

[54] PRESSURE CASTING APPARATUS

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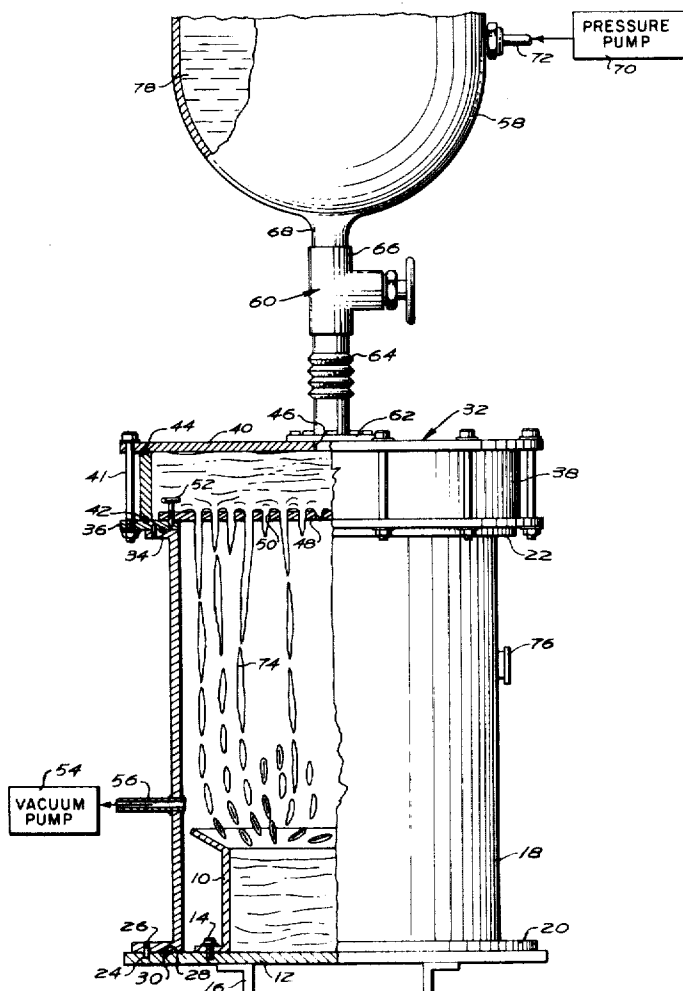
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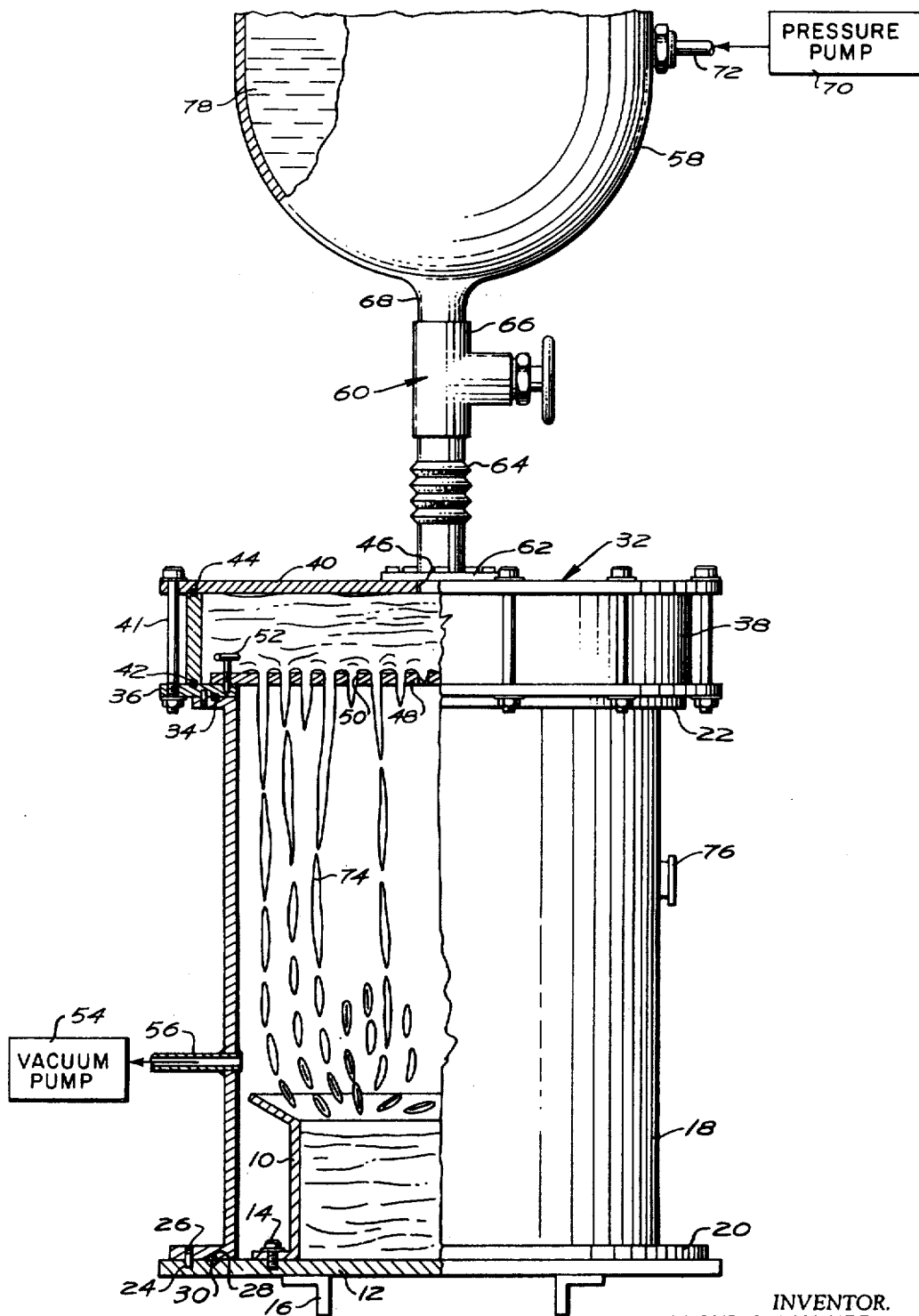
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ABSTRACT

A pressure casting apparatus for casting highly viscous material having a casting mold within a vacuum bell, whereby the vacuum prevents voids in the cast material and reduces the pressurization otherwise required on a transfer pot containing the material to be cast. The transfer pot is operably connected to a pressure casting head having pattern holes in the bottom thereof, which casting head forms the top of the vacuum bell above the casting mold. The casting process is performed by drawing a vacuum in the bell, pressurizing the transfer pot, forcing the material from the transfer pot through the casting head, and dropping the extruded material into the casting mold for curing.

4 Claims, 1 Drawing Figure





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PRESSURE CASTING APPARATUS

This application is a division of co-pending application Ser. No. 687,651, filed Dec. 4, 1967 now U.S. Pat. No. 3,600,486.

BACKGROUND OF THE INVENTION

The invention herein described was made in the course of or under a contract or subcontract thereunder with the Department of the Army.

This invention relates to a new and useful pressure casting apparatus for form casting highly viscous material into desired and useable configurations. This invention is particularly useful in the form casting of solid rocket propellants whereby a highly viscous propellant mixture is cast into a desired form and cured, after which it is further processed for utilization in a solid rocket motor.

Prior to this invention highly viscous material could be molded or form cast into desired configurations. One method of molding the material was to pour the highly viscous material into a mold using care to prevent voids within the mold. However, by this method, components within the mixture, such as metal staples, are randomly disposed throughout the mold. Another method used prior to this invention was the use of a vacuum bell with a screen therein. A charge of highly viscous material would be placed upon the screen and enclosed in the upper portion of the bell. A vacuum was drawn in the lower portion of the vacuum bell and a slight vacuum in the upper portion of the bell. The differential in pressure across the screen would cause the viscous material to be drawn through the screen as extruded fascicles. The vacuum bell would then be vibrated to control the length of the fascicles. The upper portion of the bell above the screen had to be recharged prior to each molding operation. This required disassembly of the vacuum bell and filling the upper portion thereof with sufficient viscous material so that openings would not develop through the material to destroy the differential in vacuum pressures. Each charge for the casting operation had to be substantially more material than would be required to fill the mold.

SUMMARY OF THE INVENTION

In the instant invention, a casting head defines a cavity through which highly viscous material is forced. The casting head rests on a vacuum bell within which there is a casting mold, and the casting head is of sufficient height above the mold so that the viscous material stretches and breaks prior to being deposited into the mold. The casting head is operably connected to a transfer pot containing the viscous material to be cast. Within the connection between the transfer pot and the casting head there is arranged a flexible coupling which allows the casting head to be lifted from the vacuum bell so that a filled mold may be removed and a fresh mold inserted. Several casting heads may be manifolded to a single transfer pot so that several casting operations may be simultaneously in process. A predetermined amount of highly viscous material is charged into the transfer pot. A vacuum is drawn on the vacuum bell and the transfer pot is pressurized with a gas compatible with the viscous material. The rate of flow through the casting head and the length of fascicles extruded through the casting head are a function of the difference in pressure between the transfer pot and the vacuum bell. The fascicles as they are extruded through the casting head fall into the mold, and as they are elongated fascicles, they fall into a horizontal plane so that any components, such as metal staples, contained in the fascicle become oriented in the horizontal plane, although they may be randomly dispersed within that plane. When the mold is full, the vacuum on the vacuum bell is released and the pressure on the transfer pot is reduced to prevent flow of viscous material through the casting head. The casting head may then be removed from the vacuum bell so that a new mold may be inserted.

Another object of this invention is to provide an improved apparatus whereby a single charge of feed-stock highly viscous material may be used to cast one or more molds in succession.

Still another object of this invention is to provide an improved apparatus whereby a single charge of feed-stock highly viscous material may be used to cast more than one mold simultaneously.

5 A further object of this invention is to provide an improved casting apparatus whereby filled molds may be readily replaced by empty molds.

Still a further object of this invention is to provide an improved apparatus whereby feed-stock of highly viscous material containing components such as metal staples may be forced through a casting plate having patterned holes so that the components contained in the viscous material will be in planar alignment within the filled mold.

10 These and other objects of this invention will be apparent from the detailed description which follows, when taken together with the appended drawing.

BRIEF DESCRIPTION OF THE DRAWING

20 The appended drawing is a cutaway view of the pressure casting apparatus of the present invention during the casting process.

DESCRIPTION OF THE PREFERRED EMBODIMENT

25 The instant invention concerns an improved casting apparatus. The feed-stock for this apparatus is a highly viscous material capable of flowing. The viscous material may, for example, be a polymer which is to be cast and cured. The polymer is mixed in the normal manner and may have additives therein, for instance, metal staples. Normally, the additive components contained in the viscous material will then have random dispersion and orientation throughout the mixture. However, by extruding the viscous material through a casting plate a planar orientation of the additive components will be attained.

Reference is made to the drawing showing the instant invention during the casting process. A casting mold 10 is removably mounted to a base plate 12 by a fastening means 14, which may be a bolt and nut arrangement, or may be a bolt screwed into the base plate 12. Legs 16 are rigidly affixed to the base plate 12. The legs 16 may serve several functions; for example, they provide clearance between a floor and the base plate 12. Also, the legs 16 may be positioned to slide along rails or to engage in a conveyor system to facilitate handling.

30 A cylindrical vacuum bell 18 has outwardly extending flanges 20 and 22 at each end thereof. One end of the vacuum bell 18 rests on the base plate 12 and surrounds the casting mold 10. In order to properly assure alignment of the vacuum bell 18 on the base plate 12, index pins 24 may be rigidly mounted on the base plate 12 and positioned to fit into index slots 26 located in flange 20. An air tight sealing means between the vacuum bell 18 and the base plate 12 may be attained by an O-ring 28 located between the base plate 12 and the flange 20. The O-ring 28 may be partially imbedded in a peripheral slot 30 in order to assure proper location of the O-ring 28.

35 Resting on the upper end of the vacuum bell 18 is a pressure casting head 32. There is an O-ring 34 located between the flange 22 and the pressure casting head 32 for the purpose of insuring an air tight seal between the two components.

The pressure casting head 32 is fabricated with a ring plate 36 as a base. A cylindrical pressure casting spacer member 38 separates the ring plate 36 from a head plate 40. O-rings 42 and 44 may be located around the edges of the spacer member 38 in order to insure an air tight seal. The head plate 40 has an inlet opening 46 in substantially the center thereof. The head plate 40 is spacially separated from but rigidly connected to the ring plate 36 by a connecting means, as for example, by head bolts 41 or machine screws. In order that the casting head 32 may be properly positioned on the vacuum bell 18, there may be index pins between the flange 22 and the ring plate 36.

The ring plate 36 has an opening therein, which opening has a diameter of substantially the same diameter as that of the interior of the vacuum bell 18. Overlapping and resting on top of the ring plate 36 is a casting plate 48 which covers the opening in the ring plate 36. Casting plate 48 has pattern holes 50 through rough it so that viscous material may be forced through the patterned holes 50 from the casting head 32 and be deposited in the mold 10. As a matter of convenience, the casting plate 48 may have two or more casting plate handles 52 rigidly attached thereto. The casting plate 48 may also have index pins attached to it to fit into index holes located in the ring plate 36 for the purpose of aiding the positioning of the casting plate 48 onto the ring plate 36. The holes 50 may be of uniform diameter or they may vary in size. Whether or not the holes 50 vary in size will be a function of the ability of the viscous material to be forced therethrough at substantially equal rates so that the buildup in mold 10 will be substantially uniform. In the event the holes 50 do vary in diameter, the smaller holes would be located adjacent the center of the casting plate 48 and the holes 50 would increase in size as they are located further from the center.

It is readily apparent that the casting head 32 may be rigidly connected to the vacuum bell 18 and the vacuum bell 18 may be in turn rigidly connected to the base 12. It was found in practice that the mentioned rigid connections were not required. The O-rings 28 and 34 provided a sufficient sealing means between the components such that when the vacuum was drawn on the vacuum bell 18 the separate components were drawn together, provided sufficient connection so that the component parts would not separate from each other, and were air-tight.

A means for drawing a vacuum within the vacuum bell 18 is connected thereto. One means of drawing a vacuum on the vacuum bell 18 is to connect a vacuum pump 54 to the vacuum bell 18 by use of a vacuum connection nipple 56 being operably connected to the vacuum bell 18.

In order that the viscous material may be fed into the casting head 32, a transfer pot 58 is operably connected thereto. One connecting means between the transfer pot 58 and the casting head 32 may be made up of a pipeline arrangement 60. The pipeline arrangement 60 has a piping flange 62 rigidly attached to the head plate 40 and covering the inlet opening 46 in such a manner that viscous material may pass through the piping flange 62 through the inlet opening 46 into the casting head 32. A bellows pipe 64 provides a flexure means and connects the piping flange 62 to a control valve 66. The control valve 66 as a flow control means is connected to the discharge of the transfer pot 58 by a pipe 68.

The transfer pot 58 receives a charge of viscous material to be cast. The transfer pot 58 is then sealed and pressurized. One means of pressurizing the transfer pot 58 is to connect a pressure pump 70 to the transfer pot 58 through a pressurizing nipple 72. As any viscous material may be cast by use of this invention, the pressurizing gas must be compatible with the viscous material used as feed-stock. It is readily apparent that air may be used as the pressurizing gas. However, in some instances where polymers are being cast, it may be desirable to use gaseous nitrogen as the pressurizing media.

Though disclosed herein as pressure casting one or more molds in succession, it is readily apparent that this invention may be used to pressure cast one or more molds simultaneously. A single transfer pot 58 may be connected to one or more control valves 66 by proper manifold arrangement well known to those with ordinary skills in the art.

During the casting operation, fascicles 74 are being extruded through the pattern holes 50. The casting head 32 is of sufficient height above the mold 10 that the extruded fascicles 74 stretch and break due to their own weight prior to being deposited into the mold 10. The fascicles 74 are elongated when they fall into the mold 10 so that they come to rest in a horizontal plane. Any components contained in the fascicles 74, for example, metal staples, will be oriented in the horizontal plane; however, they may be randomly dispersed within

that horizontal plane. The fascicles 74 being a viscous material and in a vacuum environment so that voids will not be present between the fascicles 74, they tend to flow together into a homogenous mass. Alternatively, the length of the fascicles may be controlled by vibrating the pressure casting apparatus by means well known to those having ordinary skill in the art.

The rate at which the mold 10 is filled may be controlled and timed so that it can be determined when one casting operation is complete. Rather than relying on time, it is preferable that the casting operation be capable of observation. A transparent viewing port 76 provides a viewing means through the vacuum bell 18 so that the mold 10 may be observed during the casting operation.

In operation, the transfer pot 58 is loaded with a feed-stock charge 78 of highly viscous material. The transfer pot 58 is closed so it can be pressurized. A vacuum of approximately 27 inches of mercury is drawn on the vacuum bell 18 by the vacuum pump 54. The transfer pot is pressurized by the pressure pump 70 to a predetermined pressure. The control valve 66 is opened to allow the flow of the highly viscous material feedstock charge 78. The pressure causes the material to flow from the transfer pot 58, through the pipeline arrangement 60 into the pressure casting head 32. The differential pressure between the vacuum bell 18 and the transfer pot 58 causes the highly viscous material to be extruded through the patterned outlet holes 50. As the casting plate 48 is of sufficient height above the mold 10, the fascicles 74 stretch and break of their own weight before being dropped into the mold 10. The stretched or elongated fascicles drop into the mold 10 through a vacuum environment and fall into a horizontal plane or arrangement. The environment within the bell 18 being a vacuum, no voids are allowed to form between the fascicles. The highly viscous material will flow together and become a homogenous mass within the mold 10.

When the mold 10 is filled, the casting operation is terminated. The vacuum with the bell 18 is released so that the bell 18 returns to ambient pressure. The pressure on the transfer pot 58 is reduced to ambient pressure and the control valve 66 is closed. Alternatively, the valve 66 may be closed and it is not essential to reduce the pressure on the transfer pot 58. The pressure casting head 32 is kept full of the highly viscous material for the next casting operation. The flexure means or bellowed pipe 64 allows the casting head 32 to be lifted from the vacuum bell 18 so that together the base plate 12 and vacuum bell 18 may be removed from under the casting head 32 and new ones placed in position. The casting operation can then be repeated while the filled mold 10 is further processed for curing the cast material.

The casting process follows a programmed procedure in order to obtain the best cast. The transfer pot 58 is charged with a viscous material for casting. A vacuum of approximately 27 inches of mercury is drawn upon the vacuum bell 18 before the transfer pot 58 is pressurized. The transfer pot 58 is then pressurized to fill the casting head 32 and force the viscous material through the casting plate 48. The pressure applied to the transfer pot 58 will determine the rate of cast and the sizing of the fascicles 74, as the casting plate 48 is high enough above the mold 10 so that the extruded material stretches and breaks into fascicles 74 due to gravitational forces. Therefore, the pressure on the transfer pot 58 is adjusted to provide the rate of cast and size of fascicles 74 desired. When the mold 10 becomes filled to the desired depth, the casting process is terminated by releasing the vacuum on the vacuum bell 18. The control valve 66 is closed so that the casting head 42 will be maintained full and thereby prevent the development of voids. The casting head 32 may then be raised from the vacuum bell 18 so that the vacuum bell 18 and base plate 12 may be removed and a fresh one inserted.

While one form and embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims.

What is claimed is

1. A pressure casting apparatus for molding highly viscous material comprising:

- a base plate;
- a cylindrical vacuum bell having outwardly extending 5 flanges at the two opposite ends thereof, one end of said bell being in touching relation to said base plate;
- a casting mold removably mounted on said plate and contained within said bell;
- a transfer pot;
- an air-tight pressure casting head having an inlet opening, a 10 cavity therein, said casting head having a center with patterned outlet holes spaced outwardly therefrom, said outlet holes being patterned such that the diameter of each outlet hole increases in proportion to the distance from said center, said casting head being arranged inter- 15 mediate said transfer pot and said bell, said casting head inlet opening being operably connected to said transfer pot, said patterned outlet holes being disposed above said casting mold, and said casting head being in touching 20 relation to the other end of said bell, so as together, said bell, said casting head and said base plate define an air-

tight chamber;

a pressurizing means operably connected to said transfer pot for creating a pressure force on said material; and

a vacuum pumping means operably connected to said vacuum bell for creating a vacuum environment within said bell.

2. A pressure casting apparatus for molding highly viscous material as described in claim 1, wherein said air-tight casting head and said air-tight vacuum chamber are sealed by sealing means which includes O-rings partially imbedded in peripheral slots.

3. A pressure casting apparatus for molding highly viscous material as described in claim 1, wherein said patterned outlet holes are disposed above said casting mold at sufficient height so that said viscous material being extruded through said outlet holes stretch, break, and fall into said mold due to gravitational force.

4. A pressure casting apparatus for molding highly viscous material as described in claim 1, and in addition, a transparent means through said bell for viewing said mold.

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