Nov. 14, 1961 J. E. COOK ET AL 3,008,271

CIRCULATING AND COOLING SYSTEM FOR A LIQUID METAL OR METAL ALLOY WITH MOLD ELEMENT

Filed Jan. 23, 1957 4 Sheets-Sheet 1

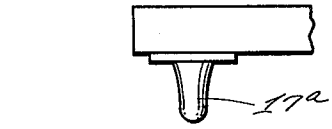


FIG. 1

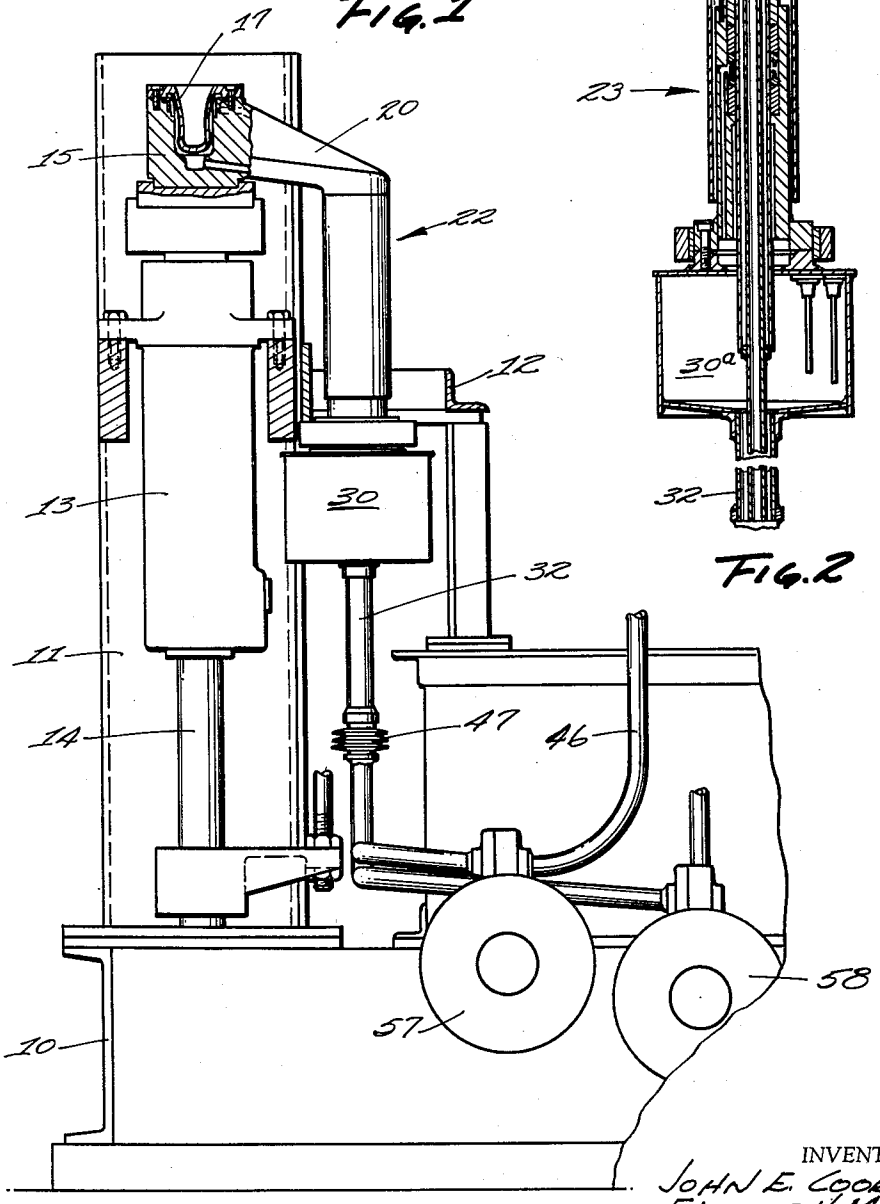


FIG. 2

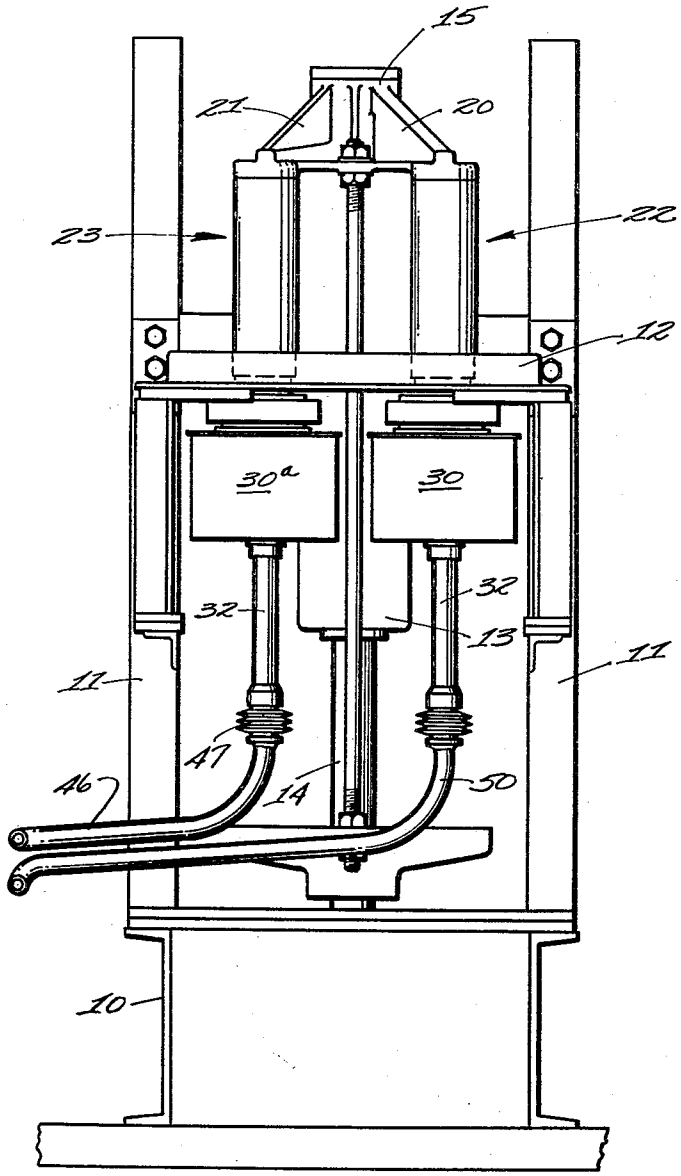
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FIG. 3



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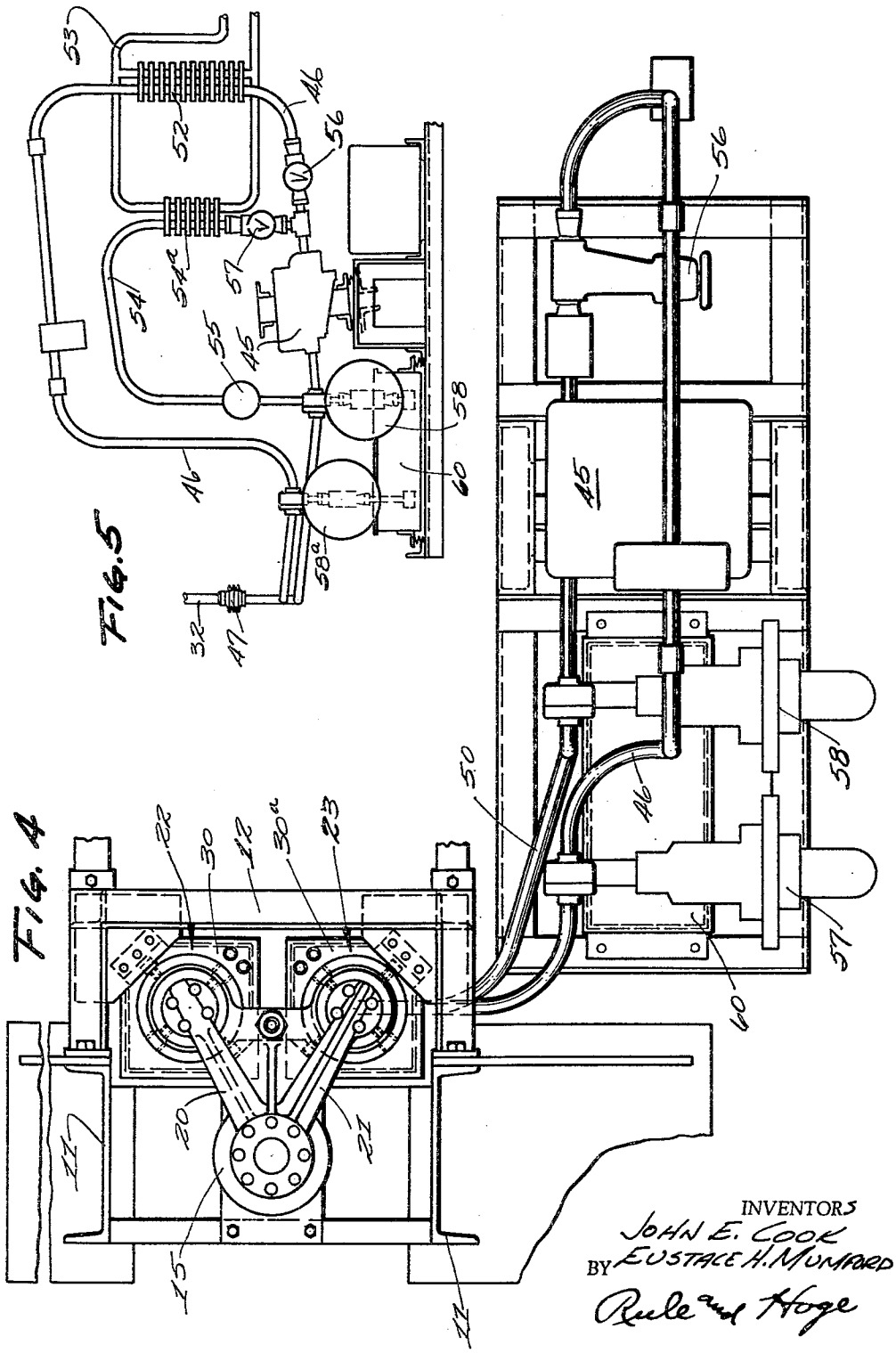


Fig. 5

Fig. 4

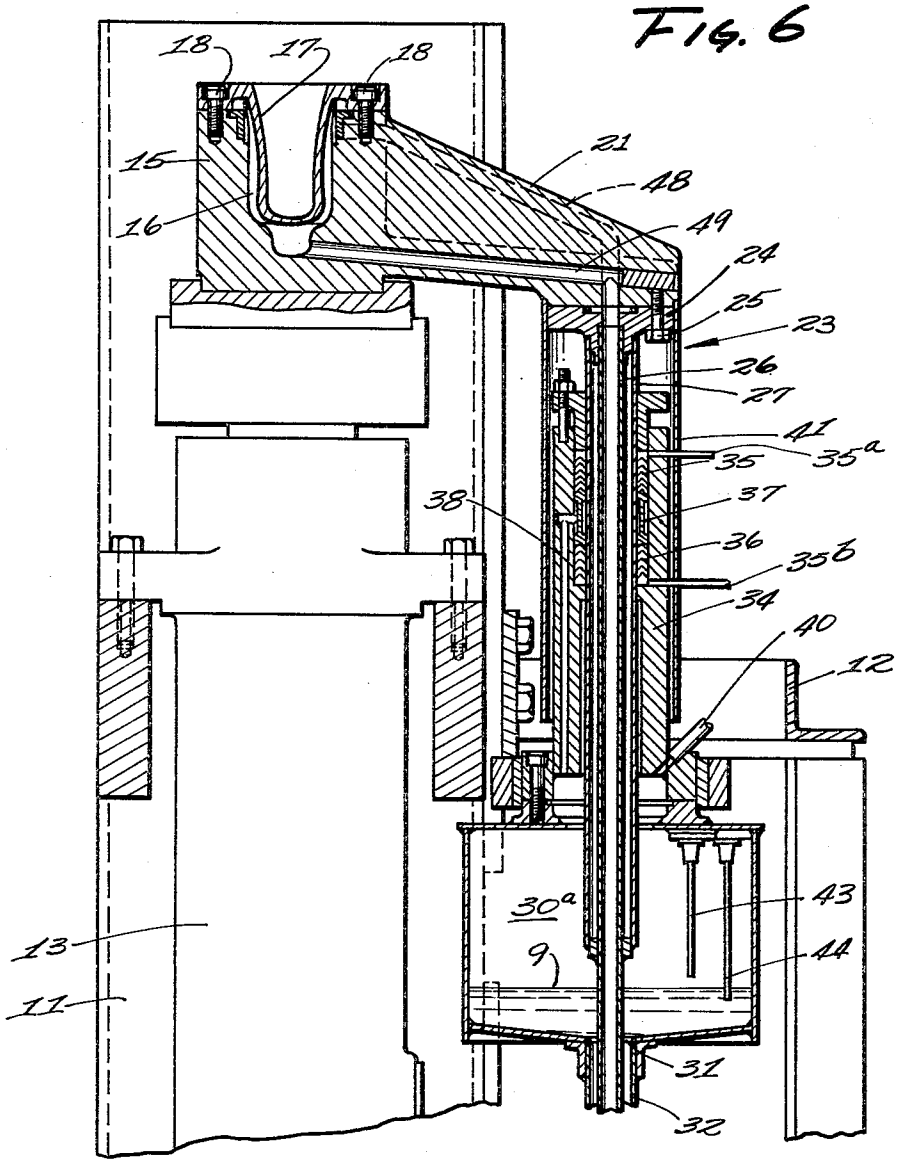
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FIG. 6



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United States Patent Office 3,008,271
Patented Nov. 14, 1961

3,008,271

CIRCULATING AND COOLING SYSTEM FOR A LIQUID METAL OR METAL ALLOY WITH MOLD ELEMENT

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Filed Jan. 23, 1957, Ser. No. 635,901
2 Claims. (Cl. 49—68)

Our invention relates to equipment including means for circulating an active liquid metal or metal alloy in a closed circuit. The liquid which serves as a coolant or heat extracter, is raised to a high temperature while in contact with a workpiece such as a hot mold or other part at a high temperature. The liquid metal is then cooled by passing it through a cooling medium or heat exchanger at another point in its path of circulation.

The invention may be used with various forms of mechanisms and for various purposes. It is of utility when employed in connection with a press molding machine such as used for press molding glass articles and is herein illustrated and described as adapted for this particular use. Such illustration and description, however, are not to be taken as limitations of the invention to the particular uses to which it may be put nor the mechanisms with which it may be employed, except as limited by the appended claims.

In a machine for molding glass articles the molds are subjected to high temperatures and some means for cooling and regulating the temperature of the molds is essential. Ordinarily air cooling systems are used for this purpose. Attempts to use water and liquids generally for such cooling purposes are opened to various objections and particularly cannot be used at the high temperatures of the molds on account of volatilization or low boiling points. The use of a metal in liquid form as a heat extracting medium has important advantages, particularly where rapid extraction of heat is required, but the use of any metals which remain in liquid form throughout the necessary range of temperatures have been found to involve practical difficulties, largely due to the fact that any metals or metal alloys which have a sufficiently low melting temperature for such use are very active in the presence of air or oxygen in any form, particularly water or moisture, so that it is necessary to prevent contact with air or moisture at all times.

In a machine such as above mentioned for press molding glass articles, the mold is commonly moved to and from a molding position, thus requiring relative movement of the parts comprised in the circulating system for the liquid metal. A primary object of the present invention is to provide a construction in which an externally cooled seal is provided between the circulating liquid metal and the atmospheer which is kept out of contact with the liquid metal. This feature eliminates many problems encountered with ordinary type packings, flexible joints and hoses which must be operated in direct contact with the liquid metal.

The apparatus as herein illustrated for practicing the invention comprises tanks which may be mounted side by side, each of a capacity to contain the entire volume of liquid metal in the system. Each tank is provided with a well extending downwardly from the floor of the tank and open to the liquid metal in the tank. Each tank is fitted with a packing gland sleeev extending upwardly therefrom in line with the well. The vertically moving ram which carries the mold has connected thereto, two tube assemblies each comprising concentric inner and outer tubes with an insulating space therebetween. These tube assemblies extend downward into the tank with the inner tube extended into the well below the tank. The

packing gland sleeves surround the said concentric tubes, with suitable insulation between the tubes and the packing gland sleeves.

Other objects of our invention and various features of novelty will appear hereinafter in connection with the following detailed description.

Referring to the accompanying drawings:

FIG. 1 is an elevation, with parts broken away and with parts shown in section, of a press molding machine to which the invention is applied;

FIG. 2 is a sectional elevation of one of the tanks and the associated tube assembly comprised in the liquid metal circulating system;

FIG. 3 is an elevation of the machine as viewed in a direction at right angles to that of FIG. 1;

FIG. 4 is a plan view of the machine;

FIG. 5 is an elevation view, partly diagrammatic, showing a portion of the metal circulating system and heat exchangers;

FIG. 6 is a view similar to FIG. 2 on a comparatively large scale and also showing the press plunger head and mold.

Referring to the drawings: The press plunger mechanism is supported on a base **10** on which is mounted a superstructure comprising upright frame members **11** which support an upper frame structure **12**. The press plunger comprises a hydraulic cylinder **13** and piston rod or plunger **14** which may be vertically reciprocated in a manner well known to those skilled in the art. Attached to the rod **14** at its upper end is a head **15** formed with a cavity **16** which provides a cooling chamber in which the hollow mold **17** is supported. The mold is attached by bolts **18** to the head **15**. The walls of the chamber **16** are spaced from the mold walls to provide for the circulation of the cooling liquid in contact with the mold. Mold charges or gobs of molten glass **17a** are periodically dropped into the mold.

The heat extracting liquid **9** (FIG. 6) used with the present invention consists preferably of a metal alloy, specifically a 22% sodium, 78% potassium alloy. Such an alloy has a low melting point such that it may be used at room temperatures or within a practical range of temperatures to which it is subjected. These may include temperatures from 700° to 1500° F., these high temperatures being reached while in contact with the hot mold walls in which the molten glass is molded. The invention contemplates also the use of gallium and any other metal or metal alloy which remains in liquid form throughout the range of temperatures to which it is subjected when used for the purpose of the present invention.

The head **15** has connected thereto or formed integral therewith horizontal arms **20** and **21** extending radially therefrom and carrying respectively tube assemblies **22** and **23**. These tube assemblies are attached to the arms **20, 21** by means of heads or disks **24** and bolts **25** (FIG. 6). Attached to and depending from each head **24** are concentric vertical tubes including an inner tube **26** and outer tube **27** with an intervening space. The tubes **26** and **27** are sealed together at their upper and lower ends, thereby providing a sealed chamber comprising an annular space between the tubes. The purpose of this construction is to provide a heat barrier between the inner tube, through which the liquid metal flows, and the outer tube where a seal is made between the tubes and the outside air as presently described. The enclosed space between the two tubes can be evacuated or insulated either with an inert solid material or simply left as a dead air space, depending upon the amount of heat stoppage or insulation required. A pair of tanks **30** and **30a** have a stationary mounting on the framework **12** and serve as reservoirs for the liquid metal. These tanks are preferably made of stainless steel which is insert or resistant to

the liquid metal. Each tank is formed with a bottom opening 31 through which the inner tube 26 extends downward into a well 32. The tube 26 when lowered extends below the tank a greater distance than the length of stroke of the press plunger, so that the lower end of the tube is always within the well and immersed in the liquid metal. The well is secured to the floor of the tank 30.

Surrounding the vertically reciprocating tubes 26, 27 is a packing gland sleeve 34 fixed to the frame 12. The upper half or upper portion of the sleeve 34 is of sufficient internal diameter to provide a packing chamber between the sleeve and the tube 27. This chamber comprises an upper section 35 and a lower section 36 separated by a chamber 37. An inert gas is introduced in this chamber at the same pressure as exists in the associated tank unit. As shown the packing gland sleeve 34 is formed with a bore 38 opening into the chamber 37 and extending downwardly therefrom through said sleeve and in communication with the interior of the tank 30. As the circulating metal must be kept out of contact with the air and moisture, an inert gas such as nitrogen is maintained within the tank at any desired pressure. This gas is introduced through a pipe 40 and the level of the liquid in the tank is maintained by varying the pressure applied through the pipe 40. It will be apparent that the pressure within the chamber 37 is the same as that within the tank. This balanced pressure above and below the insulation in the packing gland prevents any of the liquid metal or metal vapors from working upwardly through the packing and escaping. Pipes 35^a and 35^b permit the circulation of a cooling liquid, such as kerosene, through the packing material. An outer metal shell 41 attached to the head 24 surrounds and telescopes with the packing gland sleeve 34.

The volume of liquid metal 9 in the circulating system is sufficient to fill the wells 32 at all times and to maintain a certain depth of the liquid within the tanks 30. Each tank has sufficient capacity to contain the entire volume of the circulating liquid. Electrodes 43 and 44 extending downward within the tank 30 serve as a means to indicate the level of the liquid within the tank.

The circulation of the liquid metal or alloy throughout a closed circuit is maintained by a pump 45. The closed circuit for the liquid extends from the outlet side of the pump through a pipe line or conduit 46 which includes a heat exchanger 52 to and through a flexible connection or bellows 47 by which pipe 46 is attached to the lower end of the well 32 beneath the tank 30^a. The circuit continues from said well upward through the inner tube 26 of the assembly 23 and through a lateral inlet channel 49 (FIG. 6) in the arm 21 to the chamber 16. The circuit continues from the chamber 16 through an outlet channel 48 in the arm 20 to the tube 26 of the assembly 22 and through said tube and associated well 32 and thence through a return pipe 50 to the pump 45.

The pipe line 46 extends through a heat exchanger 52 (FIG. 5) which may be of conventional construction including a series of perforated metal plates. Cooling water is circulated through a pipe line 53 which extends through the heat exchanger 52 for extracting heat from the liquid metal. A pipe line 54 extending through a second heat exchanger 54^a provides a bypass around the pump 45 through which the liquid metal may be circulated when desired. A filter 55 in the bypass line serves for removing oxides or impurities from the liquid metal. Hand valves 56 and 57 in the pipe lines 46 and 54 respectively are operable to selectively control the flow through the main circulating system and the bypass. Dump valves 58 and 58^a permit the liquid metal to be drawn from the circulating system into a sump tank 60. The latter is sealed to prevent access of air or moisture into the circulating system or into contact with the liquid metal. The term "liquid metal" is intended to include metal alloys except where otherwise indicated.

The construction comprised in the assembly 22 through which the liquid metal is conducted to the cooling chamber 16 is a substantial duplicate of the assembly 23 as above described and as shown in section, FIG. 6.

Modifications may be resorted to within the spirit and scope of our invention.

We claim:

1. In an apparatus for extracting heat from a vertically reciprocable mold element at high temperatures, said apparatus including means defining a cooling chamber in said mold element having an inlet and an outlet, and means including a pump and a heat exchanger connected between said inlet and said outlet and defining, with said cooling chamber, a closed heat exchange circuit through which a liquid metal heat exchanging fluid may be circulated; the improvement wherein said last named means further comprises a pair of stationary tanks each adapted to contain a liquid metal heat exchanging fluid to a predetermined depth above the bottom thereof, an elongate well on each tank in communication with the interior thereof and extending downwardly from the bottom of the tank by a distance greater than the length of the vertical reciprocatory stroke of said mold element, a packing sleeve on each tank extending upwardly from the top of the tank, a vertically elongate outer tube received within each packing sleeve in slidable sealed engagement therewith, each of said outer tubes being fixedly secured at its upper end to said mold element for vertical reciprocation therewith and having a length sufficient to maintain the outer tube in slidable sealed engagement with the associate packing sleeve throughout full range of vertical reciprocation of said mold element, an open ended inner tube coaxially mounted within each outer tube, means at the upper and lower ends of each outer tube sealing the associated inner tube thereto to define an annular chamber surrounding the inner tube, each inner tube projecting downwardly below the lower end of said outer tube to a lower end located to be reciprocated within the associated well during reciprocation of said mold element, means connecting the upper end of one of said inner tubes to said inlet of said chamber, means connecting the upper end of the other inner tube with said outlet of said chamber, and conduit means connecting said pump and said heat exchanger in series between the respective lower ends of said wells.

2. In an apparatus as defined in claim 1, means in each of said packing sleeves defining spaced upper and lower sliding seals between the sleeve and associated upper tube, and means for maintaining an inert gas at a predetermined pressure within said tank above the surface of liquid metal heat exchange fluid contained therein and between said upper and lower seals.

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