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W. KALIN ET AL

2,658,194

AUDIBLE SIGNAL FOR FIELD TELEPHONE SETS

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FIG. 1

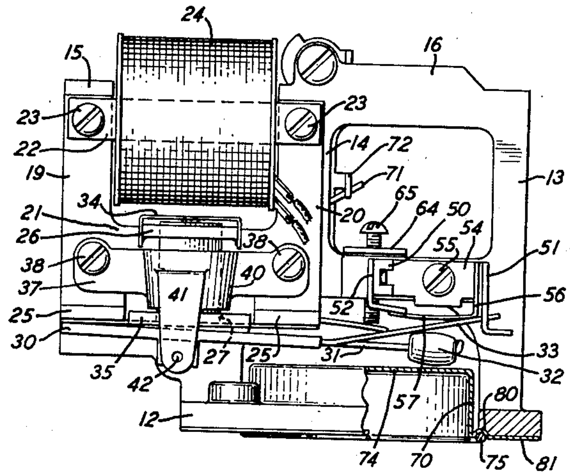


FIG. 4

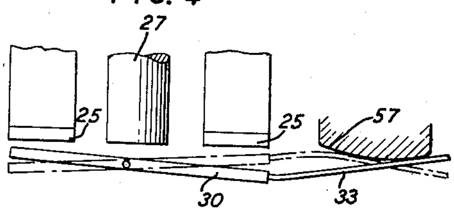


FIG. 2

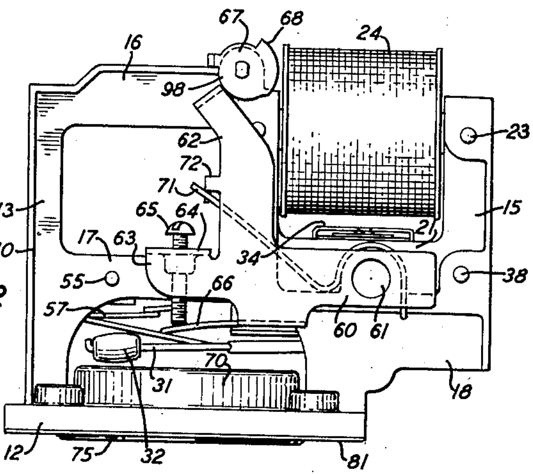


FIG. 5

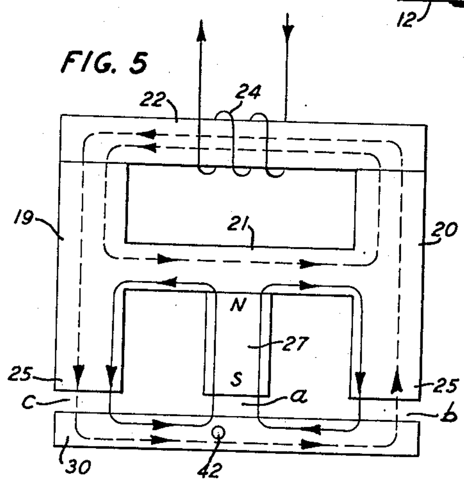
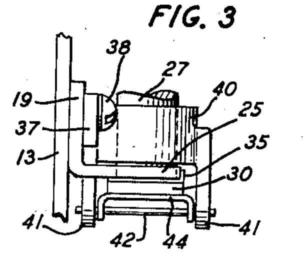


FIG. 3



INVENTORS W. KALIN
J. R. POWER
BY
G. F. Kane
ATTORNEY

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AUDIBLE SIGNAL FOR FIELD TELEPHONE SETS

Walter Kalin, Morristown, and James R. Power, Chatham, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 340—402)

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This invention relates to electromagnetically operated signaling devices and particularly to a polarized signal for use in portable field telephone sets.

The portable field telephone constitutes an indispensable item in the equipment of military forces and because of the conditions encountered in service it must meet requirements which, in some respects, are considerably more severe than those which are met by the more commonly known sets used at telephone subscribers' stations. Since the audible signal is an essential component of such field telephone sets it also must comply with requirements not usually imposed on the telephone ringer of the extensively employed subscriber's set. Not only must such signal devices be designed and constructed from a mechanical viewpoint to withstand rough handling in all kinds of severe weather and climate conditions but they must also possess electromagnetic characteristics which render them dependably operable under abnormal conditions to provide, at the will of the attendant, signals of varying intensities such as may be heard in a background of great noise or which are on the threshold of inaudibility.

It is the object of this invention to provide an audible signal which is simple in design, rugged and compact in construction, inexpensive to manufacture and which is characterized by operational and control features which render it particularly suitable for use in a field telephone set.

This object is attained in accordance with a feature of the invention by the utilization of an armature-controlling magnetic circuit involving a magnetic shunt and a polarizing permanent magnet combined in a manner substantially disclosed in J. R. Power Patent 2,547,537 of April 3, 1951 and in which the armature pivot is offset with respect to the polar axis of the permanent magnet. This feature introduces a magnetic torque at the magnet air-gap that opposes the torque of the working gaps when the armature is in its normal position. By a proper choice of pivot displacement, the net magnetic torque at this armature position may be reduced to a value that is always less than the required operating bias. The torque may then be built up to the required value by adding an adjustable spring bias. With this arrangement normal variation in magnetic strength can be tolerated without recourse to magnetic adjustment thereby greatly simplifying manufacturing procedure.

In accordance with another feature of the invention means are provided for supplying the

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spring torque referred to in the preceding paragraph in a manner such that the bias torque may be conveniently adjusted for both the normal and operated positions of the armature. These means comprise a bias spring which is staked into one end of the armature and a bias bracket against which the spring bears. To furnish the required torque in the normal position of the armature the bias spring is bent at a suitable point near the armature. In addition to adjusting the bias torque for the normal position of the armature it is necessary also to adjust it for the operated position. This latter torque is usually designed "stick margin" because it serves to prevent the armature sticking in the operated position when signaling power to the signal device is discontinued. In the operated position of the armature the magnetic component of the torque is large and is in a direction opposed to the spring bias. The "stick margin" therefore is the rather small difference between two large values and one or both such values must be accurately adjusted to obtain the required balance. Also, it is desirable that this adjustment should not affect the bias in the normal position of the armature. To obtain these objectives the bias bracket of this invention is designed with a curved surface against which the bias spring bears so that the effective length of the spring is reduced as the armature moves from its normal position to its operated position, thereby increasing the spring stiffness and the force exerted on the armature as the armature approaches its operated position. The amount of this reduction in effective spring length and increase in biasing force may be accurately controlled by rotating the curved bias bracket about its point of contact with the bias spring when the armature is in the normal position. This location of the pivot preserves the previously adjusted normal bias.

Still another feature of the invention resides in a simple but novel armature support which permits adjustment of the air-gaps between the electromagnet pole faces and the armature. Particularly, the armature support comprises a die cast detail which is fastened to the signal frame by two screws; clearance in the screw holes provides sufficient freedom of the casting to permit adjustment of the armature with respect to the magnet pole faces. The air-gaps therefore can easily and accurately be controlled by the use of spacers during assembly of the signal components.

A further feature of the invention resides in a novel form of sound generator comprising a clamped circular plate coupled to a tubular resonator and an electromagnetically controlled clapper. The plate and resonator are combined in the form of a flat-bottomed cup that is sealed into an opening in the side of the telephone set. Sound from the generator is thus radiated directly to the outside of the set while the control mechanism remains within. The set therefore can be made immersion-proof without introducing any transmission loss for the sound. In a practical application of the involved audible signal the thickness and diameter of the bottom of the cup are proportioned to have a fundamental mode of vibration at about 2700 cycles per second and the depth of the cup is chosen to resonate at the same frequency.

Still another feature of the invention contemplates the use of manually adjustable means for selectively determining the nature and intensity of the signal to be emitted by the signal device. More particularly a manually adjustable cam having two distinct facets cooperates with a pivoted lever for adjustably positioning a stop relative to the armature-supported clapper rod so that one facet serves to adjust the armature stroke in a range in which the sound signal is produced by the striking of the resonator by the clapper and the other cam facet serves to adjust the armature stroke in a range in which the clapper buzzes without striking the resonator. In order to eliminate the area of uncertainty which would otherwise exist between the two types of signals the peripheral area at which the two cam facets join is characterized by an abrupt and appreciable change or step.

These and other features of the invention will be better understood from the following detailed description when read with reference to the accompanying drawing in which:

Fig. 1 is a front plan view of the audible signal of this invention;

Fig. 2 is a rear plan view of the audible signal of this invention;

Fig. 3 is a detail view of the die cast detail used to adjustably mount the signal armature;

Fig. 4 is an enlarged fragmentary view of those elements which are involved in the spring biasing arrangement employed in this signal; and

Fig. 5 is a schematic showing of the electromagnetic circuit involved in the signal of this invention.

Referring particularly to Figs. 1 and 2, a unitary metallic frame of irregular configuration is shown at 10. This frame is preferably a die casting of any suitable non-magnetic material and may be considered as consisting of a substantially rectangular section 12 from which extends a spider-like structure consisting primarily of the vertically extending arms 13, 14 and 15 and the cross-pieces 16, 17 and 18, all of which are integrally formed one with the other and with the section 12. The various sections of the frame 10 support the control and operating elements of the signal and also the sound generator as will now be described.

The magnetic circuit of the signal of this invention includes a substantially H-shaped element of magnetic material comprising the vertical legs 19 and 20 which are integrally joined by a cross-piece 21 constituting a magnetic shunt. The space between the upper ends of the legs 19 and 20 is spanned by a bar-type core 22 which, together with the legs 19 and 20, is fixed by means of screws 23 to the upper ends of frame sections 14 and 15. The core 22 supports a coil 24. Each of the legs 19 and 20 project downwardly from the shunt 21 and terminates in a right-angle projection 25 which constitute the poles of the electromagnetic circuit.

Projecting downwardly (Fig. 1) from the shunt 21 at its upper edge and centrally disposed with respect to the two poles 25 is a shelf-like integral section 26 which is provided with a centrally located aperture into which a small bar-type cylindrical permanent magnet 27 is loosely fitted. This magnet is shown in broken lines in Fig. 1 and projects downward from the support 26 so that its lower face is in substantial horizontal alignment with the faces of the projecting pole-pieces 25.

A U-shaped metal retainer 34 is clamped over the two opposite edges of the shelf-like projection 26 and is provided with a centrally disposed boss on the undersurface of the base of the U which abuts a disc associated with the coil end of the permanent magnet 27. This element precludes displacement of the permanent magnet which might otherwise result from shock or other cause.

The lower, or armature end of the permanent magnet 27 rests on a metal element 35 each end of which is spot-welded to the undersurface of the pole-pieces 25. The element 35 serves to align the magnet end with the pole-pieces and also as an armature stop.

A motor unit comprising armature 30, clapper rod 31 and its associated loosely mounted clapper 32 and biasing spring 33, is removably mounted on the frame by means of a die casting 37 which, with the legs 19 and 20 of the magnetic circuit element is secured to the frame by the screws 38. The casting 37 is essentially a straight bar which substantially parallels the shunt piece 21 and is provided with an integral annular or ring-like centrally disposed projection 40 within which the permanent magnet 27 is confined. Two integrally formed and substantially diametrically opposed lugs 41 project downwardly from the casting 37 as clearly shown in Fig. 3 and, in suitable apertures at their extremities house a bearing pin 42 which, in turn, carries an armature support which is an inverted U-shaped member 44 located between the lugs 41 and upon which the armature 30 is supported for oscillatory movement on the bearing pin 42.

It will be observed that the longitudinal center line of the lugs 41 at which the pivot pin 42 is located does not coincide with the longitudinal or polar axis of the permanent magnet 27 so that the axis of rotation of armature 30 is displaced with respect to the polar axis of the magnet. Viewing Fig. 4 this displacement is to the left of the polar axis.

On the cross-piece 17 of the frame 10 is mounted an irregularly-shaped bracket 50. This bracket consists of a central portion which abuts the cross-piece 17 and from each end of which depends a substantially L-shaped member. The L-shaped member 51 is provided with an aperture through which the free end of biasing spring 33 protrudes, the other end being staked to the right edge (viewing Fig. 1) of armature 30. The L-shaped member 52, as will appear from a later description, serves as a means for adjusting a laterally extending arm 57 of a bias bracket 54 which functions as a stop for the biasing spring 33.

The bias bracket 54 comprises a straight flat portion which is contiguously related to the central portion of bracket 50, the two being held in this relationship and secured to the frame member 17 by a screw 55. The left end (viewing Fig. 1) of bias bracket 54 is provided with a detent which passes through a suitable aperture in the central portion of the bracket 50 and into a hole in the frame. By virtue of this detent the bias bracket 54 is prevented from rotational displacement about the screw 55. From the right end of the bracket a vertically depending arm 56 terminates in a laterally extending arm 57 which is arcuate in configuration. The free end of arm 57 is disposed immediately below the laterally extending portion of L-shaped member 52 and is in touching relationship therewith.

As more clearly indicated in Fig. 4 the bias spring 33 makes contact near its outer end with the arcuate surface of the arm 57 of the bias bracket 54 when the armature 30 is in its normal position. This position is shown in both Figs. 1 and 4. Further reference will be made to Fig. 4 in a later description. Suffice it to say now that by manipulating the laterally projecting leg of L-shaped bracket member 52 the curved arm 57 is rotated about its point of contact with spring 33 when the armature 30 is in its normal position.

Particular reference now will be made to Fig. 2. On the frame piece 21 is mounted an irregularly-shaped metallic member or lever which serves as a manually adjustable means for regulating the sound output of the audible signal. This member consists primarily of a horizontal portion 60 (viewing Fig. 2) fixed for pivotal movement to the frame piece 21 by any suitable means such as by the rivet 61; a vertical arm 62; and a smaller horizontal extension 63. The extension 63 is provided with an inwardly (Fig. 2) projecting horizontal section 64 which provides a seat for an adjustable screw 65, the free end of which communicates with an integral arm 66 projecting from the lower end of the vertical arm 62. The outer edge of the arm 66 is located immediately above the clapper rod 31 and by manipulating the screw 65 the normal spacing between the arm 66 and the clapper rod 31 may be adjusted and the armature stroke correspondingly regulated.

As clearly shown in Fig. 2 the vertical arm 62 of the sound adjusting lever is angularly offset at its upper end and there terminates in an arm which communicates with an adjusting stepped cam or eccentric 67. The cam 67 is so designed that as it it turned clockwise (viewing Fig. 2) the adjusting lever is caused to pivot about the rivet 61 in a counter-clockwise direction thereby causing the arm 66 to approach the clapper rod 31 and correspondingly limiting the movement of the later incident to the energization of coil 24 and the consequent movement of armature 30 to which the clapper rod is fixed. Thus, volume control is obtained by restricting the amplitude of the armature motion. It will be observed that the cam 67 is provided with two effective camming faces 98 and 68 which are separated by a positive step and are not continuous. When the face 98 is effective the strength of the sound signal emanating from the resonator as it is struck by the clapper may be adjusted between upper and lower limits. By virtue of the cam face 68 the range of control includes a region in which the armature buzzes but the clapper does not strike the resonator 70.

As there is an area of uncertainty between the striking and buzzing operations of the armature the step which is interposed between the camming faces 98 and 68 of cam 67 precludes the possibility of the signal being set for buzzing operation and resulting in an operation in which the resonator is struck by the clapper.

The adjusting lever is normally biased in a clockwise direction by a spring 71 which is wound about the shank of the rivet 61 with its lower end hooked on the lower edge of section 18 of the frame and its outer or free end abutting the projection 72 formed integrally with the vertical arm 62 of the adjusting lever.

The sound generator of this signal consists of a circular plate 74 and a tubular resonator or diaphragm 70, the latter being provided with an annular flange 81 which is fixed in any suitable manner to the frame 10. As previously indicated the plate 74 and resonator 70 are combined in the form of a flat-bottomed cup that is sealed into an opening in the side of the telephone set. At 75 is shown a soft rubber gasket which serves to seal the signal to the housing (not shown). The thickness and diameter of the bottom of the cup are proportioned to have a fundamental mode of vibration at about 2700 cycles and the depth of the cup is chosen to resonate at the same frequency. It has been found that the best signal is obtained when the clapper 32 strikes the plate 74 at a point about 70 per cent of the distance from its center to its edge. With this arrangement, practically all of the sound energy is concentrated in a 1000-cycle band centered about the resonant frequency. Tests in the presence of background noise have demonstrated that the sound emanating from this signal has excellent carrying power and attention arresting qualities. It is superior to the usual gong signal in the certainty with which it is heard under marginal conditions and also in that its perception is much less dependent on the listener's high frequency hearing acuity.

In Fig. 5 the magnetic circuit of the audible signal is shown schematically. The paths of the polarizing direct-current flux are shown by the full lines and those of the operating or alternating flux during one-half cycle of operating current are shown by broken lines. A distinctive feature of this form of magnetic circuit is that the polarizing flux flows through two arms of a magnetic shunt 21 that operates at very high flux density. Alternating-current flux also flows through this shunt and is additive to the polarizing flux in one arm when its is subtractive in the other. This unbalances the reluctance of the two arms and causes a redistribution of polarizing flux in a manner that increases the force factor.

It will be observed with reference to Fig. 5 that the armature pivot 42 is offset with respect to the polar axis of the permanent magnet 27. As hereinbefore indicated this feature introduces a magnetic torque at the magnet air-gap a that opposes the torque of the working gaps b and c when the armature is in its normal position. The virtues of this feature are clearly set forth in an earlier section of this specification.

In Fig. 4 the armature 30 and the associated bias spring 33 are disclosed in two different positions, the normal position being shown in full line and the fully operated position being indicated in broken outline. It will be noted that as the armature moves from normal position to fully operated position the point on the bias spring at which contact is made with the arcuate surface of arm 57 of the bias bracket 54 approaches the staked end of the spring so that the effective length of the spring decreases and the biasing torque increases. It will be observed that the spring makes tangential contact with the arm **57** for each position of the spring as the armature is actuated. The amount of decrease in effective spring length and increase in biasing force may be accurately controlled by rotating the arcuate arm **57** about its point of contact with spring **33** as hereinbefore mentioned.

What is claimed is:

1. In an electromagnet, a coil, a pole-piece, an armature pivotally mounted with respect to said pole-piece so that one end thereof approaches said pole-piece upon energization of said coil, and means for biasing said armature comprising a spring secured to one end of said armature and a stop for the free end of said spring having an arcuate bearing surface over which said spring rides as said armature approaches said pole-piece.

2. In an electromagnet, a coil, a pole-piece, an armature pivotally mounted with respect to said pole-piece so that one end thereof approaches said pole-piece upon energization of said coil, and means for applying a torque to said armature which increases as the armature approaches said pole-piece comprising a resilient spring fixed to one end of said armature and a stop having an arcuate bearing surface so disposed with respect to the projecting portion of said spring that said spring makes tangential contact with the bearing surface of said stop at a different point thereon for each position of the armature as it approaches said pole-piece.

3. In an electromagnet, a coil, a pole-piece, an armature pivotally mounted with respect to said pole-piece so that one end thereof approaches said pole-piece upon energization of said coil, and means for applying a torque to said armature such as to oppose its movement in the direction of said pole-piece comprising a spring fixed to one end of said armature and a stop against which the free end of said spring impinges at a point which determines the effective length of said spring when said armature is in its normal unoperated position, said stop presenting a convex surface to said spring whereby the point of contact between said spring and said stop moves in a direction such as to decrease the effective length of said spring as said armature approaches said pole-piece.

4. In an electromagnet, in combination, a magnetic circuit including a substantially U-shaped core, a coil carried by the cross-piece of said U-shaped core, a magnetic shunt interconnecting corresponding points on the oppositely disposed legs of said U-shaped core and disposed in spaced parallel relation to said coil-bearing cross-piece, a bar-type permanent magnet located with respect to said shunt so that its longitudinal polar axis is at right angles to the shunt and midway of the longitudinal axes of the oppositely disposed legs of said U-shaped core, an armature spanning the free ends of the oppositely disposed legs of said U-shaped core and one end of said permanent magnet, with the transverse center line of said armature located in the plane of the polar axis of said permanent magnet, a pivot support for said armature, and means locating said pivot support in displaced relation to the polar axis of said permanent magnet.

5. The combination in an electromagnet, a die cast mounting plate, a magnetic circuit including a coil-bearing section fixed to said plate and a bar-type permanent magnet whose polar axis coincides with its longitudinal axis, an armature adapted to oscillate under the influence of the magnetic circuit incident to the energization of said coil, and means for mounting said armature for oscillatory movement comprising a casting fixed to said plate and having a cylindrical wall encompassing said permanent magnet, a pair of integrally formed lugs depending from said casting whose vertical center lines are offset with respect to the polar axis of said permanent magnet, and means comprising a pivot pin located in the plane of the center lines of said lugs for supporting said armature.

6. The combination defined in claim 5 in which the said armature-mounting casting is secured to said mounting plate by screws which fit into corresponding threaded holes in said plate with adequate clearance to permit adjustment of said casting relative to said plate.

7. In a sound signal, a sound emitting device, a clapper rod bearing a clapper for striking said sound emitting device, an electromagnetically controlled vibratable armature to which said clapper is secured, and means for controlling the stroke of said armature comprising a stop normally in spaced relation to said clapper rod and a cam for moving said stop relative to said clapper rod, said cam having a camming surface which corresponds to a range of armature stroke lengths on which said clapper strikes said sound emitting device and a camming surface which corresponds to a range of armature stroke lengths on which the armature vibrates without said clapper striking said sound emitting device.

8. A sound signal in accordance with claim 7 in which the two camming surfaces of said cam are separated by a step to insure positive transition from one range of armature stroke lengths to the other range of armature stroke lengths.

9. In an audible signal device, a frame having a substantially circular opening therein, a cup-shaped resonator fixed at its periphery to said frame in covering relationship to said opening, a clapper adapted, when actuated, to strike the base of said cup-shaped resonator, and electromagnetically controlled means for actuating said clapper, said clapper being so disposed with respect to the base of said resonator that the resonator base is struck thereby at a point removed from its center by a distance equal approximately to 70 per cent of the distance from its center to its edge.

WALTER KALIN.
JAMES R. POWER.

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