Jan. 14, 1936. W. K. RANKIN ET AL 2,027,835

VACUUM SWITCH AND METHOD OF FABRICATING THE SAME

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Fig. 1.

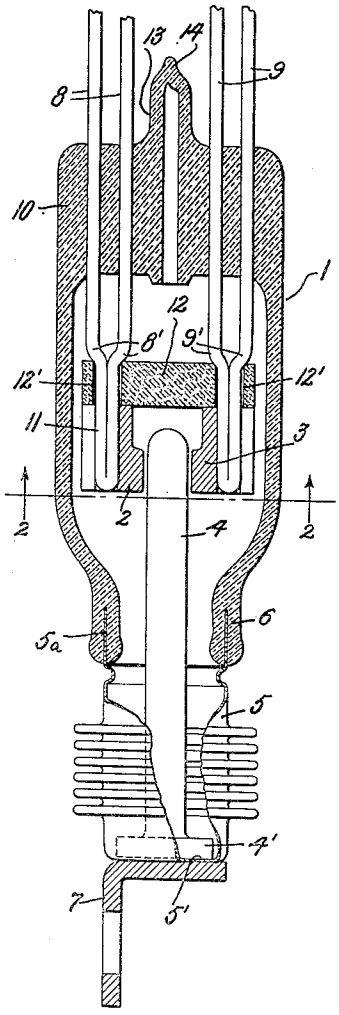
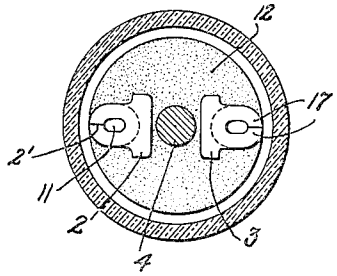



Fig. 2.




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Fig. 3.

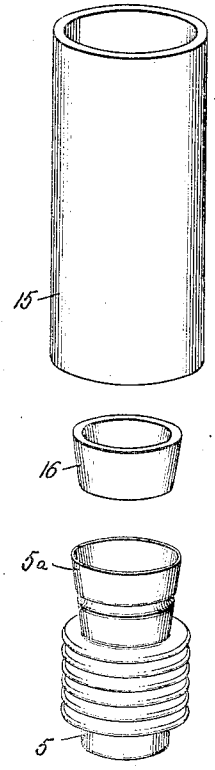



Fig. 4.

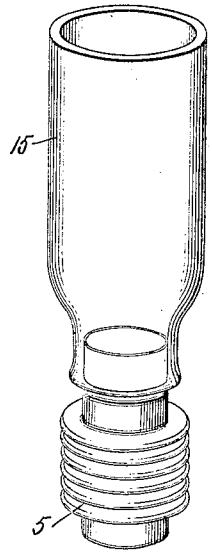



Fig. 5.

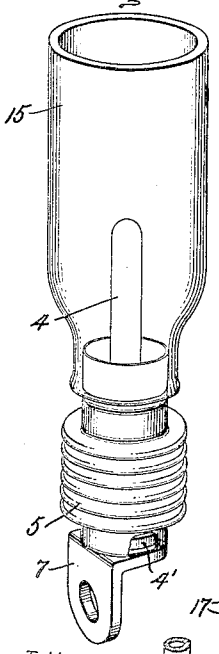



Fig. 6.

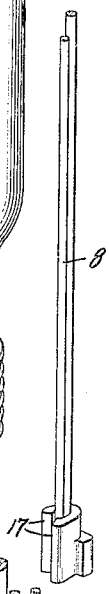
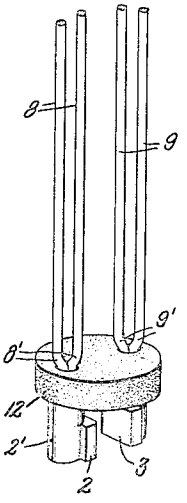



Fig. 7.



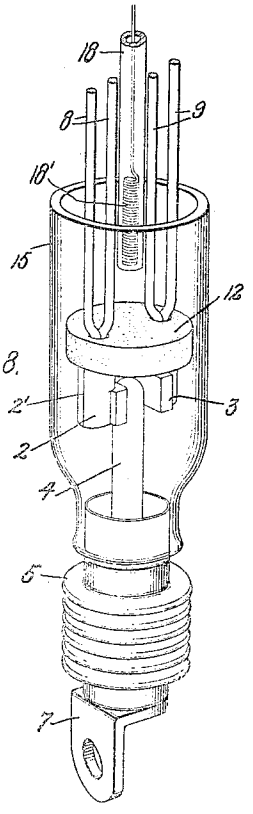




Fig. 8.

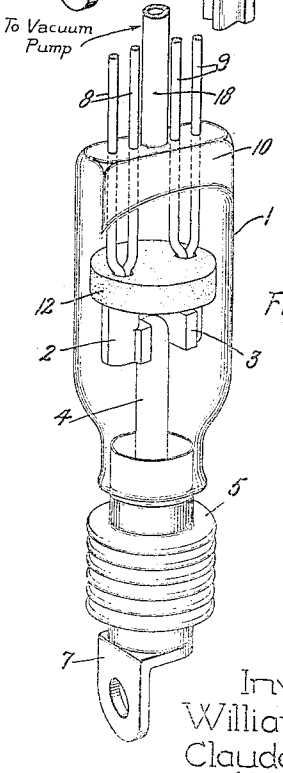



Fig. 9.

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# UNITED STATES PATENT OFFICE

2,027,835

## VACUUM SWITCH AND METHOD OF FABRICATING THE SAME

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Application October 12, 1932, Serial No. 637,562

5 Claims. (Cl. 200—144)

Our invention relates to vacuum switches and has for its object the provision of an improved low-voltage vacuum switch and method of fabricating the same, said switch being simple and inexpensive in construction and efficient and durable throughout a large number of operations.

Our invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize our 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 view, partly in section, of a completely assembled vacuum switch embodying our invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1; Fig. 3 is a detail view of structure prior to assembly thereof, illustrating the method of fabricating the vacuum switch shown in Fig. 1; Fig. 4 is a view of the aforesaid structure assembled; Fig. 5 shows a further step in the assembly; Fig. 6 is a detail view of contact structure; Fig. 7 shows a further step in the contact assembly; Fig. 8 shows the structures of Figs. 5 and 7 in assembled relation; and Fig. 9 illustrates the final sealing and exhausting operations.

The vacuum switch illustrated is of the type wherein engagement and disengagement of the contacts are effected by mechanical forces transmitted directly from the exterior of the switch to a flexible member actuating the contacts within the switch casing. Referring more particularly to Fig. 1, the operative vacuum switch comprises a highly evacuated envelope 1 composed of a suitable insulating material as glass or the like and a metallic bellows 5. Mounted within the switch envelope 1 in a manner hereinafter described is stationary contact structure including contacts 2 and 3 arranged to be selectively engaged by a movable contact 4 mounted for tilting or oscillatory movement and composed of a suitable conducting material as bronze or the like.

For the purpose of actuating the contact 4 from the exterior of the evacuated envelope while maintaining the envelope sealed, the flexible metallic bellows 5 is sealed as at 6 to the glass envelope 1 and closed at the opposite end. The contact 4, which is provided with an enlarged portion 4', is suitably secured in abutting relation to the metallic bellows at the end wall 5' as by welding or the like. An actuating arm 7 of suitable conducting material, as bronze, is likewise suitably welded in abutting relation to the exterior side of the wall 5' and may be operatively connected to suitable motive means for causing oscillation of the contact 4 between the stationary contacts 2 and 3. The arm 7 will likewise serve as a terminal of the switch since it is electrically connected to the movable contact 4.

The stationary contacts 2 and 3 are supported within the envelope 1 by conductors 8 and 9, respectively, which are composed of metal having a coefficient of expansion approximating that of glass, an example being a metal having the trade-name "Dumet metal". The conductors 8 and 9 likewise connect the contacts through the end wall 10 to exterior circuits. Each of the lead-in conductors is sealed in a manner hereinafter described through the end wall 10 to form a loop, the end of each loop being compressed as at 11 and encompassed by the corresponding stationary contact.

For the purpose of positioning and spacing the fixed contacts, an insulating member 12 composed of lava or other suitable insulating material is mounted on the lead-in conductors. To this end the insulating member 12 is formed as a disk and is provided with apertures 12' through which the loops of the lead-in conductors extend. The disk 12 is itself positioned at one side by the expanded portions 8' and 9' of the respective loops and at the other side by the contacts 2 and 3 which are secured to the portions of the conductor loops extending beyond the disk 12 as hereinafter described.

Referring more particularly to Fig. 2, the contact 2, for example, which is composed of copper or a suitable conducting material is split at 2' so that the jaw-like portions of the contact thereby produced may be spaced apart to receive the loop 11, after which the jaws are pressed together as shown in Fig. 2 so as to fix securely the contact to the lead-in conductor. When assembled the contact comprises a cylinder-like portion surrounding the lead-in conductor and pressed thereon.

The end wall 10 includes the gas exhaust passage 13 which is sealed off at 14 to maintain the proper degree of vacuum.

In accordance with our improved method of fabricating a vacuum switch, reference being had to Figs. 3 to 9, inclusive, the glass envelope and metallic bellows are united and the contact structure is positioned within the envelope, after which the envelope is pinched-sealed about the lead-in conductors. The final conditioning and exhausting operations are then performed.

Referring more particularly to Fig. 3, a glass tube 15 open at its opposite ends is sealed to the sleeve-like portion of the metallic bellows 5 in

the following manner. A tapered glass sealing collar 16 is first inserted or nested in the flared open end 5a of the metallic bellows, the upper edge of the collar extending a short distance beyond the upper edge of the bellows to form a bead. The collar is then sealed to the bellows by fusing. Following this operation the tube 15 is slipped over the end 5a of the bellows enclosing the collar 16 so that the tube is in concentric relation thereto. Heat and pressure are thereupon applied to fuse and squeeze in the glass so as integrally to unite the tube 15 to the metallic bellows and collar 16, the upper edge of the metallic bellows being completely sealed by the fusing of the glass collar and tube. The structure so assembled is shown in Figs. 1 and 4.

Positioning of the contact structure within the switch envelope is accomplished by securing the movable contact to the inner wall of the flexible metallic bellows and inserting the stationary contacts through the opposite open end of the tube 15. Referring to Fig. 5, the movable contact 4 is inserted through the upper open end of the tube 15 and butt welded to the inner bottom wall of the metallic bellows coincident with the butt welding of the actuating arm 7 to the opposite outer walls of said bellows. The movable contact and actuating arm are, therefore, secured to the bellows by a single welding operation.

The stationary contact structure is assembled as illustrated in Figs. 6 and 7. As shown in Fig. 6, a lead-in conductor, as the conductor 8, is bent in the form of a compressed loop and a stationary contact, as the contact 2, is clamped to the looped end of the conductor. As previously indicated, the stationary contact comprises a pair of jaw-like portions 17 which are spread apart as illustrated so that the looped end of the conductor may be placed between the same, after which the jaws are pressed tightly together securing the contact generally in cylindrical form to the conductor.

The next step in the contact assembly is shown in Fig. 7 wherein a pair of contacts and corresponding lead-in conductors are positioned by the insulating disk 12. The open ends of the lead-in conductors are inserted through the corresponding apertures 12' in the disk 12 so that the contacts 2 and 3 abut the disk. The leads are then fanned out as illustrated so that the disk is fixed in position with respect to the contacts.

Positioning of the stationary contact structure within the switch is illustrated in Fig. 8. The stationary contact structure shown in Fig. 7 is inserted through the open end of tube 15 so that the contacts 2 and 3 are at opposite sides of the movable contact 4 which extends generally parallel thereto, the lead-in conductors extending through the open end of the tube. A glass exhaust tube 18 provided with a helically coiled nickel wire 18' is likewise positioned in the open end of the tube 15, as illustrated.

With the parts positioned as above described, heat is applied to the open end of the tube 15 and it is pinch or press sealed at 19 to the lead-in conductors and exhaust tube as shown in Fig. 9. The nickel wire 18', which prevents fusing together of the inner walls of the glass tube 18 during sealing, is removed upon cooling by pulling the end of the wire extending exteriorly of the tube. The conditioning and exhausting operations follow and comprise annealing of the glass, baking out condensable vapors, exhausting to a high degree of vacuum by a vacuum pump connected to the exhaust tube 18 and finally sealing off the exhaust tube.

In operation the switch may serve as a single-pole double-throw contactor making possible control of a variety of circuit connections as, for example, control of signal lights and reversal of a small motor by the split-field method. While generally used to interrupt alternating current, the switch may also be used for direct-current interruption by connecting a suitable condenser across the break.

The vacuum switch above described has exceptional durability and long life due to the relatively small movement at the flexible metallic sealing-in bellows. When a high degree of vacuum is attained, the contacts need separate but a very small distance due to the superior dielectric characteristics of the vacuum. Furthermore, the contacts do not oxidize or become dirty; therefore, the contact resistance remains substantially constant.

During assembly of the switch the fixed contacts 2 and 3 need not be alined accurately with respect to the center of the switch envelope since the metallic bellows 5 provides for centering of the movable contact 4 by tilting with respect to the stationary contacts, after which the device is in readiness for operation.

It should be understood that our invention is not limited to specific details of the method and construction herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of our invention.

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

1. A vacuum switch comprising an evacuated envelope, a lead-in conductor sealed through a wall of said envelope, a stationary contact secured within said envelope to an end of said conductor, said contact comprising a cylinder-like portion arranged to surround and clamp said conductor, the axis of said cylinder being generally in alinement with said conductor, and a movable contact extending through the opposite wall of said envelope generally parallel to said conductor coacting with a side wall of said cylindrical stationary contact.

2. A vacuum switch comprising an evacuated envelope, a lead-in conductor sealed through a wall of said envelope, said conductor being in the form of a loop, a stationary contact encompassing and secured to the end of the conductor loop within said envelope, and a coacting movable contact sealed with respect to said envelope and arranged to engage said stationary contact.

3. A vacuum switch comprising an evacuated envelope, a pair of lead-in conductors each in the form of a loop sealed through a wall of said envelope, each loop extending within said envelope and compressed at its end, a stationary contact encompassing and secured to the compressed end of each of said loops, an insulating disk having apertures through which the compressed ends of said loops extend, and a coacting movable contact disposed between said stationary contacts for selective engagement therewith.

4. A method of fabricating a vacuum switch which comprises nesting a glass collar within the open end of a metallic bellows and sealing said collar thereto, positioning in concentric relation a glass tube over the aforesaid end of said bellows, applying heat to fuse and seal said collar and tube over the open end edge of said bellows, welding a movable switch contact member to

an inner wall of said bellows, inserting coacting stationary switch contact structure having lead-in conductors within said tube through the end opposite said bellows, fanning out said lead-in conductors, and pinch sealing the aforesaid end of said tube about said conductors so that they support said stationary switch contact structure.

5. A method of fabricating a vacuum switch comprising forming a glass bead at the periphery of the open end of a metallic bellows, positioning in concentric relation a glass tube open at its opposite ends over the aforesaid end of said bellows, fusing said bead and tube together so as to seal the edge of said bellows, positioning both a movable switch contact member within said tube through the remaining open end thereof so as to abut an inner wall of said bellows and a switch actuating member exteriorly of said bellows so as to abut the opposite side of said wall, welding simultaneously said contact and actuating members to said wall, inserting coacting stationary switch contact structure within the end of said tube opposite said bellows, and pinch sealing the aforesaid end of said tube.

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