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Pondelicek et al.

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[54] **APPARATUS FOR LUBRICATING A DIE STRUCTURE EMPLOYED IN DIE CASTING OPERATIONS**

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[52] **U.S. Cl.** **164/312,** 164/72

[51] **Int. Cl.** **B22d 17/10**

[58] **Field of Search** ..... 164/303, 306, 312, 164/317, 72, 267, 347; 425/90, 94, 95, DIG. 115, 98, 107; 184/7 D; 264/39, 329, 338

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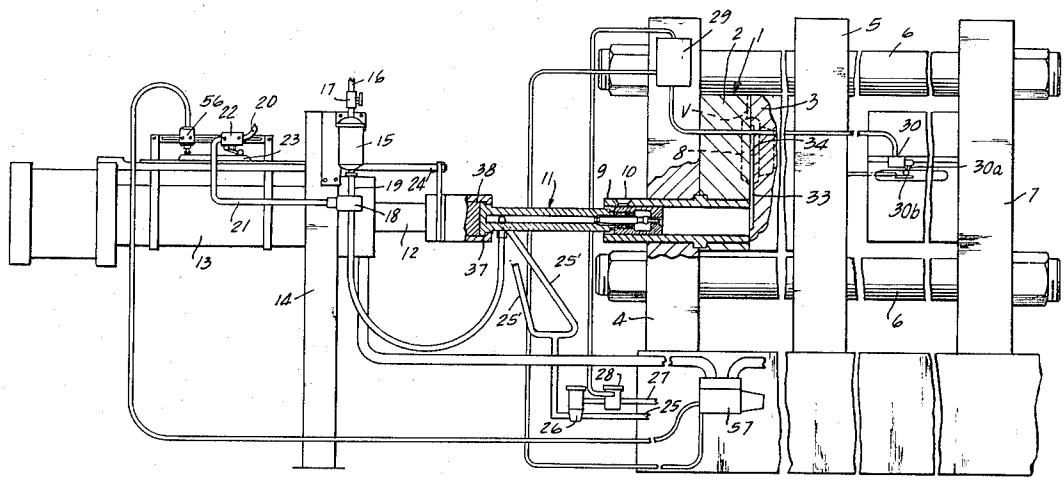
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[57] **ABSTRACT**

An apparatus for lubricating a die structure employed in die casting operations, and die therefore, whereby a quantity of lubricant is injected under gas pressure into the die cavity, and in which the plunger runs of the die casting machine is provided with a chamber for receiving the die lubricant, which chamber communicates with the inner end of the plunger and thus through the metal supply shot sleeve with the die cavity, the lubricant being discharged from the plunger by gas under pressure into the die cavity, with the apparatus being constructed to effect discharge of lubricant into the die cavity when the members of the die are in a closed position, and the plunger is in a position blocking the pour hole in the shot sleeve.

5 Claims, 3 Drawing Figures



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SHEET 1 OF 2

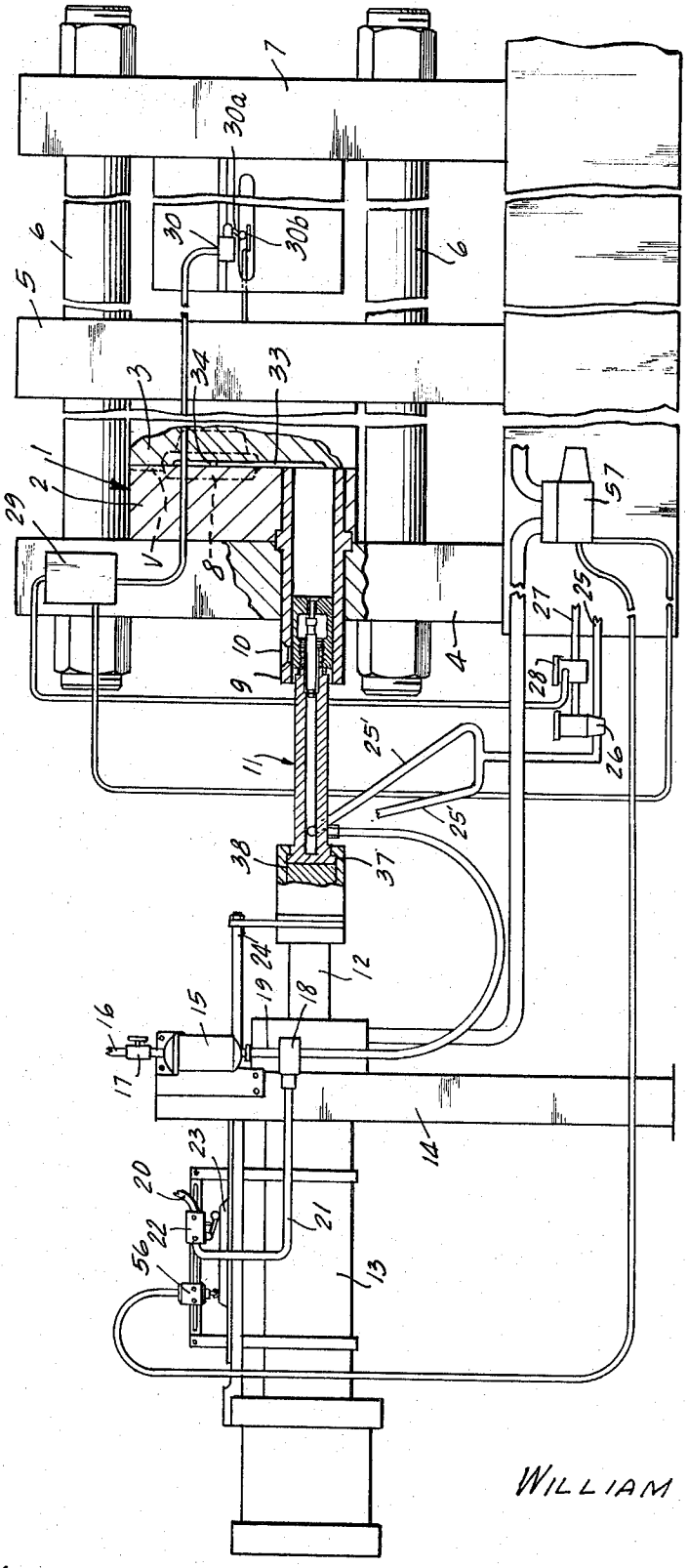


Fig. 1

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Fig. 2

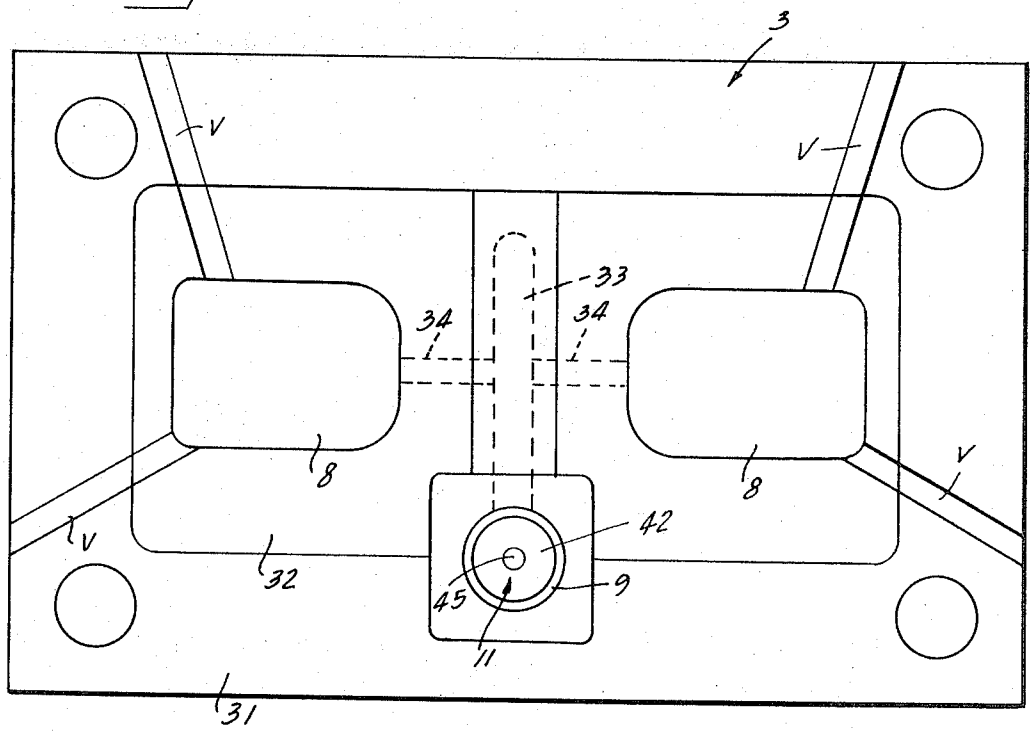
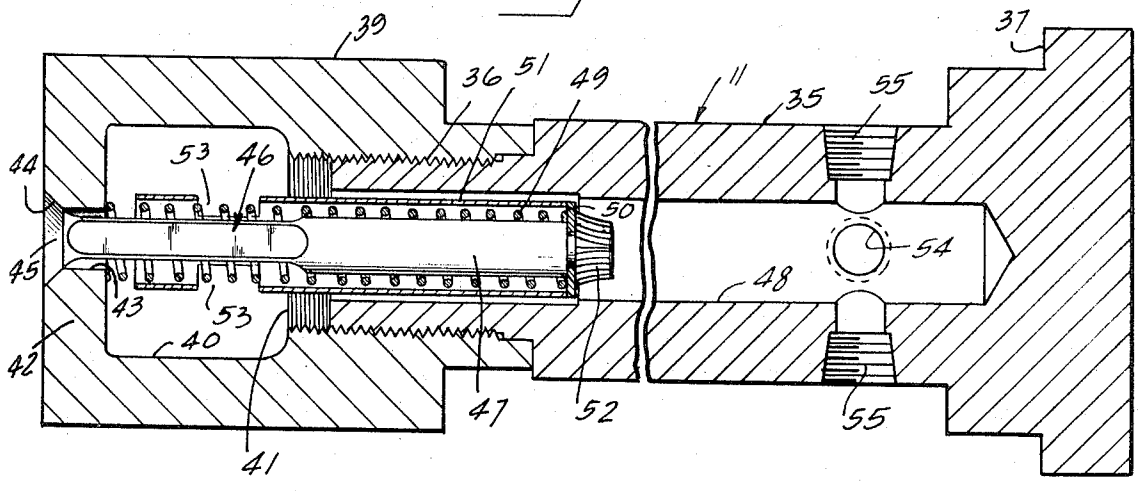


Fig. 3



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APPARATUS FOR LUBRICATING A DIE STRUCTURE EMPLOYED IN DIE CASTING OPERATIONS

BACKGROUND OF THE INVENTION

The present invention is directed to an improved construction for carrying out the method described in our prior copending application, Ser. No. 13,289, filed Feb. 24, 1970, now U.S. Pat. No. 3,645,319.

As pointed out in said copending application, it is common practice in the use of die casting equipment to attempt to apply a suitable lubricant to the surfaces defining the die cavity, thereby increasing the efficiency of the apparatus by a reduction in rejects and improvement in the ultimate casting of aluminum or other metal.

Prior to our method it had been common practice in the past for an operator to spray a solution of a lubricant onto the cavity surfaces of the open die structure between each die casting operation. Obviously no accurate control could be maintained over the amount of lubricant utilized or was there any way of governing the deposit and retention of the lubricant on the die surface. Invariably in such cases, an excessive amount of lubricant, as well as the necessary carrier agent therefor, were employed resulting in not only a waste of lubricant and solvents but the creation of a considerable amount of smoke and air pollution, which in fact is the greatest source of smoke and air pollution around a die casting machine. In the case of aluminum casting, the lubricant may comprise aluminum powder and silicones in a carrier agent as for example water, kerosene, or other suitable hydrocarbon solvents. Tests have indicated that with such types of carrying agents deposition of lubricant in an effectual layer did not take place until the cavity surface is suitably cooled to a temperature below 375° F. However, the chilling of the die considerably increases the possibility of poor casting and porosity, leading to a high reject percentage, and also results in a high thermal gradient in the steel die leading to early die fatigue.

The invention disclosed in our pending application was a method and apparatus for effecting a very efficient lubrication of the die structure with an elimination of the disadvantages of prior practices and proceeded from the direct opposite of prior methods of effecting lubrication when the die members are in open position, and instead effected the coating of the die surfaces following closing of the die members, the method also having the very important advantage of not only effectively lubricating the surfaces of the die cavities but also the effective lubrication of ejector pins as well as any side cores, etc., and where the apparatus was employed in a cold chamber operation efficient lubrication of such sleeve and plunger tip is likewise achieved.

At the same time, there was achieved the distribution of substantially the exact amount of lubricating material necessary to achieve the desired results, the material being directly injected without the use of carrier agents, as in the past, to eliminate much of the smoke and air pollution previously occurring in the use of a die casting machine. As the lubricant is applied to the die surface when the die members are in closed position and no solvents are required, it has been found that efficient coating may be obtained at an optimum operating temperature of the die. Furthermore, as no solvents or other carriers are required and as optimum amounts of lubricant may be employed a considerable reduction in cost of lubrication may be achieved and at the same time eliminate need of additional lubricants for the metal injecting plunger, etc.

However, in such prior apparatus this die member was provided with a chamber or passageway which communicates, preferably through a suitable valve, with the die cavity, means being provided for injecting a measured quantity of lubricant into such chamber or passageway as the die members approach a closed position and then upon closing thereof, a blast of a gas, for example air, was discharged, under pressure, into such chamber or cavity whereby the lubricant was expelled in a substantially completely vaporized form into the die cavity, reaching all surfaces of the latter, under the action of the gas pressure, as well as the ejector pins and the shot sleeve and plunger structure etc.

Consequently, in addition to providing the die casting machine with means responsive to closing movement between the platens of the machine to actuate the lubricant injection mechanism as well as control the gas discharge operative to transport the lubricant into the die cavity, a special die construction was required in the apparatus illustrated in said prior application.

BRIEF SUMMARY OF THE INVENTION

The present invention eliminates the disadvantages of the previous apparatus, and enables the method involved to be practiced with substantially any type of die structure having adequate venting provisions, enabling the practice of the method with substantially standard type dies, at the most, providing somewhat enlarged vent holes if not initially adequate for the purposes.

The desired results are achieved in the present invention by providing the plunger ram or piston of the die casting machine with a chamber for receiving the die lubricant which is expelled through a valve in the inner end of the plunger ram at the proper time into the die by means of air under pressure, such injection taking place when the die is closed and the plunger ram is in a position to block the pour hole in the shot sleeve through which metal is supplied to the die. Both the plunger actuating mechanism and the die closing mechanism are suitably provided with means for actuating switches and valve means for controlling the desired positioning of the die members, plunger ram and discharge of the lubricant under air pressure into the die structure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like reference characters indicate like or corresponding parts:

FIG. 1 is a side elevational view of a die casting machine with portions of the plunger ram and shot sleeve illustrated in section;

FIG. 2 is an elevational view of the die section such as illustrated in FIG. 1, together with the shot sleeve etc; and

FIG. 3 is an enlarged longitudinal section of the plunger ram illustrating details thereof.

DETAILED DESCRIPTION OF THE INVENTION

THE GENERAL APPARATUS

Referring to FIG. 1, the reference numeral 1 designates a die structure, illustrated as being of relatively simple form and comprising a pair of die members 2

and 3, the stationary die member 2 being carried by a stationary platen 4 rigidly mounted on the bed of the machine, and the ejector die member 3 (only partially shown) being rigidly carried by a movable platen 5 slidable on a plurality of guide rods 6 supported at one end in the stationary platen 4 and at their opposite ends in a stationary support member 7. The movable platen 5 is adapted to be moved toward and away from the stationary platen, and thus separate or close the die members 2 and 3, by suitable mechanism, not illustrated, forming a part of the standard die casting machine, the details of which form no part of the present invention.

The die members 2 and 3 are adapted to cooperate to define a die cavity 8, a portion of which is illustrated in FIGS. 2 and 3, with suitable communication being provided between such die cavity and a shot sleeve indicated generally by the numeral 9, the sleeve having an opening 10 therein communicating with the interior of the sleeve and thus with the die cavity, a suitable hollow piston or plunger 11, being reciprocably movable in the sleeve by means of a reciprocable rod 12, reciprocable in a hydraulic cylinder 13. In operation of the mechanism thus far described, the arrangement will normally be such with respect to the metal supply system of the die casting machine that the pour hole 10 in the shot sleeve is open to the atmosphere when the rod 12 and thus the plunger 11 carried thereby is in its extreme left-hand position, as viewed in FIG. 1 (in which the piston is illustrated in an intermediate position). At the proper time the molten aluminum or other metal is supplied to the shot sleeve through the opening 10, and the rod 12 and plunger 11 associated therewith moved toward the right as viewed in FIG. 1 to inject the metal into the die cavity, the initial movement of the plunger closing the opening 10 (as illustrated in FIG. 1). In this type of casting operation the amount of metal will likewise normally be proportioned to ensure complete filling of the die cavity with a minimum of excess metal.

In the embodiment of the invention illustrated, mounted on the stationary upright 14 is a lubricant container 15 adapted to contain a supply of die lubricant under pressure, suitably supplied for example, by an air line 16, controlled by a suitable reducing valve 17. Carried by the stationary upright 14 is a lubricant-metering device 18, the inlet side of which communicates with the reservoir 15 through a supply conduit 19. The device 18 illustrated is adapted to be operated by air pressure supplied thereto from a supply line 20 which is connected to the device 18 by a conduit 21 through a control valve 22. The valve 22 is adapted to be actuated by a cam 23, carried by an arm 24, movable with the piston rod 12 and plunger 11 which is adapted to actuate the valve 22 in the withdrawing direction of the plunger or piston i.e., from right to left as viewed in FIG. 1.

As hereinafter described in detail, a lubricant is initially injected into the hollow plunger 11 and subsequently exhausted into the die cavity by means of air pressure through a supply line 25 under control of a pilot operated valve 26 which is adapted to be pneumatically actuated by air from a supply line 27 under control of an electrically operating valve 28 actuated by a timer 29 which in turn is adapted to be actuated by a switch 30 having an actuating arm 30*a* engageable with an elongated cam member 30*b* carried by the movable platen 5.

The valve 28 and timer 29 are of commercially procurable construction with the valve structure 26 being pneumatically opened and automatically closed after a predetermined time interval. Thus, upon operational engagement of the cam member 30*b* with the arm 30*a* to actuate the switch 30, the valve 28 is opened to supply actuating air to the valve 26, opening the same and permitting air from the conduit 25 to enter the die and thereby exhaust vaporized lubricant, discharged from the metering device 18 into the plunger 11. At this point in the operation the actuating rod 12 and plunger associated therewith are in a position to close the pour hole 10 whereby the lubricant and air will be exhausted into the die cavities and not through the hole 10.

Thus, following each stroke of the piston in closing direction, as the piston, moving in return direction (from right to left), the switch 22 will be actuated to actuate the metering device 18 and insert lubricant into the plunger 11. Likewise, each time the platen 5 and the die member 3 carried thereby are moved from open position in a closing direction (to the left as viewed in FIG. 1), as the die member 3 reaches a closed position with the die member 2, the switch 30 will be actuated by the cam 30*b* to supply actuating air to the interior of the plunger 11 to produce an air discharge into the die cavity and inject the desired quantity of lubricant into the die structure, any air pressure being relieved through the air vents V in the die structure. Following this operation the plunger 11 is returned to its extreme withdrawn position and a measured quantity of molten metal introduced into the shot sleeve 9. The rod 12 and associated plunger 11 are then actuated to the right to force the metal into the die structure. The movable platen 5 is subsequently actuated to open the die, permit removal of the casting and the initiation of a new cycle.

THE DIE STRUCTURE

In the particular construction illustrated in FIG. 2 the die member 2 comprises a base or block 31 and an insert 32 having the die cavities 8 associated therewith, connected with the adjacent end of the shot sleeve 9 by a main runner 33 and two branch runners 34, formed in the die member 3, the location of which are illustrated in dotted lines in FIG. 2. The air vents V in the die member 2 are of a size and in number to insure adequate venting for the air discharge and effective lubrication of the die structure.

THE PLUNGER STRUCTURE

The plunger or piston 11 is illustrated in detail in FIG. 3, and comprises a shank portion 35, provided at its inner end, disposed within the shot sleeve 10, with external threads 36 and at its opposite end with an outwardly directed annular flange 37 by means of which the plunger may be operatively mounted on the end of the rod 12, as for example by means of a locking collar or ring 38 suitably rigidly secured to the end structure of the rod 12. The operating end of the piston or plunger 11 is formed by a hollow cylindrical head member 39 having a chamber 40 therein and is provided with a bore 41 having internal threads cooperable with the threads 36 on the adjacent end of the shank member 35.

The transverse wall 42 of the head member 39, forming the inner end wall of the plunger 11, is provided with an axially extending bore 43 therein which, in the

embodiment of the invention illustrated, terminates at its outer end in an outwardly flaring valve seat 44 for cooperation with the head 45 of a valve member, indicated generally by the numeral 46, having a stem portion 47 extending inwardly from the head 45, with the stem 47 extending into the coaxially extending bore 48 of the hollow shank member 35.

The valve member 46 is adapted to be retained in operative, normally closed position by means of a compression spring 49 encircling the stem 47 and having one end bearing on the end wall 42 and its opposite end seated on the adjacent end wall 50 of a sleeve member 51 which encircles the spring 49 to eliminate possible engagement of the coils thereof with the shank member 35. The sleeve 51 is secured to the adjacent free end of the stem 47 by any suitable means as for example swedging the extreme end of the rod as indicated at 52. In the embodiment illustrated, the sleeve 51 terminates in spaced relation with respect to the end wall 42 and thus limits the travel of the valve member 46 in opening direction. The sleeve also may be provided with radially disposed openings 53 therein to insure adequate air and lubricant flow through the bore 43, even if the sleeve 51 is in engagement with the end wall 42.

The shank member 35 is provided with a threaded bore 54 for reception of a suitable hose coupling by means of which lubricant may be injected from the reservoir 15 into the bore 48 for subsequent discharge into the die cavity. The shank member 35 is also provided with a pair of threaded bores 55 by means of which the air lines 25' may be operatively connected to the bore 48 for the discharge of the air therein and along with the lubricant discharged through the bore 43 into the shot sleeve 9 and the cavity of the die 1.

OPERATION OF THE APPARATUS

The overall operation of the apparatus illustrated in the drawings is as follows:

Assuming that the die members 2 and 3 are in closed position and the die cavity has been filled with metal, upon solidification of the metal, as determined, for example by a suitable time lapse, the movable platen 5 is brought into a position opening the die structure to permit the casting to be removed therefrom.

A new cycle is initiated by actuation of the switch 30 responsive to such opening movement of the platen 5, thereby initiating actuation of the timer 29. Responsive to actuation of the latter, the plunger 11 is moved in a withdrawing direction (to the left as viewed in FIG. 1), under the control of the four-way hydraulic valve 56, suitably controlling the operation of hydraulic cylinder 13 to position the plunger 11 at an intermediate point of its withdrawing stroke, whereby the pour opening 10 in the shot sleeve 9 is closed by the head 39 of the plunger. During such withdrawal travel of the plunger 11, the cam member 23, movable therewith, will actuate the switch 22 to operate the metering device 18 and inject a supply of lubricant into the bore 48 of the plunger.

In the embodiment illustrated, the control of the hydraulic cylinder 13 and stopping of the plunger 11 in the position illustrated in FIG. 1, may be effected by a limit switch 56 actuable by the cam 23 when the plunger reaches the desired point on its withdrawal travel, actuating the four-way hydraulic valve 57 to discontinue operation of the hydraulic cylinder 13.

The timer 29 is operable to actuate the electrical valve 28 which in turn will result in actuation of the valve 26, permitting air under pressure to be discharged through the lines 25' into the bore 48, resulting in opening of the valve member 46 whereby the discharged air will literally vaporize the lubricant ejected into the die cavity and distribute the same quite uniformly over the entire surface of the die cavity as well as on the ejector pins and in the shot sleeve 9, with the air pressure being relieved through the ports V. Upon completion of this operation, the timer is operative to actuate the four-way valve to effect withdrawal of the plunger 11 to its extreme outward position, uncovering the pour hole 10, followed by the admission of molten metal therethrough into the shot sleeve. The plunger 11 is then actuated under control of control apparatus usually associated with die casting equipment, whereby the molten metal is forced into the die cavity. Following solidification of the molten metal, the cycle is repeated.

It will be appreciated that the amount of lubricant, as well as the pressure and volume of air, as determined by the timer associated with the pilot valve, will vary with the size and shape of the die cavity and number of cavities, if more than one, and any one skilled in the art will readily be able to determine the desired amount of lubricant and operating values suitable to achieve optimum operation in any particular application. Thus, the amount of lubricant preferably should be reduced to merely that necessary to provide adequate lubrication, as heretofore discussed, with the pressure and volume of air employed being so selected that it is sufficient to insure efficient vaporization of the lubricant and transportation and deposition thereof on all the desired surfaces. It would appear that for most applications the air pressure may range between 40 and 150 lbs. with the timer maintaining the air pressure for a duration of from 3 to 10 seconds. While the amount of lubricant will of course vary with the size and shape of the die, i.e., the surface area involved, the amount of lubricant will also depend upon specific lubricant employed and the desired extent or thickness of the lubricant on the die surface. This can be readily determined by the operator, starting with an amount of lubricant approximately equivalent to the effective amount of lubricant previously employed in a spraying process or the like.

It will be apparent from the above disclosure that the present invention simultaneously substantially eliminates three serious problems in die casting practices, not only providing highly efficient low cost lubrication of the die structure, but at the same time producing most immediate and dramatic results in the elimination of much of the smoke and air pollution found around die casting machines during previous types of lubricating cycles, and third, the very important ability to permit efficient lubrication of the die surfaces etc., at higher die surface temperatures. At the same time, these results are achieved with little or no modification in die construction, at most merely requiring an enlargement of air vent passages. This in turn, eliminates radical heat gradient in the die structure.

Having thus described our invention it will be obvious that various immaterial modifications may be made in the same without departing from the spirit of our invention, since we do not wish to be understood as limiting ourself to the exact form arrangement and combination of parts shown and described.

We claim:

1. In a die casting apparatus, having a stationary platen and a movable platen constructed to receive and support die members cooperable to form a die cavity for the receipt of molten metal, an elongated hollow shot sleeve adapted to connect with said die members for supplying molten metal thereto, said longitudinal shot sleeve having a transverse pour opening therein for the receipt of molten metal into said sleeve, a ram plunger having a chamber therein, said plunger being slidably movable in said shot sleeve, a lubricant supply, means arranged to communicate with said supply and said chamber for controlling the supply of a predetermined amount of lubricant thereto, a gas supply under pressure, a valve having an inlet connected to said gas supply and an outlet connected to said chamber, means responsive to relative movement of said plunger ram for actuating said lubricant controlling means to effect an injection of lubricant into said chamber prior to said plunger uncovering the pore opening in said shot sleeve, and means responsive to relative movement between said stationary and movable platens for controlling said gas valve to effect discharge of gas under pressure into said chamber following injection of lubricant therein, after said die members have reached closed position and while said pore opening is operatively closed by said plunger, operative to discharge and substantially uniformly distribute lubricant throughout the die cavity.

2. A die casting apparatus according to claim 1, wherein said lubricant-controlling means comprises a pneumatically actuated metering device, and said controlling means therefor comprises an air valve operative to control the flow of actuating air to said metering device.

3. A die casting apparatus according to claim 2, wherein said lubricant-controlling means includes cam means responsive to movement of said ram plunger, engageable with means for actuating said valve controlling air flow to said pneumatically actuated metering device.

4. A die casting apparatus according to claim 3, wherein said gas controlling means comprises a pneumatically operated pilot valve and a controlling timer, with said controlling means therefor comprising an electrically actuated air valve operative to control the flow of actuating air to said pilot valve.

5. A die casting apparatus according to claim 4, wherein said gas controlling means includes switch means responsive to movement between said platens for actuating said electrically actuated air valve.

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