July 21, 1925.

1,546,427

H. A. AFFEL

AUXILIARY SIGNALING CIRCUITS

Filed May 18, 1921

3 Sheets-Sheet 1

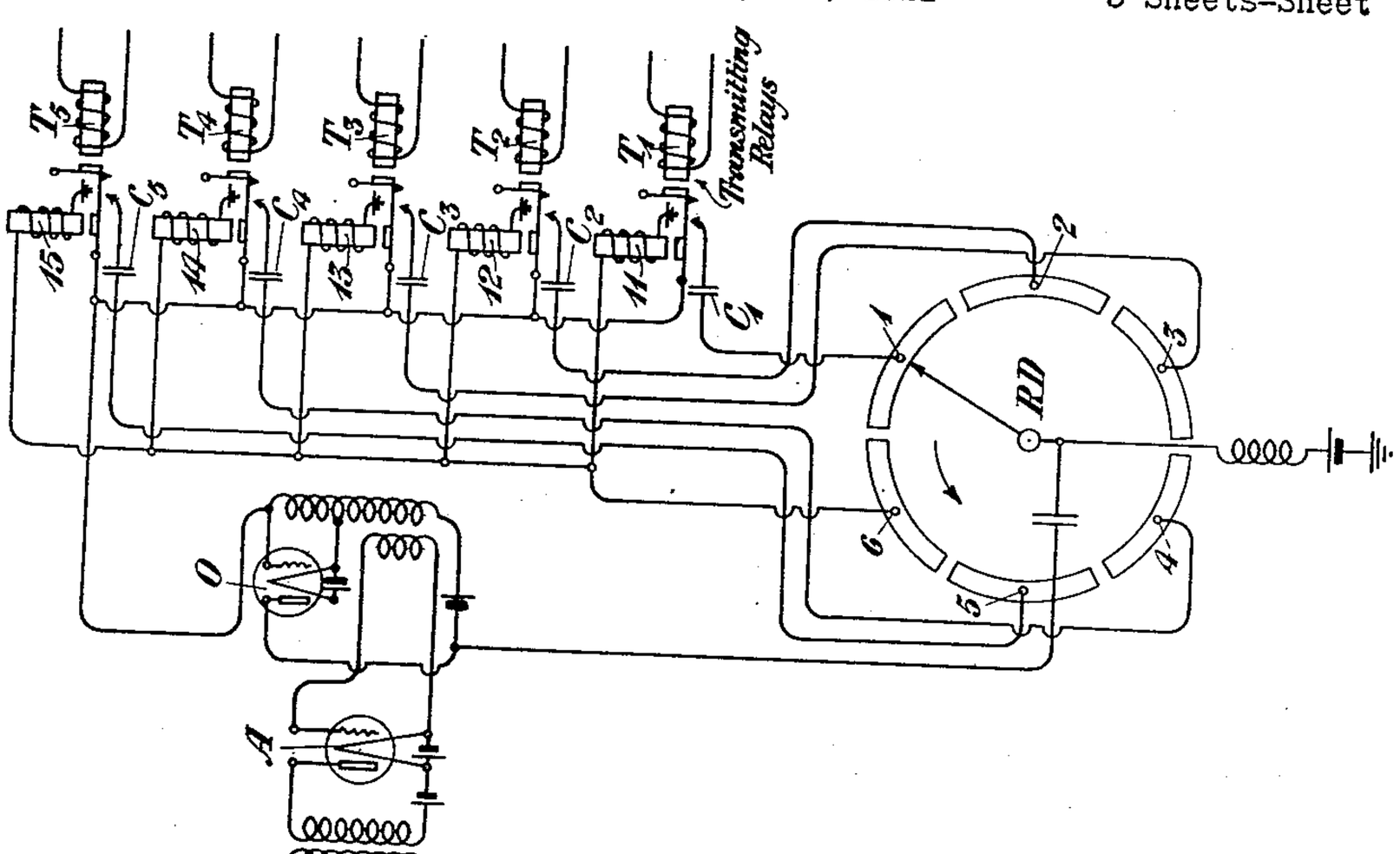

Fig. 1

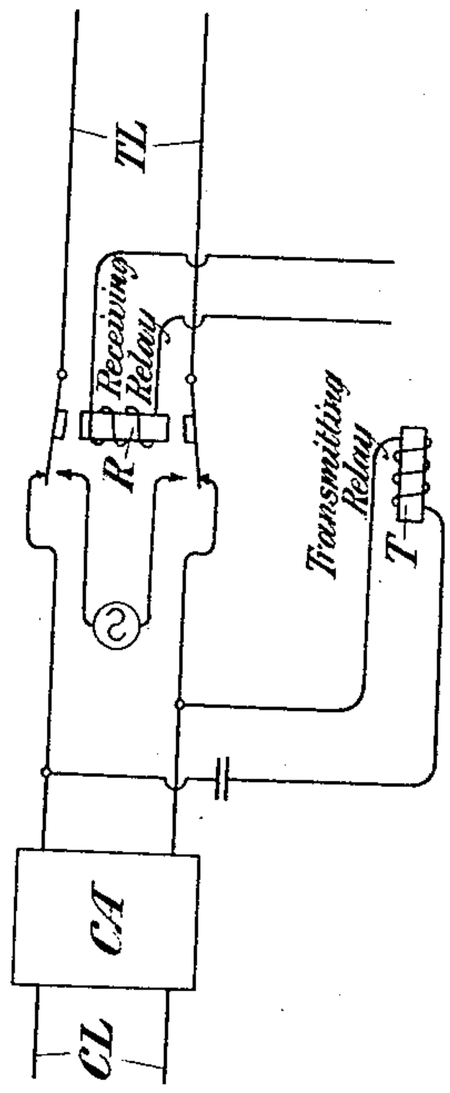

Fig. 2

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AUXILIARY SIGNALING CIRCUITS

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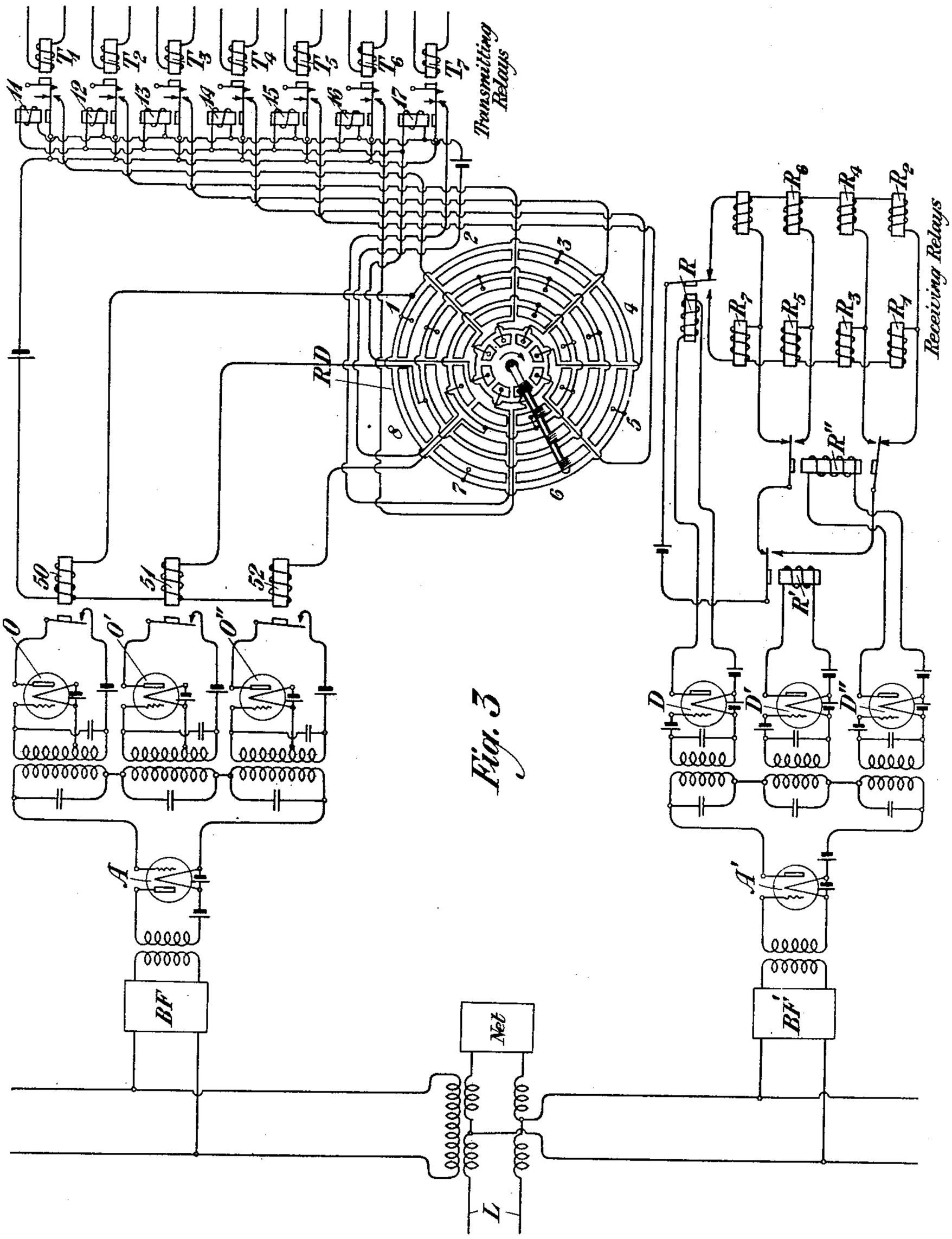

Fig. 3

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AUXILIARY SIGNALING CIRCUITS

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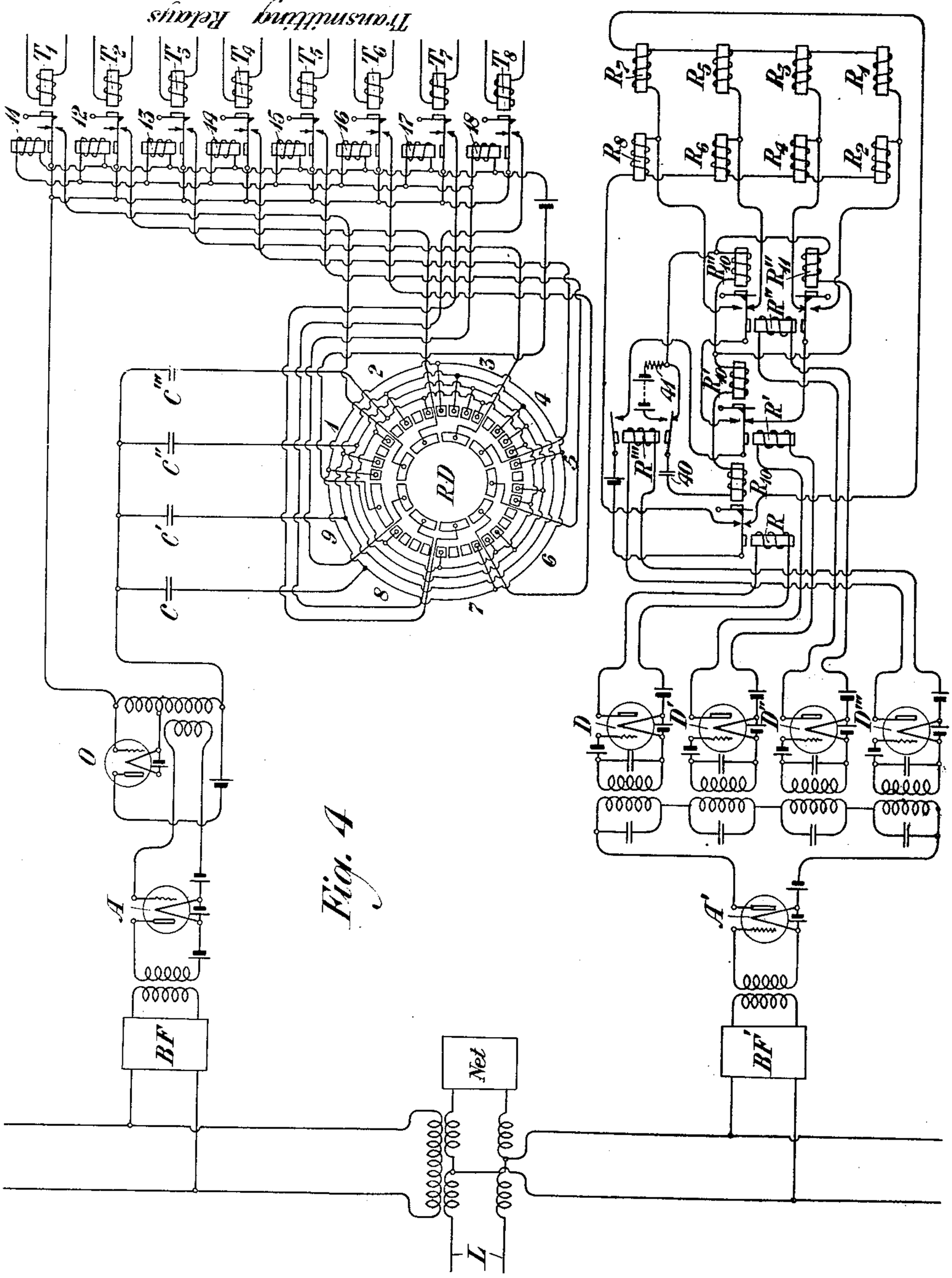

Fig. 4

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Patented July 21, 1925. 1,546,427

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

AUXILIARY SIGNALING CIRCUITS.

Application filed May 18, 1921. Serial No. 470,593.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Auxiliary Signaling Circuits, of which the following is a specification.

This invention relates to signaling systems, and more particularly to the provision of means for transmitting auxiliary signals over long toll wire or carrier telephone circuits.

Where it is desired to transmit auxiliary signals such as ringing signals over long toll wires or over carrier telephone circuits, difficulty is frequently experienced in transmitting the ringing signals because of the intermediate repeater included at various points in the toll circuit or carrier telephone circuit. It frequently occurs, however, that a number of such circuits parallel each other and terminate at the same points. It is therefore possible to employ an external circuit extending between these points for the transmission of the ringing or other auxiliary signals.

In accordance with the present invention it is proposed to utilize a carrier telegraph circuit in order to provide signaling channels for the toll lines or carrier telephone circuits paralleling the carrier telegraph circuit.

While it would be possible to use a separate carrier telegraph channel as the signaling means for each telephone circuit, this method is not desirable, inasmuch as it involves the use of channels inherently capable of transmitting high speed signals for the transmission of the low speed signals involved in ringing and other auxiliary operations. Furthermore, this method would require a maximum amount of apparatus, since essentially a complete carrier transmitting and receiving circuit would be necessary for each signaling channel. The method is therefore both uneconomical in the use of the frequency range and the physical apparatus employed.

Another method would be to use a single carrier telegraph circuit to transmit all of the ringing or other auxiliary signals involved, other channels of such a system being employed if desired for the transmission of telegraph signals in the usual manner. In order that such a single high speed carrier telegraph channel might serve to transmit the signals of a plurality of telephone line, synchronous distributors would have to be provided at either end of the carrier telegraph channels, so that the carrier telegraph channel itself serves as a means upon which several relatively low speed signaling channels may be superposed. The necessity for rather complex apparatus to ensure synchronism in a system of this kind would make its cost rather large and for this reason the invention described in the following pages is proposed as an improvement over both the methods above referred to, and in a sense may be considered a combination of the two.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, in which Figure 1 illustrates one form of apparatus to be associated with a carrier telegraph channel in order that the channel may serve to transmit the ringing signals for a plurality of telegraph lines, Fig. 2 of which illustrated the circuit connections for associating one of the signaling channels superposed upon a carrier telegraph channel with the corresponding telephone line, and Figs. 3 and 4 of which illustrate modified forms of the invention.

Referring to Fig. 1, L designates a line circuit which may be employed for the transmission of carrier currents in a manner well known in the art. As illustrated, the line L terminates at each end in branches including band filters BF and BF′, which are selective of the carrier frequencies assigned to a particular telegraph channel. Multiple connections are indicated on the drawing to show the manner in which other channels may be associated with the ends of the line L. In the illustration it is assumed that such other channels may be used for transmitting carrier telegraph signals in the usual manner, and, as this apparatus is well understood and constitutes no part of the present invention, it is not illustrated. The channels involving the filters BF and BF′ are associated with transmitting and receiving apparatus, whereby these channels may be employed to transmit ringing signals for a number of telephone toll or carrier lines. For this purpose a rotary distributor RD having six segments is provided, and con-

nections from five of the segments lead to the circuit of a vacuum tube oscillator O, these connections being in turn controlled by the contacts of relays 11, 12, 13, 14, and 15 under the control of transmitting relays T_1, T_2, T_3, T_4 and T_5. The connections from the several segments include capacity elements C_1, C_2, C_3, C_4 and C_5, whereby the frequency of the oscillator may be determined. If desired, an amplifier A may be inserted between the oscillator and the band filter BF to amplify the carrier frequencies to be transmitted over the corresponding telegraph channel.

Since in practice the telegraph channel is a high speed channel and is therefore designed to transmit a fairly broad range of frequencies, it is possible to subdivide the frequency range of the channel between the auxiliary channels provided by the distributor RD, each segment of which controls the transmission of a different frequency. This is possible because the low frequency ringing or auxiliary signals superposed on the several carrier frequencies which may be generated by the oscillator O for transmission over the signal telegraph channel do not produce wide bands on either side of the individual carrier frequencies generated by the oscillator O.

A sixth segment is provided in connection with the distributor RD for controlling the relays 11 to 15 inclusive. The contacts of these relays are so arranged that when the relays are energized and the armatures drawn up the armatures are locked in the drawn-up position by means of catches upon the armatures of the transmitting relays T_1 to T_5 inclusive. Consequently, upon the energization of any one of the transmitting relays, as for example the relay T_3, the armature of the corresponding relay 13 is released to close the circuit through the capacity C_3 as soon as the brush arm passes over the third segment. As the brush arm passes over the sixth segment, it energizes relays 11 to 15 inclusive to restore any armatures which may have been released from their attracted positions.

At the receiving station a vacuum tube amplifier A′ may be associated with the band filter BF′ and a plurality of tuned circuits 21, 22, 23, 24, and 25 are provided for selecting the several frequencies transmitted over the carrier telegraph channel. Each tuned circuit is associated with a corresponding detecting arrangement as indicated at D_1 to D_5 inclusive. Receiving relays R_1 to R_5 inclusive are associated with the detectors and respond to the signals detected from the carrier frequencies to control the ringing or other signals at the receiving station.

The manner in which any one of the five auxiliary signaling channels afforded by the arrangement of Fig. 1 may be associated with a corresponding telephone circuit is illustrated in Fig. 2. In Fig. 2 a carrier transmission line CL is illustrated as being associated through a terminal carrier apparatus CA with a toll line TL. A transmitting relay T, which may be any one of the relays T_1 to T_5 inclusive of Fig. 1, is bridged across the toll line in order to respond to ringing currents incoming from said line, and a receiving relay R, which may be any one of a series of relays R_1 to R_5 of a system transmitting in the opposite direction from that of Fig. 1, is arranged to control the transmission of ringing current over the toll line TL from its junction point with the carrier line.

Further details of the apparatus may be understood from the description of the operation as follows: Let it be assumed that a ringing signal is incoming from the line TL and it is desired to transmit this signal to a similar line connected to the opposite end of the carrier circuit CL without transmitting the signal over the carrier circuit. The incoming ringing signal from the line TL will operate the transmitting relay T. If now it be assumed that the relay T is the transmitting relay T_3, for example, of Fig. 1, the armature of said relay will release the armature of the relay 13, which accordingly retracts so that a connection is established from the terminal of the upper winding of the oscillator O, over the contact of the relay 13 and through the condenser C_3 to the third segment of the distributor RD. Whenever the brush arm of the distributor passes over the third segment, therefore, a connection will be completed to the lower terminal of the coil of the oscillator O and the oscillator will generate a series of oscillations whose frequency is determined by the capacity C_3 and whose duration is determined by the period of time required for the brush arm to pass over the segment 3. As the brush arm passes over the other segments from 1 to 5 inclusive, the oscillator may transmit other frequencies if any of the remaining relays T_1 to T_5 are actuated. As the brush arm passes over the segment 6 a circuit is completed from battery, through the windings of each of the relays 11 to 15 inclusive, thereby energizing these relays to attract their armatures and open the circuits through the condensers.

The carrier frequency generated by the oscillator O as the brush of the distributor RD passed over the segment 3 is transmitted over the line L and through the band filter BF′ to the amplifier A′. This frequency is selected by the tuned circuit 23 and impressed upon the detector D_3 to operate the receiving relay R_3 at the distant station.

Assuming that the relay R_3 is located at the distant end (not shown) of the carrier line CL of Fig. 2, and assuming further that at the distant station apparatus identical to that illustrated in Fig. 2 is provided, the actuation of the relay R_3 will operate to transmit ringing current to the toll line connected to the distant end of the carrier line in the same manner as is indicated by the relay R in Fig. 2. Consequently the ringing signal incoming from the line TL is transmitted over the line L of Fig. 1 to the distant station and from that point transmitted over the toll line associated with the opposite end of the carrier line of Fig. 2.

Fig. 3 illustrates a modified circuit arrangement, in which the ringing or other signals are transmitted by combinations of one or more frequencies simultaneously transmitted, a plurality of oscillators being provided for generating the carrier frequencies. As illustrated, three oscillators O, O′ and O″ are provided, the circuits of these oscillators being controlled by relays 50, 51, and 52, which are connected to three rings of the distributor RD, the distributor in this case being provided with four rings instead of one, as in Fig. 1. The fourth ring of the distributor RD is provided with individual segments connected with the contacts of relays 11 to 17 inclusive, and the contacts of these relays are controlled by transmitting relays T_1 to T_7 inclusive in the same manner as in Fig. 1, so that any particular transmitting relay may through the distributor RD control the energization of a corresponding combination of the relays 50, 51, and 52. Each transmitting relay is arranged to control a different combination of the relays 50, 51, and 52, so that a different combination of frequencies is transmitted by the oscillators O, O′ and O″.

The receiving apparatus comprises detectors D, D′, and D″, each having tuned circuits in their input circuits and each tuned circuit being responsive to one of the frequencies generated by the three oscillators. The detectors control the circuits of relays R, R′, and R″ and these relays operate to selectively control the energization of receiving relays R_1 to R_7 inclusive. It will be understood that the relays R_1 to R_7 inclusive are associated with the corresponding telephone circuits in the manner in which the relay R of Fig. 2 is associated with the line TL and that the transmitting relays T_1 to T_7 will similarly be associated with said telephone circuit in the manner in which the relay T is associated with the circuit TL in Fig. 2.

The operation is as follows: A signal operating the relay T_5, for example, causes the armature of the relay 15 to be released. A circuit is thereby completed from battery over the contact of the relay 15, fifth segment of the inner ring of the distributor RD, and over the fifth segment of the second ring and the outer ring through the windings of relays 50 and 52 in parallel, back to battery. The circuits of these relays are therefore completed as the brush arm passes over the fifth segment of the distributor, and these relays cause the oscillators O and O″ to transmit oscillations through the amplifier and band filter to the line L and over said line to the distant station.

The operation of the receiving apparatus at the distant station may be understood from a description of the operation of the receiving apparatus at the station illustrated, in response to a signal transmitted from the distant station. Assuming that two frequencies are incoming from the line L and are transmitted into the receiving channel through the band filter and amplifer provided therein, the two frequencies will be separated through the tuned circuits into the detectors D and D″, thereby actuating the relays, R and R″. As a result of the operation of these relays, a circuit is completed from battery, over the front contact of relay R through the winding of relay R_5, over the upper front contact of relay R″, and over the back contact of relay R′ to battery. The receiving relay R_5 is accordingly actuated to transmit the ringing signal to the corresponding telephone line.

Fig. 4 illustrates an arrangement in which the signals are transmitted by a plurality of separate carrier frequencies. In this case, however, instead of three separate oscillators for supplying the carrier frequencies, a single oscillator is employed, and it sends different frequencies successively instead of simultaneously to determine the proper signaling channels. As illustrated, three frequencies are employed to select any one of a combination of eight signaling channels, and a fourth frequency is used as a controlling or "trigger" frequency to finally transmit the signal determined by the combination of three frequencies previously transmitted. In order to selectively control the oscillator to determine the frequency generated, four capacities C, C′, C″ and C‴ are provided, and the selective inclusion of one of these capacities in the circuit of the oscillator O is under the joint control of the transmitting relays T_1 to T_8 inclusive and the associated relays 11 to 18 inclusive. The rotary distributor RD is interposed between the capacities and the relays to time the connection of the capacities and thereby time the transmission of the frequencies. The distributor RD in this case is provided with two rings, the inner of which has nine segments, eight corresponding to the individual transmitting relays T_1 to T_8 inclusive, and the

ninth being for the purpose of restoring the contacts of the relays 11 to 18 inclusive. In the outer ring are groups of four segments, each group of four corresponding to one of the first eight segments of the inner ring. The four segments in each group in the outer ring are variably connected to the capacities C, C′, C″ and C‴, and complete the connection of these capacities to the oscillator over the brush arm of the distributor.

The receiving apparatus comprises four detectors D, D′, D″ and D‴. The detectors D, D′ and D″ control three relays R, R′ and R″, whose armatures when attracted are held in attracted position by locking engagement with the armatures of auxiliary relays R_{10}, R_{10}' and R_{10}'' and R_{11}''. The fourth detector D‴ controls a relay R‴, which at its upper contact is arranged to complete the circuit selectively set up by the relays R, R′, and R″ through one of the receiving relays R_1 to R_8 inclusive. At its lower front contact relay R‴ is arranged when energized to complete a circuit to charge up a condenser 40 included in circuit with the relays R_{10}, R_{10}' and R_{11}''. The impulse of current in charging the condenser does not actuate these relays, as a resistance 41 is included in the circuit. When the armature of the relay falls off, however, the condenser is permitted to discharge through the relays over a path independent of the resistance 41, thereby actuating the relays R_{10}, R_{10}', R_{10}'' and R_{11}'' to restore the contacts of the selecting relays R, R′ and R″.

The operation is as follows: Assuming that a ringing signal comes in from the telephone line with which the relay T_5 is associated, said relay is energized to attract its armature, thereby permitting the armature of the relay 15 to fall off and establish a connection from the upper terminal of the winding of the oscillator O over said contact to the fifth segment of the inner ring of the distributor RD. When the brush arm of the distributor passes over this segment, the circuit thus prepared is completed successively over the first segment of the corresponding group of four in the outer ring, through the condenser C to the lower terminal of the winding of the oscillator O, over the third segment of the group through the capacity C″, and over the fourth segment of the group, and through the capacity C‴. The oscillator is therefore caused to oscillate successively at the frequencies determined by the capacities C, C″ and C‴, the oscillator being, however, inactive at the moment the brush arm passes over the second segment of the fifth group in the outer ring of the distributor, since this segment is for the combination under consideration unconnected with the capacity C′. The three frequencies successively generated by the oscillator O are transmitted over the line L to a distant station to cause the actuation of a signal at the distant end of the line with which the transmitting relay T_5 is associated.

The manner in which the signaling apparatus at the distance station operates in response to the three transmitted frequencies may be understood from a consideration of the similar operation taking place when the same frequencies are transmitted from the distant station to the station illustrated in order to transmit the signal in the reverse direction. The three frequencies generated are received from the line L and transmitted through the band filler and amplifier of the receiving channel. At this point they are selected by the tuned circuits associated with the input sides of the detectors, and are therefore impressed upon the detectors D, D″ and D‴. The detectors D and D″ actuate the relays R and R″ to shift their armatures from their back contacts to their front contacts in which position they are locked by the armatures of the relays R_{10}, R_{10}'' and R_{11}''. In response to the fourth frequency the detector D‴ actuates the relay R‴ which, at its upper contact, completes a circuit from battery over said upper contact, over the upper back contact of relay R′, upper front contact of relay R″, through the winding of receiving relay R_5, and over the front contact of relay R, back to battery. Relay R_5 is thereby energized and transmits a signal to the corresponding telephone line. At the same time the condenser 40 is being charged over the lower front contact of the relay R‴ through the high resistance 41, which prevents the actuation of relays R_{10}, R'_{10}, R_{10}'' and R_{11}''. As soon as the impulse through the relay R‴ ceases, however, with the cessation of the fourth or "trigger" frequency the lower armature of the relay R‴, in falling off, completes a circuit whereby the condenser 40 discharges over a circuit independent of the resistance 41 and through the windings of relays R_{10}, R_{10}' R_{10}'' and R_{11}''. These relays are accordingly energized to release the armatures of the relays R, R′ and R″, so that the circuit is restored to normal ready for another selection.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a transmission system a plurality of transmission circuits, an auxiliary circuit common to said transmission circuits over which signals originating at one end of any one of said transmission circuits may be transmitted to actuate corresponding signaling means associated with the other end of the corresponding circuit, means to translate

said signals into characteristic carrier frequencies for transmission over said auxiliary circuit, and integrating detectors at the distant station for translating the characteristic carrier frequencies into the corresponding signal.

2. In a transmission system a plurality of transmission circuits, an auxiliary circuit common to said transmission circuits over which signals originating at one end of any one of said transmission circuits may be transmitted to actuate corresponding signaling means associated with the other end of the corresponding circuit, means to translate said signals into combinations of different carrier frequencies for transmission over said auxiliary circuit, and integrating detectors at the distant station for translating the various combinations of carrier frequencies into signals corresponding to the original signal.

3. In a transmission system a plurality of transmission lines, an auxiliary signal circuit common to said lines, a distributing arrangement for transmitting signals originating with any of said lines to said auxiliary line, means associated with said distributing apparatus for tranlating said signals into carrier frequencies for transmission over said auxiliary line, means at the distant end of said auxiliary line for selecting the carrier frequencies and translating them into signals corresponding to the signals originating with the lines at the transmitting station, and means for impressing said signals upon the corresponding line at the receiving station.

4. In a transmission system a plurality of transmission lines, an auxiliary signal circuit common to said lines, a distributing arrangement for transmitting signals originating with any of said lines to said auxiliary circuit, means associated with said distributor for translating the signals incoming from any of said transmission lines into combinations of carrier frequencies for transmission over said auxiliary circuit to a distant receiving station, means at the receiving station for selecting said frequencies and translating the combinations into signals corresponding to the signals originating at the transmitting station, and means for impressing said signals upon the corresponding transmission lines at said transmitting station.

5. In a transmission system a plurality of transmission lines, an auxiliary signal circuit common to said lines, a distributing arrangement for transmitting signals originating with any of said lines to said auxiliary circuit means associated with said distributor for translating the signals originating with any of said transmission lines into carrier frequencies for transmission over said auxiliary circuit to a distant receiving station, means at said distant station for translating said carrier frequencies into signals corresponding to the original signals at the transmitting station, and means for selectively transmitting said signals to the line corresponding to that with which the signals originated.

6. In a transmission system a plurality of transmission lines, an auxiliary signal circuit common to said lines, a distributing arrangement for transmitting signals originating with any of said lines to said auxiliarly circuit, means associated with said distributor for translating signals originating with any of said lines into combinations of carrier frequencies for transmission over said auxiliary circuit to a distant receiving station, selective means at said distant receiving station responsive to combinations of carrier frequencies to translate said combinations into signals corresponding to the original signals at the transmitting station, and means to transmit said signals to lines corresponding to the lines with which the signals originated.

7. In a transmission system a plurality of transmission lines, an auxiliary signaling circuit common to said lines, signal relays associated with each transmission line responsive to signals originating with said lines, a rotary distributor associated with said lines, said distributor operating in conjunction with said relays to control the transmission of signals from said lines over said common signaling circuit, means associated with said rotary distributor for translating said signals into carrier frequencies for transmission over said auxiliary signal circuit to a distant receiving station, and means at said distant receiving station for translating said carrier frequencies into signals corresponding to the original signals.

8. In a transmission system a plurality of transmission lines, an auxiliary signaling circuit common to said lines, signal relays associated with each transmission line responsive to signals originating with said lines, a rotary distributor associated with said lines, said distributor operating in conjunction with said relays to control the transmission of signals from said lines over said common signaling circuit, means associated with said rotary distributor for translating said signals into carrier frequencies for transmission over said auxiliary signal circuit to a distant receiving station, means at said distant receiving station for translating said carrier frequencies into signals corresponding to the original signals, and means for selectively transmitting said signals to the lines corresponding to the lines with which the signals originated.

9. In a transmission system a plurality of transmission lines, an auxiliary signaling circuit common to said lines, signal relays

associated with each transmission line responsive to signals originating with said lines, a rotary distributor associated with said lines, said distributor operating in conjunction with said relays to control the transmission of signals from said lines over said common signaling circuit, means associated with said distributor for translating said signals into combinations of carrier frequencies for transmission over said auxiliary signaling circuit to a distant receiving station, and means at said distant receiving station for selectively translating said combinations of frequencies into signals corresponding to the original signals.

10. In a transmission system a plurality of transmission lines, an auxiliary signaling circuit common to said lines, signal relays associated with each transmission line responsive to signals originating with said lines, a rotary distributor associated with said lines, said distributor operating in conjunction with said relays to control the transmission of signals from said lines over said common signaling circuit, means associated with said distributor for translating said signals into combinations of carrier frequencies for transmission over said auxiliary signaling circuit to a distant receiving station, means at said distant receiving station for selectively translating said combinations of frequencies into signals corresponding to the original signals, and means for selectively impressing said signals upon the lines corresponding to the lines with which the signals originated.

In testimony whereof, I have signed my name to this specification this 16th day of May 1921.

HERMAN AFFEL.