Oct. 26, 1937. F. T. JENKINS ET AL 2,097,406

MERCURIAL ELECTRICAL CUT-OUT

Filed Feb. 5, 1935 2 Sheets-Sheet 1

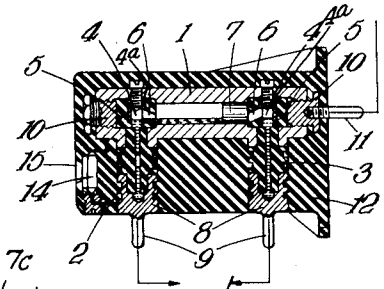


Fig. 1.

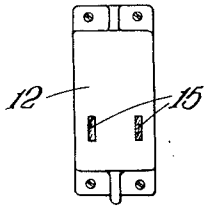


Fig. 2.

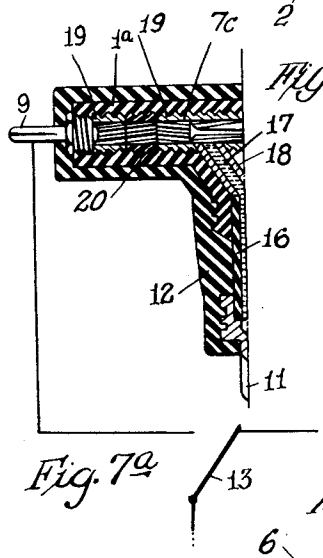


Fig. 7a

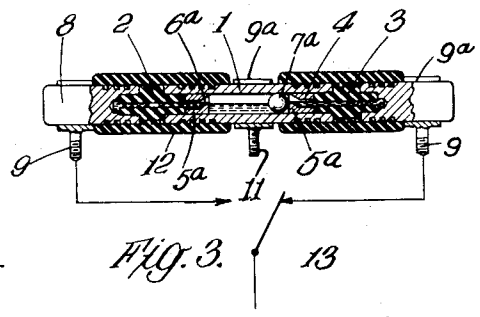


Fig. 3.

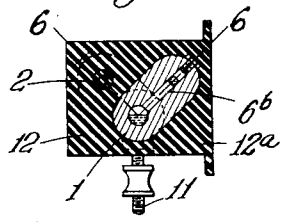


Fig. 4.

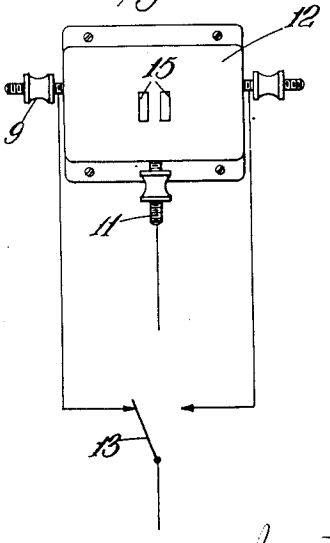


Fig. 5.

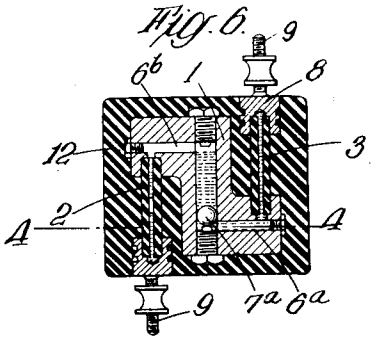


Fig. 6.

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MERCURIAL ELECTRICAL CUT-OUT

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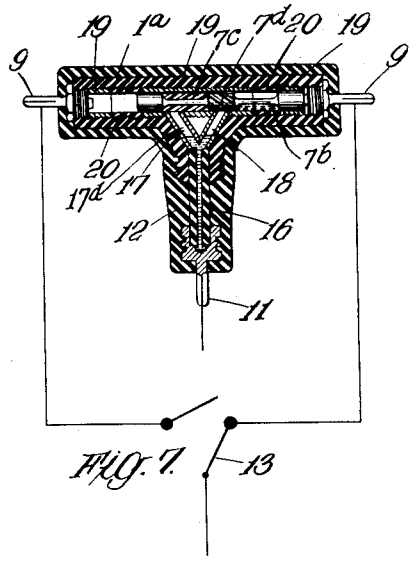



Fig. 7.

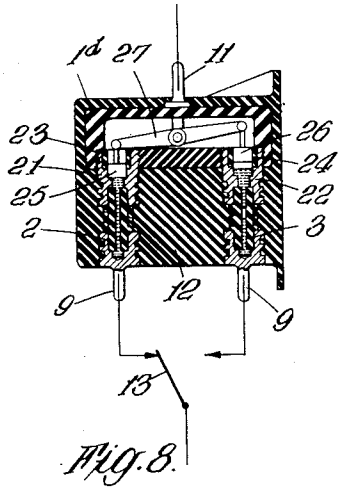



Fig. 8.

Fig. 9.

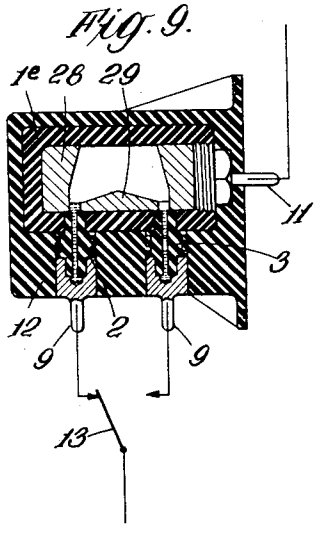



Fig. 10.

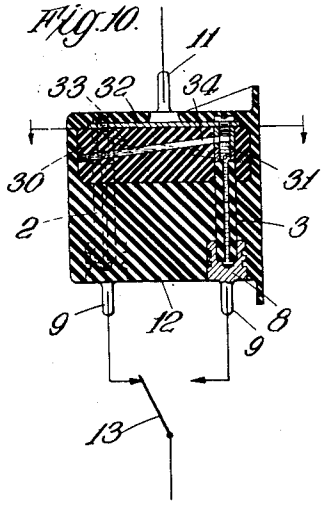
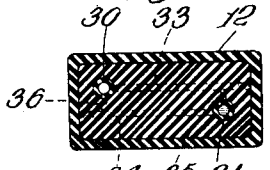



Fig. 11.

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# UNITED STATES PATENT OFFICE

2,097,406

## MERCURIAL ELECTRICAL CUT-OUT

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Application February 5, 1935, Serial No. 5,110
In Great Britain February 9, 1934

24 Claims. (Cl. 200—113)

The present invention relates to mercurial electrical cut-outs, that is to say, to cut-outs of the type wherein the current to be controlled is passed through a fuse consisting of a column of mercury, a portion of which, on the current exceeding a predetermined value, is vaporized by the heat generated therein due to its electrical resistance, mercury being thereby expelled from the column the continuity of the circuit being accordingly broken.

In such cut-outs, as hitherto proposed, it has been necessary, after the rupture of the circuit by an electrical overload, to reform the broken column and to remake the same circuit, and a very large number of devices have been proposed for this purpose, all of which involved the manipulation of some external part, which directly or indirectly acted on the mercury within the apparatus for the aforesaid purpose. In certain forms pressure was exerted on rubber balls, diaphragms or the like, which pressure was communicated to the mercury. The use of rubber however has certain disadvantages, more especially its perishable nature, and it is believed that such apparatus never came into commercial use. In all other cases it was necessary to have some passage permitting a part to be moved externally which communicated with the interior, and however carefully such passage was protected it was not possible to obtain hermetic sealing of the apparatus.

According to the present invention, however, alternative paths are provided for the passage of the current through the apparatus, which is so designed and constructed that when any one such path is broken by the rupture of the mercurial thread or column through an overload, this action automatically renders available an alternative path through the interior of the apparatus. This may be accomplished directly by the mercury forced outwards by the breakage of the thread or column itself completing the alternative path, or indirectly by its actuation of some part which achieves this object and examples illustrating different manners in which this may be accomplished are given hereafter.

In general these alternative paths have different external connections, e. g., electrodes connected to a two way switch, so that the flow of the current is not re-established until such switch or the like is actuated, but in certain cases it may be desired that the circuit should be re-established after rupture with only a minimum time lag, such as is afforded by the change of paths, and in such cases the provision of different external connections becomes unnecessary or arrangements may be made for temporarily bridging such connections.

It will therefore be seen that this invention enables mercury cut-outs to be constructed in which the mercury is hermetically sealed from access of air and this is of great importance since any exposure of the mercury to atmosphere renders it liable to oxidation, which would affect the electrical resistance of the circuit.

In the forms of the invention herein illustrated by way of example two alternative paths are provided, the breakage of either leading to the establishment of the other.

According to a further feature of our invention means may be provided for providing one or more supplementary circuit-breaking points in series with the mercury fuse.

In a convenient form of construction the apparatus comprises a cylinder containing mercury and fitted with a freely movable plunger and two tubes communicating with opposite ends of the cylinder (which constitutes a common reservoir) by means of openings through that one of which, for the time being in circuit, on the passage of excess current, mercury is ejected against the plunger in such a direction as to impel it toward the other opening through which mercury is thereby forced to complete the column in the corresponding tube.

In other convenient forms, a plunger is dispensed with, the communication between the two tubes being such as to permit mercury expelled from one tube to pass to the other, and in a further convenient form one mercury column is used having branch tubes communicating therewith, the mercury being expelled through either one of such branches whilst the other is occluded in order to make a gap in one path for the current through the device and to bridge a gap in another path.

Although in the examples illustrated the mercury column is of uniform cross section, it will be appreciated that this is not necessarily a feature of the invention. In certain of the forms illustrated the column is reformed under the simple action of gravity, which would obviously be insufficient for this purpose if tubes with capillary restrictions were used unless there was a considerable head of mercury above the capillary restriction, and it must be understood that where it is desired to use such tubes the apparatus must be so formed and/or dimensioned that the pressure necessary to reform the column will be available.

In order that the invention may be clearly un-

derstood and readily carried into effect, it will now be described more fully with reference to the accompanying drawings which illustrate, by way of example, various forms of cut-out in accordance therewith and wherein:—

Figures 1 and 2 are respectively a longitudinal section and front elevation of one form of mercurial cut-out,

Figure 3 is a longitudinal section of a modification,

Figures 4 and 5 are respectively a cross section on line 4—4 of Figure 6 and a front elevation of a further form of cut-out,

Figure 6 is a section on the lines 6—6 of Figure 4,

Fig. 7 is a longitudinal section of a modified form of cut-out.

Fig. 7a is a longitudinal section of one-half of a cut-out similar to that shown in Fig. 7 but on an enlarged scale to show the rifled construction of the plunger and cylinder.

Figs. 8 and 9 are longitudinal sections of two further modifications.

Figures 10 and 11 are respectively a longitudinal section and a sectional plan of still another form of cut-out.

In the form of cut-out illustrated in Figures 1 and 2, a cylinder 1 constituting the reservoir is made of conductive material and is mounted with its axis substantially horizontal. The tubes 2 and 3, of ceramic non-conducting material, are substantially vertical and project through the peripheral wall of the cylinder 1 in proximity to its opposite ends. The bore of each tube communicates with a small chamber 4 in a block 5 of insulating material fitted in the end of the cylinder 1, these chambers communicating with the cylinder by means of passages 6 opening respectively into the chambers at a level somewhat above the point at which the bore of the tube 2 or 3 enters the chamber and extending in a downward direction toward the cylinder 1, as shown. Either the chamber 4 (as shown) or the passage 6 is lined with conducting material 4a which serves, when the mercury column is complete as indicated within the tube 3, to establish electrical connection between it and the cylinder 1 or the mercury contained therein. A plunger 7, freely movable in the cylinder 1, is located between the outlets of the passages 6; thus, on mercury being ejected from one of these passages due to rupture of the mercury column in the tube 2 or 3 communicating therewith, sufficient pressure is exerted on the plunger 7 to impel it toward the opposite end and thus force mercury through the passage 6 in the opposite insulating block 5 and thence, via the small chamber 4, into the corresponding ceramic tube, thereby completing the column therein. The lower ends of the ceramic tubes 2 and 3 are respectively fitted in blocks 8 of conductive material provided with pin connections 9, terminals or other suitable means for connection to the external circuit. The ends of the cylinder 1 are closed by plugs 10, to one of which there is fitted a pin connection 11 or the like. The whole apparatus is enclosed in a moulding 12 of the material known by the registered trade name "Bakelite" or other suitable substance, the terminals or the like projecting therefrom. The lower end of the lining to chamber 4 terminates so far short of the bottom of block 5, that if the column remakes other than by the rupture of the other column, the level of the mercury falls below the lining and maintains the interruption of the circuit.

In order to provide for the alternative passage of current through the mercury columns, connections are led from the pins or terminals 9 to a two-way switch 13, represented diagrammatically, the main circuit being connected, as shown, to the common terminal of this switch and to the terminal 11. The two-way switch may be of any suitable form and may be either separate from the cut-out itself or incorporated with or attached to the Bakelite or like moulding.

In order to indicate which of the mercury columns is complete and which is ruptured, there is associated with each an indicator, which, as shown, is preferably of the type described in U. S. A. patent application Serial No. 642,123, consisting of a tube 14 filled with neon or other suitable gas and connected respectively between the cylinder 1 and the corresponding plug 8. The tubes 14 are thus respectively in parallel with the mercury columns, and when either column is ruptured, an indication of this fact is afforded by the glowing of the corresponding tube. As indicated, the tubes 14 are housed in a cavity within the Bakelite or like moulding, and are viewed through apertures 15 located opposite the tubes.

The various parts of the apparatus are so dimensioned, and the amount of mercury inserted is such that, as indicated, one of the mercury columns is complete while the other is ruptured; consequently, when it is desired to introduce the cut-out into circuit the two-way switch 13 is turned to the position shown communicating with the complete mercury column which then carries the current. On rupture of this column the circuit through it is broken, the force of the rupture being employed to complete the other column as above described. The complete circuit is, however, not immediately re-established, this action only taking place when the two-way switch is moved to the position in which connection is made between its common terminal and that communicating with the second mercury column. If the cause of the excess current still persists, rupture of the second mercury column will, of course, ensue, the force thereof being employed, in the above-described manner, to re-establish the first-mentioned column. Thus one or other of the mercury columns is always complete and ready for the conveyance of current immediately on operation of the two-way switch in the appropriate direction.

It is by no means essential that the mercury columns shall occupy a vertical position: for instance, in the alternative construction of cut-out depicted in Figure 3 the ceramic or like tubes 2 and 3 are substantially co-axial with the cylinder 1 constituting the common reservoir and are fitted into its ends. In this case the blocks at the ends of the cylinder 1 and indicated at 5a are of conductive material and the passages 6a slope upwardly toward the interior of the cylinder so that on rupture of one of the columns, a small quantity of mercury is trapped in the corresponding passage: this serves to make contact with the main body of the mercury contained in the cylinder 1 when, on rupture of the opposite column, a plunger 7a travels along the cylinder so as to cause the mercury level to rise and fill the inclined passage and the ceramic tube communicating with it. As indicated, the plunger 7a may be made in the form of a ball, and the pins or the like

9 and 11 may be carried by spring clips which grip around the member with which they make contact.

In the modification shown in Figures 4, 5 and 6 the ceramic tubes 2 and 3, which occupy the horizontal position, instead of being co-axial with the cylinder 1 are located parallel thereto, communication with the cylinder being by means of passages 6b through its peripheral wall. The total length of the device is by this means considerably less than in the case of the co-axial arrangement, illustrated in Figure 3, and, by disposing the axes of the ceramic tubes and of the cylinder at the angles of a triangle, as shown, rather than in a single plane, an exceedingly compact form of cut-out is made possible.

In mercurial cut-outs, especially those of high-current-carrying capacity and particularly if the mercury column be vertical, there is a possibility, that, after rupture of the column owing to the condensation of the vaporized mercury in the gap or for other reasons, the column may become re-established, and for this purpose it may be desirable to provide one or more supplementary circuit-breaking points in series with each mercury column. Constructions embodying this feature are illustrated in Figures 7 and 8. Further, in the case of the construction depicted in Figure 7, the two ceramic tubes 2 and 3 wherein rupture occurs are combined into a single tube 16, the alternative paths, essential in accordance with the present invention, being provided by branches 17 and 18 having linings of conductive material and communicating with the interior of cylinder 1a whose wall is made of non-conducting material. The plunger 7b within the cylinder 1a is of conducting material and, as shown, is provided with three heads, these being so spaced that when the plunger is in either of its extreme positions one of the branches 17 or 18 is occluded by the central head. The cylinder 1a is provided over portions of its length with three sleeves 19 of conductive material separated by intervening sections 20 of insulating material, the length of the central sleeve 19 being such that the central head of the plunger 7b is always in contact with it. When the plunger is in the position shown in Fig. 7 the circuit is completed, through the pin connection terminal 9 shown to the right of the figure, the sleeve 19 at the right-hand end of the cylinder 1 and the plunger 7b. On rupture of the mercury column in the ceramic tube 16, due to excess current, mercury is ejected from the branch 17 and impinges against the left-hand head of the plunger 7b, thus impelling the latter toward the left and causing break of circuit between the right-hand head of the plunger and the right-hand sleeve 19 and making contact between the left-hand head and the left-hand sleeve 19. At the same time the branch 18 is uncovered and mercury is swept into it by motion of the plunger, thereby completing the mercury column therein in readiness for such time as the two-way switch 13 shall be changed over to its opposite contact. Circuit is then established through the left-hand pin 9, the sleeve 19 connected with it and the plunger 7b. On rupture again occurring, the plunger is restored to its original position by ejection of mercury from the branch 18.

It is possible that very violent ejection of the mercury might impel the plunger against one of its end contacts with such force as to cause it to rebound and therefore fail to establish circuit: to obviate this possibility the cylinder and plunger may be correspondingly rifled as indicated diagrammatically by numerals 7c, 7d in Fig. 7, thereby minimizing the suddenness of impact.

In the form of cut-out illustrated in Figure 8, the ceramic tubes 2 and 3 are maintained separate and are electrically connected to the cylinder 1d of the insulating material by means of conducting blocks 21, 22 provided respectively with insulating sleeves 23, 24 constituting cylinders for pistons 25, 26 the rods of which are pivoted to a rocking lever or levers 27 and electrically connected with the terminal 11. In the case of the tube 2, shown as operative for the time being, the plunger 25 is in contact with the block 21, but, when it is driven outwards owing to rupture of the mercury column, it bears only on the insulating sleeve 23, thus forming a supplementary point at which the circuit is broken. At the same time, owing to the rocking of the lever or levers 27, the plunger 26 descends, thus coming into contact with the conducting block 22 and forcing mercury into the tube 3 to re-establish the mercury column therein.

The provision of a plunger in the cylinder or associated with the mercury columns is by no means essential, and in Figures 9, 10 and 11, two forms of cut-out are illustrated in which the plunger is dispensed with. In the cut-out shown in Figure 9, the cylinder 1e, which in this case is of insulating material, is provided with a lining 28 of conductive material, the base of which is formed with an excrescence 29 which permits mercury to collect either on one side or the other. The mercury column in the ceramic tube 2 being shown as completed, when it is ruptured mercury is thrown over the excrescence 29 to the space above the tube 3, which is thereby filled ready for use when the switch 13 is changed over to its contact connected therewith: likewise, on rupture of the columns in the tube 3, the mercury is thrown back over the excrescence 29 to the space above the tube 2, thereby filling that tube ready for use when the switch 13 is changed back again.

In the mercury cut-out shown in Figures 10 and 11, the ceramic tubes 2 and 3 communicate respectively with chambers 30, 31 having metallic liners connected with the common terminal 11 by a metal plate 32. Inclined passages 33 and 34 and cross passages 35 and 36 respectively connect the chambers, so that, on ejection of mercury from one of the tubes e. g., 3 (in which a momentary rupture is indicated), it flows along the passages 33, 35 or 34, 36, as the case may be, to reach the other tube which is thereby filled with mercury. It will be understood that no passage of current can take place by mercury flowing back to this tube since the level will be too low to reach the conducting liner 31. It must be understood that the drawings used for the purpose of illustrating the examples are diagrammatic only, and that in designing any actual apparatus according to our invention the various parts must be so proportioned that on the rupture of a column sufficient mercury is expelled, or sufficient movement given to the plunger or like part, to ensure the completion of the alternative path and further that there is no risk of both paths being available for the current simultaneously. In some cases e. g., in Fig. 9 diverting means may be added to ensure the expelled mercury passing over the dividing line. The action of the apparatus is facilitated if the tubes containing the mercury columns have smooth internal surfaces and we have found that the substance sold under the reg-

istered trade-mark "Pyrex" is very suitable for this purpose, a tube of this material of 0.6 mm. diameter serving for a 5 amp. normal rating. Although our invention in no way depends on the special materials used in constructing the apparatus, we have found that "Pyrex", or ordinary ceramic or soda glass tubes are suitable for low tension circuits with moderate amperage such as occur in ordinary domestic use and fused silica for high tension such as power station work and the like.

In some cases in which it may be desirable to employ a cut-out in accordance with this invention, it may be required for a short period of time to carry a current of an amount sufficient to rupture the mercury column; such conditions may, for example, arise in respect of the heavy starting current taken by a motor. In such a circuit two cut-outs may be included in parallel, the column in the one being of greater current-carrying capacity than that in the other, and suitable means being provided for connecting the columns alternatively in circuit; such alternative connecting means may be of such a character as automatically to restore the cut-out of smaller capacity into circuit a given time after that of larger capacity has been switched in. Or the additional cut-out capacity may be equal to or smaller than the main cut-out, the two together providing for a temporary increase in capacity. Where it is essential to minimize the interruption of a circuit due to rupture, this can be effected by bridging the pins, terminals, or connections that are normally connected to the two-way switch 13, thus dispensing with the latter by the provision of a pivoted arm 13a, as shown, for example, in Fig. 7, or by the use of a pull-off bar or bridging the gap by means of an ordinary wire.

The ceramic tubing may with advantage be provided with a series of external annular ribs and grooves which inter alia provide a better grip for the covering material and also assist in heat dissipation.

The cut-out may be initially charged by any convenient method, e. g., by connecting the mercury column tube or one of such tubes to a vacuum pump and allowing the mercury, stored for example at atmospheric pressure to flow into the exhausted cut-out through such tube. The second column where this is provided may be formed or completed by establishing a rupture of the column already made. A tube connecting the column tube with the pump may be pinched or fused to seal off the device. The charge introduced into the cut-out is of such an order that upon such a rupture occurring the required amount of mercury is available for establishing the column in the other tube. If desired the parts of the apparatus not filled by the mercury may be exhausted of air or charged with a non-oxidizing gas.

In each of the forms illustrated a space for expansion of the mercury, which is ejected, is provided. In the first three forms illustrated the expansion space is formed by the cylinder 1 and the chambers or passages communicating with it; in Fig. 7 an expansion space is formed by the cylinder 1; in Fig. 8 the space formed below the piston when in raised position serves as an expansion space; in Fig. 9 the cylinder 1 and in Figs. 10 and 11, the chambers 31 and the passages 33, 34, 35 and 36 form the expansion space.

What we claim and desire to secure by Letters Patent of the United States is:—

1. A mercurial electric cut-out provided with two tubes containing mercury columns, said tubes being contained in alternative paths for the passage of the current through the apparatus, a common reservoir with which both said tubes communicate, said reservoir being constituted by a cylinder provided with a plunger whereby when one said path is broken by the expulsion of mercury from one said tube by the current under control exceeding a predetermined value, the expelled mercury causes the plunger to move and displace mercury into the other tube so that the other of said alternative paths is automatically made available for the passage of the current.

2. A mercurial electric cut-out provided with a single tube provided with branches contained in alternative paths for the passage of the current through the apparatus, a cylinder with which both said branches communicate, and a plunger arranged in said cylinder so that when one said path is broken by the expulsion of mercury from said tube and one said branch by the current under control exceeding a predetermined value, the plunger is displaced by the expelled mercury and caused to make available for the passage of the current the other of said alternative paths, said plunger being provided with three heads and being so dimensioned that when it is in either of its extreme positions one of the branches is occluded by the central head and the other branch opens into the space between the central head and that at one end of the plunger.

3. A mercurial electric cut-out as in claim 2, wherein the openings of the branches into the cylinder are so located and shaped as to direct any mercury ejected from the branch which is uncovered against the corresponding head at the end of the plunger.

4. A mercurial electric cut-out as in claim 2, wherein the cylinder is provided with conducting sleeves at its ends communicating with terminals for connection to an external circuit and is also provided with an intermediate conducting sleeve separated from the end conducting sleeves by insulating material and of such a length that the central head of the plunger, of conductive material, is always in contact with it.

5. A mercurial electric cut-out provided with a single tube provided with branches contained in alternative paths for the passage of the current through the apparatus, a cylinder with which both said branches communicate and a plunger in said cylinder, said cylinder and plunger being correspondingly rifled and said plunger being arranged so that when one said path is broken by the expulsion of mercury from said tube and one said branch by the current under control exceeding a predetermined value, the plunger is displaced by the expelled mercury and caused to make available for the passage of the current the other of said alternative paths.

6. A mercurial electric cut-out containing alternative paths for the passage of the current through the apparatus and at least one supplementary circuit breaking point provided in series with the mercury forming part of each path, piston means controlling the opening and closing of said supplementary breaking point, a cylinder in which said piston means are arranged, said cylinder communicating with the mercury containing part of the cut-out so that the piston means are actuated by the mercury expelled when the current exceeds a predetermined value, said piston being arranged so that when it is so actu-

ated it renders available an alternative path for the current through the apparatus.

7. A mercurial electric cut-out containing alternative mercurial paths for the passage of the current through the apparatus, said paths being arranged so that any one of said paths which for the time being is closed includes a mercurial fuse which is adapted to rupture when the current passing through it exceeds a predetermined value and means whereby on rupture occurring of the circuit along one path mercury expelled from said fuse automatically renders available an alternative path through the apparatus, said alternative path including said mercurial fuse which allows the current to pass in such latter path so long as said current does not exceed a predetermined value.

8. A mercurial electric cut-out containing a plurality of mercurial fuses each adapted to rupture and break the circuit when the current passing through it exceeds a predetermined value, expansion space between said fuses, alternative paths for the passage of the current through the apparatus each containing one of said fuses, said paths being arranged so that when the current under control exceeds a predetermined value mercury is expelled from the fuse in the path for the time being closed and passes directly to another of said fuses so as to re-make the said last mentioned fuse and automatically render an alternative path available for the passage of the current through the apparatus.

9. A mercurial electric cut-out provided with two tubes containing mercury, an expansion chamber between said tubes, said tubes being substantially parallel with each other and in communication with opposite ends of said expansion chamber, said mercury-containing tubes being in different paths for the current through the cut-out and being arranged so that when the path of the current through the mercury in one tube is interrupted by the expulsion of mercury from that tube, mercury is caused to enter the other tube and render available the other path for the current, the mercury in each tube thereby in turn serving as a fuse to interrupt the circuit through the cut-out when the current passing exceeds a predetermined value.

10. A mercurial electric cut-out provided with two tubes containing mercury, said tubes being contained in alternative paths for the passage of the current through the cut-out, a common reservoir with which said tubes communicate, said tubes being substantially in line with, and in communication with opposite ends of, said reservoir, said reservoir being constituted by a cylinder provided with a plunger whereby when one of said paths is broken by the expulsion of mercury from one said tube by the current under control exceeding a predetermined value, the other of said alternative paths is automatically made available for the passage of the current by the expelled mercury indirectly causing the column of mercury in the other of said tubes to be completed.

11. A mercurial electric cut-out containing alternative mercurial paths for the pasage of the current through the apparatus, said paths being arranged so that the one of said paths which for the time being is closed includes a mercurial fuse which is adapted to rupture and break the circuit when the current passing through it exceeds a predetermined value, and means whereby on rupture occurring of the circuit along one path mercury expelled from said fuse automatically renders available the alternative path through the apparatus, said alternative path then containing the said mercurial fuse which allows the current to pass so long as the current does not exceed a predetermined value, each of said paths containing at least one supplementary circuit-breaking point in series with the mercury in the path.

12. A mercurial electric cut-out containing alternative paths for the passage of the current through the apparatus, said paths being arranged so that any one of said paths which for the time is closed includes a mercurial fuse which is adapted to rupture and permit the expulsion of mercury therefrom when the current passing through it exceeds a predetermined value, and means whereby on rupture occurring of the circuit along one path mercury expelled from said fuse automatically renders available an alternative path through the apparatus, said alternative path containing a mercurial fuse which allows the current to pass so long as the current does not exceed a predetermined value, in combination with switching means which require to be actuated before the current can pass through the available alternative path.

13. A mercurial electric cut-out containing at least three contacts within a sealed space, two interior paths for the passage of the current through the apparatus between said contacts, said paths being arranged so that any one of said paths which for the time being is closed includes a mercurial fuse contained within said space, means whereby when that path is broken by the expulsion of mercury therefrom by the current under control exceeding a predetermined value, the other of said paths is automatically made available for the passage of the current, a two-way switch, connections external of said space between said contacts and said switch, said switch requiring to be actuated before the current can pass through such other path, said other path when switched in serving to pass the current under control until the current again exceeds a predetermined value, whereupon that path is broken by the expulsion of mercury therefrom and the first mentioned path automatically made again available for the passage of the current.

14. Mercurial electric cut-out provided with tubes containing mercury, the columns of mercury contained in said tubes being adapted to rupture when the current passing through them exceeds a predetermined value, deflecting means associated with said tubes, the mercury in one tube being segregated from that in another and expansion space being provided between the tubes, the mercury-containing tubes being in different paths for the current through the cut-out and being so arranged that when the path of the current through the mercury in one tube is interrupted by the expulsion of mercury from that tube, the expelled mercury is deflected to another tube thereby to render available another path for the current through the cut-out, the mercury in each tube thereby in turn serving as a fuse to interrupt the circuit through the cut-out when the current passing exceeds a predetermined value.

15. Mercurial electric cut-out provided with tubes containing mercury the mercury in one tube being segregated from that in another and an expansion chamber being provided between the tubes, said chamber having a conductor wall forming a common terminal for one end of said tubes, said tubes each having a separate terminal at the other end, the mercury containing tubes being in different paths for the current through

said terminals and being so arranged that when the path of the current through the mercury in one tube is interrupted by the expulsion of mercury from that tube, the expelled mercury is transferred to another tube thereby to render available another path for the current through the cut-out, the mercury in each tube thereby in turn serving as a fuse to interrupt the circuit through the cut-out when the current passing exceeds a predetermined value, and means to prevent the mercury expelled from one tube from returning to that tube.

16. A mercurial electric cut-out containing alternative mercurial paths for the passage of the current through the apparatus, said paths being arranged so that any one of said paths which for the time being is closed includes a mercurial fuse which is adapted to rupture when a current exceeding a predetermined value passes therethrough and means whereby when that path is broken by the expulsion of mercury therefrom such path is kept broken and another of said paths is automatically made available for the passage of the current, said alternative path containing a mercurial fuse which allows the current to pass so long as the current does not exceed a predetermined value.

17. A mercurial electric cut-out provided with alternative paths for the passage of the current through the apparatus, each path comprising a tube containing a mercury column adapted to rupture and break the circuit when the current passing through it exceeds a predetermined value, a common expansion chamber between the tubes with which said tubes communicate, and means whereby when one said path is broken by the expulsion of mercury from one said tube by the current under control exceeding such predetermined value, another of said alternative paths is automatically made available for the passage of the current by the expelled mercury causing the column of mercury in another of said tubes to be completed, the mercury in said last mentioned tube allowing the current to pass in said last mentioned alternative path unless said current again exceeds a predetermined value.

18. A mercurial electric cut-out containing a sealed interior space, alternative mercurial paths within said space for the passage of the current through the apparatus, a contact within said space common to the alternative paths and separate contacts within said space appertaining to each path, said paths being arranged so that any one of said paths which for the time being is closed includes a mercurial fuse which is adapted to rupture when a current exceeding a predetermined value passes therethrough and means whereby when that path is broken by the expulsion of mercury therefrom such path is kept broken and another of said paths is automatically made available for the passage of the current, said alternative path containing a mercurial fuse which allows the current to pass so long as the current does not exceed a predetermined value.

19. A mercurial electric cut-out containing alternative paths for the passage of the current through the apparatus, each of said paths containing a mercurial fuse which is adapted to rupture when a current exceeding a predetermined value passes therethrough, a sealed space in the interior of the cut-out for containing the mercury and providing an expansion space therefor, contacts within said sealed space defining said alternative paths therethrough, the contacts of said paths at one end at least of said paths being separated from each other, one of the paths between said contacts being normally broken and one being normally available for use, means for preventing transfer of mercury into the fuse in the broken path until said latter path ruptures, and means whereby when the path for the time being in circuit is ruptured by expulsion of mercury therefrom, mercury is automatically introduced into another path so as to make said latter path available for use, said newly made path thereby containing a mercurial fuse which allows the current to pass so long as the current does not exceed a predetermined value.

20. A mercurial electric cut-out according to claim 17, having exterior contact faces communicating electrically with said interior contact faces.

21. A mercurial electric cut-out containing alternative paths for the passage of the current through the apparatus, said paths being arranged so that any one thereof which for the time being is closed includes a mercurial fuse which is adapted to rupture when a current exceeding a predetermined value passes therethrough, and an element movable by the mercury expelled as a result of a rupture for automatically causing another of said paths to be made available for the passage of the current, said alternative path containing a mercurial fuse which allows the current to pass so long as it does not exceed a predetermined value.

22. A mercurial electric cut-out provided with a single tube containing mercury, branch tubes from said tube contained in alternative paths for the passage of the current through the cut-out, a contact member for each path, a common reservoir with which both said branch tubes communicate, the column of mercury contained in said single tube serving as a fuse which ruptures when the current exceeds a predetermined value, said fuse being contained in whichever path is for the time being closed, a movable element in said reservoir adapted to be displaced by mercury expelled from said column when a current overload occurs, the movement of said element causing electrical connection to be broken at one of said contacts and made at another and serving to displace mercury back into the single tube so as to make the latter again available for use.

23. A mercurial electrical cut-out containing alternative mercurial paths for the passage of the current through the apparatus, said mercurial paths being arranged so that any one of said paths which for the time being is closed includes a mercurial fuse which is adapted to rupture when a current exceeding a predetermined value passes therethrough, said mercurial paths being contained within a sealed space in the cut-out, means whereby when any one of said paths is broken by the expulsion of mercury therefrom another of said paths is automatically made available for the passage of the current, said alternative path containing a mercurial fuse which allows the current to pass so long as it does not exceed a predetermined value, and external contacts communicating with said paths and adapted for connection with different electrical paths external to such mercurial paths.

24. A mercurial electrical cut-out comprising a plurality of mercurial electrical fuses, an expansion chamber between said fuses, a sealed interior within which said fuses and said expansion space are contained, exterior contacts, current-conducting lines within said interior connecting said contacts and providing alternative

current paths, each line containing one of said fuses, one of said fuses being normally arranged so that the line therethrough is broken and another of said fuses being arranged to complete another of said lines, said latter fuse being adapted to be ruptured when the current passing through it exceeds a predetermined value, said fuses being arranged so that when the one in circuit ruptures due to a current overload mercury is caused to flow into and complete another fuse, and means for preventing mercury from returning to the ruptured fuse and remaking the corresponding line.

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