Feb. 1, 1938. J. SLEPIAN ET AL. 2,106,857

VAPOR ELECTRIC DEVICE

Filed July 26, 1935

Fig. 1.

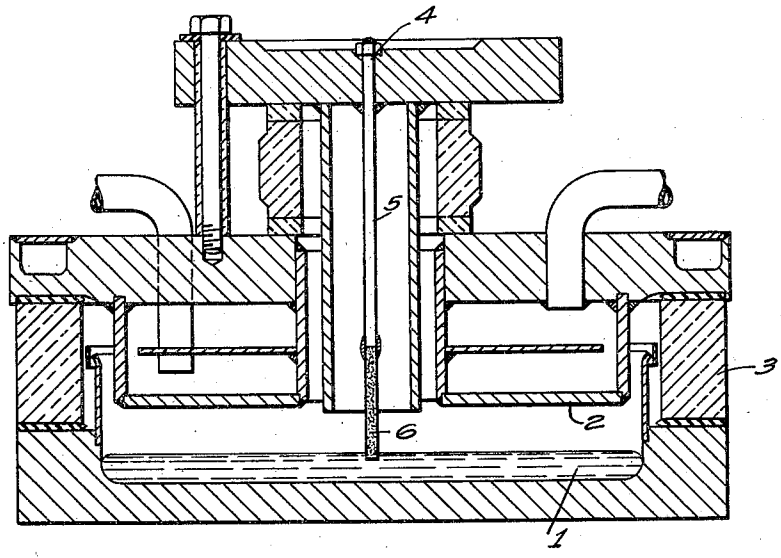
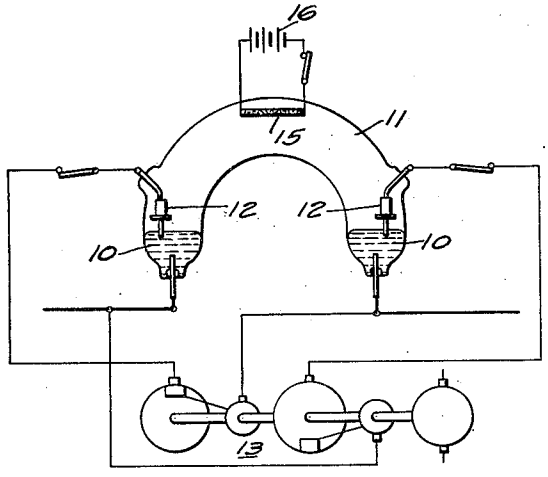


Fig. 2.



WITNESSES:

E. A. McCloskey.

S. A. Strickler

INVENTORS

Joseph Slepian and

Leon R. Ludwig.

BY O. B. Buchanan

ATTORNEY

Patented Feb. 1, 1938 2,106,857

UNITED STATES PATENT OFFICE

2,106,857

VAPOR ELECTRIC DEVICE

Joseph Slepian, Pittsburgh, and Leon R. Ludwig, Forest Hills, Pa., assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 26, 1935, Serial No. 33,292

6 Claims. (Cl. 250—27.5)

Our invention relates to a vapor electric device and particularly to means for maintaining the valve action of the electrodes of such a device during periods of application of inverse potential to one of the electrodes.

In the application of arc-type valve devices, it is desirable to have one or more of the electrodes withstand negative potential or inverse potential for definite periods without the formation of an inverse arc to the electrode. This is particularly desirable in such devices as Ignitron inverters, where the cathode which is usually composed of mercury or vaporizable compounds is required to withstand a high negative potential during the major portion of its inactive period. Also, in mercury arc devices in which all of the electrodes are composed wholly or in part of mercury, it is desirable that one or all of the electrodes should be capable of withstanding negative potential without breaking down.

It has been observed that when substantially pure mercury is used for forming the electrodes and the devices are properly treated out, the electrodes will successfully withstand periodic or sustained applications of inverse potential without the formation of an inverse arc so that the device is said to have a high negative reluctance. However, in operation, the electrodes soon become polluted or dirty after this has occurred, the electrodes have a very much lower negative reluctance.

We have discovered that this lowered negative reluctance is apparently caused by accumulations of dirt or other impurities on the surface of the electrodes. It has been observed that when a mercury electrode covered with patches of compounds such as nitrogen compounds is exposed to an inverse potential, the space discharge to the polluted electrode concentrates at the patches of impurities, which concentration tends to produce a cathode spot on the involved electrode and frequently results in an inverse arc or backfire originating at the dirty spots.

It is accordingly an object of our invention to provide a vapor electric device which is maintained substantially free of arc backs. We have found that this can be accomplished by introducing into the device a quantity of reducing gas which will combine with the impurities such as nitrogen and other material normally found in or evolved in such converters. This gas should be of a kind such as carbon monoxide or hydrogen which forms stable compounds with the impurities.

In certain types of vapor electric devices such as make-alive valves, it is frequently desirable to place the anode in proximity to and directly exposed to the cathode and then to strongly cool the anode so that the anode is in effect a condenser for the vapor given off by the cathode. Such devices have heretofore had an undesirable backfire rate as the anode surface is wholly or partially covered with condensed mercury and any impurities in the mercury tend to remain on the anode surface providing a patch having a low negative reluctance.

By introducing a quantity of reducing gas into the device these impurities may be combined into stable compounds which have no effect on the converter. Preferably, a quantity of reducing gas such as carbon monoxide is provided slightly in excess of the quantity of residual foreign gases usually found in such a device.

As the carbon monoxide combines with impurities, such as nitrogen, in the device, it is desirable to replace the combined material with fresh gas. While, of course, this could be accomplished by means of suitable containers connected to the device, we prefer to evolve the replacement gas inside the converter. This can be accomplished by providing in the converter a quantity of material which, during normal operation of the device, evolves carbon monoxide.

We have found that the composition resistance material known as "Zircon", when heated, will evolve a satisfactory amount of carbon monoxide to maintain the monoxide pressure in the device.

Other objects and advantages of our invention will be apparent from the following detailed description taken in conjunction with the accompanying drawing, in which

Fig. 1 is a schematic sectional elevation of a make-alive valve embodying our invention, and

Fig. 2 is a similar view of a vapor arc device embodying the modified form of our invention.

In the apparatus according to Fig. 1, the valve comprises a cathode 1 of mercury or mercury compounds, an anode 2 directly exposed to the vapor evolved in the cathode 1, said anode 2 being strongly cooled so that it acts as a condenser for the vapor. The valve container is completed by a suitable ring 3, preferably of insulating material or any suitable material insulated from the anode and cathode and in vacuum tight relation thereto. A suitable excitation electrode such as a make-alive electrode 4 having a stem 5 of conducting material and a tip 6 of resistance material is placed in contact with the cathode 1 and by the passage of current therethrough operates to create a cathode spot and control the

normal conducting arc in the device. During the operation of this device, the cooled cathode 1 is covered wholly or in part with condensed mercury and as the anode 2 is periodically required to withstand inverse potential, we provide a filling of carbon monoxide or other reducing gas for combining impurities found in the container, preferably this filling of carbon monoxide is at a pressure several times, for instance 5 to 10 times, the pressure of the normal residual gases found in the device. This carbon monoxide combines with impurities already in or evolved in the device to produce stable compounds which are not detrimental to the operation of the device.

During the operation, the carbon monoxide or other reducing gas is consumed so that the pressure is diminished. If the valve device is substantially leak-proof and the device has been thoroughly treated out, the diminished gas pressure may be permitted. For most devices, it is desirable to maintain the quantity of reducing gaseous material in the converter. In order to maintain the pressure, fresh gas must be added from a suitable source.

We have found that the make-alive electrode 4 may be composed wholly or in part of such gas evolving material. The gas may be supplied from a suitable container such as a pressure flask connected to the container by a valve which permits only a slight flow of gas into the container. The gas may also be evolved in the container and thus eliminate the complication of flask and valves. This may be accomplished by placing a quantity of material in the container which will evolve the necessary gas preferably by suitable excitation such as the application of heat or the passage of electric current therethrough. We have found that the resistance compound, composed essentially of zirconium silicate with a clay binder and a small percentage of lamp black to control the conductivity, sold under the trade name of "Zircon" will, when heated, by the passage of make-alive current therethrough evolve a sufficient quantity of gas to replace that consumed in the operation of the device and thus maintain the gas pressure substantially constant. This resistor material may be utilized as the make-alive tip 6 or inserted between the stem 5 and a tip 6 of suitable resistance material such as carborundum or boron-carbon compositions such as boron carbide.

Since the carbon monoxide or other reducing gas consumes the deleterious compounds normally found in the device, the mercury surfaces both of the cathode and of the condensed mercury on the anode will be kept substantially pure so that the negative reluctance is not reduced and there will be little tendency for the formation of inverse arcs in the device.

In the modification according to Fig. 2, a plurality of mercury electrodes 10 are placed in a suitable evacuated container 11 and one or both of the mercury electrodes 10 are provided with suitable excitation means such as make-alive electrodes 12 fed by controller 13 for providing a cathode spot at the desired time. Heretofore, such devices have been very unreliable in operation as the mercury surfaces soon become contaminated with foreign material and of very low negative resistance with consequent frequent breakdown and undesired arcs formed in the device. We have found that by adding a quantity of reducing gas, such as carbon monoxide, the mercury surfaces are maintained substantially pure and clean and the negative reluctance of the device is not impaired.

In the operation of this device, it is desirable to renew or maintain the quantity of reducing gas in the container. This may be easily accomplished by providing a quantity of suitable material inside the container and providing means for heating the material whenever it is desired to evolve more of the reducing gas. While any suitable means may be provided for heating the gas evolving material, we prefer to form the gas evolving material into a suitable resistance body 15 and to heat the same by passing an electric current from any suitable source such as a battery 16.

While, for purposes of illustration, we have shown and described particular embodiments of the invention, it will be apparent to those skilled in the art that many changes and modifications can be made thereon without departing from the true spirit of our invention or the scope of the appended claims.

We claim as our invention:

1. An electric valve comprising a mercury cathode, an anode closely spaced from and directly exposed to said cathode, said anode serving as a condenser for the vapor emitted from said cathode, said anode-condenser during normal operation of said valve being subject to periods of inverse potential and means for maintaining the negative reluctance during said periods, said means including a quantity of carbon monoxide at a pressure of several microns in said valve, a make-alive electrode in said valve, at least a portion of said make-alive electrode consisting of a material which will evolve carbon monoxide on the passage of current therethrough.

2. An electric valve comprising a substantially evacuated container, a vaporizable cathode in said container, a strongly cooled anode closely spaced with respect to said cathode so that said cooled anode condenses the vapor given off by the cathode whereby said anode is normally at least partially covered with cathode material and a quantity of carbon monoxide in said container, said carbon monoxide being in quantity greater than the residual foreign gas in said container, and means for replenishing the carbon monoxide in said container.

3. An electric valve comprising a substantially evacuated container, a pair of main electrodes in said container each of said electrodes, during normal operation, being composed at least in part of mercury, an auxiliary electrode associated with one of said main electrodes, said auxiliary electrode being adapted for initiating a cathode spot on said main electrode, and a filling of carbon monoxide in said container, said carbon monoxide having a pressure five to ten times greater than that of the residual foreign gases in the container, and means actuated by current flow in said auxiliary electrode for replenishing the carbon monoxide.

4. An electric valve comprising a substantially evacuated container, a pair of main electrodes in said container each of said electrodes, during normal operation, being composed at least in part of vaporizable catnode material, an auxiliary electrode associated with one of said main electrodes, said auxiliary electrode being adapted for initiating a cathode spot on said main electrode, and a filling of carbon monoxide in said container, said carbon monoxide having a pressure five to ten times greater than that of the residual foreign gases in the container, and means actuated by

current flow in said auxiliary electrode for replenishing the supply of carbon monoxide in said container.

5. An electric valve comprising a substantially evacuated envelope, at least two main electrodes therein both of which normally have at least a portion of their surface covered with mercury, at least one of said electrodes being required to withstand inverse potential without breaking down, a quantity of carbon monoxide in said envelope, and means including a carbon monoxide evolving material for maintaining the quantity of carbon monoxide.

6. A vapor electric valve comprising a pair of main electrodes, at least the surface of said electrodes being covered with mercury, a make-alive electrode for initiating current flow in said valve, means for maintaining the negative reluctance of said valve comprising a quantity of carbon monoxide in the space between said electrodes, and means associated with said make-alive electrode for maintaining the quantity of carbon monoxide.

JOSEPH SLEPIAN.
LEON R. LUDWIG.