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SIGNALING SYSTEM

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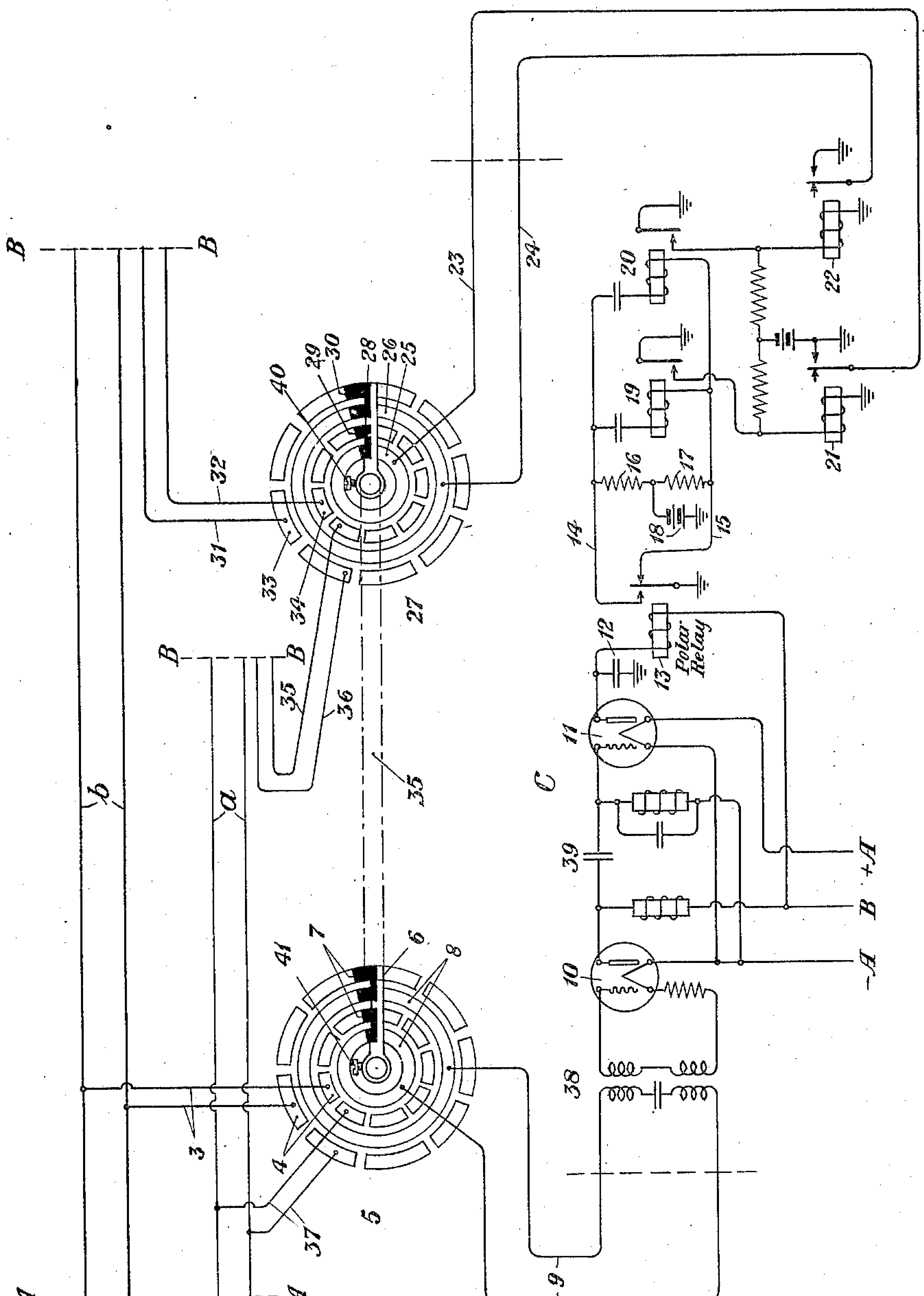

Fig. 1

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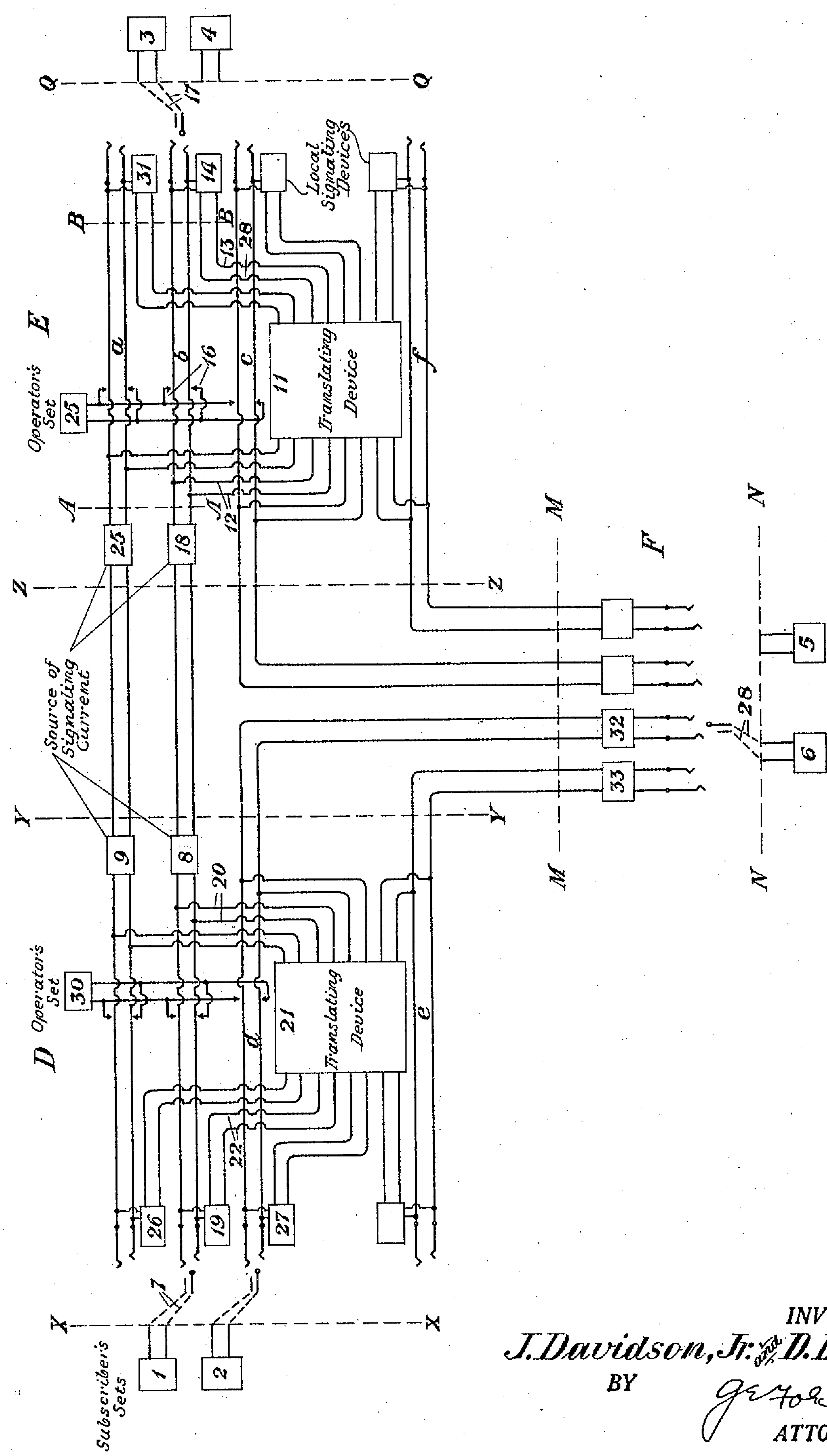

Fig. 2

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UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

Application filed March 9, 1928. Serial No. 260,534.

This invention relates to a signaling system for operating circuits such, for example, as telephone circuits, and its object is to furnish an economical and efficient method of utilizing certain equipment required in such a signaling system.

This invention relates to a method of signaling over operating circuits such, for example, as toll telephone circuits, in which alternating current interrupted at a definite rate, interrupted direct current or multi-frequency current is used as the signaling agent. The system will be described for the case where interrupted alternating current is used for signaling, after which the circuit modifications required to utilize interrupted direct current or multi-frequency current as the signaling agent will be pointed out.

The general operation of the system is this: Alternating current, interrupted at a definite rate, is transmitted over a toll telephone circuit from one office to another. At the incoming end, this signaling current flows into a translating device which functions in such a manner as to cause a suitable operation of the local signaling equipment associated with the trunk over which the signaling current was sent. The signal transmitted might be such as to light the guard lamp at the incoming end of the trunk, or to cause ringing current to be applied to the tip and ring conductors of the trunk, or any other desired signal might be operated in this way. The particular manner in which the local signaling equipment associated with a trunk functions is determined by the rate at which the incoming alternating current is interrupted. For example, a 1000-cycle single frequency alternating current, interrupted k times per second, might cause the guard lamp associated with the trunk to light, while the same current, interrupted j times per second, might cause ringing current to be applied to the tip and ring conductors.

The translating device, which is required at the incoming end of the trunk to receive the complex signaling current and cause a corresponding suitable operation of the local signaling equipment associated with the trunk, is expensive, and, for this reason, it would be desirable if one such translating device could be utilized to care for the signals incoming over a number of trunks. The present invention accomplishes this purpose and provides a method whereby one translating device can be utilized to simultaneously and efficiently receive complex signaling currents incoming over a number of trunks and pass on the desired signals to the local signaling equipment individual to said trunks.

The exact means by which this purpose is accomplished can best be explained by reference to the attached drawings of which

Figure 1 shows a detailed circuit diagram of the translating device together with the necessary switching apparatus required to enable it to simultaneously serve a number of trunks, while

Fig. 2 shows, in schematic form, a complete telephone system utilizing the signaling system described above.

Referring to Fig. 2, a and b represent a plurality of toll trunk circuits extending between offices D and E, while d and e show a plurality of toll trunks extending from office F to D, and c and f show a plurality of toll trunks extending from office F to E; 1 and 2, 3 and 4, 5 and 6, represent subscribers' loops connected to the switchboards in offices D, E and F, respectively. The equipment shown between lines xx and yy is located in office D; correspondingly, that between zz and qq is located in office E, and that between mm and nn is located in office F.

Suppose that subscriber 1 desires to talk with subscriber 3. Subscriber 1 removes his receiver from the hook, thus giving a signal to the operator at D, who thereupon plugs into the subscriber's line jack by means of cord circuit 7. Upon receiving the called number, the D operator plugs the other end of cord 7 into an idle trunk b terminating at office E. The D operator thereupon operates switching device 8, which breaks the circuit toward 1 and causes 1000-cycle single frequency current, interrupted j times per second, to be sent out over trunk circuit b toward E. Upon arriving at office E, this signaling current flows into translating device 11 over leads 12; 11 thereupon functions in such a manner as to place a ground on lead 13 which causes a suitable operation of the local signaling device 14 associated with trunk *b* at office E. In the present case, 14 functions to light the guard lamp associated with the incoming end of the trunk, thus informing the E operator that a call has been placed upon trunk *b*. The E operator connects her telephone set 25 across trunk *b* through contacts 16. Upon receiving the number of the called station, the E operator connects trunk *b* to the called subscriber's loop 3 by means of cord circuit 17, and rings on the circuit. Should subscriber 3 not answer promptly, or if, after the subscriber has answered, should the E operator disconnect prematurely by pulling down cord circuit 17, the D operator may send a peremptory signal over the line by causing switching device 8 to again operate to send 1000-cycle current over the line, interrupted this time *k* times per second instead of *j* times per second, as previously. This signaling current, upon arriving at E, will flow into translating device 11, which will function this time to place a ground on lead 28 terminating in local signaling equipment 14 associated with trunk *b*. This signal will cause the guard lamp associated with trunk *b* to flash intermittently, thus informing the B operator to immediately connect her telephone set 25 to trunk *b*. In the same manner as described above, any number of signals could be sent to signaling equipment 14 by providing additional leads similar to 13 and 28 between translating device 11 and equipment 14. For each different type of signal, it would be necessary to send out from the transmitting station alternating current interrupted at a different frequency.

Should calls be placed on trunks *a* and *b* simultaneously and signals transmitted over these trunks simultaneously, the translating device 11 will nevertheless function to receive the signals incoming over trunk *a* and transmit them to local signaling equipment 31 associated with *a*, and, at the same time, receive the signals incoming over trunk *b* and transmit them to signaling equipment 14 associated with trunk *b*. In the same manner, 11 would function to receive signals simultaneously incoming over any number of circuits up to the capacity of the device which device would in turn cause the desired operation of the local signaling equipment individual to each of said trunks.

Trunks *a* and *b* are arranged for two-way signaling, so that if 3 later desired to call 1, the operator E would connect 3 to an idle trunk *b* over cord 17. She would thereupon operate device 18 which would cause interrupted alternating current to be sent over the line toward D. This current, upon arriving at D, would flow into translating device 21 which would in turn cause a suitable operation of signaling device 19 associated with trunk *b* at the D office. Correspondingly, signals simultaneously sent over a plurality of trunks from E to D would be received by 21 which would in turn cause suitable operations of the local signaling devices individual to said trunks.

The plurality of trunks *a* and *b* operating in conjunction with translating devices 11 and 21 could be arranged to furnish through supervision by well-known means, in which case on a call from 1 to 3, the D operator would have complete supervision of the connection and would ring in subscriber 3 as well as 1, the E operator acting only upon instructions received from the D operator. In this case, the operation of devices 8 and 18 could be made semi-automatic. For example, when the D operator connected 7 to *b*, it would automatically cause device 8 to send suitable signaling current to E, which would cause 11 to light the guard lamp associated with trunk *b* at office E, thus informing the E operator of a call waiting on the trunk. Upon connection of trunk *b* with 3 by means of 17 signaling device 18 would operate to send signaling current to D, which flowing through 21 would light the guard lamp in 19 to inform the D operator to ring on the circuit. The D operator would operate 8 to send a different signaling current to E from that previously transmitted. This signaling current arriving at E, would flow into 11, which would in turn, cause 14 to ring on circuit 3. In the same manner, devices 11 and 21 would cooperate with the signaling equipment of the trunk to inform the D operator as to each step in the building up and tearing down of the connection. In addition, the E operator would receive signals telling her when to connect or disconnect a trunk.

Trunks *d* and *e* show a plurality of circuits between offices F and D, arranged for one-way signaling only. In this case, if subscriber 6 desires to call subscriber 2, the F operator connects 6 to an idle trunk *d* by means of cord 28. She then operates device 32 to send signaling current over the line, which flows into 21 and causes a suitable operation of 27. The same cycle of operations would be followed if 6 desired to call 4 in office E. Thus, a signaling system has been described, in which the translating device can be utilized for either one-way or two-way signaling.

An explanation has been given above, showing, in a general way, the functioning of the translating device as part of the signaling system described. The exact manner in which the translating device and its associated switching apparatus simultaneously receives signals incoming over a number of toll lines and pass on suitable signals to the corresponding local signaling equipment individual to said toll lines, will now be taken up.

Referring to Fig. 1, AA to BB represents sections of the plurality of trunks *a* and *b* which sections are located in office E, as shown by referring again to Fig. 2. With reference to Fig. 2, assume again that subscribed 1 desires to call 3, and that the D operator has connected 7 to trunk *b* and operated device 8 to send signaling current out over the line. Referring, now, to Fig. 1, this signaling current, incoming at office E, flows into leads 3 and impresses a voltage across segments 4 of commutator 5. Rotating brush arm 6 revolves at a predetermined rate of speed over the segments of commutator 5. While passing over segments 4, the alternating voltage is impressed across conductive rings 8 by means of brushes 7, and thence to the input to the translator device C over leads 9, which are permanently connected to conductive rings 8. The alternating voltage is amplified by vacuum tube 10 and modulated in tube 11. The detected current flowing in the plate circuit of tube 11 consists of a series of direct current pulses having the same frequency of interruption as the interrupted signaling current received at AA plus various high frequency alternating current components. These latter components are filtered off to ground through condenser 12. The direct current pulses flow through polar relay 13 which operates on each pulse, thus alternately placing a ground on leads 14 and 15 through the front and back contacts of relay 13. By means of the circuit arrangement shown whereby a lead from ground through battery 18 is connected between equal resistances 16 and 17 which latter in turn are connected in series between leads 14 and 15, the operation of relay 13 impresses an alternating voltage between leads 14 and 15 of the same frequency as that at which the polar relay flashes. An alternating voltage is thus impressed across aircuits 19 and 20, each of which is tuned by means of the condenser connected in series with the inductive relay to operate at a definite frequency. Circuit 19 is tuned to operate on one frequency, while 20 operates on another and different frequency. By suitably selecting the frequency at which the alternating signaling current incoming at AA is interrupted, it is thus possible to operate relay 19 or 20, as desired.

When relay 19 operates, it places a shunt to ground on relay 21 to release it. Relay 21, in releasing, places a ground through its back contact on lead 23. In the same manner, when relay 20 operates, it shunts out relay 22 which, in releasing, places a ground on lead 24. Leads 23 and 24 terminate on conductive rings 25 and 26, respectively, of commutator 27. Commutator 27 is identical in construction with commutator 5 and has a brush arm 28 which revolves in synchronism with brush arm 6 of commutator 5. In fact, brushes 6 and 28 may be connected on the same driving shaft, as indicated by the dashed lines 35. Leads 31 and 32, connected with commutator segments 33 and 34, respectively, are associated with the local signaling apparatus located at office E of trunk circuit *b*, as was described above in connection with Fig. 2. Leads 31 and 32 of Fig. 1 being the same leads as 28 and 13 of Fig. 2. Similarly, leads 35 and 36 terminate in the local signaling equipment associated with trunk *a*; and so on for a plurality of trunks up to the capacity of the switching apparatus.

Brush arms 6 and 28 may be adjusted at any angle with respect to each other by means of screws 41 and 40, respectively, 28 being so placed with respect to 6 that a signal current received at 3, incoming over trunk *b*, is translated in device C and delivered to the local signaling equipment associated with trunk *b*. In other words, the signaling current incoming at 3, after being translated in C, operates relay 19 or 20, as the case may be, just at the moment that brush arm 28 sweeps over segments 33 and 34 of commutator 27. In the same manner, signals simultaneously incoming over any number of trunks up to the capacity of the device are translated and distributed by a revolving brush arm 28 and delivered to the signaling equipment individual to said trunks.

The translating device C has a very high input impedance so that it causes no clicks or other disturbances on the trunk circuits which would disturb conversations between subscribers. By providing more concentric rows of segments on commutator 28 with a lead from each segment in a radial line leading to the local signaling equipment associated with a given trunk in the manner indicated by leads 31 and 32, and also correspondingly increasing the number of tuned circuits similar to 19 and 20 in device C, the translating device could be made to transmit any number of different types of signals to the local signaling equipment associated with a given trunk. At the same time it would be necessary to provide means at the outgoing end of the trunk to interrupt the signaling current at a different rate to operate each of the tuned circuits similar to 19 and 20 located in device C.

The signaling system described above has been stated to operate by means of interrupted alternating current. No change in the arrangement of the translating device or the switching apparatus would be required in order to use multi-frequency uninterrupted alternating current as a signaling agent. Thus, the signaling current might consist in frequencies of 1,000 and 1,050 cycles received simultaneously over trunk *b*. This current, flowing into leads 3 and being picked up by 6 and delivered to 9, would be amplified and modulated by means of 10 and 11, respectively. In this case, the current flowing in the output of 11 would consist of the difference frequency of the input frequencies, namely,

$$1{,}050-1{,}000=50 \text{ cycles,}$$

together with various high frequency components. The high frequency components would be filtered off to ground by 12, while the difference frequency would flow through and cause the polar relay 13 to flash for each cycle with the difference current. The operation of the remainder of the circuit would be as described above in connection with interrupted alternating current.

To cause the translating device C to function on interrupted direct current, it would be necessary to replace the input transformer 38 with a high resistance connected across the input to 10. The device would then be arranged suitably for functioning on interrupted direct current.

Brush arm 6 remains on a given set of commutator segments 4 sufficiently long during each revolution to cause a number of cycles of alternating current to be impressed across leads 14 and 15, and thus select and operate 19 or 20, as the case may be.

What is claimed is:

1. The combination of a plurality of operating circuits, a plurality of signaling devices individual to said operating circuits at a given point, a translating device located at said point separate and distinct from said individual signaling devices but adapted to operate in conjunction therewith, switching apparatus for successively connecting said translating device between each operating circuit and its corresponding individual signaling device.

2. The combination of a plurality of operating circuits extending between two points, a plurality of local signaling devices at each end of and individual to said operating circuits, a translating device at each end of said operating circuits, said translating devices being separate and distinct from the local signaling devices but adapted to operate in conjunction therewith, switching apparatus located at each end of said operating circuits for successively connecting the translating device thereat between each operating circuit and its corresponding local signaling device located at the same end of the operating circuit with the translating device.

3. The combination of a plurality of operating circuits extending between two points, a plurality of local signaling devices at one said point individual to said operating circuits, a translating device at said point separate and distinct from the local signaling devices but operating in conjunction therewith, switching apparatus for successively connecting the translating device between each operating circuit and its corresponding local signaling device.

4. In a telephone system the combination of a plurality of telephone circuits extending between two offices, a plurality of local signaling circuits individual to said telephone circuits at each office, a translating device at each office adapted to operate in conjunction with the local signaling circuits, and switching apparatus adapted to automatically and successively connect the translating device between each telephone circuit and its corresponding local signaling circuit located in the same office with the translating device.

5. In a telephone system the combination of a plurality of telephone circuits extending between two offices, a plurality of local signaling circuits individual to said telephone circuits at one of said offices, a translating device at such office adapted to operate in conjunction with the local signaling circuits, switching apparatus for automatically and successively connecting the translating device between each telephone circuit and its corresponding local signaling circuit.

6. In a telephone system, in combination, a plurality of operating circuits, a plurality of local signaling devices individual to said operating circuits at a given point, a translating device located at said point adapted to operate in conjunction with said local signaling devices, switching apparatus connected to the input and output terminals of the translating device, said switching apparatus operating preferably at the same speed whereby the translating device is successively connected between each operating circuit and its corresponding local signaling device.

7. In a telephone system, in combination, a plurality of telephone circuits, a plurality of local signaling circuits individual to said telephone circuits at a given point, a translating device located at said point, said translating device consisting in sequence of an amplifier unit, a modulator unit, means under control of the modulator unit for impressing an alternating voltage across a pair of conductors, a system of resonant electrical networks connected between said alternating potential carrying conductors, each of said resonant electrical networks containing a relay and tuned to permit said relay to operate at a definite frequency which operating frequency is different for each resonant electrical network, means controlled by each tuned circuit relay for causing an operation of the local signaling circuit associated with a given telephone circuit, the operation of each tuned circuit relay causing the local signaling circuit to function uniquely as compared to its operation for any other tuned circuit of the translating device, switching apparatus consisting of two identical commutators, leads from each of the plurality of telephone circuits terminating upon a different pair of segments on one commutator and leads from the local signaling circuit associated with each telephone circuit terminating upon the cor-

responding pair of segments of the second commutator, a brush arm for each commutator, said brush arms rotating preferably in synchronism and adapted to automatically and successively connect the translating device between each telephone circuit and its corresponding local signaling circuit.

8. The method of signaling which consists in signaling independently over any number of a plurality of telephone circuits terminating at a given office, by transmitting complex signaling currents over such telephone circuits, translating said signals in a single system of apparatus located at said office, delivering the translated signals to the local signaling circuits individual to said telephone circuits at said office in such a manner that a signal incoming over a given telephone circuit is delivered to the local signaling circuit individual to said telephone circuit.

9. The method of signaling independently over any number of a plurality of telephone circuits terminating at a given office which consists in transmitting complex signaling currents over said telephone circuits, causing said signaling currents to be delivered successively to a single translating device located at said office, and successively delivering the translated signaling currents to the local signaling devices individual to the telephone circuits at said office in such a manner that the signaling current incoming over each of said telephone circuits is delivered to the corresponding local signaling devices individual to said circuits with the same effect as though each telephone circuit were equipped with an individual translating device connected between the telephone circuit and the local signaling device individual to said circuit.

10. The method of signaling which consists in transmitting complex signaling currents over any number of a plurality of operating circuits terminating at a given point, successively delivering the received signaling currents to a common translating device located at said point, amplifying and modulating the signaling currents in said translating device, generating an alternating voltage in accordance with the frequency of the modulated current, applying the alternating voltage thus generated to a system of resonant electrical networks each containing a relay to operate the relay in the network resonant to the frequency of the impressed voltage, controlling the operation of the local signaling devices individual to the operating circuits at the common point in accordance with the functioning of the relays in the resonant electrical networks, successively connecting the control circuit from the resonant electrical networks to the local signaling devices individual to the operating circuits in such a manner that the signaling current incoming over each operating circuit is caused to activate the local signaling device individual to said operating circuits.

11. The combination of a plurality of operating circuits extending between two points, local signaling circuits individual to said operating circuit at the first point, a translating device thereat, switching means to successively connect at the first point, the translating device between each operating circuit and said local signaling circuit individual thereto, local signaling circuits individual to said operating circuits at the second point, a translating device thereat, and switching means to successively connect at the second point, the translating device between each operating circuit and the local signaling circuit individual thereto at the second point.

In testimony whereof, we have signed our names to this specification this 8th day of March, 1928.

JOHN DAVIDSON, Jr.
DWIGHT L. MOODY.