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IMPULSE REPEATER

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FIG. 1

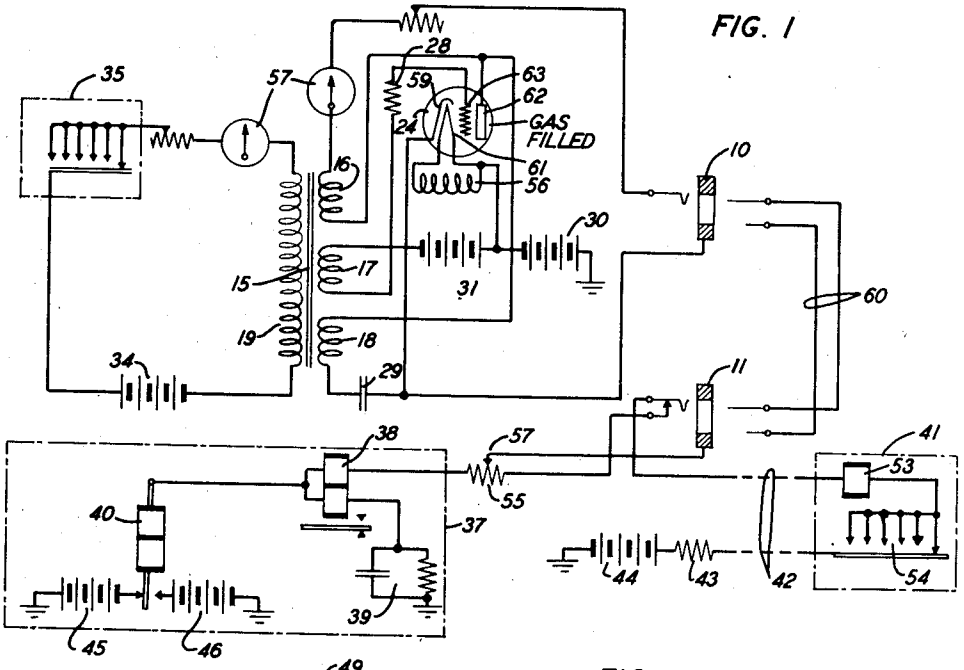
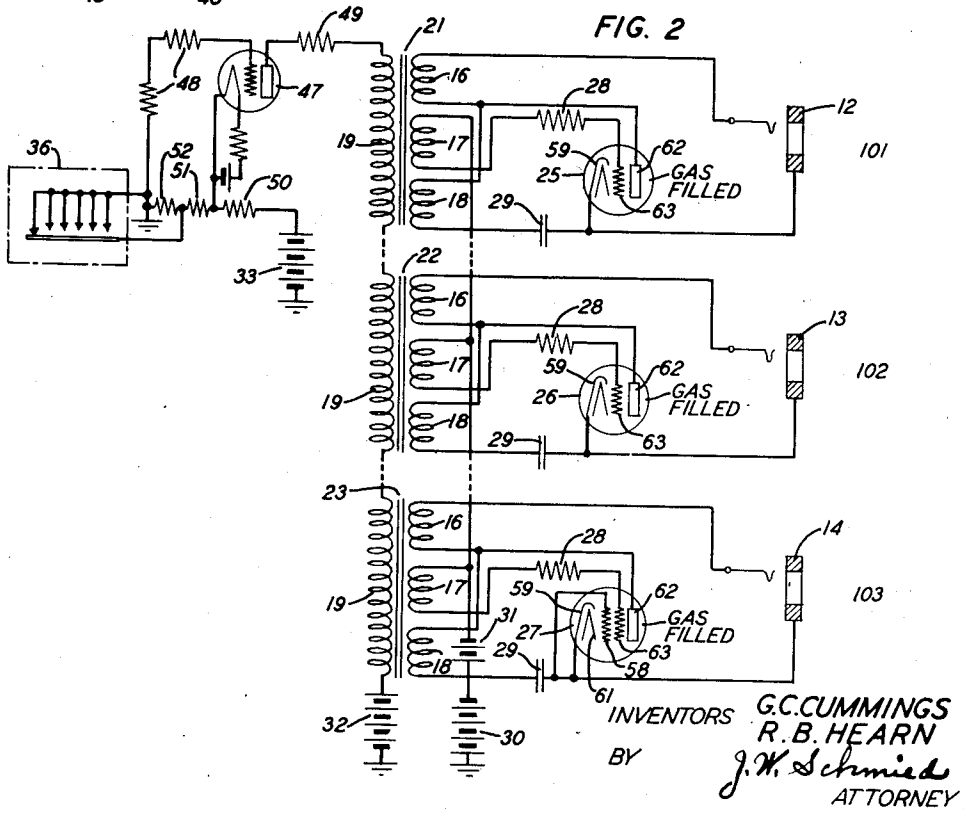


FIG. 2



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IMPULSE REPEATER

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5 Claims. (Cl. 178—69)

This invention relates to an impulse repeating and transmitting device and more particularly to an impulse repeating and sending device for repeating and transmitting telegraph signal impulses without appreciable distortion for test purposes.

In order to test and adjust telegraph apparatus it is usually necessary to have a source of standard telegraph signal impulses. To permit the simultaneous testing and adjusting of a plurality of telegraph lines and devices without interference between the various lines and devices under test it is usually necessary to provide separate sources of the standard telegraph signal impulses or else to repeat the signal impulses through one-way telegraph repeaters or relays to the various lines and devices without appreciable distortion.

In the past it has been the practice to provide a source of test signals and a plurality of telegraph relays for repeating and transmitting the signals to the different lines and devices. To prevent excessive distortion of the signals due to the repeating relays, these repeating relays must be accurately adjusted every day that they are used. Even then they may distort the signals as much as 5%.

It is an object of this invention to provide a relay circuit which does not have any moving parts or contacts by employing gaseous conduction tubes for repeating the signal impulses to the various lines and devices without appreciable distortion for long periods of time without any attention or adjustment.

It has been the practice in the past in impulse repeaters employing gaseous conduction tubes to employ the tubes in pairs, each tube of which serves to restore the other tube to a non-conducting condition when it starts to conduct. In addition to employing two tubes and associated apparatus this arrangement is subject to other disadvantages such as both tubes conducting and remaining conducting at the same time.

It is the further object of this invention to provide an improved impulse repeating arrangement employing a single gaseous conduction tube in combination with a single coil core having windings to start a current flow through the tube and other windings to terminate the current flowing through the tube.

In brief, a specific embodiment of this invention provides a source of standard signal impulses which are repeated and transmitted to a plurality of lines and devices by impulse repeaters, each repeater of which is individual to one of said lines or devices and comprises a single gaseous conduction tube in combination with a single coil or transformer having windings thereon to initiate and terminate discharges through the tube.

These and other objects and features of the invention may be more fully understood from the following description when read with reference to the attached drawing in which:

Fig. 1 illustrates in detail a circuit arrangement of an impulse repeater in accordance with this invention employing a single gaseous conduction tube in combination with a single coil core or transformer having windings wound thereupon to initiate discharges through the tube and other windings wound thereupon to terminate discharges through the tube. This figure also illustrates the manner in which such a repeater may be connected to a telegraph line for test purposes;

Fig. 2 shows diagrammatically a multiple sender for transmitting test signal impulses to a plurality of lines or devices in accordance with this invention employing a plurality of gaseous conduction tube repeaters similar to the one shown in Fig. 1 for repeating the standard signal impulses to the telegraph lines and apparatus to be tested.

The tube 24 shown in Fig. 1 is a gaseous discharge tube employing a heated cathode 59, an anode 62 and control element 63. As shown in Fig. 1, a heater type cathode is employed. The cathode emitting surface 59 is heated by means of heater 61 which may be energized from a source of current (not shown) by means of winding 56. Winding 56 is preferably a low voltage winding on a power transformer connected to a source of alternating current and provides the power for heating cathode 59. Of course direct current may be used to heat the cathode in which case winding 56 is not used. The control element 63 is interposed between cathode 59 and anode 62. The control element 63 is arranged to control the starting or initiation of a discharge through the tube. However, once the discharge is initiated through the tube, the control element loses all further control of the discharge. Tubes of this type have been called gaseous discharge tubes, trigger tubes, "thyratron" tubes, grid control tubes, grid glow tubes, grid controlled arc rectifier tubes, etc. While heater type cathodes are shown, it is to be understood that a directly heated or filament type of cathode as well as multi-element or multi-cellular cathodes may be employed. It is also within the scope of this in-

vention to employ additional elements within the tube structure as will be pointed out hereinafter.

The input or control element 63 of this tube is controlled through a transformer or coil 15. Coil 15 is provided with winding 17 which is connected through resistance 28 to the control element 63 of tube 24. Winding 17 is also connected through batteries 30 and 31 to ground. Batteries 30 and 31 provide biasing potential for the control element while resistance 28 limits the control element or grid current through the tube and also through the winding 17 of coil 15. In some cases it may be preferable to connect the heater directly to the cathode. If this is done batteries 30 and 31 may be combined to form a single biasing battery.

Coil 15 is provided with a primary winding 19 which is connected in series with a source of potential 34 to a telegraph signal transmitter 35. Transmitter 35 may be of any suitable type which is capable of sending substantially perfect telegraph signal impulses. This transmitter may continuously transmit impulses representing a single character, a group of characters, or some standard test sentence.

In addition to windings 17 and 19, windings 16 and 18 are provided on coil 15 for extinguishing or terminating discharges through tube 24. Winding 16 is connected in series with the anode 62 and cathode 59 and jack 10 in the output circuit of tube 24, while winding 18 is connected in series with condenser 29 between anode 62 and cathode 59.

When the circuit through the primary winding of coil 15 is closed by transmitting device 35, current will start to flow through the primary winding 19 of transformer or coil 15. This induces a potential in winding 17 which is applied to control element 63 which, in turn, initiates a discharge between anode 62 and cathode 59 causing current to flow in the output circuit of the tube through jack 10. When the signal transmitting device 35 opens the circuit of primary winding 19 of transformer 15, current will stop flowing therethrough. This will induce potentials in windings 16 and 18 which are in such a direction as to reduce the anode potential sufficiently to interrupt or terminate the discharge through the device. It is to be noted that when the circuit of the primary winding is interrupted, a potential is also induced in winding 17 which tends to aid the extinguishing action windings 16 and 18 since it is now in the opposite direction from that when primary winding 19 was closed. Also, when current starts to flow through primary winding 19 potentials are induced in windings 16 and 18 which tend to aid the potential induced in winding 17 to initiate discharges through the tube. It should be further noted that the potential induced in winding 16 is applied in series with the output or load circuit of tube 24, while the potential induced in winding 18 is applied directly between the anode and cathode of discharge device 24.

It is not necessary to provide both windings 16 and 18 since the voltage induced in either winding alone may be made sufficient to extinguish discharges through tube 24. However, it has been found that the operation of tube 24 is more reliable when both of these windings are provided. It is to be noted that condenser 29 is connected in series with winding 18 to prevent this winding from providing an effectively short-circuit to both the anode and cathode of tube 24 and the output circuit to direct current.

As shown in Fig. 1, the gas discharge tube 24 is arranged to be connected to a telegraph line and to act as a telegraph repeater for repeating telegraph signal impulses from transmitting device 35 to a telegraph line or other equipment to be tested.

A typical telegraph line is shown in Fig. 1. This line comprises a subscriber's station 41 having a receiving magnet 53 and a transmitting device 54 which is connected by means of a line 42 to a central station. At the central station, one conductor of the line is connected to grounded battery 44 through a protective resistance 43. The other conductor is connected through test jack 11 and compensating resistance 55 to a telegraph repeater 37 or its equivalent having a receiving relay 38 which responds to signal impulses transmitted from transmitting device 54 at the subscriber's station 41 and also a transmitting relay 40 for transmitting telegraph signal impulses to receiving device 53 at subscriber's station 41. The gaseous discharge tube repeater shown in Fig. 1 is connected to this telegraph line by inserting the plugs of cord 60 in jacks 10 and 11. This connects the anode-cathode circuit of discharge tube 24 directly in series with the telegraph line between subscriber's station 41 and the repeater 37. This introduces additional impedance or resistance in the telegraph line circuit which, under certain conditions, is undesirable. When desired the additional impedance introduced by the potential drop between the anode and cathode of tube 24 may be compensated for either by removing an additional resistance or a portion of the compensating resistance 55 from the circuit when the repeater is connected in the line circuit. Such an arrangement is shown in Fig. 1 where tap 57 is connected to compensating resistance 55 in such a manner that only a portion of the compensating resistance is employed when the gaseous tube 24 is connected in the line circuit. The voltage drop across the tube may also be compensated for by connecting an additional battery or other source of potential in series with the anode-cathode circuit of tube 24.

When no signals are being transmitted over this line circuit and the output circuit of tube 24 is not connected in series with the line circuit, current normally flows over the line circuit from negative battery 45, through the contacts of transmitting relay 40 of repeater 37, upper winding of receiving relay 38, through compensating resistance 55, jack 11 over the line 42 to the subscriber's station 41, through receiving magnet or relay 53 and transmitting contacts 54 at the subscriber's station, back over line 42 and resistance 43 to grounded positive battery 44 at the central station. When signal impulses are transmitted to the subscriber's station, relay 40 connects positive battery through its contacts to the above circuit, under which condition both ends of the line are connected to positive battery so that no current then flows in the line. When signal impulses are transmitted from station 41, current flowing in the line circuit is interrupted by transmitting contacts 54.

When the repeater is connected in series with this line circuit, batteries 44 and 45 furnish the anode potential for the repeater tube 24. This circuit may be traced from the grounded positive battery 44, through resistance 43, subscriber's line 42 and station equipment 41 through the tip of jack 11, cord 60, tip of jack 10, through winding 16 to the anode 62 of tube 24, cathode 59 of tube

24, sleeve of jack 10, conductor of cord 60, sleeve of jack 11, tap 57 of compensating resistance 55, through upper winding of relay 38, and left-hand contacts of transmitting relay 40 to negative battery 45 which is also grounded. When signals are transmitted from transmitting device 35, the discharges through the anode-cathode circuit of tube 24 are interrupted and initiated in accordance with the signals to be transmitted. This causes the current flowing through this tube and thus through the line 42, as well as the subscriber's equipment 41 and repeater 37, to be similarly interrupted.

In some telegraph systems, the polarity of the batteries connected to the telegraph line are just the reverse of the polarities of the batteries 44, 45, and 46 shown in Fig. 1. In lines of this type it is necessary to reverse the connections to jack 11 so positive potential is always applied to the anode 62 of tube 24.

It is to be noted that there are no moving parts in the repeater shown in Fig. 1. Furthermore, the response of the gaseous discharge tubes of the type employed is very rapid, requiring only a few micro-seconds to initiate a discharge through them and only a few micro-seconds to terminate discharges through them so that the signals are repeated substantially as they are received without the addition of any appreciable distortion due to the operation of the repeating device.

The meters 57 shown in Fig. 1 are used to determine the values of the various resistances and other circuit elements of the circuit. Once these values have been determined, these meters may be dispensed with since there are no circuit elements or other apparatus required which necessitate frequent adjustments. It is therefore evident that the repeater shown in Fig. 1 requires very little, if any, adjustment or maintenance after it is adjusted and put into operation.

Fig. 2 shows a plurality of repeaters, such as shown in Fig. 1, connected through an additional repeating device to a telegraph signal impulse transmitter 36 similar to the transmitter 35 of Fig. 1. Only a first repeater 101, an intermediate repeater 102, and a last repeater 103 are illustrated in Fig. 2 but it is to be understood that as many additional intermediate repeaters may be added as is required.

The heating circuit of the heaters of tubes 25, 26, 27, etc., of the repeaters shown in Fig. 2 have not been shown in detail but it is to be understood that they are connected to any suitable source of heating current as, for example, one or more low voltage transformer windings similar to the winding 56 shown in Fig. 1. Only one set of grid biasing batteries 30 and 31 is required for all of the repeaters shown in Fig. 2.

As shown in Fig. 2, the signals from the signal transmitting device 36 are first repeated by a repeating tube 47. Of course, the primary windings 19 of transformers 21, 22, and 23 may be connected directly to the impulse transmitting device 36 if desired. However, by providing repeating tube 47 the contacts of the transmitting device 36 are required to control only a small amount of power, that is, both low current and low voltage circuits need be controlled by these contacts. This greatly reduces the wear on these contacts so that they may transmit substantially perfect telegraph test signals over long periods of time without appreciable wear and without frequent adjustment or other maintenance.

Tube 47 may be similar to tube 24 as shown in Fig. 1 and, in turn control a plurality of other repeater circuits similar to the repeater circuits shown in Fig. 1. However, a high vacuum tube is shown in Fig. 2 to control a plurality of gaseous discharge tubes, of which tubes 25, 26 and 27 illustrate a first, an intermediate and a last tube. By employing a high vacuum tube 47, the current and voltage which transmitting device 36 is required to control is still further reduced, thus further decreasing the wear of the transmitting contacts.

Tube 47 is connected to the telegraph impulse transmitter 36 through impedance networks comprising impedance 48, 51 and 52. The grid or control biasing potential for this device is provided by battery 33 in combination with resistances 50, 51 and 52. The anode battery 32 is connected through the primary windings 19 of transformers 21, 22, and 23 which are associated with tubes 25, 26 and 27, respectively.

The operation of each of the repeaters of Fig. 2 is similar to the operation of the repeater shown in Fig. 1. However, the operation of each of the tubes in Fig. 2 is independent of the operation of the other tubes. Only one tube may have operating potentials applied to the anode and consequently repeat signal impulses or all of the tubes may have potential applied to their anodes and consequently repeat signal impulses. The anode-cathode circuit of each tube is entirely independent of the circuits of the other tubes. There can, therefore, be no reaction between the lines and apparatus under test through the tubes or repeating circuits employing the tubes.

Tube 47 is illustrated in Fig. 2 as a three-element tube. However, it is within the scope of this invention to employ multi-element tubes in this position, such as 4 or 5, or more elements. Furthermore, it is within the scope of this invention to employ multi-element gaseous discharge tubes at any one or all of the positions shown in either of Figs. 1 and 2. These multi-element tubes may also be employed in combination with three-element tubes, such as shown in Fig. 2, where tubes 25 and 26 are three-element heater type tubes, while tube 27 is a four-element heater tube. The fourth element 58 of tube 27 is a shielding grid which shields the control grid and thereby reduces the current flowing in the input circuit through resistance 28 and winding 17.

A more detailed description of a representative multi-element tube, such as illustrated by tube 27 of Fig. 2, may be found in an article entitled, "Shielded grid thyratrons" by O. W. Livingston and H. T. Maser, published in Electronics for April 1934, pages 114 to 116.

What is claimed is:

1. An impulse repeater comprising a single multi-element gaseous conduction tube having an anode, a cathode and a control element, a single coil structure having a winding connected to said control element and cathode, an output circuit connected to said anode and cathode, a second winding on said coil connected in an auxiliary circuit between said anode and cathode and in parallel with said output circuit and means for applying signal impulses to said windings.

2. In combination, a single gaseous conduction tube having anode, cathode and control elements and a single coil core having a plurality of separate windings, an input circuit connected to one of said windings, one of said windings being connected in a circuit including said cathode and control element, output circuits connected to said

anode and cathode, a second winding on said coil connected between said anode and said output circuit and a third winding wound on said coil connected in an auxiliary circuit between said anode and cathode.

3. A multiple telegraph sender for transmitting telegraph signal impulses to a plurality of telegraph circuits comprising a plurality of gaseous conduction tubes each having input and output circuits, a single coil core individual to each of said tubes having separate windings connected to said input and said output circuits for initiating and terminating discharges through the associated tubes, means for simultaneously applying telegraph signal impulses to all of said coils for simultaneously controlling all of said tubes and means for individually connecting the output circuits of each of said tubes to each of said telegraph circuits.

4. An impulse repeater comprising a single gaseous conduction tube having an anode, a cathode, and control electrode, circuit connections to said electrodes whereby said control element initiates discharges through said device which discharges continue substantially independently of the potential applied to said control element, a single coil connected to said circuit connections, means connecting one winding on said coil to said control electrode, another winding on said coil connected in series with said anode, a third winding on said coil connected in an auxiliary circuit which is connected between said anode and cathode and an input winding on said coil for applying signaling conditions thereto to initiate and terminate discharges through said gaseous conduction tube in accordance with the signals applied thereto.

5. A multiple telegraph sender for transmitting telegraph signal impulses to a plurality of telegraph circuits comprising an impulse repeater in accordance with claim 9 connected to each of said plurality of circuits, a single telegraph transmitting device and means for simultaneously applying the signals transmitted therefrom to the coil of each of said impulse repeaters whereby telegraph signals transmitted by said transmitting device are repeated to each of said circuits substantially free from distortion.

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