

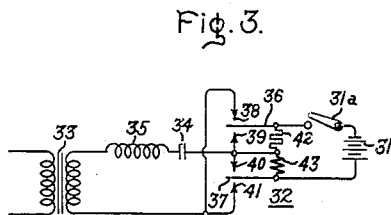
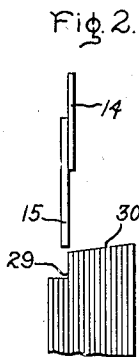
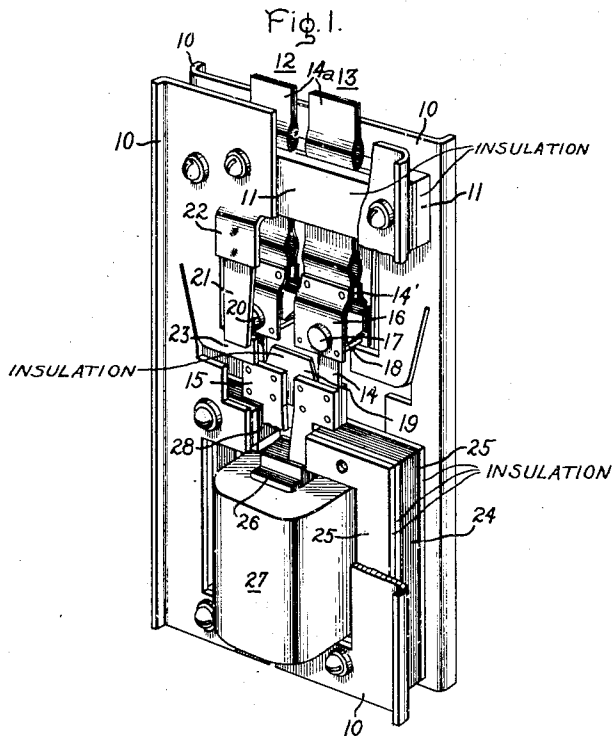
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H. W. LORD

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ELECTRIC SWITCH

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ELECTRIC SWITCH

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5 Claims. (Cl. 200—90)

My invention relates to electric switches, and more particularly to vibratory switches of the type commonly employed in systems for converting direct current to alternating current or alternating current to direct current.

In the operation of vibratory switches of the above type difficulty is often experienced because of sparking at the contacts which may be caused by a variety of operating conditions. For example, any unevenness in the vibration of the vibratory element may tend to cause a temporary departure from synchronous operation of the vibrator. Nonuniform or jerky movement of the vibrating element may also cause excessive bouncing of the contacts which contributes to increased sparking. In accordance with the teachings of my invention, I provide an improved vibratory switch which overcomes the above noted disadvantages and provides for a more uniform application of driving force to the vibratory element.

It is an object of my invention to provide a new and improved vibratory switch.

It is another object of my invention to provide a new and improved vibratory switch of the type commonly employed in electric rectifier or inverter circuits which is characterized in its operation by a more uniform application of driving force to the vibratory element.

It is still another object of my invention to provide a new and improved vibratory switch in the operation of which sparking at the contacts is reduced to a minimum.

In accordance with the illustrated embodiment of my invention the switch comprises a frame made up of four similar sheet metal stampings, each of which is provided with integral arms, which form the supports and stops for the stationary contact mountings. The movable contacts are actuated by a vibratory element which is clamped between insulating blocks located near one end of the frame. The vibratory element has an armature portion cooperating with a stationary magnetic structure including an intermediate leg having a pole face arranged in opposed relation to the end of the armature of the vibratory element. In the equilibrium position of the vibratory element the end of the armature thereof is in alignment with one edge of the pole face of the stationary magnetic circuit. The pole face is notched at this edge to provide an increased air gap and an increased force on the vibratory element to start the vibrating element from its equilibrium position. In order to provide for the application of driving force on the armature over an extended range of movement, the pole face

slopes upwardly toward the edge of the pole face away from the equilibrium position of the armature to provide a pull on the armature over an extended portion of the travel of the vibratory element. This provides for a more uniform actuation of the vibratory element and improved operation of the switch.

My invention will be better understood by reference to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. In the drawing, Fig. 1 is a perspective view of a vibratory switch embodying my invention; Fig. 2 is a view showing a detail of the switch of Fig. 1, and Fig. 3 is a schematic representation of an inverter circuit of a type in which a vibrator embodying my invention may be used to advantage.

Referring now to Fig. 1, I have shown my invention embodied in a vibratory switch comprising a frame made up of four similar sheet metal stampings 10. The frame members 10 are arranged two on each side in opposed relation so that the parts of the switch may be mounted therebetween. Near one end of the frame are provided transverse clamping blocks 11 of insulating material between which are clamped two identical movable contact assemblies 12 and 13. Each of the movable contact assemblies includes an elongated vibratory element or reed 14 to one end of which is secured a soft iron armature 15. Intermediate the portion of the reed 14 which is clamped between the supports 11 and the armature 15 the reed is provided with a widened section 14' to the opposite sides of which are secured supporting plates 16 for the movable contacts 17. With the exception of the widened section 14' the reed 14 is of varying cross section to provide substantially uniform stress throughout the length thereof during operation. The supporting plates 16 are wider at the free ends thereof than the reed at that point, thereby permitting the supporting or spacing rods 18 to extend between the backs of the supporting plates 16 to reinforce the movable contact assemblies and prevent undesirable vibration of the movable contact assemblies with respect to the reeds 14. In order to provide a low resistance in connection with the movable contacts thin sheets 14a of good conducting material, such as copper, are arranged on each side of the reed 14 and connected with the contacts 17. As previously stated, the assemblies 12 and 13 are identical and therefore only one has been described. The reeds of the two assemblies are secured together

by an insulating plate 18 so that the two reeds function as if the entire assemblies were constructed with a single reed.

In accordance with one feature of my invention I provide a simple and improved means for mounting the stationary contacts which provide for easy adjustment of the initial position of the stationary contacts and in addition an independent adjustment of the initial tension or biasing force applied to the stationary contacts.

Referring now to Fig. 1, each of the stationary contacts is secured near one end of an elongated resilient support 21 which is riveted or welded to a bendable extension 22, formed integrally with one of the frame members 10. The member 21 extends slightly beyond the contact 20 to form a stop which engages an arm 23 which is also formed integrally with the frame member 10 and extends in a direction substantially perpendicular to the longitudinal axis of the frame member. From an inspection of Fig. 1, it will be readily apparent that the normal position of the fixed contact 20 may be adjusted by bending the arm 23 and that independently of this adjustment of the position of contact 20 the bias or initial force provided by the resilient arm 21 may be adjusted by bending the extension 22. It will be understood that each of the four fixed contacts which cooperate with the movable contacts 17 will be mounted in the same manner. This arrangement of providing for independent adjustment of the biasing force and position of the fixed contacts by bending a portion of the support which forms an integral part of the frame has been found to be a very simple, inexpensive, and desirable construction from the standpoint of operation as well as manufacture. Certain features of the supporting and adjusting arrangement for the contacts described above and shown in the illustrated embodiment of my invention are claimed in my divisional application Serial No. 476,920, filed February 24, 1943, and assigned to the assignee of the present application.

In accordance with another feature of my invention I provide an improved construction for actuating the vibratory element 14 with particular reference to the continued application of driving force after initial movement of the armature member 15. Referring again to Fig. 1, a stack of laminations 24 are secured between the frame members 10 at the end opposite the clamping members 11 which support the vibratory element in fixed relation to the frame. The laminations may be spaced from the frame member by suitable spacers 25 of sheet insulating material. The laminations are of E-shape, including the intermediate leg 26 about which is positioned an energizing coil illustrated generally by numeral 27. The open side of the E-shaped punchings form an air gap within which the armature members 15 of the vibratory elements are arranged to move. The intermediate leg 26 provides a pole face extending generally in opposed relation to the ends of the armature members 15 which are shaped to lie rather closely to the ends 28 of the laminations 24 so that substantially all of the air gap flux passes between the ends of the armature members 15 and the pole face of the intermediate leg 26 of the magnetic circuit.

As illustrated more clearly in Fig. 2, the end of the armature members 15 are substantially in alignment with one edge of the pole face of the intermediate leg in the equilibrium position of the vibratory element. This edge of the pole face

is provided with a notch 29 to increase the air gap at this point and to provide for a rapid reduction of the air gap as the vibratory element moves to the right, as viewed in Fig. 2. If the air gap from the notch 29 to the right-hand edge of the laminations were constant, no additional pull would be exerted on the armature as the vibrating element moves to the right. To provide a more gradual actuating force which extends over a longer period of time, I provide the pole face with an inclined portion 30 so that the air gap between the members 15 and the pole face gradually decreases as the vibrating element 14 moves to the right, as viewed in Fig. 2. This provides for a pull on the armature as long as the actuating coil 27 is energized.

In Fig. 3 I have illustrated a circuit of a type in which the switch embodying the present invention may be employed. Referring now to Fig. 3, a source of direct current voltage, such as a battery 31, is alternately connected to an output circuit in a reversed sense by means of a vibrating reversing switch illustrated generally by the numeral 32 which may, to advantage, be of the type illustrated in Fig. 1. A manual switch 31a may be provided to control the connection of source 31 with the switch 32. The load circuit comprises an output transformer 33 in series with the primary winding of which is connected a capacitor 34 and tuning inductance 35. The reactance of the transformer 33 and inductance 35 tune the capacitor 34 to substantially the desired frequency of the output circuit. The reversing switching means comprises two vibratory elements 36 and 37 each of which is connected to a different terminal of the direct current source 31, and a plurality of fixed contacts 38, 39, 40 and 41. Connected in series across the direct current source 31 is a resistor 42 and an actuating or driving coil 43. The common terminal of the resistor and driving coil is electrically connected to fixed contacts 39 and 40. These contacts are also connected to one terminal of the capacitor 34 while the fixed contacts 38 and 41 are connected to the terminal of the transformer primary winding opposite the one with which the inductance 35 and capacitor 34 are associated.

In the operation of the circuit of Fig. 3 the vibratory elements 36 and 37 are moved upwardly under the action of the operating coil 43 when the line switch 31a is closed. As soon as the vibratory element 37 makes contact with the fixed contact 40, the coil 43 is short circuited to remove the actuating force. With these contacts closed current flows in one direction through the oscillating circuit including the capacitor 34, inductance 35 and the primary winding of the output transformer 33. When the vibratory elements move in the opposite direction into engagement with the fixed contacts 39 and 41 the direction of current flowing through the primary winding of the transformer 33 is reversed. The natural frequency of the vibratory elements of the switch 32 is substantially the same as the desired frequency of the alternating current circuit 33. With the arrangement of Fig. 3, it is apparent that the coil 43 is energized for the full time that the movable element is moving from one set of fixed contacts to the other and, when used with an arrangement such as illustrated in Fig. 2, insures that an actuating force is applied to the vibratory element over an extended range of movement.

While I have shown and described a particular embodiment of my invention, it will be obvious to

those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. A vibratory switch comprising in combination a plurality of contacts, an elongated vibratory element having an armature portion for controlling the engagement of said contacts, said vibratory element being mounted in fixed position at a point longitudinally spaced from said armature portion, electromagnet means for exerting a driving force on the armature of said vibratory element including a coil and a pole face arranged to cooperate with the armature portion of said vibratory element to form an air gap therebetween, said pole face being shaped to provide a progressively decreasing air gap when said vibratory element is moved from its equilibrium position to one of its extreme positions to provide an actuating force on said vibratory element throughout an extended range of movement thereof, and means associated with said vibratory element for controlling the circuit of said coil in accordance with the position of said vibratory element to maintain said coil deenergized during a portion of each period of vibration of said element and energized during the remainder of each period.

2. A vibratory switch comprising in combination a plurality of contacts, an elongated vibratory element for controlling the engagement of said contacts and having an armature portion, said vibratory element being mounted in fixed position at a point longitudinally spaced from said armature portion, means providing a magnetic circuit including a pole face cooperating with said armature to provide an air gap therebetween, a coil associated with said magnetic circuit, means associated with said vibratory element for energizing said coil throughout a portion of a predetermined range of movement of said vibratory element and for maintaining said coil deenergized for the remaining movement of said element, said pole face being arranged with respect to the equilibrium position of said vibratory element and shaped so that said air gap is suddenly reduced upon initial movement of said vibrating element in one direction from its equilibrium position and is gradually reduced upon further movement of said vibratory element in the same direction to impart a driving force to said element throughout an extended period during which said coil is energized.

3. A vibratory switch comprising in combination a frame including spaced members, an elongated vibratory element having one end mounted in fixed relation with respect to said frame and having the opposite end extending between said members and provided with an armature, a magnetic circuit arranged between said members and provided with a pole face cooperating with said

armature to provide an air gap, a coil associated with said magnetic circuit, said vibratory element and said pole face being so shaped that as said vibratory element moves from its equilibrium position to one of its extreme positions the air gap is suddenly reduced by initial movement of the vibrating element and is then gradually reduced upon further movement of the vibratory element to provide a driving force on said element over an extended range of movement thereof, and means associated with said vibratory element for controlling the circuit of said coil in accordance with the position of said vibratory element to maintain said coil deenergized during a portion of each period of vibration of said element and energized during the remainder of each period.

4. A vibratory switch comprising in combination a frame including a plurality of sheet metal members arranged in opposed relation, a vibratory element clamped between said members near one end thereof and having an armature secured to the free end thereof, contacts secured to said vibratory member to be moved thereby, fixed contacts supported from said frame on each side of said vibratory element to be alternately engaged by said first mentioned contacts as said element is vibrated, means providing a magnetic circuit positioned between said frame members and cooperating with the armature of said vibratory element to provide an air gap, an energizing coil associated with said magnetic circuit, means associated with said vibratory element for energizing said coil throughout a portion of a predetermined range of movement of said vibratory element and for maintaining said coil deenergized for the remaining movement of said element, the cooperating portions of said armature and said magnetic circuits being shaped to provide a decreasing air gap as said vibratory element moves in one direction from its equilibrium position to apply a driving force to said vibratory element throughout an extended interval during which said coil is energized.

5. A vibratory switch comprising in combination an elongated vibratory element having one portion mounted in fixed position and a portion remote from said first mentioned portion provided with an armature, a magnetic structure including a stack of punchings shaped to provide a substantially rectangular magnetic circuit with an intermediate leg, said magnetic circuit having an opening in one side thereof opposite one end of said intermediate leg, the armature portion of said vibratory element being shaped to move in the opening formed in the side of said magnetic circuit with the end thereof opposite the end of said intermediate leg, the end of said intermediate leg being so shaped that the air gap between the end of the armature and the end of the intermediate leg decreases as the armature moves toward one edge thereof to provide a pull on said armature for an extended period during each cycle of vibration of said vibratory element.

HAROLD W. LORD.