

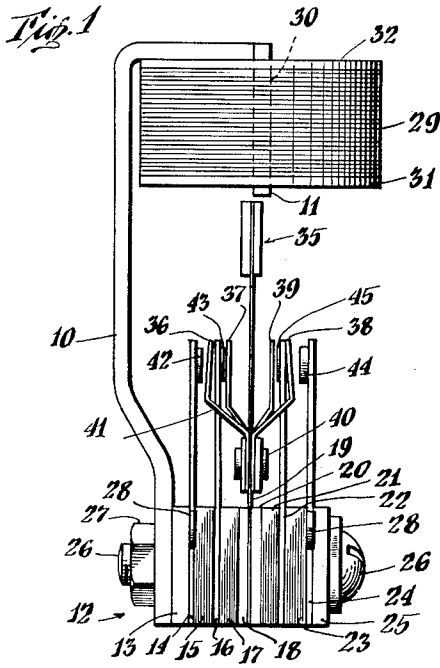
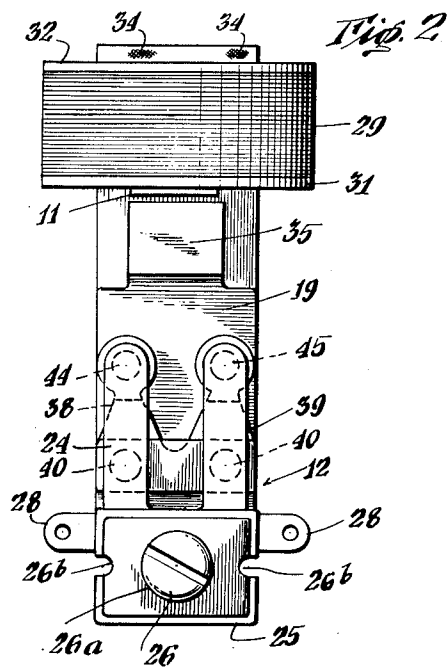
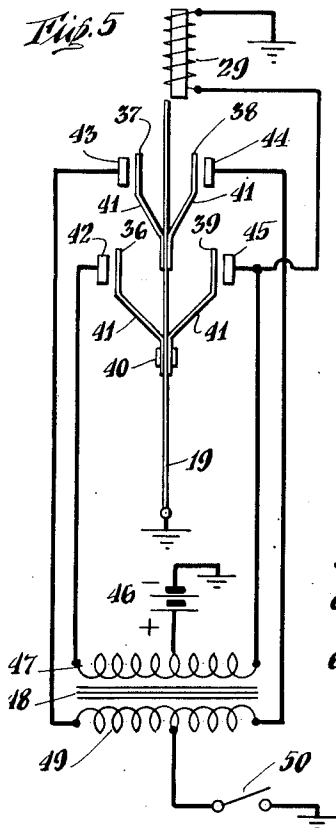
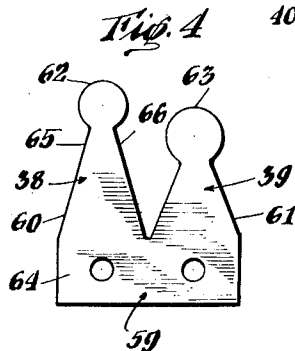
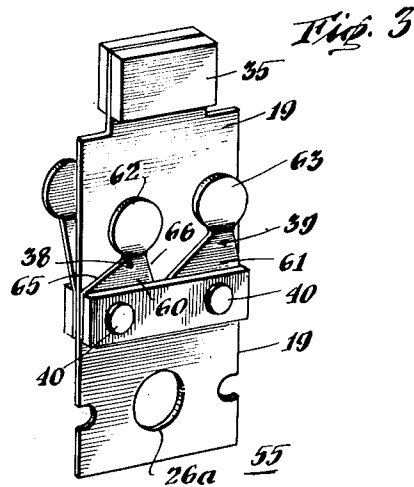
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VIBRATOR WITH KEYHOLE CONTOUR REED ARM

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VIBRATOR WITH KEYHOLE CONTOUR
REED ARM

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9 Claims. (Cl. 200—90)

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This invention relates to vibrators and, more particularly, to electromagnetic vibratory interrupter devices and to the cooperating electric contacts and reed arms thereof operating at relatively high operating frequencies.

An object of the invention is to improve vibrators.

Another object of the invention is to provide vibrators having low energy loss due to the necessary retarding of the vibratory contacts during each cycle of the operation.

A further object of the invention is to improve the mountings for cooperating electric contacts.

An additional object is to minimize the effects of contact wear on the contacts of vibrators.

Another object of the invention is to distribute the interchange of contact material from one contact to another over a considerable area without producing an appreciable change in contact spacing.

It is a further object of the invention to provide a vibrator wherein the mass of the reed contacts is reduced to a minimum consistent with desired contacting surfaces whereby substantially ideal conditions for efficient operation at high frequencies are readily found and sustained.

Still another object of the present invention is in effect to eliminate the well known discrete and comparatively heavy contact disc from the vibratory portion of an electro-mechanical vibrating system.

A further object of the invention is to provide a contact arm assembly for a vibrator in which the problem of contact adjustment is minimized.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

In the drawing:

Figure 1 is a side elevational view of a vibrator embodying features of the present invention;

Figure 2 is a front elevational view of the vibrator shown in Figure 1;

Figure 3 is a perspective view of the reed and contact arm assembly;

Figure 4 is a face view of a preferred contact supporting blank to accommodate two contacts, and;

Figure 5 is a circuit diagram of one type of circuit in which the structure of my invention may be used.

This invention may also be considered an improvement of vibrators of the type described in the patent application, Serial No. 579,232, filed

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February 22, 1945, in the name of R. J. Aust and Clarence Huetten, which issued as Patent Number 2,490,895 on December 13, 1949, and assigned to the same assignee of the present application.

In order to assist in producing a maximum efficiency for any particular vibratory device, the mass of moving parts must be kept within a reasonable limit. Also, the contact spacing between the vibratory contacts and the relatively stationary ones cannot vary any appreciable amount without adversely affecting both the operation of the vibrator and its period of usefulness. Some vibrators such as the high frequency type operating in the region of 250 cycles per second require exceptionally low mass moving contacts and very accurate alignment of contacting surfaces. In every vibrator the approximate loss of energy every time a moving contact strikes can be expressed as equal to $\frac{1}{2}MV^2$ where M is the effective mass of the contact and V is the velocity with which it strikes. Hence, any reduction in M improves the operating efficiency of the concerned vibrator. Even though the mass of each of the vibrating contacts is reduced, this alone would not produce a more efficient vibrator. During the operating life of a vibrator the contacts positively polarized erode at a certain rate as a function of current density, temperature, contact pressure, etc. Such erosion establishes a primary cause of changing contact spacing and its attendant disadvantages. In the case of high frequency vibrators it has been found that the weight factor of the moving contacts can be most expeditiously handled by making each moving contact and its support arm or reed integral, the free or outer end of the reed arm acting directly as the moving contact. Of course, it is preferable that the moving contact be coated at least on the current carrying side with a low resistance and corrosion resisting metal which may be electro-deposited thereon as described in the named patent application No. 579,232. It has also been shown that although the contact spacing in vibrators of the latter type can be properly maintained by so polarizing the contacts that material is transferred to the vibratory contacts, yet certain variations in the accumulation of material on the surface of the vibratory contact were found. Therefore, imperfect contact and alignment of contacting surfaces resulted. However, if the mating surfaces of the contacts are large enough the change of contact spacing will be satisfactory during the life of a vibrator. In other words, the previous accumulation of material on the contacting surface now has the opportunity of distributing itself over a greater area, and therefore, the previous variations in the thickness of material deposited on the vibrating contact surface is made more uniform. In any particular vibrator a certain minimum contact force must be de-

veloped with a given contact arm or reed arm deflection to obtain satisfactory vibrator life. The latter consideration determines the stiffness of the contact arm. Since the contact or reed arm must be capable of being deflected a predetermined amount as many as 1,000,000,000 times in some cases, the factor of stress and fatigue therefrom must be carefully considered. From the above it can be realized that many factors enter into the construction of a vibrator even from the viewpoints of vibrating contacts and of the contact or reed arm assembly. A reed arm or contact support in which the vibrating contact pivots or swings about a region adjacent the contact itself so as to facilitate perfect alignment of the vibrating contact with the relatively stationary one throughout the life of the vibrator has been developed heretofore; but proper considerations of contact mass and of the distribution of stresses in the reed arms were not made. The pivot point for the present contact shifts downwardly or throughout the contact arm to the point at which the reed arm is fixed at an intermediate region of the vibrating reed in order to more fully carry out the concept of a low mass vibratory contact but having a relatively large contact surface.

Heretofore, the vibrating contact surface, while pivotal about a region adjacent itself to provide so-called sliding contact with the relatively fixed contact, yet the factors of weight and maximum contacting surfaces in addition to the problem of reed arm stresses were not sufficiently considered.

The present invention defines, in one of its aspects, a reed arm construction in which circular vibrating contact is supported by a cantilever support. In this type of construction the bending stress is distributed throughout the length of the cantilever support while at the same time the mass of the reed arm and contact is lowered by making the arm and contact integral, the integral connection between the two having a minimum cross section sufficient only to prevent shearing.

The invention, in another aspect, concerns itself with the problem of adjusting a vibrator of the high frequency type. It can be recognized that in the process of reducing the losses of a vibrator caused by the braking action in each cycle of operation of the vibrating mass such as the contact itself, short distances of travel of the vibrator contacts are encountered. Therefore, the adjustment of this type of vibrator is very critical and in order to facilitate the mass production of such vibrators and at the same time to produce the proper alignment between the contacting surfaces, the vibrating contacts themselves are placed in what might be considered a staggered relationship as shall be more clearly disclosed hereinafter.

It has also been discovered that due to the particular construction of the reed arms and contacts the former tendency of contact material to collect on the moving contacts is substantially eliminated by a phenomena not fully understood, but it is believed to be associated with the favorable stresses set up in both the reed arms and contacts during the movement thereof. The formerly collected contact material appears to disappear as a fine dust. The loss of the material, since it is distributed over a relatively large area, has a negligible effect on contact spacing throughout the life of the vibrator.

Referring now more particularly to Figures 1 and 2 of the drawing, reference numeral 10 denotes a frame member of ferromagnetic material.

One end of this frame is bent at right angles to the body thereof so as to accommodate a pole piece 11 welded at points 34 or otherwise fixed to the free end of the bent portion. A stack generally denoted by the reference number 12 is secured to the other end of the frame member 10.

Progressing from the frame member 10, the stack comprises an insulative spacer 13, interrupter side arm 14, insulative spacer 15, rectifier side arm 16, spacers 17 and 18, reed or hinge plate 19, spacers 20 and 21, rectifier side arm 22, insulative spacer 23, interrupter side arm 24 and pressure plate 25. As it will be observed in Figure 2, each of the clamped elements is provided with a single mounting hole 26a in the stack portion thereof, such holes or apertures being arranged in registering position and having a single bolt 26 extending therethrough which cooperates with a nut 27 to maintain the structure in its clamped position. The bolt may be surrounded by an insulative sleeve (not shown) in the conventional manner in order to prevent shorting of the metallic elements by the bolt. This one-hole mounting of the stack assembly is made possible by the special construction of the side springs, shown in Figure 2, each of which comprises a stack portion and an upwardly extending spring portion carrying the contacts at their ends, the spring portions of the interrupter and rectifier side springs extending in staggered relation. Preferably, the stack portions of the side springs are provided with integrally formed lateral extensions constituting soldering lugs 28 to facilitate the attachment of electrical conductors thereto. In addition, cut-out portions 26b are provided in the stack portion of the side arms and also in all stack-clamped elements. These cut-out portions may be engaged by means of a suitable tool or jig thereby to positively assure exact registry of all elements of the stack before permanently clamping them together by means of the single stack screw 26 and nut 27.

A driver coil 29 with a central opening 30 is secured to the pole piece 11 in a conventional manner with apertured end insulative flanges 31 and 32 made of fibre, or the like. These flanges jointly define a winding space in which there are arranged the windings of wire constituting the driver coil.

A vibratory system 55, which is an important phase of the present invention, comprises a reed or hinge plate 19 clamped in stack 12 at one end thereof and having an armature 35 composed of two elements bonded to the free end of the reed in a well known manner, and four reed or contact supporting arms 36, 37 and 38 and 39 secured to an intermediate point of the reed 19 by means of rivets 40.

It will be noted that in contrast to conventional practice, the reed arms do not carry any discreet contact discs but each merely comprise either spring steel of novel form as shown in Figures 3 and 4 or some other metal of equivalent characteristics with analogous contour, which may be provided with a thin layer 41 of contact metal. The reed arms cooperate with substantially fixed contact discs 42, 43, 44 and 45 mounted at the ends of side springs 14, 16, 22 and 24 respectively. Good results have been obtained by using silver-plated spring steel reed arms operating against interrupter side spring contact discs constituted of a suitable silver alloy and by using spring steel reed arms plated with any one of the noble metals, such as platinum, or its alloys, operating against rectifier side spring contact discs constituted of

tungsten. In both cases the unit may be operated with negative potential on the reed whereby the metal transfer will tend to go to the reed arms on the interrupter side to be dissipated therefrom.

The vibratory system 55 including cantilever mounted reed arms 36, 37, 38 and 39 provide a movable mass of relatively light weight as contrasted with prior vibrating systems as will be more clearly delineated hereinafter. In Figure 4 a pair of composite reed arms 38 and 39 are shown as having intermediate contact supporting portions 60 and 61 respectively, of cantilever construction. An oblong base section 59 of the pair of composite reed arms 38 and 39 is mounted on the reed 19 by rivets 40 as shown in Figures 2 and 3. A similar pair of reed arms 36 and 37 are mounted on the opposite side of the reed 19. Each of the reed arms carries a contact of relatively large surface such as the contact 62 for the reed arm 38 or such as the contact 63 for the reed arm 39, the respective contacts being joined to the weakest end or free end of the cantilever supports 60 and 61 respectively. Since the contacts and the supports therefor are made of thin metal sheets and form a planar surface involving the particular cantilever construction, the energy loss from the vibrating mass, as far as the reed arms themselves are concerned, is considerably minimized. It will be understood that the above phase of the present invention does not depend upon the concept of a pair of reed arms supported in the specific manner discussed as it can be realized by one versed in the art that the particular type of support for a vibrating contact may be applied as well to a simple non-synchronous electromagnetic vibrator from which no rectification is desired. Referring to Figure 4, the material in an intermediate phase of construction of a pair of vibrating reed arms including integral contacts therefor may be considered as a blank or intermediate product from which the final vibrating reed arm is fabricated. As shown in both Figures 1 and 3, the reed arms, such as 38 and 39, are bent so as to form a staggered relationship between contacts 62 and 63 for the purpose of making adjustment of all the vibrating contacts easy. It will be noted that the contacts such as 62 and 63 in their final disposition within the interrupter shown in Figure 1 are in horizontal alignment, and, of necessity in order to provide an offset or staggering of the supporting means, the cantilever means 38 and 39 must be of unequal length as shown in Figure 4. The concept of this invention is also not limited to the aspect of having the movable contacts in the same horizontal plane and staggered, however, but rather the disposition of the respective vibrating contacts and the respective stationary ones mating therewith may be at different elevations as one versed in the art can appreciate.

Taking one vibrating contact and its support therefor, it can be seen that a contact such as 62 having a flat smaller contacting portion than the support itself but of considerable area is joined to a generally triangular-shaped resilient flat body portion 60 with its base merged into a reed-clamped portion 64. The support for each vibrating contact may be characterized also as composed of a flat resilient body having flared edges 65, 66 extending from contact means such as 62 to form at least one cantilever beam integral therewith from which the contact surface of the contact 62 may swing. Looking at the mechanics of the vibration for each vibrating contact, it will be seen that a contact such as

62 swings a minimum in an arc about a region adjacent the junction of the cantilever support 60 with the contact itself, this arc being a continuation of the curvature of the support 60 when stressed by the driver of the vibrator; and, the stresses applied to such a contact when it makes contact with the fixed ones are transferred downwardly from the cantilever 60 in a well known manner. This type of support for a vibrating contact makes it possible to have substantially perfect alignment between the fixed and vibrating contacts. Further, since the contacts are thin, circular, and flat bodies, and are supported by the tapered flat reed arms having distributed compliance therein, the mass of each reed arm and its associated contact is reduced to a point heretofore unattained.

The operation of the vibrator of the invention will be best understood by reference to Figure 5 illustrating a preferred form of circuit organization in which the vibrator may be used. Similar reference characters have been used in Figures 1 and 2 and Figure 3 to denote corresponding parts. It will be noted that reed 19 is grounded and that the negative terminal of direct current source 46 is likewise grounded in order to impart negative polarity to the reed arms, if desired. Stationary interrupter contact discs 42 and 45 respectively connected to the two ends of primary winding 47 of step-up transformer 48 and the center tap of the primary winding is connected to the positive terminal of the source. One end of driver coil 29 is connected to stationary interrupter contact 45 while its other end is connected to ground. Rectifier contact discs 43 and 44 are respectively connected to the two ends of secondary winding 49, and the rectified voltage is withdrawn between terminals 50, one of which is connected to the center tap of the secondary winding and the other is grounded. Since the circuit is similar to that of a conventional shunt type synchronous vibrator, its operation will be readily understood by those skilled in the art without any further description. It will be sufficient to state that since contact material transferred to the movable contacts dissipates therefrom in the form of a fine dust, and since the area from which this dust comes is relatively large, the loss of such material can have only a minor effect on contact clearance. On the other hand, erosion on the rectifier contacts, if any, will occur in both directions, and will not interfere with the proper operation of the vibrator.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. A vibratory interrupter comprising a ferromagnetic frame, a pole piece connected thereto, a stack mounted at one end of said frame, a driver coil having an axial space therein mounted on said pole piece adjacent the other end of said frame, a vibratory system clamped in said stack and including an armature cooperating with the free end of said pole piece and a plurality of staggered cantilever-supported substantially thin contacts, the latter comprising a base portion, a circular contact, and an integral connection therebetween, said connection being constricted to have a minimum cross section sufficient only to prevent shearing, stationary circular contact means clamped in said stack and adopted to co-

act with said contacts on said vibratory system, and circuit means for energizing said respective contacts.

2. A vibrator of the high-frequency type comprising a vibratory reed, means for vibrating said reed, a sheet metal contact support arm including an intermediate portion of cantilever form secured to said reed at an intermediate point thereof, an end portion of the outer planar side surface of said support arm constituting a thin circular vibratory contact of relatively large surface, said contact being of the same thickness as said intermediate portion and being integrally joined therewith by means of a constriction, a second sheet metal contact support arm, means for securing said second arm in spaced substantially parallel relation to said reed-supported arm, said second arm carrying a relatively heavy contact on its free end in mating relation to said vibratory contact, said vibratory contact being polarized negatively through a portion of said vibrating means.

3. A vibratory device comprising a vibratory reed, means for vibrating said reed, a compliant sheet-metal reed arm including a contacting portion of substantial circular area and minimum mass joined to a triangular-shaped portion at an apex thereof to form a constriction having a minimum cross section sufficient only to prevent shearing, a base for the triangular portion of said reed arm being secured to said reed at an intermediate region thereof, a relatively rigid sheet metal contact support arm, means securing said rigid arm in spaced substantially parallel relation to said reed-supported arm, said rigid arm carrying a contact on its free end facing said first contacting portion whereby distributed stressing of said reed arm during the operation of said vibrator is produced.

4. A reed arm for a vibrator comprising a relatively thin and elongated plate-shaped and reed-clamped body, a relatively thin and light plane-surfaced circular contacting body having a definite thickness, and a thin and relatively large plane-surfaced body of said same thickness having tapered sides joined to said reed-clamped body and integrally merged into said contacting body at a constricted portion thereof to form a one piece reed arm having an integral plane contacting surface pivotal about a portion of said tapered body connecting said contacting body.

5. A reed arm for a vibrator having substantially fixed contacts, comprising contact means having at least one contact surface of substantial circular area, and a constriction formed by a flat resilient body having flared edges extending from said contact means to form at least one cantilever beam integral therewith from which each of said contact surfaces may swing with a distributed stress being placed thereon, said beam being constructed and arranged for anchoring at a lower end thereof and for parallel disposition with respect to said fixed contacts.

6. A reed arm for a vibrator comprising a light, flat and circular contact portion having a relatively inflexible characteristic, and a flexible body portion having two opposed sloping edges extending from said contact to form a generally keyhole contour having a constriction formed by said contact in said sloping edges, said flexible body portion being constructed and arranged for reed-mounting in a lower region thereof.

7. A one-piece reed arm for intermediate reed-mounting in a vibrator comprising a relatively rigid flat portion having a contacting surface of relatively large area, a relatively flexible flat portion having edges protruding from said rigid portion at angles therefrom to have the configuration of a keyhole such as to form a vibratable arm having a cantilever characteristic, a junction being formed between said rigid flat portion and said flexible flat portion, and a flat base portion integral with said flexible cantilever portion opposite said contacting surface, said rigid portion being bent transversely to said contacting surface at said junction, said base portion being bent at said cantilever in a direction opposite to said transverse bend of the rigid portion.

8. A contact arm assembly for a vibrator having a stack-clamped reed and being of the type wherein a pair of contact arms are effectively clamped at one end in substantially parallel relation and carry respectively opposed plane contacts at their free ends, said contacts being brought into direct face-to-face contact by vibration of one of said arms, said assembly comprising a sheet metal arm with a substantially wide base portion for attachment to an intermediate portion of said reed, said arm including a flexible main body portion tapered and struck up from said wide base to form a planar surface, and a planar contact body forming a constriction with said body portion and joined to the outer end of said tapered body portion and aligned therewith whereby said pair of arms and contacts are normally held substantially parallel to each other in the absence of external forces but permitting limited rotation of said contact surface about a pivot point which shifts throughout the length of said tapered body portion as the result of a distributed compliance therein when said contact engages the opposed contact and said opposed contact is not already in alignment therewith.

9. A reed-mounted composite double contact supporting structure for a vibrator formed from a relatively thin sheet of material having a high fatigue characteristic, comprising two spaced circular plate-like contacts, two spaced cantilever supports therefor and integrally joined therewith at constrictions formed therein, one of said supports being offset from the other to provide a staggering of said spaced contacts for easy adjustment with said vibrator, and a base portion integral with said supports for mounting said supports and said contacts on said reed.

CLARENCE HUETTEN.

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