Aug. 30, 1966 L. L. ALSTON ETAL 3,269,987

ELECTRIC SWITCH WITH FRANGIBLE AND EXPENDABLE ELECTRODES

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FIG. 1.

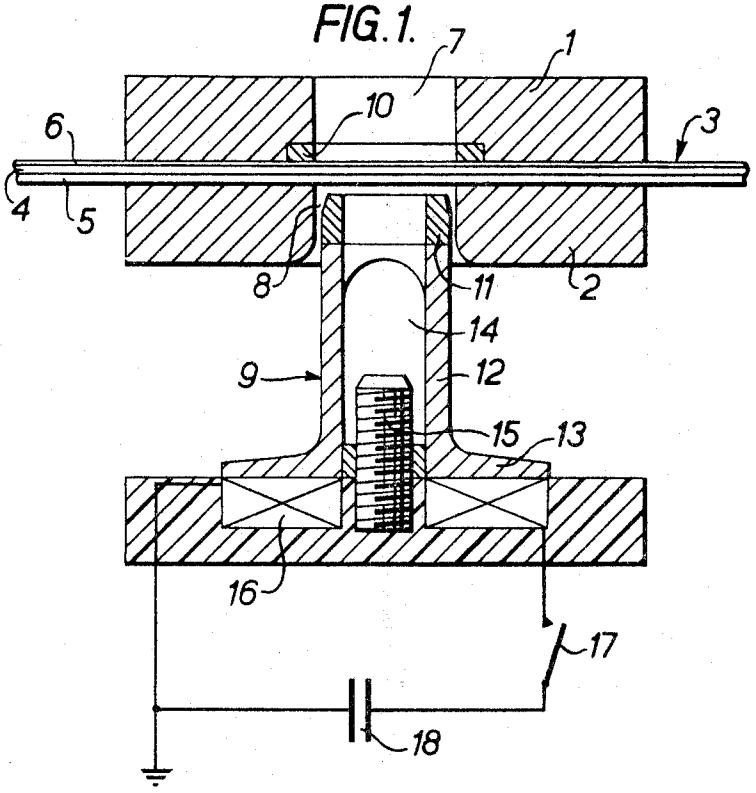
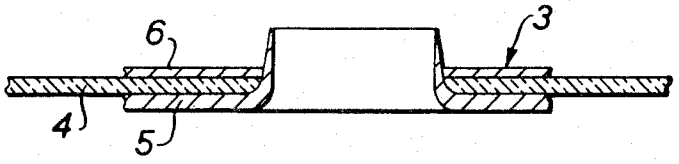


FIG. 2.



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FIG.3.

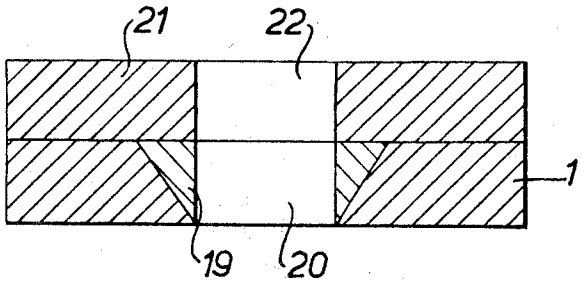
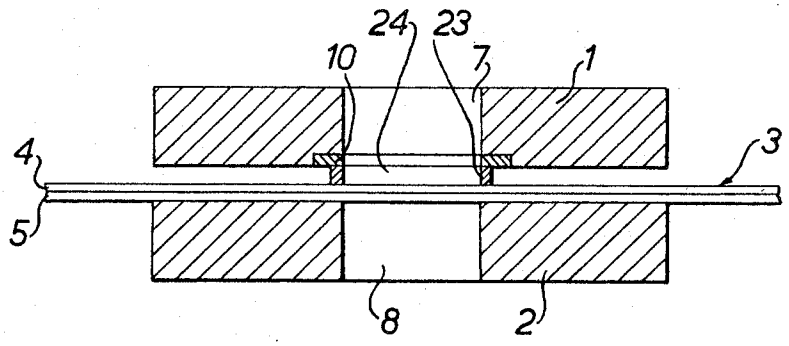


FIG.4.



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ELECTRIC SWITCH WITH FRANGIBLE AND EXPENDABLE ELECTRODES

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5 Claims. (Cl. 200—61.08)

This invention relates to electric switches which are made to close mechanically.

In the development of clamp switches for nuclear fusion experiments a need has arisen for a switch which is able to hold off 40 kilovolts until the instruction is given for it to close. When closed the switch must have a very low resistance, a low inductance, and be able to carry 100 kiloamps and at least some hundreds of coulombs. It is required that the switch close in a time of the order of 100 microseconds from the instant of giving the instruction. The jitter, that is the variation in the time taken to close, must be small.

Hitherto no mechanical switch has met these requirements, and it is an object of the present invention to provide a mechanical switch which is capable of doing so.

According to the present invention, an electric switch comprises a layer of electrically-insulating material sandwiched between two expendable electrodes, two main electrodes between which the sandwich is held such that the two main electrodes contact the two expendable electrodes respectively, the electric supply to be switched being arranged to be connected across the main electrodes, a pair of aligned apertures in the main electrodes normal to the general plane of the sandwich, a plunger, and means operated when the switch is to be closed to force the plunger into the apertures such that the sandwich is pierced and deformed portions of the expendable electrode first pierced contact the other expendable electrode and complete the electric path between the main electrodes.

Preferably each expendable electrode is formed by a metallic layer, the expendable electrode first pierced by the plunger being formed of a relatively soft and ductile metal and the other expendable electrode being formed of a relatively hard metal. Preferable the expendable electrodes are formed of soft annealed copper and hard rolled copper respectively.

A switch in accordance with the present invention will now be described by way of example with reference to the accompanying drawing, in which:

FIGURE 1 shows the essential parts of the switch diagrammatically,

FIGURE 2 shows an enlarged detail of part of the switch after closure,

FIGURE 3 shows a modification to a part of the switch and

FIGURE 4 shows another modification to a part of the switch.

Referring now to FIGURE 1 of the drawing, the switch includes a pair of main electrodes **1** and **2**, between which is positioned a sandwich **3** comprising a polythene layer **4** between copper layers **5** and **6** which form expendable electrodes. The layer **5** is formed of soft annealed copper and the layer **6** is formed of hard rolled copper.

The main electrodes **1** and **2** have aligned apertures **7** and **8**, respectively, into which a plunger **9** is forced when the switch is to be closed. The inner edge of the main electrode **1** has a hard steel insert **10** on the side nearer the plunger **9**.

The plunger **9** has a hollow, tapered tip **11** of steel at

the end which is to pierce the sandwich **3**. The remainder of the plunger **9** is of duralumin and consists of a hollow shaft **12** and a disc **13**. The plunger **9** is movable axially on a brass guide **14** carried on an insulating rod **15**, and in the rest position shown has the disc **13** adjacent a resin-encapsulated coil **16**.

In one embodiment of the switch the apertures **7** and **8** each have a diameter of 1.025 inches, the plunger **9** has a diameter of 0.980 inch, and the tip **11** is tapered at an angle of 20° to the axis of the plunger **9** for a distance of 0.125 inch from the end.

One end of the coil **16** is earthed and the other end is connected by way of a very fast, electronic, subsidiary switch **17**, such as a trigatron, to an energising capacitor **18**.

The operation is as follows. The electric supply to be switched is connected across the main electrodes **1** and **2** which, with the switch open, are insulated from one another by the polythene layer **4**. The capacitor **18** is charged to a suitable potential, which in the embodiment mentioned is 8 kilovolts.

When the switch is to be closed, the subsidiary switch **17** is closed so causing the capacitor **18** to discharge through the coil **16**. The rapidly rising current in the coil **16** induces an oppositely sensed current in the disc **13** and this results in the plunger **9** being forced into the apertures **7** and **8**, so that the tip **11** pierces the sandwich **3**. This causes a section of the polythene **4** and the layer **6** (which is hard) to be punched out. The appropriate part of the layer **5** (which is soft and ductile) is however extruded to contact the layer **6** to which it may become welded due to the current which then flows between the main electrodes **1** and **2** via the layers **5** and **6**.

This extrusion, which is illustrated in FIGURE 2, is such that the plunger **9** is protected from damage by arcing as any contact burning which occurs is largely confined to the layers **5** and **6**.

To reopen the switch the plunger **9** is withdrawn and a fresh sandwich **3** is substituted ready for the next closure. This substitution can be arranged to be done automatically.

In the embodiment mentioned the layer **5** is 0.02 inch thick and the layer **6** is 0.01 inch thick. The polythene **4** is 0.02 inch thick which enables the switch to hold off 40 kilovolts and to be closed in 40 microseconds. When closed the switch has a resistance of a few microhms.

Referring now to FIGURE 3, the steel insert **10** (FIGURE 1) may be replaced by a very hard sintered aluminium oxide insert **19** having an aperture **20** which is aligned with the aperture **8** (FIGURE 1). The insert **19** is tapered so that the annular surface which bears on the layer **6** is very narrow. To hold the insert **19** in place the main electrode **1** has a further portion **21** secured to it, the portion **21** having an aperture **22** aligned with the aperture **20**.

Where the switch is to carry a heavier current the sandwich **3** may be modified as shown in FIGURE 4, to which reference is now made. In this case the layer **6** is replaced by an annular copper ring **23** having an aperture **24** which is arranged to be aligned with the apertures **7** and **8**.

The switch may, of course, be used for purposes other than nuclear fusion experiments.

We claim:

1. An electric switch comprising a layer of electrically-insulating material sandwiched between two expendable electrodes, two main electrodes between which the sandwich is held such that the two main electrodes contact the two expendable electrodes respectively, the electric supply to be switched being arranged to be connected across the main electrodes, a pair of aligned apertures

in the main electrodes normal to the general plane of the sandwich, a plunger, and means operated when the switch is to be closed to force the plunger into the apertures such that the sandwich is pierced and deformed portions of the expendable electrode first pierced contact the other expendable electrode and complete the electric path between the main electrodes.

2. An electric switch comprising a layer of electrically-insulating material sandwiched between two metallic layers which form expendable electrodes, two main electrodes between which the sandwich is held such that the two main electrodes contact the two expendable electrodes respectively, the electric supply to be switched being arranged to be connected across the main electrodes, a pair of aligned apertures in the main electrodes normal to the general plane of the sandwich, a plunger, and means operated when the switch is to be closed to force the plunger into the apertures such that the sandwich is pierced and deformed portions of the expendable electrodes are in contact and complete the electric path between the main electrodes.

3. A switch in accordance with claim 2 wherein the expendable electrode first pierced by the plunger is formed of a relatively soft and ductile metal and the other expendable electrode is formed of a relatively hard metal.

4. A switch in accordance with claim 3 wherein the expendable electrode first pierced by the plunger is formed of soft annealed copper and the other expendable electrode is formed of hard rolled copper.

5. An electric switch comprising a layer of electrically-insulating material sandwiched between two metallic layers which form expendable electrodes, two main electrodes between which the sandwich is held such that the two main electrodes contact the two expendable electrodes respectively, the electric supply to be switched being arranged to be connected across the main electrodes, a pair of aligned apertures in the main electrodes normal to the general plane of the sandwich, a plunger having at one end a tip portion adapted to enter said apertures and at the other end a disc-like portion the general plane of which is normal to the length of the plunger, a coil situated adjacent said disc-like portion, and means to energise said coil when the switch is to be closed, so that a current of opposite sense to the current in said coil is induced in said disc-like portion and the tip portion of the plunger is forced into the apertures such that the sandwich is pierced and deformed portions of the expendable electrodes are in contact and complete the electric path between the main electrodes.

No references cited.

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