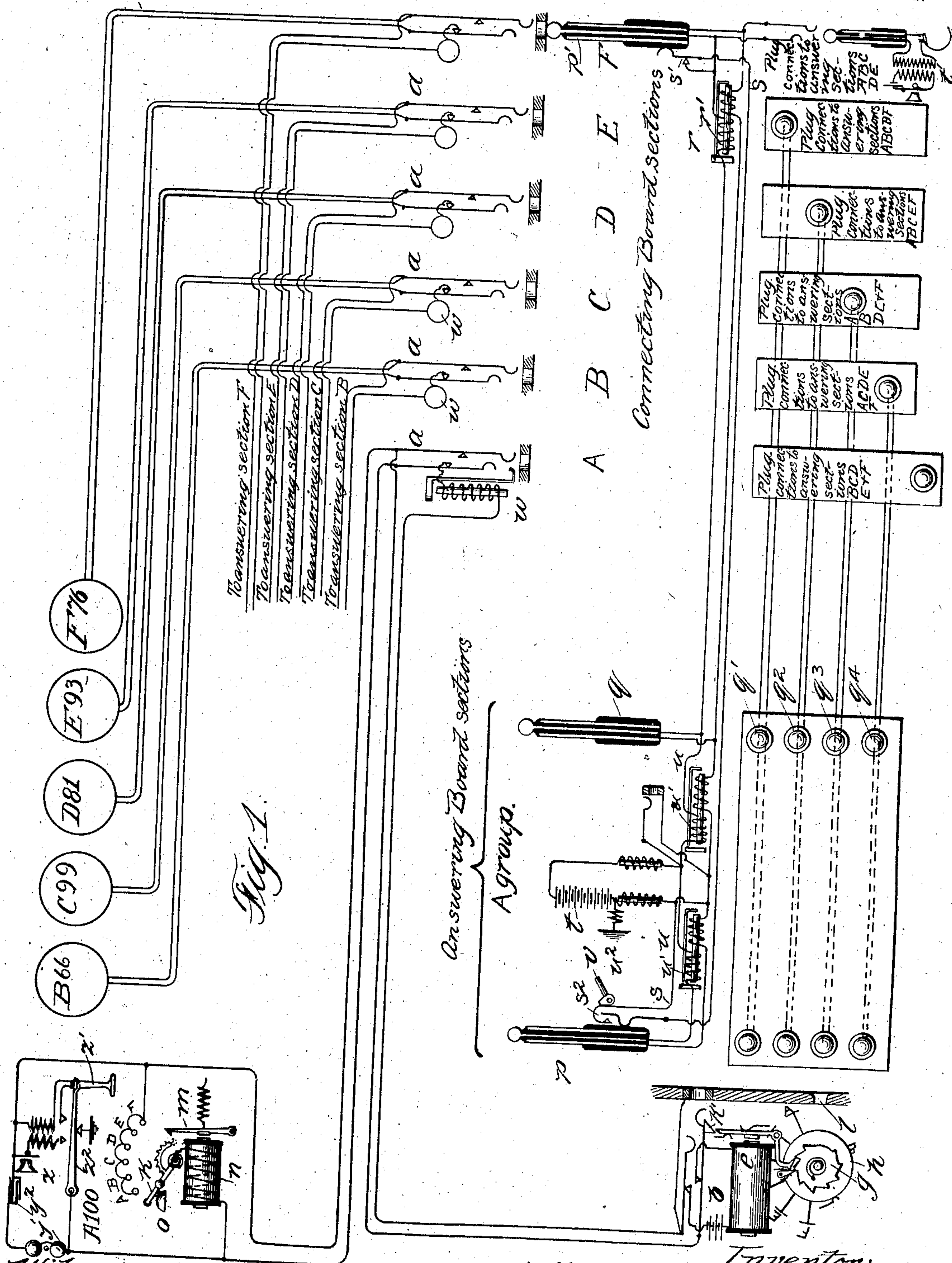


No. 816,135.

H. D. STROUD. PATEN  
TELEPHONE EXCHANGE SYSTEM.  
APPLICATION FILED MAR. 25, 1901.

PATENTED MAR. 27, 1906.

3 SHEETS—SHEET 1.



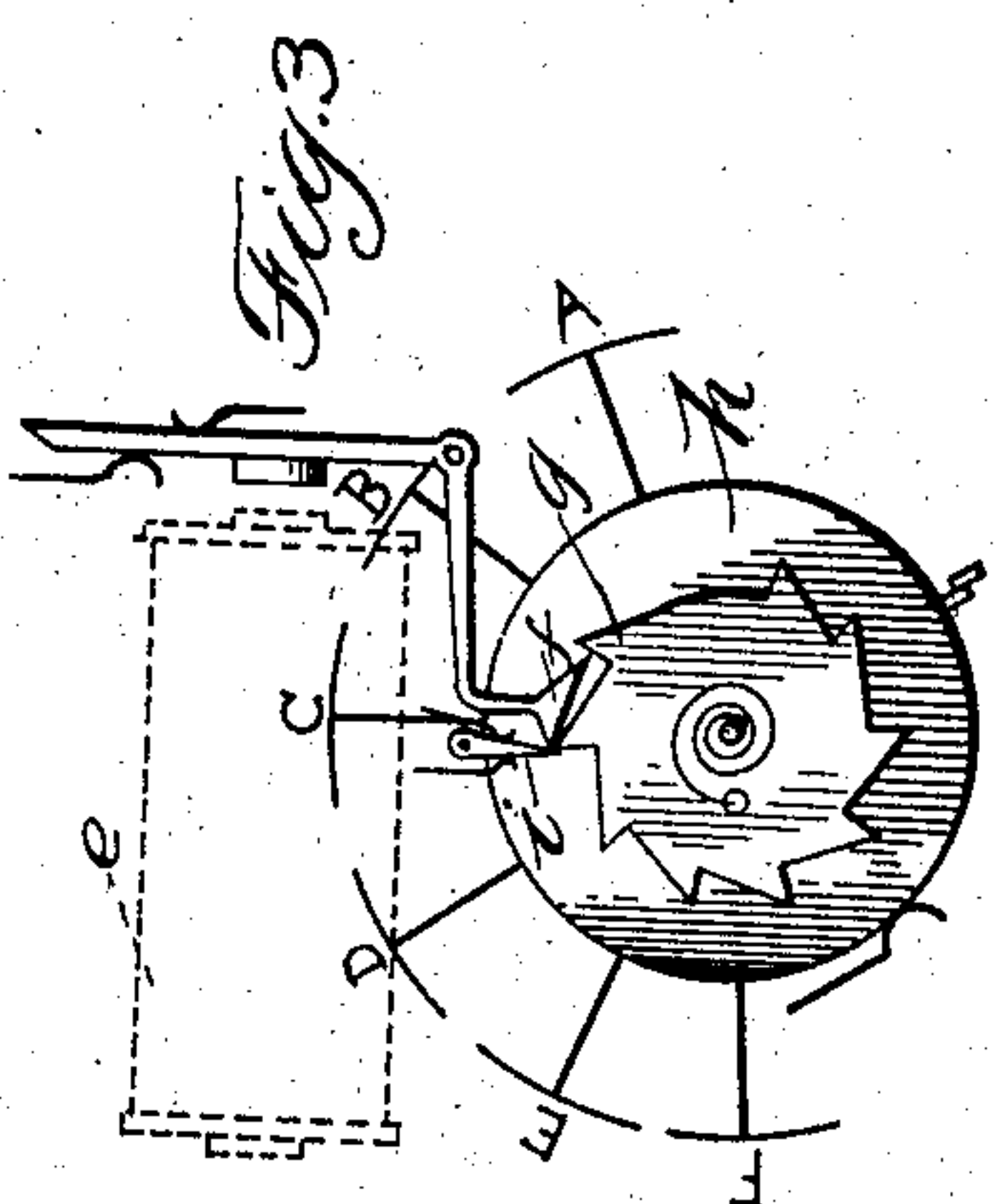
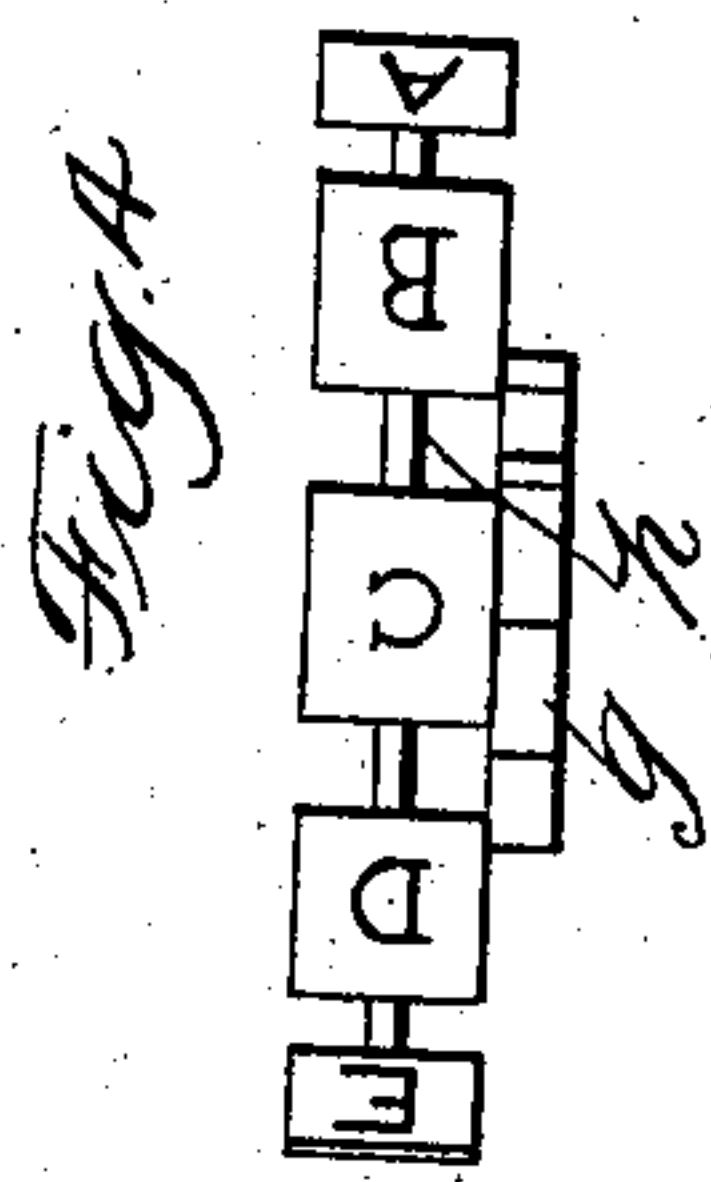
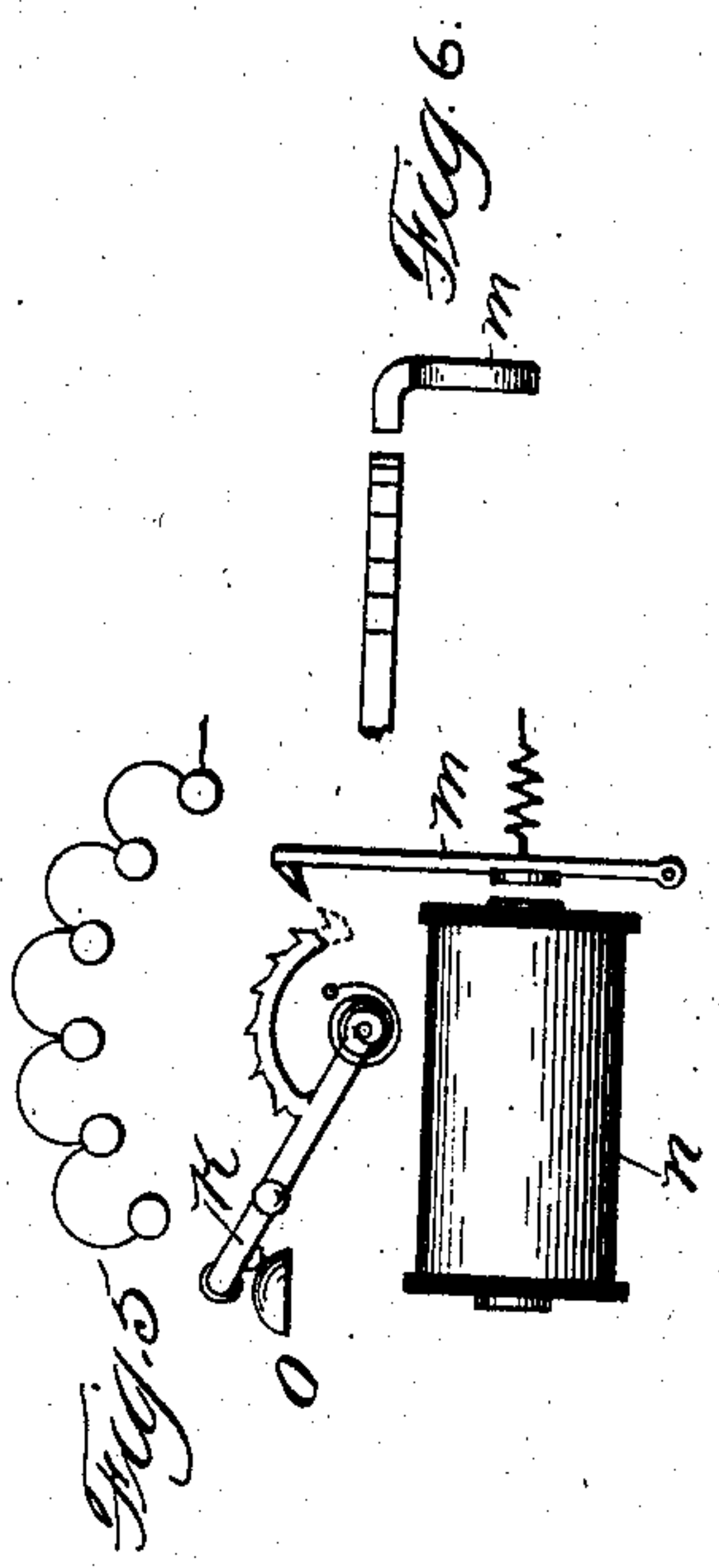
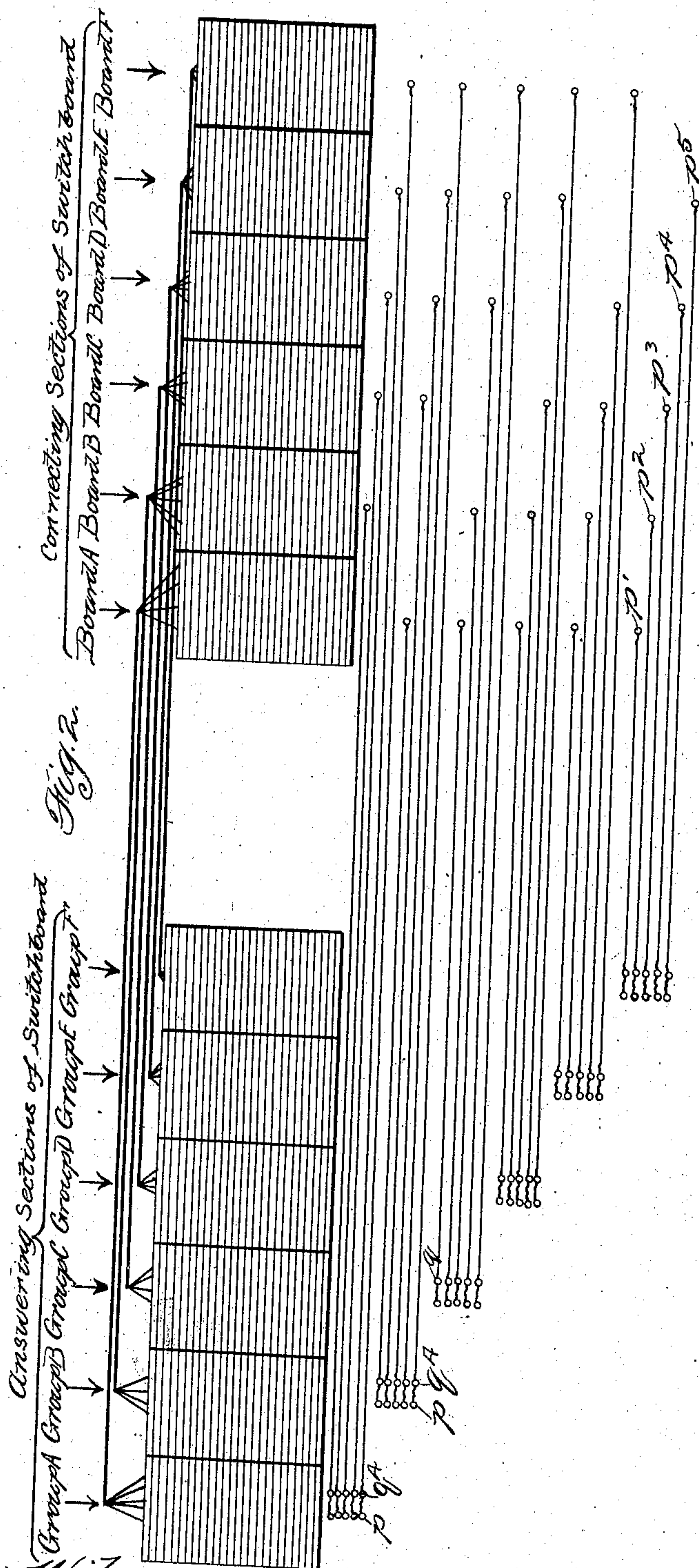
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Harvey L. Hanson.

Inventor:  
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By Charles A. Brown, Clegg & Belfield  
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3 SHEETS—SHEET 2.



Witnesses:  
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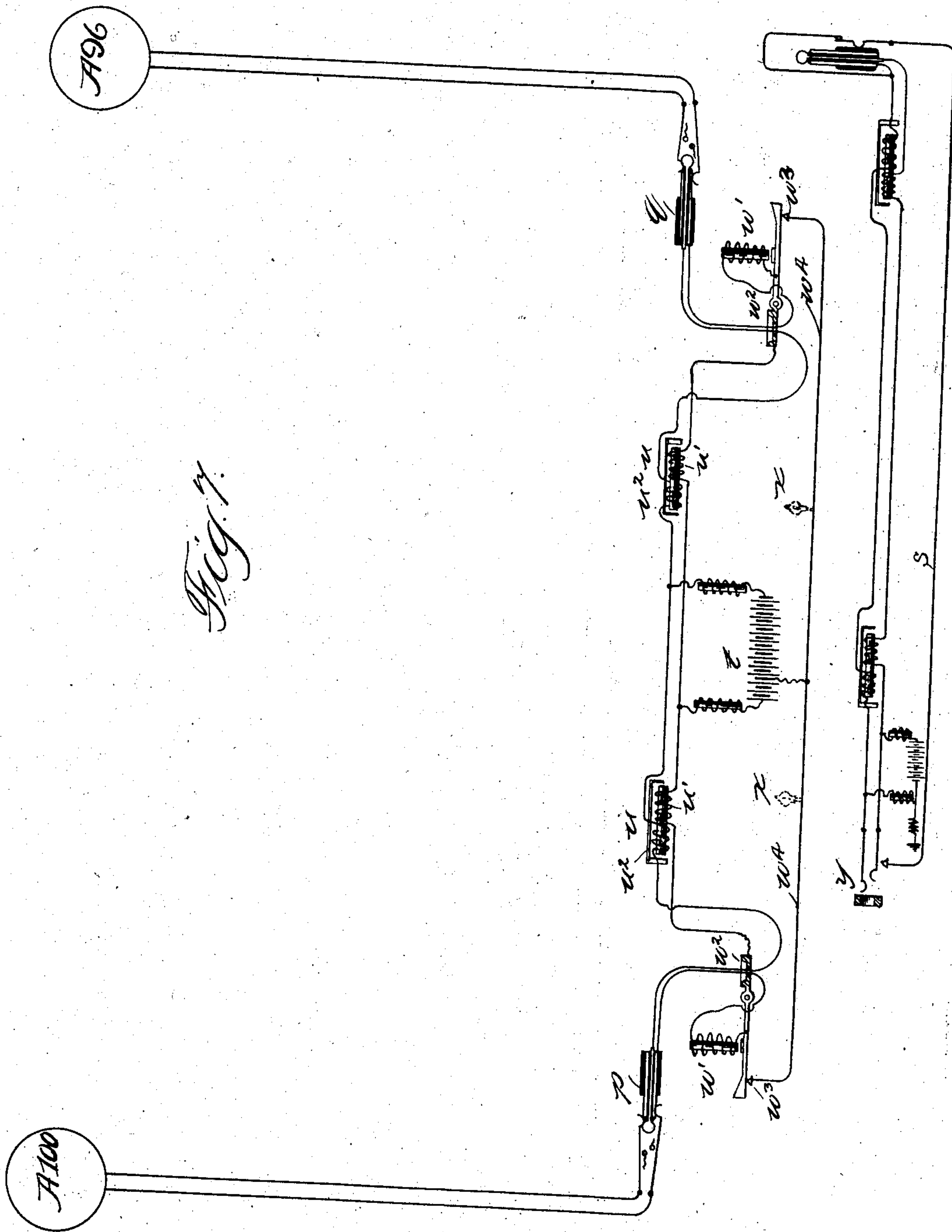


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3 SHEETS—SHEET 3.



Witnesses:  
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# UNITED STATES PATENT OFFICE.

HAROLD D. STROUD, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

## TELEPHONE-EXCHANGE SYSTEM.

No. 816,135.

Specification of Letters Patent.

Patented March 27, 1906.

Application filed March 25, 1901. Serial No. 52,788.

*To all whom it may concern:*

Be it known that I, HAROLD D. STROUD, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Exchange Systems; of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephone-exchange systems, and has for its object the provision of improved means whereby subscribers may be brought into communication.

The invention contemplates the provision of boards or sections of boards to which subscribers' telephone-lines extend at some of which connections may be partially completed, while at the remaining sections the connections may be completely established.

Generally speaking, the preferred embodiment of one feature of my invention consists in connecting each subscriber's line with two divisions of a board, providing line-signaling means at one of the said divisions to enable the subscriber to initiate a call and connecting means extending between the divisions of the board, in combination with means for conveying intelligence between these divisions, so that an operator at one division of the board may form a continuation of the subscriber's telephone-line to the other division of the board, at which latter division the connection between the subscribers may be completed.

Another feature of my invention may be generally stated to consist in a telephone-exchange system in which subscribers' lines extend from substations to an exchange, where the lines are divided up into a number of groups, in combination with means whereby a subscriber whose line is in one group may in sending in a signal indicate to the operator a particular group containing the line of another subscriber with whom connection is desired, switching apparatus being interposed between the groups and provided with means for conveying signals or other form of intelligence between the groups, whereby the operators at these groups may cooperate in effecting a complete connection.

In the preferred embodiment of my inven-

tion the last feature thereof is preferably employed in connection with telephone-exchange systems in which the subscribers' lines in addition to being divided into groups are also each connected to two divisions of the board, one division constituting an answering division, where the connection is partially completed, and the remaining division constituting the connecting-division, where the connection between the subscribers is finished. Thus there are for each set or group of subscribers' lines two duplicated groups of connections at the exchange. In other words, each subscriber's line is connected at the exchange to two spring-jacks, the spring-jacks being connected in multiple, one spring-jack being located upon the answering section or division of the board and the other upon the connecting-section of the board. Each subscriber is preferably provided with a device by which a selective device at the exchange may be operated to indicate to the answering operator the particular group of lines among which the called-for subscriber's line is included.

My invention contemplates, further, the provision of improved supervisory signaling appliances to be employed in the cord-circuits extending between the divisions of the board that may be included directly in the cord-circuit and have their operative condition controlled by the subscribers' apparatus and by the cord-connecting apparatus, the magnets of the supervisory signals being provided with differential coils, which are both preferably included in circuit when the parties are in conversation, so that the impedance thereof is removed from the circuit by the oppositely-acting coils of the differential winding and the signal is maintained quiescent at the same time, one of the coils being cut out of the circuit when the signal is to be conveyed, leaving the remaining coil to act alone, which thereupon may effect the operation of a signal corresponding thereto.

I also provide means, in combination with the connecting cord-circuits extending between the answering and connecting sections of the board, whereby the operator in selecting a plug of the cord-circuit extending to the particular connecting-section where the connection is to be completed may effect the op-



eration of a signal at the connecting-section to enable the operator at the latter section to select a corresponding plug, so that through the agency of these selected plugs at the answering and connecting sections complete connection may be effected between subscribers. The cord-circuits extending between the answering and connecting sections of the board are also preferably provided at the answering-section with an additional plug, so that the operator at that section may complete a connection if the called-for subscriber is in the same group with the calling subscriber.

I will explain my invention more fully by reference to the accompanying drawings, in which—

Figure 1 is a general diagrammatic view illustrating a number of substations, one being shown connected with an answering and a connecting station, while the remainder are shown connected with the connecting-sections. Fig. 2 is a general diagrammatic view illustrating the multiple arrangement of each pair of sections, each pair including an answering and a connection section, and the disposition of a number of cord-circuits between the answering and connecting sections. Fig. 3 is a detailed view of one form of selective line-signaling appliance to be operated by each calling subscriber, each line having such an appliance. Fig. 4 is a plan view of the character-wheel illustrated in Fig. 3. Fig. 5 is a view illustrating the mechanism located at each subscriber's station for operating the selective device at the exchange. Fig. 6 is a plan view of part of the mechanism illustrated in Fig. 5, showing a detent mechanism that may be employed. Fig. 7 shows a modified form of cord-circuit and apparatus.

Like parts are indicated by similar characters of reference throughout the different figures.

In Fig. 1 I have illustrated six substations belonging to distinct groups. Station A may belong, say, to a group of three hundred lines that may be connected first to a board A, Figs. 1 and 2, being the connecting-section of the switchboard, and then to a switch in group A at the answering-section of the switchboard. Subscriber B may likewise be one of a group of three hundred also having duplicated connections at the exchange, each line of this group having one connection at the board B and at answering group B. The same with reference to subscribers C 99, D 81, E 93, and F 76, each of which may be one of a group of three hundred having similar connections at the exchange. Thus each line is provided with two spring-jack connections at the exchange—one at an answering-section and the other at the connecting-section. Because of peculiar test-signal apparatus, which I will hereinaf-

ter more fully set forth, the subscribers' lines first extend to the connecting-sections of the board and thereafter to the answering-sections; but I do not limit myself to this arrangement.

Referring particularly to Fig. 1, the subscribers there illustrated have their lines (in this case each having two limbs) connected at the connecting-board sections with the line-jacks *a a a*, which line-jacks in turn are connected to the jacks at corresponding answering-sections, the jacks at the connecting-board A being connected with the jacks at the answering-board A, the jacks at the connecting-board B being connected with the jacks at answering-board B, the jacks at connecting-board C being connected with the jacks at answering-board C, and so on throughout the series. There is located at each of the answering-sections a selective signaling appliance *b* for each subscriber's line which is normally connected with both limbs of each line. Each selective device comprises in one embodiment of the invention an operating-electromagnet *e*, through which impulses of current may be intermittently sent by suitable apparatus at the subscriber's station to be hereinafter described. The armature of the electromagnet is provided with a pawl *f*, that may upon each attraction of the armature rotate a ratchet-wheel *g* one step, the ratchet-wheel having fixedly secured thereto a character-wheel *h*, upon which letters or other suitable character devices "A," "B," "C," &c., may be provided. A detent *i* prevents backward rotation of the ratchet-wheel after each forward actuation thereof upon attraction of the armature connected with the pawl. The longer line-spring of the jack is preferably provided with a cam-block *k'*, that engages the inclined end of the armature when an operator engages a plug with the said line-spring, which cam-block upon descending serves to release the pawl *f* from engagement with the ratchet-wheel *g* and at the same time thrusts the detent *i* to one side to permit the character-wheel to be restored to its normal position.

The device that I preferably employ at the subscribers' stations for effecting the step-by-step operation of the selective device at the exchange is illustrated in Figs. 1, 5, and 6. I have illustrated a switch *k*, that is normally included in an open bridge between the sides of the telephone-line, this switch engaging as it is rotated a plurality of contact-buttons (marked "A," "B," "C," "D," "E," "F,") which are electrically connected, but between which sufficient space exists so that the arm *k* in passing over the buttons will successively complete and open the bridge connection between the sides of the telephone-line, and thus correspondingly effect a step-by-step operation of the relay-



magnet *e* to present the proper character to the operator to be seen through the opening *l*. Thus if subscriber A 100 is a calling subscriber and desires to be brought into communication with a subscriber of the F group the subscriber A 100 will move the switch-arm *k* to the button "F," thus effecting six steps in the revolution of the character-wheel to cause the character "F" upon the said wheel to appear before the opening *l*. The answering operator thereupon will proceed to have the connection completed, as will be hereinafter set forth. In order that the switch *k* may not be released until the answering operator has plugged into the jack of the calling subscriber, I provide a detent *m*, which is brought into engagement with the corresponding tooth carried upon the switch *k* when said switch is in electrical connection with the corresponding button, this engagement of the detent *m* with the switch *k* being effected by the actuation of the detent *m* by the electromagnet *n*, that is included in the same bridge with the switch-arm and the contact-buttons. This electromagnet *n* is deenergized when the operator at the exchange plugs into the calling subscriber's jack, the circuit including the said magnet being opened by the removal of the line-springs of the jack from their back contacts. A suitable signal may be conveyed to the calling subscriber when the answering operator plugs in, which may be in the form of a signal-bell *o*, that may be impinged upon by the switch-arm *k* when the electromagnet *n* is deenergized. The signal *o*, which may be either a visual or audible signal, is provided to inform the subscriber that his connection is about to be completed, whereafter the calling subscriber may remove his telephone from its switch-hook and give his order to the connecting operator.

There is located at each answering-board section a number of answering-plugs *p*, designed for insertion within the jacks of calling subscribers, which answering-plugs are connected with connecting-plugs *p'*, located at the connecting-sections of the switchboards. Although there are in this instance six groups of answering-sections, there are but five connecting-plugs at the connecting-sections of the switchboard, as the answering operator may complete connections between subscribers where the called subscriber has his line in the same group with the calling subscribers' line. In order that the answering operator may effect this connection between subscribers of the same group, additional plugs *q* *q'* *q''* *q'''* *q''''* are connected in multiple with the terminal plugs of the cord-circuit. The calling subscriber having operated the step-by-step selective device of his line to indicate the group—say group F—in which the called subscriber's line is located, the answering operator selects a cord-circuit

which terminates in a connecting-plug at the connecting-section F, inserts the answering-plug *p* into the calling subscriber's jack, and by that act effects the operation of a suitable indicator *r* at the connecting operator's board. This signal *r* preferably has its electromagnet provided with differential coils, one included in the tip-strand and the other in the sleeve-strand. When both of the differential coils are included in the circuit, the core of the electromagnet is not energized and no signal is effected. The coil *r'* is normally included in circuit with the tip-strand of the trunking cord-circuit and with a signal-conductor *s*, in which latter conductor are included the plug-seat switch-contacts *s'*, that are closed when the connecting-plug is in its seat. This signal-conductor includes contacts *s''* at the answering-section, which are normally separated when the terminal answering-plug is in its seat. A battery *t*, which may also furnish current for the transmitters at the substations, is included in series with suitable impedance devices, which, together with the battery, are included in bridge between the strands of the cord-circuit. The signal-conductor *s* is also connected with the said bridge conductor, so that when the answering-plug *p* is removed from its seat the circuit of the signaling-conductor *s* will be completed by the closure of the contacts *s''*, so that the indicator *r* will be operated to indicate to the connecting operator that a connection is to be established. The connecting operator thereupon withdraws the connecting-plug from its seat and at the same time includes her telephone set *t'* in circuit with the cord-circuit and the calling subscriber's apparatus and thereupon establishes the connection that is desired. The connecting operator in removing the connecting-plug from its seat separates the contacts *s'*, so that the same signal device which was operated to inform the connecting operator is thereafter placed in condition to serve as a clearing-out indicator to notify the connecting operator to disconnect when the subscribers are through conversation. The connecting operator thereupon inserts the said connecting-plug into the jack of the called subscriber, which may be, for example, F76 of the group F. There are located at the answering-section of the switchboard two clearing-out indicators *u* *u*, one on each side of the bridge conductor, including the battery *t*, which indicators are each provided with differential coils through which current from the battery *t* flows in opposite directions, as it also flows in opposite directions through the coils of the indicator *r* during the time that subscribers are in conversation. The indicators *u* *u* act as supervisory indicators, so that the answering operator does not withdraw the answering-plug until both signals are operated to indicate that both subscribers



have restored their telephone-receivers. The operating-coils  $r' u' u'$  are included in this instance in the tip-strand of the cord-circuit, and circuit is closed through these operating-coils from the ground  $u^2$ , the battery  $t$ , the tip-strand of the trunking cord-circuit, the operating-coils of the signals, thence to the tip sides of the telephone-lines to the switch-hooks and the normally grounded contacts engaging the same. If a connection is to be completed between subscribers of the same group, I prefer to employ a cam-lever  $v$ , that may be operated to separate the switch-contacts  $s^2$  to prevent the same from being closed upon the removal of the answering-plug, so that the operator at the connecting-section of the board will not receive a false signal.

In order to prevent the operators at any of the connecting-boards from effecting a connection with a called subscriber who may be connected with another subscriber at the same answering-section, I provide testing appliances  $w$  at the connecting-boards, which may be included serially in one side of the telephone-line extending from each subscriber's station to the answering-board. This test-indicator is preferably in the form of an electromagnet provided with a small shutter that may project slightly before the opening of the corresponding spring-jack when the corresponding line is in use at the answering-section, this indicator then receiving current from the battery  $t$ . If the line is not busy, there being no current through the indicator  $w$ , no busy sign will be manifested.

Referring now to Fig. 7, I will describe an improved form of cord connecting apparatus that may be used in connection with the system illustrated in Figs. 1 to 6, inclusive, or in connection with ordinary switchboards or single boards. Two telephone-lines from stations A 100 and A 96, extending to the same board, are illustrated, and the plugs  $p$  and  $q$  are inserted within the jacks of these lines. The sleeve-strand of the cord-circuit includes the operating-coils  $u'$  of the supervisory signals  $u u$ , while the tip-strand includes the counteracting coils  $u^2$ . The battery  $t$  is included in a bridge between the strands of the cord-circuit and between impedance-coils also included in the same bridge. The sleeve-strand of the cord-circuit includes also the helices of magnets  $w' w'$ , whose armatures are provided with plug-seats  $w^2 w^2$ , which, through the agency of the seated plugs, remove the other ends of the armatures from contact-anvils  $w^3$ , that constitute the terminals of a signaling-conductor  $w^4$ , connected with the battery  $t$ . When the circuit is open at a subscriber's station by the telephone being upon its switch-hook thereat, the armature of the corresponding electromagnet will be permitted to fall against its contact  $w^3$ , whereupon circuit will be closed through the corresponding operating-helix  $u'$  to effect the

actuation of the indicator  $u$ , which is permitted because the counteracting coil  $u^2$  is included in open circuit on account of the position of the switch-hook at the corresponding subscriber's station. Thus a control of the supervisory signals may be effected without grounding the system at the subscriber's station or at the exchange. Instead of locating the indicators in the strands of the cord-circuit they may be replaced by signaling-lamps  $x x$ , included serially in the conductor  $w^4$  where desired. The simple cord-circuit illustrated in Fig. 7 may be brought into trunk connection with a connecting-plug at a distant section of the switchboard by having an answering-plug  $q$  inserted within a trunking-jack  $y$ .

I have not deemed it essential to describe in detail any particular form of telephonic apparatus at the substations. I have shown at station A 100 a bell  $y'$  included between the sides of the telephone-line with a condenser  $y^2$ . The transmitter  $z$  may be included in series with the telephone-line when the telephone-receiver  $z'$  is removed from the telephone switch-hook  $z^2$ , the arrangement being such that when the telephone-receiver is upon its hook the sides of the telephone-line are not conductively connected, the condenser being the preferred means employed for preventing a flow of current over the telephone-line when the substations are idle.

It is obvious that changes may readily be made in the preferred embodiment of my invention herein shown and particularly described, and I do not, therefore, wish to be limited to the precise disclosure of the invention herein set forth; but,

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination with telephone-lines extending from subscribers' stations and passing serially through two boards at the exchange, each line having a switch connection with each board, of trunk-circuit connecting means interposed between the boards, line-indicators at one of the boards, test-indicators associated with the telephone-lines at the other board, a source of current for the trunk-circuit, and means whereby the said test-indicators are operated by said source when the trunk-circuit is connected with the line at the first board, connection of said circuit also mechanically causing restoration of the line-indicator.

2. The combination with telephone-lines extending from subscribers' stations and passing serially through two boards at the exchange, each line having a switch connection with each board, of connecting means interposed between the boards, line-indicators at one of the boards, test-indicators associated with the telephone-lines at the other board, and means whereby the said test-indicators



are operated when the lines at the first board are connected with the connecting means, the said test-indicators being located to the rear of the plug-openings and presenting a signal before the plug-openings when the corresponding line is busy to guard against the insertion of plugs, connection of said connecting means with the line also causing mechanical engagement with the line-indicator to cause restoration thereof substantially as described.

3. In a trunking cord connection, the combination with the strands of the trunk-cord, of an indicator at one terminal of the trunking connection having a controlling-electromagnet provided with differentially-wound coils, means at the other terminal of the trunking connection for closing circuit through one of the said coils to effect an operation of the said indicator, and means at the first aforesaid terminal of the trunking connection for nullifying the magnetizing effect of the said winding, substantially as described.

4. In a trunking cord connection, the combination with the strands of the trunk-cord, of an indicator at one terminal of the trunking connection having a controlling-electromagnet provided with differentially-wound coils, means at the other terminal of the trunking connection for closing circuit through one of the said coils to effect an operation of the said indicator, and means at the first aforesaid terminal of the trunking connection for nullifying the magnetizing effect of the said winding, the differential coils of the controlling-electromagnet being included in opposite sides of the said cord-circuit, substantially as described.

5. In a trunking-cord connection, the combination with the strands of the trunk-cord, of an indicator at one terminal of the trunking connection having a controlling-electromagnet provided with differentially-wound coils, means at the other terminal of the trunking connection for closing circuit through one of the said coils to effect an operation of the said indicator, and means at the first aforesaid terminal of the trunking connection for opening the circuit including the said winding, substantially as described.

6. The combination with telephone-lines extending from substations to different boards of the exchange, of a trunking cord-circuit interposed between the said boards and provided with terminal plugs, two signals, one at each terminal of the cord-circuit, each signal being provided with a controlling-electromagnet having differentially-wound coils included in opposite sides of the cord-circuit, a signaling-conductor, and plug-seat switches operated by the terminal plugs, the plug at one terminal of the cord-circuit serving to close circuit through a single operating-coil of the controlling-magnet at the other terminal of the cord-circuit, while the terminal

plug at the latter end of the trunking cord-circuit serves upon its removal to effect an operation of the switch controlled thereby to open the circuit including the said coil, substantially as described.

7. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different boards at the exchange, of a trunking cord-circuit at the exchange provided with three signals, each having a controlling-electromagnet having differentially-wound coils, the coils of each magnet being included in opposite sides of the cord-circuit, two of the said signals being located at one of the terminals of the cord-circuit, while the remaining signal is included at the remaining terminal of the cord-circuit, and a source of current included between the magnets of the signals at one terminal of the cord-circuit and in bridge between the sides of the cord-circuit, substantially as described.

8. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to an exchange, of a cord-circuit for connecting subscribers for conversation, indicators for the cord-circuit, two electromagnets having their armatures provided with plug-seat switches adapted to receive the terminal plugs of the cord-circuit, a signaling-circuit including the said indicators, and switches controlled by the armatures of the said electromagnets, the said plugs in engaging the seats provided upon the armatures serving to open the signaling-circuit, the circuit through the electromagnets being controlled by the apparatus at the substations, whereby circuits through the said indicators may be closed and opened while the plugs are in line-jacks, substantially as described.

9. In an operator's apparatus, the combination with an electromagnet of an armature, of a plug-seat provided in the armature for receiving a plug, and a switch-contact operatively associated with the said armature, substantially as described.

10. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to different boards at the exchange, of a trunking cord-circuit intervening between the boards, the said trunking cord-circuit being provided near one terminal thereof with two connecting-plugs, whereby a connection may be completed between subscribers whose lines extend to the same board, the other end of the trunking cord-circuit being provided with suitable connecting means, whereby subscribers' lines extending to different boards may be connected for conversation, a signal located at the latter end of the trunking cord-circuit, a switching device controlled by one of the plugs at the first aforesaid end of the trunking cord-circuit to effect the operation of the said signal, and means for preventing



the operation of the said switching device when lines extending to the same board are to be united for conversation through the agency of the said pair of connecting-plugs at one terminal of the cord-circuit, substantially as described.

11. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations to an exchange, each line passing through a connecting-board and terminating at an answering-board, of a spring-jack at each board connected with the line, and an indicating-signal at the connecting-board normally connected with the spring-jack thereat and with the line, the insertion of a plug in said spring-jack serving to interrupt the line and to disconnect said signal therefrom, substantially as described.

12. In a telephone-exchange system, the combination with telephone-lines extending from substations to an exchange, each line passing through a connecting-board and terminating at an answering-board, of spring-jacks and plug-openings at each board connected with said lines, and indicating-signals at the connecting-board included serially in the lines and normally connected with the spring-jacks, each signal serving when the subscriber telephonically connects himself with the corresponding line to prevent the insertion of a plug into the corresponding plug-opening, substantially as described.

13. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' stations and passing serially through switchboards at the exchange, of a trunk-circuit between the switchboards for uniting subscribers for conversation, differentially-wound-electromagnet signaling mechanism included in said trunk-circuit, and means independent of the switchboards and telephone-lines for causing actuation of said signaling mechanism for conveying intelligence between the operators at said boards.

14. In a telephone-exchange system, the combination with telephone-lines extending from subscribers' substations and passing serially through switchboards at the exchange,

of a trunk-circuit between said switchboards for uniting subscribers of one board with subscribers of the other board, differentially-wound-electromagnet signals and a source of current included in said trunk-circuit, and means independent of said switchboards and the telephone-lines for causing actuation of said signals to convey intelligence between the operators at said boards.

15. In a telephone-exchange system, the combination with telephone-lines each extending from a subscriber's station and passing serially through two switchboards at the exchange, of a trunk-circuit between said switchboard for uniting the subscribers of one board with the subscribers at the other board, differentially-wound-electromagnet signals and a source of current included in said trunk-circuit, means upon connection of said cord-circuit with the telephone-lines and upon actuation of substation apparatus for indicating to the board operators the condition of the line and substation apparatus, and means in said trunk-circuit entirely independent of the connection of said trunk-circuit with the lines for causing actuation of said signals to convey intelligence between the operators at the boards.

16. In a telephone-exchange system, the combination with telephone-lines each extending from a subscriber's station and terminating at a switchboard at the exchange, of a trunk-circuit between the switchboards at the exchange for uniting subscribers of one board with subscribers of another board, differentially-wound-electromagnet signals and a source of current included in the trunk-circuit, and switching means associated with the plugs of the trunk-circuit for causing actuation of said signals independent of the switchboards and telephone-lines whereby intelligence may be conveyed between the operators at the different boards.

In witness whereof I hereunto subscribe my name this 14th day of March, A. D. 1901.

HAROLD D. STROUD.

Witnesses:

GEORGE L. CRAGG,  
HARVEY L. HANSON.