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Hammer

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[54] **METHOD AND APPARATUS FOR FABRICATING MOLDED ARTICLES**

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[51] **Int. Cl.²** **B22D 29/04**

[58] **Field of Search** 164/132, 137, 340, 342, 164/343, 346; 249/59, 63, 64; 425/438, 441; 264/318

[56] **References Cited**

UNITED STATES PATENTS

1,887,993	11/1932	Conner et al.	249/59 X
2,336,423	12/1943	Rieser	249/59 UX
2,891,283	6/1959	Cramer et al.	249/59
3,020,594	2/1962	Makowski	249/59 UX
3,481,000	2/1969	Barfuss	425/438 X
3,843,088	10/1974	McLoughlin et al.	249/59 X

FOREIGN PATENTS OR APPLICATIONS

1,962,663	6/1971	Germany	164/132

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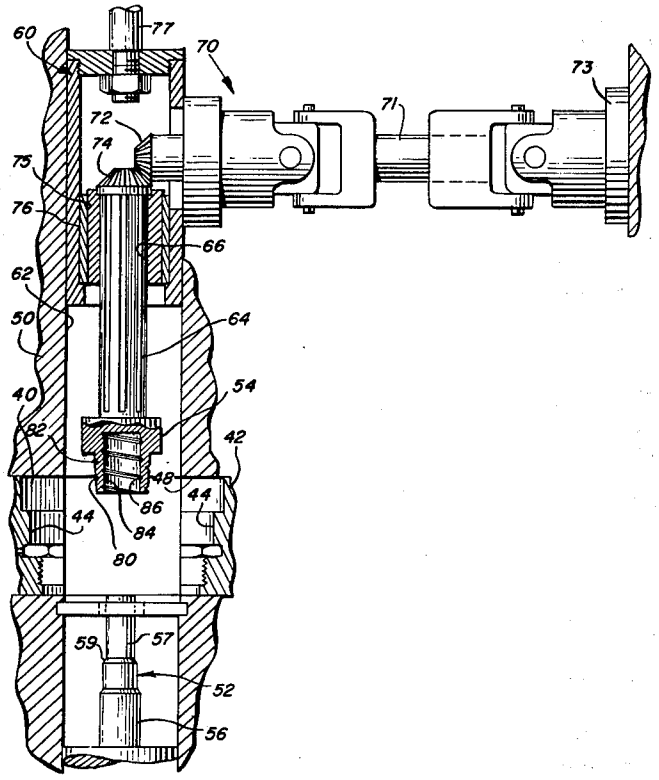
[57] **ABSTRACT**

A method and apparatus for fabricating a molded metal article having an annular space defined by two generally cylindrical side walls with at least one of the side walls having a helically threaded surface is disclosed herein. The apparatus includes a hollow core member that has a helically grooved surface and defines the annular space which is surrounded by a pair of mold halves and receives a solid core member concentrically located therein. The apparatus includes drive means for simultaneously rotating the hollow core member and retracting the hollow core member during such rotation to remove it from the annular space after the article has been molded, and while the article is held by the mold halves against either angular or axial movement.

14 Claims, 6 Drawing Figures



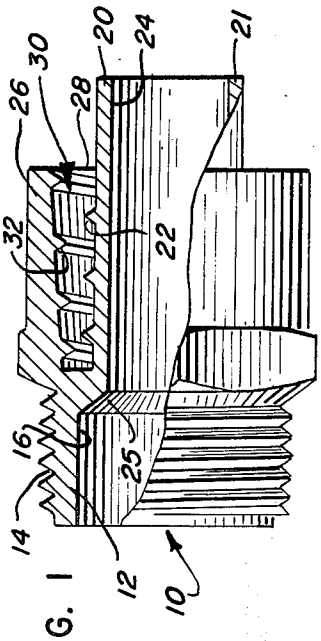


FIG. 1

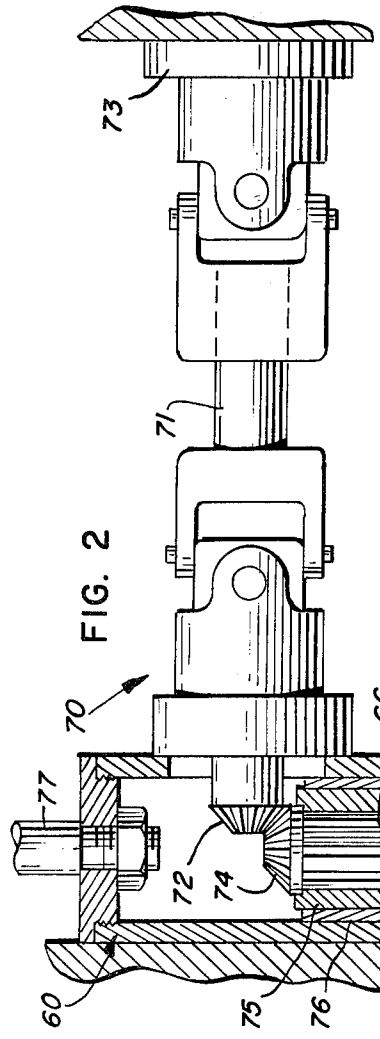


FIG. 2

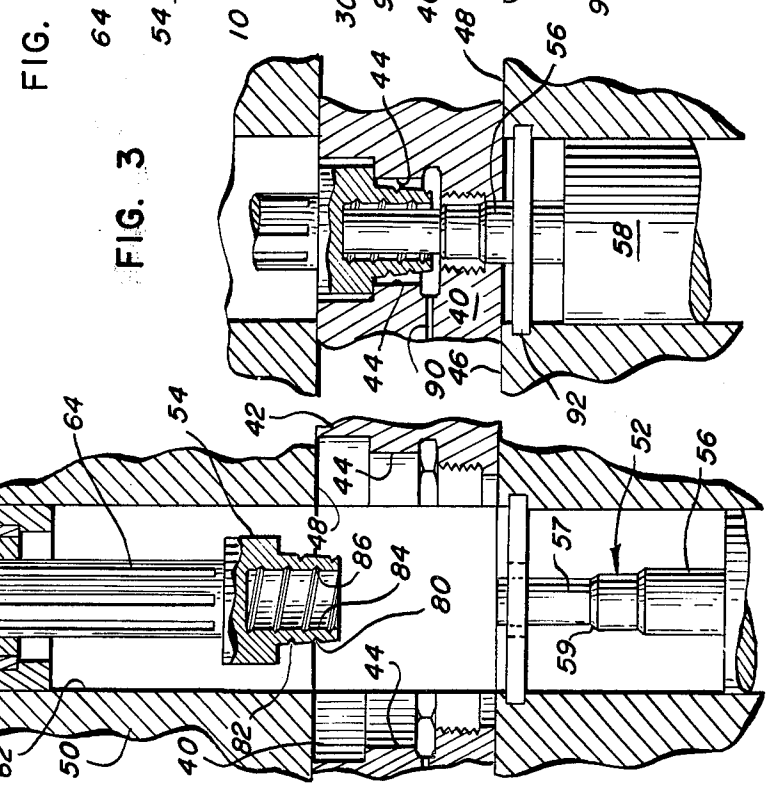


FIG. 3

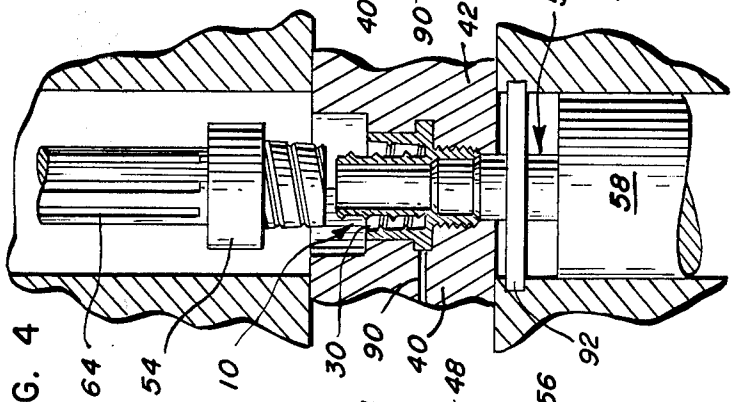


FIG. 4

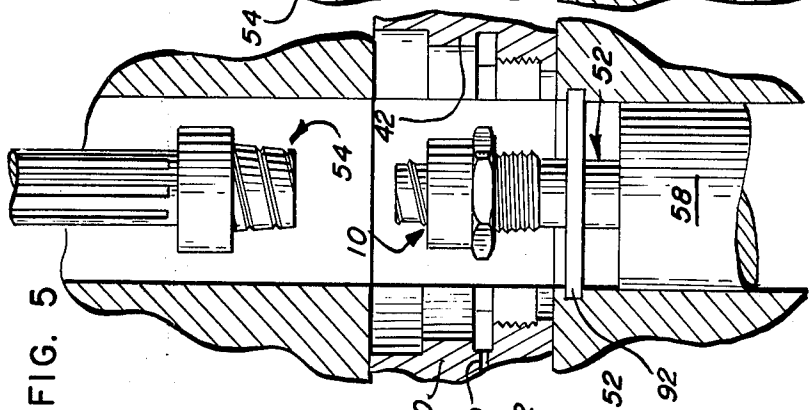


FIG. 5

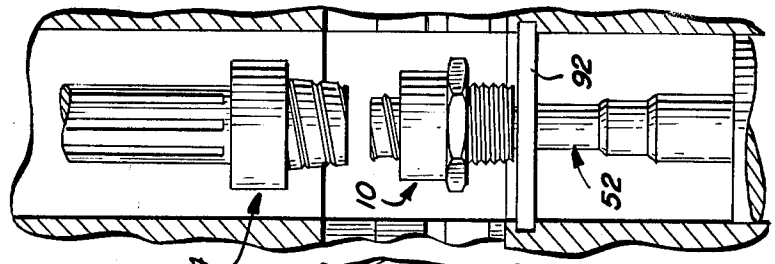


FIG. 6

METHOD AND APPARATUS FOR FABRICATING MOLDED ARTICLES

BACKGROUND OF THE INVENTION

In copending application Ser. No. **471,863**, filed of even date herewith, there is shown a connector for use in connecting a flexible conduit, such as an electrical conduit housing electrical wiring, to a support, such as a fuse box.

The connector consists of a one-piece fitting that has a threaded base and an externally threaded ferrule extending from the base with an annular flange also extending from the base concentric with the ferrule and cooperating therewith to define an annular space between the flange and the ferrule. In the specific connector illustrated in the above application, the annular space has a tapered outer wall so that the cross-section of the annular space from the outer end towards the base is constantly reducing.

One of the difficulties encountered with a connector of the above mentioned type is the method of manufacturing the finished article. Because of the unique nature of the molded article, which is formed of metal and has several internal undercuts, it is extremely difficult to remove the mold part that produces the annular space.

While various methods have been developed wherein an article of the above mentioned type can be molded, these usually require several different steps in producing the finished article. For example, in some instances it is first necessary to open the mold halves to expose a portion of the molded article and then to physically grasp the finished article with a separate tool to remove the hollow article from the remainder of the mold. This type of arrangement is shown in Conner et al. U.S. Pat. No. **1,887,993.**

Another method that is employed for manufacturing an article having a hollow threaded portion is disclosed in Rieser U.S. Pat. No. **2,336,423**. In this method, the molded article is pushed out of the mold in which it is formed by rotating a threaded core member so that it pushes against the threads of the article with which the core member is in engagement, thus placing great stress upon the threads.

Because of the various steps required in both of the above mentioned types of methods for forming articles and because of the danger of damage from the stress placed upon the threads of the newly molded article, such methods are not economically feasible or reliable for producing articles of the type herein contemplated. It will be appreciated that in order to sell the connectors at a competitive price, the overall cost must be substantially low. A significant portion of the overall cost of the finished article, such as the connector described above, is the cost of tooling and the time and effort required in utilizing the tooling to produce a finished article.

SUMMARY OF THE INVENTION

The present invention provides a simple and inexpensive molding method and apparatus for producing articles, such as connectors disclosed in copending application Ser. No. **471,863**, at a competitive cost.

The finished article can be produced and removed from the mold in a simple and expeditious manner in what may be termed a single step molding process. That is to say, the article can be removed from the mold merely by direct manipulation of the mold parts during separation thereof. The finished article can readily be removed from the mold without relying upon the expansion characteristics of the material from which the article is formed.

The apparatus of the present invention consists of a pair of mold halves that have openings therein, which cooperate to define a substantially cylindrical mold space open at both ends when the mold halves are in a closed position. A solid core member is movable between first and second positions and in the first position is concentric with and located within the cylindrical mold space.

The molding apparatus also includes a hollow core member that is located at the opposite end of the mold halves and has at least one helically grooved wall which has a given direction of advance. The hollow core member is supported for rotation on a support member which is movable between a first position wherein the hollow core member is concentric with and surrounds the solid core member in the mold space and a second position located outside the mold space. Drive means cooperate with the support member and the hollow core member to simultaneously rotate the hollow core member with respect to the support member and in a direction opposite the direction of advance of the helical groove, while simultaneously moving the support member away from the cylindrical mold space. The mold halves can then be opened and the solid core member moved axially with respect to the finished article while interrupting the motion of the article with a fixed backing member to remove the article from the solid core.

The method of utilizing the apparatus described above contemplates producing a mold space with a two-piece mold, positioning the generally cylindrical hollow core member described above within the mold space concentric with the cylindrical mold space, positioning a solid core member within the hollow core member and concentric therewith within the mold space and pouring molten metal in the space to produce the molded article. The hollow core member is then first removed by rotating the core member in a direction opposite to the direction of advance of the helically threaded surface and simultaneously withdrawing the hollow core member from the mold space to separate the hollow core member from the molded article, while holding the molded article with the two-piece mold. The two-piece mold is then opened and the solid core member retracted while the movement of the molded article is interrupted to remove it from the solid core member.

The entire method can be performed in a continuous process without any manual manipulation of the finished article to remove it from the mold. In addition, all of this is accomplished with a simple drive mechanism and a minimum number of parts.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** of the drawings shows a side elevation view, partly in section, of the molded article constructed by the method and apparatus disclosed herein;

FIG. **2** shows a side elevation view, partly in section, of the mold with the various mold members in an open or second position, which position is assumed at the completion of a cycle of operation;

FIG. 3 shows the mold members in the first or closed position to define a hollow mold space;

FIG. 4 shows the first step of opening the mold members after the article has been formed;

FIG. 5 shows the second step of opening the two mold halves; and

FIG. 6 shows the final step of removing the solid core member from the finished article.

DETAILED DESCRIPTION

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail a preferred embodiment of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated.

FIG. 1 of the drawings shows a finished connector of the type disclosed and claimed in copending application Ser. No. 471,863, portions of which that are not inconsistent herewith being incorporated herein by reference.

The finished article or connector 10 of FIG. 1 consists of base 12 that is externally threaded at 14 and has opening 16 therein. Connector or fitting 10 also includes ferrule 20 defining an outer wall 21 that has an external thread 22 thereon and an opening 24 in communication with opening 16 in base 12 with shoulder 25 between openings 16 and 24. Fitting 10 further includes an annular flange 26 that extends from base 12 and is concentric with ferrule 20.

Ferrule 20 and flange 26 cooperate to define an annular space 28 with the outer wall 30 of annular space 28 being tapered from the outer free end towards base 20 so that annular space 30 is of constantly reducing cross-section from the outer end of flange 26 to base 12 and has a minimum cross-sectional area adjacent base 12. In certain instances, it may also be desirable to have a further thread 32 defined on wall 30 with thread 32 being axially offset from helical thread 22 and having substantially the same pitch.

The apparatus for producing the article described above and shown in FIG. 1 consists of a two-piece mold or first and second mold halves 40 and 42, each having a substantially semicircular opening 44 therein. The mold halves are movable between an open or second position shown in FIG. 2 to a closed or first position shown in FIG. 3. In the first position shown in FIG. 3, the semicircular openings 44 cooperate to define a generally cylindircal mold space that is open at the upper and lower ends of mold halves 40 and 42. The means for moving the mold halves towards and away from each other between first and second positions may take numerous forms, such as fluid rams moving the mold halves 40 and 42 along guide paths 46 and 48 defined in a fixed support 50.

The molding apparatus for fabricating the molded article also includes a solid core member 52 and a hollow core member 54. Solid core member 52 has a first position shown in FIG. 3 wherein the solid core member is concentric within the generally cylindrical mold space defined by openings 44 and an enlarged portion 56 seals the lower open end of the generally cylindrical mold space. The solid core member 52 also has a second position, shown in FIG. 2, wherein a solid core member is axially spaced from the generally cylindrical opening or mold space where the molded metal article is produced. The means for moving the solid core member between first and second positions may again be of any suitable type, such as a piston rod 58 forming part of a fluid ram (not shown) with the piston rod reciprocated with respect to a cylinder (not shown) of the fluid ram.

Hollow core member 54 is supported on support means or a block 60 that is movable between first and second positions in an opening 62 defined in support 50. Support means 60 supports a circular end portion 64, forming part of hollow core member 54, in an opening 66 for rotation therein.

The apparatus also includes drive means 70 for simultaneously rotating hollow core member 54 with respect to support member 60 and moving support member or slide 60 from the position shown in FIG. 3 to that shown in FIG. 4. This drive means may take various form and consists of a motor (not shown) connected to bevel gear 72 through a clutch 73 and universal coupling 71 so that gear 72 may move vertically with respect to clutch 73. Bevel gear 72 is in mesh with bevel gear 74 fixed to circular end portion 64 of hollow core member 54. End portion 64 of hollow core 54 is rotated in a sleeve 75 that is supported by bushing 76 in slide 60. Slide 60 is moved by a fluid ram (not shown) that has piston rod 77 connected thereto. A timer (not shown) activates clutch 73 just as piston rod 77 starts to move up so that hollow core member is rotated as slide 60 moves up.

Before describing the operation of the apparatus described above, a few further details of the hollow and solid core members 52 and 54 appear to be in order. Hollow core member 54 has an outer tapered wall 80 (FIG. 2) which has a helical groove 82 defined therein while inner wall 84 has a further helical groove 86. As shown in FIG. 2, the helical grooves are axially offset from each other with respect to the central opening defined by inner wall 84. In the specific embodiment illustrated, wall 84 defines a substantially cylindrical opening. However, in certain instances it may be desirable to have the wall frustoconical in shape so as to have a constantly reducing diameter for the opening from the outer end of core member to the base of opening defined by wall 84.

In certain instances, it may also be desirable to have a small taper on the reduced portion 57 which ultimately defines opening 24 with the taper being such that the diameter of the reduced portion 57 progressively increases from the free end or leading end thereof to a step 59, which defines shoulder 25 between openings 16 and 24.

The method of the present invention is believed to be understood from the above description but will be briefly summarized here.

At the completion of a molded article, the various mold members are in the position shown in FIG. 2 which is the open position for mold halves 40 and 42 as well as solid core member 52 and hollow core member 54. The mold members are then moved to the closed or first position shown in FIG. 3 wherein a mold space is defined between the mold members and the space has the configuration of the finished article or connector 10 shown in FIG. 1. Molten metal is then forced through an opening, such as opening 90, in mold halve 40 to fill the mold space with molten metal, such as zinc. The molten metal is then allowed to cool suffi-

ciently to produce a substantially solid article **10** as shown in FIGS. **1** and **5.**

After the metal has hardened sufficiently, and this hardening process may be accelerated by providing cooling fluid through openings (not shown) in the mold members, clutch **73** is engaged to connect the motor to gear **72** which in turn will cause rotation of hollow core member **54** in a direction opposite the direction of advance of helical grooves **82** and **86** defined on the inner and outer walls of hollow core member **54.** Simultaneous to this movement, the support member or slide **60** is moved from the position shown in FIG. **3** to that shown in FIG. **4** wherein the hollow core member is removed from annular space **30** that is defined by inner and outer walls **80** and **84** of hollow core member **54.** During this movement of hollow core member **54,** article or fitting **10** is positively held by mold halves **40** and **42** to insure that the article is not carried with hollow core member **54.**

Thereafter, the mold halves **40** and **42** are moved from the closed position shown in FIG. **4** to the open or second position shown in FIG. **5.** In this position, the finished article or fitting **10** is entirely supported on solid core member **52.** The final step is to move solid core member from the position shown in FIG. **5** to that shown in FIG. **6** and, during this movement, the motion of fitting **10** is interrupted by a support member or means **92** which has an opening through which solid core member **52** extends. Thus, the support member or means **92** defines an abutment surrounding solid core member **52** to strip fitting **10** from the core member as the core member is moved from the first position shown in FIG. **5** to the second position shown in FIG. **6.** The finished article may then be ejected from the mold space by directing a blast of air from a source, not shown, so that the article is moved to a receptacle located adjacent the mold space.

As can be appreciated from the above description, the apparatus for producing fitting **10** includes a minimum number of movable parts, all of which can be manufactured at a small cost so as to substantially reduce the overall cost for producing fittings **10.**

It will be appreciated that while a single mold space has been shown, any number of mold spaces may be produced so that a plurality of fittings could simultaneously be formed in one operation. In such instances, the drive means for driving the respective gear boxes could be a single motor connected to the various gear boxes through a single clutch.

Also, while fitting **10** has been illustrated as including an annular space defined by tapered walls **21** and **26,** both of which are threaded, in certain instances, only one wall need be threaded and/or only one wall may be tapered. In other instances, both walls may be substantially circular and have a constant diameter throughout the length thereof.

What is claimed is:

1. A method of fabricating a molded article having an annular space defined by two generally cylindrical side walls with at least one of said side walls having a helically threaded surface, which comprises: producing a generally cylindrical mold space with a two-piece mold; positioning a generally cylindrical, hollow core member within said mold space concentric with the cylindrical space defined by said two-piece mold member, said hollow core member having at least one helically grooved wall with the helical groove having a given direction of advance; positioning a support member in supporting relation with respect to said hollow core member to hold said hollow core member in position in said space; positioning a solid core member within said hollow core member and concentrically therewith; pouring molten metal in the space defined between said mold members; cooling said poured metal; moving said support member away from said solid core member when the metal has cooled to a temperature sufficiently low to produce a solid molded article; simultaneously with the movement of said support member, rotating said hollow core member in the direction opposite to said direction of advance of said helical groove in the wall of said hollow member while said two-piece mold member holds said molded article against either angular or axial movement; separating said two-piece mold member; and moving said solid core member in said direction of advance to remove said molded article out of said space.

2. The method of claim **1,** including the further step of interrupting the movement of the molded article while said solid core member is moved in said direction of advance to separate said molded article from the solid core member.

3. The method of claim **1,** in which said hollow core member has a substantially cylindrical wall and a frustoconical wall.

4. The method of claim **3,** in which said substantially cylindrical wall is the internal wall of said hollow core member and is helically grooved, while said frustoconical wall is the external wall of said member and is tapered in the direction of advance of said helical groove.

5. The method of claim **4,** in which said solid core member has a frustoconical external wall tapered slightly in the direction opposite to said direction of advance.

6. A method of fabricating a molded article having an annular space defined by two generally cylindrical walls with at least one wall having a helically threaded surface, which comprises: positioning a two-piece mold member to define a generally cylindrical mold space; axially inserting a generally cylindrical hollow core member into one end of said cylindrical mold space concentric with said cylindrical mold space, said hollow core member having at least one helically grooved wall with the helical groove having a given direction of advance; axially inserting a solid core member into an opposite end of said cylindrical mold space and positioning the solid core member within said hollow core member and concentric therewith; pouring molten metal in the space defined between said mold members; allowing said molten metal to cool sufficiently to produce a solid article; rotating said hollow core member in the direction opposite said direction of advance and simultaneously withdrawing said hollow core member from the article while the article is being held by said two-piece mold member against either angular or axial movement; separating the two-piece mold member while supporting said article on said solid core member; moving said solid core member in said direction of advance; and interrupting the motion of said article to remove the article from the hollow core member.

7. The method of claim **6,** in which said hollow core member has a substantially cylindrical internal wall and a frustoconical external wall and in which said internal wall is helically grooved.

8. The method of claim 7, in which said solid core member has a frustoconical external wall tapered slightly in the direction opposite said direction of advance.

9. Apparatus for fabricating a molded article having an annular space defined by two generally cylindrical side walls with at least one side wall having a helically threaded surface having a given direction of advance, comprising: first and second mold halves each having a generally semicircular opening; means for moving said mold halves towards and away from each other between first, closed positions and second, open positions, said openings defining a generally cylindrical mold space open at opposite ends of said mold halves when said mold halves are in said first, closed positions; a solid core member located adjacent one end of said mold halves, said solid core member having (1) a first position where the solid core member is concentric within said generally cylindrical mold space defined by said mold halves and seals one end of said generally cylindrical opening and (2) a second position axially spaced from said generally cylindrical opening; means for moving said solid core member between said positions; a hollow core member located at the opposite end of said mold halves, said hollow core member having at least one helically grooved wall with the helical groove having a given direction of advance; support means for supporting said hollow core member for rotation relative to the axis of said generally cylindrical opening; and drive means for simultaneously moving said support means and hollow core member between a first position where said hollow core member is concentric with and surrounds said solid core member in said cylindrical mold space and seals the opposite end of said mold space and a second position axially spaced from said generally cylindrical mold space, said drive means including means for rotating said hollow core member relative to said support means in a direction opposite said direction of advance as said support means and hollow core member are moved from the first position to the second position, while said mold halves remain in said first, closed position.

10. Apparatus as defined in claim 9, further including means surrounding said solid core member for removing the molded article from said solid core member as said solid core member is moved from said first position to said second position.

11. Apparatus as defined in claim 9, in which said hollow core member has a substantially cylindrical wall and a frustoconical wall.

12. Apparatus as defined in claim 11, in which said substantially cylindrical wall is the internal wall of said hollow core member and is helically grooved while said frustoconical wall is the external wall and is tapered to produce a minimum thickness between said walls adjacent a free end of said hollow core member.

13. Apparatus as defined in claim 12, in which both said external walls of said hollow core member have a helical groove therein with both said helical grooves having the same direction of advance and substantially equal pitches and in which said internal and external helical grooves are axially offset from each other.

14. Apparatus as defined in claim 13, in which said solid core member has an external wall which has a slightly increasing taper from a leading end thereof.

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