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MAGNETIC CORE LATCH

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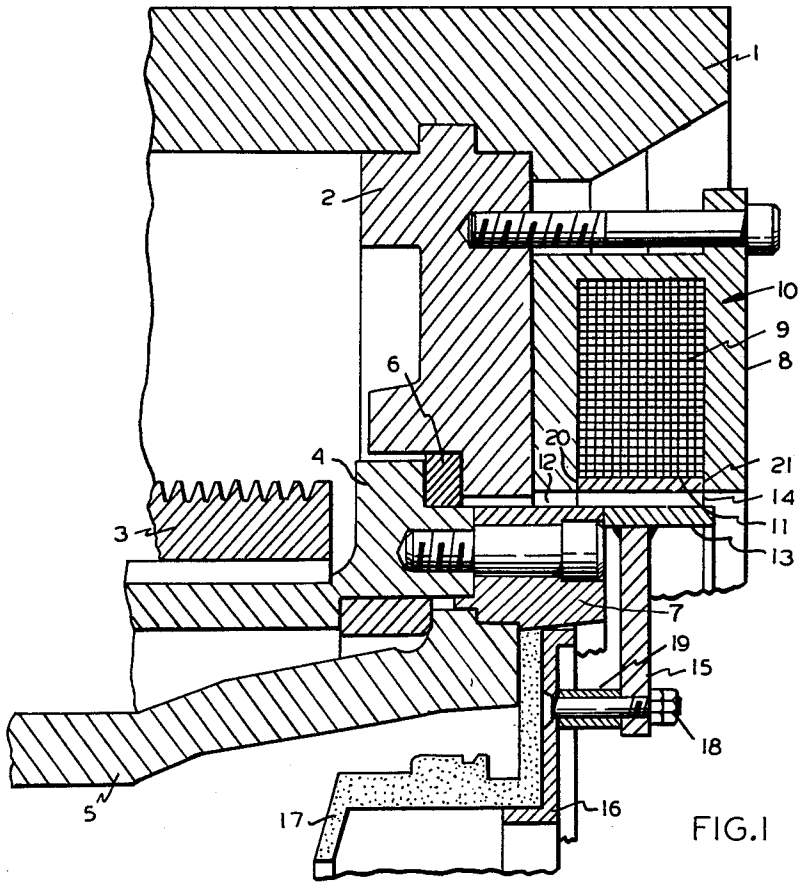


FIG.1

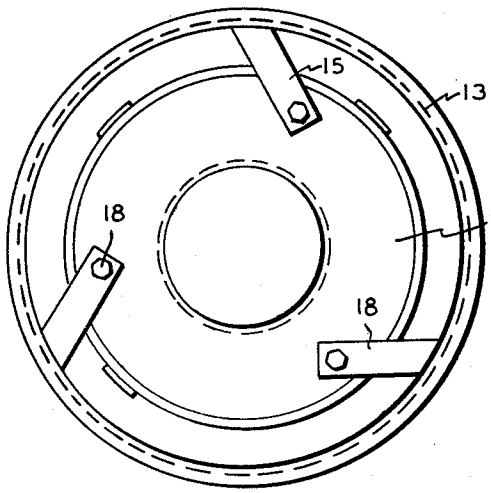


FIG.2

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MAGNETIC CORE LATCH

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This invention relates to apparatus for use in the centrifugal casting of tubular articles such as cast iron pressure pipe. More particularly the invention is concerned with an improved means for securing a core or other end forming device in place at the end of the spinning mold during the casting operation.

In the processes for casting pipe, the pipe is cast in a spinning cylindrical mold provided with a bell cavity in one end into which is inserted a core made of a material suitable for withstanding the action of the molten metal such as sand. This core forms the inside contour of the bell end of the pipe. When plain end pipe are cast an end dam of suitable refractory material is used. The means most commonly used to hold the core in place in the mold comprises a metal back-up plate, which may be separate from or integral with the core, and pins or wedges driven into holes in the mold to hold the plate and core in proper position. This means, while quite successful, has the disadvantage of requiring excessive time and effort and considerable skill by the worker to insert and remove the pins or wedges.

Mechanical latching means which employ the use of centrifugal force have been devised. With these devices the core and back-up plate are secured in place by dogs or latches forced into holding position by the action of centrifugal force. This force results from the rotation of the mold on which the latching means is affixed. These devices have been quite successful, but being mechanical they occasionally, and sometimes frequently, do not properly seat and secure the core in place. When this occurs the molten metal escapes around the core and is thrown tangently outward by centrifugal force; this is commonly referred to as a "sling-out." Since the ends of the dogs or latches are in the direct path of the flying metal during a sling-out, they are very susceptible to damage and fouling. Consequently, the cost of maintaining them is very high and considerable production time is lost while repairing or unfouling the latches after a sling-out.

The invention has for its object the provision of an improved means for securing cores in molds used for centrifugal casting which overcome the disadvantages and deficiencies of the prior devices.

More particularly, the invention has for its object the provision of a magnetic means which holds the core and back-up plate securely in position during casting and which offers no resistance to the insertion of the core and back-up plate into the mold.

Specifically, the invention has for its object the provision of a magnetic means for holding the core and back-up plate securely in position at the end of the mold wherein the core is mounted on a metal ring which functions as a plunger in a solenoid type magnet.

Other objects and advantages will be apparent from a consideration of the following description and the accompanying drawings showing a presently preferred embodiment of the invention as used in the casting of centrifugal cast iron pressure pipe.

FIGURE 1 is a sectional view taken along the longitudinal axis of a deLavaud casting machine showing the bell end construction when equipped with the invention of this application.

FIGURE 2 is a transverse view of the solenoid plunger ring showing in more detail the attachment thereto of the back-up plate.

Through experiments with simple magnetic structures it was determined that the magnet should be specifically designed to give the high holding force required. For example, for a 6" push-on joint the molten iron in the spinning mold exerts a force of 1000 pounds on the core. In order to obtain a seal between the core and mold and to have a sufficient safety factor, it was determined that a magnetic securing means should preferably exert at least 2000 pounds of force on the core. Even higher forces are required when casting mechanical joint or bolted gland pipe.

In order to obtain the desired holding force, it was considered that a magnet such as would be used for lifting or for a magnetic chuck could be used to pull against a steel ring and this force be transferred to the core back-up plate. However, since the end of the mold is not in a precisely fixed position, it was necessary to give consideration to other designs. The mold in a deLavaud casting machine rotates within a stationary water box and it is positioned longitudinally in the box by thrust rings. The mold normally floats between the thrust rings so as to permit a longitudinal movement in relation to the water box of about one-half inch. This is necessary because of expansion and contraction of the mold during the casting operation, therefore, any successful device for holding the core in place must permit this movement and still maintain holding force.

With a lifting type magnet if the core holding device were in proper position to give a very slight gap in the magnetic circuit when the mold was nearest the magnet, the longitudinal movement of the mold away from the magnet could open this gap to one-half inch. To attain the required pull across this gap would require a very powerful magnet. Furthermore when the gap became slight the magnetic pull would be much greater than desired.

The apparatus of the invention embodies a solenoid type magnet which can best be described as "a plunger type iron clad solenoid with stop." A ring of ferromagnetic material, preferably steel, acts as the solenoid plunger and the core back-up plate is attached to this ring. The core head flange on the mold extends into the coil opening and serves as a stop. As the mold moves longitudinally the stop moves correspondingly within the magnet opening without appreciable loss in holding force.

In FIGURE 1, the water box **1**, water box end flange **2**, drive sheave **3**, adapter ring **4**, mold **5**, thrust ring **6** and core head mold flange **7** illustrate the typical make-up of the bell end of a deLavaud casting machine.

Attached to the water box flange **2** is magnet **8**. This magnet comprises a wound coil **9** and cladding **10** of ferromagnetic material. This magnetic cladding extends over the two radial surfaces and the outer circumference of the coil, but does not extend completely along the inner circumference of the coil. Instead the inner circumference or an appreciable portion thereof is covered with a plate **11** of nonmagnetic material such as stainless steel which produces the effect of an appreciable air gap, e.g. 2" to 3", in the magnetic cladding. The windings and cladding of the magnet are designed to give the necessary pull from a magnet which may be conveniently attached to the water box flange. For example, a magnet suitable for use in the manufacture of 4" and 6" pipe has been constructed having 4480 turns of #19 B.S. gage wire for use with 250 volts D.C.

The magnet **8** is carefully centered about core head flange **7** which extends into the opening in the center of the magnet. The core head flange **7** is designed with an outer diameter which permits its free rotation within the magnet, but provides only a small gap **12** between the core

head flange and the inner circumference of the cladding **10**. The core head flange **7** is also made of a magnetic material. The axial thickness of the core head flange **7** is such that it will extend into and project beyond the inner edge **20** of the gap in the cladding of the magnet and act as a stop for plunger ring **13**. This prevents the plunger ring from attaining a centered position in the magnet where it is not subjected to an axial force.

The solenoid plunger is a ring **13** of a magnetic material with an outside diameter substantially the same as the outside diameter of the core head flange **7**. The ring **13** is placed inside the magnet and has an axial length at least as great as the distance from flange **7** to outer edge **21** of the gap in the cladding. When the current is turned on, the ring **13** is firmly pulled against core head flange **7** with the result that the gap in cladding **10** is bridged by magnetic material. The coil **9** is then completely enclosed by magnetic material except for the two small air gaps **12** and **14**. If the end of the mold **5** moves in either direction, the core head flange **7** moves the same distance with the result that the stop position is automatically changed to compensate for any change in the mold position and the ring **13** always attains the same relative position with respect to the end of the mold. It is important that the stop **7** always extend beyond the inner edge **20** of cladding **10** to obtain optimum pull.

Suitable support means, for example, three equally spaced arms **15** (FIG. 2) are attached to the inner surface of the ring **13**. The back-up plate **16** which supports the core **17** is fastened to the arms by bolts **18** and spacers **19** are provided to obtain the proper spacing between the mold **5** and the back-up plate **16**.

Preferably, the supporting arms **15** are designed to permit a small amount of deflection to compensate for the slight variations in core thicknesses. For example, the back-up plate **16** for a 6" push-on joint core is spaced from the axially inner end of ring **13** an amount which will provide a spacing of .070" between ring **13** and core head flange **7** when a nominal size core **17** is snugly seated between the mold **5** and back-up plate **16**. When the magnet is energized the flexibility in arms **15** permits the ring **13** to be pulled against core head flange **7** thus eliminating any air gap between them and resulting in maximum holding force. The deflection in the arms **15** will vary according to the variations from nominal in the thickness of the core so that for all operating conditions, no air gap exists between core head flange **7** and ring **13**.

In addition, transmitting the holding force through these flexible arms assures that there will always be adequate sealing between the core and the end of the mold. If the connection between the back-up plate **16** and ring **13** were made rigid, it would not be permissible for the ring **13** to contact core head flange **7**. Otherwise, there would be no assurance that the core would be in sealing engagement with the end of the mold. The resulting air gap would greatly affect the holding force developed by the magnet.

The operation of the casting machine equipped with the magnetic latch is simplified. The core is seated on the back-up plate which is mounted on the plunger ring. This whole unit is merely set in place in the magnet, and the core is latched in place by energizing the magnet. The magnet may be wired in parallel with the spinning motor so that the latch will always be operative when the mold is spinning or the magnet may be separately energized. After the pipe has been cast, the magnet is de-energized and the plunger ring assembly is removed from the magnet so that the pipe may be extracted. Since there are no moving parts mechanical wear is not a problem and there is nothing to become fouled by the molten metal if a sling-out should occur.

While the fundamental novel features of the invention have been illustrated and described as applied to a preferred embodiment, it will be apparent to those skilled in the art that modifications can be made without departing from the spirit of the invention. It is intended, therefore, that the invention be limited only as indicated by the scope of the following claims.

We claim:

1. A pipe casting apparatus comprising a generally cylindrical metal mold having a bell cavity formed at one end rotatably mounted about its longitudinal axis, a core head mold flange of ferromagnetic material attached to the bell end of the mold, an electromagnetic coil mounted in a fixed position adjacent the bell end of the mold coaxially with the axis of rotation, a ferromagnetic cladding around said electromagnetic coil having a circumferential gap of appreciable axial extent along the inside periphery of the coil, said electromagnetic coil being positioned in relation to the bell end of the mold so that said core head mold flange extends inside and projects over said circumferential gap for a distance less than said axial extent, a plunger ring positioned inside said electromagnetic coil and having an axial length at least as great as the distance between the core head mold flange and the outer edge of the circumferential gap in the cladding, said plunger ring being pulled against said core head mold flange when the electromagnetic coil is energized so that the circumferential gap is bridged by ferromagnetic material, a multiplicity of generally radially extending flexible arms projecting inwardly from said plunger ring, and a core back-up plate attached to said arms so as to support a bell core in proper position in the bell cavity of the mold.

2. A pipe casting apparatus comprising a generally cylindrical metal mold having a bell cavity formed at one end rotatably mounted about its longitudinal axis, a core head mold flange of ferromagnetic material attached to the bell end of the mold, an electromagnetic coil mounted in a fixed position adjacent the bell end of the mold coaxially with the axis of rotation, a cladding around said electromagnetic coil consisting of ferromagnetic material with the exception of a section of essentially non-magnetic material of appreciable axial extent along the inside periphery of the coil forming the equivalent of a circumferential air gap in the magnetic structure, said electromagnetic coil being positioned in relation to the bell end of the mold so that the said core head mold flange extends inside and projects beyond the inner edge of said circumferential gap for a distance less than said axial extent, a plunger ring having an axial length at least as great as the distance from the core head mold flange to the outer edge of said circumferential gap, and being positioned inside said electromagnetic coil so that when the electromagnetic coil is energized said plunger is pulled against said core head mold flange whereby said circumferential gap is bridged by ferromagnetic material, a multiplicity of inwardly extending arms projecting from said plunger ring and a core back-up plate attached to said arms so as to support a bell core in proper position in the bell cavity of said mold.

3. An apparatus according to claim 2 wherein the said inwardly extending arms are made sufficiently flexible to accommodate variations in the dimensions of the bell core.

4. A pipe casting apparatus comprising a generally cylindrical metal mold having a bell cavity formed at one end rotatably mounted about its longitudinal axis, a core head mold flange of ferromagnetic material attached to the bell end of the mold, an electromagnetic coil mounted in fixed position adjacent said bell end of the mold coaxially with the axis of rotation, a ferromagnetic cladding around said coil having a circumferential gap along the inside periphery of the coil, said electromagnetic coil being positioned in relation to the bell end of the mold so that said core head mold flange extends inside and projects beyond the inner edge of the circumferential gap, a plunger ring positioned inside said coil so that it projects beyond the outer edge of the circumferential gap, said plunger ring being pulled against said core head mold flange when the coil is energized where-

by the said circumferential gap is bridged by ferromagnetic material in the core flange and plunger ring, and means attached to said plunger ring for supporting a bell core in proper position in the bell cavity of the mold when said plunger ring is pulled against said core head mold flange.

5. A casting apparatus comprising a generally cylindrical mold mounted rotatably about its longitudinal axis, a continuous ring of ferromagnetic material attached to an end of the mold, an electromagnetic coil mounted in a fixed position adjacent said end of the mold coaxially with the axis of rotation, a ferromagnetic cladding around said coil having a circumferential gap along the inside periphery of the coil, said electromagnetic coil being positioned in relation to the end of the mold so that said continuous ring extends inside said coil and projects beyond the inner edge of said circumferential gap, a plunger ring of ferromagnetic material positioned inside said electromagnetic coil so that it projects beyond the outer edge of the circumferential gap, said plunger ring being pulled against said continuous ring when the electromagnetic coil is energized whereby the gap in the cladding is bridged by ferromagnetic material, and means attached to said plunger ring for supporting an end forming means in sealing engagement with the end of the mold when said plunger ring is pulled against said continuous ring.

6. A casting apparatus comprising a generally cylindrical mold mounted rotatably about its longitudinal axis, a stop means of ferromagnetic material attached to an end of the mold, an electromagnetic coil mounted in fixed fixed position adjacent said end of the mold coaxially with the axis of rotation, a ferromagnetic cladding around said coil having a circumferential gap along the inside periphery of the coil, said electromagnetic coil being positioned in relation to the end of the mold so that the stop means extends inside the coil and projects beyond the inner edge of the gap in said cladding, a ring of

ferromagnetic material positioned inside the coil so as to project inward beyond the outer edge of the gap in the cladding, said ring being pulled against the stop when the coil is energized whereby the gap in the cladding is bridged by ferromagnetic material, said stop and said ring being free to rotate with said mold, and means attached to said ring for supporting an end forming means in sealing engagement with the end of the mold when said ring is pulled against said stop.

7. A casting apparatus comprising a generally cylindrical mold having an enlarged bell cavity at one end, a core head mold flange made of ferromagnetic material attached to the bell end of the mold, an electromagnetic coil mounted coaxially with the axis of rotation of the mold adjacent the bell end of the mold, a ferromagnetic cladding covering said coil except for a circumferential gap of appreciable axial extent along the inner periphery of the coil, a ring of ferromagnetic material positioned in the coil so as to project inward beyond the outer edge of the circumferential gap in the cladding, said electromagnetic coil being positioned so that the core head mold flange extends into the coil and projects beyond the inner edge of the gap a distance sufficient to stop said ring from bridging the gap in the cladding, said ring being firmly pulled against the core head flange when the electromagnet is energized whereby the gap is bridged by ferromagnetic material, said ring and core head flange being loosely fitted in said coil so as to be free to rotate with the mold, a core back-up plate attached to said ring in proper relation to secure a core at the bell end of the mold when said ring is held against said core head flange.

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