July 13, 1926.

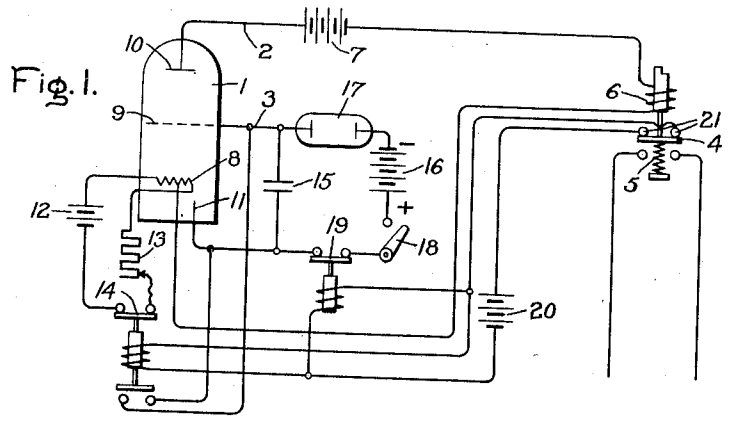
1,592,613

F. W. MEYER

LINE SWITCHING AND RELAY SYSTEM

Filed Dec. 8, 1924

Fig. 1.



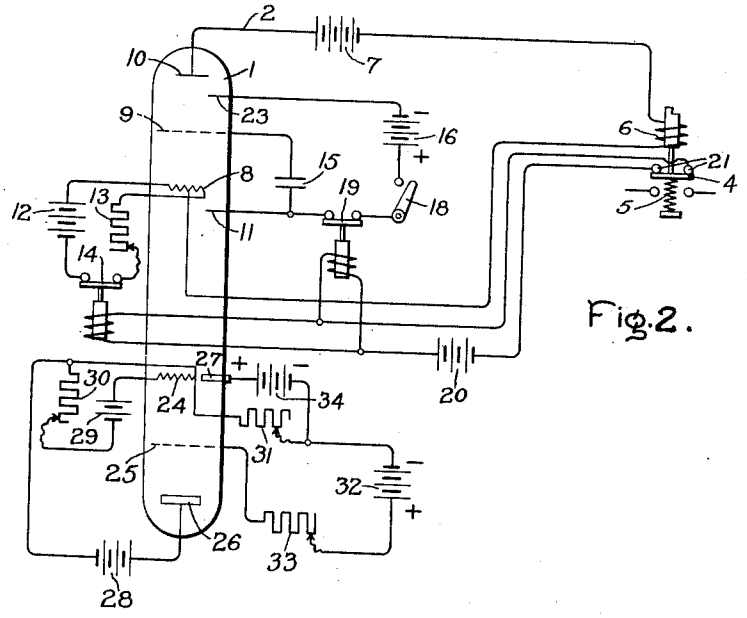


Fig. 2.

Inventor:
Friedrich W. Meyer,
by Alexander S. Lamb
His Attorney.

Patented July 13, 1926. 1,592,613

UNITED STATES PATENT OFFICE.

FRIEDRICH WILHELM MEYER, OF BRUNSWICK, GERMANY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

LINE SWITCHING AND RELAY SYSTEM.

Application filed December 8, 1924, Serial No. 754,519, and in Germany November 15, 1921.

My invention relates to relay systems which comprise means for adjusting and controlling the duration of the time interval between different switching operations, and has for its object the provision of an improved relay system which possesses high sensitivity, is dependable in its operation, involves the use of small currents for controlling its operation, and obviates both the use of moving mechanical parts for producing a time delay and the use of mechanical interrupters for controlling the comparatively heavy currents through which operation of the system is effected.

In accordance with my invention, these difficulties are avoided by the use of an electron discharge device which is arranged to have the potential of its grid or control circuit changed from a non-operative to an operative value in response to an operation which may be performed either manually or automatically, this change from a non-operative to an operative value of grid potential being effected at a rate of time predetermined by the adjustment of the apparatus.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 shows a relay system in which my invention has been embodied; and Fig. 2 shows an arrangement comprising means for maintaining the ionizable medium of the electron discharge device at its normal value during the operation of the device.

Fig. 1 shows a relay system wherein an electron discharge device comprising a receptacle 1, a plate or operating circuit 2, and a grid or control circuit 3, is arranged to control the operation of a translating device shown as a switch 4 which is biased in its open position by a spring 5 and is provided with an operating coil 6. The coil 6 and a source of current 7 are connected in the operating circuit 2. The receptacle 1 contains a cathode 8, a grid 9, an anode 10, an auxiliary electrode 11 and, as hereinafter set forth, may also contain an ionizable medium such as argon, heluim, or mercury vapor for example. A battery 12, an adjustable resistor 13 and a switch 14 have been shown as arranged to control the temperature of the cathode 8, but it will be readily understood that any other suitable means of ensuring an adequate supply of electrons at the cathode 8 may be utilized. The control circuit 3 comprises energy storage means illustrated as a condenser 15. A current source 16 and a resistance device 17 are arranged to be connected in series to the opposite terminals of the condenser 15 through switches 18 and 19. The operating coils of the switches 14 and 19 are arranged to be supplied with current from a source 20 through contacts 21 which are interconnected by the switch 4 in its open position. While the device 17 has been diagrammatically shown as an ionization device, it will be apparent that it may be any suitable type of resistor which is adjustable to a value high enough to ensure the proper time delay in charging the condenser 15, and consequently the grid 9, to a potential at which the value of current required to cause operation of the switch 4 is transmitted through the circuit 2.

Assuming a high vacuum to exist in the receptacle 1 and the various connections to be as illustrated, closure of the switch 18 will initiate charging of the condenser 15. At the beginning, the rate at which the condenser 15 is charged will be comparatively high, all or a very substantial part of the battery voltage will be utilized in transmitting the charging current through the resistance device 17 and, assuming proper design of the apparatus, the potential of the grid 9 will be of such a value as to allow the transmission of sufficient current between the cathode 8 and plate 10 to maintain the switch 4 in its illustrated open position. As the charge of the condenser 15 increases, the rate at which current is supplied to it will decrease. For this reason, the resistance drop of the device 17 will decrease and the potential of the grid will gradually approach and eventually reach a negative value at which the current of the operating circuit will be decreased to a value insufficient to maintain the switch 4 in its illustrated open position. When this occurs, the switch 4 will be moved into its closed position by the spring 5. It will of course be understood that gravity may be utilized to produce closure of the switch 4 and that the spring 5 may be omitted. The duration of the time interval between closure of the switch 18 and operation of the switch 4 is

thus dependent on the charging rate of the condenser 15 and may be definitely predetermined at any desired value by proper design or adjustment of the resistance device 17 and condenser 15. Upon closure of the switch 4, the operating coils of the switches 14 and 19 are deenergized, thereby causing the circuits of the batteries 12 and 16 to be opened, short circulating the condenser 15 through the back contact of switch 14 and allowing the electron device to assume a condition suitable for repeating the sequence of operations previously set forth.

It will be observed that no conductive connection exists between the operating circuit 2 and the control circuit 3. This arrangement is of particular advantage in that current variations or other disturbances in one of these circuits is not readily communicated to the other and a higher degree of stability in the operation of the device is ensured.

Fig. 2 shows an arrangement which is in many respects similar to that of Fig. 1, but differs therefrom in that no resistance exterior to the electron discharge device is utilized and in that means are provided for regulating the pressure of an ionizable medium or gas within the receptable 1. In this arrangement an auxiliary electrode 23 is utilized in conjunction with this gas to regulate the charging rate of the condenser 15, the conductivity of the gas being regulated by the extent of its ionization. As explained in connection with Fig. 1, the charging rate of the condenser 15 largely determines the duration of the time interval between closure of the switches 18 and 4. In the arrangement of Fig. 2, the ionizable medium between the auxiliary electrode 23 and the grid is utilized to control the charging rate of the condenser, the time interval between closure of the switches 18 and 4 being determined by the pressure of the ionizable medium within the receptacle 1.

It is well known that a certain amount of gas is absorbed in the colder parts of an electron discharge device during its operation and that this absorption of the gas produces changes in the characteristics of the device due to variation in the gas pressure. Thus within certain limits current is transmitted through the device with greater difficulty if the pressure of the gas decreases and with less difficulty if the pressure increases. If the characteristics of the device are to be maintained unchanged throughout its operation, it is therefore necessary that means be provided for maintaining the gas at a pressure which is substantially constant.

For the purpose of automatically controlling the pressure of the gas in response to slight changes thereof and for adjusting this pressure to different values, a pressure control apparatus comprising cathode 24, grid 25, anode 26 and auxiliary electrode 27 is provided. The cathode 24 and the anode 26 are interconnected through a source of current 28 and heating of the cathode 24 is controlled by current supplied from a battery 29 through an adjustable resistor 30. The cathode 24 is connected to the grid 25 through an adjustable resistor 31, a battery 32 and an adjustable resistor 33 and to the auxiliary anode 27 through the adjustable resistor 31 and a battery 34.

In initiating the operation of the pressure control apparatus, the resistors 31 and 33 are adjusted to a position where no discharge of electrons is produced between the cathode 24 and the anode 26 when the gas within the receptacle 1 is at its normal pressure. When this is done, the pressure control apparatus will be practically inactive until a change in the gas pressure occurs. If a slight decrease in the gas pressure occurs, however, the current transmitted through the auxiliary anode 27 will decrease. As a result of this decrease in current, the voltage drop of the resistor 31 will be decreased, the potential of the grid 25 will be increased to a certain positive value, electrons will be discharged between the cathode 24 and anode 26 and gas will be liberated from the anode 26 by impacting electrons in a manner tending to restore the pressure of the gas to its normal value. As the pressure of the gas approaches its normal value, the potential of the grid 25 is gradually reduced to lower positive values and eventually to zero so that the pressure control apparatus is rendered inactive. Any reduction in the pressure of the gas below its normal value thus immediately brings into operation an influence tending to restore it to its normal value and the operating characteristics of the device are maintained during its operation without appreciable change, if not changed by adjustment of the resistors 31 and 33.

The embodiments of the invention illustrated and described herein have been selected for the purpose of simply and clearly setting forth the principles involved. It will be readily understood however that the invention in its broader aspects is susceptible of being modified in many ways to meet the different conditions encountered in its application to the many uses of which it is capable.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The combination of an electron discharge device comprising a cathode, an anode, a control electrode and an auxiliary electrode, control and operating circuits for said discharge device, energy storage means arranged to be connected in said control circuit, a relay arranged to be connected in said operating circuit, a source of current for

operating said relay when the energy stored in said energy storage means has assumed a predetermined value, and means associated with said auxiliary electrode for controlling the rate at which energy is supplied to said energy storage means.

2. The combination of an electron discharge device, conductively independent control and operating circuits for said device, energy storage means arranged to be connected in said control circuit, a relay arranged to be connected in said operating circuit, a source of current for operating said relay when the energy stored in said storage means has assumed a predetermined value, and means for controlling the rate of change in the amount of energy stored in said energy storage means.

3. The combination of an electron discharge device comprising a cathode, an anode, a control electrode and an auxiliary electrode, control and operating circuits, for said device, energy storage means connected in said control circuit, a relay arranged to be connected in said operating circuit, a source of current for operating said relay when the energy stored in said energy storage means has assumed a predetermined value, a source for supplying energy to said storage means through said auxiliary electrode, and an ionizable medium for controlling the rate at which energy is supplied to said energy storage means.

4. The combination of an electron discharge device comprising a cathode, an anode, a control electrode, an auxiliary electrode, control and operating circuits for said device, a condenser arranged to be connected in said control circuit, a relay arranged to be connected in said operating circuit, a source of current for operating said relay when the energy stored in said condenser has assumed a predetermined value, and means associated with said control electrode for controlling the rate at which energy is supplied through the auxiliary electrode to said condenser, whereby operation of said relay is produced at a predetermined time after initiating the supply of energy to said condenser.

In witness whereof, I have hereunto set my hand this 25 day of November, 1924.

Dr. FRIEDRICH WILHELM MEYER.