Nov. 24, 1953 H. J. BROWN 2,660,639

ELECTRICAL VIBRATOR

Filed Feb. 19, 1948

3 Sheets-Sheet 1

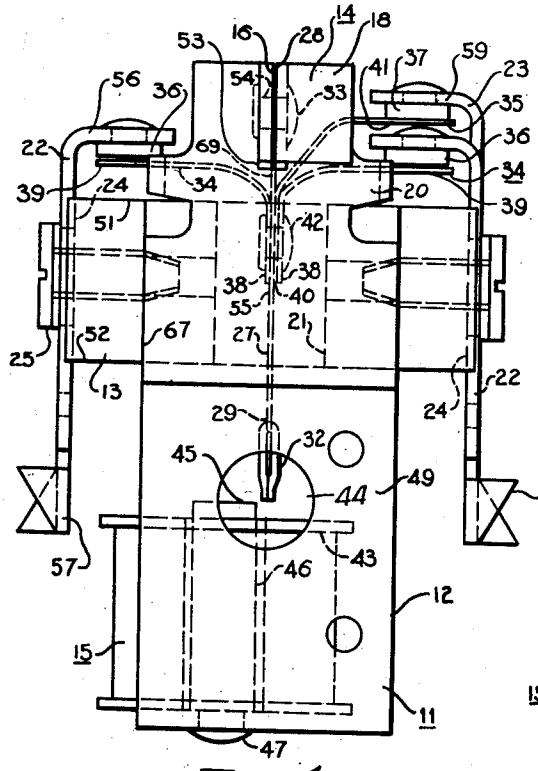


Fig 1

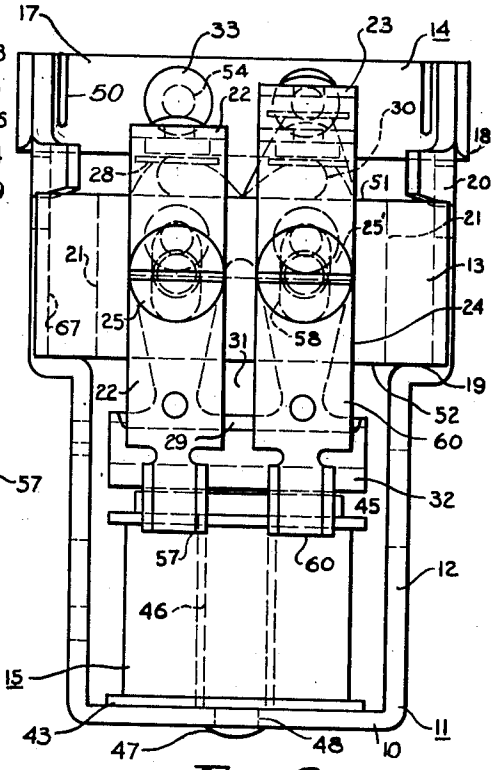


Fig 2

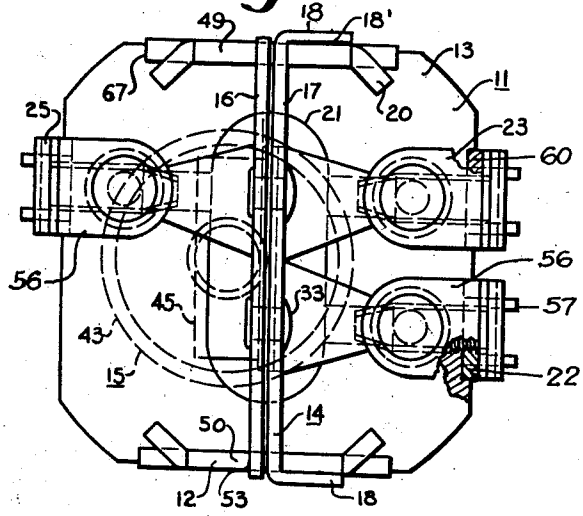


Fig 3

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Filed Feb. 19, 1948 3 Sheets-Sheet 2

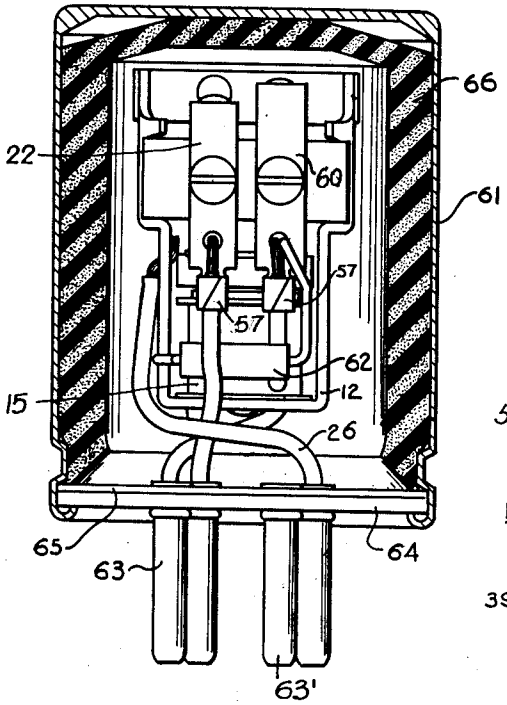


Fig 4

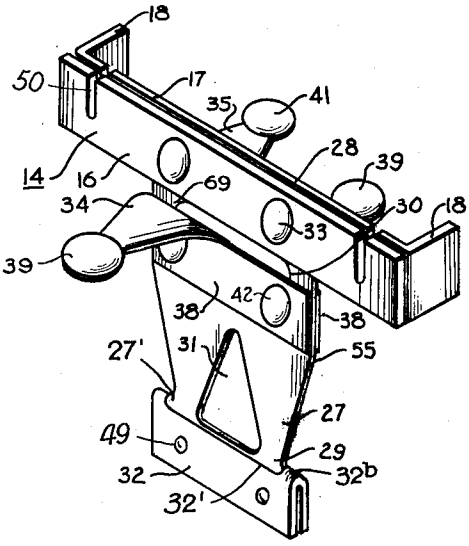


Fig 5

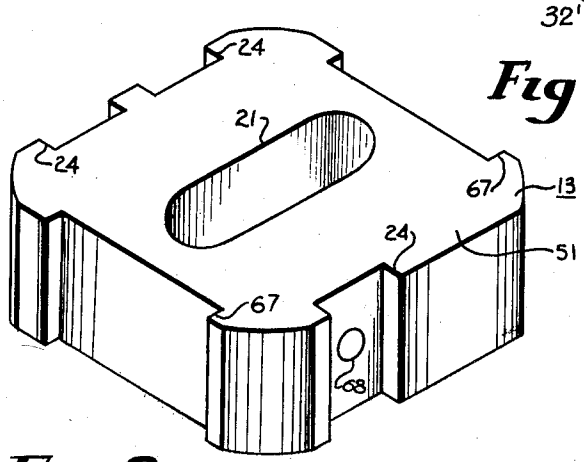


Fig 6

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Nov. 24, 1953 H. J. BROWN 2,660,639

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Filed Feb. 19, 1948 3 Sheets-Sheet 3

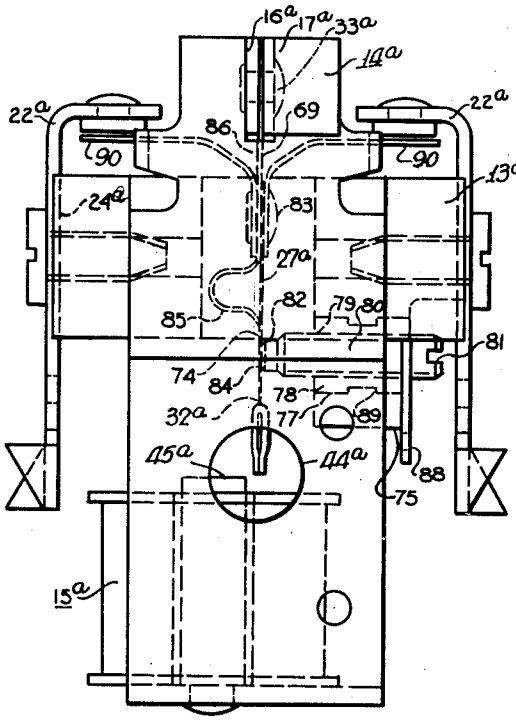


Fig 7

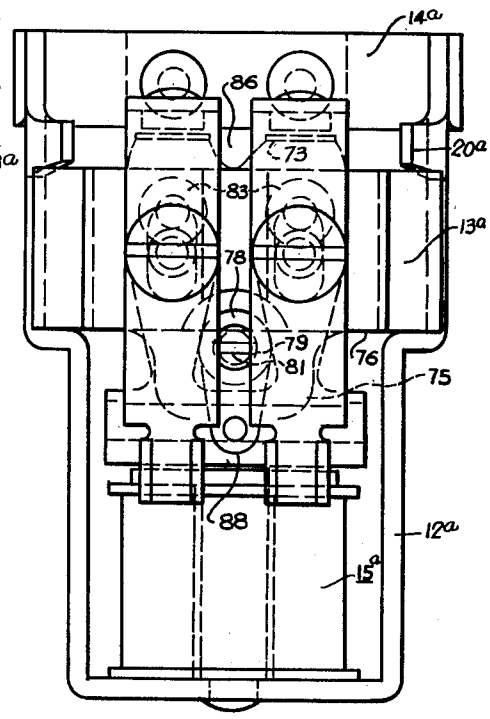


Fig 8

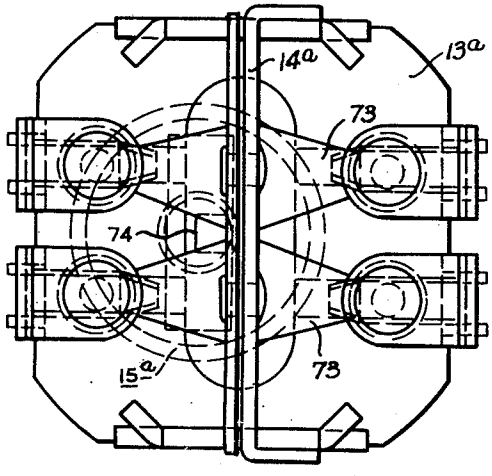


Fig 9

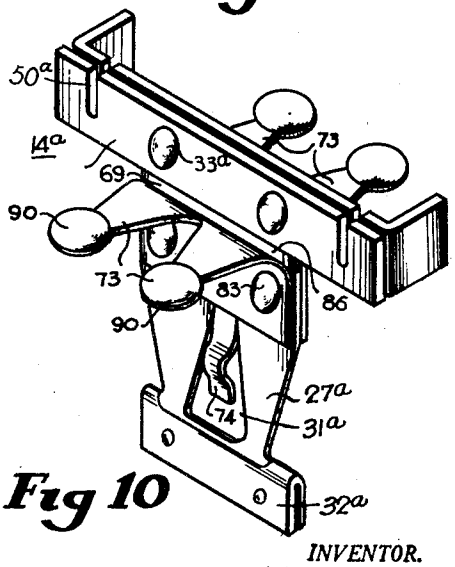


Fig 10

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UNITED STATES PATENT OFFICE

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ELECTRICAL VIBRATOR

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Application February 19, 1948, Serial No. 9,501

4 Claims. (Cl. 200—90)

1

My present invention relates to electric vibrators of the type useful for converting low to high voltage for automobile radio receiver and cognate applications.

It is among the objects of the invention to provide a vibrator of the above type of rugged construction, of relatively few parts and of small bulk for a given output, which shall be easy to assemble and all adjustments of which, including the longitudinal and lateral spacing of the armature relative to the pole of the coil and the relative position of each pair of electrical contacts thereof are easy to adjust without the danger of upsetting static or dynamic balance of the unit and without the need for a running-in operation; the performance of which vibrator shall not be subject to derangement in the course of use or to fortuitous variation or deterioration even under severe service, which vibrator has a minimum of power loss and maximum efficiency of conversion, operates with a minimum of impact, a minimum of noise and a minimum of wear of its electrical contacts, transmits a minimum of mechanical vibration to the supporting frame or casing, does not become heated unduly in operation, is not subject to undesired variation with changes in ambient temperature nor to injury on reasonable overload; the efficiency of which is nearly uniform over a relatively wide range of input voltage and is maintained even after prolonged used and without damage to or from the associated apparatus, such as transformers or buffer capacitors, even though these associated parts are not held to close tolerances in their electrical constants.

According to one feature of the invention, a vibratory sub-assembly, which includes all of the vibrating elements has one or more contact carrying arms with each contact face thereof substantially at right angles to the plane of the length and width of the armature reed and is mounted for the free end or head of said reed to pass across the pole face of the vibrator coil, the stationary contacts associated with those on the vibratory assembly being affixed with respect to the frame of the vibrator and in insulating relation therewith.

Another feature is to carry the vibratory electrical contacts upon spring arms affixed to the armature reed and exending laterally therefrom and to correlate the frequencies of vibration of the armature reed and contact carrying arms in such manner that each vibratory contact as it is about to close, moves in direction opposed to that imposed thereon by the armature reed, for a minimum of impact, a minimum of noise and a minimum of contact wear.

2

Another feature is to mount the vibratory assembly to the frame in such manner that in installing said assembly, the desired spacing of the reed armature end from the pole face of the coil may be set without strain upon the vibratory system and thereupon permanently affixed in place, the position of the reed armature end laterally of the said pole being thereupon set by manipulation of the vibratory assembly mount without strain upon any other moving or fixed parts of said assembly.

Another feature is to dispose the stationary contacts in guided relation on an insulating block affixed upon the frame and thus to effect the required adjustment of spacing thereof with respect to the corresponding vibratory contacts without straining, displacing or even touching the vibratory assembly.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention,

Fig. 1 is a side elevational view of the vibrator,

Fig. 2 is a front elevational view thereof,

Fig. 3 is a top or plan view thereof,

Fig. 4 is a cut-away view of the completed vibrator assembly inside the shielding can,

Fig. 5 is a perspective view of the vibrating assembly of the vibrator,

Fig. 6 is a perspective view of the insulator base of the vibrator,

Fig. 7 is a side elevational view of a modification of the vibrator,

Fig. 8 is a front elevational view of the modification,

Fig. 9 is a top view of the modification, and

Fig. 10 is a perspective view of the vibratory assembly of the modification.

Referring now to the drawings, the frame 11 is desirably made of a strip of suitable ferrous alloy bent into U-shape with a cross bar 10 shown at the bottom and upstanding legs 12. The operating coil 15 rests at 43 against and is desirably affixed off center, as shown, to cross-bar 10 between legs 12 by heading over at 47 the reduced rivet end 48 of its core 46 against the outer face of said frame, said core having a widened pole 45 for coaction with the armature head 32.

All of the moving and vibratory parts of the unit are incorporated in a sub-assembly shown in Fig. 5. Preferably, the mount 14 of said sub-assembly comprises a pair of metal cross-plates 16 and 17 pressed together by rivets 33 therethrough clamping in place the root 28 of the reed

27 sandwiched therebetween. The relatively wide reed of spring metal is preferably cut away at 30 near its root or mount to afford a hinge of suitable flexibility and is furthermore cut away near its free end as at 31 for effective springiness and lightness. The widened free end or foot 27' of the reed has the armature head 32 affixed thereto, which may be of any suitable construction. In a preferred embodiment, this head constitutes a rectangular plate of magnetic material having an elongated central slot 32' along which the plate is bent into a pair of identical leaves, the end bridges 32b left at the extremities of the slot 32' resting upon foot 27', the head desirably welded in place as at 49.

The vibratory assembly carries desirably two vibratory contacts 39, the contacting faces of which, as shown, extend laterally at right angles to the length and width of the armature reed at opposite faces thereof, and are set into vibration with and relative to the armature. To this end, the contacts 39 are desirably mounted upon contact carrying arms 34, each having a widened root web 38 riveted as at 42, transversely across the wide reed 27 at the mid portion 55 thereof, between the hinging opening 30 and the opening 31, and each extending as a cantilever outward at substantially right angles to said armature reed.

In the embodiment shown, the fixed contacts 36 which coact with the respective vibratory contacts 39, are mounted each on a metal carrying bar 22, which in turn is appropriately affixed to the exterior of an insulating block 13, which desirably has lateral grooves 57 across the thickness thereof, accommodating the respective legs of the supporting frame 11 between which the block 13 is mounted. The legs of the sheet metal frame are desirably bent outwardly and thence upwardly to afford shoulders 19 upon which the block 13 rests, tabs 20 from the edges of the frame legs being turned inward over the insulating block 13 to lock it in place. The bars 22, each of which carries its stationary contact 36 on the overhanging ledge 50 thereof are desirably lodged in grooves 24 along the sides of the block and across the thickness thereof, in which they are clamped in place by appropriate screws 25, desirably self tapping screws threaded into apertures 68 in the block. Desirably each bar 22 has an elongated slot 53 for the screw 25 to permit of adjustment in the distance of the stationary from the corresponding vibratory contact in initially setting up the assembly for use.

The mount 14 for the vibratory assembly is assembled to the frame by lodging its extremities in corresponding slots 53 at the free extremity of the legs of the frame, the block 13 having an elongated slot 21 therethrough in which the armature reed is accommodated. At least one of the mounting cross-bars 17 is provided with extension tongues 18 bent over at right angles to engage the face of the frame legs 12, to which it is soldered at 18' with desired spacing of the armature head 32 from the pole 45 of the coil.

The cross-bar mount 14 of the vibrator assembly is desirably transversely slotted as at 50 adjacent the ends of the bridging length thereof between the frame legs to permit a slight hinging displacement of such bridging member by resort to appropriate pliers for initially positioning the armature head as desired, laterally of the width of the pole 45. By this adjustment, the entire vibratory assembly is properly positioned laterally with respect to the pole face 45 and this without strain upon any part other than the clamp mount 14. There being no sustained stress in operation upon said clamp mount, there is but slight tendency for shift in the adjustment of said clamp mount, and any such slight change would not be translated in strain upon any other part whether of the frame or of the vibratory assembly and accordingly progressive unbalance will not and cannot occur.

As illustratively shown in the embodiment of Figs. 1 to 6, the vibratory assembly may in addition to the two vibratory contacts 36, be equipped with one or more additional vibratory contacts, such as driver contact 41. To this end there is illustratively shown an additional contact carrying arm 35, preferably substantially identical with arms 34 and affixed to the vibratory reed 27 by the same rivets 42 as affixed arms 34. Arm 35 carries contact 41 to extend laterally of one of the contacts 39. The coacting fixed contact 37 is mounted on a metal bar 60 similar to bars 22 and affixed by a screw 25' to the insulating block 13 in corresponding groove 24 across the thickness thereof in the same manner and with facility for the same adjustment of its position as in the case of the vibratory contacts 39.

The unit as thus far described with or without the driver contacts 35, 41 is equipped with terminals and installed in more or less conventional manner, as shown in Fig. 4. Desirably the three terminal leads 57 affixed to the root ends of the three bars 22, 22 and 60 carrying the respective stationary contacts 36, 36 and 41, are affixed to appropriate terminal prongs 63 installed in a fiber plate 64 covered with a cork facing 65, a resistor 62 being connected between bar 60 and the frame 12, the entire unit being enclosed in a sponge rubber liner housing 66 and introduced into a metal can 61 spun over the fiber disc 64 to complete the assembly. The fourth prong 63' is the usual dummy that serves for keying the unit to its socket.

A preferred structure of vibrator has been above described but without reference to certain important features now to be set forth which, while preferably incorporated in the structure set forth, may find utility in other structures as well.

The contact carrying arms 34 and the contact carrying arm 35, if used, are according to the present invention made of spring metal, so that they, like the armature reed 27 will have a natural frequency of vibration. Desirably the natural frequency constants, namely, the length, the elastic modulus and the masses of the moving arms, that is of the armature reed 27 and of the contact carrying arms 34, 35 are so selected that the vibratory contact will, as it is about to close, move in direction opposed to that imposed by the armature reed. In other words, while the armature reed moves, say toward the left in Fig. 1, tending to shift contact 39 upwardly toward contact closure, the arm 34 carrying said contact is at that time moving downward away from contact closure, so that the speed of approach of the moving contact 39 to the fixed contact 36 imposed by the armature reed 27 is offset in large part by the opposing movement of the contact carrying arm 34. Thus the contact closure will be with less impact, less noise and less wear than if the contact 39 were immovably affixed with respect to the moving armature reed 27, and much less than would be the case if the speed of movement of the contact 39 imposed by the independent vibration of

its carrying arm 34 were added to rather than subtracted from that imposed by the vibratory armature reed 27.

To this end, especially for vibrators in the lower ranges of frequency (i. e. in the range below 150 vibrations per second), the ratio of the compliance (i. e. the deflection within the elastic limit per unit of deflecting force) of the armature reed to that of the contact carrying arm approximates but is not less than eight times the square of the ratio of the effective lengths of said arms. When this relation obtains a minimum of adjustment is required, correctly to time the vibrator.

For best operation, the time constant, that is the ratio of the period that any of the vibratory contacts 39 is closed to that of a complete cycle of the vibrator should be not less than 80 per cent and not more than 93 per cent.

The vibratory unit, as shown in Fig. 5, with armature reed and contact carrying arms of known compliance, is assembled with due regard to proper selection of three variables that determine its performance. These variables are the effective weight of the armature, the thickness of the armature reed 27 and the thickness of the contact carrying spring arms 34. The thickness of the armature reed and of the contact carrying spring arms may be readily selected as may be the armature head 32 whose weight may be readily adjusted by suitable grinding.

The vibratory assembly is easily and correctly installed in the carrying frame therefor with but three separate adjustments, each of which is made independently of the other two and without disturbance of the other two. The three adjustments in question are the setting of the vibratory assembly in correct position longitudinally for desired spacing of the armature head 32 from the pole face 45, the setting of the armature head for proper spacing thereof laterally of the width of pole 45 and the setting of the distance between each vibratory contact and its associated stationary contact.

To set the armature reed longitudinally and fix the gap between armature head 32 and pole 45, a suitable gauge blade is interposed between the said head and said pole. In position thus determined by the gauge, the mounting cross bar 14 of the vibratory assembly is soldered to the frame 12 in manner previously described. Thereupon the bridging portion of the mounting cross bar 14 between the legs of the frame is longitudinally deflected as permitted by cross slots 50 to set the position of the armature head 32 in desired position laterally of the pole width 45.

To permit check of the critical rest position of the armature head 32 relative to the pole 45, at least one leg 12 of the frame is provided with a circular window aperture 44 exposing to inspection the armature head 32 and the associated part of the pole 45.

Independently of the above adjustments, the correct spacing between electrical contacts is established by slight sliding adjustment of the stationary contact carrying bars 22 in their grooves 24 and then tightening screw 25, a suitable gauge being interposed between the contact pairs for correct spacing in full open position thereof.

Thus in completing each setting, there is no disturbance of the accuracy of the settings previously made and there is no strain upon the metal parts in making any such setting and, therefore, no progressive deterioration in operation during use by objectionable disturbance in the static or dynamic balance as might ensue by plastic flow of metal were the vibratory parts subjected to mechanical strain or deformation for the purpose of forcefully effecting such adjustment. Accordingly, with the parts properly selected and installed in the manner above described, the operation will be reliable and its reliability will be maintained without disturbance for long periods of time.

Of course, by suitable choice of parts and appropriate positioning thereof, the device could be made to function at any frequency within practical limits, bearing in mind that frequency varies inversely with the square root of the product of the equivalent mass and the equivalent compliance of the vibratory system.

By reason of the accuracy of adjustment of which the vibrator admits, no "running-in" operation is required, and the correct setting is maintained throughout.

By reason of the low energy losses due to the elimination of excessive impart in contact closure, there is a minimum of wear and a maximum utilization of the input energy. The unit within its sound insulating housing, as shown in Fig. 4, transmits a minimum of vibration and a minimum of noise. The unit will perform without much loss in efficiency over relatively wide range of voltages. For instance, a vibrator according to the present invention, designed to operate from a 6-volt battery will operate effectively between the ranges of 2 volts and 10 volts and will withstand substantial overload throughout its voltage range and without serious injury thereto.

Moreover, the unit by reason of all of the characteristics set forth, does not require associated electrical equipment such as transformers and buffer capacitors of critical specifications, and yet there is no danger of injury to or from the latter under various conditions of operation.

Accordingly a unit for a given performance may be more compact than units that lack the characteristics set forth.

In the embodiment of Figs. 7 to 10, the vibratory contacts 39 are four in number, each mounted on its spring arm 73, the two spring arms 73 on each side being shown formed integrally. This construction serves for heavier duty or for self-rectifying operation in manner clear to those skilled in the art.

The reed and contact carrying spring arms are riveted at 33 to a separate and distinct hinge spring piece 86 preferably of greater flexibility than the reed and riveted at 33^a to the cross arm mount 14^a and affording a principal region of flexure at spring hinge portion 83. Except as above stated, and that a specifically different arrangement of driver contact is here shown, the present embodiment is similar to that heretofore described, and corresponding parts bear the same reference numerals with exponent "*a*." In this embodiment the insulating block 13^a is provided with a unitary extension 75 at the lower end thereof and desirably has molded thereinto at aperture 77 a metal bushing 78 grooved at 89 and which may be tapped at 79 to accommodate a screw 80 mounting a terminal tab 83, said screw being adjustable at a fillister head 81 and carrying a contact 82 at its inner end for coaction with a contact spring 74 which has a loop 85 for enhanced flexibility, is desirably

integral with hinge spring piece 86 and is exposed for engagement with said contact 82 through the opening 91 in the armature reed 27a.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric vibrator comprising a substantially U-shaped frame of magnetic material having its free ends spaced from each other, the legs of said frame having projecting shoulders across the width thereof, a coil mounted on the cross bar of the frame between the legs thereof, said coil having a pole, a vibratory assembly having a mount extending between and affixed to the free ends of said legs, said vibratory assembly including an armature reed longitudinally of the frame and having a head spaced longitudinally of and coacting with said pole, said vibratory assembly including one or more laterally extending vibratory arms, an electric contact carried near the free end of each of said arms, an insulating block carried on the shoulders of said legs, extending therebetween and disposed between the coil and the vibratory assembly mount, said legs having inturned tabs extending over said block to retain the latter on said shoulders, said block having a passageway therethrough for said reed, and stationary electrical contacts mounted on said insulating block and coacting with the respective contacts of the vibratory assembly.

2. An electric vibrator comprising a substantially U-shaped frame of magnetic material having its free ends spaced from each other, a coil mounted on the cross bar of the frame between the legs thereof, said coil having a pole, a vibratory assembly having a mount extending between and affixed to the free ends of said legs, said vibratory assembly including an armature reed longitudinally of the frame and having a head spaced longitudinally of and coacting with said pole, said vibratory assembly including one or more laterally extending vibratory arms, an electric contact carried near the free end of each of said arms, an insulating block carried by said frame extending between the legs thereof and disposed between the coil and the vibratory assembly mount, said block having a passageway

therethrough for said reed and having grooves on the exterior across the thickness thereof, stationary electrical contacts coacting with the respective contacts of the vibratory assembly, upstanding bars mounting said stationary contacts respectively and adjustable lengthwise of an associated groove for adjustment of the spacing of each stationary contact with respect to the corresponding vibrating contact.

3. An electric vibrator comprising a substantially U-shaped frame of magnetic material having its free ends spaced from each other, said ends each having a longitudinal slot therein, a coil mounted on the cross bar of the frame between the legs thereof, said coil having a pole, a vibratory assembly having a cross bar extending between the free ends of the frame and lodged in said longitudinal slots, said vibratory assembly including an armature reed longitudinally of the frame having its base affixed to said cross bar and having a head spaced longitudinally of and coacting with said pole, said vibratory assembly including one or more laterally extending vibratory arms, an electric contact carried near the free end of each of said arms, an insulating block carried by said frame extending between the legs thereof and disposed between the coil and the cross bar, said block having a passageway therethrough for said reed, and stationary electrical contacts mounted on said insulating block and coacting with the respective contacts of the vibratory assembly.

4. The combination recited in claim 3, in which said cross-bar is transversely slotted near its opposite ends to permit slight twisting thereof for lateral adjustment of the armature head with respect to the pole.

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