brought under the control of a subscriber when connection is made with his line, substantially as described.

14. In a telephone-exchange system a switchboard divided into sections, subscribers' lines connected to terminals grouped thereon, answering and calling plugs at each section, each answering-plug adapted to be connected to any one of a series of calling-plugs upon different sections, automatic means connected with the plug-circuit and adapted to be controlled by the subscriber, for effecting such a connection, and a signal for each calling-plug connected to its circuit, and a suitable generator, substantially as described.

15. In a selecting device for telephone-switchboards, a series of terminals connected to the various sections of a switchboard, a movable conducting-arm adapted to coöperate with said terminals, a connecting-plug connected to said movable arm, a detent adapted to retain said arm in contact with any given terminal, and means controlled by the movement of the plug for operating said detent, substantially as described.

16. In a selecting device for telephone-switchboards, a series of terminals connected to calling-plugs, a movable part adapted to make contact with any of said terminals, and, itself, connected to an answering-plug, and a controlling-detent for said movable part, adapted to be operated by the removal of the answering-plug from, and its replacement in, its seat, substantially as described.

17. Connecting means for telephone-switchboards, each consisting of an answering-plug and a series of calling-plugs, a selective device comprising a series of terminals connected with the calling-plugs, a common terminal adapted to make contact with any of said terminals and connected to the answering-plug, and a magnet for effecting the movement of said common terminal, connected to the answering-plug circuit, and adapted to be placed under the control of a subscriber when connection is made with his line in answer to a call, substantially as described.

18. Connective means for switchboards, each comprising an answering-plug and a number of calling-plugs, a series of adjacent terminals, each connected to a calling-plug, a movable terminal connected to the answering-plug and normally resting in an idle position, a magnet connected with the answering-plug circuit, and adapted to cause the movable terminal to make contact with any one of the calling-plug terminals, and means controlled by the movement of the answering-plug, in making or breaking the line connection, to return said movable terminal to its normal idle position, substantially as described.

19. In connective means for telephone-switchboards, a series of plugs and circuit-controllers therefor, supervisory signals con-

nected to said circuit-controllers, and operative only while the circuit-controllers are set, means actuated by the movement of the plugs in disconnecting through-circuits, and returning the plugs to their seats, to restore said circuit-controllers and simultaneously efface said signals, substantially as described.

20. In switchboard apparatus for telephone systems, answering and calling plugs, circuits for interconnecting the same, and circuit-controllers therefor, each circuit-controller consisting of fixed and movable terminals, a magnet or magnets connected with the answering-plug circuit and controlling the engagement of the fixed and movable terminals, a detent for each circuit-controller, a supervisory-signal circuit, and means whereby said detent is controlled by the movement of the answering-plug, and itself controls the supervisory-signal circuit, substantially as described.

21. In a telephone-exchange system, a series of switchboards or board-sections, answering and calling plugs at each board, means placed under control of a calling subscriber in answering his call, for connecting the answering-plug with the circuit of any one of a number of calling-plugs at the different boards, and a signal for each calling-plug, connected to the circuit of that plug, and to a suitable generator, substantially as described.

22. In a telephone-exchange system, a series of trunk-lines interconnecting board-sections, each trunk-line having a common answering-terminal and normally-incomplete circuits leading therefrom to a number of calling-terminals, means for completing any one of said circuits at will, a signal connected to the circuit of each calling-terminal, and serving, in its normal position, as an advance signal for that terminal of the trunk-line, and means whereby, during the use of the calling-terminal in completing a connection, the said signal is switched into position to serve as a clearing-out signal, substantially as described.

23. In switchboard apparatus for telephone-exchanges, a trunk-line, a terminal-plug therefor, a signal associated with said plug, and connected upon one side to the plug-circuit, and upon the other to a spring-contact in the plug-seat, fixed terminals between which, said spring-contact is adapted to move, and connected to separate generators in such manner that, when the plug is in its seat, the signal serves as an advance signal for the trunk-line, and at all other times as a supervisory or clearing-out signal, substantially as described.

In testimony whereof I have hereunto set my hand, this 15th day of June, A. D. 1898, in the presence of two witnesses.

EDWD. E. CLEMENT.

Witnesses:
MORTIMER A. JONES,
JNO. W. SCOTT.