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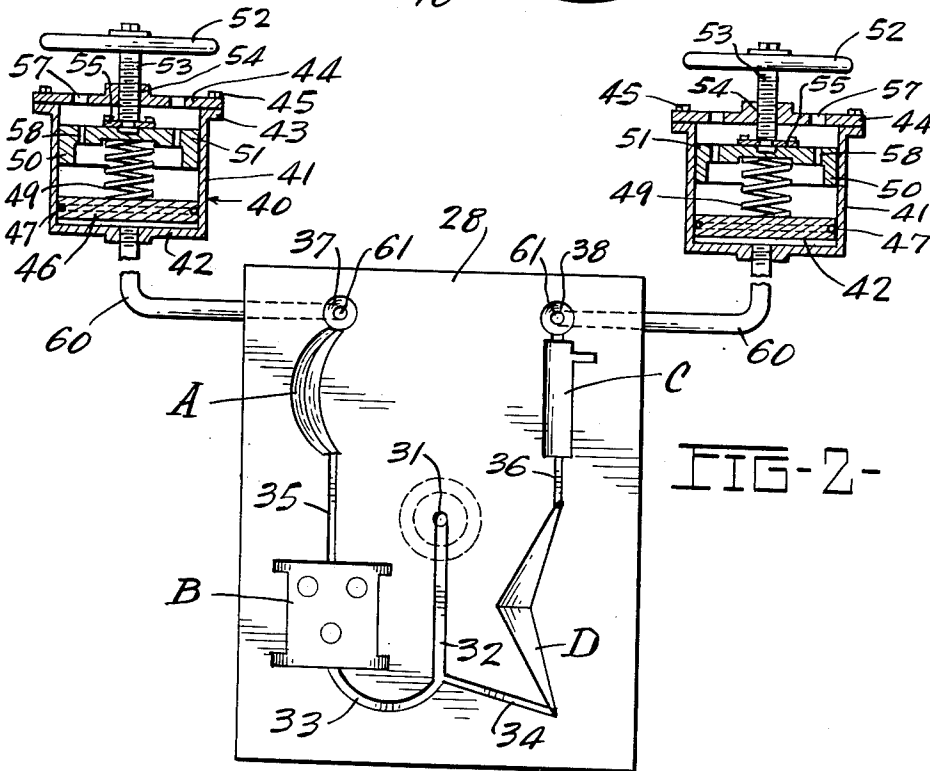
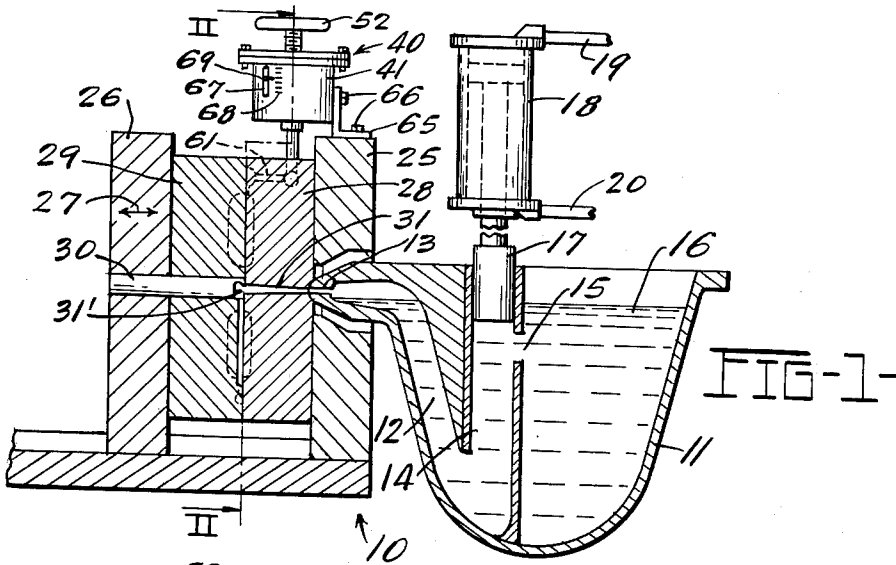
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3,056,178

APPARATUS FOR MAKING DIE CASTINGS

Filed Aug. 12, 1959

2 Sheets-Sheet 1



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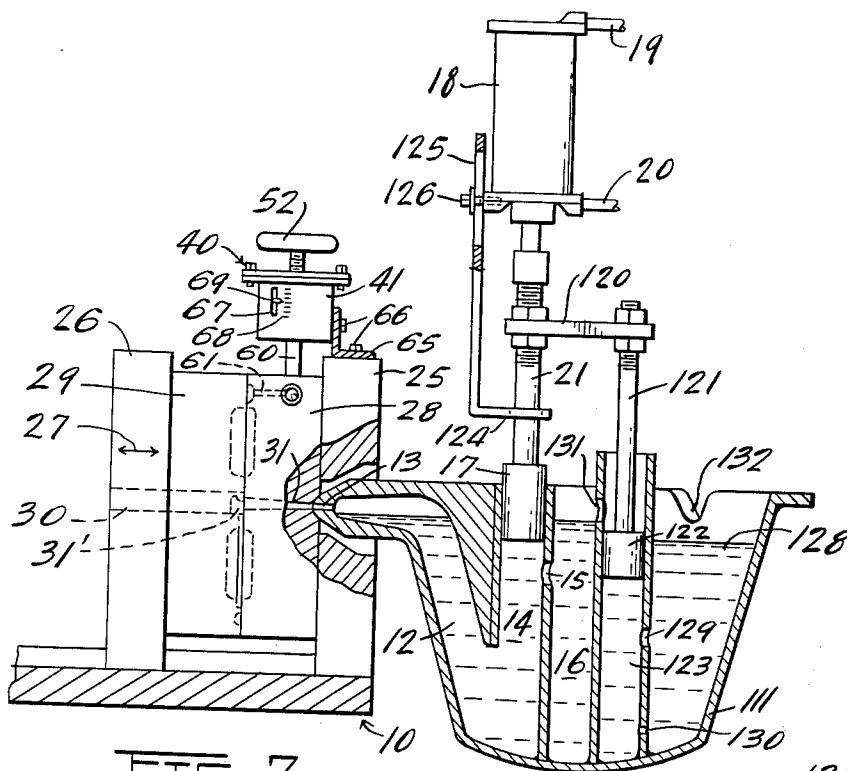


FIG-3-

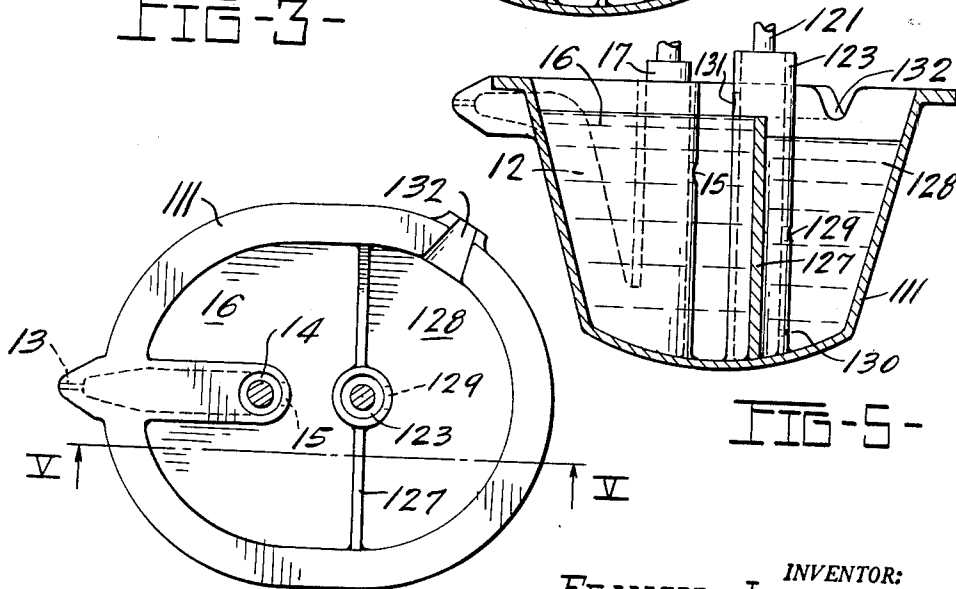


FIG-4-

FIG-5-

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APPARATUS FOR MAKING DIE CASTINGS

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This invention relates to a method and apparatus for making sound die castings and more particularly it deals with a device for exerting a relatively small pressure on the surface of the incoming metal in a casting die and thus reducing or eliminating turbulence in the flow of metal during the injection thereof.

It has long been a problem of the die casting industry to make castings free from defects such as voids, blisters, air bubbles and the like. It is believed that most of these defects are caused by the metal coming into the die so rapidly and so turbulently, that it freezes too quickly, resulting in the entraining of air and failure to fill blind holes and side chambers in the die cavity. These air bubbles, blisters, and the like materially weaken a casting, but often they can only be detected by use of X-rays.

In solving the problem, many schemes have been tried to completely evacuate the die space before injection of the metal. However, these attempts have been very costly and not always successful.

It is therefore an object of this invention to produce an efficient, simple, effective, and economic device for attachment to a die casting machine which will substantially eliminate the above mentioned casting defects.

Another object of this invention is to produce a device which will substantially eliminate turbulence in the flow of metal into a die, and at the same time allow lower injection pressures to be used.

Another object of this invention is to produce a device which will eliminate any necessity for vents or for shimmed the die halves and to eliminate all but one overflow pad, thus substantially reducing the amount of flash to be trimmed from the casting.

Another object of this invention is to provide an expansible chamber into which the air trapped in a casting die may be displaced, which entrapped air or gas acts as a buffer or deterrent to turbulence in the molten metal being injected into the die.

Another object of this invention is to insure that the same amount of air is displaced from the die cavity and its connecting ducts each time a casting is made as well as to insure that the correct amount of metal is always injected for each casting.

Another object of this invention is to provide a method of die casting which will eliminate most casting defects.

In accordance with this invention a partable casting die is provided with a gate and an inlet runner near the bottom of the cavity and a single overflow pad near the top of the cavity. An expansible chamber comprising an air cylinder with a piston free to reciprocate therein may be mounted on the machine. A conduit connects one end of said cylinder with said overflow pad in the die. A relatively light spring may be adjustably mounted in the cylinder, resiliently forcing the piston toward said one end of the cylinder. Therefore when the metal is injected into the die cavity, the air in the cavity and its metal injection duct is displaced into the cylinder, where it pushes back on the piston and compresses the spring. The size of the chamber is adjusted so that it is expanded to its maximum size at the same time that the die cavity is filled with metal, or in other words, the maximum volume of the chamber is made substantially equal to the volume of the die cavity and its injection duct. Therefore the only compression of the air or gas in the chamber which takes place is that required in overcoming the resistance of the chamber to expansion. The effect is that of placing a very small

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back pressure on the incoming metal, so that it flows in more slowly, eliminating splashing and turbulence, so that the die is completely filled with no air bubbles trapped therein. In a die with many impressions, a plurality of expansible chambers may be utilized, and the pressure on the spring may be adjusted to compensate for different size die cavities, injection pressures and/or materials to be cast. In addition, a twin-compartment metal holding pot may be provided, with means to transfer molten metal from a storage compartment to a charging compartment, so that the metal in the charging compartment and in the injecting duct or nozzle will always be at the same level to insure that the volume of air or gas in the cavity and ducts connected to it corresponds to the volume set in the expansible chamber.

The above mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a vertical sectional view of a portion of a casting machine utilizing one embodiment of this invention;

FIG. 2 is a view on an enlarged scale taken along line II—II of FIG. 1 showing the die impressions and a pair of expansible chambers connected thereto according to this invention;

FIG. 3 is a vertical sectional view similar to FIG. 1 showing an improved metal holding pot for this invention.

FIG. 4 is a plan view of only the pot in FIG. 3; and FIG. 5 is a vertical sectional view taken along line V—V of FIG. 4.

Referring now in more detail to FIGS. 1 and 3 of the drawings, a die casting machine 10 is provided with a standard pot 11 lined with refractory material for holding the molten metal to be cast, and this pot is provided with a gooseneck 12 having a nozzle 13 by means of which the metal is injected into the die. The pot or holding furnace 11 is also provided with a charging cylinder 14, in this case mounted vertically. An aperture 15 in the cylinder 14 allows it to be filled with molten metal from the pool 16. The charging piston 17 reciprocates in the cylinder 14, and when it has passed the aperture 15, begins to inject the metal through the nozzle 13. Mounted above the charging cylinder 14 is a shot cylinder 18 which is controlled by fluid pressure lines 19 and 20 and which controls the action of the piston rod 21 and charging piston 17. The improved pot shown in FIGS. 3, 4 and 5 will be described later.

The casting die, just as the shot mechanism in FIG. 1, is of standard construction. Mounted on the machine is a fixed platen 25 and a movable platen 26 as shown by arrows 27, to which are connected the fixed cover die half 28 and movable ejector die half 29, respectively. An ejector rod 30 may be provided to withdraw the sprue 31' and eject the finished casting from the machine. The gate 31, the runners 32, 33, 34, and the risers 35, 36 carry the molten metal from the nozzle 13 to the die impressions A, B, C, D.

The die cavities shown in FIG. 2 are merely for the purpose of illustration, as the cavity may be of any shape whatsoever to produce the desired casting. In this illustration, the runners 33, 34 feed the die cavities B, D at their lower ends and risers 35, 36 lead to cavities A, C. Overflow pads 37, 38, are provided at the upper ends of the impressions A, C, respectively.

Referring now to the expansible chamber, in FIG. 2 there are shown two units, both of which may be identical and thus any part designated by reference numeral on one of the units is exactly the same on the other unit. The expansible chamber 40 comprises a hollow cylinder

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41 having a bore therein and may be closed at one end with an integral bottom member 42. The cylinder 41 may be provided at its upper end with flanges 43 to which may be attached a cover member 44 by means of screws 45 or other fastening elements.

Inside the cylinder bore, a piston 46 is free to reciprocate having mounted thereon a standard O-ring or other sealing element 47. On the atmosphere side of the piston 46, a compression spring 49 or other resilient element may bear, which may seat in a recess provided at least in part by a skirt 50 on an adjustable stop 51. When the floating piston 46 contacts the end of the skirt 50, the spring 49 preferably is not completely compressed.

The position of this adjustable stop 51 may be controlled by means of an exterior hand wheel 52 which may be mounted on a threaded stem 53 engaging a tapped hole 54 in the cylinder cover 44, and which stem 53 may engage the adjustable stop 51 by means of a collar 55 which will permit relative rotational movement, but not relative axial movement between the stem and the stop. The adjustment of the stop 51 is preferably made so that when the piston 46 contacts the edge of the skirt 50, the volume of the chamber in the cylinder 40 below the piston 46 is substantially equal to the volume of the cavities in the die and the associated ducts.

In order to permit the escape of air behind the piston 42, vents 57, 58 which open to the atmosphere may be provided in the cylinder cover 44 and the adjustable stop 51, respectively.

The space between the piston 46 and the cylinder bottom member 42 communicates with the overflow pad 37 or 38 in the die block 28 by means of a conduit 60 which may be rigid pipe or any flexible tubing, and a passageway 61 through the die block.

For convenience in illustration, the expansible chamber unit 40 has been shown in FIG. 1 to be mounted on the stationary platen 25 by means of a bracket 65 and bolts or other fastening elements 66. An elongated slot or window 67 may be provided through the upper or non-pressurized end of the cylinder wall 41, and graduations 68 may be marked upon the outer cylinder wall to indicate the position of the stop 51 in the cylinder 41. Also a pointer 69 may be attached to the adjustable stop 51 to indicate its position on the scale 68.

The operation of the expansible chamber unit attached to a die casting machine will now be described: The machine having been opened to eject the previous casting, the die halves 28, 29 are brought together into intimate contact by means of the usual mechanism (not shown), and thus air is trapped in the space defined by the upper portion of gooseneck 12, gate 31, runners 32, 33, 34, risers 35, 36, cavities A, B, C, D and conduit 60, 61. Then fluid pressure is admitted through the line 19 to the shot cylinder 18, forcing down the charging piston 17, and injecting the metal through nozzle 13, gate 31, and runners 32, 33, 34 into the die cavities B, D, then up through risers 35, 36 into cavities A, C. As the molten metal fills up the die cavities the air displaced thereby has no place to escape except through the channels 61 leading from the overflow pads 37, 38, and thus the floating pistons 46 are forced upward against the action of the springs 49. As the pistons 46 are forced upwardly against the springs 49, the air in the cylinders 41 and conduits 60, 61 and also in the unfilled portion of the die cavities is very slightly compressed. The result is that of placing a very small back pressure on the surface of the metal coming into the die. Thus splashing and turbulence are eliminated, and the metal flows more steadily and slowly and completely fills the die impressions, resulting in a sound casting free from defects such as blow holes, laminations, air bubbles, or the like. When the casting machine is being set up with a new die, the position of the adjustable stop 51 may be varied by means of handwheel 52 as indicated by the pointer 69 on the scale 68 so that the piston 46 just contacts the stop 51

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at the same time that the die cavities are completely filled. Thus the air is compressed no more than enough to overcome the resistance of the spring 49, and any excess of metal injected up into the ducts 60 will be resisted by compression of the air in the cylinder 40.

In FIGS. 3, 4, and 5, an improved metal holding pot 111 is shown. The metal injecting parts, such as the gooseneck 12, the nozzle 13, the charging cylinder 14, and the shot cylinder 18 have already been described. Attached to the piston rod 21 by means of an anchor plate 120 or other means is a second piston rod 121. At the end of this second piston rod is attached a second piston 122 which reciprocates in a second cylinder 123, and thus the pistons 17 and 122 reciprocate together. A bracket having a forked end 124 extending around the piston rod 121 may be provided at its upper end with an elongated slot 125 and a locking nut 126 for adjustably attaching to the shot cylinder housing 18. The fork 124 is adjusted to contact the plate 120 just after the normal stroke of the piston rod 121 is reached, and stop the motion of the piston 17 in case of failure of the usual stroke-limiting means. This would prevent the injection of too much metal into the die.

Attached to the second cylinder 123 and extending to the side walls of the pot is a dividing wall 127, which separates the pot into a charging compartment holding the metal pool 16, and a storage compartment holding the pool 128. When a shot is made and the piston 17 reaches its lowest position, the top of the piston 122 is below an aperture 129 in the cylinder 123, so that the cylinder above the piston is filled with metal from the pool 128. A small hole 130 is provided at the bottom of the cylinder 123 to allow the metal therein to escape back into the pool 128 as the piston 122 descends below the side of the aperture 129.

As the pistons 17 and 122 now raise, the metal in the cylinder 123 flows out through a higher aperture 131 into the top of pool 16. Any excess metal flows over the top of wall 127 back into the pool 128. Thus the level of molten metal around the charging cylinder 14 is kept up to the top of wall 127, which is preferably at such a height that the metal in the gooseneck 12 is just below the nozzle opening 13.

Through the side of the storage compartment may be placed an opening 132 having its lowest point on the same level as the top of wall 127. Thus, should the pool 128 be overfilled, the excess will run off through this opening 132, and the metal in the gooseneck will not rise above the nozzle opening 13. This is important, in order to prevent metal from running into the die between shots, and from freezing there or in the nozzle, as well as to prevent the volume of air in the injection duct from changing.

Any means of connecting the piston rods 21, 121 may be used, and they may even have separate actuating cylinders timed to operate together. The wall 127 could extend up to the top of the pot 111, and have a small depression therein to allow back-flow of the metal, or it may be made without any depression, and an opening could be formed in the side of the charging chamber to allow excess metal to drain off and away from the pot entirely in which case the opening 132 would also be unnecessary. The important feature is that the level of the metal in the gooseneck must stay constant, in order to displace the same volume of air with every shot. This level cannot be above the nozzle opening, and the lower it is, the more air will be displaced, so the level is preferably just below the nozzle opening.

The following and other modifications may be made without departing from the scope of this invention: The unit may be mounted on any type of casting machine, not necessarily the gooseneck type used herein for purposes of illustration. The die cavities may be of any shape whatsoever to conform to the design requirements of the part being produced, and there may be one, two or more cavities in each die, depending on their size. One ex-

pansible chamber unit may be provided for each cavity, or each unit may serve a plurality of cavities, as shown in the drawing. Instead of the spring 49 other means to resist the movement of the floating piston may be employed, such as for example, variable fluid pressure, or the piston may be replaced by a confined bellows, or the like. If the adjustable stop 51 be used, any convenient means of adjusting its position may be utilized such as a hand crank, or a sliding stem with a locking collar; and the pointer and scale could be dispensed with and the position of the stem 53 could be utilized for determining the position of the adjustable stop. Also the unit may be mounted at any point on the casting machine, not necessarily on the fixed platen as shown herein for illustration.

While there is thus described above the principles of this invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of this invention.

What is claimed is:

1. A die casting machine comprising: a portable die having a fixed volume cavity with a molten metal inlet duct at one end thereof and a gas outlet duct at the other end thereof and said cavity being so formed between said ducts that molten metal may flow continuously from said inlet duct to said outlet duct, means to entrap the gas in the cavity before injecting molten metal therein, means for injecting molten metal through said inlet duct into said cavity against said entrapped air, means directly connected to said outlet duct for receiving and confining said entrapped gas from said cavity and exerting a gradually increasing pressure directly on the surface of said molten metal as it is injected into said cavity.
2. A machine according to claim 1 wherein said means for exerting a pressure comprises a cylinder having a piston reciprocable therein and adapted to be moved by the air displaced in said die when said metal is introduced.
3. A machine according to claim 1 wherein said inlet duct is at the lower portion of said die and said outlet duct is at the upper portion thereof.
4. A machine according to claim 1 wherein said means for injecting metal into said cavity includes a pot, and a piston reciprocable in a cylinder in said pot, said inlet duct connecting said cylinder to said cavity, whereby each reciprocation of said piston injects molten metal from said pot into said cavity.
5. A machine according to claim 2 wherein said piston is restrained from movement by a resilient means.
6. A machine according to claim 4 wherein said pot comprises first and second compartments, said piston and cylinder being in said first compartment, and a second piston and second cylinder connected to said second compartment, whereby the second piston transfers molten metal from said second compartment to said first compartment to maintain a given molten metal level in said first compartment.
7. A machine according to claim 5 wherein said resilient means comprises a spring backed up by an adjustable stop.
8. A machine according to claim 7 wherein the volume in said cylinder when said piston contacts said adjustable stop is substantially equal to the volume of said cavity.
9. A die casting machine comprising a partable die, means for injecting molten metal into said die under pressure through a first duct connected to the lower portion

of said die, means for closing the parts of said die to entrap air therein before the injection of said molten metal, and a second duct means connected at least to the upper portion of said die and extending from said die for the escape of said air, and an air tight expansible chamber for said air separate from said die and directly connected to said second duct means to place air pressure directly on the surface of said incoming molten metal.

10. A machine according to claim 9 wherein said expansible chamber includes resilient means for applying said pressure.

11. A machine according to claim 9 including means for adjusting the air space in said expansible chamber to correspond to the volume of air displaced by said metal in said die.

12. A machine according to claim 9 including means for the tightly sealing of said die for maintaining a constant volume of said air in said die and said first duct before the injection of said molten metal.

13. A machine according to claim 10 wherein said resilient means comprises a spring.

14. A die casting machine comprising: a die, first and second reservoirs for holding molten metal to be injected into said die, an overflow wall between said reservoirs, a first cylinder in said first reservoir having a discharge aperture along said wall into said second reservoir and an intake aperture below the normal level of said molten metal in said first reservoir, a first piston reciprocable in said first cylinder from below said intake aperture to below said discharge aperture for pumping said molten metal from said first reservoir into said second reservoir for maintaining a given level of said molten metal in said second reservoir defined by the top of said overflow wall, a second cylinder in said second reservoir, and a second piston reciprocable in said second cylinder for injecting said molten metal from said second reservoir into said die.

15. A machine according to claim 14 including means rigidly connecting said pistons for reciprocating both said pistons together.

16. A die casting machine comprising: a partable die, first and second reservoirs for holding molten metal to be injected into said die, means for closing the parts of said die to entrap air therein before the injection of said molten metal, a first cylinder in said first reservoir, a first piston reciprocable in said first cylinder for pumping said molten metal from said first reservoir into said second reservoir for maintaining a given level of said molten metal in said second reservoir, a second cylinder in said second reservoir, a second piston reciprocable in said second cylinder for injecting said molten metal from said second reservoir into said die, duct means connected to the upper portion of said die for the escape of said air entrapped therein, and an expansible chamber for said air separate from the cavity of said die and connected to said duct means to place air pressure directly on the surface of said incoming molten metal.

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