

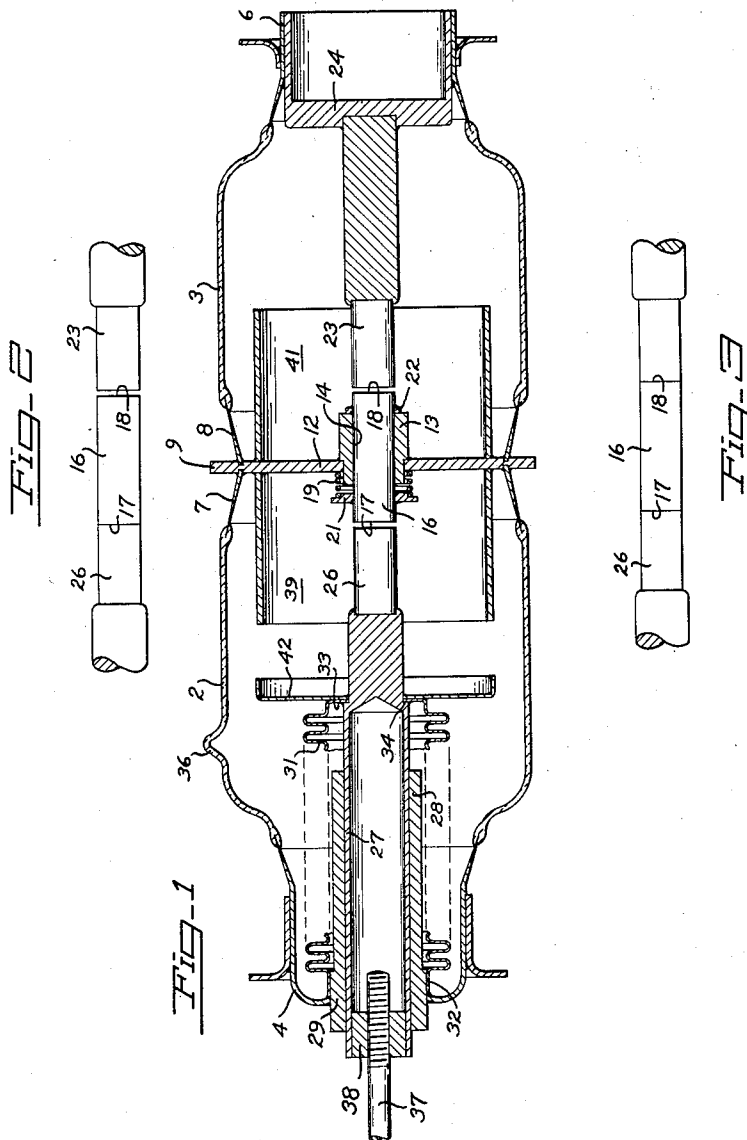
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VACUUM SWITCH

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VACUUM SWITCH

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My invention relates to vacuum switches; and particularly to a multiple-break, single throw switch.

One of the objects of my invention is the provision of a multiple-break vacuum switch in which each break is isolated from the other.

Another object is the provision of a double-break switch in which a single actuator effects both breaks.

Still another object is the provision of a multiple-break switch in which the time lag between breaks is limited to a very few milliseconds.

A still further object is the provision of a multiple-break vacuum switch in which means are provided for shielding the interior surface of the envelope from deposits of vaporized contact metal.

Another object is the provision of a double-break vacuum switch capable of handling substantially twice the current load of a comparable single-break switch.

Other objects will be brought out in the following description of the invention. I do not limit myself to the showing made by said description and the drawings, since I may use variant forms of the invention within the scope of the appended claims.

Referring to the drawings:

Fig. 1 is a half-sectional view partly in elevation taken in the plane of the longitudinal axis of the switch when in fully open position.

Fig. 2 is a fragmentary view showing the position of the contact parts when only one break has occurred during opening of the switch.

Fig. 3 is a diagrammatic view showing the position of the contact parts when the switch is completely closed.

All views are drawn approximately two-thirds actual size.

Broadly considered, my multiple-break vacuum switch comprises an evacuated envelope having a metallic end cap hermetically closing each opposite end. The end caps serve to integrally mount a pair of contact rods, each of which extends into the envelope toward the other, and one of which is slidably mounted on its associated end cap for movement toward and away from the other.

Within the envelope, spaced substantially midway between the ends thereof, is a connector contact axially aligned with the fixed and mobile contact rods and reciprocally interposed therebetween. The connector contact is spring-pressed and slidably supported in a bearing assembly integral with the envelope. Inward movement of the mobile rod toward the fixed rod is normally effected by atmospheric pressure. Such inward movement results in the mobile contact rod abutting the adjacent end of the connector contact. Continued inward movement of the abutted mobile rod and connector contact effects engagement of the remote end of the connector with the fixed contact, thus connecting the three elements in a conductive relation constituting the closed position of the switch.

Means including an actuator rod are provided for opening the switch against atmospheric pressure. The actuator rod is removably secured to the mobile contact rod and is conveniently solenoid actuated. As the mobile contact rod moves outwardly, the connector contact remains abutted to the mobile rod and moves with it under

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the impetus of its spring. Thus, a gap is formed between the fixed contact rod and the retreating connector contact. When the connector has retreated a calculated amount it is automatically stopped and a second break or gap forms between the retreating mobile contact rod and the stopped connector. Thus, two separate and distinct breaks are effected, separated in point of time by only a few milliseconds. The multiple break thus makes possible the rapid interruption of current loads at least twice as great as would be possible with a comparable single-break switch.

Means are provided within the envelope for shielding the interior surfaces thereof from high velocity particles of molten contact metal; and for isolating each break or spark gap from the other.

Specifically, the multiple-break vacuum switch of my invention comprises an evacuated envelope formed conveniently by two axially aligned cylindrical glass shells 2 and 3 having opposite remote ends hermetically sealed by metallic end caps 4 and 6 respectively. The shells have corresponding adjacent ends spaced apart and sealed hermetically to annular copper flanges 7 and 8 respectively, each copper flange terminating in and being brazed integrally to opposite sides of a perpendicular and annular shield plate 9, extending radially into the envelope in a bearing portion 12.

The bearing portion 12 serves to concentrically position within the envelope and rigidly support a cylindrical slide bearing 13, having a bore 14 serving as a slideway for the connector contact 16. The connector contact is conveniently a short length of tungsten rod sized and polished so as to reciprocate freely within the bearing bore 14, and provided with accurately cut end faces 17 and 18. As viewed in Fig. 1, the connector is urged to the left by a compression spring 19 working between the bearing plate 12 and a collar 21 brazed about the connector contact adjacent the face 17. Movement in this direction is limited to a predetermined amount by a second collar 22 brazed adjacent the face 18 and adapted to abut the bearing 13.

Thus, the connector contact is reciprocally mounted within the envelope in position to engage and disengage a fixed contact rod 23, axially aligned with the connector and integrally fixed as by brazing to the end cap 6. The parts are proportioned so that in the open position of the switch shown in Fig. 1, the connector contact face 18 is spaced a short distance from the inner end of the fixed contact rod. Movement of the connector to the right in Fig. 1 results in these two faces becoming contiguous and the spring being compressed.

Rigidity and immobility of the fixed contact rod is insured by brazing its remote end into a large diameter tungsten base 24 integrally united about its peripheral surface within the end cap 6. The integral nature of this construction also insures maximum heat conduction with a corresponding decrease in operating temperatures and electrical resistance. The large diameter end cap 6, besides acting as an efficient heat radiator because of its size, serves also as a convenient terminal for connecting the switch into a circuit.

In order to open and close a circuit through the switch, a mobile contact rod 26 is provided movably mounted on the end cap 4. This mobile rod is axially aligned with the connector contact and fixed contact rod, and is provided with a long cylindrical stem portion 27 slidable within the tubular slide bearing 28. Axial alignment of the parts is thus maintained during movement of the mobile rod, and rigidity is insured by integrally brazing the outer end 29 of the slide bearing to the copper end cap 4. Because inertia is a factor which must be considered in the design of a fast operating switch such as the one disclosed, the outer end of the mobile

contact rod has been hollowed out over a greater portion of its length so as to reduce its weight. The proportions of the parts are arranged so that the current carrying capacity of this portion of the rod will match the solid section.

Hermetically sealing the end cap 4 and forming a re-entrant portion of the housing, is an expansible metallic bellows 31. The outer cylindrical end 32 of the bellows snugly surrounds and is hermetically brazed to the outer end 29 of the slide bearing and to the end cap 4. At its inner end 33, the bellows is integrally and hermetically brazed to a shoulder 34, formed about the mobile contact rod 26. Thus it will be apparent that evacuation of the envelope through tubulation 36 will result in the bellows 31 being expanded inwardly, carrying the mobile rod with it. Such inward movement of the mobile rod will result in the inner end of the mobile rod abutting the connector contact face 17 as in Fig. 2. Since atmospheric pressure acting on the inner surfaces of the bellows exerts a greater force than the compressive force of the spring 19, the connector contact is carried to the right as viewed in Fig. 1, compressing the spring 19, and effecting a continuous connection between the rods 23 and 26 by the connector contact 16. This is the normal closed position of the switch parts shown diagrammatically in Fig. 3.

To open the switch, an actuator rod 37 is provided. The actuator rod is threaded into a plug 38 secured in the outer hollow stem 27, and is conveniently actuated by a solenoid or other motor means.

From the closed position of the switch shown in Fig. 3, movement of the mobile rod to the left permits spring 19 to move the connector contact also to the left. Leftward movement of the connector contact results in a gap being formed between the connector face 18 and the inner end of the fixed rod. Should an arc form across this gap, current will continue to flow. The width of the gap reaches its maximum value when collar 22 has engaged the bearing 13 and stopped leftward movement of the connector as shown in Figs. 1 and 2. At this point, continued leftward movement of the mobile rod 26 causes the inner end of rod 26 to pull away from connector contact face 17, forming a second gap in the circuit, only a few milliseconds after the first. In any event, the double break makes possible the efficient interruption of at least twice the current load which a comparable single-break switch could efficiently interrupt.

As shown in Fig. 1 each gap is substantially isolated from the other by bearing plate 12, and the glass shells and flanges 7 and 8 are protected by cylindrical open ended shield plates 39 and 41 respectively, axially aligned and having adjacent ends integrally brazed to opposite sides of the bearing plate. A cylindrically flanged plate 42 brazed to the mobile rod 26 and to the inner end 33 of the bellows serves to shield the bellows from molten particles of contact metal resulting from the arc.

It is believed that at least part of the successful operation of this switch is due to isolation of each arc gap within a separate chamber. It will of course be understood that while I have disclosed a double-break or gap in a vacuum switch, it is within the spirit of this invention and the scope of the appended claims to provide a vacuum switch having three or four or more gaps.

I claim:

1. A vacuum switch comprising an evacuated envelope having a metallic end cap hermetically closing each end, a mobile contact rod movably mounted on one of the end caps and extending into the envelope, a fixed contact rod mounted on the other end cap and extending into the envelope to a point spaced from said mobile rod, a connector contact movably mounted within the envelope to engage with and disengage from said contact rods, means including a transverse plate fixed within the envelope to slidably support said connector contact and to isolate each said contact rod and an associated end of said connector contact from the other contact rod and

the other end of the connector contact associated therewith, and means external the envelope for moving said mobile rod to effect said engagement and disengagement.

2. The combination according to claim 1, in which said transverse plate is rigidly fixed to the envelope wall and the connector contact is spring-pressed in one direction and movable by said mobile contact rod in the opposite direction.

3. The combination according to claim 1, in which both said end caps constitute rigid external terminals and said mobile rod, said connector contact and said fixed contact rod are axially aligned within the envelope with the connector contact interposed between the contact rods, the mobile rod being movable relative to its associated end cap, and the fixed rod being rigidly supported by its associated end cap.

4. A vacuum switch comprising an evacuated envelope including two dielectric shells having adjacent ends hermetically sealed to a metallic cylinder interposed therebetween and their remote ends hermetically sealed by metallic end caps, a mobile contact rod movably mounted on one of the end caps and extending into the envelope, a fixed contact rod mounted on the other end cap and extending into the envelope to a point spaced from said mobile rod, a connector contact movably mounted within the envelope to engage and disengage said contact rods, and means external the envelope for moving said mobile rod to effect said engagement and disengagement.

5. The combination according to claim 4, in which an annular plate is provided integrally mounted on said metallic cylinder and extending inwardly to divide the envelope into two chambers.

6. The combination according to claim 5, in which a slide bearing is integrally mounted on said annular plate, and said connector contact is slidably journaled in said slide bearing.

7. The combination according to claim 5, in which said mobile rod is limited to movement within one chamber, said fixed contact rod is fixed within the other chamber, and said connector contact reciprocates within both chambers to engage and disengage said contact rods.

8. The combination according to claim 5, in which shield means are provided within each chamber and supported on said annular plate.

9. In a vacuumized electric implement, the subcombination of a dielectric shell and a conductive end cap structure hermetically closing an end of the shell, comprising a conductive ring of varying diameter, the ring at its greatest diameter being hermetically united to the rim of the shell and at its least diameter constituting a cylindrical flange, an outwardly opening cup seated within and integrally united to the flange, and a conductive stem integral with the bottom of the cup and extending into the shell.

10. A vacuum switch comprising an evacuated envelope having a metallic end cap hermetically closing each end, a mobile contact rod movably mounted on one of the end caps and extending into the envelope, a slide bearing to slidably support said mobile contact rod, an expansible metallic bellows integrally interposed between the slide bearing and the mobile contact rod, a fixed contact rod mounted on the other end cap and extending into the envelope to a point spaced from said mobile rod, a connector contact movably mounted within the envelope to engage with and disengage from said contact rods, and means external the envelope for moving said mobile rod to effect said engagement and disengagement.

11. The combination according to claim 10 in which shield means comprising a cylindrically flanged plate is interposed between said bellows and said connector contact.

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