E. E. CLEMENT.

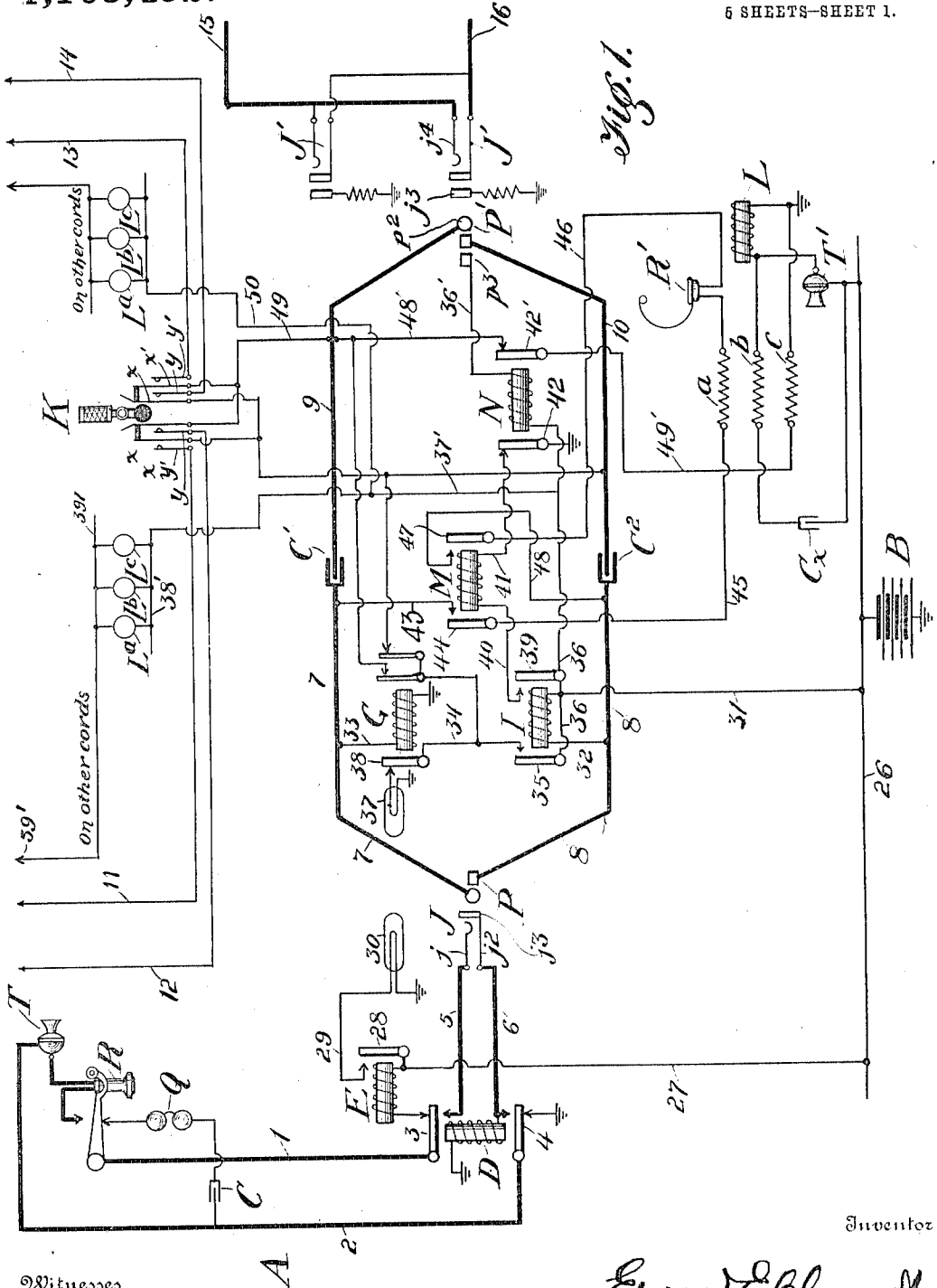
TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED OCT. 26, 1907. RENEWED APR. 28, 1914.

1,105,492.

Patented July 28, 1914.

5 SHEETS—SHEET 1.



Witnesses

H. F. Lowenstein

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5 SHEETS—SHEET 2.

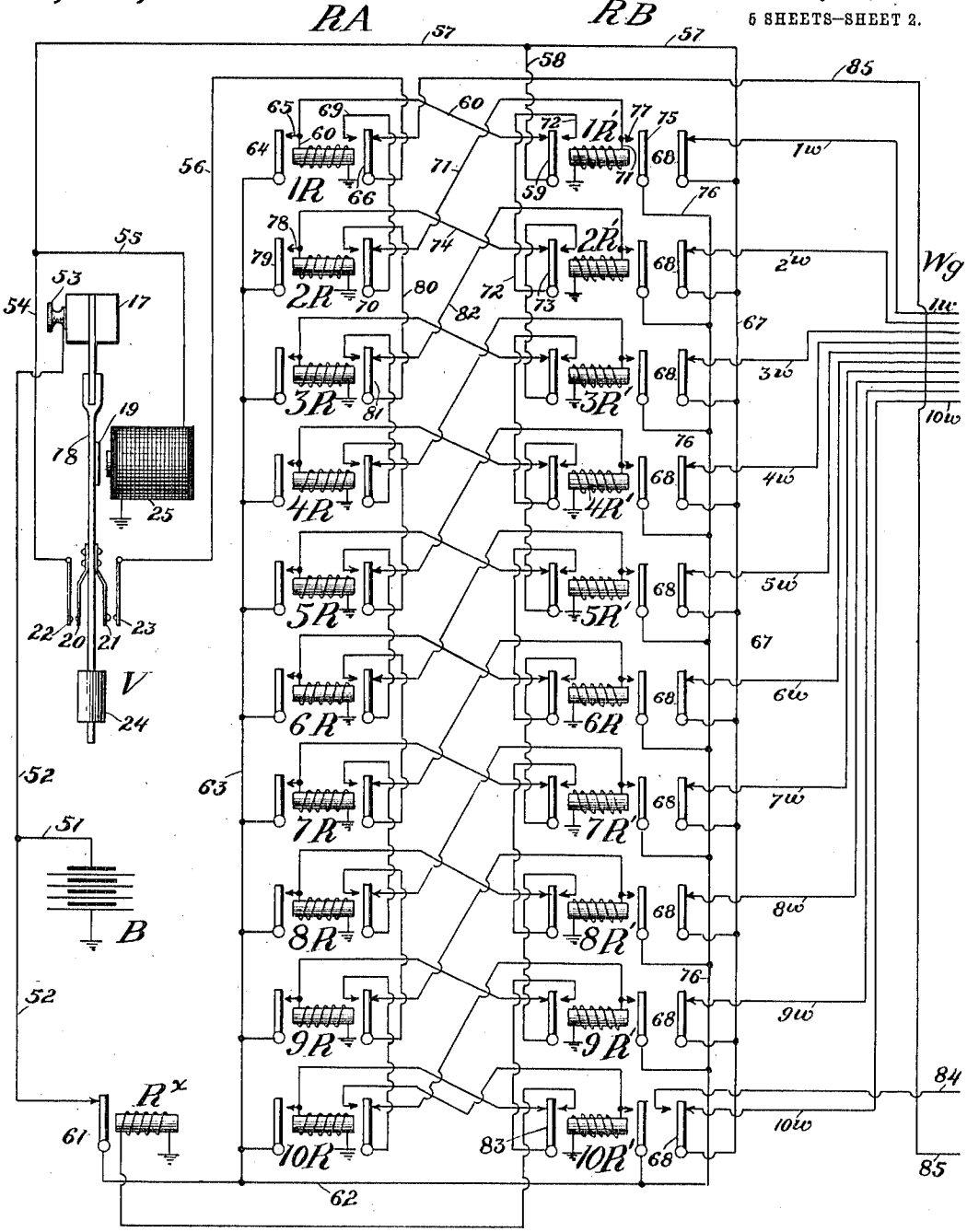


Fig. 2.

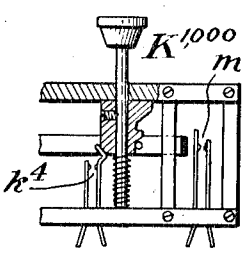


Fig. 6.

Witnesses

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5 SHEETS—SHEET 3.

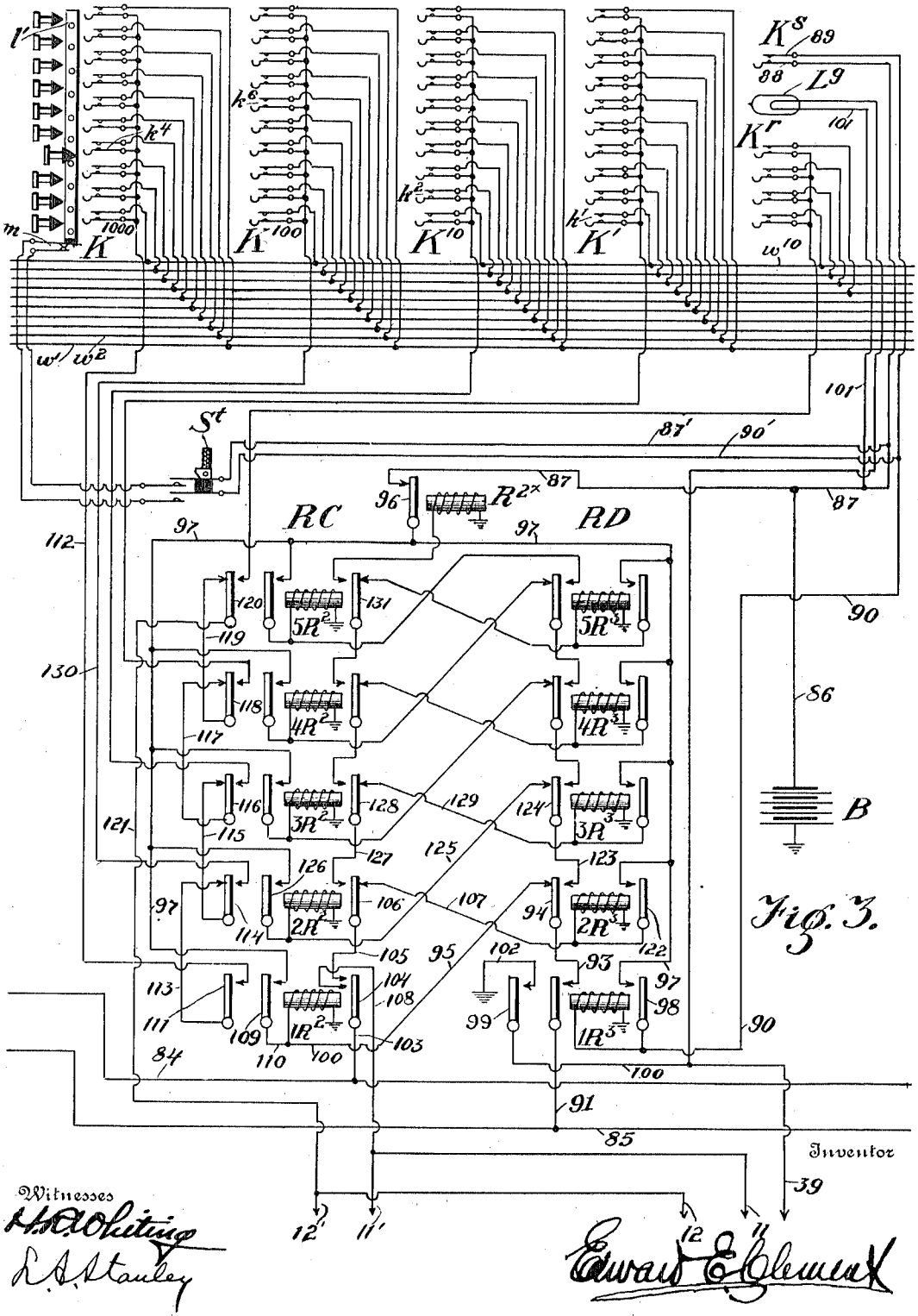


Fig. 3.

E. E. CLEMENT.

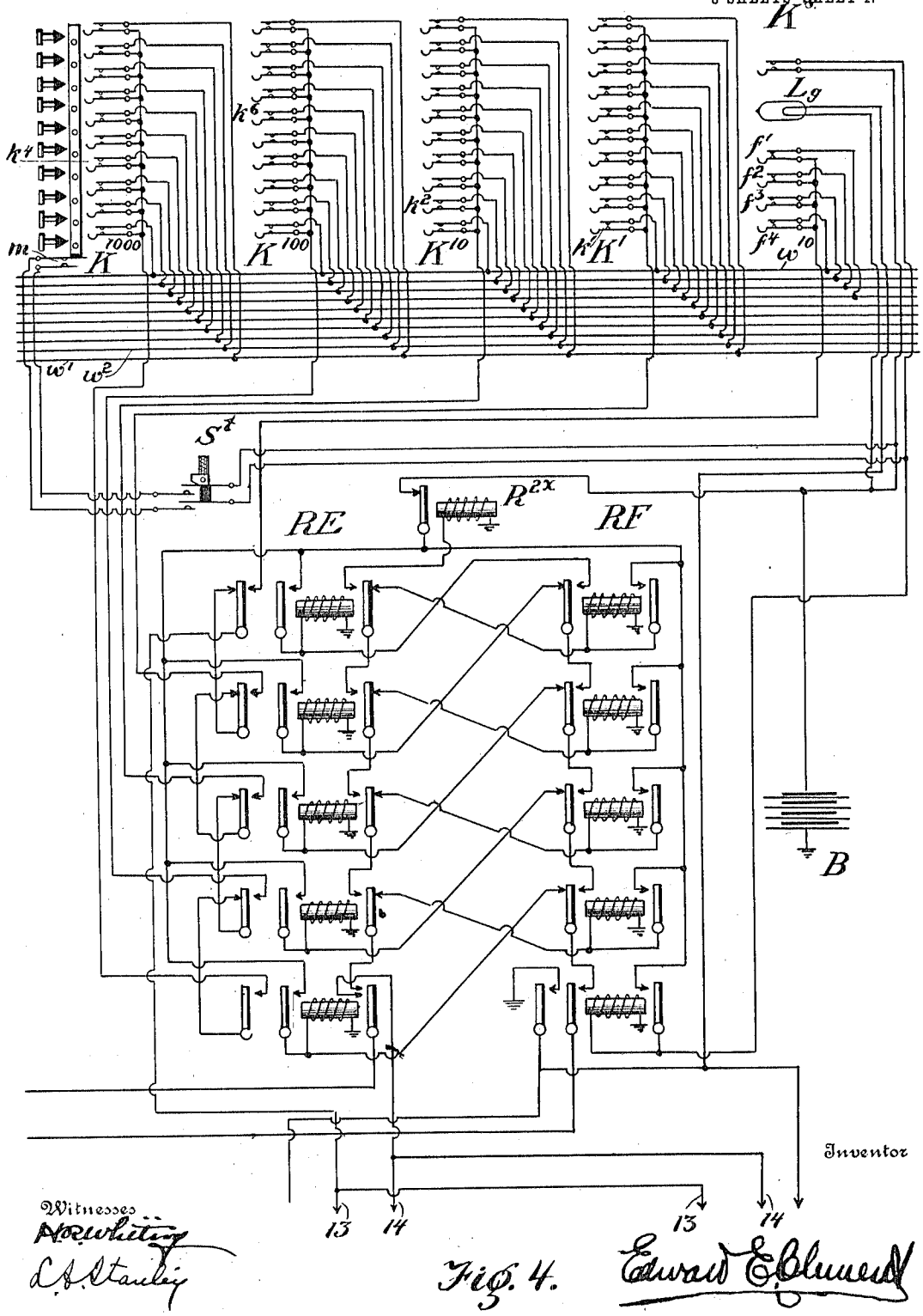
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5 SHEETS—SHEET 4.



Witnesses
Norwitting
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Fig. 4.

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5 SHEETS—SHEET 5.

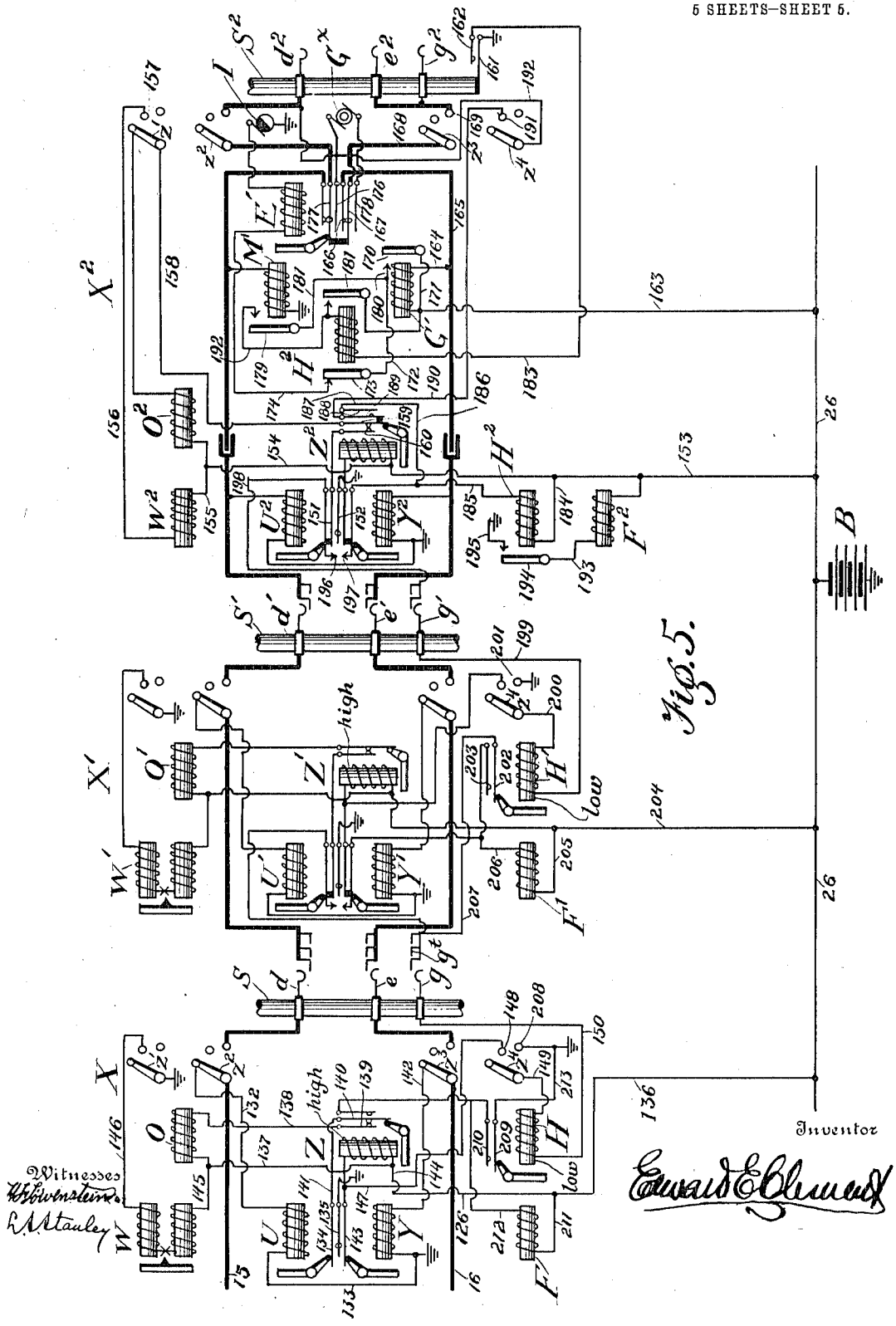


Fig. 5.

UNITED STATES PATENT OFFICE.

EDWARD E. CLEMENT, OF WASHINGTON, DISTRICT OF COLUMBIA.

TELEPHONE-EXCHANGE SYSTEM.

1,105,492. Specification of Letters Patent. Patented July 28, 1914.

Application filed October 26, 1907, Serial No. 399,283. Renewed April 28, 1914. Serial No. 835,046.

To all whom it may concern:

Be it known that I, EDWARD E. CLEMENT, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to telephone exchange systems, and has for its object the improvement of means for sending electrical impulses for the operation of automatic switches.

The systems in which sending devices are used are known ordinarily as the full automatic, in which case the impulses are generally sent from the calling subscriber's station, or the semi-automatic in which a partial connection of the circuit is effected by means of a manual connective apparatus manipulated by an operator, and further connections are effected automatically by means of impulses from an impulse sending device. My invention is particularly applicable to the semi-automatic systems and it is designed to relieve the operator of a considerable part of the work necessary for the completion of the connection.

An object of my invention is to reduce the time required to send the impulses for operating the automatic switches. Heretofore it has ben found difficult to decrease the time for sending the impulses, since with the ordinary sending devices considerable time is necessary to allow for the running down of the mechanism after setting it up for the desired number. I accomplish this decrease in the required time by providing a constantly operating impulse sending device and means for taking any desired number of impulses and projecting them upon the lines for operating the automatic switches.

A further object of my invention is to relieve the operator of all further attention to the call after she has received the number wanted and has set the apparatus for sending the impulses. This is accomplished by means of a series of sending keys and of control relays associated with said sending device in the manner described hereinafter.

Further objects and advantages will appear in the detailed description of the invention.

My invention is illustrated in the accompanying drawings in which,

Figure 1 is a diagrammatical view of a subscriber's sub-station and an operator's cord-circuit; Fig. 2 is a view showing the vibrator and its associated relays; Fig. 3 is a diagrammatical view of the sending keys and the relays associated therewith; Fig. 4 shows a key set and relays identical with that of Fig. 3; Fig. 5 shows first and second selector switches and an automatic connector switch. Fig. 6, is a detail of the three position key in Fig. 4.

Referring to Fig. 1, the subscriber's substation is shown at A and it comprises the telephone set, including the transmitter T, the receiver R, the ringers Q and the condensers C. The lines 1 and 2 lead to the central station and terminate thereat on the contacts 3 and 4 respectively of the cut-off relay D. The line relay is indicated at E and controls the signal lamp 30. On the actuation of the cut-off relay D the lines 1 and 2 are extended by means of conductors 5 and 6 to the terminal jack J.

The operator's cord-circuit consists of the plugs P and P′ normally connected by the conductors 7—8 and 9—10 through the condensers C′ and C^2 respectively. The answering supervisory relay G is connected with the strand 7 of the cord-circuit, the other end of the winding being grounded. Associated with the supervisory relay is the signal lamp 37. The supervisory control relay I has one end of its winding connected to the strand 8 of the cord-circuit and the other end connected to the battery. A relay M is arranged to automatically connect the operator's telephone set with the cord-circuit and coöperates for this purpose with the relay N. The operator's telephone set consists of the operator's receiver R′ in the secondary circuit *a* of an induction coil. The primary *b* is included in a short circuit with the condenser C^x and the transmitter T′, the latter deriving its current supply direct from the main battery through the choke coil L and ground. The tertiary winding *c* is included in a test circuit which will be described hereinafter. A switch K is provided to enable the operator to connect one of two key sets with the cord-circuit *i. e.* the one shown in Fig. 3 or that in Fig. 4 through the medium of the conductors 11—12 or 13—14 respectively.

It will be understood that the operator's manual connective means herein described is used merely as a typical connection link be-

tween the calling subscriber and the first selector switch. Obviously the impulse sending apparatus and its associated key sets could be used with automatic connection means such as primary and secondary selectors or relays adapted to connect the calling subscriber with the proper automatic switches for completing the connection. Such sets are shown in my prior applications Serial Nos. 306,292 and 296,853 filed Mar. 15, 1906 and Jan. 19, 1906, respectively. The operator's cord-circuit is shown merely for the purpose of simplifying the drawings, the invention lying in the means for sending the impulses necessary for operating the automatic switches.

The trunk lines 15—16 which terminate in the jacks J′ are each multipled to all sections of the switchboard so that any operator can reach any trunk. The trunks are arranged in groups, those of each group leading to similar switches in which the same group of subscribers' line-wires are multipled.

Referring now to Fig. 2, V denotes in general a vibrator comprising a standard 17 to which is clamped a spring member 18 having an armature 19 attached thereto and provided with spring contact members 20 and 21 adapted to contact with their anvils 22 and 23 respectively. A weight 24 is adjustably movable along the spring 18 and provides means for regulating the rapidity of vibration of the latter. The magnet 25 when energized by means of the battery B attracts the armature 19 and moves the spring in the same manner as in the ordinary bell vibrator, the result being a rapid making and breaking of the circuit.

The two parallel rows of relays shown in Fig. 2 constitute, together with the vibrator, the means by which the impulses are projected upon the lines for operating the automatic switches to effect the desired connection. These relays by their joint action project one impulse on the first wire, two impulses on the second wire, three on the third, and so on up to the last wire which finally receives ten impulses. After this the relay set, the individual relays of which have locked after pulling up, is released by means of the relay R^x when the operation is again repeated, the vibrator and the relays working continuously.

The ten conductors shown at the top of Fig. 2 lead to the key sets shown in Figs. 3 and 4. These key sets are composed of a series of keys k', k^2, k^3, etc., of the so-called self-latching selective ringing type now in common use on manual switchboards, and employ the principle shown in the patent to Ham No. 605,097, granted June 7th, 1898. When any key is pressed down it remains in this depressed position until another key in the same set is depressed, when the first key will be released and the latter will be locked in its depressed position. As will be noticed from the figures, the first key k' of each set is connected with wire w'; the second key k^2 is connected with wire w^2; the last key k^{10} being connected with the last wire w^{10}. Four keys, f', f^2, f^3 and f^4 of the set K^r are provided for party-line selective ringing and an extra key K^s is also provided for starting the impulses after the numbers have been set up. Two sets of relays operating similarly to those shown in Fig. 2 are provided for the key sets together with their release magnet R^{2x}.

In Fig. 5 there is shown an automatic first selector switch X, a second selector switch X′ and a connector switch X^2. These automatic switches are of the type shown and described in the patents to Keith and Erickson Nos. 815,176 and 815,321, granted March 13, 1906. The first selector switch and the second selector switch are similar in construction and a description of the first selector will suffice for both. It consists in general of a shaft S bearing wipers d, e and g, the first two being adapted to effect a connection of the talking circuit and the latter being a test wiper. The shaft is capable of both vertical and rotary movement, the former movement being effected through the medium of the magnet O and the latter through the magnet W. These magnets are controlled by means of the relays U and Y respectively while a side switch Z having movable arms z', z^2, z^3 and z^4 is provided for directing the successive series of impulses to the proper magnets in effecting a completion of the desired connections. A release relay H and its associated magnet F are provided for restoring the switch to its normal condition when conversation has ended.

The connector switch X^2 is similar in construction to the selector switches but has in addition the ringing relay E′ controlled by the commutator I and adapted to connect the generator G^x with the circuit for furnishing the ringing current. Talking current for the called subscriber is furnished through the windings of the relays M′ and G′, these two relays also serving in connection with the relay H′ as control relays for the ringing relay E′.

The operation of the system will be readily understood from the foregoing description of the apparatus used. Let us assume for purposes of illustration that the subscriber at station A desires to communicate with another subscriber whose number is 4621. The subscriber at station A takes down his receiver, thereby closing the line circuit through the receiver hook. This energizes the line relay E, current flowing by the following path: battery B, 26, 27, E, 3, 1, R, T, 2, 4 and ground. The armature 28 of

the line relay E then pulls up, putting battery on the conductor 29 whereupon the signal lamp 30 is lighted. On perceiving the signal the operator inserts the plug P in the jack J. The cut-off relay D is thereby energized, current flowing by the following path: battery B, 31, I, 32, 8, P, j^2, 6, D to ground. When the cut-off relay D pulls up, the line wires 1 and 2 are connected with the extensions 5 and 6 respectively by means of the armatures 3 and 4, as a consequence of which the answering supervisory relay G is energized current flowing from battery B, 31, I, 32, P, j^2, 6, 4, 2, T, R, 1, 3, 5, j, 7, 33, G to ground. The attraction of the armature 3 breaks the circuit of the line relay E and the signal lamp 30 is thereby extinguished. The operation of the sleeve relay I puts battery current on the conductor 34 through the contact 35 by the branch wire 36. The supervisory lamp 37 would therefore receive current through the contact 38 were it not for the fact that the latter is attracted when the relay G is energized. When the relay I pulls up it energizes the relay M the energizing current being traced as follows: battery B, 31, 36, 39, 40, M, 41, 42 and ground. The relay M bridges the operator's talking set between the conductors 7 and 8 of the cord, by the following path: conductor 43 (which is connected with the strand 7), contact 44, 45, the primary a of the induction coil, R', 46, contact 47, 48, the latter being connected with the strand 8. The operator, having learned the number of the subscriber wanted, depresses the number keys corresponding to the connection desired and inserts the plug P' into the jack J' leading to the first selector switch in the thousands group corresponding with the line wanted. Thereupon the relay N pulls up, cutting off the operator's set and deënergizing the relay M, the actuating current flowing from B through 26, 31, 36, N, 36', p^3, j^3 and ground. In case this particular trunk is busy, the operator receives a click in the ear on touching the jack J' with the plug P' due to current through the tertiary winding c of the induction coil.

In case the system is provided with two sets of key banks the operator may make use of either set by means of the switch K. The provision of two sets is for the purpose of enabling the numbers to be sent with greater rapidity, for while the impulses are being sent from one set the operator can be using the other set to set up the numbers by merely shifting the switch handle K of another cord to one side or the other, thereby forcing the spring contacts x, x' against their anvils y and y' and putting the conductors 11 and 12 or 13 and 14 in direct electrical connection with the cord-strands 9 and 10 by means of the conductors 49 and 50.

In case the operator desired to use the key bank shown in Fig. 3 she would shift the switch handle to the right, thereby connecting the conductors 11 and 12 with the cord-circuit. These conductors appear in the lower right hand corner of Fig. 3, the conductors 13 and 14 appearing in the lower left hand corner of Fig. 4, the extensions 11'—12' of the conductors 11—12 and the extensions 13'—14' of the conductors 13—14 in Figs. 3 and 4 respectively being multiples leading to other cords.

Referring now to Fig. 2, V, as has been before stated, denotes a constantly oscillating vibrator. It will be observed that when the spring 20 is in contact with its anvil 22 current flows through the magnet 25 by the following path: B, 51, 52, binding post 53, 18, 20, 22, 54, 55, magnet 25 and ground. At the same time relay 1R of the set RA is energized the circuit being completed as follows: battery B, 51, 52, 53, 18, 20, 22, 54, 57, 58, contact 59, 60, 1R and ground. The relay 1R then pulls up and locks, the locking circuit being from battery B, through 51, 52, contact 61 of relay R^x, conductor 62, 63, contact 64, 65, 60, 1R and ground. It will be observed that the same impulse that operates the relay 1R is placed on all the wires in the group W^g from the conductor 57 through conductor 67 and the extra contacts 68 of all the relays in the group RB.

It should be here stated that the purpose of the groups of relays RA and RB is to automatically place one impulse on the first wire 1^w, two impulses on the second wire 2^w, and so on up to ten impulses on the tenth wire 10^w. These impulses are not placed successively but are placed simultaneously and at each succeeding impulse one wire of the group is cut off from the current source. Thus all the ten wires receive the first impulse; the first wire 1^w is then cut out and the nine remaining wires from 2^w to 10^w inclusive receive another impulse; then wire 2^w is cut out and the remaining wires receive an impulse. Thus it will be seen that the first wire receives one impulse, the second two, and so on up to the last wire which receives 10. The manner in which this is done is as follows: When the magnet 25 is energized the armature 19 is attracted and the spring 18 effects a closing of the contacts 21—23. This puts current on the relay 1R' of the set RB over the following path: battery, 51, 52, 53, 18, 21, 23, 56, armature 66 (which pulled up when the relay 1R was first energized), conductor 69, contact 70 of relay 2R, 71, 1R' and ground. The armature 59 of the relay 1R' on pulling up breaks the circuit of the relay 1R and connects conductor 57 with the relay 2R through conductors 72, contact 73 of relay 2R' and conductor 74. At the same time the relay 1R' is locked through the armature 75 on its opposite end, the locking

circuit being from battery B, 52, 61, 62, 76, 75, 77, 71, 1R′ to ground. On the return of the spring 18 and the engagement of the contacts 20—22, current from the conductor 57 energizes the relay 2R (over the path already traced) which pulls up and locks through the contacts 78 and 79 by means of the same locking circuit traced in connection with the relay 1R. At the same time an impulse is placed upon the wires 2^w to 10^w inclusive through the conductors 67 and 68. It will be observed that since the relay 1R′ has pulled up and locked, its armature 68 has broken its connection with the first wire 1^w of the group W^g. This wire therefore, does not receive the second impulse which is placed upon the remaining wires.

When the armature 70 of the relay 2R pulls up, it connects the relay 2R′ with the wire 56 by means of the contact 66 of the relay 1R, conductor 69, contact 70 of the relay 2R, conductor 80, contact 81 of armature 3R and conductor 82. The relay 2R′ therefore, is actuated on the next impulse received by the wire 56 when the armature 19 is attracted by the magnet 25. When the relay 2R′ pulls up it is locked on the common locking circuit traced in connection with the relay 1R′ and its armature 68 breaks the connection with the wire 2^w. This relay also places the relay 3R in electrical connection with the wire 57 by the pulling up of its armature 73. The relay 3R is now in condition to be energized when the next impulse is received from the wire 57 and the remaining wires in the group W^g *i. e.* wires 3^w to 10^w receive an impulse in the manner described. Similar impulses are placed upon the remaining wires of the group, one wire in each case being cut off and the two rows of relays RA and RB locking as they are operated on the common locking circuits already traced. The actuation of the relay 10R places the battery current on the relay 10R′ in the manner already described and the armature 83 of the latter on pulling up connects the release relay R^x with the wire 57 and puts it in condition to be actuated by the next impulse on the wire 57. It will be noticed that the contact 61 of the release relay forms part of the locking circuits for both the rows of relays RA and RB. The attraction of the armature 61 breaks this locking circuit and all of the relays let go, thereby restoring the relays to their original condition as shown in Fig. 2. The retraction of the armature 83 of the relay 10R′ breaks the actuating circuit of the release relay and it also lets go, thereby restoring the entire apparatus to its original condition and ready for another cycle of operations, the action being continuous. The last impulse received from the wire 57 is placed on a wire 84 by means of the contact 68 of the relay 10R′. The succeeding impulse from the wire 56 is placed through the medium of the armature 66 of the relay 1R (the latter having retracted after the release of the locking circuit was broken), on a wire 85, these two wires 84 and 85 being extended to the relay sets RC and RD of Fig. 3 on to the relay sets RE and RF of Fig. 4. This impulse on the wire 85 is in reality the starting impulse for the control relays associated with the key sets and should be considered as the necessary impulse preceding the next cycle, not as an impulse following a completed cycle.

Referring to Fig. 3, the wires of the group W^g are shown extended from Fig. 2 to their connections with the key banks. The means by which the impulses are taken from the wires W^g and placed upon the cord conductors by means of the key sets is as follows: I have assumed that the operator has set up the numbers 4621. She now depresses the starting key K^s. Current flows from battery B through conductor 86, 87, contact spring 88, 89, 90, relay $1R^3$ of the set RD and ground. The relay $1R^3$ having pulled up, the wire 85 is connected with the relay $1R^2$ through conductor 91, contact 92, 93, 94, 95, $1R^2$ and ground. At the same time it locks, the locking circuit being from battery through 86, 87, contact 96 of the release relay R^{2x}, conductor 97, contact 98, 90, $1R^3$ and ground. Associated with the relay $1R^3$ is an extra contact 99 connected with the conductor 100. When this armature pulls up it puts the battery current on the guard lamp L^g by the following path: battery, 86, 101, L^g, 100, 99, 102 and ground. The guard lamp thereupon lights up and indicates to the operator that the numbers are being sent. It will be noticed that this lamp does not light up until the relay $1R^3$ has been actuated by the closing of the starting key K^s and that when the relay has retracted, that is when the numbers have been sent, the lamp circuit is broken and the lamp is extinguished. The pulling up of the armature 99 also closes the circuit through the cord lamps L^a, L^b, L^c, shown in Fig. 1, current for these lamps being supplied by battery B in Fig. 1 through 31, 36, 37′, 38′, 39′, 100, 99, 102 and ground. The pulling up of the armature 92 of the relay $1R^3$ as has been stated energizes the relay $1R^2$. This connects the wire 84 with the relay $2R^3$ through 103, contact 104, 105, 106, 107, $2R^3$ and ground, and places the relay in condition for actuation at the succeeding impulse on the wire 84. The attraction of the armature 104 also connects the wire 84 with the wire 11 leading to the sleeve side of the cord-circuit through the conductor 108. The relay $1R^2$ is locked, the locking circuit being from battery through 86, 87, 96,

97, 109, 110, $1R^2$ and ground. The armature 111 on pulling up places one side of all the contact keys in the set K^{1000} on the wire 12 leading to the tip side of the cord-circuit through the conductors 112, 111, 113, 114, 115, 116, 117, 118, 119, 120 and 121. The key k^4 in the set K^{1000} having been depressed, the wire 4^w is connected with the wire 12 over the path traced and four impulses are placed upon the wire 12 and through the latter upon the trunk line 15 leading to the first selector switch X.

Referring again to the set RD, when the second relay $2R^3$ of this set pulls up (the energizing circuit of which has been already traced), it is locked on the common locking wire 97 by one of its armatures 122 in a similar manner to the locking of the relay $1R^3$ by the actuation of the armature 98. The other armature 94, of the relay $2R^3$, on pulling up connects the wire 85 with the relay $2R^2$ through conductor 91, 92, 93, 94, 123, 124, 125, $2R^2$, so that when the succeeding impulse is placed on the wire 85 the relay $2R^2$ is actuated. It is locked on the common locking circuit 97 through the pulling up of its armature 126 in a manner similar to the locking of the first relay of the set RC. The pulling up of its armature 106 connects the relay $3R^3$ of the set RD with the wire 84 through conductor 103, 104, 105, 106, 127, 128 and 129. At the same time the movement of the armature 106 breaks the actuating circuit of the relay $2R^3$, the actuating circuit of the relay $1R^2$ having been broken in the forward movement of the armature 94 of the relay $2R^3$. The armature 114 of the relay $2R^2$ on pulling up connects one side of the key contacts of the key set K^{100} with the wire 12 through its engagement with the front contact through conductor 130 and the remaining path already traced in connection with key set K^{1000}. The action of the remaining relays $3R^2$, $4R^2$ and $5R^2$, $3R^3$, $4R^3$ and $5R^3$ is simply a repetition of the action of the relays $2R^2$ and $2R^3$ respectively. It has been shown how the relays $1R^2$ and $2R^2$ of the set RC in co-action with the first three relays of the set RD place the conductors 112 and 130 leading to the key sets K^{1000} and K^{100} respectively, in successive connection with the wire 12 leading to the tip side of the cord-conductor and thence on to the corresponding trunks leading to the automatic switches. In like manner the pulling up of the armature 116 cuts off the key sets K^{1000} and K^{100} from connection with the wire 12 and connects the third set K^{10} and the armature 118 of the relay $4R^2$ connects the set K'. The last relay of each set serves to connect the fifth set of keys K^r for the purposes of selective ringing where the impulse sending device is to be used in connection with a party-line system. The pulling up of the armature 131 of the relay $5R^2$ connects the relay R^{2x} with the wire 84 through the similar armatures of the remaining relays of the set which have pulled up and locked. The succeeding impulse on the wire 84 therefore, actuates the relay R^{2x} which breaks the locking circuit 97, thereby releasing all of the relays of both sets and restoring them to their normal position as shown in Figs. 3 and 4, leaving them ready for further actuation when the starting key K^s is again depressed.

It will be remembered that at the beginning of the operation of the relays of the set RA in Fig. 2, one impulse is placed on the wire 85 through the conductor 56 leading to the vibrator and through the armature 66 of the relay 1R of the set RA and that one impulse is finally placed on the wire 84 by the pulling up of the armature 68 of the relay 1OR' of the set RB, this impulse being derived through the wire 57 leading to the other side of the vibrator. It has also been shown how the wire 85 furnishes the actuating current for the set of relays RC which control the circuits leading to the key sets, while the wire 84 is connected at the first actuation of the relay $1R^2$ directly to the wire 11 leading to the sleeve side of the cord and thence to the automatic switches. Bearing this in mind it will be apparent that after the numbers 4621 have been set up in the manner described and the starting key depressed, the first impulse placed upon the wire 85 and actuating the relay $1R^2$ will send four impulses from the wire 4^w through the closed contact of the key k^4 and conductor 112 to the wire 12 and thence to the trunks leading to the automatic switches. This having occurred, a single impulse coming on the wire 84 will be placed on the wire 11 leading to the sleeve side of the trunk, but this same impulse, as has been before described, puts the relay $2R^2$ in condition to be energized (through the pulling up of the relay $2R^3$) which places six impulses from wire 6^w through the closed contact k^6 of the set K^{100} on the wire 12 leading to the tip side of the trunk. Following this comes another impulse on wire 84. In like manner two impulses are sent from wire 2^w through the closed key k^2 when the relay $3R^2$ pulls up, followed by a single impulse from the wire 84 to the sleeve side of the trunk, and one impulse from the wire 1^w on wire 12, with one final impulse on the wire 11. In case the party-line keys are to be used the key depressed will place a corresponding number of impulses on the tip side of the trunk with a final impulse from the wire 84 on the sleeve side.

In Figs. 3 and 4 I have shown branch wires 87' and 90' leading from the starting wires 87 and 90 to a master contact m controlled by the locking bar of the key set K^{1000} through

the switch S^t. This provides a means for sending the numbers even more rapidly than when the starting key K^s is used. The latter key, it will be remembered, is depressed after all of the numbers have been set up. Ordinarily the calls can be answered readily by using the starting key K^s but during the busy portion of the day the operator may want to increase her speed. She therefore shifts the handle of the switch S^t thereby connecting the starting wires with the master contact. The key sets are each composed of a series of three position keys. When a key is depressed to its lowermost position it closes the master contact *m*. When released it retracts to its second position where it remains locked, holding its corresponding contact (such as k^4) locked until released by the depression of another key. The operator therefore, on depressing any key of the first key set K^{1000} closes the starting circuit and the numbers begin at once to go in. It requires a minimum time of one second before the control relays connect the succeeding key set K^{100} with the lines. In order to keep ahead of the control relays which send in the numbers the operator must set up the four numbers in four seconds or less. As an expert operator can do this with ease it will be readily seen that time will be saved by starting the impulses with the depression of the first number key. After the busy time has passed and the calls begin to come in more slowly the operator will not need to set up the numbers so rapidly and she can break the circuit at the switch S^t and again make use of the starting key K^s as before.

In the preceding paragraphs I have shown how the actuating impulses are taken from the wires upon which the impulses are being continuously placed by means of the vibrator. These impulses are intended to operate the automatic switches for effecting connection between the two subscribers, and while I have shown in Fig. 5 automatic switches of the particular type heretofore mentioned it is to be understood that any type of automatic switch operating by selective impulses may be substituted for those herein shown. While therefore, I shall describe the working of these switches in detail it is for the mere purpose of better illustrating the uses to which my invention can be put..

Referring now to Fig. 5, the first four impulses coming over the trunk wire 15 cause the actuation of the relay U, current impulses flowing from the trunk wire 15 through the switch arm z^2, 132, U, 133 and to ground. The armature of the relay U on pulling up closes the contacts 134, 135, thereby energizing the vertical magnet O through the following path: battery, 26, 136, 137, O, 138, 139, 140, 141, 134, 135, and ground. The four impulses on the magnet O cause the spindle S to step up to the fourth row of contacts. One impulse from wire 11 is now received over the sleeve side of the trunk 16 through the switch arm z^3, conductor 142, relay Y and ground. The relay Y, pulling up for a moment, closes the contacts 143 and 135 thereby energizing relay Z, controlling the side switch, through the following path: battery, 26, 136, 144, relay Z, 143, 135 and ground. The actuation of the relay Z turns the switch arms z', z^2 and z^3 one step. This results in the cutting off of the relays U and Y and the actuation of the relay W, current flowing by the following path: battery B, 26, 136, 144, 137, 145, W, 146, z' and ground. The relay W is a make and break device as indicated by the diagram. It controls the rotary action of the spindle S and at each impulse turns the latter one step, the test wiper *g* sweeping along the test contacts g^t to find an idle trunk leading to a second selector switch. If the first trunk encountered is busy, a circuit will be established through the test wiper *g* as follows: battery B, 26, 136, 144, Z, 143, 147, contact 148, switch arm z^4, 149, H, 150, *g*, g^t, and through the corresponding contact of the busy switch connected in multiple with the contact g^t, back over the wiper of the busy first selector switch corresponding to *g* and to ground through the relay corresponding to the relay H and the switch arm z^4, which is resting on the third contact in the selector switch of the busy trunk. The relay Z is wound to a high resistance while the relay H has a low resistance. When the two are in series as in this test circuit just traced, the relay Z is energized while the relay H is not. As long as the wipers *g* find busy trunks this test circuit is maintained and hence the relay Z is kept energized. When however, an idle trunk is found the test circuit is broken, the armature of the relay Z drops back and in doing so it moves the switch arms z', z^2, etc., to their third position. The movement of the switch arm z' to its third position cuts off the rotary magnet W thereby bringing the switch to rest. The movement of the switch arms z^2 and z^3 close the talking circuit of the switch, while the movement of the switch arm z^4 places the release magnet F in condition to be energized at the end of conversation. The first selector switch is now connected with the trunk leading to the second selector switch X'. Six impulses are now received by the relay U' and the spindle of the second selector switch is stepped up to the sixth row. A single impulse from the wire 11 is received by the rotary relay Y' thereby actuating the side switch Z' starting the rotary magnet W' in a manner similar to that described in connection with the first selector switch. This starts the spindle S' rotating and it continues to do so until

it finds an idle trunk leading to the connector switch X^2 when the wipers d' and e' will effect connection between the trunk wires leading to the connector switch and the second selector switch.

The operation of the connector switch is somewhat similar to that of the first and second selector switches. Two impulses are received by the relay U^2 thereby actuating the vertical magnet O^2 and stepping up the connector switch to the second row. The single impulse on the relay Y^2 operates the side switch Z^2 in the manner described and places the rotary magnet W^2, through the shifting of the switch arm z' to its second position, in condition to be energized on a subsequent actuation of the relay U^2. One impulse is now sent from the key set K' in Fig. 3 which acting through the relay Y^2 closes the contacts 151, 152 and operates the magnet W^2 thereby turning the switch spindle S^2 to the first contact in the row, the actuating current being over the following path: B, 26, 153, 154, 155, magnet W^2, conductor 156, contact 157, z', 158, 159, 160, 151, 152 and ground. The wipers d^2 and e^2 now rest upon the contacts leading to the called subscriber's line. This places the relays G' and the cut-off relay of the called subscriber's line, in series and they both pull up, the energizing current being from, battery B, 26, 163, G', 164, 165, contacts 166 and 167, 168, z^3, 169, e^2, sleeve side of subscriber's line, cut-off relay and ground. The pulling up of the armature 170 of the relay G' places battery on the ringing relay E' when the constantly rotating commutator I' is in its conducting position, as follows: battery, 26, 163, 171, 170, 172, contact 173, 174, E', 175, commutator I' and ground. This current actuates the relay E' intermittently, each actuation of said relay projecting ringing current from the generator G^x as follows: G^x, 176, 177, through the wiper d^2 and by the tip side of the subscriber's line through his ringer, returning by the sleeve side and wiper e^2, 168, 167, and 178. When the subscriber answers, his line circuit is closed and the relays G' and M' are placed in series, the talking current flowing from battery through the relay G' and the sleeve side of the subscriber's line back upon the tip side and to ground through the relay M'. The latter then pulls up its armature 179 thereby energizing the relay H', the energizing circuit being as follows: battery, 26, 163, 171, 170, 180, 187, 179, 192, H^2, 183, and to ground through the closed contacts 162 and 161, the latter being closed by the first upward movement of the spindle S^2. The actuation of the relay H' breaks the energizing circuit of the ringing relay E' by the movement of its armature 173.

In case the called subscriber is busy a test circuit is established either through the relay of the busy connector switch corresponding to the relay M', or (if the called subscriber had originated the previous call) through the relay of the cord-circuit corresponding to the relay G. In the first case the circuit would be traced from battery through 26, 153, 184, relay H^2, 185, 186, 187, 188, 189, 190 and 191, switch arm z^4, 192 and on the sleeve side of the connector switch through the sleeve relay corresponding to M' or to the cord-circuit and through the relay corresponding to the relay G. In either case the actuation of the relay H^2 puts battery on the release magnet F^2, the circuit being from battery through 26, 153, 193, 194, 195 and ground. The release magnet releases the spindle S^2 and restores the connector switch to its original position. Ordinarily this would connect a busy back signal with the trunk wires leading from the connector switch to the second selector switch and thence back over the line to the calling subscriber thereby giving him to understand that the called subscriber is busy. In either case, whether he finds the line busy or after conversation with the called subscriber (in case his line was not busy) the calling subscriber hangs up, thereby placing an impulse on both the bridged relays U^2 and Y^2, their simultaneous action causing a closure of the contacts 196 and 197. This places the relays H^2 and H' in series, the current flowing by the path B, 26, 153, 184, H^2, 185, 197, 196, 198, g', 199, H', 200, z^4, contact 201 and ground. The connector switch is released as before described and the operation of the relay H' closes the contacts 202 and 203 leading to the release magnet F' of the relay X' putting the latter in series with the relay H of the first selector switch X, current flowing through the magnets by the following path: battery, 26, 204, 205, F', 206, 203, 202, 207, g, 150, H, 149, z^4, 208, and ground. The actuation of the relay F' releases the second selector switch and restores it to its normal condition while the actuation of the relay H closes the contacts 209 and 210 and establishes a release circuit for the magnet F, said release circuit being from battery through 26, 136, 211, F, 212, 210, 209, 213 and ground. This releases the first selector switch and restores it to its normal condition. The breaking of the circuit at the subscriber's substation deënergizes the supervisory relay G thereby establishing a circuit through the lamp 37 from the battery through 31, 36, 35, 34, 38, 37, and ground. The operator receiving the clearing out signal withdraws the plugs P and P' from their jacks thereby restoring the whole system to its normal condition.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. An impulse sending device comprising

the following instrumentalities: a group of impulse transmitting conductors, a common vibrator furnishing impulses thereto, and means to govern said impulses in recurring cycles so as to supply a predetermined distinctive number of impulses to each conductor in each cycle.

2. An impulse sending device comprising the following instrumentalities: a group of impulse transmitting conductors, a common vibrator furnishing impulses thereto, means governing said impulses in recurring cycles so as to supply a predetermined distinctive number of impulses to each conductor in each cycle, and means for selectively connecting said conductors with a transmission circuit.

3. An impulse sending device comprising the following instrumentalities: a group of impulse transmitting conductors, a common vibrator furnishing impulses thereto, means governing said impulses in recurring cycles so as to supply a predetermined distinctive number of impulses to each conductor in each cycle, and a set of switching devices corresponding to and connected with the respective conductors and adapted to selectively connect the same to a transmission circuit.

4. An impulse sending device comprising the following instrumentalities: a group of impulse transmitting conductors, a single impulse producing device therefor, means distributing the impulses from said device in recurring cycles so as to supply a predetermined distinctive number of impulses to each of said transmitting conductors during each cycle, and a set of switching keys corresponding to and connected with the respective transmitting conductors each adapted when operated to connect its conductor with a transmission circuit.

5. An impulse sending device comprising the following instrumentalities: a group of impulses transmitting conductors, a single impulse producing device therefor, means distributing the impulses from said device in recurring cycles so as to supply a predetermined distinctive number of impulses to each of said transmitting conductors during each cycle, switching means associated with said conductors and adapted to selectively connect the same with a transmission circuit, and means to produce successive selective transmission during a plurality of cycles.

6. An impulse sending device comprising the following instrumentalities: a group of impulse transmitting conductors, a single impulse producing device therefor, means distributing the impulses from said device in recurring cycles so as to supply a predetermined distinctive number of impulses to each of said conductors during each cycle, means corresponding to and connected with the respective conductors adapted to connect them to a plurality of branch transmission wires, and means for connecting one branch after another to a main transmission circuit during successive cycles, whereby a definite predetermined number of impulses will be transmitted for each cycle over said main circuit.

7. A calling device comprising the following instrumentalities: a constantly actuated impulse sending device, a group of impulse receiving conductors, and step by step relays adapted to place upon said conductors a constantly recurring series of impulses, the impulses received by each conductor varying in number from those received by any other conductor of the group.

8. A calling device comprising the following instrumentalities: a constantly actuated impulse sending device, a group of impulse receiving conductors, a series of groups of contact keys associated with said conductors, means for placing upon said impulse receiving conductors a constantly recurring series of impulses varying in number with each conductor of the group, and means for bringing into operation each group of contact keys successively and for placing upon a trunk or transmission line impulses from any selected impulse receiving conductor.

9. A calling device comprising the following instrumentalities: a constantly actuated impulse sending device, a group of impulse receiving conductors, a series of groups of contact keys associated with said group of impulse receiving conductors and adapted to connect the latter with trunk lines, controlling means for bringing each group of keys into operation successively, and means for placing upon said group of impulse receiving conductors impulses varying in number with each conductor and for actuating said controlling means.

10. A calling device comprising the following instrumentalities: a constantly actuated impulse sending device, a group of impulse receiving conductors, a series of groups of contact keys adapted to connect the latter with trunk lines, controlling relays for bringing the groups of contact keys into successive operation, and a series of step by step relays adapted to place a constantly recurring series of impulses upon said impulse receiving conductors and to furnish actuating impulses for the operation of the control relays.

11. A calling device comprising the following instrumentalities: a constantly acting impulse producing device, a group of impulse receiving conductors adapted to be connected with trunk lines, a series of relays corresponding in number to the impulse receiving conductors, and a second series of relays coöperating with the first series to place upon said impulse receiving conductors a constantly recurring series of impulses varying in number with each conductor of the group.

12. A calling device comprising the following instrumentalities: an impulse sending device, impulse receiving conductors, key sets for connecting said conductors with trunk lines, control relays for bringing said key sets into operation, means for placing an impulse simultaneously upon all of the impulse receiving wires, and means to thereafter cut off the individual wires of the group one by one in succession, at each step placing a simultaneous impulse upon all the remaining wires.

13. A calling device comprising the following instrumentalities: an impulse sending device, a group of impulse receiving conductors, and a plurality of groups of co-acting relays arranged to place upon the impulse receiving wires a constantly recurring series of impulses, the first wire receiving the lowest number of impulses and succeeding wires receiving progressively increasing numbers of impulses.

14. A calling device comprising the following instrumentalities: a constantly actuated impulse sending device, a group of impulse receiving conductors, a plurality of groups of co-acting distributing relays adapted to be actuated by the impulses from said sending device and to pull up and lock on a common locking circuit in step by step order, and a release relay controlling said common locking circuit and arranged to be actuated in the movement of the last relay of one of said groups for releasing all the relays and restoring them to their normal condition whereby their operation is constantly and automatically repeated.

15. An impulse sending device comprising as its essential elements a constantly acting periodic circuit changer, and a plurality of coacting relays adapted to be set up in successive order so as to govern the transmission of impulses from said circuit changer.

16. A multiple circuit impulse sending device composed of a single circuit changer and a plurality of coacting distributing relays.

17. An operator's control apparatus for signaling systems comprising an impulse producing device, a plurality of selective devices, means for starting the transmission of impulses in the actuation of said selective devices, and alternative starting means separate from and independent of said devices, together with means to render the first means operative or inoperative at will.

18. In a system of selective impulse transmission, an impulse producing device, selective switching means coöperating therewith to determine the number and group relation of impulses to be transmitted, a manual key, starting means actuated thereby to cause transmission of the impulses selected, alternative starting mechanism automatically actuated in the operation of the selective switching means, and a disabling switch for said alternative starting mechanism.

19. In a system of selective impulse transmission, an impulse producing device, selective keys for determining the impulses to be transmitted therefrom, a connection therefrom to the main transmission circuit, a starting relay, a starting key controlling said relay, and starting contacts also controlling said relay, operated in the actuation of the selective keys.

20. In a system of selective impulse transmission, an impulse producing device, selective keys for determining the impulses to be transmitted therefrom, a connection therefrom to the main transmission circuit, a starting relay, a starting key controlling said relay, starting contacts also controlling said relay, operated in the actuation of the selective keys, and a switch controlling said contacts, adapted to connect the same to and disconnect them from the starting relay at will, whereby rapid operation may be had by closing said switch, without using the starting key.

21. In a system of selective impulse transmission having automatic switches and means for producing working impulses therefor, selective keys for determining the number of impulses to be rendered effective on the switches, a transmission circuit extending from the keys, a plurality of branch circuits including contacts in the individual keys adapted to be closed when the same are actuated, and selective switching means acting synchronously with and in obedience to the impulses in the transmission circuit to test the keys in succession in order to determine selectively which key has been actuated, and means to stop the transmission of impulses, and thereby to stop the movement of any automatic switch then in circuit, when said key has been reached.

22. In a system of selective impulse transmission, means for producing impulses, selective keys for determining the impulses to be transmitted therefrom, a transmission circuit, starting means controlling the operative continuity of the transmission circuit, a circuit including said starting means, and starting contacts in said circuit, associated with and operated in the actuation of the selective keys, whereby the setting of the keys to determine the number of impulses will automatically start the transmission of the same.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD E. CLEMENT.

Witnesses:

PEARL THWAITE,

E. EDMONSTON, Jr.