United States Patent

[11] 3,590,904

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[21] Appl. No. **737,256**
[22] Filed **June 4, 1968**
[45] Patented **July 6, 1971**
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Chicago, Ill.
Continuation-in-part of application Ser. No. 626,812, Mar. 29, 1967.

[54] **METHOD AND APPRATUS FOR COOLING GRAPHITE MOLDS**
5 Claims, 6 Drawing Figs.

[52] U.S. Cl. **164/126,** 165/174, 164/283, 164/348, 164/138, 164/122, 164/349, 249/134, 249/80
[51] **Int. Cl.** **B22d 7/10,** B22d 27/04
[50] **Field of Search** 164/348, 349, 281, 283, 138, 122; 249/135, 79, 81; 165/174, 172, 173

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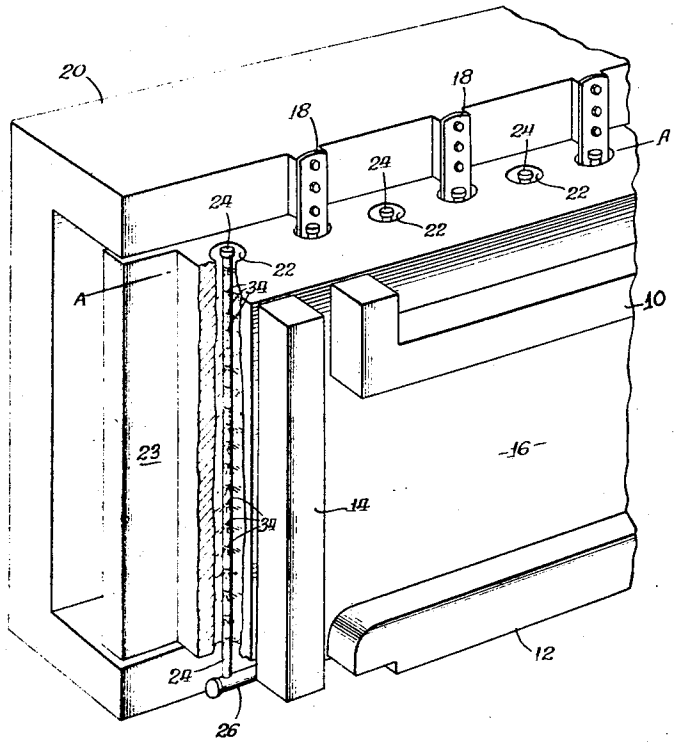
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ABSTRACT: Water sprays are located inside holes bored vertically at the centerline of graphite mold blocks, in order to cool and prolong the life of the mold.



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Fig. 1.

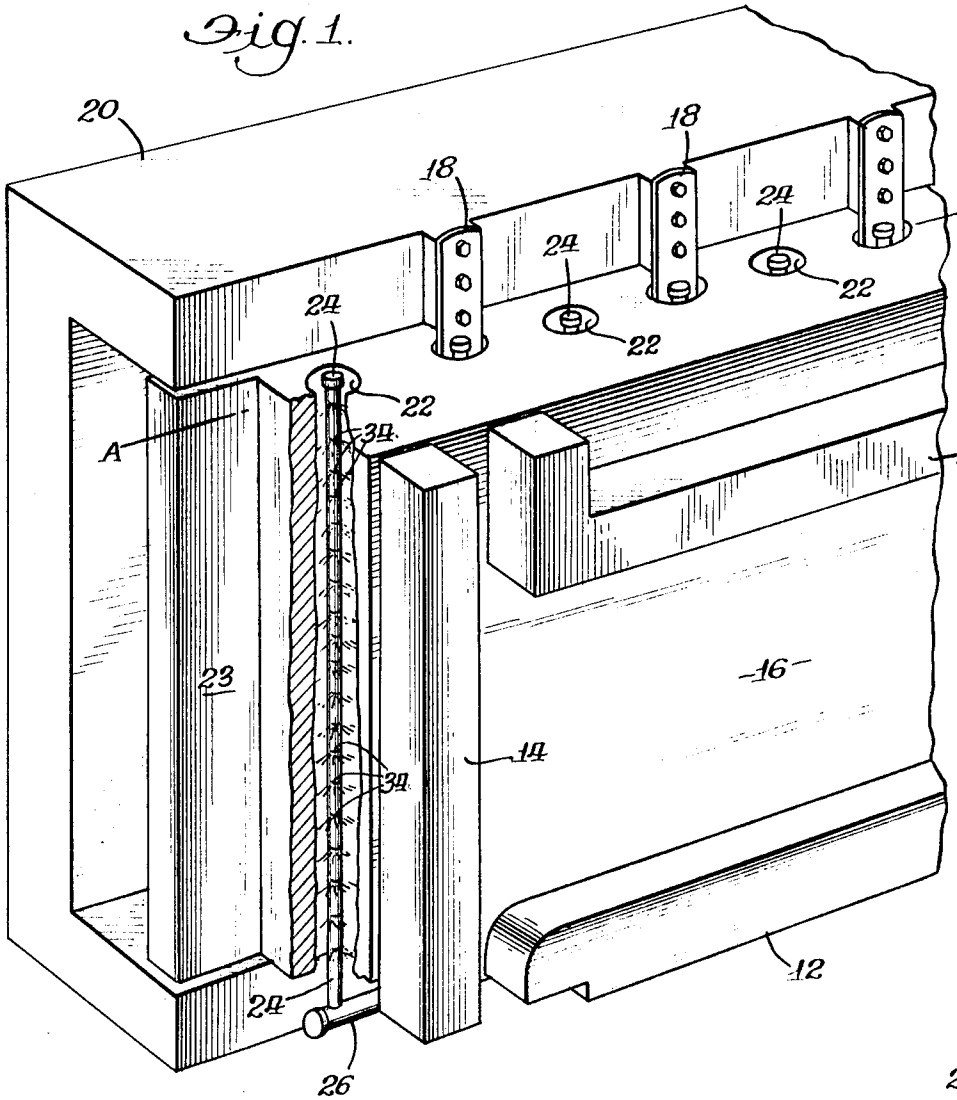
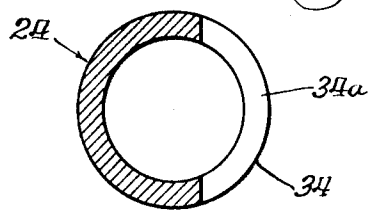


Fig. 4.

Fig. 5.



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Fig. 2.

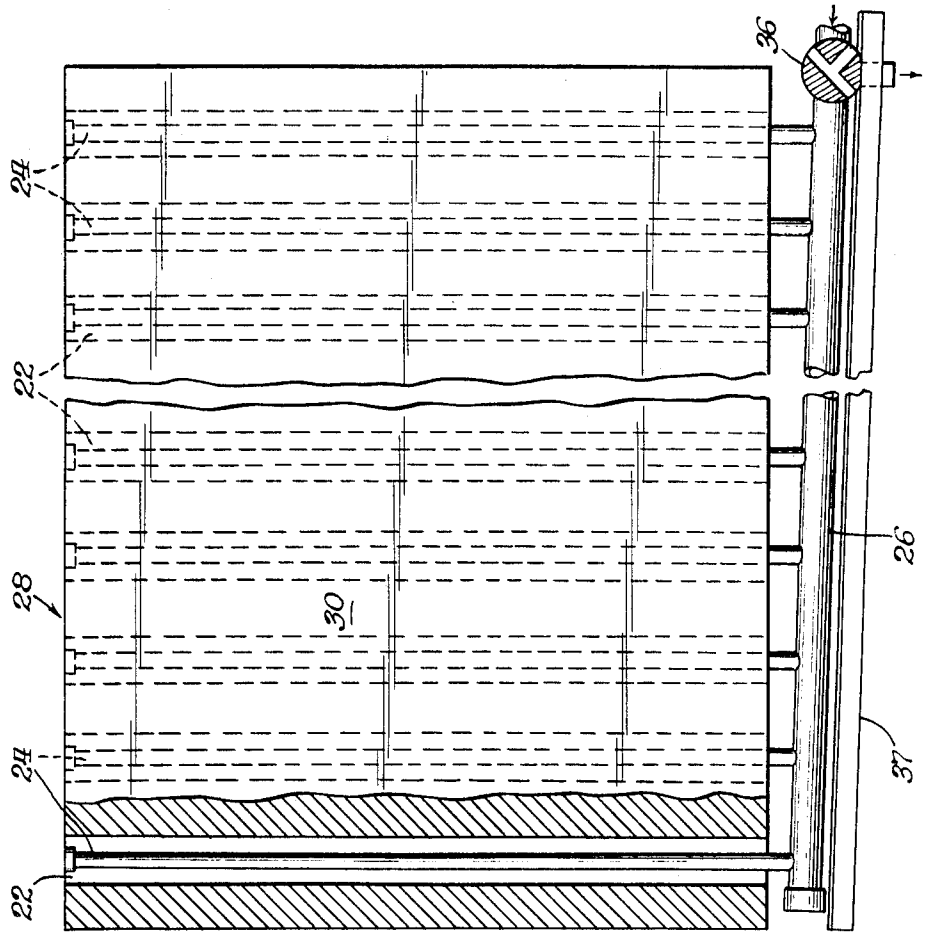
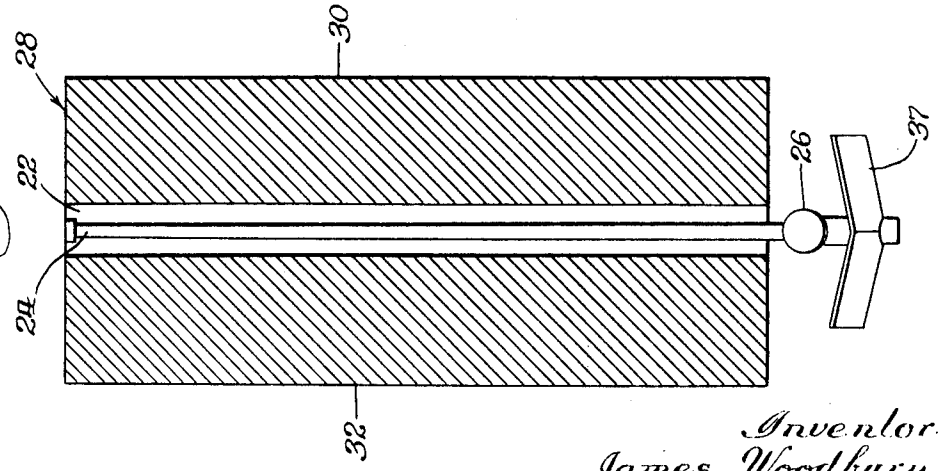


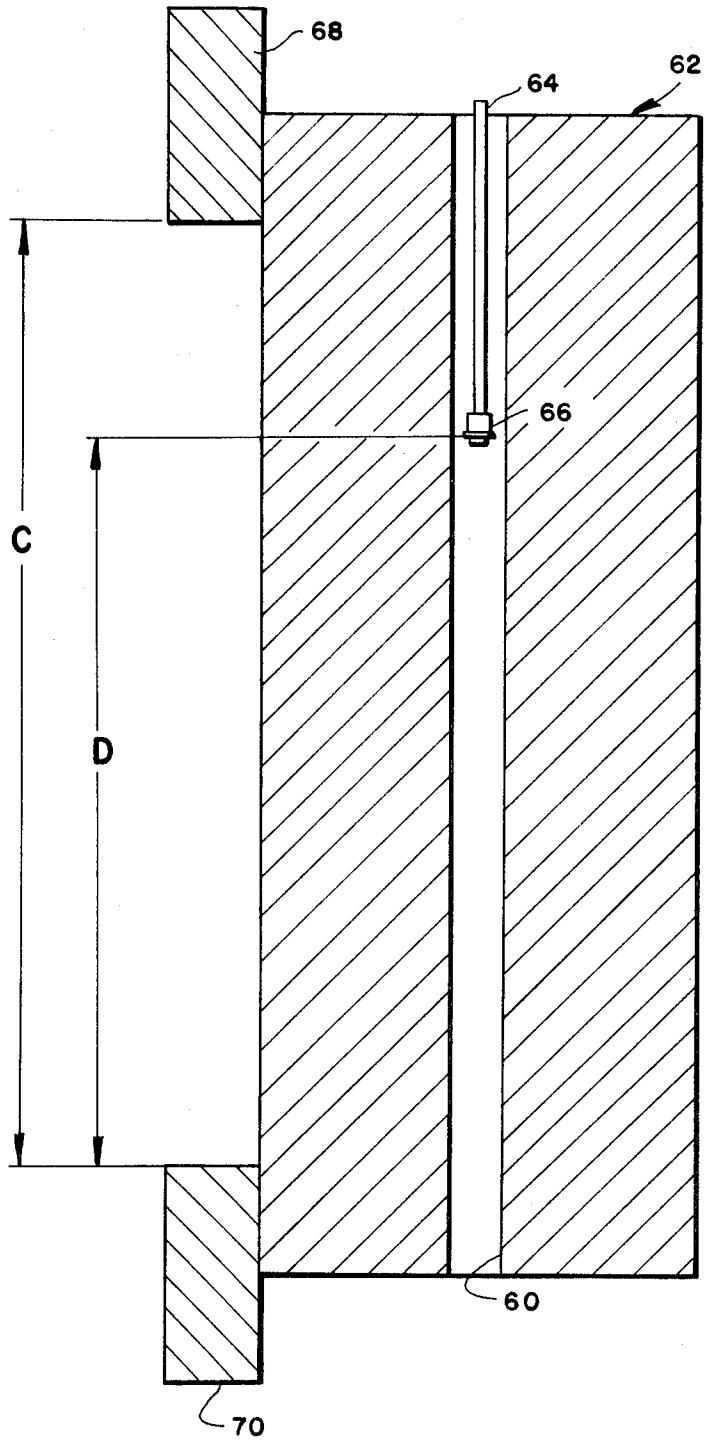
Fig. 3.



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FIG. 6



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METHOD AND APPRATUS FOR COOLING GRAPHITE MOLDS

This is a continuation-in-part of my copending application, Ser. No. 626,812, filed Mar. 29, 1967 now abandoned.

This invention pertains to a method and apparatus for cooling graphite molds and more particularly to the cooling of individual mold blocks by introducing a cooling fluid spray into internal spaces within the blocks.

It is known to use graphite molds for the casting of molten metals, such as steel. Such molds are especially useful for the casting of regular shapes, such as slabs. For this purpose, a typical mold may comprise two relatively large side blocks composed of graphite, with a plurality of smaller graphite blocks interengaged therebetween to define a casting cavity. Each side block may comprise opposed flat rectangular surfaces that are substantially identical, and hence either of such sides may be used to form part of the bounding surface of the mold cavity. As these casting surfaces become deteriorated, it is the common practice to remove surface defects by machining. With continued usage, the thickness and mass of each side block will be gradually reduced, with the consequence that the temperature of the mold will increase more rapidly within a given period of time during casting.

Various cooling problems arise in the casting of large slabs in graphite molds. During successive casting operations, heat must be removed from the mold in order that the molten metal may be properly cooled therein. Also, since graphite is subject to oxidation at temperatures above 850° F., the maintenance of a low mold temperature is highly desirable.

Various methods are employed in order to maintain the mold at a low temperature. For example, the mold side blocks may be selected to be much larger than the slab to be cast, and the mold will be capable of absorbing more heat with less increase in temperature. However, space limitations render this method impractical where large slabs are to be cast. Moreover, more time is required to cool such molds in the air between successive castings, and the machining of the casting surfaces, as mentioned above, reduces the efficiency of the mold.

Another method of cooling such molds is to direct a spray of water at the external surfaces of the mold between successive casting operations. Such methods are often undesirable because the water may deteriorate the casting surface of the mold and also form insoluble deposits which must thereafter be removed in order to render the mold reusable.

Accordingly, an object of this invention is to provide a method and apparatus for cooling a graphite mold that does not affect the casting surfaces of the mold.

Another object of this invention is to provide such method and apparatus that may be employed before, during and after the casting operation.

A further object of this invention is the provision of a cooling method and apparatus that becomes more efficient as the thickness of the graphite mold block is decreased.

The above and other objects will become apparent from the following description and claims, and in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a portion of a graphite mold which incorporates the features of the presently described invention;

FIG. 2 is a fragmentary side elevation, partly in cross section, of one of the side blocks of the mold, which incorporates the features of the present invention;

FIG. 0 IS AN END SECTIONAL VIEW OF THE SIDE BLOCK SHOWN IN FIG. 2;

FIG. 4 is an elevational view of one of the cooling pipes shown in FIGS. 1—3;

FIG. 5 is a cross-sectional view taken through line 5–5 of FIG. 4; and

FIG. 6 is an end sectional view of a side block showing another embodiment of the present invention.

With reference now more particularly to the drawings, FIG. 1 illustrates a graphite slab mold for casting steel slabs, said mold comprising a plurality of inner blocks including a top block **10**, a bottom block **12** and an end block **14**, said inner blocks being engageable with one another and with two opposing and substantially identical side blocks, one of which **16** is shown. Each side block **16** is retained by keeper plates **18** within a flask **20** having a strong back **23** for support of the structure. The inner blocks **10**, **12** and **14** are engageable with each other and with each side block **16** to define a casting cavity therebetween. Means (not shown) are also normally provided to maintain the position of the inner blocks and to move the side blocks toward and away from each other.

The present invention contemplates the provision of a plurality of vertical cylindrical bores **22** through each side block **16** substantially along the longitudinally centerline A–A thereof, in combination with a spray pipe **24** within each bore for supplying a spray of pressurized fluid therein, along with means, such as header pipe **26**, either above or below the mold assembly, for supplying pressurized coolant to the spray pipes.

FIGS. **2** and **3** shown a typical side block **28** dissociated from the mold assembly. As shown in FIG. **3**, the block **28** has two vertical surfaces **30** and **32**, and since either of sides may be used as a cavity-defining portion of the mold assembly, the block is reversible. It may also be seen that the axis of each of the bores **22** is parallel to the plane of both casting surfaces **30** and **32**, to provide a uniform cooling effect.

As shown in FIGS. **1—3**, each spray pipe **24** is of substantially less diameter than the diameter of its corresponding bore **22** and contains a plurality of openings **34** (FIG. **1**) along the enveloped portion thereof. A preferred configuration of such openings is shown in FIGS. **4** and **5**. A plurality of openings **34** are defined by cutting a plurality of transverse slots **34***a* along the length of each spray pipe **24**, which slots extend around less than half the circumference of the pipe. Also, since only one side of the mold block is heated at one time, the slots **34***a* are preferably located on the same side of the pipe and most closely adjacent to the casting surface of the block.

Again referring to FIGS. **2** and **3**, a header **26** is provided either above or below the side block **28** and is connected with each spray pipe **24**. The header may also contain a three-way valve **36** for supplying or draining coolant, such as water, to or from the spray pipes. A trough **37** may also be provided beneath the lower end of bores **22** to catch any coolant that has not been vaporized during the cooling operation. Also, since the bores **22** are open to the exterior, any vaporized coolant may escape freely into the atmosphere.

Another embodiment of the invention is shown in FIG. **6**. In this instance, spaced vertical cylindrical bores **60** are provided through each side block **62** substantially along its longitudinal centerline, similar to that previously described. The coolant spray is introduced through the top of each bore **60** by a suitable supply line **64** terminating in a conventional cone nozzle **66** intermediate the open ends of said bore. The liquid coolant is emitted only from the cone nozzle **66** in a generally downward and radially outward direction therefrom.

As hereinbefore described, the top block **68** may be raised or lowered relative to the bottom block **70**, the distance C therebetween defining the height of the casting cavity. In the present embodiment, the supply line **64** and its nozzle **66** are adjusted to extend downwardly for a total distance D from the bottom block that will always be less or substantially equal to the distance C between the top and bottom blocks, **68** and **70**, respectively. The distance D is preferably selected to be about equal to the minimum height casting that is contemplated. In this manner, the coolant emitted from the nozzle **66** will initially impinge the vertical bore **60** below a line corresponding to the lowermost level of the top block **68** and will be carried downward therefrom by gravity to provide the desired cooling effect. It may be seen that the above embodiment will prevent undesirable soaking of the side block in a cooler area in the vicinity of the top block. At the same time, it has been found that the hot areas above the nozzle **66** will be cooled sufficiently by conduction.

In the practice of the invention described herein, it has been found preferably to apply the cooling spray as soon as possible after the pouring operation has been completed and thereafter for a sufficient period of time until the desired lower temperature has been reached. In a typical application, the graphite blocks may reach temperatures in the neighborhood of 1000° to 1,200° F., and preferably the cooling process is applied within the blocks until the temperature thereof has been reduced to about from 300° to 700° F., in order that successive slabs or castings may be poured in a relatively rapid order.

What I claim is:

1. A method of cooling a slab casting mold having opposed graphite side blocks, and a plurality of inner blocks engaged between said side blocks to define a casting cavity therebetween for the reception of molten metal, a plurality of substantially vertical bores through each side block, and means for spraying liquid coolant within said bores, said process comprising filling said casting cavity with molten metal in the absence of liquid coolant spraying and thereafter applying said liquid coolant spray until said side blocks have reached a desired lower temperature.

2. Apparatus for cooling a graphite block used in a mold assembly including a pair of opposed side blocks, and a top, bottom and end graphite blocks engaged between the side blocks to define therewith a casting cavity, said top block to define therewith a casting cavity, said top block being movable up and down upon separation of said side blocks to define a casting cavity of variable heights, said apparatus comprising a plurality of vertical bores extending through each side block and open at their upper and lower ends, a liquid coolant supply line extending downward from the top of at least one of said bores to a point intermediate the height thereof, means external of said side blocks for supplying liquid coolant to each of said lines, a spray nozzle connected to the end of each of said lines within said bore, said nozzle being so positioned and constructed as to cause a spray of liquid coolant to be directed toward and impinge said bore in an area below a line corresponding to the lowermost position of said top block.

3. Apparatus for cooling a mold having a graphite block comprising a plurality of bores in said block extending from the top to the bottom thereof, a pipe extending within and along at least a portion of the length of a plurality of said bores, a plurality of transverse slits along the length of each pipe, said slits extending around less than half the circumference of the pipe, and means for supplying liquid coolant to said pipes.

4. A method for cooling a mold having a graphite block, which comprises providing a plurality of substantially vertical bores in the block and spraying coolant along spaced intervals within each bore.

5. The method of claim 1 wherein the bores are provided along the longitudinal centerline of said block.