

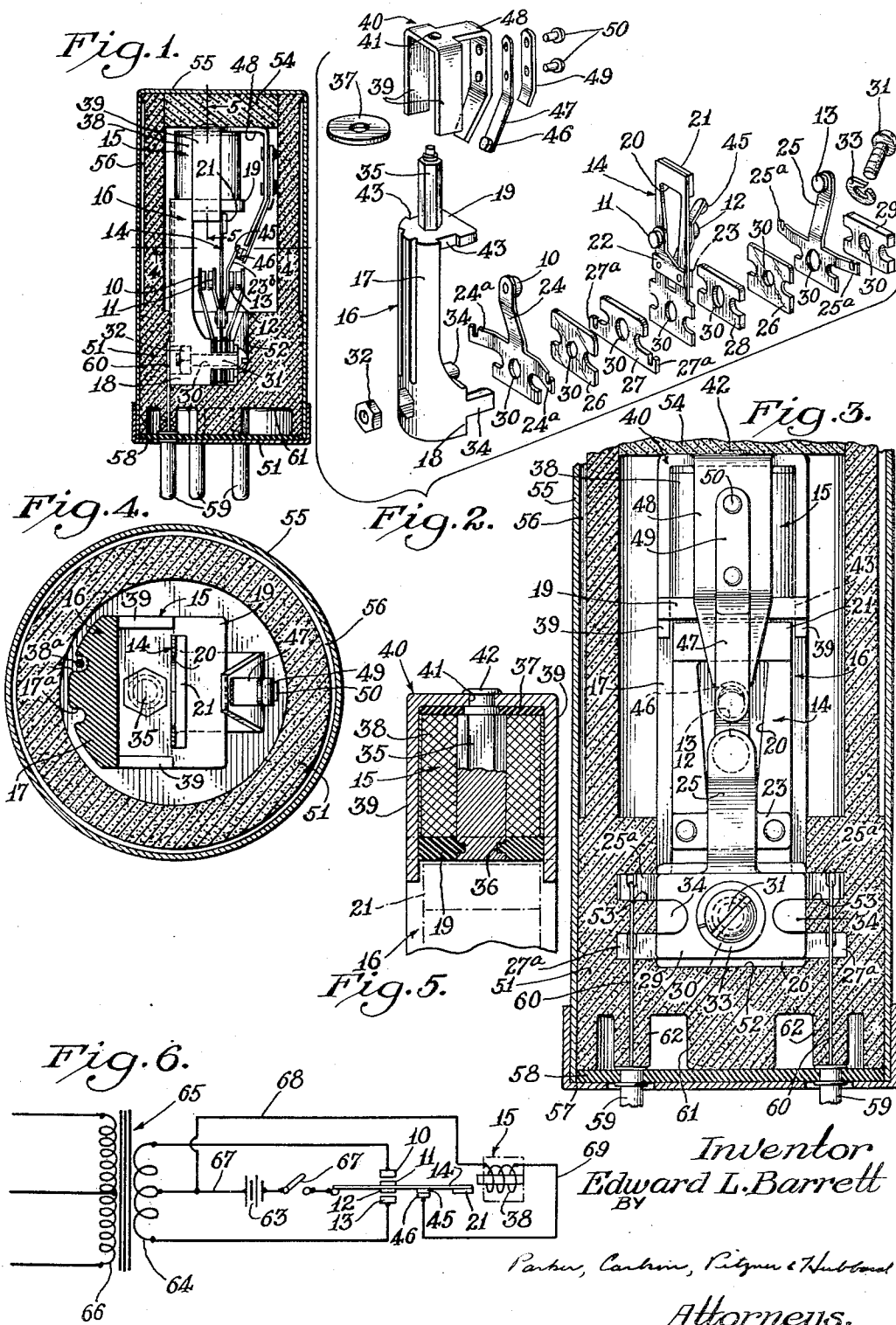
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VIBRATOR

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VIBRATOR

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The invention relates to improvements in vibrators or vibratory motors of the general type disclosed in Edward L. Barrett Patent No. 1,924,082 issued August 22, 1933. Such vibrators are utilized in so-called B-battery eliminators for radio receiving sets. These eliminators serve in general to convert low voltage direct current, such as that derived from a conventional 6 volt automobile storage battery, into high potential direct current of, for example, 200 volts, suitable for use in supplying the plate circuits of the vacuum tubes in a radio receiver. The primary function of the vibrator is to break up direct current from the low voltage source into a series of short rapid impulses which are caused to flow through the primary winding of a step-up transformer. These impulses of current in the primary winding induce a high alternating potential in the transformer secondary winding. This high alternating potential is then rectified by some suitable means comprising either a rectifier tube, as illustrated in said Barrett patent, or rectifier contacts in the vibrator itself. Vibrators which serve only to interrupt the primary current are commonly known in the art as "non-synchronous" vibrators while those that additionally serve to rectify the secondary potential as well are commonly known as "synchronous" vibrators. The present invention, like that of said Barrett patent, is applicable to either synchronous or non-synchronous vibrators.

The vibrator of said Barrett patent is particularly adapted to meet the exigencies of use in automobile installations, in that it is not affected materially in operation either by the effects of gravity, due to different positionings of it, or by wide changes in value of the low potential source of electrical current to which it is connected. Among other elements the vibrator of said Barrett patent embodies in particular, normally open interrupter contacts that are periodically opened and closed at a very rapid rate by a substantially freely vibrating reed, the latter being kept in vibration by an actuating electromagnet located entirely out of the path of the reed. Some of the improvements herein contemplated are particularly suited to meet the requirements of a vibrator in which the electromagnet is so placed outside of the reed path, although others of such improvements are also applicable to vibrators of the so-called "hammer" type in which a movable armature swings directly toward rather than past the cooperating electromagnet pole piece.

One general object of the present invention is to provide a vibrator so constructed as to reduce

the cost of production materially as compared to the prior forms. In fact, a saving of nearly 30% to 40% in cost is made by utilizing the construction herein disclosed as compared to the most economical construction heretofore available. A number of factors in the novel vibrator construction herein disclosed contribute to the achievement of this result. Among these factors are: (a) the use of a frame so fashioned as to constitute a jig for assembling at least a portion of the other vibrator parts as well as to constitute a support therefor upon the completion of the unit; (b) the use of a frame made of insulating material and so arranged that a minimum number of other pieces are required to complete the assembly or assemblies secured to it including the contact structures and cooperating reed; (c) the use of a magnet coil which is adapted to be wound in place on the assembly rather than being fashioned as a preformed coil; (d) the provision of a vibrator structure such that it can be readily slipped into a test fixture, with an action much like that of plugging in a lamp, for initial testing before the usual connecting wires are soldered to it and the device enclosed in its sound insulating casing; and (e) the use of a bare wire lead or leads protected by a dielectric frame for the device rather than lead wires wrapped with insulation.

Another general object of the invention is to provide a vibrator having improved operating characteristics and particularly, a more efficient magnetic circuit for the electromagnet and cooperating reed carried armature, as well as a diminution in mechanical noise during operation.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawing in which:

Figure 1 is a side elevation of a vibrator unit embodying the invention, with the sound insulating casing therefor shown in vertical section.

Fig. 2 is an exploded perspective view of the vibrator of Fig. 1.

Fig. 3 is an enlarged front elevation of the device of Fig. 1 with the enclosed casing shown in vertical section and the upper end portion thereof broken away.

Fig. 4 is an enlarged transverse sectional view along the line 4—4 in Fig. 1.

Fig. 5 is an enlarged fragmentary vertical sectional view along the line 5—5 in Fig. 1.

Fig. 6 is a wiring diagram of the connections of the vibrator and its associated elements.

For purposes of illustration the invention has

been shown herein as embodied in a vibrator particularly adapted for use in an automobile radio receiving set. It will be understood, however, that this vibrator is also adapted for use in other types of installations. Furthermore, the particular vibrator shown is of the non-synchronous type, although it will be apparent that additional contacts may be added to complete a synchronous vibrator construction if desired. In general, the vibrator illustrated includes two pairs of main circuit controlling make and break contacts 10—11 and 12—13 operated by a substantially freely vibratory reed 14, which is driven by an actuating electromagnet 15.

The various parts of the vibrator are assembled on a frame preferably made of molded dielectric material and designated herein generally by the numeral 16. Various suitable moldable insulating compounds are available on the market from which the frame may be made. For example, it may be molded from a phenolic condensation product commonly known as Bakelite and having asbestos mixed with it. This material forms a strong rigid structure which is not subject to warpage when heated. The preferred frame 16 shown herein (Fig. 2) is of a C-shape and embodies an elongated side member 17, having an integral and laterally facing pedestal 18 fashioned on its lower end. The second or upper arm 19 of the C-shaped frame has flat inner and outer faces and constitutes a spool end for the energizing winding of the electromagnet 15.

The reed 14 is of the cantilever type and is adapted to flex substantially throughout its length, being preferably made from a flat strip of spring steel or bronze. Except for its butt end portion, the reed 14 is of the same general form as that included in the vibrator which is disclosed in Edward L. Barrett et al. Patent No. 2,072,578 issued March 2, 1937. In particular, an elongated opening 20 is formed in the center of the reed in order to give it certain preferred flexing characteristics and also to insure unimpeded flexure of the reed despite the multiplicity of associated contacts. The opening 20 increases in width adjacent the outer end of the reed, thereby providing substantially uniform flexure to the outer end, with a consequently greater "time efficiency" for the vibrator. A rectangular armature 21 made of steel or other magnetizable material is spot welded or otherwise rigidly secured to the free end of the reed. This armature is disposed in driven relation with respect to the pole pieces of the electromagnet 15 as is hereinafter described in greater detail.

In its idle position the reed 14 occupies a substantially straight line position (Fig. 1) and in which both of the pairs of the main make and break contacts 10—11 and 12—13 are open. Upon vibration of the reed the pairs of contacts will be alternately closed and opened. For this purpose the contacts 11 and 12 are carried by contact supporting fingers 22 and 23 (Fig. 2) of an inverted T-shape with the heads of the T riveted to the side portions of the reed 14. The upwardly extending legs of the fingers 22—23 are bent laterally out of the plane of the reed. The cooperating fixed or stationary contacts 10 and 13 are, in turn, carried by contact fingers 24 and 25, preferably fashioned as stampings from resilient sheet metal, the contact supports 24 and 25 being substantially identical in form. All of the contact points 10 to 13 may be made of tungsten or other suitable contact material.

The reed 14 and opposed side contact fingers

24 and 25 are held in assembled relation on the pedestal 18 of the frame 16 in a so-called "stack." In this stack electrical insulators or laminations 26 are interposed between the reed and the contact supporting fingers on its opposite sides. Additionally the stack includes metal spacers or laminations 27 and 28, as well as a metal end plate or spacer 29. Laterally extending lugs 27* are fashioned on the side of the spacer 27 in order to complete an electric circuit to the reed and through it to the contacts 11 and 12. Registering holes 30 are formed in all of the stack parts as well as in the pedestal 18 of the frame so that the stack may be held in position by a screw 31 inserted through them and threaded in a nut 32. The holes 30 in the intermediate metal parts in the stack, i. e., the reed 14, fingers 24—25 and spacers 27—28, are made larger in diameter than the holes in the other parts so that these intermediate metal parts will not contact the screw 31. To prevent displacement of the screw 31, a lock washer 33 is utilized and the outer end of the hole 30 in the frame pedestal 18 is made hexagonal in form to receive the complementally shaped nut 32.

Simplicity in assembly of the stack parts described above is achieved by providing projections 34 on the face of the frame pedestal 18, which projections register with complemental notches fashioned in the side edges of the various stack parts (Fig. 2). These projections 34 must present electrical insulating surfaces to the stack parts since some of these, such as the contact supports 24 and 25 as well as the reed 14, must be maintained insulated from each other. Consequently, the projections 34 are preferably made integral with the frame 16 if the latter is molded from dielectric material, as is herein shown. The projections could be in the form of insulating pins secured to a metal frame but the use of integral insulating projections on a frame which is also fashioned from insulating material is in itself desirable for several additional reasons. For one thing, the projections 34 serve to determine at least approximately the longitudinal location of the reed 14 on the frame and since this is a very critical relation it is desirable that integrally formed projections be used so that there will be no possibility of error due to inaccuracy in their location. As to the function of the projections 34 in determining the longitudinal location of the reed 14, the position of the reed in this respect must be very precisely determined because of the extremely small clearance which is provided between the end of the armature 21 and the cooperating electromagnetic pole piece or pole pieces. In a vibrator construction such as that illustrated, in which the armature swings past rather than toward the active face of the electromagnetic pole piece, it is desirable that the clearance between these parts be of the order of about 0.003 of an inch. Such a small clearance necessitates very precise positioning of the reed, especially in view of the fact that if the armature rubs even slightly against the pole piece the device is rendered entirely inoperative and, on the other hand, if the clearance is materially increased the efficiency of the electromagnetic circuit is materially impaired.

One suitable method of assembling the parts described is to dimension the notches in the butt of the reed 14 so that they have about 0.004 inch clearance with respect to the projections 34 in so far as endwise movement of the reed is concerned but with practically no clearance for transverse

shifting of the reed. When the parts are so dimensioned, the stack can be assembled by placing the lamination parts on the frame in proper order and then the screw 31 partially tightened to hold the parts loosely in place. Thereafter, a thin sheet metal gauge may be inserted between the outer end face of the armature 21 and the opposed electromagnetic pole piece face and the reed pushed longitudinally toward the electromagnetic pole piece until the gauge is firmly pressed between the opposed faces. While the reed is in such position the screw 31 is tightened so as to hold the reed firmly against subsequent displacement. This general mode of assembly is described and claimed in Barrett Patent No. 2,121,851 issued June 28, 1938.

Proper location of the electromagnet 15 on the supporting frame 16 is cheaply and effectively insured by embedding a central pole piece or core 35 of the electromagnet (Fig. 2) in the frame structure during the initial molding of the latter. The pole piece 35 is made of steel or other magnetizable material and is preferably in the form of a pin of hexagonal cross section. Dislodgment of the pole piece 35 from the frame arm 19 is prevented by notching the lower end of the pole piece, as indicated at 36 (Fig. 5) so that the plastic material which makes up the frame flows into the notch during the initial molding operation. The inner end face of the pole piece 35 is flush with the face of the frame arm 19 and is located very close to, although entirely outside of the path of movement of the free end of the reed 14 which carries the armature 21.

An outer spool end for the electromagnetic winding, cooperating with the opposed inner spool and formed by the frame arm 19, is shown herein (Figs. 2 and 5) as a washer 37 of insulating material which is fitted on the shouldered outer end of the pole piece 35. Between these spool ends a coil of wire 38 is wound or spooled and finally covered with a layer of insulating paper so as to form an actuating winding for energizing the pole piece 35.

From the foregoing, it will be apparent that the winding 38 can be readily formed in place on the core 35 by, for example, placing the frame 16 and attached pole piece 35 in a winding machine and winding the wire on the pole piece or pin 35. This obviates the necessity of fashioning a preformed coil with its necessary inner spool and attaching sleeve (such, for example, as the spool 31 and sleeve 25, shown in Fig. 5 of said Barrett et al. Patent No. 2,072,578) and also dispenses with the labor and time required for adjusting and assembling such parts. Besides the advantage of winding the coil in place on the vibrator rather than preforming it, other advantages accrue from the use of an electromagnetic structure located largely outside of the confines of the supporting frame. For one thing, the length of the member 17 of the frame is shortened with consequent increase in rigidity as compared, for example, to the length of the side arms 11 of the frame 10, shown in Fig. 5 of said Barrett et al. Patent No. 2,072,578. Rigidity of the frame is, of course, a prime requisite in vibrator structures where the reed itself ordinarily vibrates at a rate of at least 100 cycles per second and if the associated structure is such that sympathetic or secondary vibrations can be set up in it, the operation of the device is likely to be impaired. Location of the electromagnet 15 outside the confines of the frame also makes it possible to shift

the electromagnet to the left (as viewed in Fig. 1) away from the center line of the reed 14 without increasing the over-all width of the vibrator but with an improvement in the electromagnetic circuit arrangement, as will hereinafter appear. This location of the pole piece 35 close to the juncture of the frame parts 17 and 19 also insures a minimum displacement of the pole piece in the event that the frame arm 19 should warp.

The magnetic circuit for the electromagnet 15 is completed by pole pieces located at the ends of the armature 21 and shown herein as formed by the arms 39 (Figs. 2 and 5) on a metal stamping 40. These arms 39 constitute a part of a generally U-shaped portion of the stamping 40, which embraces the winding 38. This stamping 40 is held in position on the outer end of the core pole piece 35 which is inserted through the hole 41 and spun or peened over as indicated at 42 (Fig. 5). The stamping 40 is made of magnetizable material such as cold rolled steel. To further hold the stamping 40 in position the arms 39 are inserted in registering notches 43 (Fig. 2) in the side edges of the frame arm 19. Preferably, the arms 39 are tensioned inwardly toward each other slightly so that when the stamping 40 is slipped into place the arms 39 will be spread apart slightly by the frame part 19, and that way accurately spaced apart a precise distance. The width of the molded frame part 19 between the bottoms of the notches 43 is fixed by a "die dimension" in the mold rather than a "mold dimension" so that it is always precise. Upon reference to Figs. 4 and 5, it will be seen that the pole piece 35 is located centrally between the side pole pieces 39 and that the ends of the latter project outwardly beyond the face of the pole piece 35. Furthermore, the upper edges of the pole pieces 39 project slightly above the flat upper edge of the face of the pole piece 35 (see particularly Fig. 4). Also, in its idle position the armature 21 is disposed with its inner face substantially in alignment with the edges of the pole pieces 39 and with its ends closely spaced with respect to them. Such an arrangement of parts insures a strong magnetic pull on the armature both at starting and during operation. In fact, with the construction illustrated it has been found that the same number of ampere-turns in the energizing winding 38 produces, in a reed with the same flexing characteristics, a substantially larger amplitude of swing for the reed and armature than in any vibrators heretofore available.

In an analysis of the magnetic circuit, it will be seen that in the absence of the armature 21 the normal magnetic flux path would be directly between the inner end of the pole piece or core 35 and the adjacent outer end portions of the pole pieces 39. In its idle position the armature 21 is located eccentrically with respect to this line of flux flow so that whenever the electromagnet is energized there is a tendency to pull the armature 21 to the left (as viewed in Figs. 1 and 4) to a position in which it bridges directly between the central pole piece 35 and the side pole pieces 39. Furthermore, when the armature 21 is in its normal or idle position, as illustrated, the reluctance of the magnetic path established by it between the pole pieces is quite low since all of the air gaps are small and, consequently, a large amount of magnetic flux links the armature. The net result is that a strong impulse is imparted to it. In particular, the gaps between the ends of the armature 21 and the side pole pieces 39 are small, while the only other air gap

in the iron circuit, namely, that between the armature and core 35 is also very small. Furthermore, the core 35, due to its hexagonal shape, presents a relatively long edge to the armature and through which the magnetic flux may be distributed as distinguished from the greater concentration of flux resulting if, say, a round core were used. Such concentration is, of course, undesirable since it chokes the flow of the magnetic flux. It is noteworthy that the eccentric disposition of the magnetic field with respect to the armature is achieved without the necessity of cutting away or notching the end of the central pole piece 35 as has been commonly done in many prior vibrators. This is possible since, in the present vibrator, the entire magnetic structure can, due to the mounting of such structure exteriorly of the confines of the frame, be shifted off center with respect to the reed and armature without increasing the over-all width of the device.

In a vibrator the actuating electromagnet is periodically energized by electric current supplied under the control of the vibrating reed so that the latter will be maintained in vibration at a predetermined frequency, which depends largely upon the inherent flexing characteristics or natural frequency of the reed. Several circuit arrangements are available for controlling the energization of the electromagnet in this general manner, one of these being illustrated in Barrett Patent No. 1,924,082, referred to above, and in which the electromagnet circuit is controlled through the medium of the main interrupting contacts in the vibrator. Another arrangement is described in Edward L. Barrett Patent No. 2,120,273, issued June 14, 1938, and in which a separate set of magnet controlling contacts are utilized for periodically interrupting the flow of current to the electromagnet. The latter form of electromagnet control has been embodied in the present vibrator, although it will be apparent to those skilled in the art that, if desired, the vibrator herein shown may be built without any separate magnet controlling contacts and the main interrupting contacts used for that purpose in the manner disclosed in said Barrett Patent No. 1,924,082.

In the preferred construction herein illustrated, the electromagnet energizing winding 38 is connected in series with a pair of magnet controlling contacts 45 and 46 (Fig. 1) which are respectively carried by the reed and stationarily mounted at the side of it, these contacts being normally closed in the idle position of the reed 14. Upon reference to Figs. 1 and 2, it will be seen that the contact point 45 is fixed to the outer end of an extension 23^a on the contact supporting finger 23, while the contact point 46 is carried by an elongated resilient spring finger 47. The finger 47 is bent toward the reed 14 and is carried by a complementally shaped, integral finger or projection 48 on the stamping 40, being held in position thereon by clamp plate 49 and rivets 50. When using such a separate set of contacts for controlling the electromagnet winding the arcing at these contacts is preferably minimized by using a winding made up of conductively sheathed wire as described and claimed in said Barrett Patent No. 2,120,273. For example, the wire of the winding 38 may be covered with a coating of insulating enamel or the like and then a conductive sheath formed on the outside of this insulating coating by dipping the wire in a silver nitrate solution such as is used for plat-

ing mirrors. This conductive sheath is connected to one terminal of the winding (Fig. 6).

An insulating support for a lead wire 38^a from the magnet coil 38 is formed by one of the grooves 17^a in the outer side of the frame 16 (Fig. 4). The other terminal of the winding 38 is soldered to the metal stamping 40. By utilizing the dielectric frame 16 to receive the lead wire 38^a, a bare wire can be used, thereby saving the cost of insulating tubing for the same. Additionally, the grooves 17^a in the frame 16 serve to define strengthening ribs in it.

That a substantially smaller number of parts are required in the vibrator described above than in devices of comparable high quality heretofore available will be readily apparent from a comparison of Fig. 2 herein with, for example, Fig. 5 of Barrett et al. Patent No. 2,072,578 referred to above. In the vibrator of the latter patent eleven parts are included in the stack, exclusive of the reed and frame, while in the present vibrator only seven such parts are required. Even this comparison is unfair to the present vibrator since the device in Fig. 5 of said Barrett et al. patent does not include any separate magnet controlling contacts. A fairer comparison would be that of the vibrator shown in Fig. 3 of said Barrett Patent No. 2,120,273 and in which it will be seen that the stack includes fifteen parts exclusive of the reed and frame.

There is a manifest saving in cost of production due to lower cost of materials with the smaller number of parts required in the present vibrator. A further saving results when such a smaller number of parts are used due to the fact that the time and labor required in assembly of the device and inspection of the assembly are less.

An important saving in the cost of assembly is also accomplished by virtue of the utilization of a frame structure which, in itself, constitutes an assembly jig for the stack parts in the manner heretofore described. When using such self-aligning, interfitted parts in the vibrator it is unnecessary to provide an assembly jig or tool, such as was heretofore required, an exemplary form being shown in Barrett Patent No. 2,121,851 referred to above.

In assembling the vibrator described herein the magnet winding 38 is spooled on the magnet core 35, which is embedded in the frame 16 during the initial molding of the latter. After the coil winding is completed the stamping 40 is fixed in position, the contact point finger 47 and clamping plate 49 having been previously affixed to the stamping 40 by the rivets 50. The laminations or parts included in the stack (shown in Fig. 2) are dropped in proper order on the face of the frame pedestal 16 and are automatically aligned in position by the lugs 34. This may be done either before or after affixing the stamping 40. The screw 31 is then inserted in the registering holes 30 and partially tightened, after which the reed 14 is gauged to its proper position as was heretofore described and the screw 31 then finally tightened down.

It will be appreciated that the lugs 34 aid not only in the assembly operation, but also prevent twisting of the stack parts about the axis of the screw 31. By reason of this action it is unnecessary to provide two or more screws for the stack as in many previous constructions and, furthermore, the screw 31 may be made larger in diameter than was heretofore advisable so that there is less likelihood of its being bent and

thereby distorting the position of parts in the stack.

A preliminary testing of the vibrator is desirable before it is finally put in its enclosing case since, when it is in the latter it is connected by soldered lead wires to its usual plug type mounting base. Consequently, if the vibrator does not operate properly after it has been fixed in position within the enclosing case it is necessary to unsolder the connections, thereby wasting much time and effort in the disassembly of the enclosing structure to determine the source of trouble. In the present vibrator structure provision has been made for a preliminary operating test of the device which does not require that any lead wires or the like be soldered or otherwise fixedly connected to the vibrator parts. In particular, lugs 24^a and 25^a have been fashioned on the sides of the contact fingers 24 and 25, respectively, and the lugs 27^a extend laterally from the sides of the spacer 27, which contacts the butt end portion of the reed 14 (Fig. 2). The lugs 24^a and 25^a are bent laterally away from each other and are disposed above the lugs 27^a so that there is a substantial separation between all of them. Consequently, the lower or butt end of the vibrator may be readily inserted into a test receptacle (not shown) having spring contacts therein arranged to engage the respective lugs so as to complete testing circuits to the vibrator. Consequently, the manipulations necessary for setting up the vibrator for test are as simple as merely plugging in a lamp or the like. During the preliminary test the operation of the vibrator can be observed and if any adjustments are necessary they can be readily made since all of the parts are still fully accessible.

After being preliminarily tested the vibrator may be conveniently placed within the sound insulating enclosing case herein shown. This enclosing structure embodies a cup-shaped sock 51 made of sponge rubber or the like, (Figs. 1 and 3) which is open at its upper end to receive the vibrator and has a complementary recess 52 in its base shaped to receive the lower end of the vibrator assembly. The side walls of the recess 52 are notched as indicated at 53 (Fig. 3) to receive the side lugs 24^a, 25^a and 27^a on the stack. In this way the side lugs perform an additional function of holding the vibrator assembly against endwise displacement within the sock 51, especially when the device is turned upside down or tilted in some such manner.

The base of the sock 51 fits snugly about the stack on the lower end of the vibrator assembly so that sidewise tilting is effectively prevented. It should also be particularly noted that the sock resiliently grips the vibrator assembly in a region close to its nodal point so that a minimum amount of vibration is transmitted from the vibrator to the sock. The upper end of the sock is closed by a disk 54 (Fig. 1) of sponge rubber or the like which is pressed in position after the vibrator is inserted into the interior of the sock. A cup-shaped metal can or casing 55, closed at its upper end, is telescoped over the sock or liner 51 and fits snugly about it. The side walls of the sock are cut away as indicated at 56 (Figs. 1, 3 and 4) so that peripheral contact is established between the sock 51 and the inner walls of the can only at the base portion of the sock and at its extreme upper end. In this way the principal contact between the sock and enclosing casing is established in the region of the nodal point of the vibrator structure so that again a minimum amount of

mechanical vibration is transmitted to the exterior can structure.

The lower end of the can 55 is closed by a cap 57 which holds in place a disk of insulating material 58 on which are mounted the usual hollow connecting prongs 59. Lead wires 60 from the terminal lugs 24^a and 27^a in the stack are soldered to these lugs and to the lower ends of the prongs 59. These wires are led through suitable apertures in the base of the sock 51 and are insulated by it. An annular recess 61 (Fig. 3) is formed in the base of the sock 51, and nipples 62 projecting into this recess enclose the lower ends of the wires 60. With the construction described an effective enclosing structure for the vibrator is provided which is very simple in construction and embodies only a single and unitary tubular sock as distinguished from the two-part constructions which have been heretofore ordinarily utilized. The cost of such a molded rubber sock as that shown is about the same as that for one of the two parts previously used so the cost is approximately halved.

In the operation of the vibrator it is connected in a circuit substantially like that of Fig. 6. Current is supplied from a low voltage direct current source, such as a storage battery 63, and the vibrator serves to interrupt the current so that it flows in impulses through the primary winding 64 of a suitable step-up transformer 65, thereby inducing a high alternating potential in the transformer secondary winding 66. Upon closure of a starting switch 67 current is supplied to the electromagnet energizing windings 38 (through a circuit 67-68-38-69-46-45-14-67) thereby causing the armature 21 to be attracted and swung upward (as viewed in Fig. 6) to close contacts 10-11. Closure of these latter contacts completes a circuit from the battery 63 through the upper half of the transformer winding 64. Such movement of the reed and armature also opens the magnet contacts 45-46, however, so that the magnet is deenergized and the reed permitted to spring back in the opposite direction. This return movement of the reed reopens the contacts 10-11 and closes the other set of main contacts 12-13. Closure of these latter contacts completes a circuit from the battery 63 through the other half of the transformer primary winding 64. Also, on the return movement of the reed the magnet contacts 45-46 are reclosed so that the magnet is reenergized and the cycle of contact closing and opening is repeated and continued with great rapidity.

The periodicity of reed vibration is in a large measure dependent upon the natural frequency of vibration of the reed itself, and in most vibrators at the present time the reed is arranged to vibrate at a speed of approximately 100 to 125 cycles per second. The improved electromagnet and armature arrangement heretofore described aids materially in imparting strong impulses to the armature for vibrating the reed, as was heretofore noted. Moreover, the device operates with a very small amount of mechanical noise because of the type of frame structure employed. In particular, a frame made of molded dielectric material is less resonant than a frame made of steel or such materials which have been previously employed so that it absorbs or dissipates much of the mechanical vibratory forces in the device which would otherwise be transmitted from it in the form of sound waves in the surrounding air. The magnet controlling contacts 45-46 which have heretofore been the source of a large amount

of clicking noise are particularly well isolated since any vibrations set up by them in the structure must be transmitted through the entire body of the frame and, consequently, little or none of these vibrations ever reaches the base portion of the enclosing sock 51 through which they would have to pass to reach the outer casing. In general, it will be seen that a very much improved form of vibrator has been provided which embodies a number of features that contribute very materially not only to a reduction in cost but also to improvement in operating characteristics.

Although a preferred embodiment of the invention has been illustrated and described in some detail there is no intention thereby to limit the invention to such preferred embodiment but on the other hand, the appended claims are intended to cover all modifications and alternative constructions within the spirit and scope of the invention.

I claim as my invention:

1. A vibrator embodying a stack of lamination parts including a reed, a pair of contact fingers on opposite sides thereof and electrical insulating laminations interposed between adjacent end portions thereof, said vibrator being characterized by the inclusion of a supporting frame for said stack made of dielectric material and having an integral projection thereon contacting both said reed and said contact fingers in said stack for locating the same in predetermined relation with respect to each other.

2. A vibrator embodying a cantilever type vibratory reed with an armature on the free end thereof, and a cooperating actuating magnet located close to but entirely out of the path of said reed and armature, said electromagnet presenting to the extreme end face of said armature a pole piece located beyond the same and with a predetermined clearance therebetween longitudinally of the reed, said vibrator being characterized by the inclusion of a supporting frame made of dielectric material and to one end portion of which said electromagnet is fixed and on the opposite end portion of which is provided an integral projection engageable with said reed for locating the latter longitudinally with respect to said frame and with said predetermined clearance between said armature and pole piece.

3. A vibrator comprising, in combination, a frame made of molded dielectric material and including an elongated side member with an integral laterally facing pedestal on one end thereof having a projection on the face thereof, a flat cantilever type vibratory reed disposed with one side of the butt end portion thereof overlying the face of said pedestal and with the free end thereof extending toward the opposite end of said side member, means including an actuating electromagnet for vibrating said reed, said electromagnet embodying a magnetizable pole piece embedded in fixed position in the molded dielectric material adjacent said opposite end of said frame side member and disposed with an active face thereof presented to the outer end portion of said reed, and said reed having an aperture therein registering with said projection on said pedestal for locating said reed on said frame with respect to said pole piece.

4. A vibrator comprising, in combination, a frame made of molded dielectric material and including an elongated side member with an integral laterally facing pedestal on one end thereof, said pedestal having a pair of projections on the face thereof spaced apart with respect to each

other transversely of the pedestal face, a flat cantilever type vibratory reed disposed with one side of the butt end portion thereof overlying said face of said pedestal and with the free end thereof extending toward the opposite end of said side member, an armature carried on the free end of said reed, an actuating electromagnet cooperating with said armature to vibrate said reed, said electromagnet embodying a magnetizable pole piece in the form of a pin embedded in fixed position in the molded dielectric material adjacent said opposite end of said frame side member and disposed in generally longitudinal alignment with said reed and with the inner end thereof presented to the outer end of said armature in closely spaced relation thereto, and said reed having notches fashioned in the side edges of the butt end portion thereof dimensioned to receive said projections on said pedestal face for locating said reed and the armature thereon with respect to said pole piece.

5. A vibrator embodying a plurality of structurally separate parts secured together as a unit and including a supporting frame, a vibratory reed and a resilient sheet metal contact finger, said vibrator being characterized by the provision of interfitting portions on said parts and including a dielectric projection on said frame part engageable with all of said other parts for locating the same in predetermined position with respect to each other in the assembly.

6. A vibrator embodying a plurality of structurally separate parts secured together as a unit and including a supporting frame with an electromagnet fixed thereon, and a vibratory reed with an armature fixed thereon for cooperation with said electromagnet, said vibrator being characterized by the provision of an aperture in said reed and an interfitting dielectric projection on said frame for locating said reed in predetermined position on said frame and with respect to said electromagnet during assembly of the unit.

7. A vibrator embodying an elongated frame and a substantially freely vibratory cantilever reed fixed to one end of said frame and extending toward the other end thereof, as well as a plurality of make and break contacts arranged to be actuated by the vibratory movement of said reed, characterized by the provision of an elongated pole piece fixed to said other end of said frame and projecting outward therefrom with the major portion thereof free of any confinement by the frame and in general longitudinal alignment with the reed and accurately spaced with a small clearance from the free end of the reed, and an energizing coil encircling the projecting portion of said pole piece, whereby the coil may be wound on the pole piece after the latter has been accurately and permanently fixed in position on said frame.

8. A vibrator comprising, in combination, a frame made of molded dielectric material with at least a portion thereof arranged in substantially a C-shape, a generally upright vibratory cantilever reed having one end thereof fixed to one leg of the C with the free end thereof disposed closely adjacent the inner face of the other leg of the C, a magnetizable pole piece in the form of a pin embedded in the molded dielectric material of said other leg with the inner end thereof located closely adjacent the free end of said reed and with the outer end thereof projecting freely and without obstructions beyond the end of the frame arm and in general longitudinal alignment with said reed, and an energizing winding wound

on the projecting portion of said pole piece.

9. A vibrator comprising, in combination, a frame made of molded dielectric material with at least a portion thereof arranged in substantially a C-shape, a generally upright vibratory cantilever reed having one end thereof fixed to one leg of the C and with the free end thereof disposed closely adjacent the inner face of the other leg of the C, a magnetizable pole piece in the form of a pin embedded in the molded dielectric material of said other leg with the inner end thereof located closely adjacent the free end of said reed and with the outer end thereof projecting freely beyond the end of the frame arm and in general longitudinal alinement with the reed, a flat piece of material secured to the outer end of said pin to form a spool end thereon opposed in spaced relation to the outer face of said other frame arm, and an energizing winding spooled on said pin.

10. A vibrator comprising, in combination, a frame made of molded dielectric material and including an elongated side member with an integral laterally facing pedestal on one end thereof, a cantilever type vibratory reed having the butt end portion thereof fixed to said pedestal and extending toward the opposite end of said side member, an armature carried by the free end of said reed, a magnetizable electromagnet pole piece in the form of a pin embedded in the molded dielectric material at said other end of said frame and disposed in generally longitudinal alinement with said reed, the inner end of said pin being disposed in closely spaced relation with said armature and the outer end portion of said pin being free of obstruction by said frame, an energizing winding on the outer portion of said pole piece pin, a generally U-shaped portion of magnetizable metal fashioned as a stamping from sheet metal and having the bottom of the U fixed to the outer end of said pole piece pin and with the side arms thereof embracing the sides of said winding and projecting in operative relation with said armature.

11. A vibrator comprising, in combination, an elongated supporting frame made of non-magnetic cast material and provided with an integral transverse member at one end thereof, a cantilever type vibratory reed fixed to the opposite end of said frame and extending toward said one end thereof, an armature extending transversely across the free end of said reed, and an actuating electromagnet for said armature, said electromagnet including a pole piece structure embodying a U-shaped stamping of resilient magnetizable metal facing toward the free end of said reed with the arms of the U located opposite the ends of said armature in closely spaced relation thereto, said U-shaped piece of resilient metal being disposed to embrace said transverse member on said frame with the arms of the U resiliently pressed against the same to space them accurately from the ends of the armature.

12. A vibrator comprising, in combination, a frame made of molded material and including an elongated side member with an integral laterally facing pedestal on one end thereof, a flat cantilever type vibratory reed disposed with one side of the butt end portion thereof overlying the face of said pedestal and fixed thereto, the free end of said reed extending toward the opposite end of said side member, a contact finger extending along one side of said reed and also fixed to said pedestal, an armature carried on the free end of said reed, means including an actuating electro-

magnet cooperating with said armature to vibrate said reed, said electromagnet embodying a magnetizable pole piece in the form of a pin embedded in fixed position in the molded frame material adjacent said opposite end of said frame member and disposed in generally longitudinal alinement with said reed and projecting away from the free end thereof, said electromagnet also including a generally U-shaped stamping of magnetizable metal fixed to the outer end of said pin and with the arms thereof projecting along the sides of said pin in spaced relation thereto and into operative relation with said armature to form additional electromagnet pole pieces, said stamping also including an integral ear projecting toward said reed, a second contact finger carried by said ear and projecting toward said reed, and cooperating contacts carried by said reed and respective contact fingers.

13. A vibrator comprising, in combination, an elongated supporting frame made from molded dielectric material, a cantilever type vibratory reed fixed to one end portion of said frame and extending along the same, an armature carried by said reed, an actuating electromagnet for said armature carried by said frame at a point spaced from said one end portion and including an energizing winding, and a lead wire for said winding, said frame being fashioned with integral and longitudinally extending reinforcing ribs on the outer surface thereof adapted to receive said lead wire therebetween.

14. A vibrator comprising, in combination, a vibratory cantilever type reed having a generally rectangular armature fixed to the free end thereof, contact means arranged to be actuated by said reed in the vibratory movement thereof, and an actuating electromagnet for said armature disposed close to but entirely out of the path of movement of the latter, said electromagnet embodying a U-shaped pole piece structure with a central core projecting through the middle of the U longitudinally thereof and arranged generally longitudinally of said reed, said central core being displaced from the idle position of said armature in the direction of initial movement thereof resulting from the energization of said electromagnet, the side arms of said U-shaped pole piece structure being arranged to project past the opposite ends of said armature in closely spaced relation thereto but displaced from the idle position thereof in the direction of said initial movement, and said electromagnet also including an energizing winding encircling said core.

15. A vibrator comprising, in combination, a vibratory cantilever type reed having a generally rectangular armature fixed to the free end thereof, contact means arranged to be actuated by said reed in the vibratory movement thereof, and an actuating electromagnet for said armature disposed close to but entirely out of the path of movement of the latter, said electromagnet embodying a U-shaped pole piece structure with a central core projecting through the middle of the U longitudinally thereof and arranged generally longitudinally of said reed, said central core being displaced from the idle position of said armature in the direction of initial movement thereof resulting from the energization of said electromagnet, the cross-section of said core being hexagonal in form with a face of the hexagon toward said armature, the side arms of said U-shaped pole piece structure being arranged to project past the opposite ends of said armature in closely

spaced relation thereto but displaced from the idle position thereof in the direction of said initial movement, said displacement being less than that of said core, and said electromagnet also including an energizing winding encircling said core.

10 16. A vibrator embodying a stack of generally laminated parts secured together as a unit, and including a vibratory reed with contact fingers located adjacent opposite sides thereof and insulating laminations interposed therebetween,

said vibrator being characterized by the provision of electric terminals projecting laterally from the sides of said stack in spaced relation to each other transversely of the stack and electrically connected to individual elements of the stack structure so that the vibrator assembly may be readily inserted in a test receptacle or the like to connect test circuits to said terminals.

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