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[54] ELECTRICAL COIL AND METHOD OF MANUFACTURING SAME

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[52] **U.S. Cl.** **335/299,** 336/147, 336/198
[51] **Int. Cl.** **H01f 5/00**
[58] **Field of Search** 335/213, 250, 282, 299, 266; 336/138, 145, 147, 220, 221, 180, 198

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Assistant Examiner—F. E. Bell
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[57] **ABSTRACT**

An encapsulated printer coil having two bobbins on each one of which a coil is wound. The coil is wound from a single continuous wire and is wound such that the polarity on one bobbin is opposite from the polarity on the other bobbin. Coil winding to achieve this result occurs by placing the bobbins in axial alignment on a common mandrel and winding the wire in a single rotational direction on both bobbins. The bobbins are subjected to a two-step curing. When initially molded, the bobbins are partially cured to provide wall resilience during winding. They are finally cured during the final encapsulation step. The wire has an epoxy overcoat. Prior to encapsulation the wire is heated by having a current pass through it and pressure is exerted on the wire by having the coil compressed between two jaws. This provides a pre-encapsulation sizing and fixing of the wires. Mold gate positioning and dimensioning provide minimum winding disturbance during encapsulation.

17 Claims, 24 Drawing Figures

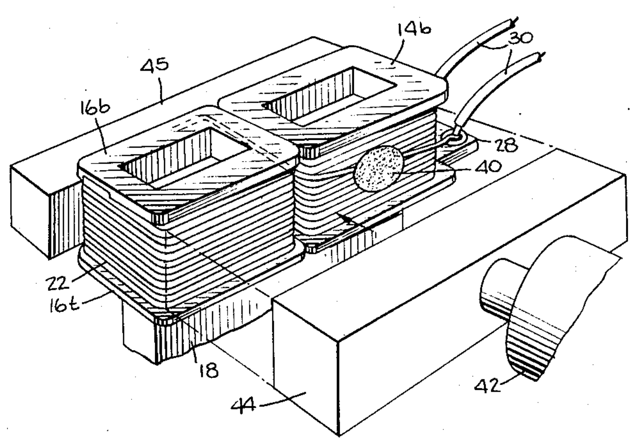


Fig. 1.

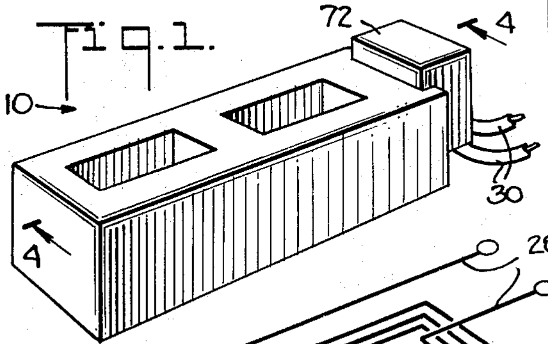
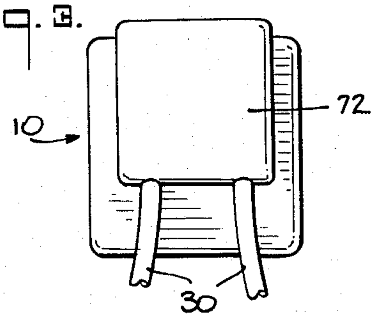
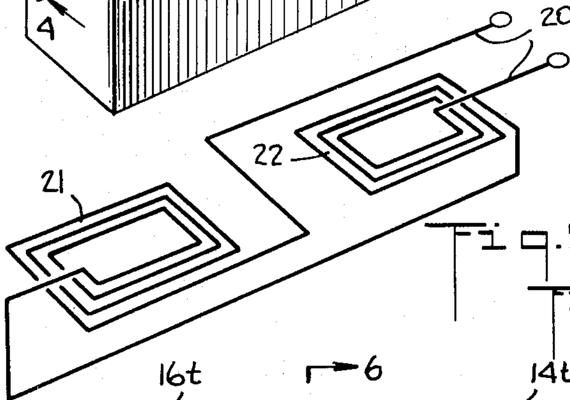


Fig. 3.





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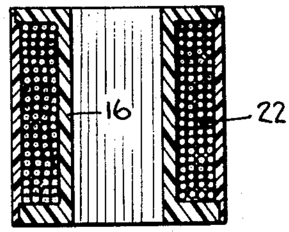

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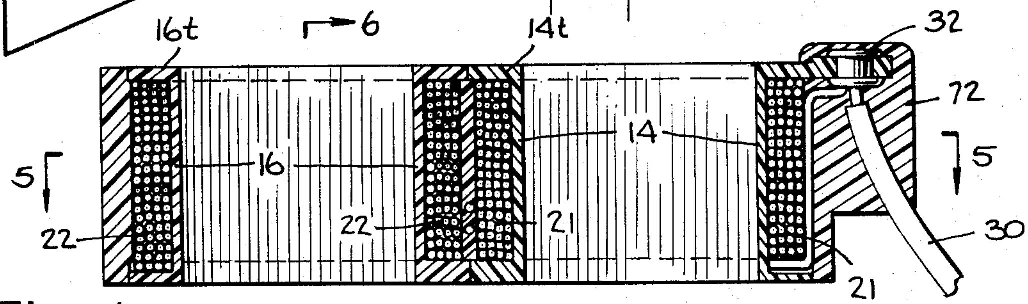
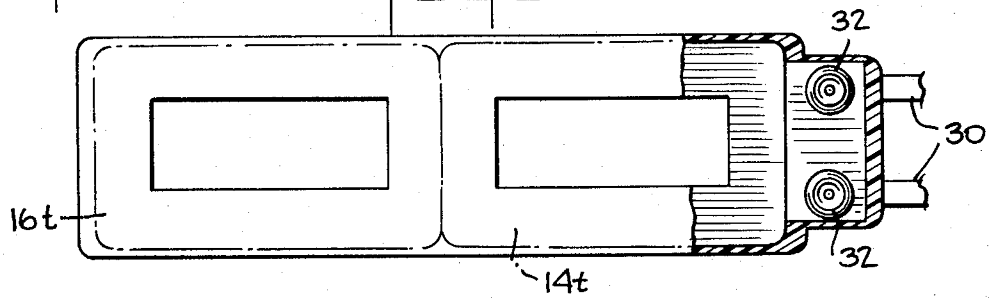


Fig. 4.

Fig. 2.



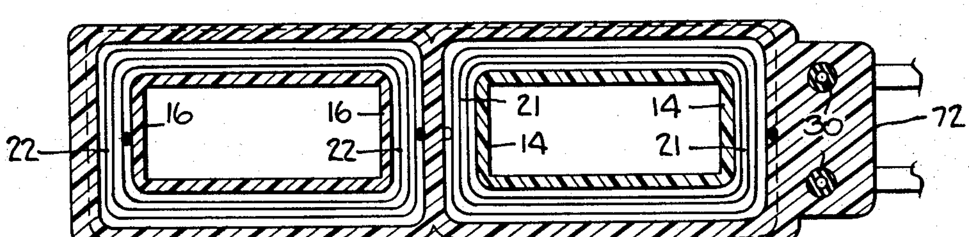


Fig. 5.

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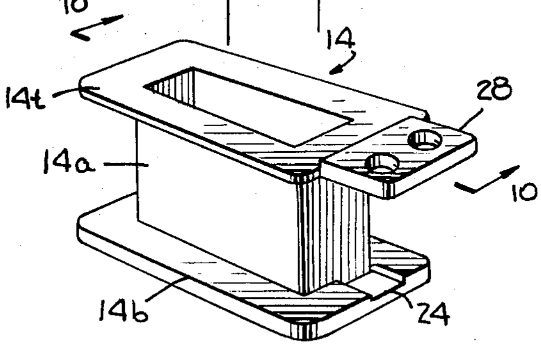

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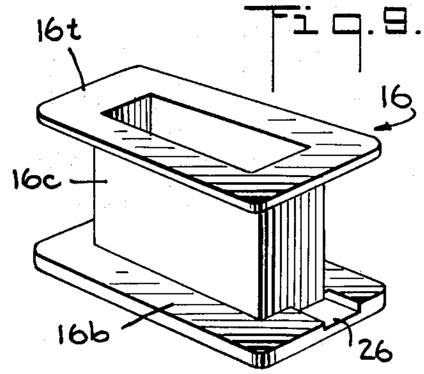

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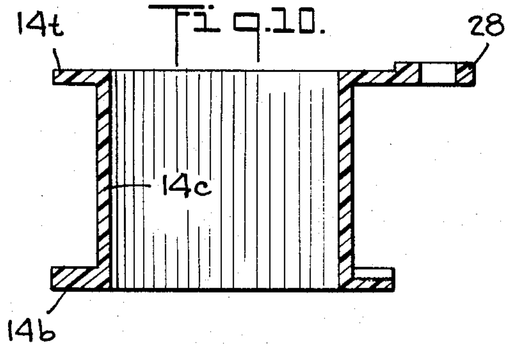

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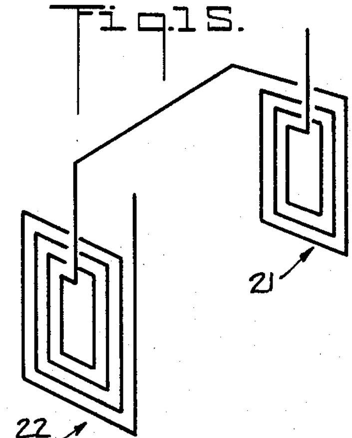

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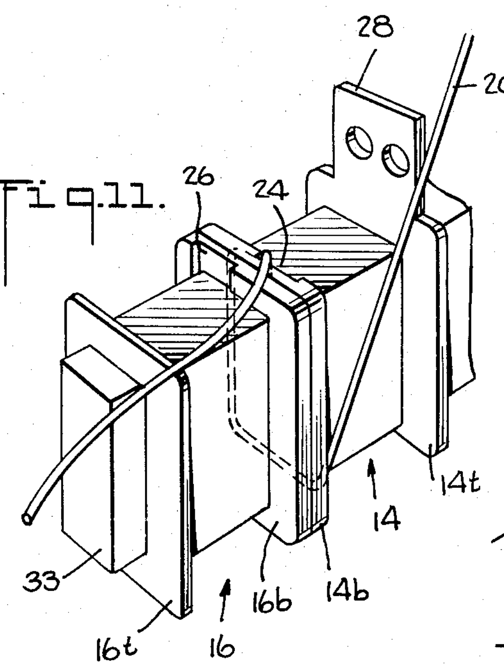

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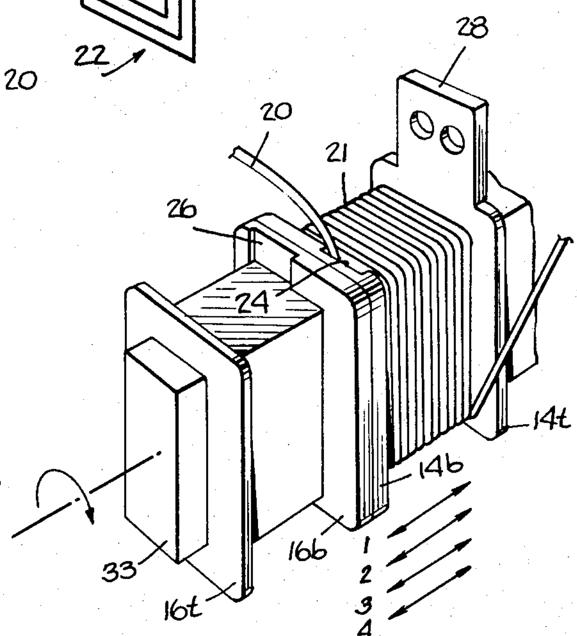

Fig. 12.

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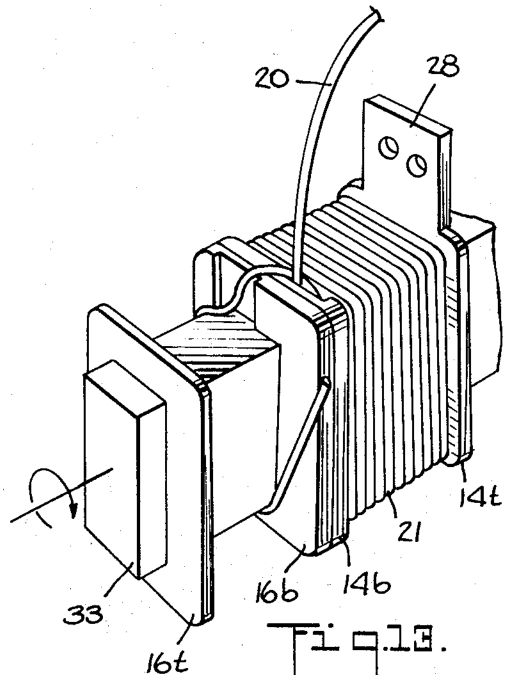
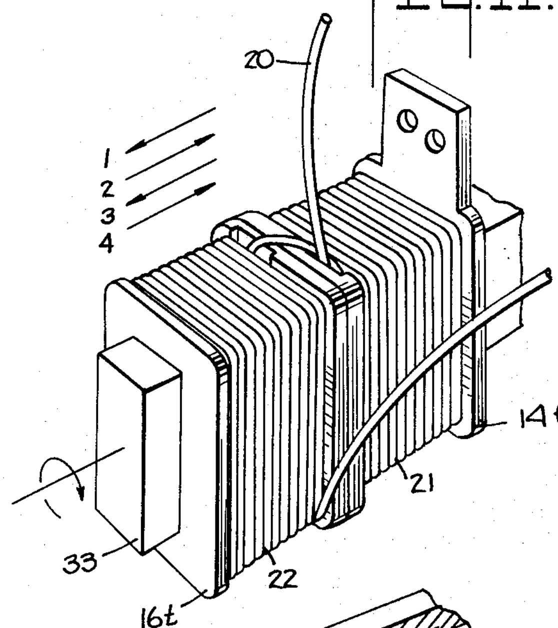


Fig.13.

Fig.14.



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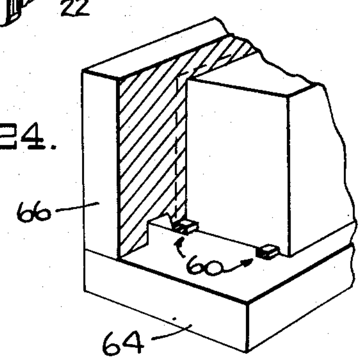

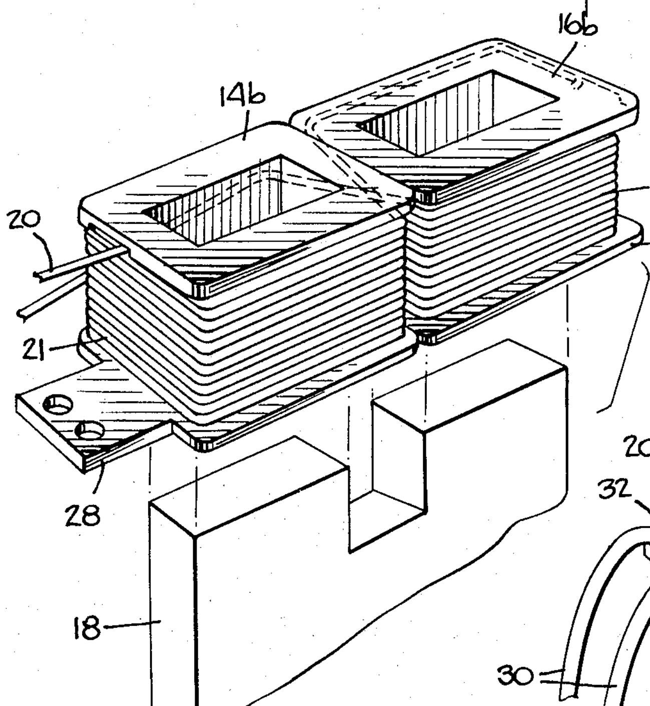

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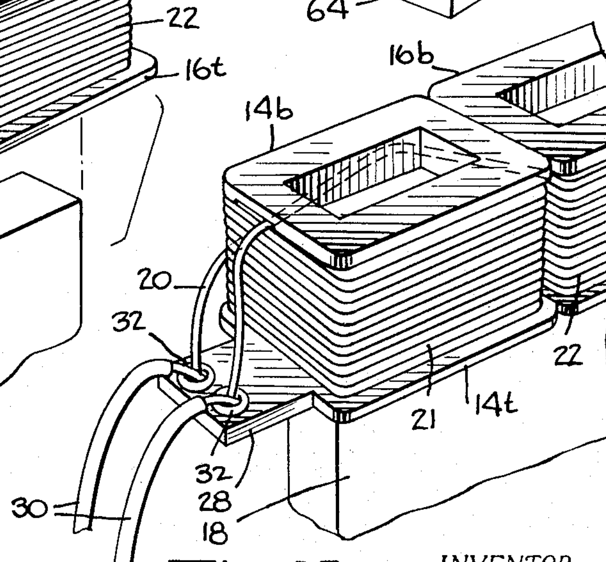

Fig.17.

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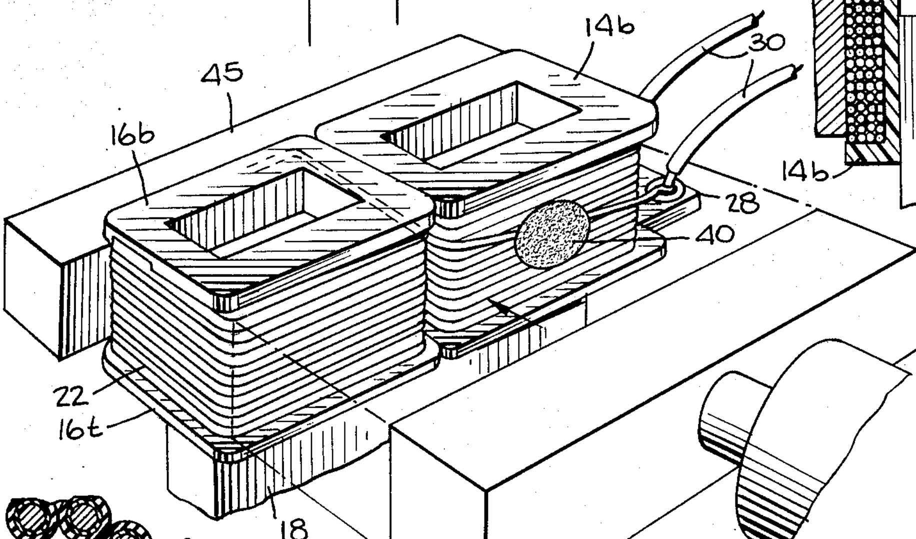
Fig. 18.



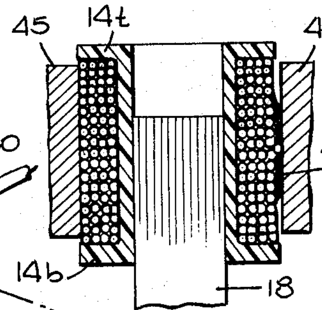
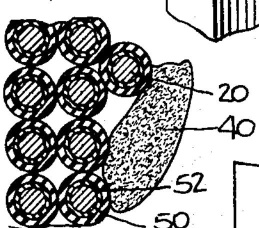


Fig. 19.

Fig. 21.



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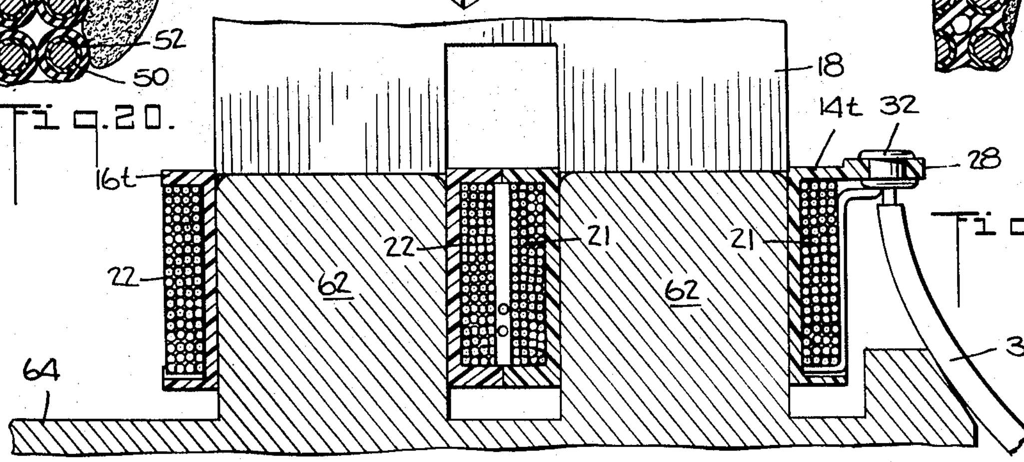

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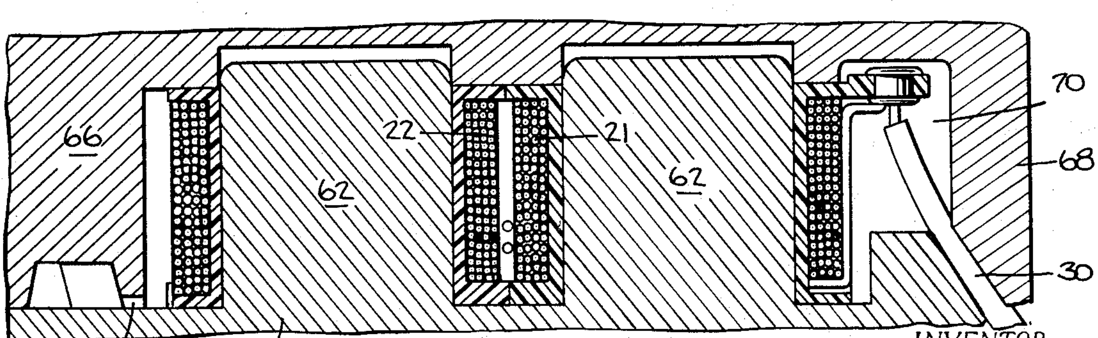

Fig. 23.

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ELECTRICAL COIL AND METHOD OF MANUFACTURING SAME

This invention relates in general to an electrical coil structure and to the method for manufacturing the coil and particularly to a coil assembly that can be employed as part of the armature of a solenoid hammer assembly used in computer impact printers.

BACKGROUND OF THE INVENTION

Electrical coils for mounting on a magnetic core (or armature) have been employed as solenoids in impact printers. The solenoid when energized attracts a movable pole piece which in turn, through a series of levers, causes the selected letter to strike and print on paper. There is a separate solenoid hammer assembly associated with each character on the type drum. At increasingly high printing speeds, 3,000 lines per minute are now achieved, the printer coils involved operate under severe environmental conditions. Because a large number of coils are involved, it is of some importance that the cost of each coil be kept to a minimum. However, it is perhaps of even greater importance that the coils involved withstand the extreme shock conditions to which they are subjected and that they retain a relatively long life so as to minimize expensive printer down time and repair.

In order to obtain precision printing and equal hammer velocity for each character involved, the coils involved must be designed to provide a very precise field strength. Since initial adjustments on the printer can be made and are made, it is perhaps more important that once a coil has been adjusted it retain its operating characteristics unaltered over a considerable period of time under the extreme environment, particularly shock, conditions to which it is subjected.

It is further important that the considerable amount of heat generated by the high currents which are put through the solenoid coils be readily dissipated.

Furthermore, because there are a large number of coils, one associated with each key, mounted in a relatively limited space, it becomes important that the coils be as small as possible.

It is a broad purpose of this invention to provide a printer coil which will be a distinct improvement over previously known devices as far as the above criteria are concerned.

More specifically, it is a main purpose of this invention to provide an improved printer coil so as to meet the increasingly severe environmental requirements at the increasing printing speeds being called for while at the same time maintaining the characteristics of long life, stable operating characteristic, adequate heat dissipation, small size and reasonable cost.

It is a further important purpose of this invention to provide such an improved printer coil while at the same time providing an improved control over the magnitude of the field strength and over the positioning of the field relative to the armature and movable pole piece.

SUMMARY OF THE INVENTION

In brief, this invention involves a method of manufacturing a dual bobbin coil in which the two bobbins are mounted in axial alignment on a common mandrel. A single continuous wire is wound in a clockwise direction on the first bobbin and then wound, without reversing direction or the winding procedure, on the second bobbin, again in the same clockwise direction. In this fashion, a continuous winding, all in the same direction is effected which therefore makes it possible to maintain a constant tension on the wire being wound so that a more uniform and reproducible product is provided.

After the wire is wound on the two axially aligned bobbins, they are removed from the mandrel and one of the two bobbins is rotated (about an axis perpendicular to the bobbin axis) to a position such that its flanges are brought in coplanar alignment with the flanges of the other bobbin. In this position the axes of the two bobbins are now parallel but not in linear alignment. In this rotated position, one of the two bobbins will have a clockwise winding, while the other bobbin will have a counterclockwise winding. The two bobbins are held in this flange co-planar alignment by a U-shaped carrier mount.

Two leads, one from one bobbin and the other from the second bobbin, are then brought to a small projection on one of the flanges, at which point the leads are fastened to eyelets on the flange projection. The entire dual bobbin coil, including flange projection is then encapsulated in a single homogeneous heat conducting material.

The result is a uniquely stable, precise and rugged impact printer coil.

A groove along the inner surface of one of the flanges in each bobbin is used to permit start lead placement that avoids interfering with the winding and aids to assure a layer winding having an exact number of turns and up to 90 percent efficient use of the winding space. It is because of the very efficient use of space that the coil can be encapsulated to provide an end product that still has dimensions sufficiently small to meet the space requirements in the printer.

The bobbins themselves are only partially cured before the winding operation so that there will be less tendency for them to break during winding and handling. The final curing of the bobbins occurs during the final encapsulation.

The magnet wire employed for the winding has a dual coat. A first polyamide coat serves as insulation. An overcoat of a liquid epoxy resin that is partially cured serves to make possible a pre-encapsulation step that stabilizes the coil windings within the bobbins. Prior to encapsulation, a pellet of epoxy material is placed adjacent to the loose lead wire, current is sent through the windings to heat them and two jaws exert pressure on both sides of both windings. As a consequence, the pellet melts and sets, holding the loose lead wire against the winding. Also, the epoxy overcoat melts and sets to fix the windings in place. Furthermore, the jaws size the windings. As a consequence, the intermediate product placed on the mold for final encapsulation has a fixed width and in addition is dimensionally stable.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and purposes of this invention will become apparent from the following detailed description and and drawings, in which:

FIG. 1 is a perspective view of the end product of this invention; namely, an encapsulated dual bobbin solenoid coil.

FIG. 2 is a top view of the FIG. 1 coil with the encapsulation partially broken-away and the top flanges of the bobbins otherwise shown in phantom.

FIG. 3 is a front edge view of the FIG. 1 coil; namely, a view from the right in FIG. 1.

FIG. 4 is a longitudinal vertical cross-section taken along the plane 4—4 of FIG. 1.

FIG. 5 is a horizontal longitudinal cross-section taken along the plane 5—5 of FIG. 4.

FIG. 6 is a lateral cross-sectional view through one of the bobbins taken along the plane 6—6 of FIG. 5.

FIG. 7 is a schematic illustration of the rotational direction of the two windings in the FIG. 1 coil.

FIG. 8 is a perspective view of the front bobbin employed in the FIG. 1 coil.

FIG. 9 is a perspective view of the rear bobbin employed in the FIG. 1 coil.

FIG. 10 is a vertical longitudinal cross-sectional view of the front bobbin and is taken along the plane 10—10 of FIG. 8.

FIG. 11 is a perspective view of an early step in the winding of the two bobbins.

FIG. 12 is a perspective view of a further stage in the winding of the two bobbins.

FIG. 13 is a perspective view of a stage subsequent to that of FIG. 12 in the winding of the two bobbins.

FIG. 14 is a perspective view of a stage subsequent to that of FIG. 13 in the winding of the two bobbins.

FIG. 15 is a schematic illustration of the rotational direction of the windings in the two bobbins when in the position shown in FIG. 14:

FIG. 16 is a perspective view of the two bobbins after the winding shown in FIG. 14 and after the bobbins have been rotated to a position relative to one another that corresponds to the position they have in the end product.

FIG. 17 is a figure similar to FIG. 16 but showing the step of attaching leads to terminals.

FIG. 18 is a perspective view of a sizing and preencapsulation step taken after the step shown in FIG. 17.

FIG. 19 is a lateral vertical cross-sectional view through the bobbin and pellet shown in FIG. 18 immediately prior to the application of sizing jaw pressure.

FIG. 20 is an expanded view of the area in FIG. 19 showing the lead wire and pellet prior to the application of sizing pressure.

FIG. 21 is a view similar to that of FIG. 20 after the application of sizing pressure.

FIG. 22 and 23 are cross-sectional views showing the intermediate product in a mold cavity just prior to the introduction of encapsulating molding compound.

FIG. 24 is a perspective view of the gate arrangement for the mold cavity.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The drawings all relate to the same embodiment of this invention. In connection with this invention and the following description, it should be kept in mind that in order to achieve the purposes of this invention it was necessary to devise new structural features in the end product and also to devise new techniques of manufacturing the end product. The combination of structural features and manufacturing techniques results in an end product **10** that meets the spatial requirements for the solenoid coils that are used to actuate the printer keys and at the same time provides the improved performance characteristics discussed above under the Background of the Invention.

The end product **10** is illustrated in FIGS. **1** through **7**. Its structural details and how it is fabricated can best be understood after understanding how the unencapsulated intermediate product **12**, illustrated in FIGS. **16** and **17** is fabricated from the bobbins shown in FIGS. **8** through **10**. This fabrication of the intermediate product **12** is illustrated in FIGS. **12** through **15** and is described below in connection with the discussion of the intermediate product.

In connection with the end product illustrated in FIGS. **1** through **7**, it need only be pointed out initially that the product **10** is an encapsulated dual bobbin **14**, **16** coil having two windings **21**, **22**. External leads **30** are connected to the magnet wire ends by means of eyelets **32** on a terminal board **28**. This terminal board **28** is a thickened extension of the top flange **14***t* of the bobbin **14**. A single continuous magnet wire **20** is employed as the windings **21** and **22**. The winding **21** has a rotational orientation opposite to that of the winding **22** so that a single pulse of current through these two windings in series will cause a polarity in the bobbin **16** that is opposite to the polarity in the bobbin **14**.

The Intermediate Product

FIGS. **16** and **17** illustrate the coil prior to encapsulation. This intermediate product **12** consists of a first bobbin **14** and a second bobbin **16**. These two bobbins are shown on a U-shaped carrier **18** since the intermediate product **12** is held on such a carrier **18** until it can be encapsulated. The carrier **18** is necessary to properly position and align the bobbins **14**, **16** prior to encapsulation.

A single continuous piece of polyamide coated No. 27 magnet wire **20** is wound in such a fashion as to give an exact turn layer winding in the winding space in each of the two bobbins. Thus, two coils connected in series are provided. Because of the method of this invention, described hereinafter, a single piece of wire **20** can be employed to provide both of the windings **21** and **22**. These two windings **21**, **22** thus are in series and are wound in such a direction that a pulse of actuating current through the windings **21**, **22** will provide a field having a polarity in one direction in the winding **21** of the bobbin **14** and a field having a polarity in the opposite direction in the winding **22** of the bobbin **16**. FIG. **7** schematically illustrates this winding arrangement.

As may best be seen in FIGS. **8**, **9** and **10**, the bobbins **14**, **16** each have a thin wall tubular core **14***c*, **16***c* and each have thin wall top flanges **14***t*, **16***t* and thin wall bottom flanges **14***b*, **16***b*. The use of the term top and bottom herein is dictated by the orientation of the drawings in FIGS. **8** and **9** and has no other significance. Along the inner surface of the bottom flanges **14***b*, **16***b* of each bobbin is a groove, **24**, **26** which extends from flange edge to the core **14***c*, **16***c*. The start lead for each winding **21**, **22** is laid along one of the grooves **24**, **26**. As a consequence, the start lead does not interfere with the layer winding and thus permits a very efficient use of the winding space. The grooves **24**, **26** are off-set from the center line so that the winding start can be precisely established as being at the longitudinal center line.

A 90 percent space factor has been obtained in part because of the employment of these grooves **24**, **26** and in part because of the use of a single continuous wire **20**, thereby avoiding splicing. Further space efficiency is provided by the use of an extension **28** on the first bobbin top flange **14***t* as the terminal board for the two ends of the wire **20**. External leads **30** are connected to the magnet wire **20** ends by soldering both wire **20** and lead **30** ends to brass eyelets **32**.

In one embodiment, to accommodate the coated No. 27 magnet wire, the grooves **24**, **26** are 0.015 inches deep. In turn, this requires that the bottom flanges **14***b*, **16***b* be approximately 0.020 inches thick. The top flanges **14***t*, **16***t* need be only 0.012 inches thick. Minimum flange wall thickness is desired to save space. The terminal board extension **28** of the flange **14***t* is thicker than the flange **14***t* in order to provide adequate support for the lead **20**, **30** connectors.

To obtain good heat transfer characteristics, the bobbins **14**, **16** are preferably molded from a glass fiber reinforced diallyl pthalate (DAP) having approximately ¼ inch long glass fibers. One example of such molding material is the Allied Chemical DAP molding compound 52–40–40–F. The bobbins **14**, **16** employed in manufacturing the intermediate product **12** are transfer molded but are not fully cured. This undercuring of the bobbins **14**, **16** means that the bobbins are more resilient than if they were fully cured and thus, the flange breakage in the winding operation is reduced. It also means that there is a better weld between the encapsulating material and the bobbin material during the final encapsulation molding operation.

The flange wall thickness of the bobbins **14**, **16** is approximately 0.012 inches on the top flanges **14***t*, **16***t*, and 0.020 inches on the bottom flanges **14***b*, **16***b*. These wall thicknesses with the above-mentioned molding material in an undercured state provides sufficient strength to support the windings and prevent distortion or warpage during winding. These wall thicknesses also provide adequate insulation in use. Furthermore, by having as thin a wall as these, the end product is kept to as small a size as possible.

Formation of Intermediate Product

The formation of the intermediate product and in particular, the method of providing the windings **21**, **22** from a single continuous wire **20**, so as to avoid splicing, is of major importance herein. It must be appreciated that a single pulse of current through the windings **21**, **22** has to provide a polarity in one direction in the winding **21** and a polarity in the opposite direction in the winding **22**.

The manner of achieving this result is shown through the successive steps illustrated in FIGS. **11** through **17**. First the bobbins **14** and **16** are placed on a common mandrel **33**. On this mandrel **33** the flange **14***b* containing the start lead groove **24** is placed adjacent to the flange **16***b* containing the start lead groove **26**. A start lead is then placed in the groove **24**, and a standard winding machine is used to complete the winding 21 as a four layer winding of 22 turns per layer. The last layer is incomplete by two turns so that a predetermined 86-turn winding is achieved. Hand wheel adjustment of the last half-turn may be necessary in order to obtain precisely 86 turns. A precise number of turns is desirable in order to obtain uniformity in the bobbins.

After the first winding 21 is completed, the wire 20 is brought over the edges of the adjacent flanges 14*b*, 16*b* to be placed along the other start lead groove 26 (see FIG. 13). The same winding procedure is then followed to provide another 86 turns of a four layer winding as the second winding 22. As shown in the Figures, the second winding 22, like the first winding 21, is wound by rotating the mandrel 33 in a clockwise direction. Thus, the windings 21 and 22 when on the mandrel 33 are in the same rotational direction. Accordingly, a constant tension can be maintained on the wire 20 during the entire course of winding the windings 21 and 22. In this fashion, a more precise and accurate winding is attained. In addition, the maintaining of a constant tension on the wire 20 as both windings are made aids in assuring that the 90 percent space factor is achieved.

The wire guide in the winding machine will have to be set, in winding the winding 21, so that the guide starts on the left and moves to the right. Because the starting condition of the wire guide has to be reversed when accomplishing the winding 22, it may be necessary to transfer the mandrel 33 from a first winding machine to a second winding machine when going from the accomplishment of the winding 21 to the accomplishment of the winding 22.

The windings 21, 22, now wound as a pair, are removed from the mandrel 33 and rotated as if one edge 14*e*, 16*e* of the adjacent flanges 14*b*, 16*b* were hinged to one another. These edges 14*e*, 16*e* are opposite from the edges containing the start lead grooves 24, 26. The two windings 21, 22 are then placed on the U-shaped carrier 18 in order to maintain their proper position and orientation during later processing steps.

When the bobbins 14, 16 are rotated from the relative position shown in FIG. 14, to the relative position shown in FIG. 16, the relative rotational direction of the windings 21, 22 switches from the same rotational direction, as shown in FIG. 15 to opposite rotational directions, as shown in FIG. 7. Thus, by this common mandrel 33 winding technique, a continuous wire can be employed (to avoid splicing) and a constant tension can be maintained during the winding of both windings 21 and 22; yet the end product 10 will have the desired opposite polarity condition.

Encapsulation Method

Encapsulation of the intermediate product 12 to provide the finished product 10 is important in order that the finished product have mechanical stability. The intermediate product 12 if used without encapsulation will tend to fail in use because of the vibrations that cause the turns to abrade the protective polyamide insulation coating on the magnet wire 20. The result would be shorts and failures. Encapsulation prevents relative movement between the turns. However, the amount of encapsulation must be the minimum possible in order to avoid creating an end product whose dimensions make it unusable in the intended impact printer application.

It is important that the encapsulation avoid displacing the windings 21, 22 relative to one another and also avoid damage to the thin flange walls of the bobbins 14, 16. It is further important that the encapsulation avoid damaging the insulating of the windings.

The problems of maintaining positional accuracy and avoiding breakage during encapsulation, minimizing overall increase of dimensions and maximizing heat transfer for the end product when in use are solved by the following encapsulation technique.

a. Pre-encapsulation

An important pre-encapsulation step is illustrated in FIGS. 18 through 21. The magnet lead wire from the second winding 22 must be brought across the surface of the first winding 21 to the terminal board 28.

This last-half turn of magnet wire 20 must be held against the surface of the winding 21 during the encapsulation cycle in order to insure that it is encapsulated and does not appear partially exposed along the surface of the encapsulated end product.

An epoxy pellet 40, of a material compatible with the final epoxy encapsulating material, is placed over the lead wire on the side of the winding 21. Current is then passed through the windings 21, 22 for a sufficient time to heat the windings. In one case, a 10-volt alternating current source was applied to the leads 30 to provide approximately 10 amperes of current for approximately 8 seconds. After the coil windings 21, 22 have thus been heated, a timer valve arrangement (not shown) actuates an air cylinder 42 to cause a movable jaw 44 to apply relatively slight pressure to the epoxy pellet 40. The combination of heat and pressure melts the epoxy pellet 40, cures the epoxy to form a strong bond between the lead wire from the winding 22 and the surface of the winding 21.

Furthermore, there is a stationary jaw 45 along the entire back surface of the two windings 21, 22. The movable jaw 44 has dimensions so that it applies pressure not only to the pellet 40 but also to the entire front surface of the two windings 21, 22. As a consequence, a degree of pressure is applied which serves to size the windings 21, 22 and to reduce their width. In addition, as illustrated in FIG. 20, magnet wire 20 has not only a polyamide insulating coat 50, but also a partially cured epoxy overcoat 52. Under the heat and pressure of this pre-encapsulation step, the epoxy overcoat 52 softens and bonds the turns of the windings 21, 22 to each other. As a consequence, exact placement of the windings 21, 22 on the bobbins 14, 16 is achieved and an additional degree of strength and stability is imparted to the windings.

b. Final Encapsulation

After this pre-encapsulation treatment, the intermediate product is placed in a transfer mold for the final encapsulation to produce the product shown in FIGS. 1 through 7. The encapsulating material is a mineral filled, thermally stable, long flow epoxy molding compound which is flame retardant such as the Plastics Engineering Company Plenco 2005 molding compound. The loose epoxy resin is preformed into round pellets in order to eliminate air bubbles which might be trapped in looser material and which would cause the surface of the encapsulated coil to have air pockets, blisters or poor finish. These round preforms are placed in an R.F. pre-heater to further reduce their melt viscostiy so that a very low molding pressure can be employed to provide an even fill of the mold cavity.

A mold pressure between 40 and 50 pounds per square inch is employed which with the long flow epoxy molding compound involved, insures that the bobbins are not displaced during molding nor are the flanges damaged, yet a thorough impregnation of the magnet wire 20 is achieved. By "long flow" herein it is meant that the viscosity of the molding compound is very low at the melting temperature of the molding compound. A flow of between 40 and 50 inches as measured by the Mesa flow standard is the viscosity preferred.

Because of the thin bobbin walls and close clearances in the mold, a novolac catalyst, as contrasted with an amino catalyst should be employed in the mold compounds used for the bobbins 14, 16, the pellet 40, and the final encapsulating material.

Because the encapsulating material is mineral filled, it has good heat conductivity properties and thus aids in the transfer of heat from the windings to the surface of the end product coil. The fill time is about 30 seconds. As a consequence, there is no movement of the coil windings and no exposed magnet wires. Furthermore, there are no shorted turns caused by hot epoxy encapsulation material removing the polyamide insulation which might occur if short flow material were employed and/or a fast, high pressure mold fill approach taken.

Mold Cavity

The location and size of the gates employed in the mold cavity are of considerable importance to insure that the winding will not move under the pressure of the transfer molding. Two gates 60 are employed as best seen in FIG. 24. These two gates **60** are at the two corners X of the mold cavity diagonally opposite from the mold corners closest to the terminal board **28**. These two gates **60** are positioned parallel with the plane of the thicker bottom bobbin walls **14***b*, **16***b*.

The gates **60** are approximately square in cross-section, being, in one embodiment, 0.020 inches wide and 0.020 inches tall. The gate land in that embodiment was 0.060 inches long. A land as long as this is of value in providing friction to heat the encapsulating material and thus maintain low viscosity. This friction also serves to slow down the rate at which the encapsulating material is introduced and to lower the pressure at which it is introduced. A molding pressure as low as 40 to 50 pounds per square inch has thus been attained. The gates **60** are positioned so that the encapsulating material enters in a location where the molding material initially strikes the bottom flanges **14***b*, **16***b* and thus turbulence is created to thereby generate additional heat and keep viscosity low. The use of two gates, placed as shown, assures a balanced flow of encapsulating material up both sides of the windings. This balanced flow plus the relatively low molding pressures minimized bobbin and winding displacement in the mold cavity.

As may best be seen by contrasting FIGS. **22** and **23**, the intermediate product is transferred from the carrier **18** to complementary bobbin supports **62** that are part of the lower half **64** of the mold. The external lead **30** rests on a sloping surface portion of the bottom half **64** of the mold. The top half **66** of the mold contains a downwardly extending wall **68**. The wall **68** makes flush contact with the upwardly facing sloping surface of the bottom half **64** except for openings between the wall **68** and bottom half **64** through which the external leads **30** extend. These openings, as indicated in FIG. **23**, are somewhat more constricted at their inner end than at their outer end so that the leads **30** are pinched when the mold halves are brought together. As a consequence, the leads **30** can be encapsulated within the space **70** without having the encapsulating material run out of the mold. Thus, a head **72** (see FIGS. **1** and **3**) is formed in the space **70** and complete coil encapsulation is achieved.

FIG. **24** represents the bottom part **64** and top part **66** of the mold. In order to better suggest the nature of the gates **60**, the back portion of the top part **66** has been cut-away. The back of the end product **10** is shown. The two gates **60** are, in FIG. **24**, represented by the molding material that is in the gates and that is attached to the product **10** and that would be shown if the rear portion of the top half **66** of the mold were broken away.

What is claimed is:

1. A dual winding solenoid coil comprising:

first and second bobbins, each of said bobbins having first and second flanges spaced from one another on a winding core to define a winding space therebetween, said bobbins being positioned adjacent to one another, a first flange of said first bobbin being substantially on the same plane as a first flange of said second bobbin, a second flange of said first bobbin being substantially on the same plane as a second flange of said second bobbin,

a single continuous wire winding within said winding spaces of said bobbins, said wire being wound in a first rotational direction on a first one of said bobbins and being wound in a second rotational direction on a second one of said bobbins, whereby a pulse of current through said wire will provide a polarity in a first direction in said first one of said bobbins and in a second direction, opposite to said first direction, in said second one of said bobbins, and

a start lead slot in each of said bobbins, said start lead slot being a groove along a winding space facing surface of said first flange of each of said bobbins, said groove in each of said bobbins extending from the position of the radially innermost turn of wire outward.

2. The coil improvement of claim **1** further comprising:

an outward extension of one of the edges of one of said first flanges of said first bobbin, and

first and second terminals on said extension, a first end of said wire being connected to said first terminal and a second end of said wire being connected to said second terminal.

3. The coil improvement of claim **1** wherein:

said first and second bobbins, including said flange extension and terminals, and said windings are encapsulated in a single homogeneous mineral filled thermo-setting material.

4. The coil improvement of claim **1** wherein:

said second flange of each of said bobbins is thicker than said first flange of each of said bobbins, said flanges being thin walled flanges composed of an undercured glass fiber filled diallyl pthalate molding compound.

5. The coil improvement of claim **2** wherein:

said second flange of each of said bobbins is thicker than said first flange of each of said bobbins, said flanges being thin walled flanges composed of an undercured glass fiber filled diallyl pthalate molding compound,

said extension being thicker than said first flange of said first bobbin.

6. The coil improvement of claim **1** wherein:

said start lead groove has a main axis that is parallel to a longitudinal plane bisecting the bobbin involved and which plane includes the main axis of the bobbin involved, said start lead groove being substantially on one side of said plane and positioned so that the first turn of wire will start at a position approximately at said plane.

7. The coil improvement of claim **2** wherein:

said start lead groove has a main axis that is parallel to a longitudinal plane bisecting the bobbin involved and which plane includes the main axis of the bobbin involved, said start lead groove being substantially on one side of said plane and positioned so that the first turn of wire will start at a position approximately at said plane.

8. The coil improvement of claim **3** wherein:

said start lead groove has a main axis that is parallel to a longitudinal plane bisecting the bobbin involved and which plane includes the main axis of the bobbin involved, said start lead groove being substantially on one side of said plane and positioned so that the first turn of wire will start at a position approximately at said plane.

9. The coil improvement of claim **4** wherein:

said start lead groove has a main axis that is parallel to a longitudinal plane bisecting the bobbin involved and which plane includes the main axis of the bobbin involved, said start lead groove being substantially on one side of said plane and positioned so that the first turn of wire will start at a position approximately at said plane.

10. The coil improvement of claim **5** wherein:

said start lead groove has a main axis that is parallel to a longitudinal plane bisecting the bobbin involved and which plane includes the main axis of the bobbin involved, said start lead groove being substantially on one side of said plane and positioned so that the first turn of wire will start at a position approximately at said plane.

11. The method of fabricating a dual bobbin, dual winding coil comprising the steps of:

molding first and second bobbins, each bobbin having a winding core and spaced apart flanges at the end of said core to define a winding space therebetween,

axially aligning said bobbins,

using a single continuous wire, winding a first winding in a first rotational direction on a first one of said bobbins and then winding a second winding in said first rotational direction on said second one of said bobbins,

maintaining a substantially constant tension on said wire during said step of winding, an

rotating said bobbins relative to one another to cause said flanges of said first bobbin to align in a co-planar fashion with said flanges of said second bobbin and to cause said first and second windings to have opposite rotational orientations.

12. The fabricating method of claim 11 further comprising the steps of:

selecting a thermo-setting material having good heat conductivity properties as the material from which said bobbins are molded during said step of molding, and

undercuring said bobbins during said step of molding so that said flanges are less brittle than would be the case if the bobbins were fully cured.

13. The fabricating method of claim 11 further comprising the steps of:

employing as said single continuous wire a wire having a partially cured epoxy overcoat, and

applying heat and pressure to the windings of said bobbins when said bobbins are aligned with their flanges in said co-planar fashion, said pressure being applied transverse to front and back sides of said winding, said heat and pressure being sufficiently great to cause said undercured epoxy overcoat to further melt and cure to provide a fixing of the turns of said winding and a sizing of the width of said windings between said front and back surfaces of said windings.

14. The fabricating method of claim 12 further comprising the steps of:

employing as said single continuous wire a wire having a partially cured epoxy overcoat, and

applying heat and pressure to the windings of said bobbins when said bobbins are aligned with their flanges in said co-planar fashion, said pressure being applied transverse to front and back sides of said winding, said heat and pressure being sufficiently great to cause said undercured epoxy overcoat to further melt and cure to provide a fixing of the turns of said winding and a sizing of the width of said windings between said front and back surfaces of said windings.

15. The fabricating method of claim 13 further comprising the steps of:

connecting the ends of said single continuous wire to terminals positioned on an extension of a flange of said first bobbin, and

placing a pellet of molding compound over the lead wire from said second winding that is connected to one of said terminals to hold said lead wire against the front surface of said first winding, pellet being subjected to said heat and pressure, whereby said pellet permanently holds said lead wire against said front surface of said first winding.

16. The fabricating method of claim 14 further comprising the steps of:

connecting the ends of said single continuous wire to terminals positioned on an extension of a flange of said first bobbin, and

placing a pellet of molding compound over the lead wire from said second winding that is connected to one of said terminals to hold said lead wire against the front surface of said first winding, pellet being subjected to said heat and pressure, whereby said pellet permanently holds said lead wire against said front surface of said first winding.

17. The fabricating method of claim 11 further comprising the step of:

encapsulating said bobbins and windings when rotated to said co-planar flange alignment arrangement,

said step of encapsulating including the step of introducing encapsulating material into the encapsulating mold in a balanced fashion by gating the encapsulating material into the mold cavity through two gates positioned at the mold corners closest to the end corners of one of said flanges, the opening of these gates being such that the encapsulating material flows equally along each of the two sides of the bobbin pair.

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