FIG. 3

FIG. 4

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ATTORNEYS
MANDREL FOR CONTINUOUS CASTING MOLD

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Filed Sept. 10, 1964, Ser. No. 3,996,687

2 Claims. (Cl. 164—223)

This invention relates to apparatus for the continuous casting of metal, such as copper, brass or aluminum and has for its object the provision of an improved mandrel for use in a mold to cast hollow billets or tubes.

Apparatus for continuously casting hollow billets usually comprises a mold having an inner lining of graphite, a graphite mandrel suspended in the mold forming an annular upright space in which the metal is poured and solidified, means for lubricating the graphite surface and means for cooling and vibrating the mold and drawing the cooled billet out of the mold. The mandrel of the invention is used in a casting apparatus of this type.

The improved mandrel of the invention is formed of graphite, and is constructed to be suspended in the graphite mold so as to provide the space for pouring the metal and forming the hollow billet. The mandrels used for continuous casting are largely surrounded with molten metal and usually are heated to temperatures approximating the temperature of the metal. At such temperatures the graphite is subject to corrosion and breakage. Accordingly the mandrels used heretofore have relatively short life and are the cause of delaying inceptions. The cooling and lubricating of the mandrel have not been satisfactory heretofore and have not contributed to a solution of the problem of extending the useful life of mandrels used in hollow billet casting.

The graphite mandrel of the invention is hollow and is provided with means in the hollow space for cooling and/or lubricating the mandrel. The mandrel is preferably fitted with a cooling means, preferably a tubular coil for circulating a cooling fluid inside the mandrel, and a means for introducing the fluid in heat-exchange contact with the mandrel. In one of its aspects the mandrel includes a means for introducing and distributing a lubricant in the mandrel. The invention preferably provides a core inserted into the mandrel for the distribution thereof in a lubricant to be distributed to the graphite to the casting surface. Advantages of the invention include a combination of the cooling means and the core for distributing lubricant. The tubular coil is constructed to make a close fit in the mandrel to add strength or reinforcement to the mandrel and to absorb the heat to protect the mandrel and facilitate the solidification of the metal.

In the accompanying drawings

FIG. 1 is a fragmentary side elevation, with parts in section, of billet casting apparatus illustrating the use of the improved mandrel of the invention;

FIG. 2 is a side view, partly in section, illustrating the mandrel of FIG. 1 having a lubricant distributor core;

FIG. 3 is a sectional side view of the mandrel provided with a coolant coil, and

FIG. 4 is a side view, with parts in section, of a mandrel having both a coolant coil and a core for the distribution of a lubricant.

The apparatus of FIG. 1 comprises a metal mold support 1, circular in cross-section, a graphite mold or liner 2, a graphite mandrel M, coupling ring 3, preferably formed in two parts and bolted in snug contact with the mold support 1. The support 1 and the mold 2 are preferably provided with cooling means and the mold 2 with lubricating means. The mandrel support 4 may be circular in plan, has an annular groove 5 which centers it on the mold support 1, bolts 6 for securing it to the coupling ring 3 and an annular recess 7 for receiving the annular flange 8 of the mandrel head 9 which is preferably circular in transverse section. The mandrel support has a depending shield 10 which covers the part of the mandrel head extending above the top surface of the liquid metal L to protect it from oxidation. The annular top flange 8 is fairly deep and is strengthened where it joins the rest of the mandrel by the fillet 11 which bears on a correspondingly curved part of the annular recess 7. The cover plate 9 is secured to the support 4 by bolts 10 and holds the mandrel in place.

The graphite mandrel M illustrated comprises two main parts the upper head part 9 and the lower tapered part 12. The mandrel head has a cylindrical recess or cup 13 at the top for receiving molten metal and three radially disposed ducts D through which melt flows into the casting space.

The mandrel M shown in FIG. 2 is preferably constructed by machining and boring a single piece of graphite to form the head portion 9 including the cup 13 which is the subject of the copending application of William H. Ludwig, Ser. No. 398,844, filed Sept. 24, 1964. The lower inner portion 12 of the mandrel, from the surface 14 to the bottom end 15 is hollow, advantageously having a cylindrical inner surface 16 and the outer surface 17 from about the surface 14 downward is tapered downward to compensate for the shrinkage of the solidified billet. This portion of the mandrel which is tapered and a short section thereabove is normally contacted with the metal of the billet. FIG. 1 shows the liquid metal L surrounding the head and the solidified billet therebelow. It is important to lubricate both the mold and the mandrel and this may be achieved by forcing a suitable gas through pores or small holes in the graphite.

The mandrel of the invention includes effective means for introducing and distributing a fluid lubricant in the mandrel. The interior hollow space within surface 16 has a snug fitting, generally cylindrical, core 18 which has a helical groove 19 providing channels facing the inside surface 16. The uppermost end of the helical groove is connected to an upright duct such as a bore hole 20 which connects to a tube 21 for introducing a lubricant gas through the groove and into contact with the mandrel inner surface 16. The core 18 is held in position within the mandrel by the graphite screw plug 22. The core not only serves as a lubricant distributor but a reinforcement for the fragile hollow mandrel.

FIG. 3 illustrates a hollow graphite mandrel M similar to the mandrel of FIG. 2 having a hollow center in which is mounted a coiled metal tube 25 which is in direct contact with the inner wall surface 16. This tube is preferably of good heat conducting metal such as copper and is in heat-exchange contact with the mandrel. The inlet end 26 of the tube passes upwardly through hole 27 and the outlet end 28 passes up through hole 29. It will be noted that the incoming coolant fluid, preferably refrigerated gas, enters the coil near the top where the mandrel is hottest and leaves the mandrel at the bottom where the mandrel is the coolest. The graphite plug 30 secures the coil in position.

FIG. 4 illustrates a graphite mandrel M as shown in FIGS. 2 and 3 having a hollow center within the surface 16 in which a tubular coolant coil 25 is mounted as in FIG. 3. The space within the coil has motor 18 as shown in FIG. 2. The mandrel of FIG. 4 provides the cooling coil of FIG. 3 in combination with the core and groove means of FIG. 2 for the introduction and distribution of a lubricant.

The mandrel support shown in FIG. 1 is the subject of the copending patent application of George C. Earl, Jr., Ser. No. 395,541, filed Sept. 10, 1964.
We claim:
1. In apparatus for the continuous casting of hollow metal billets which includes an upright stationary outer annular graphite mold having an annular interior and an open ended bottom mounted snugly within mold support, an inner upright hollow graphite mandrel extending into the annular mold from above to provide an interior annular space between the mandrel and the mold, means communicating with the upper portion of the annular space between the annular mandrel and the annular mold for feeding molten metal continuously downwardly into said annular space where molten metal freezes to form a continuous progressively advancing hollow billet, the improvement in combination therewith which comprises:
(a) the inner upright hollow mandrel has an axial opening therein having an inside cylindrical surface extending upwardly from its lower end;
(b) the inner hollow mandrel has within its axial opening a core which has a snug fit within the inside cylindrical surface, and the generally cylindrical surface of the core has a helical groove providing lubricant distributing channels facing the inside cylindrical surface of the mandrel, and the upper end of the helical groove connects to an upright duct through which a lubricating gas is supplied to the helical groove and into contact with the mandrel inside surface; and
4. (c) a plug is fitted at the lower end of the cylindrical inside surface of the mandrel to retain the core therein and to close the lower end of the helical groove.
2. Apparatus according to claim 1 in which a helically coiled metal tube is mounted in direct contact with the inside cylindrical surface of the hollow mandrel, and the surface of the core has a snug fit with the inner surface of the coiled tube, connections being made to the opposite ends of the coiled tube for the supply and discharge of a coolant fluid, both the core and coolant coiled tube being retained within the hollow mandrel by said plug.

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