Dec. 26, 1933. D. C. PRINCE 1,941,273

VACUUM SWITCH

Filed Oct. 29, 1931

Fig. 1.

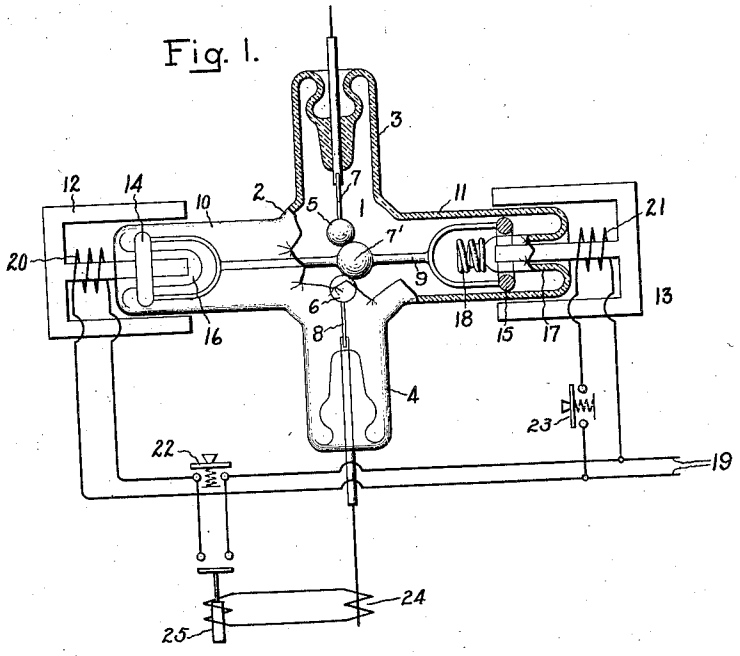


Fig. 2.

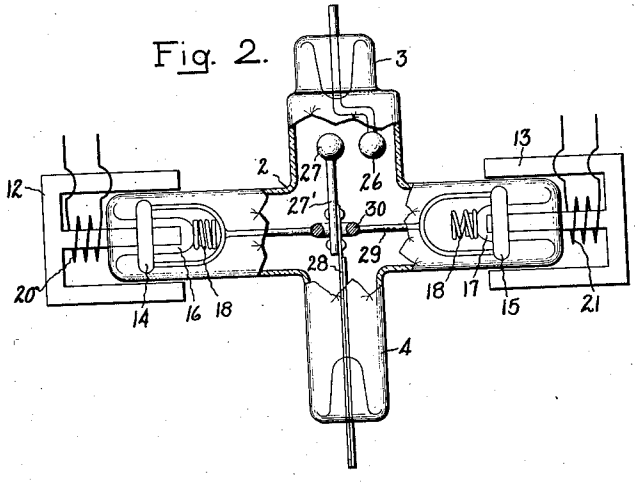
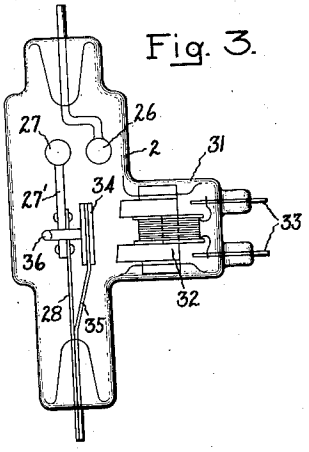


Fig. 3.



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VACUUM SWITCH

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6 Claims. (Cl. 200—87)

My invention relates to vacuum switches and has for its object the provision of an improved high vacuum switch which shall be simple and rugged in construction and positive and efficient in operation.

My invention will be more fully set forth in the following description referring to the accompanying drawing, 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 drawing, Fig. 1 is a partly diagrammatic illustration, partially in section, of a vacuum switching arrangement embodying my invention; Fig. 2 is a similar view illustrating another form of my invention; and Fig. 3 illustrates another form my invention may take.

The vacuum switching arrangement illustrated in Fig. 1 comprises switch contact structure generally indicated at 1 mounted, as will be hereinafter described, in the highly evacuated casing or envelope 2. The envelope 2 is preferably of insulating material, as glass for example, and is provided with lateral extensions 3 and 4 in which the lead conductors for the contacts 5 and 6 are sealed in any suitable manner. The contacts 5 and 6, which are arranged to be bridged by the relatively movable contact 7' in the closed circuit position, are mounted on flexible lead conductors 7 and 8 respectively and are provided with curved contacting surfaces as spherical portions.

The relatively movable bridging contact 7' is likewise provided with a curved or spherical contact surface coacting with the contacts 5 and 6 so that when the contact 7' is biased into and out of contact engagement, a combined rolling and wiping action results at the contact surfaces by reason of the flexing of contact supports 7 and 8.

For the purpose of effecting relative movement of the contacts, the contact 7' is provided with an operating rod 9 extending laterally into extensions 10 and 11 formed in the envelope 2. Actuating means for the rod 9 preferably comprises a pair of electromagnets 12 and 13 disposed at the ends and exteriorly of extensions 10 and 11 respectively, the magnets being inductively related to a pair of closed short-circuited rings 14 and 15 suitably carried at the opposite ends of the operating rod 9 and disposed within the extensions 10 and 11 respectively. The relation between a magnet and its corresponding short-circuited coil or ring is such that energization of the magnet, as by an alternating current, causes repulsion of the ring by reason of the induced current generated therein. That is, the magnet produces an inductive reaction repelling the ring. The extensions 10 and 11 are each provided with a reentrant portion 16 and 17 respectively serving not only as positioning and guiding means for the short-circuited rings, but also for receiving the middle leg of the corresponding E-shaped magnet so that the short-circuited coil is, prior to actuation, wholly within the field of the magnet.

In order to absorb the force of the circuit opening movement, which is generally effected quickly and with minimum delay, the reentrant portion 17 may be provided with suitable buffer means as a spring 18 for checking without shock opening of the contact 7'. The closing movement may be checked by the resilient supports of the contacts 5 and 6.

By way of example, there are illustrated control circuits for actuating the vacuum switch in the usual manner. For the purpose of opening and closing the switch a control source 19 is arranged to be connected to the energizing coils 20 and 21 of the magnets 12 and 13 respectively, the coil 20 being energized through an opening switch 22 and the coil 21 through a suitable closing switch 23. For tripping or opening the vacuum switch upon occurrence of an overload or short circuit, a current transformer 24 connected in the main circuit is arranged to actuate in a well-known manner the relay 25 so as to energize the opening coil 20 through the control source 19.

The operation of the arrangement shown in Fig. 1 is believed to be obvious from the above description. When the bridging contact 7' is moved into engagement with the contacts 5 and 6 due to energization of coil 21 and consequent repulsion of the short-circuiting ring 15, the supporting means for the contacts 5 and 6 are flexed to a certain extent with the result that a rolling and wiping action between the contact faces insures good contact engagement. When the switch is opened due to energization of coil 20 and the consequent repulsion of ring 14 the consequent combined rolling and wiping action between the contact faces results in causing positive separation of the contact surfaces in the event that small particles are "frozen" or stuck together due to the welding action of heavy currents. Furthermore, the sudden inductive repulsion of the short-circuited ring 14 exerts a percussive-like force tending to separate the contact surfaces and break any frozen portions.

The construction shown in Fig. 1 is preferably such that all the parts within the switch en-

velope may be freed of occluded gases and other objectionable impurities without difficulty. For example, the short-circuited rings 14 and 15, as well as the supporting means therefor and the operating rod 9, are preferably of material which may be effectively degassed as by heating with induced currents. The short-circuited rings may be of copper or nickel, which for example are much more easily degassed than iron, or they may be composed of a refractory metal as tungsten or molybdenum, although in the latter instance the materials have more resistance to induced currents. The vacuum switch envelope and enclosed elements are thoroughly freed of occluded gases, as by well-known baking-out processes, so that, once attained, a high vacuum may be maintained within the envelope notwithstanding heating of the contacts and other parts by the current. The degree of evacuation is preferably as high as can be practically attained and may be of the order of 1/100 of a micron.

It will be apparent that, if desired, one of the actuating magnets may be dispensed with and suitable biasing means, as a spring for example, substituted so as continually to bias the movable contact in one direction. In this arrangement the single magnet overcomes the bias of the spring or other means in operating the movable contact.

In the form of my invention shown in Fig. 2, the switch envelope 2 is generally similar to that shown in Fig. 1 with the exception that but one of the contacts need be flexibly mounted within the envelope. In the present arrangement, a pair of contacts are employed including a fixed contact 26, suitably sealed through the extension 3 in the envelope, coacting with a movable contact 27. The contact 27 is mounted for limited pivotal movement, as by the resilient strip 28 sealed through the extension 4, engagement of the curved or spherical surfaces of the contacts 26 and 27 resulting in a combined rolling and wiping action as in the preceding instance. The operating means for the contact 27 may also comprise a pair of magnets 12 and 13 energized by the closing and opening coils 20 and 21 respectively. The short-circuited rings 14 and 15 are suitably connected to an operating rod 29 which is provided with a loop or ring 30 within which a supporting portion 27′ of the contact 27 is positioned. As shown, there is provided a lost motion connection between the operating rod 29 and the contact 27 arranged so that initial movement and momentum of the corresponding short-circuited ring are attained before engagement with the movable contact 27. This results in a percussive or hammer-like blow being delivered to the movable contact so that the contact surfaces may be readily separated if any "freezing" should occur. Furthermore, due to the resilient supporting strip 28 the contact surfaces are subjected to a prying action due to the lever action of the movable contact and are readily separated. The curvature of the resilient strip 28, due to the bias of the operating rod 29, also results in a combined rolling and wiping action of the contact surfaces positively freeing the same.

The operation of the contact actuating rod 29 is substantially the same as described in connection with Fig. 1, the envelope 2 being suitably provided, as at the reentrant portions 16 and 17, with suitable buffer structure 18. Energization of the closing coil 20 causes repulsion of the ring 14 with the result that the contact portion 27′ is engaged by the loop 30 pivoting the contact 27 about its resilient support into engagement with the coacting contact 26. As above indicated, the resilient nature of the contact support 28 permits continued movement of the actuating rod 29 to a certain extent after actual engagement of the coacting contact faces. This continued movement, as in the case of Fig. 1 produces a combined rolling and wiping action of the contact faces. Opening of the switch is effected by energization of the opening coil 21 in any suitable manner causing repulsion of the ring 15 and corresponding movement of the actuating rod 29. Due to the lost motion connection at the loop 30, the contact support 27′ is sharply struck after initial movement of the actuating rod, tending to free the contact surfaces. If the sticking persists, however, continued movement of the rod 29 causes flexing of the support 28 and consequent rotation of the contact 27 about its own contact face. Due to the strong lever action any frozen particles are readily broken by the aforesaid prying action.

In Fig. 3 there is illustrated a vacuum switch generally similar in so far as the contact structure is concerned to that illustrated in Fig. 2. In this case the switch envelope 2 is provided with an extension 31 housing an actuating electromagnet 32 energized as by leads 33 sealed through the wall of the envelope. The magnet 32, however, may be positioned exteriorly of the glass envelope 2 for the purpose of simplifying the degassing operation of the switch. Coacting with the magnet 32 is an armature 34 resiliently mounted, as by a spring 35, with respect to the switch envelope wall. The spring 35 as well as the resilient support 28 of the contact 27 may be suitably sealed through the wall of the switch envelope as indicated. For the purpose of actuating the contact 27 the armature 34 is provided with a hook or loop member 36 providing a lost motion connection between the armature 34 and the contact 27 of the character above described. The closing magnet 32 when energized attracts the armature 34 causing movement of the contact 27 by the hook or loop 36 to closed circuit position. This operation may be substantially the same as that described, the resilient support 28 flexing so as to produce a combined rolling and wiping action of the contact surfaces. Opening of the switch is effected by deenergization of the magnet 32. The armature 34, which is normally biased to the position shown in Fig. 3 by its supporting spring 35, flies back and sharply strikes the contact support 27′ freeing the contacts and causing opening of the circuit. As in the previous instance the momentum of the armature 34 results not only in a percussive blow tending to free the contact surfaces but also in a prying action at the contact surfaces by rotation of the contact 27 about its contact face.

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

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

1. A vacuum switch comprising an evacuated envelope, relatively movable contacts having coacting spherical contact surfaces within said envelope, one of said contacts having a spring mounting, a member having a lost motion

connection with the aforesaid contact, and electromagnetic operating means for actuating said member so that said spring mounting is flexed by said member in the closed circuit position, said lost motion connection causing said member in moving to the open circuit position o impart a hammer blow to said spring mounted contact to effect a combined rolling and wiping movement between said spherical contact surfaces.

2. A vacuum switch comprising a highly evacuated envelope, coacting contacts mounted for relative movement within said envelope, an actuating member within said envelope for one of said contacts including a rod, short-circuited conducting rings carried at opposite ends of said rod, and electromagnetic means at opposite ends of said envelope and exteriorly thereof inductively related to each of said rings selectively energized to cause engagement and disengagement of said contacts.

3. A high vacuum switch comprising an evacuated envelope, contacts mounted for relative movement within said envelope, one of said contacts mounted on a spring within said envelope, an operating member having a lost motion connection with said contact arranged so that upon engagement of said contacts further closing movement of said operating member effects flexing of said spring and relative movement of the contact surfaces and upon disengagement initial movement of said operating member is acquired for imparting a hammer blow to said spring mounted contact prior to separation of said contacts.

4. A vacuum switch comprising an evacuated envelope, coacting stationary and movable contacts mounted within said envelope, a spring member on which the movable contact is mounted, an armature having a lost motion connection with said movable contact, means resiliently mounting said armature, and electromagnetic means coacting with said armature, energization of said electromagnetic means attracting said armature against the bias of its resilient mounting causing engagement of said contacts, de-energization of said electromagnetic means releasing said armature so at it imparts a hammer blow to said movable contact by reason of said lost motion connection freeing and separating said contacts.

5. A vacuum switch comprising an evacuated envelope, coacting contacts mounted for relative movement within said envelope, a contact actuating member within said envelope including a short-circuited conducting ring, and an electromagnet disposed exteriorly of said envelope inductively related to said ring, said ring and contacts being operatively connected through a lost-motion connection arranged so that said ring upon actuation by said electromagnet imparts a hammer-like blow to effect contact opening movement.

6. A vacuum switch comprising an evacuated envelope, coacting contacts mounted for relative movement within said envelope, actuating means within said envelope operatively connected to said contacts including a short-circuited ring composed of a low-resistance, easily-degassed metal such as copper or nickel, and electromagnetic means disposed exteriorly of said envelope inductively related to said ring for actuating the same and effecting relative movement of said contacts.

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