Feb. 6, 1951 C. E. GEHRAND 2,540,479

MERCURY SWITCH RELAY

Filed Oct. 8, 1947

Fig-1

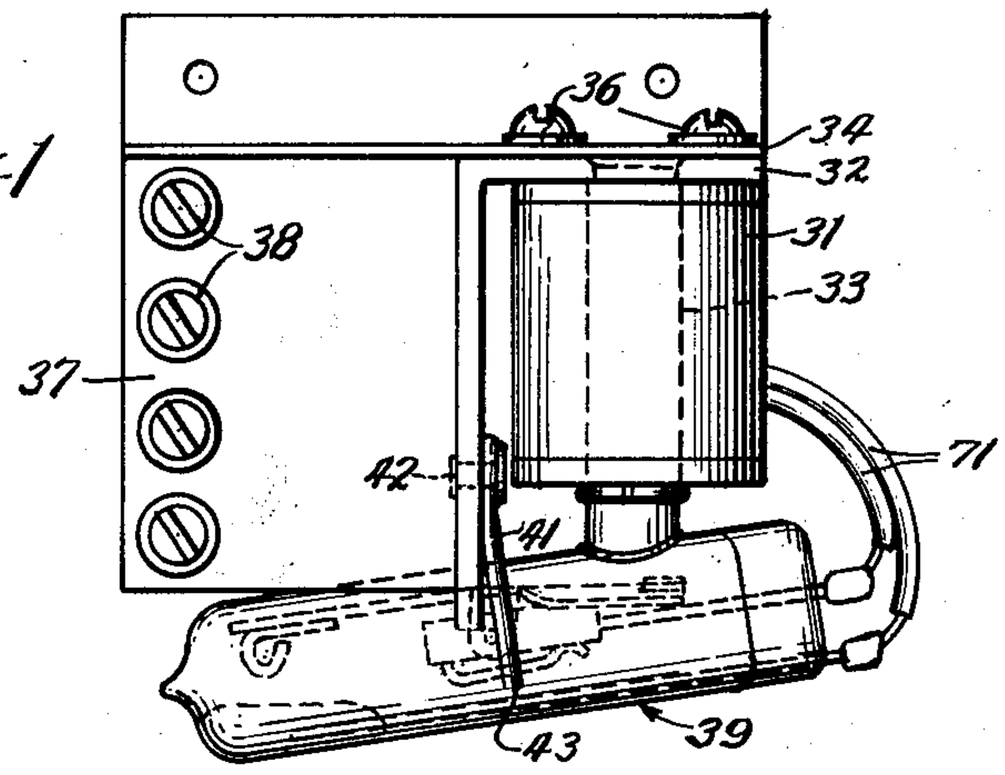


Fig-2

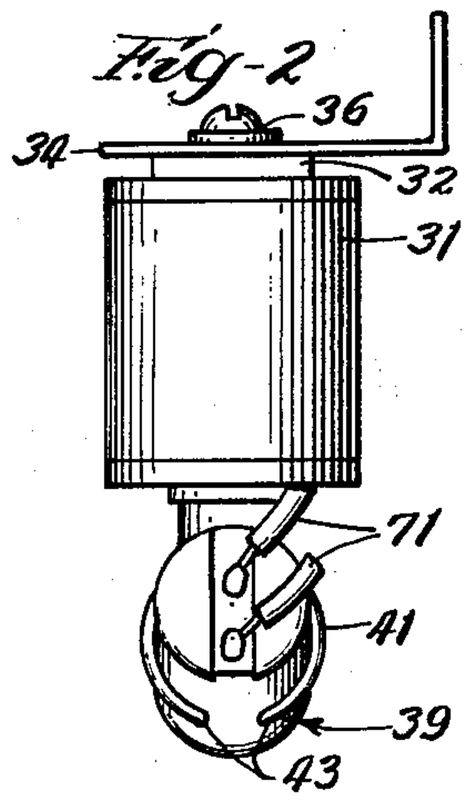


Fig-3

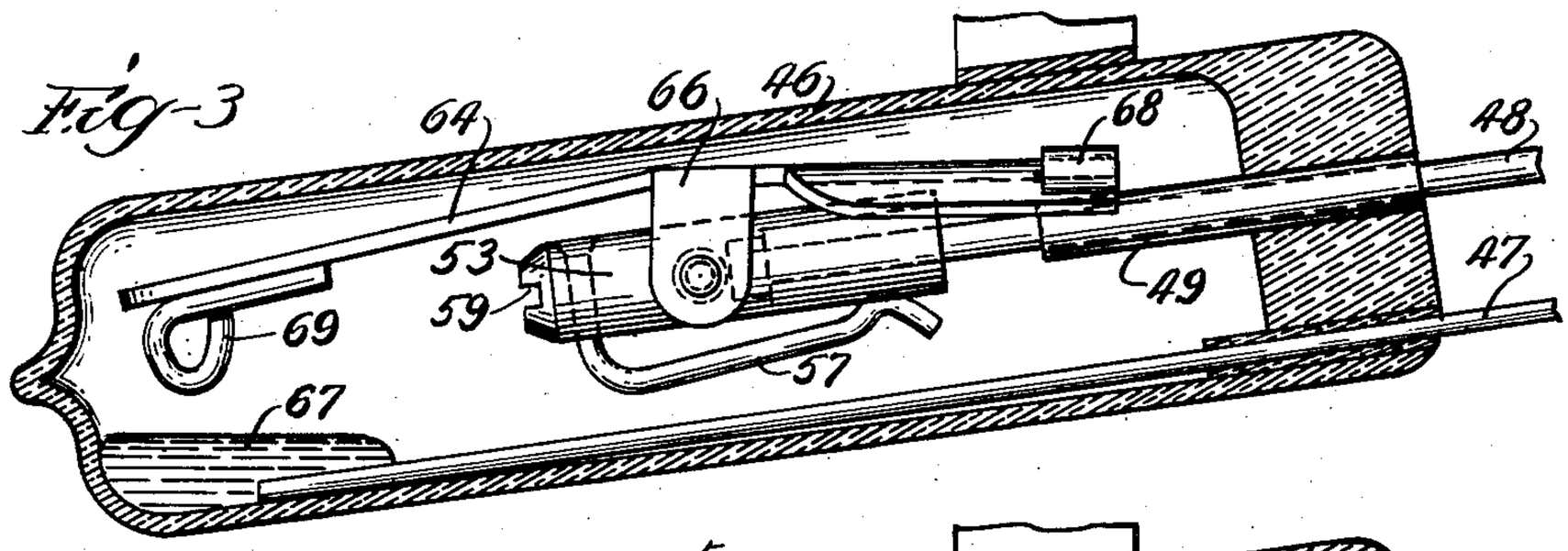


Fig-4

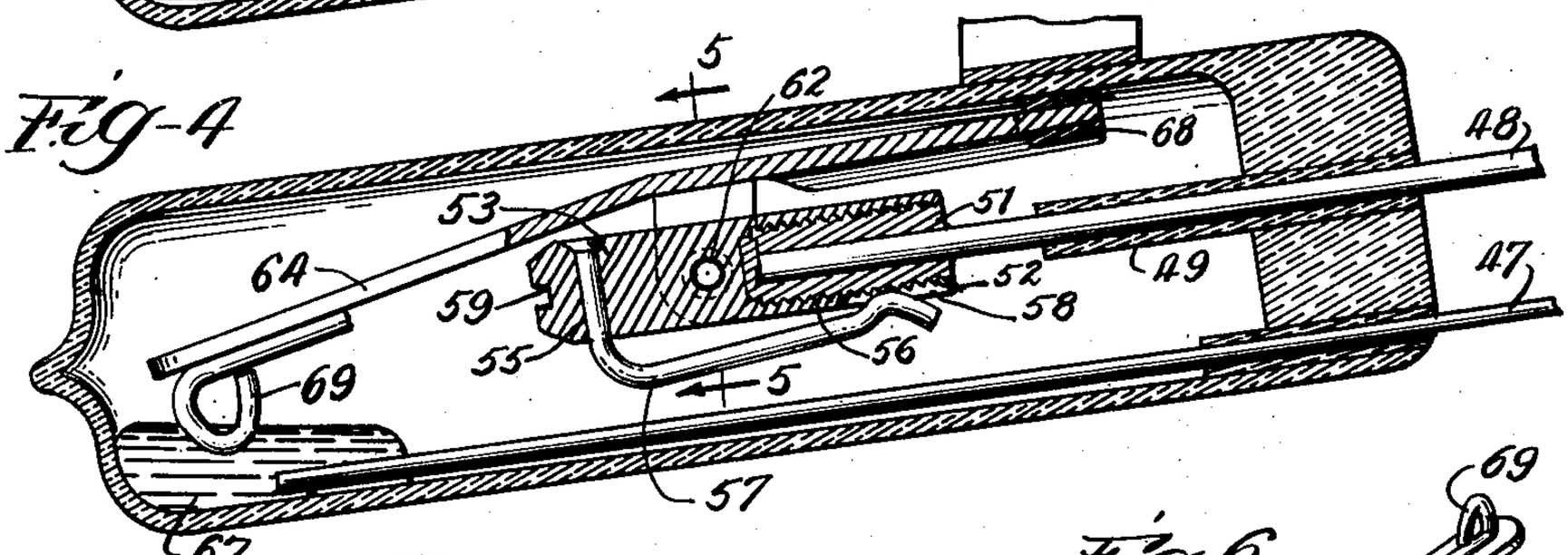


Fig-5

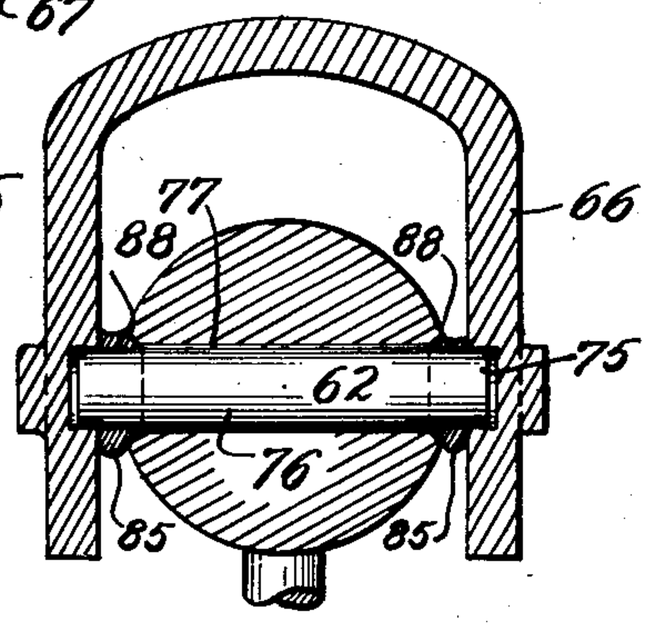
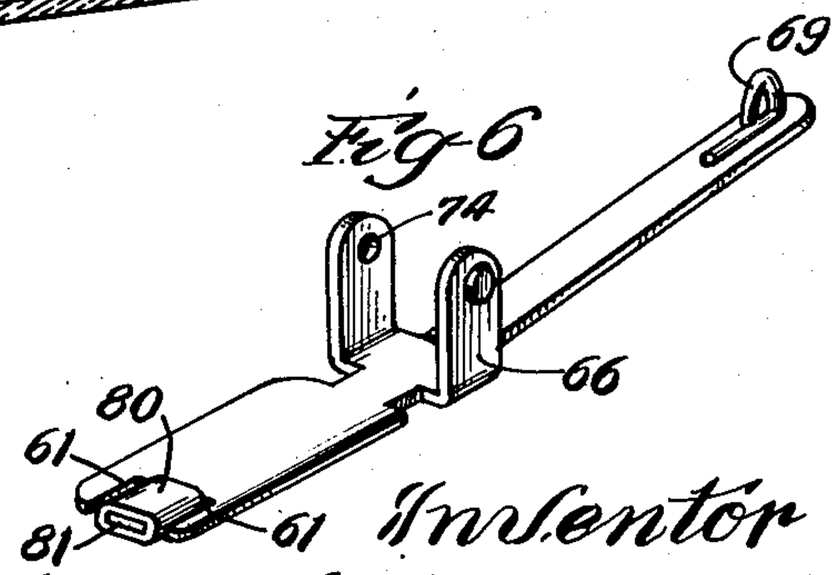


Fig-6



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Patented Feb. 6, 1951 2,540,479

UNITED STATES PATENT OFFICE

2,540,479

MERCURY SWITCH RELAY

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Application October 8, 1947, Serial No. 778,631

4 Claims. (Cl. 200—152)

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This invention relates to mercury switch relays and has as its principal object to provide a low resistance, non-arcing, hinged, electrical joint for a contact element.

Generally speaking, this is accomplished by making a hinged joint for the contact element swing about a bearing member such as a pin of copper or the like dipped in mercury to enclose it in a thin layer of amalgam and mercury which at once lubricates the hinge and makes a low-resistance, non-arcing electrical connection through it.

Further objects and advantages of the invention will appear as the disclosure proceeds and the description is read in connection with the accompanying drawing in which

Fig. 1 is a side view of a mercury switch relay embodying the invention;

Fig. 2 is an end view looking from the right in Fig. 1;

Fig. 3 is a longitudinal section through the mercury switch envelope showing the working parts in elevation;

Fig. 4 is a longitudinal section through the relay including the working parts;

Fig. 5 is a transverse section taken on the line 5—5 of Fig. 4;

Fig. 6 is a perspective view of the hinged contact bearing arm forming a part of the relay.

These drawings and the corresponding description are used for the purpose of illustrative disclosure only, and are not intended to impose unnecessary limitations on the claims.

General description

This invention is an improvement on that disclosed in the application of Larson Serial No. 775,220, filed September 20, 1947, now Patent No. 2,491,986, which application is a continuation-in-part of Larson application, Serial No. 432,297, filed February 25, 1942, now abandoned, and on that account the drawings and the general disclosure are made to follow the Larson disclosure.

The relay is magnetically operated by a mechanism including a coil 31 having an L-shaped iron circuit 32, one leg of which extends over the top of the coil 31 into contact with an iron core 33, and the other leg of which extends downwardly parallel to the iron core 33 and is concave at its lower end to receive the mercury switch, generally indicated by 39. The coil 31 and the iron circuit 32 are mounted upon a supporting flange 34 by screws 36. A terminal panel 37 is shown attached to flange 34 and carries terminal posts 38.

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The mercury switch 39 is supported against the core 33 and the iron circuit 32 by a clamp 41 attached to the iron circuit by a rivet 42 and having curved legs 43 extending around and firmly engaging the switch 39 to hold it in place.

The mercury switch includes an envelope 46 (see Figs. 3 and 4) through the base of which are sealed electrodes or lead-ins 47 and 48 shown encased partly in glass sleeves 49.

The lead-in or electrode 47 extends along the bottom of the envelope 46 to cooperate with a mercury fill 67, normally retained in the position shown in Figs. 3 and 4 by tilting the envelope as shown. The electrode or lead-in 46 extends along the axis of the envelope 46 to about the mid-portion where it is fitted with a metal collar 51, shrunk or welded on and threaded on its outside as indicated at 52.

A cylindrical metal cap 53, having a central threaded bore 56, is screwed over the collar 51, as shown best in Fig. 4, and made fast by a locking device consisting of a spring wire 57, having one end made fast in a transverse bore 55, and the other end bent to extend through a slot 58 into contact with the threads 52 of the collar 51. The left end of the cap 53 is provided with a kerf 59 to receive a screw driver or other tool. The assembly of those parts will be apparent from the drawing, as will also the fact that the locking device will retain the cap 53 in adjusted position with respect to the vertical plane extending through the axis of the lead-in 48.

The electrical circuit through the mercury switch is made and broken by contact element 69, carried by a contact arm 64, hinged on the cap 53 and operated in one direction by the magnet shown in Fig. 1. The hinge connection for the contact arm is the important feature of this invention, and here is shown in an embodiment especially suitable for the switch disclosed in the aforementioned application of Larson.

The contact arm 64 is provided with a pair of downwardly directed, spaced apart fingers 66, which span the cap 53 and are spaced from its adjacent portions so as to prevent friction between those fingers and the adjacent portions of the cap. Adjacent to the free end of each finger 66, it is punched out or counter-sunk at 74 to receive the adjacent end 75 of a hinge pin 76 extending through a transverse bore 77 in the cap 53, and in this embodiment, the fingers 66 are bent towards each other and compressed against the ends 75 of the pin 76 to make them grasp it and bind it securely.

The pin 76 is preferably made of copper or

like metal and fitted within the bore 77 with a clearance of .003 to .004 of an inch, and before being inserted into the bore 77, it is liberally dipped in mercury, whereby it may be said to be "pre-wetted," for apparently the mercury "wets" the copper, as it is said by metallurgists, and forms with its outer portion an amalgam enclosing the pin, and itself enclosed in an excess of mercury which forms at once a lubricant for the hinged joint and a low resistance electrical connection through it. At least, this is believed to be the explanation of the character of joint formed by pre-dipping the copper pin in mercury and inserting it in the bore 77 with a clearance on the order of .003 to .004 of an inch. The probable basis for this explanation appears in "Encyclopaedia Britannica," 14th ed., page 724, vol. I.

Because the relay is operated magnetically, the contact arm 64 is made of magnetic material such as iron, or its alloys, or a metal of the iron group, and proper balance is attained by arranging the axis of the pin 62 in the field of the iron circuit substantially as shown.

In order to prevent undesired magnetic effects from interfering with the quick operation of the switch, the thimble 53, and the collar 51, should be made of nonmagnetic material such as is commonly known as 18 and 8 chrome-nickel-iron alloy, perhaps most generally referred to as stainless steel.

The right end of the contact bar 64 in Figs. 3 and 4, or the left end as it appears in Fig. 6 is notched at 61 to receive a silencer 80. It is shown as a flattened tube forced over a tongue 81 formed by the slots 61. This silencer may be of any suitable material that does not amalgamate with the mercury or injure the envelope 46. In this instance, it is made of silicone (polysiloxane) rubber which is trimethyl silicone available in several colors and white is preferable. This material stands high temperature, is not affected by mercury, and is sufficiently resilient to cushion the blows of the bar 64 against the envelope 46 and the insulation 49. Other rubber compositions and the like will be readily found available.

The gist of this invention appears to reside in making the hinged joint for the contact element swing about a bearing member amalgamated with mercury and presenting sufficient liquid to lubricate the hinge and form the low resistance electrical conductor through it. Whether the amalgam is sufficiently liquid to do this, or contains excess mercury sufficient to do this would appear to be immaterial. The proper characteristics are illustrated by pre-dipping a copper pin in mercury.

Other forms of hinged joint will readily occur to skilled designers. Some will use needle bearings, some pin bearings, some pintle bearings, and some pintles formed by balls or hemispherical elements, but these and others are regarded as matters of choice.

In addition to the metals commonly known to amalgamate with mercury, there are many alloys and platings that are amalgamable and suitable. Mention is here made of a few selected ones: (1) Everdur, which is an alloy containing approximately 96% copper, 3% zinc, and 1% manganese, and characterized by high tensile strength on the order of 140,000 pounds and low conductivity on the order of 6% of copper. The high tensile strength is important when the pin is assembled as here described, for that will make it resist bending which might interfere with the free movement of the hinge. Generally speaking, materials for the bearing should be selected for strength to hold the form and low electrical resistance. (2) Signal bronze, an alloy containing approximately 97% copper, 2% tin, and 1% silicon, having a tensile strength on the order of 100,000 pounds and a conductivity on the order of 35% of that of copper. (3) High strength bronze, an alloy containing 98.8% copper and 1.2% tin, having a tensile strength on the order of 40,000 pounds and conductivity approximately 40% that of copper.

All of the electrical conducting parts should be chosen for low conductivity where the characteristic of the switch is desired. With such a selection and a hinged bearing such as described here, a mercury switch relay with .01 ohm resistance may be had. This means that the relay can carry a heavy load without heating up, and hence will have long life.

In the operation of the switch shown in the drawing, it has been observed that mercury appears accumulated in the areas 85, Fig. 5, between the fingers 66, and the adjacent portions of the cap 55. Perhaps these accumulations may be condensation of mercury vapor formed when the circuit is opened and closed. At any rate, the mercury accumulations appear in those areas and contribute to the high conductivity of the switch or the low resistance through the hinge. In this Fig. 5, attempt is made to show the enclosing thin layer of amalgam wet with mercury that extends through the bore 77, and the washers of mercury, if they may be so called, formed by mercury adhering somewhat as indicated in the drawing around the projecting portions of the pin 76 inside the fingers 66.

In some instances, the mercury for the hinge bearing may be had entirely from condensed vapor caused by preliminary test operations of the switch, making it possible to omit the pre-dipping.

The amalgamation by pre-dipping the pin 76 may be accelerated by adding a small amount of commercial nitric acid to the mercury, but of course, pins given that treatment will have to be neutralized before use in the switch.

I claim:

1. In a mercury switch, a switch envelope, a mercury fill in the switch envelope, spaced electrodes in the switch envelope, and means for electrically connecting said electrodes through said mercury fill including a contact member movable into and out of contact with said mercury fill and a hinge for the contact member out of contact with the mercury fill, and having a bearing part of amalgamable material dipped in mercury, whereby a thin coating of amalgam is formed on the bearing part, said film constituting a lubricating and an electrical connection through said hinge, the film being maintained by mercury vapor in the envelope coming in contact with exposed portions of said amalgamable bearing part.

2. In a mercury switch, a switch envelope, a mercury fill in the switch envelope, spaced electrodes in the switch envelope, and means for electrically connecting said electrodes through said mercury fill including a contact member movable into and out of contact with said mercury fill and a hinge for the contact member having a bearing part of copper, whereby mercury vapor within the envelope maintains a film of amalgam over said bearing part to serve as a

lubricating and electrical connection through said hinge.

3. In a mercury switch, a switch envelope, a mercury fill in the switch envelope, spaced electrodes in the switch envelope, and means for electrically connecting said electrodes through said mercury fill including a contact member movable into and out of contact with said mercury fill and a hinge for the contact member out of the mercury fill when the switch is closed, including fingers spanning and spaced from a support, and a copper pin fitted closely through the support and grasped by the fingers, said pin being surrounded by a thin coating of amalgam within the support, and by washers of amalgam between the support and the fingers.

4. In a mercury switch of the type having an envelope, a mercury fill and spaced electrodes therein one of which is electrically disconnected

with the mercury fill in the open position of the switch, a connector for the last mentioned electrode including a non-magnetic stainless steel support and a metal arm, both out of the mercury, and a hinge pin of copper dipped in mercury connecting the arm and the support.

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