

March 10. 1931.

E. J. PRATT

1,795,439

MAGNETIC DEVICE

Filed March 26, 1930

3 Sheets-Sheet 1

FIG. 1

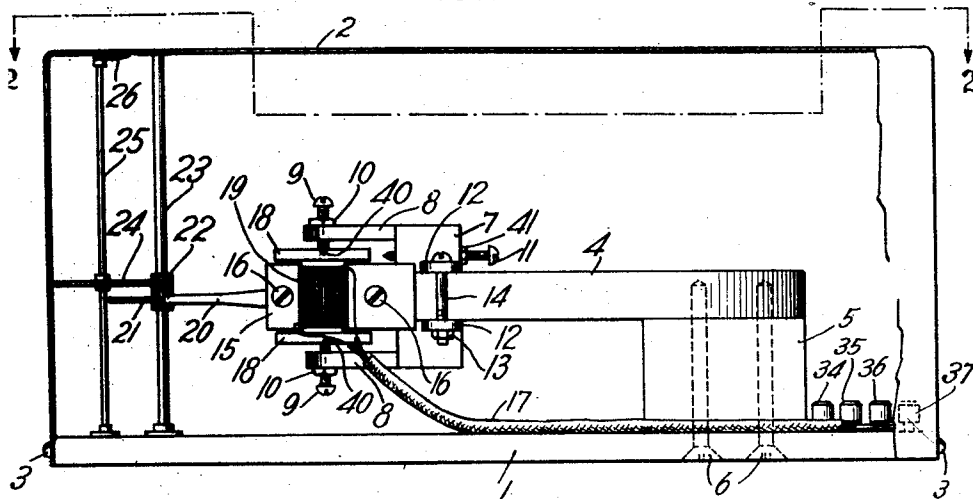
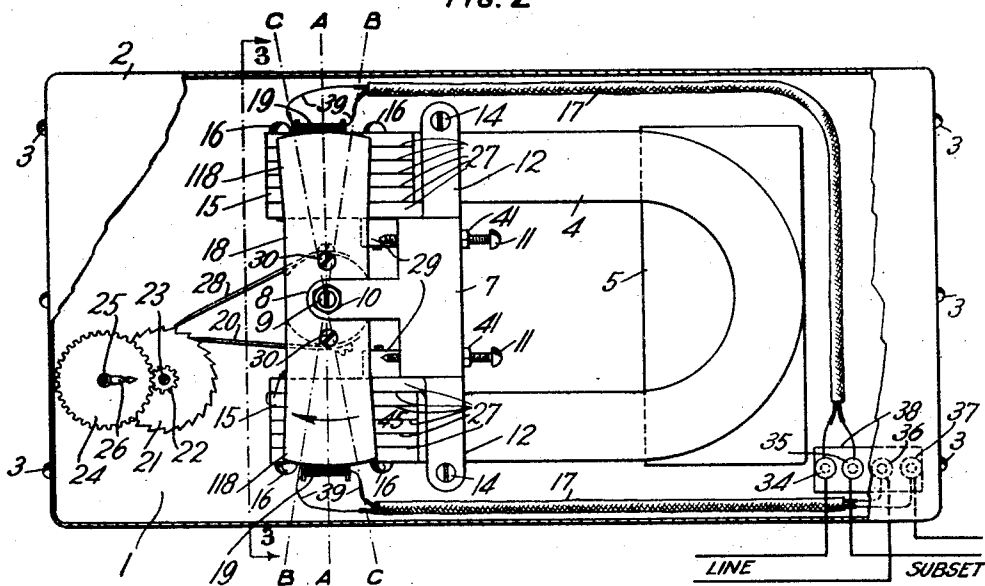


FIG. 2



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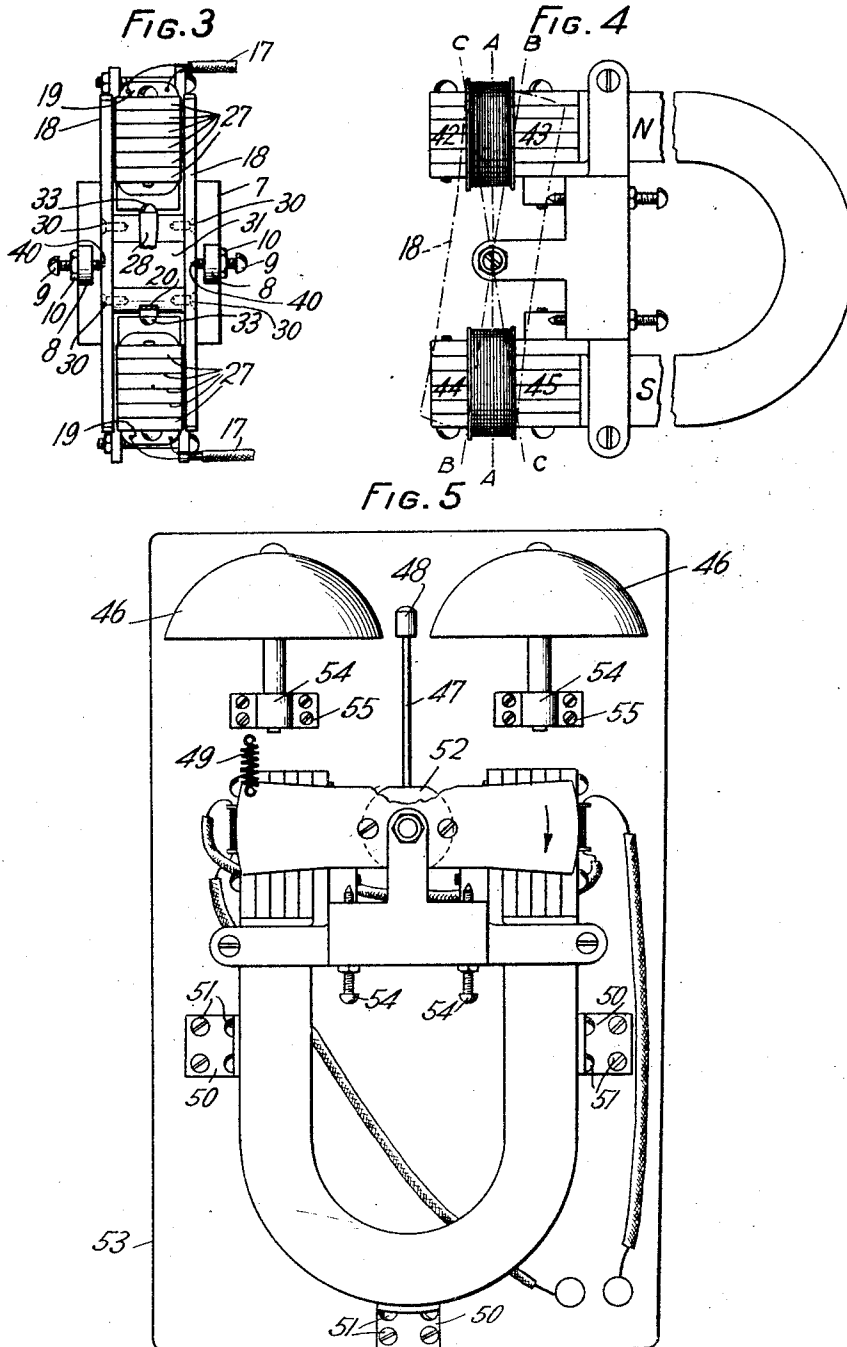
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FIG. 6.

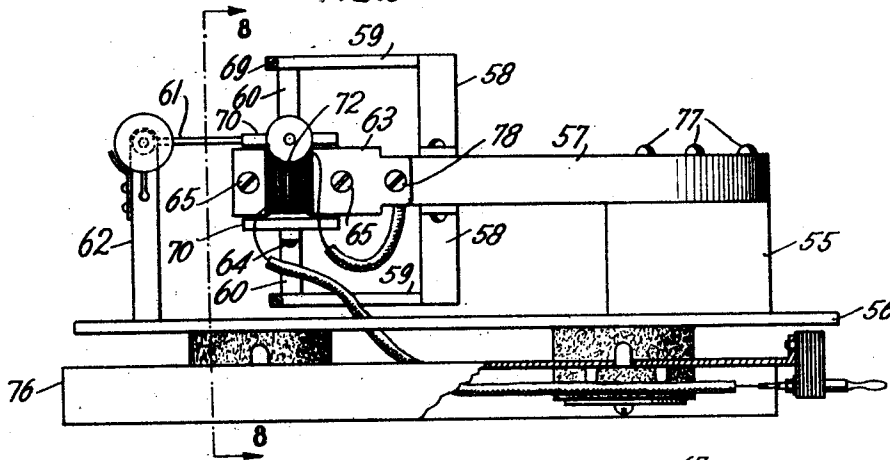


FIG. 7

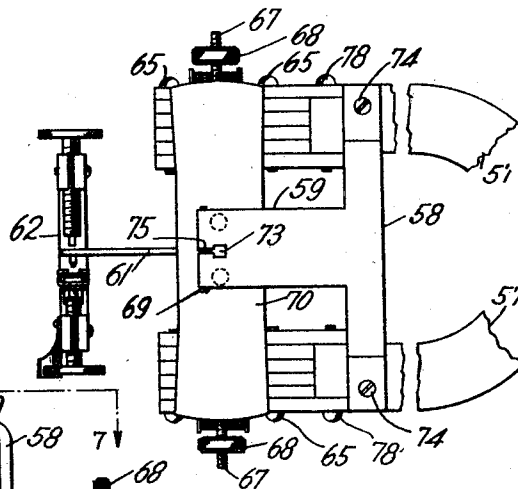
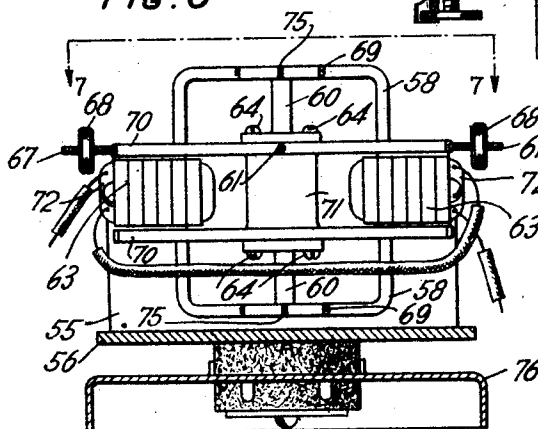


FIG. 8



UNITED STATES PATENT OFFICE

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MAGNETIC DEVICE

Application filed March 26, 1930. Serial No. 438,976.

This invention relates to magnetic devices and particularly to such devices when employed in meters, relays, ringers, loud speakers and the like.

One object of this invention is to increase the sensitivity, to improve the efficiency and to insure greater reliability of operation of magnetic devices.

One feature of this invention resides in so constructing a magnetic device that there is permitted a relatively greater freedom of movement of its movable element as well as the use of greater flux densities in the air gap between the movable and fixed elements of the magnetic device without interfering with its efficiency or inviting undesirable biasing of the movable element.

Another feature of this invention consists in the movable member employed in the magnetic device, said member being so shaped as to produce a slight amount of magnetic bias when it is in either of its extreme positions.

In accordance with this invention there is provided a magnetic device embodying the features of this invention comprising a permanent magnet having pole pieces attached to its extremities, said pole pieces having restricted portions in which energizing coils are wound, and an armature comprising parallel pieces disposed one above and one below said coils and arranged to oscillate in such a manner as to overlap the restricted portions of said pole pieces and the unrestricted portions on either side of the restrictions.

A more complete understanding of this invention will be obtained by reference to the appended drawings wherein:

Fig. 1 is a front elevation of the magnetic device comprising this invention employed in a telephone register;

Fig. 2 is a plan view of the magnetic device of Fig. 1 showing its structure more in detail;

Fig. 3 is an end view of Fig. 2 along line 3-3;

Fig. 4 shows the armature of the magnetic device in one of its operable positions;

Fig. 5 shows the magnetic device of Figs. 1 to 3 as a magnet motor in a ringer; and

Figs. 6, 7 and 8 illustrate the application of this invention to a relay.

The magnetic device comprising this invention is shown in Figs. 1, 2 and 3 applied to a device for registering the time of duration of telephone calls. Mounted on a base plate 1 and spaced therefrom by a member 5, for instance of brass, is a U-shaped permanent magnet 4. Fastening screws 6 hold the magnet and spacing member in the desired position on and with reference to the base plate. The magnet 4 is provided with pole pieces 15 preferably built up of a plurality of laminations 27 which may be of soft iron, or, as found satisfactory in a model embodying the features of this invention, of a nickel-iron alloy comprising approximately 55% iron and 45% nickel. It has been found desirable to form one lamination of each of said pole pieces with spaced projecting portions 12 between which the polar extremities of the permanent magnet are thrust and held therein by drawing portions 12 together by means of bolts 14 and nuts 13. Positioned between the innermost laminations of each pole piece is a member 7, of non-magnetic material, such as brass, which is provided with forwardly extending arms 8 and with projecting portions 29 through which the latter projects one of the screws 16 which secure together the laminations 27 of the pole pieces 15. Each pole piece has a restricted portion intermediate its ends in which a coil 19 is wound. The coil winding terminations are connected to wires in the cords 17 whose other ends are secured to the binding posts 34, 35, 36 and 37 on the terminal block 38. To the proper terminals, for instance as shown, may be connected the telephone line

wires and the telephone wires leading to the subscriber's subset. An armature comprising parallel pieces 18, secured by the screws 30 to a spacer member 31 of non-magnetic material and held at a desired separation thereby, is pivotally supported on the pivot points 40 of screws 9 which thread through the forwardly extending arms 8 of the member 7. When the armature has been properly positioned by adjustment of set screws 9, the latter may be held in their adjusted positions by lock nuts 10. It will be noted that each armature piece has enlarged extremities 118 the purpose of which will be more fully explained with reference to Fig. 4. The armature pieces are adapted for movement in planes parallel to those of the lateral faces of the pole pieces 15 and for oscillation on the pivot points 40 so that they overlap both the restricted and non-restricted portions of said pole pieces. The movement of the armature in response to the periodic reversals in the direction of current flow through the coils 19 may be communicated to a suitable gear train by means of the pawls 20 and 28 engaging with the ratchet 21 and secured to the spacer member 31 by screws 33. Secured to the shaft 23 with the ratchet 21 is a spur gear 22 which meshes with a second gear 24 mounted on a shaft 25 carrying at one end thereof a pointer 26 capable of indicating on a dial (not shown), for visual inspection, the time of duration of a particular call, or for indicating the cumulative time during which use was made of a particular subscriber's line over a given period. It is to be understood that the gear train shown is merely illustrative and might be similar to that shown in the pending application of E. J. Pratt and D. D. Miller, filed May 31, 1929, Serial No. 367,490. The degree of movement of the armature may be limited by screws 11 which thread through the member 7, may be screwed in or out to a desired extent and then secured in the adjusted position by tightening the lock nuts 41 against the member 7. The magnetic device mounted on the base plate 1 may be enclosed in the protector casing 2 which is secured to the base plate by means of screws 3.

The armature has been described as comprising two spaced parallel magnetic pieces 18 pivotally supported for oscillation in planes parallel to the lateral faces of the pole pieces 15. As shown by Fig. 2, each armature piece has enlarged extremities which are so shaped that when the armature piece is in the position shown, each extremity overlaps the restricted and nonrestricted portions of the pole piece face adjacent thereto. When the armature is centered, say along the line B—B in its extreme right hand position, portions of the periphery of each armature piece will be substantially in alignment with one edge of the restriction in each pole piece and each extremity of the armature will overlap both the

restricted and non-restricted portions of the pole piece. This is shown clearly in Fig. 4 the armature's position being indicated by the dotted lines. When the armature piece is in its extreme left hand position centered along the line C—C, portions of the periphery of said armature piece will likewise be substantially in alignment with one edge of the restriction in each pole piece. The portions of said armature piece so situated are the lateral edges of the extremities thereof. When the armature is in either of the extreme positions represented by the center lines B—B and C—C, it will be held thereat by a slight biasing force resulting from the armature's peculiar shaping. When the armature is in other than its extreme positions this biasing force does not exist. This condition can be obtained, it has been found, by properly proportioning the width of the armature to that of the coil restriction.

Inasmuch as the armature comprises two pieces which are rigidly secured together, the position assumed by one armature piece will likewise be assumed by the other. The operation of this device, therefore, will be explained with reference to the reactions of one armature piece only, it being understood that that of the other armature piece will be similar. Refer now to Figs. 2 and 4. The telephone register may be located either at the central office or at the subscriber substation and the energizing coils 19 are connected in series with the telephone lines leading to said substation. The initial position of the armature is immaterial since the device is to measure successive units of conversation time which are measured by the periodic reversals of the talking current in the telephone lines over which a talking circuit has been completed. Assume that the armature is in the position illustrated by Fig. 2 or centered along the line A—A of Fig. 4 and that there is no talking current flowing through the energizing coils 19. The main polarizing flux of the permanent magnet polarized as indicated, will have the following circuit: N, non-restricted portion 42 of one pole piece, armature 18, non-restricted portion 45 of the other pole piece, to S of the permanent magnet. Another circuit will be: N, nonrestricted portion 42 of one pole piece, armature 18, non-restricted portion 44 of the other pole piece, to S of the permanent magnet. The main polarizing flux will also have similar paths through the other armature piece disposed adjacent the other and lower lateral faces of the pole pieces. Assume now that a talking circuit has been completed through the telephone lines with which the coils 19 are in series. If the current flow is in one direction the polarizing magnetic flux will be strengthened in regions 43 and 44 of the pole pieces and weakened in regions 42 and 45 and, to maintain the reluctance of the magnetic cir-

cuit at a minimum, the armature piece will oscillate on its pivot points to center along the line B—B in one extreme position. When at the termination of a definite interval, the direction of flow of the talking current is reversed, the magnetic flux in regions 42 and 45 will be strengthened and that in regions 43 and 44 weakened, whereby the armature piece, in again endeavoring to assume a position in which the reluctance of the magnetic circuit is at a minimum, oscillates to a position centering along the line C—C. It will be noted that the portions 42, 45 and 43, 44 of the pole pieces are diagonally opposite or non-contraposed and are in a similar magnetic condition at the same time. If the subscriber, against whom the units of conversation time are being charged, continues to use the circuit, the oscillations of the armature piece likewise continue as long as the periodic reversals of the direction of flow of the talking current take place. The other armature piece, it is understood, will react likewise. Each oscillation of the armature is communicated to the gear train by means of the pawls 20 and 28, whereby the time of use of the telephone lines may be recorded. It is to be understood that the armature pieces and spacer are made sufficiently heavy so that the armature will not respond to momentary impulses, even though they greatly exceed the normal actuating forces.

It will be apparent from Fig. 3 that the armature pieces 18 are very closely adjacent the lateral faces of the pole pieces 15 and that the air gaps between said faces and said armature pieces, are very small. This is possible inasmuch as the armature pieces are, by this invention, adapted for movements in planes parallel to those of the faces of the pole pieces and, though the air gaps be small, are in no danger of "freezing" thereto. These small air gaps permit of the use of high flux densities and result in a much more efficient magnetic device.

In Fig. 5, the magnetic device described with reference to Figs. 1 to 4 is employed as a magnet motor in a polarized ringer. A reed 47 is screwed into the spacer member 52 and is provided with a weighted end 48 positioned between the gongs 46 which are supported on the base plate 53 by the brackets 54 and screws 55. A biasing spring 49 constrains the armature against rotative movements other than in response to currents of a particular polarity. The magnet motor may be supported above the base plate 53 by L shaped brackets 50 fastened to said base plate and the U shaped permanent magnet 60 by screws 51.

The principle of operation of this ringer is the same as that of the telephone register described above except that the time interval between current impulses is shorter and the armature is biased against movement in a

particular direction. The oscillations being more rapid, the inertia of the armature in the ringer should be of lower order than that of the armature employed in the telephone register. The degree of movement may be controlled by the adjustable screws 54. In this embodiment of the invention, it is also desirable to employ an armature whose spaced pieces are shaped similarly to the armature shown in Fig. 2 in order that for movements in its normal operating range it will be free of any torque due to the magnetic flux of the permanent magnet.

Referring to Figures 6, 7 and 8 still another embodiment of this invention is disclosed, there taking the form of a relay of the type adapted to produce current variations at a definite frequency in a direct current circuit. Although the assembly of the relay may differ structurally from the register and ringer described above, its principle of operation is the same.

Supported upon a plate 56, which is mounted upon a resilient base 76 similar to that shown and described in U. S. Patent 1,523,423, issued January 20, 1925 to J. F. D. Hoge, is a metal block 55 of non-magnetic material. Attached to this block by screws 77 is a U-shaped permanent magnet 57 to whose polar extremities are secured laminated pole pieces 63 having restricted portions in which energizing coils 72 are wound. The laminations comprising each pole piece are maintained adjacent by fastening screws 65. Each pole piece is secured to a pole of the permanent magnet by a screw 78 passing through the elongated portions of the outer laminations and the permanent magnet. The armature consists of parallel magnetic pieces 70 disposed on opposite sides of the energizing coils and closely adjacent the lateral faces of the pole pieces so as to overlap their restricted and non-restricted portions. A spacer member 71, which may be welded or soldered or otherwise secured to each of the armature pieces, maintains them at a desired separation. Each armature piece is fastened by screws 64 to a T-shaped member 60 of spring metal which has a rectangular termination 73 held within a similarly shaped recess in the forwardly extending arm 59 of the bracket 58, which is mounted upon the permanent magnet 57 and secured thereto by screws 74, so that the member 60 may be held tightly in the arm 59. The latter is split at 75 and a screw 69 is provided passing through the bifurcations whereby the termination 73 may be rigidly clamped in the recess. The upper armature piece may be provided with threaded extensions 67 integral therewith, or consisting of studs, upon which movable weights 68 may be placed so that the natural period of the armature may be adjusted to the desired value. Extending from one armature piece is a reed 139

61 adapted to vibrate within the contact block 62 which may be similar to that shown and described in U. S. Patent 1,586,549, issued June 1, 1926 to J. R. Fry.

5 By initially properly dimensioning the armature pieces 70, the spacer member 71, the reed 61, the member 60, and, after assembly, by adjusting the positions of the weights 68 and the degree of clamping of the termina-
10 tions 73, the armature may be made to respond to a variable force of a single frequency. The operation of this device as a relay is similar to its operation in the other devices described, the passage of alternating currents
15 through the energizing coils 72 producing regions of greater or lesser magnetic strength in the non-restricted portions of the lateral faces of the pole pieces 63 causing the arma-
20 ture to oscillate so as to assume positions in which the reluctance of the magnetic circuit is at a minimum. In so oscillating at the frequency to which the armature has been tuned to vibrate, the reed 61 will be caused to com-
25 plete and interrupt the circuit connected to the contact block 62. The efficiency of this relay in comparison with previously proposed devices of like function should be higher in-
asmuch as the small air gaps employed allow high flux densities to be used and relatively large movements of the vibrating mem-
30 ber without any possibility of the latter "freezing".

It is apparent that the magnetic device described above with reference to meter-
35 ing, ringing and relaying apparatus, may have a variety of other applications, for instance, it might be used as a driving unit in a loud speaking telephone. The armature could be made sufficiently low in mass to re-
40 spond to the voice frequencies to be reproduced and the movement of the armature could be communicated to a diaphragm by a reed connected thereto. It is not intended by the recitation of such particular uses or
45 adaptations to limit the scope of this invention other than is indicated by the appended claims.

What is claimed is:

1. The combination in a magnetic device
50 of a field structure including a source of unidirectional magnetic flux having a plurality of pole pieces, said pole pieces having restrictions intermediate their ends, energizing coils in said restrictions, and an armature
55 comprising two parallel pieces one on one side of said coils and one on the other side of said coils and arranged to oscillate in such manner as to overlap restricted and unrestricted portions of said pole pieces.

60 2. The combination in a magnetic device of a permanent magnet, pole pieces adjacent to the poles of said permanent magnet, a coil wound around each pole piece intermediate
its ends and an armature comprising a plural-
65 ity of pieces disposed parallel to and arranged

to oscillate on a shaft extending perpendicular to the planes of the lateral faces of said pole pieces.

3. The combination in a magnetic device of a permanent magnet and pole pieces there-
70 for, said pole pieces having restrictions therein, energizing coils in said restrictions, and an armature mounted to oscillate in such a manner as to overlap the restricted and unre-
75 stricted parts of said electromagnetic members on either side of said restrictions, the sides of said armature being so shaped that when said armature is in its extreme posi-
80 tion one side of the armature is substantially parallel to the edge of the coil restriction.

4. The combination in a magnetic device of a field structure including a source of uni-
directional magnetic flux and a plurality of pole pieces, each pole piece having a restric-
85 tion therein and an energizing coil in said restriction, an armature comprising spaced parallel pieces mounted on opposite sides of the pole pieces for oscillation relative there-
to, and means driven by said armature.

5. The combination in a magnetic device
90 of a U shaped permanent magnet, pole pieces adjacent each pole thereof, said pole pieces each having a restricted portion and an ener-
gizing coil mounted therein, an armature
95 comprising two parallel pieces one on one side of said coils and one on the other side of said coils, said pieces mounted on a shaft extending perpendicular to the plane of the lateral faces of said pole pieces, and means
100 driven by said armature.

6. The combination in a magnetic device of a permanent magnet, pole pieces adjacent thereto, each pole piece having a restriction therein and an energizing coil in said re-
105 striction, and an armature comprising spaced pieces mounted on opposite sides of the pole pieces for oscillation relative thereto in response to the current impulses passing through each coil.

7. A magnetic device comprising a field
110 structure including a source of unidirectional magnetic flux and a plurality of pole pieces, each pole piece having a restriction therein, an energizing coil in each restriction, and an armature supported parallel to the restricted
115 and unrestricted portions of at least one lateral face of each of said pole pieces and adapted to oscillate in a plane parallel thereto in response to current impulses traversing
120 said energizing coils.

8. A magnetic device comprising a per-
manent magnet, pole pieces, each pole piece
having a restriction therein in which an
energizing coil is wound, and an armature
125 supported adjacent the lateral faces of said pole pieces, the width of said armature and that of the coil restriction being so propor-
tioned that for movements of the armature
in its normal operating range it will be sub-
130

stantially free of any torque due to the main polarizing flux.

9. A magnetic device comprising a U shaped source of unidirectional magnetic flux, pole pieces adjacent the extremities thereof, a member of non-magnetic material between said extremities, said member being secured to said pole pieces and having forwardly extending portions, and an armature disposed adjacent the lateral faces of said pole pieces, said armature being pivotally supported between the extending portions of said non-magnetic member.

In witness whereof, I hereunto subscribe my name this 21st day of March, 1930.

EDWARD J. PRATT.