

Dec. 31, 1963

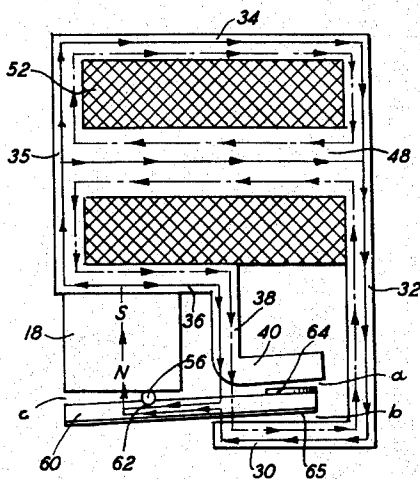
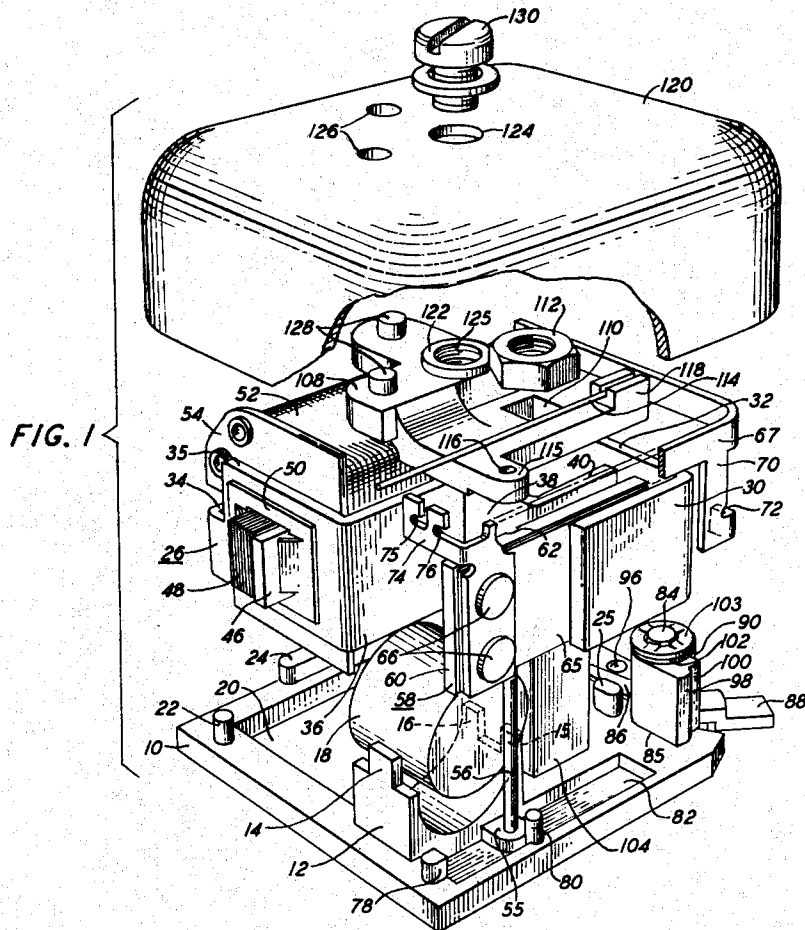
W. KALIN ETAL

3,116,481

ELECTROMAGNETICALLY OPERATED POLARIZED BELL RINGER

Filed Dec. 27, 1960

2 Sheets-Sheet 1



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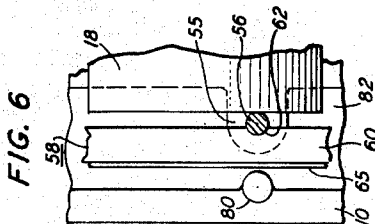
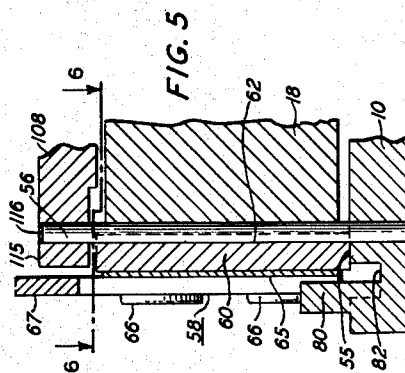
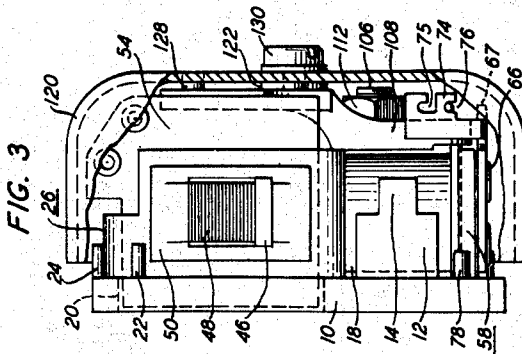
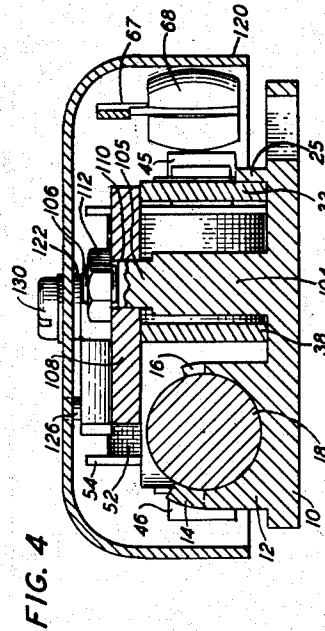
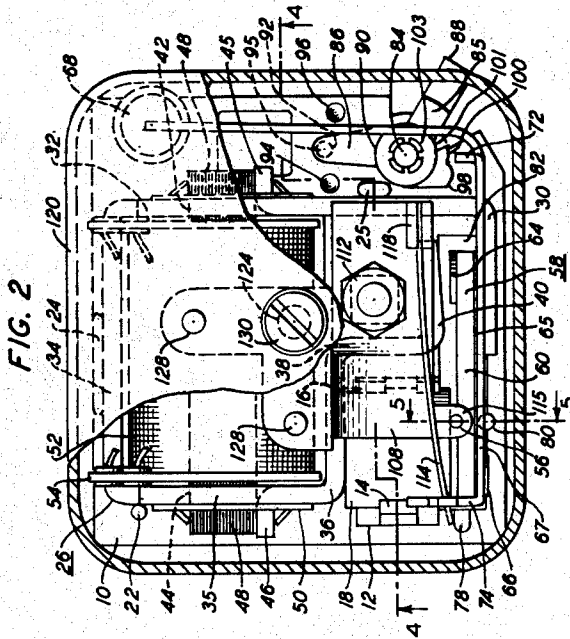
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ELECTROMAGNETICALLY OPERATED POLARIZED BELL RINGER

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Filed Dec. 27, 1960, Ser. No. 78,614
15 Claims. (Cl. 340—397)

This invention relates to electromagnetically operated signaling devices and particularly to polarized ringers of the type employed in telephone sets.

Since the advent of the combined type of telephone set in which the base of the set houses those components of the substation equipment previously contained in a separate enclosure, continuous efforts have been directed to the redesign of such components with a view toward space conservation and an ultimate reduction in the size and weight of the telephone set without limiting the operating capabilities of these components. Because the ringer has been one of the largest of the components included in the base, particular attention has been directed toward it.

A significant advance in the design of the telephone ringers from the viewpoint of efficiency of operation, economical use of available space, and reduction in weight was made in the ringer disclosed in Patent 2,590,500 issued jointly to H. A. Bredehoft and M. S. Richardson on March 25, 1952. This ringer has been incorporated in the base of the desk set referred to in the industry as the 500 set.

Recently, however, interest has developed in a telephone set that has a base of smaller size than the 500 set and therefore is adaptable to a greater variety of locations in the telephone subscriber's home, and for such a set the above ringer is much too large.

An object of this invention is to provide a small compact ringer that retains the operating capabilities of the large ringers.

This and other objects of the present invention are realized in an illustrative embodiment thereof wherein the ringer comprises a unitary pole piece, a core supported by the pole piece, and a coil disposed about the core. The pole piece provides a path for the magnetic flux generated by the coil and includes spaced opposing members for effecting an air gap. An armature extends into the air gap and is movable between the spaced members in a substantially fixed plane, the armature pivoting about a pin member that extends perpendicular to its plane of movement. The armature has a groove formed in a surface thereof for accommodating the pin member and is biased against the pin member by a permanent magnet, the pin being positioned intermediate the armature and the magnet and determinative of the air gap therebetween. The pin is located eccentric to the polar axis of the permanent magnet and the magnet biases the armature to an unoperated position. In addition, the permanent magnet is contiguous with a portion of the pole piece and thus provides a polarizing magnetic flux. A clapper-carrying rod is affixed to the armature and the entire assembly enclosed within a rectangular gong. Energization of the coil by an alternating current causes the armature to intermittently move the clapper against the inside surface of the gong.

A complete understanding of the invention and of these and other features and advantages thereof may be gained from consideration of the following detailed description taken in conjunction with the accompanying drawing wherein one embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawing is for the purposes of illustration and description and is not to be construed as defining the limits of the invention.

In the drawing:

2

FIG. 1 is an exploded perspective view of the ringer of this invention;

FIG. 2 is a top view of the ringer with a portion of the gong broken away;

FIG. 3 is a side view of the ringer with a portion of the gong broken away;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2;

FIG. 5 is an enlarged fragmentary sectional view taken along line 5—5 of FIG. 2 showing the relationship between the base, armature, pivot pin, and permanent magnet of the ringer;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 5; and

FIG. 7 is a diagrammatic illustration of the magnetic circuit of the ringer, showing the various flux paths set up therein.

Referring to the drawings and particularly to FIG. 1, the ringer of this invention comprises an essentially rectangular base 10 that is advantageously diecast from a zinc alloy or other suitable nonmagnetic material. The base includes a cradle 12 the inner surface of which is cylindrically concave and the sides of which terminate in tabs 14, 15, and 16. A cylindrical permanent magnet 18 is positioned in the cradle, and the tabs are swaged over to secure the magnet in place.

To the rear of the cradle 12, the base 10 is provided with a large rectangular aperture 20, and bosses 22, 24, and 25 are spaced therearound. A unitary pole piece 26 rests on the base and encompasses the aperture, the bosses in conjunction with the cradle acting to locate the pole piece in its proper position on the base. As shown in FIGS. 1 and 2, the pole piece is essentially a flat, ribbon like member that includes a first pole face portion 30, a portion 32 that extends to the rear of and at right angles to the first pole face portion, a portion 34 that extends to the left of and at right angles to the portion 32, a portion 35 that extends to the front of and at right angles to the portion 34, a portion 36 that extends to the right of and at right angles to the portion 35, a portion 38 that extends to the front of and at right angles to the portion 36, and a second pole face portion 40 that extends to the right of and at slightly less than a right angle to the portion 38. The configuration of the pole piece approaches that of a closed figure, the continuity being broken by a space between the first pole face 30 and the second pole face 40. This space defines the air gap of the magnetic circuit of the electromagnetic system of the ringer, and the slight inclination of the portion 40 from a 90-degree angle provides an air gap that is nonuniform in breadth. With the pole piece properly positioned on the base, the portion 36 abuts against the rear face of the permanent magnet 18. The pole piece is advantageously formed from a good magnetic material such as cold rolled steel that is annealed and nickel plated after forming.

Referring now to FIGS. 1, 2, and 3 and particularly to FIG. 2, the portions 32 and 35 of the unitary pole piece 26 have rectangular apertures 42 and 44 respectively formed therein. The apertures are opposite one another and the forward edges thereof are defined by lips 45 and 46 that respectively project outwardly from the portions 32 and 35. A laminated core 48, which consists of a plurality of rectangular silicon steel laminations stacked as a unit, is seated in the apertures, the ends of the core extending therethrough. The core laminations are secured to the lips 45 and 46 of the pole piece by means of fasteners 50 such as the sheet metal fasteners sold under the trademark "Speed Nut."

A single coil 52 wound on a spool 54 is disposed about the laminated core 48, the bottom of the coil and of ends of the spool extending into the aperture 20 in the base 10 when the pole piece 26 is properly positioned on the base.

To achieve minimum coil volume, the coil is random wound on the spool. In one specific embodiment over 21,000 turns of 42-gauge single polyurethane enamel insulated wire are wound on a spool approximately three-quarters of an inch square by one inch long. Advantageously the coil is provided with two intermediate taps arranged so that the ringer may be connected for bridged two-party flat or message rate service and automatic ticketing service. In one specific embodiment the taps are placed to divide the coil into three segments having direct current resistance of 2600 ohms, 1600 ohms, and 1000 ohms.

Turning again to FIG. 1 immediately in front of the cradle 12, the base 10 is provided with an armature bearing surface 55, and a pivot pin 56 is located in a hole therein. The lower end of the pin is staked to the base, the staking being advantageously performed on the bottom surface of the base to prevent distortion of the bearing surface 55, while the upper end of the pin extends perpendicularly from the base. The pin is contiguous with the front face of the permanent magnet 18 and is the fulcrum about which an armature assembly 58 pivots. By design, the pivot pin is located a predetermined distance to the right of the magnetic or polar axis of the permanent magnet for a purpose to be set forth more fully hereinafter.

As shown most clearly in FIGS. 1, 2, and 6, the armature assembly 58 comprises a rectangular armature 60 having a transverse groove 62 in the rear surface thereof. The groove is of a size to accommodate the forward surface of the pivot pin 56 and the depth of the groove in combination with the diameter of the pivot pin is determinative of the air gap between the permanent magnet and the armature. In one specific embodiment the pivot pin has a diameter of .040 inch and the groove has a depth of 0.15 inch thereby providing an air gap of .025 inch between the armature and the permanent magnet when the armature extends parallel to the face of the magnet. The pivot pin is made of a nonmagnetic bearing material such as Phosphor bronze, while the armature is made from a good magnetic material such as cold rolled steel.

Respectively secured to the back and front surfaces of the armature 60 are operate and nonoperate nonmagnetic stops 64 and 65. The operate stop 64 is advantageously nonmetallic to eliminate the motor noise that would occur if the armature made metal-to-metal contact in the operate position. Typically the operate stop is a nylon stud that is press fit into a hole in the armature. The nonoperate stop 65 on the other hand may be metallic and typically consists of a sheet of Phosphor bronze fastened as by rivets 66 to the front surface of the armature.

The rivets 66 besides affixing the nonoperate stop 65 to the armature 60 also secure one end of a clapper rod 67 thereto. The clapper rod extends parallel to the armature and then bends rearwardly therefrom, the unsecured end of the rod having a clapper 68 mounted thereto. The rod has a portion 70 that depends therefrom adjacent the bend therein and that includes a rearwardly extending tab 72. The rod further has a portion 74 that extends rearwardly therefrom adjacent the secured end thereof and that includes notches 75 and 76. These portions are advantageously an integral part of the rod, the entire unit being formed from a single sheet of a nonmagnetic resilient material such Phosphor bronze.

The armature assembly 58 is positioned with the groove 62 of the armature 60 in engagement with the pivot pin 56, with the right end of the armature extending between the first pole face portion 30 and the second pole face portion 40 of the pole piece 26, and with the bottom surface of the armature resting on the armature bearing surface 55 of the base 10. The magnetic force of the permanent magnet 18 maintains the groove 62 of the armature in registration with the pivot pin 56. This

magnetic force is of a magnitude to maintain the armature assembly in its proper position during normal service conditions. However, to prevent the armature assembly from being dislodged should the telephone in which the ringer is housed be dropped or similarly abused, bosses 78 and 80 of the base and a gong 120, hereinafter described in more detail, restrain any rectilinear movement of the armature assembly away from its proper position. The boss 78 is to the left of and spaced a small distance from the left end of the armature 60, and a portion of the gong 120 is to the right of and spaced a small distance from the clapper 68. Thus the boss 78 and the gong respectively restrain rectilinear movement of the armature assembly to the left and to the right. The boss 80 is directly in front of the pivot pin, and the rear surface of the boss is spaced from the front surface of the pin a distance slightly greater than the combined thickness of the armature and the nonoperate stop 65 minus the depth of the groove 62 in the armature. Accordingly, the boss 80 is normally not in contact with the armature assembly but, when necessary, restrains rectilinear movement of the assembly in a forward direction. Rectilinear movement of the assembly in a rearward direction is, of course, prevented by the pivot pin 56.

The armature 60 rotates about the pivot pin 56, the right end of the armature moving between a nonoperate position wherein the nonoperate stop 65 is in contact with the first pole face portion 30 and an operate position wherein the operate stop 64 is in contact with the second pole face portion 40. Because the pivot pin 56 is positioned to the right of the polar axis of the permanent magnet 18, the magnet, besides biasing the armature against the pivot pin, also imparts a clockwise torque to the armature that tends to maintain the armature in the nonoperate position. To insure clearance between the bottom surface of the armature 60 and the top surface of the base 10 in the area of armature travel, the base is provided with a recess 82.

Referring now to FIGS. 1 and 2, to the right of the recess 82, the base 10 has a round upstanding post 84 and a volume control member 85 is pivotally mounted thereon. The member includes a stepping finger 86, a lever arm 88, and a cylindrical cam 90. The stepping finger 86 has a hemispherical protrusion 92 on the underside of the remote end thereof that cooperates with three spaced hemispherical indentations 94, 95, and 96 in the base to positively locate the volume control member in one of three positions. The member is rotated from one position to the other by means of the lever arm 88 which extends beyond the edge of the base. As shown most clearly in FIG. 2, when the lever arm is rotated to position the hemispherical protrusion 92 of the stepping finger 86 in the indentation 94, a projection 98 on the profile of the cam 90 engages the tab 72 on the clapper rod 67, and the armature assembly 58 is prevented from rotating, thereby placing the ringer in a silent or off condition. When the lever arm 88 is operated to position the protrusion 92 of the stepping finger 86 in the indentation 95, a projection 100 on the profile of the cam is in juxtaposition with the tab 72 on the clapper rod 67. The projection 100 is spaced a lesser distance from the tab 72 than the full travel of the tab, and thus the travel of the armature assembly is limited, placing the ringer in a low volume condition. Finally, when the lever arm 88 is operated to position the protrusion 92 of the stepping finger 86 in the indentation 96, a portion 101 on the profile of the cam is in juxtaposition with the tab 72 on the clapper rod, and this portion is spaced a greater distance from the tab than the full travel of the tab. The travel of the armature assembly is therefore not impeded, and the ringer is in a full volume condition. The volume control member is advantageously an integral member formed from a moldable resilient material such as the acetyl resin sold under the

trademark "Delrin." It is pivotally secured to the post 84 by any well-known means such as a washer 102 and a sheet metal fastener 103.

As shown in FIGS. 1 and 4, to the left of the post 84, the base 10 has a square upstanding post 104, the upper end of which is reduced in cross section to form a square key portion 105 and a threaded portion 106. A clamp plate 108 is placed over the post, the square key portion 105 of the post extending into a square aperture 110 in the plate. The clamp plate rests on the top edges of the pole piece 26, and the key portion of the post cooperates with the square aperture in the plate to properly align the plate with respect to the base. A nut 112 is screwed on the threaded portion of the post, and the nut when tightened forces the clamp plate down on the pole piece and secures the pole piece to the base. The clamp plate is advantageously die cast from a nonmagnetic material such as a zinc base alloy.

Besides locking the pole piece 26 in place, the clamp plate 108 buttresses the pivot pin 56 and supports a bias spring 114. A forwardly extending finger portion 115 of the clamp plate has an aperture 116 therein that receives the upper end of the pivot pin, the aperture 116 being slightly greater in diameter than the pivot pin to facilitate the assembly of the plate on the pin, while a boss 118 of the plate has a slot therein that receives the right end of the bias spring 114, the surface of the boss around the slot being swaged over to stake the spring in place.

The left end of the bias spring 114 is positioned in either the notch 75 or the notch 76 in the portion 74 of the clapper rod 67. It is seen in FIG. 2 that in both these positions the bias spring is flexed and therefore exerts a biasing force on the armature assembly 58 that tends to rotate the assembly clockwise to the nonoperate position. As hereinbefore mentioned, the pivot pin 56 is located to the right of the polar axis of the permanent magnet 18, and therefore the magnetic force of the magnet also acts to rotate the armature assembly clockwise to the nonoperate position. The combination of these forces provides what may be termed the net stiffness of the armature assembly, that is, the rate at which the torque acting on the armature assembly in the absence of any ringing current varies as the armature assembly position is varied. In the present invention the notches 75 and 76 provide two different values of stiffness, the biasing spring being flexed to a greater degree when placed in the notch 76 than when placed in the notch 75 and therefore exerting a greater biasing force in the former position than in the latter. As the characteristics of a ringer are in part determined by the net stiffness of the armature, the notches permit varying the ringer characteristics to suit the ringer for the different uses to which it is put in the telephone plant. In one specific embodiment the position of the pivot pin, the strength of the permanent magnet, and the flexibility of the bias spring are chosen so that when the spring is positioned in the notch 75, the major portion of the desired bias is provided by the magnet and the spring provides only the bias necessary for positive adjustment and compensation for ringer tolerances.

The clamp plate 108, in addition to the aforementioned functions, also serves as the mounting surface for a rectangular gong 120. The gong rests on a shoulder 122 of the plate, the gong having a central aperture 124 that is placed in coincidence with a tapped hole 125 in the shoulder. The gong further has two asymmetric apertures 126 that receive complementary asymmetric bosses 128 on the plate. The gong is secured to the plate by a screw 130 that is threaded into the tapped hole 125, the asymmetric apertures in the gong cooperating with the bosses of the plate to key the gong to the plate. This keying action prevents rotation or shifting of the gong after final adjustments have been made and assures exact repositioning of the gong should it be removed, for ex-

ample, for the purpose of changing the position of the bias spring 114. The gong is formed from a good sound radiating material, such as brass, and is free to vibrate around its sides. It is rectangular in shape, and incloses the major portion of the ringer assembly, occupying a minimum of space.

As illustrated in FIGS. 2 and 4, with the gong 120 in place and with the clapper 68 in a rest position, that is, in the position it assumes when the armature assembly 58 is in a nonoperate position, the clapper is spaced from the inside surface of the gong. But when the armature assembly moves from the operate position and then returns to the nonoperate position, the inertia of the clapper coupled with the resiliency of the clapper rod 67 causes the clapper to travel beyond its normal rest position and strike the gong. The distance between the clapper and the gong when the gong is in a rest position is advantageously chosen to minimize damping of the gong, which occurs if the distance is too small, but at the same time to insure against the clapper not striking the gong at low voltage operation, which occurs if the distance is too great.

Referring now to FIG. 7, the magnetic flux paths in the electromagnetic system embodied in the ringer of this invention are diagrammatically illustrated therein. The biasing flux path, that is, the path traversed by the flux set up by the permanent magnet 18 is represented by a continuous line, while the path of the flux set up by the ringing current is represented by broken lines. The arrow heads on the continuous line indicate the direction of the biasing flux in the circuit at all times, while the arrow heads on the broken lines indicate the direction of the ringing current flux during one-half cycle of the ringing current, it being understood that this flux direction is reversed every one-half cycle.

The permanent magnet flux emanating from the south pole S of the permanent magnet 18 enters the portion 36 of the unitary pole piece 26 and traverses three parallel paths: one including the portion 38, air gap *a*, armature 60, and back to the north pole N of the magnet by way of air gap *c*; another by way of the portions 35, 34, 32, and 30, air gap *b*, armature 60, and thence back to the permanent magnet by way of the air gap *c*; and a third over a path that includes the core 48 in place of the portion 34 in the path just traced.

When the armature is near the center of the air gap in which it operates, the total torque resulting from the bias flux in gaps *a* and *b* is small since they are substantially equal. The flux in gap *b* tends to pull the armature 60 toward the first pole face portion 30, while the flux in gap *a* tends to pull the armature toward the second pole face portion 40. Hence, insofar as the bias flux in gaps *a* and *b* is concerned, the armature 60 is substantially balanced. The biasing flux traversing the gap *c*, however, produces a clockwise torque, tending to move the armature against the nonoperate stop 65. The strength of this magnetic bias depends upon the dimensions of the gap *c*, and since it is desirable that the bias be uniform from ringer to ringer, the dimensions in gap *c* are critical. In the present invention, the dimensions of the gap *c* are essentially controlled by the diameter of the pivot pin 56 and the depth of the groove 62 in the armature 60. Since the dimensions of these two elements can be held to fairly close tolerances, the bias exerted by the magnet is substantially constant from ringer to ringer.

When ringing current is applied to the coil 52, the first half-cycle causes flux to flow leftward in the core 48 whence it divides one part of the flux being additive to the biasing flux in the portions 35, 34, and 32 and the second part of the flux being opposite to the biasing flux in the portion 35, additive to the biasing flux in the portions 36 and 38, and air gap *a*, and opposite to the biasing flux in the air gap *b*, and portions 30 and 32. Under this condition the total flux in gap *a* predominates, and the armature 60 moves counterclockwise to an operated po-

7
 sition, thereby moving the clapper 68 (FIG. 2) away from the inside surface of the gong 120. On the next one-half cycle of ringer current the conditions are reversed, and the flux in gap *b* predominates to assist the biasing flux in gap *c* and the bias spring 114 (FIG. 2) in restoring the armature to its original position. The inertia of the clapper carries it beyond its rest position and causes it to strike the inside surface of the gong.

Although but one embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention as the same will now be understood by those skilled in the art.

What is claimed is:

1. A ringer comprising a gong, clapper means for striking the gong, an armature supporting the clapper means, flux generating means including a permanent magnet, pole means situated adjacent to the flux generating means, the pole means having spaced opposing members, the armature extending between the spaced opposing members and in juxtaposition with the permanent magnet, the armature having a groove in the side thereof facing the permanent magnet, and a pivot pin situated in the groove.
2. A ringer as in claim 1 wherein the permanent magnet is a bar magnet having a polar axis, and the pivot pin is asymmetrically located with respect to the polar axis, whereby the permanent magnet biases the armature toward one of the spaced opposing members of the pole means.
3. A ringer as in claim 2 wherein the pivot pin is cylindrical and is situated intermediate the permanent magnet and the armature and is contiguous with a face of the permanent magnet, the diameter of the pivot pin less the depth of the groove in the armature being determinative of the dimensions of the air gap between the permanent magnet and the armature.
4. A ringer as in claim 1 wherein the pivot pin is cylindrical and is situated intermediate the permanent magnet and the armature and is contiguous with a face of the permanent magnet, the diameter of the pivot pin less the depth of the groove in the armature being determinative of the dimensions of the air gap between the permanent magnet and the armature.
5. A compact ringer as in claim 1 wherein the flux generating means further includes a core and a coil disposed about the core, and the pole means has apertures therein through which the ends of the core extend, and securing means secure the core in intimate contact with the pole means.
6. A ringer as in claim 5 wherein one edge defining each of the apertures in the pole means includes a lip, and the securing means secure the ends of the core in intimate contact with the lips.
7. A ringer as in claim 6 wherein the pole means comprises a unitary, ribbon like member having a broad front and rear surface and a narrow top and bottom surface, the broad surfaces all extending perpendicular to a plane common to the bottom surface.
8. A ringer as in claim 1 wherein the gong is rectangular in shape.
9. A ringer as in claim 8 wherein the rectangular gong is the cover for the ringer.
10. A ringer as in claim 1 wherein the clapper means comprises a clapper rod having a clapper secured to one end thereof, the other end of the clapper rod extending along the length of the armature and having a notched portion and a biasing spring having one end thereof positioned in the notched portion, the biasing spring biasing

the armature toward one of the spaced opposing members of the pole piece.

11. A ringer as in claim 10 further including a base, and a clamping plate securing the pole means to the base, the other end of the biasing spring being mounted to the clamping plate.

12. A ringer comprising a gong, clapper means for striking the gong, an armature supporting the clapper means, flux generating means including a permanent magnet, pole means situated adjacent to the flux generating means, the pole means having spaced opposing members, the armature extending between the spaced opposing members and adjacent to the permanent magnet, the armature having a groove therein adjacent to the permanent magnet, and a pivot pin situated in the groove.

13. A ringer comprising a core, a winding disposed about the core, pole means disposed about the winding, the pole means including spaced opposing pole faces, a permanent magnet having one end thereof adjacent to the pole means, a pivot pin situated adjacent to another end of the magnet, an armature having a groove in one side thereof, the armature being positioned with the groove in registration with the pivot pin, the armature further being positioned between the spaced opposing pole faces of the pole means, clapper means secured to the armature, and a gong positioned adjacent to the clapper means.

14. A ringer comprising a core, a winding disposed about the core, a unitary pole piece disposed about the winding, the ends of the pole piece providing spaced opposing pole faces, a permanent bar magnet having one end thereof in juxtaposition with the pole piece, a cylindrical pivot pin positioned in juxtaposition with the other end of the magnet, an armature having a groove in one side thereof, the armature being positioned with the groove in registration with the pivot pin, the armature further being positioned between the spaced opposing pole faces of the pole piece, clapper means secured to the armature, and a gong positioned adjacent to the clapper means.

15. A ringer comprising a linear core, a winding disposed about the core, a unitary ribbon like pole piece disposed about the winding, the ends of the pole piece providing spaced opposing pole faces, the pole piece substantially encompassing the winding and having apertures through which the ends of the core extend, one of the edges defining each of the apertures including a lip, fastening means securing the ends of the core in intimate contact with the lips, a base accommodating the pole piece, a permanent bar magnet secured to the base, the magnet having one end thereof in juxtaposition with the pole piece, a cylindrical pivot pin having one end thereof mounted in the base, the pivot pin being contiguous with the other end of the magnet and asymmetrically located with respect to the polar axis of the magnet, a clamping plate having a hole therein that receives the other end of the pivot pin, the clamping plate securing the pole means to the base, an armature having a groove in one side thereof, the armature being positioned with the groove in registration with the pivot pin, the armature further being positioned between the spaced opposing pole faces of the pole piece, a clapper rod secured to the armature, one end of the clapper rod having a clapper secured thereto, the other end of the clapper rod having notches therein, a biasing spring having one end thereof secured to the clamping plate and the other end thereof positioned in one of the notches of the clamping rod, and a gong positioned adjacent to the clapper.

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