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Turner et al.

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[45] **May 14, 1974**

[54] **COIL MANUFACTURING PROCESS**

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[52] **U.S. Cl.** **264/250,** 242/118.41, 264/275, 264/294, 264/297

[51] **Int. Cl.** **B29d 3/00**

[58] **Field of Search** 264/297, 250, 251, 294, 264/271, 275, 277, 278; 242/118.41

[56] **References Cited**

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[57] **ABSTRACT**

A plurality of bobbins are simultaneously molded directly onto a common arbor. The arbor with the bobbins is then placed in a multiple coil winding machine for the simultaneous winding of a coil on each bobbin. Various finishing and testing operations may then be performed on the coil while still using the arbor as a carrier. The entire assembly is then placed in a molding apparatus whereby each of the coils is simultaneously overmolded while still in place on the common arbor. Subsequent to the overmolding operation, the individual encapsulated coils may be stripped from the arbor.

2 Claims, 6 Drawing Figures

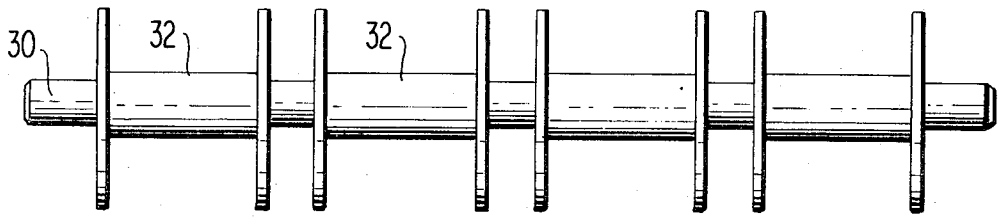


FIG. 1

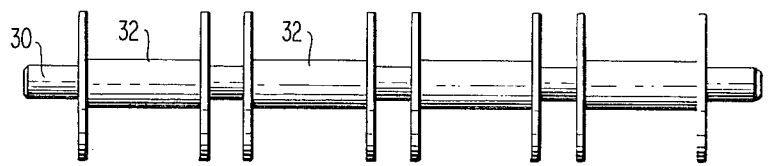
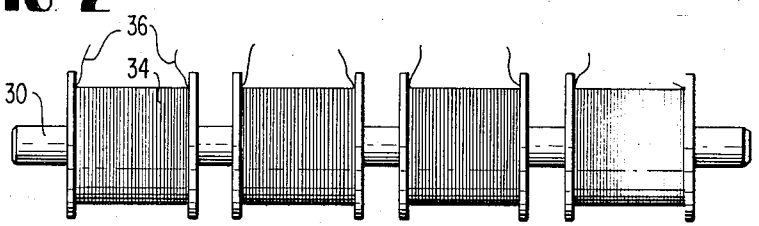


FIG. 2



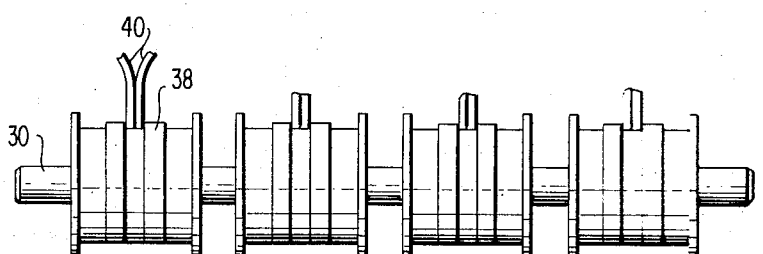
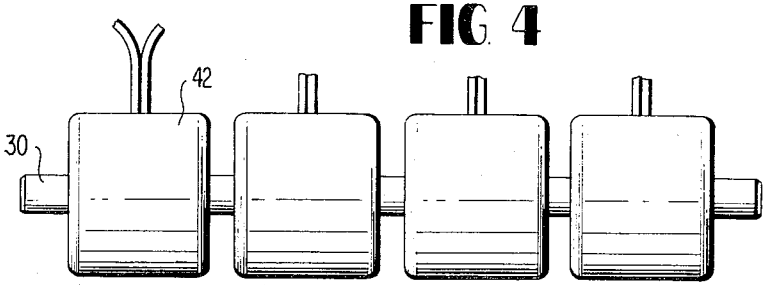


FIG. 3

FIG. 4



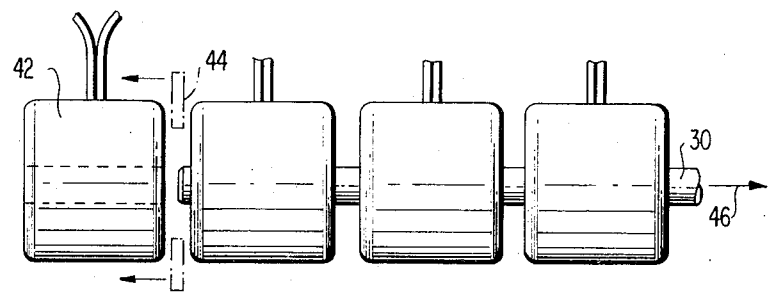


FIG. 5

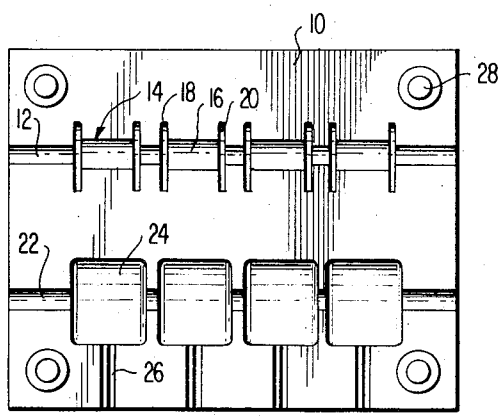


FIG. 6

COIL MANUFACTURING PROCESS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a coil manufacturing process and more specifically to a process for simultaneously manufacturing a plurality of coils on a common arbor which is utilized as a support throughout the entire operation from the molding of the individual bobbins to the removal of the completed individually encapsulated coils.

2. Prior Art

In the magnetic industry, the need for the mass production of coils is extremely great and a large number of procedures have been utilized for the mass production of these coils. A number of processes are used wherein the coils are wound without any coil form but the best quality coils are usually formed on bobbins. In the past, the bobbins have been manufactured in a separate operation and a great deal of effort and technology has centered about the automated handling of the bobbins for inserting them into a coil winding machine and subsequently processing the wound bobbins. However, even under the best automated circumstances the loading of the coils into a multiple coil winding machine, is time consuming and complicated due to the need for properly locating each of the bobbins relative to the coil winding apparatus. Likewise, if it is desired to encapsulate the wound bobbins, a similar loading operation involving a great deal of accuracy insofar as positioning is concerned, is required when loading the wound bobbins into a mold form. In each of these cases, it is clear that a large amount of time and effort is spent in handling the individual bobbins while moving from one step of the process to another.

SUMMARY OF THE INVENTION

The present invention is directed to an improved process for the manufacture and handling of the individual bobbins and the subsequent operations performed on the bobbins including winding, testing, encapsulating, finishing and marking.

The present invention is directed to a manufacturing process wherein a plurality of individual bobbins are molded directly on a common arbor in fixed spaced-apart relation to each other. According to the present invention, the bobbins then remain on the arbor in their fixed relative positions during all subsequent operations performed thereon including the winding of a coil on each bobbin, the stripping, leading, soldering, taping and testing of each coil, and the subsequent encapsulation of each individual coil.

The present invention is directed to a manufacturing process wherein a plurality of complete individual bobbin supported encapsulated coils are formed on a common arbor from which the completed individual coils may be stripped without any subsequent cutting or separating operation.

The present invention is directed to a coil manufacturing process which reduces the handling of individual bobbins to an absolute minimum and which is extremely fast, accurate and reliable for the mass production of encapsulated coils.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a plurality of bobbins molded on a common arbor.

FIG. **2** is a side view similar to FIG. **1** showing a coil wound on each bobbin.

FIG. **3** is a view similar to FIG. **2** subsequent to the stripping, leading, soldering, taping and testing of the coils.

FIG. **4** is a view similar to FIG. **3** showing the coils subsequent to over molding.

FIG. **5** is a view similar to FIG. **4** showing the step of removing the arbor from the finished coils.

FIG. **6** is a plan view of one-half of an exemplary mold for molding the individual bobbins and for over molding the coils.

DETAILED DESCRIPTION OF THE INVENTION

In carrying out the coil manufacturing process according to the present invention, a suitable molding apparatus such as that shown in FIG. **6**, is required. The mold-half **10** in FIG. **6**, would of course, cooperate with a complementary mold-half as well as suitable means for supplying the plastic material to the mold. However, since these features are not critical to the present process and are old and well known in the art, it will suffice for the purposes of the present invention to merely describe the configuration of the mold cavities in the mold-half **10**.

As illustrated in FIG. **6**, the mold-half **10** is provided with a first elongated semi-cylindrical cavity **12** which extends from one edge of the mold-half to the other. One or more bobbin cavities **14** are provided along the length of the arbor cavity and are comprised of a semi-cylindrical core cavity **16** flanked at each end by semi-cylindrical flange cavities **18** and **20**.

Also, formed in the mold-half **10** is a second elongated semi-cylindrical arbor receiving cavity **22**. One or more semi-cylindrical coil receiving cavities **24** are spaced along the length of the arbor receiving cavity for receiving an arbor having one or more wound bobbins thereon. A plurality of grooves **26** are provided leading from each coil cavity **24** to the edge of the mold-half **10** for reception of the lead wires for the coil. Suitable fastening means **28** are provided at each corner of the mold-half **10** for securing the complementary mold-half having identical cavity configurations therein through the mold-half **10**.

Although FIG. **6** shows a cavity arrangement for molding the bobbins on an arbor and a cavity arrangement for over-molding the wound bobbins on an arbor, it is also contemplated that a particular mold could be used exclusively for the manufacture of bobbins on an arbor and a separate mold to be used exclusively for the over-molding of the coil assembly while still on the arbor. As previously pointed out, one or more bobbins may be molded on a single shaft or arbor and the mold may be provided with cavities for the reception of one or more arbors.

According to the present coil manufacturing process, an arbor **30** is inserted in the mold cavity **12** and one or more bobbins **32** are molded directly on the arbor. Generally, the arbor is of circular cross-section and the molding operation is sufficient to fixedly secure the

bobbins to the arbor to prevent relative movement therebetween. In some instances, it is contemplated that it might be necessary to provide the arbor **30** with an elongated flat portion or a raised key portion to assist in securing the bobbins against rotational movement relative to the arbor. The tolerances of the mold cavity relative to the arbor **30** are such that the individual bobbins **32** molded thereon are completely separate from each other and are not interconnected by a film of plastic material about the arbor.

In carrying out the molding operation, any suitable thermoset or thermoplastic molding means may be utilized. The molding operation may involve the use of transfer molding means, compression molding means or injection molding means. For the thermosetting type molding operation a glass and mineral filled epoxy resin may be utilized although it is contemplated that any other suitable material could be used. For the thermoplastic type molding operation a glass reinforced nylon or polyester material is generally utilized although it is possible to resort to other types of plastics.

Subsequent to the molding of the bobbins **32** on an arbor **30,** the entire assembly is removed from the mold and placed directly into a multiple coil winding machine. The particular type of coil winding machine is of no patentable significance since these are old and well known in the art. The spacing of the bobbins on the arbor is however, preset depending upon the type of coil winding machine utilized so that the bobbins will be properly oriented in the machine upon insertion of the arbor therein. By forming the bobbins directly on the arbor in a fixed, predetermined manner, it precludes the necessity of individually loading a number of individual bobbins into a multiple coil winding machine and adjusting their relative positions with respect to each other prior to the actual winding operation. In the coil winding machine, the predetermined number of turns of wire **34** are placed on each bobbin **32** with the end of the coil **36** protruding outwardly therefrom.

The wound bobbins, which are still rigidly secured to the arbor **30** are then removed from the coil winding machine for further operations thereon. The arbor **30,** with one or more coils thereon, may then be placed in any suitable jig for forming subsequent operations thereon such as stripping, leading, soldering, taping and testing. As shown in FIG. **3,** the coils have been provided with a covering of insulating material **38** such as tape or the like, and the leads **40** protrude from the center portion of the coil.

The entire assembly, including the arbor and the bobbins having the finished coils wound thereon is then inserted into a mold having cavities such as cavities **22, 24** and **26** as shown in FIG. **6.** An overmolding operation then takes place to encapsulate each bobbin and coil assembly with a plastic covering **42** as shown in FIG. **4.** Once again, the tolerances of the mold are such that no plastic material interconnects adjacent coil assemblies along the surface of the arbor **30.**

The completed coil assemblies may now be removed from the arbor **30.** A suitable restraining device **44** is utilized to hold the coil stationary while a force is applied by any suitable means to drive the arbor **30** in the direction of the arrow **46** to separate the coil assemblies from the arbor. It is also possible to hold the arbor **30** and shift the elements **44** by any suitable means to strip the finished coil assemblies from the arbor. Thus, it is seen that the present invention provides a coil manufacturing process which is extremely accurate and fast inasmuch as minimal handling of individual bobbins is required during the manufacturing operation. The highest efficiency is gained by using a plurality of cavities in conjunction with an arbor cavity but any number including one, may be used. The present invention allows the bobbins to be precisely molded on the arbor and this same arbor may be utilized in the winding of the coils, subsequent testing and finishing operations and overmolding operations. The present invention is also advantageous even if overmolding is not desired, since the coils could be readily removed from the arbor **30** after the winding operation in their condition as shown in FIG. **2** or after the taping and leading operation as shown in FIG. **3.** It is also contemplated that further operations could be performed on the finished bobbins subsequent to their overmolding such as stamping, testing, degating or deflasing. In all such subsequent operations, the finished coils would still remain in rigid position on the arbor and would not be stripped therefrom until completely finished. Subsequent to the stripping operation, the arbors may be returned for reuse in the original bobbin molding cycle.

The present invention provides substantial additional economic advantages, since the molds are less complex to make and are thus, less expensive since draws and ejector systems become unnecessary due to the fact that the arbor ends are exposed and readily removable from the mold. The principle of loading arbors may be extended to bobbins whose configuration does not lend itself to molding in the line without difficult draws. These bobbins may be molded on a single arbor positioned upright in the mold. Arbors are then used for winding, etc., in the same manner as disclosed above. Two or more single arbors may also be jointed by suitable means for multiple winding and handling. The individual finished coils are returned to the cover mold where the arbor is again used as a loading insert.

Since each of the bobbins is supported fully by the arbor, there is no problem of having the bobbin window or central opening compressed during a winding operation. Such deformation of the bobbin window in the past, has made subsequent loading of bobbins on a shaft extremely difficult and time consuming.

As shown in the disclosed embodiment, the bobbins and the overmolding therefor, are provided with a generally cylindrical configuration. However, it is obvious that the bobbin molding cavities as well as the overmolding cavities may be provided with any suitable configuration such as square, rectangular, or the like. The extent of the overmolding operation may also vary from a complete encapsulation of the entire bobbin including the end flanges to a partial encapsulation which merely covers the coil on the bobbin and extends up to or overlaps the peripheral edges of the end flanges. It is also contemplated that rigid metal terminals could be molded directly into the bobbin for connection to the coil rather than using lead wires as presently illustrated in the drawings. In the event that such terminals are utilized, the mold forms could be appropriately modified to accomodate such terminals in grooves similar to the grooves **26** presently utilized for lead wires.

The present coil manufacturing process is extremely efficient inasmuch as all operations can be run concurrently in a closed loop process. The fact that the bobbins are molded directly on an arbor and kept directly thereon through the entire work cycle reduces the

number of handling steps with respect to the individual bobbins and accordingly decreases the time required for the manufacture of a complete coil.

What is claimed is:

1. A coil manufacturing process comprising molding a plurality of bobbins simultaneously on a single shaft in spaced-apart relation completely independent from each other, winding a coil simultaneously on each of said bobbins while said bobbins are still secured to said shaft, overmolding a protective coating on each of said bobbins simultaneously to provide a plurality of independent unattached coil assemblies on said shaft, and separating the bobbins from said shaft.

2. A coil manufacturing process as set forth in claim 1 wherein additional testing and finishing operations are performed on said coils prior to said overmolding while still maintaining said coils in secured relation to said arbor.

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