Aug. 30, 1938. W. J. MEANS 2,128,427

VACUUM SWITCH

Filed Sept. 26, 1936

FIG. 1

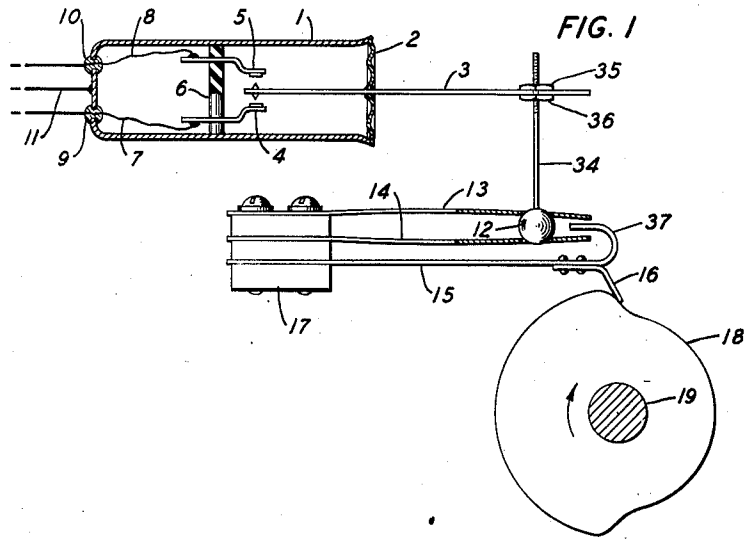


FIG. 2

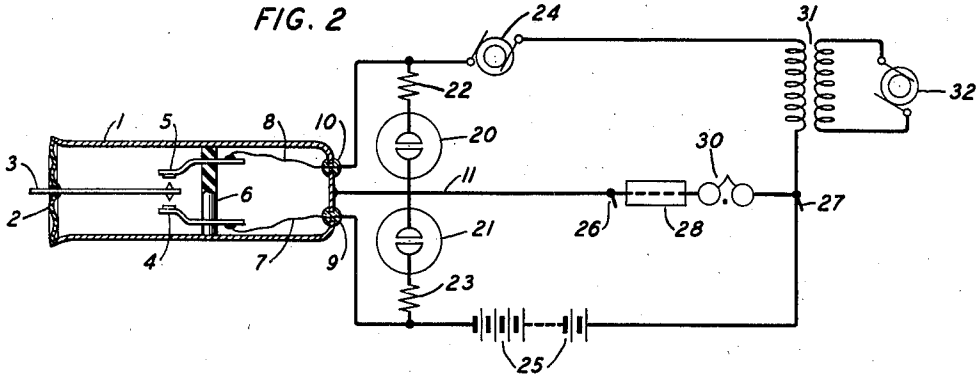
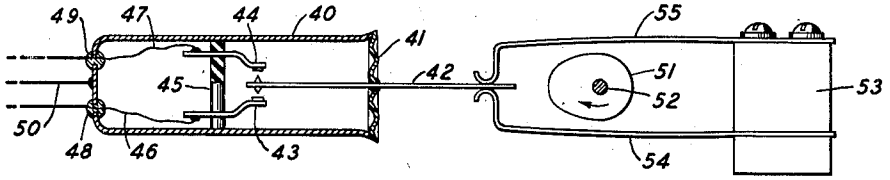


FIG. 3



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2,128,427

VACUUM SWITCH

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9 Claims. (Cl. 200—6)

This invention relates to a vacuum contact switch and more particularly to mechanisms for obtaining and maintaining uniform contact pressure in such a switch.

Insofar as is known, the usual methods for operating the contact arm of vacuum contact switches comprises the use of a cam directly associated with the contact arm as shown in Patents 1,836,654 to W. Dorn et al., and 1,997,288 to H. F. Anderson. This appears to be satisfactory in a majority of devices with which a switch of this character is employed, since the number of operations per day is not great. However, where the movable arm is constantly and rapidly operated as, for example, in an interrupter, uniform contact pressure and long life are extremely difficult to obtain without critical adjustments and costly maintenance. When the movable contact arm is directly associated with the surface of a cam a degree of contact pressure is obtained by flexing the movable arm which is unreliable insofar as contact pressure is concerned, and also places undue strain upon the diaphragm support for the arm. In some instances, flexibility has been obtained by using a flexible glass envelope and glass rods directly associated with a cam for operating the contacts. In an arrangement of this character, the contact pressure is uncertain, since the glass supports for the contacts and the movable arm or arms cannot be accurately positioned. The life of the contact switch parts in a switch of this character is comparatively short when used as an interrupter.

It is therefore an object of the present invention to provide operating mechanism for a vacuum contact switch arranged to produce and maintain a definite gram pressure between the contacts and the switch.

It is a further object of the invention to provide a flexible diaphragm for supporting the movable contact arm and provide cold cathode glow discharge tubes for contact protection means to insure long life of a continuously operating vacuum contact switch and to assist in obtaining and maintaining an exact contact pressure between the contacts of the switch.

These objects are set forth in a specific embodiment of the invention for a ringing current interrupter in which the contact of the movable contact arm is pressed against a stationary contact within the evacuated container by an external spring which is operable only when the pressure of another spring is removed. In this embodiment, the movable contact within the evacuated container is maintained an equal distance from each stationary contact by two opposed external springs of equal stiffness which engage the movable contact arm. A rotating cam is used to remove the pressure of one spring against the other by successively flexing alternate springs. One spring is thus removed from the operating path of the alternate spring, which latter spring causes the engagement of the movable contact with a stationary contact.

The invention will be better understood from the following description and drawing in which

Figs. 1 and 3 illustrate the two forms of the vacuum contact switch operating mechanism for the movable contact arm; and

Fig. 2 illustrates a ringing interrupter circuit using the vacuum contact switch as an interrupter and spark-absorbing devices associated with the switch contacts.

In the illustrated embodiment of Fig. 1, a metal evacuated container for the contacts is shown. This form of container is preferable for the contact switch of the invention but any suitable material may be used in place of metal. The stationary contacts 4 and 5 are supported within the container by an insulated part 6 rigidly fastened to the container. The lead wires 7 and 8 are suitably insulated from the metal container by the use of sealed-in insulators 9 and 10. A flexible metal diaphragm 2, which may be a corrugated disc or sylphon bellows, is sealed to the container. This diaphragm acts as a support and fulcrum for the movable contact arm 3, which is accurately positioned and sealed therein. The movable contact arm 3 is conductively connected to the diaphragm which is conductively connected to the metal framework or envelope. The conductor 11 therefore acts to electrically associate the movable contact in a circuit with either conductor 7 or 8. Rod 34, having an insulated member 12 thereon, is adjustably connected to the movable contact arm 3 by threaded members 35 and 36. The insulated member 12 is maintained under equal pressure from springs 13 and 14. Spring 15 is a combination member stressed downward, having one section 16 extending downward to the cam 18 and a second section 37 extending upward between the springs 13 and 14. The rotation of the cam 18 on shaft 19 causes section 37 to move upward and downward for removing the pressure of springs 13 or 14 on the member 12. The alternate spring 14 or 13 not moved by the cam is thus free to operate the contact arm 3 through link 34 by exerting pressure on member 12. Ac-

cording to the drawing, spring 13 is first moved upward by pressure of the cam against spring 15 to permit the contact arm 3 to be moved upward under the control of spring 14. The movable contact is thus associated with stationary contact 4. In a second position of the cam 18, the member 37 draws the spring 14 downward under the control of spring 15. The pressure of spring 14 is thus removed from spring 13, permitting the latter spring to function for moving the contact arm 3 for connecting its contact with stationary contact 5. In each case, the movable contact arm is entirely under the control of either spring 13 or 14, and consequently a uniform contact pressure is obtained between the movable contact and the stationary contacts 4 and 5. This method of operation further insures minimum flexing of the diaphragm 2 upon each operation of the springs 13 and 14, since the arm 3 can remain substantially rigid. In addition to this step to produce long life, a diaphragm with annular corrugations is used which in some cases may be in the form of a sylphon bellows. This also eliminates the critical adjustment ordinarily required between the cam and the movable arm to insure a given contact pressure.

It is evident from the foregoing description that the gram contact pressure of the movable contact against a stationary contact is equal to the free stiffness characteristic of the spring 13 or 14, minus the stiffness required to flex the diaphragm of the container, which acts as a fulcrum for the movable contact arm. The stiffness characteristic of the corrugated or sylphon bellows type metal diaphragm may be of a set value and consequently the stiffness characteristic of the operating springs may be of set values for securing a particular gram contact pressure. It is also apparent that in the combination described, the diaphragm is only flexed a small amount equal to the movement of the movable contact arm, since the desired contact pressure is obtained by the movement and pressure of the spring against the arm which may remain rigid whereas in the usual method the contact arm is operated by pressure from a rigid cam which must flex the movable arm and accordingly flex the diaphragm more than required for the normal movement of the arm.

Fig. 3 illustrates a second form of the mechanism for controlling the movable contact arm. The vacuum contact comprising members 40 to 50 is the same as shown in Fig. 1. The operating mechanism for the movable contact arm comprises a cam 51 centrally located between springs 54 and 55 and operated on cam shaft 52. The spring support 53 and cam shaft 52 are, of course, held on the mounting or framework which also maintains the vacuum contact switch in position. The rotation of the cam 51 successively moves spring 54 downward and spring 55 upward. The movement of spring 54 downward permits motion of spring 55 for operating the contact arm 42 and causing the engagement of the contact thereon with contact 44. The upward movement of spring 55 causes spring 54 to actuate the movable contact arm 42 for the engagement of the contact thereon with contact 43.

The vacuum contact, according to either form of Fig. 1 or Fig. 3, is shown in Fig. 2 associated with a circuit for applying interrupted ringing current in the manner used for telephone circuits. The alternating current supply is shown diagrammatically at 24. A tone circuit is superimposed upon the alternating current for the purpose of slightly exaggerating the ringing tone for transmission to the calling telephone subscriber. The tone source is shown diagrammatically at 32, which is transmitted to the ringing circuit through the primary and secondary windings of transformer 31. The battery 25 is used in this circuit for maintaining apparatus operated when ringing current is not associated with the telphone circuit. This is known to those versed in the art as "silent period battery". The dotted lines and the rectangle 28 indicate apparatus in a telephone exchange for applying the ringing current to the individual subscriber stations, such as diagrammatically illustrated as 30. A plurality of such apparatus is used in a telephone exchange and therefore multiple straps 26 and 27 are indicated to show that the ringing interrupter circuit is common to a large plurality of telephone circuits. According to this arrangement, when the movable contact 3 is associated with the stationary contact 5, ringing current from source 24 is applied to the subscriber station ringer 30. When the movable contact is associated with the stationary contact 4, silent period battery is applied to the circuit for maintaining certain apparatus of the telephone exchange operated. As is well known, the ringing current and silent period are successively applied until the subscriber responds by removing the receiver from the subscriber station set. In case the subscriber does not answer, the ringing current is cut off by manual or automatic means.

It is the usual practice to use condensers and resistances to reduce contact arcing. In the present circuit arrangement, the use of a condenser would offer a low resistance path to ringing current and tones superimposed on the fundamental voltages. An arrangement has, therefore, been devised using cold cathode glow discharge tubes 20 and 21 bridged across the contacts of the vacuum contact switch in series with resistances 22 and 23 for use as a current discharge device when the contacts are separated. These tubes will flash momentarily when the circuit is broken and thus permit inductive energy to be dissipated in the resistance of the circuit and the internal resistance of the tubes. These tubes are arranged for a break-down voltage higher than the potential normally across the open contacts. They also have a restoring voltage of such character that the tube will extinguish itself as seen as the circuit voltage falls to normal. The resistances 22 and 23 also serve the purpose of protecting the tube from excessive current. The foregoing arrangement protects the contacts from being pitted by the electric arc and thus insures a comparatively long life for these contacts and exact contact engagement during their life.

It is not the intention to limit the invention to the specific structures disclosed, since the principle may be applied in various manners.

What is claimed is:

1. An electric switch comprising an evacuated container having a flexible diaphragm formed as a part of said container, stationary contacts in said container, a movable contact arm extending through said diaphragm and supported thereby, two springs having equal stiffness arranged to exert equal pressure in opposite directions on said movable contact arm, and means for relieving the pressure of either one of said springs against said contact arm for operating

the contact arm under the control of the opposite spring.

2. An electric switch comprising an evacuated container having a corrugated flexible diaphragm formed as a part of said container, stationary contacts in said container, a movable contact arm extending through said diaphragm and supported thereby, two springs having equal stiffness arranged to exert equal pressure in opposite directions on said movable contact arm, and means for relieving the pressure of either one of said springs against said contact arm for operating the contact arm under the control of the opposite spring.

3. An electric switch comprising a metal evacuated container having a corrugated metal flexible diaphragm formed as a part of said container, stationary contacts in said container and insulated therefrom, a movable contact arm extending through said diaphragm and electrically connected thereto, two springs having equal stiffness arranged to exert equal pressure in opposite directions on said movable contact arm, and means for relieving the pressure of either one of said springs against said contact arm for operating the contact arm under the control of the alternate spring.

4. An electric switch comprising an evacuated container having a flexible diaphragm formed as a part of said container, stationary contacts in said container, a movable contact arm extending through said diaphragm and supported thereby, a pair of springs having equal stiffness, a member under pressure of said stiffness between said springs adjustably connected to said movable contact arm, and means for relieving the pressure of either one of said springs against said member for operating the contact arm under the control of the alternate spring.

5. An electric switch comprising an evacuated container having a flexible diaphragm formed as a part of said container, insulated contacts in said container, a movable contact arm extending through said diaphragm and sealed thereto, said diaphragm acting as a pivot member for the contact arm, means for operating said contact arm in a manner to obtain an exact contact pressure between a contact on said arm and the insulated contacts, including an adjustable member connecting the contact arm with an operating spring, a second spring for exerting equal pressure against said first spring for normally maintaining the spring inoperative, and means to remove the pressure of said second spring for operating the contact arm under the control of said first spring.

6. An electric switch comprising a movable contact arm, pressure members associated with said arm and arranged to exert equal and opposite pressures thereon, stationary contacts, and means for alternately disassociating said pressure members from said arm to cause said arm to alternately engage said stationary contacts.

7. An electric switch comprising a movable contact arm, pressure members arranged to exert equal and opposite pressures on said arm, and means for alternately actuating said members to render the unactuated member effective in actuating said movable arm.

8. An electric switch comprising a movable contact arm, a first pressure member arranged to exert a pressure in a particular direction on said arm, a second pressure member arranged to exert an equal pressure in the opposite direction on said arm and means for actuating either of said pressure members whereby the other pressure member functions to actuate said contact arm.

9. An electric switch comprising an evacuated container having a flexible diaphragm formed as a part of said container, stationary contacts in said container, a movable contact arm extending through said diaphragm and supported thereby, means comprising a pair of springs for applying equal and oppositely directed forces to the extending portion of said arm whereby said arm is held in equilibrium and is pivoted about its point of support on said diaphragm when either of said springs is actuated and means for alternately actuating said springs to cause it to engage said stationary contacts alternately.

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