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MERCURY SWITCH RELAY

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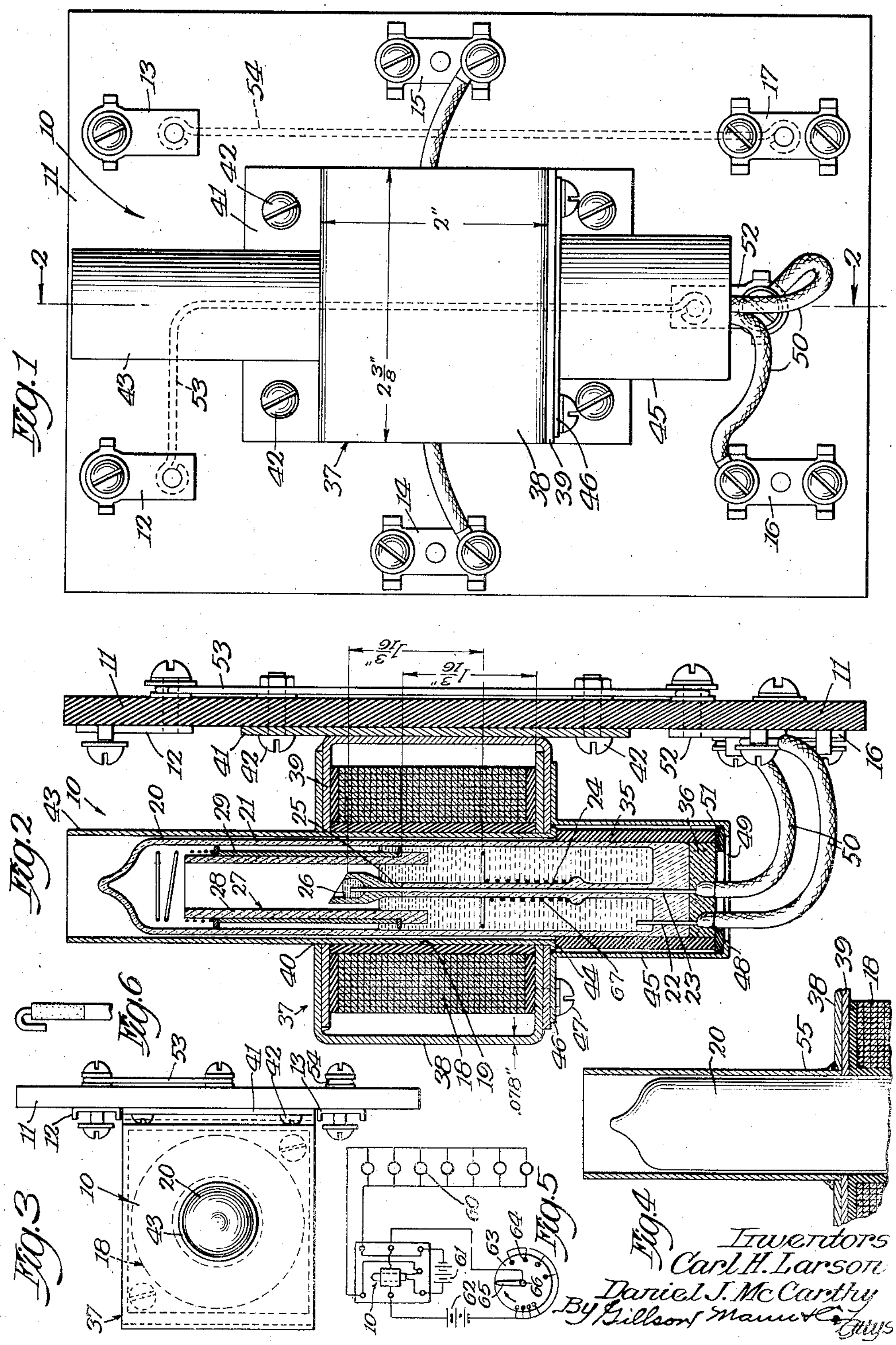

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MERCURY SWITCH RELAY

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18 Claims. (Cl. 200—112)

This invention relates to mercury switch relays of the type in which a floating armature sealed within a switch envelope is moved in response to a relay coil to displace more or less mercury, and thus change the condition of the electrical circuit through the electrodes.

Some of the more important objects of the invention are as follows: To provide a high speed relay of the type which is capable of opening and closing a circuit several times per second; to provide a switch mounting in which the position of the switch with respect to the relay coil may be accurately determined and fixed at the factory; to shield all projecting portions of the switch envelope, so as to protect the switch from accidental blows and obscure the arc which occurs when the relay is used with high inductive loads; to simplify the iron circuit associated with the relay coil; and to reduce the cost of the relay unit.

Further and other objects and advantages will become apparent as the disclosure proceeds and the description is read in conjunction with the accompanying drawing, in which

Fig. 1 is a front elevational view of a relay constructed in accordance with this invention;

Fig. 2 is a vertical, sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a plan view of the relay (the scale being somewhat reduced);

Fig. 4 shows a modified form of the invention;

Fig. 5 is a wiring diagram showing the application of the switch to an autocall system; and

Fig. 6 is a fragmentary view of another form for the central electrode.

The disclosure of a preferred form of the invention is made for the purpose of complying with section 4888 of the revised statutes, but it will be understood that the claims are to be construed as broadly as the prior art will permit.

In the illustrative embodiment of the invention, the relay is used for operating a series of signals and the relay carries a high inductive load. The relay generally indicated at 10 is mounted on a vertical panel 11 having a number of terminal clips on its forward face. Clips 12 and 13 are adapted to be connected to the signals which are to be operated; clips 14 and 15 are adapted to connect the relay coil with the control circuit; and clips 16 and 17 are adapted to be connected to a suitable source of power for operating the signals.

The relay 10 comprises a coil 18 having a core opening 19 adapted to receive a mercury switch 20 of the mercury displacement type. The switch comprises a glass envelope 21, preferably of borosilicate glass, through the base of which electrodes 22 and 23 are sealed, the latter being encased within a glass sleeve 24 for a portion of its length and above that by a sleeve 25 of refractory material, which terminates in a cup 26 into which the bared end of the electrode 23 projects.

A displacer generally designated 27, comprising a sleeve 28 of refractory material over which a sleeve 29 of magnetic material is telescoped, constitutes the armature of the switch. When the relay coil 18 is energized, the displacer 27 is lowered by the action of the magnetic flux, with the result that a sufficient amount of mercury is displaced to establish contact between the mercury that is normally within the cup 26 and that which is within the envelope proper. Upon deenergizing the coil 18, the displacer rises to its position of floating equilibrium and the mercury level again falls to the position shown in Fig. 2.

When the relay is being used for operating certain types of signals, such as call signals of the bell clapper type, it is necessary for the switch to be adjusted, so that it is capable of opening and closing the electrical circuit through the switch a given number of times per second. It is obvious that the position of the switch within the coil 18 is very important in determining the capacity of the switch to operate at a given frequency. Means are therefore provided for fixing the uppermost limit of the switch within the coil as determined by tests at the factory, and then providing a retainer for holding the switch in such position.

The proper position of the switch within the coil is determined empirically at the factory, and, when once this has been determined, a bakelite sleeve 35 is slipped over the lower portion of the switch envelope and secured in place by a sealing compound 36 inserted in the projecting end of the sleeve. Since the sleeve 35 has an outside diameter that is greater than the core opening 19, the sleeve base determines and fixes the uppermost position of the switch within the relay coil.

Associated with the coil 18 is an iron circuit generally designated 37 which comprises yokes 38 and 39, each of which consists of a flat bar of cold rolled electrical iron bent in the form of a U, the ends of the yokes 38 and 39 overlapping, as shown in Fig. 2, and having vertical apertures 40 aligned with the core opening 19. The two yokes form a box-like iron circuit for the magnetic flux set up by the coil and the vertical web of the yoke **39** is spot welded or otherwise secured to a plate **41** which is secured to the panel **11** by screws **42**. The yokes **38** and **39** are also spot welded or otherwise held together.

In order to improve the electrical qualities of the electric circuit, it is preferably annealed at 1750° F. for a period of approximately five hours before being assembled in the relay.

A brass tube **43** having its lower end spun over, as indicated at **44**, is adapted to fit within the core opening **19** and project above the relay coil. The purpose of this tube is to position and hold the coil **18** within the magnetic circuit **37** thereby preventing the coil from contacting or producing mechanical pressure against the glass envelope; to protect the top of the switch envelope from damage due to accidental blows; and to obscure the arc that has formed within the switch when the relay is being used to control an electrical circuit having a high inductive load.

All metal parts of the relay are cadmium-plated or otherwise suitably finished.

In assembling the relay, the coil **18** is first slipped into place within the magnetic circuit **37** and then the brass tube **43** is thrust upwardly into the core opening **19**. Next the switch envelope **20** with its base **35** is inserted from the bottom into the tube **43** until the top of the sleeve **35** strikes the spun edge **44** of the tube **43**. At this position, the switch is properly located within the relay coil and will have the desired operating characteristics. The switch is held in this position by a retaining cup or protector **45**, preferably of brass, having a wide flange **46** screwed to the iron circuit **37** by screws **47** to hold the cup in place. The depth of the cup is such that when the screws **47** are screwed tightly into the iron circuit **37**, the base of the cup **48**, which is apertured as indicated at **49** to accommodate the switch leads **50**, will firmly engage the base of the switch envelope and hold it against the lower edge of the tube **43**. Preferably rubber gaskets **51** are interposed as shims between the base of the sleeve **35** and the cup base **48**, in order to better protect the switch from damage due to blows. It will be noted that the inside diameter of the cup or protector **45** is slightly greater than the outside diameter of the sleeve **35**, and this slight clearance assists in protecting the tube from damage.

In practice, the base **35** and the cup **45** are standardized, so that when once the desired position of the switch has been empirically determined at the factory, it will always be held in this position.

The retaining cup **45** may be quickly removed whenever it is desired to take out the switch for examination and inspection.

In the particular embodiment of the invention shown, one of the leads **50** is connected to the terminal clip **16**, and the other is connected to a terminal clip **52**. A jumper **53** on the back of the panel connects the clip **52** with the clip **12**, and a similar jumper **54** connects the clip **13** with the clip **17**.

Instead of having the tube **43** extend through the coil **18** as shown in Fig. 2, it may be made a more or less integral part of the yokes **38** and **39** by using a shorter tube **55** and having its lower end soldered or otherwise secured to the top leg of the yokes **38** and **39** (see Fig. 4). Preferably the opening **40** in the top leg of the overlapped yokes is of sufficient size to permit the bottom of the tube **55** to rest on the lower leg of the overlapped yokes.

It will be noted that the switch mounting shown in Fig. 4 has the disadvantage that the tube **20** may be damaged by a blow on the coil **18** and for this reason, it is preferable to have the brass tube **43** extend completely through the coil as shown in Fig. 2.

In auto call systems, such as are used in manufacturing establishments for indicating that a particular person is wanted on the telephone, it is necessary for the relay to be sufficiently fast in its response to the energizing coil to open and close the electrical circuit through the switch element as many as five or six times a second. The problem of building a relay for this function is made more difficult for the reason that the relay controls a relatively large number of signals which together constitute a high inductive load on the relay. The switch element of the relay must, therefore, have sufficient capacity and stamina to take care of this high inductive load.

In dealing with this problem, we have found that the following factors must be considered:

A. The more iron that is used in the iron circuit and in the armature of the switch, the slower will be the response of the armature to the coil.

B. The weight and buoyancy of the displacer and the proportion of iron to ceramic used in the displacer must be such that when the coil is energized, the displacer will immediately move to its lower position, and when the coil is deenergized, the buoyancy of the displacer will immediately move the displacer to its uppermost position. Not only is this relationship important, but it is, furthermore, desirable to have the mass of the displacer and the proportionment of iron to ceramic such that the forces acting upon the displacer to move it from one position to another bear appropriate relation to the frequency of the coil energization and the duration of each energization. Stated in other words, the switch parts should be constructed so that the displacer will have a natural frequency of oscillation which assists rather than opposes the forces producing the artificial oscillation.

C. In order to carry the high inductive load, it is desirable to use a mercury to mercury contact, although this necessarily limits the speed at which the relay will operate. If the inductive load is such that a metal to mercury contact may be used, the central electrode may be formed as shown in Fig. 6 in order to get speedier action of the relay.

As a specific illustration of how the parts may be proportioned both as to size and material, the following detailed information is given, but it will be understood that this specific illustration is introduced merely for the purpose of complying with section 4888 of the revised statutes and does not constitute in any way a limitation upon the appended claims unless the prior art demands a more limited construction of the claims to preserve their validity.

O. D. of switch envelope	22–22.6 mm.
I. D. of switch envelope	17.3–17.9 mm.
Weight of displacer	22 grams
I. D. of ceramic sleeve **28**	11/32″
O. D. of ceramic sleeve **28**	.560″ at the top; 5/8″ at the bottom (the bottom enlargement being 1/4″ high)
Iron sleeve **29**	1 3/16″ long and 1/32″ thick
I. D. of ceramic cup **26**	11/64″
O. D. of ceramic cup **26**	17/64″

Top face of cup inclined approximately 30° from horizontal.
Ceramic sleeve **28** made of Alsimag No. 35, a product of the American Lava Corporation, Chattanooga, Tennessee.
Iron sleeve **29** made of Svea metal, a product of the Swedish Iron & Steel Co. of New York, N. Y.

The principal dimensions of the iron circuit and of other parts of the relay are indicated on the drawing.

In Fig. 5, there is a diagram of the electrical circuit for an auto call system. The signals are indicated at **60**, the relay at **10**, a power source for the signals at **61**, a power source for the coil **18** at **62** and a call board at **63**. The call board consists of a disk having a plurality of contacts **64** over which a blade **65** pivoted at **66** and rotating at a constant speed is adapted to wipe, the contacts being selectively movable into and out of contact with the rotating blade. When a call is to be made, the proper contacts are set for engagement with the blade **65** and each time the blade wipes over one of the contacts, an impulse is sent through the coil **18**, with the result that an indication is produced on the signal **60**.

The bank of contacts on the left of the call board **63** (Fig. 5), it will be noticed, are placed closer together than those on the right in the same figure. These contacts in practice are often set apart at a distance which permits the blade to wipe over all of the closely spaced contacts within the period of one second, and each contact must produce its impulse clearly and distinctly on the signal **60**. The necessity for instantaneous operation of the relay **10** is, therefore, apparent.

In practice, the closely spaced contacts produce electrical impulses in which the ratio of closed circuit to open circuit is approximately equal.

A spring **67** of the type shown in Fig. 3 of the application of Clarence E. Gehrand and Carl H. Larson, Ser. No. 23,556, filed May 27, 1935 is secured to the central electrode and serves as a stop for the displacer in its downward movement in cases where an abnormally high voltage is applied to the coil **18**. This enables the switch to maintain its speed of action even when the coil **18** is overenergized.

The mercury fill in the envelope is such that when the displacer **27** is resting on the spring **67**, the mercury level is from $\frac{3}{32}''$ to $\frac{1}{8}''$ above the low edge of the ceramic cup **25**.

We claim:

1. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury displacement switch mounted within the coil including a vertical switch envelope, a base on the envelope fixing the uppermost position of the envelope within the coil, and a retainer for supporting the switch in its uppermost position.

2. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury displacement switch mounted within the coil including a vertical switch envelope, a base on the envelope fixing the uppermost position of the envelope within the coil, and a retainer attached to the iron circuit for supporting the switch in its uppermost position.

3. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury displacement switch mounted within the coil including a vertical switch envelope, a base on the envelope fixing the uppermost position of the envelope within the coil, and a cup adapted to receive the envelope base and support the switch in its desired position.

4. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury displacement switch mounted within the coil including a vertical switch envelope projecting above the coil, means for supporting the switch in the coil, and a sleeve of non-magnetic material around the projecting portion of the envelope.

5. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury displacement switch mounted within the coil including a vertical switch envelope projecting above the coil, means for supporting the switch in the coil, and a sleeve of non-magnetic material around the projecting portion of the envelope, said sleeve being rigid with the iron circuit.

6. In a mercury switch relay, a coil having a core opening, a box-like iron circuit around the coil, a mercury displacement switch mounted within the core opening and including a vertical switch envelope, a base on the envelope fixing the uppermost position of the envelope within the coil, and a retainer for supporting the switch in its uppermost position.

7. In a mercury switch relay, a coil having a core opening, a box-like iron circuit around the coil, and a mercury displacement switch mounted within the core opening and including a vertical switch envelope, said iron circuit comprising a pair of yokes having lapped end portions provided with apertures aligned with the core opening.

8. In a mercury switch relay, a coil having a core opening, a box-like iron circuit around the coil, and a mercury displacement switch mounted within the core opening and including a vertical switch envelope, said iron circuit comprising a pair of yokes arranged on opposite sides of the coil, each of said yokes consisting of a flat bar bent to U form.

9. In a mercury switch relay, a coil having a core opening, a box-like iron circuit around the coil, a mercury displacement switch mounted within the core opening and including a vertical switch envelope, a base on the envelope fixing the uppermost position of the envelope within the coil, and a retainer for supporting the switch in its uppermost position, said iron circuit comprising a pair of yokes arranged on opposite sides of the coil, each of said yokes consisting of a flat bar bent to U form.

10. In a high speed mercury switch relay, the combination of a relay coil, means for intermittently energizing the coil at a rate of several times per second, a mercury switch relay mounted in operative relation with the coil and comprising a switch envelope, electrodes projecting into the envelope, a mercury fill, a magnetically responsive displacer shiftable in response to the coil to displace more or less mercury according to its position within the envelope and thereby determine the condition of the electrical circuit through the electrodes, the parts of said relay being of such mass and proportions that the displacer has a natural frequency which corresponds roughly with the frequency of energization of the coil.

11. In a high speed mercury switch relay, the combination of a relay coil, means for intermittently energizing the coil at a rate of several times per second, a mercury switch relay mounted in operative relation with the coil and

comprising a switch envelope, electrodes projecting into the envelope, a mercury fill, a magnetically responsive displacer shiftable in response to the coil to displace more or less mercury according to its position within the envelope and thereby determine the condition of the electrical circuit through the electrodes, the parts of said relay being of such mass and proportions that the displacer has a natural frequency of oscillation which assists rather than opposes the forces producing the artificial oscillation.

12. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope mounted in the coil and having its upper end projecting a substantial distance beyond the coil and a protector substantially rigid with the iron circuit and telescoped over the switch envelope with the upper portion of the protector extending substantially to or above the top of the envelope whereby the latter is protected against blows.

13. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope within the coil having an end projecting a substantial distance beyond the coil and a protector substantially rigid with the iron circuit and telescoped over the switch envelope with an end of the protector extending substantially to or beyond said projecting end of the envelope whereby the envelope is protected against blows.

14. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope having its lower end projecting below the iron circuit and a protector substantially rigid with the iron circuit and telescoped over the switch envelope with the lower portion of the protector extending substantially to or below the bottom of the envelope whereby the envelope is protected against blows.

15. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope having its lower end projecting below the iron circuit and a protector substantially rigid with the iron circuit, telescoped over the switch envelope and spaced slightly therefrom with an end of the protector extending substantially to or beyond an end of the envelope whereby the envelope is protected against blows.

16. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope having its lower end projecting below the iron circuit and a protector substantially rigid with the iron circuit, telescoped over the switch envelope and spaced slightly therefrom with the lower portion of the protector extending substantially to or below the bottom of the envelope whereby the envelope is protected against blows.

17. In a mercury switch relay, a coil, an iron circuit associated with the coil, a mercury switch envelope within the coil, a base on the envelope fixing the uppermost position of the envelope within the coil, a cup receiving the envelope base and fixing the lowermost position of the envelope within the coil, and shim means cooperating with the base for supporting the envelope in desired position within the coil.

18. In a mercury switch relay, the combination of a coil, an iron circuit associated with the coil, a mercury switch envelope within the coil having one of its ends projecting beyond the iron circuit, and a protector, substantially rigid with the iron circuit, telescoped over the projecting end of the switch envelope and extending substantially to or beyond said end of the envelope whereby the envelope is protected against blows.

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