A. SIMON.

ALTERNATING CURRENT MAGNET.

APPLICATION FILED OCT. 8, 1906.

969,809.

Patented Sept. 13, 1910.

2 SHEETS—SHEET 1.

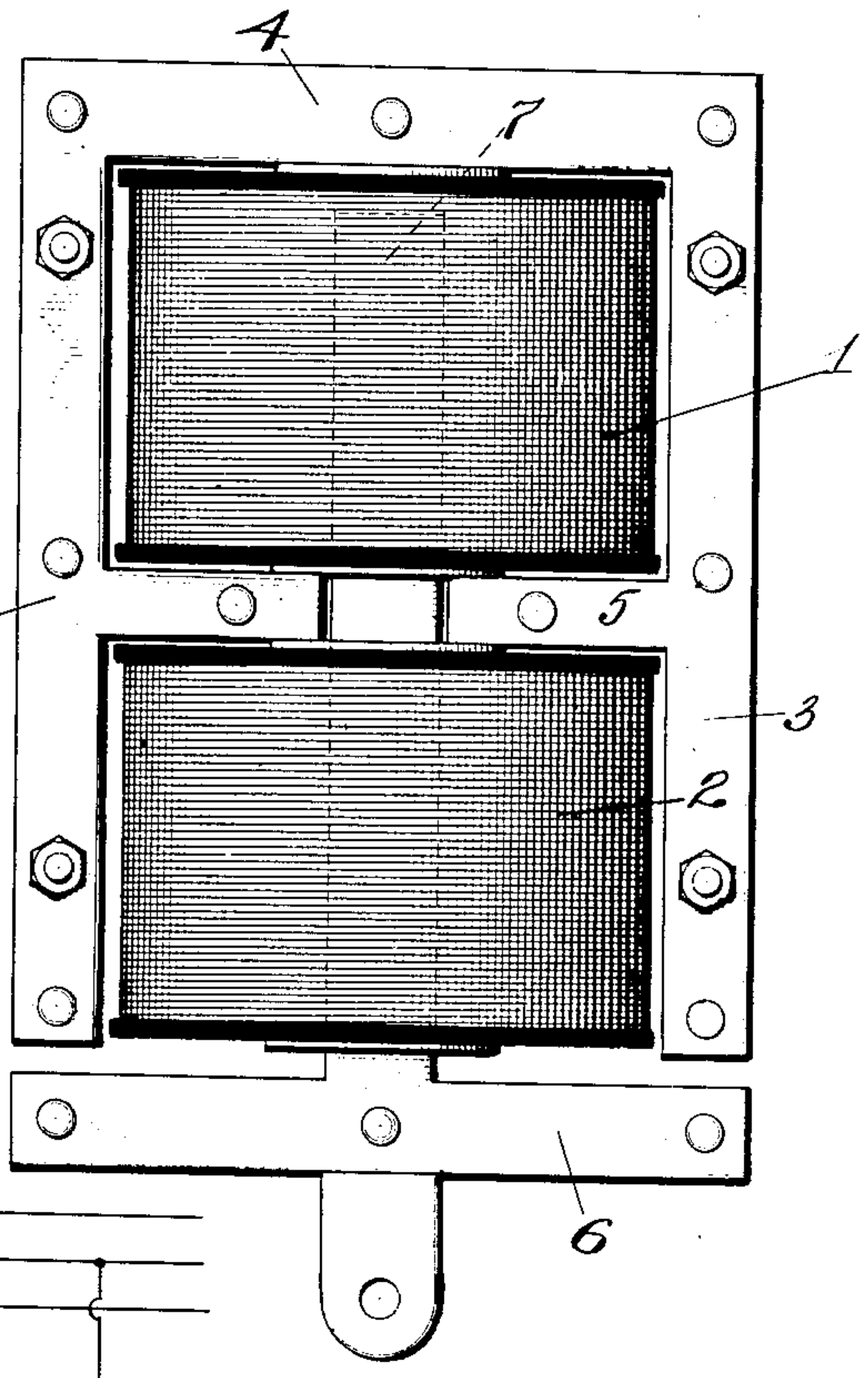

Fig. 1.

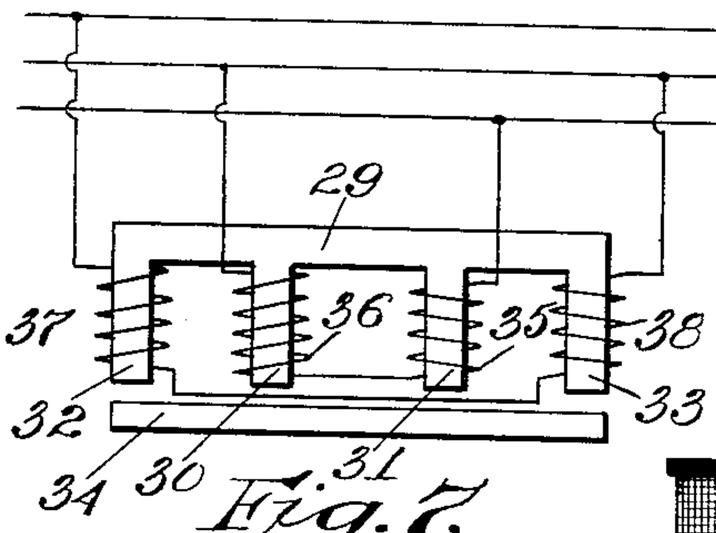

Fig. 7.

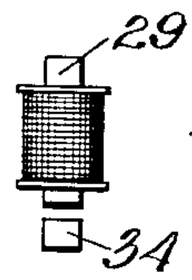

Fig. 8.

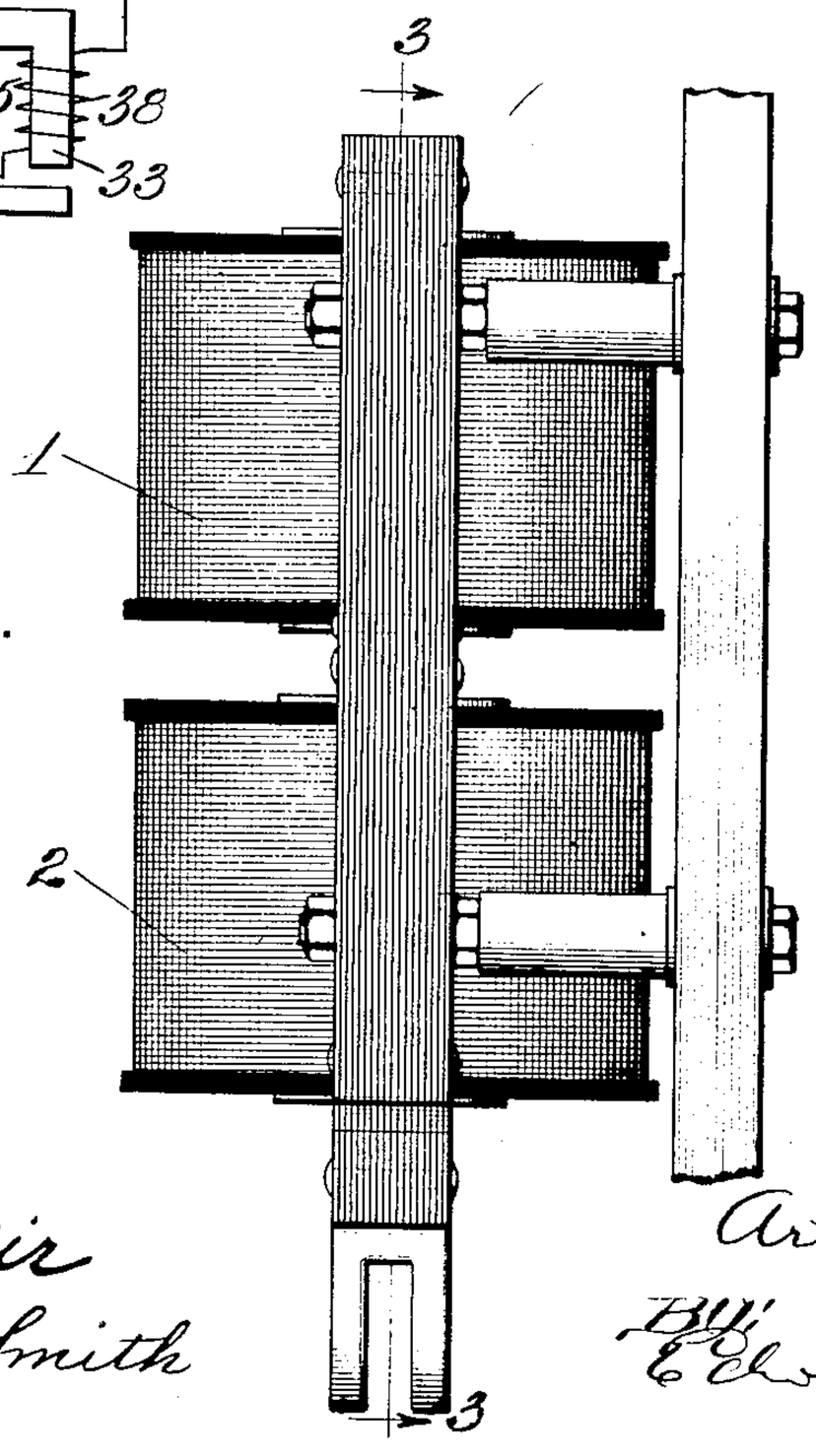

Fig. 2.

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2 SHEETS—SHEET 2.

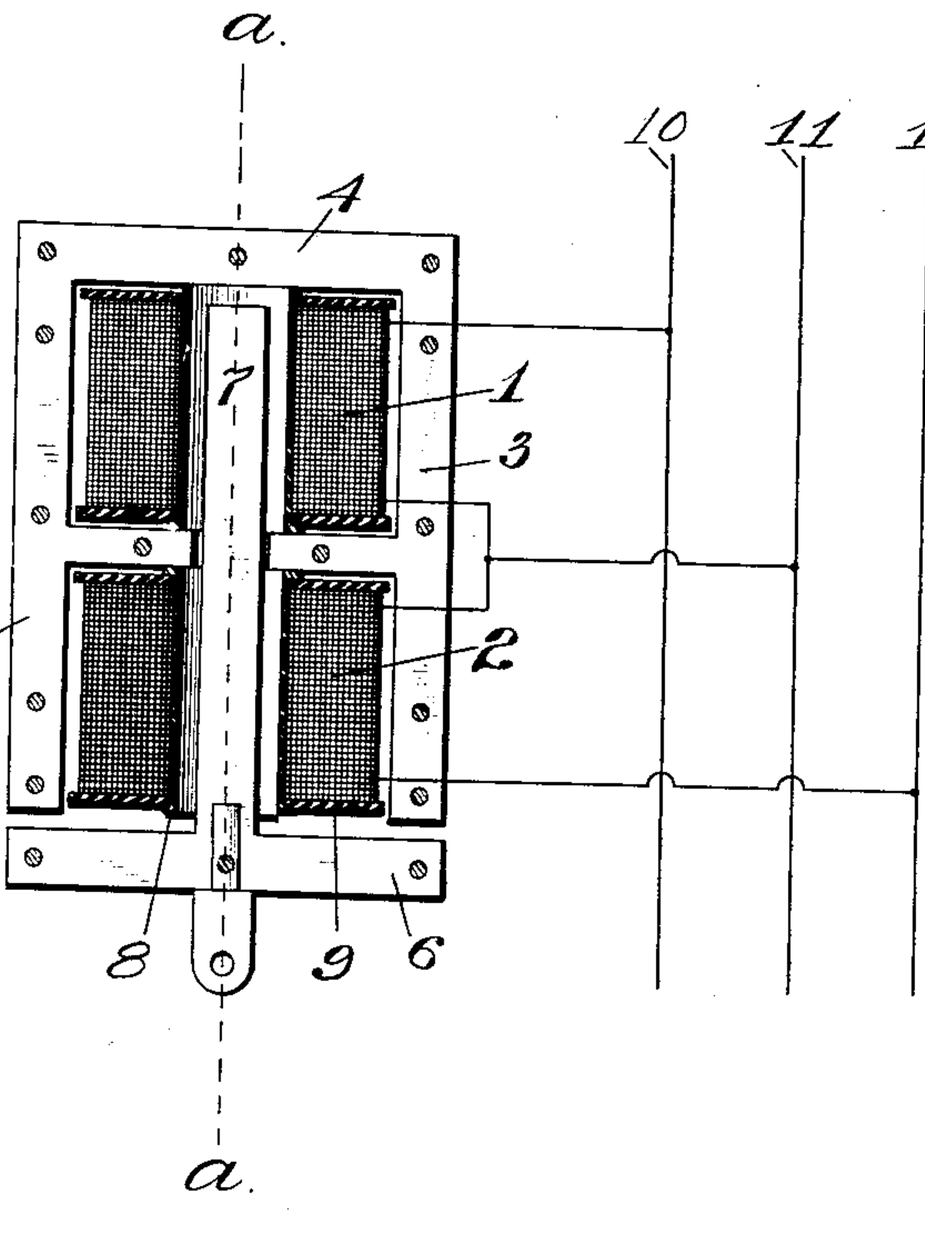


Fig. 3.

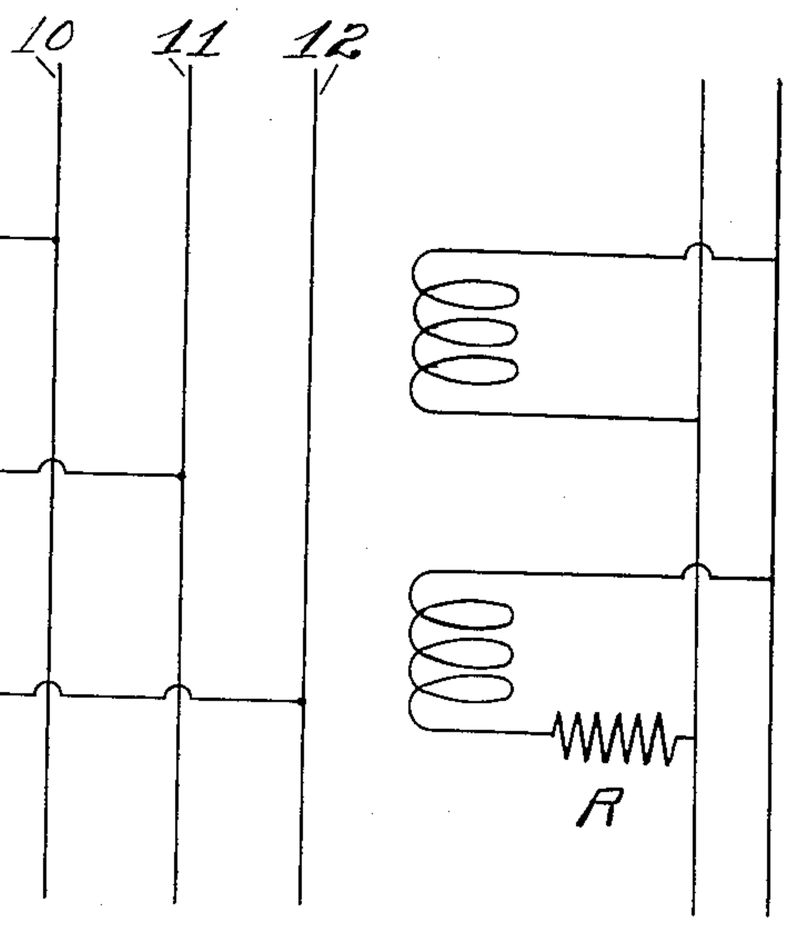


Fig. 4.

Fig. 5.

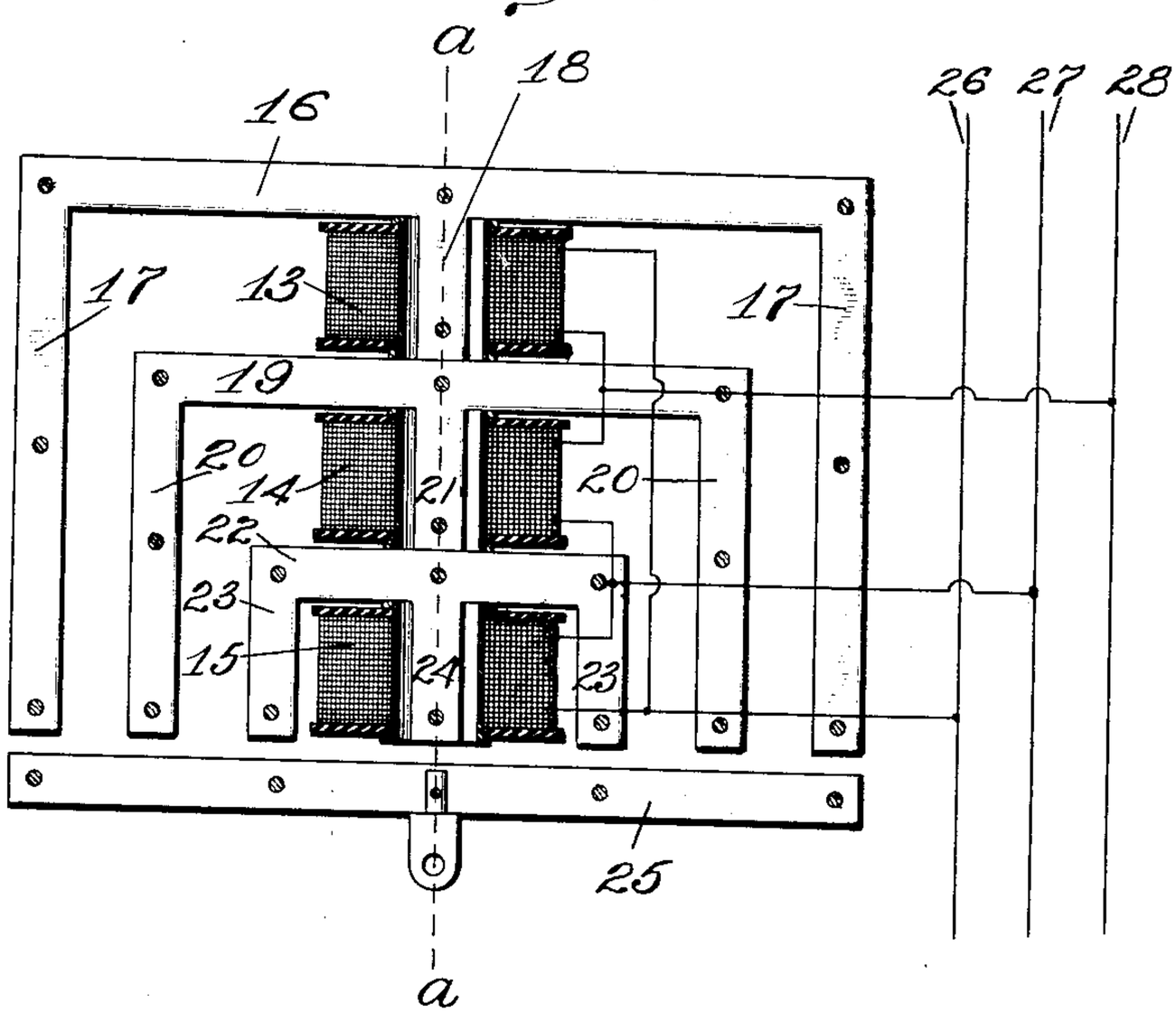
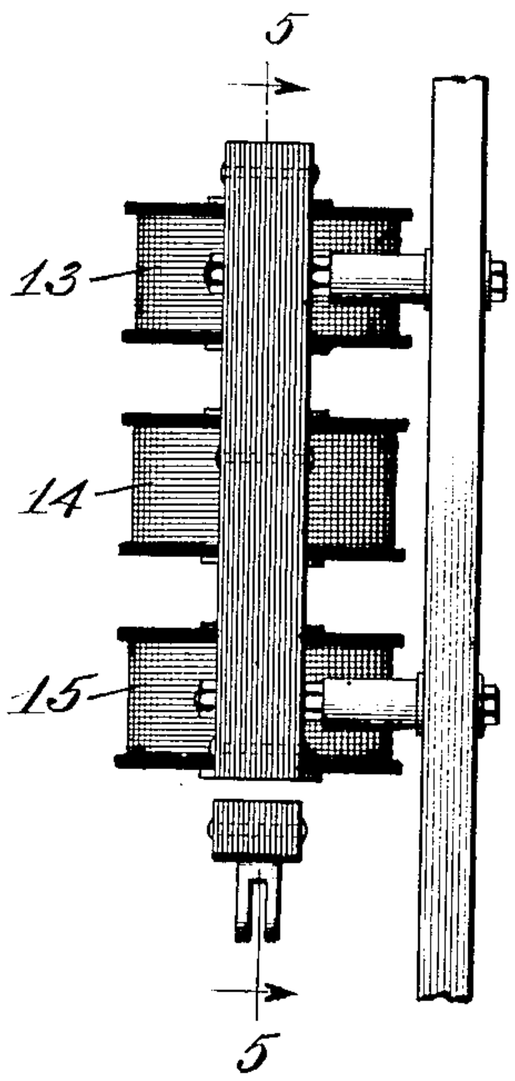


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ALTERNATING-CURRENT MAGNET.

969,809. Specification of Letters Patent. **Patented Sept. 13, 1910.**

Application filed October 8, 1906. Serial No. 338,005.

To all whom it may concern:

Be it known that I, ARTHUR SIMON, subject of the Emperor of Germany, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Alternating-Current Magnets, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in alternating current magnets.

My invention has for its object to produce an alternating current magnet which will exert sufficient minimum pull to keep its armature firmly sealed and in which the center of pull upon the armature will remain substantially stationary.

According to my invention in its preferred form, the magnet is provided with a magnet frame and an armature with which is associated a plurality of windings that produce magnetic fluxes of different phase. The resultant minimum pull of these windings is sufficient to keep the armature firmly sealed to the magnet frame. The magnet frame and the armature conjointly form circuits or paths for the magnetic fluxes. When the magnet frame and the armature are apart the magnetic circuit of each phase is provided with an air gap, and these air gaps completely separate all parts of said armature from said frame. The circuits or paths for the fluxes and the air gaps in said paths, are symmetrical to a common axis so as to distribute the magnetic fluxes symmetrically about a common central line or axis, thereby causing the center of pull upon the armature to remain stationary. Moreover these paths are in the same plane so that the plane of the fluxes does not shift. Inasmuch as the minimum resultant pull of the windings is sufficient to keep the armature firmly sealed to the magnet frame, the fluxes remain in the same plane and the center of pull remains stationary, the armature will not vibrate or chatter in any way.

The terms "magnet" and "electromagnet" as used herein are intended to comprehend solenoids as well as other forms of electro-magnets. Also, the term "armature" applies to any member or part that is attracted by the magnet.

In order to explain my invention I have assumed the electromagnets which are illustrated in the accompanying drawings. It will of course be understood that my invention may be embodied in various forms to attain the results which are sought and that electromagnets which embody my invention may be used in any relation.

Figure 1 is an elevation of one form of my alternating current magnet. Fig. 2 is a side view thereof. Fig. 3 is a sectional view on the line 3—3 of Fig. 2, showing one way of connecting the coils to an alternating current circuit. Fig. 4 shows another way of connecting the coils to an alternating current circuit. Fig. 5 is a sectional elevation of one modified form of my electromagnet, the section being taken on the line 5—5 of Fig. 6. Fig. 6 is a side elevation of the magnet illustrated in Fig. 5. Fig. 7 is an elevation of another modified form of my electromagnet, and Fig. 8 is a side view thereof.

The electromagnet which is illustrated in Figs. 1, 2 and 3 is provided with two coils, or windings, 1 and 2, which are preferably arranged in substantially axial alinement. These coils are energized by an alternating current, and produce magnetic fluxes of different phase. These coils are preferably mounted in a laminated magnet frame which is formed with side pieces 3, a top piece 4 and central cross piece 5. Below the lower extremities of the side pieces 3 is arranged an armature 6, substantially parallel to the top piece 4 and cross piece 5. Of course, the magnet frame and the armature may be made in various forms, according to the structure of the magnet. The armature is provided with upward extension or plunger 7 which extends through the coils 1 and 2 and passes through the cross piece 5. Between the cross piece and the core piece there is only sufficient mechanical clearance to allow the plunger to move freely. The coil 1 is surrounded by the upper portions of the side pieces 3, the top piece 4 and the cross piece 5. The coil 2 is surrounded by the lower portions of the side pieces 3, the cross piece 5 and the armature 6.

The magnet frame and the armature form two circuits or paths for the magnetic fluxes in the same plane, one for each coil. When the armature is separated from the magnet frame as shown in Fig. 1, an air gap is interposed in the magnetic circuit of each coil,

the air gap in the magnetic circuit of the coil 1 being arranged between the top of the plunger 7 and the top piece 4, and the air gap of the coil 2 being arranged between the lower extremities of the side pieces 3 and the armature 6. These air gaps completely separate the armature from the magnet frame. When the armature is sealed to the magnet frame, the air gaps are practically eliminated, the armature being in engagement with the lower extremities of the side pieces, the top of the plunger 7 being in engagement with the top piece 4.

The coils 1 and 2 may be wound upon tubes of nonmagnetic material 8 between insulating disks 9.

The magnetic circuits or paths for the fluxes of the coils 1 and 2 and the air gaps in these circuits are arranged symmetrically to a common axis so as to distribute the magnetic fluxes symmetrically about a common center line, as shall be hereinafter explained.

The magnetic flux of the coil 1 passes principally through the upper portion of the plunger 7, thence dividingly to the top piece 4, the upper portion of the side pieces 3 and the cross piece 5 back to said plunger. The magnetic flux of the coil 2 passes principally through the lower portion of the plunger 7, thence dividingly through the cross piece 5, the lower portion of the side pieces 3 and the armature 6, back to said plunger. The magnetic fluxes are thus distributed in the same plane and symmetrically to a common center line or axis *a*, *a*. Fig. 3, thereby causing the center of pull upon the armature to remain stationary.

The manner in which the coils 1 and 2 may be connected to a three-phase alternating current circuit is illustrated in Fig. 3. The circuit is provided with mains, 10, 11 and 12. One terminal of the coil 1 is connected to the main 10 and one terminal of the coil 2 is connected to the main 12, while the other terminal of each of said coils is connected to the main 11. The coils are thus energized by currents of different phase, and accordingly magnetic fluxes of different phase are produced. The minimum value of the resultant pull of the windings is therefore always above zero, and it is sufficient to keep the armature firmly sealed to the magnet frame. It will be understood that the coils may be connected to a circuit of any number of phases so long as the same produce magnetic fluxes of different phase.

Fig. 4 exemplifies the way the winding may be made to produce fluxes of different phase if connected to a single phase alternating current circuit or to one phase of a polyphase alternating current circuit. I have illustrated a single phase circuit, across which both windings are connected. The phase of the current in one or the other of the coils may be either advanced or retarded by any suitable means. The drawing shows an inductance R, for retarding the phase of the current in the coil 2.

Another form of my electromagnet is illustrated in Figs. 5 and 6. It is provided with three coils 13, 14 and 15 which are arranged in substantially axial alinement. The coils 13, 14 and 15 are mounted upon a magnet frame which may be considered as having three parts, one for each coil. The part for the coil 13 is provided with a top piece 16 and side pieces 17, 17 and a core or center piece 18, the coil 13 being arranged around said core piece. The part for the coil 14 is provided with a top piece 19, side pieces 20, and a core or center piece 21, the coil being arranged around said core piece. The part for the coil 15 is provided with a top piece 22, side pieces 23, and a core or center piece 24, said coil being arranged around said core piece. The several parts of the frame are preferably arranged one within the other, the core or center pieces 18, 21 and 24 being arranged in alinement and suitably connected so as to join the several parts of the frame together. The three parts of the frame are preferably made in separate pieces, and then fastened together, so that the coils may be readily placed in position. It will be understood that the frame may assume other forms than that illustrated. The lower extremities of the side pieces, 17, 20 and 23, of the several parts of the frame are preferably arranged in horizontal alinement. The magnet is provided with an armature 25 which is adapted to engage these extremities. The armature and the magnetic frame form circuits or paths for the magnetic fluxes, one for each coil, as shall be hereinafter described. When the armature is separated from the magnet frame as shown in Fig. 5, an airgap is interposed in the magnetic circuit of each coil, the several air gaps being arranged between the armature 25 and the lower extremities of the side pieces, of the several parts of the frame. These air gaps completely separate the armature from the magnet frame. The paths or circuits for the magnetic fluxes and the airgaps of these circuits are arranged symmetrical to a common axis and in the same plane so as to distribute the magnetic fluxes symmetrically about a common center line or axis in the manner which is hereinafter described. The magnetic circuit of the coil 13 extends through the core 18, the top piece 16, the side pieces 17, armature 25, core pieces 24 and 21. The magnetic circuit of the coil 14, extends through the core piece 21, top piece 19, side pieces 20, armature 25 and core piece 24. The magnetic circuit of the coil 15 extends through the core piece 24, top piece 22,

side pieces 23, and armature 25. These magnetic circuits distribute the magnetic fluxes and in the same plane and symmetrically about the common center line or axis *a*, *a*, Fig. 5, and accordingly the center of pull upon the armature remains substantially stationary. The preferred manner of connecting the coils 13, 14 and 15 in circuit is illustrated in Fig. 5. The circuit is provided with mains 26, 27, and 28. The coil 13 is connected between the main 28 and the main 26, the coil 14 is connected between the main 28 and the main 27 and the coil 15 is connected between the main 27 and the main 26.

The modified form of my invention provides a structure which is adapted for any number of coils. The magnet may therefore be constructed so as to provide a coil for each phase of any polyphase current circuit. The form of the magnet frame provides an independent magnetic circuit for each coil and in each of these circuits is arranged an air gap.

Figs. 7 and 8 show another way of forming my magnet so as to distribute the fluxes of different phase in the same plane and symmetrically about a common axis. The magnet frame is provided with a top piece 29, from which extend inner core-pieces 30, 31, and outer core pieces 32, 33. The core-pieces extend downwardly from the top piece and below the same is arranged an armature 34. The core pieces 30 and 31 are surrounded by coils 35 and 36 respectively, and the core pieces 32 and 33 are surrounded by coils 37 and 38 respectively. The coils 35 and 36 are connected in series with each other as are the coils 37 and 38. The former produce a flux of one phase, and the latter a flux of another phase. The flux of the coils 35 and 36 flows principally around a path or circuit formed by the top piece 29, core piece 30, armature 34, and core-piece 31; and the flux of the coils 37 and 38 flows principally around a path formed by the top piece 29 core piece 32, armature 34 and core piece 33. The fluxes of different phase are thus distributed in the same plane symmetrically to the common axis *a*, *a*, Fig. 7.

The several forms of magnet that I have described will illustrate the various features of my invention, and serve to show the variety of ways in which my invention may be embodied.

Having thus described my invention, which I claim as new and desire to secure by Letters Patent, is—

1. In an alternating current magnet, in combination means for producing fluxes of different phase and means for distributing the fluxes symmetrical to a common axis and in the same plane.

2. In an alternating current magnet, in combination a plurality of coils for producing magnetic fluxes of different phase, means forming magnetic circuits or paths for said fluxes in the same plane, said paths being adapted to distribute the fluxes symmetrically about a common axis.

3. In an alternating current magnet, in combination, a plurality of coils adapted to produce magnetic fluxes of different phase and paths for said fluxes arranged symmetrically about a common axis in the same plane.

4. In an alternating current magnet, a plurality of coils for producing magnetic fluxes of different phase, paths for said fluxes arranged in the same plane, each path being provided with an airgap and said paths and said airgaps being arranged symmetrical to a common axis.

5. In an alterating current magnet, in combination a plurality of coils adapted to produce magnetic fluxes of different phase, a magnet frame, and an armature adapted to be attracted to said frame, said frame and said armature forming paths for said fluxes and said paths being arranged in the same plane and symmetrical to a common axis.

6. In an alternating current magnet, a plurality of coils arranged in substantially axial alinement and adapted to be connected across different phases of an alternating current circuit and means for providing magnetic circuits for said coils in the same plane.

7. In an alternating current magnet, in combination a plurality of coils arranged in substantially axial alinement, a magnetic frame forming magnetic circuits for said coils in the same plane.

8. In an alternating current magnet, in combination a plurality of coils adapted to produce magnetic fluxes of different phase and arranged in substantially axial alinement, and a magnetic frame and armature forming a magnetic circuit for each coil, each magnetic circuit being provided with an airgap when the armature is separated from the frame.

9. In an alternating current magnet, in combination a magnetic frame, an armature, a plurality of coils adapted to produce magnetic fluxes of different phase mounted upon said frame and arranged in substantially axial alinement, said frame and said armature being so formed as to provide a plurality of magnetic circuits, one for each coil and each circuit being provided with an airgap arranged between said armature and said frame when said armature is separated from said frame.

10. In an alternating current magnet, in combination, a plurality of alternating current windings arranged in substantially axial alinement, a magnet frame and movable armature forming a magnetic circuit

for each of said windings, said frame and said armature having portions passing through said windings and extending around each of the same in the direction of the magnetic fluxes produced thereby, said windings being adapted to produce magnetic fluxes of different phase to magnetically attract said armature in the same direction.

11. In an alternating current magnet, in combination, a plurality of coils adapted to produce magnetic fluxes of different phase arranged in substantially axial alinement, a magnetic frame having said coils carried thereby, an armature and a core piece extending through said coils.

12. In an alternating current magnet in combination a plurality of coils arranged in substantially axial alinement, a magnetic frame having parts thereof extending around said coils, and an armature having an extension or core piece extending through said coils, an airgap being interposed in the magnetic circuits of said coils between said armature and said frame and said extension and said frame when said armature is separated from said frame.

13. In an alternating current magnet, in combination a plurality of coils arranged in substantially axial alinement, a magnetic frame having side pieces, a top piece and a cross piece, and an armature having a core piece extending through said coils, one coil being surrounded by said top piece, said side pieces and said cross piece, and the other coil being surrounded by said cross piece, said side pieces, and said armature.

14. In an alternating current magnet, in combination a plurality of coils adapted to produce magnetic fluxes of different phase and arranged in substantial axial alinement, and a magnet frame and armature forming suitable paths for said fluxes, one for each flux.

15. In an alternating current magnet, in combination, a plurality of coils adapted to produce fluxes of different phase and arranged in substantial axial alinement, and a magnet frame and armature forming paths for said fluxes, one for each flux, said armature and said frame being so formed as to distribute said fluxes symmetrically about a common axis and in the same plane.

16. An alternating current magnet comprising an armature, a frame, and means for producing magnetic fluxes of different phase, arranged symmetrically about a common axis in the same plane, the armature and frame of said magnet being so formed that when the former is separated from the latter air gaps symmetrical to said axis are introduced in the magnetic circuits of said electro-magnet whereby symmetrical pulls are exerted by said fluxes between said frame and said armature.

17. In an alternating current magnet, in combination a plurality of coils for producing magnetic fluxes of different phase, a frame and armature forming circuits or paths for said fluxes, one for each flux, said paths being arranged symmetrically about a common axis in the same plane and said magnet having, when deënergized, suitable air gaps arranged symmetrically about said axis whereby symmetrical pulls are exerted by said fluxes between said frame and said armature.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

ARTHUR SIMON.

Witnesses:
R. E. LUDWICK,
R. C. FENNER.