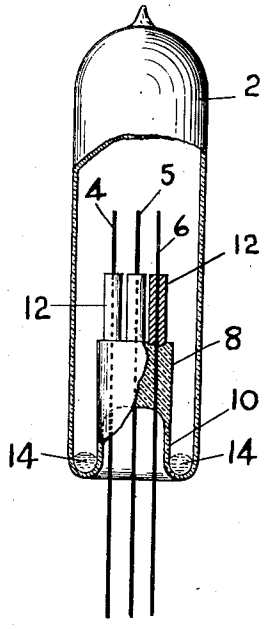
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W. H. T. HOLDEN

PROTECTIVE DEVICE

Filed July 25, 1921



INVENTOR

WILLIAM H.T. HOLDEN

BY

J. B. Ebert

ATTORNEY

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UNITED STATES PATENT OFFICE.

WILLIAM HENRY TOWNE HOLDEN, OF BLOOMFIELD, NEW JERSEY, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA.

PROTECTIVE DEVICE.

Application filed July 25, 1921. Serial No. 487,537.

My invention relates to devices for protecting electrical circuits from abnormal voltages, lightning and other hazards and more particularly it relates to protective devices of the type which utilize electrical discharges thru gases.

Some of the particular uses to which the present invention may be put may be mentioned as being an eliminant of foreign noises in telephone receivers and of the interfence factor in telephone circuits; as a protector on series lamp circuits to prevent high voltage on the series-transformer secondaries; for meter protection on high-tension circuits where there is danger of high potential being impressed on the meter thru failure of the instrument transformer; and for the protection of certain transformers and choke coils against high-frequency surges.

An object of the invention is the provision of an electrical protective device having improved current-carrying capacity.

Another object of the invention is the provision of a protective device wherein the heat generated by an electrical discharge will not damage the same.

A further object is the provision of an electrical discharge device in which a wide range of gases or vapors may be employed.

Other objects will be manifest from a reading of the following description.

A copending application of Shackelford and Holden, filed Feb. 15, 1921, bearing Serial Number 445,247, and assigned to the Westinghouse Lamp Company, discloses a discharge tube which employs a mixture of certain gases and vapors as the conducting medium between electrodes, whereby the tube is given a larger current-carrying capacity and has other valuable characteristics not possessed by tubes of the prior art. The present invention is an improvement over the device just described in that it provides a more durable discharge tube and one having an improved current-carrying capacity and operable with a greater variety of gaseous media.

Although the present invention is similar, in certain respects, to another disclosure contained in a copending application of Holden, filed May 5, 1921, Serial Number 467,137, and assigned to the Westinghouse Lamp Company, it is differentiated from the latter partly in being operable on electrical circuits of higher voltages.

Means for preventing excessive electric power from entering a receiving circuit may be provided by disposing, in shunt relation to the same, an element which has a very high impedance for voltage values below which the receiving circuit is designed to operate but which has a very low impedance and a high current-carrying capacity for voltages exceeding the normal operating voltage of the circuit. Such an element may be an electric discharge tube of the gas-filled type which, in accordance with the present invention, contains a plurality of electrodes.

The protective device which is an embodiment of the present invention employs a plurality of electrodes sealed into an envelope containing an ionizable gaseous medium which permits an electric current to flow therethrough when the voltage impressed on the circuit reaches an abnormal value. The present device provides a by-path of low resistance for the diversion of the excess current caused by an abnormal voltage.

Protective devices of the type herein contemplated should be designed to prevent the passage of current therethrough while the line voltage is normal but to break down at a definite predetermined voltage and to have a large current-carrying capacity when functioning. All of these desirable characteristics are attained in a device embodying my present invention.

The high impedance necessary to prevent a discharge through the protective device at normal line voltage is secured by the provision of suitable electrodes and gaseous medium therebetween. The nature of the electrodes and the gaseous medium provided are such that, when the protective discharge occurs, the tube assumes a low impedance and, therefore, a high current-carrying capacity.

The part played by the electrodes in changing the tube from a high to a low impedance is accomplished by maintaining the electrodes below an electron-emitting temperature while the line voltage is normal and causing them to be heated to an electron-emitting temperature when a discharge occurs. The emission of electrons from the electrodes diminishes the impedance of the

tube which thereby acquires a large current-carrying capacity. At the same time, the low impedance allows the tube to operate without an excessive generation of heat, whereby one of the objects of the invention is accomplished.

Any gas or vapor or a mixture of gases or vapors which will promote the discharge and be chemically inert towards the materials of the tube may be used as the conducting medium. The nature of the gasous filling will depend on the desired break-down voltage of the tube, since different gaseous media become conducting at different voltages. In the use of the majority of gases, the pressure in the tube is preferably below that of the atmosphere and may be varied to regulate the desired break-down of a tube provided with electrodes spaced a given distance apart. The pressure, however, is of such magnitude that it will not have a tendency to suppress the discharge.

The accompanying drawing constituting a part of this application is a side elevation, partly in section, of one embodiment of my invention.

In particular, the drawing shows a cylindrical glass envelope 2 containing electrically-conductive gaseous media such as argon and mercury vapor, and enclosing electrodes 4, 5 and 6 preferably closely and equally spaced substantially parallel to each other and formed, preferably, of a refractory metal, such as tungsten, sealed into a press 8, forming part of stem 10, in a manner employed in sealing leading-in wires into incandescent lamps. Surrounding the respective electrodes and having their ends seated into slight depressions in the end of press 8 are sleeves 12 formed of a refractory insulating material, such as that known commercially as lava. The sleeves 12 are provided for the purpose of preventing an electric discharge from passing between the electrodes at any point sufficiently near the press 8 to damage the same and also increase the length of the insulating surface therebetween. At 14, spaced from the electrodes, is indicated a pool of mercury which supplies the vapor constituting one of the conducting media.

In the application of these devices, two of the electrodes, preferably 4 and 6, are connected to the circuit to be protected while electrode 5 is grounded. Either the grounded electrode or one of the line electrodes, may, however, under conditions which will readily suggest themselves to those skilled in the art, be dispensed with, while, under some circumstances, four electrodes may be required to afford protection, such, for instance, as in the case of a three-phase circuit, one electrode being required for each of the three line wires and the fourth electrode being grounded. The electrodes 4, 5 and 6, as stated above, are equally spaced from each other, this arrangement being for the purpose of securing a more nearly simultaneous discharge from each line electrode to the grounded electrode than if they were not equally spaced.

While the line voltage remains below the predetermined voltage, my protective device does not function and the electrodes are below an electron-emitting temperature, but when the voltage reaches an excessive value likely to prove injurious to the circuit, a discharge takes place from electrodes 4 and 6 to electrode 5, and reversely, thereby providing a by-path or short-circuiting route for diverting the excess circuit from the line to be protected. In order to raise the electrodes to an electron-emitting temperature when the discharge begins, I prefer to use the simple method of constructing the electrodes of such materials and dimensions that they will possess a heat conductivity allowing them to be quickly raised to an electron-emitting temperature. The means utilized in this instance to raise the electrodes to that temperature is the electric discharge itself, altho other means may be employed to accomplish the same result.

It is known that, in an electric discharge, the cathode drop constitutes the largest factor of the total potential fall; and in my device the emission of electrons from the electrode which is the cathode at any instant greatly reduces the cathode drop and thereby greatly diminishes the impedance of the tube. The electrons also produce an intense ionization in the gaseous medium, which gives the same a large current-carrying capacity. The tube thereby operating with a low-voltage arc, the amount of heat liberated in the tube is very much less than if the electrodes were such as to remain below an electron-emitting temperature; and thereby a further object of my invention is attained.

It will thus be seen that, during the operation of my device, there is provided the combination of electron-emitting electrodes and a conducting gas which together provide a low-resistance arc which promotes the discharge.

While a patent to Newcomb, #1,289,521 assigned to the Westinghouse Electric and Mfg. Co. discloses the use of a plurality of electron-emitting electrodes, my device is differentiated from that disclosure in the nature and pressure of the gaseous medium and in the spacing of the electrodes; and the effect of these differences is that, in Newcomb's device, those elements tend to quench the discharge whereas, in my device, they promote the discharge.

I have described one device embodying my invention but it is obvious that many modifications may be made therein without the exercise of the inventive faculty; for instance, automatic means may be provided for heat-

ing the electrodes to an electron-emitting temperature when a discharge occurs instead of utilizing the discharge itself for that purpose. It is, therefore, to be understood that such modifications come within the scope of this invention and are intended to be embraced in the appended claims.

What is claimed is:

1. A protector for electric circuits comprising a gas tight envelope having a plurality of symmetrical electrodes sealed through one end thereof and extending thereinto in substantially parallel closely spaced relation, insulating sleeves about said electrodes adjacent the point at which the electrodes are sealed through the envelope, a filling of rare gas within said envelope at a reduced pressure and a quantity of mercury contained therein, said electrodes being of such size and of such material as to be heated to an electron emitting temperature when the break down voltage is exceeded, said electrodes being spaced sufficiently close together and the gas pressure being of such magnitude that the electron emission from said heated electrodes substantially reduces the impedance of the device.

2. A protector for electric circuits comprising a gas tight envelope, a stem having a press sealed in one end thereof, a plurality of symmetrical electrodes sealed through said press and extending thereabove in substantially parallel relation, insulating sleeves encircling said electrodes adjacent said press, a filling of a monatomic gas within said envelope at a reduced pressure and a quantity of mercury contained therein, at least two of said electrodes being of such size and material as to become heated to an electron emitting temperature when the break down voltage is exceeded and said electrodes being spaced sufficiently close together and the gas pressure being of such magnitude that the electron emission from said heated electrodes materially reduces the impedance of the device.

In testimony whereof, I have hereunto subscribed my name this 23d day of July, 1921.

WILLIAM HENRY TOWNE HOLDEN.