Oct. 11, 1955 W. I. McLAUGHLIN 2,720,562

MERCURY TYPE CIRCUIT BREAKER

Filed Nov. 22, 1952

Fig. 1.

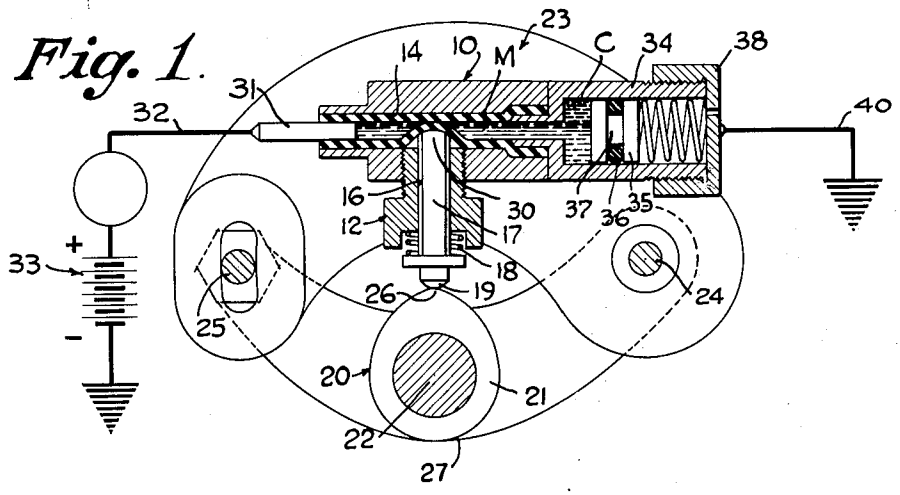


Fig. 2.

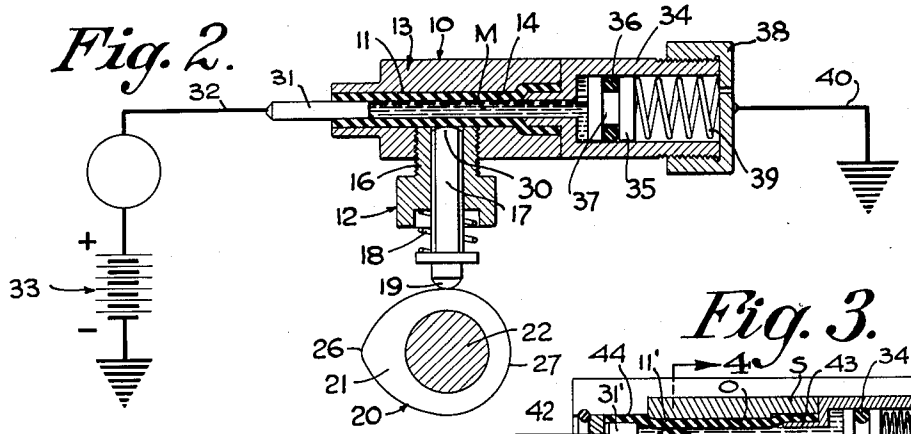
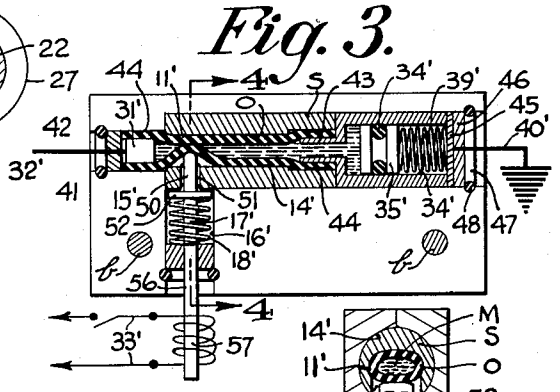


Fig. 3.



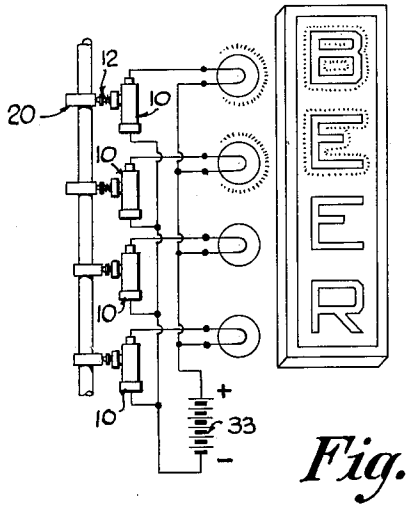


Fig. 5.

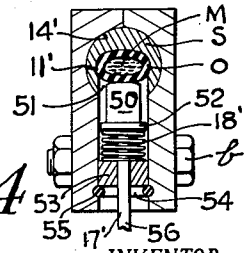


Fig. 4

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MERCURY TYPE CIRCUIT BREAKER

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4 Claims. (Cl. 200—32)

This invention relates broadly to electrical switches and more particularly to a mercury type switch and novel means for compensating for expansion and contraction of the mercury therein.

In the past, a great deal of research has been conducted with a view of eliminating hard metal contact points in switch structures to thereby avoid the expense and trouble caused by arcing and pitting of these contact points. With the exception of vacuum tube mercury type switches little progress has been made in alleviating the deficiencies and problems entailed with hard metal contact points. I have discovered by experiment that a short rubber tube filled with mercury and plugged at both ends with lead wires serves as a circuit breaker when the tube is pinched to separate the mercury within the tube. While this division of a column of mercury into two insulated halves satisfactorily eliminates most of the deficiencies of metal contact points, it too has its faults due to time lag between open and closed positions, i. e., the return of the mercury to a single column after the pinching of the rubber tube is released.

The present invention is directed to a novel matter of maintaining the mercury within a flexible tube under constant pressure but yieldable to compensate for displacement within such tube when the latter is pinched.

Another object is to provide a deformable mercury containing tube with a confining shell for resisting inflation of the tube when the latter is pinched and the mercury therein compressed.

Yet another object is to provide a housing for a deformable mercury containing tube with a relief chamber communicating with one end of such tube to compensate for displacement of the mercury within the tube when the latter is pinched. In connection with the foregoing, it is another object to provide a tube pinching plunger disposed to pinch the mercury tube at a point remote from the relief means to transmit most or all of the compressive force against the mercury toward the relief means.

Another object is to provide a relief or compensating means in combination with a deformable type mercury switch with means for maintaining the mercury within the switch under a substantially constant pressure to thereby assure prompt circuit closing action upon release of the pinching action against the deformable tube.

These and other objects and advantages of the present invention will become more apparent from a reading of the following description and claims in the light of the drawings in which:

Fig. 1 is a longitudinal section through a mercury switch embodying the present invention.

Fig. 2 is a view similar to that of Fig. 1 but showing parts thereof in a different position.

Fig. 3 is a longitudinal section through a similar form of mercury switch entirely encased within a housing.

Fig. 4 is a cross section of Fig. 3 taken substantially along line 4—4 in Fig. 3; and

Fig. 5 is a diagrammatic illustration of one of the many uses to which the present switch may be put.

In the drawings, I have shown a switch assembly 10 including a deformable tube 11 which may be of rubber, plastic or the like having its ends closed by electrical conductor members for confining a quantity of mercury M within the tube 11. The arrangement includes means 12 between the closed ends of the tube 11 for pinching

the tube to separate the mercury therein into two separated columns insulated from each other to break the electrical circuit between the electrical conductor members at the ends of the tube.

In accordance with the present invention, the foregoing simple mercury switch structure is confined within a metal housing 13 having an internal chamber 14 formed therein of a size to receive the deformable tube 11 for maintaining the latter in its normal state of expansion but permitting the latter to be pinched in the manner as shown in Fig. 1 by the means 12. In this connection, the housing 13 further includes a guide sleeve 16 having its axis disposed perpendicular to the axis of the chamber 14 and tube 11 for guiding a plunger 17 for movement toward and from the deformable tube. The plunger 17 is urged by a spring 18 into ineffective position away from the tube 11, and has its free end 19 disposed in engagement with an actuating mechanism 20, for example, a cam 21 on a rotor shaft 22.

For purposes of illustration, I have shown the switch housing 13 in Fig. 1 mounted on an arm 23 having one end pivoted on a stud shaft 24 which is stationary and its other end adjustable relative to a stud bolt 25 for movement toward and from the rotor shaft 22. The rotor shaft 22 revolves about an axis parallel to the stud shaft 24 and is fixed relative thereto so that the free end 19 of the plunger always engages the periphery of the cam 21. As illustrated, the cam 21 has its periphery provided with an acclivity 26 which extends a greater radial distance from the balance of the periphery which forms the declevity surface 27 of the cam. Consequently, when the free end 19 of the plunger rests on the declevity 27 the inner end 30 of the plunger is disposed just out of the chamber 14 as shown in Fig. 2. Contrariwise, when the acclivity 26 is radially in alignment with the axis of the plunger the inner end 30 of the latter is disposed within the chamber 14 pinching the tube 11 as shown in Fig. 1. Obviously, very many different arrangements of actuating mechanisms may be employed, the present disclosure being for purposes of illustration only.

As seen in Figs. 1 and 2, one end of the tube 11 is sealed by a plug 31 of electrical conductive material having connection with a wire 32 on one side of an electric circuit 33, diagrammatically illustrated. The other end of the tube 11 has open communication with a chamber C provided at one end of a cylinder 34. The cylinder 34 has a round nipple neck 43 upon which the open end of the tube 11 is stretched. Cement is applied to the nipple neck 43 so as to obtain a good seal between the latter and the tube 11. The cylinder 34 has a baffle or diaphragm 35 arranged therein for cushioning the pressure of the mercury as it is compressed within the tube 11. In the present disclosure, the baffle is in the form of a piston arranged in the cylinder 34 for reciprocation which piston 35 has a suitable sealing ring 36 arranged in an annular ring groove 37 for maintaining sealed contact with but affording sliding movement of the piston relative to said cylinder. The opposite end of the cylinder is suitably closed by a cap 38 against which a compression spring 39 bears, the opposite end of which spring bears against the piston 35 to maintain the latter in its extreme position away from the cap 38.

From the foregoing it will be seen that the mercury M confined within the tube 11 contacts the piston to complete the electrical circuit via the spring 39 and cap 38 to an electric wire 40 on the ground side of the electric circuit 33. Consequently, when the column of mercury is divided by pinching of the tube 11 as seen in Fig. 1 the circuit 33 is broken. More important, however, is the fact that upon pinching of the tube 11 to break the circuit, the mercury is displaced within the tube and into the chamber C provided in the cylinder 34. The pressure of the displaced

mercury against the piston **35** causes the latter to be displaced within the cylinder against the action of the compression spring **39**. The spring **39** is calculated to yield due to displacement of the mercury and piston but also to maintain a uniform pressure against the piston and mercury to assure prompt return of the mercury to a full column upon release of the plunger from pinching relation against the tube **11**. Note also that there is a reserve space provided within the chamber C to aid in keeping the entire area of the mercury side of the piston **35** in constant contact with the mercury M. This assures uniform back pressure of the mercury against the piston and a true balance with the counterpressure afforded by the spring **39**.

In addition to the foregoing, it will be noted, especially in Fig. 3, that the plunger **17'** is disposed more closely to that end of the mercury column or tube which is remote from the pressure compensating chamber, piston and cylinder. In this manner, very little of the mercury is confined in the far or dead end of the tube **11** when it is pinched by the plunger. In other words, the greater quantity of the mercury is in communication with the live end of the tube **11** which opens to the pressure compensating chamber C so as to relieve the tube itself from excessive strain. It should be understood, however, that since the tube **11** is wholly confined within the housing **13** any tendency of the tube to bulge or expand beyond its normal diameter or size is minimized if not completely eliminated.

Refer now to Fig. 3 wherein I have shown a more simplified construction of mercury switch embodying the principle of the present invention. In this form of construction, the housing **13'** consists of a solid block which, if desired, may be a split block adapted to be secured together by suitable bolts *b* in the conventional manner. This housing **13'** has an elongated main passage **14'** one end **15'** of which is of reduced size and a shorter passage **16'** disposed perpendicular to the main passage and very near that end thereof which is of reduced size.

The deformable tube **11'** is encased in a shell S having an ovoid internal passage O, as best seen in Fig. 4. This ovoid passage receives the otherwise round tube **11'** to maintain the latter in an oval shape within the shell S. The shell S is inserted at the larger end of the main passage **14'**, the inner end of the shell engaging the shoulder **40** adjacent the reduced end **15'** of the passage. Part of the tube **11'** extends into this reduced end **15'** of the passage **14'** and receives the conductor plug **31'** connected to the wire **32'** as before. A non-conductive or phenolic washer **41** is placed against the extreme end of the tube **11'** and is locked in place by a snap ring **42** seated in an annular groove provided in the reduced passage **15'**.

The opposite end of the tube **11'** fits over a round nipple neck **43** formed on one end of a cylinder **34'**. The nipple **43** is suitably cemented to the tubing which is stretched around the nipple. The same cementing is applied to the conductor plug **31'** around which the opposite end of the tube is stretched. In each case a spring ring clamp **44** surrounds the tube to secure the latter against the conductor plug and the nipple, as the case may be, to assure a pressure seal at the ends of the tube.

The cylinder **34'** is much the same as the one illustrated in Figs. 1 and 2 in that it provides a chamber C' communicating with mercury M' in the deformable tube. It also has a piston **35'** therein as well as a compression spring **39'** but is not capped in the same manner. In this form, the open end of the cylinder **34'** is closed by a conductive washer **45** connected to a wire **40'**. A phenolic washer **46** lies flush against the conductive washer **45** and is held in place by a snap ring **47** suitably seated in an internal annular groove **48** formed adjacent the open end of the main passage **14'** in the housing **13'**.

Referring now to the shorter passage **16'** which is perpendicularly disposed to the main passage **14'**, a plunger **17'** is arranged for reciprocation in this shorter passage **16'**. The plunger **17'** has a tube engaging head **50** which is substantially the same width as the ovoid passage O.

This widened head **50** is disposed in a slot **51** cut into the shell S for guiding the plunger **17'** for reciprocation into and out of the main passage **14'**. The plunger **17'** has a flange **52** formed thereon against which one end of a compression spring **18'** bears. The opposite end of the spring **18'** bears against a guide sleeve **53** which fits snugly in the passage **16'** and is held in place therein against the action of spring **18'** by a snap ring **54**. The snap ring fits into an annular groove **55** formed in the internal wall of the passage **16'** so as to secure the guide sleeve **53** in place for maintaining constant spring pressure against the plunger **17'**. In this manner the head **50** of the plunger is constantly urged into tube pinching position as seen in Fig. 3.

The free end **56** of plunger **17'** is shown connected to the armature of a solenoid **57** which is normally deenergized but is adapted to be energized upon completion of an electrical circuit **33'** diagrammatically illustrated. In this manner, the solenoid coil, when energized, will overcome the action of spring **18'** to attract the plunger **17'** away from the tube **11'** to allow the mercury M' to complete circuit between the wires **32'–40'**. It should here be noted that the plunger arrangement in Fig. 3 can be made to operate in the fashion illustrated in Figs. 1 and 2 by changing the disposition of the flange **52** relative to the plunger **17'** so that this flange bears against the guide sleeve **53**. Thus the compression spring **18'** can be disposed between the flange **52** and the shell S to normally maintain the head end **50** of the plunger out of the main passage **14'** and within the slot **51**. Consequently, the free end **56** of the plunger **17'** can be disposed against a cam for operation in the manner as hereinbefore explained in connection with Figs. 1 and 2.

Either of the above explained forms of switches can be used in many different arrangements for making and breaking an electrical circuit. One such arrangement is illustrated in Fig. 5 wherein a plurality of switches **10** have their plunger disposed in actuating contact with a like number of cams. In this arrangement each switch is closed in sequence to illuminate lamps L successively to spell out letters on a sign and/or to illuminate all lamps L simultaneously so that the entire wording on a sign can be read.

Switches such as those illustrated in the accompanying drawings have been used with success as a commutator for an internal combustion engine. Due to the complete elimination of arcing these switches are exceptionally useful in hazardous locations such as near explosives, gasoline, or where dust particles or vapors form an explosive mixture with air.

At all events, the provision of means for maintaining thet mercury under constant pressure, i. e., neither too high nor too low, assures positive and prompt action of return of the mercury to a single column or circuit closing condition. Moreover, since the mercury tube of the present invention is completely encased within a housing it can never expand beyond its normal shape. This saves the deformable tube from stretching or bulging and keeps the mercury under most favorable conditions. Should the mercury within this switch expand or contact due to temperature changes, such expansion and/or contraction is compensated for by the spring loaded piston within the chamber or reservoir C.

While I have described the foregoing switch structure in specific detail it will be apparent that it is susceptible to variations, modifications and alterations without departing from the spirit of my invention. I, therefore, desire to avail myself of all variations, modifications and alterations as fairly come within the purview of the following claims.

What I claim as new and desire to protect by Letters Patent is:

1. In an electric switch of the type having a deformable tube containing a column of mercury adapted to be separated by pinching of said tube; a housing for confining said

tube to its normal shape, a chamber formed within said housing in axial alignment with said tube and communicating with one end of said tube for receiving mercury therefrom when said tube is pinched, a cylinder in said chamber having an open nipple neck secured to said one end of said deformable tube, a piston in said cylinder, a cap for closing that end of said cylinder opposite the nipple neck thereof and yieldable means between said cap and piston for maintaining said piston in constant contact with the column of mercury confined within said tube.

2. In an electric switch of the type including a deformable tube having means sealing one end thereof connected to an electrical conductor, a second electrical conductor means connected to the opposite end of said tube, a body of mercury filling the interior of said tube, and means reciprocable toward and from said tube for separating the mercury therein into two isolated masses, the combination with said second electrical conductor means of a cylinder providing a chamber communicating with said opposite end of said tube for receiving mercury therefrom, a baffle in said chamber adapted to yield upon an increase of pressure in that mass of mercury communicating with said chamber, an electrical conductive cap on said cylinder and electrical conductive means between said cap and baffle cooperating with said baffle for maintaining a constant counterpressure against the latter and the mass of mercury in said chamber for promptly forcing the latter toward said tube when said reciprocable means moves away from said tube.

3. In an electric switch of the type including a deformable tube containing a column of mercury adapted to be separated upon pinching of said tube; a combined electrical conductor and pressure compensator comprising a housing having a passage confining said deformable tube to its normal shape, a lead wire secured in one end of said tube, a cylinder axially aligned with said tube and having a reduced nippled end secured to the other end of said tube, a cap for closing the opposite end of said cylinder, a lead wire connected to said cap, a baffle within said cylinder, and means for electrically connecting said baffle to said cap and for yieldably urging said baffle against said column of mercury for maintaining the latter under uniform pressure.

4. In an electrical switch of the type including a deformable tube containing a column of mercury adapted to be separated upon pinching of said tube; a combined electrical conductor and pressure compensator comprising a cylinder having a reduced nipple at one of its ends secured to one end of said tube in axial alignment with the column of mercury in said tube for admitting mercury into said cylinder upon pinching of said tube, a piston in said cylinder, a cap on the other end of said cylinder, a lead wire connected to said cap, and a spring between said piston and cap completing the circuit from said column of mercury to said lead wire and for maintaining said cylinder in constant contact with said column of mercury and the latter under constant pressure.

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