June 9, 1964 M. A. SCHWARTZ 3,136,002

CORE FOR CASTING

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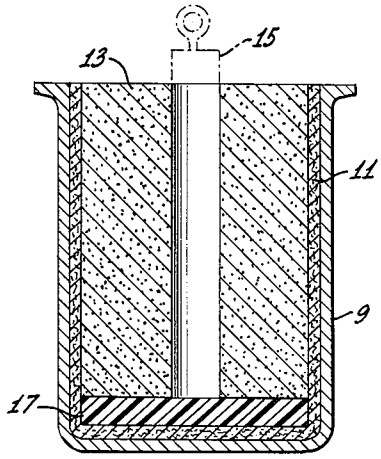


Fig. 1

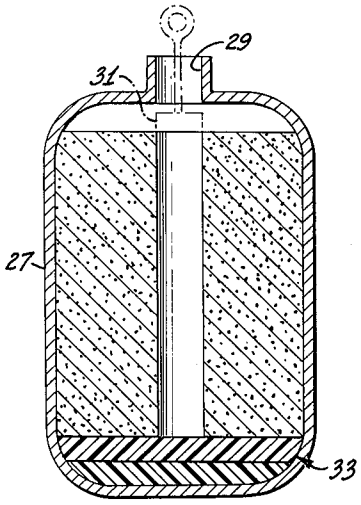


Fig. 4

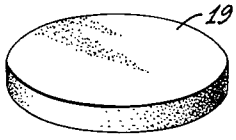


Fig. 2

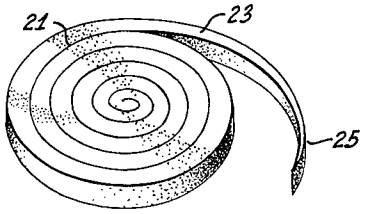


Fig. 3

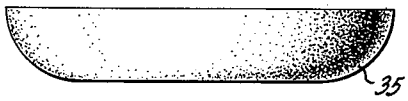


Fig. 5

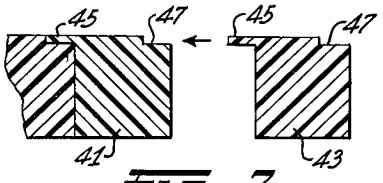


Fig. 7

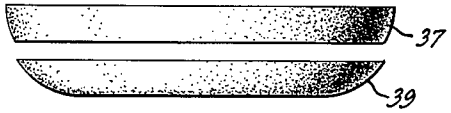


Fig. 6

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CORE FOR CASTING

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This invention relates to a casting technique and more particularly relates to a core structure which can be easily insterted or removed from a mold or casting.

In making many castings, it is desirable to provide a core which can be removed through a small opening after the casting is completed. In the past, cores have been made of various materials such as wax, sand, salt, plaster or the like which can be removed by heating, shaking, washing or the like. Cores have also been used wherein the core is made of a plurality of keyed segments of a solid material and wherein the core can be removed in segments. Such methods have not been fully satisfactory and furthermore have not provided a means wherein the core can also be inserted through a small opening. For instance, in the casting of rocket propellants, it is frequently necessary to make the casting in a chamber having only a relatively small opening therein so that it is not only necessary to extract the core after the casting is made through a small opening but also to insert it originally through a small opening.

In accordance with the present invention, a core is made of a coilable material such as a strip, rope or tube which material will inherently assume the shape of the desired core yet which is sufficiently flexible that it can be inserted and removed through a relatively small opening. Thus, the invention contemplates using a rope-like member of elastomeric material which can be inserted or withdrawn through a relatively small opening so that it will assume a desired, predetermined shape when it is not subject to external forces.

In accordance with one embodiment of the invention, a core is first made in a solid piece of an elastomeric material, and the material then is cut into the form of a helix or other suitable shape so that it becomes rope-like and thus be inserted into the desired opening and later withdrawn therefrom. In accordance with another embodiment of the invention, the core is formed from a strip of thermoplastic material while the material is warm and the material then cooled to set it to the desired configuration. The elastomer will tend to hold its set form, but can be drawn out in rope form for insertion and withdrawal. In accordance with still another embodiment of the present invention, the core is cut in such a manner that overlapping segments are formed.

In the drawings forming part of this application:

FIGURE 1 is a sectional view of a rocket motor showing the method used in casting a propellant grain therein.

FIGURE 2 is a perspective view of a core suitable for use in the rocket motor of FIGURE 1.

FIGURE 3 is a perspective view of a core, such as that shown in FIGURE 2, which has been cut in the form of a helix.

FIGURE 4 is a sectional view of a rocket motor of another geometry.

FIGURE 5 is a side view of a core suitable for use in the motor of FIGURE 4.

FIGURE 6 is a side view of the core shown in FIGURE 5 having a first lateral cut therein.

FIGURE 7 is an enlarged sectional view through a core showing the method of forming the core in overlapping segments.

Turning now to a description of the invention by reference characters, there is shown in FIGURE 1 a rocket

motor having a casing 9 with an insulation 11 therein. In such a motor, it is desired to cast a propellant grain such as that at 13 leaving a hollow space both at the center of the motor and at the closed end thereof. For making the hollow space in the center, a withdrawable mandrel 15 is normally employed. Such mandrels may be placed within the casing, the propellant grain cast therearound and the mandrel withdrawn after the grain has set. Thus forming the center opening provides no particular problem. However, a very substantial problem is provided by the necessity of leaving an open space adjacent to the closed end of the casing or even through some part of the middle of the grain. Thus, a core 17 must be provided which can be withdrawn through the small central opening after the casting has been made.

In accordance with one embodiment of the present invention, a core blank 19 is first cast or cut out of a larger piece of the material. The core 19 is made of an elastomer such as natural or synthetic rubber, polyethylene, polypropylene, nylon, Teflon or other materials it being understood, of course, that the material must have some flexibility yet possess sufficient mechanical strength and thermal stability to resist ultimate casting pressures and temperatures. The core 19 may be made sligthly different in size than the desired ultimate size since during cutting, there may be a tendency for the core to change size slightly. The core blank 19 is then cut in a suitable configuration so that it can be removed through the center hole after the casting is complete. If the material is not sufficiently rigid to enable it to be cut or sawed, it can be accomplished by a freezing process. Thus, as is shown in FIGURE 3, a long helical cut 21 is made in the core blank so that it assumes the form of a rope as is shown at 23. Preferably the end is tapered as at 25 to provide a smooth exterior configuration.

Although the method illustrated in FIGURES 1 through 3 is a preferred embodiment wherein a solid core is cut into the form of a helix, it will be obvious that a rope-like core such as that shown in FIGURE 3 be made in other ways. For instance, such a core could be cast in the form of a helical rope while another possible method of making such a core would be to bend mechanically a strip of material to the form shown in FIGURE 3 and then heat the material to the extent that it will retain the coil form upon cooling.

In FIGURES 4, 5 and 6 there is shown a core which is formed into more than one rope-like segment for ease in insertion. Further, this series of figures illustrates the situation encountered when the core must both be inserted and removed through a small opening. According to this embodiment of the invention, a rocket motor has a case 27 which has a relatively small neck opening 29. Here again, it is desired to provide both a central opening and also an open space at one end of the casing. The central opening can easily be provided by means of the mandrel 31, but the provision of a core 33 to provide for the open space at the end is a more difficult matter. Since the core 33 must be relatively thick, it is impractical to cut the core in a single spiral, such as that shown in FIGURES 1 through 3, since it would lack sufficient flexibility for insertion and withdrawal. Here the core is first made in a single piece 35 and this piece is then split laterally to form two segments 37 and 39. Each of the segments 37 and 39 is then formed as a spiral similar to the manner shown in FIGURE 3. Thus, two relatively small flexible spirals are provided which can be separately inserted and withdrawn. Of course, more than two such spirals might be used and they might be of different configurations depending upon the particular job at hand.

In forming a spiral, such as that shown in FIGURE 3, there is always the possibility that the core will have a

small crack between the various turns through which a small amount of the material being cast might flow. In order to avoid this situation, the cut may be along the lines shown in FIGURE 7. Here two adjacent turns 41 and 43 of a core are shown and on each an overhanging lip 45 and an indentation 47 are provided. Thus, when the core is wound, the lip 45 will fit into the indentation 47 of the adjacent turn so that there is little possibility of material passing between the turns of the core. Instead of making the cut on the lines shown, it is also possible to make a straight cut as is shown in FIGURE 3 and fasten a thin spiral strip of material to the top of the core with the strip overhanging one side of each turn of the core to provide a seal against material passing between the core turns.

Although the cores have been described as being circular with a helical cut, it is obvious that the cores can be made in various shapes with other cuts therein. For instance, the cut might be in the form of scallops, zigzags, Greek square or the like.

I claim:

1. In combination:

(*a*) a hollow casing partially filled with a rocket propellant grain, said grain having a passage extending at least partially therethrough;

(*b*) and a removable core within said casing at the terminus of the said passage for filling at least a portion of said casing temporarily, said core being capable of being removed through the said passageway to form a void in the said casing, said core comprising a solid body of an elastomeric material, said elastomeric material being cut entirely through one dimension thereof to form a single continuous length of material coiled upon itself and having two opposite ends, the adjacent severed portions of material so formed being free of means securing said adjacent portions together whereby opposite ends of said elastomeric material may be pulled apart to form a continuous, elongated member.

2. In combination:

(*a*) a hollow cylindrical casing partially filled with a rocket propellant grain, said grain having a passage extending at least partially therethrough;

(*b*) and a removable core within said casing at the terminus of the said passage for filling at least a portion of said casing temporarily, said core being capable of being removed through the said passageway to form a void in the said casing, said core comprising a solid disc-shaped body of an elastomeric material, said elastomeric material being cut entirely through its thinnest dimension to form a single continuous length of coiled material in the form of a helix, the adjacent severed portions of the material so formed being free of means securing said adjacent portions together whereby opposite ends of said elastomeric material may be pulled apart to form a continuous, elongated member.

3. In combination:

(*a*) a hollow casing intended to be partially filled with an initially fluid rocket propellant capable of being solidified after being injected into the said casing to form a solid propellant rocket grain;

(*b*) and a removable core therein for partially filling said casing while fluid material is being injected into said casing and while said fluid material is solidifying, said core being capable of being removed to form a void in said casing, said core comprising a solid, normally planar body of an elastomeric material, said elastomeric material being cut entirely through its thinnest dimension to form a single continuous length of material coiled upon itself and having two opposite ends, the adjacent severed portions of material so formed being free of means securing adjacent portions together whereby opposite ends of said elastomeric material may be pulled apart to form a continuous, elongated member, said adjacent portions being alternately provided with a lip extending from one of said portions and an indentation in the corresponding adjacent portion of a size to register with one another whereby to provide a smooth, continuous surface when the said elastomeric material is in the normally coiled position.

4. A method for casting a solid propellant grain in a rocket engine casing comprising:

(*a*) inserting in the said casing a core, said core comprising a solid body of an elastomeric material, said elastomeric material being cut entirely through one dimension thereof to form a continuous length of material coiled upon itself and having two opposite ends, the adjacent severed portions of material so formed being free of means securing said adjacent portions together whereby when opposite ends of the said core are pulled in opposite directions, a continuous elongated member is formed;

(*b*) injecting into the said casing an initially fluid rocket propellant material capable of solidifying therein said fluid material being excluded from one of said ends of said core whereby to provide access to said end of said core;

(*c*) permitting the said fluid material to solidify;

(*d*) and thereafter withdrawing the said resilient core material by grasping and pulling out one end thereof.

5. A method for casting a solid propellant grain in a rocket engine casting comprising:

(*a*) inserting in the said casing a core, said core comprising a solid body of an elastomeric material, said elastomeric material being cut entirely through one dimension thereof to form a continuous length of material coiled upon itself and having two opposite ends, the adjacent severed portions of material so formed being free of means securing said adjacent portions together whereby when opposite ends of the so formed coil are pulled in opposite directions, a continuous elongated member is formed;

(*b*) placing a solid mandrel in the said casing in contact with the said elastomeric core;

(*c*) injecting into the said casing an initially fluid rocket propellant material capable of solidifying therein, said initially fluid material being injected to an extent insufficient to cover the end of the said mandrel farthest removed from the said core of elastomeric material;

(*d*) permitting the said fluid material to solidify;

(*e*) withdrawing the said mandrel whereby to provide a passage through the said solidified material extending to the said core of elastomeric material;

(*f*) and thereafter withdrawing the said resilient core material by grasping and pulling out one end thereof.

6. A method for casting a solid propellant grain in a rocket engine said engine having a cylindrical casing with one open end comprising:

(*a*) inserting in the said casing a disc-shaped core, said core comprising a solid body of elastomeric material, said elastomeric material being cut entirely through its narrowest dimension to form a helix, the adjacent severed portions of said material so formed being free of means securing said adjacent portions together whereby when ends of said helix are pulled in opposite directions a continuous elongated member is formed;

(*b*) placing a solid rocket propellant mandrel in the said casing in contact with the said elastomeric core;

(*c*) injecting into the said casing an initially fluid material capable of solidifying therein, said initially fluid material being injected to an extent insufficient to cover the end of the said mandrel farthest removed from the said core of elastomeric material;

(*d*) permitting the said fluid material to solidify;

(*e*) withdrawing the said mandrel whereby to provide

a passage through the said solidified material extending to the said core of elastomeric material;

(*f*) and thereafter withdrawing the said resilient core material by grasping and pulling out one end thereof.

7. A method for casting a solid propellant grain in a rocket engine said engine having a cylindrical casing with one open end comprising:

(*a*) inserting in the said casing a disc-shaped core, said core comprising a solid body of elastomeric material, said elastomeric material being cut entirely through its narrowest dimension to form a helix, the adjacent severed portions being cut alternately whereby one portion is provided with a lip and the adjacent corresponding portion has an indentation therein, said lip and indentation being adapted to register with one another whereby to form a continuous smooth surface when the said helix is in its coiled position, the adjacent severed portions of material so formed being free of means securing said adjacent portions together whereby when opposite ends of the said helix are pulled in opposite directions, a continuous elongated member is formed;

(*b*) placing a solid mandrel in the said casing in contact with the said elastomeric core;

(*c*) injecting into the said casing an initially fluid rocket propellant material capable of solidifying therein, said initially fluid material being injected to an extent insufficient to cover the end of the said mandrel farthest removed from the said core of elastomeric material;

(*d*) permitting the said fluid material to solidify;

(*e*) withdrawing the said mandrel whereby to provide a pasage through the said solidified material extending to the said core of elastomeric material;

(*f*) and thereafter withdrawing the said resilient core material by grasping and pulling out one end thereof.

8. In combination:

(*a*) a hollow casing intended to be partially filled with an initially fluid material capable of being solidified after being injected into the said casing to form a solid;

(*b*) and a removable core therein for partially filling said casing while fluid material is being injected into said casing and while said fluid material is solidified, said core being capable of being removed to form a void in said casing, said core comprising a solid body of an elastomeric material, said elastomeric material being cut entirely through one dimension thereof to form a single continuous length of material coiled upon itself and having two opposite ends, the adjacent severed portions of material so formed being free of means securing said adjacent portions together whereby opposite ends of said elastomeric material may be pulled apart to form a continuous elongated member.

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