July 6, 1948. O. I. PRICE 2,444,469

METHOD OF MANUFACTURE AND CONSTRUCTION OF SOLENOIDS, MAGNETS, AND COILS, AND THE PROTECTION OF THE WINDING THEREOF

Filed Oct. 9, 1944 2 Sheets-Sheet 1

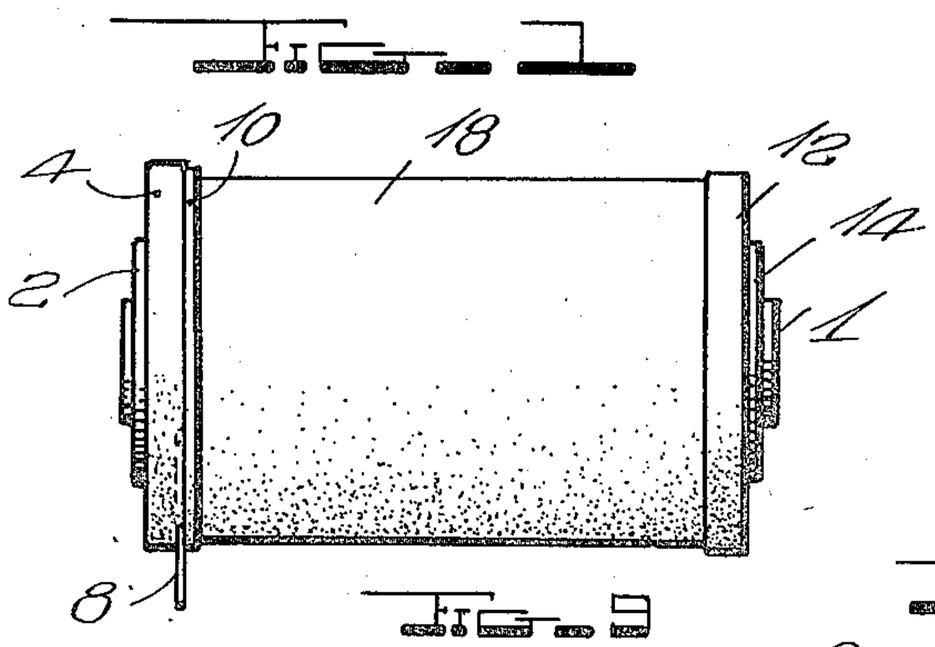


FIG. 2

FIG. 3

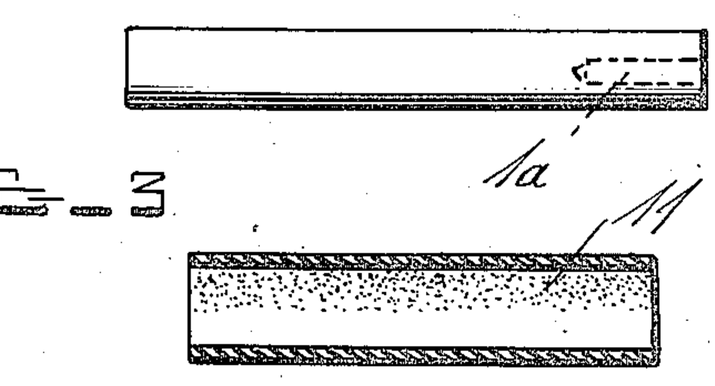


FIG. 4

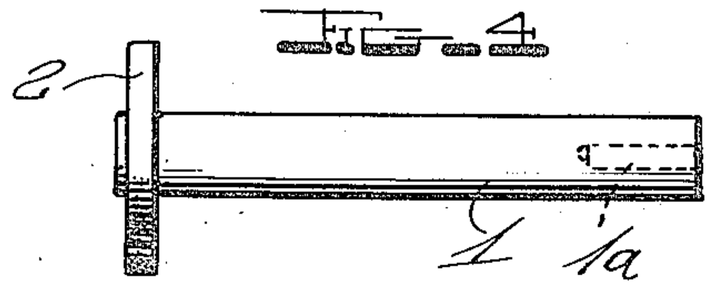


FIG. 5

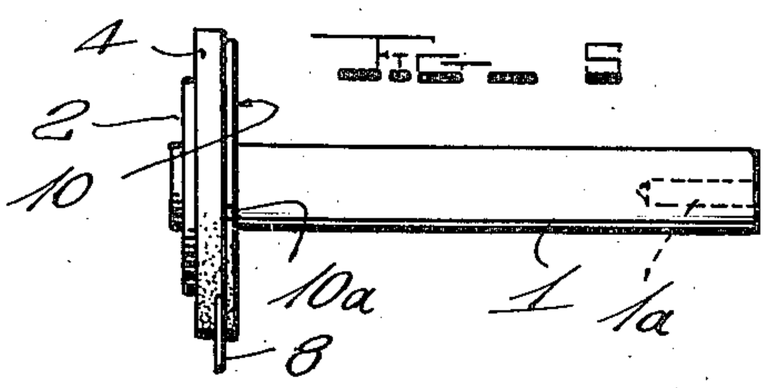


FIG. 6

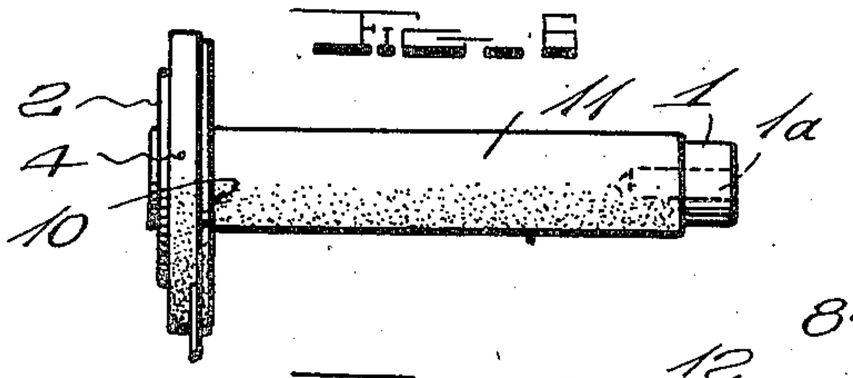


FIG. 7

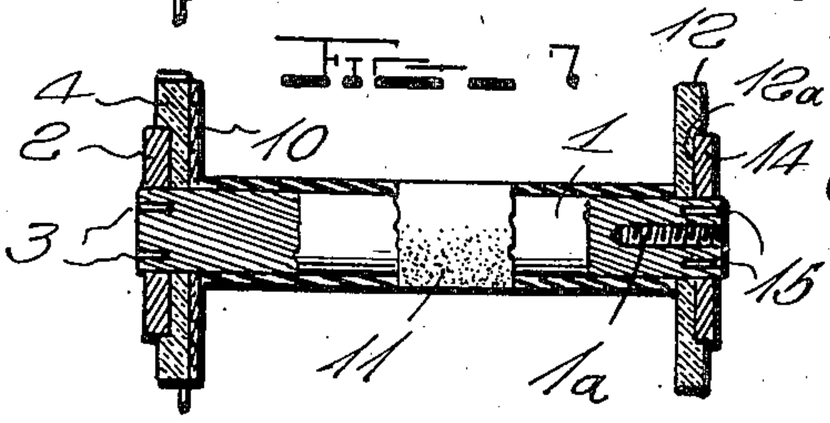


FIG. 8

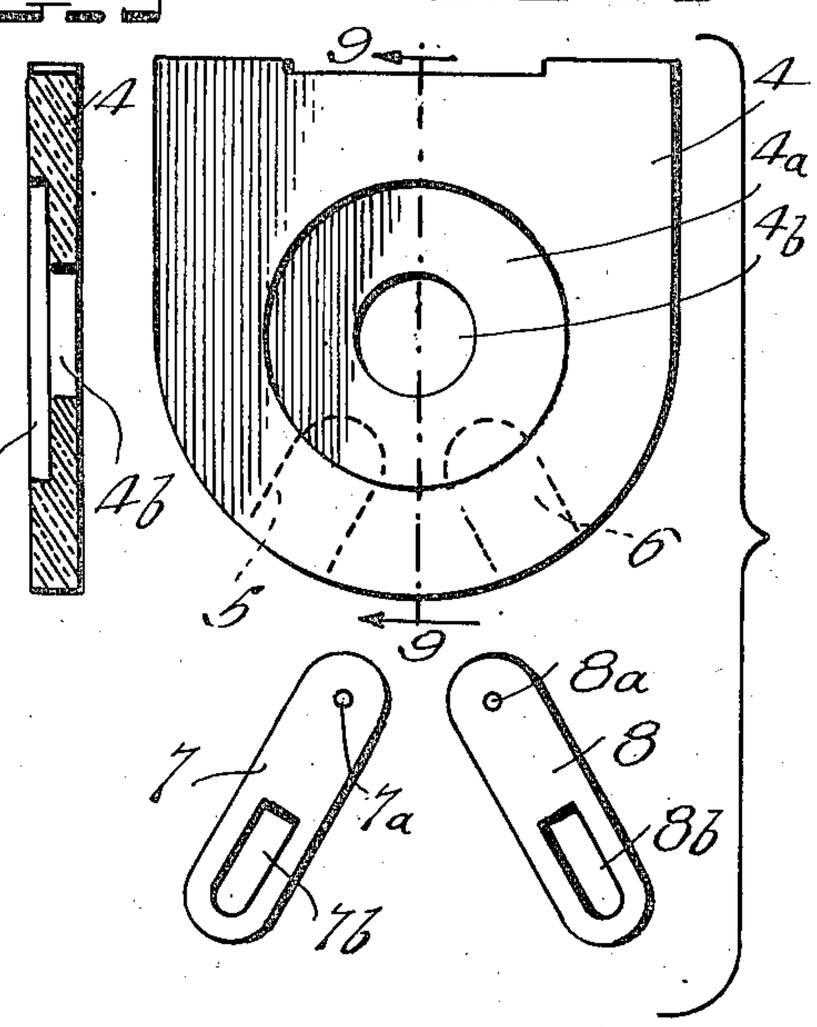
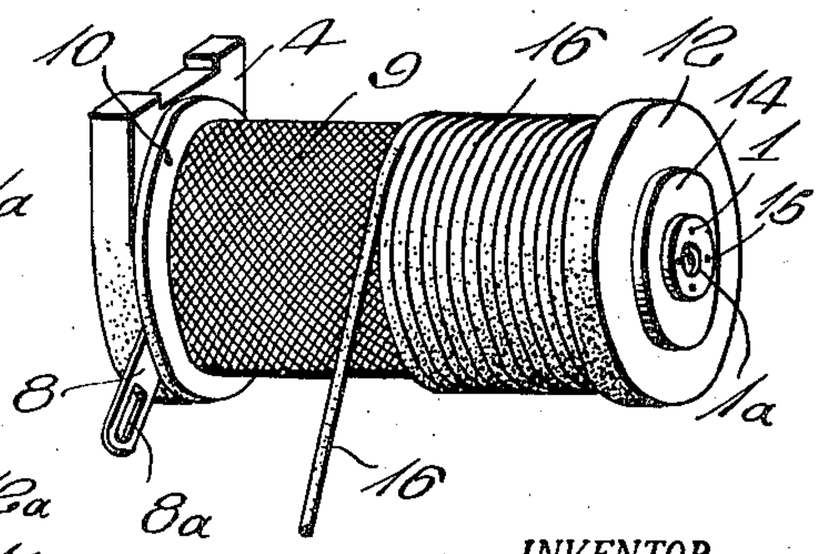


FIG. 9

FIG. 10



INVENTOR.
Osborne I. Price,
BY
John D. Grady
ATTORNEY

July 6, 1948. O. I. PRICE 2,444,469

METHOD OF MANUFACTURE AND CONSTRUCTION OF SOLENOIDS, MAGNETS, AND COILS, AND THE PROTECTION OF THE WINDING THEREOF

Filed Oct. 9, 1944 2 Sheets-Sheet 2

FIG. 12

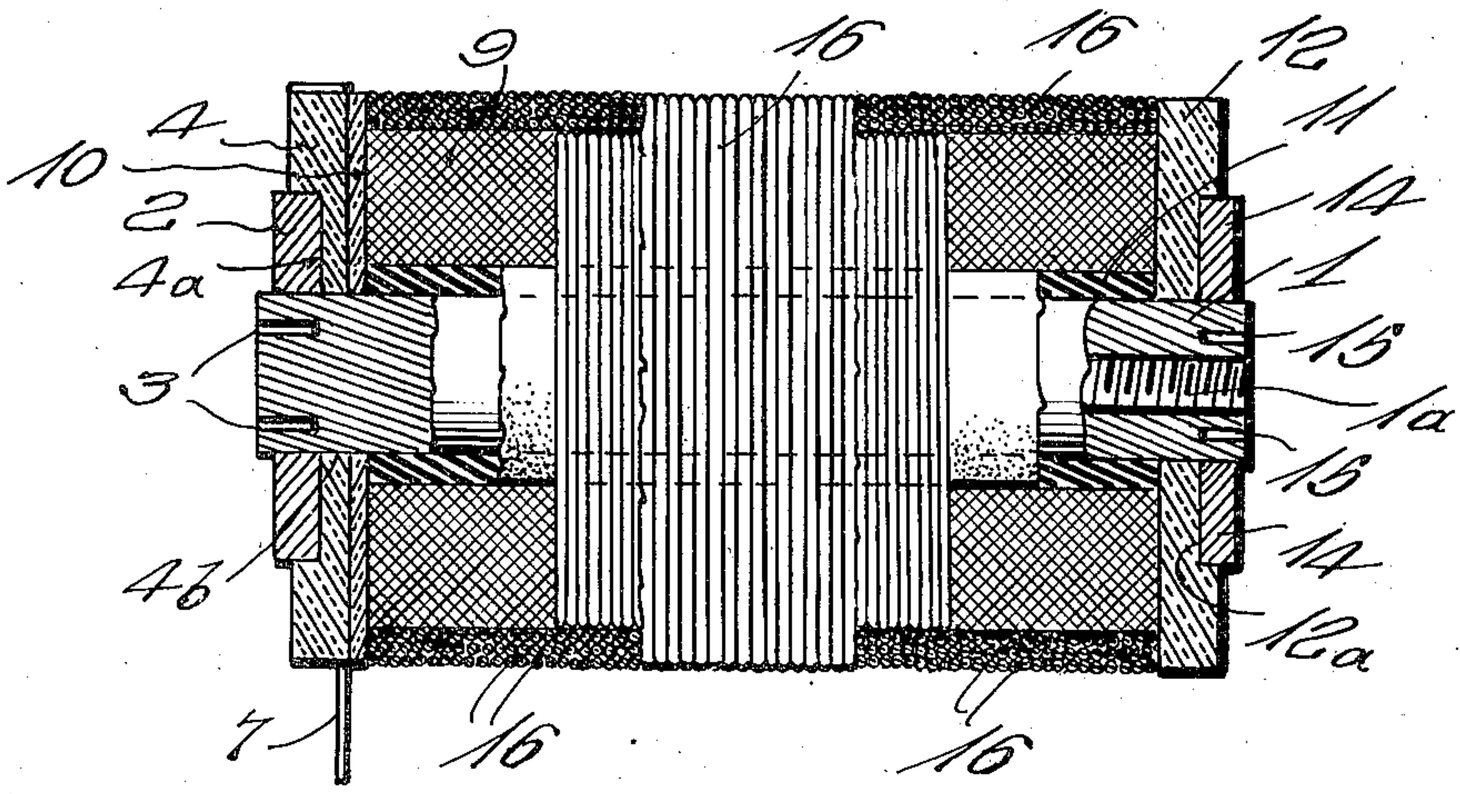


FIG. 13

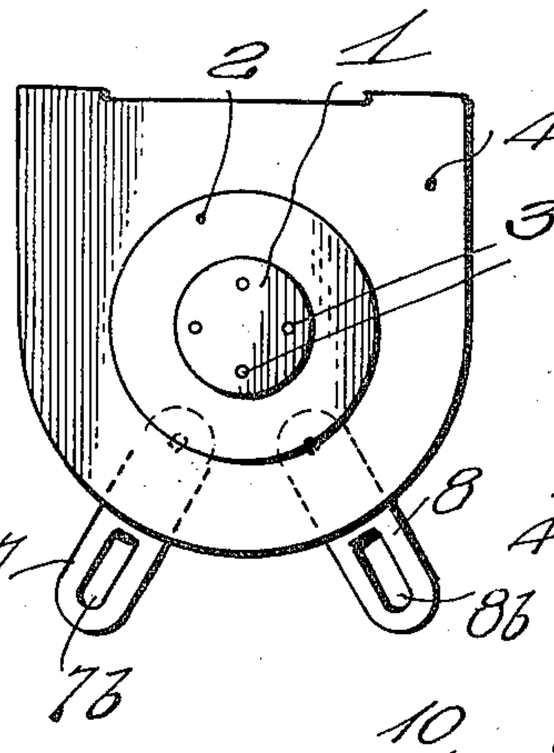


FIG. 15

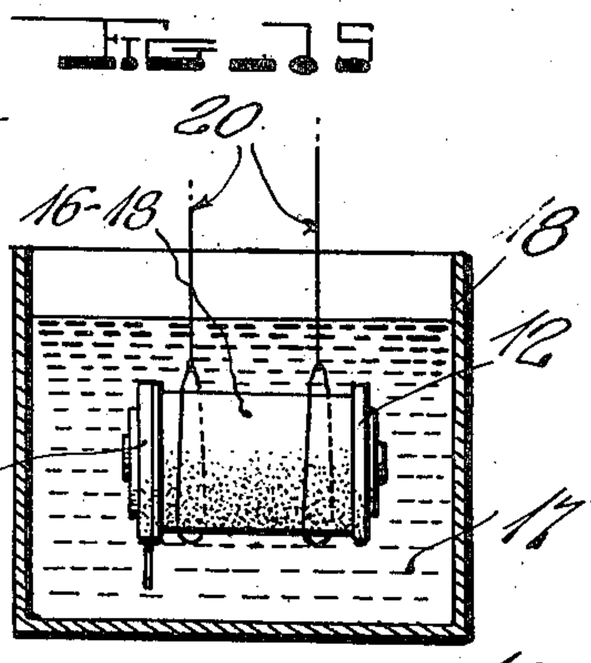


FIG. 14

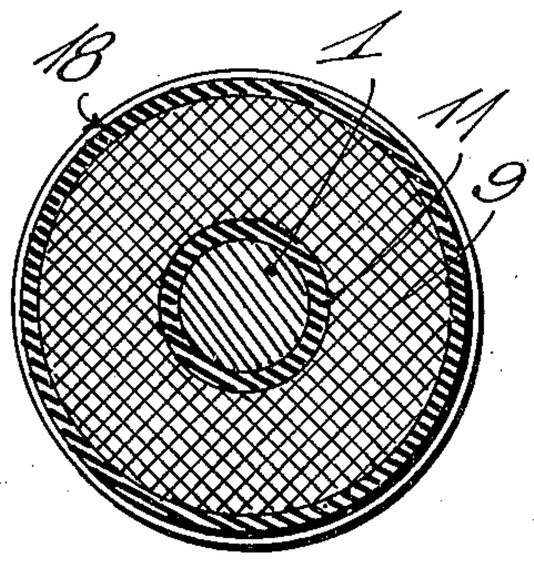


FIG. 11

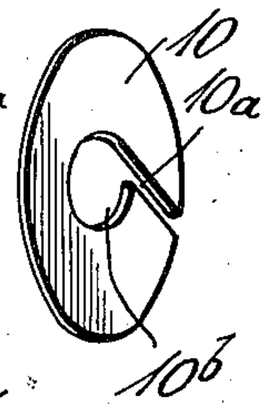


FIG. 16

FIG. 17

INVENTOR.
Osborne I. Price,
BY
John B. Brady
ATTORNEY

Patented July 6, 1948 2,444,469

UNITED STATES PATENT OFFICE

2,444,469

METHOD OF MANUFACTURE AND CONSTRUCTION OF SOLENOIDS, MAGNETS, AND COILS, AND THE PROTECTION OF THE WINDING THEREOF

Osborne I. Price, Frederick, Md., assignor to Magnetic Devices, Inc., Frederick, Md., a corporation of Maryland

Application October 9, 1944, Serial No. 557,820

2 Claims. (Cl. 154—80)

1

My invention relates broadly to the protection of articles of manufacture against humidity and fungus and more particularly to the method of manufacture and construction of solenoids, magnets and coils and the protection of the winding thereof.

One of the objects of my invention is to provide a method of protecting articles of manufacture against atmospheric dampness and fungus growth which comprises winding the article to be protected with a thread-like member of chemically soluble insulating material for substantially enclosing the article in a wrapping and then treating the wrapping thus formed with a solvent for flowing the thread-like members constituting the wrapping into a substantially homogeneous coating for the protection of the article.

Still another object of my invention is to provide a method of protecting electromagnets which consists in assembling an electromagnetic winding with respect to a magnetic core and overlaying the magnetic winding with a winding of thread-like insulating material which is chemically soluble and thereafter treating the wrapping of the thread-like material with a chemical solvent for reducing the thread-like wrapping to a substantially homogeneous mass constituting a protective coating and seal for the electromagnetic winding.

Still another object of my invention is to provide a method of protecting electrical windings generally by wrapping the windings with a chemically soluble thread for enclosing the electrical winding and then treating the wrapping with a chemical solvent for reducing the wrapping to a plastic and homogeneous coating protectively enclosing the winding against humidity and fungus growth.

Still another object of my invention is to provide a method for manufacturing electromagnets in which coil ends are formed from semi-soluble insulating material providing confining abutments for a magnetic coil with a winding of semi-soluble thread-like insulating material disposed over the magnetic coil between the semi-soluble insulating ends thereof whereby the assembly may be treated with a chemical solvent operating to flow the material of the insulated end and the thread-like wrapping into a homogeneous mass protecting the magnetic winding.

Still another object of my invention is to provide a construction of electromagnet in which end members of semi-soluble insulation material

2

are associated with a magnetic core for confining opposite ends of an electromagnetic winding with respect to the magnetic core with a disc-like member of semi-soluble material disposed between one end of the electromagnetic winding and one of the coil ends for receiving and confining terminal members between the disc-like member and the associated coil end together with a thread-like member of insulation material wound over the magnetic core whereby the assembly when treated with a chemical solvent has the component members thereof integrally flowed together to form a substantial seal and protective enclosure for the electromagnetic winding.

A still further object of my invention is to provide a construction of electrical coil winding in which a winding is arranged on a coil form having end flanges of cellulose acetate with the coil winding wound with a cellulose acetate thread forming a protective layer thereover and wherein the cellulose acetate coil ends and the cellulose acetate thread are treated with acetone for substantially dissolving the coil ends and protective thread and flowing the coil ends and thread into a homogeneous protective layer for sealing the winding against atmospheric dampness and fungus growth.

Other and further objects of my invention reside in an improved method of construction of electromagnetically wound devices as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is a side elevational view of an electromagnet constructed in accordance with my invention; Fig. 2 is a side elevational view of the magnetic core of the electromagnet shown in Fig. 1; Fig. 3 is a longitudinal sectional view of an insulated tube which is telescoped over the magnetic core for supporting the coil winding; Fig. 4 is a view of a first assembly stage showing a magnetic end retaining flange supported on the end of the magnetic core; Fig. 5 illustrates the next succeeding manufacturing stage in which a coil end of cellulose acetate is moved into abutting relation with a metallic end flange with the cellulose acetate disc which clamps the coil terminals in position shown juxtapositioned with respect thereto over the magnetic core; Fig. 6 shows the tubular member of insulation material slipped into position over the magnetic core arranged as illustrated in Fig. 5; Fig. 7 shows the assembly of the opposite coil end of cellulose acetate and the metallic end flange of the core applied in posi-

tion ready for receiving the coil winding; Fig. 8 is a front elevational view of the cellulose acetate coil end illustrating the recesses therein for receiving the coil terminals and the recess for receiving the metallic end flange of the magnetic core, the view also showing the two terminal strips removed from the slots provided in the coil end; Fig. 9 is a sectional view through the cellulose acetate coil end taken on line 9—9 of Fig. 8; Fig. 10 illustrates the assembled electromagnetic device receiving the protective covering of cellulose acetate thread; Fig. 11 is a perspective view of the cellulose acetate disc which is provided for confining the coil terminals in position in the recesses provided in the cellulose acetate coil end; Fig. 12 is a longitudinal sectional view through an electromagnetic device constructed in accordance with my invention and showing three layers of protective cellulose acetate thread thereon preparatory to the chemical treatment operation; Fig. 13 is an end view of the electromagnetic device shown in Fig. 12; Fig. 14 is a transverse sectional view taken on line 14—14 of Fig. 16; Fig. 15 is a view of a chemical treatment operation in which the assembled electromagnetic device in the form illustrated in Fig. 12 is immersed in a solvent such as acetone; Fig. 16 is a view of the electromagnetic device subsequent to the chemical treatment in the solvent as illustrated in Fig. 15; and Fig. 17 is a detailed view of a modified form of assembly of a metallic end flange with respect to the magnetic core of a magnetic device constructed in accordance with my invention.

My invention is directed to a manufacturing process and construction of article of manufacture generally as particularly exemplified in an electromagnetic device in which insulation materials are selected for enveloping the electromagnetic device, which have special properties of flowing together into a homogeneous coating under the action of a chemical solvent. The homogeneous coating thus forms a seal for protecting the electromagnetic device against atmospheric dampness and is especially resistant to "fungus" growth. With the wide dissemination of communication equipment in the South Pacific and tropical countries the performance of electrical apparatus involving electromagnetic windings has been greatly impaired by the action of atmospheric dampness, humidity conditions and fungus growth on the magnetic windings. Electrolytic destruction of magnetic windings has been particularly prevalent. Failure of electromagnetic devices by open circuit conditions in the windings has resulted in an enormous loss of communication equipment at times and in areas where such equipment has been essential to military operations.

The construction of electromagnet according to my invention eliminates customary trouble due to insulated end washers swelling out or "bell-mouthing" to such an extent that the armature may strike on the edges of the insulation washer or end pieces. By substantially supporting the insulation end member with a metallic flange, the winding space length for the coil is greater, due to the fact that the end members can be located close to the very ends of the cores. The metallic flange, preferably ferrous on the end of the coil next to the frame can be placed "flush" with the end of the core. By this method more winding space is gained, and consequently a great number of turns of wire which is of great importance. The cellulose acetate end pieces, and the cellulose acetate tube which covers the "core" can be

sealed with a small brush by applying acetone at the junction of the tube, and end pieces before winding. It is entirely feasible to assemble the metallic end members on the core, and then mold the cellulose acetate end members and the tube around the core, and at the same time insert the lugs in the mold making the completed coil form with the lugs all molded together before winding. This can be accomplished instead of fabricating the separate parts and assembling same.

The metallic end flanges may have a single slit half way across their face to prevent the formation of a "shorted-turn," should the coil be used for high speed relays or alternating current. The end flange next to the frame is preferably made of ferrous material as this will form a better magnetic junction with the frame. The metallic end flange on the armature end can be made of ferrous or non-ferrous material, depending upon the characteristic of the magnetic circuit.

In some cases it is advisable to use a ferrous end flange on this end; and in cases where the core is small in diameter, the gap between the core and the armature is small, it is desirable to increase the flux density of the core by having a large ferrous end flange on the armature end in order to reduce the magnetic reluctance of the air gap. In other cases it is desirable to use a non-ferrous end flange for this application.

The coil form is thus prepared to be wound with wire, and after winding, the outside is served with cellulose acetate thread and either brushed or immersed or sprayed with acetone to bond the thread and end pieces together. This may also be accomplished in a drying vacuum process or the whole coil may be placed in a split form or mold and heat applied to bring about the sealing operation. Cellulose acetate is a good insulating material for these cores and coils, but, heretofore it has not been practical for use because it "cold flows" at a low temperature due to the pressure of the wire on the inside. Therefore, I have provided metallic flanges at each end of the core to prevent this "cold flow" and "bell-mouthing," and by so doing have produced a coil that is completely covered, inside at the core, the ends, and top coated, and then sealed against moisture and fungus. By the method of my invention I insure a substantial seal of the electromagnetic windings against the entry of atmospheric dampness and fungus growth and completely protect such windings in a permanent manner.

Referring to the drawings in detail reference character 1 represents the magnetic core of an electro-magnetic device which is suitably drilled and tapped at one end as represented at 1*a* for mounting the core in a suitable frame support. The core may have a metallic end flange 2 positioned over one end thereof and secured adjacent the end of the core by suitable staking over the core for expanding the core end slightly by use of a punch struck into the end of the core as represented by the incisions 3. The metallic end flange 2 may be of non-magnetic material such as brass and serves as an abutment for the end member 4 which is formed from suitable insulation material. For illustrative purposes only I have designated this material as cellulose acetate as this material is soluble with acetone which is specified by way of example as a chemical treatment bath. It will be understood, however, that any form of insulation material which is reducible to a semi-soluble or a plastic or flowable state under the action of a chemical solvent or heat

may be employed in the method of my invention. The cellulose acetate end member is suitably formed by molding or stamping in the shape illustrated in Fig. 3 in which a circular recess 4*a* is formed therein for engagement with the end flange 2 and a central aperture 4*b* is formed therein to allow the end member 4 to be passed over the end of core 1 for abutment against the end flange 2. The end flange 2 may be molded into the end member 4. The end member 4 is also provided with a pair of angularly disposed recesses or pockets represented at 5 and 6 for receiving the terminal lugs 7 and 8 which serve as the connection means through eyelets 7*a* and 8*a* for the ends of the coil winding shown at 9. The terminals 7 and 8 are each provided with soldering eyelets 7*b* and 8*b* for establishing connection to the external circuit. The thickness of the terminals 7 and 8 is such that when inserted or molded in the recesses or pockets 5 and 6 the surface of the terminals extends flush with the inner plane surface of end member 4.

After the end member 4 has been moved to position in abutment with end flange 2 the disc-like member 10 also formed from insulation material such as cellulose acetate is slipped into position over the core 1 either by bending the disc transversely on either side of the slotted portion 10*a* thereof as illustrated in Fig. 11 or by sliding apertured portion 10*b* of the disc 10 over the end of the magnetic core 1 to a position in which disc 10 is disposed immediately adjacent end member 4 and serves as a retainer and insulated cover for the terminals 7 and 8 located in the recesses or pockets 5 and 6 of end member 4. The assembly thus formed has the appearance illustrated in Fig. 5.

As shown in Fig. 6 the tube of insulation material 11 shown more clearly in Fig. 3 is now telescopically slipped over the core 1 abutting at one end against the disc-like member 10. An end member of insulation material such as cellulose acetate shown at 12 is slipped over the end of the core 1 and then a confining and abutting end flange 14 slipped over the end of magnetic core 1 and into a recess 12*a* formed in the end of the cellulose acetate coil end 12. The metallic end flange 14 may be of magnetic or non-magnetic material. The end flange 14 is retained in position by staking over the extreme end of the magnetic core 1 by use of suitable upsetting of the metal represented at 15. The magnetic core 9 may now be wound by mounting the assembly illustrated in Fig. 7 in a coil winding machine and the turns of the magnetic winding 9 wound on the assembly between the cellulose acetate disc 10 and the cellulose acetate member 12. Upon completion of the coil winding 9 I then wind over the coil winding 9 a thread of insulation material represented at 16 in Fig. 10. This insulation material may be cellulose acetate which is particularly desirable because of its freeness from electrolytic action and because of the fact that it is readily soluble by the application of acetone or other solvent. However, I do not wish my invention limited to the use of thread of cellulose acetate as other threads and insulating materials and solvents may be used. The cellulose acetate thread 16 may be wound to the right and left to provide several layers as represented in Fig. 12. The end of the thread-like member 16 may be secured around one of the terminals 7 or 8.

The magnetic coil assembly is now ready for treatment in a chemical solvent bath or by a heat process. Various quantity production processes

may be employed, such as endless conveyors, for carrying the assembled magnetic coils through a solvent bath for a time period sufficient to reduce the peripheral portions of the coil ends 4 and 12, the peripheral portion of the disc-like member 10 and the layers of thread 16 to a semi-soluble, plastic free flowing condition. Also the coils may be placed in a mold and the coating and end members united by heat or pressure or both. The assembly when suspended in or passed through the bath 17 as represented for example at 20 in Fig. 15 has the envelope thereof reduced to a homogeneous mass as represented at 18 extended integrally at the peripheral ends into each other forming a tight seal impervious to moisture as represented in Fig. 16. The immersing process shown generally in Fig. 15 contemplates either the dipping of the assembled electromagnetic devices into the bath 17 within container 18 or the continuous moving of the electromagnetic device through the bath by a conveyor system timed to effect the required surface flow of the cellulose acetate material forming the end members 4 and 12 intermediate disc-like member 10 and the thread-like member 16. Also the electromagnetic devices may be given a chemical and heat treatment after first being subjected to a vacuum and heat process to remove air and moisture therefrom. For purposes of simplification I have shown in Fig. 16 the limits of the coating envelope formed from thread 16 at the juncture thereof with disc-like member 10 and end member 12, but in the final product there is no such defined juncture as the material of the end member 4 and disc-like member 10 flows into and receives from thread-like member 16 a plastic flow which forms an integral homogeneous seal around the turns 9 of the magnetic coil. At the opposite end of the device the material of the end member 12 flows into and receives from the material of the thread-like member 16 the plastic mass thereof forming an integral and homogeneous seal around the turns of the winding 9. The solvent, which in the case of the cellulose acetate coil support construction is acetone, does not attack the insulation of the turns of the wire or the wire itself, but is merely a solvent for the cellulose acetate.

Various changes in the construction of the core assembly which receives the magnetic winding may be made. For example, as shown in Fig. 17 metallic end flange 2 may be replaced by a disc-like member 19 having a central outstruck portion 19*a* which is welded to the end of magnetic core 1 as represented at 1*b*. The end flange 19 thus serves as an abutment against which the end member 4 of cellulose acetate is assembled.

One of the outstanding advantages of employing the method and construction set forth in my invention herein for coil windings, solenoids, magnetic coils and articles generally is the aesthetic and ornamental appearance which is imparted to the device.

While I have illustrated my invention in connection with an electromagnetic device, it is to be understood that the principles set forth herein are applicable generally to all types of coils, transformers and other devices, and while I have described my invention in one of its preferred embodiments I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

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

1. The method of constructing a magnet which comprises forming a magnetic core with a metallic end flange, abutting the metallic end flange with a semi-soluble insulation coil end coextensive with a substantial surface area thereof, applying a magnetic coil to the core, abutting the end of the coil with a semi-soluble insulation coil end, abutting the semi-soluble insulation coil end with a metallic end flange coextensive with a substantial surface area thereof, winding a semi-soluble layer of thread-like insulation material over the magnetic coil and treating the assembly with a chemical solvent for flowing the insulation material of the coil ends and the thread-like insulation material into a homogeneous mass for protecting the magnetic coil intermediate the metallic end flanges.

2. The method of constructing a magnet which comprises forming a magnetic core with a metallic end flange, abutting the metallic end flange with a semi-soluble insulation coil end coextensive with a substantial surface area thereof, applying a disc-like member of semi-soluble insulation material against said coil end over the core, introducing terminal lugs for the coil intermediate the disc-like member and the coil end, introducing a coil winding over the core and abutting against the disc-like member with the ends thereof electrically connected with the terminal lugs, applying a coil end of semi-soluble insulation material over the end of the core abutting

the end of the coil winding, applying an abutting metallic end flange over the end of the core against the last mentioned coil end of semi-soluble insulation material coextensive with a substantial surface area thereof, winding a layer of thread of semi-soluble insulation material over the coil winding and treating the assembly with a solvent for flowing the layer of thread and the coil ends and disc-like member into a substantially homogeneous mass supporting the terminal lugs and protectively sealing the coil winding intermediate the metallic end flanges.

OSBORNE I. PRICE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,633,577	Franks	June 28, 1927
1,837,733	Stearns	Dec. 22, 1931
1,874,723	Dawson	Aug. 30, 1932
1,888,275	Larsen	Nov. 22, 1932
1,998,827	Worrell et al.	Apr. 23, 1935
2,091,234	Branson	Aug. 24, 1937
2,172,445	Lutz	Sept. 12, 1939
2,195,233	Boyer	Mar. 26, 1940
2,209,850	Shand	July 30, 1940
2,266,925	Verril	Dec. 23, 1941