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SIGNALING SYSTEM

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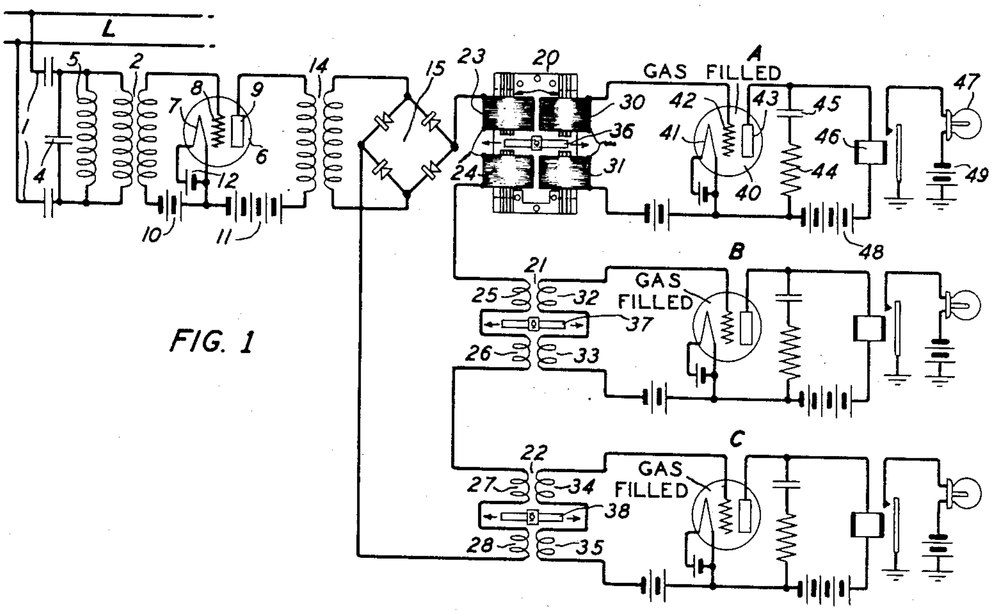

FIG. 1

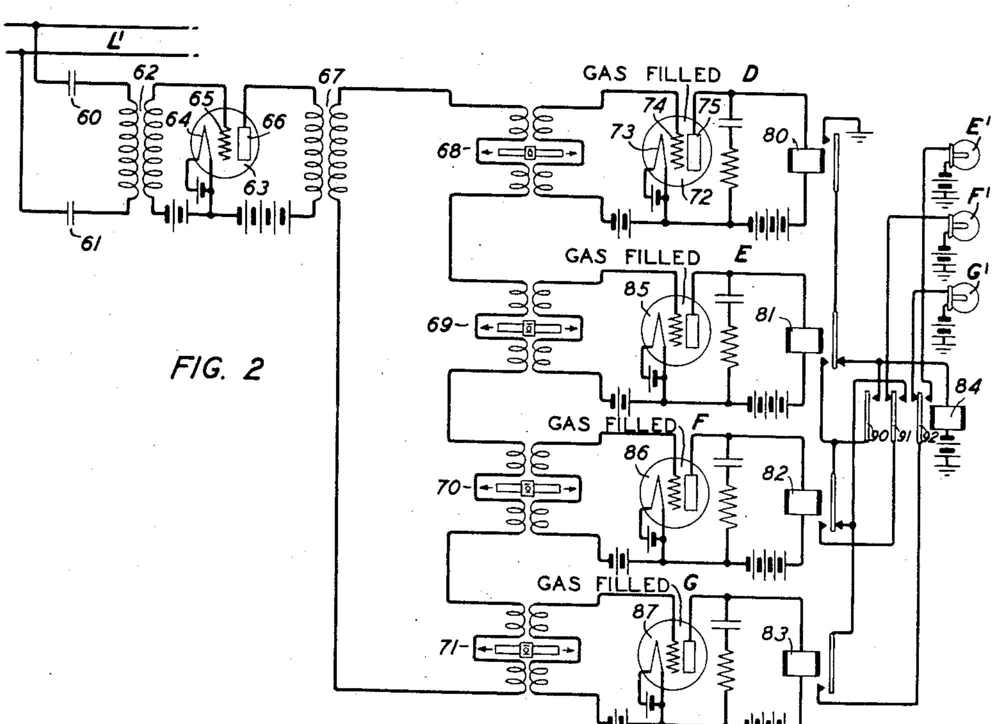

FIG. 2

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SIGNALING SYSTEM

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4 Claims. (Cl. 250—27)

This invention relates to transmission systems and more particularly to improvements in signaling arrangements associated with such systems.

The selective signaling arrangements of the invention are useful in toll telephone systems employing signaling currents within the voice frequency range. In one specific system of this character a signaling current of base frequency of 1000 cycles is transmitted which may be interrupted at different low frequency rates such as 15, 25, or 35 cycles. Selective signaling apparatus is used in various capacities each apparatus being tuned to operate at a particular low frequency rate. The base frequency and the frequency of the interruptions may be greatly varied as shown in the art. Another specific system of this character embodies a multi-channel voice frequency signaling arrangement.

In some voice frequency selective signaling systems it has been the practice to utilize series resonant circuits tuned to various low frequencies for actuating signals of distinguishing characteristics. These circuits comprise cumbersome and expensive apparatus such as large and very accurately made retardation coils in series with condensers of various capacities. Other voice frequency selective signaling systems utilize sensitive polarized relays which are actuated by the output of a two-stage receiving amplifier detector. The polarized relay, through its contacts, causes a condenser to be alternately charged and discharged through a local direct current relay and an inductance which tunes the circuit to the low frequency transmitter. The aforementioned inductance used in this system is again a very cumbersome and expensive piece of apparatus.

It is therefore the object of this invention to provide a selective signaling circuit which may be accurately tuned to voice frequency currents or to low frequency interruptions of voice frequency currents, using apparatus which may be economically manufactured and conveniently mounted in a small space.

In the arrangement of the invention a small and economically made instrument known as a transducer is utilized in combination with a gas-filled thermionic tube for operating the selective signaling apparatus according to the frequency or combination of frequencies transmitted. The transducer of each signaling circuit may be easily and very accurately tuned to the frequency designated for the operation of a particular signaling instrument. The transducer comprises a driving coil and a pick-up coil which are independent of each other and independent of mutual coupling. A reed is mounted between the coils and is arranged to be vibrated by the driving coil in a manner to change the cross-sectional area of the reluctance gap of the pick-up coil in resonance with the frequency of the current transmitted through the driving coil. From the foregoing it is apparent that the driving coil is connected through an output transformer to the toll line and receives the signaling current transmitted over this line. The pick-up coil is connected in a direct current circuit with the grid and anode of a gas-filled thermionic tube. The change in the cross-sectional area of the reluctance gap of the pick-up coil actuates a current flow in the grid circuit of the thermionic tube to start a gaseous discharge path in said tube and consequently create a current flow in the plate circuit for operating a signaling relay. The current flow in the plate circuit for operating the relay is maintained until a circuit change takes place to quench the discharge started by the operation of the transducer.

The invention may be more fully understood from the following description, together with the accompanying drawing, Figs. 1 and 2, in which the invention is illustrated.

Fig. 1 is a circuit diagram embodying apparatus for low frequency signaling; and

Fig. 2 is a circuit diagram embodying apparatus for signaling in the voice frequency range.

Fig. 1 illustrates a transmission line L over which signaling currents may be transmitted. For example, a base frequency of 1000 cycles may be used for signaling purposes. In order to obtain several distinctive signals, this base frequency may be interrupted at different rates, such as 15, 25 and 35 cycles. A signal receiving circuit bridged across line L at a particular station and is tuned to the signaling frequencies transmitted over line L to said station. The 1000 cycle base frequency signal current interrupted at the rate of 15, 25 or 35 cycles received from line L is stepped up by the input transformer 2 and applied to the grid 8 of the thermionic amplifier tube 6. The amplified current is then applied to the output transformer 14 over the plate circuit of tube 6. The output current is rectified by means of the full wave rectifier 15 which may be a copper oxide rectifier as shown. The rectified current is transmitted in series through driving coils 23, 24, 25, 26, 27, and 28 of the transducers, 20, 21, and 22. Let it be assumed that the transducer 20 is tuned to respond to a frequency rate of 15 cycles, that transducer 21 is tuned to respond to a frequency rate of 25 cycles, and that transducer 22 is tuned to respond to a frequency rate of 35 cycles. The transmission of one of the above frequencies operates a signaling circuit A, B, or C having the transducer which is tuned to the particular low frequency interruption transmitted. If the frequency of the interruptions is at the rate of 15 cycles, it may be assumed that the transducer 20 responds for operating the signaling circuit A.

Each transducer comprises a pair of driving coils, such as 23 and 24, a pair of pick-up coils, such as 30 and 31, and a reed, such as 36, tuned to operate at a particular frequency. The reed terminates in a bar piece which extends between the coil pole-pieces. A signal of the proper frequency transmitted through the driving coils causes the reed and bar to vibrate transversely in the direction of the arrows in resonance with the frequency transmitted. The driving coils and the pick-up coils are independent of mutual coupling. Thus, an interrupted current transmitted through the driving coils can only generate a voltage in the pick-up coils by vibrating the reed to change the cross-sectional area of the reluctance gap. This creates an alternating current in the pick-up coils of a voltage to start an arc between the control electrode 42 and cathode 41 of the gas-filled thermionic tube 40. A current flow is thus created in the anode-cathode circuit which may be traced from anode 43 through the winding of relay 46 to the positive pole of battery 48. The relay 46 is wound and adjusted to operate on the anode-cathode current flow for closing its contact to establish a circuit for signal lamp 47. This circuit may be traced from ground through the relay contact and filament of lamp 47 to battery 49.

With a gas-filled tube such as 40, once the arc has started, it will continue without further application of an input signal if a suitable anode-cathode voltage is maintained without superposed alternating current to quench the arc. In the arrangement described a condenser 45 and resistance 44 are serially connected between the anode 43 and cathode 41. With no input potential on the tube due to the line the battery in the input circuit maintains a sufficiently negative potential on the control electrode 42 to prevent an anode-cathode discharge due to the battery 48. Further, condenser 45, when no discharge is taking place, is charged to the potential of battery 48. When the transducer responds to line voltage and the control electrode 42 swings positive, a discharge occurs between the anode and cathode, due to battery 48, and current starts to flow in the output circuit including relay 46 which thereupon operates. Due to the lowered resistance of the anode-cathode gap at this moment condenser 45 also starts to discharge in a circuit including resistance 44 and the anode-cathode gap. By properly choosing the value of the condenser 45 and resistance 44 with respect to the impedance of relay 46, the condenser 45 will rapidly discharge to such a low potential that the arc discharge between the anode and cathode will be extinguished.

As soon as the charge on condenser 45 drops below its initial value current will start to flow from battery 48, through relay 46 to recharge the condenser to the battery voltage, but owing to the values chosen for the elements of the circuit, condenser 45 will discharge much more rapidly than it can charge until the current through the tube drops to zero, which occurs as soon as the voltage across condenser 45 is too low to maintain the arc between the anode and cathode. The tube output current is thus interrupted, but current will continue to flow from battery 48 through the winding of relay 46 and into condenser 45 until it is recharged to the point at which the anode-cathode voltage of tube 40 reaches the value sufficient to cause the tube to again break down. When this occurs a comparatively large current will again flow from condenser 45 through the anode-cathode path of tube 40 again discharging the condenser to a value which is insufficient to maintain the discharge. Thus, the tube will alternately fire and be extinguished, when condenser 45 is charged and discharged, as long as the control electrode 42 of tube 40 is at a voltage such that the battery voltage 48 is sufficient to cause the tube to fire. There will, however, be a continuous flow of current from the battery 48 through the relay 46 both when the condenser 45 is charging and when it is discharging so that relay 46 will hold operated as long as the control electrode 42 of tube 40 is more positive than the critical potential required for an arc to strike between the anode and cathode. The voltage of the biasing battery for the control electrode 42 must be more negative than this critical value so that, upon the removal of the input voltage or during the negative half cycles thereof, no discharge can take place.

In order that relay 46 may remain operated throughout the negative half cycles of input potential, it is merely necessary that the condenser 45 shall not be fully charged through the impedance of relay 46, during this interval, but on the removal of the input voltage, as the tube does not again become conducting, the condenser will soon become fully charged and current in the winding of relay 46 will cease to flow and the relay will release. Another way of stating the foregoing is that the frequency of the charge-discharge cycle of condenser 45 must be low in comparison to the input frequency delivered by the pick-up windings of the transducer. This circuit may be slightly altered in any well-known manner to obtain a locking input signal which may be extinguished at the will of the operator.

The circuits B and C operate in the selective signaling circuit in the same manner as circuit A with the exception of the transducers which, as herein stated, are adjusted for operation on different input frequencies. The arrangement is not limited to three signaling branches since the number may be increased as required.

In certain instances the relays such as 46 and lamp such as 47 may be omitted and the light caused by the arc in the gas-filled thermionic tube used as the signaling means.

The circuit arrangement of Fig. 2 comprises a multi-channel voice frequency signaling system. Signaling currents within the voice frequency range may be transmitted over line L' for the selective operation of the signals of this circuit. The signaling current transmitted may be of a single frequency or a combination of frequencies. The preferred system uses a combination of voice frequencies within the range of 500 cycles to 900 cycles. The frequencies may be selected as 500 cycles, 600 cycles, 750 cycles, and 900 cycles, and the transducers 68, 69, 70 and 71 tuned accordingly. The combinations of frequencies which may be simultaneously transmitted over line L' may be as follows: 500, 750, and 900; or 500, 600, and 700; or 500, 600, and 900. The circuit illustrated in Fig. 2 is arranged for selective operasion by the transmission of such frequency combinations.

The foregoing voice frequency currents are impressed upon the input coil 62 connected in circuit with the vacuum tube amplifier which impresses the amplified current upon the output coil 67. Let it be assumed that the transducer 68 is tuned to operate at the rate of 500 cycles, transducer 69 at the rate of 600 cycles, transducer 70 at the rate of 750 cycles, and transducer 71 at the rate of 900 cycles. The transmission of the foregoing first combination causes the impression of 500, 750, and 900 cycles currents upon the driving coils of the transducers and cause the reeds of transducers 68, 70, and 71 to vibrate for changing the cross-sectional area of the reluctance gap of these coils in resonance with these frequencies. A current is thus created in the pick-up coils of transducers 68, 70, and 71 of a voltage to start an arc between the anodes and cathodes of the gas-filled thermionic tubes 72, 86 and 87 of signaling branches D, F, and G. A current is thus created in the plate circuits of the signaling branches D, F, and G for energizing relays 80, 82, and 83 as described for the signaling relays of Fig. 1. The operation of relay 80 establishes a circuit for the operation of relay 84 which may be traced from ground through the front contact of relay 80, rear contact of relay 81, winding of relay 84, to battery. The operation of relay 84 disconnects lamps F' and G' from the signaling system and establishes a circuit for lamp E'. The circuit for lighting lamp E may be traced from ground through the front contact of relay 80, back contact of relay 81, front contact 90 of relay 84, front contact of relay 82, front contact 91 of relay 84, front contact of relay 83, front contact 92 of relay 84, lamp E, to battery. A second combination of frequencies, such as 500, 600, and 700 cycles causes the operation of transducers 68, 69, and 70 which breaks down the gas-filled thermionic tubes 72, 85 and 86 of circuits D, E, and F for operating relays 80, 81, and 82. The operation of these three relays establishes a circuit for lamp F which may be traced from ground through the front contact of relay 80, front contact of relay 81, front contact of relay 82, back contact 91 of relay 84, lamp F, to battery. The third combination comprising the transmission of 500, 600, and 900 cycle currents causes the operation of transducers 68, 69, and 71. An arc is thus started in the gas-filled thermionic tubes of signaling branches D, E, and G for the operation of relays 80, 81, and 83. A circuit is thus established for the illumination of lamp G which may be traced from ground through the front contact of relay 80, front contact of relay 81, front contact of relay 83, back contact 92 of relay 84, lamp G, to battery.

What is claimed is:

1. In a frequency selecting receiver, a transducer comprising a magnetic structure, driving and pick-up coils wound thereon and a tuned reed adapted to be vibrated by current of the desired frequency applied to the driving coil and to general alternating current of a like frequency in the pick-up coil, an electromagnetic signal controlling device, and a gas-filled discharge device having an anode, a cathode, and a control electrode, an input circuit therefor including said pick-up coil, said cathode, and said control electrode, and an output circuit therefor serially including a source of direct current, said signal controlling device, and said anode and cathode, and a condenser and a current limiting impedance serially connected between said anode and cathode in parallel with said direct current source and signal controlling device, said output circuit elements having such values with respect to each other that when the input potential generated in said pick-up coil is of such a value as to cause an arc discharge to occur between said anode and cathode said signal control device will operate and remain operated until the value of said input potential has been less than that required to initiate said arc discharge for a period longer than the duration of one-half cycle of said input frequency.

2. In a frequency selecting receiver, a transducer comprising a magnetic structure, driving and pick-up coils wound thereon, and a tuned reed adapted to be vibrated by current of the desired frequency applied to the driving coil and to generate alternating current of a like frequency in the pick-up coil, an electromagnetic signal controlling device, and a gas-filled discharge device having an anode, a cathode and a control electrode, an input circuit therefor including said pick-up coil, said cathode, and said control electrode, and an output circuit therefor serially including a source of direct current, said signal controlling device, and said anode and said cathode, and a condenser and a current limiting impedance serially connected between said anode and cathode in parallel with said direct current source and signal controlling device, said output circuit elements having such values with respect to each other that the time constant of said condenser and current limiting impedance, when a discharge is taking place between said anode and cathode, is substantially less than the time constant of said signal controlling device under the same condition.

3. In a frequency selecting receiver, a transducer comprising a magnetic structure, driving and pick-up coils wound thereon, and a tuned reed adapted to be vibrated by current of the desired frequency applied to the driving coil and to generate alternating current of a like frequency in the pick-up coil, an electromagnetic signal controlling device, and a gas-filled discharge device having an anode, a cathode and a control electrode, an input circuit therefor including said pick-up coil, said cathode and said control electrode, and an output circuit therefor serially including a source of direct current, said signal controlling device, and said anode and cathode, and a condenser and a current limiting impedance serially connected between said anode and cathode in parallel with said direct current source and signal controlling device, said output circuit elements having such values with respect to each other that said condenser will alternately discharge through said arc discharge path and charge from said direct current source through said signal controlling device to alternately extinguish and strike said arc discharge until said input potential has been reduced below the value required to initiate said arc discharge.

4. In a frequency selecting receiver, a transducer comprising a magnetic structure, driving and pick-up coils wound thereon, and a tuned reed adapted to be vibrated by current of the desired frequency applied to the driving coil and to generate alternating current of a like frequency in the pick-up coil, an electromagnetic signal controlling device, and a gas-filled discharge device having an anode, a cathode and a

control electrode, an input circuit therefor including said pick-up coil, said cathode and said control electrode, and an output circuit therefor serially including a source of direct current, said signal controlling device, and said anode and cathode, and a condenser and a current limiting impedance serially connected between said anode and cathode in parallel with said direct current source and signal controlling device, said output circuit elements having such values with respect to each other that said condenser will discharge through said impedance and the anode-cathode path more rapidly than it can charge from said direct current source through said signal control device.

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