

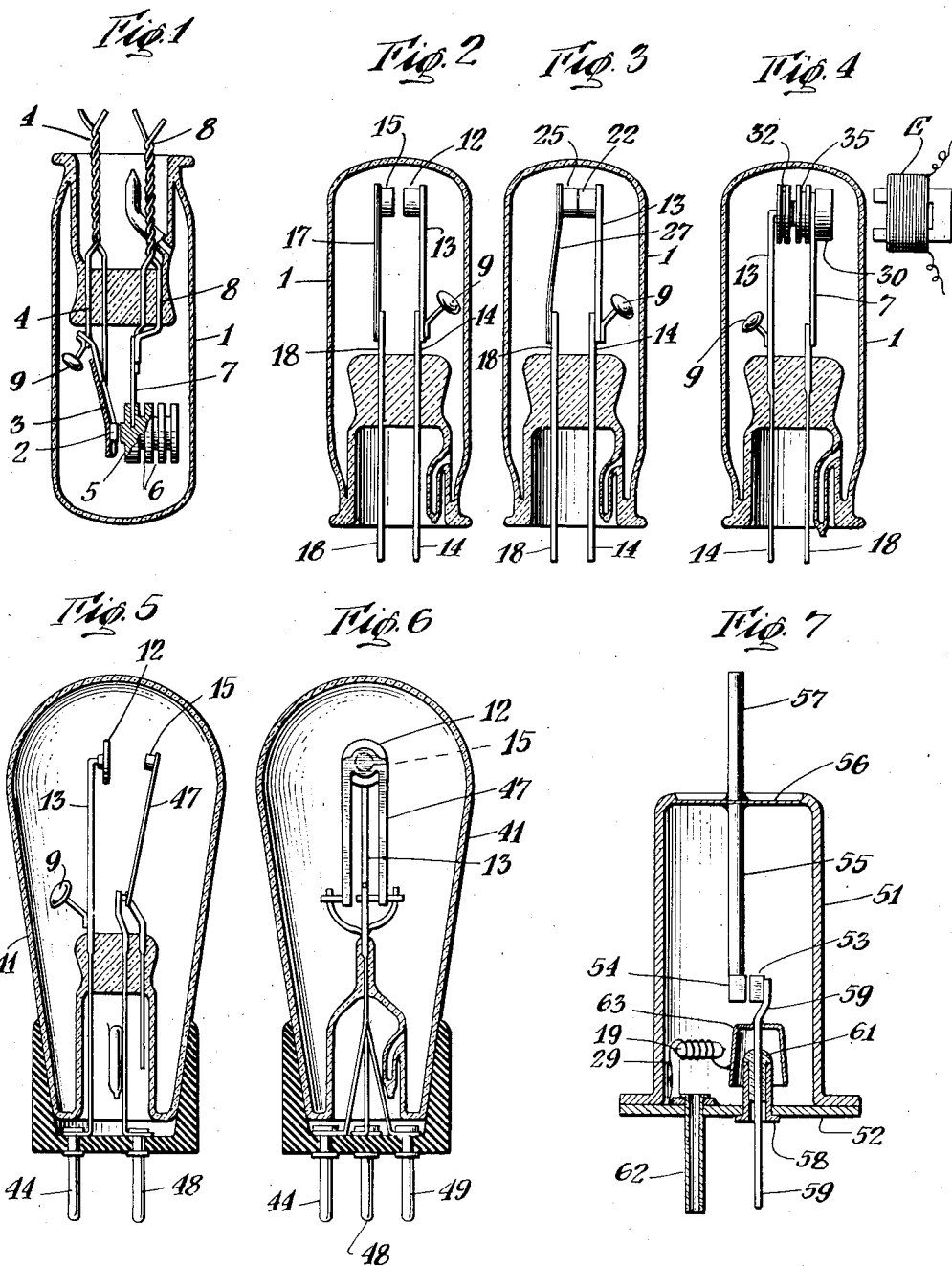
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ELECTRICAL SWITCH

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ELECTRICAL SWITCH

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This invention relates to electrical switches and circuit opening and closing contact devices.

The general object of the invention is the provision of devices of this character of novel operation and design, which are capable of breaking currents of large magnitude with negligible deterioration of the electrical contacts, which provide the advantages of mercury contacting devices without the disadvantages heretofore encountered in the use of such devices, which insure safe and dependable operation over long periods of time and which may be easily and economically manufactured.

A specific object of the invention is the provision of a time delay relay suitable for operation in a thermal circuit breaker.

Another object is the provision of a thermostatically operated switch.

A further object is the provision of a gravity operated switch.

Still another object is the provision of an electro-magnetically operated switch.

Other objects will be apparent from the disclosure and from the drawing in which

Fig. 1 illustrates a device of the invention in which the movable contact is operated by gravity;

Fig. 2 shows a device in which the movable contact is mounted on a thermostatic member;

Fig. 3 shows a time delay relay or circuit breaker, the movable contact being mounted on a thermostat adapted to move away from the fixed contact and open the circuit when excess current is developed;

Fig. 4 illustrates a magnetically operated circuit breaker, the movable contact being adapted to open or close the circuit under magnetic influence;

Figs. 5 and 6 are views of another form of time delay switch in which the current circulating through the thermostat metal causes movement thereof to open or close the circuit;

Fig. 7 shows an embodiment of the invention in a metal tube housing.

The present invention comprises an electrical circuit opening and closing device housed in a sealed chamber, which has been highly evacuated and which contains a mercury vapor atmosphere. At least one of the circuit closing contacts is formed of a metal which amalgamates with mercury, so that due to the presence of the mercury vapor, and the exclusion of air and gases from the evacuated chamber, the contact has at all times a protecting film of mercury on its surface. Preferably, one or both of the contacts has

an intimately joined backing of a relatively large mass of high heat conducting metal, having a heat capacity adequate to maintain the contact temperature below the point where complete volatilization of the mercury might take place and capable of absorbing and dissipating the energy losses in operation.

The advantages of employing mercury as an electrode in the breaking of a contact or in opening an electrical circuit have long been known, and the use of liquid mercury (in a gaseous atmosphere to prevent maintenance of an arc) to effect such breaking, has always been considered necessary. In prior devices, employing a mercury contact in a sealed or housed chamber, the current has been discharged through a definite path length of liquid mercury. Such prior devices have employed a cooperating contact of a metal not readily amalgamable with mercury, usually iron or nickel, and in order to avoid the production of a mercury arc, have usually employed an atmosphere of hydrogen. The device of this invention does not employ liquid mercury as a contact element and the internal resistance drop characteristic of devices where the current path is through a column of liquid mercury is eliminated. Both contacts of my present device are formed of solid metal, at least one is movable and the mercury is actively present only as a film which amalgamates with and is absorbed on to the surface of one or both of the contacts, thereby providing negligible contact resistance.

The rapid current-breaking operation of mercury type switches is also observable in the switch of this invention, but due to the low electrical resistance at the contact surfaces and the high heat capacity of the contacts, less mercury vapor is observable. The snap switch action, characteristic of the present device, even with an extremely low speed of contact movement, is apparently due to the presence of a surface mercury film on the contact; due to the low ionization potential of mercury, any sparking at the time the circuit is opened, will tend to take place through the mercury vapor rather than through the contact metal vapor; due to the high heat conductivity and capacity of the contacts, an immediate condensation and de-ionization of the mercury vapor obtains. Ordinarily, in liquid mercury switches, a high pressure inert atmosphere is necessary in order to prevent the mercury from maintaining an arc.

The use of a relatively large mass of metal for one or both of the contacts is highly desirable where high power is to be controlled. The high

heat capacity provided by the metal is necessary to avoid rise in temperature of the contacts to a point where an excessive amount of mercury is volatilized from the contact surface. This metal member should also preferably have the maximum radiating area so as to be able to rapidly dissipate the energy lost in making and breaking contact.

While in most cases it will be desirable to form the contacting surfaces of both contacts from metals of the first periodic group which readily amalgamate with mercury such as copper, gold, silver or alloys thereof, only one of the contacts may be formed from such metal and the co-operating contact may be formed from a refractory metal such as tungsten or molybdenum. One form of contact which tenaciously holds a film of mercury is a large copper element having a gold plated working face. During the evacuation of the device, the contacts as well as other metal parts are heated to as high a temperature as possible in order to drive out any occluded gases, and this heating tends to make the plating more adherent. The plating may be electro-deposited or rolled on, in accordance with well known practice.

In order to describe various embodiments of the invention, reference is made to the drawing, in which, unless otherwise indicated, similar numerals indicate similar parts.

In Fig. 1, the highly evacuated sealed glass bulb 1, housing stationary copper contact 2, mounted on heavy heat dissipating support member 3, is connected to terminal 4. The movable copper contact 5, having a large flanged heat dissipating mass 6, is supported on molybdenum spring 7, which is in turn suspended from and connected to terminal 8. Mercury is held in glass and nickel cylinder 9. In the manufacture of the device, the mercury remains in the cylinder until after the tube has been evacuated, after which time the cylinder is inductively heated by means of high frequency, causing the glass to soften and the pressure of the mercury vapor forcing the cylinder open so that the mercury is condensed on the walls of the tube. The evacuation is preferably of a high order in order to free the tube of gases which might cause premature sparking or maintenance of an arc. After the tube has been sealed off, the mercury will commence to form an amalgam with the copper contacts, the amalgamation taking place for a considerable depth. The heavy weight 6, provides gravity operation and contact is made or broken by merely turning the bulb to the desired position.

In Fig. 2, movable silver faced contact 15, is mounted on thermostatic metal support 17, welded to terminal 18, and under the influence of heat will move over to make contact with silver molybdenum contact member 12, mounted on support 13, welded to support 14.

In Fig. 3, gold plated copper contact 25, is mounted on bent bimetallic thermostatic element 27, and is normally positioned to maintain a closed circuit in juxtaposition with stationary tungsten contact 22. When excess current is developed so that the temperature of thermostatic element 27, is sufficiently raised, the switch will operate as a thermal circuit breaker, contact 25 moving away from contact 22 and opening the circuit.

Fig. 4 shows a circuit breaker operated externally by means of an electromagnet. Movable tungsten silver contact 35, brazed to iron weight 30, is normally in juxtaposition with heavy heat-

radiating silver contact 32. When excess current flows through electromagnet E, the iron weight 30, carrying contact 35, is attracted away from stationary contact 32, thus breaking the circuit.

Figs. 5 and 6 are side and front views respectively, of another form of thermostatically operated switch in which the cross section of the thermostatic metal loop member 47, is such as to give rapid heating when current is discharged through each leg of the loop. Prong 44, is the terminal for stationary contact 12, and prongs 48 and 49 are terminals for supplying current to thermostatic member 47.

The metal tube type embodiment of the invention, as shown in Fig. 7, offers the most practical structure where mechanical strength is desired. The construction is similar to that used in metal vacuum tubes, the case 51 being welded to bottom steel disc 5a. Metal eyelet 58, is inserted into a hole punched in the disc 52, and welded into place to form a bottom header for the tube. The lead rod 59, together with a small cylinder of glass 61, is inserted in the eyelet. Metal exhaust tubulation 62, is welded into place. Movable silver contact mounted on rod 55, which is welded to the thin top, 56, of metal tube 51, is controlled by the movement of terminal rod 57, welded to the outside of tube 51, directly opposite rod 55. Capsule 19, containing mercury is heated to the bursting point by short-circuiting of tungsten wire 29, connected to base 52 and shield 63. The circuit may be closed by moving rod 57 so as to cause contact 54 to move over against stationary contact 53, mounted on terminal rod support 59. If magnetic operation of the contact is desired, the actuating magnetic core can be mounted inside of the metal tube with the magnetic coil externally mounted.

While Fig. 7 is the only form of metal tube structure shown in the drawing, the assemblies shown in Figs. 1-6 can also be used in metal housings.

At the time the mercury is volatilized into the container, the contact becomes coated with condensed mercury which amalgamates with the contact surface. Even though at normal room temperatures, the pressure of the mercury atmosphere in the bulb is only 0.0012 mm., there is a continual migration of mercury to amalgamable metal parts, as can be observed by the change in color of the copper heat absorbing pieces with time. The initial condensation of the volatilized mercury on the contacts reduces very materially the time that would otherwise be required to completely amalgamate the contact surface sufficiently to give the surface tension and contact breaking effects of a mercury film. The gold plated contacts amalgamate the most rapidly, due to the high affinity of gold for mercury.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which is formed from a metal amalgamable with mercury, a mercury atmosphere in said chamber and a film of mercury on at least one of said contacts.

2. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which has a working face comprising an amal-

gan of mercury, and a mercury atmosphere in said chamber.

3. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which has a working face comprising an amalgam of mercury with one of the metals gold, silver, or copper, and a mercury atmosphere in said chamber.

4. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which is formed from a mass of high heat conducting metal having a working face comprising a mercury amalgam, and a mercury atmosphere in said chamber.

5. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is gravity controlled and at least one of which is formed from a metal amalgamable with mercury, a mercury atmosphere in said chamber, and a film of mercury on at least one of said contacts.

6. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is thermostatically controlled, and at least one of which is formed from a metal amalgamable with mercury, a mercury atmosphere in said chamber, and a film of mercury on at least one of said contacts.

7. An electrical make and break device comprising an evacuated sealed chamber having therewithin a pair of solid cooperating contacts, at least one of which is electro-magnetically controlled, and at least one of which is formed from a metal amalgamable with mercury, a mercury atmosphere in said chamber, and a film of mercury on at least one of said contacts.

8. An electrical make and break device comprising an evacuated sealed envelope having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which is formed of a metal amalgamable with mercury, a mercury atmosphere in said chamber and a substantially immobile thin film of mercury on at least one of said contacts, terminals connected with said contacts extending from said envelope.

9. An electrical make and break device comprising an evacuated sealed metal chamber having therewithin a pair of solid cooperating contacts, at least one of which is movable and at least one of which is formed from a metal amalgamable with mercury, a mercury atmosphere in said chamber, and a film of mercury on at least one of said contacts.

10. An electrical circuit opening and closing device comprising a highly evacuated sealed chamber containing a mercury vapor atmosphere, a pair of cooperating contacts therein, at least one of which is movable, said contacts having working faces of mercury amalgamated with a metal of the gold, silver, copper group, said contact faces being backed by relatively large heat dissipating masses of metal adapted to cool said contacts during operation so as to prevent complete volatilization of mercury therefrom.

11. An electrical circuit opening and closing device comprising an evacuated air-tight chamber containing a mercury vapor atmosphere, a pair of solid hard cooperating contacts, at least one of which has a working face capable of tenaciously holding thereon a thin film of mercury, a mass of high heat-conducting metal in direct intimate contact with the circuit-breaking contact surfaces and having a heat capacity adequate to maintain the contact temperature below the point where complete volatilization of the mercury would take place, and capable of absorbing and dissipating energy losses arising during operation of the device.

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