

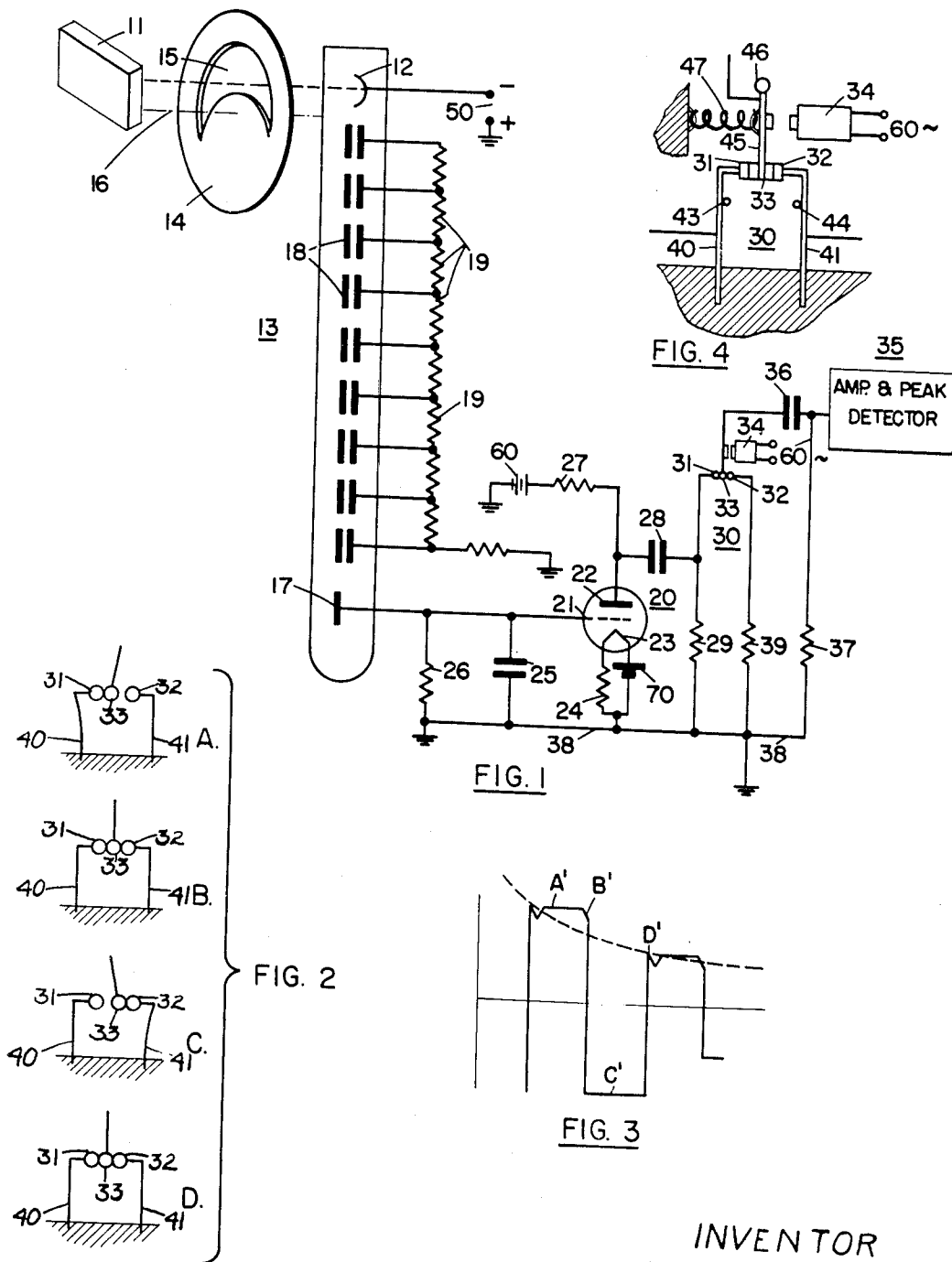
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CIRCUIT STABILIZER

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CIRCUIT STABILIZER

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This invention relates to means for quickly stabilizing electrical circuits which are subject to long persistence transients and more particularly to a means for overcoming long time constants of circuits which contain high value resistors.

In circuits which contain capacitors or inductors in series with high value resistors, a change in a voltage applied to the circuits frequently gives rise to transients which require an objectionably long time to decay. This has been found to be particularly true in those circuits which include electrometer amplifiers, photo-tubes and other electronic equipment which operate on minute currents.

The current output of electrometer tubes and photo-tubes is very small and in order to obtain a perceptible voltage signal output, output resistors of high value must be used. When coupling capacitors or inductors are used in series with the high value output resistors, a change in the supply voltage to the tube results in a transient which, due to the large time constant of the circuit parameters, requires an objectionably long time to decay.

An object of this invention is to provide means for reducing the decay time of transients in circuits which have long time constants.

Another object of this invention is to provide a low value resistor and switching means for quickly stabilizing such circuits.

Other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the annexed drawings, which illustrate a preferred embodiment, and wherein:

Fig. 1 is a schematic illustration of a radiation detector incorporating the invention;

Fig. 2 is a schematic illustration showing the various positions of the switch of Fig. 1;

Fig. 3 is a diagrammatic presentation of the output voltages of the circuit of Fig. 1; and

Fig. 4 is an enlarged view of the switch of Fig. 1.

Referring now in detail to Fig. 1, a phosphor type transducer 11 converts incident radiation into light which is directed to fall upon a photo-emissive cathode 12 of a photo-multiplier tube 13. Interposed between the transducer 11 and the photo-emissive cathode 12 is an opaque member 14 having a transparent crescent-shaped portion 15. The member 14 is mounted for rotation about an axis 16 and is rotated at a speed of about 60 revolutions per minute by means not shown. Light striking the photo-emissive cathode 12 causes the emission of electrons from the cathode 12 which electrons are accelerated toward an anode 17 by a voltage 50 applied thereto. Between the cathode 12 and the anode 17 are secondary emission electrodes or dynodes 18 which increase and multiply the current flow through the photo-multiplier tube 13 in a manner well known in the art. A voltage divider formed by resistors 19 provides the voltage gradient for the operation of the tube 14.

A control grid 21 of an electrometer tube 20 is directly

connected to the anode 17 across a grid return resistor 26 and a capacitor 25. The electrometer tube 20 comprises also an anode 22 and a filamentary cathode 23. Current is supplied to the filament 23 by an "A" battery 70 through a current limiting resistor 24, and the anode 22 is supplied by a "B" battery 60 through an anode load resistor 27. The anode 22 is coupled through a blocking capacitor 28 to a high value output resistor 29 and to a vibrating switch 30. The switch 30 comprises resilient contacts 31 and 32 and a vibrating contact 33 which is actuated by an electromagnet 34 supplied from a source (not shown) of 60 cycle current. One end of the resistor 29 is connected to the contact 31 and the voltage across the resistor 29 is applied to an amplifier and peak detector circuit 35 by the vibrating contact 33 through a coupling capacitor 36. The amplifier and peak detector circuit 35 is connected to a ground 38 through a resistor 37. A low value resistor 39 is connected between the contact 32 and ground for periodic connection across the high value resistors 29 and 37.

In many types of instruments of which the described radiation detector is an example, the range of the instrument is changed by varying a supply voltage. In the radiation detector described, the range of the instrument is changed by varying, through any conventional means, the voltage supplied to the photo-multiplier 13 by the source 50. When the supply voltage to the photo-multiplier 13 is varied, there is a sudden change in the dark current of the tube which produces a pulse on the control grid 21 of the electrometer tube 20. Because of the small current flow in the circuit and the high output impedance of the tube 20, the resistor 29 must be of a high value. The time constant of the capacitor 28-resistor 29 combination is very large and because of this, a transient pulse appearing on the anode 22 would take an objectionably long time to decay. Such a pulse, appearing in the detector, would produce an erroneous indication until its energy was dissipated. To reduce the period of time required for a transient pulse to decay, provision is made, in the form of the vibrating switch 30, to periodically connect the low value resistor 39 across the resistor 29.

Any conventional vibrating switch, for example such as shown in Fig. 4, may be used. Two flexible contact arms 40 and 41 each have an end affixed to a support 42. The other ends of the flexible arms 40 and 41 carry contacts 31 and 32 respectively. Stop members 43 and 44 limit the inward movement of the arms 40 and 41. The vibrating contact 33 is mounted on an arm 45 which is pivotable about an axis 46. A periodically energized electromagnet 34 attracts the arm 45 against the action of a tension spring 47 causing the contact 33 to touch the contact 44 and to bend the flexible arm 41 away from the arm 40. Upon deenergization of the electromagnet 34, the tension spring 47 pulls the arms 45 back, bending the flexible arm 40 and causing the contact 33 to move away from the contact 32 and to touch the contact 31. For a brief interval in each half of the swing of the arm 45, all three contacts are connected together.

The operation of the switch 30 is best described with reference to Fig. 2 which depicts its four operating positions. Fig. 3 is a curve of the voltage across the resistor 37 upon the occurrence of a transient pulse. When the vibrating contact 33 is connected with the contact 31 as shown in sketch A of Fig. 2, the voltage across the resistor 29 is applied to the capacitor 36 charging it by causing current to flow through the resistor 37. In Fig. 3, the voltage across the resistor 37 in this position of the switch 30 is shown as the top of a square wave designated as A'. In the position shown in sketch B, the vibrating contact 33 is swinging toward the contact 32

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and all three contacts are connected together. At this time, the low value resistor 39 is connected in parallel with both the resistors 29 and 37 and the capacitors 28 and 36 discharge through the resistor 39. This is shown as a slight decrease in voltage at B' of Fig. 3. As the vibrating arm 45 continues its movement, it urges the vibrating contact 33 against the contact 32 and away from the contact 31, causing the flexible arm 41 to bend. This is shown in sketch C of Fig. 2. In this position of the switch, the capacitor 36 continues to discharge through the resistor 39 and the current flow through the resistor 37 is reversed from that of position A of the switch. In Fig. 3, this appears as the negative flat peak C' of the square wave. In the fourth position of sketch D of Fig. 2, the vibrating arm 45 has reversed its direction of travel and the three contacts are together again. The capacitor 28 discharges through the resistor 39 and the capacitor 36, having been completely discharged in position C of the switch, begins charging, the current through the resistor 37 again reversing. In Fig. 3, the voltage across the resistor 37 is shown as the peak D'. This voltage decays slightly in this position of the switch, but assumes a steady value when position A is again reached. Fig. 3 also illustrates the decay of the pulse over a period of two successive cycles. The dashed curve represents the general pattern of the decay.

Since the value of the resistor 39 is low, the time constant of the capacitor 28-resistor 39 combination is low and whenever the vibrating switch 30 is in the position shown by sketches B or D of Fig. 2, the energy stored in the capacitor 28 is quickly dissipated. In the positions shown by sketches B, C, and D of Fig. 2, the energy stored in the capacitor 36 is quickly dissipated. Any transient pulse appearing at the anode 22 of the electrometer 20 quickly decays through the low value resistor 39 and the circuit is rapidly stabilized.

Obviously, many modifications and variations of this invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A radiation detector comprising an electrometer amplifier having an anode and a cathode, a switch having a first flexible contact, a second flexible contact and a moving contact, a capacitor coupling said anode to said first flexible contact, a high value resistor connecting said first flexible contact to said cathode, a low value resistor connecting said second flexible contact to said cathode, an output circuit coupled to said moving contact, a second high value resistor connecting said output circuit with said cathode, and means for periodically connecting said three contacts together whereby said two high value resistors are paralleled by said low value resistor.

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2. A radiation detector comprising a photo-multiplier transducer having an output, an electrometer amplifier having an anode, a cathode and a control grid, said output being directly coupled to said control grid, a switch having a first contact, a second contact and a vibrating contact, a capacitor coupling said anode to said first contact, a high value resistor connecting said first contact with said cathode, a low value resistor connecting said second contact to said cathode, an amplifier and peak detector circuit having its input connected to said vibrating contact, a second high resistor coupling said vibrating contact with said cathode, and means for periodically connecting said three contacts together whereby said two high value resistors are paralleled by said low value resistor.

3. Apparatus for coupling a signal from a first circuit having a large time constant to a second circuit also having a large time constant, said first circuit comprising a first reactor, a high value first resistor, and a source of electrical signals connected in series with said first reactor and said first resistor; said second circuit comprising a second reactor, and a high value second resistor connected in series with said second reactor; said apparatus comprising a low value third resistor, and means for repetitiously connecting the junction of said first reactor and said first resistor to the junction of said second reactor and said second resistor to transfer electrical signals from said first circuit to said second circuit and for thereafter connecting said third resistor in parallel with said first and second resistors to quickly dissipate energy stored in said first and second reactors.

4. A circuit for coupling an electrical signal from a source to a detector, said circuit comprising a first capacitor, a high value first resistor, a source of electrical signals containing unwanted transients connected in series with said first capacitor and said first resistor, a second capacitor, a high value second resistor, a detector connected in series with said second capacitor and said second resistor, a low value third resistor, and means for repetitiously connecting the junction of said first capacitor and said first resistor to the junction of said second capacitor and said second resistor to transfer signals from said first to said second capacitor and for subsequently connecting said third resistor in parallel with said first and said second resistors to temporarily decrease the time constants of said series connections.

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