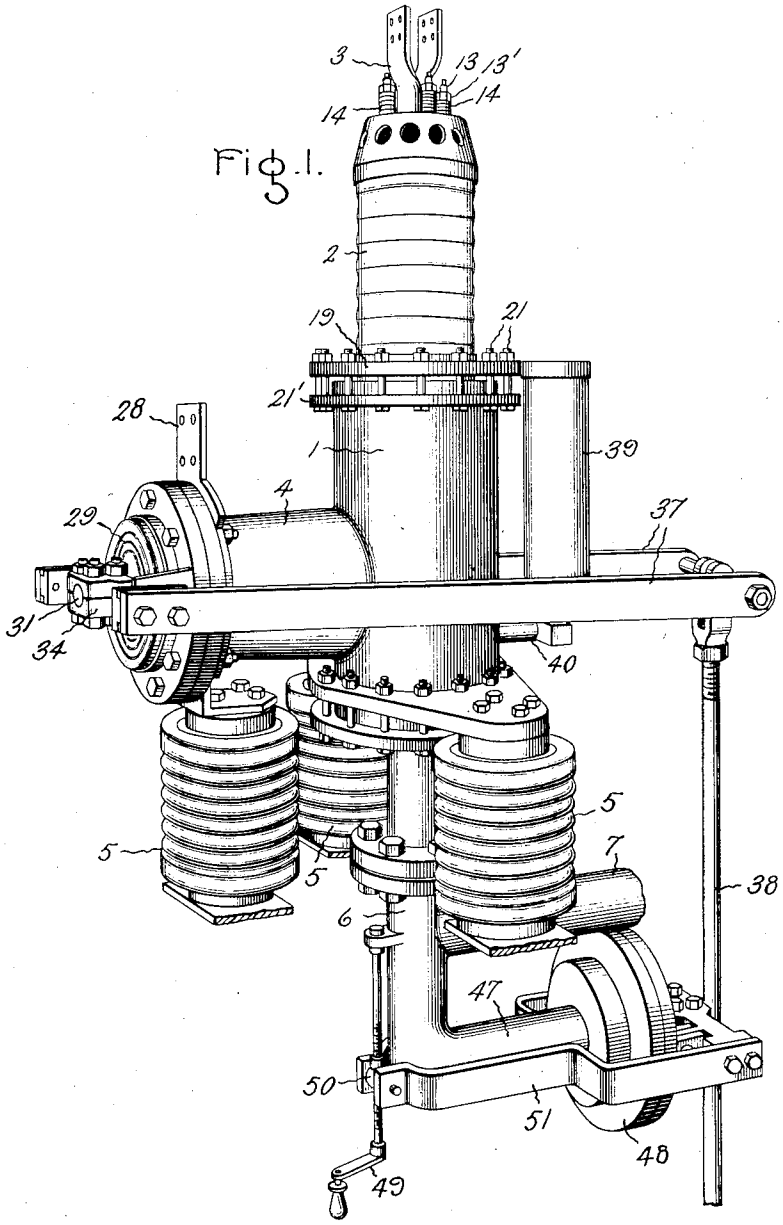
March 27, 1934. W. K. RANKIN 1,952,184

VACUUM SWITCH

Filed Dec. 18, 1929 2 Sheets-Sheet 1

Fig. 1.



Inventor:
William K. Rankin,
by Charles V. Mullan
His Attorney

March 27, 1934. W. K. RANKIN 1,952,184

VACUUM SWITCH

Filed Dec. 18, 1929 2 Sheets-Sheet 2

Fig. 3.

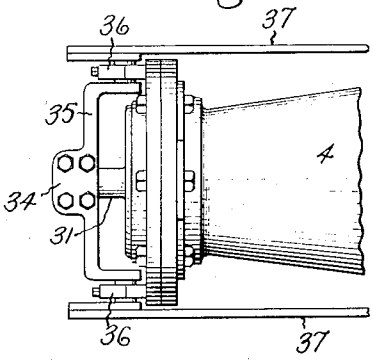
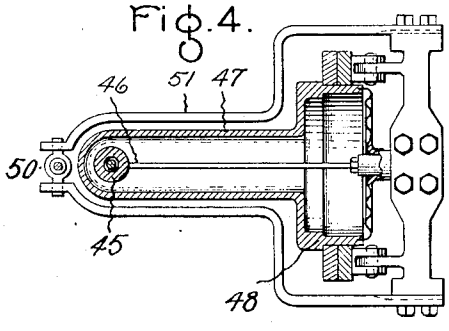


Fig. 2.

Fig. 4.



Inventor:
William K. Rankin,
by Charles E. Mullen
His Attorney.

Patented Mar. 27, 1934 1,952,184

UNITED STATES PATENT OFFICE

1,952,184

VACUUM SWITCH

William K. Rankin, Lansdowne, Pa., assignor to General Electric Company, a corporation of New York

Application December 18, 1929, Serial No. 415,030

2 Claims. (Cl. 200—144)

My invention relates to vacuum switches, and more particularly to that type wherein relatively movable contacts within an evacuated chamber are directly and positively separated by means exteriorly of said chamber.

In vacuum switches of the type wherein an operating lever for the switch contacts extends exteriorly of the vacuum chamber through a sealing diaphragm, the life of the sealing means has generally been limited to a comparatively small number of switching operations due to excessive stresses set up in the sealing diaphragm by movement of the switch rod. When the switch rod, as is generally the case, extends through and is sealed to the sealing diaphragm the stresses set up near the union often cause small cracks in the seal, thereby impairing the vacuum to such an extent that the switch fails to interrupt its rated capacity. It may also happen that the sealing diaphragm, which is generally composed of metal, may become slightly porous so as to leak gas when it is heated during operation of the switch, thereby impairing the vacuum.

An object of my invention is to provide an improved vacuum switch structure wherein the switch contact operating member may be actuated an indefinite number of times without causing failure of the sealing diaphragm, and wherein the evacuated switch chamber shall be maintained vacuum-tight.

Another object of my invention is the provision of a sealing diaphragm which shall have an unbroken surface with respect to the switch contact operating member, and which shall permit direct and positive actuation of said member by means exterior of the evacuated switch chamber.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawings, Fig. 1 is a perspective view of a vacuum switch embodying my invention; Fig. 2 is an elevational view, partly in section, of the vacuum switch illustrated in Fig. 1; Fig. 3 is a fragmentary top view of the diaphragm operating structure illustrated in Figs. 1 and 2, and Fig. 4 is a sectional view taken along the line 4—4 of Fig. 2.

In Fig. 1 there is illustrated a vacuum switch comprising a main vacuum chamber 1 having mounted at its upper end an insulating bushing 2 for a lead-in conductor stud 3. The vacuum chamber 1 comprises a cylindrical casing of metal, such as copper or steel, to which is secured, as by welding, an extension casing 4 for containing the movable element of the switch. The vacuum switch is suitably supported by the insulating bushings 5 which are mounted on fixed supports.

In order that the vacuum chamber shall be vacuum-tight when heated due to current traversing the switch, the walls of the switch casing are composed of a substantially deoxidized metal which precludes any leakage of gas through the metal at a temperature lower than approximately 750° C. If the metal has not been sufficiently deoxidized, the oxides in the metallic structure permit a certain amount of gas leakage therethrough when it is heated thereby impairing the vacuum.

A conduit 6, communicating with an extension 7, is provided for evacuating the switch chamber from air and other gases, the extension 7 being connected to a suitable pump (not shown) during the evacuating process.

Referring more particularly to Fig. 2, the lead-in conductor stud 3 extends through the bushing 2 and terminates in a fixed contact 8 for coacting with a movable contact 9. The sealing bushing 2, which comprises no part of the present invention and is described and claimed in a copending application, comprises an outer insulating shell 2' disposed between end caps 10 and 11. The conductor stud 3 is secured to a collar 12 to which are fixed a plurality of spaced rods 13, each of said rods being biased upwardly by a spring 14 seating on the upper side of the cap 10 and bearing against a washer or stop member 13' on the rod. It will be noted, therefore, that the springs 14 tend to bias the conductor stud upwardly with respect to cap 10 through which the conductor stud may move freely. The lower end of the conductor stud is provided with a nut 15 which when tightened bears against a shield 16, a plate 17, and an insulating spacer 18 to draw the conductor stud downwardly and to place the springs 14 under tension. The function of the shield 16 is to prevent short circuiting of the insulating spacer 18 by the formation of a conducting metallic coating thereon. When the casing 1 is highly evacuated free molecules are released from the surface of the metal walls and travel across the intervening space towards the insulating spacer. If no means are provided for intercepting these free molecules from the metal walls, a molecular deposition of the metal is formed on the insulating member so that it is soon short-circuited and the conductor stud

placed in contact with the casing. The shield 16, however, being cup-shaped, substantially encloses for the most part the outer surface of the member 18 so that it serves to intercept the free molecules and any other metallic particles tending to short-circuit the insulating spacer. The spacing member 18 abuts an intermediate sealing plate 20 which is maintained in position by a clamping plate 19 and an annular row of bolts 21 coacting with a flange 21' forming a substantially integral part of the switch chamber. In a simple construction the members 19, 21 and 21' are sometimes omitted and the top 20 silver soldered directly on the casing 1.

The sealing means for the conductor stud comprises an insulating sleeve or collar 22 of material such as glass having its upper edge sealed to a flexible member, as a copper spinning 23, and its lower edge to a similar member 24. The sealing member 23 is fused or otherwise sealed to a flange 25, in turn suitably sealed to the conductor stud. The lower edge of the sealing member 24 is sealed to the sealing plate 20 which is in turn sealed, as by welding or by a low melting point alloy, to the main chamber 1, thereby completing the seal for the conductor stud.

The movable contact 9 of the switch which is adapted to engage the stationary contact 8, is mounted at the end of a switch operating member, as a rod or lever 26, extending through the switch extension casing 4. The contact 9 is electrically connected to the exterior of the switch through a flexible conductor 27 which is electrically connected to the metallic casing 4 and terminal member 28. The sealing means for the switch operating rod comprises in the present instance a flexible diaphragm 29 of suitable resilient material secured and sealed at its outer periphery, as at 30, to the casing 4. The diaphragm 29, which is substantially defined by a single plane, has concentric corrugations and is provided centrally thereof with an extension or hub-like portion 31 which is closed at the outer end and extends exteriorly with respect to the casing 4. Within the recess formed by the portion 31 is disposed the end 32 of the switch lever. The diaphragm 29 accordingly presents an unbroken surface with respect to the switch operating member and obviates the necessity of a sealed union between the diaphragm and said member. The extension 31 is considerably thicker than the portions of the diaphragm near its outer periphery, and is reinforced at 33, tapering in thickness, where the extension joins the plane of the diaphragm, it being at this point where high stresses may be set up by movement of the switch member.

The material of the diaphragm 29 is preferably of metal which will not permit leakage of any gas therethrough at any temperature below 750° C. An example of such a metal is completely deoxidized copper. The term "completely deoxidized", however, shall be understood to include that condition wherein the metal may be annealed in hydrogen gas just below its melting point without becoming porous. Although the diaphragm and switch parts may become heated to an appreciable extent during operation of the switch, the operating temperature will be considerably less than 750° C. so that no leakage of gas will take place through the diaphragm to impair the vacuum.

It should be noted at this point that the switch operating member is sealed entirely within the evacuated chamber, and that no portion thereof extends exteriorly of the flexible sealing diaphragm. This arrangement is a decided advantage over that type of vacuum switch wherein the switch operating member, in order to be directly and positively actuated, extends bodily through the sealing diaphragm and is joined thereto by a sealed union. In the latter instance, the stresses set up at the sealed union may not only impair the vacuum within the container, but necessitate a very slight movement of the switch member in order that the diaphragm shall not be actually cracked or broken.

In accordance with my invention, the switch operating member 25, though totally sealed within the vacuum chamber, is directly and positively actuated by a pivoted structure disposed exteriorly of the vacuum chamber, which is controlled in any suitable manner. To this end, the hub, or extension 31 of the diaphragm is engaged by a clamp 34 which serves not only to grip the extension 32 of the switch member tightly through the resilient diaphragm material, but to transmit pivotal movement thereto in a manner presently described. The clamp 34 is provided with extensions 35 having pivot studs mounted within the fixed bearing members 36, as best illustrated in Fig. 3. The clamping structure, therefore, comprises a pivoted yoke which may be connected to a pair of operating levers 37 extending along opposite sides of the switch casing and connected to the main operating rod 38 which may be actuated in any suitable manner. As illustrated in Fig. 3, the center line of the pivotal mountings for the operating yoke extends through the plane of the diaphragm 29 so that pivotal movement is imparted to the switch operating member 26 with a minimum movement at the sealing diaphragm, and particularly with absence of transverse movement. Furthermore, the stress is reduced to a minimum in the diaphragm for a given opening movement of the switch.

In the event that an appreciable angular movement of the switch lever 26 is required, the sealing diaphragm may take the form of a metallic bellows, or of a multiple diaphragm arrangement, wherein the pivot point of the lever is substantially in the plane of the union between the diaphragm and the casing, as illustrated in the present instance.

For the purpose of determining the degree of vacuum within the switch casing, there is provided apparatus, designated generally at 39, comprising a Parini Hale hot wire gauge and an ionization gauge. This apparatus is known in the art and a detailed disclosure thereof is not believed necessary. The apparatus is in communication with the interior of the switch chamber through a tube 40.

In order that a very high degree of vacuum may be maintained at all times within the switch casing, an auxiliary chamber (not shown), in communication with the switch chamber may be provided containing a suitable gas absorbing material, as zirconium, for example. If the parts of the switch have not been thoroughly degassified by well known methods for removing occluded gases from the switch parts, the gas absorbing material is effective to remove these gases if, and when, they are formed so as to maintain the original high vacuum.

A means for sealing off the switch casing after it has been evacuated to a desirable extent may comprise any suitable arrangement, and in the present instance the lower end of the switch casing, which communicates with the exhaust

conduits 6 and 7 is adapted to be sealed by the cap 41 whose outer edge seats within an annular recess 42 in the lower wall of the switch chamber within which a low melting point alloy 43 is placed. The cap 41 is seated within the recess 42 while the alloy is molten so that upon cooling a perfect seal is made. For the purpose of properly seating the cap 41 after the switch casing has been evacuated, an operating rod 44 secured to the cap extends through the exhaust conduit 6 and terminates in a pointed portion 44' bearing within a recess formed in a second lever 46 extending through a lateral extension 47 of the conduit. The rod 44 is normally biased into engagement with the rod 46 of a weight 45 secured centrally on the rod 44 by cotter pins or the like. A sealing diaphragm structure 48, more clearly illustrated in Fig. 4, and similar in structure to that previously described, is adapted to transmit movement between the operating crank 49 having a screw connection, as at 50, with the operating arms 51 of the diaphragm, for raising or lowering the cap 41. A strip 52 of resilient material, mounted at one end with respect to the switch casing and connected to the cap 41, is provided for guiding the movement of the cap with respect to its seat. The operation of the sealing arrangement is believed to be obvious, it being necessary to state merely that the alloy 43 is melted by suitable application of heat when the switch is to be sealed and the crank 49 rotated so as to move the rod 44 and seat the cap 41 within the alloy, which is then permitted to harden.

Other apparatus and means for sealing the cap have been devised, and by way of further example, the cap may be raised instead of lowered into a position exteriorly of the casing so that the seal may be readily inspected.

When the switch is to be installed for actual operation, the evacuating and sealing structure comprising the parts 6, 7, 48 etc. are removed. The loose connection between the rods 44 and 46 permits the conduit 6, and the apparatus associated therewith, to be lowered after it has been unclamped at its upper part from the rest of the structure.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a vacuum switch comprising an evacuated chamber and relatively movable contacts disposed therein, a continuous flexible diaphragm independent of and sealing a contact operating member within said chamber, said diaphragm having an extension within which one end of said operating member is disposed, and pivotally mounted contact actuating means exterior of said chamber engaging said extension for transmitting pivotal movement through the diaphragm to said operating member for causing engagement and disengagement of said contacts.

2. In a vacuum switch comprising an evacuated chamber, relatively movable contacts disposed therein and a pivoted operating member for causing engagement and disengagement of the contacts, the combination of a flexible diaphragm forming a part of said chamber for sealing said operating member entirely therein, said diaphragm having an unbroken surface and comprising a hub-like recess centrally thereof within which one end of said operating member is disposed, and switch actuating means exteriorly of said chamber in engagement with said hub-like portion for imparting pivotal movement to the operating member.

WILLIAM K. RANKIN.