

March 19, 1968

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3,373,793

APPARATUS FOR SELECTIVELY COOLING METAL MOLDS

Filed May 2, 1966

2 Sheets-Sheet 1

FIG. 1

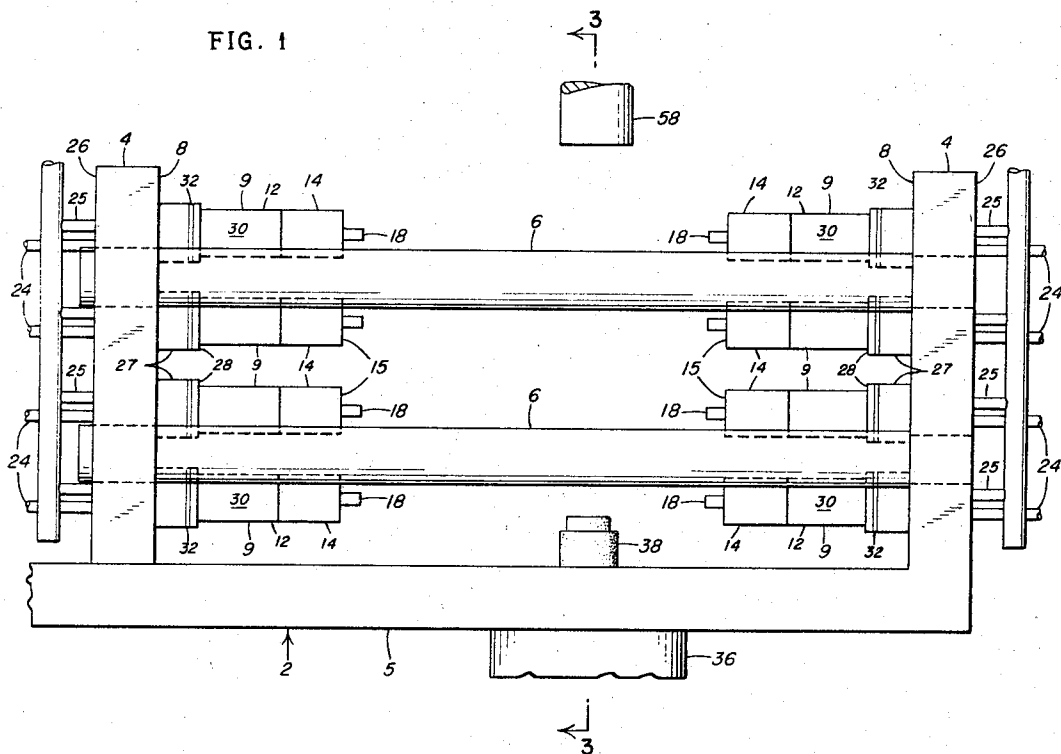
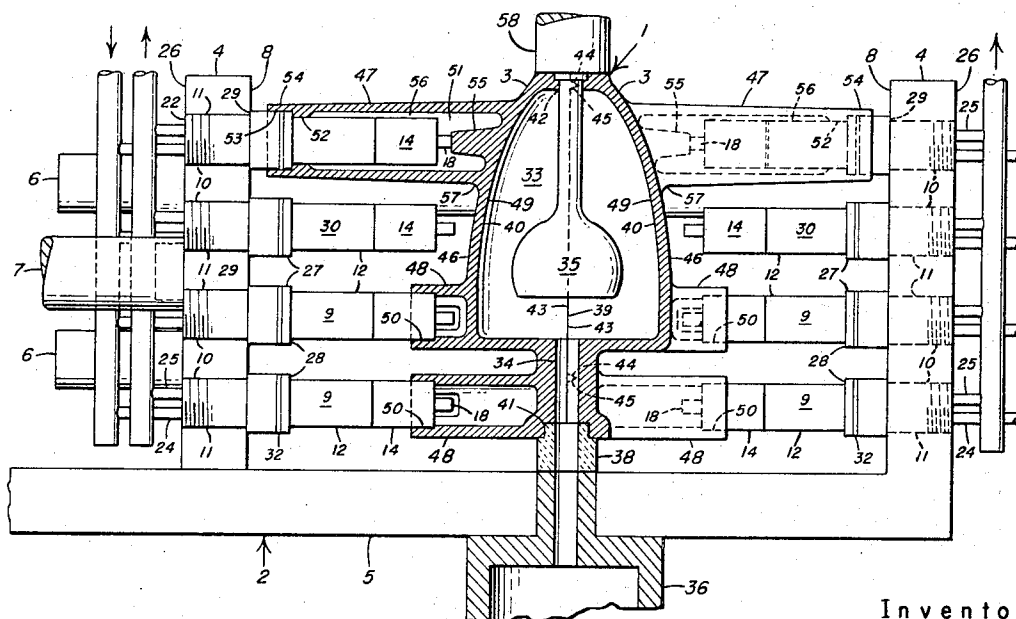


FIG. 2

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FIG. 3

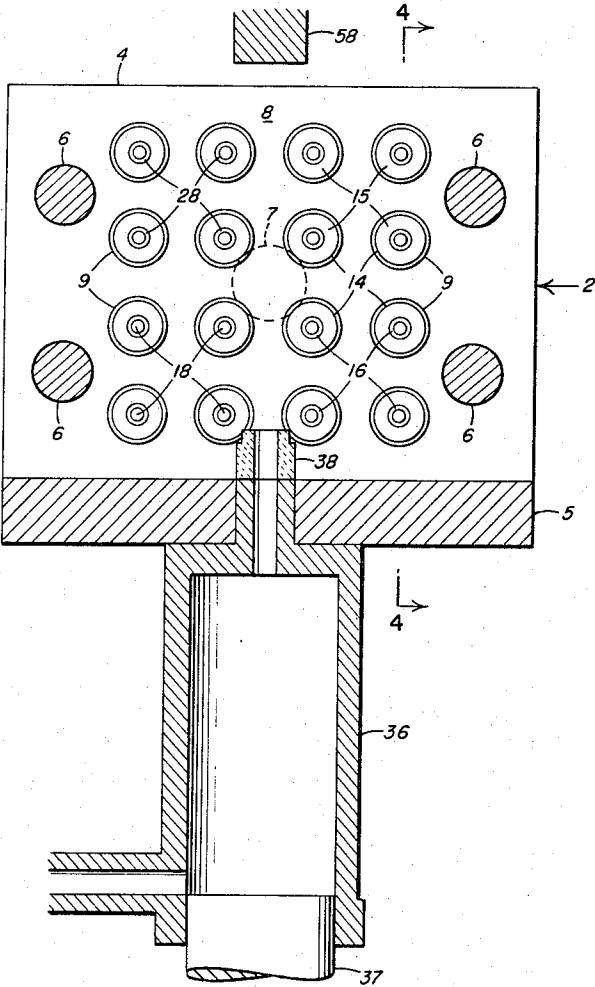
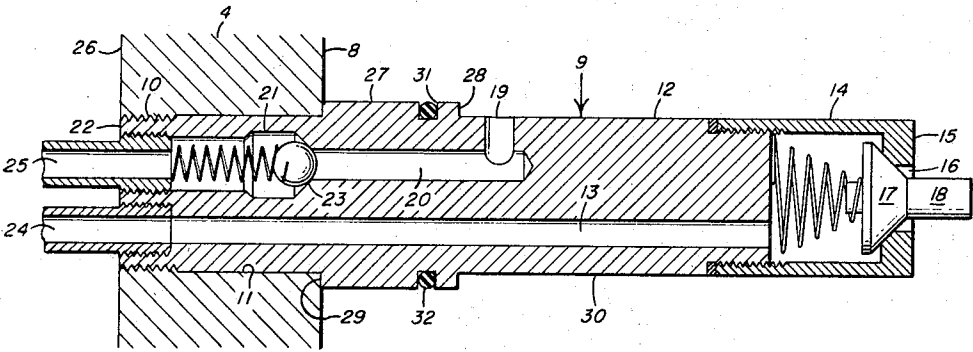


FIG. 4



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APPARATUS FOR SELECTIVELY COOLING METAL MOLDS

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Continuation-in-part of application Ser. No. 444,459, Mar. 31, 1965. This application May 2, 1966, Ser. No. 546,992

10 Claims. (Cl. 164—341)

ABSTRACT OF THE DISCLOSURE

Casting apparatus having relatively movable mold holders and expendable metal molds, a number of laterally spaced nozzles in an arrangement on each holder and sockets on the back of each mold each for releasably seating a nozzle, the socket on each mold being predetermined in number and relation relative to the nozzles on the related holder for selectively seating certain thereof and cooperating with the certain nozzles for holding the mold on the holder and cooling an area of the mold determined by the relation during the casting operation.

This invention relates to apparatus for casting and particularly die casting metals in metal molds. This application is a continuation-in-part of my copending application Ser. No. 444,459, filed Mar. 31, 1965 now U.S. Patent No. 3,258,818, issued July 5, 1966.

The above copending application discloses a method of casting a run of metal castings in metal molds in a plurality of casting operations in which one of a plurality of usually identical molds is used and expended in each operation. While applicable generally to the casting of metals in metal molds, the method is particularly adapted for casting high melting metals, such as the ferrous metals, brass and bronze, in molds made of relatively low melting metals, such as aluminum and its alloys, and has the salutary effect of freeing the run of casting from dependency for preciseness on the life of a single mold. To be usable in the method, the metal mold must be of such thermal diffusivity and mass as to maintain its integrity to the point of freezing to shape of the metal cast therein.

The method especially lends itself to die casting in which the metal being cast is injected under pressure into the metal mold and in such use it is desirable that the molds themselves be die castable, so that they can be supplied at the rate at which they are expended and thus make it unnecessary to start the run with a large stock of molds on hand. Aluminum and its alloys, termed generally "aluminum," are mentioned in the copending application as particularly suited for use as the mold metal in die casting metals according to the method, in combining high thermal diffusivity and ready die castability in permanent metal molds with inertness to ferrous and other high melting metals.

As explained in the above application, the expendable metal mold, to maintain its integrity to the point of freezing to shape of the cast metal, must have sufficient mass to absorb the heat of the cast metal unless provision is made for rapid dissipation of heat during the casting operation by the forced circulation of water or other suitable cooling medium. Dependence solely upon the mass of the expendable metal mold to dissipate the heat of the cast metal, while effective, can prove uneconomical for casting large or complex-shaped castings in correspondingly complicating both the casting of the expendable molds and the preferred reuse of the mold metal. A further complication is the need in numerous instances

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to cool different areas of the cast metal at different rates to prevent such occurrences as cold shuts or the forming of shrinkage cavities. It is with these complications that the present invention is concerned.

The primary object of the present invention is to provide apparatus for casting metals in expendable metal molds whereby by selective forced circulation of a cooling medium, not only is the mass of the expendable mold minimized but different areas of the mold can be cooled at different rates.

Another object of the invention is to provide apparatus for casting metals in expendable metal molds wherein the molds expended in a run of castings are each held during a casting operation by the same permanent mold holder and the expendable molds and holder are of such arrangement and construction as to permit the forced circulation of a cooling medium over any selected area of a mold during its casting operation, while ensuring that the mold is securely held.

A further object of the invention is to provide in apparatus for casting metals in expendable metal molds a master mold holder which is adapted by suitably configuring a confronting surface of a mold to both hold and selectively cool molds of a wide range of sizes and cooling requirements.

An additional object of the invention is to provide in apparatus for casting metals in expendable metal molds a master mold holder having on its mold-confronting face a plurality of nozzles of such arrangement and construction as by suitably configuring the confronting face of a mold, to enable any nozzle to be inactive or act as a support or a coolant supplier or both, depending on the requirements of the particular mold.

Other objects and advantages of the invention will appear hereinafter in the detailed description, be particularly pointed out in the appended claims and be illustrated in the accompanying drawings, in which:

FIGURE 1 is a side elevational view of a preferred embodiment of the improved apparatus of the present invention for casting metals in metal molds, with the holder separated and mold removed;

FIGURE 2 is a vertical sectional view, in part central, taken longitudinally of the improved apparatus with a mold in place and the parts in position for a casting operation;

FIGURE 3 is a vertical sectional view taken along lines 3—3 of FIGURE 1; and

FIGURE 4 is a fragmentary vertical sectional view on an enlarged scale taken along line 4—4 of FIGURE 3.

Referring now in detail to the drawings in which like reference characters designate like parts, the improved apparatus of the present invention for casting metal in expendable metal molds following the method of my copending application Ser. No. 444,459, while adapted for gravity casting, is particularly designed for die casting and will be so described as exemplary of the invention.

As applied to die casting, the improved metal casting apparatus is comprised of a split or plural-part mold or die 1 and a plural-part holder or clamp 2 for holding and clamping together the parts 3 of the mold or die during a casting operation. The holder 2 is formed of a pair or plurality of parts, holder members of jaws 4, each for holding or supporting one of the parts 3 of the mold 1. The holder parts 4 are separable for insertion of the mold 1 at the beginning and removable of both the mold and the casting cast in it at the end of a casting operation. In the preferred holder 2, the holder parts 4 are a pair of relatively reciprocable platens or blocks, one fixed or stationary and mounted on a suitable base 5 and the other movable and mounted for horizontal sliding or relative reciprocation along the base on guide rods 6 fixed to the

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stationary platen. So mounted, the platens 4 not only are maintained in correct longitudinal alignment but can be relatively reciprocated and made to apply the required clamping pressure to the mold 1 during casting by suitable means, such as a fluid-actuated piston 7, acting on the movable platen. While the illustrated horizontal reciprocability of the platens 4 will usually be more satisfactory, they can be mounted for vertical reciprocability if vertical opening and closing of the mold 1 is desired.

Although not limited in their shape, the platens 4 have been shown as generally rectangular blocks having substantially flat inner or confronting faces 8. Depending on the form of the mold 1, at least one and preferably each of the platens 4 carries or mounts on its inner face 8 a plurality of laterally spaced nozzles 9 projecting, extending or instanding from and substantially normal to that face toward the confronting inner face of the other platen. Preferably identical and disposed parallel to each other, the nozzles 9 of each platen 4 may be arranged in any desired pattern over the face, those shown being equidistantly spaced and arranged in a rectangular pattern or grid of straight parallel horizontal and vertical rows intersecting at right angles. To facilitate maintenance, the several nozzles 9 desirably are removably mounted on their respective platens 4, as by providing each with an externally threaded shank 10 screwed or threaded into one of a plurality of correspondingly arranged, internally threaded apertures or openings 11 in and extending through each platen normal to the latter's inner face 8.

Each of the illustrated nozzles 8 serves as a combined inlet or injector and outlet or drain for the water or other cooling medium it applies. To this end each nozzle has extending longitudinally through its body 12 a coolant inlet passage 13 opening forwardly into a cap 14 screwed onto the inner or front end of the body and having in its own preferably flat front end 15 an annular central outlet orifice or port 16 normally closed internally by a spring-pressed poppet or like check valve 17 in the cap and having a stem or push pin 18 projecting forwardly through the orifice beyond the cap's front end. Rearwardly or outwardly of the cap 14 a drain port 19 opens radially onto a side of the body 12 and connects inside the body to an outlet passage 20 extending rearwardly therefrom longitudinally of the body to an outlet or drain cavity 21 in and opening onto the rear or outer end 22 of the body. Normally partly plugged at its outer end, the cavity 21 contains a spring-pressed ball or like check valve 23 normally blocking flow between the cavity and the outlet passage 20 and openable in response to a predetermined pressure in the passage. Coolant inlet and outlet lines 24 and 25, respectively, desirably flexible in the case of the movable platen 4, and leading to the outer faces 26 of the platens, are suitably connected to the outer ends of the inlet passage 13 and outlet cavity 21 of each nozzle 9.

At the front end of its shank 10 and rearwardly of the drain port 19, the body 12 of each nozzle 9 has an enlarged cylindrical or annular collar portion 27 bounded at opposite ends by forwardly and rearwardly facing annular shoulders 28 and 29, the latter abutting against or engaging the inner or front face 8 of the related platen 4. Immediately forward of the shoulder 28, the body 12 is stepped inwardly or inset at the side to form with the cap 14 a reduced preferably cylindrical front or neck portion 30 on the nozzle extending from the shoulder to the cap's front end 15. The collar portion 27 is interrupted intermediate its ends by an annular groove 31 seating an O-ring or like gasket 32.

The thermal diffusivity of the platens 4 is unimportant as they do not enter directly into the absorption of the heat from the metal cast in the mold 1. They, therefore, may be made of steel or other material of suitable permanence and rigidity. Since also designed for permanency the nozzles 9 preferably are made of stainless steel, brass or like high melting metal, non-corrodable by the coolant. As opposed to the permanent platens 4 and nozzles 9, the

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mold 1 is expended in a single casting operation and must only be of such thermal diffusivity and mass as to maintain its integrity to the point of freezing to shape of the cast metal. Even so, the mass of the mold can be drastically reduced and the rate at which it dissipates heat over any given area can be varied at will by judicious or selective use of the nozzles 9 in the manner now to be explained.

In accordance with the teaching of my copending application Ser. No. 444,459, the mold 1 can be made of a variety of metals, with aluminum or its alloys, herein termed generally "aluminum," the preferred mold metal for casting at least the ferrous metals, brass and bronze, as combining high thermal diffusivity and ready die-castability with inertness to such metals. These same properties are also responsible for the preference of aluminum as the mold metal for making the expendable molds 1 of the apparatus of this invention. Depending on the size and shape of the one or more castings to be produced in a particular run, each expendable mold 1 may have the illustrated single mold cavity 33 fed through a gate 34 or a plurality of cavities connected by branch gates and there may be in any cavity one or more cores 35, as needed for the shape of the particular casting to be cast therein. In line with conventional practice, the one or main gate 34 will usually be in the bottom or a side of the mold and the mold will have vents (not shown) wherever necessary for escape of air from the mold cavity 33 as the latter is being filled. Too, for injecting the liquid metal under pressure into the mold cavity 33, in the die casting for which the illustrated apparatus is particularly designed, the apparatus will include a charging cylinder 36 for holding a metered quantity of the liquid metal sufficient to fill the mold and a fluid-actuated plunger 37 for injecting the metal from the charging cylinder into the mold. For casting high melting metals, the charging cylinder, if to be permanent, should be heat-insulated from the mold by a ceramic sleeve 38.

Separable along a parting line indicated at 39, the mold parts 3 will each have impressed or formed in its face 40 its portion of the mold cavity 33, gate 34 or, as in this case, the opening 41 seating the insulating sleeve 38, and any other indentations, such as the core print 42. Also, the faces 40 may have formed in or on them on their contacting surfaces 43 beyond the mold cavity aligning pins and sockets 44 and 45 for aligning the mold parts when the mold is closed.

Conventional in their faces 40, the mold parts 3 depart from convention in their backs 46 to adapt them to be held or mounted on and selectively cooled by coolant from the nozzles 9. A mold part 3 seldom will need to use all of the nozzles 9 with which the adjoining or associated master platen 4 is fitted for either cooling or clamping and positioning. But it can use whatever nozzles it needs for either or both purposes by forming on its back 46 one or more cooling sleeves 47 and clamping and positioning ribs 48, each integral with and projecting rearwardly from the wall 49 of the mold part and located or positioned to engage or receive one of the nozzles 9. For satisfactory clamping and positioning, each mold part should have a total of at least three and preferably four sleeve or sleeves 47 and rib or ribs 48 and the sleeves and/or ribs should be so staggered or spread that the clamping pressure applied through the nozzles will be substantially uniformly distributed over the contacting surfaces 43 of the faces 40.

Projecting or extending rearwardly or inwardly from the back 46 of the related mold part 3 substantially normal to the inner face 8 of the adjoining associated or related platen 4, each of the cooling sleeves 47 and positioning ribs 48 is a socketed member adapted to be slid onto an axially aligned nozzle during mounting or placement of the mold part on the platen. Each rib 48 has a rearwardly opening cylindrical socket 50 of a diameter and depth to slidably receive or seat the front part of the cap 14 of the aligned nozzle 9, the latter in such case

serving simply as a mounting post by which the mold part is held against rearward and lateral movement. Each cooling sleeve 47 also has a rearwardly opening cylindrical socket or pocket 51 but its socket is deeper and adapted substantially fully to contain or receive the aligned nozzle.

A sliding fit between the rear or outer end portion of the sleeve and the intermediate or collar portion 30 of the nozzle and end abutment or engagement between the forwardly facing shoulder 28 at the front of the collar portion 27 on the nozzle and a rearwardly facing instanding annular abutment, stop or shoulder 52 longitudinally interrupting the socket 51 and forming a cylindrical seat 53 therein forwardly of the sleeve's rear or outer end 54, enable that nozzle, as well, to act as a mounting post. However, to use its nozzle for cooling as well as for mounting, the sleeve has its sliding joint with its nozzle sealed by the O-ring 32 and has in the front end of its socket 51 a central rearwardly projecting lug or abutment 55 aligned with and engageable or contactable by the stem 18 of the valve 17 for opening that valve as the nozzle is seated. To prevent leakage, the longitudinal spacing between the rear end 54 of the sleeve 47 and the O-ring 32 preferably is such as to seal the joint between the sleeve and nozzle before the valve 17 is displaced or opened by contact of its stem 18 with the valve-displacing or opening lug 55.

The front portion 30 of the nozzle 9 forwardly of the collar portion 27 is both shorter and of less diameter than the portion of the socket 51 forwardly of the abutment 52 in which it is contained. Consequently, when the nozzle is seated in the sleeve 47, coolant from the inlet line 24 is injected through the orifice 16 against the back 46 of the mold part 3 and flows through a sealed annular passage 56 between the nozzle and the sleeve to the drain port 19. Once the pressure in the sleeve has built up to the point at which the check valve 23 is predetermined to open, the coolant will flow at that pressure between the inlet and outlet lines 24 and 25 until the mold part is removed. In process, the coolant, during a casting operation, will cool the area of the mold part 3 adjoining the base or inner end 57 of the sleeve by absorbing or conducting heat from the surface of the mold part contained by the sleeve, including the presented or exposed portions not only of the wall 49 but also of the lug 55 and the sleeve itself.

Selectively area or spot coolable, as predetermined by the placement of the cooling sleeve or sleeves 47, and at a rate determinable or controllable for a particular coolant by its flow rate, inlet temperature and the surface area of the mold metal exposed to it, the expendable molds 1 of the apparatus of this invention need far less mass and permit far greater flexibility in design than an expendable mold that must depend on its own mass for absorbing the heat to the point of freezing to shape of the metal cast therein. Too, the multiple point support afforded by the multiplicity of nozzles 9 on which one or each mold part 3 is mounted, ordinarily will enable a sufficient pressure to be applied through the fluid-actuated piston 7 acting on the or either movable platen 4 to hold the mold parts 3 together during a casting operation against the internal pressure exerted by the liquid metal injected into the mold cavity 33. However, if desired, or required in a particular case, the clamping pressure exercisable on the mold 1 through the platens 4 may be supplemented by one or more auxiliary clamps. Thus, when, as in the illustrated embodiment, the liquid metal is injected into the bottom of the mold 1, the apparatus may include an auxiliary, preferably fluid-actuated clamp 58 disposed to apply a downward vertical force on the top of the mold in opposition to the upward force of the injected metal.

In performing a casting operation on the apparatus of this invention, the platens 4 will initially be separated sufficiently to receive the parts 3 of the mold 1. Preformed to the desired shape on both faces 39 and backs 45, the

mold parts 3 will be mounted on their respective platens by sliding their cooling sleeve or sleeves 47 and locating rib or ribs 48 onto the aligned nozzles 9 to the point at which the nozzles are seated. Any core 35 and insulating sleeve 38 then is positioned in one of the mold parts 3, usually the stationary part, and pressure is applied to the clamping piston 7 to bring the parts together. Any auxiliary clamp 58 is next clamped against the mold 1, whereupon the liquid metal is injected into the cavity 33 by actuation of the plunger 37. After a predetermined interval, which in any case will be sufficient for the cast metal to freeze to shape, the auxiliary clamp 58 will be retracted and the mold parts 3 separated, the latter by actuation of the piston 9 to retract the platens 4 to their initial position. Finally, the casting and the mold parts will be removed, the former for any necessary finishing and the latter preferably for melting and reuse in making further molds.

From the above detailed description, it will be apparent that there has been provided an improved apparatus for casting metals in expendable metal molds in which one or either mold part is held in and selectively cooled by a master mold holder adapted for use with a wide variety of molds. It should be understood that the described and disclosed embodiment is merely exemplary of the invention and that all modifications are intended to be included that do not depart from the spirit of the invention and the scope of the appended claims.

Having described my invention, I claim:

1. Apparatus for casting metals in expendable metal molds, comprising holder means, a number of laterally spaced nozzles in an arrangement on said holder means and each connected to a source of coolant, expendable mold means, and socketed means on said mold means each for releasably seating and receiving fluid from one of said nozzles, said socketed means being predetermined in number and arrangement relative to said nozzles for seating certain thereof and cooperating with said certain nozzles to hold said mold means on said holder means and cool a selected area of said mold means determined by said relative number and arrangement during a casting operation.

2. Apparatus according to claim 1 for die casting metals in expendable metal molds, including means for applying clamping pressure through the holder means and at least some of the certain nozzles to the mold means during the casting operation.

3. Apparatus according to claim 2, wherein the holder means is a permanent master mold holder, the nozzles are of the same type, the expendable mold means are a plurality of molds each holdable on said holder and expendable in a single casting operation, there are on each mold a plurality of laterally spaced socketed means of any of a plurality of types, and the number, types and positions of the socketed means on each mold are predetermined to enable the mold holder to hold and selectively cool any of said plurality of different molds.

4. Apparatus according to claim 3, wherein each mold and its socketed means are in integral die casting.

5. Apparatus according to claim 3, wherein each nozzle includes spaced port means for injecting and draining coolant respectively into and from socketed means of one type on the mold means.

6. Apparatus according to claim 5, wherein the spaced port means of each nozzle are spaced inlet and outlet ports connected therethrough respectively to coolant inlet and outlet lines, each nozzle has valve means normally closing said inlet port, the one type of socketed means is a cooling sleeve seating in a socket therein one of said nozzles and containing said ports of said nozzle in said socket, said sleeve sealingly engages said nozzle rearwardly of said ports, and said socket contains means positioned to act on said valve and open said inlet port for flow of coolant between said ports on seating of said nozzle therein.

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7. Apparatus according to claim 6, wherein another type of socketed means is a positioning rib having a socket for seating an end of one of said nozzles without opening the inlet port thereof.

8. Apparatus according to claim 6, wherein the outlet port of each nozzle is normally closed by a check valve openable under a predetermined pressure for controlling the pressure at which the coolant will flow through the socket between the ports.

9. The apparatus according to claim 2, wherein the holder means are a pair of separable platens, each expendable mold is formed of separable parts, the laterally spaced nozzles are mounted on an inner face of at least one of the platens, and the socketed means are formed on at least one mold part and cooperate with certain of the nozzles for holding the mold part on the platen and cool-

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ing a selected area of the mold part during a casting operation.

10. Apparatus according to claim 9, wherein the platens are relatively reciprocable by fluid-actuated means and clamping pressure on the mold parts during a casting operation is applied by said fluid-actuated means through the platens and at least some of the certain nozzles.

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