April 23, 1957 B. W. CORLEY 2,789,327

APPARATUS FOR CONTINUOUS METAL CASTING

Filed Sept. 21, 1954

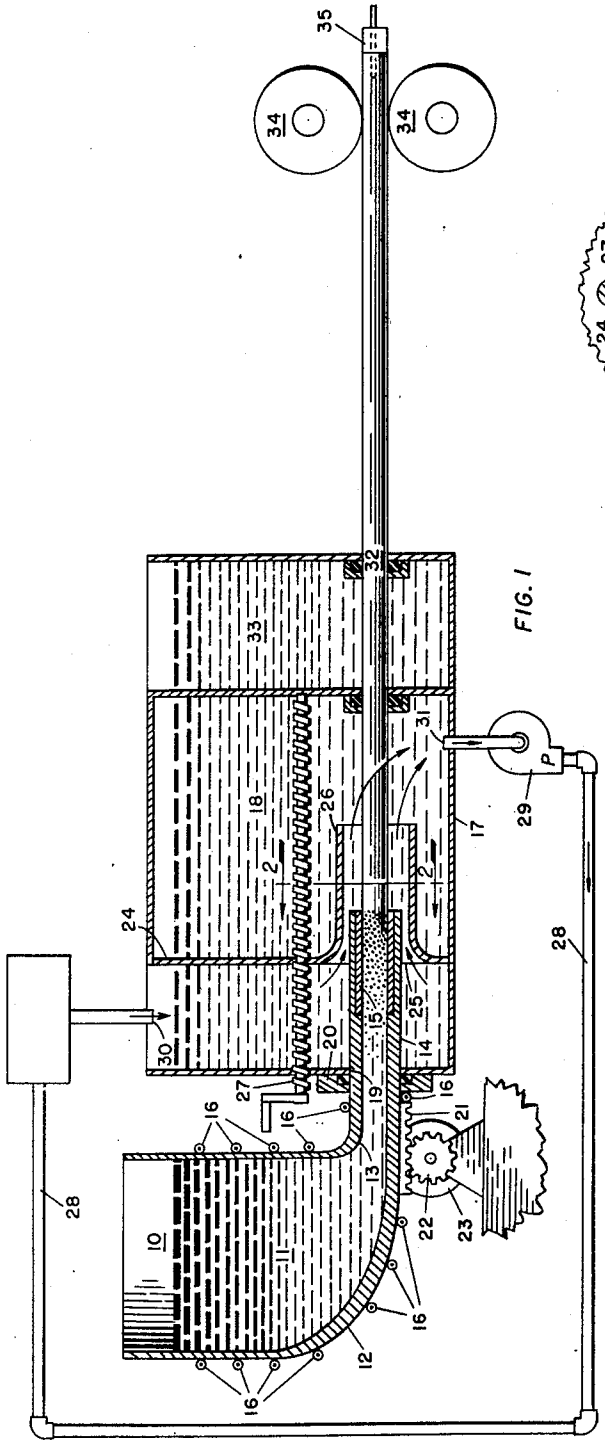


FIG. 1

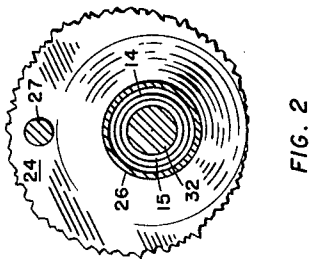


FIG. 2

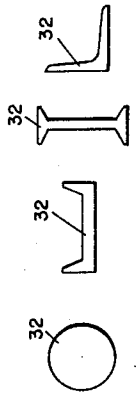


FIG. 3

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United States Patent Office 2,789,327 Patented Apr. 23, 1957

2,789,327

APPARATUS FOR CONTINUOUS METAL CASTING

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Application September 21, 1954, Serial No. 457,347

2 Claims. (Cl. 22—57.2)

This invention relates to a method and apparatus for continuously casting metal shapes, and more particularly to the cooling of the die and the metal shapes.

The continuous casting of metal bars or shapes is generally known to the art. Broadly, the practice consists in pouring molten metal into one end of a tubular die having a uniform cross section of the desired shape. A starting bar is projected into the outlet end of the die to form a head upon which the molten metal may begin to solidify. Since the die is cool, the molten metal begins to solidify against the interior surface of the die first. As the metal begins to solidify upon the starting bar, the bar is pulled gradually through the outlet, carrying with it the solid cast metal shape. As the cast metal leaves the die outlet, it is chilled, tempered, or further treated as desired. If the dies are vertical, the metal passes through the die by virtue of its own weight, but the length of the shapes or the bars are limited by the height of the die. If the casting is horizontal, means such as rollers must be provided to extrude the cast bars or shapes from the die. In continuous metal casting, it is desirable to cool the dies slowly, so that the metal will not solidify too quickly and freeze to the interior surface of the dies, and it is also desirable to quickly chill the cast metal as soon as it leaves the die outlet. Water is commonly used as a cooling medium because of its economy and availability. However, in previous attempts to use water as a cooling medium for continuous metal casting, the water has a tendency to flow into the die, creating vapor pockets which make the metal bars defective, besides creating live steam which may spit and injure persons in the vicinity.

It is therefore an object of this invention to overcome the disadvantages enumerated and to provide a method and apparatus for continuous metal casting in which the cooling medium will not be allowed to enter the die.

It is a further object of this invention to provide an apparatus for continuously casting metal bars or shapes, in which adjustable parts are incorporated to vary the cooling effect upon the die and the cast bar or shape.

Another object of this invention is to provide a method and apparatus for continuous metal casting in which metal bars of different configurations and sizes may be formed.

Further objects and advantages of the invention will be apparent from the following description, taken in conjunction with the drawings, wherein:

Fig. 1 is a sectional elevation of one embodiment of the invention;

Fig. 2 is an end sectional elevation taken along the line 2—2 of Fig. 1; and

Fig. 3 illustrates some of the shapes capable of being cast by the apparatus shown in Fig. 1.

Briefly stated, the invention comprises a die placed in a horizontal position and submerged in a cooling bath. The die may be inserted within a tubular jacket which is connected to the outlet of a hopper containing molten metal. Within the cooling bath is a vertical partition having an orifice through which a portion of the jacket containing the die extends. To the orifice is attached a nozzle

which is preferably concentric with the die and the tubular jacket, and has a reduced circular cross sectional area toward its outlet, its diameter always being greater than that of the outer diameter of the tubular jacket. Means are provided for circulating the cooling medium in the cooling bath through the nozzle so that the path of the fluid will be constricted about the die outlet and the fluid will be directed away from the outlet, thus cooling the metal shapes rapidly and creating a venturi effect which will prevent any fluid from entering the die. That portion of the die away from the outlet will cool slowly because of the slower motion of the larger mass of cooling medium. If either the cast bar or the die is cooling improperly, the nozzle may be laterally adjusted to vary the rate of flow of the cooling medium about the die outlet. Also, the die jacket may be longitudinally adjusted by means such as a rack and pinion so that the jacket may be withdrawn or extended into the cooling bath. The hopper is provided with heaters to keep the metal in molten condition until it enters the die. A starting bar of any type well known to the art may be projected into the die outlet to allow the molten metal to solidify, and after the metal has hardened sufficiently, the starting bar may be pulled outward and the motion of the cast bar may be continued to unlimited lengths by rollers or other suitable means, or may be cut at any desired point into various lengths.

Referring now to the drawings in more detail, Fig. 1 discloses a hopper **10** for containing the molten metal **11**, and having a gently sloping bottom **12** for more efficiently directing the molten metal through the outlet **13** and through the tubular jacket **14** to the die **15**. The hopper **10** and tubular jacket **14** are surrounded by heating elements **16** so that the metal may be kept in its liquid state until it enters the die **15**. The tubular jacket **14** is recessed near its end so that it may receive and retain the die **15** in a fixed position. A tank **17** containing a cooling medium **18**, such as water, is provided with an aperture **19** for receiving the tubular jacket **14** containing the die **15**. The aperture **19** is provided with sealing means **20** around its periphery to prevent the cooling medium **18** from escaping between the aperture **19** and the tubular jacket **14**, and yet allow the tubular jacket to move in and out of the tank **17**. The jacket **14** and hopper **10** may be adjusted to move longitudinally in and out of the tank **17** by suitable means such as a rack **21** and pinion **22**. The rack **21** may be fixed to the jacket **14** and the pinion **22** may be attached to a fixed part of the apparatus and operated by a hand wheel **23**.

A vertical partition **24** within the tank **17** is provided with an orifice **25** sufficiently large to receive the die containing portion of the tubular jacket **14**. To the orifice **25** is attached a nozzle **26** the outlet portion of which has a reduced circular cross section. However, no portion of the nozzle **26** has a diameter equal to or less than the outer diameter of the tubular jacket **14**. The vertical partition **24** is adjustable in a direction perpendicular to its surface by any suitable means such as a worm screw **27**. By this means, the space between the nozzle **26** and die jacket **14** may be varied.

The cooling medium **18** is maintained at a level sufficient to keep the die and jacket completely submerged at all times. The medium is kept continuously flowing by a circulating system **28**, which contains a suction pump **29**. The inlet **30** to the tank **17** is preferably located in the top of the tank and on the side of the vertical partition **24** nearest the hopper **10**. The outlet **31** is located in the bottom of the tank **17** on the opposite side of the vertical partition **24**. This arrangement provides continuous circulation of cooling medium around the die jacket **14** and through the limited space between the nozzle **26** and the die jacket **14** in a direction

away from the die outlet and along the cast shape or bar 32. It will be noted that both the die 15 and the cast bar 32 are completely submerged, and an additional cooling compartment 33 may be provided to render the cast metal capable of handling. Rollers 34 or any other suitable means may be provided for extruding the bar 32 continuously from the die 15 and means may be provided for cutting the casting at any desired length.

The operation of the apparatus is as follows:

The tubular jacket 14 containing the die 15 is inserted into the tank 17 through aperture 19, and is adjusted to its desired position by the rack 21 and pinion 22, controlled by the hand wheel 23. The vertical partition 24 is then adjusted by the worm screw 27 so that the nozzle 26 is properly spaced from the die jacket 14 to provide a narrow passage around the die jacket to increase the velocity of the cooling medium passing therethrough. The tank 17 is filled with the cooling medium 18 to a level that will completely submerge the tubular jacket 14 and die 15. The suction pump 29 is then started and the cooling medium is circulated, entering the tank 17 through the inlet 30, circulating about the tubular jacket 14 containing the die 15, and then flowing through the narrow passage created by the nozzle 26 and the die jacket 14, and then to the outlet 31 through the pump 29 and the circulating system 28.

A starting bar 35 of any suitable type, such as one having a threaded end, is thrust into the die outlet to form a surface upon which the initial molten metal may solidify. Heating elements 16, such as electrical coils about the hopper and the tubular jacket, are then operated to provide sufficient heat that the metal will remain molten until it enters the die 15. Molten metal 11 is then poured into the hopper 10, where it flows by gravity across the sloping bottom 12 through the outlet 13, through the tubular jacket 14 into the die 15, and against the starting bar 35. As soon as the molten metal enters the die 15, it is slowly cooled by the action of the cooling means 18 circulating around the outside of the die containing tubular jacket 14. When that portion of the metal in contact with the die surface solidifies and a certain portion has solidified about the engaging portions of the starting bar 35, the bar 32 is withdrawn from the die 15 slowly.

As the bar 32 emerges from the die outlet, it is immediately subjected to the rapid cooling action of the high velocity cooling medium 18 flowing between the nozzle 26 and the die jacket 14. This rapid cooling is very necessary in producing a high quality casting, as it tends to equalize the temperature of the center and the periphery of the cast bar, thus reducing the incidence of voids and other imperfections.

After the cast bar 32 is rapidly cooled by the action of the nozzle 26, its extrusion is continued from the die 15 and the bar 32 is pulled through the cooling medium 18 horizontally until it is cooled enough to be handled. It is then withdrawn from the bath or series of baths and passed through a pair of rollers 34 which continually extrude the casting from the die. The starting bar 35 is then unscrewed or broken off from the casting and the cast bar 32 may be cut into desired lengths or may be further treated.

The length to which a casting may be extended is unlimited.

The high velocity of the cooling medium 18 passing between the nozzle 26 and the die jacket 14 not only provides a rapid transfer of heat away from the casting but also creates a vacuum in the vicinity of the die outlet and prevents any cooling medium 18 from flowing into the die 15 to cause imperfections in the casting, such as voids and shrinkage caused by steam pockets.

The cooling effect of the nozzle 26 may be transferred to any portion of the die 15 or casting 32 by horizontal adjustment of the vertical partition 24. By adjusting the partition 24 toward the hopper 10, a greater portion of the die 15 may be subjected to the rapid cooling effect of the nozzle 26; and by adjusting the partition 24 away from the hopper 10, more of the casting surface 32 may be quickly cooled if desired. Adjustment of the partition 24 may also be made to maintain the relative position of the tubular jacket 14 and nozzle 26 when the nozzle itself is being longitudinally adjusted with respect to the tank 17. If the molten metal is being cooled to rapidly and it is desired that the metal leave the die at a higher temperature, the tubular jacket 14 may be withdrawn from the tank 17 by turning the hand wheel 23 actuating the pinion 22 to drive the rack 21 in a direction away from the tank 17. If dies are used which will produce cast shapes of greater cross-sectional dimensions, the greater resulting cooling demand may be satisfied by adjustment of the tubular jacket 14 farther into the tank 17 to effect greater surface contact between the cooling medium 18 and the jacket 14. In brief, the adjustment of the tubular jacket 14 is to vary the slow cooling effect of the large relatively static mass of cooling medium 18, whereas the adjustment of the vertical partition 24 is to vary the rapid cooling effect caused by the nozzle 26. The velocity of the cooling medium 18 itself may be regulated by controlling the speed of the suction pump 29. Any suitable cooling medium may be employed, but water is preferable because of its availability, economy, and heat storage capacity.

The die 15 is replaceable by other dies which will mold various shapes 32, such as those disclosed in Fig. 3. If a larger or smaller die 15 and tubular jacket 14 are used, the partition 24 and nozzle 26 may be adjusted accordingly. The die 15 may be made of any suitable material, such as a refractory material or a metal. Best results are obtained in this process if the castings are made of metal which will shrink upon solidification, such as non-ferrous metals, brass, aluminum or copper.

It will be apparent to those skilled in the art that various changes may be made in the invention, without departing from the spirit and scope thereof, and therefore the invention is not limited by that which is shown in the drawings and described in the specification, but only as indicated in the appended claims.

What is claimed is:

1. An apparatus for continuously casting metal shapes comprising a horizontally disposed die having a cylindrical outer surface and having an inlet and an outlet, means for introducing molten metal into said die inlet and means for extruding cast metal shapes from said die outlet, a bath containing a fluid cooling medium surrounding said die, the volume of said bath being at least fifteen times greater than the displacement of said die in said bath, a solid vertical partition separating said bath into first and second sections, said partition having a single aperture, the major portion of said die being disposed in said first section and only the die outlet portion protruding through said aperture into said second section, a tubular nozzle having a flared base attached to the periphery of said aperture and projecting into said second section substantially beyond said die outlet, the inner diameter of said nozzle being slightly greater than the outer diameter of said die, and vacuum means for circulating said cooling medium in said bath through said nozzle from said first section into said second section to withdraw any fluid cooling medium away from said die outlet.

2. The invention according to claim 1 in which means are provided for horizontally adjusting said die in relation to said nozzle.

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