May 31, 1932. W. H. EDWARDS 1,860,458

TELEPHONE SIGNALING SYSTEM

Filed June 15, 1931

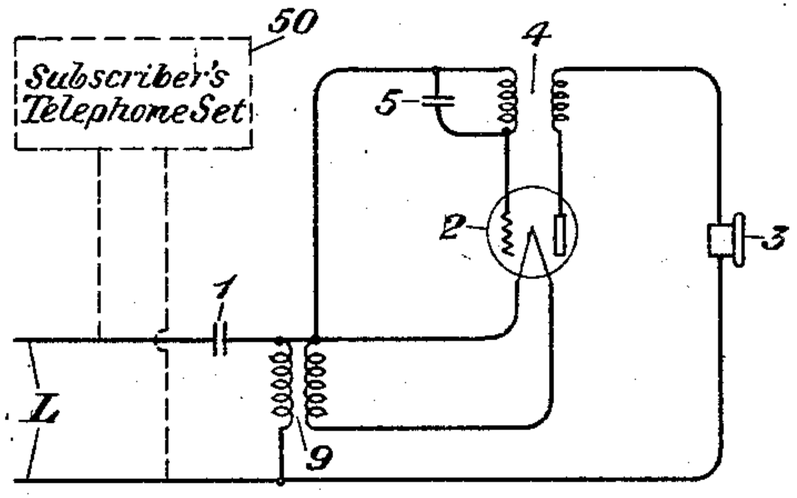

Fig. 1

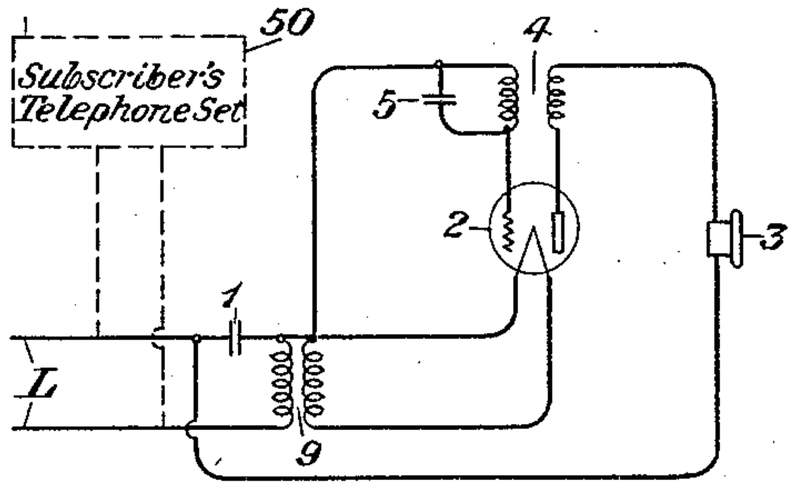

Fig. 2

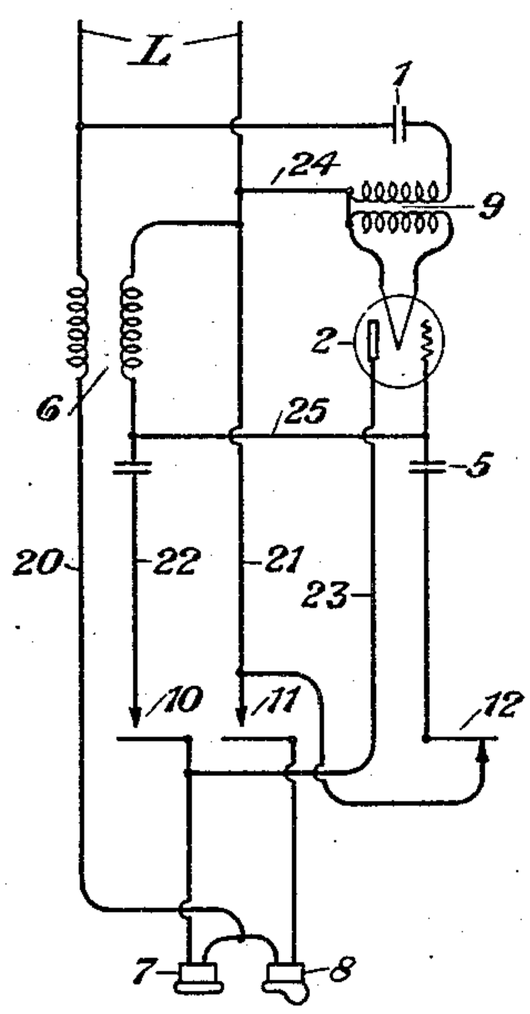

Fig. 3

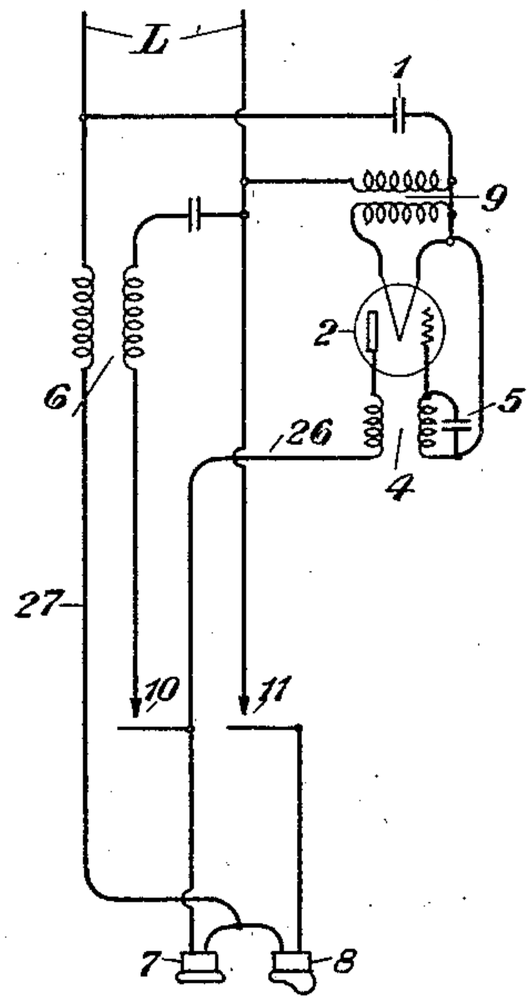

Fig. 4

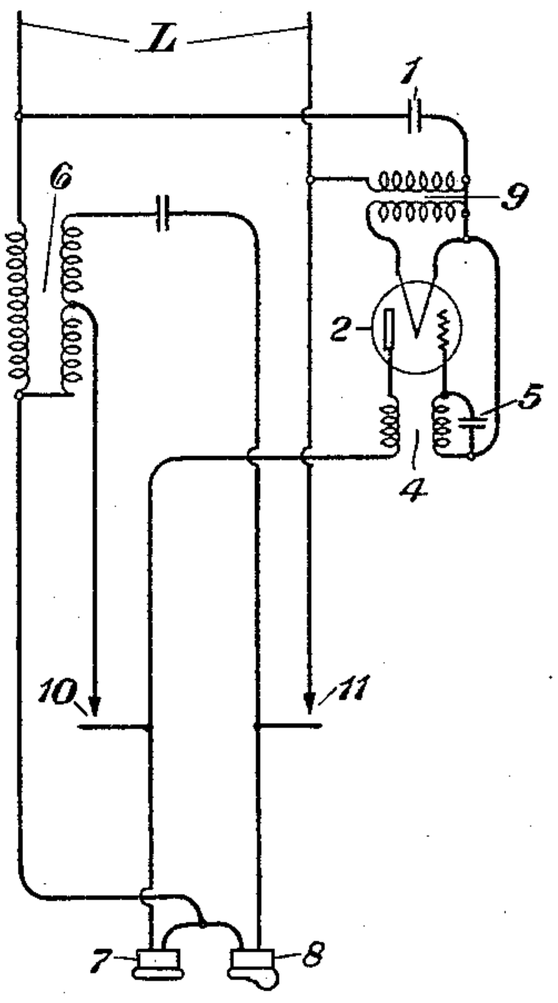

Fig. 5

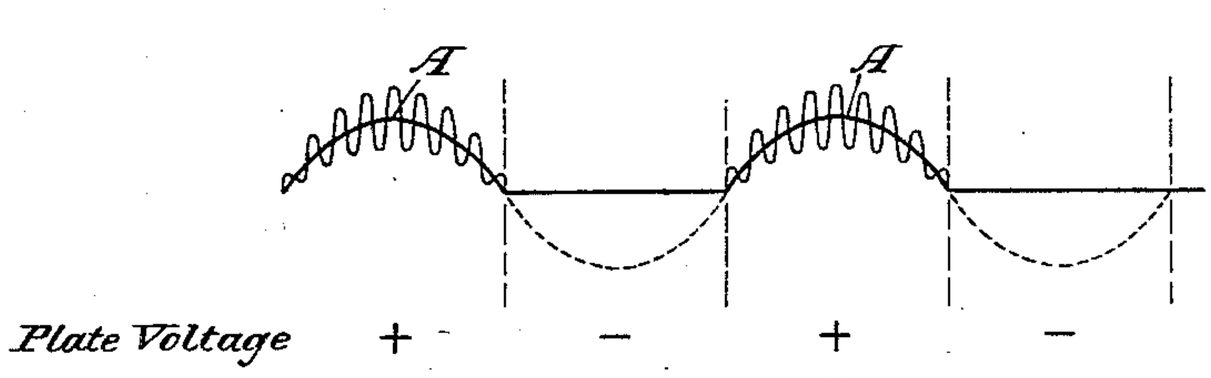

Fig. 6

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UNITED STATES PATENT OFFICE

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TELEPHONE SIGNALING SYSTEM

Application filed June 15, 1931. Serial No. 544,605.

This invention relates to telephone systems, and more particularly to improvements in signaling arrangements for subscribers' stations connected to such systems.

In the signaling arrangements of the invention there is provided at the subscriber's station a vacuum tube oscillator whose circuits are so arranged that it will be energized entirely by the ringing current coming in over the line. The telephone receiver at the subscriber's set may be energized by the oscillator to give the audible signal, or a separate receiver or loud speaker may be provided therefor. The arrangements of the invention can also be utilized to transmit an audible signal back over the line if desired.

The ringing arrangements of the invention will make it easier to control the pitch and volume of the signal than heretofore, and will also give a more pleasing tone than former signaling arrangements. The fact that the signaling arrangements of the invention may be operated solely by the incoming ringing current will result in reduced initial cost of the devices and lower maintenance thereafter. The absence of moving parts other than the receiver diaphragm also tends to reliability and low maintenance.

Arrangements have been suggested in the past for operating telephone receivers or loud speakers directly from ringing current. However, the efficiency of these elements is low at ringing frequencies and further means are desirable which will give an audible current of the proper frequency in the receiver. One method of doing this has been to use a vacuum tube oscillator circuit employing A and B batteries, which functions when a relay controlled by the ringing current is operated. The use of relays and of a power supply set for the A and B current is expensive and also undesirable from a maintenance standpoint. The arrangements of the invention present distinct advantages over the suggestions of the prior art in that they provide a frequency changing device which is simple in form and which will operate directly from the ringing current without the need of supplementary battery supply. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

In a copending application in the name of W. H. Edwards, Serial No. 544,604, filed June 15, 1931, the signaling arrangements of the invention are shown in connection with party telephone lines.

The invention may be more fully understood from the following description, together with the accompanying drawings, in the Figures 1 to 6 of which the invention is illustrated. Fig. 1 is a circuit diagram illustrating the invention schematically. Fig. 2 is a modification of the arrangements of Fig. 1. Figs. 3, 4 and 5 are circuit diagrams showing the application of the invention to subscriber's hand telephone sets of different types. Fig. 6 is a curve showing the operating characteristics of the plate current of the oscillators. Similar reference characters have been utilized to denote like parts in all of the figures.

Fig. 1 shows signaling arrangements for a subscriber's station employing a vacuum tube oscillator 2 directly energized by the ringing current coming in over the line L. A subscriber's telephone set 50 is shown schematically and may be connected to the line L. In the line L is a ringing transformer 9. This ringing transformer supplies through its secondary winding current for the filament of the vacuum tube 2. The plate voltage is obtained by including the primary of the transformer in the plate circuit. A condenser 1 is provided between the line and the transformer primary to provide an open circuit to any direct current voltage applied to the line. The oscillating circuit shown may be of the tuned grid type, the tuning being accomplished by the provision of the circuit with condenser 5. A means of feeding back energy from the plate circuit to the grid circuit is provided by the transformer 4. A responsive device 3, such as a telephone receiver or loud speaker, is provided in the output or plate circuit of the oscillator 2 to give the audible signal to the subscriber in response to the incoming ringing current. This

device provides a signal whose pitch and volume are variable. The pitch can be changed by varying the constants of the tuned circuit or by varying condenser 5. Volume can be controlled by varying the amount of loss in the circuit. Fig. 6 shows the manner in which the plate current varies in operation. In Fig. 6 the curve A shows the audible frequency components of the plate current. As alternating ringing current is used to supply the plate voltage, the tube 2 is not operating during the time this voltage is negative and oscillates at varying degrees of strength while the voltage is positive, as indicated. This results in the production by the receiver 3 of an audible frequency modulated at ringing frequency, which may sound like a warble to the ear.

The circuit arrangements of Fig. 1 may be further utilized to give an audible ringing signal back to the central office and the calling party. This would be advantageous in that it indicates at the central office or at the calling subscriber's set that the station signaling device of the invention is functioning, whereas the ringing signal ordinarily provided for the calling subscriber merely indicates that the ringing circuit at the central office is functioning. The transmission back to the calling subscriber of an audible signal is accomplished in the following manner. The alternating current in the plate circuit of the oscillator in returning to the filament finds the primary winding of transformer 9 to be of high impedance and follows a lower impedance path back to the filament, which path comprises the line L to the ringing supply at the central office and condenser 1. In this manner an audible signal may be sent to the calling subscriber by the oscillator signaling device of the invention itself.

Fig. 2 is a modification of the arrangements of Fig. 1. The arrangements of Fig. 2 differ from those of Fig. 1 only in the manner in which the plate voltage of the oscillator tube is obtained. The ringing voltage across the ringing condenser 1 is used to obtain the plate voltage in this instance rather than the voltage across the primary winding of the transformer 9 in Fig. 1. The arrangements of Fig. 2 will not send an audible signal back to the calling subscriber as a low impedance path through the condenser 1 to the filament is provided for the alternating currents in the plate circuit. The D. C. component path is through the ringing machine at the central office. Instances might arise where it would be desirable not to transmit an audible signal back over the line as these signals might cause cross-talk into adjusting circuits if the currents were of sufficient magnitude.

In Fig. 3 the arrangements of the invention are shown as applicable to a subscriber's hand telephone set. In this arrangement the telephone receiver 7 of the hand set is utilized as the responsive device to give the signal. The circuit shown is of the side tone variety, and the circuit for the transmitter 8 is as follows with the hand set removed from the hand set mounting: from the line L over conductor 20, through the transmitter 8, contact 11, conductor 21 to the line L. A receiver circuit is provided which is as follows: from the receiver 7 through the transmitter 8, contact 11 conductor 21, winding of induction coil 6, conductor 22, contact 10 to the receiver 7. The incoming currents are transmitted over the transmitter circuit previously traced and transmitted to the receiver circuit through the induction coil 6. When the hand set is on the mounting the talking circuits described above are opened and a circuit including a condenser 1 and a transformer 9 is bridged across the line L. The filament current for the oscillator 2 is obtained through this transformer. This transformer and condenser are equivalent to a telephone ringer and condenser from the standpoint of ringing frequency impedence. The plate circuit for the oscillator may be traced as follows: from the plate electrode over conductor 23, through the receiver 7, over conductor 20, out over one side of line L and back over the other side of line L, over conductor 24 to the filament. Thus it will be seen that the plate voltage for the tube 2 is obtained by utilizing the ringing voltage across the line L. Accordingly, the signaling device of the invention will transmit back to the calling subscriber an audible signal. The grid circuit for the oscillator is as follows: from the grid electrode, over conductor 25, winding of induction coil 6, over conductor 24 to the filament. The induction coil 6 will act as a feed-back coil from the plate circuit to the grid circuit under these conditions. The grid circuit may be tuned by the condenser 5 which is connected thereto in a manner similar to that shown in Fig. 1. The receiver 7, as has been pointed out, is included in the plate circuit of the oscillator. The induction coil 6 and the receiver 7 are used in both talking and signaling circuits. When the hand set is on the mounting, the induction coil 6 serves as a feed-back coil and the receiver 7 produces the audible signal for the subscriber. When the hand set is removed, the induction coil 6 and the receiver 7 are connected in the regular talking circuit. This arrangement makes it unnecessary to provide a separate responsive device such as the device 3 of Fig. 1.

In Fig. 4 the arrangements of the invention are shown applied to a side tone circuit in such a manner that an audible signal will not be transmitted back over the line to the central office or calling subscriber. A feedback coil 4, separate and distinct from the induction coil 6, is provided in this arrange-

ment. The plate circuit for the oscillator 2 is as follows: from the plate electrode over conductor 26, through the receiver 7, over conductor 27 to the central office for the pulsating of a component and through the condenser 1 for the a. c. component to the filament. The voltage across the condenser 1 is utilized in this instance to provide the plate voltage and the audible signals are not transmitted back over the line.

In Fig. 5 the arrangements of the invention are shown as applied to an anti-side tone circuit. This type of circuit is well known in the art. In this modification of the invention the voltage across the ringing condenser 1 is utilized to obtain the plate potential, and the audible signals will not be sent back over the line to the calling subscriber. In this arrangement the subscriber's receiver 7 is also used to give the audible signal.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many other and widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, said set including signaling means comprising a vacuum tube oscillator having its filament and plate circuits so connected to said line that the signaling currents transmitted over said line will be utilized as operating currents for said circuits, and an audible responsive device connected in the plate circuit of said oscillator.

2. A telephone line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer in said telephone line at said subscriber's set, a condenser in series with the primary winding of said transformer, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for completing the plate circuit of the oscillator through said telephone line to the filament and in shunt across the condenser and primary winding of said transformer, and an audible responsive device connected in the plate circuit of said oscillator.

3. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line and including a telephone receiver, a vacuum tube oscillator associated with said telephone set and having its filament and plate circuits so connected to said line that the signaling currents transmitted over said line will be utilized as operating currents for said circuits, and means for completing said plate circuit of said oscillator through said telephone receiver.

4. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line and including a telephone receiver and an induction coil connection between the talking circuit and the receiver circuit, a vacuum tube oscillator associated with said telephone set and having its filament and plate circuits so connected to said line that the signaling currents transmitted over said line will be utilized as operating currents for said circuits, means for utilizing said induction coil connection as a feed-back connection between the plate and grid circuits of said oscillator when said subscriber's set is not in use, and means for connecting said subscriber's receiver in said plate circuit of said oscillator.

5. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer in said line at said subscriber's set, a condenser in said line between said line and the primary winding of said transformer, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across the primary winding of said transformer will constitute the plate circuit potential therefor and so that the plate circuit will be completed for its direct current component through the primary winding of said transformer and so that the plate circuit will be completed for its alternating current component over said line, and an audible responsive device connected in the plate circuit of said oscillator.

6. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer in said line at said subscriber's set, a condenser in said line between said line and the primary winding of said transformer, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across said condenser will constitute the plate circuit potential therefor and so that the plate circuit will be completed for its direct current component over said line and through the primary winding of said transformer and so that the plate circuit will be completed for its alternating current component through said condenser, and an audible responsive device connected in the plate circuit of said oscillator.

7. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer having its primary winding bridged across said line at said subscriber's set, a condenser in series with said primary winding, a vacuum tube oscillator having its filament cir-

cuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across said condenser and primary winding will constitute the plate circuit potential therefor and so that the plate circuit for both its direct current and alternating current components will be completed over said line, and an audible responsive device in the plate circuit of said oscillator.

8. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer in said line at said subscriber's set, a condenser in said line between said line and the primary winding of said transformer, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across the primary winding of said transformer will constitute the plate circuit potential therefor, and an audible responsive device connected in the plate circuit of said oscillator.

9. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer in said line at said subscriber's set, a condenser in said line between said line and the primary winding of said transformer, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across said condenser will constitute the plate circuit potential therefor, and an audible responsive device connected in the plate circuit of said oscillator.

10. A line over which signaling currents are being transmitted, a subscriber's telephone set connected to said line, a transformer having its primary winding bridged across said line at said subscriber's set, a condenser in series with said primary winding, a vacuum tube oscillator having its filament circuit connected to the secondary winding of said transformer, means for connecting said oscillator to said line so that the voltage drop of said signaling current across said condenser and primary winding will supply the plate circuit potential therefor, and an audible responsive device in the plate circuit of said oscillator.

In testimony whereof, I have signed my name to this specification this 12th day of June 1931.

WILLIAM H. EDWARDS.