Aug. 15, 1967 D. A. J. DAVIS 3,336,552

ENCAPSULATED ELECTRICAL COIL

Original Filed March 1, 1962 2 Sheets-Sheet 1

Fig. 1.

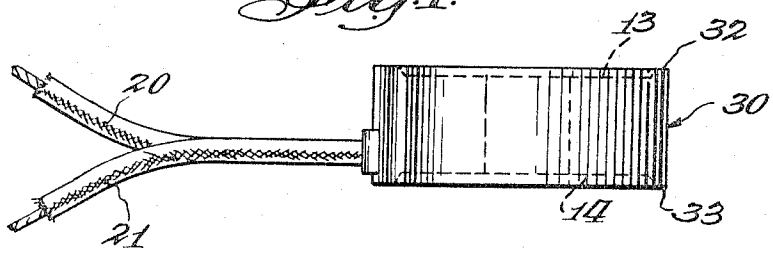


Fig. 2.

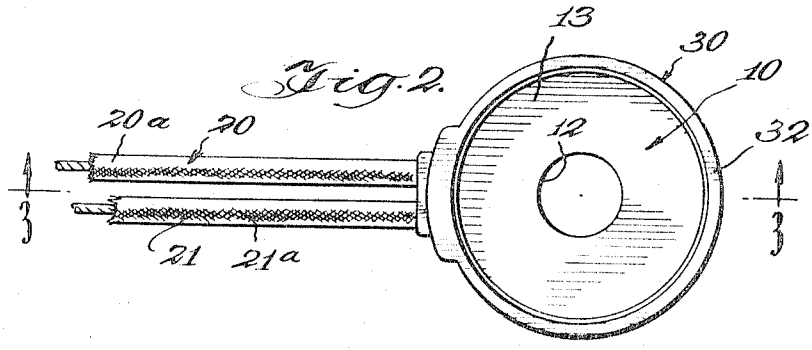
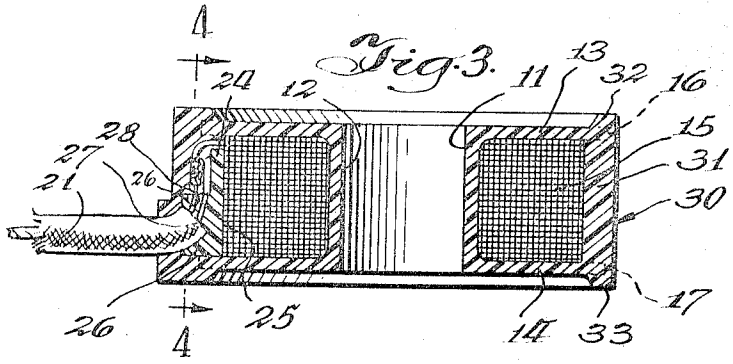


Fig. 3.



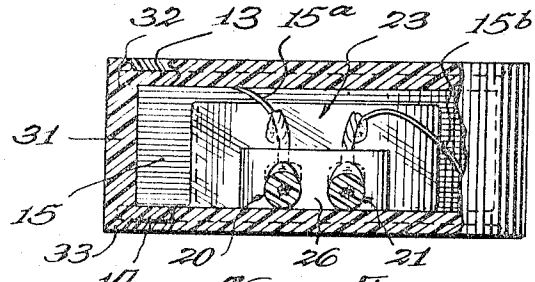


Fig. 4.

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Fig. 6.

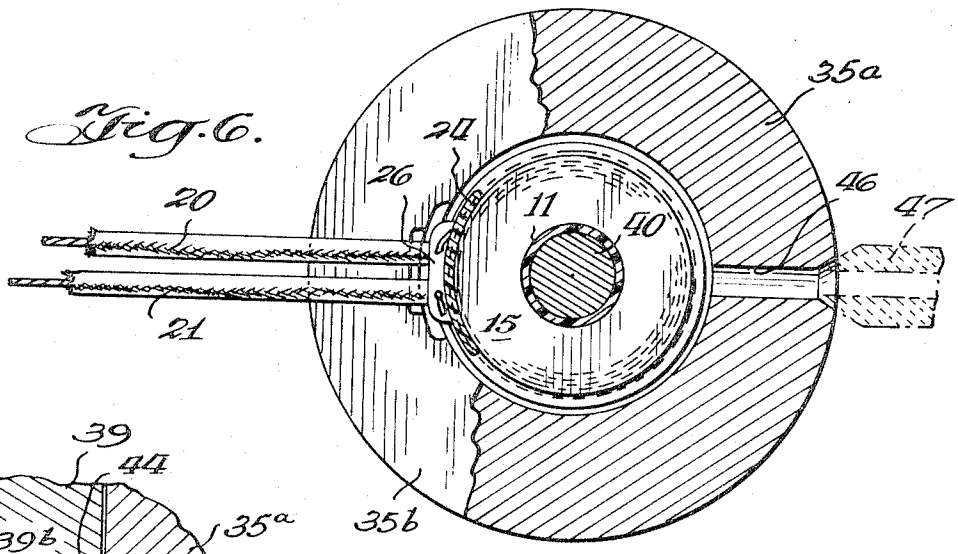


Fig. 7.

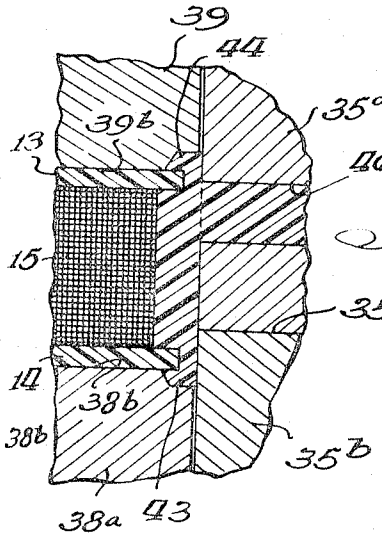
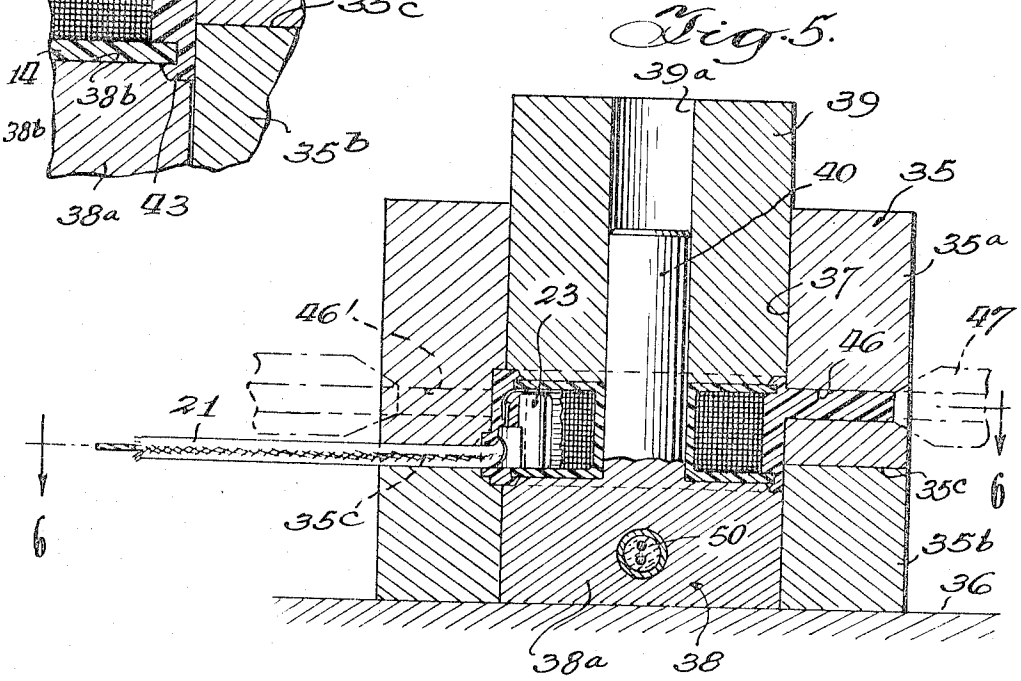


Fig. 5.



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ENCAPSULATED ELECTRICAL COIL

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Original application Mar. 1, 1962, Ser. No. 176,579, now Patent No. 3,238,286, dated Mar. 1, 1966. Divided and this application Oct. 7, 1965, Ser. No. 493,731
3 Claims. (Cl. 336—96)

ABSTRACT OF THE DISCLOSURE

An encapsulated electrical coil including a coil form having a bobbin configuration with a coil receiving central portion and a pair of end discs defining a coil receiving channel within which a coil is wound with end wires of the winding extending therefrom. Terminal leads for the coil are supported by a unitary terminal mounting member including a base portion within the bobbin channel and provided with an arcuate inner surface in intimate engagement with the surface of the coil and a boss portion having a pair of recesses for receiving the terminal leads with a pair of holes through which the ends of the terminal leads pass for connection with the winding end wires. An outer casing encloses the coil and terminal mounting member with the casing being sealed with the end discs of the bobbin form and with the terminal leads.

Background of the invention

This application is a division of my application, Ser. No. 176,579, filed Mar. 1, 1962, now Patent No. 3,238,286 for Method for Manufacturing an Electrical Coil.

In some situations it is necessary that an electrical coil be sealed against moisture, and such a seal is often desirable even though it is not absolutely required. A coil which is sealed is not affected by variations in the humidity of its environment, has a longer life and has more stable electrical operating characteristics than an unsealed coil. Present coils are usually sealed by impregnating the coil with a sealing compound, as an epoxy resin. Impregnation procedures are often expensive and time consuming, particularly where it is necessary to carry the impregnation out in an evacuated atmosphere to insure that the impregnant fills all the spaces within the coil.

An object of this invention is the provision of an improved sealed or encapsulated coil having a terminal mounting member for receiving insulated terminal leads of the coil and a casing surrounding and sealing the coil and the mounting member.

One feature of the invention is the provision of an encapsulated electrical coil construction having a coil wound on a form and engageable with a terminal mounting member, an outer casing sealing the coil and the mounting member. A further feature is that the outer casing has a frictional seal with generally planar exposed surfaces of the coil form.

Still another feature is that the coil construction includes a form having a bobbin-like configuration with a coil receiving central hub and a pair of end discs, a coil wound on the hub between the end discs, with the end discs having annular portions extending outwardly beyond the coil surface, and an outer casing for the coil having a body section between the end discs of the bobbin and in intimate contact with the coil and having locking portions overlying and sealed only with the annular portions of the bobbin end discs.

Yet a further feature is that the coil has insulated terminal leads affixed to a terminal mounting member carried by the coil and the outer casing encloses both the coil and the terminal mounting member.

Yet another further feature is that the mounting member carried by the coil has an arcuate surface in engagement with the coil windings, and an apertured boss with recesses for receiving the insulated ends of the terminal leads, the inner conductor portions thereof passing through holes in the boss to the coil winding.

Further features and advantages of the invention will readily be apparent from the following specification and from the drawings, in which:

FIGURE 1 is an elevation of an encapsulated coil embodying the invention;

FIGURE 2 is a plan view thereof;

FIGURE 3 is an enlarged sectional view taken generally along the line 3—3 of FIGURE 2;

FIGURE 4 is a broken section taken generally along line 4—4 of FIGURE 3;

FIGURE 5 is a section through a mold apparatus embodying the invention;

FIGURE 6 is a transverse section taken generally along the line 6—6 of FIGURE 5; and

FIGURE 7 is an enlarged fragmentary view of a portion of the mold structure.

Electrical coils are often operated in an environment where they are subject to external conditions, as moisture, which may penetrate the windings of the coil and change the coil's electrical characteristics or completely ruin it. With the novel coil construction of this invention, a coil may easily and inexpensively be sealed against external effects, and may even be operated under water.

Turning now to the drawings and more particularly to FIGURES 1 through 4, an illustrative embodiment of an encapsulated coil incorporating the invention is shown. A bobbin-like coil form **10** includes a coil receiving central portion or hub **11** having a bore **12** therethrough. A pair of disc-shaped end portions **13** and **14** extend outwardly from the portion **11** at either end thereof. The coil itself comprises a plurality of turns **15** of a suitable wire wound about the coil receiving central portion **11** and between the flange-like disc portions **13** and **14**, with the outer layer of the windings being spaced an appreciable distance, as of the order of $\frac{3}{32}$ inches in a coil 1¼ inch in diameter inside the edges **16** and **17** of the discs.

The coil form is preferably of a molded plastic material, as nylon.

A pair of terminal leads **20** and **21**, each having a suitable insulating covering **20***a* and **21***a* are connected with wires **15***a* and **15***b* at the ends of winding **15**. The terminal leads **20** and **21** are carried by and affixed to a terminal mounting member or yoke **23** which has a base portion **24** with an arcuate inner surface **25** that fits against the outer surface of winding **15**. An enlarged or thickened boss portion **26** of the mounting member has a pair of recesses **27** therein to receive the end of the insulating coverings **20***a* and **21***a* of the terminal leads and is provided with holes **28** through which the inner conductors of the terminal leads pass.

The outer covering or jacket **30** for the coil is preferably formed, as by an injection molding operation to be described below, of a suitable insulating material. For example, the covering may be of the same nylon material as the coil form. The outer covering **30** has a main body portion **31** lying between the peripheral extensions of the bobbin end members **13** and **14**. Annular cover portions **32** and **33** overlap the edges of the bobbin end members and interlock therewith, forming a tight mechanical seal. This seal or interconnection between the cover **30** and the coil form holds the two parts together and prevents the entry of moisture or other undesired contaminating materials. The cover **30** also seals about the insulating covering **20***a* and **21***a* of the terminal leads.

For many uses of an electric coil, the mechanical inter-

lock between the encapsulant body and the coil form is adequate. However, where necessary, a physical bond may be provided by utilizing the proper temperature conditions during the molding operation, softening the coil form material so that the cover bonds with it.

Referring now to FIGURES 5, 6 and 7, a suitable mold for encapsulating the coil of FIGURES 1 through 4 is shown. The mold includes an outer mold member or block **35** shown resting on a surface **36**. The mold is in two parts, **35***a* and **35***b* which mate along a separation line **35***c*. Extending through the mold is a centrally located bore **37** in which two further mold members **38** and **39** are slidably received. Mold member **38** comprises a cylindrical portion **38***a* filling the lower portion of bore **37** and having a centrally located upstanding rod portion **40**. Mold member **39** is generally cylindrical in cross section and fills the upper portion of bore **37**, having a central passage **39***a* in which rod portion **40** is received.

A coil to be encapsulated is inserted into the cavity of the mold, between the upper face **38***b* of the cylindrical portion **38***a* of mold member **38** and the lower face **39***b* of mold member **39**. The terminal leads **20** and **21** of the coil extend outwardly through grooves formed in the mating faces of mold parts **35***a* and **35***b* as best seen in FIGURE 5.

The coil to be encapsulated, i.e., the coil form and winding, is positioned in the mold cavity defined by the bore **37** through mold parts **35***a* and **35***b*, the upper face of portion **38***a* of mold part **38** and the lower face of mold part **39**. The upper surface of portion **38***a* of mold part **38** sealingly engages the lower face of bobbin end member **14**, while the lower face of mold part **39** sealingly engages the upper surface of bobbin end member **13**. The respective upper and lower faces **38***b* and **39***b* terminate inside the peripheral edge of the bobbin end members, the mold parts forming annular channels **43** and **44**, one associated with the bottom of the coil and the other with the top, within which the annular cover portions **33** and **32** are formed.

Encapsulating material is introduced into the mold cavity through a passage **46** which enters the mold cavity at a point substantially on a diameter of the coil passing through the point of juncture between the coil and the terminal leads therefor. The fluid encapsulating material flows around the coil in each direction and forms a solid body filling the mold cavity. The diametric relation between the inlet port and the coil terminals allows the material to flow evenly about each side of the coil, without obstruction of one path more than the other by the terminal leads and the terminal mounting structure. Where the encapsulating material may have a tendency to lift the ends of the terminal mounting yoke **23**, the inlet passage is preferably located immediately adjacent the terminal lead structure, as shown in broken lines at **46'**.

The encapsulating material, which may be a suitable thermosetting plastic material, as nylon, is introduced into the mold from a heating chamber (not shown) through a connector **47**. The heating chamber and material feeding apparatus may be of any suitable construction.

In accordance with the invention, the winding **15** is placed on the coil form in the usual manner by a suitable winding machine. The terminal leads **20** and **21** are mounted in yoke of insulating material **23** which is then secured to the surface of winding **15**, as with a double-faced adhesive tape, or other suitable adhesive material. The ends **15***a* and **15***b* of the winding are then mechanically and electrically connected with the conductors of the terminal leads **20** and **21**. The coil is placed in the mold cavity and the mold parts assembled as shown in FIGURE 5. Liquid encapsulating material is then introduced into the mold under suitable conditions of temperature and pressure, to form the jacket **30** around the coil. As thermosetting plastic materials have a tendency to shrink slightly upon setting, a firm mechanical bond is achieved between the jacket casing, the coil support and the winding itself. If a physical bond between the encapsulating material and the coil form is desired, the temperature condition within the mold should be such that the coil form is softened upon the introduction of the liquid encapsulating material. Where necessary, the mold itself may be heated as by an electric element **50** carried in one of the mold parts.

It is important that a good mechanical seal be maintained between the mold parts and the coil support during the encapsulating operation, to prevent excessive flashing of the encapsulating material.

Where nylon is used as the encapsulating material, and it is desired to achieve a physical bond between the encapsulating coating and the coil support, the temperature of the mold should be of the order of 150° Fahrenheit during injection. The injected molten nylon may have a temperature of the order of 500° Fahrenheit, the heat of the mold and of the molten nylon softening the bobbin, allowing the bobbin and covering to bond together. After the mold cavity is filled, it is allowed to cool, completing the bond between the covering and the coil form and causing the coating to shrink tightly about the winding **15**.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. In an encapsulated coil having a bobbin with a coil receiving central portion and a pair of end discs, one at either end of the central portion, defining a coil receiving channel, a coil wound on the central portion of said form within said channel and having winding end wires extending therefrom and terminal leads for said coil with insulating coverings and inner conductors, the improvement comprising: a completely encapsulated unitary terminal mounting member of insulating material carried by said coil between said end discs, having a pair of recesses in which the ends of the insulating coverings of the terminal leads are received and from which the inner conductors of the terminal leads pass to points of connection with the end wires of the winding.

2. The encapsulated electrical coil construction of claim **1** wherein said unitary terminal mounting member comprises a base portion within said channel and provided with an arcuate inner surface in intimate engagement with the surface of said coil; a boss having a pair of recesses for receiving the ends of the insulating coverings of said terminal leads; and a pair of holes through which the inner conductors of said terminal leads pass for holding the leads for connection with said winding end wires.

3. The encapsulated coil construction of claim **2** wherein said boss is disposed on top of said base portion as the base portion engages said coil surface, said recesses being located on the outer periphery of said boss such that the terminal leads extend outwardly from the boss and away from said coil, and said holes extending from said recesses to a point at the side of said boss above said base portion for connection with the end wires of the winding.

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