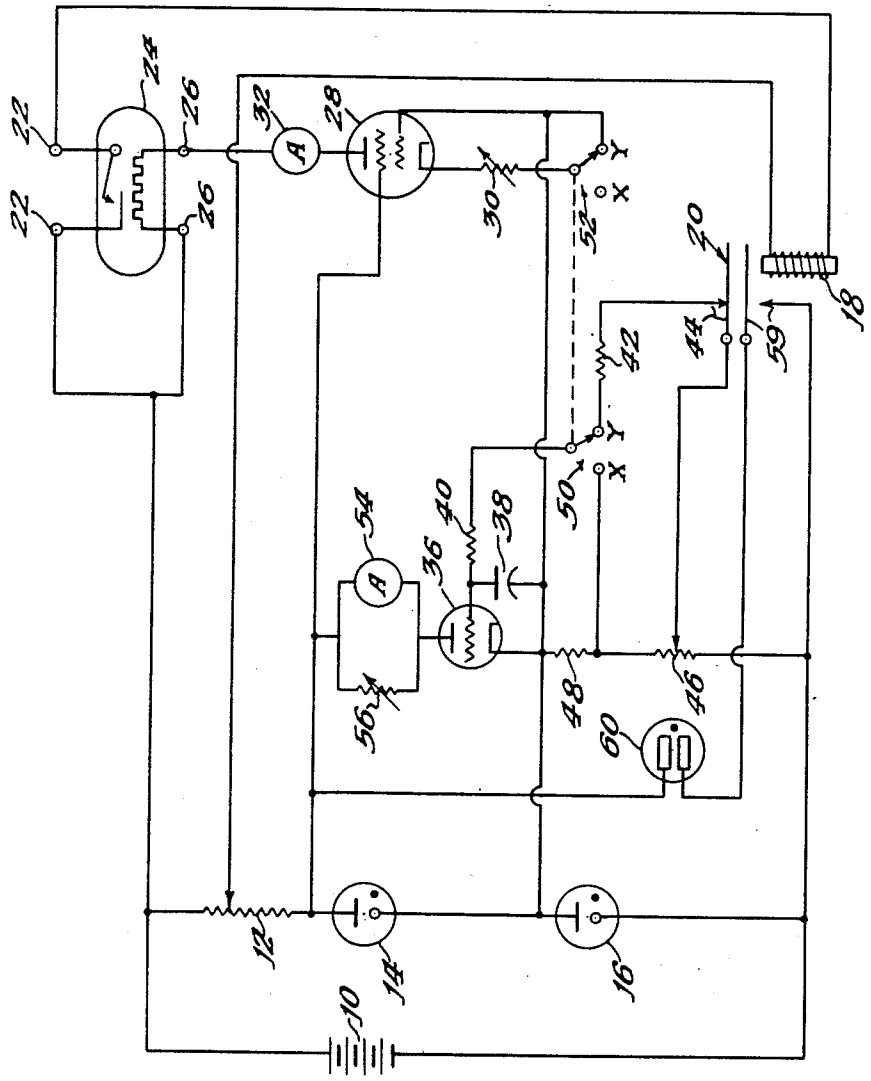
Oct. 28, 1952 C. B. GOULD 2,615,967

TIME-DELAY RELAY TESTING DEVICE

Filed May 26, 1947



INVENTOR.
Charles B. Gould
BY
Robert A Lawson
Attorney.

Patented Oct. 28, 1952

2,615,967

UNITED STATES PATENT OFFICE

2,615,967

TIME-DELAY RELAY TESTING DEVICE

Charles B. Gould, Cleveland, Ohio, assignor to the United States of America as represented by the United States Atomic Energy Commission

Application May 26, 1947, Serial No. 750,466

3 Claims. (Cl. 175—381)

1

This invention pertains to a novel electrical circuit for measuring the time-delay of a time-delay relay.

As is well known in the art, a time-delay relay commonly has controlling terminals and controlled contacts. The essence of the operation of the time-delay relay is the time lag which exists between the instant of changing the status of the potential applied to the controlling terminals and the subsequent actuation of the controlled contacts. The change of status of the potential applied to the controlling terminals may be either the application or removal of a voltage, and the actuation of the controlled contacts may be such as either to open or to close an electrical circuit which is controlled by the relay. Various types of time-delay relays are in use, the most common types being the thermal type and the clock-work type.

It is the principal object of this invention to provide a novel electrical circuit for measuring the time-delay of a time-delay relay. Other aims and objects will appear from the description below and from the drawing, in which is depicted a schematic electrical diagram of a circuit for measuring the time-delay of a time-delay relay incorporating the teachings of the invention.

Referring to the drawing, a source of direct voltage 10 is connected across a series combination of a potentiometer 12 and two voltage-regulator tubes 14 and 16, the positive terminal of the voltage source 10 being connected to the potentiometer 12. The potential appearing across the tapped portion of the potentiometer 12 is connected to the windings 18 of a conventional solenoid relay 20 through the normally open controlled contacts 22 of a time-delay relay 24, whose time-delay is under measurement.

As illustrated in the drawing, the time-delay relay is of the thermal type wherein a potential applied to the controlling terminals heats a resistance element which causes the bending of a bi-metallic member, thus closing the controlled contacts 22. However, it will be understood that the circuit of the drawing may be used with any type of time-delay relay.

The voltage across the potentiometer 12 and the voltage-regulator tube 14 acts as a voltage supply for the controlling terminals 26 of the time-delay relay 24. The controlling terminals 26 are in the plate circuit of a vacuum tube 28, the plate current of which is controllable by a variable resistance 30 in the cathode circuit. The plate current of the tube 28, and thus the current flowing through the controlling terminals 26 of the time-delay relay 24, may be read from the milliammeter 32 which is connected in series therewith.

The potential across the voltage regulator tube 14 constitutes the voltage supply for a vacuum tube 36 which has a condenser 38 connected between the grid and cathode thereof. The grid of the vacuum tube 36 is connected through resistances 40 and 42 and the normally closed contacts 44 of the relay 20 to the tap on a potentiometer 46, which is connected in series with a fixed resistance 48 across the voltage regulator tube 16. The tap on the potentiometer 46 is negative in potential with respect to the cathode of the vacuum tube 36.

2

The connection between the grid of tube 36 and the tap on the potentiometer 46 is made through a terminal of a two-position selector switch 50 which is ganged with a similar two-position selector switch 52 which is in the cathode circuit of the vacuum tube 28. The selector switches 50 and 52 each have two positions designated in the drawing as X and Y. When the switches 50 and 52 are in the position Y, the connections are as described above. When the switches 50 and 52 are, however, in the position X, the cathode circuit of the vacuum tube 28 is open, thus allowing no current to flow through the controlling terminals 26 of the time-delay relay 24. Also, when the switches are in the position X, the grid of the vacuum tube 36 is connected to the junction between the fixed resistance 48 and the potentiometer 46, which point is less negative with repect to the cathode of the vacuum tube 36 than is the tap on the potentiometer 46.

Persons skilled in the art will readily see that when the switch 50 is in the position X, the condenser 38 will charge up to the potential appearing across the resistance 48. Such charge on the condenser 38 will then constitute a negative bias on the grid of the vacuum tube 36. The corresponding plate current of the vacuum tube 36 may be read from a milliammeter 54, shunted by a variable resistance 56, in the plate circuit of the vacuum tube 36. When the switch 50 is switched to position Y, the condenser 38 will commence to charge to a potential such that the grid of the vacuum tube 36 is further negative with respect to the cathode. As the grid becomes more negative with respect to the cathode, the plate current in the tube 36 will decrease correspondingly. The rate of charging of the condenser 38 is determined by the capacitance of the condenser 38 and the resistance of the resistors 40 and 42. As is well known in the art, for times which are short compared to the time constant of the resistance and capacitance, the charging of the condenser will be linear; that is to say, the negative voltage of the grid of the tube 36 with respect to the cathode will increase linearly with elapsed time. The vacuum tube 36 is operated at a linear portion of its characteristic, i. e., in a region where the decrease in plate current varies linearly with the increase in negative grid voltage. This is accomplished by the bias provided in the manner above stated before the

switch 50 is thrown to position Y. Thus, the current indicated on the milliammeter 54 decreases linearly with time when the switch 50 is thrown to position Y.

The operation of the circuit illustrated in the drawing in measuring the time-delay of the time-delay relay 24 may now easily be understood. Preparatory to making the measurement, the switches 50 and 52 are maintained in the X position. In this position, the current through the milliammeter 54 preferably deflects the indicator thereon to full-scale. No current flows to the controlling terminals 26 of the time-delay relay 24 because the cathode circuit of the tube 28 is open. The contacts 44 of the relay 20 are closed since the controlled contacts 22 of the time-delay 24 are open, and thus allow no current flow through the windings 18 of the relay 20.

When the measurement is to be made, switches 50 and 52 are thrown to the Y position. In this position, current flows through the controlling terminals 26 of the time-delay relay 24. At the same time, the condenser 38 commences to charge. The charging of the condenser 38 continues until the controlled contacts 22 of the time-delay relay 24 under measurement close. At this point, the circuit through the windings 18 of the relay 20 is thereby closed and the contacts 44 are opened so that the condenser 38 immediately ceases charging. At the same time a second pair of contacts 59 of the relay 20 is closed, thus closing a circuit through a glow-tube 60, the lighting of which indicates to the operator that the reading may be taken. The reading is taken from the milliammeter 54, which is calibrated in terms of the correspondence between elapsed time and decrease in current. Such calibration is preferably linear.

Thus the operator may by reading the milliammeter 54 measure the time-delay between the application of voltage to the controlling terminals 26 of the time-delay relay 24 and the closing of the controlled contacts 22 thereof. It will be seen that the charge of the condenser 38 will remain since there is no discharge path with the contacts 44 open. It will, however, be understood that because of inherent leakage in the condenser 38 and grid currents in the tube 36, the reading must be taken within a fairly short time after the controlled contacts 22 close.

Calibration by adjustment may be made adjustment of the variable resistor 56 which shunts the meter 54 and the tap on the potentiometer 46. The time-delay of the time-delay relay 24 is a function of the magnitude of the current through the controlling terminals 26. This current may be read on the milliammeter 32, and may be adjusted by the variable resistor 30. By successive adjustments of the variable resistor 30, the time-delay of the relay 24 may be measured for various values of such current.

Sample values for the circuit parameters of the embodiment of the invention shown in the drawing are as follows:

Voltage supply 10	volts	300
Potentiometer 12	ohms	5,000
Voltage-regulator tube 14		VR–105
Voltage-regulator tube 16		VR–75
Milliammeter 32	ma	0–20
Vacuum tube 28		6F6
Variable resistor 30	ohms	5,000
Milliammeter 54	ma	0–6
Variable resistor 56	ohms	50
Vacuum tube 36		6J5

Resistor 48	ohms	300
Potentiometer 46	do	25,000
Condenser 38	mfd	8
Resistor 40	ohms	25,000
Resistor 42	do	100,000

The exact embodiment illustrated in the drawing does not, of course, represent the only application of the teachings of this invention. Persons skilled in the art will readily devise equivalent circuits utilizing the teachings of this invention. Therefore, the invention shall be deemed to be limited only by the claims.

What is claimed is:

1. Apparatus for the measurement of elapsed time comprising, in combination, an electronic tube having an anode, a cathode and a control-grid, a condenser connected between the control-grid and the cathode, a bias voltage source adapted to charge the condenser so that the grid is biased negatively with respect to the cathode, charging means adapted to charge the condenser to a negative potential greater than the negative potential of the bias voltage source, switching means connected to said bias voltage source, charging means and condenser simultaneously to disconnect the bias voltage source from, and connect the charging means to, the condenser at the commencement of a time under measurement, and indicating means responsive to changes in anode current of the electronic tube.

2. Apparatus for measuring the time-delay of a time-delay relay having controlling terminals and controlled contacts comprising, in combination: a first circuit including a source of potential, a pair of terminals adapted to be connected to the controlling terminals of the time-delay relay, and a first switch having an open and a closed position, all connected in series; a second circuit including a grid-controlled vacuum tube, a current meter in the plate circuit, a condenser connected between the grid and the cathode, a resistor in series with the grid, a grid-bias voltage supply having its positive terminal connected to the cathode and having terminals of respectively lesser and greater negative potential with respect to said cathode, and a second switch ganged with the first switch and connecting said resistor to the terminal of lesser negative potential when the first switch is in the open position and to the terminal of greater negative potential when the first switch is in the closed position; and relay means to open the connection between said resistor and said terminal of greater negative potential, said relay means being adapted to be actuated by the closing of the controlled contacts of the time-delay relay under measurement.

3. The apparatus of claim 2 wherein there is provided a visual indicator and switching means coupled to the aforementioned relay means to actuate said visual indicator upon the closing of said controlled contacts.

CHARLES B. GOULD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,021,766	Bivens	Nov. 19, 1932
2,269,603	Rockwood	Jan. 13, 1942
2,377,969	Richter	June 12, 1945