Sept. 20, 1955 C. C. CALDWELL 2,718,570

ELECTRIC VIBRATOR CONTACT DAMPENING MEANS

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Fig. 1.

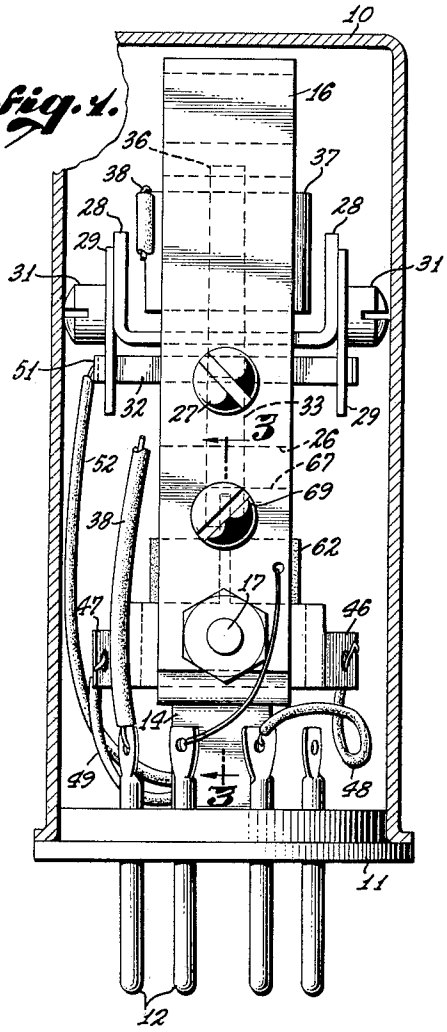


Fig. 2.

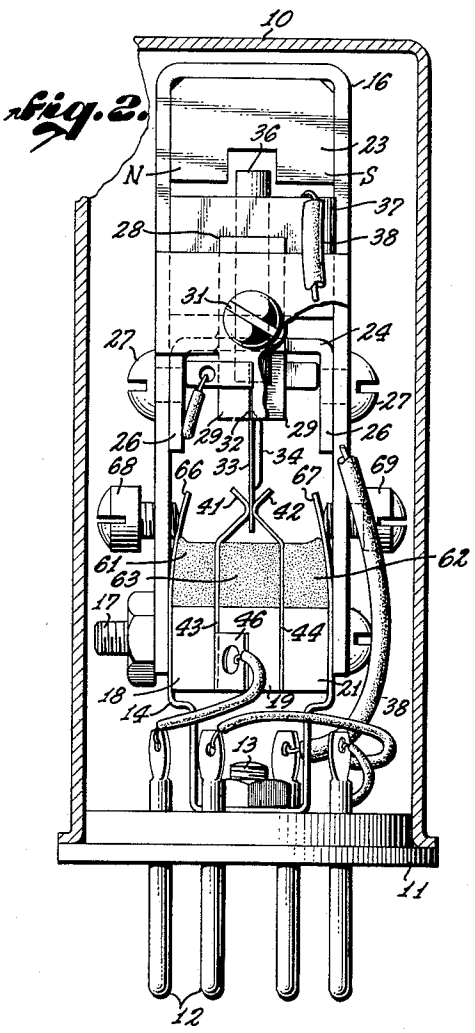


Fig. 3.

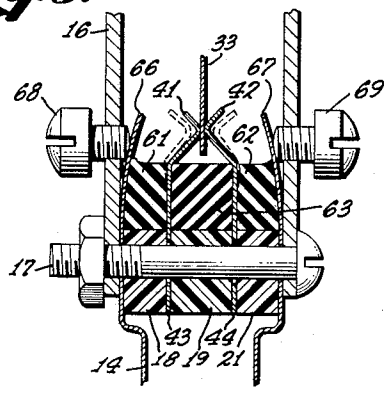
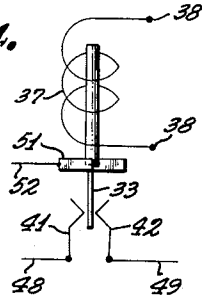


Fig. 4.



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Fig. 5.

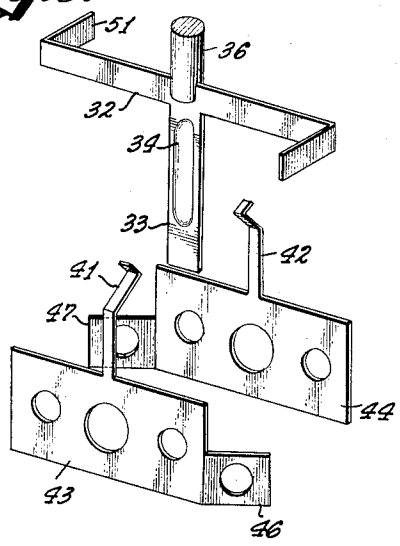


Fig. 6.

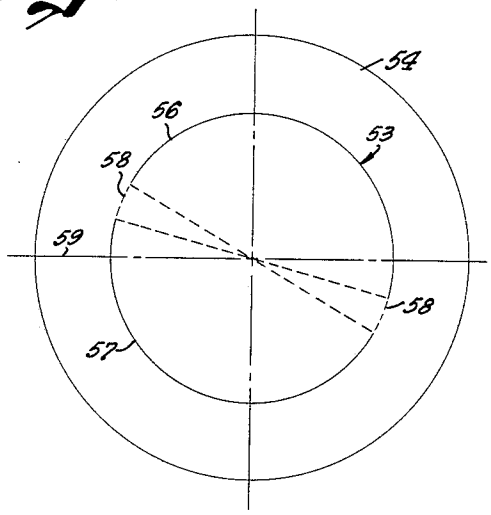


Fig. 7.

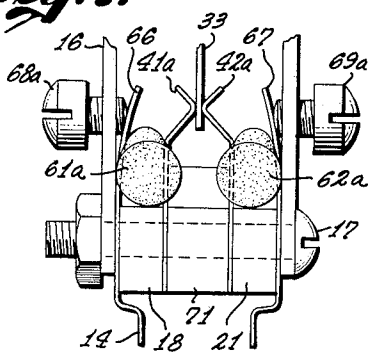
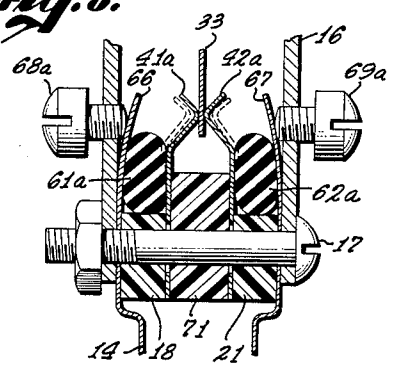


Fig. 8.



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ELECTRIC VIBRATOR CONTACT DAMPENING MEANS

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Application February 5, 1954, Serial No. 408,361

3 Claims. (Cl. 200—90)

This invention relates to electric vibrators, and more particularly to a means for controlling and adjusting the switching characteristics of a vibrator.

Vibrating switches are well known in the art, consisting of a switch arm maintained in vibration generally electromagnetically, which repetitively engages and disengages from a relatively fixed contact, so as to repeatedly open and close a circuit. It is an object of this invention to provide means for controlling the switching characteristics of such a vibrator, that is to say, means for controlling the exact time in the vibration cycle during which the switch will be closed, and correspondingly controlling the exact time during which the switch will be open.

In vibrators of the type here under consideration, the so-called stationary contact is often made resilient for improved contact pressure characteristics, and in fact is often made in the form of an elongate switch member capable of flexing backward when engaged by the movable or vibrating switch arm. This flexible or resilient characteristic of the contact member means that the contact member is inherently vibratable itself, and thus has a tendency to vibrate freely after stress is relieved therefrom as when the switch arm disengages from the contact member. It is another object of this invention to provide means for controlling and adjusting the vibrating characteristics of such a contact member, and thus to more accurately control and regulate the switching characteristics of the vibrator.

It is another object of this invention to provide an electric vibrator of the type discussed hereinbefore, which may be small and light in weight, and in which the switching characteristics may be easily, surely, and dependably adjusted to precise and accurate specifications.

In the manufacture of small vibrators of the type here under consideration, the contact members are so small that in order to achieve the necessary precision in switching characteristics an extremely high precision in part manufacture must be maintained, thereby greatly increasing the cost of the vibrator. It is an object of the present invention to provide means for adjusting the switching characteristics of the vibrator to high precision and accuracy after the vibrator is manufactured, thereby permitting wider tolerances with consequent decrease in production cost.

It is another object of this invention to provide an adjustment in a vibrator by means of which the switching characteristics may be quickly and easily adjusted with high precision.

In accordance with these and other objects which will become apparent hereinafter, certain embodiments of the present invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 is a side elevation of a vibrator with the container sectioned to show the parts of the vibrator.

Fig. 2 is an elevation similar to Fig. 1, taken at right angles thereto.

Fig. 3 is a fragmentary section taken generally on line 3—3 in Fig. 1.

Fig. 4 is a schematic circuit diagram showing generally the circuit connections involved.

Fig. 5 is an exploded perspective view showing certain of the switch parts.

Fig. 6 is a diagram illustrating the switching characteristics desired in the present invention.

Fig. 7 is a fragmentary, elevational view of a modified form of the invention.

Fig. 8 is a cross section of the embodiment shown in Fig. 7.

Referring to the figures, the present invention has been illustrated in connection with a double-throw switch type of vibrator. In this type of vibrator a switch arm is caused to vibrate back and forth between two nominally stationary contacts, intermittently and alternately making contact with the stationary contact members thereby to intermittently close a circuit in one direction or the other. In the embodiments shown, the vibrating switch arm is actuated by, or is in the form of, an armature which is electromagnetically vibrated by being subjected to the alternating action of a core energized with alternating current.

Referring to the drawings, **10** designates a can or container closed at the bottom by a base **11** through which pass a plurality of conducting pins **12** insulated from each other, which constitute the terminals of the device. Secured to the base **11** by a bolt and nut securement **13** is an upstanding U-shaped bracket **14**. Secured to the bracket **14** is a frame **16** in the form of an elongate inverted U. The frame **16** is secured to the bracket **14** by a bolt **17** passing through the frame and bracket, and also through three insulating spacers **18**, **19**, and **21** (Fig. 3).

In the bight of the frame **16** is secured as by soldering, a permanent magnet **23** having depending north and south poles N and S, respectively. Disposed transversely within the frame **16** is a bracket **24**. The bracket **24** has a pair of depending tabs **26** secured to the frame **16** by bolts **27**. Bracket **24** is also provided with a pair of upstanding tabs **28** located generally at right angles with respect to the tabs **26**. Secured externally to the tabs **28** by means of bolts **31** are opposed T-shaped insulating plates **29**. The respective depending legs of the plates **29** are slotted to receive a stiff metal torsion reed **32** extending between the two plates **29** beneath the bracket **24** as best seen in Fig. 1. Formed integrally with or otherwise secured to the reed **32** is a thin depending switch arm **33** having a stiffening bead **34**. Formed integrally with or otherwise secured to the reed **32** is an upstanding axial armature **36**, which is aligned with the switch arm **33**. The armature **36** is made of a material having high magnetic permeability, but low magnetic retentivity, as for example, soft iron. The upper end of the armature **36** is disposed adjacent the poles of the permanent magnet **23** as shown in Fig. 2. Within the frame **16** and circumjacent the armature **36** is secured an annular coil **37** adapted to be connected to a source of alternating current through conductors **38** and certain of the pins **12**.

The reed **32** is made of a relatively stiff springy metal so that the armature **36** and switch arm **33** are permitted to vibrate about the axis of the reed **32**, but are always biased resiliently by the action of the reed to a central position as shown in Fig. 2.

When an alternating current is applied to the coil **37**, the magnetic polarity of the upper end of the armature **36** is alternated at the frequency of the applied electric current. Thus the upper end of the armature **36** is caused to vibrate back and forth by being attracted first to the north pole and then to the south pole of the

permanent magnet 23. This transverse vibration causes a corresponding transverse vibration of the lower end of the switch arm 33, which, as noted hereinbefore, constitutes virtually a depending extension of the armature 36.

Within the lower reaches of the frame 16 are mounted a pair of nominally stationary contact members in the form of elongate leaf-like contacts 41 and 42. At their lower ends the contact members 41 and 42 terminate in base plates 43 and 44, respectively, which are clamped between the three insulating members 18, 19 and 21 mentioned hereinbefore. At one side the base member or plate 43 has a terminal tab 46; and a similar terminal tab 47 extends from the opposite side of the base plate 44.

At their upper ends the contact members 41 and 42 are bent inwardly to form contact portions which engage the switch arm 33. It will be noted in Fig. 2 that the static position of the members 41 and 42 is such that both are in engagement with the switch arm 33 on opposite sides thereof. In operation, however, the vibration frequency of the switch arm 33 is so high that the arms 41 and 42 are pushed outwardly and never return to the static position shown in Fig. 2 because of a lower resonant frequency. Thus in actual operation the contact members assume a position somewhat as shown in dotted lines in Fig. 3, at which position they are intermittently and alternately engaged by the vibrating arm 33 which thus intermittently completes the respective circuits at the end of each transverse excursion. Upon de-energization of the vibrator, the contact members 41 and 42 return to the position shown in Fig. 2.

The static position shown in Fig. 2 is not necessary for satisfactory operation of the present invention, and in certain cases it may be desired to provide small spaces between the arm 33 and the two contacts 41 and 42 so that when de-energized, both circuits of the vibrator are normally open.

The terminal tab 46 of the contact 41 is brought out to one of the pins 12 by means of a conductor 48, and the terminal tab 47 of the contact 42 is similarly brought out to one of the contact pins by a conductor 49. At each end the vibrating reed 32 is turned at right angles outside the mounting plates 29, and one of the portions thus turned is employed as a terminal as shown at 51, being the common terminal, i. e., the one connected to the switch arm 33. Terminal 51 is also brought out to one of the pins 12 by a conductor 52.

As shown schematically in Fig. 4, energization of the coil 37 with an alternating current effects the closing, each cycle, of a circuit between the conductors 52 and 49, and a similar closing of a circuit between the conductors 52 and 48. In between these respective closings there will be a momentary interval when both circuits will be open, this interval being represented by the transit time of the arm 33 from one contact member to the other. If the vibrator is symmetrical as it is designed to be, the two open circuit periods in each cycle will be 180° apart cyclically.

Fig. 6 represents a circular oscillograph trace 53 on the face 54 of an oscilloscope. The trace 56 indicates that portion of the cycle during which the contact 42 is engaged, while the trace 57 represents that portion of the cycle during which the contact 41 is engaged. For optimum operation of the vibrator, it is desirable that the gaps 58 representing the open circuit condition should be exactly opposite each other, should be as small as possible, and should be as close as possible angularly to the horizontal line 59 representing zero phase shift as related to the energizing current.

The above desiderata are very difficult of attainment in a small precision device where the total height of the casing 10 may be in the order of an inch and a half. In order to achieve the desired precision of operation without excessive manufacturing cost, it is desirable that some means of adjustment for the vibrator be provided so that the vibrator may be adjusted, after fabrication, to the desired precision, thereby allowing a much greater tolerance in the actual manufacture. The problem of effecting these desiderata is further complicated by the fact that the nominally stationary contact members 41 and 42 are not actually stationary as has been pointed out hereinbefore. Instead, being made of stiff springable metal, they are in fact vibratable themselves, and hence have a certain resonant frequency of vibration. Thus when disengaged by the switch arm 33, each contact member 41, 42, tends to return to its unstressed position shown in Fig. 2, and being resilient, tends to vibrate at its resonant frequency. This vibration can of course affect the particular cyclic point at which the contact is next engaged by the arm 33. Hence it is highly desirable that both contact members 41 and 42 have substantially the same resonant vibration frequency, a characteristic very difficult to obtain except with the most precise and costly manufacturing techniques.

In accordance with the present invention, means are provided for adjusting the switching characteristics of the vibrator by adjusting the vibration characteristics of the contact members 41, 42, and also adjusting their position relative to the switch arm 33 thus to achieve the desired symmetry of operation illustrated in Fig. 6. In accordance with the present invention such means assumes the form of resilient pad means in engagement with the contacts 41, 42. Such resilient pad means is illustrated for example, in Fig. 3, by three rectangular blocks of material such as silicone rubber, the block 61 being interposed at the side of the contact member 41, that is, between the member 41 and the frame 16, the block 62 being correspondingly disposed with respect to the contact member 42, and the block or pad 63 being disposed between the two contacts 41 and 42. In order to provide adjustment of the pressure of these blocks upon their respective contact members, the arms of the bracket 14 are extended upwardly contiguous to the frame 16 to a point above the blocks or pads 61 and 62. These extensions thus constitute backing plates 66 and 67. Since the bracket 14 is made of a bendable springy material, the backing plate portions 66 and 67 may be adjusted in and out. This is achieved by means of a pair of adjusting screws 68 and 69 threaded through the opposite legs of the frame 16 and bearing against the plates 66 and 67.

By adjustment of the screws 68 and 69 the pressure of the pads 61 and 62 on the contact members 41 and 42 may be so adjusted as to create an optimum switching characteristic as shown in Fig. 6. Adjustment of the screws 68 and 69 serves a three-fold purpose. It controls the damping characteristic of the contact member and thereby changes or adjusts the resonant frequency thereof, it adjusts the bias or force which the contact member applies against the switch arm 33 when engaged thereby, and it serves to position the contact member so that the position and size of the gaps 58 may be adjusted.

Another form of the present invention is illustrated in Figs. 7 and 8. In this form the central pad 63 of Fig. 3 is replaced by a rigid insulating member 71, being in effect an upward extension of the spacer 19 of Fig. 3. The resilient pads are made cylindrical instead of in block form as shown at 61*a* and 62*a* in Fig. 8. The operation of the pads 61*a* and 62*a* is virtually the same as described hereinbefore in connection with the pads 61 and 62. The pads 61*a* and 62*a*, however, do have another interesting characteristic in that as the screws 68*a* and 69*a* are tightened inward, the contact line between the pads and the respective contacts 41*a* and 42*a* moves upward, thereby shortening the effective vibrating length of the contacts and appreciably changing their resonant frequencies. It has been found that the vibration frequency of the contact members is more sensitive to the adjusting screws when the cylindrical pads 61*a* and 62*a* are employed, than when the rectangular pads of Fig. 3 are used.

While the instant invention has been shown and described herein in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein but is to be accorded the full scope of the claims.

What is claimed is:

1. In an electric vibrator having a movable switch arm, magnetic means effective to cause oscillation of said switch arm, a contact member disposed on each side of said switch arm, each of said members being alternately engaged by said switch arm upon oscillation thereof, the combination of a resilient pad disposed adjacent each contact member and adjustable means bearing inwardly against each said pad to thereby change the resonant frequency of each said contact member.

2. In an electric vibrator having a movable switch arm, magnetic means effective to cause oscillation of said switch arm, and a contact member disposed on each side of said switch arm, each of said members being alternately engaged by said switch arm upon oscillation thereof, the combination of: a resilient pad disposed adjacent each contact member; a plate member adjacent the outer

surface of each pad and bendable to vary the pressure of each said pad against each adjacent contact member and adjustable means for causing inward bending movement of said plates.

3. In an electric vibrator having a movable switch arm, magnetic means effective to cause oscillation of said switch arm, a contact member disposed on one side of said switch arm and a second contact member disposed on the opposite side of said switch arm, each of said contact members being alternately engaged by said switch arm upon oscillation thereof, the combination of: spacing means disposed between said contact members; a resilient pad disposed adjacent each contact member; and a plate member adjacent the outer surface of each pad and bendable inwardly to vary the pressure of each said pad against each adjacent contact member.

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