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[54] **INJECTION CYLINDER FOR METAL CASTING**
1 Claim, 1 Drawing Fig.

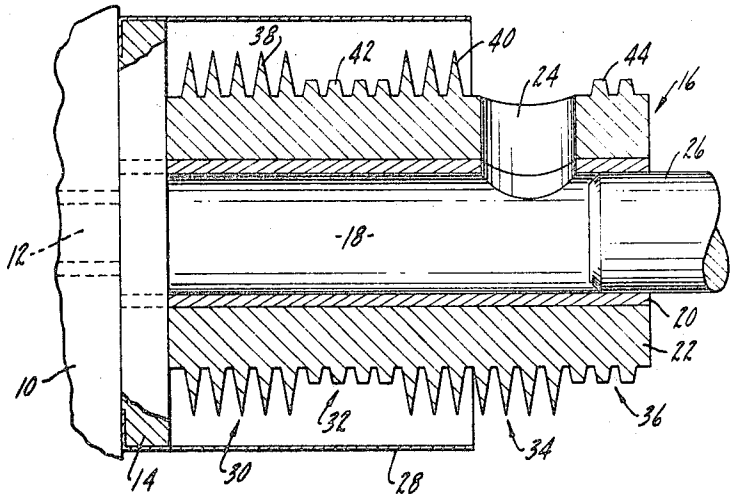
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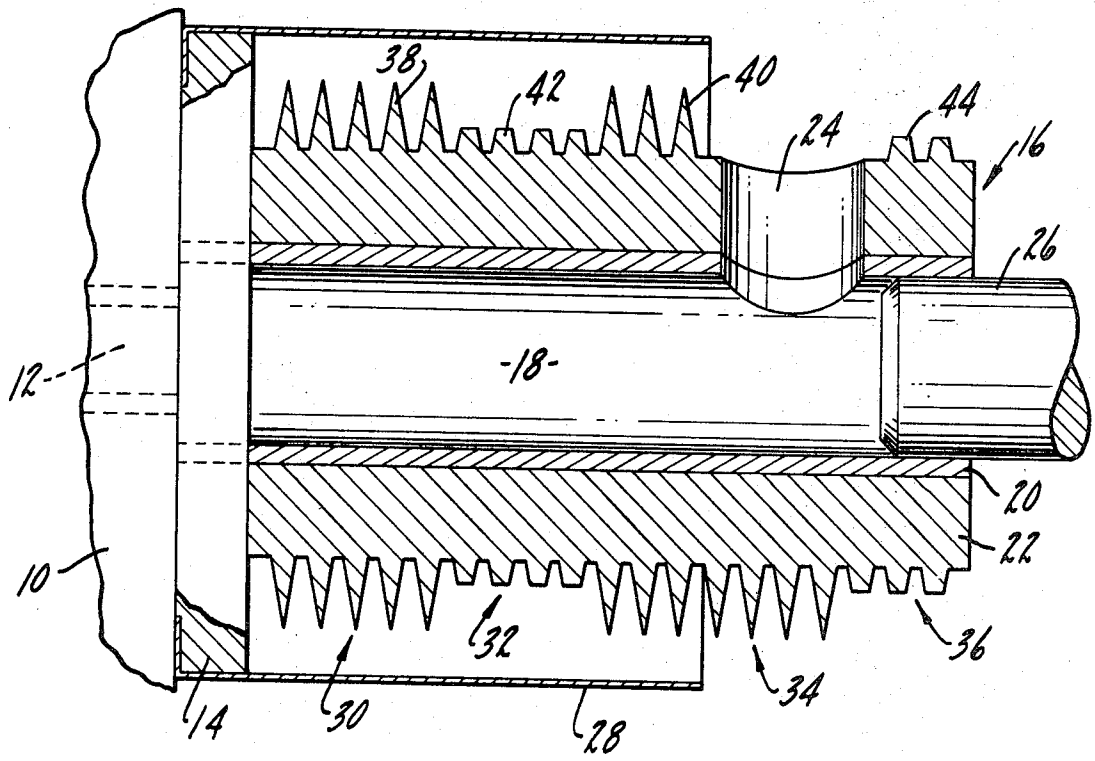
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ABSTRACT: In the die casting of molten metal, for example ferrous or high-temperature metals, the molten metal is introduced into an injection cylinder and the metal is normally moved by a reciprocating plunger from the injection cylinder into the die cavity. The introduction of molten metal into the injection cylinder can cause temperature distortion of the cylinder walls and thus permit leakage of the molten metal around the plunger which is pushing the metal into the die cavity. The temperature distortion of the cylinder wall is nonlinear. To prevent such distortion, means are provided to cool the injection cylinder, with the cooling being nonuniform in accordance with the temperature increase of various areas of the cylinder caused by the introduction of the molten metal.





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INJECTION CYLINDER FOR METAL CASTING

SUMMARY OF THE INVENTION

This invention relates to a die casting method and apparatus in which the die casting injection cylinder is cooled to prevent temperature distortion of the cylinder walls.

A primary purpose is an apparatus of the type described in which the cooling means provides increased heat radiating areas at the exterior of the injection cylinder.

Another purpose is a reliably operable injection cylinder for high temperature molten metals, including a plurality of heat radiating fins extending outwardly from the injection cylinder surface to provide cooling of the cylinder and thus prevent temperature distortion.

Another purpose is an improved method of die casting high temperature molten metals including means for preventing temperature distortion of the injection cylinder wall. Another purpose is an improved method of die casting high temperature molten metal in which the injection cylinder is selectively cooled to prevent nonlinear temperature distortion.

The invention herein described was made in the course of or under a contract with the Department of the Air Force.

Other purposes will appear in the ensuing specification, drawing and claims.

BRIEF DESCRIPTION OF THE DRAWING

The invention is illustrated diagrammatically in the attached axial section through an injection cylinder of the type described.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing, a portion of a mold is indicated at **10**, there being a mold opening **12** for the passage of molten metal into the mold cavity proper. Adjacent the mold **10** is a member **14** which is effective to mount an injection cylinder indicated generally at **16** to the mold **10**. The member **14** may include appropriate sealing means as well as means for physically attaching or fastening the injection cylinder **16** to the mold **10**.

The injection cylinder **16** may include a chamber or pressure zone **18** which is defined by a sleeve or shell **20**. Outside of the sleeve or shell **20** is a second sleeve **22**, which may be substantially thicker in radial extent than the sleeve **20**. The sleeve **22** may have a plurality of heat radiating fins extending outwardly therefrom. The fins will be described in detail hereinafter. The injection cylinder **16** may include a molten metal feed passage **24** and a reciprocating plunger **26** which moves back and forth within the chamber or pressure zone **18**. In some applications the injection cylinder may be surrounded by a cowl or the like **28** which is effective to enclose the entire cylinder, as will be described hereinafter.

The inner sleeve or shell **20** is preferably formed of a high heat resistance metal such as molybdenum or any of the high resistant steels or nickel chromium alloys which have a good rate of heat resistance and also good heat conductivity. This is important in order to conduct heat rapidly to the second laminate which then radiates heat into the surrounding area.

Normally the inner shell **20** will be relatively thin in radial thickness, for example on the order of one-quarter inch to one-half inch. The outer shell **22**, which may be formed of copper, aluminum or one of their alloys, is of sufficient thickness so that it will be able to withstand the mechanical demands made by the high internal pressures necessary to force the molten metal into the die cavity. For example, the pressure within the chamber **20** can range from 4500 p.s.i. to 20,000 p.s.i. at working temperatures in the range of 800°F. to 1100°F.

When molten metal is introduced into the chamber **18**, the wall **20** will be heated by the molten metal, but on a nonuniform or nonlinear basis. There is a zone **30**, adjacent the mold **10**, in which the highest temperatures will be reached during the die casting operation. There is a second zone **32**, adjacent the end zone **30**, in which the temperatures are substantially lower. There is a third zone **34**, which is adjacent the

molten metal feed opening **24**, which again will have substantially high temperatures in the end zone **30**. There is a fourth zone **36** which is generally about the plunger in its rest position, in which again the temperatures will be somewhat the same as the zone **32** and substantially lower than the temperatures in the zones **30** and **34**. In order to prevent nonlinear distortion it is necessary first to cool the entire injection cylinder, and secondly, to selectively cool the injection cylinder so that the areas having the greatest temperature increase will receive the greatest cooling effect. The heat radiating fins formed about the cylinder are thus selectively arranged to provide the greatest cooling effect in the zones **30** and **34**. The heat radiating fins **38** in the zone **30**, and the heat radiating fins **40** in the zone **34**, are of substantially greater radial extent than the fins **42** in the zone **32** and the fins **44** in the zone **36**. Thus, those areas receiving the greatest temperature increase due to the introduction of molten metal into the chamber **18** will have the greatest heat radiating areas, and thus will receive the greatest cooling.

As an example of the type of temperatures which can be reached within the chamber **18** of the molten metal is a temperature of about 1500°F. The temperatures in the end zone **30** will range from 800°F. to 1100°F. In the center zone **34** the temperatures will range from 620°F. to 1060°F. The temperatures in the cooler zone **32** will range from about 290°F. to 590°F. and the temperatures in the zone **36** are in the area of 300°F.

In some applications it is desirable to provide cooling air about the injection cylinder. For this purpose, the cowl **28** surrounds the injection cylinder and thus provides a defined path for the cooling air. Water cooling may also be provided, however, it has been found to be more advantageous to provide air cooling due to the opening of the feed passage **24** in the space adjacent the cooling area.

The use, operation and function of the invention are as follows:

The introduction of molten metal, for example at a temperature of about 1500°F., into a cold cylinder will cause expansion of the cylinder walls, particularly uneven expansion on the receiving side of the wall. The piston or plunger **26** will also expand, however, it has less exposed area at its outer periphery and hence will not expand the same amount as the walls of the injection cylinder. Thus a clearance will be formed between the periphery of the plunger and the chamber wall **20**. This clearance will permit the molten metal to be squeezed between these surfaces as the plunger pushes the metal into the mold opening **12**. Not only will the loss of metal, due to the clearance between the walls, reduce the amount of metal actually injected into the mold cavity, but such leakage or seepage can cause damage to the die injecting mechanism.

By cooling the injection cylinder, the temperature distortion of the cylinder wall is substantially minimized and to a large extent eliminated. In some applications it may also be desirable to cool the plunger, but this is not necessary in every case. It is important to selectively cool the injection cylinder in accordance with the temperature increases of the cylinder from the molten metal. Not only is it necessary to minimize temperature distortion of the entire cylinder, but it is necessary to make sure whatever expansion there is in the cylinder wall is uniform, and not nonlinear. For this reason, those portions of the injection cylinder which receive the greatest temperature increase due to the molten metal have heat radiating fins of greater radial extent, thus providing greater cooling area.

The makeup of the injection cylinder is important. An inner laminate of a high heat resistant steel, for example one of the nickel chromium alloys, or molybdenum, has been found to be satisfactory. Such materials have a good rate of heat resistance and also good heat conductivity. The heat resisting inner laminate will resist and contain the heat, and yet by its own rate of heat conduction transfer the heat to the outer shell **22** which is cast around it. Either aluminum or copper, or one of their alloys, have been found to be satisfactory for the outer shell **22** and for the heat radiating fins forming a part thereof.

The details of the mold and the plunger reciprocating mechanism have not been shown herein, but such mechanisms are common in the art.

Whereas the preferred form of the invention have been shown and described herein, it should be realized that there are many modifications, substitutions and alterations thereto, within the scope of the following claims.

We claim:

1. In a system for die casting molten metal, a mold having an input opening, an injection cylinder positioned adjacent said mold, an open-ended chamber in said injection cylinder in alignment with the mold opening, a plunger reciprocal in said chamber for injecting molten metal from the chamber into said mold, a molten metal feed passage opening into said chamber, and means for providing nonuniform differential cooling along the length of said injection cylinder between said mold input opening and said molten metal feed passage to minimize its thermal expansion due to the introduction of molten metal therein, and thus prevent leakage of molten metal between the chamber wall and plunger, including a plurality of radially extending fins about the periphery of said injection cylinder, said fins being of varying radial extent, with those fins having the greatest radial extent being located adjacent the mold and adjacent the injection cylinder feed passage.