

April 7, 1942.

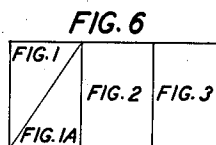
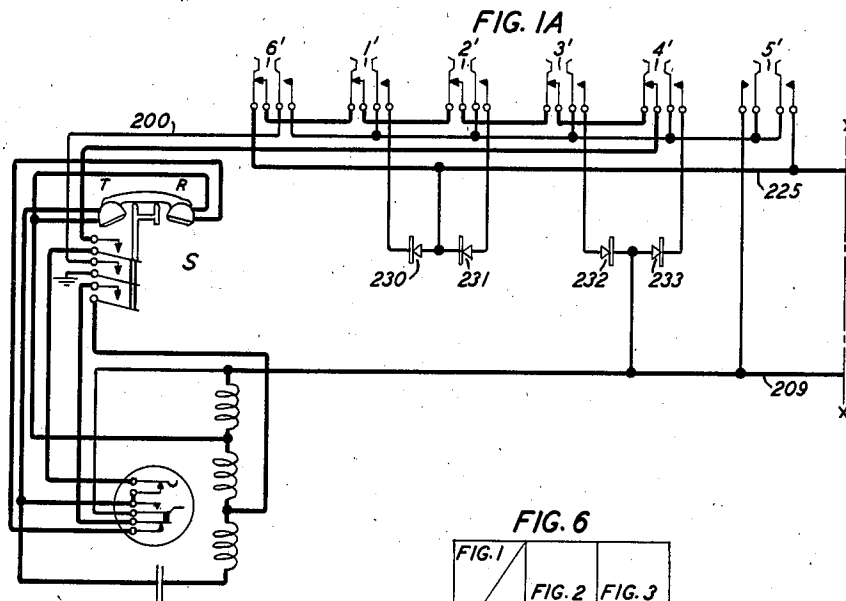
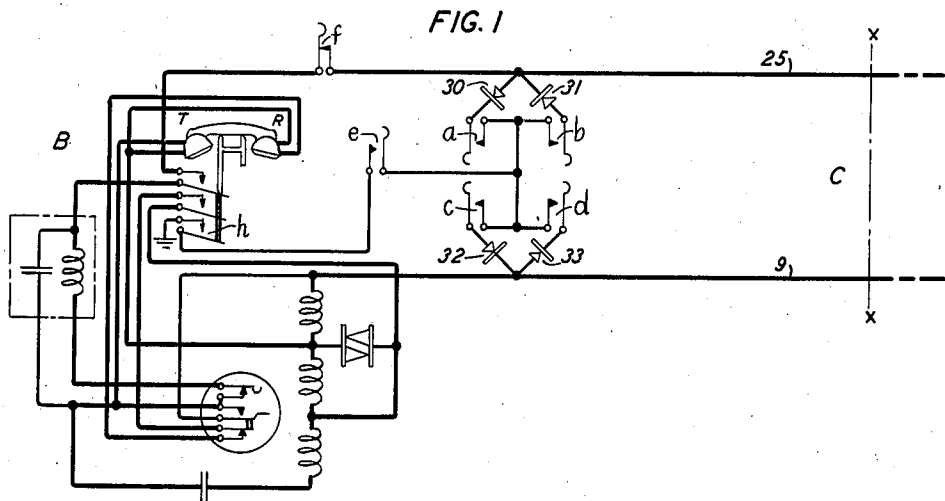
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2,278,410

TELEPHONE SYSTEM

Filed Oct. 8, 1940

4 Sheets-Sheet 1



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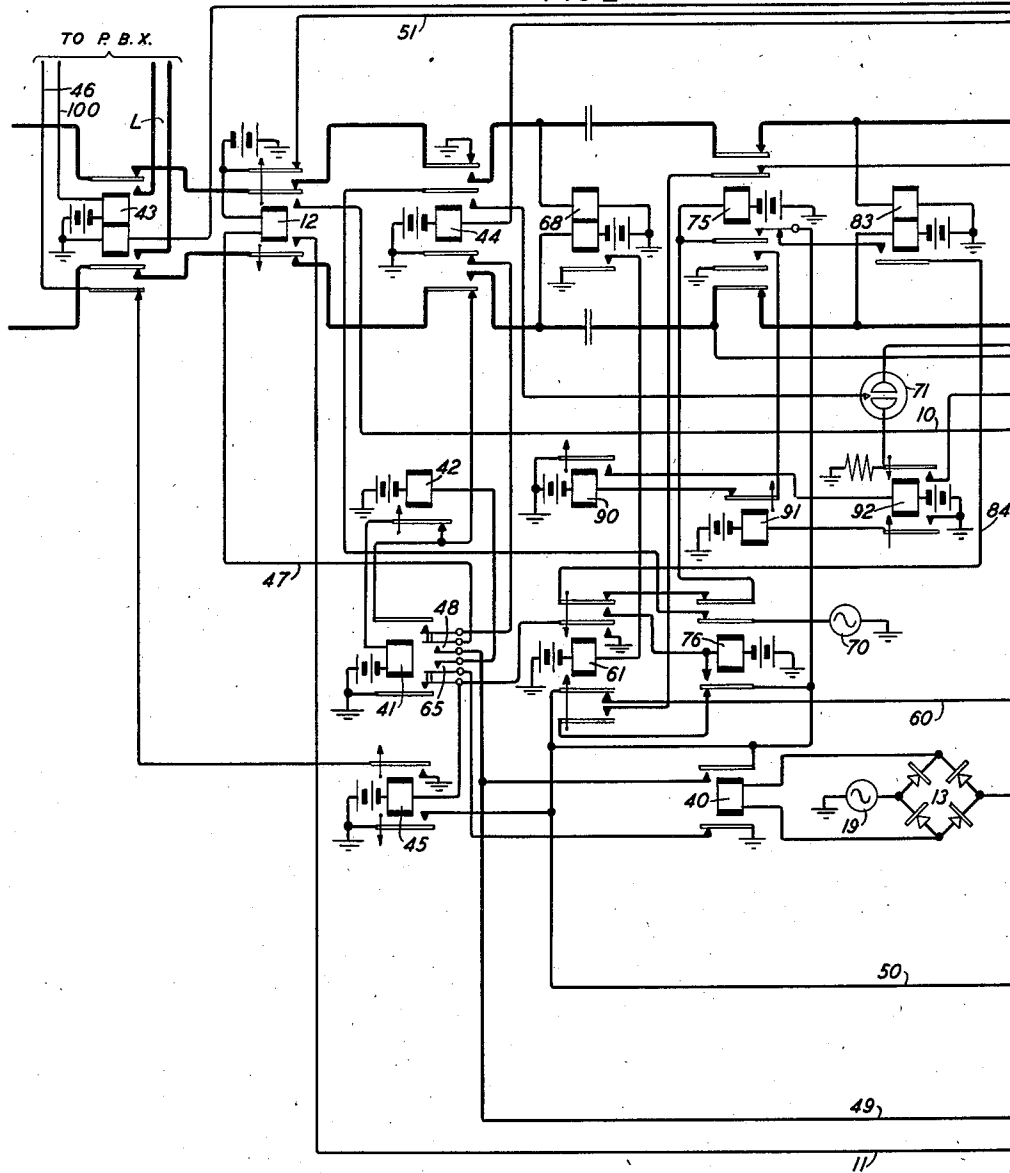
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TELEPHONE SYSTEM

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FIG. 2



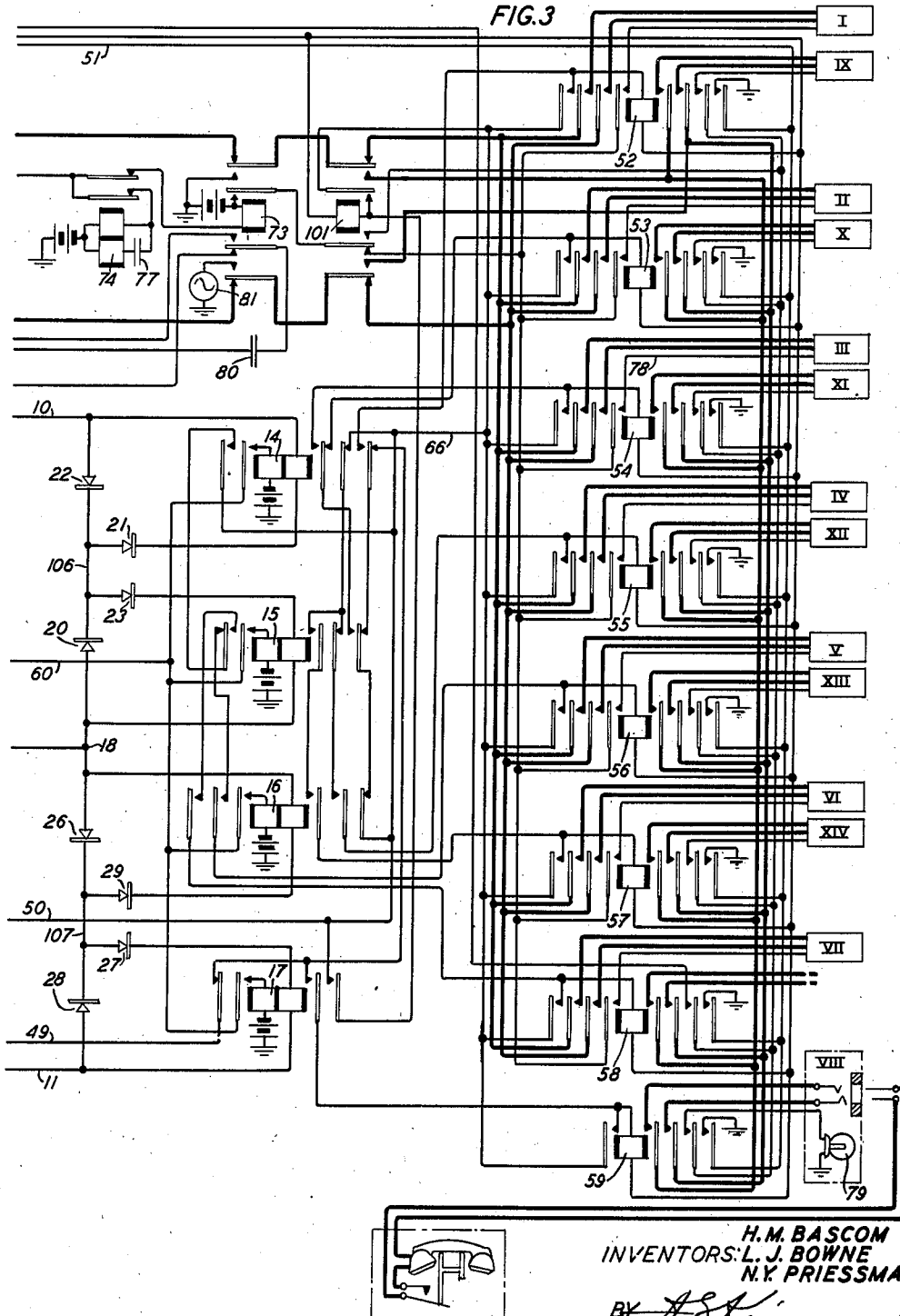
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FIG.3



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TELEPHONE SYSTEM

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FIG. 4

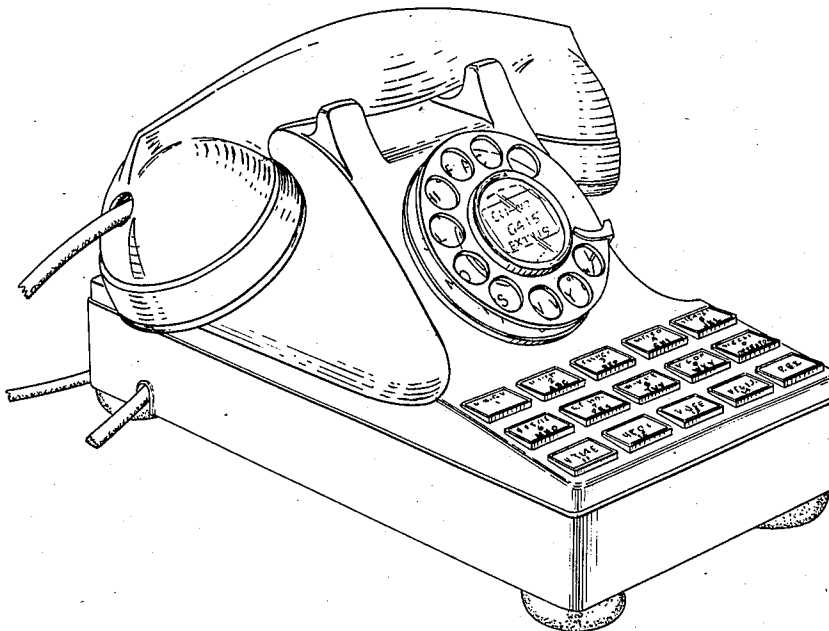


FIG. 5

STATION	KEY OPERATED FIG. 4	KEYS OPERATED FIG. 1A	SPRING CONTACTS CLOSED FIG. 1	CONDUCTORS T OR R	CURRENT DIRECTION	SELECTING RELAYS OPERATED	CONNECTING RELAYS OPERATED
<i>I</i>	1	1-6	a	T	+	14	52
<i>II</i>	2	2-6	b	T	-	15	53
<i>III</i>	3	1, 2-6	a, b	T	+, -	14, 15	54
<i>IV</i>	4	3-6	c	R	+	16	55
<i>V</i>	5	1, 3-6	c, a	T, R	+, +	14, 16	56
<i>VI</i>	6	2, 3-6	c, b	T, R	+, -	15, 16	57
<i>VII</i>	7	1, 2, 3-6	c, a, b	T, R	+, +, -	14, 15, 16	58
<i>VIII</i>	8	4-6	d	R	-	17	59
<i>IX</i>	9	1, 4-6	a, d	T, R	+, -	14, 17	101, 52
<i>X</i>	0	2, 4-6	b, d	T, R	-, -	15, 17	101, 53
<i>XI</i>	11	1, 2, 4-6	a, b, d	T, R	+, -, -	14, 15, 17	101, 54
<i>XII</i>	12	3, 4-6	c, d	R	+, -	16, 17	101, 55
<i>XIII</i>	13	1, 3, 4-6	a, c, d	T, R	+, +, -	14, 16, 17	101, 56
<i>XIV</i>	14	2, 3, 4-6	b, c, d	T, R	-, +, -	15, 16, 17	101, 57
P.B.X.	15	5, 6	a, b, c, d	T, R	+, -, +, -	14, 15, 16, 17	101, 58

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2,278,410

TELEPHONE SYSTEM

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14 Claims. (Cl. 179—42)

This invention relates generally to telephone systems and particularly to direct access keying systems.

A direct access keying system may be suitably defined as a telephone system wherein direct access to any of a plurality of frequently called subordinate lines may be had at an executive or primary station by the simple actuation of a key individually assigned to the particular subordinate line or station with which telephonic connection is desired.

It is the object of this invention to provide an improved system of this character wherein any of a plurality of subordinate or secondary lines is rendered selectively accessible to a subscriber at an executive or main station over the regular private branch exchange extension line by a single key operation.

This object is attained in accordance with a feature of the invention by the provision of a highly sensitive and novel selecting circuit involving two groups of selecting relays, each group adapted to be controlled over a single line wire extending from the main station, and in the use of series and shunt connected varistors, or rectifiers, which render the selecting relays selectively responsive to currents of different polarities transmitted over either or both of the line wires. The polarity of the current transmitted, and the line wire or wires utilized for such transmission are determined by means of a keying device located at the executive station which functions to connect oppositely poled rectifiers, singly or in combinations, to either or both of the line wires. The selecting relays respond singly or in combinations, depending upon the direction of the current transmitted over either or both of the line wires to cause the connection of a particular subordinate line to the calling executive station.

Another feature of the invention contemplates placing the transmission of the unidirectional currents under the joint control of the selecting keys and the receiver switchhook contacts at the primary station, thus eliminating the possibility of signaling the subordinate stations when the selecting keys are inadvertently or otherwise accidentally actuated.

A further feature of the invention resides in the use of means which function to prevent the completion of a connection to a called subordinate station until the keying device, which is actuated to effect the selection of the desired station, has been restored to its unactuated position.

These and other features of the invention will be readily understood from the following detailed description made with reference to the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of an executive's substation equipment including the polarity selecting keys by which any of a plurality of subordinate stations may be selectively signaled;

Fig. 1—A illustrates an alternative keying arrangement whereby the same number of selections possible with the keying arrangement of Fig. 1 are effected with fewer keys;

Figs. 2 and 3 when placed side by side and to the left of either Figs. 1 or 1—A, complete the circuit arrangement involving the features of the present invention;

Fig. 4 is a fifteen-button telephone handset which may be employed at the executive station; and

Fig. 5 is a table illustrating the contact operations and consequent relay operations effected by the actuation of each of the keys with which the primary station is equipped.

The following description is directed to the operation of the system in extending calls from the primary station B, Fig. 1, to any of a plurality of subordinate stations indicated in Fig. 3, or to a private branch exchange by way of the line L.

Before entering into a description of the actual switching operations which take place in initiating a call from station B to any of the subordinate stations, a brief description will be made of the fundamental control or selecting circuit. This circuit comprises two wires 10 and 11 which extend in parallel from the innermost front contacts of relay 12 to one of the input terminals of the full wave rectifier 13 by way of the operating windings of selecting relays 14, 15, 16 and 17, the relays 14 and 15 constituting one group in parallel with the other group made up of relays 16 and 17. Starting at the point 13, it will be noted that a path for the positive half cycles originated at the source 19 passes through the positively poled rectifiers 20 and 21 which are connected by lead 106, and thence to the wire 10 by way of the operating winding of relay 14. Rectifier 22, which is negatively poled, is connected in shunt with the operating winding of relay 14 and rectifier 21. A path for the negative half cycles extends from the point 18, through the operating winding of relay 15 and thence to the wire 10 by way of the negatively poled rectifiers 23 and 22, which are connected by lead 105. The positively poled

rectifier 20 shunts the operating winding of relay 15 and its serially connected rectifier 23. When relay 12 operates, as will be explained hereinafter, the wire 10 is connected to the tip conductor 25 of line C extending to the substation B. Obviously, therefore, when such connection is made, relays 14 and 15 will selectively respond to the transmission of positive and negative impulses, respectively, transmitted over the tip conductor 25 of line C.

In similar manner, a path from the point 18 passes through the positively poled rectifiers 26 and 27, which are interconnected by lead 107, and thence to the wire 11 by way of the operating winding of relay 17. The negatively poled rectifier 28 is connected in shunt with the operating winding of relay 17 and its serially connected positively poled rectifier 27. A second circuit also extends from the point 18, by way of the operating winding of relay 16 and the serially connected, negatively poled, rectifiers 29 and 28, which are interconnected by lead 107, to the wire 11. The positively poled rectifier 26 is connected in shunt with the operating winding of relay 16 and its serially connected rectifier 29. When relay 12 operates, the wire 11 is connected to the ring conductor 9 of line C extending to the substation B so that, when such connection is made, relays 16 and 17 will selectively respond to the negative and positive impulses, respectively, transmitted over the ring conductor of line C.

At the executive station B there is provided a key-set, indicated in Fig. 4, which comprises fifteen buttons or keys. The structural features of this device do not constitute a part of the present invention and therefore have not been illustrated. Suffice it to say that the buttons of this key-set control the spring contacts *a*, *b*, *c*, *d*, *e* and *f* in such a manner that contact *e* is closed and contact *f* is opened whenever any one of the fifteen buttons is actuated and that contacts *a*, *b*, *c* and *d* are closed singly or in combinations in accordance with the operation of the fifteen buttons and in a manner indicated by the table illustrated in Fig. 5. That is, button No. 1 closes contact *a*; button No. 2 closes contact *b*; button No. 3 closes contacts *a* and *b*; button No. 4 closes contact *c*; button No. 5 closes contacts *c* and *a*; button No. 6 closes contacts *c* and *b*; button No. 7 closes contacts *c*, *a* and *b*; button No. 8 closes contact *d*; button No. 9 closes contacts *d* and *a*; button No. 10 closes contacts *d* and *b*; button No. 11 closes contacts *d*, *a* and *b*; button No. 12 closes contacts *d* and *c*; button No. 13 closes contacts *d*, *c* and *a*; button No. 14 closes contacts *d*, *c* and *b*; and button No. 15 closes contacts *a*, *b*, *c* and *d*.

The contacts *a* and *b*, when closed, connect the positively and negatively poled rectifiers 30 and 31, respectively, to the tip conductor 25 of line C, whereas the contacts *c* and *d*, when closed, connect the negatively and positively poled rectifiers 32 and 33, respectively, to the ring conductor 9 of line C. The contact *h* is part of the switchhook pile-up at station B and is closed whenever the receiver at station B is removed from its support to furnish ground to the rectifier spring contacts *a*, *b*, *c* and *d*. Contact *f* is opened by the operation of any key before contact *e* closes to remove the station bridge in order to separate the two leads during the signaling period.

When contact *a* is closed the positive half cycles generated at 19 traverse the tip conductor 25 from the wire 10 to ground by way of the spring contacts *e* and *h*; when contact *b* is closed the negative half cycles generated at 19 traverse

the tip conductor 25 from the wire 10 to ground by way of the spring contacts *e* and *h*; when contact *c* is closed the negative half cycles from source 19 traverse the ring conductor 9 of line C to ground by way of contacts *e* and *h*; and when contact *d* is closed the positive half cycles from source 19 traverse the ring conductor 9 of line C to ground by way of contacts *e* and *h*.

From the foregoing brief description it is apparent that the subscriber at station B can cause to be transmitted over either or both the tip and ring conductors of line C, positive and negative impulses, singly and in combinations, to cause the selective operation of relays 14, 15, 16 and 17, singly and in combinations.

It will be assumed that the subscriber at executive station B desires to communicate with the subscriber at station III represented by the block in Fig. 3. Key No. 3 at station B will be actuated after the receiver thereat is removed from its support. As hereinbefore indicated, the actuation of key or button No. 3 results in the closure of contacts *a* and *b* as well as of contact *e*, and the opening of contact *f*. Contact *f* opened, removes the station subset from the line, and contact *h*, controlled by the receiver switchhook, connects ground to the various rectifiers 30, 31, 32 and 33.

With the receiver at station B removed from its switchhook, and prior to the actuation of key No. 3, a circuit for operating relay 41 is established which may be traced from grounded battery, winding of relay 41, armature and back contact of relay 42, back contact and outer lower armature of relay 44, back contact and lower armature of relay 12, back contact and inner lower armature of relay 43, ring conductor 9 of line C, through the closed substation loop, normal contact *f*, tip conductor 25 of line C, upper armature and back contact of relay 43, inner upper armature and back contact of relay 12 to ground, by way of the outer upper armature and back contact of relay 44. Relay 41, operated, establishes an obvious circuit for relay 45 which, when operated, connects ground to the lead 46 of private branch exchange line L, marking this line busy at the associated private branch exchange. Relay 41, operated, locks to ground at the inner lower armature and back contact of relay 44.

Relay 12 now operates in a circuit extending from grounded battery, winding of relay 12, conductor 47, contacts 48 of relay 41, conductor 49, outer left armature and back contact of relay 17, back contacts and outermost right armatures of relays 14, 15 and 16, conductor 50, to ground at the lower armature and front contact of relay 45.

At its outer upper armature, relay 12 removes battery from lead 51 which is included in the operating circuits for relays 52 to 59, inclusive, and 101, so that these relays will not operate to extend a call to their associated subordinate stations until the keying device employed to make a selection is operated and released, as will be more fully described hereinafter.

At its inner upper armature and lower armature, relay 12 interrupts the continuity of the tip and ring conductors extending to the subordinate stations, and connects the leads 10 and 11 to the tip and ring conductors 25 and 9, respectively, extending to the executive station B, so that the selecting relays 14, 15, 16 and 17, which are associated with the leads 10 and 11, are now prepared for selective operation under control of the key-set at the executive station.

The operation of any of the fifteen station-selecting keys at the executive station causes the closure of one or more of the spring contacts *a*, *b*, *c* and *d* so that whenever any such key is operated to effect the transmission of either or both positive and negative impulses from the source 19 and its associated full-wave rectifier 13, over either or both the tip and ring conductors 25 and 9, relay 40 will operate. At its lower armature relay 40 removes ground from the winding of relay 42 to insure the non-operation of this relay until the selecting key at the calling station is restored. With relay 42 maintained in its released condition, relay 41 is held locked to ground at the back contact and inner lower armature of relay 44, and with relay 41 and relay 40 operated, an operating circuit for relay 12 is maintained to ground at the lower armature and front contact of relay 45. Thus it is that battery is removed from the conductor 51 to prevent relays 52 to 59, inclusive, from operating until the actuated selecting key at the calling station is restored.

With key 3 operated, contact *f* is open and contacts *a* and *b* are closed, as are contacts *e* and *h*, the last being controlled by the receiver switch-hook contacts. The closure of spring contacts *a* and *b* connects the tip rectifiers 30 and 31, respectively, to ground, thus completing a transmission path for both positive and negative half cycles originated at the source 19. Selecting relays 14 and 15 accordingly operate. The path in which relay 14 operates extends from the source 19, full-wave rectifier 13 and relay 40, positive poled rectifiers 20 and 21, operating winding of relay 14, conductor 10, front contact and inner upper armature of relay 12, back contact and upper armature of relay 43, tip conductor 25 of line C, positive poled rectifier 30, closed contacts *a*, *e* and *h*, to ground. The circuit in which relay 15 operates extends from source 19, rectifier 13, relay 40, operating winding of relay 15, negative poled rectifiers 23 and 22, conductor 10, front contact and inner upper armature of relay 12, back contact and upper armature of relay 43, tip conductor 25 of line C, negative poled rectifier 31, contacts *b*, *e* and *h* to ground. Thus when key or button No. 3 is actuated, both relays 14 and 15 operate, the former on positive impulses generated at 19, and the latter on negative impulses from the same source.

Relays 14 and 15 lock operated in a circuit extending from grounded batteries, the left windings, front contacts and inner left armatures of relays 14 and 15 in parallel, conductor 60, back contact and inner lower armature of relay 61, to ground by way of the lower armature and front contact of relay 45. A circuit for relay 54 is now partially completed, extending from ground, front contact and lower armature of relay 45, conductor 60, outermost right armature and back contact of relay 16, outermost right armature and front contact of relay 15, innermost right armature and front contact of relay 14, winding of relay 54, conductor 51 to the open back contact of the outer upper armature of relay 12. Obviously, relay 54 does not operate until relay 12 restores its armatures and connects battery to the conductor 51. The release of relay 12 occurs when key No. 3 at the executive station is restored to normal. When this is done, contacts *a*, *b* and *e* are opened and contact *f* closed. The opening of contacts *a*, *b* and *e* opens the circuit for the transmission of the positive and negative impulses from source 19, so that relay 40 is no longer op-

erated. In releasing its lower armature relay 40 completes an operating circuit for relay 42 extending from grounded battery, winding of relay 42, contacts 65 of relay 44, back contact and lower armature of relay 40 to ground. Relay 42 operates and opens the locking circuit for relay 41, which relay when released, opens the operating circuit for relay 12. Battery associated with the outer upper armature of relay 12 is now connected to the lead 51, thus completing the operating circuit to relay 54.

At its outermost right armature and front contact, relay 54 establishes an obvious operating circuit for relay 44. At its outermost left armature and front contact, relay 54 completes a locking circuit to ground at the lower armature and front contact of relay 45, by way of conductors 66 and 59. It will be understood that relay 45, being slow-to-release, does not restore its armatures immediately upon the release of relay 41. At its other three left armatures, relay 54 completes the line connections to the station III.

When relay 44 operated, as described above, the line conductors are extended to the calling station B, and since the substation loop is completed with the receiver removed from its support, relay 68 operates in an obvious circuit. At its armature and front contact, relay 68 establishes an obvious operating circuit for relay 61.

At its inner upper armature relay 61 completes an operating circuit for relay 45 which, therefore, remains operated. At its inner lower armature and back contact, relay 61 opens the locking circuit to relays 14 and 15, which relays restore their armatures. At its outer lower armature relay 61 completes a circuit for ringing relay 73 extending from grounded battery, winding of relay 73, back contact and outer armature of relay 74, back contact and inner upper armature of relay 75, front contact and outer lower armature of relay 61, back contact and lower armature of relay 76 to ground by way of the lower armature and front contact of relay 45. Relay 74 is included in this circuit in parallel with relay 73. Relay 74 is a slow operating relay since, due to the capacity of condenser 77, it permits current to flow in both windings which, at this time, are differentially connected. When the condenser charges to a certain potential which will be opposing the operating potential, the current in the lower winding will be lowered to such a value as to permit the current in the upper winding to operate the relay. When the operating circuit to the relay is opened, the condenser is connected in the circuit to cause the relay to hold operated until the condenser discharge is enough to release the relay. At this time the windings of the relay will be series aiding. When relay 74 operates, the relay 73 releases. Relays 74 and 73 continue to operate and release until the called party at station III answers.

When relay 73 operates, battery at its front contact and inner upper armature is connected to the lead 78 extending to station III which causes a lamp signal corresponding to lamp 79 associated with station VIII to be lighted.

When relay 44 operated it connected the alternating current source 70 to the tube 71 which fires, and since one of the electrodes thereof is connected to the ring side of the line by way of the front contact and inner lower armature of relay 73 and condenser 80, an audible ringing signal is received at the executive station B.

Relay 73 in operating also connects the alternating current source 81 to the called station III

so that the ringer (if used) associated with that line is operated as an audible call signal.

When the called party answers, relay 83 operates over the closed called station line loop. Relay 83 operates only during the silent period of the ringing cycle. Cut-off relay 76 now operates in a circuit extending from grounded battery, winding of relay 76, front contact and outer upper armature of relay 61, conductor 84, front contact and armature of relay 83, normal make-before-break contacts of relay 75, to ground by way of the lower armature and front contact of relay 45. Relay 76 stops the relay 74 functioning and prevents relay 73 from reoperating. Relay 76 locks operated under control of relay 45, opens the circuit to relay 75 and opens the 60-cycle ringing circuit from tube 71. The circuit is now in condition for talking, relays 68, 61, 45, 44, 83, 76 and 54 being operated.

The connection is held under control of the calling station B. When the handset thereat is replaced on its mounting at the completion of conversation, relay 68 will restore its armature, thus releasing relay 61, which in turn releases relay 45. Release of relay 45 causes relays 76 and 54 to release. Release of relay 54 releases relay 44 and also relay 83 if the called station has not disconnected. Thus the circuit is restored to normal.

If the handset at station B is replaced on its mounting before key No. 3, or any other similar key is operated, relay 42 will operate after an approximate six-second interval. Relay 42 operated, releases relay 41 which releases relay 12 and also relay 42, to restore the circuit to normal.

If the called station III is busy, relay 83 will operate immediately upon the operation of relay 54. The operation of relay 83 causes relay 75 to operate in a circuit which may be traced from grounded battery, winding of relay 75, outer upper armature and back contact of relay 76, back contact and outer upper armature of relay 61, conductor 84, front contact and armature of relay 83, normal make-before-break contacts of relay 75, to ground at the lower armature and front contact of relay 45. Relay 75 operated, causes relays 90, 91 and 92 to operate to cause an interrupted busy tone to be sent to the executive station B and prevent ringing current from being connected to the called line by opening the circuit to relay 73.

In Fig. 3 the subordinate stations are identified by the Roman numerals I to XIV, inclusive, the tip and ring conductors, which may be connected to station XV, not disclosed, being shown as loose conductors. This has been done for the purpose of indicating that at least one of the keys at the executive station may be employed for obtaining direct access to a private branch exchange or central office trunk, such as indicated at L, Fig. 2. Assuming such provision is made, key P. B. X. could be assigned to the trunk L and when actuated, subsequent to the removal of the receiver from its support at station B, spring contacts *a*, *b*, *c* and *d* would be closed in accordance with the table shown in Fig. 4. The closure of contact *a* connects the positive poled tip rectifier 30 to ground by way of contacts *a*, *e* and *h*, the last being closed when the receiver at station B is removed from its support. Contact *b* connects the negative poled rectifier 31 to the tip side of the line; contact *c* connects the negative poled rectifier 32 to the ring side of the line; and contact *d* connects the positive poled rectifier 33 to the ring side of the line. Both positive and nega-

tive impulses therefor traverse the tip and ring conductors 25 and 9 of line C, and conductors 10 and 11, to be selectively transmitted through the operating windings of relays 14, 15, 16 and 17 from the source 19. Relay 14 responds to positive impulses transmitted over the tip conductor; relay 15, to negative impulses over the tip conductor; relay 16, to negative impulses over the ring conductor; and relay 17, to positive impulses transmitted over the ring conductor. Relays 14, 15, 16 and 17, operated, lock under control of relays 61 and 45. Relays 14, 15 and 16 cooperate in preparing an operating circuit for relay 58 which may be traced from ground, front contact and lower armature of relay 45, conductor 50, outer left armatures and front contacts of relays 14 and 15, front contact and outermost left armature of relay 16, winding of relay 58, and thence to the open outer upper armature contact of relay 12. Relay 101 also is prepared for operation by the operation of relay 17. When relay 12 restores its armatures in the manner hereinbefore described, battery is connected to the outer upper back contact of relay 12 to complete the operating circuits for relays 58 and 101.

Relay 101 in operating locks under control of relay 45. At its outer upper and lower armatures, relay 101 transfers the tip and ring conductors of the extension line from the left armatures of relays 52 to 58, inclusive, to the right armatures thereof. With relay 58 operated, an obvious circuit under control of relay 73 is completed for relay 43, which relay in operating locks by way of its upper winding to ground on the lead 100, and at its upper and inner lower armatures transfers the line C from the extension line to the direct trunk L to the private branch exchange. Thus the executive station B may have direct access, not only to a plurality of subordinate stations but also to one or more trunks extending to a private branch exchange or central office. With the line to relay 58 opened, this relay releases, releasing all operated relays except relay 43. At the end of the call, relay 43 releases by the removal of ground from the lead 100 of the direct trunk L to the private branch exchange.

On calls originated at a private branch exchange, ground will be connected to lead 100 of the trunk L, to cause the operation of relay 43. Relay 43 functions to connect the executive line C directly to the trunk L extending to the private branch exchange.

It will be understood that more than one of the keys or buttons may be assigned to private branch exchange or central office trunks.

It is believed unnecessary to trace through calls originating at station B for each of the other subordinate stations. The general operation of the system is identical to that already described, and the manner in which the selecting relays 14 to 17, inclusive, and the station connecting relays 52 to 59, inclusive, operate in response to the actuation of certain of the keys at the executive station is clearly indicated by the table in Fig. 5.

It may be well to indicate, however, that switching relay 101 operates whenever relay 17 is actuated to transfer the tip and ring conductors from the left armatures of relays 52 to 58, inclusive, to the right-hand armatures thereof. In this manner each of the relays 52 to 58, inclusive, serves two subordinate lines, or their equivalent.

The line at station VIII is shown terminating in a jack to which connection may be made by means of a jack-ended cord to which there is con-

nected a telephone handset. All the lines may be thus terminated, or if desirable, they may be directly associated with a substation set.

In Fig. 1—A there is disclosed an executive substation S equipped with but six keys which may be employed to obtain the results obtained with the fifteen keys employed at station B. There are five selecting keys, 1', 2', 3', 4' and 5' and a "start" key 6'. The method of selecting a station with this telephone set differs from the fifteen station sets hereinbefore described, in that it requires the operation of one or more code keys and the operation of the start key. The third column of the table shown in Fig. 5, indicates the manner in which the keys of the six-button set are operated to effect the station selections. As therein indicated, the station codes may be composed of one to three key operations. Keys 1' to 5', inclusive, are of the mechanically locking type and are released by the actuation of the start key 6', but before the key is released, ground is connected through the start key contact and the receiver switchhook contacts to the common ground lead 200 to all of the keys.

In order to clearly set forth the operation of this system it will be assumed that the executive at station S desires to communicate with the subscriber at subordinate station VII. The receiver is removed from its switchhook and the same relay operations are effected as when the receiver at station B is removed from its support as hereinbefore described. Keys 1', 2' and 3', in accordance with the table of Fig. 5, are then actuated and mechanically locked. Then the start key 6' is operated.

It will be understood now, that relay 12 has operated to connect the leads 10 and 11 of the selecting circuit to tip and ring conductors 225 and 209, respectively, extending to the substation S. The actuation of key 1' connects the tip side of the line to varistor or rectifier 230; key 2' connects the tip side of the line to rectifier 231; and key 3' connects the ring side of the line to rectifier 232. The operation of start key 6' connects ground through these rectifiers to the tip and ring sides of the line so that positive and negative impulses traverse the tip side of the line, conductor 10 and the operating windings of relays 14 and 15, while positive impulses only will traverse the ring side of the line, conductor 11 and the operating winding of relay 16. Relays 14, 15 and 16, therefore, operate and lock under control of relay 45 in a manner which is apparent from the previous description of the operation of the fifteen-button key system.

With relays 14, 15 and 16 operated and locked, a circuit for the operation of relay 58 is prepared which extends from ground, front contact and lower armature of relay 45, conductor 50, outer left armatures and front contacts of relays 14 and 15, front contact and outermost left armature of relay 16, winding of relay 58, to the open back contact and outer upper armature of relay 12 by way of conductor 51. When relay 12 releases in a manner fully explained in a preceding description, relay 58 operates and locks, connecting the subordinate station VII to the line.

It is believed unnecessary to describe in detail any further station selections since the table in Fig. 5 covers all key combinations and the relay operations effected thereby. It will be observed, however, that the fifteenth combination in this system is effected by operating key 5' and start key 6', which results in the connection of ground to the tip and ring conductors at the station S.

Thus both positive and negative polarities are transmitted over both the tip and ring conductors and conductors 10 and 11, to effect the operation of relays 14, 15, 16 and 17. The functions performed by these relays have been described in detail hereinbefore in connection with the operation of key No. 15 at executive station B. Suffice it to repeat here that relay 43 eventually operates to connect the executive line C to the direct trunk L to the private branch exchange or central office.

The particular form of selecting circuit involving neutral relays with positive and negative varistors connected in series and shunt therewith, results in a system, highly selective to the transmission of current impulses of different polarities, and increases the margins within which the selecting relays will function. It will be noted that each selecting relay 14, 15, 16 and 17 has two similarly poled rectifiers connected in series with its operating winding, and an oppositely poled rectifier connected in shunt with its operating winding and one of the series connected rectifiers. The series connected rectifiers offer a very high resistance to the unwanted polarity, that is, the polarity on which a certain relay is to non-operate, whereas the shunt connected rectifier or varistor serves to by-pass the unwanted polarity and constitutes a relatively low resistance path for this purpose. It will also be noted that the shunt varistor for each relay is also one of the series varistors of the other relay.

Though applicants have illustrated the fundamental relay-varistor selecting circuit in its application to a station or line selecting system, it is apparent that its use is not so limited. The keys at station B, or ten of them, for example, might constitute the elements of a telephone designation sender which functions to transmit codes consisting of positive and negative impulses, singly and in combinations, to characterize the digits of telephone numbers. In such a system the selecting relays would function to control relays in a register or similar device.

By placing the impulse transmission under the joint control of the selecting keys and the receiver switchhook contacts at the executive station, the possibility of effecting station selections by the inadvertent or otherwise accidental actuation of a key, with the receiver on its support, is obviated.

As hereinbefore specified, relay 40 operates whenever any station selecting key is operated at the executive station when the telephone thereat is removed from its support in order to maintain relay 12 operated until the selecting key is restored to normal. Relay 12, at its outer upper armature, controls the connection of battery to the conductor 51 which is included in the operating circuit for relays 52 to 59, inclusive, and for relay 101, and as long as this relay is operated, the circuit for these relays is incomplete. Obviously, therefore, no station selection can be effected until relay 12 restores its armatures which is accomplished when relay 40 releases upon restoration of a station selecting key to normal. Unless such provision is made, a station selection might be completed when the executive subscriber actuates a station selecting key and then decides to abandon the call by replacing the telephone on its support.

The selecting keys at stations B and S may be mounted directly on the telephone handset or, if desirable, in a separate key box.

What is claimed is:

1. The combination in a telephone impulse-transmitting system, of a transmitting station, a receiving point, a source of positive and negative current impulses, a line interconnecting said transmitting station and said receiving point, means for selectively applying the positive and negative impulses of said source to said line singly and in combinations, and a receiving circuit for said impulses comprising a pair of unidirectional current conducting branches interposed between said source and said means, each branch including two similarly poled rectifiers and the winding of a relay and a rectifier of each branch shunting the relay winding and one of the rectifiers of the other branch.

2. The combination in a telephone system, of a transmitting station, a receiving point, a pair of wires interconnecting said transmitting station and said receiving point, a source of positive and negative current impulses at the receiving point, means at the transmitting station for selectively applying positive and negative impulses from said source singly or in combinations to either or both of said wires, and receiving equipment at said receiving point, for said impulses comprising a pair of unidirectional current conducting branches interposed between said source and each of said wires, each of said branches consisting of two similarly poled rectifiers and the winding of a relay, all serially connected, and a rectifier of each branch shunting the relay winding and one of the rectifiers of the other branch of the same pair of branches.

3. The combination in a telephone system, of a plurality of signal control relays, and means for selectively operating said relays comprising, a source of positive and negative current impulses, a line, means for selectively transmitting the positive and negative impulses of said source over said line singly and in combinations, and an impulse receiving circuit associated with said line and interposed between said transmitting means and said source comprising, a pair of selecting relays, a pair of similarly poled rectifiers connected in series with one of said relays, a second pair of similarly poled rectifiers connected in series with the other of said relays, the rectifiers of one pair being poled opposite to the rectifiers of the other pair, and a circuit connection for connecting each of said relays and one of its serially connected rectifiers in shunt with one of the rectifiers serially connected with the other of said relays.

4. The combination in a telephone system, of a transmitting station, a receiving point, a source of positive and negative current impulses at the receiving point, a conductor interconnecting the transmitting station and the receiving point, means for selectively applying the positive and negative impulses of said source to said conductor singly and in combination, and a receiving circuit, at said receiving point, for said impulses, comprising a pair of unidirectional current conducting branches interposed between said source and said conductor, each branch consisting of two similarly poled rectifiers and the winding of a relay all serially connected, with the lead interconnecting the similarly poled rectifiers of each branch common to both branches.

5. The combination in a telephone system of a transmitting station, a receiving point, a source of positive and negative impulses at said receiving point, a pair of wires interconnecting said transmitting station and said receiving point,

means at said transmitting station for applying the positive and negative impulses of said source, singly or in combination to each of said wires, and impulse receiving means interposed between each source and each of said wires comprising, a pair of relays, a pair of positive poled rectifiers connected in series with one of said relays, a pair of negative poled rectifiers connected in series with the other of said relays, and a rectifier shunting each of said relays and one of its serially connected rectifiers and poled oppositely to the serially connected rectifiers.

6. The combination in a telephone system, of a primary station, a secondary station, an extension line, switching means for connecting said secondary station to said extension line, a key at said primary station, means responsive to the actuation of said key subsequent to the removal of the receiver at said primary station for preparing said switching means for operation, and means effective upon the release of said key for operating said switching means.

7. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations and normally associated with said primary station, switching means individual to said secondary stations for connecting said stations to said extension line, keys at said primary stations, means controlled thereby when operated subsequent to the removal of the receiver at said primary station for selectively preparing an operating circuit for said individual switching means, and means effective upon the release of said keys for completing the operating circuit prepared by the operation of said key controlled means.

8. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations normally associated with said primary station, switching relays for connecting said secondary stations to said extension lines, key controlled means at said primary station, means responsive to the operation of said key controlled means when a particular key at said primary station is actuated subsequent to the removal of the receiver thereat for preparing an operating circuit for a particular one of said switching relays, and means responsive to the release of the actuated key for completing the operating circuit for the said particular one of said switching relays.

9. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations normally associated with said primary station, switching relays for connecting said secondary stations to said extension line, an operating circuit for said switching relays, a plurality of selecting relays, key controlled means at said primary station responsive to the actuation of a key thereat for selectively operating said selecting relays whereupon the operating circuit for a particular one of said switching relays is prepared, and means responsive to the release of the actuated key at said primary station for completing the operating circuit prepared by said selecting relays.

10. In a telephone system, a telephone line having tip and ring conductors, a primary station on said line, a plurality of secondary lines, a switching device for connecting each of said secondary lines to said telephone line, and means for selectively actuating said switching devices

comprising, a source of alternating current, a pair of relays connected in circuit with said source of alternating current and arranged to respond respectively to positive and negative current impulses, a second pair of relays connected in circuit with said source of alternating current and arranged to respond respectively to positive and negative current impulses, a keying device at said primary station, means responsive to the removal of the receiver at said primary station for connecting the windings of said first pair of relays to the tip conductor of said line and the windings of said second pair of relays to the ring conductor of said line, and means controlled by said keying device, when actuated, for selectively transmitting the positive and negative impulses from said source of alternating current over said tip and ring conductors to prepare said switching devices for operation, and means effective upon the release of said keying device for operating said switching devices.

11. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations extending from said primary station, switching means for connecting each of said secondary stations to said extension line, and means controlled from said primary station for selectively operating said switching means comprising a source of positive and negative current impulses, a selecting circuit extending therefrom and including a pair of selecting relays, each of said relays having a pair of unidirectional current conducting devices connected in series therewith and poled so as to pass impulses of a particular polarity, a unidirectional current conducting device shunting each of said relays and poled oppositely to the series connected devices, means responsive to the removal of the receiver at said primary station for connecting said selecting circuit to one of the line conductors extending to said station, and means at said primary station for causing the transmission of either positive or negative impulses from said source over said selecting circuit to cause the selective operation of said selecting relays.

12. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations and normally associated with said primary station, switching means for connecting each of said secondary stations to said extension line, and means for selectively operating said switching means comprising a group of selecting relays, a source of positive and negative impulses, a positive poled rectifier connected in series with one of said relays and said source, a negative poled rectifier connected in shunt with said one of said relays and its series connected rectifier, a negative poled rectifier connected in series with another of said relays and said source, a positive poled rectifier connected in shunt with said other of said relays and its series connected rectifier, means responsive to the removal of the receiver at said primary station for connecting said group

of relays to one of the line conductors extending to said primary station, and means at said primary station, effective subsequent to the removal of the receiver thereat, for causing either positive or negative impulses, or both, to be transmitted over said line conductor to selectively operate said group of relays.

13. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations and normally associated with said primary station, switching means for connecting each of said secondary stations to said extension line, and means for selectively operating said switching means comprising, a source of positive and negative current impulses, a pair of selecting relays connected in series with said source and arranged to respond selectively to current impulses of one or the other polarity, means responsive to the removal of the receiver at said primary station for connecting one of said pairs of relays to one of the line conductors extending from said primary station, and the other of said pairs of relays to the other line conductor extending from said primary station, means at said primary station, effective subsequent to the removal of the receiver thereat, for causing the selective transmission of the positive and negative impulses from said source, singly or in combinations, over either or both the line conductors extending from said primary station to cause the selective operation of said selecting relays.

14. The combination in a telephone system, of a primary station, a plurality of secondary stations, an extension line common to said secondary stations and accessible to said primary station, switching means for connecting each of said secondary stations to said extension line, and means for selectively operating said switching means comprising a source of positive and negative current impulses, a plurality of selecting relays arranged in two groups of two relays each, a relay of each group arranged to respond to positive impulses from said source and another relay of each group arranged to respond to negative impulses from said source, means responsive to the removal of the receiver at said primary station for connecting each group of selecting relays to a different line conductor extending from said primary station, and means for selectively transmitting the positive and negative impulses from said source over either or both of the line conductors, comprising a pair of oppositely poled rectifiers for each of said line conductors, and means effective subsequent to the removal of the receiver at the primary station for effectively associating the said oppositely poled rectifiers with their respective line conductors singly or in combination.

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