Dec. 19, 1961 J. E. JENNINGS 3,014,106

VACUUM SWITCH

Filed March 3, 1958

Fig_1

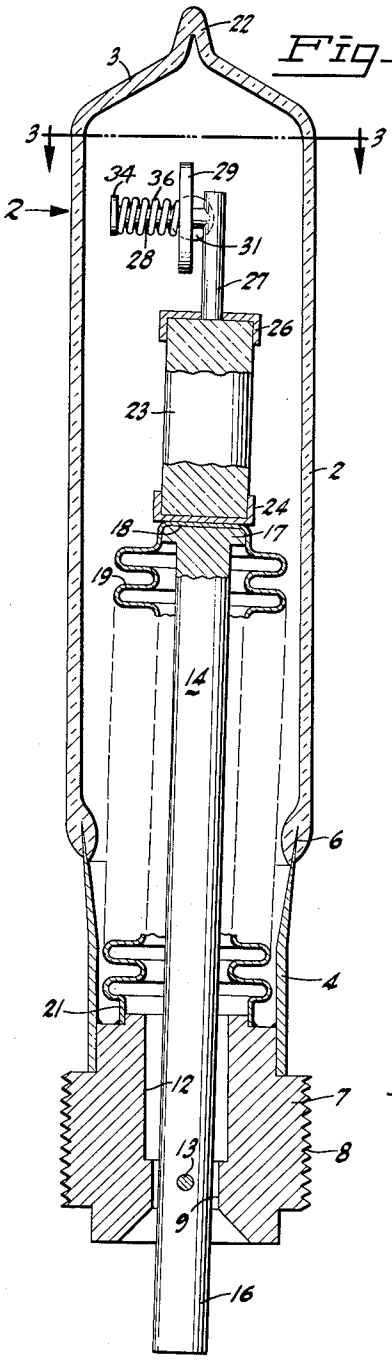


Fig_3

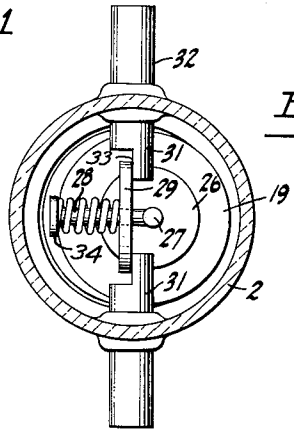


Fig_2

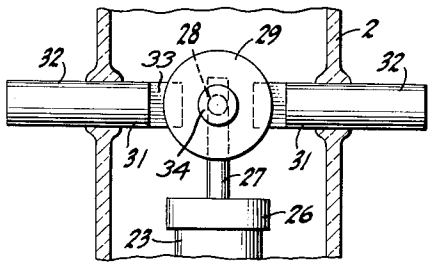
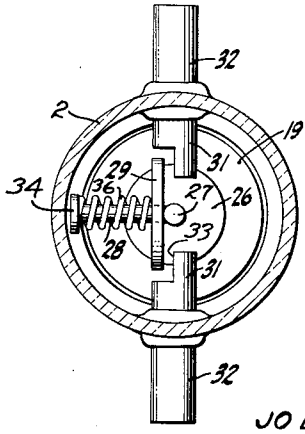


Fig_4



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3,014,106
VACUUM SWITCH

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My invention relates to vacuum switches, and particularly to such switches in which a movable actuating stem extends hermetically through the envelope wall.

One of the objects of my invention is to provide a bellows seal for the actuating stem of a vacuum switch in which the active portion of the bellows is not subjected to the injurious heat of brazing used to unite other portions of the structure.

Another object is the provision of a vacuum switch assembly having particular application in the design of miniature vacuum switches.

Still another object is the provision of means in a vacuumized envelope for pivotally mounting a contact actuating stem on the envelope wall at a point far removed from the contact.

A still further object is the provision in a vacuum switch assembly of flexible means for sealing a vibrating actuating stem in the wall of the vacuumized envelope, and so mounting it that the stresses of flexing are widely distributed to prolong the useful life of the flexible means indefinitely.

Another object is the provision of a miniature vacuum switch having a self-centering, low contact resistance contact assembly.

Another object is the provision of a miniature vacuum switch in which the actuating mechanism is insulated from the contact assembly.

Still another object is the provision of a miniature vacuum switch in which the contact assembly is provided with resilient overtravel protection to absorb the impact of contact and retain the contact button resiliently pressed against the contact points when a circuit is made therethrough.

The invention possesses other objects some of which with the foregoing will be brought out in the following description of the invention. I do not limit myself to the showing made by the said description and the drawings, since I may adopt variant forms of the invention within the scope of the appended claims.

Referring to the drawings:

FIG. 1 is a vertical sectional view partly in elevation showing the contact elements in closed position.

FIG. 2 is a fragmentary sectional view partly in vertical section taken in the direction indicated by the arrow 2 in FIG. 1.

FIG. 3 is a horizontal sectional view taken in the plane indicated by the line 3—3 of FIG. 1.

FIG. 4 is a horizontal sectional view taken in the same plane as FIG. 3 but showing the contact elements in open position.

All of the figures are drawn approximately four times actual size.

Broadly considered, the vacuum switch of my invention comprises a vacuumized envelope having an end cap hermetically arranged on one end thereof. A bellows, integrally brazed at one end to the end cap and having a closed inner end extending into the envelope, hermetically seals the envelope against the atmosphere. Within the envelope are arranged a pair of spaced contact points which are fixedly supported on the envelope wall and extend outwardly therefrom in integrally continuous terminal leads adapted for connection into a circuit. Contact means within the envelope and mounted on the inner end of the bellows are transversely movable from outside the

envelope to engage and disengage the contact points to make and break a circuit therebetween. An actuating stem pivotally mounted on the end cap and connected to the inner end of the bellows and the contact means serves to actuate the contact means to engage and disengage the contact points. Means are provided electrically insulating the contact means from the actuating stem and bellows.

In more specific terms, the vacuum switch of my invention comprises a generally cylindrical dielectric shell or bulb **2**, closed at one end by a dielectric wall **3** and at the other end provided with an end cap including a hollow copper anode shell **4** having one end feather-edged and hermetically sealed at **6** to the open end of the dielectric bulb **2**. The other end of the shell is brazed to one end of a copper bearing block **7** having an externally threaded portion **8** useful in mounting the switch on a panel or for attaching a switch actuating mechanism such as a solenoid.

The bearing block is centrally counterbored to provide a small diameter bore **9** adjacent its outer end, and a larger diameter bore **12** adjacent the inner end of the block. A journal or pivot pin **13** fixed transversely across the smaller bore **9** provides a bearing for the pivotal actuating stem **14** intermediate its ends to provide an outer end **16** and an inner end **17** extending into the bulb. The inner end **17** of the actuating stem is brazed to the closed reinforced inner end **18** of an expansible metallic bellows **19**. The outer open end **21** of the bellows surrounding the stem is hermetically brazed to the inner end of the block and seals the envelope against the atmosphere, which is free to enter the bellows through the bores **9** and **12**. Evacuation of the envelope is conveniently effected through a tubulation **22** formed in the dielectric wall **3** of the bulb.

It will thus be seen that pivot pin **13** permits lateral or transverse movement of the actuating stem, and that a small displacement of the outer end **16** of the stem in unit time will result in a relatively larger displacement of the inner end of the stem in the same time. This permits an exceedingly fast make and break operation of the switch with the lateral deflection caused in the bellows imposing such a small amount of resistance to movement of the stem as to be negligible. Spot-welding of the switch contacts as in larger, older type vacuum switches is thus avoided. The pivot pin and stem arrangements of course prevent longitudinal expansion and contraction of the bellows, while permitting transverse flexure and the free circulation of air within the bellows to carry off heat emanating from within the envelope.

Fixed on the inner end of the bellows within the envelope is a dielectric post **23** constituting an axially alligned continuation of the actuating stem beyond the inner end of the bellows. The post is preferably of high strength ceramic, metallized at each end and having metal caps **24** and **26** brazed on the ends thereof. The cap **24** is brazed directly to the inner end **18** of the bellows to provide a rigid and aligned continuous assembly with the actuating stem.

The cap **26** at the other end of the post serves to rigidly support an axially aligned freely extending tungsten rod **27**, which, like the ceramic post **23**, also constitutes an integral extension of the actuating stem **14** within the envelope. Integrally fixed adjacent the free end of the axially extending tungsten rod **27** is a short transverse tungsten shaft **28** having one end brazed to the rod **27** and extending freely outwardly therefrom at right angles. The shaft **28** serves to slidably mount a flat circular tungsten plate or contact button **29**, which is proportioned to span the space between a pair of axially aligned oppositely extending contact points **31**, each of which is rigidly supported hermetically on the bulb wall **2** and

extends out of the envelope in an integrally continuous external terminal lead **32**. Each contact point within the envelope is formed with a flat contact face **33** on which the flat contact button impinges in flat surface contact.

Surrounding the shaft **28** between the contact button and a stop disk **34** spot-welded on the outer end of the shaft is a coil spring **36** which, in the open position of the switch, normally resiliently retains the contact button pressed against the tungsten rod **27**. This eliminates vibration of the contact button and provides resilient overtravel protection for the contact assembly when the contact button is engaged with the contact faces **33** on contact points **31**. The resiliently pressed, self-centering action of the contact button insures that the contact button will accommodate itself to any minor irregularities existing in the alignment of the contact faces. This accommodation, and the resilient pressure exerted against the contact button by the spring, result in minimum contact resistance permitting a current load of 10 amperes and a potential rating of 10 kv. before external flashover. This low contact resistance insures a minimum power loss when high current flows through the switch. To my knowledge these ratings have never been approached in a vacuum switch as small as mine, which measures less than one inch in diameter and only about 2½ inches long.

Its small size, simplicity, reliability, and operating characteristics makes it very useful in aircraft or ground equipment for network switching and transfer switching; as an interrupter or contactor; for alternating and direct currents; and in radio frequency applications. The switch is especially suited for use where space is a limiting factor and explosive-proof operation is a desirable characteristic. The simplicity of the switch elements makes it possible to conveniently braze the actuating stem assembly into an integral, unitary whole without subjecting the intermediate portions of the bellows to destructive temperatures. The effective life of the bellows is thus prolonged about four times what it would be if subjected to extreme temperatures.

It will of course be understood that various types of actuating mechanisms may be utilized to actuate the switch stem. Thus, the switch is capable of reciprocal oscillation to alternately make and break a circuit therethrough, or the switch may be closed or opened and locked in selected position. Also, the switch is easily converted from the single-pole, single-throw type shown, to a double-pole, single throw or other configuration.

I claim:

1. A vacuum switch comprising a vacuumized envelope having an end cap arranged at one end thereof, a bellows having a transversely displaceable closed end within the envelope and its open end integrally united with the end cap to hermetically seal the envelope, a transversely displaceable actuating stem pivotally mounted on the end cap and aligned with the bellows and integrally united with the closed end thereof and extending into the envelope, a section of the stem being of dielectric material, a pair of spaced contact points arranged within the envelope and integrally continuous with terminal leads outside the envelope, and a contact button movably mounted on the actuating stem and movable thereby into and out of engagement with the contact points to make and break a circuit therebetween.

2. The combination according to claim 1, in which an overtravel spring is interposed between the contact button and the stem to resiliently absorb the impact of contact and retain the contact button resiliently pressed against the contact points when a circuit is made therethrough.

3. The combination according to claim 1, in which said dielectric section of the stem is interposed between the contact button and the bellows to insulate the bellows therefrom.

4. The combination according to claim 1, in which the envelope is symmetrical about a longitudinal axis and the contact points are axially aligned and extend transversely and hermetically through the envelope wall and at right angles to the longitudinal axis, and said contact button is movable in a direction substantially perpendicular to both said contact points and the longitudinal axis.

5. In a switch having a vacuumized envelope, a hollow block sealed hermetically to an end of the envelope, an elongated bellows having an open end integrally united to the hollow block and a closed transversely displaceable end extending into the envelope, a bearing disposed in the block, an actuating stem mounted on the bearing and extending coaxially through the bellows for pivotal movement about an axis transverse to the bellows, a contact point within the vacuumized envelope integrally continuous with a terminal lead hermetically sealed in the envelope wall and extending outside the envelope, a contact button in the envelope arranged on the closed end of the bellows to engage and disengage the contact point upon transverse pivotal movement of the actuating stem, and dielectric means interposed between the contact button and the bellows to electrically insulate the contact button from the bellows and said hollow block.

6. A vacuum switch comprising a vacuumized envelope having an end cap arranged at one end thereof, a bellows having a closed end within the envelope and its open end integrally united with the end cap to hermetically seal the envelope, an actuating stem mounted on the end cap for pivotal movement about an axis transverse to the bellows and fixed to the closed end of the bellows, a dielectric rod mounted on the closed end of the bellows in alignment with the stem, a transverse shaft mounted on the dielectric rod, spaced aligned contact points arranged transversely within the vacuumized envelope and integrally continuous with terminal leads hermetically sealed in the envelope wall and extending outside the envelope, a contact button slidably mounted on the transverse shaft and movable by the actuating stem to engage and disengage the aligned contact points to make and break a circuit therebetween, and an overtravel spring interposed between the contact button and the transverse shaft to absorb the impact of contact and retain the contact button resiliently pressed against the contact points when a circuit is made therethrough.

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