United States Patent

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[33] **Japan**
[31] **Nos. 42/60482 and 42/70266**

[54] **COOLING APPARATUS FOR MOLDS**
5 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **134/114,** 62/64; 98/115; 118/323; 134/172; 277/135
[51] **Int. Cl.** **B08b 3/02**
[50] **Field of Search** ..... 134/114, 167, 168, 172, 191; 277/135; 62/64, (Inquired); 98/115, (Inquired); 118/323, (Inquired)

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ABSTRACT: A water-cooling apparatus for use in a method of cooling molds for casting steel ingots in which the molds are air-cooled in a cooling pit until their surface temperature becomes less than about 500° C., and then water-cooled with a water-cooling apparatus. The apparatus has a gate-shaped moving deck provided with means for jetting cooling water onto the molds and which deck runs above the said cooling pit, and a cooling water channel extends along the track of said moving deck.

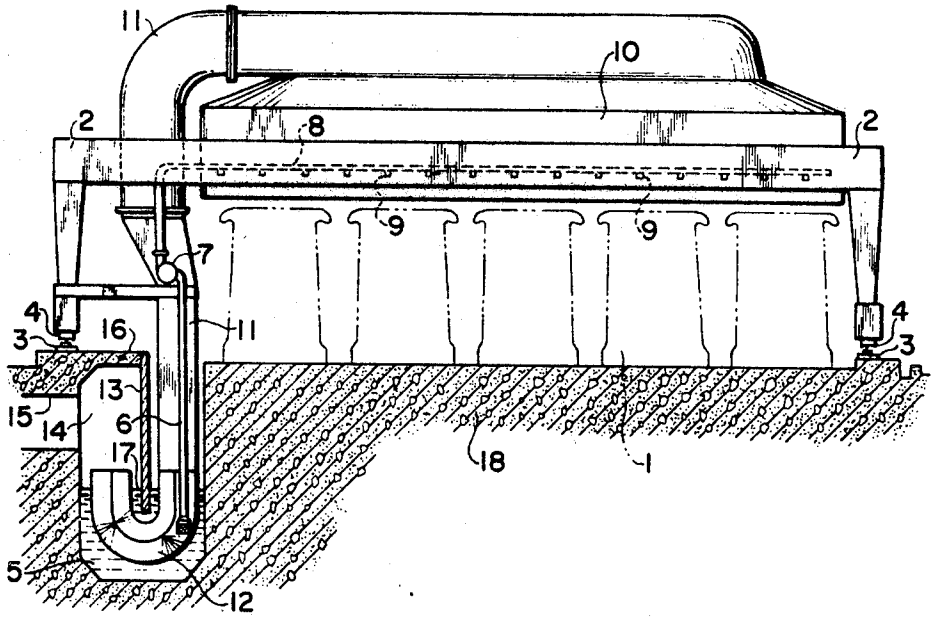


FIG. 1

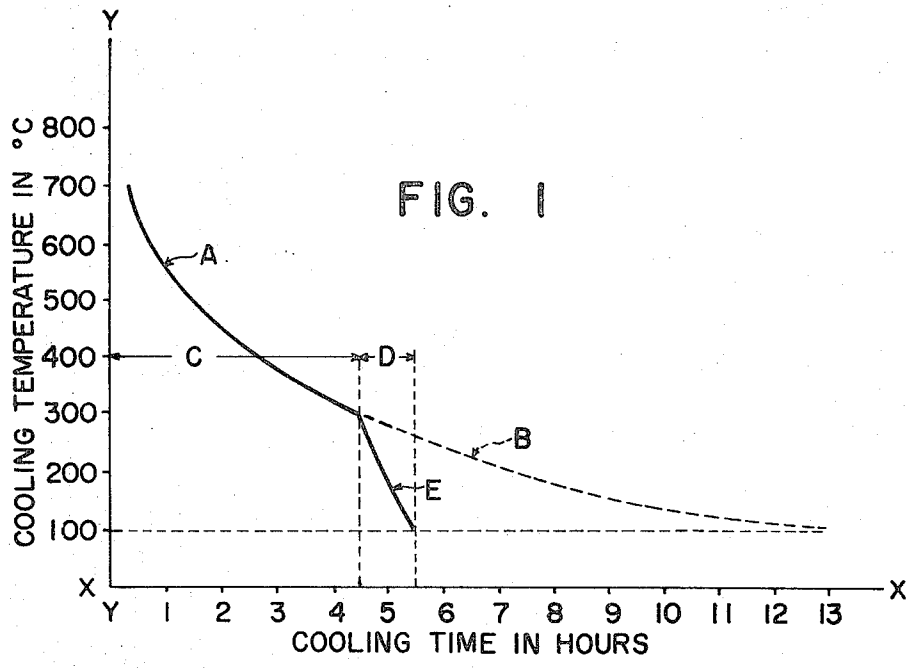
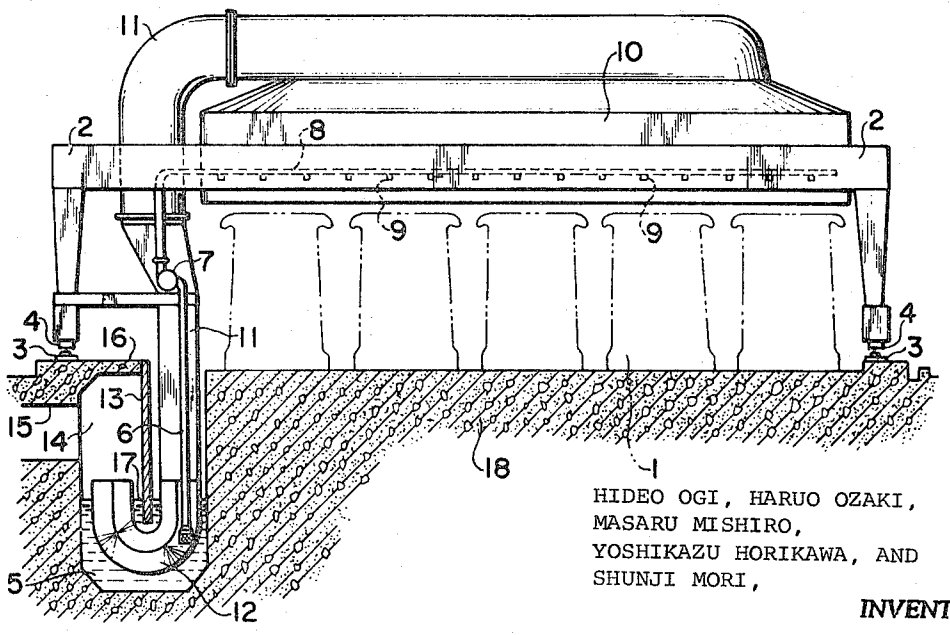


FIG. 2



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FIG. 3

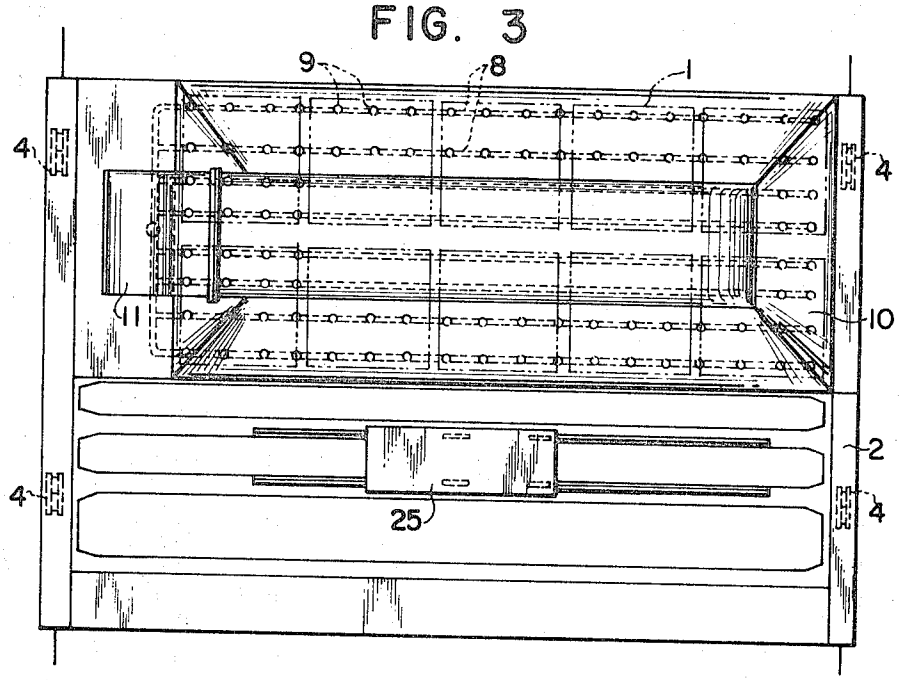
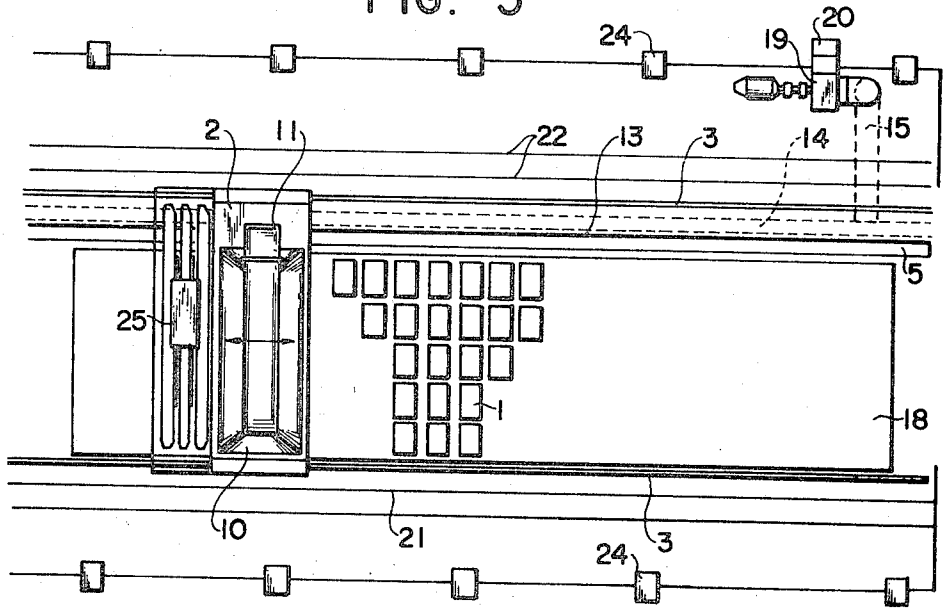


FIG. 5



HIDEO OGI, HARUO OZAKI, MASARU MISHIRO, YOSHIKAZU HORIKAWA, AND SHUNJI MORI : INVENTORS

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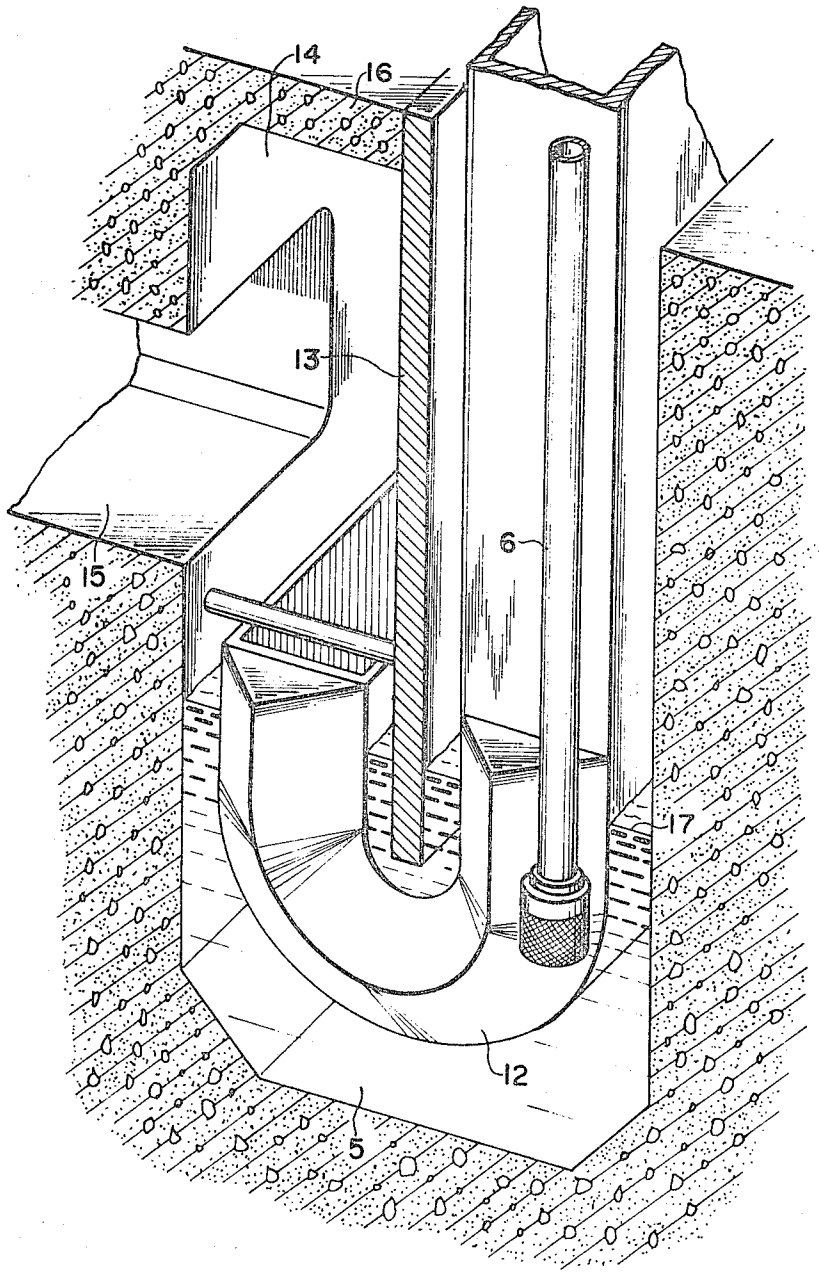
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FIG. 4



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COOLING APPARATUS FOR MOLDS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates generally to an apparatus for cooling molds and the like and more particularly to a water-cooling apparatus for cooling molds for casting steel ingots.

2. DESCRIPTION OF THE PRIOR ART

In steel making plants, conventionally, in order to increase the frequency of the use of molds for casting ingots, just after the ingots are extracted, the molds are quickly cooled by air-cooling or water-cooling so they can be used again.

However, when such molds are cooled by air-cooling, there are disadvantages that it takes a long time to cool them down to about 100° C. at which they can be used and that a large mold cooling area is required.

On the other hand, when the molds are to be cooled by water-cooling, they are dipped into a water tank or water is jetted on them and therefore there are the disadvantages that a lag large volume nontransparent white smoke or white smoky stream is generated to which causes difficulty in the operation of an ingot crane installed indoors, and, due to the thermal stress and the nonuniformity of cooling of the inner surface of the thus quickly cooled mold, the inner surface will be caused to crack and the life of the mold will be shortened and the surface condition of the steel ingot cast in such mold will not be good. Further, there has been suggested method wherein, in order to prevent the generation of a large volume of white smoke or stem, for example, molds are mounted on a moving carriage and are water-cooled while they are passed through a special mold cooling chamber. However, in said method, there is the disadvantage that an additional crane operation and corresponding equipment are required to load and unload the moving carriage with molds as well as the above mentioned disadvantages due to the quick cooling of molds.

SUMMARY OF THE INVENTION

An object of the present invention is to solve such problems as are mentioned above by using both air-cooling and water-cooling and to provide a cooling apparatus for molds wherein molds can be reasonably cooled within a comparatively short time.

Another object of the present invention is to provide a water-cooling apparatus for molds wherein a large volume of white smoke or white smoky steam generated in water-cooling molds can be caught and can be completely discharged out of doors, the above mentioned disadvantages due to the quick water-cooling of the mold can be prevented by simultaneously using air-cooling and many molds can be simultaneously cooled with a simple apparatus.

Another object of the present invention is to provide an apparatus for cooling molds and the like by which it is easy to control the mold temperature, thereby stabilizing the quality of steel ingots.

In order to attain the above mentioned objects, the present invention provides a cooling pit in which are placed many molds at a high temperature just after set steel ingots are extracted from them, and in which the molds are air cooled until their surface temperature becomes less than about 500° C. A water-cooling apparatus is positioned above the above-mentioned cooling pit, and carries out water-cooling by spraying cooling water onto the molds and adjusting the quantity of water so that the maximum cooling velocity at the time of the above-mentioned air-cooling of the mold will not be exceeded. The water-cooling apparatus comprises a gate-shaped moving deck provided with means for jetting cooling water on to the molds and mounted so as to run above the said mold cooling pit, a cooling water channel extending along rails on which said moving deck runs, a cooling water suction pipe extending into said water channel and communicating with the above-mentioned cooling water jetting means, a water-sealed exhaust conduit formed by partitioning off a part of the above-mentioned cooling water channel, and an exhaust hood provided on the above-mentioned moving deck with an exhaust conduit pipe extending therefrom into said water sealed exhaust conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a curve showing the relation between the mold temperature after the ingot is extracted and the cooling time and showing a comparison of the air-cooling method and the method according to the present invention;

FIG. 2 is an elevation view, partly in section of an example of the water-cooling apparatus according to the present invention;

FIG. 3 is a plan view of the apparatus of FIg. 2;

FIG. 4 is an enlarged perspective view partly in section showing the structure of the water-sealed part of the apparatus; and

FIg. 5 is a general plan view of a mold treating area equipped with the water-cooling apparatus as shown in FIGS. 2—A.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described in the following with reference to the drawings.

FIG. 1 showing an example of an air-cooling curve of a mold when using a conventional air-cooling system, it is seen that, in order to cool a mold from its temperature just after an ingot is extracted from it to a suitable temperature for the next use, which is below about 100° C. and at which the inner surface of the mold can be given proper care, about 13 hours are required as shown by the curves A and B.

On the other hand, in the present invention, the cooling process is divided into two stages and, in the first cooling stage, though there will be variations depending on the size of the mold, the mold is cooled by air-cooling for about 4 to 5 hours to a temperature below about 500° C., for example, to 300° C. along the curve A because as understood from the cooling curve, even if the mold is left to cool in a position in which the mold temperature is high, the cooling velocity will be high and, even if the mold is water-cooled thereafter, no defect such as the cracking of the mold will be caused below such temperature. Then, in the second cooling stage shown by D after the first cooling stage, the mold is uniformly water-cooled for about 0.2 to 1.5 hours so that it is below 100° C. with showers of water from above the mold by a water-cooling apparatus according to the present method. In such case, the relation between the mold temperature and the cooling time is as in the curve E. Further, the quantity of the cooling water is adjusted so that the cooling velocity in the second cooling stage does not exceed but is substantially equal to the maximum cooling velocity in the above mentioned first cooling stage. Generally, as understood from the cooling curve, in a situation in which the mold temperature is high to begin with, if air-cooling is carried out, needless to say, a very long time will be required to cool the mold down to the required temperature but, in two stage cooling wherein the mold is initially cooled from the high temperature by air-cooling and is water-cooled to the final low temperature, as described above, the mold can be cooled at a velocity substantially equal to the maximum cooling velocity during air-cooling all through and defects due to the quick water-cooling of the mold can be prevented. In addition, if the mold is water-cooled at a velocity which exceeds the maximum cooling velocity of air-cooling, needless to say, the mold will be caused to crack. Further, because the mold temperature in the second cooling stage is less than about 500° C., the volume of the nontransparent white smoky steam will be much smaller than if water-cooling is carried out throughout the entire cooling operation. In this method, by using the water-cooling apparatus according to the invention, all of the steam is caught and is discharged out of doors as described later.

A preferred embodiment of the mold water-cooling apparatus according to the present invention will be explained in the following with reference to the drawings.

In FIG. 2, 3 and 4, casting molds 1 are conveyed into a cooling pit 18 after a steel ingot is extracted from them and a gate-shaped moving deck 2 is mounted on rails 3 provided on both sides of the cooling pit 18. Said moving deck 2 has a plurality of running wheels 4 which run to and fro on the above mentioned rails 3. A cooling water channel is provided on one side of the cooling pit 18 and below the bottom of the pit 18, and has a water-sealed exhaust conduit 14 defined by a depending shielding plate 13 having the upper edge fixed in airtight fashion to a beam 16 extending along the upper part of one side of said water channel 5. The structure of this water-sealed space is clearly shown in FIG. 4. The lower edge of said shielding plate 13 is space from the bottom wall of the channel 5. In the water channel 5 below the plate 13 is positioned the lower U-shaped part 12 of an exhaust conduit 11, the upper end of which is connected with an exhaust hood 10 provided on the upper part of the above mentioned moving deck 2. The U-shaped part 12 extends under the lower edge of shielding plate 13 and opens into the above mentioned exhaust conduit 14 formed by the shielding plate 13 and running parallel with the water channel 5. A suction pipe 6 provided with a strainer has its lower end in the water channel 5. A pump 7 is fixed to the upper end of said suction pipe 6. A cooling water pipe system 8 arranged in the form of a lattice is mounted on the lower part of the girder of the moving deck 2. A Water jetting nozzles 9 are fixed to said piping. An exhaust port 15 extends from the above mentioned exhaust conduit 14 out of the area so that steam generated by cooling the molds and caught by the above mentioned exhaust hood 10 will be led into the exhaust tunnel 14 and then discharge from the exhaust tunnel 14 through the exhaust port 15.

The mold cooling area provided with the cooling apparatus shown in FIG. 2 is shown in FIG. 5. An exhaust fan 19 is connected with the above mentioned exhaust port 15 and provided between pillars 24 of the building. An exhaust chimney 20 is connected to said exhaust fan 19 outside the building. Rails 21 and 22 form a track for pulling in a water pouring carriage and for cars for receiving cooled molds.

The operation of the cooling apparatus according to the present invention will now be further explained.

Many molds 1 having had ingots extracted by a mold crane are immediately conveyed by the same crane to the mold cooling area are place in the cooling pit 18 and are naturally air-cooled. By said natural air-cooling, the first cooling stage is finished and the molds are below about 500° C. The second water cooling stage is carried out by running the gate-shaped moving deck above the molds 1. In said second cooling stage, cooling water in the water channel 5 is first sucked up through the suction pipe 6 by the pump 7, is then pressurized and is jetted toward the molds 1 in the pit from the water jetting nozzles 9 though the piping 8. A large volume of white smoky steam generated at the time of jetting the cooling water is sucked into the exhaust hood 10 above the water jetting nozzles 9 by the suction from the exhaust fan 19, is drawn through the exhaust conduit pipe 11 and is then discharged into the exhaust conduit 14 through the U-shaped exhaust pipe part 12 positioned in the water channel 5. The white smoke in said exhaust conduit 14 is further sucked by the exhaust fan 19 through the exhaust port 15 and is forcibly exhausted out doors. Further, as the shielding plate 13 is airtightly fixed to the beam 16 as mentioned above, atmospheric air is completely prevented from coming in and, as the shielding plate 13 is spaced from the bottom of channel 5, the movement (in the direction indicated by the arrow in FIG. 5) of the U-shaped exhaust pipe part 12 during the running of the deck is not obstructed. At any position along the cooling pit 18, the cooling water can be continuously sucked up and the generated steam can be continuously sucked up and the generated steam can be continuously exhausted.

The water level 17 in the water channel 5 is kept always at a constant value by a level gauge and the quantity corresponding to the quantity of water used for cooling is automatically supplied.

As mentioned above, with the present water-cooling apparatus, water can be continuously fed at any position along the cooling pit 18 and at the same time the large volume of the white smoky steam generated at the time of water-cooling can be completely discharged out of doors.

The molds 1 cooled to below 100° C. in the second cooling stage as mentioned a above may be moved to any other place and may be treated there so as to be used again. Or else, for example, the inner surfaces of the molds may be swept and inspected from the gate-shape moving deck 2 and may be painted with oil with a laterally traveling carriage 25 attached to the moving deck 2 a shown in FIG. 3. Further once the relation between the temperature of the mold to be cooled in the second cooling stage and the time is established even if the temperature is not measured each time thereafter, the cooling can be adjusted and therefore the operation is very easy.

As described above, according to the mold cooling method using the apparatus of the present invention the long time of about 13hours required for the conventional air-cooling can be shortened to about 5.5 hours without impairing the durability of the mold. That is to say, according to the present invention, not only can the time required for cooling be shortened, but also the frequency of use required for the mold can be increased and the space of the mold cooling place can be kept small and the number of molds needed can be greatly reduced.

An advantage of the present invention is that it makes it easy to control the temperature of the molds, thereby stabilizing the quality of steel ingots poured and solidified in the molds. In the case of rimmed steel ingot, for example, whether its quality is good or not, depends also on the degree to which blow holes are present near the surface of the ingot. The part of the ingot where no blow holes or very few, if any, exist, is called solid skin, the thickness of which is related to the temperature of molten steel in the ladle on one hand, and is greatly influenced by the temperature of the mold on the other hand. It has been ascertained that the thickness of said skin is reduced unless the temperature of the mold is below a certain point, say, 130° C.

In this case, it is easily understood that cooling with the apparatus of the present invention to achieve rapid cooling of the used mold in preparation for next use in as short a time as possible, is very useful for stabilizing the quality of steel ingots.

In addition to the above advantages, cooling water used in the cooling according to the present invention rinses the dust out of the the mold, resulting in a smooth, beautiful surface of the steel ingots.

The apparatus according to the present invention has been described as being for the cooling of molds for steel ingots, however, the present invention is not limited to this use, but is also applicable to the cooling of cast products in general and all other things to be cooled, when conditions require exhausting of the steam generated from jets of cooling water out of the building.

We claim:

1. A water-cooling apparatus for cooling molds and the like comprising a pit for holding a plurality of molds from which ingots have been extracted after casting, rails extending along said pit, a gate-shaped moving deck having wheels running on said rails so as to run above the said pit, means provided on said moving deck to jet cooling water onto the molds, a cooling water channel along one side of said pit, a cooling water suction pipe extending into said channel and connected with said cooling water jetting means, partitioning means provided in said channel to form a water sealed exhaust conduit, an exhaust hood carried by the moving deck, and an exhaust pipe secured to and communicating with the hood, said pipe extending through water provided in the channel and opening into the exhaust conduit.

2. An apparatus as claimed in claim 1 wherein said cooling water jetting means is a piping arranged in the lower part of a girder of the moving deck and having a plurality of water jetting nozzles fixed to said piping.

3. An apparatus as claimed in claim 1 wherein said cooling water channel is provided on one side of said pit and extends below the level of the bottom of the pit.

4. An apparatus as claimed in claim 1 wherein said water-sealed exhaust conduit is further formed by a beam extending along one side of said channel, a shielding plate depending from said beam and having the lower end spaced from the bottom of said channel.

5. An apparatus as claimed in claim 1 wherein the exhaust pipe has a U-shaped part in the cooling water channel which extends under said partitioning means and opens into said exhaust conduit.