July 12, 1949. J. D. LEITCH 2,476,049

LIFTING MAGNET

Filed July 13, 1945 3 Sheets-Sheet 1

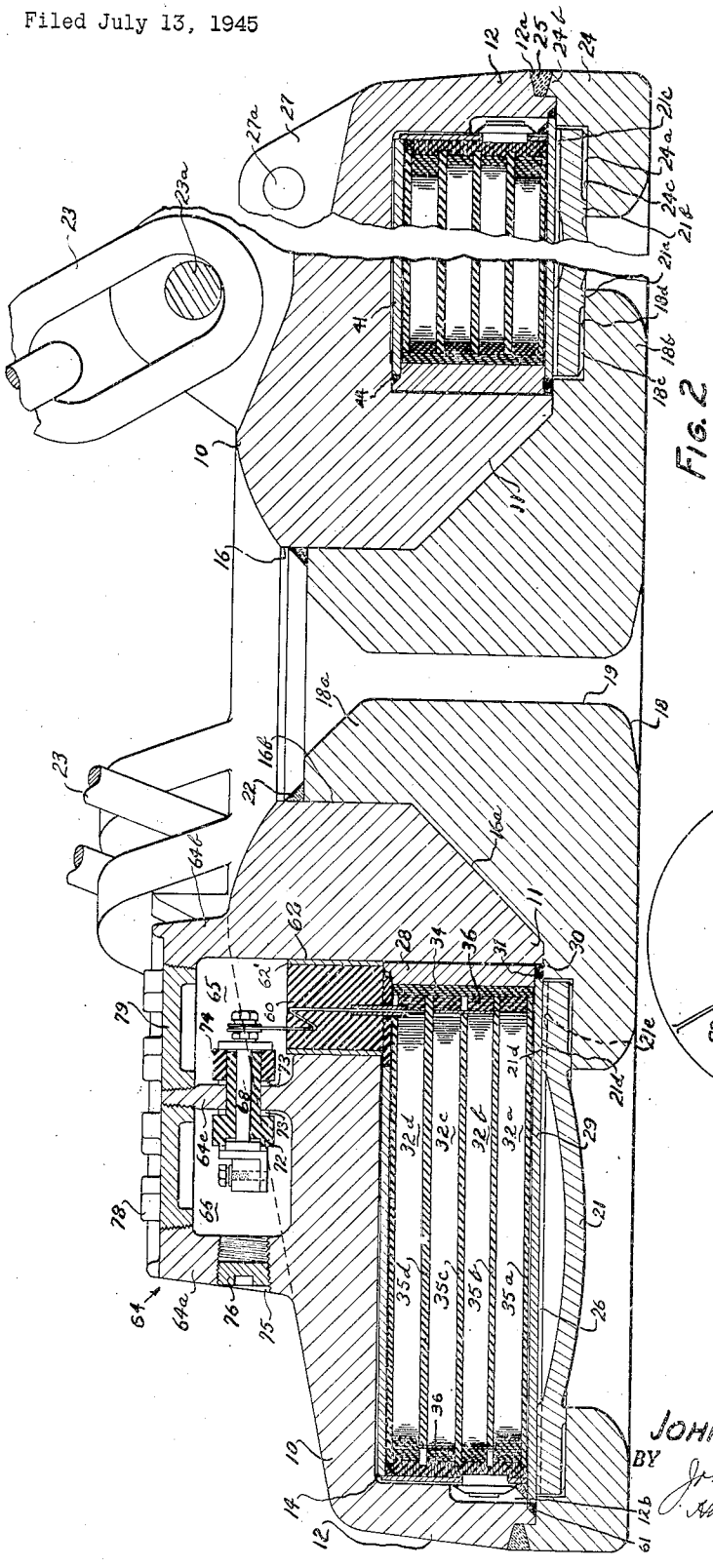


FIG. 2

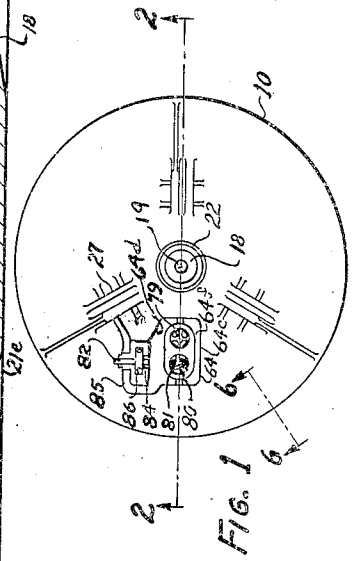


FIG. 1

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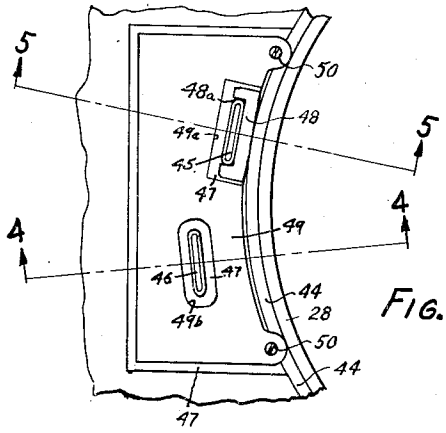


FIG. 3

FIG. 4

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3 Sheets-Sheet 3

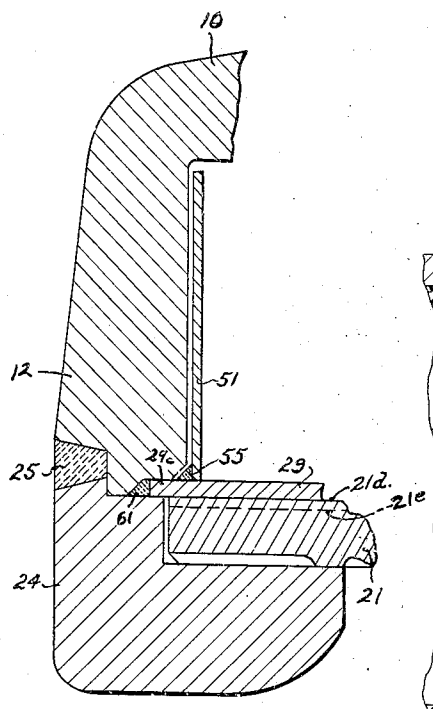
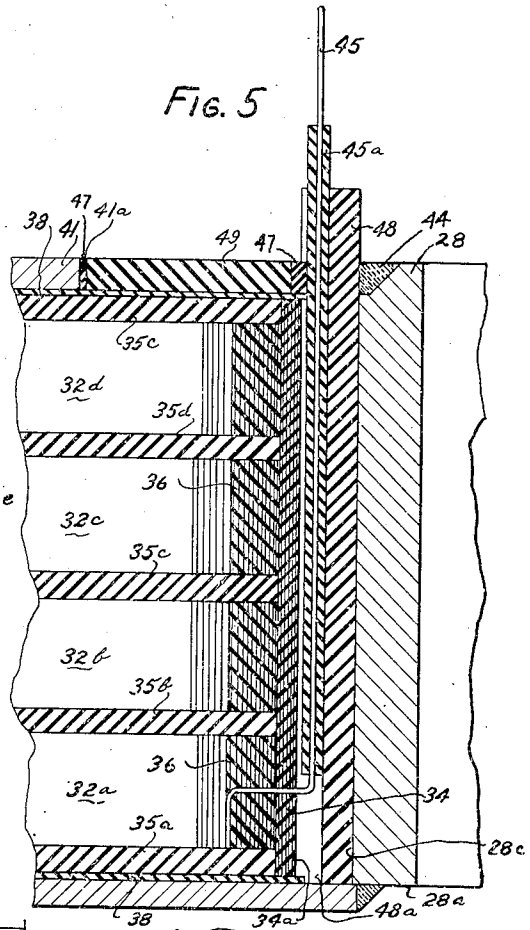


FIG. 6

FIG. 5



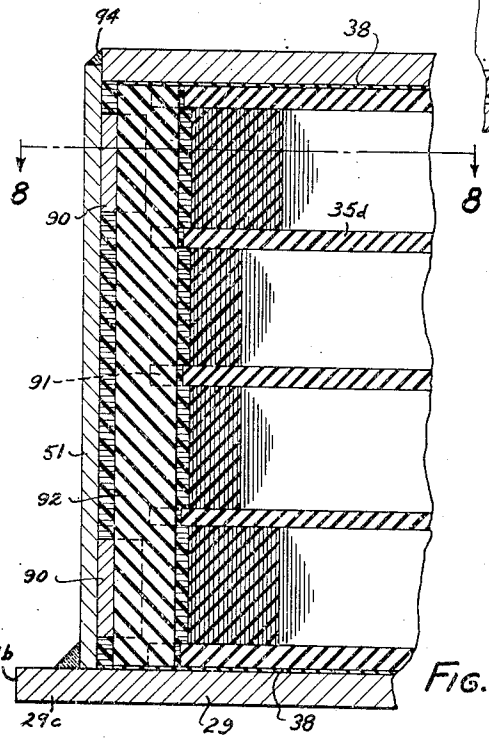


FIG. 7

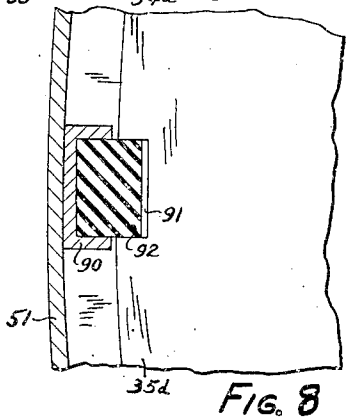


FIG. 8

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2,476,049

UNITED STATES PATENT OFFICE

2,476,049

LIFTING MAGNET

John D. Leitch, Shaker Heights, Ohio, assignor to The Electric Controller & Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application July 13, 1945, Serial No. 604,845

10 Claims. (Cl. 175—367)

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This invention relates to improvements in electromagnets, and particularly to improvements in the construction of relatively large electromagnets of circular configuration used for lifting and transporting material.

The most widely used type of lifting magnets comprises a hollow inverted bowl-like yoke or frame of cast steel having an integral peripheral flange and an integral central boss which defines with the flange an annular channel or groove, the flange serving as an outer pole piece and the boss serving as an inner pole piece. An annular magnetizing winding is mounted in the channel coaxial with respect to the inner and outer pole pieces, and the channel opening is generally closed by an annular sealing plate or inner bottom plate tightly fastened to the inner and outer pole pieces and forming with the magnet frame an enclosure for the winding. The winding usually comprises a plurality of relatively flat coils of round or rectangular copper wire wound upon a suitable spider which may, or may not, include the inner bottom plate and which are in stacked coaxial relation to each other. Before being placed in the annular channel, the completed winding is impregnated with a liquified thermal plastic or thermal setting material which, upon solidification, forms an insulating coating over what would otherwise be relatively exposed portions of the winding. The winding and spider are positioned within the annular channel and are accommodated therein with top clearance and with radial clearance with respect to the outer circumferential wall. The spaces between the winding and the walls and top of the channel generally are filled with the same insulating material which is used to cover the winding by pouring or forcing or otherwise introducing the material in a molten state through an opening provided in the top of the magnet frame.

Although circular lifting magnets constructed as above described have been in every day use for a great many years, they have certain disadvantages. For example, after the lapse of an indeterminate period of time, moisture collects within the convolutions of the winding and causes short circuits resulting in an immediate reduction in efficiency and eventual damage to the winding of such nature that the winding must be replaced or repaired. In order to repair or replace the winding, it is necessary to remove the winding from the magnet frame which can only be done, in case the insulating material is a thermal plastic material, by heating the entire magnet to a high enough temperature to melt the insulating material. Since circular lifting magnets are often

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over five feet in diameter and weigh several tons, furnaces of such large size as not to be generally available are required for the heating operation. If the insulating material is thermal setting, it must be completely broken up and pulled apart before the winding can be removed.

It has been recognized that if the winding could be sealed within an air and moisture proof container separate from the frame, that the disadvantage of moisture collecting within the coil would be eliminated and the problem of coil replacement would be greatly simplified. In the case of relatively small rectangular and special purpose magnets, windings enclosed in hermetically sealed enclosures have been used and their use is rapidly becoming standard practice. However, prior attempts to provide a separate hermetically sealed enclosure for a winding of a relatively large circular magnet have not produced a magnet satisfactory for commercial exploitation. One of the reasons for this failure is that relatively large circular magnets are usually used for general lifting purposes, and when so used, are customarily subjected to such excessive physical and electrical abuse that an extremely rugged construction must be used throughout. For instance, heretofore unsurmountable problems have been involved in enclosing an annular winding having a large external diameter within a hermetically sealed container and then fastening the container within the annular winding space of a magnet frame in such a manner that during use of the magnet the container stays in its proper position and so that the winding does not rotate relative to the container. These problems are complicated by the necessity of providing a spider or mandrel upon which the coils may be easily wound, the requirement that a good magnetic circuit be provided, the requirement that the winding be completely insulated from all metal portions of the magnet, and the requirement that the fastening means between the coil unit and the magnet frame not only hold the coil unit securely in place under the above mentioned excessive abuse, but also be such as to permit expeditious removal of the coil unit from the magnet frame when necessary.

The foregoing problems are solved and advantages are provided by the herein described invention in an extremely simple manner. In accordance with the present invention, a winding suitable for a large circular lifting magnet is enclosed within a hermetically sealed and welded container of annular shape having an outer peripheral flange defined by an extended portion

of the bottom of the container. The outer marginal portion of the flange is fastened to the outer pole piece of the magnet frame by a continuous annular weld and the inner bottom edge portion of the container is fastened to the inner pole piece by a continuous annular weld. The provision of the peripheral flange permits the outer side wall portion of the coil container to be made of thin sheet metal welded to the top and bottom members of the container since the large weld provided to secure the coil container to the magnet frame is spaced from the side wall by the width of the flange and thus the heat therefrom does not adversely affect the side wall portion or the welded connection between the side wall portion and the bottom of the container. Since all of the welds are annular and coaxial with the frame, to remove the coil from the annular groove or channel in the frame, it is only necessary to machine out annular welds, which can be done by machine tools that are generally available and by a single centering of the magnet in the machine. The winding in a preferred embodiment is prevented from rotating relative to the enclosure by the combined action of frictional forces between the winding and the top and bottom walls of the enclosure and by adhesive properties of insulating material within the container.

It is an object of this invention to provide an improved lifting magnet of the circular type.

Another object is to provide a lifting magnet having the foregoing advantages, and in which the foregoing disadvantages are eliminated.

Still another object is to provide an improved winding construction for a circular lifting magnet.

Further objects are to provide an improved lifting magnet of the circular type having a hermetically sealed coil unit separate from the magnet frame, to provide a lifting magnet having a hermetically sealed coil enclosure welded to the magnet frame, to provide a hermetically sealed coil enclosure for a circular lifting magnet having an external peripheral flange portion for use in welding the enclosure to the magnet frame, to provide an improved terminal box construction for a lifting magnet, to provide improved means for preventing rotation of a winding insulated from and sealed within a metallic enclosure, and to provide an improved terminal lead construction for a lifting magnet.

Other objects and advantages will become apparent from the following description wherein reference is made to the drawings, in which

Fig. 1 is a top plan view of the magnet;

Fig. 2 is an enlarged diametrical sectional view taken generally along the line 2—2 of Fig. 1;

Fig. 3 is a relatively enlarged fragmentary top plan view of a portion of the coil assembly;

Figs. 4 and 5 are sectional views taken generally along lines 4—4 and 5—5, respectively, of Fig. 3;

Fig. 6 is a fragmentary diametrical sectional view taken generally as indicated at 6—6 in Fig. 1;

Fig. 7 is a fragmentary diametrical sectional view of a portion of a modified magnet, and

Fig. 8 is a fragmentary sectional view taken generally along line 8—8 of Fig. 7 with parts omitted.

Referring principally to Fig. 2, the lifting magnet illustrated in the drawings comprises a circular magnetic frame 10 having integral therewith a cylindrical inner pole piece 11 and an annular outer pole piece 12. The pole pieces 11 and 12 form downwardly projecting concentric extensions of the frame 10 and define an annular

winding space 14 therebetween which is open at the bottom to receive an annular coil unit to be described. The inner pole piece 11 is in the form of a hollow cylinder with an axial opening 15 extending through the magnet frame which opening has a lower frusto-conical portion 16*a* and an upper cylindrical portion 16*b*. A unitary inner or central pole shoe 18 has an upper integral portion 18*a* complementary to and fitting snugly in intimate flux conducting relation with the surfaces of the opening 16 and a lower flange-like portion 18*b* provided with an annular shouldered recess 18*c* for receiving an inner marginal portion of an annular non-magnetic protective plate 21 preferably formed of cast manganese steel. The pole shoe 18 has the usual axial opening 19 therethrough and is secured in position by a means located entirely at the top of the magnet frame 10 and preferably by a continuous annular welded connection 22 formed at the outer marginal portion of the top surface of the pole shoe.

The outer marginal portion of the plate 21 is received in an annular shouldered recess 24*a* of an annular outer pole shoe 24 having an upwardly extending annular flange 24*b* around its outer periphery which fits into an annular shouldered recess 12*a* cut in the outer periphery of the outer pole piece 12 adjacent its lower face. A continuous welded connection 25 may be made between the pole shoe 24 and the pole piece 12 along the top of the flange 24*b* to secure the pole shoe 24 in position. This welded connection 25 is annular and coaxial with the pole piece.

Because manganese steel is difficult to machine, provision has been made for reducing to a minimum the amount of finishing required on the plate 21. To this end, concentric downwardly extending annular projections or ridge portions 21*a* and 21*b* are formed on the plate 21 and have their lower face surfaces finished and in engagement with the outer marginal portions of horizontal finished surfaces 18*d* and 24*c* of the recesses 18*c* and 24*a*, respectively. With the exception of the finished areas of the ridges 21*a* and 21*b*, the lower face surface of the plate 21 may be left unfinished. The plate 21 is preferably of hollowed ribbed construction, as suggested in Fig. 2, to provide greater strength and rigidity for unit weight and to insure a sound casting. Clearance 26 is provided at the top of the ribs so that finishing of the entire top surface of the plate 21 is not necessary. In order to further reduce the amount of finishing required on the top surface of the plate 21, the inner and outer marginal portions thereof are provided with a plurality of circumferentially spaced raised areas or pads 21*c* which have their top surfaces 21*d* finished thereby to provide concentric interrupted annular bearing areas for the coil unit, the surfaces 21*e* between the pads being left unfinished.

Hoisting chains 23 are secured respectively as by pins 23*a* to a plurality of circumferentially spaced lugs 27 formed on the top of the frame 10. The lugs 27 extend to the outer peripheral edge of the frame and have respective openings 27*a* therein for receiving cables or the like (not shown) for the purpose of exerting sidewise forces on the magnet when necessary.

So long as an annular winding space 14 is provided, the specific arrangement of the pole shoes, protective plate, and the magnet frame is immaterial to the present invention; the construction described for illustrative purposes is similar to that described and claimed in a copending patent application of D. C. Wright and A. L. Ward,

Serial No. 466,732, filed November 24, 1942, which issued as Patent No. 2,410,794 on November 5, 1946.

The coil unit comprises a spider having a tubular hub 28 of magnetic material which fits snugly around the central pole piece 11 and an annular bottom plate 29 which may be also formed of magnetic material to facilitate welding. The inner marginal portion of the plate 29 overlaps the outer marginal portion of the lower face 28a (Figs. 4 and 5) of the hub, and the plate 29 and the hub 28 are secured together by a continuous welded connection 31 confined closely to the inner edge 29a of the plate so as to leave space for a subsequently made weld 30 (Fig. 2) between the hub 28, the weld 31, and the inner pole piece 11. Thus the welded connection 31 also is annular and coaxial with the magnet frame.

A plurality of multi-layer coil sections 32a, 32b, 32c and 32d are wound upon suitable insulation 34 such as sheet mica which surrounds the hub 28, and are in stacked relation and spaced apart by annular insulating plates 35b, 35c and 35d. The lowermost coil section 32a is spaced from the plate 29 by an annular insulating plate 35a. Each of the coil sections comprises alternate layers of thin copper strap (not shown) and asbestos tape (not shown), the tape preferably being impregnated as by dipping in a suitable thermal setting or polymerizing insulating material such as tung oil immediately prior to winding. Layers of similarly impregnated asbestos tape 36 provide additional insulation at the inner and outer portions of the respective coil sections, and a lower mica disc 38 (Figs. 4 and 5) is provided between the insulation plate 35a and the bottom plate 29. The central insulation plate 35c has a notch 35x (Fig. 4) to provide space for a connector 39 interconnecting the coil sections 32b and 32c, and the plates 35b and 35d have notches 35y to provide space for respective connectors 40a and 40b interconnecting the coil sections 32a and 32b and the coil section 32c and 32d, respectively. An upper mica disc 38 is disposed between a top insulation plate 35e and an annular top magnetic plate 41 the inner marginal area of which is received at the right, Fig. 2, in an annular shouldered recess 28b (Figs. 4 and 5) formed in the outer periphery of the hub 28 near its upper face. The recess 28b has a frustoconical inner wall surface 28c thereby to provide space for a substantially continuous welded connection 44 (Fig. 2) between the plate 41 and the hub 28.

The inner marginal portion of the top plate 41 is cut away at 41a to provide space for a pair of coil leads 45 and 46, and likewise the insulation plate 35e has a notch 35z. A vertical slot 28c (Fig. 5) in the outer wall surface of the hub 28 is aligned with a vertical slot 34a in the inner wall surface of the insulation 34 to define a channel for receiving an elongated C-shaped insulator 48 having a longitudinal groove 48a for receiving the lead 45. A lower end portion of the lead 45 is bent at right angles to the upper portion, passes through aligned slits formed in the insulation 34 and 36 halfway between the plates 35a and 35b, and is connected as by brazing to the bottom coil section 32a. The lead 45 is covered for the major portion of its length by suitable insulation 45a.

The lead 46 connected as by brazing to the top coil section 32d adjacent to the associated insulation 36 is covered for a portion of its length by suitable insulation 46a. The notched portion 41a of the top plate 41 receives an insulator 49 having a slot 49b for receiving the lead 46. The insulation 49 is fastened to the hub 28 by screws 50 and a hermetically tight seal is made around the insulator by caulking the joints between the insulator 49 and the top plate 41, the weld 44, and the leads 45 and 46 with asbestos cord 47 and then impregnating the cord as by pouring a suitable heat resisting varnish over the caulked joints. It should be noted that the groove 28b adjacent to the insulators 48 and 49 may be substantially filled with deposited welding metal as a continuation of the welded connection 44.

Before the top plate 41 is welded to the hub 28, a flat strip of sheet metal which forms the outer side wall portion 51 of the winding enclosure is secured to the plate 41 by a continuous annular welded connection 52 thereby to form in effect a flanged cover for the winding. The upper marginal portion of the wall 51 overlaps the outer peripheral edge 41b of the plate 41, and is bent to circular form while being welded, a welded connection (not shown) being used to seal the mutually abutting edges of the strip.

After the weld 44 between the top plate 41 and the hub 28 has been made, an annular welded connection 55 is made along the lower marginal portion of the wall 51 to secure the wall 51 to the bottom plate 29 and complete the coil-containing enclosure. Preferably the stacked coil sections 32a, 32b, 32c and 32d and associated insulation plates of the winding normally form, before installation, an uncompressed structure that is slightly higher than the final distance between the bottom plate 29 and top plate 41 so that the winding must be compressed in order to make the weld 55. The winding thereafter tends to expand to resume its initial vertical dimension thereby to cause frictional forces which oppose rotation of the coil sections with respect to each other and to the enclosure. When the magnet is in use, the increase in temperature of the winding causes a further expansion thereby to increase the frictional forces opposing rotation between the parts of the winding and between the winding and its enclosure. The welded connection 55 between the side wall 51 and the bottom plate 29 is spaced from the outer peripheral edge 29b of the plate 29 thereby defining a flange portion 29c integral with the plate 29.

A pair of diametrically opposed openings 56 (Fig. 4) in the lower marginal portion of the wall 51 receive respective tank flanges or bushings 58 which are welded to the wall as at 59. After the coil and enclosure have been thoroughly dried, the enclosure is evacuated and thermal setting insulation 60 such as tung oil is forced under pressure through threaded openings 58a in the bushings 58 and fills all of the voids between the outer peripheral wall of the coil and the coil enclosure. The preferred material for the insulation 60 is a mixture of a polymerizing oil such as tung oil, a suitable oil soluble resin, and a retarder, which mixture preferably has adhesive properties thereby to cause the winding and enclosure to be fastened to each other. After the mixture has been introduced, respective plugs 63 are threaded into the openings 58a and the assembled coil unit is heated to polymerize the insulating material 60 as well as the material used to impregnate the asbestos tape. Of the thermal setting materials shown in the prior art for use in connection with magnet coils which are not

hermetically sealed, those having adhesive properties may be used herein instead of the material above described.

The coil unit is received in the annular channel 14 with the bushings 58 fitting into respective circumferentially spaced recesses 12b (Fig. 2) formed on the outer pole piece 12. The annular welded connection 30 between the weld 31, the hub 28, and the inner pole piece 11 secures the coil unit to the inner pole piece 11 and a continuous annular welded connection 61 formed at the outer peripheral edge 29b of the plate 29 within a shouldered recess adjacent the lower face of the pole piece 12 secures the coil unit to the outer pole piece 12. Since the weld 61 is spaced from the side wall 51 by the width of the flange 29c, a larger and stronger weld can be made without risk of deforming, overheating, or otherwise damaging the thin sheet metal of the wall 51 and the welded connection 55 when making the weld 61.

The leads 45 and 46 extend in circumferential spaced relation through an opening 62 in the frame 10 extending from the top of the annular recess 14 and enter a terminal box 64 formed on the top of the frame. A tube or sleeve 62' pressed into the opening 62 rests upon the insulator 49 and the hub 28. The annular joint around the bottom of the sleeve 62' is sealed from the inside of the sleeve by impregnated asbestos cord (not shown), and then the sleeve 62' is preferably filled with the material 60 which is allowed to polymerize without externally applied heat.

The terminal box 64 (Figs. 1 and 2) has end walls 64a and 64b, side walls 64c and 64d, and a central wall 64e defining two chambers 65 and 66. The upper end portions of the leads 45 and 46 are secured to respective circumferentially spaced terminal studs 68 which are received in respective spaced openings in the wall 64e, each of the studs 68 being insulated from the wall 64e by a sleeve 72 and a spacer or collar 74. Suitable gaskets 73 are provided to make a hermetic seal around the studs 68. Circumferentially spaced openings 75 closed by respective pipe plugs 76 are provided in the wall 64a to permit drilling of the openings in the wall 64e and manipulation of the magnet connections. A top wall 64f of the terminal box 64 has a pair of threaded openings which are closed by plugs 78 and 79, respectively. Leads 80 and 81 (Fig. 1) of a cable 82 are secured to the respective terminal studs 68 within the chamber 66 and pass through a suitable seal (not shown) in the side wall 64d. The cable 82 is protected from mechanical abuse by a wall 85 extending outwardly from the wall 64c and having a portion extending in parallel spaced relation to the wall 64d until it merges into one of the lugs 27. A lead clamp 88 is provided to secure the cable 82 in position.

The modification of Figs. 7 and 8 provides means in addition to the adhesive and frictional forces of the principal embodiment for holding the winding against relative rotation with respect to its enclosure. In Figs. 7 and 8, pairs of vertically aligned and spaced U-shaped brackets 90 are secured, as by spot-welding, to the inner surface of the wall member 51 at circumferentially spaced positions (only one pair being shown). Opposite the pairs of brackets 90, the insulation plates 35a to 35e, inclusive, are provided with respective notches 91 for receiving an elongated locking member 92 formed of insulating material.

An alternative method of winding the coil sections 32a, 32b, 32c, and 32d is to be preferred when the locking members 92 are used. In the alternative method, the hub 28 and the plate 41 secured together by the welded connection 44 constitute the spider upon which the coil sections are wound. After the coil winding operation, the members 92 are slipped into position in the recesses 91 and then the bottom plate 29 is secured to the hub 28 by the welded connection 31. The wall member 51 is then secured to the plate 29 at one point and then progressively bent to cylindrical configuration and welded in place by the welded connection 55. A welded connection 94 (Fig. 7) is formed between the top edge of the wall member 51 and the outer peripheral edge of the plate 41. It will be noted that before the welded connection 94 is made, the coil sections can be compressed and that since the upper portion of the wall members 51 overlaps the outer edge of the plate 41, the vertical dimension of the plate 51 is not critical.

Thus the coils not only are hermetically sealed but also are fixed in position circumferentially relative to the magnet frame. This is accomplished (a) by securing the coils in fixed position in the hermetically sealed container either by a combination of frictional forces due to the axial compressive stresses on the coils with the adhesive forces due to the insulating material which is thermal setting and bonded to the coils and to the walls of the container or with mechanical interlocking of the coil insulation discs with the insulation strips interlocked, in turn, with the container walls, and (b) by securing the container, in turn, to the magnet frame by continuous annular welds coaxial with the frame. Since all of the welds are annular and coaxial, all can be removed easily for servicing or disassembling the magnet by centering of the magnet frame in a suitable rotary cutting machine and machining off the weld.

I claim:

1. A lifting magnet comprising a magnetic frame member having concentrically arranged inner and outer pole pieces extending downwardly therefrom and defining an annular winding space therebetween, an annular, hermetically-sealed, coil-containing enclosure received in said winding space, said enclosure comprising a relatively thick metal bottom wall portion and an outer cylindrical metal side wall portion, said bottom wall portion and said side wall portion being welded together, and said bottom wall portion having an integral marginal portion extending outwardly from said side wall portion to define a flange, and a welded connection between the outer peripheral portion of said flange and said outer pole piece.

2. A lifting magnet comprising a magnetic frame member having concentrically arranged inner and outer pole pieces extending downwardly therefrom and defining an annular winding space therebetween, an annular, hermetically-sealed, coil-containing enclosure received in said winding space, said enclosure comprising a relatively thick metal bottom wall portion and an outer cylindrical metal side wall portion of less thickness than the bottom wall portion, said bottom wall portion and said side wall portion being welded together, and said bottom wall portion having an integral marginal portion extending outwardly from said side wall portion and transversely with respect to the axis of said pole pieces to define a flange, and a welded connection between the outer peripheral portion of said flange and said outer pole piece.

3. A lifting magnet comprising a magnetic frame member having concentrically arranged inner and outer pole pieces extending downwardly therefrom and defining an annular winding space therebetween, an annular, hermetically-sealed, coil-containing enclosure received in said winding space, said enclosure comprising a relatively thick metal bottom wall portion and an outer cylindrical side wall portion formed of relatively thin sheet metal, a continuous annular welded connection between said wall portions securing said wall portions together with an integral marginal portion of said bottom wall portion extending outwardly from said side wall to define a flange, and a welded connection between the outer marginal portion of said flange and the inner marginal portion of said outer pole piece, whereby said last named welded connection can be made without effect on said first named welded connection or on said side wall portion.

4. An annular, hermetically-sealed coil unit for reception into an annular groove in the lower face of a circular lifting magnet frame, comprising an annular metal container having a tubular hub portion and an outer cylindrical side wall portion joined by planular top and bottom members, a winding wound upon said hub portion between said top and bottom members, said winding when uncompressed being of greater thickness than the normal distance between said top and bottom members and being held in compressed condition by and between said top and bottom members thereby to cause frictional forces which oppose relative rotation between portions of said winding and between said winding and said container.

5. An annular hermetically-sealed coil unit for reception into an annular groove in the lower face of a circular lifting magnet frame, comprising an annular metal container having a tubular hub portion and an outer annular side wall portion joined by planular top and bottom wall members, a winding wound upon said hub portion between said top and bottom members, said winding when uncompressed being of greater thickness than the normal distance between said top and bottom members and being compressed by said top and bottom members thereby to cause frictional forces which oppose relative rotation between said winding and said container, said winding further being of lesser diameter than the inside diameter of said side wall portion thereby to define an annular space within and at the outer marginal portion of said container, and insulating material within said space and having the property of adhering to said winding and to said walls thereby opposing relative rotation between said container and said winding.

6. In a circular lifting magnet frame having a top surface sloping downwardly and outwardly from the axis of the magnet, a terminal box comprising a closed chamber defined by four side walls cast integral with said frame and a portion of the frame forming the bottom wall, one of said side walls of said box extending in the direction of said slope and having an opening for magnet leads, an integral wall extending laterally outwardly from said one side wall and positioned further from the axis than said lead opening, a suspension lug on said magnet frame, said outwardly extending wall having a portion extending generally alongside and spaced from said one wall and merging at its inner end with said lug thereby to provide a protective barrier for and exteriorly of said opening.

7. A lifting magnet comprising a frame having

concentrically arranged inner and outer pole pieces extending downwardly therefrom and defining a winding space therebetween, an opening between said space and the top of said frame, a cylindrical hub member surrounding said inner pole piece, an axially directed groove in said hub member facing said winding space, a multi-layered winding on said hub member, a terminal lead received in said groove and extending from the lowermost layer of said winding through said opening, and an elongated C-shaped insulator received in said groove and partially enclosing said lead.

8. In a lifting magnet, a frame having an annular groove in the lower face, an annular, hermetically-sealed coil unit for reception in said groove and comprising an annular container having an inner cylindrical hub portion, an outer cylindrical side wall portion, and a winding wound upon said hub portion and of lesser diameter than the inside diameter of said side wall portion thereby to define an annular space within said container, and circumferentially spaced means in said space and mechanically interlocked with the winding and with said side wall portion for opposing relative rotation of the winding and side wall portion.

9. In a lifting magnet, a frame having an annular groove in the lower face, an annular, hermetically-sealed coil unit for reception in said groove and comprising an annular container having an inner cylindrical hub portion, an outer cylindrical side wall portion, and a winding wound upon said hub portion and of lesser diameter than the inside diameter of said side wall portion thereby to define an annular space within said container, said winding comprising a plurality of axially spaced coils and insulating discs therebetween and interlocked with the adjacent coils, and said discs being of greater diameter than the coils and extending into said annular space, and circumferentially spaced means interlocking said discs and said side wall portion for opposing relative rotation of said coils and side wall portion.

10. In a lifting magnet, an annular, hermetically-sealed coil unit, a magnet frame having an annular groove in the lower face accommodating said unit, said unit comprising an annular metal container having a tubular hub portion and an outer annular side wall portion joined by planular top and bottom wall members, a winding wound upon said hub portion between said top and bottom members, said winding when uncompressed being of greater thickness than the normal distance between said top and bottom members and being compressed by said top and bottom members thereby to cause frictional forces which oppose relative rotation between said winding and said container, said winding further being of lesser diameter than the inside diameter of said side wall portion, thereby to define an annular space within and at the outer marginal portion of said container, insulating material within said space adhering to said winding and to said walls and thereby opposing relative rotation between said container and said winding, and means anchoring the container to the frame for opposing relative rotation of the container and the frame about the axis of the groove.

JOHN D. LEITCH.

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