Dec. 10, 1929. H. H. ABBOTT 1,738,519

SIGNALING SYSTEM FOR SUBSCRIBERS' TELEPHONE CIRCUITS

Filed March 23, 1928 2 Sheets-Sheet 1

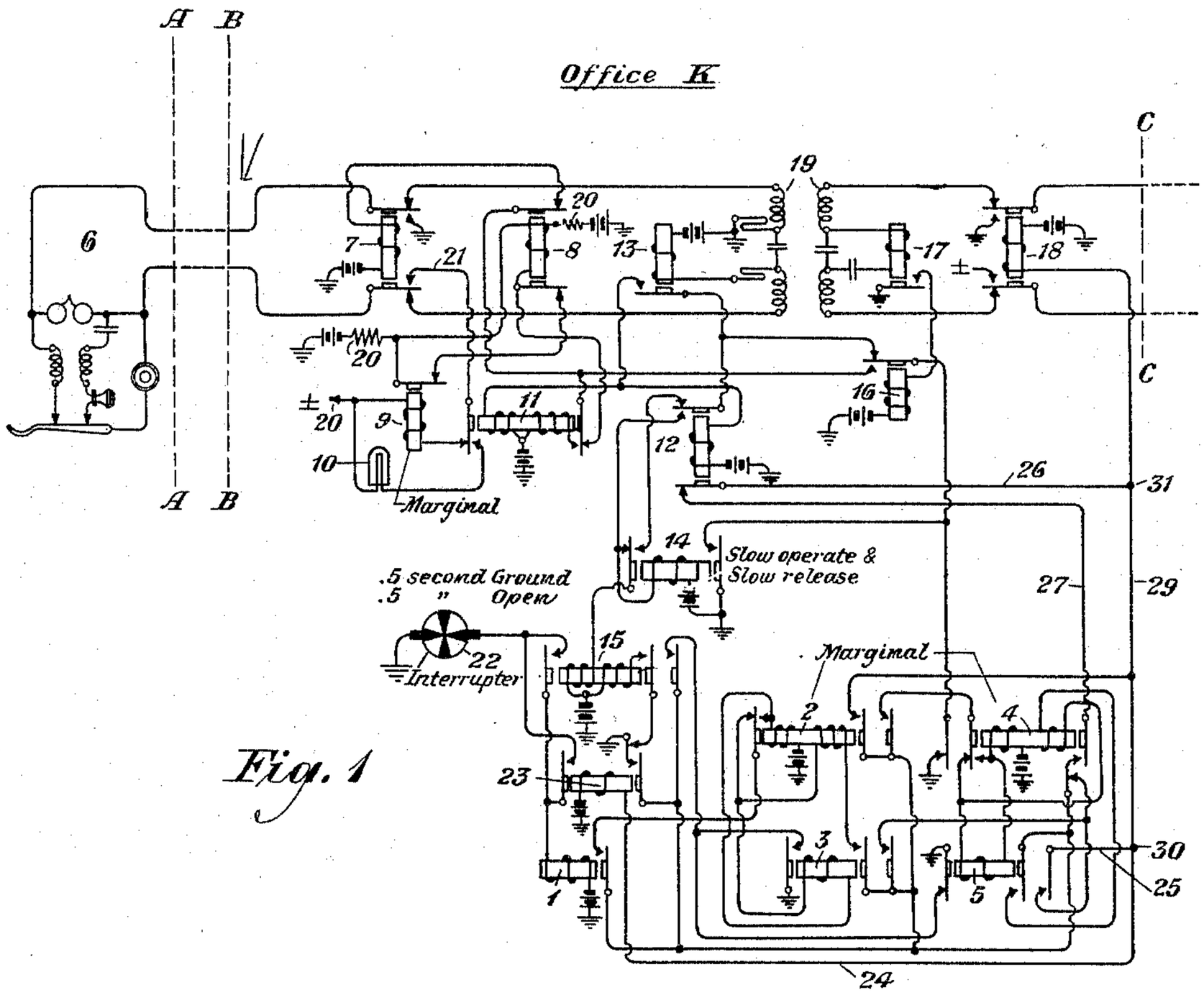

Fig. 1

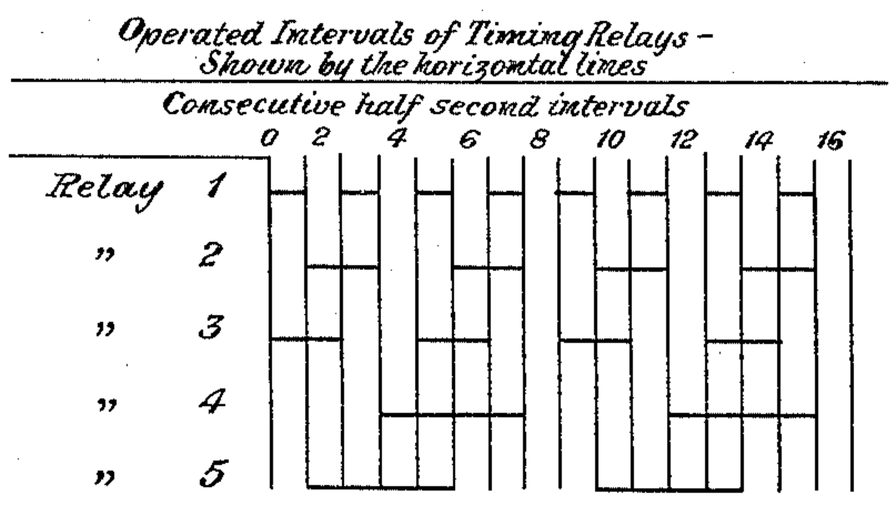

Fig. 4

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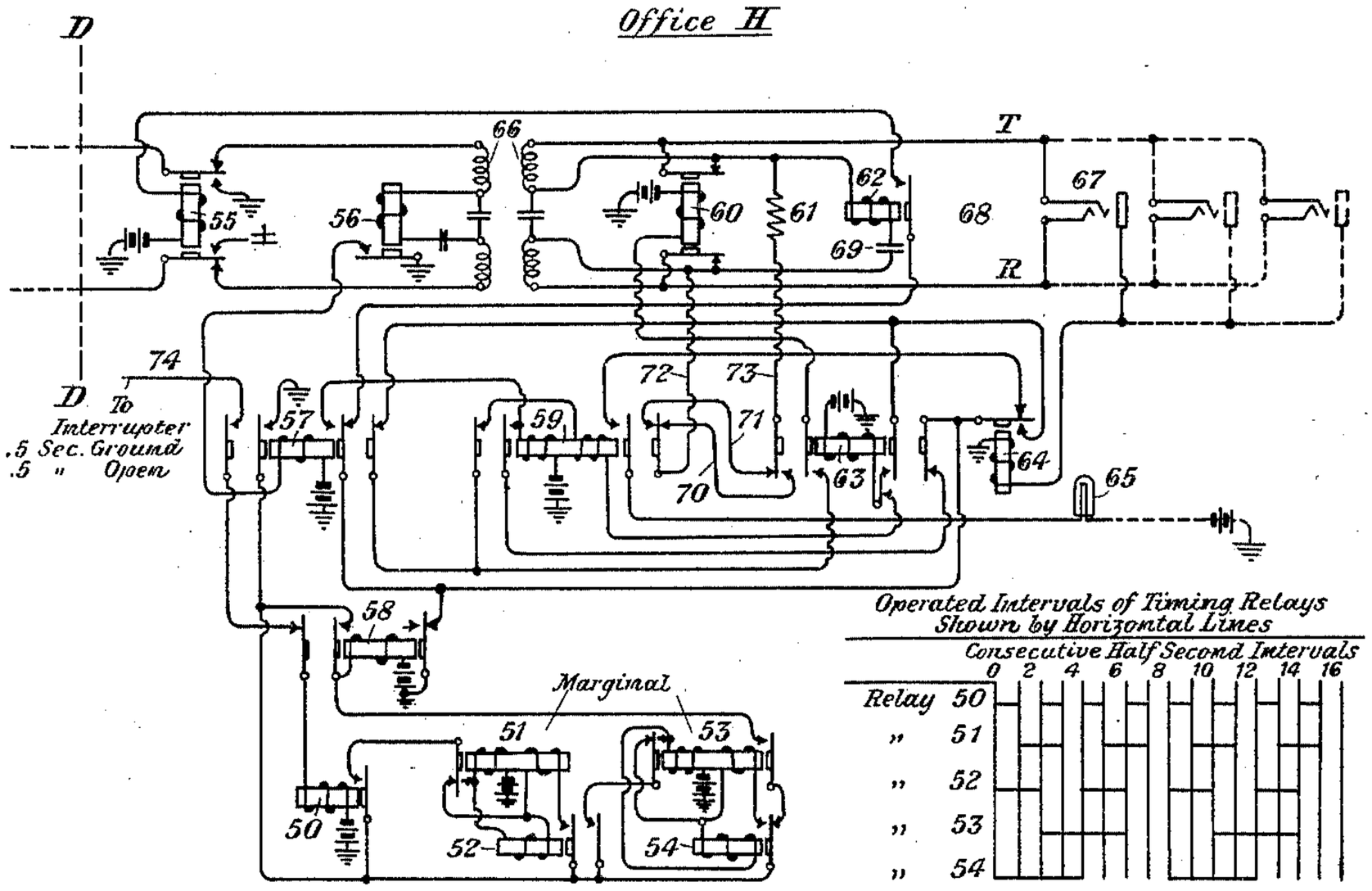

Fig. 2

Fig. 5

Fig. 3

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SIGNALING SYSTEM FOR SUBSCRIBERS' TELEPHONE CIRCUITS

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This invention relates to a signaling system for operating circuits, such, for example, as telephone circuits. More specifically, the invention relates to a signaling system to be used on a so-called "foreign exchange subscriber's line".

The term "foreign exchange subscriber's line" requires some definition. A foreign exchange subscriber's line is one in which the telephone set is located in one telephone exchange area and the circuit appears on the switchboard serving a different exchange area. By way of example, a subscriber may be located in one city and have its telephone there, but at the same time may, for business or other purposes, desire that telephone to appear on the switchboard in a distant city. Assume that the subscriber lives in city A and wishes his telephone to appear on the switchboard in city B. The subscriber's line is connected to the central office of city A but does not appear on the switchboard there. It is merely wired through this office, being permanently connected to a long distance line connecting cities A and B, and at city B the long distance line is connected permanently to a wiring circuit which causes the distant subscriber's line to appear in the regular answering jack group for the subscribers served by the telephone exchange of city B. Thus, when the subscriber in city A removes his receiver from the switchhook, no signal is given at the central office in city A, but a light appears under the answering jack associated with that line in city B, and the "A" operator in city B answers the call in the regular way, just as though the distant subscriber were located in city B.

The use of foreign exchange lines is not limited to the case where a subscriber in one city wishes his telephone to appear on the switchboard in a different city, but also may be used in the case of a subscriber whose telephone would normally appear on the switchboard in exchange C, located in one part of the city and who wishes that telephone to appear on the switchboard of exchange area B, located in a different part of the city. An example of this latter case would be where a doctor, having his office at home in the residential portion of the city, would desire his telephone to appear on the switchboard serving the business portion of the city.

It can readily be seen that with these foreign exchange lines, signaling between the foreign exchange subscriber and the central office constitutes a much more difficult problem than is encountered in the case of the usual subscriber's circuit, in which the telephone set is located but a short distance from the central office. Where the foreign exchange subscriber is located in one city and his telephone circuit appears in the switchboard in a distant city, it frequently happens that the toll line used in completing the permanent connection to the distant city is arranged for telegraphic communication in addition to telephonic communication, in which case all available direct current channels would be taken up by the telegraphic equipment. In this case, of course, the usual direct current signaling between subscriber and operator would have to be abandoned. Even in cases where the direct current channels are available on such foreign subscriber's lines, it might well happen, owing to the extreme length of many of such lines, that direct current supervision between subscriber and operator would not be feasible.

The purpose of the present invention, therefore, is to furnish a method of signaling over such foreign exchange subscriber's lines by utilizing alternating current for this purpose. More specifically, the circuit is arranged to utilize for this purpose the ordinary ringing current supply which is used for ringing on subscriber's lines. Direct current supervision is utilized between the foreign exchange subscriber's telephone set and the local central office, but between the local central office and the foreign central office the ringing current supply is utilized.

The circuit is so arranged that when the foreign exchange subscriber removes his received from the switchhook it causes the signaling equipment at the local office to function in such a manner as to send out ringing current for approximately one second to the foreign office. This ringing current, incoming at the foreign office, operates the sig-

naling equipment there to cause a steady lighting of the line lamp associated with the answer jack of the foreign exchange line. Furthermore, when the A operator plugs in, the foreign exchange circuit is so arranged as to cause the supervisory apparatus in the "A" cord circuit to function in a normal manner. Similarly, when the foreign exchange subscriber flashes or hangs up, suitable pulses of ringing current are transmitted from the local to the foreign office, there to cause the supervisory equipment to function in the same manner as would be the case for a local subscriber.

It is understood, of course, that the signaling current transmitted between the local and the foreign offices need not be the low frequency ringing current but may be any type of signaling current which is satisfactory for the particular interoffice circuit in question. It is only required that ringing current be used to operate the signaling apparatus at the foreign and local offices, suitable equipment being installed of course to transform the low frequency ringing current sent out from one office to the signaling current used on the interoffice circuit and to transform the signaling current back to a low frequency ringing current at the distant end. An example of this occurs where a composite set is used to transform 16-cycle into 135-cycle ringing current for transmission over a toll line, and at the distant end a similar composite set is used to change the signaling current back again to 16 cycles.

The exact manner in which the signaling system of the present invention functions, is best obtained from a detailed description of its operation on various types of connections between the foreign exchange subscriber and a distant subscriber. This will now be given.

In the drawings, Figure 1 shows a foreign exchange subscriber's telephone circuit, the loop connecting such circuit to the local office and the signaling equipment associated with such circuit at the local office. Fig. 2 shows the incoming end of the foreign exchange line at the foreign or distant office, and shows the signaling equipment associated with the line at that point. Fig. 3, reading from left to right, shows in order an ordinary interoffice trunk equipped for automatc ringing and a portion of an A operator's cord circuit, while the dashed line portion of the extreme right shows schematically a connection from the A cord circuit to a subscriber's telephone set. Figs. 1, 2, and 3, arranged consecutively from left to right in the order named, show a complete connection between the foreign exchange subscriber and a distant subscriber, the connection being established over an interoffice trunk. Fig. 4 is a chart showing the sequence of operation of relays 1 to 5, inclusive, of Fig. 1 when relay 1 is connected to the interrupter 22. The functioning of these relays determines the type of signal transmitted from the local office K, Fig. 1 to the foreign office H, Fig. 2. Fig. 5 shows a chart similar to that of Fig. 4. The chart of Fig. 5 shows the sequence of operation of relays 50 to 54, inclusive, of Fig. 2 when relay 50 is connected to the interrupter lead 68. These relays measure and interpret the signaling impulses incoming from office K to office H.

Referring to Fig. 1, the portion to the left of line AA shows the foreign exchange subscriber's telephone set. The portion between AA and BB indicates the loop connecting the foreign exchange subscriber's telephone set to the local office. The equipment shown between BB and CC shows the signaling circuit of the foreign exchange line located at the local office, which is designated "office K". The portion between CC of Fig. 1 and DD of Fig. 2 indicates the telephone circuit connecting the local office K with the foreign office H, at which the foreign exchange subscriber's line appears on the switchboard. The portion to the right of DD, Fig. 2, shows the signaling equipment located at office H associated with the foreign exchange subscriber's line. In Fig. 3 the portion to the left of EE shows the signaling equipment associated with the incoming end of an ordinary interoffice trunk, the trunk being in this case assumed to terminate at office H. The portion between EE and FF designates the connection over the interoffice trunk between the outgoing office I and the incoming office H. Between FF and GG jack 108 designates the outgoing end of the interoffice trunk, while 118 designates a portion of an A operator's cord circuit. The portion to the right of GG shows in schematic form the connection through intermediate apparatus from the "A" cord circuit to a calling subscriber's circuit.

Circuit operation on call to foreign exchange subscriber

Assume, now, that the subscriber at J, Fig. 3, desires to talk with the foreign exchange subscriber 6, Fig. 1. The subscriber at J removes his receiver from the switchhook in the usual manner, which furnishes a signal to the "A" operator at office I. The "A" operator plugs an "A" cord circuit into the answering jack and takes the called number. She then connects the other end of the "A" cord to an idle trunk 117, which terminates at office H, where the foreign exchange subscriber's line appears on the switchboard. When the "A" operator plugs the cord 109 into jack 108, relay 105 at the incoming end of the trunk operates on battery supplied from the "A" cord circuit and closes a circuit from battery through lamp 100, front contact of relay 105, lower back contact of relay 101, through the lower winding of 101 to ground, thus causing

lamp 100 to light. Relay 101 does not operate on current through its lower winding. The "A" cord supervisory relay 110 does not operate in series with both windings of relay 105 since the upper winding of this relay is of high resistance and allows only a small current flow insufficient to operate relay 110. The lighting of lamp 100 furnishes the "B" operator at office H with a signal that a call has been placed on the trunk 117. After the "B" operator receives the called number she connects the plug 116 of trunk 117 in jack 67 of the foreign exchange subscriber's line. Current thereupon flows from battery through lamp 100, upper winding of relay 101 to the sleeve circuit of jack 67, Fig. 2, through relay 64 to ground, thereby causing both relays 101 and 64 to operate. The operation of relay 64 merely prepares the foreign exchange line 68 for future operation. The operation of relay 101 connects the tip lead of the trunk through to the repeating coil and connects battery through winding of relay 102, back contact of relay 103, back contact of relay 104, lower front contact of relay 101, front contact of relay 105, to ground through the upper winding of relay 101 and the sleeve circuit of jack 67. This connects relay 102 in parallel with lamp 100, which reduces the current through lamp 100 sufficiently to extinguish it. Relay 102 operates and connects ringing current to the foreign exchange line 68. This circuit is traced from the ringing lead 120 through marginal relay 104 out over the ring side of the trunk to the ring side of the line 68 through the lower back contact of relay 60, Fig. 2, through condenser 69, relay 62, upper back contact of relay 60, to the tip side of the line and back to ground through the upper front contact of relay 102. Relay 104 is marginal and does not operate at this time. Relay 62 of Fig. 2 operates in synchronism with the ringing current pulses supplied from the trunk. Relay 56 is not operated by this ringing current, as the right windings of repeating coil 66 are short-circuited through the back contacts of relay 60. The operation of relay 62 connects ground to operate relay 55 over a circuit from ground at the right back contact of relay 58, right inner back contact of relay 57, front contact of relay 62, through the winding of relay 55 to battery. Relay 55 thereupon operates and connects ringing current across the tip and ring of the foreign exchange line, sending ringing current from the foreign office H to the local office K. This ringing current, upon arriving at office K, flows through relay 17, causing it to operate in synchronism with the ringing pulses. The operation of relay 17 operates relay 16 directly by means of ground through the lower front contact of relay 17. The operation of relay 16 furnishes ground to operate relay 7 on a circuit from battery through the winding of 7, upper back contact of relay 8, front contact of relay 16, to ground at the left outer back contact of relay 4. The operation of relay 16 also connects ground to the winding of relay 8 through the right back contact of relay 11, but relay 8 does not operate at this time on battery supplied through resistance 20 as its winding is short-circuited by the circuit from the upper lead of the winding of 8, back contact of relay 9, lower back contact of relay 8 to the lower lead of the winding.

The operation of relay 7 connects ringing current to ring the bell of subscriber's telephone set 6. The circuit is traced from ringing current supplied over lead 20, through marginal relay 9, left back contact of relay 11, lower front contact of relay 7, through the subscriber's set 6, back over the tip side of the line to ground at the upper front contact of 7. Relay 9 does not operate at this time, being marginal.

The subscriber answers by removing the receiver from the switchhook which connects a low resistance path through the transmitter and left induction coil winding in parallel with the bell. This allows additional ringing current to flow through relay 9, causing it to operate during the first ringing interval after the receiver is removed. The operation of relay 9 opens the circuit shunting the winding of relay 8, causing relay 8 to operate over the circuit described above. The operation of relay 8 opens the operating circuit at relay 7 at the upper back contact of relay 8. The release of relay 7 disconnects ringing current from the subscriber's line and hence, causes relay 9 to release. Relay 8 remains operated, however, since the short-circuiting path across its winding is open at the right back contact of 8, due to the operation of this relay. The release of relay 7 permits relay 13 to operate from battery through the winding of 13 over the ring side of the line through the subscriber's set and back to ground through the upper left winding of repeating coil 19. The operation of relay 13 prepares a circuit for the operation of relays 11 and 12 dependent on the condition of relay 16 when the receiver of subset 6 is removed from the switchhook. If the receiver is removed during a silent interval of the ringing current supply relay 16 will be released and relays 11 and 12 will operate immediately, the former on battery through its left winding, the latter on battery through its winding, both circuits being traced to ground through the front contact of relay 13, back contact of relay 16 to ground at relay 4. If the receiver of subset 6 is removed during a ringing interval, relay 16 will be found operated so that relays 11 and 12 will not operate until 16 releases at the end of that particular ringing pulse. Before the next succeeding ringing pulse occurs, the signaling apparatus of the foreign ex-

change line will function to disconnect the ringing current from trunk 117 and will thus prevent the further operation of relay 16. The signaling apparatus of the foreign exchange line as will be explained below functions within approximately the first second after relay 12 operates. Assuming the automatic ringing supplied from trunk 117 to be alternately two seconds ring and four seconds quiet it will be seen that the signaling equipment of the foreign exchange line will have ample opportunity to function during a silent interval of the ringing current.

The operation of relay 11 releases relay 8 by opening the holding circuit for the latter at the right back contact of 11. Relay 7 is prevented from operating again by the open circuit at the front contact of relay 16. The operation of relay 11 connects battery through its right winding to the front contact of relay 16. At the same time battery through the left winding of relay 11 is connected to the back contact of relay 16 through make contact of relay 13. Thus, relay 11, after being operated by relay 13, will remain operated whether relay 16 is operated or released. The purpose of this feature is to permit ringing on the foreign exchange line when the receiver is off the hook, this being a desirable feature on certain long distance calls. It is necessary, in such instances, to insure that relay 11 be operated independently of relay 16 in order to prevent relay 8 from operating and disconnecting the ringing current from the subscriber's set 6 when the central office operator rings on the circuit with the receiver off the hook. It will be noted further that when relay 11 operates, it disconnects relay 9 from ringing lead 20 and substitutes therefor, the current limiting lamp 10. This is merely to protect relay 9 from the large current value that would otherwise flow through this relay when ringing occurred while the receiver of subset 6 is off the hook.

Returning now to the operation of relay 12. When this relay operates in the manner described above, it furnishes ground to operate relays 14 and 15, through the back contact of relay 16 to ground at relay 4. Relay 14 is slow to operate and release. Consequently, as soon as relay 12 operates, a circuit is traced from battery through the left winding of relay 15, back contact of relay 14, front contact of relay 12, back contact of relay 16 to ground at relay 4. Relay 15 thereupon operates and immediately locks up through its right winding and inner front contact to ground at relay 23. An instant later relay 14 operates and locks to ground through the back contact of relay 16 and the right front contact of relay 14.

The operation of relay 15 connects an interrupter 22 to the winding of relay 1. The interrupter operates to connect the winding of relay 1 alternately to ground one-half second and to an open circuit one-half second. The operating circuit for relay 1 is traced from battery through the winding of relay 1, front contact of relay 15 to the interrupter. The operation of relay 1 is in accordance with the chart of Fig. 4, where the horizontal lines show the operated intervals of the relay. The first half-second shows relay 1 operated, the second half-second released, the third operated, the fourth released, and so on. The operation of relay 1 starts the functioning of timing relays 2 to 5, inclusive. The function of these timing relays is to determine the duration of a pulse of ringing current to be transmitted from office K to office H. The length of this pulse determines the manner in which the apparatus at office H will function. A one-second interval of ringing current transmitted to H will be interpreted by the apparatus there as a receiver-off-the-hook signal, while a three-second interval of ringing current will be interpreted as a receiver-on-the-hook signal. Intermittent operation of the switchhook by the foreign exchange subscriber will in turn, produce intermittent operation of the signaling apparatus at office H through the medium of these timing relays in a manner to be explained below. The operation of these timing relays will now be taken up in detail.

When relay 1 operates the first time, as shown by the chart in Fig. 4, it closes a circuit to operate relay 3 from battery through the left winding of relay 2, winding of relay 3, back contact of relay 2, front contact of relay 1, right outer front contact of relay 15 to ground at the left back contact of relay 5. Relay 2 is a marginal relay and does not operate at this time. Upon the release of relay 1 during the second time interval, as shown by the chart of Fig. 4, it opens the operating circuit of relay 3 at the back contact of relay 1. Relay 3, however, remains operated, due to the fact that current now flows from battery through the left winding of relay 2, winding of relay 3, right outer front contact of relay 15 to ground at the left front contact of relay 3. Since current now flows through both windings of relay 2, this relay operates. The operation of relay 2 causes relay 5 to operate on a circuit from battery through the left winding of relay 4, winding of relay 5, left inner back contact of relay 4, right outer front contact of relay 2, right outer front contact of relay 15 to ground at the left front contact of relay 3. Relay 4 is a marginal relay and does not operate at this time. The operation of relay 2 also furnishes ground to operate relays 18 and 23. Both circuits are traced from battery through the windings of the respective relays through the right inner front contact of relay 2 to the common ground at the left front contact of relay 3. When relay 23 operates, it locks to ground through its right front contact. The

same operation removes the ground from the right winding of relay 15 causing its release. The other operated relays are not affected by the release of relay 15, due to the fact that the ground at relay 23 replaces the ground obtained through the right front contact of relay 15 prior to its release. It will be noted that the ground at relay 23 is made before the operating circuit of relay 15 is opened, thus preventing a release of the operated relays. The release of relay 15 does not disconnect the interrupter from relay 1 since the operation of relay 23 furnishes an alternative path therefor. The operation of relay 18 connects ringing current to the foreign exchange line for transmission from office K to office H.

Beginning the third timing interval, as seen from the chart of Fig. 4, relay 1 operates again, and since relay 2 is now operated relay 3 is shunted out of the circuit together with the right winding of relay 2, due to the fact that a circuit is now traced from battery through the left winding and left front contact of relay 2, front contact of relay 1 to ground at relay 23. Relay 3 thereupon releases, relay 2 remaining operated by the current through its left winding.

Beginning the fourth interval, relay 1 releases and opens the holding circuit of relay 2 at the contacts of relay 1. Relay 2 thereupon releases. Meantime, relays 23 and 18 obtain ground on a circuit traced from point 30, which is common to the two relay circuits, over lead 25 through the make contact of relay 5 and the back contact of relay 4 to ground at the front contact of relay 23. The release of relay 2 opens the holding circuit for relay 5, but this relay remains operated on a circuit traced from battery through the left winding of relay 4, winding of relay 5, right winding of relay 4, right inner front contact of relay 5 to ground at relay 23. Relay 4 thereupon operates and opens the holding circuit for relays 23 and 18 at the back contact of relay 4. At the same time, however, the operation of relay 4 closes a circuit from lead 27 through the front contact of relay 4 to ground at relay 23. This furnishes an additional ground path for relays 18 and 23, which path, however, is under control of relay 12. For relay 23 the circuit is traced from battery through the winding of relay 23, over lead 24, lead 29, lead 26, lower back contact of relay 12, lead 27, front contact of relay 4 to ground at 23. The circuit for relay 18 is traced from battery through relay 18, to point 31, and thence the same as for relay 23. Consequently, if at the moment relay 4 operates relay 12 is released, then relays 18 and 23 will remain operated over this circuit. However, if relay 12 is operated when relay 4 operates, then all possible paths to ground are opened for relays 18 and 23, and these relays will release. In the present case, since the receiver of subset 6 is off the hook, relay 13 remains operated, in turn holding relay 12 operated, and consequently, in the present instance, when relay 4 operates, relay 23 releases. The release of relay 23 removes the ground lead controlling the operation of the timing relays. Relays 18, 4 and 5 thereupon release. In addition, the release of relay 23 disconnects the interrupter from relay 1, causing it also to release. It will be observed from the above that relay 18 was operated for a period of one second, for it operated and released under the control of relay 2 which, it will be seen by referring to the chart of Fig. 4, was operated for one second. Hence, in this case, ringing current is transmitted over the foreign exchange line from offices K to H for a one-second interval.

Referring now to Fig. 2, this one-second interval of ringing current, upon arriving at office H, causes the operatoin of relay 56. Relay 62 is not affected owing to the fact that the right windings of repeating coil 66 are short-circuited under the control of relay 60. The operation of relay 56 furnishes ground through its front contact to operate relay 57. The operation of relay 57 removes the ground connection for relay 55 at the right inner back contact of relay 57 so that there is no possibility of relay 55 being operated to send ringing current back to office K at this time. The operation of relay 57 closes a circuit to operate relay 59 from battery, through the left winding of relay 59, right inner front contact of relay 57 to ground at relay 58. Relay 59 locks to ground under the control of relays 63 and 58 over a circuit from battery, through the left winding and left inner front contact of relay 59, right outer back contact of relay 63, to ground at the right back contact of relay 58. The operation of relay 59 connects resistance 61 between the tip and ring leads of the foreign exchange circuit. This circuit is traced from the tip side of the line through the upper back contact of relay 60, through resistance 61, left outer back contact of relay 63, right outer front contact of relay 59, through the lower back contact of relay 60 to the ring side of the circuit.

The connection of resistance 61 between the tip and ring leads causes ringing current to be disconnected from trunk 117. This is accomplished as follows: As was explained above, ringing current is being supplied to operate relay 62 of circuit 68 through marginal relay 104 of the inter-office trunk 117. When, however, resistance 61 is connected in shunt with relay 62 and condenser 69, the low resistance path thus introduced, allows an increased current to flow through marginal relay 104 causing its operation. The operation of relay 104 opens the short-circuiting path connected across the winding of relay 103 causing 103 to operate in series with relay

102 to ground over the sleeve circuit of jack 67. Relay 103 locks up over a circuit from battery through the front contact and winding of relay 103, to ground, as just described. The battery thus connected to the front contact of relay 103 opposes the further flow of current through relay 102, causing this relay to release. The release of relay 102 disconnects ringing current from the tip and ring leads of the trunk and thus causes the release of relay 104. The supervisory lamp 100 remains extinguished, being shunted out by the circuit from battery through relay 103, which is connected in parallel with the circuit from battery through lamp 100, these two circuits obtaining a common ground in the sleeve circuit of jack 67.

The release of relay 102 closes the tip and ring leads of trunk 117 through to the repeating coil 107. This closes a direct current path to operate relay 106, the circuit consisting of battery 119, relay 106 and resistance 61 of Fig. 2. Relay 106 thereupon operates the short-circuits the high resistance winding of relay 105. This increases the current flow through the "A" cord supervisory relay 110 sufficiently to cause its operation. The operation of relay 110 in turn connects resistance 113 in shunt with the "A" cord supervisory lamp 111, thus extinguishing the lamp, to inform the "A" operator that the foreign exchange subscriber has answered the call.

Meantime, while the above is occurring, the operation of relay 57, Fig. 2, also connects the interrupter lead 74 to relay 50, causing this relay to be periodically operated and released for half-second intervals in the same manner as was described for relay 1 of Fig. 1. The horizontal dashed lines in the chart of Fig. 5 show the operated intervals of relay 50. The operation of relay 50 controls the operation of the timing relays 51 to 54, inclusive, the function of these latter relays being to measure the period during which ringing current is applied to relay 56, and in this way to interrupt the type of signal being transmitted from office K in order to cause suitable functioning of the signaling apparatus located at office H. In the present case, as described above, relay 56 is operated for one second.

During the first timing interval, as seen from Fig. 5, relay 50 operates and causes the operation of relay 52 over the circuit from battery, through the left winding of relay 51, winding of relay 52, back contact of relay 51, front contact of relay 50, to ground at the left front contact of relay 57 which is operated while 56 is held up. Relay 52 thereupon operates, relay 51 being marginal does not operate at this time. The operation of relay 52 in turn causes the operation of relay 54 on a circuit from battery, through the left winding of relay 53, winding of relay 54, left back contact of relay 53, right outer front contact of relay 52, to ground at relay 57. Beginning the second timing interval, relay 50 releases and opens the holding circuit for relay 52, which relay, however, remains operated on a circuit from battery through the left winding of relay 51, winding of relay 52, right winding of relay 51, right inner front contact of relay 52, to ground at relay 57. Relay 51 now operates. During the third timing interval, relay 50 operates again, and since relay 51 is now operated, relay 52 is shunted out owing to the fact that a circuit is traced from battery, through the left winding and front contact of relay 51, front contact of relay 50 to ground at relay 57. Relay 51 remains operated by this circuit. The release of relay 52 opens the holding circuit for relay 54 but this relay remains operated on a circuit from battery through the left winding of relay 53, winding of relay 54, right winding of relay 53, front contact of relay 54, to ground at relay 57. Relay 53 thereupon operates. When relay 50 releases during the fourth interval it opens the holding circuit of relay 51, causing it to release, no other change occurring during this interval.

Thus, for an interval of two seconds, the timing relays merely measure the elapsed time without altering in any way the signaling apparatus of circuit 68 at office H. In the meantime, it should be recalled that relay 56 has been operated for approximately a one-second interval only since it was receiving a signaling current corresponding to a receiver-off-the-hook signal from office K. Hence, some time before relays 51 to 54 inclusive have completed the cycle described above, relay 56 will release, in turn releasing relay 51. The release of relay 57 disconnects the interrupter from relay 50 at the left outer front contact of relay 57 and also removes the ground connection holding the timing relays operated at the left inner front contact of relay 57. Relay 50 and all operated timing relays are thereupon restored to normal.

Meantime, relay 59 remains locked to ground through its left inner front contact to ground at relay 58. The release of relay 57 causes the operation of relay 63 over a circuit from battery through the winding and right inner back contact of relay 63, right winding and left outer front contact of relay 59, right outer back contact of relay 57, front contact of relay 64, to ground at relay 58. As soon as relay 63 operates it locks up through its right inner front contact to ground through the front contact of relay 64 and the back contact of relay 58. The operation of relay 63 releases relay 59 by opening the circuit through the left winding of relay 59 at the right outer back contact of re-

lay 63. The circuit through the right winding of relay 59 is opened at the right inner back contact of relay 63. With the operation of relay 63 and the subsequent release of relay 59 resistance 61 remains connected across the tip and ring leads of circuit 68, due to the fact that the release of relay 59 and the operation of relay 63 transfers leads 72 and 73 from the short-circuiting lead 71 to the short-circuiting lead 70. Consequently, relay 106 of Fig. 3 remains operated and in turn causes relay 110 in the "A" cord circuit to remain operated so that the "A" cord lamp 111 remains extinguished.

The operation of relay 63 closes the circuit to operate relay 60 from battery through the winding of relay 60, left inner front contact of relay 63, right outer back contact of relay 57, front contact of relay 64, to ground at relay 58. The operation of relay 60 removes the short-circuiting leads from around the right windings of repeating coil 66. The circuit is now ready for conversation between subscribers.

Assume that the call progresses in the normal manner to completion. When the foreign exchange subscriber hangs up, a receiver-on-the-hook signal will be transmitted from office K to office H. This signal will consist in a three-second interval of ringing current which will cause the apparatus at office H to function in such a manner as to furnish a disconnect signal to the "A" operator. This is accomplished as follows: When the receiver of the subscriber's set 6 is placed on the hook it will open the holding circuit for relay 13 of Fig. 1, causing that relay to release. The release of relay 13 in turn releases relays 11 and 12, which were held operated, through the front contact of relay 13 to ground at the make contact of relay 14. The holding circuit for relay 14 is opened by the release of relay 12, but 14, being slow release, remains operated for a short period after the release of relay 12. During this short interval relay 15 operates from battery through its left winding and the front contact of relay 14, back contact of relay 12, to ground at relay 4. Relay 15 immediately locks up through its right winding and right inner front contact to ground at the right back contact of relay 23. The operation of relay 15 connects the interrupter to relay 1 in the manner described previously, causing relay 1 to start functioning in accordance with the chart of Fig. 4. The timing relays 2 to 5, inclusive together with relays 23 and 18, will again be operated in the same manner as was previously described in connection with the receiver-off-the-hook signal. It will be recalled that relays 23 and 18 operated upon the operation of relay 2, and that upon the release of relay 2 these relays were in turn released, for the reason that when relay 2 was released at the beginning of the fourth interval relay 12 was operated so that there are no paths closed through which relays 23 and 18 could obtain a ground connection. In the present case, however, relay 12 was released upon the subscriber hanging up so that this time, when the fourth timing interval is reached and relay 2 releases, relays 23 and 18 will remain operated over the circuit described above through the right back contact of relay 12. For relay 23 this circuit was traced from battery through the winding of relay 23, lead 24, lead 29, lead 26, lower back contact of relay 12, lead 27, right front contact of relay 4, which is operated (see chart, Fig. 4), to ground at the right front contact of relay 23. Relay 18 remains operated from battery through the winding of relay 18 to lead 26, the remainder of the circuit being the same as described above for relay 23. From this point on the operation of the timing relays must be traced to show how the apparatus is released at the end of three seconds.

During the fifth timing interval relay 1 operates, causing relay 3 to operate, as described above, from battery through the left winding of relay 2, winding of relay 3, left back contact of relay 2, front contact of relay 1, to ground at relay 23.

During the sixth interval relay 1 releases and opens the holding circuit for relay 3. Relay 3, however, remains operated on the circuit from battery through the left winding of relay 2, winding of relay 3, right winding of relay 2, right inner front contact of relay 3, to ground at relay 23. Relay 2 thereupon operates and in turn causes relay 5 to release by shunting it out, the holding circuit for relay 4 being traced from battery through the left winding and right inner front contact of relay 4, right outer front contact of relay 2, to ground at relay 23.

During the seventh timing interval relay 1 operates and shunts out relay 3, causing it to release, the holding circuit for relay 2 being traced from battery through the left winding and left front contact of relay 2 to ground at relay 23.

During the eighth timing interval relay 1 releases, which opens the holding circuit for relay 2, causing it to release. The release of relay 2 opens the holding circuit for relay 4 at the right outer front contact of relay 2, and thus relay 4 releases which opens the holding circuit for relays 18 and 23. All timing relays are therefore released during this interval, and since all possible paths to ground for relays 18 and 23 are opened, these relays now release. Thus it will be seen that relay 18 has been operated for an interval of three seconds, that is, referring to the chart, from the beginning of the second timing interval until the beginning of the eighth timing interval. While relay 18 is operated it again sends ringing current from office K to office H.

Referring now to Fig. 2, it will be recalled from the explanation given above that the receiver-off-the-hook signal left relay 63 locked up to ground at the back contact of relay 58. Also, relay 60 was held up through the left inner front contact of relay 63 and the right outer back contact of relay 57 to ground at relay 58. In the inter-office trunk 117, relays 101, 103, 105, and 106 are still operated, and in the "A" cord circuit relay 110 remains operated. The three-second interval of ringing current, upon arriving at office H, operates relay 56, which in turn operates relay 57. The operation of relay 57 releases relay 60 and reoperates relay 59 through the right front contact of 57 to ground at relay 58. The operation of relay 59 opens the lead containing resistance 61 by disconnecting lead 72 from lead 70. The direct current path between tip and ring leads of circuit 68 is opened by this latter operation, causing the release of relay 106 in trunk 117. The release of relay 106 removes the shunt from the high resistance winding of relay 105, thus causing the release of relay 110 in the "A" cord circuit to relight the "A" cord supervisory lamp 111, and furnish the "A" operator with a signal that the call is complete.

In addition to the above, the operation of relay 57 connects a ground lead for operating the timing relays and also connects the interrupter to relay 50. The timing relays 51 to 54 will again start to measure off time in the manner described above in connection with the receiver-off-the-hook signal. At that time, the operation of these relays was traced over the first four timing intervals, and it was found that during this period they did not affect the operation of the apparatus at office H in any manner. At the end of the fourth interval relays 53 and 54 were found to be operated. For the receiver-off-the-hook signal, however, relay 57 was released before the fourth timing interval was reached and all timing relays were restored to normal. In the present case, at the end of the fourth timing interval relay 57 remains operated owing to the fact that relay 56 is operated for three seconds instead of one as formerly. Consequently, relays 53 and 54 are still held up, obtaining ground at the left inner front contact of relay 57. During the fifth timing interval, the chart of Fig. 5 shows that relay 50 is operated, causing the operation of relay 52 again from battery through the left winding of relay 51, winding of relay 52, back contact of relay 51, front contact of relay 50, to ground at relay 57. The operation of relay 52 shunts out relay 54 which releases, the holding circuit for relay 53 being now traced from battery through the left winding and left front contact of relay 53, outer front contact of relay 52, to ground at relay 57. The release of relay 54, together with the fact that relay 53 remains operated, causes the operation of relay 58 on a circuit from battery through the winding of relay 58, right front contact of relay 53, back contact of relay 54, to ground at relay 57. Relay 58 immediately locks to ground at relay 57 through its left inner front contact. The operation of relay 58 removes ground from relays 59 and 63, causing both relays to release. Hence, the lead containing resistance 61 remains open and no change occurs in the cord circuit 118.

Returning again to the timing relays, when relay 58 operates it disconnects the interrupter from relay 50 at the left outer back contact of relay 58, thus causing relay 50 to release. The release of relay 50 causes the operation of relay 51 from battery through the left winding of relay 51, winding of relay 52, right winding of relay 51, front contact of relay 52, to ground at relay 57. Thus, relays 51, 52 and 53 are now operated, and these relays remain operated until the conclusion of the three second-ringing interval when relay 56 is released. When this occurs relay 57 releases, removing the ground connection, which releases all operated timing relays.

Meantime, the "A" operator has noted the steady light on lamp 111, due to the release of relay 110. She therefore disconnects plug 109 from jack 108, which in turn causes the release of relay 105 at office H. The release of relay 105 opens the holding circuit for relay 103 at the contact of relay 105. Relay 103 thereupon releases and in so doing removes the shunt from around lamp 100. Lamp 100 thereupon relights and gives the "B" operator a signal to disconnect. The "B" operator thereupon disconnects plug 116 from jack 67, thus opening the circuit for lamp 100, which is extinguished, and removing the battery from relay 64, Fig. 2, which releases. All apparatus involved in the connection is thus returned to its normal condition.

Call from foreign exchange subscriber

When the call originates with the foreign exchange subscriber, the apparatus functions as follows:

When the receiver is removed from the switchhook of subscriber's set 6, relay 13 at the office K operates. The operation of 13 causes the operation of relays 11 and 12 through the front contact of relay 13 to ground at relay 4. The operation of relay 11 removes the relay 9 from the ringing circuit and also opens the operating circuit for relay 8. The operation of relay 12 starts the functioning of the timing relays in the manner described above, first by causing relay 15 to operate and lock up followed by the operation of relay 14. The operation of relay 15 connects the interrupter to relay 1, which in

turn causes timing relays 2 to 5, inclusive, to function in accordance with the chart of Fig. 4. Since this is the receiver-off-the-hook condition, relay 18 will be operated for one second to send ringing current from office K to office H, as was described above in connection with a call to the foreign exchange subscriber.

The one-second interval of ringing current upon arriving at office H operates relay 56 which, in turn, causes the operation of relay 57. The operation of relay 57, in turn, causes relay 59 to operate through the right, inner, front contact of relay 57 to ground at relay 58. Relay 59 immediately locks up through its left, inner front contact and through the right, outer, back contact of relay 63 to ground at relay 58. The operation of relay 59 causes the line lamp 65 to light from battery through lamp 65, right, inner front contact of 59, back contact of relay 64 to ground at relay 58. The operation of relay 57 also connects the interrupter to relay 50 and connects ground to the timing relay circuits to start the functioning of the timing relays, as was described previously. The operation of relay 59 in addition to lighting the line lamp 65 also connects the resistance 61 across the tip and ring leads of circuit 68 by connecting lead 72 to lead 71. The "A" operator upon noting the lighted line lamp 65 will connect an "A" cord circuit, similar to 118, Fig. 3, to circuit 68 by inserting plug 109 into jack 67. As soon as the cord circuit is connected to circuit 68, the "A" cord supervisory relay 110 will operate over the direct current path through resistance 61, and will thus prevent the supervisory lamp 111 from lighting. The battery obtained on the sleeve of circuit 68 due to connection of "A" cord circuit will cause the operation of relay 64. The operation of this relay opens the circuit to extinguish lamp 65. The operation of relay 64 also closes a circuit to operate relay 63 upon the release of relay 57, through the right winding and left, outer, front contact of relay 59, right, outer, back contact of relay 57, front contact of relay 64 to ground at relay 58. As soon as relay 63 operates, it locks up through its right, front contact. The operation of relay 63, in turn, releases relay 59 by opening the circuits through both windings of this relay at the right, inner and outer back contacts of relay 63. The simultaneous release of relay 59 and operation of relay 63 maintains resistance 61 connected across the tip and ring leads of circuit 68 by connecting leads 73 and 72 to lead 70. The operation of relays 63 furthermore closes the circuit to operate relay 60. The operation of relay 60 removes the short-circuiting leads from around the right windings of repeating coil 66, thus preparing the circuit for talking. When the "A" operator has obtained the called number, she proceeds to establish the connection in the usual manner.

When the call is complete and the subscribers hang up, the apparatus functions in the same manner as was explained above in connection with a call to the foreign exchange subscriber.

Flashing by the foreign exchange subscriber

If the foreign exchange subscriber desires the immediate attention of an operator, he will operate his switch-hook intermittently in the usual manner. Assuming that the subscriber has had the receiver off the hook for a few seconds before he commences to flash relays 11 to 14, inclusive, Fig. 1 will be operated. All other relays will be in the normal condition. When the flashing is started upon first placing the receiver upon the hook of subset 6, relay 13 releases, causing relay 12 to release. As soon as relay 12 releases and before relay 14 releases, relay 15 will operate through the left, front contact of relay 14 and the left, back contact of relay 12 to ground at relay 4. Relay 15 immediately locks to ground at relay 23 and starts the functioning of the timing relays. Once the timing relays are started in this fashion, at least a one-second interval of ringing current will be transmitted from office K to office H. This is due to the fact that the only control that the foreign exchange subscriber has over the operation of the timing relays is through the medium of relay 12, and once 12 has function to start the operation of the timing relays, in the manner described immediately above, these relays will function for the first three timing intervals of the chart of Fig. 4 irrespective of whether relay 12 is operated or not during this period for the reason that, as soon as relay 15 operates, it locks to ground at relay 23 and thus the functioning of the timing relays for the first three timing intervals is independent of relay 12. Beginning with the fourth timing interval, however, all circuits to ground for relays 23 and 18 are opened except the path through the back contact of relay 12. This condition was explained above in connection with a call to the foreign exchange subscriber. In the present case, when the fourth timing interval is reached, assume that the subscriber happens to have the receiver on the hook during this interval, relay 12 will be released and relays 23 and 18 will be held up for another three timing intervals; thus, until the end of the seventh interval. At the beginning of the eighth timing interval, all timing relays are released with the result that there is no possible path to ground to hold relays 23 and 18 operated, irrespective of the condition of relay 12. Consequently, relays 18 and 23 must release at this time. If, therefore, at any time, subsequent to the beginning of the eighth interval, the subscriber removes the

receiver from the hook, the operation of the timing relay will start all over again to send a new pulse of ringing current from office K to office H. In the case just described, the ringing pulse transmitted was of three-second duration. Going back for a moment, suppose that, at the beginning of the fourth timing interval, the subscriber happened to have the receiver off the hook. In that case, relay 12 would be operated so that all timing relays as well as relays 18 and 23 would be released at the beginning of the fourth timing interval. A subsequent replacement of the receiver on the switchhook would cause the timing relays to start functioning again since, as soon as relay 12 released, relay 15 would operate again through the left, front contact of relay 14 and the back contact of relay 12. The duration of a ringing interval will therefore be of one or three seconds duration dependent upon the operation or non-operation of relay 12 at the next succeeding fourth timing interval. From the above discussion, it will be seen that when the foreign exchange subscriber flashes, ringing pulses of one second or three seconds duration will be transmitted from office K to office H. Whether a given pulse will be of one second or three seconds, duration will depend not upon the rapidity with which the subscriber flashes but merely upon whether or not the subscriber has the receiver on or off the hook during the fourth timing interval after timing relays start to function. This, of course, will be a mere matter of chance so that, on the average, if the subscriber flashes continuously for a period, a random mixture of one-second and three-second interval pulses following each other will be transmitted from office K to office H.

Assume, now, that a train of impulses consisting of such a random mixture of one-second and three-second ringing intervals caused by the flashing of the foreign exchange subscriber arrive at office H. If an "A" cord circuit, similar to 118, is connected to circuit 68; this train of ringing pulses will cause the "A" supervisory lamp 111 to flash intermittently. This is accomplished as follows:

Relays 56 and 57 operate in synchronism with the incoming ringing pulses. As soon as relay 57 operates, it causes relay 59 to operate to ground at the back contact of relay 58. With an "A" cord connected to circuit 68, it will be remembered that relay 63 is operated so that when relay 59 operates, it opens the lead containing resistance 61 connected between the tip and ring leads of circuit 68. This occurs, due to the disconnection of lead 72 from lead 70. The disconnection of resistance 61 causes the release of cord circuit supervisory relay 110 and relights supervisory lamp 111. The operation of relay 57 starts timing relays 50 to 54, inclusive, functioning. If the particular ringing pulse in question is of one-second duration, relay 57 releases before the timing relays affect the circuit in any manner, since the only effect of the timing relays is to operate relay 58 and this does not occur until relay 53 operates and relay 54 is released, which in turn does not occur until the beginning of the fifth timing interval. Therefore, as soon as relay 57 releases, it causes the release of all timing relays, as described above, disconnects the interrupter and also releases relay 59, since the locking circuit of relay 59 through the right, outer, back contact of relay 63 is open due to the operation of this latter relay. The release of relay 59, again connects resistance 61 across the tip and ring leads of circuit 68, causing the reoperation of the "A" cord supervisory relay 110 which extinguishes lamp 111.

Assume that the next ringing pulse is of three-second duration, relays 56 and 57 will again operate, causing the relay 59 to operate and disconnect resistance 61 from across the tip and ring leads of circuit 68 which again causes lamp 111 to relight. At the same time, the operation of relay 57 starts the functioning of the timing relays. In this case, at the beginning of the fifth timing interval, relay 57 will still be operated so that according to the chart of Fig. 5, when relay 54 releases during this interval, relay 53 will be operated. This will cause relay 58 to operate and disconnect the interrupter from relay 50. The opening of the ground lead at the right contact of relay 58 releases relays 59 and 63, which leaves the lead containing resistance 61 open so that lamp 111 remains lighted. Timing relays 51, 52 and 53 remain operated until relay 57 releases at the end of the three-second ringing interval, at which time the disconnection of the ground lead at the left inner contact of relay 57 releases all timing relays and restores that to normal, at the same time releasing relay 58. When the next succeeding ringing pulse arrives, relay 57 upon operating will cause relay 59 to operate and since, in this case, relay 63 is released, the operation of relay 59 will connect resistance 61 between the tip and ring leads of circuit 68 which will extinguish the "A" cord supervisory lamp 111. If this ringing pulse is of one-second duration, relay 63 will operate upon the release of relay 57 at the same time releasing relay 59, leaving resistance 61 connected across the tip and ring leads so that it will require the next succeeding pulse of ringing current to relight the supervisory lamp 111 when relay 59 operates again upon the operation of relay 57. On the other hand, if the pulse in question were three seconds long, relay 58 would operate and release relay 59 before relay 63 was operated, thus opening the lead containing resistance 61 and relighting the supervisory lamp 111.

It will thus be seen that regardless of the rapidity with which the subscriber operates the switchhook of subset 6, a random series of ringing pulses of one-second and three-seconds duration will be transmitted from office K to office H. These ringing pulses upon arriving at office H will cause the signaling apparatus there to function in such a manner as to cause an intermittent flashing of the "A" cord supervisory lamp.

What is claimed is:

1. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's telephone set, a telephone line connected thereto and extending permanently through a first central office and terminating in a second central office distant from the first, signaling means at the first office controlled by the position of the foreign exchange subscriber's switchhook and adapted to transmit ringing current from the first to the second office for definite intervals of time in accordance with changes in the position of the switchhook associated with the foreign exchange set, such ringing current being transmitted for one interval of time upon removal of the receiver from the switchhook and for a different interval of time upon replacement of the receiver upon the switchhook, signaling means at the second central office associated with the foreign exchange line adapted to receive and interpret the ringing currents transmitted from the first office and thereby to suitably operate supervisory means associated with the foreign exchange line at the second office in accordance with the position of the switchhook of the foreign exchange subscriber's set, such signaling means at the second office being further adapted upon connection to the foreign exchange subscriber's line at the second office of a telephone line extending to a distant subscriber to operate signaling means associated with such last mentioned telephone line in accordance with the position of the switchhook of the foreign exchange subscriber's set, thus suitably controlling the progress of a call between the foreign exchange subscriber and the distant subscriber, means to apply ringing current to the foreign exchange subscriber's telephone set under control of ringing current supplied from a telephone circuit connected to the subscriber's line at the second office, means to apply such ringing current whether the receiver is on or off the hook if such ringing is manually operated from the telephone circuit connected to the foreign exchange line, means to apply such ringing current only when the receiver is on the hook if automatically operated.

2. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's telephone set, a telephone line connected thereto and extending permanently through a first central office and terminating in a second central office distant from the first, signaling means at the first office controlled by the position of the foreign exchange subscriber's switchhook and adapted to transmit ringing current from the first to the second office for definite intervals of time in accordance with changes in the position of the foreign exchange subscriber's switchhook such ringing current being transmitted for a predetermined interval of time upon removal of the receiver from the switchhook and for a predetermined interval of time different from that first mentioned upon replacement of the receiver upon the switchhook, signaling means at the second office associated with the foreign exchange subscriber's line adapted to receive and interpret the pulses of ringing current thus transmitted, such signaling means being adapted upon reception of the signal corresponding to the receiver-off-the-hook to light a lamp associated with such subscriber's line at the second office and to connect a resistance between the tip and ring leads of such line at that point thereby completing a direct current path between such leads which otherwise are provided with means to prevent the flow of direct current between such leads, such signaling means at the second office being adapted to disconnect said resistance and extinguish the subscriber's lamp upon reception of the ringing pulse corresponding to the replacement of the receiver upon the switchhook, means to extinguish the subscriber's lamp lighted by removal of the receiver from the switchhook upon connection to the subscriber's line of a telephone trunk or a link circuit, means to apply ringing current to the foreign exchange subscriber's set in accordance with ringing current supplied from a telephone trunk or link circuit connected to the subscriber's line at the second office.

3. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's telephone set, a telephone line connected thereto and extending permanently through a first central office and terminating in a second central office distant from the first, signaling means at the first office controlled by the position of the foreign exchange subscriber's switchhook and adapted to transmit ringing current from the first to the second office for definite intervals of time in accordance with changes in the position of the foreign exchange subscriber's switchhook such ringing current being transmitted for a predetermined interval of time upon removal of the receiver from the switchhook and for a predetermined interval of time different from that first mentioned upon replacement of the receiver upon the switchhook, signaling means at the second office associated with the foreign exchange subscriber's line adapted to

receive and interpret the pulses of ringing current thus transmitted such signaling means being adapted upon reception of the signal corresponding to the receiver-off-the-hook to light a lamp associated with such subscriber's line at the second office, means to extinguish said lamp upon reception of the ringing pulse corresponding to the replacement of the receiver upon the switchhook, additional means to extinguish said lamp lighted by removal of the receiver from the switchhook upon connection to the foreign exchange subscriber's circuit of a telephone trunk or link circuit, means to apply ringing current to the subscriber's set in accordance with ringing current supplied from a telephone trunk or link circuit connected to the subscriber's line at the second office such means being adapted to apply ringing current whether the receiver is on or off the hook if manually applied from the trunk or link circuit, means at the second office upon reception of the receiver-off-the-hook signal to connect a resistance between the tip and ring leads of the subscriber's line thereby establishing a direct current path between said leads, said resistance path being adapted to disconnect the ringing current from a telephone trunk circuit equipped for automatic ringing where such a trunk has been connected to the subscriber's line, said resistance path being adapted to control means in the trunk for extinguishing the supervisory lamp of an "A" cord circuit connected to the outgoing end of a telephone trunk circuit the incoming end of which is connected to the subscriber's line, said resistance being adapted further to extinguish the supervisory lamp of an "A" cord circuit when connected directly to the subscriber's line, means at the second office to open the direct current resistance path between the tip and ring leads of the subscriber's line upon reception of the signaling pulse corresponding to the receiver-on-the-hook signal, the disconnection of said resistance being adapted to relight the "A" cord supervisory lamp in either case mentioned above.

4. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's telephone set, a telephone line connected thereto and extending permanently through a first central office and terminating in a second central office distant from the first, a telephone trunk circuit equipped for automatic ringing extending from a third central office to the second, an "A" operator's cord circuit connected to the trunk circuit at the third office, means associated with the subscriber's circuit at the second office to normally prevent the flow of direct current between the tip and ring leads of said circuit, means associated with the subscriber's circuit at the second office to send ringing current from the second to the first office under control of ringing current supplied from the trunk circuit upon connection of the trunk circuit thereto, means at the first office to apply ringing current to the subscriber's set in synchronism with said ringing pulses received from the second office, means at the first office under control of the foreign exchange subscriber's switchhook to send ringing current from the first to the second office for predetermined intervals of time in accordance with changes in the position of the subscriber's switchhook, one interval of current being transmitted when the receiver is removed from the switchhook and a different interval of current being transmitted when the receiver is replaced upon the switchhook, means at the second office to receive and interpret the ringing pulses thus transmitted and upon reception of the ringing pulse corresponding to the receiver-off-the-hook to connect a resistance between the tip and ring leads of the subscriber's circuit at the second office such resistance serving to complete a direct current path between said tip and ring leads and causing the operation of means in the trunk to disconnect the automatic ringing from the trunk, and extinguish the supervisory lamp of the "A" cord connected to the trunk at the third office, said means associated with the subscriber's line at the second office being further adapted upon reception of the ringing current corresponding to the replacement of the receiver upon the switchhook to open the direct current path between the tip and ring leads of the subscriber's circuit at the second office and thus cause relighting of the "A" cord lamp at the third office.

5. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's telephone set, a telephone line connected thereto and extending permanently through a first central office and terminating in a second central office distant from the first, an "A" operator's cord circuit at the second office, means associated with the subscriber's circuit at the second office to normally prevent the flow of direct current between the tip and ring leads, means at the first office under control of the foreign exchange subscriber's switchhook to send ringing current from the first to the second office for predetermined intervals of time in accordance with changes in the condition of the subscriber's switchhook a short pulse of current being transmitted upon removal of the receiver from the switchhook a longer pulse being transmitted upon replacement of the receiver, means at the second office to receive and interpret the ringing pulses thus transmitted and thereby upon reception of the signal corresponding to the receiver-off-the-hook to light a lamp associated with the subscriber's line there and to connect a resistance between the tip and ring

leads of such line thus establishing a direct current path between such leads for extinguishing the "A" cord supervisory lamp upon connection of the "A" cord circuit to the subscriber's line, means to extinguish the subscriber's lamp upon connection of the "A" cord to the subscriber's line, said interpretive means at the second office upon reception of the ringing pulse transmitted upon replacement of the receiver upon the switchhook operating to open the resistance path between the tip and ring leads of the subscriber's line and thus cause the lighting of the "A" cord supervisory lamp, said means operating further to open the subscriber's lamp circuit at a point distinct from that controlled by the "A" cord circuit to prevent the relighting of said lamp upon disconnection of the "A" cord circuit.

6. In a telephone system in combination a foreign exchange subscriber's telephone circuit consisting of a subscriber's set, a telephone line connected thereto and extending permanently through a first central office and terminating upon the switchboard of a second central office distant from the first, a relay at the second office controlled by ringing current supplied from a telephone trunk or link circuit connected to the subscriber's line at the second office, said relay being operative to send ringing current over the subscriber's line from the second to the first office, such ringing current in turn operating means at the first office to apply ringing current to the subscriber's telephone set, signaling means at the first office consisting of a circuit interrupter operative to continuously and periodically open and close a circuit for short equal intervals of time and a system of relays associated with said interrupter, said signaling means being operative upon removal of the receiver from the switchhook to send ringing current from the first to the second office for a short interval of time, and upon replacement of the receiver upon the switchhook to similarly transmit ringing current from the first to the second office for a longer interval of time, and upon intermittent operation of the switchhook to transmit a series of pulses of ringing current between said offices, signaling means at the second office consisting of an interrupter similar to that first mentioned and a system of relays associated therewith said signaling means being adapted to receive and interpret the pulses of ringing current transmitted from the first office, and upon reception of the ringing current transmitted upon removal of the receiver from the switchhook to light a lamp associated with the subscriber's line at the second office and to connect a resistance between the tip and ring leads of said line at said office thereby completing a direct current path between such leads, signaling means consisting of a relay in the sleeve circuit of the subscriber's line operative upon connection of a telephone circuit thereto having battery on the sleeve to extinguish said subscriber's lamp, said interpretive signaling means at the second office operative upon reception of the ringing current transmitted from the first office upon replacing the receiver upon the switchhook, to open the direct path between the tip and ring leads of the subscriber's line, and also to open the circuit containing the subscriber's lamp at a point distinct from that controlled by the relay in the sleeve circuit to prevent the relighting of said lamp upon disconnection of the telephone circuit from the subscriber's line, said interpretive means at the second office being further adapted upon reception of the series of ringing pulses transmitted from the first office upon intermittent operation of the switchhook, to alternately open and close the direct current path across the tip and ring leads of the subscriber's line.

7. In a telephone system in combination, a telephone circuit extending from a first to a second point, signaling means under control of a relay associated with said telephone circuit at the first point and adapted upon operation of said relay to transmit ringing current from the first to the second point over said telephone circuit for a definite interval of time, and upon the subsequent release of said relay to similarly transmit ringing current from the first to the second point for a definite interval of time different from that first mentioned, signaling means associated with said telephone circuit at the second point, said signaling means being adapted to receive and interpret the pulses of ringing current transmitted from the first point and to produce a distinct and unique operation of the signaling means at said second point in accordance with the length of the ringing pulse received.

8. In a telephone system in combination, a telephone circuit extending from a first point through a second point and terminating at a third point, switching means at the first point for connecting a direct current bridge across said telephone circuit at said first point, means inserted in the telephone circuit at the second point for causing the flow of direct current over said circuit between the second and first points upon connection of said direct current bridge at the first point, a relay inserted in said direct current path at the second point and operable by said direct current, signaling means controlled by said relay and adapted upon operation of said relay to transmit ringing current over said telephone circuit from the second to the third point for a predetermined short interval of time, and upon the subsequent release of said relay to similarly transmit ringing current for a predetermined short interval of time different from that first

mentioned, signaling means associated with said telephone circuit at the third point adapted to receive and interpret said pulses of ringing current and to produce a distinct and unique operation of said signaling means at the third point for each different length of ringing pulse received.

9. In a telephone system in combination, a subscriber's telephone set, a telephone circuit connected thereto and extending through a first central office and terminating at a second central office distant from the first, signaling means at the first office under control of the subscriber's switchhook and adapted upon removal of the receiver from the switchhook to transmit ringing current from the first to the second office over said telephone circuit for a predetermined short interval of time, and upon the subsequent replacement of the receiver upon the switchhook to similarly transmit ringing current for a predetermined short interval of time different from that first mentioned, signaling means at the second office associated with said telephone circuit adapted to receive and interpret said ringing pulses received there and to cause a distinct and unique operation of said signaling means at the second office for each distinct length of ringing current thus received.

10. In a telephone system in combination, a subscriber's telephone set, a telephone circuit connected thereto and extending through a first central office and terminating in a second central office, means inserted in the telephone circuit at the first office for causing the flow of direct current from the first office and over said telephone circuit through the subscriber's set upon the removal of the receiver from the switchhook, a relay inserted in said direct current path and operable by said direct current, signaling means at the first point under control of said relay and adapted upon the operation of said relay to transmit ringing current over the telephone circuit from the first to the second office for a predetermined short interval of time, and upon the subsequent release of said relay to similarly transmit ringing current for a predetermined short interval of time different from that first mentioned, signaling means associated with said telephone circuit at the second office adapted to receive and interpret said ringing currents and to cause a distinct and unique operation of said signaling means at the second office for each distinct length of ringing current received.

11. In a telephone system in combination, a subscriber's telephone set, a telephone circuit connected thereto and extending through a first central office and terminating in a second central office distant from the first, means inserted in said telephone circuit at the first office for causing the flow of direct current over said circuit and through the subscriber's set upon removal of the receiver from the switchhook, a relay inserted in said direct current path and operable by said direct current flow, signaling means at the first office under control of said relay, consisting of an interrupter for periodically opening and closing an electrical circuit and a system of relays, said signaling means being adapted upon removal of the receiver from the switchhook to transmit ringing current over said telephone circuit from the first to the second office for a predetermined short interval of time, and upon the subsequent replacement of the receiver upon the switchhook to similarly transmit ringing current to the second office for a predetermined short interval of time different from that first mentioned, signaling means associated with the telephone circuit at the second office consisting of an interrupter for periodically opening and closing an electrical circuit and a system of relays, said signaling means being adapted to receive and interpret the pulses of ringing current received from the first office and to cause a distinct and unique operation of said signaling means at the second office for each different length of ringing current received.

12. A method of signaling over a telephone circuit which consists in arranging signaling means under control of a relay such that operation of said relay by closing a circuit to cause the flow of current therethrough will cause said signaling means to transmit ringing current over the telephone circuit for a predetermined interval of time, and upon the subsequent release of said relay by opening said circuit will cause said signaling means to transmit ringing current over said telephone circuit for a predetermined interval of time different from that first mentioned, associating signaling means with the far end of such telephone circuit such that each distinct length of ringing current received by said signaling means over said telephone circuit will cause a distinct and unique operation of said signaling means.

In testimony whereof, I have signed my name to this specification this 22nd day of March, 1928.

HENRY H. ABBOTT.