Nov. 21, 1939. H. A. BREDEHOFT 2,180,334

SIGNALING SYSTEM

Filed Jan. 20, 1938 2 Sheets-Sheet 1

FIG. 1

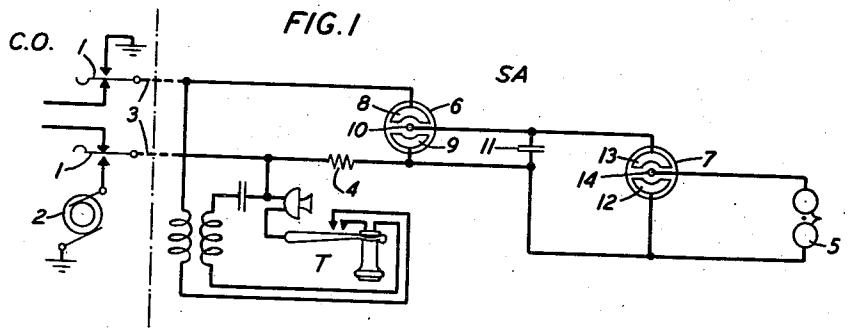


FIG. 2

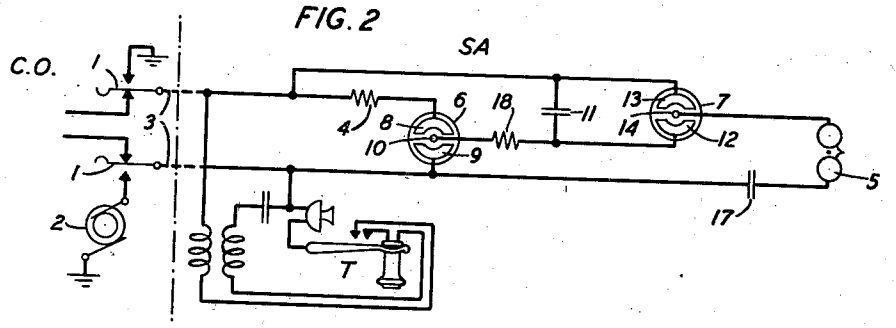
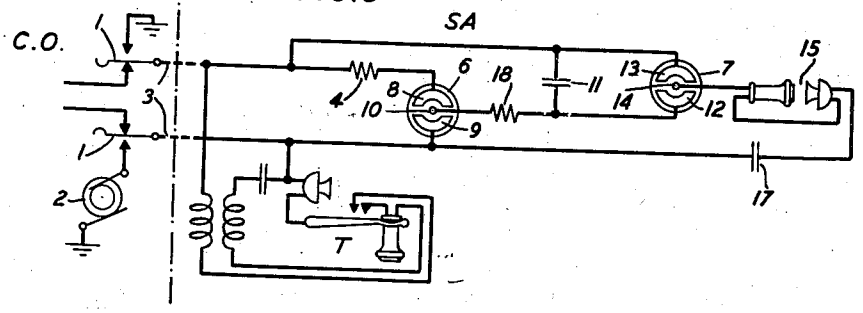


FIG. 3



INVENTOR
H.A.BREDEHOFT
BY
W.T. McKenney
ATTORNEY

Nov. 21, 1939. H. A. BREDEHOFT 2,180,334

SIGNALING SYSTEM

Filed Jan. 20, 1938 2 Sheets-Sheet 2

FIG. 4

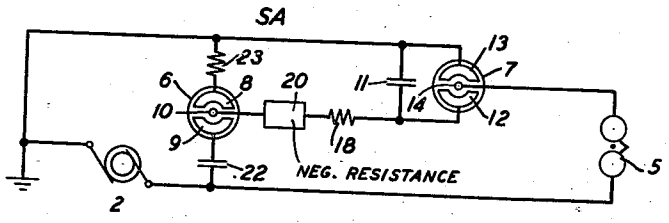


FIG. 5

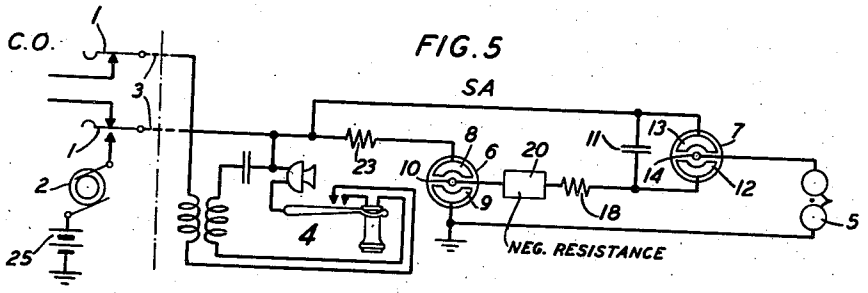
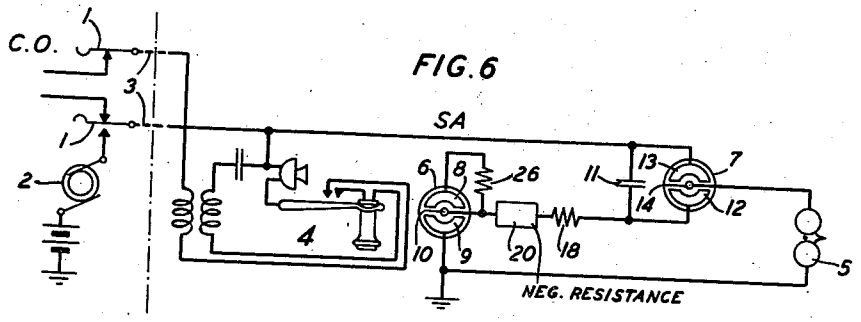


FIG. 6



INVENTOR
H.A.BREDEHOFT
BY
W.T.McKenney
ATTORNEY

Patented Nov. 21, 1939 2,180,334

UNITED STATES PATENT OFFICE

2,180,334

SIGNALING SYSTEM

Harold A. Bredehoft, Millington, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application January 20, 1938, Serial No. 185,852

14 Claims. (Cl. 179—84)

This invention relates to signaling system and particularly to systems for operating signals at intervals.

An object is to provide signaling arrangements of this type which are simple in construction and reliable in operation.

Heretofore signals have been operated at intervals by the aid of glow tubes and other discharge devices. Such systems have also been employed in telephone systems for operating ringers at substations at intervals by the application of alternating current at intervals at a central office.

It is a feature of the present invention to provide a system for operating a subscriber's ringer at a substation at intervals by the continuous application of ringing currents to the subscribers' lines from a central office.

Another feature is an arrangement in which the signal may be operated at intervals increasing in frequency until the signal is operated steadily by the application of current thereto. The circuit arrangement for this system includes two discharge tubes. The operation of a subscriber's ringer at intervals necessitates the conversion of the ringing current from the central office into direct current by one tube while the other tube, in series with a condenser, is used for the operation of the ringer at intervals. The arrangement for operating the signal at intervals increasing in frequency includes, in addition to these two discharge tubes, an element such as boron having a non-linear resistance characteristic.

The invention has been illustrated in the accompanying drawings in which:

Fig. 1 shows a circuit arrangement in accordance with the applicant's invention for operating a ringer at a substation at intervals by the continuous application of alternating currents at a central office;

Figs. 2 and 3 show modified forms of the applicant's invention as disclosed in Fig. 1;

Fig. 4 shows a circuit arrangement in accordance with the applicant's invention for operating a signal at intervals increasing in frequency by the application of alternating current; and

Figs. 5 and 6 show modifications of the applicant's invention as disclosed in Fig. 4 applied to a telephone system.

Referring now to the drawings and particularly to Fig. 1, a key 1 has been shown at a central office CO which may be operated to apply current from the alternating current source 2, which may be the usual ringing current source, to the two conductors of a telephone line 3 terminating at a substation SA in a telephone set T and a ringer 5 joined to the line 3 through tubes 6 and 7 connected in a circuit in accordance with the applicant's invention. These tubes may be of any well-known type including a cathode, an auxiliary control electrode and a main anode. These tubes operate by the usual method of establishing a potential between a control electrode and a cathode to cause ionization of the tubes to start a discharge between the main anode and the cathode as is well known in the art.

The system as disclosed in Fig. 1 operates as follows: When the key 1 is operated, alternating current from the source 2 is applied to the conductors of line 3. This establishes a potential difference between the cathode 8 and the control electrode 9 to cause ionization in a tube 6. This in turn causes rectified current during the positive half wave to flow over a circuit from source 2, key 1, resistance 4, condenser 11, anode 10, cathode 8, key 1 to ground. As the ionization of the tube is continuous, this current is maintained and may comprise a series of positive impulses more or less atenuated to form a continuous undulating direct current. This direct current now begins to charge condenser 11. As the opposite terminals of this condenser are connected respectively to the control electrode 12 and the cathode 13 of the tube 7, a corresponding potential difference will be established between these electrodes. Depending now on the characteristics of the tube, this potential will cause ionization in tube 7 when the charge on the condenser has reached a certain value. When this takes place current will flow through the tube over a circuit from key 1, resistance 4, windings of ringer 5, anode 14 and cathode 13 of tube 7, anode 10 and cathode 8 of tube 6, key 1 to ground. The condenser 11 now discharges through the tube 7 between the control electrode 12 and the cathode 13 and this decreases the potential difference between these electrodes to a point where ionization ceases which in turn interrupts the flow of current through the tube 7 and the ringer 5. It should be observed that the discharge of condenser 11 takes place at a comparatively rapid rate and the ringer 5 will, therefore, operate for a correspondingly short interval. The charging process of the condenser 11 from current through tube 6 is, however, continuous, but takes place at a comparatively slower rate. Hence, these operations of charging and discharging the condenser may take place at repeated intervals of time and at a rate to cause

the ringer 5 to be repeatedly operated at intervals determined by the electrical characteristics of tubes 6 and 7, condenser 11 and resistance 4.

As is usual in systems of this type when the subscriber answers a call by lifting his receiver from the switchhook in his telephone set T, the usual tripping relay at the central office will operate to disconnect the alternating current source 2 from the line and connect the talking battery for conversation. The talking battery will, of course, be of such character as not to cause the tube 6 to operate.

Fig. 2 is practically identical with Fig. 1 except that the circuit for charging the condenser 11 extends between the control electrode 9 and the anode 10 and a resistance 18 has been inserted in this circuit to delay or regulate the period of charging the condenser. The periods between the intervals of operation of the ringer 5 may therefore be increased or decreased as required by varying the resistance 18. The circuit for the ringer 5 has also been shown somewhat differently in that it does not extend through the tube 6, but is instead connected from the cathode 13 directly through key 1 to ground. A condenser 17 may also be inserted in the ringer circuit to quicken the operation of the ringer on each impulse.

Fig. 3 is identical with Fig. 2 except that a howler arrangement 15 has been substituted for the ringer 5 to cause a tone to be produced at intervals.

Fig. 4 shows a circuit similar to that disclosed in the preceding figures arranged to operate a ringer at intervals increasing in frequency. To accomplish this a boron element 20, or any other element having a negative coefficient of resistance, has been inserted in the circuit for charging the condenser 11 between the anode 10 and the resistance 18. This circuit operates as follows: When the tube 6 first operates, the period of charging the condenser 11 sufficiently to cause tube 7 to operate will depend on the initial resistance of the element 20, and, as this initial resistance is at its highest value at this time, the first charging period will therefore be of a certain corresponding duration. When the tube 7 ceases to operate the second period of charging the condenser will occupy a comparatively shorter time interval as the resistance of the element 20, due to its change in temperature, has decreased. Tube 7 will, therefore, operate the second time at a shorter time interval after the recharging of the condenser 11 than after the first charging of the condenser. It also follows that succeeding operations of the tube 7 will take place at correspondingly shorter intervals as determined by the continuous decrease of resistance of the element 20. That is to say, the longer the circuit is closed from the source 2, the shorter will be the succeeding charging periods of the condenser 11 and the operation of tube 7 will therefore take place at intervals increasing in frequency. Hence, the ringer 5 may by means of this circuit arrangement be controlled to operate at intervals increasing in frequency and the rate of increase in frequency may be adjusted to suit any desired requirement. For example, the resistance 18 and the element 20 may be adjusted to cause the increase in frequency of the operation of the ringer 5 to be such that the ringer will eventually operate at a constant rapid rate giving the appearance of continuous ringing. A condenser 22 and a resistance 23 may be inserted in the circuit for the cathode 8 and control electrode 9 to insure quick initial operation of the tube 6 and reduce the current drain during the maintaining of this tube in operation. This circuit has not been shown applied in a telephone system as the features of the invention as illustrated in this figure may be applied to any system in which it is required that a signal be operated at intervals increasing in frequency.

Fig. 5 shows the principles of the system disclosed in Fig. 4 applied to a telephone system and the circuit for ringer 5 is similar to that shown in Fig. 4. It is, however, somewhat differently arranged in that the control electrode 9 is connected directly to ground while the source of current at the central office comprises an alternating current source 2 and a direct current source 25 in series connected in a circuit from the cathode 8, resistance 23, key 1, alternating current source 2, direct current source 25 to ground. Hence the source of current in this circuit has a positive bias as the direct current from source 25 is superimposed on the current from the alternating current source 2. The ionization of the tube 6 will therefore be initiated by the voltage of cathode 8 and the ground potential on control electrode 9. Otherwise this circuit functions in the same manner as the circuit in Fig. 4.

Fig. 6 is similar to Fig. 5 and operates in the same manner except that the circuit for establishing the ionizing potential between the cathode 8 and the control electrode 9 extends from ground, the direct current source 5, the alternating current source 2, key 1, condenser 11, resistance 18, element 20, resistance 26, cathode 8 and the ionization of tube 6 is caused by the voltage on cathode 8 and the ground potential on the control electrode 9.

What is claimed is:

1. In a telephone system, a central office, a subscriber's station, a line connecting said central office and station, a source of ringing current at said central office connectable to said line, a ringer at said station connected to said line, and means responsive to continuous current from said source when connected to said line for operating said ringer at intervals.

2. In a telephone system, a central office, a subscriber's station, a line connecting said office and station, a ringing current source connectable to said line at said office, a ringer connected to said line at said substation, and means operative on the continuous connection of said ringing source to said line for operating said ringer at intervals for periods of definite duration.

3. In a telephone system, a central office, a subscriber's station, a line connecting said central office and station, a source of ringing current at said central office connectable to said line, a ringer at said substation connected to said line, a three-element gas-filled discharge tube connected to said line at said substation, and means responsive to continuous current from said source when connected to said line for discharging said device at intervals and means responsive on each discharge of said device for operating said ringer.

4. In a telephone system, a central office, a subscriber's station, a line connecting said central office and station, a source of alternating current at said central office connectable to said line, an alternating current responsive ringer at said substation connected to said line, and means for operating said ringer at intervals by con-

tinuous alternating current from said source when said source is connected to said line.

5. In a signaling device, a source of current, a signal, and means responsive to current from said source for operating said signal at intervals increasing in frequency.

6. In a signaling device, a source of current, a signal, and means responsive to current from said source for operating said signal at intervals at a rate increasing with time until a practically constant rate is reached.

7. In a signaling device, a source of current, a signal, and means responsive to current from said source for operating said signal at intervals increasing in frequency until the signal becomes operated practically continuously.

8. In a signaling device, a source of current, a signal, and means responsive to current from said source for operating said signal at intervals constant in duration, but increasing in frequency.

9. In a signaling device, a source of current, a signal, and means including a discharge tube and responsive to current from said source for operating said signal by discharges from said tube at intervals increasing in frequency.

10. In a signaling device, a source of current, a signal, and means including discharge devices of the cold cathode type and responsive to current from said source for operating said signal by discharges from said discharge devices at intervals increasing in frequency.

11. In a signaling device, a source of current, a signal, and means including an element having the characteristics of decreasing its resistance with time as current is applied to it and a discharge tube responsive to current from said source for operating said signal by discharges from said tube at intervals increasing in frequency.

12. In a signaling device, a source of current, a signal, a discharge tube, a condenser, and means whereby the application of current from said source to said condenser causes the charging of said condenser to certain values at intervals increasing in frequency for operating said tube each time said condenser has accumulated said charge of a certain value and for operating said signal each time said tube is operated.

13. In a signaling device, a source of current, a signal, a discharge tube having two control electrodes and an anode element, a condenser in series with said control electrodes, a signal in series with said anode and said source of current, means including an element having a non-linear resistance characteristic for charging said condenser from said source of current, said tube, condenser and means for charging said condenser being so adjusted and connected that the condenser is charged and discharged through the tube to operate said signal at intervals increasing in frequency from the time the current is applied to said means until the frequency of said interval causes a practically continuous operating discharge over the anode of said tube for the continuous operation of said signal.

14. In a telephone system, a central office, a substation, a line connecting said central office and station, a source of current at said central office connectable to said line, a ringer at said substation connected to said line, and means responsive to current from said source when it is connected to said line for operating said ringer at intervals increasing in frequency.

HAROLD A. BREDEHOFT.