June 3, 1930. P. TROMBETTA 1,761,759

ELECTROMAGNET

Filed Jan. 15, 1929

Fig. 1.

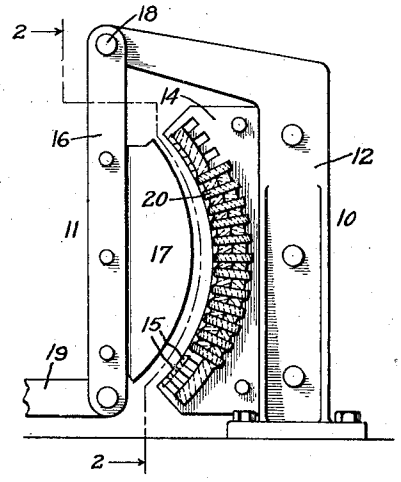


Fig. 2.

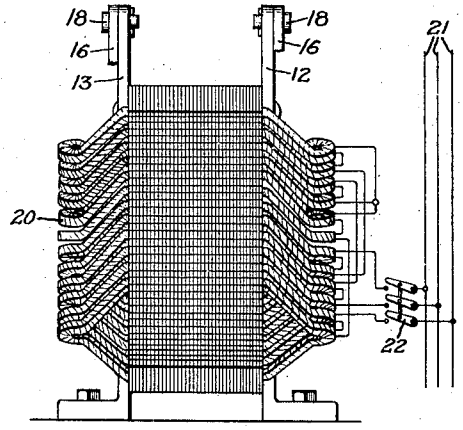


Fig. 3.

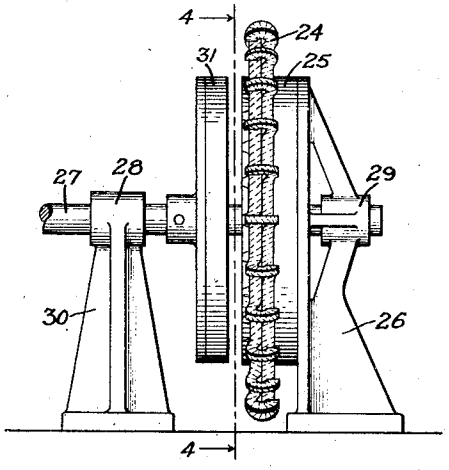


Fig. 4.

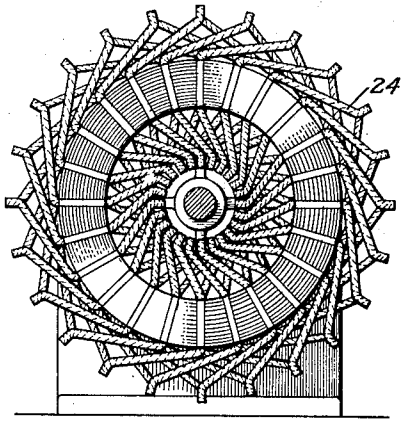


Fig. 5.

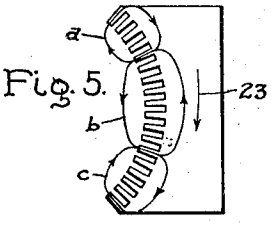
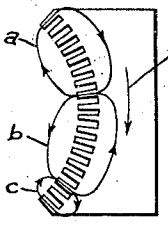


Fig. 6.



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UNITED STATES PATENT OFFICE

PANFILO TROMBETTA, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

ELECTROMAGNET

Application filed January 15, 1929. Serial No. 332,634.

My invention relates to electromagnets, more particularly to electromagnets energized by alternating current, and has for its object the provision of an improved device of this character in which a substantially uniform pulling force will be obtained.

In general, electromagnets operated with alternating current have been subject to a disadvantage due to the vibration of the armature or other article being held by the magnet. In many instances, as in the case of lifting magnets, electromagnetic brakes and chucks, the vibration of the material being held is often dangerous and at least detrimental to the efficient operation of the device. It is the purpose of my invention, therefore, to provide an electromagnetic device which may be operated with alternating current and by means of which the article or articles to be held will be attracted to the magnet by a pulling force which is substantially as constant as that which could be obtained by the use of direct current.

With this object in view, in carrying out my invention I have provided an electromagnet having a distributed, polyphase winding, this winding being arranged to produce a flux which moves substantially transversely of the direction of constant pull. Since the field distribution in a core having a polyphase winding is sinusoidal and does not change in value while the field moves across the core, it follows that the pull exerted in a direction normal to the core is constant and therefore there is no vibration or chattering between the article being held and the magnet.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing Fig. 1 is a side elevation of an electromagnet embodying the invention in one form. Fig. 2 is a view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows, and showing diagrammatically the electrical connections to the winding; Fig. 3 is a side elevation of an electromagnet embodying a modification of the invention; Fig. 4 is a view taken along the line 4—4 of Fig. 3 looking in the direction of the arrows, and Figs. 5 and 6 are diagrammatic representations of the flux produced at different instants by the winding shown in Figs. 1 and 2.

Referring to Figs. 1, 2, 5 and 6 of the drawing, I have disclosed one form of my invention as embodied in a magnet having a fixed or stator member 10 and a movable armature member 11. The stator member 10 comprises L-shaped bracket members 12 and 13 which serve to support a core 14, this core 14 being preferably formed of a plurality of laminations as is shown more clearly in Fig. 2. It will be noted that the core 14 has a concave face in which are provided a plurality of slots 15. The armature member 11 comprises a pair of strips 16, 16 which serve to support an armature 17. The strips 16, 16 are suspended from pivot supports 18 in such a manner that the armature 17 may readily swing toward and away from the concave face of the core 14. The armature 17 is also preferably laminated. The portion of the armature nearest the core 14 has a convex shape, curvature of this convex face and the curvature of the concave face of the core 14 being substantially the same, so that the armature 17 may lie closely adjacent the core 14. A rod or strip 19 is pivotally attached to the lower ends of the strips 16 and serves to transmit motion from the armature 17 to a member or device to be controlled.

In accordance with my invention, I have provided a winding 20 suitably secured in the slots 15 of the core 14 and as will be observed with reference to Fig. 2, this winding is of the star-connected three phase type. The winding is shown as energized from a three phase supply line 21 through a suitable switch 22.

When the winding 20 is energized a moving field is established in the core 14, this field moving in the direction of the arrow 23 shown in Figs. 5 and 6. With reference to Figs. 5 and 6, as the field moves in the direction indicated, the pole designated by line *a* will increase while the pole repre-

sented by line *c* will decrease by a proportionate amount. Finally the pole *c* will disappear altogether and at that instant the pole *a* will be equal to the pole *b*. At the next instant, however, the pole *b* will start to decrease while a new pole will be formed at the upper extremity of the core. It will be observed that the sum of the flux remains always constant and for this reason the pulling force exerted upon the armature 17 will vary substantially inversely proportional to the distance between the armature 17 and the core 14. When these members are in engagement the pull will remain constant and vibration and chattering of the armature 17 will thus be eliminated.

With reference to Figs. 1, 2, 5 and 6, the winding establishes a moving field which starts at one end of the core and ends at the other end. In cases where it is desired to have a continuous rotating field, I have provided the construction shown in Figs. 3 and 4. In this magnet a polyphase winding 24 is secured in slots in a laminated core 25, this core being fixedly supported by a suitable bracket 26. In this construction a shaft 27 is slidably mounted in bearings 28 and 29 formed respectively in brackets 30 and 26. A circularly laminated armature 31 is formed in the shape of a disk or plate and is rigidly secured to the shaft 27. Upon energization of the winding 24, the armature 31 will be attracted toward the core 25 with a pull substantially inversely proportional to the square of the distance between the armature and core, and any suitable device attached to the shaft 27 will be moved accordingly. The magnet shown in Figs. 3 and 4 is more powerful for a short stroke than the magnet shown in Figs. 1 and 2 and for this reason the continuous field magnet is especially applicable for use as a magnetic brake, while the magnet shown in Figs. 1 and 2 is applicable for use with many forms of switching apparatus, since a larger stroke can be obtained with this form of magnet.

While I have shown the windings 20 and 24 as being secured in slots in the stator members, it should be understood that it is not necessary that the winding be all in the stator member. It would be possible to have slots in both the core of the stator member and in the armature member with windings in each set of slots. Again, the entire winding could be mounted in the armature member, leaving the core or stator member with no slots whatever. With reference particularly to the magnet shown in Figs. 1 and 2 it should be noted also that the radius of curvature of the face of the core 14 can be anything from plus infinity to minus infinity excluding those values near zero. Due to the curved form of the core 14 a relatively large winding can be used while the vertical length of the armature may be small.

It should be understood that the invention is not limited to a device in which an armature is attracted to a core. The winding may, for instance, be placed on a flat horizontal core and the device used as a magnetic chuck.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An alternating current electromagnet having opposed magnetic members, and a distributed, polyphase winding arranged to establish a flux which pulls the members together and which moves transversely of the direction of pull of said magnet.

2. An alternating current electromagnet comprising a core, a distributed polyphase winding secured across the face of said core having a face, and a magnetic member movable normal to the face of said core, said winding being arranged to establish a substantially constant flux which moves transversely of the direction of movement of said member.

3. An alternating current electromagnet comprising a core, having slots therein, a distributed, polyphase winding secured in said slots, and a magnetic member movable into engagement with said core, said winding being arranged to establish a flux which constantly moves substantially at right angles to the direction of movement of said magnetic member.

4. An alternating current electromagnet comprising a core having a face, a distributed polyphase winding secured across the face of said core and magnetic member mounted to be movable normal to the face of said core, said winding being arranged to establish a continuous flux which moves in a plane substantially perpendicular to the direction of movement of said member.

5. An alternating current electromagnet comprising a core having a face, an armature mounted in opposing parallel relation with the face of said core, a star-connected, three phase winding extending across the face of said core, said winding being arranged to establish a substantially constant flux which pulls the members together and which moves transversely the face of said core.

6. An alternating current electromagnet comprising a fixed support, a core secured to said support, an armature pivotally mounted on said support to be movable substantially perpendicularly of the face of said core, a star-connected three phase winding arranged across the face of said core, said winding being arranged to establish a flux moving transversely with respect to the direction of movement of said armature whereby said armature is attracted toward said core with a force substantially inversely proportional to the square

of the distance between the core and the armature.

7. An alternating current electromagnet comprising a core having a concave face, a distributed, polyphase winding on said core, an armature pivotally mounted to be movable toward and away from the face of said core, the side of said armature nearest said core being convex for registering relation with the concave face of said core, said winding being arranged to establish a flux moving always in one direction across the face of said core.

8. An alternating current electromagnet comprising a core having a concave face, slots in the concave face of said core, a distributed polyphase winding in said slots, an armature pivotally mounted to be movable toward and away from the face of said core, the side of said armature nearest said core being convex for registering relation with the concave face of said core, a star-connected, three phase winding on said core, said winding being arranged to establish a flux which moves across said core substantially transversely with respect to the direction of movement of said armature, the sum of said flux being constant whereby said armature is attracted to said core with a substantially constant force.

In witness whereof, I have hereunto set my hand this 11th day of January, 1929.

PANFILO TROMBETTA.