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COMPOSITE RINGER FOR TRANSMISSION SYSTEMS

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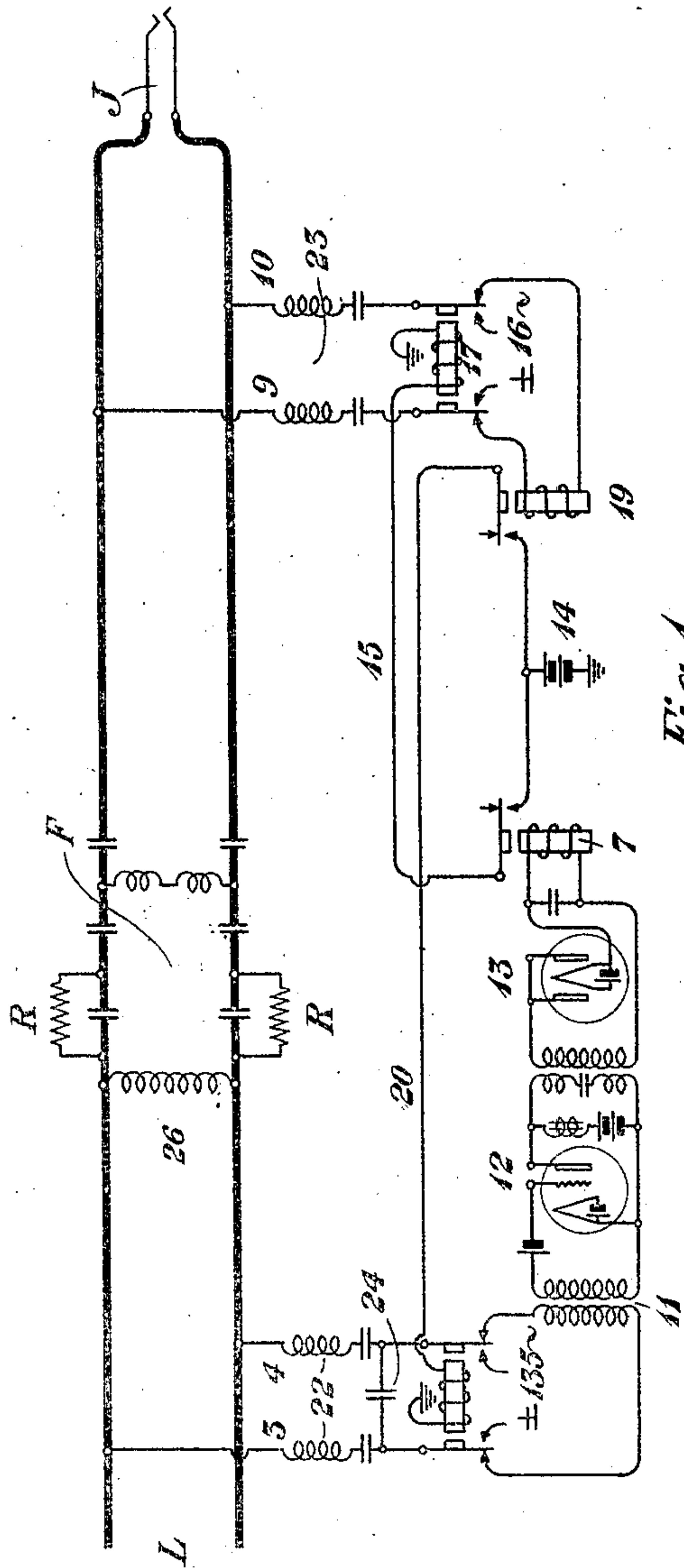


Fig. 1

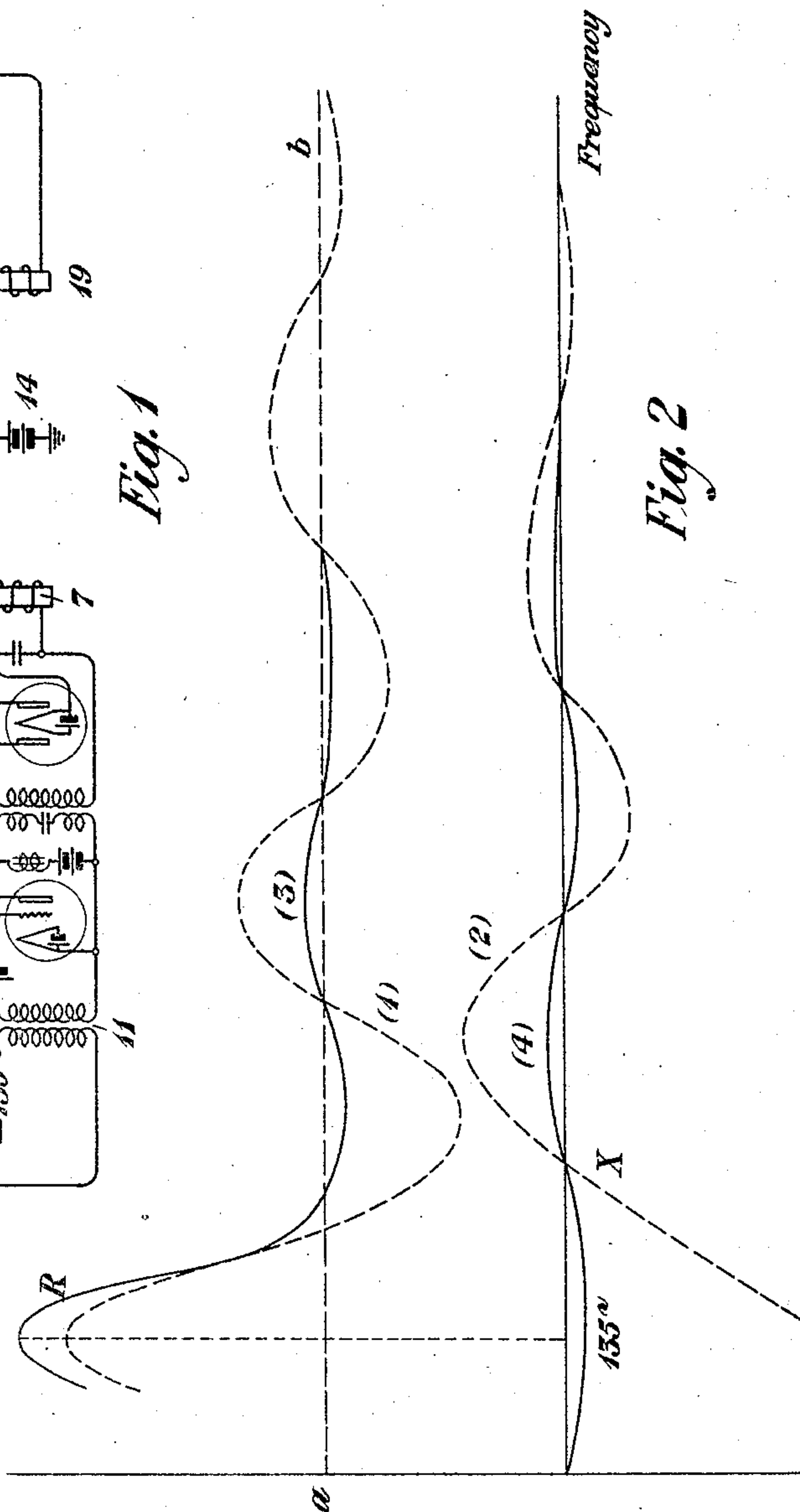


Fig. 2

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COMPOSITE RINGER FOR TRANSMISSION SYSTEMS.

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To all whom it may concern:

Be it known that I, HARRY NYQUIST, a citizen of the United States, residing at Elmhurst, in the county of Queens and State of New York, have invented certain Improvements in Composite Ringers for Transmission Systems, of which the following is a specification.

This invention relates to transmission lines arranged for transmission of a plurality of currents of different frequencies, and, in particular, to a transmission line making use of so-called "composite ringing circuits." The object of the invention is to improve the transmission for the signaling or ringing currents and at the same time to reduce the reflection effects due to the various impedance elements in the line, which reflections at times become serious. Still another purpose is to eliminate series relay contacts in the transmission line and to obtain freedom from interference from switch-hook impulses and other such disturbances at the subscribers' stations or at a switchboard. Another object of the invention is to eliminate impedance irregularities normally present in certain elements used in such circuits.

It has been the practice in certain telephone lines to utilize as a carrier channel for signaling purposes an alternating current of a frequency in the neighborhood of approximately 135 cycles. This frequency has been selected in order that the signaling currents shall not interfere with telegraphic apparatus which may be associated with the line, the selective circuits associated with the telegraph apparatus being adapted to transmit the Morse impulses, which may have a frequency range from zero to approximately 60 cycles, and being further adapted to attenuate currents of higher frequencies, such as that of the signaling currents and the telephone currents. However, the signaling apparatus associated with such a line, such as at a switchboard, is adapted to operate with currents having frequencies in the neighborhood of 16 cycles. Such currents would interfere with the telegraph apparatus if they were transmitted over the line, as they would be within the telegraphic frequency range. Accordingly, means must be provided for changing the incoming 135 cycle signaling current transmitted over the line into 16 cycle current, so that it will properly operate the signaling apparatus at

the switchboard, and the 16 cycle current transmitted out over the switchboard must be changed into 135 cycle current before being transmitted out over the transmission line. A device accomplishing these purposes is commonly called "a composite ringer."

The invention is an improvement on such composite ringers and will be more fully understood from the following description, taken in connection with the accompanying drawing, in which Figure 1 illustrates a circuit embodying one form of the invention, and Fig. 2 is a diagram illustrating the relation between the impedance and frequency of a certain part of the circuit of Fig. 1. In the drawing there is shown a line L over which may come a telephone message or signaling current, the signaling current being of a frequency in the neighborhood of 135 cycles. The telephone current is permitted to pass directly over the transmission line to the jack J by means of which it may be associated with any switchboard of substation circuit. The signaling circuit is bridged across the line at 3 and 4 and is permitted to operate a relay 7, doing this directly or through the mediary of certain apparatus which will be described hereinafter. The operation of the relay 7 will in turn control a circuit to impress on the transmission circuit 16 cycle oscillations on the conductors 9 and 10, which low frequency signals will then be transmitted over the circuit. In order to obtain this sequence of operations, the impulses coming on the line 3, 4 are shown as passing into the primary of a transformer 11, the secondary of which is connected to the input of an amplifying device 12. The amplified output may now be used to operate an A. C. relay directly or may be rectified, as shown in the figure, by means of the device 13, to supply direct current to the relay 7. The operation of this relay 7 will close the normally opened circuit 14, 15, 17, the relay 17 then operating to connect the 16 cycle source with the line as previously mentioned. In signaling from the switchboard to the line L, 16 cycle current passes into the conductors 9 and 10 and operates the low frequency relay 19, which closes the normally opened circuit 14, 20, 21. The excitation of the relay 21 connects a source of 135 cycle frequency current to the line L by means of the conductors 3 and 4.

In order to prevent signals being transmitted in the opposite directions simultaneously, the circuit is interlinked in such a manner that the operation of the relay 19, upon receipt of signaling currents from jack J, will disconnect the conductors 3 and 4 from the input of the amplifier 12 at the same time as the source of 135 cycle frequency is connected to the line 3, 4. Similarly, the receipt of signaling current of 135 cycles from the line, which will cause the operation of the relay 7, will disconnect the conductors 9, 10 from the relay 19 at the instant that it connects the 16 cycle generator to the jack J.

In order to prevent 16 cycle signaling current from being transmitted over the line, or to prevent 135 cycle signaling current from being transmitted to the switchboard or substation, there is introduced in the line circuit a wave filter of the high pass type, which permits all frequencies above a critical frequency to be transmitted with substantially no attenuation, but which attenuates to a very high degree all frequencies below this critical value. In order also to increase the efficiency of the transmission of the signaling currents, I introduce in the conductors 3 and 4 a device 22, consisting of inductances and capacities, by means of which this circuit may be tuned for the high signaling frequency. Also, in the conductors 9 and 10 I may introduce a device 23 for the purpose of tuning this circuit to the low signaling frequency. Across the conductors 3 and 4 I find it convenient to shunt a large capacity 24, which will form a substantially short circuit for currents of relatively high frequency, such as telephone currents.

As thus far described, the circuit arrangement is one which has been in practice heretofore. It is the purpose of my invention to improve the transmission of a ringing current and I accomplish this, in part, by bridging across the line an impedance element 26, which impedance will generally be an inductance. The magnitude of this impedance is such as to render the circuit anti-resonant for the signaling frequency of 135 cycles when the circuit is viewed from the direction of the incoming line. It is pointed out that the right-hand inductance of the filter itself, which is bridged across the line conductors, is a very low impedance to the signaling currents and hence would act as practically a short circuit across the line conductors. Accordingly, the condensers of the filter may be deemed to be in parallel with the inductance 26. It will thus be seen that there exists an inductance and capacity in parallel connected serially with the line conductors of the incoming line, which, due to the proportions of the elements, will render the circuit anti-resonant for the signaling frequency. By this expedient the impedance of

the telephone line for that frequency is very substantially increased and these impulses are, therefore, transferred with greater efficiency to the circuit 3, 4.

A further cause of trouble in connection with the introduction of a filter F in the line is that its impedance shows certain irregularities, depending upon frequency. These irregularities are illustrated in Fig. 2, in which curve 1 shows approximately the form of the resistance characteristic of a transmission line with the filter in circuit, the resistance being shown for different frequencies. At the same time this circuit will exhibit a certain amount of reactance and the general form of the reactance curve for the transmission line with the filter is given in curve 2. It is seen, therefore, that the impedance varies substantially with the frequency and it is desirable that these irregularities should be smoothed out. I have found that by placing shunt resistances around certain of the condensers of the filter, as indicated at R of Fig. 1, these irregularities are materially reduced, so that the resistance characteristics would be substantially of the form of the full curve 3 of Fig. 2, whereas the reactance X would be given by the full curve 4.

In general, when electric impulses, such as telephone currents, are impressed upon an impedance device, such as the filter F, there will be partial reflection of the electric wave, which reflections frequently become sufficiently large to materially affect the quality of the transmitted speech. In order to diminish this effect, I find it desirable to so adjust the impedance of the circuit 3, 4, still keeping this circuit tuned for the high signaling frequency, that when taken in connection with the filter and its associated circuit, the impedance, as seen looking into the filter and signal circuit, shall be substantially equal to the impedance of the transmission line as seen looking away from the filter. Under these conditions, the reflection losses will be reduced to a minimum.

It will be noted that in the circuit arrangement as described, the usual series relay contacts for connecting the sources of signal current to the line have been eliminated, and thus a source of numerous troubles has been removed. With the high selectivity introduced by the circuit for different frequencies, it is feasible to have all the circuits conductively connected with each other and each will transmit its own frequency to the exclusion of the others, and thus there is obtained an efficient and convenient composite ringer.

It is to be understood that various changes may be made in my invention as disclosed above without departing from the spirit or scope of the invention as set forth in the ap-

pended claims. For example, the amplifier 12 or the rectifier 13 may be omitted, or in certain cases, both may be omitted, in which case the relay 7 will be an A. C. relay sufficiently sensitive to be operated by the incoming signals of 135 cycle frequency. Also, that while I have shown the device 23 in the circuit 9, 10 to tune this circuit to the low frequency signal, this tuning may be dispensed with for the reason that the filter F offers so high an impedance to this exceedingly low frequency that the efficiency of its transmission to the side branch 9, 10 is quite high.

What is claimed is:

1. A transmission line arranged for the transmission of telephone and signal currents, a composite ringer circuit associated with the line including a relatively high and a relatively low frequency signaling circuit, a filter in said line permitting the passage of telephone currents only, and an impedance element associated therewith, rendering the telephone circuit anti-resonant for one of said signaling frequencies.

2. A transmission line arranged for the transmission of telephone and signal currents, a composite ringer circuit associated with the line including a relatively high and a relatively low frequency signaling circuit, a filter in said line permitting the passage of telephone currents only, and an impedance element associated therewith, rendering the telephone circuit anti-resonant for the relatively high signal frequency.

3. A transmission line arranged for the transmission of telephone and signal currents, a composite ringer circuit associated with the line, including a relatively high and a relatively low frequency signaling circuit, a filter in said line permitting the passage of telephone currents only, and an inductance element associated therewith, rendering the telephone circuit anti-resonant for the relatively high signal frequency.

4. A transmission line arranged for the transmission of telephone and signal currents, comprising a composite ringer circuit associated with the line, including a relatively high and a relatively low frequency signaling circuit, a filter in said line permit-

ting the passage of telephone currents only, said filter comprising series and shunt elements, and means to eliminate impedance irregularities in said filter, said means comprising energy absorption elements shunted about said series elements in said filter.

5. A transmission line arranged for the transmission of telephone and signal currents comprising a composite ringer circuit associated with the line, including a relatively high and a relatively low frequency signaling circuit, a filter in said line permitting the passage of telephone currents only, energy absorption elements associated with said filter to eliminate impedance irregularities therein, and an impedance element associated with said filter to render the telephone circuit anti-resonant for the signaling frequency.

6. A transmission line arranged for the transmission of telephone and signal currents, comprising a composite ringer circuit associated with the line, including a relatively high and a relatively low frequency signaling circuit, a filter in said line permitting the passage of telephone currents only, energy absorption elements associated with said filter to eliminate impedance irregularities therein, and an inductance element associated with said filter to render the telephone circuit anti-resonant for the signaling frequency.

7. A transmission line arranged for the transmission of telephone and signal currents, comprising a composite ringer circuit associated with the line, including a relatively high and a relatively low frequency signaling circuit, the high and the low frequency signaling circuits being bridged across the line, a filter in said line permitting the passage of telephone currents only, said filter comprising series and shunt elements, and means to reduce the reflection loss to a minimum, said means comprising impedance elements shunted about the series elements of said filter.

In testimony whereof, I have signed my name to this specification this 8th day of September, 1921.

HARRY NYQUIST.