

5 Sheets—Sheet 1.

No. 536,787.

Patented Apr. 2, 1895.

Attest.
Joseph Abateley
J. W. Miller Pierce

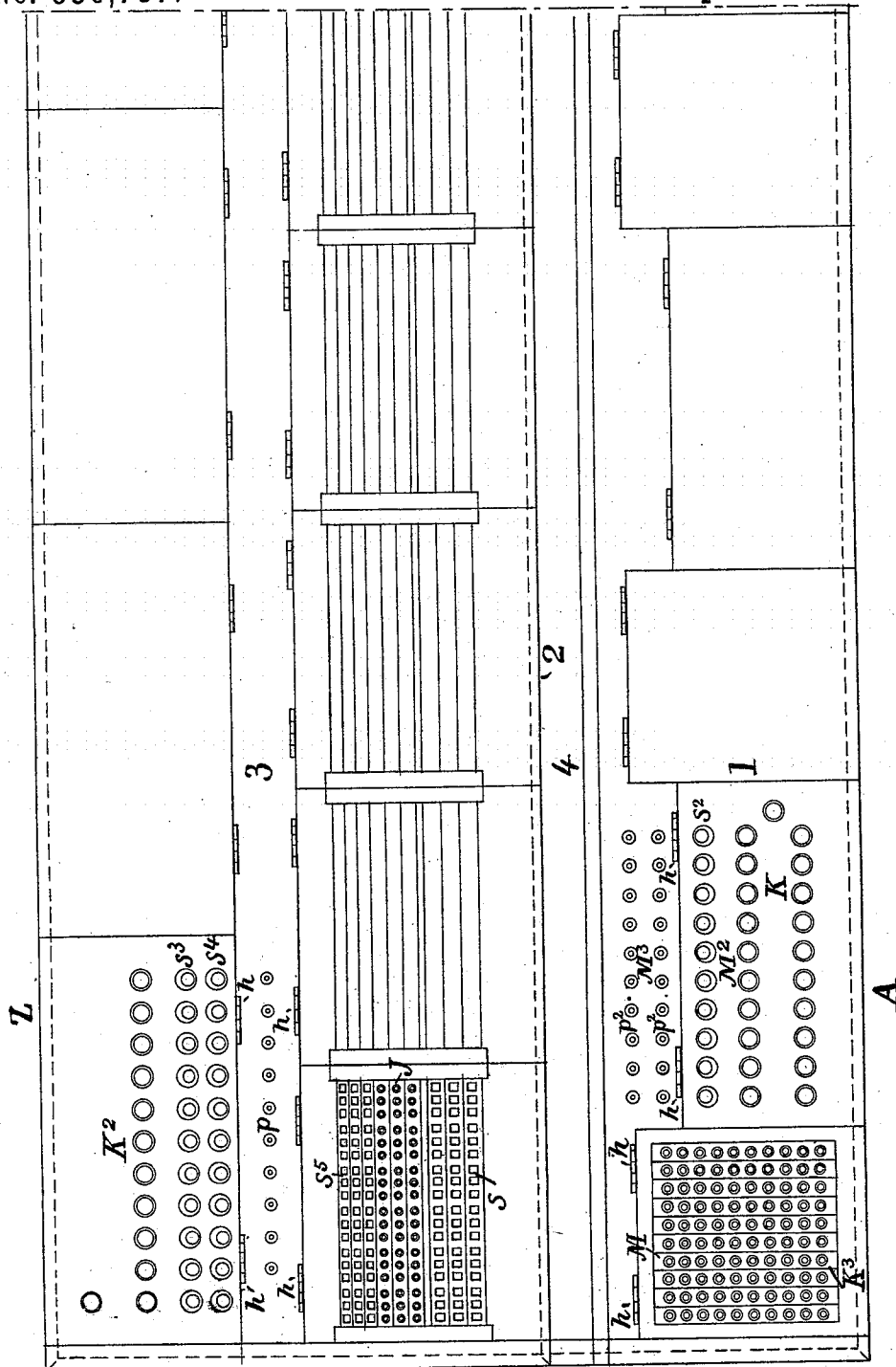
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Theodore Spencer.

H. V. HAYES & T. SPENCER.
TELEPHONE EXCHANGE SYSTEM AND APPARATUS.

No. 536,787.

Patented Apr. 2, 1895.

Fig. 2.



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(No Model.)

5 Sheets—Sheet 3.

H. V. HAYES & T. SPENCER.
TELEPHONE EXCHANGE SYSTEM AND APPARATUS.

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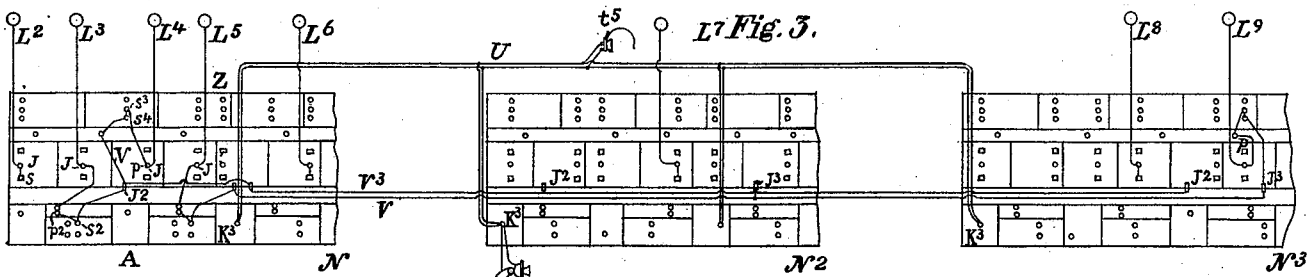
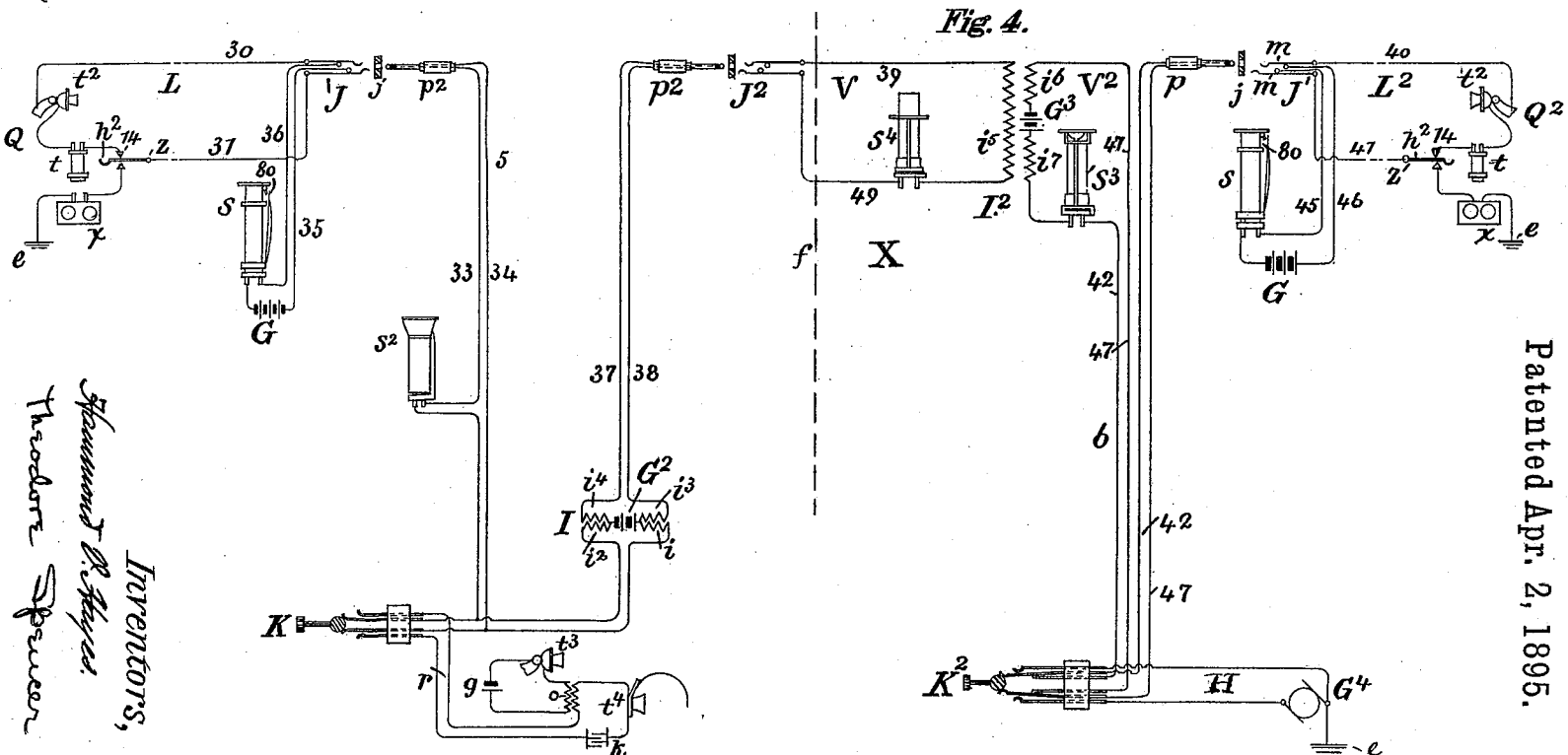


Fig. 4.



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Fig. 5.

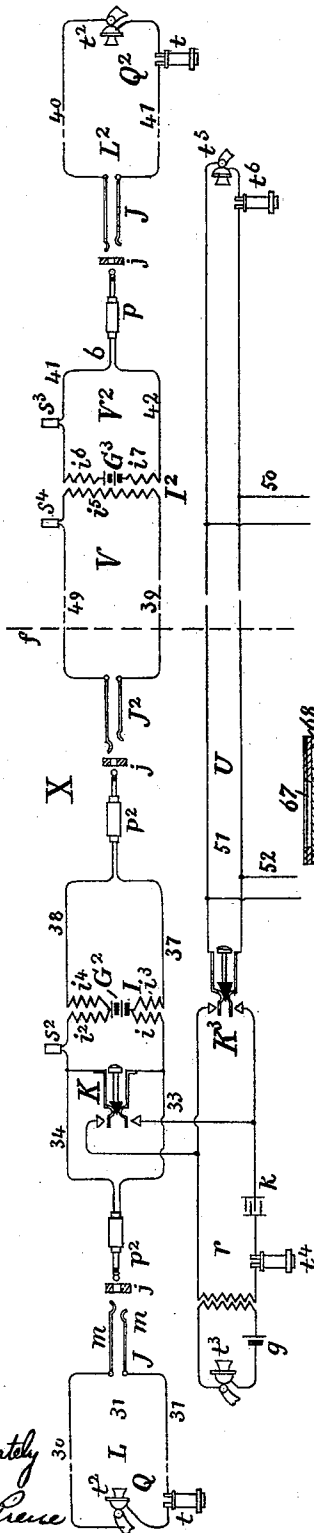
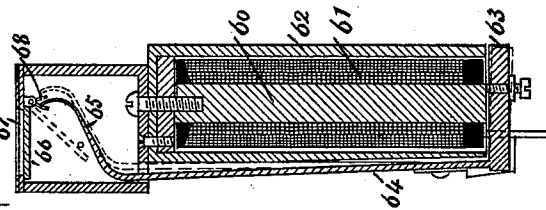


Fig. 6.



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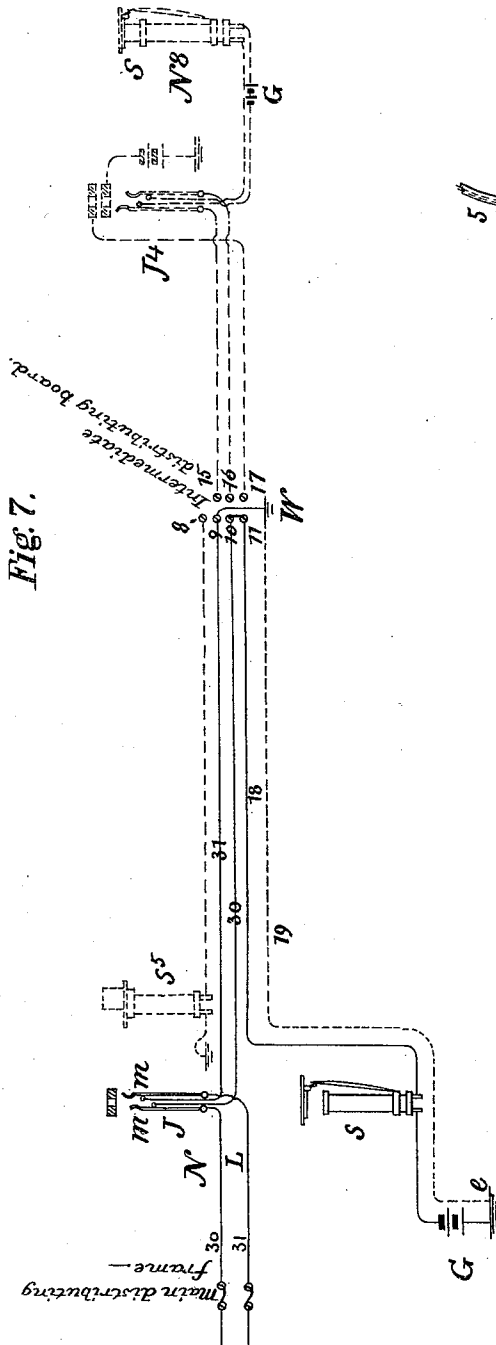
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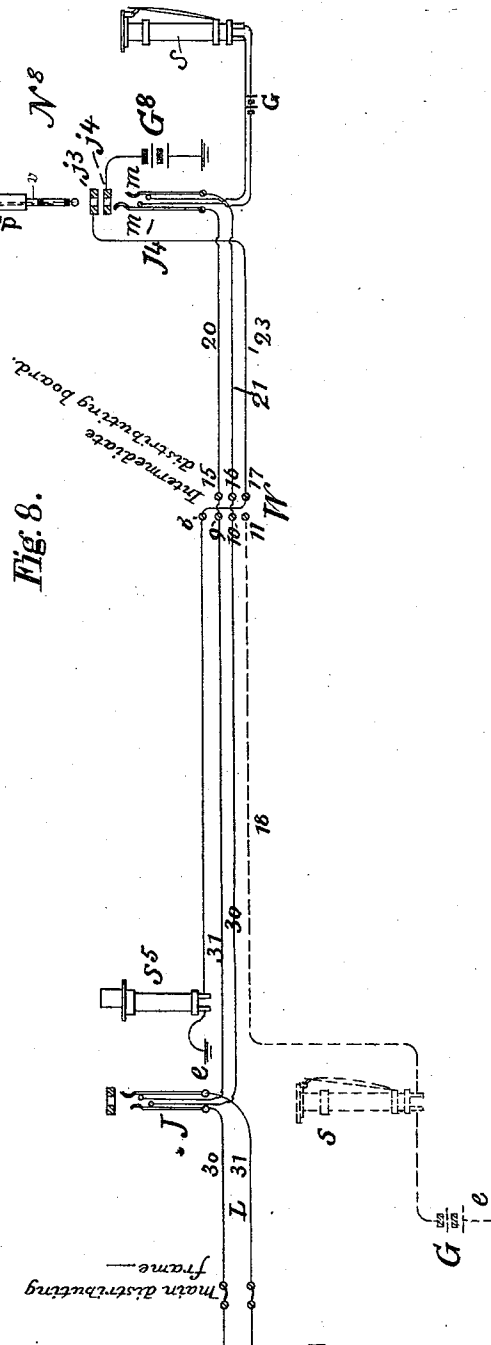
Patented Apr. 2, 1895.

Fig. 7.



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Fig. 8.



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UNITED STATES PATENT OFFICE.

HAMMOND V. HAYES AND THEODORE SPENCER, OF CAMBRIDGE, ASSIGNORS
TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSA-
CHUSETTS.

TELEPHONE-EXCHANGE SYSTEM AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 536,787, dated April 2, 1895.

Application filed September 10, 1894. Serial No. 522,607. (No model.)

To all whom it may concern:

Be it known that we, HAMMOND V. HAYES and THEODORE SPENCER, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain improvements in Telephone-Exchange Systems and Apparatus, of which the following is a specification.

This invention concerns telephone exchange systems and apparatus, and constitutes an improvement in the construction and arrangement of switchboards, and their auxiliary appliances; and in switchboard signals, the circuits in which they are connected, and their mode of operation.

Switchboards with vertical operating faces, with horizontal operating surfaces, and with working surfaces partly vertical and partly horizontal, have been known and used before. The switchboard which forms a part of this invention has two horizontal working faces or keyboards and an intermediate vertical operating face, worked by the attendants who perform the operations which belong to the front horizontal working face. By means of this form, the advantages belonging both to the vertical and horizontal face types of switchboard can be combined; and in addition to a full force of operators stationed at the front of the switchboard, to perform such necessary duties of call-answering, and connection and disconnection-making, as are arranged to be performed by the appliances on the front keyboard, and the intermediate vertical face, a second force may be employed, stationed at the rear keyboard to perform the remaining portions of each connection and disconnection, and to ring up the second party to such connection.

This improvement is productive of a considerable increase of speed in performing the regular central office manipulations. The operators stationed at the front of the switchboard may for brevity and distinction be characterized as A operators. In like manner, and for the same reason the operators stationed at the rear position may be termed Z operators. Each switchboard section may be subdivided into three operators' stations,

and any convenient number of lines may have their calls answered at each such section. In a board which has been planned, one hundred and eight subscribers' lines have been appropriated to each operator; or three hundred and twenty four subscribers' lines to the entire switchboard section. Each incoming substation line is normally represented on its own switchboard section only, and its circuit passes when not in use, by means of the resting contacts of a suitable spring jack socket, to its individual call annunciator or call signal, and then to its return conductor, the circuit thereof including a source of electrical energy such as a battery, which may be common to a number of lines. The line plug socket, and the call signal are both mounted on the rear horizontal face, and the mouth of said socket, and the display window or aperture of said signal are both also by preference mounted horizontally, and substantially flush with the table top.

Each A operator has at her disposal a number of pairs of connecting cord conductors, having plug terminals; and keys and switches whereby her telephones may be connected with any desired pair of cords, or alternatively into instruction or order circuits hereinafter to be mentioned. If desired, the A operators may also be furnished with ringing keys, which are capable of connecting a call generator with any of the said pairs of cords in a manner well understood, for the purpose of sending an outgoing call over any line temporarily connected with such pair of cords; and an electro-magnetic signal, serving as a disconnecting annunciator is included in the circuit of each pair of connecting cords. The terminal plugs of the several pairs of cords, the disconnecting annunciators, the listening and instruction keys or buttons, together with the ringing keys if supplied, are all mounted on the front horizontal face or table.

Since, as previously indicated, the subscribers' lines connect only with their own terminal sections, it is obvious that office trunks must be furnished, extending from each section to every other section; whereby the lines of different sections may be inter-

connected. These trunk conductors are mainly under the control of the Z operators, a definite number being assigned to each; and each trunk extends from the rear table face of some one of the switch sections, to the front table faces of all, or any desired number of the switch sections. The single end of each trunk has a plug terminal, and each of the several divisions of the multiple end is provided with a plug socket.

In operation, when any Z operator is notified by any A operator, that a connection is desired with a line represented at her table, she knows at once which trunks are free, by observing which of the trunk plugs are not inserted in any linespring jack, and she thereupon names the number of some one trunk which is at liberty, instructing the A operator in question, to connect the calling line therewith. By thus allowing the second part of the connection to be made by a second or trunk operator, and by causing the said operator to nominate the trunk which is to be used, the work of the central office is materially expedited, because the initiatory operator is spared the labor and time of testing the several trunk sockets terminating at her board, until she finds one which is free. We term the multiple ends of the trunks at the front face of the switch sections, "outgoing ends," or "outgoing trunks;" and when reference is made to that end of the trunk, which is located at the Z operator's station, and which terminates in a plug, they are usually termed "incoming trunks." The spring jacks or sockets which form the multiple connections of the outgoing trunks, are all framed or mounted in the vertical face of the switchboard, and are therefore placed horizontally, with their apertures facing the A operator. The plug terminals of the several trunks rest on the rear horizontal face of the section in front of the Z operators, and are shown as being arranged behind the subscribers lines spring jacks or plug sockets. The conductors of the said trunks, and of course all other wiring of the switchboards are extended in the interior thereof. The second or Z operator sends the outgoing calls for the line wanted, or for either of two connected lines, and accordingly is provided with ringing keys for that purpose, which are mounted on the rear horizontal section, and in the present instance are shown as being arranged near the rear edge thereof.

We interpose a repeating induction coil in the circuit of each of the several pairs of connecting cords at the front or A operators' stations; and we also interpose a repeating induction coil in the circuit of each office trunk. Thus the electrical connection between the two ends of a pair of cords, as well as that between the two ends of an office trunk is inductive only. This mode of arrangement is very convenient, as when adopted, a battery or other generator can be placed on either side of the said inductive connection to work

a signal or indicator, when the circuit of said generator is closed; while another indicator, controlled by a like generator on the other side of such inductive connection may remain inoperative until further manipulations are performed which close its circuit also. By this arrangement therefore we are enabled to work a series of automatic visible signals between the several switchboard operators, without the necessity of employing any conductors except those actually constituting the telephone or communication circuit.

The communications which at the beginning of a connection are exchanged between the A and Z operators concerned, are preferably transmitted by means of an instruction circuit in a manner well understood; and the instruction circuit to each Z operator, extends to the station of all of the A operators, and is at each section controlled by a suitable key.

In addition to the disconnecting or clearing-out signal already mentioned, which is included in the connecting cord of the first operator, we employ in each connection two other automatic signal indicators. Both are primarily intended for the information of the second operator, and they are therefore placed on the rear table face, having their signal indicating portions substantially flush with the surface thereof. Electrically, they are connected in the circuit of the trunk conductor, but in circuit with different helices of the interposed repeating coil. By this arrangement one of them is controlled by the first operator, and the other by the second operator concerned in any given circuit connection.

All of the signals mentioned are automatically operated.

The subscribers' circuits are by any of the well-known modes held normally open, but on the removal of the telephone from its place of rest, they are automatically closed; the line annunciator at the central station is thus actuated to give the call signal. When the operator receiving the call, inserts the plug of the answering cord of a pair in the plug socket of the calling circuit, one of the disconnecting signals which together with a sufficient battery is in the cord circuit, is connected with the main line, through which the circuit of the said battery is thereby closed. This signal is thus set, and continues to give a definite indication until the subscriber replaces his telephone, and thereby once more opens the line, enabling the said signal to indicate a different signal, which serves as an order to disconnect.

One of the two beforementioned trunk line signals is practically identical in its connections and function with the clearing out signal just described, it being in circuit with the trunk plug which is inserted in the socket of the line wanted to indicate the removal and replacement of the telephone at the substation of such line. It is in fact the disconnection signal of the said second line.

The remaining trunk signal is to inform the

Z operator when the A operator connects and disconnects the trunk line to which it belongs, and it is set when the said A operator places the plug of the second cord in the trunk plug-socket. Current is by such action supplied to the circuit, and the signal is thus maintained in one condition as long as the connection is maintained, but changes when the cord plug of A is withdrawn from the socket. By this organization an extremely simple signaling system, requiring no extra or auxiliary circuits or conductors, is sufficient for all communication between the two operators concerned in the manipulations of each connection; or between either operator and the subscriber; the only additional element in such communication being the employment of the telephone and the instruction circuit while the original order is being given and acted upon.

In the accompanying drawings, Figure 1 is a cross section of a switchboard embodying our invention showing the details of the board in a diagrammatic way but clearly enough to identify them with the more specific figures which follow. Fig. 2 is a plan or top view of the switchboard showing the major portion of a section, and the external appearance of one division complete, indicating the several appliances assigned to an operator. Fig. 3 is a diagram showing three sections of the switchboard, with connected substations, and connections between substations whose terminals are upon the same section, and also between substations whose terminals are upon different sections of the switchboards; also an instruction circuit and the various trunk and other main line conductors for the several operations. Fig. 4 is a diagram showing the connection for conversation between two united substations; and Fig. 5 is a diagram showing in less detail the same connections as Fig. 4, with the addition of an associated instruction circuit between the two operators who make the connections for the substations concerned. Fig. 6 is a vertical longitudinal section of an automatic re-setting annunciator employed in the circuits upon the switchboard. Figs. 7 and 8 are diagrams illustrating a plan for relieving an overworked section of a portion of its circuits, the said section retaining appliances for connecting with such lines, when they are called for by others.

Referring to Figs. 1 and 2, the switchboard as hereinbefore indicated, is in form, one which combines in itself the table or horizontal operating face, and vertical operating face characteristics. In the style shown, the switchboard is composed of a lower portion A^4 and an upper portion B^4 , the two portions being secured together at their approximating flanges c . It may be made of any desired material, and has been made with a framework or body, a^2 , of iron, having an outer casing b of wood. Cross braces or bars b^3 stiffen and strengthen the structure. Longitudinal braces b^2 hold the lower portions of

the sections together, and the longitudinal braces b^4 and b^5 perform the same office for their upper portions.

The top of the switchboard comprises the front table surface or keyboard 1, which may be horizontal, or if desired, made slightly sloping as shown; the rear table or horizontal surface or keyboard 3; the vertical operating face 2, and a depression or trench 4, between the base thereof and the table 1. As shown, the said front table surface is lower than the rear surface, and we prefer this construction; but if desired the two table surfaces may be on the same level, in which case the depression 4 will of course be deeper. To the table surfaces are secured many of the several appliances employed in manipulation, and the said tables are divided into as many portions as may be considered desirable, and hinged as at h , so that they can be thrown back to afford access to the appliances and connecting wires inclosed below.

The first, or A, operators, are stationed along the front edge of table 1, and manipulate the several appliances mounted thereon, and upon the vertical surface 2; but the appliances on the upper table surface 3 are operated by operators Z. The bars 59 and 69 shown in cross section in Fig. 1, serve as a support or rest for the feet of the operators, and if required may also be utilized as additional brace rods.

The keyboard 1 as indicated, is divided into a number of definitely conformed compartments of space M , M^2 and M^3 . The appliances used by the operator presiding at this keyboard, are distributed between these compartments on a uniform plan, similar appliances at each section being arranged in similar compartments. In the compartments M , are placed the push buttons or telephone keys K^3 whereby the operators' telephones may be connected in any of the instruction circuits respectively leading to the rear keyboard operators at the several sections.

At M^2 , the two front rows K indicate ordinary listening keys, adapted when operated, to connect the operators' telephones with any cord circuit for communication with a substation, and the clearing out annunciators or signals s^2 of the calling lines, connected in the cord circuit are placed in the rear row.

The space M^3 is devoted to the pairs of plug terminals p^2 of the initial operator's paired connecting cords 5, the said plugs normally standing on end in their places under the pull exerted by the weights w which according to established usage, rest in the loops or bights of the cords to keep them taut.

On the front portion of the rear keyboard are mounted throughout the switchboard the call annunciators s , normally associated with the substation lines assigned to the section; the spring jacks or plug sockets J of such lines; and a set of auxiliary or substitute signal appliances s^5 to which reference will hereinafter be made.

The middle section of the rear keyboard, is occupied by the plugs p forming the incoming terminals of the office trunks 6; and mounted in its rearmost section are the local trunk signals s^1 ; the disconnection or clearing out trunk signals s^2 which respond to the movements of the telephone switch at the called station; and the trunk ringing keys K^2 , for ringing up the wanted station.

The vertical face 2 of the switchboard is altogether occupied by the spring jacks or plug sockets J^2 which are multiplied among the sections, and form the outgoing terminals of the office trunks 6. When a connection is made between any line and one of these trunks, one of the plugs p^2 of a pair is placed in the line socket J , and the other plug p^2 of the same pair, in the trunk socket J^2 .

It being now a standard practice to employ metallic or double wire telephone circuits, it may be assumed that the connection cords 5 and 6 both include two conductors. The cords 5 stretched by their weight w within the space below the keyboards, are suspended at their inner ends by a supporting strand to a suitable tag which forms the terminal of each conductor, and which is screwed to a metal bracket d ; the brackets for the two members of all the pairs being mounted on non-conducting bars or blocks c^2 , which again are affixed to a stand D . From the two brackets of each pair of cords, extension conductors lead as more fully indicated in Fig. 4, to a repeating coil I , where an inductive connection is formed between the conductors of the two cords of the pair, and said conductors likewise lead to the front keyboard keys and switches, whereby at will, the supervisory appliances may be associated therewith. In like manner the trunk terminal cords 6 extending into the body of the switch-board, are provided with similar terminal and supporting attachments, which connect with other metal brackets d , from which the main trunk conductor V , is led to its spring jack terminals J^2 at all of the sections.

The switchboard terminal and attachment which we prefer, is described and claimed in a separate application for Letters Patent filed by Wilton L. Richards of even date herewith, on an improvement in terminal attachments for flexible conductors and bearing the Serial No. 522,619.

Figs. 3, 4 and 5 should be considered together, as they relate mainly to the interconnection of any two circuits.

The substation circuits with complete normal connections are shown only in Fig. 4. L is one and L^2 the other of two substation circuits shown in connected relation, by means of an office trunk, except that the plugs concerned for clearness of explanation are not thrust into their respective sockets. The substations Q and Q^2 are each provided with transmitting and receiving telephones t^2 and t , a call bell x and an automatic switch z actuated by removing the telephone from the

switch hook h^2 , and replacing it thereon. L has two conductors 30 and 31, and L^2 has two conductors 40 and 41. When the line is disengaged, and the telephone t in place, the metallic telephone circuit is open at the upper switch contact 14, and the conductor 31 or 41 is by means of the switch z and its lower contact 13 connected through the call bell x with the earth at e . This circuit arrangement is adopted in order that the metallic circuit shall be open when not in use, and closed by the act of removing the telephone, so that the said act may automatically send a call signal; and it also provides a closed circuit through the call bell, in order that the latter can always be operated from the central station. Other circuit arrangements such as that disclosed by Letters Patent No. 474,323, granted May 3, 1892, to Hammond V. Hayes are well known in the art, and may readily be adopted if desired.

At the central station X , the substation circuits pass first through their spring jacks or plug sockets J , each of which has a socket ring j , and by means of the resting contacts thereof, are connected with the conductors 35, 36 and 45, 46 of their call signal continuations, and through the said signals s and a battery or equivalent generator G , which may be common to a number of circuits. By inserting a connecting plug into the socket ring j the two jack springs m will be severed from their resting contacts, cutting off the call annunciator and generator, but at the same time they are enabled to form new circuit connections with the two conducting surfaces of the plug itself, and through these with the operators' telephones.

In Figs. 4 and 5 the several appliances of the operator, are shown in their circuit relations. The apparatus of the operator A is to the left, and that of operator Z to the right of the dotted line f . The operator A of course has a number of complete connecting cords 5, but since the electrical arrangement of all of them is the same, it is sufficient to show and describe one. The said conducting cord 5 has a double conductor terminal plug p^2 at both ends; one of these being adapted to be inserted in the substation plug socket j and the other into office trunk plug socket j^2 . The two conductors 33 34 of the former plug are in permanent inductive connection with the two conductors 37, 38 of the latter, by means of the repeating induction coil I , the two windings of the said coil being included in circuit with the said two sets of conductors respectively. The generator G^2 is in a portion of the circuit common to and at the center of both windings, and its position in each, between the two halves of said winding i' , i^2 , i^3 , and i^4 , aids in the maintenance of that balance which is desirable in telephonic circuits. The answering cord circuit contains the clearing out signal s^2 , and the circuit further is provided with a loop or bridge connection r controlled by the key K to the operator's transmitter

t^2 and receiver t^4 ; the latter being preferably arranged in the ordinary way with a local battery g and induction coil o ; while a condenser k is included in the telephone loop r to prevent the passage that way of the current from the generator G^2 . The office trunk circuit $v v^2$, as before stated has a plug socket spring jack J^2 on the vertical surface of each switch section, and is therefore accessible to all A operators. These jacks are preferably connected in parallel branches, after the fashion of the standard branch terminal switchboard, but if so desired they may be connected in series. For clearness, the jack of one section only is shown, and the trunk circuit as a whole is indicated as extending from the said terminal jack, on the upright portion 2 of one switchboard section to its distant terminal plug p , at the rear keyboard 3, of some other, or even of the same switchboard section. Like the answering operator's cord 5, the trunk $V V^2$ is divided conductively by an induction coil I^2 , which however has one of its windings i^5 undivided, the other being divided by an interposed generator G^3 into two substantially equal parts i^6 and i^7 . The generator G^3 is placed in one winding only of the coil I^2 , because it is intended to vitalize that portion of the trunk circuit which contains the winding i^5 only, when the plug p^2 of the A operator is inserted in the trunk jack socket J^2 , and in that event by the generator G^2 . The trunk circuit is when not employed, open or discontinuous, one portion V in the spring jack J^2 ; and the other portion V^2 in the plug p . The portion V is composed of the conductors 39 and 49, and the winding i^5 , and includes the trunk visible signal appliance s^4 . The portion V^2 is composed of the conductors 47 and 42 continuing into the terminal cord 6, the generator G^3 , the two winding portions i^6 and i^7 , and contains also the disconnecting signal s^2 , and the ringing key K^2 , which can be operated to bring into circuit the call generator G^4 through the loop H and thereby to send an outgoing call signal over any line L^2 which may be called for, and in whose jack socket j the plug p is placed. A ground connection e , may be added to the call generator G^4 if the system includes any earth completed lines.

The instruction circuit U is shown in Fig. 5. Each Z operator may have one, and her telephones $t^5 t^6$ are in its circuit. The circuit U , may extend either by branch loops 50 51 52 or serially, to keys K^3 , placed in front of the several A operators, which when manipulated bring the telephones of A into the instruction circuit with the telephones of Z, whereupon necessary instructions may be interchanged. By such means any A operator pressing a given key may connect with the circuit leading to the telephone of the Z operator at the switch section of a desired line.

If the plugs $p p^2$ in Figs. 4 and 5 be pushed into their respective sockets, the substation Q will be united by a continuous talking circuit with substation Q^2 through the central sta-

tion X. This talking circuit is by the repeating induction coils $I I^2$ rendered inductively continuous; but is also rendered conductively discontinuous, being thereby divided into three independent conductively continuous circuits; the first extending from the substation Q to the induction coil I , the second between the induction coils I and I^2 , and the third from the coil I^2 to the substation Q^2 . The battery or generator G^2 is common to the first and second such conductive circuits, and the generator G^3 vitalizes the third. The said generators have a two-fold function. As respects the end circuits, they develop an initial current to be varied by the operation of the substation transmitters t^2 for the production of voice currents; and in each of the three circuits they cause a current to circulate for the operation of the visible signals s^2 , s^3 and s^4 , the two former in response to the movements of the telephone switches z of the substations Q and Q^2 , as the receivers are taken from, or replaced on their respective hooks, and the latter in response to the movements of the plug p^2 as it is thrust into, or withdrawn from the socket J^2 of the trunk jack J^2 .

Another advantage of the conductive discontinuity accomplished by the presence of the interposed induction coils, is that these several signals are most conveniently made responsive, each to the circuit controlling device only, whose movements it is designed to follow.

Any well known forms of self setting or automatic visible signal appliance may be used for the two clearing out signals s^2 and s^3 , the trunk signal s^4 and the call indicators s .

In a switchboard which has been planned, the form of signal chosen for use as s^2 , s^3 , and s^4 , is generally that depicted in Fig. 6; while for the call signals s , a smaller and lighter but not essentially different form has been provided. As indicated at 80, (Fig. 4) the call annunciators may be fitted in a manner well understood, with circuit closing attachments, whereby the display of the call signal, is enabled on occasion to also close a local circuit, and actuate a night bell (not shown).

The form of visible signal indicated in Fig. 6 is not claimed herein, since a separate application for patent, Serial No. 522,612, is filed of even date herewith therefor by Theodore Spencer, the invention claimed therein being entitled an improvement in electro-magnetic signals; and it is sufficient to state here, that, it comprises a tubular magnet having an iron core 60, and surrounding tube 62; an interposed magnetizing helix 61, an armature 63, an armature lever 64 having a curved end 65; and a signal target or plate 66, with a short lever attachment 68 engaged by the said curved end, which on the attraction of the armature elevates the signal target to a horizontal position immediately below the aperture or window 67, but which permits the said target to fall away therefrom when the said armature is retracted.

From what has been stated, it will be evident that all of the signals to which reference has been made are automatic in both directions, moving their signal plates in one direction—say that of display—by electro-magnetic attraction, and in the opposite direction in the present instance by the action of gravity; and that a definite signification may be assigned to both display and withdrawal.

In Fig. 3, three partial sections of a switchboard are shown, indicating the various circuit arrangements which may be made. The said sections are characterized by the reference letters N, N², N³, and on each a given number of substation lines may terminate. Thus L² to L⁶ are shown as being assigned to N; L⁷ is connected on N²; and L⁸ and L⁹ on N³. Each line passes as more fully shown in Fig. 4 first to its spring jack J, and then to its call annunciator s V V³ are office trunks extending, one from a plug terminal p at section N where it is controlled by operator Z of that section, to spring jack terminals J² at other sections, and likewise at its own; and the other from the plug terminal p at section N³ to the spring jack terminals J³ at all sections. The diagram also shows the instruction circuit U to which we have referred, and indicates that it extends from the telephone t⁵ of the Z operator at N², to the keys or buttons K³ at the front keyboards of all sections. Lines L, L⁶ on section N, L⁷ on section N², and L⁸ on section N³ are shown as being disengaged.

L³ and L⁴ are two substation lines terminating at the same section, and illustrate the mode of uniting two circuits under such conditions. Being both on the same section they obviously may be united by simply inserting the two terminal plugs of an A operator's connecting cord 5 in their respective jack sockets j dispensing with the intervention of an office trunk, and with the work of the Z operator; but for uniformity of practice it is preferred to employ the trunk and second operator even when the entire operation can be performed at the same section. Therefore it will be perceived that the connection shown is effected by inserting one of the plugs p² of the cord 5 in the jack J of the calling line L³, the other in the jack J² of a given trunk V³, and the plug p of the latter in the jack J of the called line L⁴. The line L⁵ is shown as being united with L⁹ on the section N³, in exactly the same way except that the office trunk V is employed for a greater distance, its plug being placed at the same section N³. In each case, always supposing the trunk to be interposed, the second operator Z is required to send the call signal to the line wanted.

In the operation of this system, a substation—say 39—wants 523. 39 takes his telephone from the switch z, and in so doing cuts off the earth terminal e of the conductor 31, disconnects his call bell, and closes the metallic circuit of the generator G through his

own telephones, and through his call annunciator s, which displays the call signal. Operator A answers by inserting the answering plug p² of any pair in the jack socket j of 39, and by this act cuts off the call annunciator and the original generator G from the line L, and substitutes for them a continuation circuit through the plug p², the conductors 33 and 34, the clearing out signal s², the battery G² and the windings i i² of the inductorium I; and the current from G² flowing through the closed circuit thus formed, and through the signal s², displays the said signal. Operator A presses the telephone key K thereby bridging the telephones t³ t⁴ to the circuit, and asking for the order finds that substation 523 is wanted, the current from the generator G² being utilized by the subscriber's transmitter t². The operator then presses key K³ introducing her telephones into the particular instruction circuit U, which connects with the telephones of trunk operator Z, placed at the switch section where are located the terminal devices of 523, and says that 39 wants 523. Trunk operator Z looks over her trunk plugs, and finding a particular one disengaged, says "connect on trunk V" or equivalent words. It will be noted that the trunk operator Z determines which trunk shall be used. Thereupon the first operator places the companion plug p² of that first used in the jack socket j² of trunk V, and a second signal circuit, viz: that of the generator G² and the signal S⁴ located at the table 3 concerned is closed, by way of the conductors 37, 38, the inductorium windings i³ i⁴, plug p², jack J², conductors 39 and 49, and the winding i⁵ of the inductorium I². The signal s⁴ comes into operation and assures the trunk operator that the given instruction has been rightly understood, and correctly acted upon, for it is clear that the said signal can only be displayed when the A end of the trunk circuit is connected with the generator G², by the introduction of plug p² into the jack socket j². The second operator having told the first, which trunk to use, immediately takes up the terminal plug p thereof and places it in the jack J of line 523, and pressing key K² sends the call signal over said line. As soon as the customer at the called station removes his telephone to answer the call, the circuit of the generator G³ is closed through the independent clearing out signal s³ of line 523, by way of telephones t and t², line conductors 40 and 41, jack J, plug p, trunk conductors 42, 47 of trunk section V², and windings i⁶ i⁷ of inductorium I², and the said signal s³ likewise is now displayed, so that while any two lines L L² are connected into a compound circuit for conversation, three automatic signals s², s³, and s⁴ are displayed, each being in an independent conductive section of such compound circuit; the first s² being located in view of operator A at the initial end of the connection, and the other two at the Z side of the switchboard section where

the said compound circuit is completed. The display of s^3 , the answering plug being in its jack J, indicates positively to operator A that customer 39 has not replaced his telephone on its hook. The display of s^3 indicates in like manner to the operator Z, that customer 523 has not replaced his telephone. The display of s^4 , shows to operator Z, first, that A has made a connection with the trunk, particularized, and, secondly, that such connection still remains unbroken. As long as s^4 is displayed, it stands as a block signal for the trunk with which it is associated, and Z cannot again order such trunk to be used until it disappears. Furthermore, should the said signal remain displayed after disconnection has been made at either end of the substation lines with which the associated trunk has been connected, the chief operator by it, is enabled readily to note that a trunk line remains unnecessarily out of use, and can thus intelligently instruct A to free it at once. These being the facts, it is evident that when customers 39 and 523 hang up their telephones, their respective signals s^2 and s^3 change or vanish, and the operators noting the disconnecting signals indicated, at once make the disconnections thus automatically called for; and when A withdraws the second plug p^2 of the pair which has been employed, from the trunk jack J^3 , the trunk signal s^4 also changes, and thereby notifies Z, that the trunk V is now disengaged and may be reassigned.

Figs. 7 and 8 illustrate a convenient means for transferring the call receiving and answering attachments of a portion of the lines of an overworked switchboard section N, to a relief section N^8 , a frequent necessity in central station work. In our system, when this is done, it is requisite that the original spring jack socket of a transferred line shall remain at the original spring jack, in order that when the said line is called for, and is to be the second factor of a compound talking circuit, it shall be under the control of the same operator Z, who makes the required second connection by means of the untransferred jack. Since however the line involved is now represented at two sections of the switchboard, it is possible that when called for, it may already be engaged in a connection initiated by itself, and made with it, at its new answering section N^8 . To the end that should the said line be thus already engaged, it shall not be interfered with by a second connection unwittingly made by operator Z at the original section N, we associate with the jack socket J at N, an auxiliary or substitute visible signal, which is automatically actuated by the act of answering a call made by such line at the new answering section N^8 , and which continues to display itself until such first connection is dissolved, whereupon it disappears, indicating to the operator Z at section N, that the line L is now free.

The full lines in Fig. 7 show the original

circuit arrangement, and the broken lines, the possible plan of transfer connections; but in Fig. 8 the converse in the case, and the circuit which is supposed to have been transferred to N^8 , has its new connections made in full lines, and its discontinued connections in broken lines.

The several lines L are permanently connected with a suitable intermediate or rearranging board or frame W placed electrically between the original spring jacks J and the call annunciators s, whereby the lines may with convenience be cross connected as desired; and each line circuit is provided at such board with connection screws as shown. Ordinarily three only of these, 9 10 and 11 are utilized, and the circuit of line L is traceable as follows: By conductor 30, through jack contact m to screw 10, thence by a link conductor to screw 11, conductor 18, call annunciator s, generator G, to earth at e, or other return conductor indicated by a dotted line 19, and thence to screw 9, and line conductor 31 leading through the complementary jack contact m out to the substation. The remaining appliances and circuits of the figure may if desired be placed in their appropriate positions and locations, but have no present relation to the line circuit which has been described. For this reason they are as before stated shown in broken lines. If sections N N^2 , &c., be overworked, a certain portion of their busy lines may by a simple change at the intermediate distributing board W be transferred to a relief answering section N^8 , as shown in Fig. 8. Screws 10 and 11 are disconnected from each other, and 9 from the return conductor 19, or earth, 11 being left vacant, 10 united to 16, and 9 to 15. Screws 8 and 17 are also united. The original call annunciator s and its conductor 18 are thus thrown into disuse. At the new switchboard section N^8 , is provided for line L a new answering jack J^4 through which the line when quiescent connects with a continuation leading to the call battery G and a new call annunciator s. Conductors 20 and 21 unite the screws 15 and 16 of the intermediate distributing board with the jack springs m. The spring-jack J^4 has a double socket ring, the two portions thereof j^3 and j^4 being insulated from each other. The socket ring j^4 is connected with a battery or equivalent generator G^3 and earth, and the ring j^3 is united to a wire 23 which at its other end is attached to screw 17 of the board W. An auxiliary automatic signal s^5 is associated with the original plug-socket j of line L at section N, and is connected between the earth, or a conductor leading to that pole of generator G^3 which is not united to ring j^4 , and the conductor 23, so that it is in the circuit of the said generator which however is normally open at the ring j^4 . The answering plug p^2 of cord 5 has a conducting surface v which when the plug is inserted to answer the call, unites the rings j^3 and j^4 and closes

the circuit of the generator G^8 through the substitute signal s^9 which displaying its signal plate apprises the operator Z at the section where line L was originally placed, that a plug is in the answering jack J^2 , and that the said line is already engaged on a connection of its own initiation, and that therefore no second connection must for the present be made with it, on the call of other lines.

Having fully described our invention, we claim—

1. A telephone switchboard having two horizontal or approximately horizontal operating surfaces or keyboards, one on each side, at one of which are located connecting cords, and at the other terminal plugs of office trunk lines, and a vertical surface supporting plug socket terminals for the trunk lines, arranged between said horizontal surfaces and associated with one of them, whereby calls may be answered and connections initiated at one side of the switchboard by inserting the plugs of the connecting cord into the sockets of the calling substation and one of the trunk lines, the said connections being completed at the other side of the switchboard by inserting the plug of said trunk line into the plug socket of the called sub-station, substantially as described.

2. A telephone switchboard of the table type, having a rear horizontal operating face or keyboard on which are mounted the substation called annunciators and spring-jacks, office trunk plug terminals, call sending keys, trunk signals and the clearing out signals for called lines; a front horizontal or sloping operating face or keyboard supporting the plug terminals of paired connection cords, telephone connecting keys, and the clearing out signals for calling lines; and a vertical operating face in which are supported the plug-socket terminals of the said office trunks, substantially as specified herein.

3. In a telephone switchboard, a vertical operating face containing plug sockets constituting the initial terminals of a series of office trunk lines each extending from some one operator's position at the rear of the switchboard to all operators' positions at the front of said switchboard; an operating face or keyboard, on an approximately horizontal plane extending frontward from the lower edge of said vertical face, and means associated therewith for answering calls, and for uniting calling lines with the spring jacks of said office trunks; and a second table or keyboard on a higher horizontal level extending rearwardly from the upper edge of said vertical face; and means associated therewith for uniting the remaining ends of said office trunks to the lines wanted, and for sending outgoing call signals to the latter substantially as described.

4. The combination in a telephone central office system in a sectional switchboard having answering operators' positions on one side, and connection completing operators' posi-

tions on the other side, of a group of subscribers' lines terminating at each section, each line having a connection device and call indicating device at its own section only; office trunk lines each extending from some one completing operators' positions, to all of the answering operator's position, and provided at both termini thereof with connection devices; flexible conductors at both answering and completing operators' positions for uniting the two ends of said trunk respectively, to a calling and a called subscriber's line; a clearing out signal at the answering operator's position responsive to the replacement of the telephone of the calling substation; and two independent signals at the completing operator's position, one responsive to the replacement of the telephone of the called substation serving as a clearing out signal, and the other responsive to connections and disconnections of the office trunk at the position of the answering operator, and serving as a trunk connection signal substantially as described and for the purposes specified.

5. In a telephone central office system the combination in a sectional switchboard having answering operators' positions on one side, and connection completing operators' positions on the other side, of a group of substation lines converging to the several sections, each line having a call indicating device, and a spring jack at its own section only, the latter being accessible to both answering and completing operators at such section; office trunk lines extending between a plug and cord terminal at some one completing operator's position and spring jack terminals at all of the answering operators' positions; connecting cords and plugs at the answering operators' positions for uniting the said jacks of the said substation lines with the said trunk jacks; an instruction circuit extending from each completing operators' telephones to the positions of all of the answering operators; and keys or buttons adapted to connect the telephones of said answering operators in the said instruction circuits substantially as described.

6. The combination substantially as hereinbefore described of a series of substation telephone circuits; a central station switchboard with which the said circuits are connected, having connection initiating and connection completing operators' positions; connecting cord conductors placed in pairs, at the said initiating positions respectively, and both members of each pair being provided with terminal plugs; a series of office trunk lines each extending from a plug terminal at some one of the completing operators' positions, to spring jacks or sockets at the several initiatory operators' positions; induction coils interposed in the said connection cords and trunk lines to sever conductive continuity but maintain inductive continuity between the terminals thereof; signal indicating devices included in

circuit with the windings of said induction coils electrical generators placed respectively in both windings of the connection cord induction coil, and in one of the windings of the trunk induction coil; whereby when any two subscribers' lines are united into a through telephone circuit, by the said connecting cords and trunk lines, a series of conductively independent circuits each including a current generator are likewise formed from the same conductors.

7. The combination in a central office system of two substation telephone circuits united by means of an office trunk line, and a connecting cord conductor, the said trunk having a terminal plug at a connection completing operators' position, to engage with the socket of the called circuit, and a plug socket at its other end, and the said conducting cord having a plug at both ends, one placed in the plug socket of the calling subscriber, and the other in the said trunk plug socket; two induction coils, one interposed in the said trunk line circuit, and the other interposed in the said connection cord circuit, so that the two ends of each are severed conductively, but united inductively; a battery or like generator included in both windings of the cord conductor coil, and in that winding only of the trunk line coil which is nearest the called substation circuit; and three automatic signal indicators two of which are placed at the connection completing operators' position but in circuit with the two windings respectively of the trunk induction coil, and the third placed at the answering operators' position in circuit with the calling subscribers' line; all substantially as and for the purposes specified.

8. A speaking telephone circuit extending between two terminal stations through an intermediate station, and divided by interposed induction coils into a series of independent conductively continuous sections, each containing a circuit controller; a signal current generator controlled thereby; and an automatic signal indicating device responsive thereto; substantially as described.

9. A compound telephone circuit formed of two substation circuits united at a central station by a temporary connecting link conductor, and containing telephones for through communication at the said two substations, and two interposed induction coils at the central station; combined with three superimposed signaling circuits formed of the same conductors by the interposition of said induction coils, and each including a circuit controller, a battery, and a switchboard signal, two of the said signaling circuits being extended from the two substations concerned, to their terminal switchboard points, and the third extending between such terminal switchboard points; substantially as described.

10. The combination of a telephone circuit uniting two terminal stations through an intermediate station; telephone transmitters in-

cluded directly in the said circuit at the said terminal stations; two induction coils at said intermediate station also included in the said circuit and dividing it into three independent conductively continuous sections, two extending between the two substations and the nearest induction coil, and one between the two induction coils; an automatic clearing out signal indicator, a circuit changer actuating the same, and a battery serving both to vitalize the telephone transmitter and operate the signal, in each of the two end signaling circuits; and a trunk signal, a plug and spring jack circuit changer, and a battery for operating the signal alone, in the central signaling circuit; substantially as specified.

11. The combination substantially as herebefore described, of a series of substation circuits connecting their respective substations with different points of a central station switchboard; an office trunk line extending between the said points of said switchboard, fitted with connection devices at its ends, and adapted to be united at one end directly to one of said substation circuits; connection cords in pairs adapted to unite another of said substation circuits to the remaining end of said trunk to form a through circuit between the substations of the said lines; two induction coils interposed respectively between the two cords of each pair; two clearing out or disconnecting signal circuits formed by the said induction coils between the said substations and their switchboard terminal points, and each including at its own substation an automatic circuit changer operated by the replacement of the telephone, and at the central station an electrical generator, and a clearing-out signal; and a trunk signal circuit formed by the said induction coils between the said two switchboard terminal points including a circuit changer operated by the connections and disconnections of the said connecting cord and office trunk, a current generator, and a signal indicator at the other end of said trunk responsive to the operation of said circuit changer, for the purpose of reporting such connections and disconnections.

12. The combination in a telephone central office system with a telephone line extending from a central station to a substation, a spring jack and a call annunciator on a terminal switchboard of said line; a second spring jack therefor, on a relief switchboard; a call annunciator therefor, associated with said spring jack on the said relief switchboard; an associated circuit extending between the said terminal and relief switchboards; a battery or other generator included in the said associated circuit; a signal indicator included in said associated circuit and placed adjacent to the spring jack on the terminal switchboard; a circuit closer for the said associated circuit mounted in the spring jack of the said relief switchboard, and operated by the insertion

of the answering plug therein; and intermediate distributing connections located between the spring jacks of the terminal and relief switchboards; substantially as and for
5 the purposes specified.

In testimony whereof we have signed our names to this specification, in the presence of

two subscribing witnesses, this 1st day of September, 1894.

HAMMOND V. HAYES.
THEODORE SPENCER.

Witnesses:

GEO. WILLIS PIERCE,
JOSEPH A. GATELY.