June 12, 1945. G. E. INMAN 2,378,222

ELECTRIC DISCHARGE APPARATUS

Filed Jan. 12, 1943

Fig. 1.

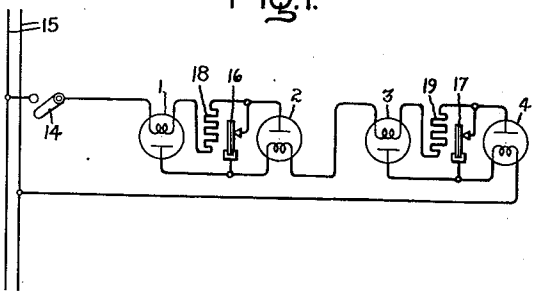


Fig. 2.

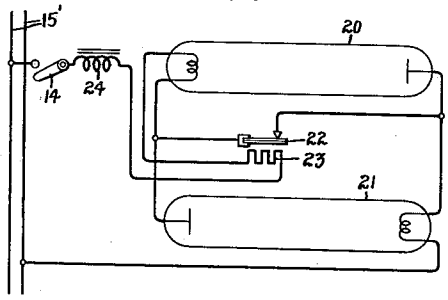


Fig. 3.

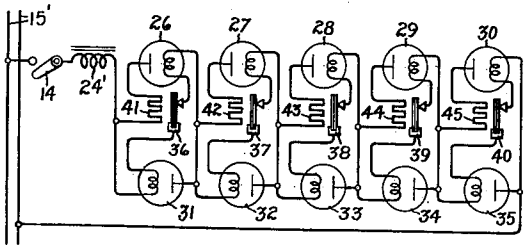


Fig. 4.

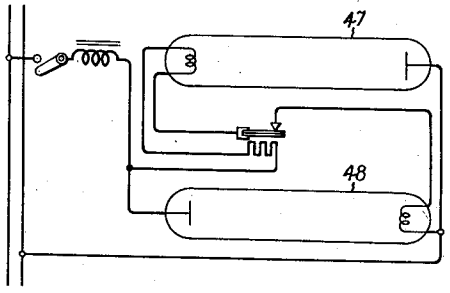


Fig. 5.

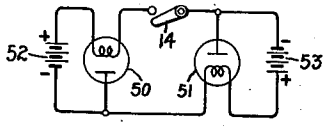
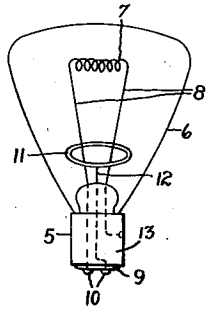


Fig. 6.



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George E. Inman,
by Harry E. Dunham
His Attorney.

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UNITED STATES PATENT OFFICE

2,378,222

ELECTRIC DISCHARGE APPARATUS

George E. Inman, East Cleveland, Ohio, assignor to General Electric Company, a corporation of New York

Application January 12, 1943, Serial No. 472,103

9 Claims. (Cl. 315—95)

My invention relates to electric discharge apparatus and particularly to circuits for electric discharge devices having rectifying properties, such for example as rectifying fluorescent lamps. It is the object of my invention to provide an improved circuit for the operation of a plurality of such devices with a minimum amount of equipment.

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

Referring to the drawing, Figs. 1, 2, 3, 4 and 5 are circuit diagrams; Fig. 6 represents by way of example only one form of discharge device or lamp such as is shown diagrammatically in Figs. 1, 3 and 5.

In Fig. 1, I have represented at 1, 2, 3 and 4 four similar discharge devices which, for example, may be fluorescent lamps like that shown in Fig. 6. The lamp shown in that figure is of small size being rated at 4 watts and being adapted to operate at about 12 volts. It comprises the 3-contact base 5 and the evacuated refractory envelope 6 containing a small amount of mercury and a rare gas such as argon at low pressure, the inner surface of the envelope being coated with a suitable fluorescent material. The lamp has the filamentary cathode 7 which may comprise a coiled coil of tungsten wire coated with a mixture of barium and strontium oxides. The ends of the cathode connect by the supporting leads 8 extending through the insulating block 9 of the base with one of the external contacts 10 thereof and with the shell 13. Within the envelope and spaced from the cathode is the anode 11, shown as a wire ring having the supporting lead 12 by which it connects with the other external contact 10. By reason of the above described construction the lamp passes current substantially in only one direction; hence, it is rectifying.

The lamps in Fig. 1 may be considered as comprising two similarly connected pairs, lamps 1 and 2 being one pair and lamps 3 and 4 being the other pair. The two pairs are connected in series to be supplied through the control switch 14 from the source of alternating current 15 whose voltage may have a range of 38–44 volts. The lamps of each pair are connected with the source with the one in reverse to the other; hence, being rectifying in character, they pass opposite half cycles of the current supplied. It will be seen that the current passing between the cathode and the anode of lamp 1 passes through the cathode of lamp 2 and likewise the current passing between the cathode and the anode of lamp 2 passes through cathode of lamp 1. The same is true of lamps 3 and 4. The cathode of each lamp has sufficient resistance and has sufficient current-carrying capacity to properly ballast the other lamp associated with it forming the pair. It also allows the other lamp of the pair to operate at full current. Although I have illustrated the series circuit in Fig. 1 as comprising only two pairs of lamps it will be understood that it may comprise many more pairs than illustrated depending upon the voltage of the source.

Although the voltage of the source will cause the lamps to continue to operate after having been started it is insufficient to cause them to start unless their cathodes are heated to an electron emitting temperature. Heating of the cathodes preferably is effected by passing through them current taken from the source. For controlling this current I have shown the starting switches 16 and 17, the former connected between the cathodes of lamps 1 and 2 and the latter connected between the cathodes of lamps 3 and 4, whereby when the main switch 14 is closed cathode preheating current flows from the source through the cathodes of the four lamps in series. The temperature of the cathodes quickly rises to the point of electron emission after which the opening of the switches 16 and 17 applies the full voltage of the source across lamps 1 and 3 in series and across lamps 2 and 4 in series. The lamps presumably start and continue to operate with lamps 1 and 3 operating on one-half cycle and lamps 2 and 4 operating on the other half cycle. I prefer to have the starting switches open automatically. In Fig. 1, I have shown them as normally closed thermal switches of the bimetallic type each having a resistance heater 18 connected to be traversed by the cathode preheating current, the construction of the switch and heater being such that by the time the lamp cathodes have become sufficiently heated by the current flow therethrough the starting switches will open. Thereafter the passage of lamp current taken by the lamps 2 and 4 through the heaters provides the heat necessary to maintain those switches open.

In Fig. 2, I have shown the circuit comprising a single pair of positive column rectifying lamps 20 and 21, the two lamps of the pair being reversely arranged as in Fig. 1. The circuit also includes the thermal starting switch 22 having the heater 23 connected to be heated by the cathode preheating current and in this case by the

current supplied to both lamps. Inasmuch as the cathode of a positive column lamp of common construction may not have sufficient resistance to properly ballast the other lamp, I have shown the circuit provided with the additional ballast 24 in the form of a reactor. The source of supply 15' in this case may be an ordinary lighting circuit of 118 volts or higher depending upon the dimensions of the lamps.

In that form of my invention illustrated by Fig. 3 the lamps are arranged in two series circuits connected in parallel with each other, the lamps in one circuit operating on the positive half cycles of the supplied alternating current and the lamps in the other circuit operating on the negative half cycles. Thus lamps 26, 27, 28, 29 and 30 form one series circuit and may be considered as operating on the positive half cycles of the supply current and lamps 31, 32, 33, 34 and 35 form another series circuit operating on the negative half cycles. The two series circuits are connected in parallel with each other and are supplied through the single ballast reactor 24' and the main switch 14 from the source 15' which may be a 118 volt lighting circuit. The circuit may be thought of as comprising a plurality of pairs of lamps, such for example as lamps 26 and 31, lamps 27 and 32, etc., one lamp of a pair operating on one half cycle and the other operating on the other half cycle. For preheating the lamp cathodes by current flow therethrough the cathodes of each pair of lamps are connected together by thermal switches as before, the switches being represented at 36, 37, 38, 39, and 40. These switches, however, function only to control the flow of cathode preheating current as they do not open until after the lamps have started. The switches 36—40 inclusive are provided respectively with the heaters 41—45 inclusive which are shown connected in series respectively with the anodes of lamps 26—30 inclusive. In this form of my invention when the main switch is closed, current flows in series through the ballast 24', the cathodes of all of the lamps and all of the thermal switches. After the cathodes have become heated by this current flow the voltage applied across each lamp from the source is sufficient to cause it to start. The flow of lamp current through the several heaters then causes the thermal switches associated therewith to open thereby cutting off the flow of preheating current to the cathodes.

Fig. 4 illustrates a form of the circuit shown in Fig. 3 which includes a single pair of positive column lamps represented at 47 and 48. The circuit otherwise is similar to that of Fig. 3.

In Fig. 5 I have shown a form of my invention in which the rectifying lamps are operated from a source of direct current. The lamps are shown at 50 and 51 and the source of direct current is represented as comprising the two batteries 52 and 53. Battery 52 has its positive terminal connected through the cathode of lamp 50 and through the switch 14 with the anode of lamp 51 and has its negative terminal connected with the anode of lamp 50 and with one end of the cathode of lamp 51, whereby the battery 52 supplies operating current to lamp 51 through the cathode of lamp 50, which cathode functions as the ballast. Similarly the battery 53 has its positive terminal connected through the cathode of lamp 51 with the anode of lamp 50 and its negative terminal connected with the anode of lamp 51 and with the cathode of lamp 50 so that it supplies operating current to lamp 50 through the cathode of lamp 51 which cathode functions as the ballast. Upon closing the switch 14, preheating current flows in a series circuit including the two batteries, the switch, and the two cathodes. When the cathodes have become sufficiently heated the lamps start, lamp 50 being operated by the battery 53 ballasted by the cathode of lamp 51 and lamp 51 being operated by the battery 52 ballasted by the cathode of lamp 50.

For convenience in the specification and claims I refer to the cathodes of the discharge devices as resistive and as filamentary. However, I do not desire to be limited to such cathodes as I may employ devices having cathodes provided with separate resistive heaters of well known form in which case the cathodes are preheated by current flow through the heaters instead of through the cathodes themselves and in the case of those forms of my invention illustrated by Figs. 1, 2 and 5 the cathode heater of one device performs a ballasting function for another device.

I have chosen the particular embodiment described above as illustrative of my invention and it will be apparent that various modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

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

1. In combination, a plurality of electric discharge devices connected to be operated in parallel from a source of current supply each having an anode and a resistance cathode, means connecting with the anode of each device for supplying the device with operating current through the cathode of another device, whereby said cathodes function as ballast for said devices.

2. In combination, a plurality of electric discharge devices and means connecting said devices to be operated in parallel from a source of current supply each device having an anode and a resistance cathode, said means connecting the anode of each device through the cathode of another device with said source of current supply, whereby the cathode of each device functions as ballast for another device.

3. In combination, a plurality of electric discharge devices each having an anode and a resistance cathode constructed to be preheated by current therethrough, means connecting said anodes to be supplied with operating current from the opposite sides respectively of a source of alternating current, the anode of each device being connected through the cathode of the other device, and a switch connected between said cathodes to control the flow of heating current thereto and to control the starting of said devices.

4. In combination, a plurality of rectifying electric discharge lamps each having an anode and a filamentary cathode, means connecting the anode of each lamp with one end of the filament of the other lamp, means connecting the other ends of said filaments each with one side of a source of alternating current, and a thermal switch responsive to the lamp current connected between said anodes.

5. In combination, a plurality of rectifying electric discharge lamps each having an anode and a filamentary cathode, means connecting the anode of each lamp with one end of the filament of the other lamp, means including a ballast impedance connecting the other ends of said filaments each with one side of a source of alternating current, a thermal starting switch connected between said anodes. and a heater there-

for connected to be energized by the lamp current.

6. In combination, a plurality of rectifying electric discharge devices each having a cathode constructed to be preheated by current flow therethrough, means connecting said devices in parallel and with one in reverse to the other to be supplied from a source of alternating current, and switching means connecting said cathodes in series to be supplied with heating current from said source.

7. In combination, a plurality of rectifying electric discharge devices each having a cathode constructed to be preheated by current flow therethrough, means connecting said devices in parallel and with one in reverse to the other to be supplied from a source of alternating current, a switch connecting said cathodes in series to be supplied with heating current from said source, and an actuator for said switch connected to be responsive to lamp current.

8. In combination, a plurality of rectifying electric discharge lamps each having a filamentary cathode, means connecting said lamps in parallel and with one in reverse to the other, means including a ballast impedance for connecting said parallel-arranged lamps with a source of alternating current, a thermal switch connected between said cathodes in series to be supplied with preheating current from said source, and a heater for said switch connected to be responsive to lamp current.

9. In combination, a plurality of rectifying electric discharge lamps each having an anode and a filamentary cathode, means connecting the anode of each lamp with one end of the filament of the other lamp, means including a ballast reactor for connecting said anodes respectively with the opposite sides of a source of alternating current, a thermal starting switch connected between the opposite ends of said filaments, and a heater for said switch connected in series with one of said anodes.

GEORGE E. INMAN.