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B. KUGELMANN.

AUTOMATIC TELEPHONIC INSTALLATION.

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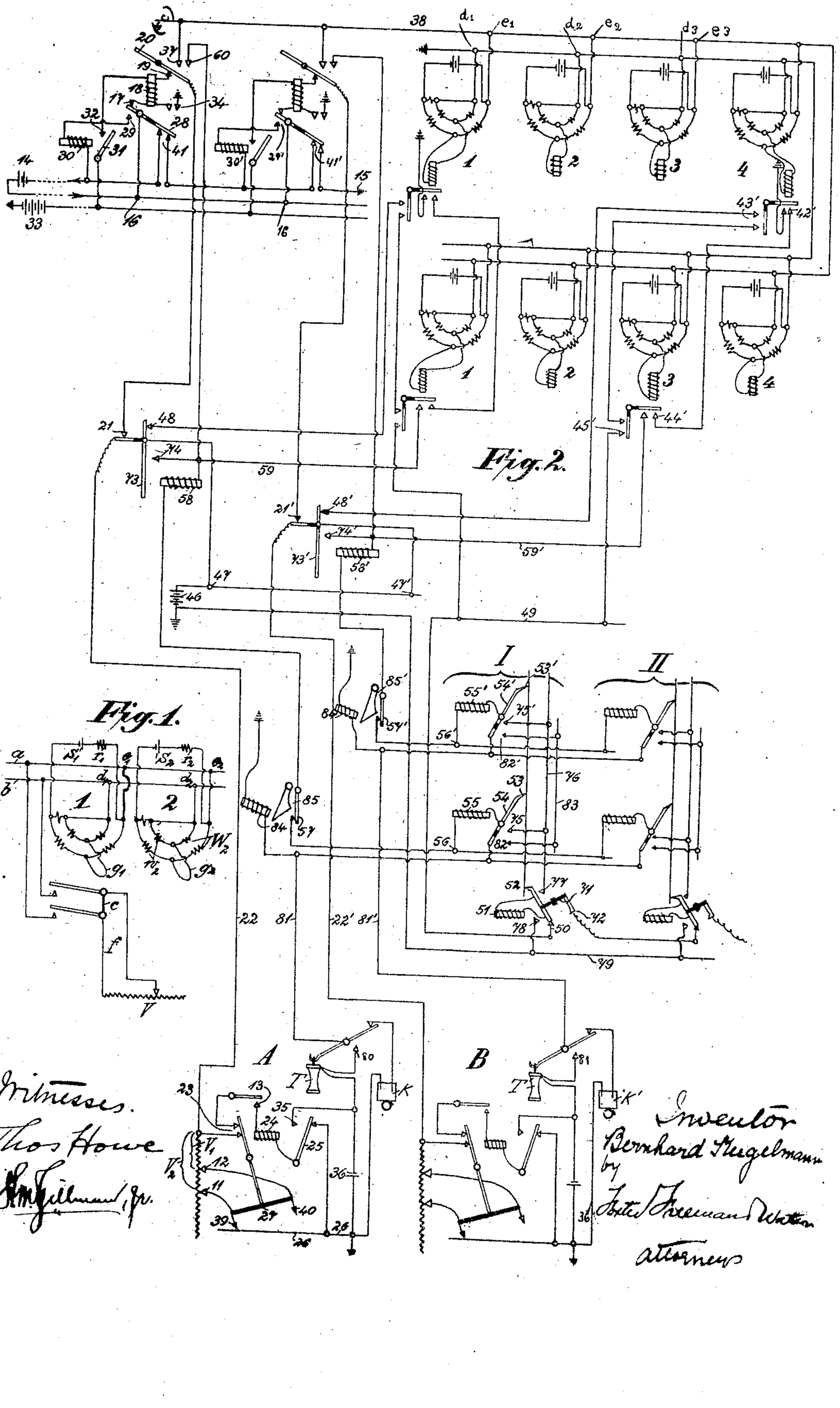

Fig. 2.

Fig. 1.

Witnesses.
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AUTOMATIC TELEPHONIC INSTALLATION.

No. 814,219. Specification of Letters Patent. Patented March 6, 1906.

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To all whom it may concern:

Be it known that I, BERNHARD KUGELMANN, a subject of the King of Bavaria, residing at Bad Kissingen, Bavaria, Germany, have invented certain new and useful Improvements in Automatic Telephonic Installations, of which the following is a specification.

In the automatic telephonic installation forming the subject of the present invention each subscriber is connected by a separate double line-wire with the central station.

The new device consists, mainly, in providing at the central station a number of Thomson bridges connected in parallel to one conductor common to all. This arrangement represents the selection device common to all the subscribers. By means of a suitable appliance in the house of each subscriber he can deprive the lead of any bridge of current if he introduces a suitable resistance in his line-wire to the central station. In the example described the bridges at the central station are arranged in two columns corresponding to units and tens for each four bridges, (in correspondence with the ciphers 1 to 4.) Each subscriber has at the central station an auxiliary circuit, which auxiliary circuit contains in a special switch arrangement electromagnetical devices for establishing telephonic connections. This auxiliary circuit is opened in each of the two columns at a bridge—the two bridges corresponding to the two ciphers of the calling-number of the subscriber—and can be closed for a moment by any other subscriber by means of sensitive relays by a rapid succession of current intermissions in the leads of the said two bridges. As the selection device (bridges) is common to all the subscribers, a device is necessary to prevent the subscribers from disturbing each other in operating the selection device. On account of that the arrangement is such that the calling subscriber after introducing the before-mentioned resistances is not yet connected to the selecting device, but first sends a current into a waiting device at the central station. The connection with the selecting device is effected automatically by means of the waiting device by a current impulse sent to the calling subscriber in such manner that only one subscriber at a time is connected. The telephonic connection results by a current impulse caused by the calling subscriber, which current impulse selects at the central station from a number of switch apparatuses, in every one of which every subscriber possesses an electromagnetical switch device, the nearest unoccupied one, occupies it by means of a common electromagnet, and bridges over the way to the nearest unoccupied switch apparatus. The telephonic connection of the calling subscriber at this unoccupied switch apparatus is effected by closing the auxiliary circuit of the calling subscriber either by means of a relay at the central station or by earthing the line at the subscriber's station, so the electromagnetical switch device of the calling subscriber, which is in connection with the auxiliary circuit, is excited at this switch apparatus and connects, by means of its armature, the line-wire of the calling subscriber with the telephone-wire. The called subscriber, however, will be connected to this telephone-wire, as his auxiliary circuit is closed by the common selection device—in consequence of the momentary absence of current caused by the calling subscriber in the corresponding bridges—and thus the electromagnetical switch device of the called subscriber, which is in connection with the auxiliary circuit, will be excited at this switch apparatus. The telephonic connection of a subscriber is maintained by the current passing through his auxiliary circuit and through a stop-relay and its armature, which prevents the subscriber from being called from another subscriber through the electromagnetical switch device and over the common electromagnet and armature that are at the corresponding switch apparatus. If, for example, it be assumed that the installation in question is to be sufficient for the simultaneous speaking of twelve subscribers, there will be required six switch apparatuses.

In the accompanying drawings is shown a diagram of connections for two subscribers, the number of subscribers being sixteen with twice four bridges and one hundred with twice ten bridges. The insulation is indicated by thick black lines.

Figure 1 shows the principle of the selecting device on which the invention is based. Fig. 2 shows a complete arrangement of the system for two subscribers.

In Fig. 1 the bridges connected parallel to each other, of which two are shown, are in permanent connection with a circuit *a b* common to all subscribers, each subscriber being able to connect himself with such circuit by

means of the waiting device and the armature *c* equal to 20 in Fig. 2, and to effect for a moment an absence of current in a desired bridge-lead by means of the variable switch resistance V at the subscriber's station. If in bridge 2, $W^2 = n w^2$. If R is the combined resistance of all the other bridges connected to the leads *a b* including sources of current S and resistances *r*, if *f* is the resistance of the line-wire to the subscriber and V the variable resistance included at the subscriber's station, the latter can produce absence of current in the bridge branch g^2, if the combined resistance connected to the points d_2 e_2 is

$$C = \frac{R\,(f + V)}{R + f + V} = n\,h_2.$$

In this the sources of current S of the other bridges are neglected. In case they are considered, h^2 is to be replaced by the expression $h^{2\prime}$. If R is sufficiently large, the subscriber must, as shown by the above formula, effect considerable alteration of V for producing a comparatively small change in the value of the above expression, which is a great advantage of this arrangement, as alterations of *f* have no material influence. In consequence hereof the Thomson bridges are preferable to other bridges, as they possess themselves a high resistance and admit of a sufficiently large R. At each subscriber's station there is a switch resistance with two movable contacts; further, an electromagnetical device (electromagnet 24, armature 27) which is operated from the waiting device at the central station and causes the resistances V′ and V^2, intercalated in order to put in function the common selective device, to be in rapid succession earthened through the contacts 39 and 40. This earth connection is produced by exciting the electromagnet 24, which attracts the armature 27, so that the contacts 39 40, attached to the armature 27, are successively in contact with the conductor 26. The waiting device at the central station, which causes that only one subscriber can be in connection with the common selective device, consists, essentially, of the current sources 33 14, and the subscriber's relays 18 30 with their armatures 28, 20, and 31 being in connection with said current sources. If, for example, subscriber A (call-number 11) desires to speak with subscriber B, (call-number 43,) he places the contacts 11 and 12 upon the points of the switch resistance corresponding to bridge 4 of the first column and bridge 3 of the second column, and he then closes contact 13. The waiting device is assumed to be unoccupied. From the common source of current 14, whose negative pole is at 15, a current impulse passes through the connection-point 16, contact 17, relay 18, contact 19, armature 20, contact 21, line-wire 22, contacts 23 and 13, relay 24, armature 25, and through 26 to earth. This current is not sufficiently strong to attract the armatures 20 and 27. On the other hand, armature 25 is attracted and also armature 28. In that position the two armatures are kept attracted by the current from earth at the calling-subscriber's station, current source 36, contact 35, armature 25, relay 24, contacts 13 and 23, line-wire 22, contact 21, armature 20, contact 19, relay 18, contact 34, earth—the relays 24 and 18 remaining weakly energized. Armature 28 causes a current to pass from current source 14 through connection-point 16, contact 29, relay 30, and back to 14. In consequence hereof relay 30 attracts its armature 31 and effects a contact of short duration at 32, so that from the common strong current source 33, whose negative pole is connected to earth, a current impulse flows on the one hand through relay 18, contact 34, to earth and on the other hand through contact 19, armature 20, contact 21, line-wire 22, contacts 23 and 13, relay 24, contact 35, and current source 36 to earth. (Armature 31 is only for a moment in connection with contact 32. When armature 31 is in its normal position or attracted by relay 30, contact 32 is open.) The relays 18 and 24 in consequence of this strong current attract their armatures 20 and 27, so that the resistances included by the subscriber are connected consecutively and momentarily through contact 37, common lead 38 with the bridges, and through contact 39 or 40 with the return-lead of the bridges—that is, in the present case—to earth. Although contact 32 is only closed for a moment, and consequently the heavy current flows over the relays 18 and 24 for only a very short time, the armature 20 will, nevertheless, owing to a certain inertia, keep the contacts 37 60 closed until the following connecting operations have taken place. The same is true of the armature 27, which interrupts its own circuit, but under the influence of the current impulse completely carries out its movement, which is necessary in order to bring contact 39 and immediately following contact 40 in contact with conductor 26. The mechanical construction therefor may be the same as the usual construction for relay-armatures. The schematic view deviates from this latter construction in which the relay-armatures are represented, because in the present drawings the succession of contacts 39 and 40 is sought to be clearly shown schematically.

Fig. 2 shows that a subscriber can only energize his relays 18 and 24 by closing contact at 13 when the armatures 28 of all the other subscibers are at rest, and consequently the contacts 41 are closed, as only in this case current source 14 has earth connection at 15. On the other hand, it will be seen that subscribers who have simultaneously excited their relays 24 and 18 by means of current

source 14 and by means of their armatures 28 have at the same time effected contact at 29 will consecutively receive the return impulses for effecting the necessary connections, inasmuch as only the relay 30 of a subscriber that is nearest to the positive pole of the current source 14 and is in connection therewith will be energized. As for the relays of the others this current source is interrupted at contact 41 until the armature 28 of the said subscriber is again in the position of rest. When the return impulse has taken place, relay 18 no longer receives current, for, as already mentioned, contact 32 is only temporarily closed and contact 23 is interrupted by the impulse, so that armature 28 at once assumes the position of rest. The common selection device by which the auxiliary currents are closed consists of two columns of bridges. The drawing shows eight bridges in two columns. The bridges are connected by the points e' e^2 with conductors 38 by the points d' d^2 with the earth. The auxiliary circuit of the desired subscriber 43 is closed by the relay of the bridge 4 of the first column and the bridge 3 of the second column. If there are auxiliary circuits, the call-numbers of which are to contain "0"—for instance, "40"—or numbers less than ten—for instance, call-number "07" and others—then every column must receive a bridge with the number "0." The connection of the subscriber's station A to the bridges produces in consequence of what has been said above for a moment absence of current consecutively in the bridge-leads of the bridge 4 of the first and bridge 3 of the second column. The relays in the bridge-leads consequently let their armatures drop and close the contacts 42′ 43′ and rapidly succeeding 44′ 45′. In consequence hereof a current impulse flows from the common current source 46 (whose negative pole is earthed) to the switch apparatuses. The drawing shows two switch apparatuses I and II. At every switch apparatus there is attributed to every subscriber in connection with his auxiliary circuit an electromagnetical switch device, (electromagnet 55 55′,) which in operating connects the line-wire 81 81′ of the subscriber to a common telephonic line 83 through a contact, 82 82′. There is further a common electromagnet 51 provided at every switch apparatus, serving by means of its armature 71 and the contacts 52 and 72 to offer a way to the current impulse effecting the connection to this switch apparatus or, if it is occupied, to offer the way to the nearest other one. The current impulse flows on an unoccupied switch apparatus through the electromagnetical switch device (electromagnet 55) of the calling subscriber, (because this electromagnet has on the one hand earth connection over connection-point 56, armature 57, relay 58, contact 60 21, line 22, contacts 12 40, conductor 26, earth, on the other hand over contact 60, line 38, and over the bridges at the central station. For, as mentioned above, contact 60 remains closed for a moment owing to a certain inertia of the armature 20. For the same reason as mentioned above the contact 40 is also closed until the following circuits are closed, which lasts for only a fractional part of a second,) and also through the electromagnetical switch device (electromagnet 55′) of the called subscriber, because this is earthened by means of the selection device through contact 44′ 42′. If it be assumed that the first switch apparatus is unoccupied, then in the present example the current impulse flows on the one hand through 47′, connection-point, contacts 48′, 43′, and 45′, to the common lead 49 and through contact 50, relay 51, contacts 52 and 53′, armature 54′, electromagnet 55′, connection-point 56′, armature 57′, relay 58′, conductor 59′, contacts 44′ 42′ to earth. As at this moment, as just before mentioned, the auxiliary circuit of the calling subscriber is also connected to earth at contact 60, the current impulse branches from contact 52 through the switch-electromagnet 55 of the caller—namely, through contact 53, armature 54, electromagnet 55, connection-point 56, armature 57, relay 58, contacts 60 21, line-wire 22, contacts 12 40, conductor 26 to earth (A current whose intensity is dependent upon the resistance of the bridges passes through the conductor 38 to earth.) The electromagnet 51 is energized and attracts armature 71, so that this switch apparatus is engaged and is bridged over at 72 for current impulses of other subscribers. Furthermore, the switch-electromagnets 55 and 55′ of the two subscribers are excited and attract their armatures 54 54′. Also the electromagnets 58 58′ interrupt the contacts 21 21′ by means of their armatures 73 73′. The energizing of the said electromagnets 51, 55, 55′, 58, 58′ is maintained by means of a current which now flows back from the common current source 46 through connection-point 47′, contact 74′, relay 58′, armature 57′, connection-point 56′, electromagnet 55′, armature 54′, contact 75′, common lead 76, contact 77, relay 51, contact 78, conductor 79 to 46. In a corresponding manner the current for the calling subscriber flows through 47, 74, 58, 57, 56, 55, 54, 75, 76, 77, 51, 78, 79, 46. When the calling subscriber takes his receiver T off the hook, a current flows from current source 36 through the speaking circuit-contact 80, line-wire 81, armature 54, contact 82, common speaking-wire 83, through 82′ 81′, audible signal K′ of the called subscriber to earth. This current also branches from 81 through relay 84 to earth, so that the suspended swinging armature 85 is attracted. This armature 85 is so arranged that in the normal condition the contact at spring 57 from armature

85 is closed. The contact at spring 57 is also closed so long as relay 84 is excited, and consequently armature 85 attracted. If relay 84 becomes currentless, (by replacing the receiver of the subscriber,) armature 85, which is hung freely movable, returns to position of rest, swings hereby beyond this position of rest and opens for a moment the contact at 57. The same is true of armature 85′ of the called-up subscriber. After the speaking is finished this armature in swinging back interrupts contact 57 and reëstablishes the position of rest of the influenced circuits. Armature 85′ acts in the same way.

Having thus particularly described and ascertained the nature of my said invention and the best means I know of carrying the same into practical effect, I claim—

1. In an automatic telephone system, the combination with the lines of the subscribers, of a number of switch apparatuses, each including one common speaking-way and a series of relay devices, one of such devices in each series being attached to each subscriber's line for control by the subscriber, each relay device adapted to join the corresponding line of the subscriber to the said common speaking-way, and each apparatus when occupied bringing the next unoccupied switch apparatus into the sphere of control of the subscribers.

2. In an automatic telephone-exchange system the combination with the lines of the subscribers, of a number of switch apparatuses, each including a series of relay devices, auxiliary circuits, a common selecting device at the central station, comprising a plurality of Thomson bridges divided into columns of a certain number of bridges, the several columns representing respectively units and tens of the numbers of subscribers, the auxiliary circuit of a subscriber being closed by the relays of those bridges, which correspond to the call-number of this subscriber.

3. In an automatic telephone-exchange system the combination with the lines of the subscribers, of a number of switch apparatuses, each including a series of relay devices, of a selecting device, relay arrangements at the central station, a relay arrangement 24 at the substation for each subscriber, contact devices 29 on the central station, contact devices 41 on the central station, a circuit for each subscriber over all said contact devices, 41, being adapted to close the said contact device 29 of the subscriber, a circuit for each subscriber over a number of the said contact devices 41 and over the contact device 29 of the subscriber, being adapted by energizing the said relay arrangements to connect simultaneously calling subscribers successively with the said selecting device.

4. In an automatic telephone-exchange system the combination with the lines of the subscribers, of a number of switch apparatuses, each including a series of relay devices, auxiliary circuits, a selecting device, a common lead 49, a current source 46, an electromagnet 51 for each switch apparatus an armature of this electromagnet 51, a contact 52 for each switch apparatus, over which the said current source 46 and the said switch apparatus are in connection during the position of rest of the said armature 71, a contact 72 for each switch apparatus over which the said current source 46 is in connection with the next unoccupied switch apparatus during the actuation of the said armature 71, contacts 77 and 78 for each switch apparatus over which the said current source 46 is in connection with the energized relays of the said switch apparatus during the actuation of the said armature 71, relays 58, 58′ for each of the said auxiliary circuits adapted to separate its auxiliary circuit from the said selecting device on actuation.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

BERNHARD KUGELMANN

Witnesses:
G. BARDEL
E. BARDEL.