Dec. 11, 1951 R. W. AUGUSTINE ET AL 2,578,032

VARIABLE PERCUSSION HERMETICALLY SEALED ELECTROMAGNETIC CALL-SIGNAL DEVICE

Filed May 20, 1949

2 SHEETS—SHEET 1

FIG. 1

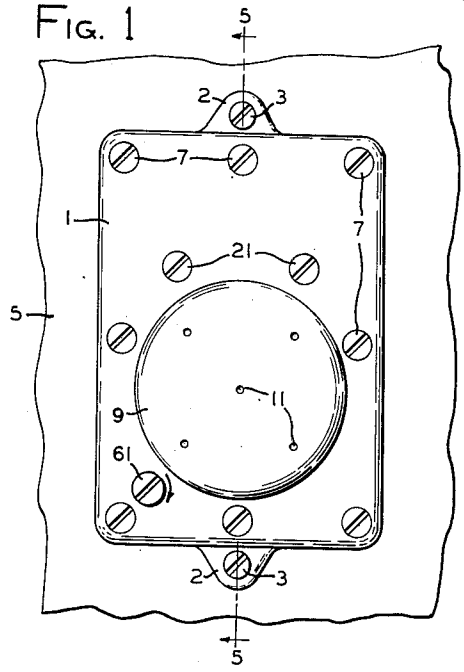


FIG. 2

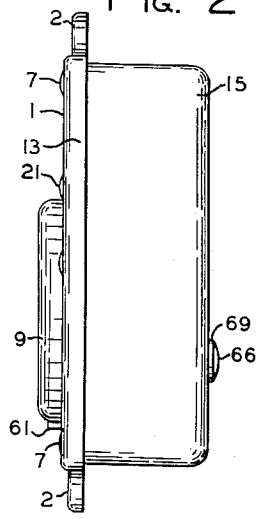


FIG. 3

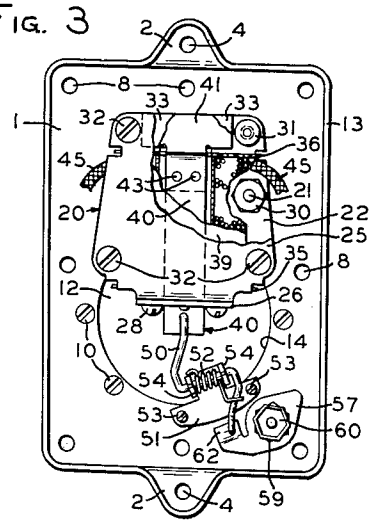
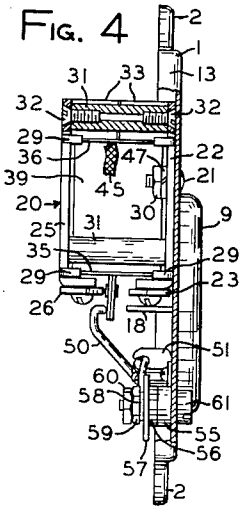


FIG. 4



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FIG. 5

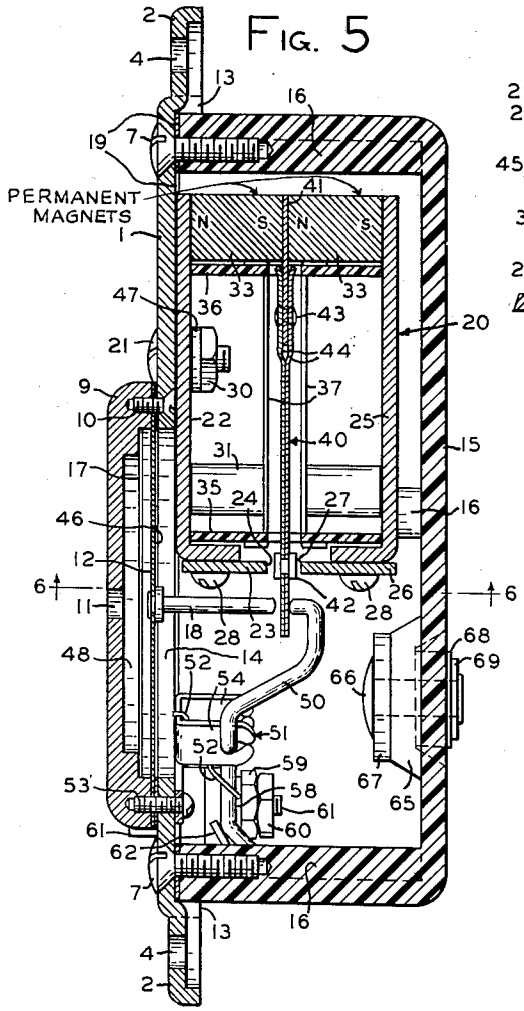


FIG. 6

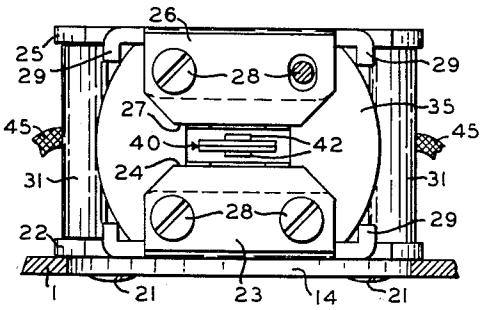


FIG. 7

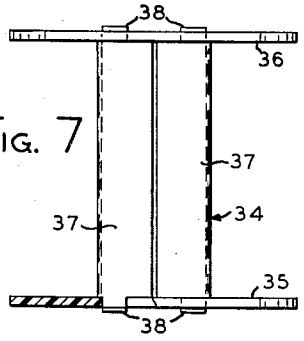


FIG. 8

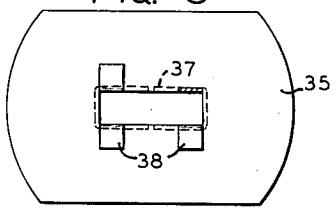


FIG. 9

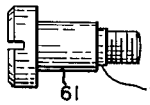


FIG. 9A

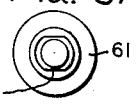


FIG. 10

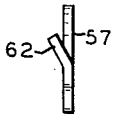


FIG. 10A



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VARIABLE PERCUSSION HERMETICALLY SEALED ELECTROMAGNETIC CALL-SIGNAL DEVICE

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Application May 20, 1949, Serial No. 94,378

10 Claims. (Cl. 177—7)

1

This invention relates to a polarized variable-percussion hermetically sealed electromagnetic call-signal device for use with a telephone set in place of the polarized ringer ordinarily employed thereat. Its principal object is to provide a lightweight and relatively compact device of the foregoing type (a) which operates satisfactorily over the normal frequency range of currents used for operating telephone ringers, (b) which provides an abundant and generally uniform acoustic output over a substantial range of values of operating current, and (c) which includes readily adjustable means for varying the acoustic output between wide limits while maintaining the desired performance range with respect to the magnitude and frequency of operating current.

Another object is to provide a sturdy device of the foregoing type suitable for mounting within a hermetically sealed housing to enable it to withstand the adverse conditions to which portable military telephone sets are subjected.

In the disclosed preferred embodiment, the operating structure is mounted on one side of a mounting plate sealed by a housing applied thereto. The device comprises essentially a sound emitting diaphragm mounted across an opening in the mounting plate and polarized electromagnetic structure including an armature percussively related to the diaphragm.

The electromagnetic structure includes a balanced push-pull armature suspended for vibratory movement along a line between pole members of opposite polarity. A feature of the invention resides in an arrangement for suspending the armature on a reed member clamped between serially related permanent magnets employed to magnetize said pole members.

The armature is surrounded by an electromagnetic winding, or coil, which serves to drive it toward one pole member responsive to a given half cycle of received alternating current, and to drive it toward the other pole member responsive to the next succeeding half cycle.

On its movement toward one pole member, the armature strikes a stop pin affixed to the diaphragm, and on its movement toward the other pole member it engages a backstop member. A special feature of the invention is that the backstop member is adjustable toward and away from the end of the stop pin, or frontstop member, which serves in the disclosed construction to lower and raise the acoustic output level of the diaphragm by lowering and raising the percussive impact thereon. A cam device operable through a packingly sealed opening in the mounting plate serves to adjust the position of

2

the backstop member. The armature is biased magnetically by the permanent magnets and the pole members to stand normally in firm engagement with the stop member to which it was last moved.

A further feature is that responsive to current of operating value the armature is movable from one stop position to the other in an exceedingly small interval of time because of its lack of loading with substantial amounts of magnetically inert material, such as the clapper-rod and clapper of the usual telephone ringer. This feature, in combination with the permanent-magnet action in biasing the armature to stand firmly in either its frontstop or its backstop position to define a critical value of operating current, renders its speed of operation (and consequently its percussive impact) substantially independent of the magnitude of the operating current over a large range of current values. The biasing effect holds the armature until the current reaches its critical value. Since the armature thereupon moves so quickly to its alternative position, the operating current does not ordinarily have time to rise, or to fall, substantially in value while the armature is moving. Therefore, except for excessively high values of operating current (which necessitate exceedingly high rates of increase of current value), the full stroke of the armature always occurs responsive to about the same momentary value of operating current, irrespective of its peak value.

The noted fast-moving characteristic of the armature also enables the desired response thereof to occur with about the same force at a low frequency, ten or twelve cycles for example, as it does at a comparatively high frequency, such as seventy cycles.

An additional feature resides in the configuration and composition of the reed through which the armature is suspended. The active part is of a width comparable to that of the armature, which is narrower than the permanent magnets. The part clamped between the permanent magnets is widened to a T-shaped configuration whose head portion is about coexistensive with the end face of either magnet. By making the reed of magnetic material, such as spring steel, a magnetic gap between the magnets is avoided.

A further feature relates to the construction of the armature to facilitate attachment of the reed thereto. The armature (which is of oblong profile and cross-section) is composed of two similar flat portions riveted together front and rear, with the active portion of the reed clamped between them at the rear end. The armature parts

are held together at the front by a double-headed non-magnetic rivet so located that the head portions serve to prevent direct contact between the armature and either pole member, thus insuring a so-called "residual" non-magnetic gap in any condition of adjustment and operation of the device.

Other objects and features will become apparent as the description progresses.

The accompanying drawings, comprising Figs. 1 to 10, together with auxiliary views 9A and 10A, show a preferred embodiment of a device constructed according to the principles of the invention.

Fig. 1 is a front view of the device mounted on the housing of a telephone set.

Fig. 2 is a right-side view of the device.

Fig. 3 is a rear view of the device with the cover removed and with portions broken away.

Fig. 4 is a left-side view with portions cut away.

Fig. 5 is an enlarged right sectional view taken along line 5—5 of Fig. 1, with the electromagnet coil removed.

Fig. 6 is a pole-end sectional view generally along line 6—6 of Fig. 5, with the cover and other parts removed.

Figs. 7 and 8 are plan and end views of the coil bobbin, drawn on an enlarged scale.

Figs. 9 and 10, and their respective auxiliary views 9A and 10A, show in enlarged scale the volume-control stud and the cam member associated therewith.

Construction

Referring to the drawings, the structure includes sound-emitting diaphragm 12 and an electromagnetically controlled armature 40 for actuating it. The diaphragm and the electromagnetic structure are mounted on plate 1, to which housing 15 is sealingly applied. Mounting plate 1 (preferably made from aluminum sheet stock) has strengthening flanges 13 formed at the edges thereof.

Diaphragm 12 extends across circular opening 14 through plate 1, and is peripherally clamped between its protective cover 9 and the mounting plate by a suitable number of equally spaced screws 10 and 53. A sealing gasket 46 lies between the diaphragm and the mounting plate. A stop pin 18 is centrally affixed to diaphragm 12 to transfer the impact of armature 40 thereto.

Diaphragm cover 9 has a central inner recess at 48 (Fig. 5) providing communication with the atmosphere through openings 11 in the manner common in telephone-receiver construction. The side walls defining recess 48 are counterbored to provide a circular ledge to which a suitable moisture-proof membrane 17 is secured (as by cementing) to protect the diaphragm from corrosion.

Housing 15 is preferably molded of a suitable plastic material, and has embossment portions 16, which are tapped to receive screws 7 which pass through openings 8 in plate 1 and secure it in place. A sealing gasket 19 is interposed between the plate and housing.

As shown in Fig. 1, the assembled device may be mounted to cover a receiving opening in a side wall of a telephone-set housing 5, and secured thereto by screws 3 passing through openings 4 (Fig. 3) in mounting tabs 2.

As shown best in Fig. 5, the electromagnetic structure 20 for armature 40 is of E-shaped profile. A pair of permanent magnets 33 are

disposed end-to-end in series-aiding relationship to comprise the back portion; similar pole members 22 and 25 comprise the outer arms; and armature 40 comprises the middle arm. Electromagnet coil 39 encircles armature 40 to drive it toward one pole member or the other according to the instant direction of current-flow therethrough. The parts comprising electromagnetic structure 20 are clamped together by eight screws 32 which pass through openings in the plate-like pole members 22 and 25 and are threadedly received in the ends of four tapped non-magnetic spacer rods 31. Assembly 20 is secured to the rear side of mounting plate 1 by screws 21, washers 47 and nuts 30.

A feature of the disclosed construction is that using two permanent magnets 33 (rather than only one long one) permits reed member 41 to be clamped between them to support armature 40 with the fixed end thereof in close association to the neutral magnetic point. Member 41, which is shown disproportionately thick in Fig. 5 to avoid crowding the lines in the drawing, is preferably of thin magnetic sheet material and, its clamped portion is of about the same size and shape as the opposed ends of the magnets 33 to avoid a non-magnetic gap between the magnets.

Member 41 has a central tongue portion which is clamped between the similar parts 44, of which the armature 40 is made to facilitate securing reed member 41 thereto. Two rivets 43 hold the two parts 44 and the tongue of reed 41 together at the fixed end of the armature, while rivet 42 holds the two parts 44 together at the free end of the armature. Rivet 42 is non-magnetic, and is so placed as to prevent "freezing" magnetic contact between armature 40 and either pole member in any contemplated condition of adjustment of the device. The ends of parts 44 are curved outwardly adjacent to the magnets to give a longer unclamped reed portion. Preferably, the reed suspension of the armature is so flexible that it exercises only a minor influence on the movement of the armature between its limits of travel.

The energizing coil 39 is wound around coil bobbin 34, separately shown in Figs. 7 and 8. The terminal ends (not shown) of the coil windings are connected to lead-out wires 45 which extend to terminal members 66 carried by and extending through embossments 65 in cover 15. Each terminal member 66 comprises a tubular rivet peened at the ends and filled with solder. Part 69 is a flat metal washer and parts 67 and 68 are suitable packing members acting to seal parts 66 and 65.

The coil bobbin 34 comprises spoolheads 35 and 36 held against the abutting ends of two similar channel members 37 by integral retaining tabs 38. The non-circular profile of each spoolhead prevents rotational displacement of the coil bobbin when clamped between pole members 22 and 25 and held against lateral displacement by inwardly sheared tabs 29 thereof.

The active pole faces of pole members 22 and 25 are represented by faces 24 and 27 of extension pole members 23 and 26, which are adjustably secured in place by screws 28 passing through elongated openings (see Fig. 6) in the extension members. The adjustable mounting of the extension members enables them to be shifted individually as required.

The desired volume-control (variation of acoustic output) is accomplished through the medium

of a rocker arm 50 (Figs. 3 to 5), in the form of a bent rod pivotally supported near the midportion by two arms 54 of support bracket 51, which is secured to the under side of plate 1 by two of the screws (designated 53) which hold part 9 in place.

One end (the backstop end) of arm 50 provides an adjustable backstop for the armature in opposition to the front stop provided by pin 18. A coiled spring 52 encircles the pivoted portion of arm 50, with one spring end fixed with the support bracket 51 and the other spring end urging arm 50 away from the mean position of the armature.

The other end of arm 50 (the cam end) engages inclined portion 62 of rotatable cam member 57 shown best in Figs. 10 and 10A. The rotation of cam member 57 back and forth acts, in conjunction with spring 52, to rock arm 50 to move the backstop end thereof away from and toward stop pin 18 to increase and decrease the armature stroke. The percussive force of the armature on pin 18 and consequently the volume of output, is thereby increased and decreased.

The noted rotation of cam member 57 is controlled by volume-control stud 61, which extends through an opening in plate 1. As shown in Figs. 1, 4, 9, and 9A, stud 61 has a slotted head portion which lies outside of plate 1, and has a main portion which passes through parts 1, 55, 56, and 58, a keying portion 64 matching opening 63 in cam member 57, and a threaded end portion for receiving retaining and locking nuts 59 and 60. Parts 56 and 58 are metal washers, and part 55 is a suitable washer-like packing member acting as a seal between parts 1 and 61.

Adjustment and operation

Referring to Figs. 5 and 6, with cover 15 removed, armature 40 is moved against the end of pin 18, and pole-extension member 23 is adjusted to provide a desired small working gap between it and the adjacent head of non-magnetic rivet 42, following which its assembly screws 28 are firmly tightened to retain this first basic adjustment. Next, pole-extension member 26 is adjusted to a desired position determining maximum stroke of armature 40 between it and pin 18, and its screws 28 are tightened firmly to retain this second basic adjustment. With the backstop end of arm 50, beyond reach of armature 40, the device is in its position of loudest response to alternating current of operating value passing through coil 39. With the pole faces 24 and 27 comparatively far apart, when armature 40 is comparatively near either, the influence of the other tending to pull it away is relatively small, requiring a comparatively sizeable current flow through the operating coil to neutralize and reverse the flux through the armature to cause it to reverse its position. The basic sensitivity therefore depends upon, among other things, the closeness of the setting between pole faces 24 and 27, while the maximum energy which a current of bare operating value can impart to the armature is greater, the greater the separation between the pole faces.

With the two noted basic adjustments having been made, the energy of travel of armature 40 toward stop pin 18 (and consequently its percussive effect on the diaphragm) is lowered as rocker arm 50 is adjusted to move the backstop end thereof progressively toward the end of pin 18. The forward travel energy is lowered because the increased distance of armature 40 from pole face 27 reduces the effective force acting upon the armature during its forward travel and also reduces the distance of such travel.

The energy of travel of the armature to its position of rest against arm 50 is similarly reduced by the above-noted volume-decreasing adjustment, but to a lesser extent, for the rocker-arm adjustment does not vary the distance between the armature (in frontstop position) and pole face 24. Consequently, when the volume adjustment is set very low, the armature will move forward in response to a relatively weak current of corresponding direction, but will not return to its backstop position until a comparatively strong current (of reverse direction) is passed through the coil to overcome the tractive force emanating from pole face 24. This feature is of value to prevent more than an initial tap of the armature at the start of dialing when the device is used on an automatic telephone set.

We claim:

1. In a call-signal device, a mounting plate and a housing sealingly fixed together to define a closed chamber, said plate having an opening therethrough into said chamber, a diaphragm fixed at its periphery to said plate in covering relationship to said opening, a striker fixed with and supported on said plate within said chamber, striker-control means within the chamber responsive to the flow of electric current therethrough for moving the striker to strike a part fixed with the diaphragm.

2. In a call-signal device, a mounting plate and a housing sealingly fixed together to define a closed chamber, said plate having an opening therethrough into said chamber, a diaphragm fixed at its periphery to said plate in covering relationship to said opening, a striker fixed with and supported on said plate within said chamber, striker-control means within the chamber for moving the striker to strike a part fixed with the diaphragm, and means for adjusting said striker from a point outside the chamber to regulate the striking force of the striker, said adjusting means including a control part extending movably through an opening in a defining sidewall of the chamber and a further part lying within the chamber in proximity to the striker and controlled by the control part.

3. In a call-signal device, a mounting plate having an opening therethrough, a diaphragm fixed at its periphery to said plate in covering relationship to said opening, a striker fixed with and supported on said plate, and an electromagnetic striker controller associated with said striker and responsive to the flow of electric current through the controller for moving the striker to strike a part fixed with the diaphragm.

4. In a call-signal device, a mounting plate having an opening therethrough, a diaphragm fixed at its periphery to said plate in covering relationship to said opening, a reciprocable striker for striking a part fixed with the diaphragm and actuating mechanism therefor both mounted on said plate, and means for adjusting the length of stroke of said striker to regulate the striking force thereof, said means including a control part extending through an opening in the mounting plate and movable therein, and a further part mounted on said plate in proximity to the striker and controlled by the control part.

5. In a call-signal device, a generally E-shaped polarized magnetic structure, pole members of opposite magnetic polarity comprising the outer

arms of the structure, a pair of permanent bar magnets disposed end-to-end in series-aiding relationship comprising the principal back portion of the structure, a reed member comprising a T-shaped sheet of magnetic spring material having its head portion clamped between the adjacent ends of the permanent magnets and of a configuration corresponding thereto, the stem portion of the reed member extending along the line of the middle arm of the structure, an armature comprising the principal portion of the middle arm of the structure, said armature being suspended on said stem portion of said reed member and corresponding in width thereto, and means operatively associated with the armature for emitting audible signals responsive to movements of said armature.

6. A polarized magnetic structure including a pair of permanent magnets clamped together in series aiding relationship between two pole members, said pole members extending laterally from the permanent magnets to provide opposed pole faces, a reed clamped at one end between the permanent magnets, an armature fixed with the free end of the reed and extending from the junction of the permanent magnets to a location between said pole faces, and means operatively associated with the armature for emitting audible signals responsive to movements of said armature.

7. A polarized magnetic structure including a pair of permanent magnets clamped together in series aiding relationship between two pole members, said pole members extending laterally from the permanent magnets to provide opposed pole faces, a reed clamped at one end between the permanent magnets, an armature fixed with the free end of the reed and extending from the junction of the permanent magnets to a location between said pole faces, said armature comprising two similar overlying portions clamped together with the free end of the reed clamped between them, and means operatively associated with the armature for emitting audible signals responsive to movements of said armature.

8. A polarized magnetic structure including a pair of permanent magnets clamped together in series aiding relationship between two pole members, said pole members extending laterally from the permanent magnets to provide opposed pole faces, a reed clamped at one end between the permanent magnets, an armature fixed with the free end of the reed and extending from the junction of the permanent magnets to a location between said pole faces, said armature comprising two

similar overlying portions clamped together with the free end of the reed clamped between them, said armature portions being clamped together at the forward end by a rivet extending through the portion thereof which lies between said pole faces, said rivet being of non-magnetic material and having head portions preventing contact between the armature and the pole faces respectively, and means operatively associated with the armature for emitting audible signals responsive to movements of said armature.

9. In an electromagnetic signalling device, an armature turnably supported at one end and free at the other, a pair of armature stops, audible signal means associated with one of said stops for transmitting an audible signal when said one stop is struck by the armature, permanent-magnet means biasing said armature firmly against either stop at which it is at rest, and electromagnet means coacting with said permanent-magnet means for overcoming the biasing means to carry the free end of the armature into engagement with said stops alternately in response to successive half cycles of alternating current.

10. In an electromagnetic signalling device, an armature turnably supported at one end and free at the other, a pair of armature stops, audible signal means associated with one of said stops for transmitting an audible signal when said one stop is struck by the armature, permanent-magnet means biasing said armature firmly against either stop at which it is at rest, electromagnet means coacting with said permanent-magnet means for overcoming the biasing means to carry the free end of the armature into engagement with said stops alternately in response to successive half cycles of alternating current, and adjustment means for moving one said stop to vary the distance between the stops according to the desired intensiy of the said emitted audible signal.

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