Aug. 6, 1957 P. DUFFING 2,802,079

OSCILLATING ARMATURE AND SWITCH PROVIDED THEREWITH

Filed June 28, 1955 2 Sheets-Sheet 1

Fig. 1

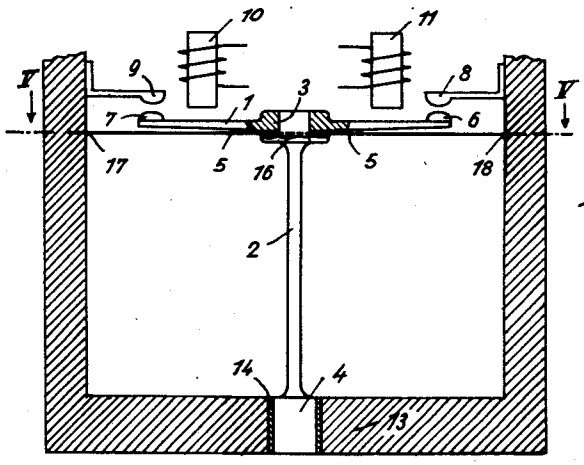


Fig. 2

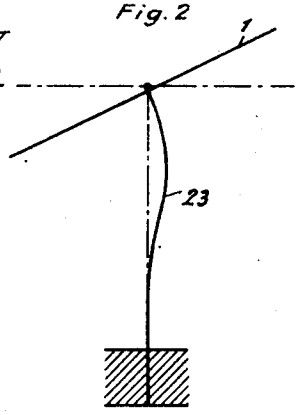


Fig. 4

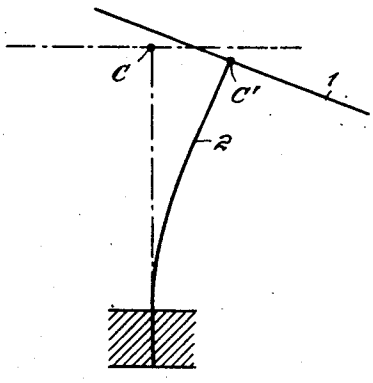
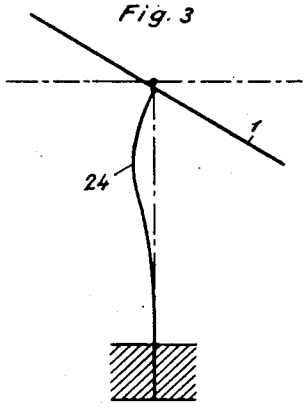


Fig. 3



Inventor:

Paul Duffing

Aug. 6, 1957 P. DUFFING 2,802,079

OSCILLATING ARMATURE AND SWITCH PROVIDED THEREWITH

Filed June 28, 1955 2 Sheets-Sheet 2

Fig. 5

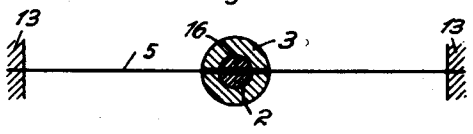


Fig. 6

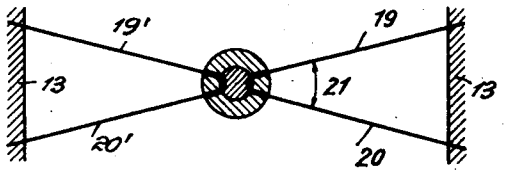


Fig. 7

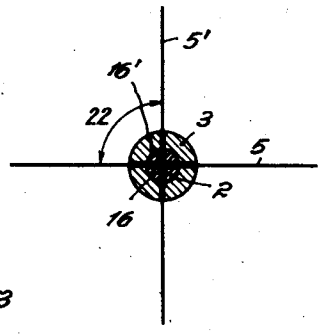


Fig. 8

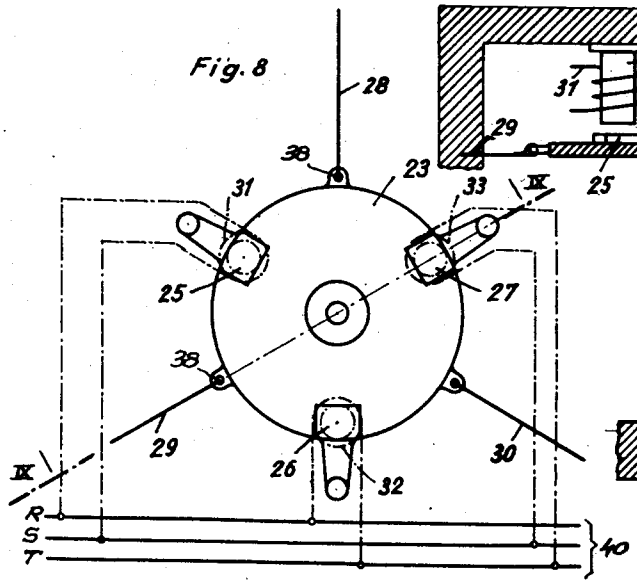


Fig. 9

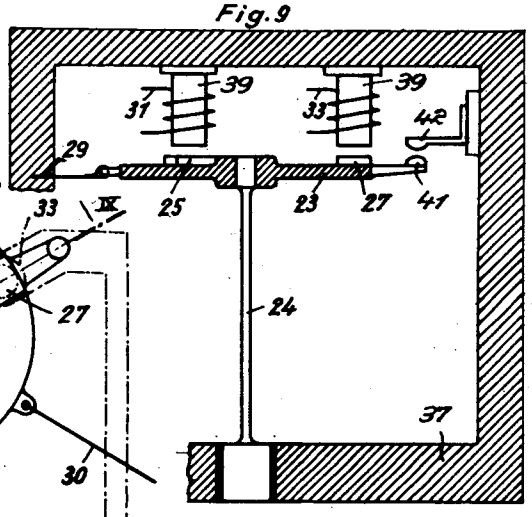
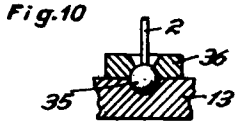


Fig. 10



Inventor:

Paul Duffing

United States Patent Office 2,802,079 Patented Aug. 6, 1957

2,802,079

OSCILLATING ARMATURE AND SWITCH PROVIDED THEREWITH

Paul Duffing, Berlin-Siemensstadt, Germany, assignor to Siemens-Schuckertwerke Aktiengesellschaft, Berlin and Erlangen, Germany, a German joint-stock company

Application June 28, 1955, Serial No. 518,603

11 Claims. (Cl. 200—90)

In the electrical art, continually-operated switches adapted to alternately establish and interrupt electrical circuits in rapid succession, in fractions of a second, at great accuracy with respect to the timing of the operation and the guidance of the contacts, are employed for various purposes, for example for rectifying alternating currents.

The present invention relates to a switch, for that purpose, including an armature element mounted for pivotal movement about its center and carrying contacts substantially equally spaced from such center and adapted to be oscillated about its center by electromagnets for actuation of the contacts.

The principal objects of the present invention are to improve the switch to minimize friction and wear in the means serving to mount the armature for oscillation, and to simplify the switch by the elimination of need for springs in addition to the mounting means, and by the elimination of the necessity of lubricating and servicing the movable elements of the switch.

Further objects of the present invention will appear from a detailed description of various embodiments thereof following hereinafter. It is to be understood, however that such detailed description serves the purpose of illustrating the invention rather than that of limiting or restricting the same. In the drawings:

Fig. 1 is a diagrammatic sectional view of an electromagnetically actuated switch involving an oscillating armature provided with the novel mounting means, the support or frame and the central part of the armature being shown in section,

Fig. 2 is a diagrammatic representation of the armature and of the supporting rod shown in Fig. 1 illustrating the flexure of the supporting rod coincidental to a counterclockwise oscillation of the armature,

Fig. 3 is a diagrammatic representation similar to that of Fig. 2 showing the flexure of the supporting rod coincidentally to a clockwise oscillation of the armature,

Fig. 4 is a diagrammatic representation similar to that of Figs. 2 and 3, showing an abnormal and undesirable flexure of the supporting rod,

Fig. 5 illustrates the section taken along the line V—V of Fig. 1,

Fig. 6 is a sectional illustration similar to that of Fig. 5 of a modified embodiment of the invention,

Fig. 7 is a sectional illustration similar to that of Fig. 5 of still another embodiment of the invention,

Fig. 8 is a plan view of a switch having a disk-shaped armature embodying the present invention, the supporting frame being omitted, and the electrical connections being shown diagrammatically,

Fig. 9 is a sectional view of the switch shown in Fig. 8, the section being taken along the line IX—IX of Fig. 8, and

Fig. 10 is a sectional view of a modified detail of the switches shown in Figs. 1 and 9.

The switch illustrated in Fig. 1 comprises an armature element **1** formed by a two-armed lever, movable contacts **6** and **7** carried by the ends of the lever, a supporting frame **13**, and the novel means for mounting the armature element for pivotal movement about its center. The novel means include a flexible rod element **2** extending from the center of the armature element transversely to the latter towards the support **13**, the upper end of the rod element **2** being rigidly fixed to the armature element **1** and the lower end of the rod element **2** being suitably connected to the support **13**. It also includes anchoring means **5** cooperatively coordinated to at least one of the elements **1** and **2** and to the support **13**, and adapted to restrain displacement of the center of the armature with respect to the support **13**. In the embodiment shown, the lower end of the flexible rod element **2** is rigidly connected to the support **13**. Alternatively, however, the lower end of the flexible rod element **2** may be connected to the support **13** for universal pivotal adjustment, for instance by means of a spherical joint as shown in Fig. 10 comprising a sphere **35** fixed to the lower end of rod **2** and clamped between a semispherical recess of the supporting frame **13** and a socket ring **36** fixed to the frame **13** by suitable means not shown. When so adjusted and fixed this connection is likewise a rigid one. As shown in Fig. 1, the lower end of the rod **2** may be formed with a cylinder **4** of larger diameter extending into a bore of the support **13** and fixed therein by a suitable binder, such as a solder or a suitable cement **14**. Alternatively, however, the lower end of rod **2** may be welded to the support **13**.

The movable contacts **6** and **7** cooperate with stationary contacts **8** and **9** suitably mounted on the support **13**. Electromagnets **10** and **11** are mounted on the support **13** by suitable means not shown so as to be disposed in juxtaposition to the arms of the armature **1** for the purpose of alternately attracting the same and thereby imparting an oscillation to the armature for the alternate actuation of the two pairs of contacts **6**, **8** and **7**, **9**.

As shown in Figs. 1 and 5, the anchoring means which restrain displacement of the center of the armature with respect to the support **13** comprises elongated members or stays, such as wires, strips or the like, which are connected to the armature element **1** and extend therefrom substantially in the longitudinal direction of the armature element **1** to a point **17**, or **18** respectively, located on the support **13**. In the embodiment shown in Figs. 1 and 5, such elongated members are formed by sections of a single wire **5** which extends through, and is fixed, for instance soldered in, a transverse bore of a central hub portion **3** of the armature **1**. The upper end of the flexible rod **2** is formed with a cylindrical portion of larger diameter which is inserted in a central bore of the hub portion **3** and is provided with a diametrical bore **16** registering with the bore of the hub portion **3** and accommodating the wire **5**. Preferably, the cylindrical portion is soldered in the hub portion **3** to constitute a rigid connection.

Alternatively, as shown in Figs. 6 and 7, there may be four lengths of wire extending from the hub portion **3** towards the support **13** and suitably connected to the latter. In the embodiment illustrated in Fig. 6, the elongated members **19** and **20** are formed by an integral piece of wire which extends through diverging radial bores of the hub portion **3** and is suitably fixed therein by solder. The diverging ends **19** and **20** of the wire extend into bores of the support **13** and are likewise soldered therein. Similarly, a wire forming the elongated members **19'** and **20'** is provided on the opposite side of the hub portion **3** to connect the same with the support **13**. In this manner, displacement, in any direction, of the center of the armature with respect to the support **3** is restrained. In the embodiment shown in Fig. 7, the wire **5** is supplemented by a wire **5'** extending at right

angles thereto through a bore 16' provided in the hub portion 3 and the upper cylindrical end portion of rod 2. The angle 22 between the two wires 5 and 5' may be a right angle. The ends of the wires 5, 5', 19, 20, 19' and 20' may extend into bores provided in the supporting frame 13 and may be soldered in such bores.

The operation of the switch described hereinabove with reference to Figs. 1, 5, 6 and 7 is as follows:

Alternate energization of electromagnet 10 and of electromagnet 11 causes the ends of armature 1 to be alternatively attracted. Attraction by electromagnet 10, for instance, causes the armature to be rocked in clockwise direction, as diagrammatically illustrated in Fig. 3 on an exaggerated angular scale, whereby the contacts 7 and 9 will be closed, whereas the contacts 6 and 8 will be kept separated. Attraction of the right hand arm of the armature by electromagnet 11 causes the armature 1 to be tilted in anti-clockwise direction, as diagrammatically indicated in Fig. 2, whereby the contacts 6 and 8 will be closed, while the contacts 7 and 9 will be separated. The tilting movement of the armature 1 causes the rod 2 to be flexed in the manner indicated at 23 and 24 in Figs. 2 and 3. In the absence of the anchoring means 5 attraction of the armature 1 by the electromagnet 10 would tend to move the armature 1 and the rod 2 to the position diagrammatically indicated in Fig. 4 in full lines. It will be noted that owing to the flexure of the flexible rod 2, the center of the armature would move from its normal position indicated at C to the abnormal position C'. It is the purpose of the anchoring means 5 to prevent such displacement from C to C'. A comparison of Figs. 2 and 3 of Fig. 4 clearly shows the effect of the anchoring means 5 on the movement of the armature and on the flexure of the rod 2.

The flexible rod element 2 constitutes a restoring spring tending to reset the armature 1 into its resting position which is indicated in Figs. 2, 3 and 4 by dash-dotted lines. It will appear that the switch is free from friction and wear. The flexible rod element 2 is so dimensioned that its deformation remains well between the limits of its elasticity to ensure that the switch may be operated as often as desired without risking fracture of the flexible rod 2.

The cross section of the rod 2 may be chosen as desired. Preferably, the cross section is circular. Alternatively, the rod 2 may be made tubular.

For the purpose of adjusting the distance of the contacts 7, 9 or 6, 8 in assembling the switch, the elements may be brought to their operative position shown in Fig. 1 before the solder or cement 14 is applied, the proper distance of the contacts being ensured by the interposition of a suitable gauge. Then the cylindrical portion 4 is soldered or brazed to the support 13 by pouring a suitable binding metal 14 into the gap therebetween. Another adjustment is rendered possible by the mounting of the lower end of rod 2 illustrated in Fig. 10 by means of a universally adjustable joint rendering it possible to adjust the rod 2 in radial direction by releasing the clamping ring 36 prior to such adjustment and by subsequently tightening same again.

Any suitable material may be used for the flexible rod element, such as metal, particularly steel and bronze, or insulating material, particularly glass, nylon, perlon or the like.

The novel switch may be employed for any purpose where the actuation must be rapidly performed and where the elimination of friction and wear is desirable. That applies for instance to contact rectifiers in which the contacts must be actuated at great rapidity and accuracy of movement. Moreover, the novel switch may be employed for relays, for instance for synchronous switches, as the invention offers the further advantage that the movable masses of the armature and of the flexible rod may be reduced to a minimum, and as the movements to be performed by these elements have a very small amplitude which may be of a microscopic magnitude. The novel switch may be also employed, however, for circuit interrupters and relays adapted to interrupt powerful circuits.

In Figs. 8 and 9 a switch for controlling three-phase currents is illustrated. The switch comprises a disk 23 of non-magnetic material, three armatures 25, 26 and 27 mounted on the disk substantially equally spaced from the center thereof and from one another, and a flexible rod 24 extending from the center of the disk 23 transversely to the latter towards the supporting frame 37. The upper end of the rod 24 is rigidly fixed to the disk 23, being provided with a cylindrical portion of a large diameter fitted into a central bore of the disk 23. The lower end of the flexible rod 24 is connected to the frame 37 and for that purpose is preferably provided with a cylindrical portion of enlarged diameter soldered in a bore of the frame 37. Here again suitable anchoring means are cooperatively coordinated to the disk 23 and the frame 37 and are adapted to restrain lateral displacement of the center of the disk with respect to the frame.

In the embodiment shown, the anchoring means comprises a plurality of elongated members, for instance wires 29, which connect points 38 of the disk 23 to the frame 37. The points 38 are located intermediate the armatures 25, 26, 27 and are equally spaced from the center of the disk. The members 29 extend transversely to the rod 24. Electromagnets, such as 39, are mounted on the frame 37 in juxtaposition to the armatures 25, 26 and 27. The windings 31, 32 and 33 of the armatures are connected to the three phases R, S, T of a three-phase circuit system 40 as shown in Fig. 8.

The switch is provided with three pairs of cooperating contacts, each pair comprising one contact, such as 41, mounted on the disk 23 and one contact, such as 42, mounted on the frame 37. Which of the three pairs of contacts will be opened and which pair will be closed depends on the relative energization of the three electromagnets 31, 32 and 33. Hence, it will appear that the armature 23 constitutes in effect a wobble disk capable of oscillating about an axis coinciding with any diametrical line of the disk.

While the switch shown in Fig. 9 is equipped with three electromagnets, the number thereof may be any suitable number depending on the nature of the particular system 40.

While the invention has been described in connection with a number of preferred embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as fall within the scope of the invention or the limits of the appended claims.

What I claim is:

1. In a switch of the character described, the combination comprising an armature element, electric contacts and an armature carried thereby, a support structure, and means for mounting said armature element for pivotal movement about its center, said means including a longitudinally directed flexible element extending from said center transversely to said armature element, one end of said flexible element being rigidly fixed to said armature element and the other end being connected to said support, means to restrain lateral displacement of said center, while permitting the bowing of the flexible element, and at least one magnet positioned to direct magnetic force at the armature to tilt the armature element, causing the flexible element to be bowed, the tilting of the armature element making and breaking the said electric contacts, said magnetic force being directed substantially longitudinally of the flexible element.

2. In a switch of the character described, the combina-

tion comprising an armature element, electric contacts and armatures carried thereby, a support structure, and means for mounting the armature element for pivotal movement about its center, said means including a flexible rod element extending from said center transversely to said armature element towards said support, one end of said rod element being rigidly fixed to said armature element and the other end being connected to said support, and non-rigid anchoring tie means extending from one of said elements substantially in the direction of said armature element to a point located on said support and adapted to restrain displacement of said center transversely to said rod element, while permitting the bowing of the flexible element, and a plurality of magnets positioned to direct magnetic force at the individual armatures to tilt the armature element, causing the flexible element to be bowed, the tilting of the armature element making and breaking the said electric contacts, said magnetic force being directed substantially longitudinally of the flexible element.

3. The combination claimed in claim 2 in which said anchoring means comprises a plurality of elongated members connected to said armature element and extending therefrom substantially transversely to said rod element towards said support and being connected to the latter.

4. The combination claimed in claim 1 in which said other end is provided with means to rigidly connect it to said support.

5. The combination claimed in claim 4 in which said other end is connected to said support by an adjustable universal pivot joint provided with means to make the joint rigid.

6. The combination claimed in claim 5 in which the universal pivot joint is a spherical joint.

7. The combination claimed in claim 1 in which said armature element consists of a disk and of a plurality of armatures circumferentially distributed and mounted on said disk.

8. A switching system of the character described com-

prising a disk, three armatures mounted on said disk substantially equally spaced from the center thereof and from one another, a supporting frame, a longitudinally directed flexible rod extending transversely to the disk, one end of said rod being rigidly fixed to the center of said disk and the other end being connected to said frame, anchoring means operatively connected to restrain displacement of said center transversely of the rod, while permitting the arching of the flexible rod, three electromagnets mounted on said frame each in juxtaposition to one of said armatures to direct magnetic force at individual armatures in a direction substantially longitudinal to the flexible rod to oscillate the disk, the oscillation of the disk causing the arching of the flexible rod, a three-phase circuit system connected to said electromagnets, and three pairs of cooperating contacts, each pair comprising one contact mounted on said disk and one contact mounted on said frame the oscillation of the disk making and breaking said electric contacts.

9. The combination claimed in claim 8, the anchoring means comprising elongated tie members connecting points of said disk located intermediate said armatures and equally spaced from said center to said disk, said members extending transversely to said rod.

10. The apparatus defined in claim 1, the armature element carrying a plurality of armatures, there being a like plurality of magnets each directing magnetic force at individual armatures as aforesaid.

11. The apparatus defined in claim 1 in which the means to restrain comprises a number of equally spaced wires connected between the support structure and one of said elements.

References Cited in the file of this patent

UNITED STATES PATENTS

1,209,281	Gardner	Dec. 19, 1916
2,401,600	Arnold	June 4, 1946
2,499,632	Coake	Mar. 7, 1950