Aug. 23, 1955 J. R. POWER 2,716,232

FLUX MODULATED RINGER

Filed Oct. 25, 1950

FIG. 1

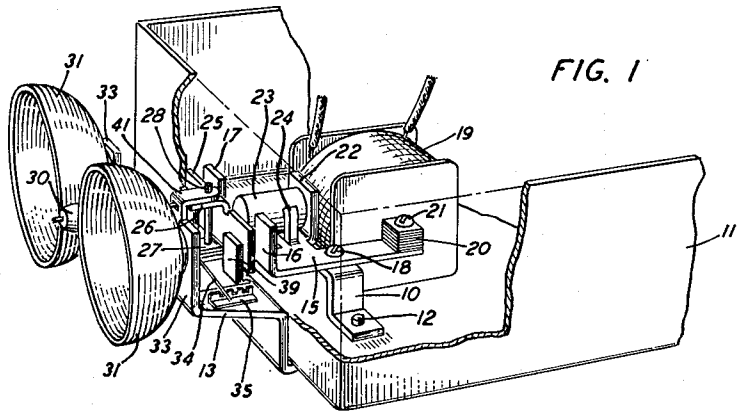


FIG. 2

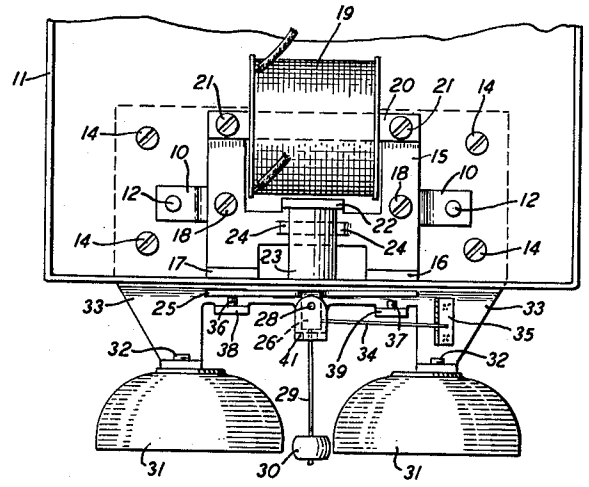
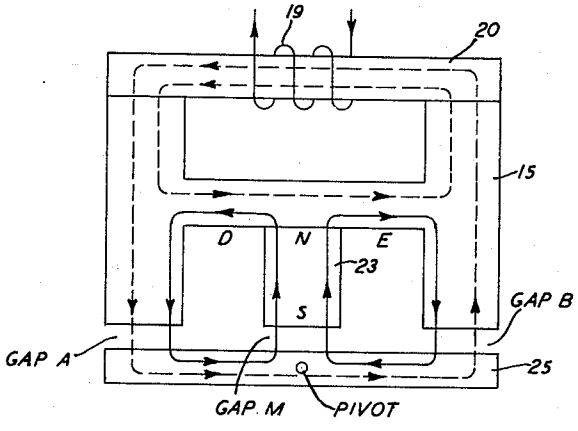


FIG. 3



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FLUX MODULATED RINGER

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5 Claims. (Cl. 340—387)

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

It is the object of this invention to provide an improved type of ringer which is simple in design, compact in construction, small in size, inexpensive to manufacture and which is responsive to electric signals of various frequencies having a minimum power input.

A further object is to provide a ringer of waterproof construction without diminishing the volume of sound radiated therefrom.

These and other incidental objects have been attained in accordance with a particular feature of this invention by the utilization of a magnetic circuit of novel configuration which lends itself to the use of a permanent magnet of small size, simple pole-pieces and a single coil-bearing core, all combined to effect a small compact assembly which will function with maximum efficiency and high sensitivity.

A chief characteristic of an efficient telephone ringer is that the magnetic circuit embodied therein be of such design as to permit a maximum value of flux set up by the ringing current to be effective in actuating the ringing armature. To obtain such a ringer there has been employed in this invention a magnetic shunt constructed of magnetic iron and interposed between the extended pole-pieces of the magnetic core in parallel relation to said core. Attached to this shunt is a small permanent magnet which extends therefrom toward the pivoted portion of the ringing armature. For any given half cycle of ringing current the polarizing flux set up by the permanent magnet and the coil flux set up by said current will be additive in one pole-gap and opposed in the other, thereby creating unbalanced forces which tend to rotate the ringing armature.

In addition to the coil flux flowing through the pole-gap, some of said flux will flow through the magnetic shunt wherein it will add to the polarizing flux in one-half of said shunt and subtract therefrom in the other half. As the shunt is so constructed that its flux density established by the permanent magnet alone is very high, changes in density due to the coil flux flowing therethrough will substantially change the reluctance in the two legs of said shunt. These changes in reluctance, will in turn, destroy the symmetry of the polarizing circuit, with the result that more of the polarizing flux will flow through the pole-gap in which the core and polarizing fluxes are additive, thereby further increasing the torque tending to rotate the armature.

An additional feature of this invention contemplates a magnetic circuit arrangement wherein the ringer may be waterproofed by enclosing the coil, magnet and pole-pieces in a watertight housing, with the armature, clapper and gongs remaining outside said housing. Such an arrangement protects the coil and electrical terminals, and at the same time permits unrestricted radiation of the sound produced.

Still another feature of the invention which contributes materially to the over-all objectives of smallness in size, increased capability and lower costs, resides in the use of a single operating coil.

These and other features of the invention will be readily understood from the following detailed description when read in reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of the ringer embodying the features of the invention, said ringer is shown partially enclosed in a waterproof housing, a section of which has been cut away in order to show the construction of the ringer in greater detail;

Fig. 2 is a front plan view of the ringer shown in Fig. 1; and

Fig. 3 is a schematic illustration of the magnetic circuit of the ringer showing the various flux paths set up therein.

Referring now to Figs. 1 and 2, mounting brackets **10** are shown as the chief support for the portion of the ringing structure which is enclosed in water-tight housing **11**, and base plate **13** serves to support the portion of the ringer structure positioned outside said housing. Brackets **10** are secured to housing **11** by means of screws **12**, and base plate **13** is similarly secured by screws **14**. As an alternative, brackets **10** could be fastened directly to base plate **13**, or made a part thereof, depending upon the need for water-tight housing **11** in any particular application of this ringer.

An H-shaped magnetic iron pole-piece **15**, which has turned-up legs **16** and **17** forming pole-faces of the operating magnetic gap, is attached to brackets **10** by means of screws **18**. Mounted across the opposite legs of pole-piece **15** is the electromagnet comprising coil **19** and laminated silicon-steel core **20**, said core being secured to pole-piece **15** by means of screws **21** which accommodate suitable nuts, not shown. The use of laminated silicon steel for the core, although not essential to satisfactory operation of the ringer, reduces the eddy-current loss thereby helping to maintain a high impedance at voice frequency, a desired condition. A small permanent magnet **23** of substantially round section, preferably constructed of "Alnico V," having its polar axis at right angles to the magentic axis of the electromagnet is placed against turned-up extension **22** of the cross-bar portion of pole-piece **15**. This permanent magnet is held in place by means of crimped legs **24**.

A substantially rectangular-shaped armature **25** is provided with integral bent-over extensions **26** and **27** having suitable holes which accommodate the pivot pin **28** in such a manner as to permit the armature to rotate freely about the pin, said pin being supported from base plate **13** by bracket **41**. Armature extension **26** serves to support a clapper rod **29** which is staked therein. A clapper **30** is staked to the other end of said clapper rod and so placed that said clapper will strike gongs **31** when armature **25** rotates about its pivot point. Gongs **31** are mounted by means of screws **32** into projecting portions **33** of base plate **13** which serve as supporting posts for said gongs.

A biasing spring **34** is staked to extension **27** of the armature, the free end of which may be selectively engaged in one of several notches in the edge of plate **35** which is fastened to base plate **13**. The biasing spring is under such tension that when engaged in one of said notches it will exert a force on the armature tending to hold said armature at the limit of its travel in one direction. The magnitude of this force is adjustable by the selection of the notch in which the spring is engaged. The two stops **36** and **37** are attached to turned-up portions **38** and **39**, respectively, of base plate **13**, and are so positioned as to limit the rotation of armature **25**. Said stops serve as means for preventing the armature from striking housing **11** as shown in Fig. 2. However, if the ringer is operated without housing **11**, then said stops are needed to prevent sticking of the armature to the pole-faces.

Fig. 3 illustrates diagrammatically the magnetic flux paths of the magnetic system embodied in the ringer of this invention. The polarizing flux path, that is, the path traversed by the flux set up by permanent magnet **23**, is represented by continuous lines and the path of the flux set up by the ringing current is represented by broken lines. The arrow heads on the continuous lines 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 the half cycle of alternating current of direction indicated by the arrow heads on coil **19**, it being understood that the flux direction in the latter case is reversed during every half cycle of ringing current. Pole-piece **15** is represented for simplicity as an H-shaped section of magnetic material. The cross bar of said pole-piece will hereinafter be referred to as the magnetic shunt designated by legs D and E.

The polarizing flux emanating from the north pole N of the permanent magnet **23** enters the magnetic shunt portion of pole-piece **15** wherein it divides and traverses two branches: one of which includes leg D of said shunt, air-gap A, armature **25** and thence back to the south pole S of magnet **23** by way of air-gap M; the second path includes leg E of said shunt, air-gap B, armature **25** and thence back to south pole S by way of air-gap M. When the armature **25** is in its neutral position, that is, air-gaps A and B being of equal length, the polarized flux distribution is symmetrical and flows along the paths previously described. Under such condition the flux in gap A equals that in gap B and the magnetic forces in said gaps exert equal and opposite torques on the armatures thereby cancelling one another.

Now assuming that a ringing current traverses coil **19** in the direction indicated, said current will cause flux to flow from core **20** downward into the left leg of pole-piece **15** whence it divides, one branch following a path back to the opposite end of core **20** through air-gap A, armature **25**, air-gap B and the right leg of pole-piece **15**. This coil flux will be additive to the polarizing flux in gap A and opposed to the polarizing flux in gap B. The torques in gaps A and B will, therefore, be unbalanced tending to rotate the armature in a clockwise direction about its midpoint so as to actuate said ringer.

In addition to the above-described path some coil flux will flow through the shunted portion DE of pole-piece **15** in a direction from left to right, assuming the current in coil **19** is as indicated, this flux being additive to the polarizing flux in leg E and opposed to the polarizing flux in leg D. Pole-piece **15** should be so constructed that the flux density in shunt DE is of high magnitude due to the polarizing flux of permanent magnet **23** alone. This is accomplished by constricting the cross-section of said shunt to the extent that the flux density in the shunt is far above the knee of the saturation curve. If the shunt is not so constricted a greater portion of coil flux will pass through said shunt rather than through the pole-gaps. With pole-piece **15** properly designed the changes in density due to the coil flux will cause substantial changes in the reluctance of the two legs: increasing in E and decreasing in D. These changes in reluctance will, in turn, destroy the symmetry of the polarizing flux circuit, and as a result more of said polarizing flux will flow through gap A and less through gap B. The net effect of this shift in polarizing flux is to further increase the torque tending to rotate the armature. This flux modulation feature has been found to substantially increase the force factor of said armature thereby producing a more efficient ringer.

It should be apparent that during the following half cycle of ringing current the polarity of coil flux will be opposite to that herein described so that the fluxes will be additive in air-gap B, thereby tending to rotate armature **25** in a counter-clockwise direction, and so on during succesive half cycles of alternating current.

It is to be understood that the form of this invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the scope of the invention.

What is claimed is:

1. A magnetic circuit comprising a coil, a core having one section on which said coil is mounted and provided at each end with a polar extension of magnetic material projecting at right angles to the coil-mounting section of said core, an armature pivotally mounted at its center with each of its ends disposed in spaced relation to a different one of the polar extensions of said core, a shunt of magnetic material coupling said polar extensions, and a bar-type permanent magnet contiguously associated with said magnetic shunt and disposed in spaced relation to said armature midway of the ends thereof and with its polar axis at right angles to the longitudinal axis of said armature.

2. A polarized electromagnetic device comprising a coil, a core on one section of which said coil is mounted, pole-pieces of magnetic material fixed to said core and extending at right angles from the ends thereof, a shunt of magnetic material disposed between said pole-pieces, a pivotally mounted armature bridging said pole-pieces and adapted to pivot about a center transverse axis thereof, and a straight bar-type permanent magnet having its polar and longitudinal axes coincident, said magnet having one end in fixed abutting relation to said shunt and projecting therefrom in a direction such that the center transverse axis about which said armature pivots is located on the polar axis of said permanent magnet.

3. A polarized electromagnetic device comprising a coil-bearing core having one of a pair of parallelly disposed members of magnetic material projecting in the same direction from each of the ends of said core to effect a substantially U-shaped element, a magnetic shunt member parallelly disposed with respect to said coil-bearing core and joining said parallelly disposed members intermediate the free ends thereof and the said coil-bearing core, an armature spanning the free ends of said parallelly disposed members and pivotally mounted at its center point in spaced relation to the free ends of said parallelly disposed members to effect a pair of air-gaps, and a bar-type permanent magnet having one end in fixed abutting relation with said shunt member substantially at its center and the other end in alignment with the free ends of said parallelly disposed members and in spaced relation to the center point of said armature whereby the polarizing flux produced by said permanent magnet traverses two separate paths each including one of said air-gaps and a substantially half-section of said shunt member and in which said half-sections the polarizing flux travels in opposite directions.

4. The combination of a watertight housing and a telephone ringer consisting of two independent unit assemblies, one of said assemblies comprising a magnet core having pole-pieces, a coil mounted on said core and a permanent magnet, the other of said assemblies comprising an armature, a pair of gongs and a clapper supported by said armature between said gongs, means removably mounting said first assembly wholly within said housing and means removably mounting said second assembly exteriorly of said housing.

5. The combination defined in claim 4 in which the said ringer assemblies are so relatively disposed that the pole-pieces of the interiorly mounted assembly are magnetically coupled with the armature of the exteriorly mounted assembly through a wall of said housing.

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