April 14, 1953 W. B. BRUENE 2,635,213

TIME DELAY CIRCUITS

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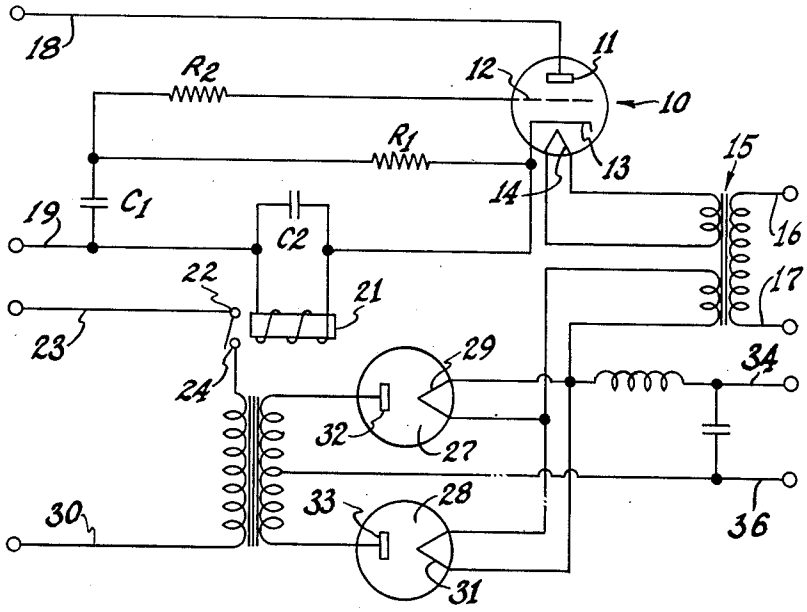


Fig. 1

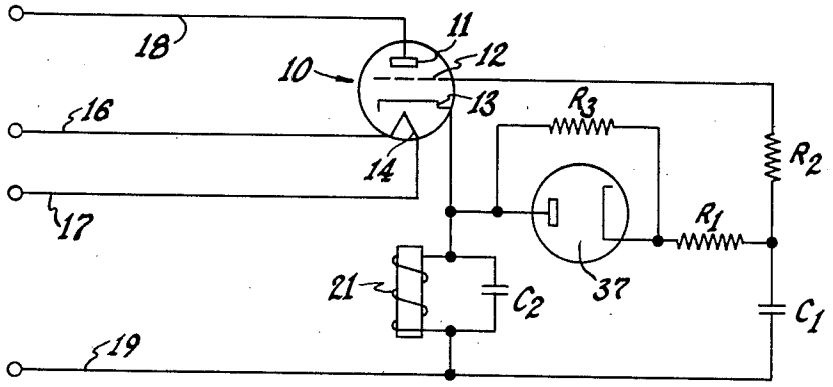


Fig. 2

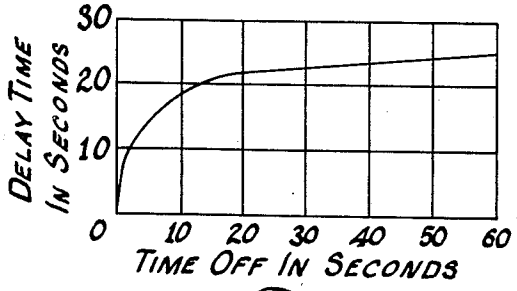


Fig. 3

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TIME DELAY CIRCUITS

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This invention relates in general to time delay circuits and in particular to apparatus which will recover from an interruption of power in a time depending upon the length of the interruption.

In the operation of many electronic devices it is desirable to allow a portion of the equipment to be turned on before other equipment. For example, when a large radio transmitter is put on the air, it is desirable to allow the filaments to heat up to an emission temperature before applying voltage to the rectifier tubes. At times the power to the transmitter may be interrupted either permanently or momentarily. In the case of the permanent interruption, the filament must once again be heated prior to the application of plate voltage, but if the interruption is a momentary one wherein the heater has remained at an emission temperature during the brief power-off interval, it is desirable to have the plate voltage turned on again as soon as practicable.

It is an object of this invention therefore to provide a control means which does not turn off the plate voltage during short interruptions of power.

Another object of this invention is to provide means for turning on the plate voltage of an electronic device at a time related to the length of the power-off period.

Another object of this invention is to provide a delay apparatus which actuates a circuit after an interruption has occurred at a time proportional to the interruption period.

Further objects, features and advantages of this invention will become apparent from the following description and claims when read in view of the drawings, in which:

Figure 1 is the wiring diagram of the time delay circuit of this invention;

Figure 2 is a wiring diagram of a modification of the invention; and,

Figure 3 is a plot of interruption time versus delay time.

Figure 1 illustrates a triode tube 10 which has a plate 11, control grid 12, cathode 13, and filament heater 14. The filament heater 14 may be connected to a suitable filament voltage supply received from a transformer 15 which is connected to a suitable power source through the leads 16 and 17. The cathode 13 of tube 10 is connected to a relay coil 21 in parallel with a condenser C_2. The opposite sides of the relay 21 and the condenser C_2 are connected to the lead 19. Also connected to the cathode 13 is a resistor R_1 which is in series with a condenser C_1 that has its opposite side connected to the lead 19. A grid

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leak resistor R_2 is connected between the condenser C_1 and the grid 12. The plate 11 is connected to a lead 18. A high voltage is applied between leads 18 and 19. The relay 21 has a movable armature 22. The armature 22 is connected to a lead 23 and is movable to engage a contact 24 when in its closed position. Actuation of the armature 22 makes electrical contact between the contact 24 and the lead 23.

In Figure 1 the contact 24 is shown connected to the power supply of a pair of vapor diode rectifiers 27 and 28 which have their filaments 29 and 31 connected to a second winding of transformer 15. The leads 23 and 30 are connected to a power source. Thus the filaments of the rectifiers will be heated, prior to the application of voltage to the plates 32 and 33. This will assure satisfactory operation of the rectifiers and will prevent sputtering of the cathode. The output of the rectifiers might be supplied, for example, to the plate circuit of a transmitter connected to terminals 34 and 36.

In operation, when power is supplied to the leads 16, 17, 18, 19, 23, and 30, simultaneously, the relay 21 will be actuated a predetermined time after the power is turned on. When the filament power supplied to leads 16 and 17 is connected, no current flows through the tube 10 until the filament 14 has reached an emission temperature. This causes the cathode 13 to emit electrons. Then current will flow through the tube 10 upon the positive half cycles, if alternating current is applied between the leads 18 and 19. If direct current is applied between these leads, currents will flow all the time after the cathode commences to emit electrons. This plate current passes through the relay 21 connected in parallel with the condenser C_2. The voltage drop across the relay 21 and the condenser C_2 causes the condenser C_1 to start charging through resistance R_1. The grid voltage is determined by the difference in charge between C_1 and C_2 so the rate at which the cathode voltage increases is determined by the time constant R_1 and C_1 and also the amplification factor of the tube. The charging current of condenser C_1 is equal to the grid-cathode voltage divided by R_1 which is rather small and nearly constant over most of the timing cycle. This circuit allows relatively long delays to be obtained with reasonable values of R_1 and C_1.

When the voltage across the relay 21 has built up sufficiently, it will close the armature 22, thus connecting the lead 23 to contact 24. The

cathode voltage continues to build up to an equilibrium point and remains there.

If the power supply to leads 18 and 19 and 16 and 17, respectively, is removed or lost for a short period of time, the armature 22 will not disconnect the contact 24 from lead 23 because the large capacitor C_2 across the relay will keep current flowing in the relay until the voltage drops to approximately one-half of its operating value. As the relay voltage drops, condenser C_1 starts discharging through resistances R_1 and R_2 through the tube. When the tube cathode cools down sufficiently, the tube discharge through R_2 will not be large and then the major discharge of C_1 will be through R_1. The discharge time will be several times less than the charging time, and if power is reapplied before the discharge is complete, but the relay armature 22 has opened, it will close with less delay than it would have had the circuit been completely discharged. Thus, a momentary loss of power may cause no delay when power is resumed, or only a short delay, depending upon the amount of time power is off and value of time delay circuit components.

The values of the components in this circuit might be, for example.

R_1, 1.2 megohms.
R_2, 1.2 megohms.
C_1, 1 microfarad.
C_2, 20 microfarads electrolytic.
Direct current resistance of relay 21, 15,500 ohms.

Relay 21 is actuated at 82 volts and disengages at 50 volts. With the above components and 230 volts A. C. applied between leads 18 and 19, twenty-nine seconds elapsed after closing of the circuit before the relay was actuated. This is ample time for allowing the filaments of the rectifier tubes to heat.

Figure 3 is a plot of "delay time" versus "time off" where "delay time" is the time to operate relay 21 when power is turned on and "time-off" is the length of the interruption of power. Thus if the tube 10 has reached equilibrium with the relay 21 closed and power is interrupted for ten seconds, the relay would be actuated 18 seconds after power was re-applied. If the "time off" is equal to one second or less, however, there would be no delay because the relay would stay closed for this short time.

Figure 2 illustrates a modification of this invention wherein a diode 37 is connected in parallel with a resistor R_3 between the cathode 13 and resistor R_1. This diode makes it possible to charge C_1 through the resistor R_1, but prevents C_1 from discharging through R_1 alone. Resistor R_3 allows a slow rate of discharge of the condenser C_1.

It is seen that this invention provides means for controlling the application of high power to apparatus after there has been a momentary interruption of power. There are many uses which might be made of this invention and the diode rectifiers of a transmitter have been used as illustrative examples only.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention as defined by the appended claims.

I claim:

1. Control means for connecting a power supply to a plate circuit a predetermined time after the application of power to a portion of the circuit comprising, a first electron tube, a filament heater of said first electron tube connected to said power supply, a first resistor connected to the cathode of said first electron tube, a first condenser connected in series with said first resistor and to one side of said power supply, a second condenser, an electromagnetic relay connected in parallel with said second condenser and the parallel combination connected between the cathode of the first electron tube and the one side of said power supply, the plate of said first electron tube connected to the other side of said power supply, a controlled tube with its filament connected to the power supply, the plate of said controlled tube connected to said power supply, and a two position switch in the plate circuit of said controlled tube and connected to the electromagnetic relay.

2. Means for controlling the application of high voltage from a power supply between plate and cathode of a controlled tube comprising, a first electron tube, a high voltage power supply, a transformer with its primary connected to high voltage supply, a heater for said first electron tube connected to the secondary of said transformer, the plate of said first electron tube connected to one side of said power supply, a first resistor connected to the cathode of said electron tube, a first condenser connected in series with the first resistor and the other side of said high power supply, an electromagnetic relay, a second condenser connected in parallel with said electromagnetic relay, said second condenser and relay connected between the cathode of said first electron tube and the other side of said power supply, heaters for said controlled tube connected to the secondary of said transformer, the plate of said controlled tube connected to the power supply, and the armature of said relay connected in series with the plate of said controlled tube to open and close the plate circuit of the controlled tube in response to operation of said relay.

3. Means for controlling the power to a pair of diode rectifiers comprising, a first electron tube, a transformer connected to a power supply, the filament heater of said first electron tube connected to the secondary of said transformer, the plate of said first electron tube connected to one side of the power supply, a first resistor, a first condenser connected in series with said first resistor between the cathode of said first electron tube and the other side of the power supply, a second resistor connected between the control grid of said first electron tube and said first condenser, a second condenser, an electromagnetic relay connected in parallel with said second condenser, the cathode of said first electron tube connected to one side of said second condenser, the other side of said power supply connected to the opposite side of said second condenser, the filaments of said diode rectifiers connected to the secondary of said transformer, a high voltage supply connected to the plates of said diode rectifiers, and said relay controlling the application of power from said high voltage supply to the plates of said diode rectifiers.

4. Means for actuating an electromagnetic relay so that its closing and opening times are functions of the time it has been open comprising, a first electron tube, a heater of said first electron tube connected to a power supply, the plate of said first electron tube connected to one side of the power supply, a first condenser connected to the other side of the power supply, a

first resistor connected to the other side of said first condenser, a rectifier tube with its plate connected to the cathode of the first electron tube and its cathode connected to the first resistor, a second resistor connected between the control grid of the first electron tube and the first condenser, a third resistor connected in parallel with said rectifier tube, a second condenser, and the electromagnetic relay connected in parallel with said second condenser and one side of the relay connected to one side of the power supply and the other side connected to the cathode of the first electron tube.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,047,127	Huber	July 7, 1936
2,073,701	Lazzarini	Mar. 16, 1937
2,183,412	Sledd	Dec. 12, 1939
2,297,740	Brown	Oct. 6, 1942
2,422,020	Kingsmill	June 10, 1947
2,442,238	Haungs	May 25, 1948
2,467,008	Brown	Apr. 12, 1949
2,473,640	Faulk	June 21, 1949
2,483,126	Davids	Sept. 27, 1949