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VACUUM SWITCH

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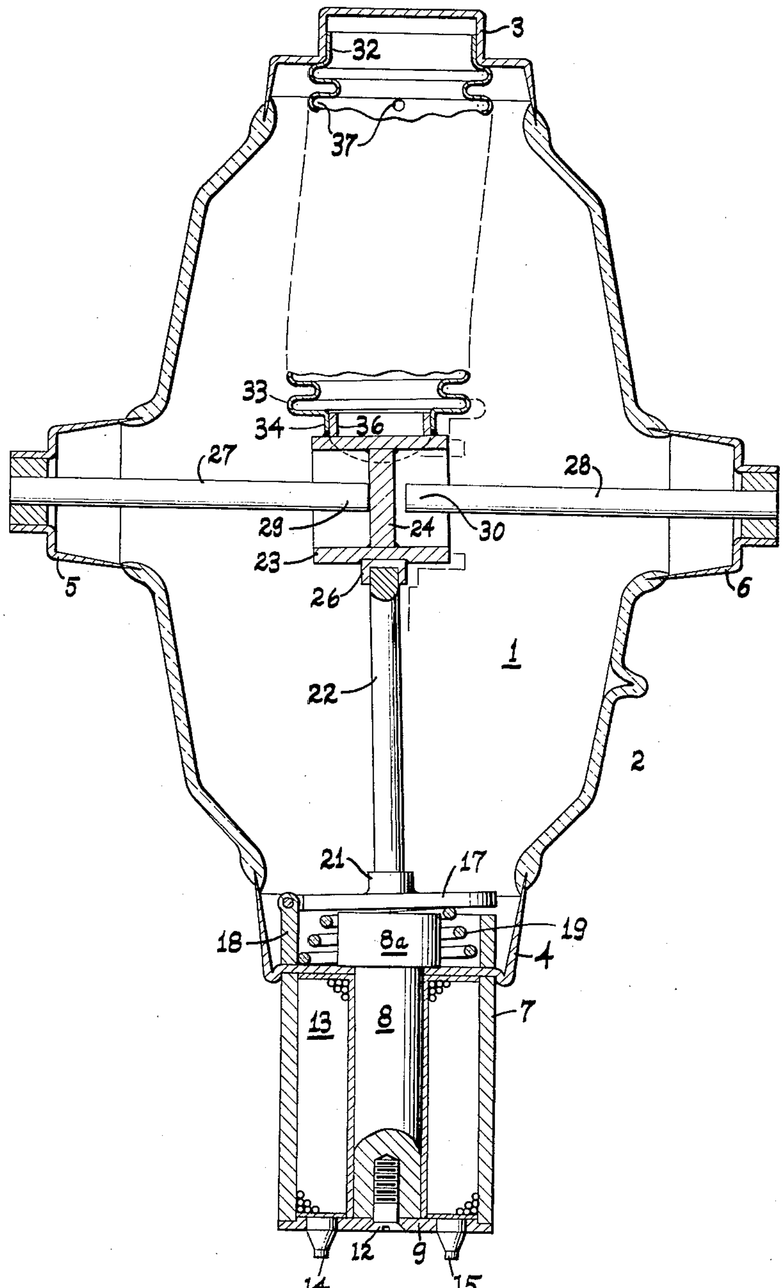

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1

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VACUUM SWITCH

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My invention relates to vacuum switches and particularly to such switches of single pole, single and double throw type, and which may be normally open or normally closed.

One of the objects of my invention is the provision of a switch of very high voltage rating while at the same time characterized by a minimal amount of material, light weight of moving parts, and small size.

Other objects include the provision of a switch in which actuation of moving parts requires a minimal amount of energizing power; and frictional losses in the contacts are sharply reduced.

Still another object of my invention is to take advantage of the controlled flexibility of a generally cylindrical but corrugated shell or "bellows" to provide a conductor connecting a fixed element to a movable element. Such conductor has a relatively low inertia, high current carrying capacity, low inductance, and long life capabilities.

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

The figure of the drawing is a vertical sectional view taken in the long axis of the switch, the parts of which are shown in NC position.

In terms of broad inclusion, I have provided an elongated dielectric bulb closed on each of its two ends with a metallic wall to form a vacuumized chamber. At one end the wall is formed in part by a cup-shaped copper seal on the rim of which the bulb is secured by a common metal-to-glass hermetic union. On the outside surface of the cup seal bottom, a ferrous cylindrical housing is brazed concentric with the long axis of the bulb. A ferrous cylindrical core concentric with the housing pierces and is integrally and hermetically united with the copper wall or cup seal bottom, extending on one side into the vacuumized chamber and on the other side into the cylindrical housing where it forms with the housing an annular chamber, in which coil means are disposed to energize the core. The coil means is mounted on a removable ferrous cover plate closing the free end of the housing so that it may readily be changed.

Within the vacuumized chamber are fixed aligned contact rods oppositely mounted in the side wall of the bulb, spaced apart at the long axis thereof and each provided with a contact or lead external to the chamber.

A pivotally mounted armature within the vacuumized chamber and immediately above the end of the core is responsive to the energized core; and provides a rigid mounting for a dielectric stem, which carries on its free end a contact plate positioned between the ends of the contact rods, so that movement of the armature moves the contact plate a short distance from engagement with one to engagement with the other, but of course without engaging both at the same time.

2

The contact plate is in the center of a hollow copper cylinder so that the end of each contact rod is surrounded by a part of the cylinder and thus shielded.

The upper end of the bulb (as seen in the drawing) is closed by a copper cup seal forming the common metal-to-glass hermetic unit with the edges of the glass. A generally cylindrical but corrugated shell or bellows selected for its controlled flexibility is brazed at one of its ends into the end seal, and at its other end is brazed to the cylindrical shield opposite its mounting stem.

The union of the bellows with both shield and end seal is integral but need not be hermetic since the bellows is vented into the vacuum chamber within the bulb.

The bellows thus provides a feed-in conductor of high current carrying capacity, and low inductance and inertia. Because of its controlled flexibility in all directions within the limits of its required movements extremely long life may be expected with complete absence of lash or momental whip during operation. The use of the bellows in connecting the fixed seal to a movable switch element provides a wide range of controlled flexibility, that is, without slack or looseness at any place within its range of movement.

In greater detail my vacuum switch comprises a vacuumized chamber **1** within an elongated dielectric bulb **2**, which is substantially symmetrical about both vertical and horizontal axes. The bulb is conveniently of glass but the wall is interrupted at four points, where the two axes intersect it. At these points the bulb is closed hermetically by metallic walls formed by copper seals **3** and **4** on the vertical axis; and by seals **5** and **6** on the horizontal axis. The seals in general have a cup shape, and the sides or flanges are hermetically united with the glass in the common metal-to-glass union.

Brazed to the outer flat surface of the seal **4** is a ferrous shell **7**. A magnetic core **8** pierces the center of the seal and is hermetically brazed thereto. The core is formed with an enlarged head **8*a*** which lies within the vacuum chamber. A closure plate **9** for the core chamber, secured to the core at its outer end by a screw **12**, provides a mounting for a magnetic coil **13** for energizing the core. Leads **14** and **15** for connecting the coil into a control circuit are arranged in the cover plate. The mounting of the coil on the closure plate provides a convenient means for quick replacement by a coil of the same or different electrical values.

Adjacent the inner end of the core and within the vacuum chamber is a ferrous armature **17**, pivoted on one side of the mounting ring **18**, brazed to the inner surface of the seal **4**. A coil spring **19** seated between the armature head and the mounting ring presses the armature away from the core. Energizing the core pulls the armature back to a seat in the plane of the core face and the upper edge of the mounting ring.

Rigidly fixed on the armature within the small flange or step **21** is a ceramic or sapphire stem **22** on the opposite end of which is mounted a cylindrical copper shell **23**, provided with a tungsten partition **24** midway between its open ends. Securing the rod to the shell is accomplished by a flange or step **26** the base of which is brazed to the shell at a flattened area thereon.

Rigidly and hermetically bushed within the copper seals **5** and **6**, and in alignment with each other in the horizontal axis of the bulb are tungsten rods **27** and **28** respectively. The contact points of these rods **29** and **30** respectively are spaced apart with the tungsten partition **24** between them; and the length of the stem **22** is such that the axis of the cylindrical copper shell **23** coincides approximately with the horizontal axis of the bulb. Usually the ends of the contact rods **27** and **28** are parallel to the long vertical axis of the bulb; and the spacing between contacts, and also the length of the stem can be varied in accordance with the voltage demand.

The sizes, proportions and arrangements of the parts and especially of the two faces of the partition 24, are such that when the armature 17 is pressed upwardly by spring 19, the partition 24 is thrown in flat contact tightly against the flat face of contact point 29; the moving unit of armature, stem, copper shell and partition being then slightly tipped to the left of the vertical axis about the pivotal mounting of the armature 17. This is the normally closed position of the switch contacts.

When the core 8 is energized to pull the armature down upon its seat, the moving unit snaps over to substantially vertical position with the opposite face of the tungsten partition tight against the flat face of contact point 30. This is the normally open position of the switch contacts for the SPST type of switch. Full flat face engagement of the partition with contact end 30 is of course important in the SPDT type of switch.

Means are provided for supplying electrical energy to the copper shell and tungsten partition to establish a circuit through the rod 27 or rod 28 depending on the position taken by the partition against contact point 29 or against contact point 30. This of course follows selective operation of the magnetic coil.

Brazed into the cup of the upper copper seal 3 is the upper cylindrical end 32 of the bellows 33, the lower cylindrical end 34 being brazed to the cylindrical flange 36, which in turn is brazed to the cylindrical copper shell 23. The bellows is entirely within the vacuumized chamber and one or more apertures 37 through its walls permits its evacuation when the bulb is so processed.

The mounting of the normally cylindrical bellows in the seal 3 normally positions its axis coincident with the long axis of the bulb, and this is its position when the partition 24 lies against the contact point 30. At this time, all parts from upper seal to armature are substantially without resilient bias or stress. As the magnetic core is deenergized and the tungsten partition swings through its small arc to engage the contact point 29, the lower end of the bellows swings through a similar arc, thus effecting a small but general distortion of the bellows resulting in a slight bias therein effective toward overcoming inertia of the moving parts when the core is energized. Operation of the switch to utilize one or the other of the circuits, therefore requires a bare minimum of power; and because engagement and disengagement of the contact points is in an arc so flat as to be substantially a straight line, there is no perceptible friction loss between the contacts.

The bellows in the use described provides another unique advantage, in that it provides a continuous and unbroken flexible conductor without the slack or looseness which characterizes the usual "pig tail" connection. The bellows is also of low inertia and inductance, but high current carrying capacity. Because of its symmetrical and small but widely distributed distortion, which avoids a concentration of stresses, the bellows can be expected to give a long and trouble free service.

Besides providing an ideal mechanical element for the mounting of the several cooperating parts of my switch, the cylindrical copper ring 23 provides a splendid shield around the contact points at the moments of closing and opening the circuit therethrough.

My switch has the capability of operating at high D.C. voltages, around 10 kv. or more, and simultaneously can carry sizeable amounts of current. Although the uses of my new switch have been considered mainly in the D.C. and A.C. services, it will also find uses in radio frequency applications.

I claim:

1. A vacuum switch comprising a dielectric bulb closed at top and base with metallic walls and therewith enclosing a vacuumized chamber, a magnetic core integral with the base wall and extending on both sides thereof, core energizing means adjacent the external end of the core, an armature pivotally mounted on the base wall adjacent the inner end of the core, means resiliently pressing the armature away from the core, spaced contact points within the chamber fixedly mounted on the bulb and each having an integral lead external to the bulb, a dielectric stem rigidly mounted on the armature, a conductive contact plate rigidly fixed on the stem between the contact points, and a bellows rigidly connected at its respective ends to the top wall and to the contact plate.

2. The combination according to claim 1 wherein the contact plate is surrounded by a cylindrical shield the opposite open ends of which also surround the contact points.

3. In a vacuum switch a vacuumized dielectric bulb, oppositely extending contact rods mounted in the bulb and having adjacent contact points spaced apart and each having a lead outside the bulb, a conductive cylindrical shell enclosing the adjacent contact points and having a conductive partition extending thereacross and between the contact points, a conductive bellows mounted in the bulb and having a lead outside thereof, the opposite end of the bellows being conductively connected to the partition, and means including a dielectric stem fixed to the cylindrical shell for moving the shell-partition unit selectively between the contact points.

4. In an electric switch, a vacuumized bulb, spaced contact points mounted on the wall of the bulb and each having an external lead, a shield surrounding said contact points, a conductive plate between the contact points and within the shield, a conductive bellows having one end mounted in the wall of the bulb and having an external lead and the other end conductively connected to the conductive plate, and means including a dielectric stem fixed to the conductive plate for moving the conductive plate selectively between the contact points.

5. In an electric switch, a vacuumized bulb, spaced contact points mounted on the wall of the bulb and each having an external lead, a conductive plate between the contact points, a conductive bellows having one end mounted in the wall of the bulb and having an external lead and the other end conductively connected to the conductive plate, and means including a dielectric stem fixed to the conductive plate for moving the conductive plate selectively between the contact points.

No references cited.