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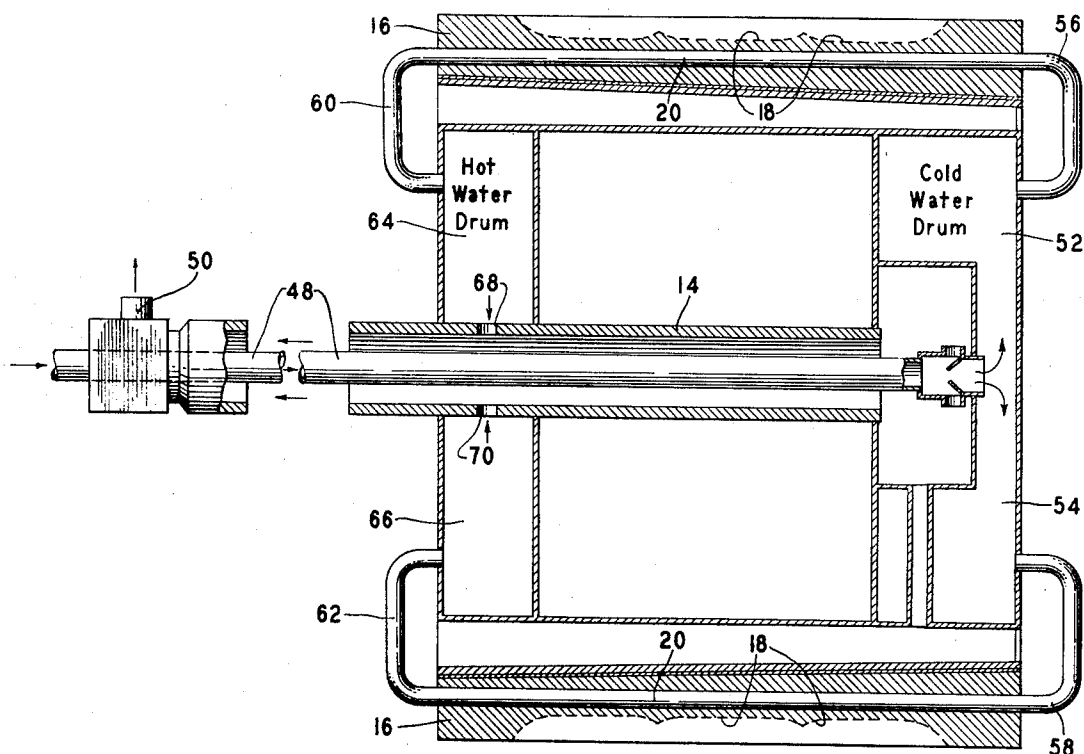
[54] **CONTINUOUS CASTING DEVICE**
3 Claims, 4 Drawing Figs.

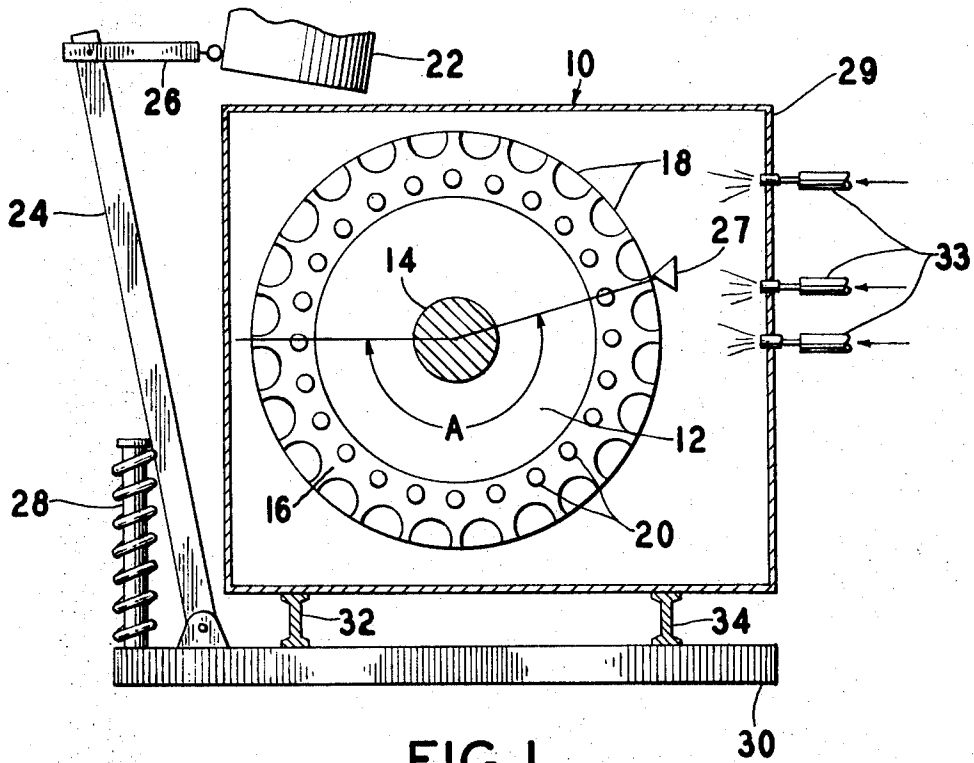
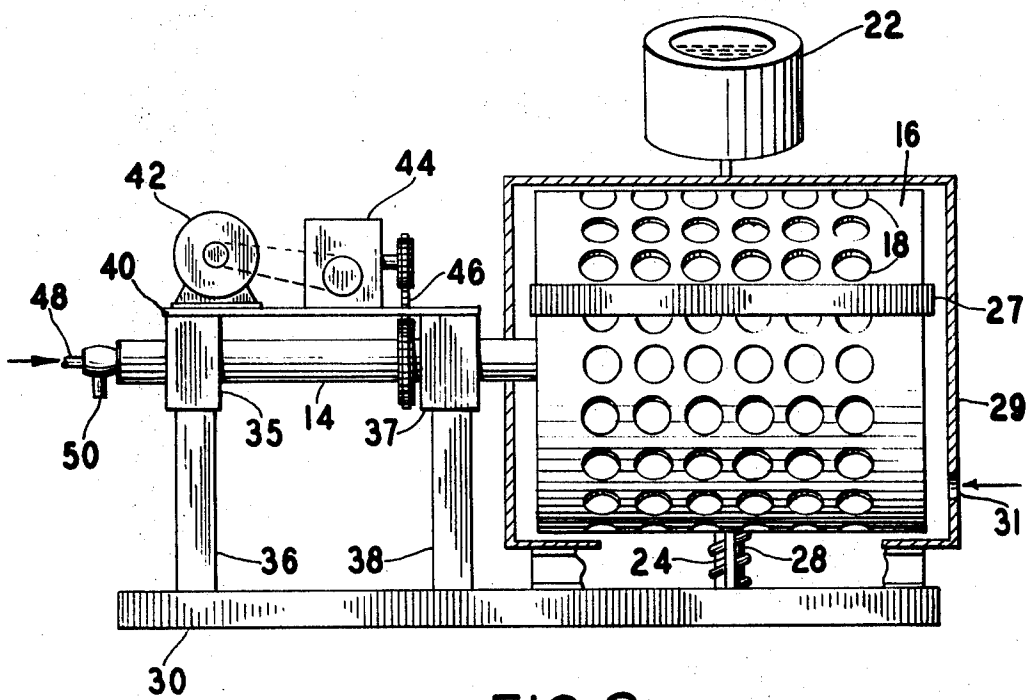
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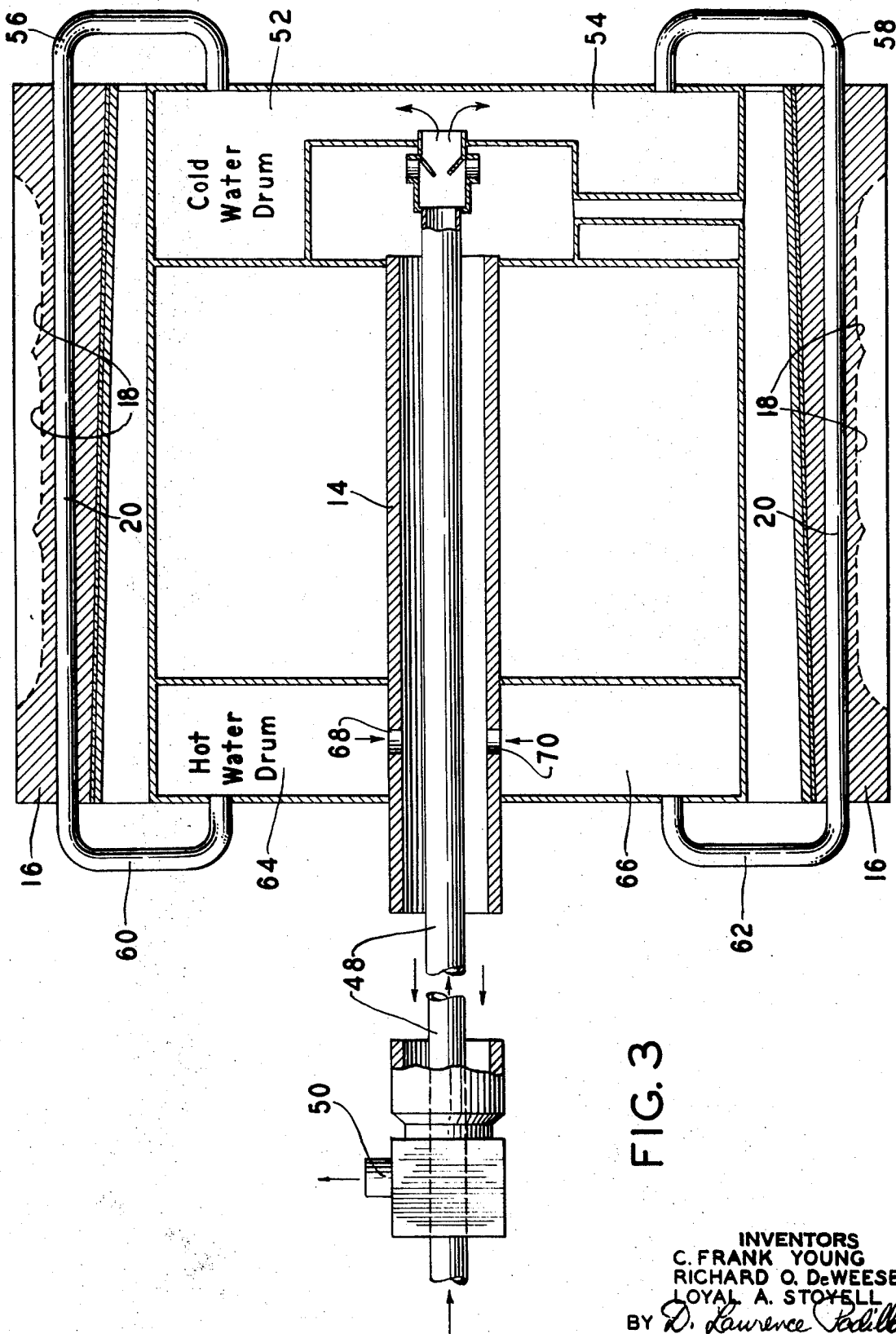
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ABSTRACT: A continuous casting device comprising a rotating mold having a plurality of cavities on its outer surface into which molten metal is poured. As the device rotates, the metal solidifies and properly sized products in the shape of the cavities are drawn out of the cavities by the force of gravity as the cavities are rotated to an inverted position.





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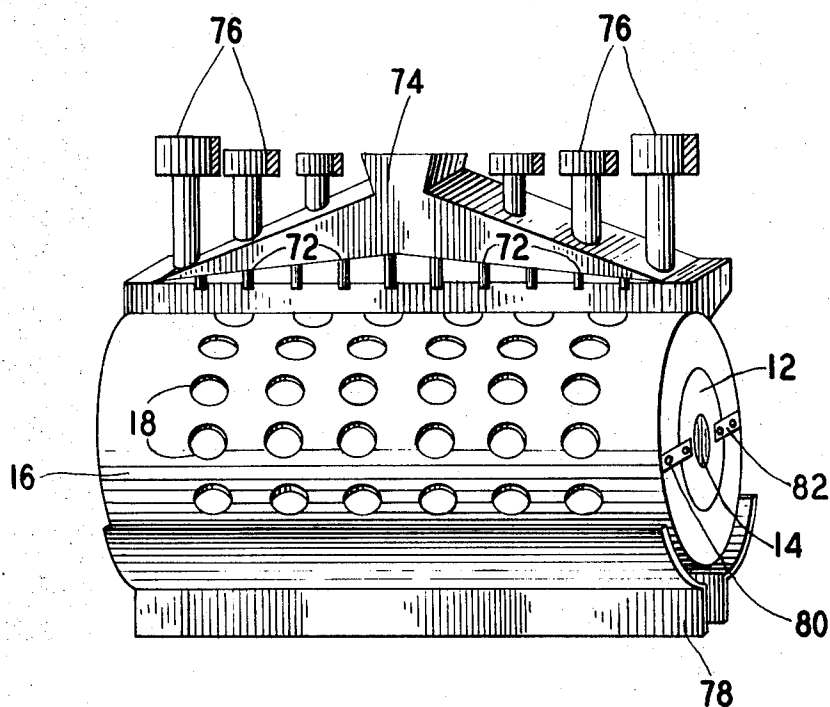


FIG. 4

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CONTINUOUS CASTING DEVICE

This application is a continuation of Ser. No. 715,032, filed Mar. 21, 1968, now abandoned.

FIELD OF INVENTION

This invention relates to the continuous casting of metals, and more specifically, to an apparatus capable of continuously and directly producing alloy products from a furnace.

DESCRIPTION OF PRIOR ART

A wide variety of metallurgical processes are directed to the production of alloys which are to be used as additions in subsequent metallurgical processing. The current methods of producing these alloys generally are accompanied by much waste and inefficiency. In one such method, the molten alloy is poured directly from the ladle into chills where it solidifies. Subsequent crushing and sizing procedures result in excessive fines production. Furthermore, thick layers of slow freezing alloy cause excessive segregation while the alloy is in the chills, thereby adversely affecting the end product. In addition, oxidation of the large surface area of the exposed alloy during the process can render the final product unsatisfactory for use.

Since the alloy products are to be generally used as additions in the production of other alloys, their size should be carefully controlled. Producing alloy pieces having the proper dimensions after large masses of the molten metal have solidified in chills is a time consuming and often inefficient task. Furthermore, continuous production of the end product is difficult and cumbersome equipment is required.

SUMMARY OF THE INVENTION

The apparatus which is the subject matter of this invention provides properly sized alloy products continuously and without intermediate handling, that is, directly from the furnace. As hereinafter further explained, the apparatus may be modified to produce alloy products of various sizes either simultaneously or at selected intervals. Oxidation protection may be provided during the processing of the alloy, thus avoiding any undesirable oxidizing effects.

Broadly, the invention comprises a mold having a plurality of cavities on its outer surface area and means to rotate the mold. The apparatus is placed below the furnace ladle in which the molten alloy is processed such that the alloy may be poured from the ladle directly into the cavities on the mold surface. As the alloy is poured, the mold is continuously rotated thereby constantly presenting a row of empty cavities to the metal being poured. The alloy which is poured into the cavities quickly solidifies and the formed alloy products are discharged by gravitational force before the cavities are rotated into position below the flowing furnace metal again. The discharged products are collected and are generally ready for immediate use.

The molten metal assumes the shape of the cavity into which it is poured. Thus, the shape, dimensions and volume of the alloy products produced can be controlled by a proper design of the cavities. If desired, several cavity sizes can be placed on a single mold surface to facilitate production of alloy products of different sizes. Furthermore, the mold may be a combination of two segments, a base member and a removable sleeve member positioned thereon, the sleeve member being provided with cavities. With this construction any number of surface "jackets" can be interchangeably employed with the base member thus providing an important degree of flexibility.

DESCRIPTION OF THE DRAWINGS

The apparatus of the invention will be further described by referring to the drawings, wherein:

FIG. 1 is a front elevation view, partly in section of one embodiment of the apparatus of the invention;

FIG. 2 is a side elevation view of the apparatus in FIG. 1;

FIG. 3 is a plan view, in section, illustrating one form of a cooling system employed in the apparatus of the invention; and

FIG. 4 is an isometric view of another embodiment of the apparatus of the invention.

In FIG. 1, the apparatus of the invention designated generally by the numeral 10 includes a base member 12, a shaft 14, and a surface sleeve member 16. The sleeve member 16 is provided with a plurality of cavities 18 about its periphery and a number of channels 20. The channels carry a fluid coolant as will hereinafter be further explained. A container means 22 which houses the molten metal to be poured into the cavities 18 is pivotally supported on each side by a support rod such as 24 and a crossbar such as 26. A spring tension means 28 maintains the container 22 in close proximity to the apparatus 10 by applying a pressure thereto through the various support rods and crossbars. The entire assembly rests on the frame 30.

Excellent results have been achieved by employing a retaining bar 27 to retard excess flow of molten metal down the side of the mold after it is poured and to prevent premature "drop out" of the metal before solidification. The retaining bar 27 is positioned at the beginning of the "A" zone shown in FIG. 1 and is held in direct contact with the surface during operation. The "A" zone depicts the general area on the surface of the mold when it is rotated clockwise in which the metal is solidified and the cavities are sufficiently inverted to cause the metal products to fall therefrom. The "A" zone measures approximately 180° of the circumference of the mold beginning at a point about 90° from the top of the mold and extending in the direction of rotation.

A cover 29 surrounds the mold assembly to provide an enclosure into which a gas may be forced such as through opening 31 (FIG. 2). In this manner oxidation protection of the metal can be readily accomplished during the operation of the system. Such gases as argon and nitrogen are quite suitable for this purpose. The cover is supported on frame 30 by supports 32 and 34. A plurality of nozzles 33 are placed in the side of the cover 29 and are employed to spray a fog of water or other gas or liquid onto the rotating cavities to provide quick cooling. The nozzles can also be used to provide the gaseous oxidation protection blanket, if desired.

In FIG. 2, the equipment required to rotate and support the continuous casting device of the invention is more clearly illustrated. Drive shaft 14 is mounted in bearings 35, and 37 which in turn are supported on frame 30 by support columns 36, and 38. Platform 40 holds a motor 42 and driving means 44 which includes drive chain 46, all of which cooperate to rotate the drive shaft 14. Affixed to the shaft 14 is an intake pipe 48 for receiving a coolant and an exhaust orifice 50 for discharging the coolant after it passes through the continuous casting device.

In operation, the motor 42 is actuated by a power supply (not shown) and causes the driving means 44 to turn the drive shaft 14 through the drive chain 46. The shaft 14, the base member 12 and the sleeve member 16 all rotate together at the same speed. The molten metal which had been caused to flow to the container 22 from one or more furnaces (not shown) is poured onto the sleeve member surface and into the cavities 18 by a manual or automatic manipulation of the pivotal members to tilt the container. The rotational speed of the apparatus is such as to cause the metal to solidify and fall out substantially in the area designated by the letter "A" in FIG. 1. The solidified metal will fall out of the cavities as the force of gravity takes effect, and the product pieces are collected preferably by means of a chute (as shown in FIG. 4). The emptied cavities are then ready for another filling as they pass beneath the container. In this manner, continuous production can be effected.

It will be appreciated that the flowing metal will not necessarily be confined to the cavities, that is, the surface area between cavities on the sleeve member will also have solidified metal during normal operation. However, since the

thickness of this surplusage is minimal relative to that of the cavity product, it is easily separated from the useable products which are formed. While this overflow product will normally be produced in the apparatus as described, its presence can be avoided by the introduction of a control system designed to pour metal only into cavities. However, since only a minor amount of waste product is formed with the apparatus as described, such a control system is economically unnecessary for most metals or alloys being processed.

It will be appreciated that if the volume or depth of each cavity is too great, continuous rotation of the mold cannot be effected since long cooling periods will be necessary before the metal solidifies. Thus in order for the system to operate continuously that is, to provide a continuous production of solid metal products at a reasonable rate, each cavity volume should be generally less than 100 cubic inches and the depth of each should be less than 2 inches on a mold 30 inches in diameter. Of course, the acceptable volume will vary with the dimensions of the mold, a very large mold being capable of continuous rotation with cavities of larger volume than a smaller mold. However, very large troughs would not be acceptable in the continuous casting device of the invention. Continuous rotation of the mold can be carried out by varying the speed of the motor to conform to the size of the cavities employed.

The rotational speed of the apparatus during the operation of the system is partly a function of the freezing rate of the metal being poured. Generally, between $\frac{1}{4}$ and 4 revolutions per minute is a satisfactory speed for most alloys. A mold having a cross-sectional outside diameter of 30 inches and provided with cavities having dimensions of 6—8 in.³, will be rotated at a speed of less than one revolution per minute for alloys such as 50 percent FeSi, and silico-manganese. Of course, since the rate at which the metal will solidify is itself dependent on the initial temperature of the metal as it is poured into the cavities, this temperature should be somewhat limited. Generally, the molten metal should be at a temperature less than 50° C. above its melting point while it is being poured.

In view of the extremely high temperature which the device of the invention will be subjected to, some manner of cooling should be provided. One such cooling system is shown in FIG. 3. As there illustrated, an intake pipe 48 is positioned within the hollow drive shaft 14 and communicates with cold water drums 52 and 54. Tubes 56 and 58 carry the coolant through channels 20, thence to tubes 60 and 62 into hot water drums 64 and 66. Orifices 68 and 70 then permit the coolant to flow into the area surrounding pipe 48 and out exhaust orifice 50. In this manner, each segment of the rotating mold may be cooled during the operation of the system.

The capacity of the continuous casting apparatus of the invention can readily be increased by simply increasing the useable surface area and thus the number of cavities. However, practical considerations such as keeping the metal to be poured in a molten state must be resolved. FIG. 4 illustrates one arrangement which is quite suitable for use in large capacity devices. The device is substantially similar to that shown in the previous illustrations except for the auxiliary equipment. For example, a plurality of nozzles 72 depend from the container 74 in which the molten metal is stored. A plurality of heaters 76 maintain the metal at a temperature above its melting point. The heaters are necessitated by the large volume of the container 74. A product chute 78 facilitates the collection of products as they fall from the rotating sleeve member 16. The sleeve member 16 is shown connected to the mold base member 12 by means of bolts 80 and 82. It can readily be observed that the proper positioning of the nozzles, i.e., directly over the rows of cavities, will reduce the amount of waste product produced. Furthermore, better stream control can be achieved with the small opening in the nozzle as compared to the large container spout.

The following Examples are illustrative of the apparatus of the invention.

EXAMPLE I

A graphite sleeve member having an outside diameter of 30 inches and a thickness of $3\frac{1}{2}$ inches was bolted to a base member having an outside cross-sectional diameter of 23 inches and a length of 24 inches. The sleeve member was also 24 inches long and was provided with 100 circular cavities each being $1\frac{1}{2}$ inches deep and $3\frac{3}{8}$ inches in diameter at their outer surface. The equally spaced cavities were arranged in 5 rows, there being 20 cavities about the periphery of the sleeve member in each row. One inch diameter channels drilled through the length of the sleeve member carried a water coolant in the manner shown in FIG. 3. A cover about 40 inches high by about 36 inches width and about 26 inches in length composed of asbestos and cement was placed around the mold. Argon gas was fed through an opening in the bottom of the cover. A $\frac{1}{2}$ horsepower variable speed motor rotated the mold at a speed of $\frac{1}{4}$ r.p.m. through a driving gear train having a ratio of 400 to 1 from motor to drive shaft. The drive shaft was 5 inches in diameter and 60 inches long and was composed of steel. Molten silico-manganese alloy maintained at approximately 1300° C. was poured directly from a furnace. The spout of the furnace was positioned 6 inches above the rotating cavities and the alloy was poured slowly into the cavities. One thousand pounds of products were formed in 15 minutes and approximately 90 percent were useable as compared to an expected factor of less than 70 percent when the alloy is poured into chills and then crushed to the proper size. In addition, the products formed were smooth and of excellent quality.

EXAMPLE II

Same as Example I except the sleeve member was fabricated from four copper segments each 24 inches long, $22\frac{1}{2}$ inches wide O.D. and $2\frac{1}{4}$ inches thick. Two segments were equipped with $\frac{3}{4}$ inch by $\frac{3}{4}$ inch by 2 inch long grooves in each corner and the remaining two segments had correspondingly shaped dowels. The four segments were arched and connected together to form a circle having an outer diameter of $28\frac{1}{2}$ inches and were placed around a base member 24 inches in diameter. The sleeve member was provided with 60 cavities in 3 rows of 20 each. The cavities measured 6 inches long by $3\frac{1}{2}$ inches wide by 1 inch in depth.

It will be appreciated that while the preferred embodiment has been described, many modifications are possible. As hereinbefore indicated, the base member and sleeve member above-described can be one integral piece instead of two separate members. Furthermore, many other cavity sizes and layouts are possible. In addition, the metal may be poured from the furnace or furnace ladle through one or more chutes or pipes which terminate in a spout above the rotating cavities. Heaters can be positioned at various intervals to keep the metal in a molten state. The apparatus of the invention need not be cylindrical in shape to be effective, but maximum efficiency is achieved with a cylindrical device. Other configurations, coupled with the proper rotational speed, would be successful.

It is claimed:

1. A continuous casting apparatus comprising in combination:
 - a. a cylindrical base member;
 - b. a sleeve member removably secured about the outer surface of said base member and contiguous therewith, said sleeve member having a plurality of cavities in its outer surface;
 - c. sleeve cooling means comprising a plurality of channels disposed in said sleeve member with each channel coupled at one end to an intake coolant supply and at the opposite end to an exhaust coolant supply and having means for forcing said coolant from said intake supply through said channels into said exhaust supply;
 - d. means for continuously rotating said base member and said sleeve member, said means comprising a drive shaft affixed to substantially the center portion of said cylindrical

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cal base member and motor means for rotating said drive shaft;

e. means for pouring a molten metal into the cavities as they are rotated whereupon during rotation said metal in said cavities solidifies and the solid metal is caused to fall from said cavities when rotated to a substantially inverted position.

2. The apparatus of claim 1 wherein a cover is positioned over and spaced apart from said sleeve member so as to enclose said sleeve member while providing a space between the outer surface of said sleeve member and the inner surface of said cover, said cover having at least one opening for passing

said molten metal into said cavities and means for introducing a non-reactive gas into the space between said sleeve member and said cover.

3. The apparatus of claim 2 wherein a plurality of nozzles are secured to said cover with the exit openings thereof positioned adjacent to and directed at the outer surface of said sleeve member, said nozzles being connected to a fluid coolant supply whereupon during the operation of said apparatus, said fluid coolant is caused to be sprayed through said nozzles onto said metal filled cavities in said sleeve member for quickly cooling said metal.

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