A still further object of the invention is to provide cold chamber die casting equipment, and automatic controls therefor, which lend themselves to a wide range of adjustment and regulation without regard to changes in volume in the die cavity thereof.

Other additional objects and advantages will be appreciated by those skilled in the art to which the invention appertains on consideration of the following description and appended drawings, in which:

FIG. 1 represents a side elevational view of an integrated die casting machine falling within and illustrative of the scope of the invention.

FIG. 2 represents a diagrammatic wiring diagram of electrical circuitry employed in cyclic control of automatic operation of the installation illustrated in FIG. 1.

FIG. 3 represents a fragmentary top view to enlarged scale and more detail of a portion of the injection cylinder or cold chamber, the mechanism of FIG. 1;

FIG. 4 represents a front elevational view of the illustration in FIG. 3.

FIG. 5 represents an end elevational view of the illustration of FIG. 4; and

FIG. 6 represents a fragmentary sectional elevation taken on the plane 6—6 of FIG. 3.

In general terms, improved mechanisms illustrative of the invention comprise modified conventional or newly constructed cold chamber, plunger-injection die casting or equivalent machines in which accurately timed and controlled low level vacuum raised molten metal, or similar flowable and castable materials, is delivered in predetermined metered quantities or shots to the cold chamber of such equipment in timed relationship to subsequent transfer and charging of the so-delivered shot or shots into a die cavity in direct communication with the cold chamber, operation of the aforesaid delivery and casting cycle being automatically controlled and executed by a single manually operated switch device.

Referring to the appended illustrations for a more detailed description of a successful commercial installation of the invention, 10 represents the stationary half or section of a mold detachably and rigidly secured to the fixed platens 12 of a conventional cold chamber die casting machine. A second cooperating section or half 14 of the mold is detachably supported and carried by the rectilinearly translatable platens 16 of the machine, whereby the mold halves 10 and 14 can be brought into abutting closed and separated open condition. At least one of the mold sections 10 and 14 is cavitated, as at 18, to provide a die matrix or cavity in accordance with the exterior configuration and weight or volume of the article to be cast.

The translatable platen 16 supports a conventional fluid-operated ejector cylinder 20 the piston of which carries an ejector plate 22 provided with one or more ejector pins 24 extending forwardly therefrom through a plurality of apertures in the mold section 14, the purpose of which ejector mechanism is to forcibly free a finished casting from adherence within or contact with the translatable mold section 14 on completion of a casting operation.

The cold chamber or injection cylinder 26 of the machine is fixedly secured in respect to the stationary platen 12, communicates at its inner end with the mold cavity or matrix 18, and is open at its outer opposite end to receive an injection plunger or piston 28 slidably supported therewithin. The injection cylinder 26 is preferably horizontally disposed and a double acting fluid-operated cylinder 30 in axial alignment therewith, through the medium of its enclosed piston 32 and rigidly carried connecting rod 34, is employed to reciprocate the injection plunger 28 over the axial length of the cold chamber 26.

The cold chamber die casting machine thus far described is more or less conventional in its design and
structure and machines of this general type are in regular commercial use with an opening or charging gate in the upper surface of the injection cylinder 26, in advance of the plunger 28, serving as the entrance for a molten or flowable liquid charge of material to be cast into the injection cylinder 26 prior to advancing the injection plunger 28 to fill the die 18 therewith.

The present invention departs from the above-described conventional die casting equipment by providing a new and novel vacuum metering system in integrated combination and assembly therewith.

The incorporated metering mechanism or system comprises a generally box-shaped housing or hopper 36 in registered assembly over the normally closed or charging aperture in the upwardly directed surface or wall of the cold chamber or injection cylinder 26. In conversion of existing conventional cold chamber die casting machines, as hereinabove described, the hopper 36 is configured on its underside surface to accurately match and conform to the exposed surface of the injection cylinder 26 immediately surrounding the opening therethrough and a gasket 38 of preferably elevated temperature resisting material is employed between the aforesaid matching surfaces before drawing the hopper into tight sealing unitary assembly on the exposed surface of the cold chamber or injection cylinder by means of a clamp bar 40 engaging the underside exposed surface of the injection cylinder 26 and secured by eye bolts 42 fixedly suspended from the hopper 36 and extending through the bar 40, where they receive strain washers and nuts 44 adjustable to exert the required seal tight assembly closing the clamp.

The otherwise open top of the hopper 36 is also sealed closed by a cover plate 46 and interposed gasket 48. The cover plate 46 is secured in unitary assembly on the upper edge surface of the hopper 36 by means of four corner hook-shaped members 50 engaging the outer exposed surfaces of the plate 46 at their upper hooked ends and having their lower ends pivotally pin or bolt-connected in pairs to end bifurcated cross bars 52 below and transverse to the longitudinal axis of the injection cylinder or cold chamber 26. A centrally disposed adjustable bolt member 54, threaded through each of the cross bars 52 and provided on its normally unheaded end with a cylindrical concaved pedestal washer 56, provides attainment of seal tight clamping pressure between the corner hook-shaped members 50, cover plate 46, interposed gasket 48, and upper edge surface of the housing or hopper 36.

The cover plate 46 is drilled otherwise provided with an aperture to receive and secure therewithin a vacuum pipe or conduit 60 in direct communication with the interior of the hopper 36 and cold chamber 26 in direct communication therewith. A second aperture is also provided through the cover plate 46 to receive an angularly compound directed pipe or delivery conduit 62 which extends some distance below the underside of cover plate 46 in which flat plane the aforesaid vacuum line or conduit 60 had been terminated. The angularly directed conduit 62 is preferably connected through a union to one end of an inverted U curvilinearly bent length of conduit 64 extending downwardly below the exposed surface level of castable flowable material within a reservoir 66 of such material. In the case of molten metal, as distinguished from other flowable liquid materials responding to die casting practice, such as many of the commercial plastics, the reservoir 66 would preferably be a crucible or similar molten metal holding device.

Any one of several commercially available vacuum sources has been successful in providing the required induced vacuum in the line or conduit 60. A typical vacuum source has been illustrated in FIG. 1 and comprises a vacuum pump 68 in direct circuit connection through a valve 70 and vacuum regulator 72 which responds under atmospheric pressure, controllably reduced by a pressure reducing valve 74, to a desired vacuum level established by predetermined setting of the regulator 72, as registered on a gauge 76. Further, the vacuum level developed and established by this system, as by leaks into the vented die cavity 18 and cold chamber temperature variations, are sensed and automatically corrected by providing the bypass conduits or lines 78 and 80 which supply negative pressures to open or close a diaphragm incorporated within the vacuum valve 70 to return the vacuum level to equilibrium and then supply differential in the main vacuum line 82 to zero. The surge vessel 84 may be, and preferably is, included in the vacuum system, as well as a three-way spring-return solenoid operated vacuum controlling valve 86 to be herein further described in more detail, and clean-out trap 88. A four-way spring-return solenoid operated valve 90 is also provided, and will be explained more fully hereinafter, for fluid-pressure actuation and control of the previously identified injection plunger actuating cylinder 30.

Automatic operation of the improved die casting mechanism of the invention is provided through the integrated incorporation therewith of electrically energized and responsive accurately timed electric units and circuitry. On specific reference to FIGS. 1 and 2, it will be observed that the stationary frame and movable platen 16 of the die casting machine support a microswitch 92 and a cam fixedly mounted on the camshaft 36, as illustrated in FIG. 1, in response to engagement condition of the mold sections 10 and 14 and retracted position of the injection plunger 28 in readiness for the performance of a metering and cavity charging casting cycle.

Closing of the manually operated switch 100 across supply lines L1-L2 causes simultaneous energization of high precision adjustable electronic timer 102, as well as energizing the three-way spring-return solenoid vacuum controlling valve 86, to connect the vacuum line 60 with the above-explained and described vacuum source to thereby initiate evacuation of the cavity chamber or injection cylinder 26 and die cavity 18 in direct communication therewith. The thus initiated and induced vacuum also reacts through the upper open end of the delivery conduit 62 and its contiguous portion 64 with the result that atmospheric pressure on the exposed surface of the molten material in the reservoir 66 forces the same upwardly through the continuously delivery conduit 62 into the cold chamber 26. The selected size or uniform cross section of the delivery conduit 62-64, coupled with the level or intensity of the vacuum established by the vacuum regulator 72, determines the rate of flow of the molten or flowable material delivered to the cold chamber 26. Also, the energized time interval set by the adjustable timer 102 is controlling the amount or quantity of flowable material delivered from the reservoir 66 to the cold chamber 26. By adjusting the time interval of timer 102, any desired and accurately metered predetermined quantity of flowable castable material can thereby be delivered to the cold chamber 26 to accommodate any particularly selected capacity of die cavity 18.

When the timer 102 times out, or its energized time interval expires, the electric circuit including the vacuum controlling solenoid valve 86 is de-energized causing spring-return shifting of the same to open the vacuum line 60 to atmosphere through the spray nozzle 88. The de-energization simultaneously closes the normally open contacts (FIG. 2) in the electric circuit of a second high precision adjustable electronic timer 106, herein termed the injection plunger delay timer, to energize the same for a predetermined and definitely established time interval sufficient to permit reverse directional drainage of flowable material therewithin, by syphon action, on termi-
nation of the aforesaid vacuum metering and delivery cycle established by the time interval set by the timer 102. This additional time interval imposed by timer 106 insures against possible freezing, congealing or dripping of flowable material from an undrawn delivery conduit 62-64 into the cold chamber 26 in detrimental interference to subsequent repositioning of the injection plunger 28 or subsequent vacuum delivery against frozen or congealed material within the conduit 62-64. Time out or de-energization of the delayed time interval performed by timer 106 serves to close the normally open contacts (FIG. 2) in the electric circuit of four-way spring-return solenoid valve 90 controlling fluid pressure to the apparatus and practice of the invention. One of these two features concerns the relatively small bore bypass conduit line 108 (FIG. 1), which connects into the vacuum drawing source to provide an induced relatively low vacuum around the tip of the injection plunger 28 to counterbalance atmospheric leakage into the cold chamber 26 resulting from peripheral wear of the plunger 28. A close tolerance piston or plunger within the cold chamber obviates the need of conduit 108. The second feature is concerned with valve 110 (FIGS. 1, 3, 4 and 5) through the wall of the cold chamber adjacent the injection plunger 28 in its withdrawn or retracted position. This latter aperture permits introduction of lubricant for plunger 28, when required, and would be normally sealed off.

It will be fully understood and appreciated that the apparatus selected for purposes of describing the invention is exemplary only, and not limiting, of the scope of the invention hereinafter defined in the appended claims.

We claim:

1. In a die casting apparatus including an atmospherically vented cavitated die, a horizontally disposed cylindrical cold chamber in open communication therewith, a power-operated injecting plunger reciprocal within said cold chamber to charge flowable liquid casting material delivered thereto directly into said cavitated die, and a charging aperture through an upper wall surface of the cold chamber adjacent and in advance of the injecting plunger in its retracted position within the cold chamber remote to said cavitated die, the improvement comprising:

(a) a housing carried by said cold chamber providing an upwardly and outwardly directed sealed chamber in open communication through said charging aperture with the cold chamber and vented cavitated die,

(b) an imperforate wall open ended flowable liquid casting material delivery conduit extending axially coextensively downwardly through and from above an upper wall of said housing and having its open discharge end terminating therewithin isolated from interior walls of the cold chamber and in substantially axially tangential disposition in respect to an interior wall of said cold chamber closely adjacent said charging aperture,

(c) said conduit being curvilinearly downwardly axially contiguously directed to locate its opposite end below an atmospherically exposed surface of a source of flowable casting material located below the cold chamber,

(d) means for inducing a low level vacuum within said cold chamber in advance of the injecting plunger in its retracted position remote to said cavitated die,

(e) electrically energizable operating circuitry incorporating a pair of electrically responsive timed valves sequentially controlling initiation and duration of the induced vacuum and activation of a source of power initiating the injection stroke of the injecting plunger within the cold chamber in consecutively time-delayed sequence,

(f) energization of one of said valves being timed to expire and cut-off the induced vacuum and a metered quantity of flowable liquid casting material responding to the induced vacuum delivered to said cold chamber through said flowable liquid casting material delivery conduit,

(g) energization of the other said valves for initiating the injection stroke of said injecting plunger being set to initiate the injecting plunger charging stroke in selective timed delay following expiration of the induced vacuum controlling valve,

whereby flowable liquid casting material within the delivery conduit is directionally oppositely drained into the cold chamber and source of flowable liquid casting material from opposite open ends of the delivery conduit before initiation of the charging stroke of the injecting plunger.
2. A die casting apparatus in accordance with claim 1 in which the means for inducing low level vacuum is communicatively connected through the upper wall of said housing and is terminated in a plane above the plane of the open discharge end of the flowable liquid casting material delivery conduit within said housing.

3. A die casting apparatus in accordance with claim 1 in which the means for inducing low level vacuum is communicatively connected through the upper wall of said housing above the plane of the open discharge end of the flowable liquid casting material delivery conduit within said housing and in advance thereof towards the cavitated die.

4. A die casting apparatus in accordance with claim 1 in which the electrically energizable operating circuitry incorporates a protective microswitch permitting energization of the electrically energizable operating circuitry only when the cavitated die is conditioned to receive a charge of flowable liquid casting material from the cold chamber.

5. A die casting apparatus in accordance with claim 1 in which the electrically energizable operating circuitry permits energization of the electrically energizable operating circuitry only when the injecting plunger is in fully retracted position within the cold chamber remote to said cavitated die.

References Cited by the Examiner

UNITED STATES PATENTS
2,955,335 10/1960 Morgenthurn 22—73
3,093,871 6/1963 Adams 22—73 X

FOREIGN PATENTS

J. SPENCER OVERHOLSER, Primary Examiner.
R. S. ANNEAR, Assistant Examiner.