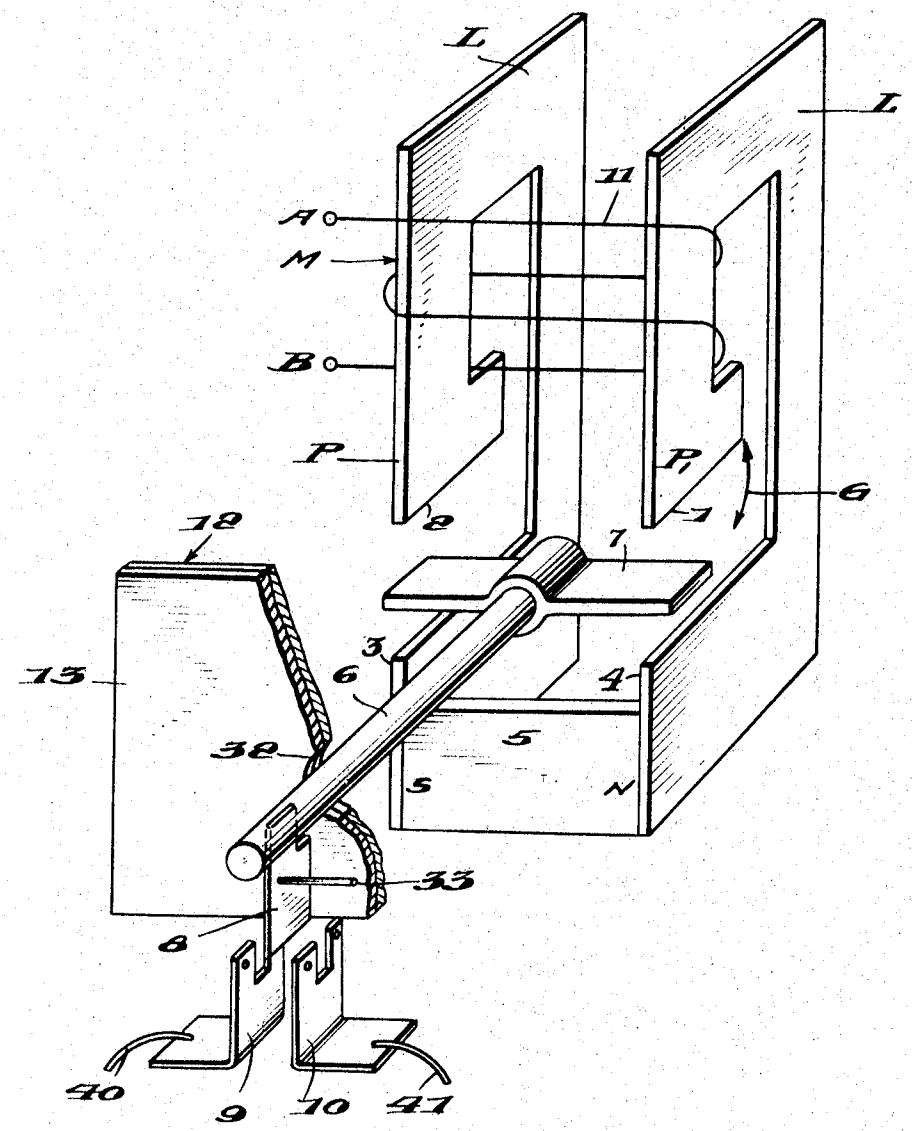
Oct. 31, 1967 G. W. McCALL 3,350,668

ELECTROMECHANICAL CHOPPER

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Fig. 1.



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Fig. 2A.

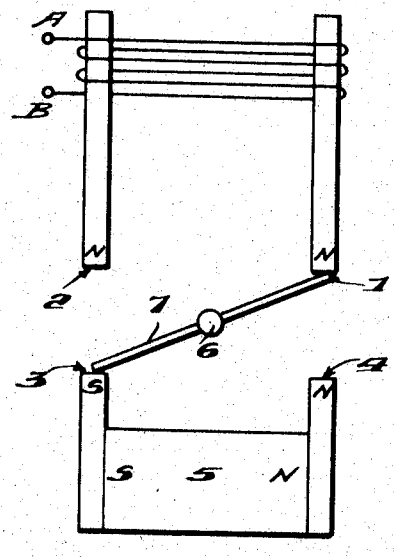


Fig. 2b.

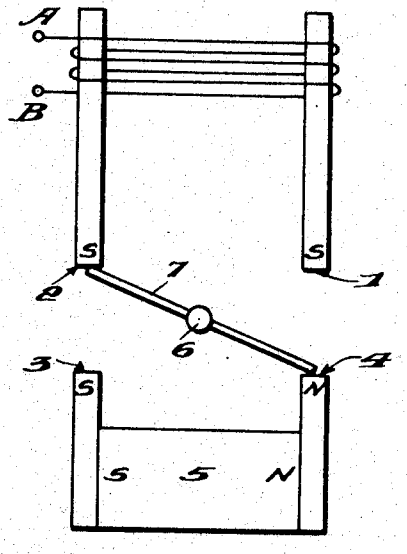
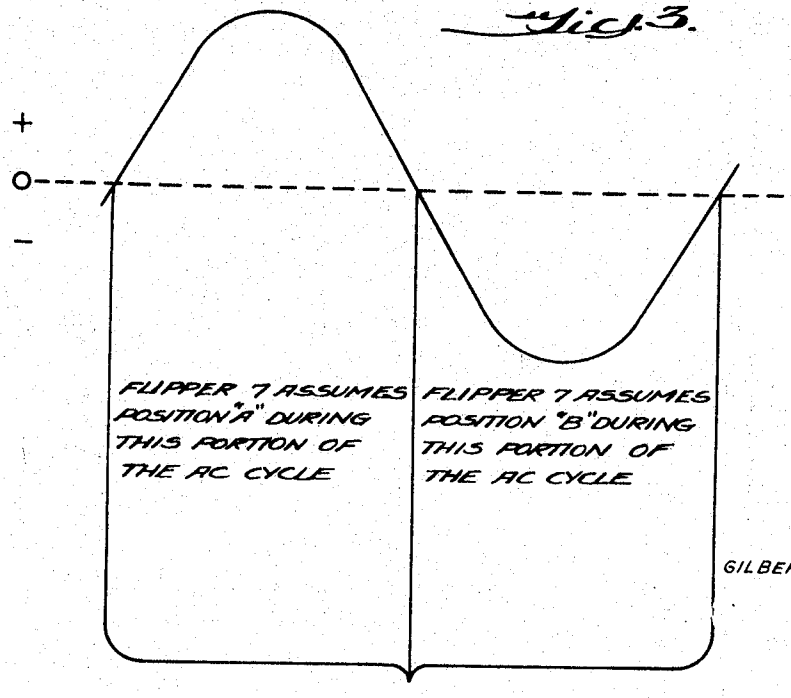


Fig. 3.



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Fig. 4.

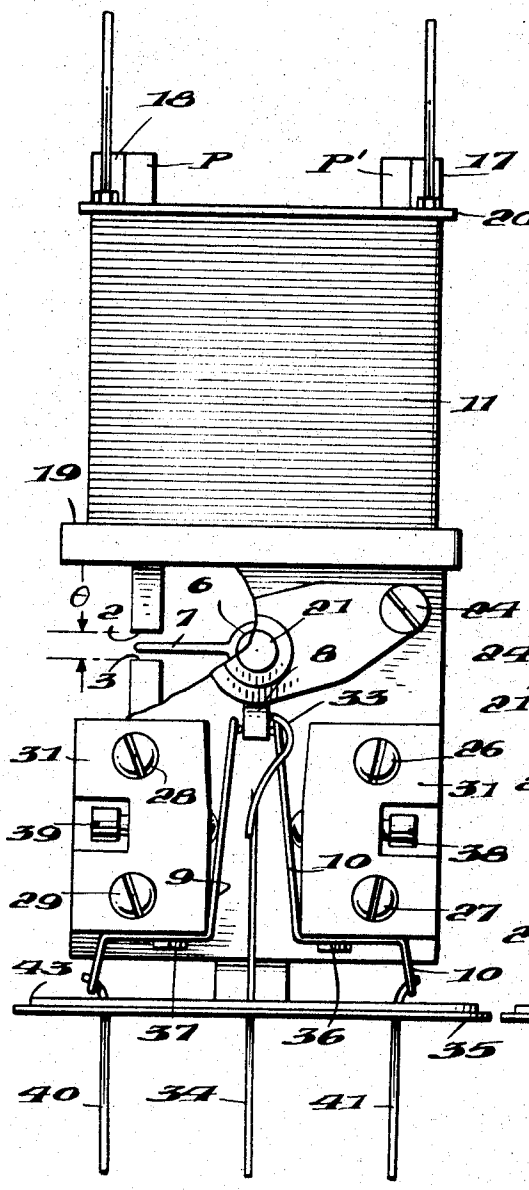
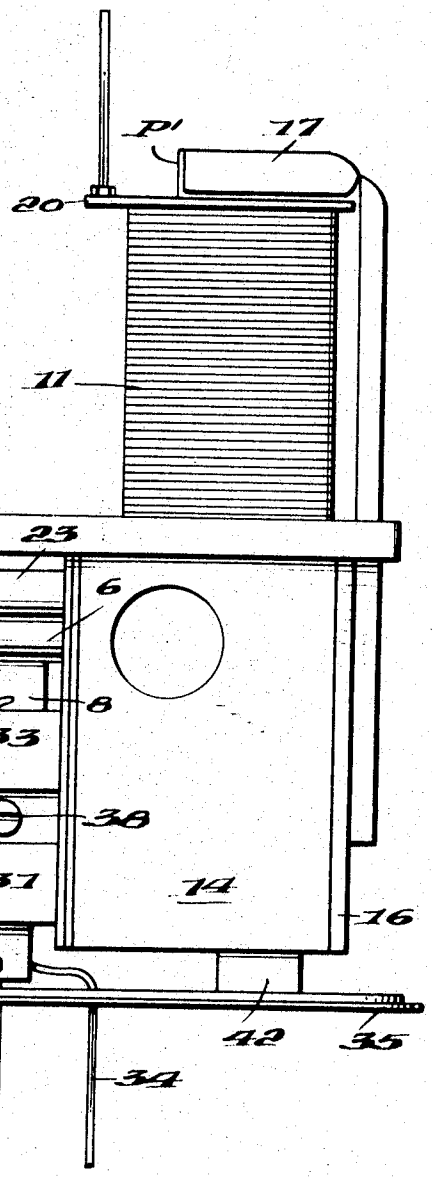


Fig. 5.



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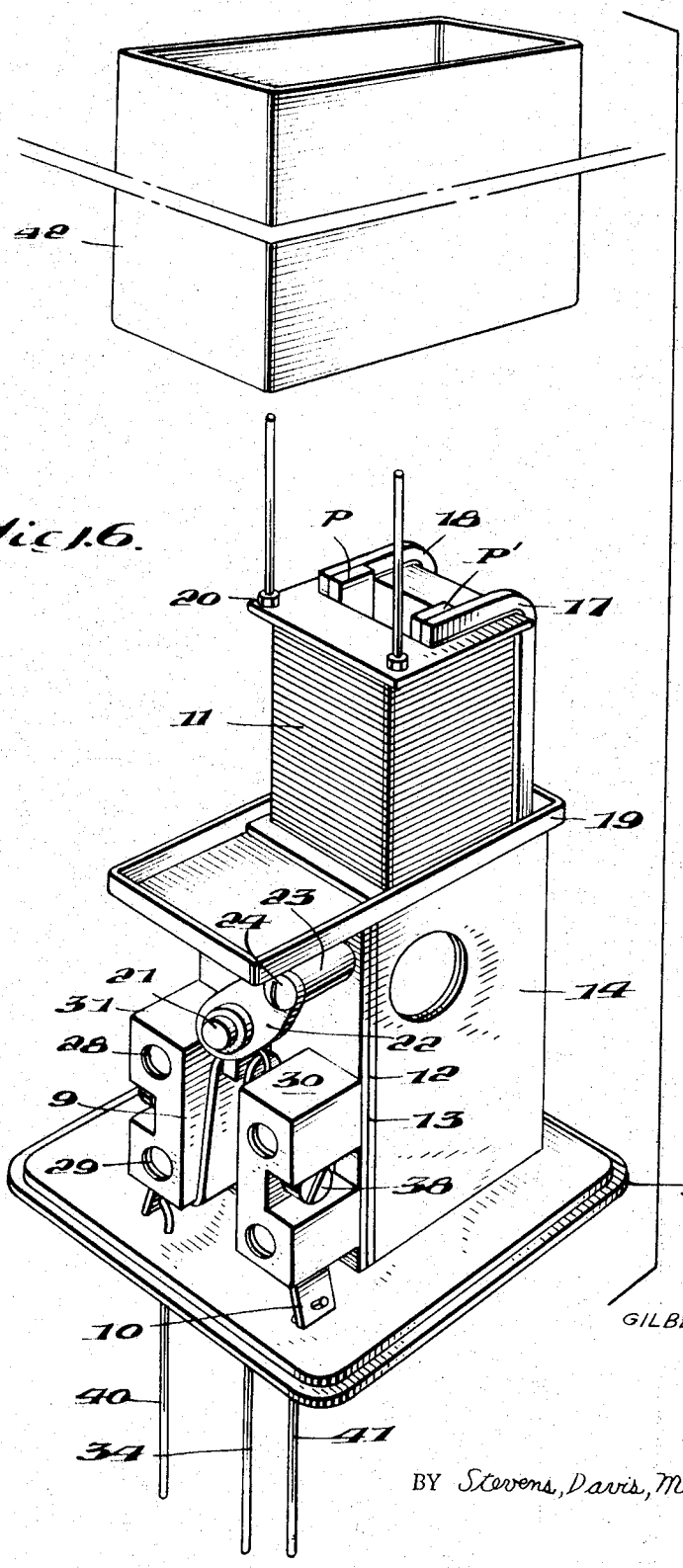
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ELECTROMECHANICAL CHOPPER

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Fig. 6.



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3,350,668

ELECTROMECHANICAL CHOPPER

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Filed Dec. 22, 1965, Ser. No. 515,693
4 Claims. (Cl. 335—91)

ABSTRACT OF THE DISCLOSURE

An electromechanical chopper comprising a pair of transversely aligned C-shaped core members with a permanent magnet spacing the core members operatively near the poles on the same relative sides of the air gaps. An armature mounting shaft supports the armature for free rotation within arcs in the air gaps, and a chopper contact arrangement is provided on the shaft spaced from the armature. A coil operatively wound relative to the other poles receives an AC energizing signal and is wound to simultaneously impart the same north or south characteristic to said other pole so that during operation the armature simultaneously sees two diagonal-like poles and two opposite diagonal unlike poles.

This invention relates to an electromechanical chopper of the type utilizing a novel magnetic drive circuit for the electrical current chopping device.

This invention is an improvement on United States Letters Patent No. 3,115,562 of David A. Robinson, assignor to Airpax Electronics Incorporated, Fort Lauderdale, Fla.

It is an object of this invention to provide an electromechanical chopper utilizing a novel magnetic drive circuit and a highly efficient electrical current chopping device.

It is another object of this invention to provide an electromechanical chopper with an arrangement of a coil, a magnet and contacts rendering the device capable of operating over a wide frequency range, the output of which is exceptionally stable and has very low noise characteristics.

It is another object of this invention to provide an electromechanical chopper in which the electromagnet is employed to complement the permanent magnet field rather than modulate the permanent magnet field.

It is another object of this invention to provide an electromechanical chopper wherein a single permanent magnet and a single electromagnet is employed to provide the energy for chopping electrical current.

Further and other objects will become apparent from the description of the accompanying drawings in which like numerals refer to like parts.

In the drawings:

FIG. 1 is a diagrammatic illustration showing the arrangement of parts cooperating to form an electromechanical chopper;

FIGS. 2*a* and 2*b* illustrate diagrammatically the operation of the electromechanical chopper;

FIG. 3 further illustrates the operation of the chopper as represented in FIGS. 2*a* and 2*b*;

FIG. 4 is a front elevational view of the chopper assembly; and

FIG. 5 is a side elevational view thereof.

FIG. 6 is an overall perspective view of the chopper assembly.

Referring to the drawings, the chopper or contact modulator illustrated therein is driven by a double core magnetic coil in conjunction with a permanent magnet.

Inasmuch as no springs are used to bias flapper **7**, the device is nonresonant and therefore capable of operating over a wide range of frequency.

In FIG. 1 there is an electromagnet M having two separated core elements P and P1. These cores are connected to the pole shoes **3** and **4** of the permanent magnet **5** by means of laminations L and L1. There is an air gap G between the electromagnet pole shoe faces **1** and **2** and the permanent magnet pole shoe faces **3** and **4**. An armature assembly A is mounted in such a manner as to oscillate freely about its longitudinal axis. An armature flapper **7** extends symmetrically on each side of the armature shaft. The armature flapper **7** is positioned so as to extend between the pole shoes and divide the air gaps into two smaller air gaps. On the other end of shaft **6** is a rigidly mounted contact **8** which moves with any motions of the armature shaft. Stationary contacts **9** and **10** are mounted adjacent the moving contact **8** so as to contact moving contact **8** as the shaft **6** is rotated a few degrees from its neutral position. A driving coil **11** is mounted about the pole pieces P and P1. When an alternating current is applied to terminals A and B of the driving coil **11**, the resultant magnetic flux at pole faces **1** and **2** will be instantaneously the same polarity, changing polarity simultaneously with the polarity change of the alternating current passing through the coil. The permanent magnet **5** retains the fixed polarity of the pole faces **3** and **4**. It is therefore evident that at any instant the flapper **7** is exposed to three like poles and one unlike pole (FIG. 2). The flapper **7** will be repelled by the like poles **2** and **4** (FIG. 2*a*) or **1** and **3** (FIG. 2*b*) while it is simultaneously being attracted to the unlike poles **1** and **3** (FIG. 2*a*) or **2** and **4** (FIG. 2*b*). The shaft **6** will rotate in a given direction until contact **8** touches one of the stationary contacts **9**, **10** which restrains further motion in that direction and prevents the ends of the flapper **7** from contacting the pole shoes. Thus it is evident that alternating fluxes at pole faces **1** and **2**, generated by alternating current in coil **11**, will cause the moving contact **8** to move back and forth between stationary contacts **9** and **10** at the same frequency as the frequency of the alternations of current passing through coil **11**. If a DC current is fed to moving contact **8**, the circuit with stationary contacts **9** and **10** will be alternately made and broken. Therefore, when the stationary contacts **9** and **10** and the moving contact **8** are connected to a suitable circuit, a chopped DC current is achieved.

Air gap G has a high flux density, therefore a laminated shield is placed between the flux field and the contacts. Shield **12** is Mumetal to shield the contacts from magnetics and shield **13** is beryllium copper to shield the contacts from electrostatics. Armature shaft **6** is constructed of a nonferrous material and will not transmit magnetic fluxes through the aperture of shields **12**

and 13 through which shaft 6 oscillates. The Mumetal shield 12 and the beryllium copper shield 13 are spaced farther away from the magnetic circuit than the spacing of the air gap G, ensuring the concentration of magnetic fluxes in the gap area G.

FIGS. 4 through 5 illustrate the actual construction of the chopper. The frame 14 is a rigid brass U-shaped piece, the through slot of which forms a space into which the pole pieces are fitted. Pole pieces 3 and 4 are spaced apart by the permanent magnet 5 while the electromagnet pole pieces P and P1 are spaced apart by the slotted back plate 16 which covers the back and top of the frame 14. Pole pieces P and P1 are dimensioned so as to maintain the air gap G with respect to pole pieces 3 and 4. From the uppermost ends of the pole pieces P and P1 are pole piece extensions 17 and 18 intimately attached and extending to the horizontal extensions of pole pieces 3 and 4. Thus the magnetic circuits of both the electromagnet and the permanent magnet are defined as tightly closed loops, allowing flux to flow only through air gap G.

The top plate 19 is affixed to the top of the frame 14 and back plate 16 assembly. Pole pieces P and P1 extend through the top seal plate. A nonmetallic bobbin 20, upon which the drive coil 11 has been wound, is fitted onto the extensions of P and P1. Pole piece extensions 17 and 18, connecting pole pieces P to pole piece 3 and connecting pole piece P1 to pole piece 4, pass through the top plate 19. The top plate is made of nonmagnetic cupro nickel to eliminate shorting out the magnetic circuit and to provide a weldable seal about the top of the device.

A jewel bearing 21 is mounted coaxially with the device and secured by the bearing support 22. The bearing support spacer 23 acts as a rigid mount and holds the bearing support at the proper spacing to obtain the correct pressure needed to secure the shaft 6. In alignment with bearing 21, is a corresponding bearing 32 mounted in the back plate 16. The front flux shields 12 and 13 are secured to the frame 14 by means of screws, 24 which also holds the front bearing support 22 to the bearing support spacer 23, screws 26 and 27 which also hold the right contact block 30 to the shield, screws 28 and 29 which also hold the left contact block to the shield, and screw 25. The shields 12 and 13 are mounted in a position to ensure the alignment of aperture with the bearings 21, 32.

Bearings 21 and 32 form the mount for the rotatable shaft 6 on which is mounted a thin lightweight flapper 7 of magnetic material and constant rectangular cross section and positional in such a manner that the ends are extended into the respective gaps G between the pole shoes.

The moving contact 8 is secured to the shaft 6 at a location between the front bearing 21 and the front shield 13, extending downward to the plane of the flapper 7. A soft wire, gold alloy for instance, is secured to the moving contact 8, forming the electrical and movable connection from the moving contact 8 to the electrical connection 34 through the chopper header 35.

The stationary contacts 9, 10 are secured to their respective contact blocks 30, 31 by means of screws 36, 37. The contact blocks 30, 31 are secured to the frame 14, through the front shields 12, 13, by means of screws 26, 27, 28, 29 and held in such a position as to locate the stationary contacts 9, 10 in the same plane as the moving contact 8 and at a height that causes contact with the moving contact 8 whenever the shaft 6 is rotated. The contact blocks 30, 31 have thread mounted screws 38, 39 which are used to adjust the relative spacing of the stationary contacts 9, 10 to the moving contact 8. The contact blocks 30, 31 are constructed of any insulating material, insulating the stationary contacts 9, 10 from the front shield 13. The ends of the stationary contacts 9, 10 are secured to the respective terminal wires 40, 41, providing an electrical connection from the stationary contacts 9, 10 through the header 35.

The chopper header 35 has a stud 42 upon which the frame 14 is secured by means of pressing the knurled portion of the stud 42 into a proper sized aperture located in the bottom of the frame 14. The purpose of the stud is to rigidly mount the device to a terminal block or header 35 and to maintain a space between the contacts 9, 10 and the header 35.

A rectangular can 42, of a size relative to the outside dimensions of the top plate 19 and to the outside dimension 43 of the header 35, is fitted over the device and hermetically sealed at the top plate 19 and at the header 35 forming a sealed shielded chamber for the contacting devices and forming a cup about the drive coil portion of the device into which an epoxy potting material may be poured. This type of construction will ensure a very rigid structure.

It should be noted that due to the single coil arrangement that a greater number of turns of wire can be made upon the single coil by simply extending the length of the chopper and consequently there will be no increase in the size of the header. Any requirement for an increased number of turns will require no more space for a plug-in type mounting on a printed circuit arrangement.

It should also be noted that all magnetic circuits have tightly closed loops, restricting the magnetic flux to very definite paths. This feature provides an optimal driving energy ratio to power input in the electromagnetic coil and minimizes magnetic flux leakage that might cause electrical noise at the contact area. Noise is further minimized by the laminated copper and Mumetal shields for the simultaneously shielding of the contact area from both electrostatic and electromagnetic fields.

From the foregoing arrangement it will be seen that a very efficient low noise electromagnetic chopper device is achieved and it is to be understood that certain changes, alterations, modifications and substitutions may be made without departing from the spirit and scope of the appended claims.

What is claimed is:

1. An electromechanical chopper comprising a supporting structure, a pair of C-shaped core members mounted on said structure and each including a pair of poles defining an air gap therebetween, the poles of said core members being transversely aligned, a single permanent magnet separating said core members so as to magnetize the poles on the same relative sides of the air gaps to have north-south characteristics respectively, a coil operatively wound relative to the other core member poles to affect the characteristics of said other poles without substantially affecting the characteristics of said first-mentioned poles and adapted to be energized by an AC source, said coil being wound to impart simultaneously the same north or south characteristic to said other poles depending upon the instantaneous sign of the energizing AC source signal, an armature mounting shaft held by the support structure and an armature fixed to the shaft for free armature movement through arcs between the poles defining air gaps, the armature movement being influenced by the attraction between diagonal poles of opposite characteristics and at the same time by the repulsion between the other two diagonal poles of like characteristic, contact means coupled to said shaft to move in response to shaft rotation and being spaced from said armature, a pair of spaced contacts adjacent said contact means and arranged so that the contact means engages one contact when the shaft rotates in one direction past a predetermined center and the contact means engages the other contact when the shaft rotates in the other direction past the predetermined center, and electrical connections to said contact means and said spaced contacts for conducting electrical current therethrough during engagement.

2. An electromechanical chopper as set forth in claim 1, in which said single coil extends around a longitudinally extending portion of both C-shaped core members.

3. An electromechanical chopper as set forth in claim 1, in which a laminated shield member comprising layers of copper and Mumetal is positioned transversely of said shaft between said contacts and said magnetic poles.

4. An electromechanical chopper as set forth in claim 1, in which each said spaced contacts on each side of said contact means is bifurcated to provide parallel paths and thereby minimum electrical contact resistance.

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