

Sept. 27, 1949.

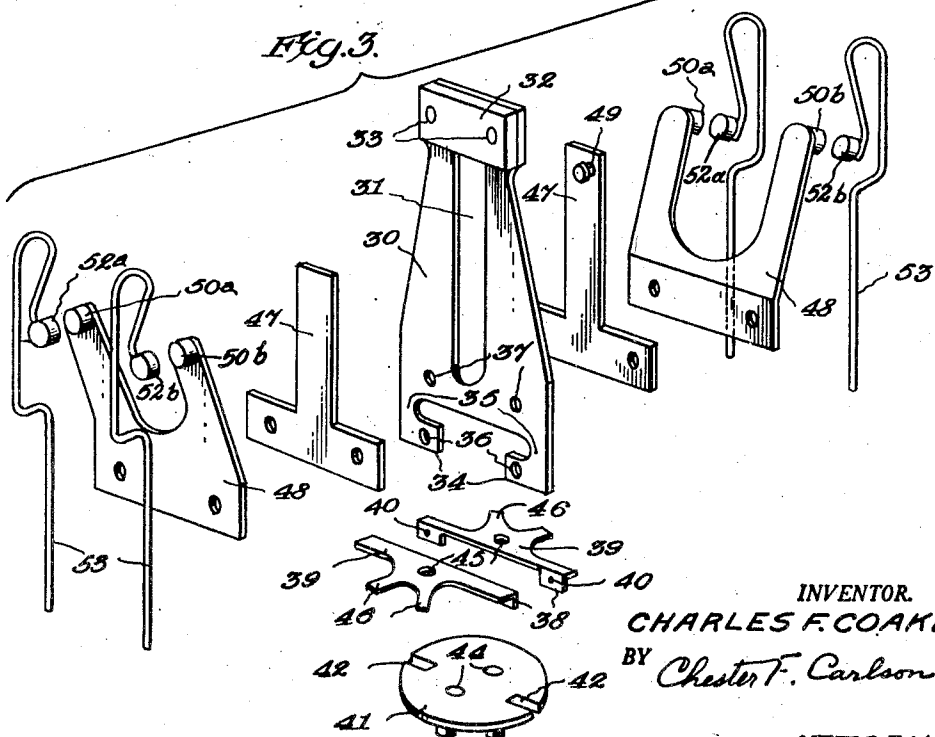
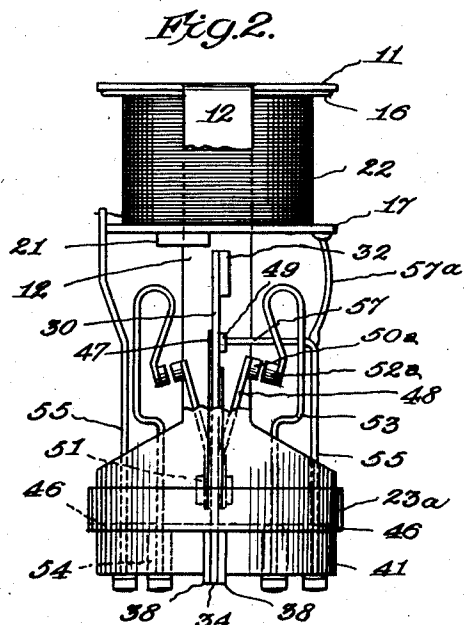
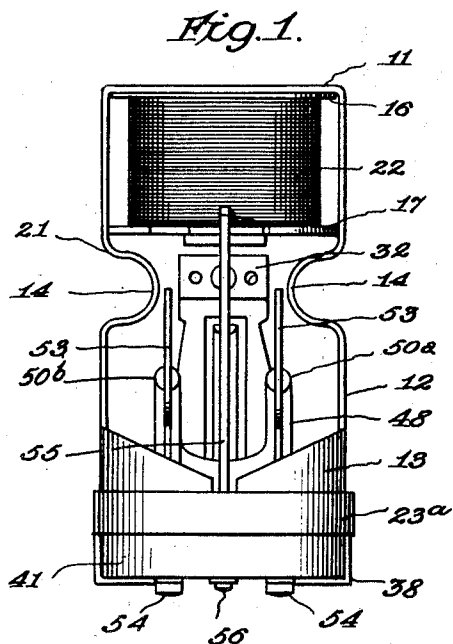
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2,483,085

VIBRATOR

Filed April 27, 1944

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

Fig. 4.

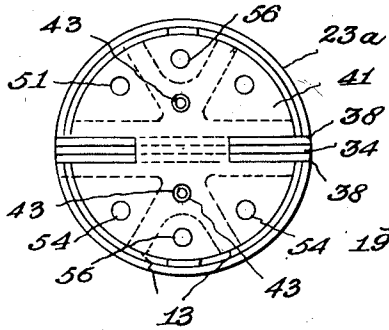


Fig. 5.

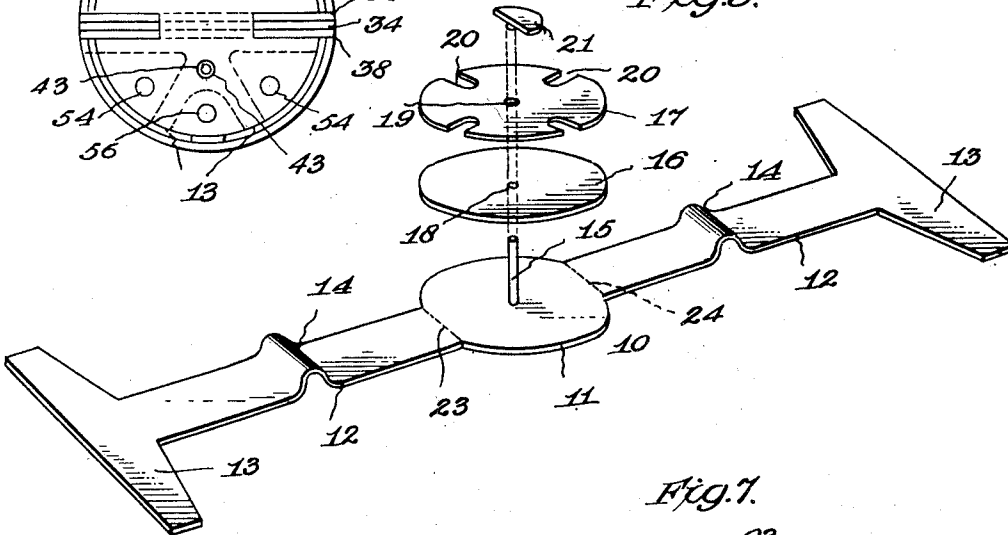


Fig. 6.

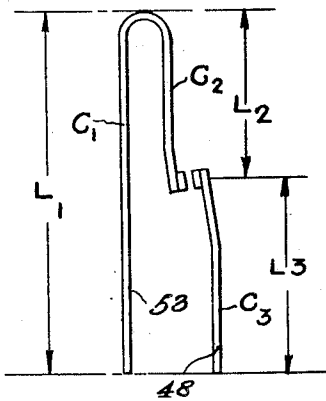
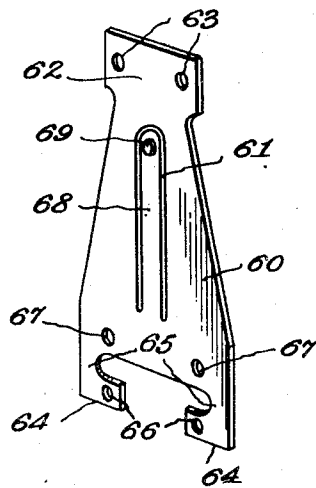


Fig. 7.



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Fig. 8.

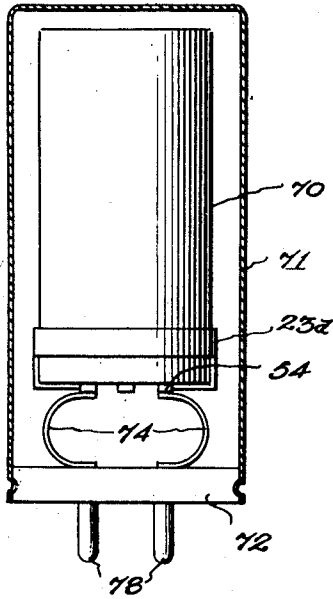


Fig. 9.

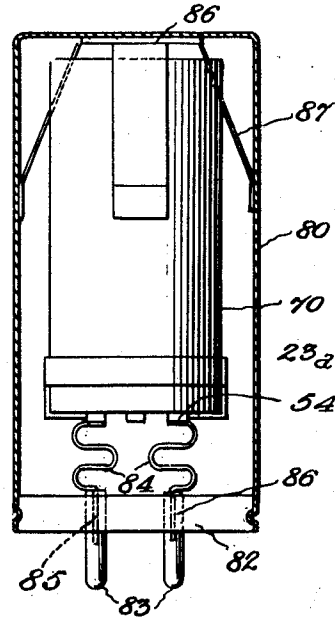


Fig. 10.

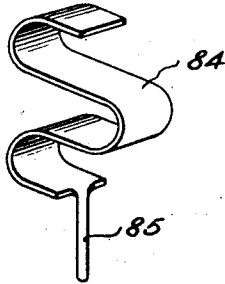


Fig. 11.

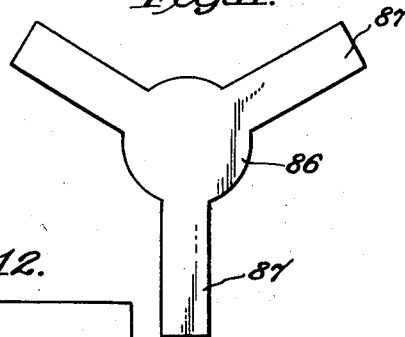
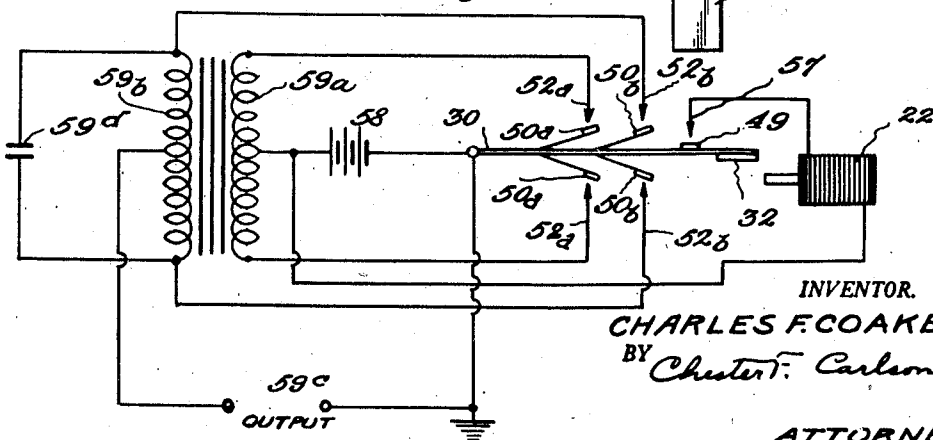


Fig. 12.



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2,483,085

VIBRATOR

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Application April 27, 1944, Serial No. 532,962

13 Claims. (Cl. 200—90)

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The present invention relates to vibrators, and, more particularly, to electromagnetic vibratory interrupters of a novel and improved character.

Heretofore, vibrators were generally built and assembled on the stack principle. Thus, the principal operative elements including a vibratory reed, the contact springs bearing relatively fixed contacts, portions of the frame, and the like, have been provided with suitably aligned holes and were clamped together by means of stack screws, the proper spacing of the several elements being assured by means of interposed spacer members. This type of construction had various disadvantages. First of all, the structure was relatively complex and its assembly required a great deal of manual labor. Also, the distance between the cooperating elements was determined by the spacer elements which had to be of uniform thickness and this condition was difficult to fulfill in quantity production. Particularly when the spacer members have been made of synthetic resins, changes in the thickness of the spacer members would occur even after the assembly was finished and would endanger the proper spacing and critical adjustment of the contact discs with respect to each other. Moreover, this type of construction was relatively bulky and made the construction of vibrators of small dimensions practically impossible.

The difficulties were accentuated by the recent trend in vibrator design directed to the provision of vibrators of very small dimensions. This trend was connected with the circumstance that most essential components of radio receivers and transmitters, such as condensers, tubes, and the like, are now available in very small dimensions and have permitted the development of apparatus of great compactness. This was the situation, for example, in automobile and portable receivers of all types. Furthermore, in recent years extremely small portable radio receivers, the so-called personal radios and small vacuum-tube operated hearing aid devices have been placed on the market in large quantities and these devices have created a demand for vibrators of greatly reduced dimensions which so far the industry has been unable to satisfy. Although these problems were well known in the art and various suggestions and proposals were made to eliminate the foregoing difficulties and disadvantages inseparably connected with conventional vibrator structures, none of these suggestions and proposals was completely satisfactory and successful on a practical and commercial scale.

It is an object of the present invention to pro-

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vide a vibrator of novel and improved character which eliminates the said disadvantages and inconveniences experienced in the manufacture and operation of conventional vibrators.

It is another object of the present invention to provide a novel type of electromagnetic vibratory interrupter which dispenses altogether with the conventional stack-type construction and provides a basically novel structure in which the principal cooperating parts are fixed to a metallic frame by means of welding and similar operations.

It is a further object of the present invention to provide a vibratory interrupter structure which may be assembled in a manner comparable to the procedure followed in the manufacture of miniature vacuum tubes whereby an extremely strong structure may be combined with the desirable feature of very small dimensions.

It is also within the contemplation of the invention to provide a vibratory interrupter in which a magnetic circuit of low reluctance is obtained by means of a U-shaped frame member with integrally formed pole-pieces which at the same time forms the central structural member of the complete assembly supporting all of the other cooperating elements of the system.

The invention also contemplates a vibratory interrupter which is simple in structure, has greatly reduced dimensions previously unobtainable in the vibrator art and which may be readily manufactured and sold on a practical and industrial scale at a low cost.

Other and further objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings; in which

Fig. 1 illustrates a longitudinal sectional view, having parts in elevation, of a vibrator embodying the principles of the present invention;

Fig. 2 depicts a similar sectional view taken at right angles to the plane of Fig. 1;

Fig. 3 shows an exploded perspective view of parts of the vibratory reed and contact assembly of the vibrator;

Fig. 4 is a bottom plan view of the vibrator;

Fig. 5 is a perspective view of the frame member of the vibrator and some of its cooperating elements prior to its final shaping and application of the vibrator coil thereto;

Fig. 6 is a somewhat diagrammatic view of one of the fixed contact members;

Fig. 7 is a perspective view of a modified form of a reed;

Fig. 8 is a longitudinal sectional view, having

parts in elevation, of a vibrator resiliently mounted within an outer casing;

Fig. 9 is a similar view of a resilient and vibration-absorbing mounting for a vibrator;

Fig. 10 is a perspective view of one of the resilient mounting members forming part of the construction shown in Fig. 9;

Fig. 11 is a plan view of a resilient spacing member; and

Fig. 12 is a diagrammatic view of one circuit in which the vibrator may be used.

For the purposes of clarity, all of the elements of the vibrator have been greatly exaggerated in dimensions, the several views in the drawings corresponding to 3 to 4 times the original dimensions of the vibrator.

Referring now more particularly to Figs. 1 to 5 of the drawing, reference character 10 generally denotes a frame member which is preferably integrally formed from ferromagnetic material but may be welded together from a plurality of pieces, if desired. As it will be best observed in Fig. 5, frame member 10 is formed with a substantially circular center portion 11 from which extend legs 12 of substantially uniform width in both directions, terminating in T-shaped, transverse tapering extensions or ears 13 at the ends thereof. Indentations or corrugations 14 are provided in intermediate regions of the frame members and are adapted to constitute pole-shoe extensions in the frame in its finished condition.

A substantially cylindrical core 15 is welded or otherwise secured to the center point of the frame member. Insulative discs 16 and 17, provided with concentric openings 18 and 19, respectively, may be slipped over core 15 and fixed thereon in parallel-spaced position to accommodate the windings of a coil therebetween. Disc 17 may be provided with a plurality of radially directed cut-out portions 20 to expose portions of the windings to the atmosphere and thereby to dissipate heat generated in the windings and also to anchor outer or last turn of the wire. At the end of core is secured a semi-circular pole-piece 21. It has been found advantageous to employ percussion welding in securing the ends of core 15 to the frame member and to the pole piece, as in this manner accurate finished dimensions are positively assured.

Although it is possible to slip a finished coil of insulated wire on core 15 before securing pole piece 21 thereto, a considerably simpler method of providing a coil in accordance with the invention comprises winding insulated wire directly around core 15 while the frame member is still in its illustrated flattened condition. This procedure not only has the advantage of simplicity but also provides a tighter wound coil closer to the core and including a larger number of turns within the same space whereby an extremely efficient electromagnetic system is obtained.

After the frame member has been provided with coil 22, its two legs are bent along lines 23 and 24 into positions in which they are parallel with respect to each other and at right angles to the plane of center portion 11. Ears 13 at the ends of the frame member are curved into a semi-circular shape either before or after this bending operation so that in the finished condition of the frame member they will define a substantially circular area. A ring 23a is welded at a plurality of points to the terminal portions of the curved ears to hold them in this position as this will be seen in Figs. 1, 2 and 4. It will be noted that this form of construction provides an extremely

strong and rigid frame structure having a generally U-shaped form closed at its lower end and having a coil 22 arranged in its bight. It will be also observed that in the completed condition of the frame member indentations 14 will extend inwardly and will cooperate with pole piece 21 to form a concentrated magnetic field.

The structure of the vibratory reed and its assembly and mounting will be best understood by referring to Fig. 3. It will be noted that reed 30 is formed with an upwardly tapering width and is provided with a slot 31 extending through the major portion of the length thereof. At its upper or free end there is secured an armature 32 of ferromagnetic material preferably by means of welding at points 33. The lower extremity of the reed ends in two extensions or ears 34 connected with the body of the reed by means of weakened portions 35 and having holes 36 therein. The lower region of the reed is also provided with two holes 37 the object of which will presently appear. Ears 34 of the reed are clamped between depending flanges 38 of reed clamping pieces 39. One of the clamping pieces is formed with small protuberances or projections 40 on its flanges adapted to cooperate with holes 36 at the lower end of the reed whereby the two clamping pieces with the reed in-between may be projection-welded together into a strong and unitary structure. The reed unit is mounted to an insulative back plate 41 having two radial recesses 42 adapted to take up the downwardly depending portions of the reed and of the clamping pieces and is secured thereto by means of rivets or eyelets 43 passed through aligned openings 44 and 45 in the back plate and in the clamping pieces, respectively. Each of the clamping pieces 39 is provided with two radially extending arms 46 the ends of which extend beyond the circumference of the back plate and are welded to corresponding portions of the edges of ears 13 in frame member 10 (Fig. 4). In this manner the frame, the vibratory reed and the back plate are strongly bonded together and provide a permanently rigid unit.

To the two sides of reed 30 are riveted two inverted T-shaped auxiliary reeds 47 and two U-shaped side arms 48. One of the auxiliary reeds 47 bears a driving contact 49 while each of side arms 48 carries a pair of power contact discs 50a and 50b. Both auxiliary reeds and side arms have openings aligned with holes 37 in the reed and are secured to the reed by means of rivets 51 passed therethrough. Preferably, the auxiliary reeds have dimensions smaller than those of slot 31 in reed 30, so that they are capable of displacement through said slot.

Vibratory contacts 50a and 50b on side arms 48 cooperate with relatively fixed contacts 52a and 52b carried at the ends of contact side arms, or supporting members, 53. These supporting members are preferably formed of strong and resilient wire of circular cross section bent into the illustrated shape whereby a strong and at the same time resilient contact supporting structure is provided. The lower ends of the supporting members or wires are held in metal bushings 54 moulded in back plate 41. Similar arms or wires 55 are held in bushings 56 of which one provides connection to one end of coil 22 while the other carries a contact point 57 cooperating with driving contact 49 on auxiliary reed 47 and is connected to the other end of coil 22 by means of a wire 57a. Bushings 54 protrude to some extent beyond the lower surface of back plate 41 and

their lower rounded extremities constitute terminal surfaces which may cooperate with suitable contact springs in a socket or may have conductors in the form of flat springs attached thereto, as it will be explained more fully hereinafter.

From the foregoing description, the operation of the vibratory interrupter embodying the principles of the invention will be readily understood. A source of low voltage 58 (Fig. 12) has one of its terminals connected to the center tap of the primary winding 59a of a step-up transformer, its other terminal being connected to reed 30. Vibratory contacts 50a carried by side arms 48 cooperate with relatively fixed interrupter contacts 52a respectively connected to the ends of the primary winding 59a, while vibratory contacts 50b, likewise carried by side arms 48, cooperate with relatively fixed rectifier contacts 52b respectively connected to the ends of secondary winding 59b. The reed also carries on its auxiliary reed a driving contact 49 cooperating with a fixed contact 57 forming a normally closed circuit with current source 58 and coil 22.

In the normal condition of rest, contacts 49 and 57 complete the circuit of coil 22 which being energized will attract armatures 32 of reed 30, thereby interrupting the driver circuit and deenergizing the coil, and so forth. Thus, the reed will be maintained in continuous vibratory motion during which vibratory contacts 50a will alternately open and close interrupter contacts 52a and will alternately pass current through the two halves of the primary winding 59a of the transformer. An alternating current of higher voltage will be induced in secondary winding 59b of the transformer and will be rectified by means of vibratory contacts 50b and rectifier contacts 52b. The rectified output may be withdrawn at output terminals 59c respectively connected to the center tap of secondary winding 59b and reed 30. A buffer condenser 59d is connected across the secondary winding of the transformer in the conventional manner.

With respect to the side springs or supporting wires 53 holding the relatively fixed contacts 52a and 52b, it has been found that certain conditions have to be maintained in order to obtain best results. Thus, first of all, it is very desirable to employ percussion welding for securing the contact disc to the supporting wire as this permits selection of contacts of definite mass and for this reason is greatly superior to brazing and other conventional fastening methods which generally add an undetermined mass to that of the contact disc proper. It was also discovered that in order to maintain the relatively fixed contacts at all times parallel to the vibratory contacts on the side arms of the reed, it is necessary to establish certain relations between the compliance C_1 of the longer branch L_1 of the spring arm, the compliance C_2 of the shorter branch L_2 of said arm and the compliance C_3 of the side arm L_3 of the vibratory reed (Fig. 6). It is preferred to employ wire of circular cross section for the spring arms as a wire of this type may be readily adjusted in all directions.

Fig. 7 is a perspective view of a modified vibratory reed which is stamped out or punched from a single sheet of resilient material. The shape of this reed 60 is substantially the same as that of reed 30 shown in Fig. 3 and it is likewise provided with downwardly depending terminal portions 64 having holes 66 therein and connected with the body portion of the reed by means of weakened

portions 65. Holes 67 are provided for the purpose of attaching side arms bearing the power contacts (not shown). The upper end 62 of the reed has two holes 63 provided therein to which an armature may be secured by means of projection welding. In the body portion of the reed there is punched a U-shaped slot 61 which defines an auxiliary reed 68 bearing a driving contact disc 69 at its free end. This modified embodiment of the reed has the advantage of greater structural simplicity as it is integrally formed by means of a simple stamping operation.

In most cases it is preferred to place an outer cover or can 70 over the contemplated vibrator structure in order to protect it from dust, moisture and mechanical injury. It is also desirable to provide resilient mounting for the vibrator to prevent the transfer of vibrations to the base and to eliminate vibrator noise. A preferred structure for accomplishing this result is illustrated in Fig. 8 in which the vibrator is shown as being surrounded by a can or casing 70. This inner casing is surrounded by an outer casing or can 71 having slightly larger dimensions and held by a base plate 72 constituted of an insulating material. In this base plate are inserted or moulded metal prongs 73 extending through the thickness of the base plate and adapted to cooperate with a suitable socket in the conventional manner for quick insertion and replacement of the vibrator. Resilient flat metal springs 74 of suitably curved shape serve for providing both electrical and mechanical connection between the vibrator terminals 54 and the prongs 73, one such mounting spring being provided for each terminal and prong. For example, in the type of vibrator illustrated, four to six such supporting springs may be provided, the ends of each spring being soldered, welded or otherwise secured to a vibrator terminal and its corresponding prong. In general, four supporting springs would be used in a non-synchronous vibrator and six such springs in a synchronous or self-rectifying vibrator. In this manner, a simple and efficient resilient mounting is obtained which establishes the necessary electrical connections and at the same time also effectively suppresses vibrator noise.

The modified mounting illustrated in Fig. 9 is very similar to the one shown in Fig. 8. The vibrator is protected by a can or casing 70 surrounded by means of an outer casing 80 secured to a base plate 82. The can or casing may be made of sheet aluminum, steel, or zinc. Good results are also obtained by a can constituted of lead, or some other material having a high damping constant. In base plate 82 there are fixedly mounted prongs 83 protruding into the inner space of the casing. The resilient mechanical and electrical connection between the vibrator terminals 54 and the prongs 83 is established by means of corrugated resilient strips 84 made of spring metal (Fig. 10) one end of which is soldered or otherwise secured to a terminal 54 of the vibrator while its other end is formed with a narrow extension 85 adapted to be inserted into a corresponding recess 86 in prong 83 and soldered therein. The operation of this type of resilient mounting should be self-explanatory.

To prevent excessive vibration of the upper end of the vibrator within the outer casing, it has been found advantageous to insert a resilient spacer member 86 between the upper portions of the inner and outer casings. As it will appear from Fig. 11, this member is formed from light

spring metal with a substantially circular body portion 86 from which extend a plurality of radial arms 87. This spacer is bent into the shape appearing from Fig. 9 into the interspace between the inner and outer casings and through its resiliency will yieldingly hold the inner casing against excessive displacement.

Although the present invention has been described in connection with a few preferred embodiments thereof, variations and modifications may be resorted to by those skilled in the art without departing from the principles of the present invention. I consider all of these variations and modifications as within the true spirit and scope of the present invention, as disclosed in the foregoing description and defined by the appended claims.

What is claimed is:

1. A vibratory electric current interrupter device comprising in combination a U-shaped frame member constituted of ferromagnetic sheet material having a horizontal coil-holding portion and vertically depending side portions surrounding an insulative base at the lower extremities thereof, a pair of reed-clamping pieces having reed-holding cooperative flanges secured to the lower terminal portions of said frame, an elongated reed having an armature at one end thereof clamped at its other end between the flanges of said clamping pieces, electromagnetic means mounted within said frame to form a magnetic circuit therewith including the armature of said reed, and contact means operable by said reed to control the energizing of said electromagnetic means thereby to maintain the reed in vibratory motion.

2. A vibratory electric current interrupter device comprising in combination a U-shaped frame member integrally formed of ferromagnetic materials, a substantially horizontal center portion in said frame adapted to hold a coil, vertically depending side portions for said frame having internally extending intermediate regions forming a magnetic circuit of low reluctance with said coil, clamping pieces secured to the lower extremities of said frame and having vertical reed-holding flanges, an elongated reed having one of its ends secured between said flanges, an armature at the other end of said reed and within said magnetic circuit, and contact means operable by said reed to control the circuit of said coil and thereby to maintain the reed in continuous vibrations.

3. A vibratory electric motor comprising in combination a strip of ferromagnetic material bent into a substantially U-shaped form to constitute a frame, an electromagnet mounted in the center portion of said frame, inwardly extending indented pole-piece-forming portions in intermediate regions of said frame to form a magnetic circuit of low reluctance for said electromagnet, reed-holding means secured to the lower extremities of said frame, a reed having one of its ends clamped between said holding means and having an armature at its other end extending across said pole-piece forming portions of the frame and included within said magnetic circuit, and driving contact means under the control of said reed for opening and closing the circuit of said electromagnet and thereby to maintain said reed in continuous vibrations.

4. A vibratory electric motor comprising in combination a strip of ferromagnetic sheet material having a substantially circular center portion and a pair of legs with T-shaped ears at the

ends thereof, said strip being bent into an inverted substantially U-shaped form to constitute a frame, a core depending from the circular center portion of said frame, a coil around said core, a pair of indentations in said frame inwardly extending towards the free end of said core and forming a magnetic circuit of low reluctance therewith, a pair of clamping pieces having reed-holding cooperating flanges and spider-like extensions secured to the ears of said frame, an elongated reed having one of its ends secured between said flanges and having an armature at its other end extending into said magnetic circuit in proximity to said core, driving contact means under the control of said reed for opening and closing the circuit of said coil thereby to maintain said reed in vibratory motion, and an insulative back and terminal plate secured to said clamping pieces.

5. In a vibratory electric motor, the combination comprising a generally U-shaped ferromagnetic frame having ears at its extremities curved and connected to each other to define a closed, curvilinear area, a coil mounted within said frame and cooperating with corrugations in the intermediate region thereof to provide a magnetic circuit of low reluctance, an elongated reed having an armature at the free end thereof extending into the magnetic circuit between said corrugations, a pair of flanged clamping pieces welded to the other end of said reed and having radially projecting arms secured to the curved terminal ears of said frame, contact means operable by said reed for controlling the circuit of said coil thereby to maintain the reed in vibratory motion, and a back plate conforming to the area defined by the ears of the frame and having recesses for taking up corresponding portions of said reed and its clamping pieces.

6. In a vibratory electric motor comprising a generally U-shaped ferromagnetic frame, a coil with an iron core and a pole-piece mounted between the legs of said frame, clamping pieces welded between the ends of said legs and holding a principal vibratory member having its free end extending into cooperative position with said pole-piece, an insulative back plate secured to said clamping pieces, a pair of secondary vibratory members controlled by said principal vibratory member, electric contacts mounted on said vibratory members, and relatively fixed contacts resiliently mounted on said back plate and cooperating with said vibratory contacts to control a plurality of electrical circuits.

7. A vibratory electric motor of all-welded construction which comprises a generally U-shaped ferromagnetic frame, a driving coil with a pole-piece mounted within said frame, a pair of clamping pieces welded between the ends of the legs of said frame holding a vibratory member welded thereto and having its free end extending into cooperative position with said pole-piece, a pair of spring arms respectively secured to the opposite faces of said vibratory member and extending away therefrom, an auxiliary spring arm secured in a slot in said vibratory member, vibratory contacts mounted on all of said spring arms, a back plate secured to said clamping pieces, and relatively fixed contacts percussion-welded to resilient supporting wires projecting from said back plate adapted to cooperate with said vibratory contacts to open and to close a plurality of electrical circuits including that of the driving coil whereby said vibra-

tory member will be maintained in continuous vibration.

8. A vibratory electric motor comprising in combination a principal reed having an armature at one end thereof and having an elongated slot punched therein extending throughout the major portion of said reed, an auxiliary reed having dimensions smaller than said slot and capable of displacement therethrough, a contact mounted at the end of said auxiliary reed, a ferromagnetic frame, clamping pieces between which the other end of both reeds is clamped secured to said frame, a driving coil mounted in said frame and forming a magnetic circuit therein including the armature of said reed, and a relatively fixed contact cooperating with the contact on said auxiliary reed to control the circuit of said driving coil thereby maintaining the reeds in vibratory motion.

9. A vibratory electric motor comprising in combination an elongated reed having an armature at one end thereof, a pair of clamping pieces having vertically depending flange portions between which the other end of said reed is clamped and horizontally extending portions adapted for attachment to a base, electromagnetic means adapted when energized to deflect said armature, and contact means operable by said reed to control the energizing of said electromagnetic means thereby to maintain the reed in vibratory motion.

10. A vibratory electric current interrupter device comprising in combination a U-shaped frame member of magnetic material, a driver coil mounted within said frame with its axis parallel to the side arms thereof, a vibrating reed mounted between said arms with its free end adjacent said coil, an armature on said free end, said side arms having internally projecting portions closely spaced from the ends of said armature to form therewith a path of low reluctance.

11. A vibratory electric motor comprising in combination an elongated reed having spaced depending ears, a pair of clamping pieces on opposite sides of said reed having ears secured to said first ears to form a metallic bottom plate carrying said reed, an insulating base having slots therein for securing the ears on said bottom plate which is thereby mounted on said base, electromagnetic means adapted when energized to deflect said reed, and input means including an arm mounted on each side of the reed to control the energizing of said electromagnetic means, one of said arms including a contact thereby to maintain the reed in vibratory motion.

12. A vibratory electric motor comprising in

combination a reed formed of thin sheet metal having a base portion at one end and an armature at the other end, said reed being tapered in width from said base to said armature for uniform flexing, ears extending downwardly from each end of said base portion, clamping pieces on each side of said reed having ears secured to said first ears to form a rigid support for said reed, said first ears being of a length to extend above said last ears to form a hinge below said base for the initial flexing of said reed, electromagnetic means adapted when energized to deflect said reed, and contact means to control the energization of said electromagnetic means thereby to maintain the reed in vibratory motion.

13. A vibratory electric motor comprising in combination an elongated reed having an armature at one end thereof and a U-shaped slot punched therein defining a tongue bearing a contact at its free end, a U-shaped ferromagnetic frame including a bight portion and separated extremities remote from said portion, said frame having inwardly indented pole shoe extensions at an intermediate region thereof opposite said armature, clamping means between which the other end of said reed is clamped secured to said frame at said separated extremities thereof, a driving coil mounted in said frame between said pole shoe extensions and the bight portion of said frame and forming a magnetic circuit of low reluctance therein including the armature of said reed, and a relatively fixed contact cooperating with the contact on the tongue provided in said reed and controlling the circuit of said driving coil thereby maintaining the reed in vibratory motion.

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