

Sept. 16, 1952

H. F. SCHROEDER

2,610,372

APPARATUS FOR REDUCING THE POROSITY OF CASTINGS

Filed April 20, 1949

Fig. 1.

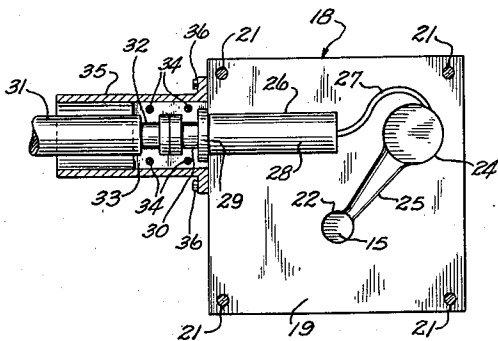
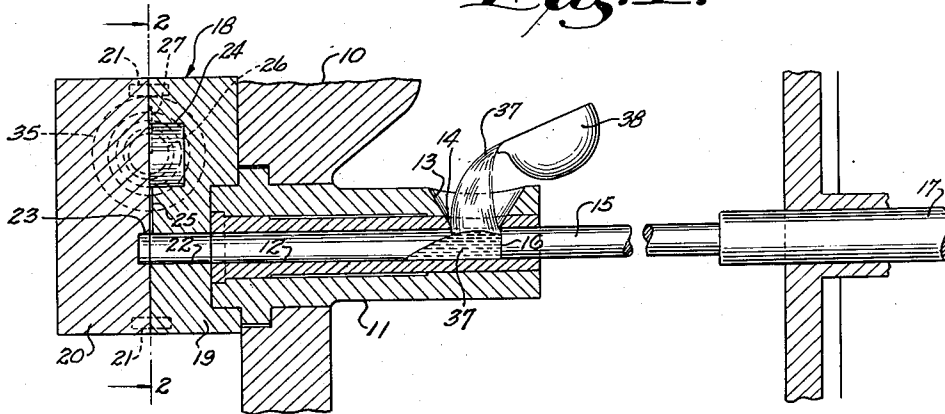


Fig. 2.

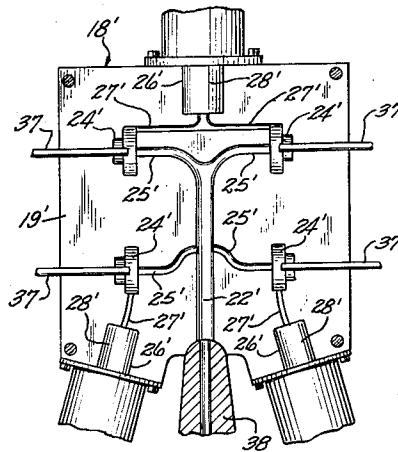


Fig. 3.

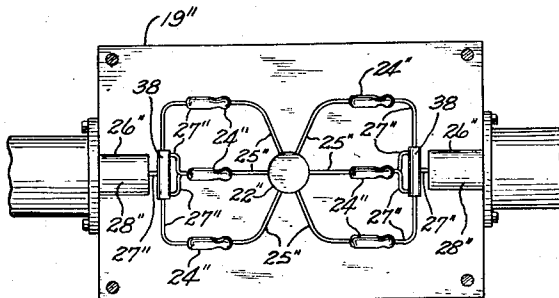


Fig. 4.

INVENTOR.
Henry F. Schroeder,
 BY *Mosell + Mosell*
 ATTORNEYS.

UNITED STATES PATENT OFFICE

2,610,372

APPARATUS FOR REDUCING THE POROSITY OF CASTINGS

Henry F. Schroeder, Milwaukee, Wis.

Application April 20, 1949, Serial No. 88,546

1 Claim. (Cl. 22-68)

1

This invention relates to improvements in the apparatus for reducing the porosity of castings.

In the manufacture of die castings molten metal is usually forced into the die cavity under relatively high pressures. The air and gases in the die are greatly compressed by the molten metal and make it difficult for the molten metal to enter the cavity to form a solid casting. In addition, this entrapped air and gas causes porosity in the resultant casting.

Porosity reduces the strength of castings and tends to cause leakage when the castings are used for containing fluids under pressure. Porosity is particularly undesirable in castings which are to be plated. Platers demand castings with such perfect surfaces that only one polishing operation thereon is required, namely the removal of the parting line. All pressure die castings have a chilled surface or skin which is several thousandths of an inch thick. At times, in order to shape a casting or to remove an imperfection, it is necessary to polish a portion of the surface other than at the parting line. Should porosity be encountered when the polishing wheel breaks through this skin, the casting cannot be plated, and it must be scrapped. In addition to the scrap which results from porosity encountered during the polishing operation, many castings are scrapped because of porosity encountered when the castings are sawed or broken from the gate.

One of the methods heretofore used in an attempt to alleviate this porous condition and to produce sound castings was the cutting of vents in the face of the die from the cavity to the outer edge thereof. This expedient, however, only partially remedied the situation, because all of the entrapped air and gas could not escape through the vents, since the vents had to be kept very small. If the vents were made too wide or too deep, the molten metal was forced from the die therethrough and endangered the workers in the vicinity of the casting machine. In addition, metal flowing into the vents produced "flash" on the finished casting which increased trimming costs.

Another expedient tried in an attempt to reduce porosity in castings and to achieve soundness and dense grain structure therein was the use of higher pressures for injecting the molten metal into the die. Some of the machines now in use exert up to 30,000 pounds per square inch injection pressure. These machines require an extremely high die locking pressure in the neighborhood of 600 tons.

2

The cost of very high pressure machines is extremely high as compared to the earlier lower pressure models, and therefore the cost of the finished castings is accordingly increased. In addition, the use of extremely high pressures forces molten metal into minute cracks in the die and into the joint between meeting surfaces of the die blocks to a much greater extent than do the lower pressures. For example, in many cases high pressures on a given die will produce a pronounced parting line, whereas relatively low pressures will produce a casting substantially free of a parting line in the same die.

With the above in mind, it is a general object of the invention to provide an improved apparatus for manufacturing castings whereby the porosity of the finished casting is reduced by the creation of a vacuum in the die cavity simultaneously with the injection of molten metal therein.

Another object of the invention is to provide an improved method of and apparatus for manufacturing castings wherein the trimming costs are reduced by the elimination of vents in the die.

A further object of the invention is to provide an apparatus of the class described which produces sound castings having dense grain structure without requiring the use of high injection pressures.

A further object of the invention is to provide an apparatus of the class described which produces castings in which the parting line is substantially eliminated, thereby reducing the cost of polishing and also enhancing the appearance of the finished casting.

A further object of the invention is to provide an improved die construction having incorporated therein an evacuating cylinder provided with an evacuating piston, said cylinder being in communication with a die cavity through a restricted aperture.

A further object of the invention is to provide an improved die construction of the class described wherein the evacuating cylinder, as well as the aperture communicating between said cylinder and the cavity, is formed in the die in such a manner that any metal which flows therein and solidifies forms an integral part of the gate and can be easily ejected with said gate.

A further object of the invention is to provide a die construction of the class described wherein the evacuational movement of the evacuating piston is synchronized with the injection operation.

A further object of the invention is to provide

a die construction of the class described wherein the operative displacement of the evacuating piston is greater than the combined volume of the sprue hole, the runners and the cavities of said die, thereby insuring that the highest possible vacuum is created by operation of the evacuating piston.

A further object of the invention is to provide an improved apparatus for reducing the porosity of castings which is applicable to multiple cavity dies as well as to single cavity dies, and which is applicable to side gated dies as well as to center gated dies.

A further object of the invention is to provide a multiple cavity die construction of the class described wherein more than one evacuating piston may be incorporated therein and operated simultaneously with the injection of the molten metal to insure complete evacuation of all of the cavities of said die.

A further object of the invention is to provide a die construction of the class described which is simple, which is relatively easy to manufacture, and which is otherwise well adapted for the purposes described.

With the above and other objects in view, the invention consists of the improved apparatus for reducing the porosity of castings and all of the parts and combinations incident thereto, as set forth in the claim and all equivalents thereof.

In the drawing accompanying and forming a part of this specification wherein are shown three embodiments of the invention and wherein the same reference characters indicate the same parts in all of the views:

Fig. 1 is a fragmentary vertical sectional view taken through a cold chamber die casting machine equipped with a center gated die constructed in accordance with the invention;

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1 and looking at the face of the pot half of the improved die;

Fig. 3 is a view, similar to Fig. 2, of a side gated die having multiple cavities and constructed in accordance with the invention, said die being provided with three evacuating plungers; and

Fig. 4 is a view similar to Figs. 2 and 3 showing a multiple cavity center gated die constructed in accordance with the invention and having two evacuating plungers.

Referring more particularly to Fig. 1 of the drawing wherein is shown a fragmentary vertical sectional view of a modern cold chamber type of die casting machine, the numeral 10 indicates the die plate which is apertured to receive a tubular cold chamber 11. The chamber 11 is preferably made of heat-treated steel and is provided with a sleeve liner 12 of any suitable heat resistant alloy such as, for example, that known as "Nitalloy." The cold chamber 11 and the liner 12 are formed with aligned pouring slots 13 and 14 near their outer ends. An injection plunger 15 is positioned in the bore of the liner 12. In Fig. 1 the plunger is in retracted position, being positioned with its tip 16 outwardly adjacent the slot 14 in the liner 12. The plunger 15 is suitably fixed to a plunger piston rod 17 which is connected to a suitable actuating piston (not shown).

Mounted on the die plate 10 is a die 18 which is conventionally formed of a cover portion or "pot half" 19 fixed to the die plate 10, and an ejector portion or "ejector half" 20 which is movable into and out of engagement with the cover portion 19. The movable mounting for the

ejector portion 20 is conventional and is not shown. The halves of the die are apertured adjacent the corners thereof to receive dowel pins 21 which insure alinement of said halves.

The die 18, shown in Fig. 1, is of the center gated type having a sprue hole 22 in the cover portion 19 and a biscuit well 23 in the ejector portion 20, the sprue hole and the biscuit well being coaxial with the bore of the liner 12. The cover portion 19 of the die 18 is formed with a cavity 24 and with a runner 25 communicating between the cavity 24 and the sprue hole 22.

The die 18 is formed with an elongated cylindrical bore 26, extending inwardly from a side thereof, the axis of said bore preferably lying in the plane of the meeting faces of the die halves 19 and 20. Each die half, therefore, is formed with a semi-cylindrical recess in the face thereof which forms a part of the bore 26.

A relatively shallow groove 27 is formed in the face of the cover portion 19 of the die 18 communicating with the inner end of the bore 26 and with the cavity 24, preferably at a point opposite the runner 25, as shown in Fig. 2, or

said groove may be in the block 20 or in both die halves 19 and 20, depending on the type of casting. A cylindrical evacuating plunger or piston 28 is slidably positioned in the bore 26. Adjacent its outer end the plunger 28 is formed with an annular shoulder portion 29 and with a portion 30 of reduced diameter. Abutting the outer end of the plunger 28 is a plunger piston rod 31 which is formed adjacent its abutting end with a portion 32 of reduced diameter. A split sleeve 33 is formed to fixedly connect the plunger

28 with the piston rod 31, and is held together by suitable bolts 34. A guide sleeve 35 is fixed to the cover portion 19 of the die 18, as by suitable bolts 36, and said sleeve surrounds the connecting sleeve 33 in a manner to permit axial sliding movement of the latter therein. The plunger piston rod 31 is connected to a suitable actuating means such as, for example, a fluid operated ram.

The evacuating plunger 28 is movable outwardly from its innermost position shown in Fig. 2. The size of the bore 26 and the distance travelled by the piston 28 is preferably such that the cubic displacement of the plunger 28 is greater than the combined volume of the die cavity 24, the runner 25, the groove 27, the biscuit well 23, and at least a portion of the sprue hole 22. It is preferable to have a relatively long stroke for the plunger 28 with a correspondingly relatively small diameter, rather than to have a short stroke and relatively large diameter therefor.

The operation of the improved apparatus will now be discussed. With the parts of the die casting machine disposed as shown in Figs. 1 and 2, a charge of molten metal 37 is poured from a ladle 38 into the sleeve 12 ahead of the injection plunger 15 through the pouring slots 13 and 14, as shown in Fig. 1. The injection plunger

15 is then moved inwardly by its actuating ram, pushing the charge of molten metal ahead of it. At the instant that the inner end 16 of the plunger passes and seals off the slot 14, the evacuating plunger 28 is started moving outwardly by its actuating ram. The evacuating plunger, during its withdrawal movement, preferably has a rate of cubic displacement greater than that of the injection plunger 15. Hence, the air is withdrawn from the die cavity at a volume rate which is greater than the volume

of the charge of molten metal. The operation of the improved apparatus will now be discussed. With the parts of the die casting machine disposed as shown in Figs. 1 and 2, a charge of molten metal 37 is poured from a ladle 38 into the sleeve 12 ahead of the injection plunger 15 through the pouring slots 13 and 14, as shown in Fig. 1. The injection plunger 15 is then moved inwardly by its actuating ram, pushing the charge of molten metal ahead of it.

At the instant that the inner end 16 of the plunger passes and seals off the slot 14, the evacuating plunger 28 is started moving outwardly by its actuating ram. The evacuating plunger, during its withdrawal movement, preferably has a rate of cubic displacement greater than that of the injection plunger 15. Hence, the air is withdrawn from the die cavity at a volume rate which is greater than the volume

rate of injection of the molten metal, thereby creating a vacuum in the cavity 24 through the groove 27, by withdrawing substantially all of the air and gases therefrom.

The removal of the air and gases from the cavity 24 permits the molten metal to flow freely into said cavity. The absence of any substantial amounts of air or gases in the cavity permits the molten metal to form a sound casting free from porosity. The molten metal fills up the cavity 24 and a certain amount of it may flow into the groove 27. Some of this metal may even be drawn into the bore 26 by the evacuating plunger.

The molten metal then solidifies, and the ejector portion 20 of the die 18 is moved away from the cover portion 19. The gate is then ejected in the usual manner. Since the bore 26 and the groove 27 are formed in the die faces, the metal which flowed into the groove 27 and the bore 26 is removed from the die with the rest of the casting because it is an integral part of said casting or gate.

Any suitable means may be used for actuating the evacuating plunger 23, but it is important that its withdrawal movement be synchronized with the inward movement of the injection plunger 15 so that the former is moving outwardly at the instant the latter seals off the pouring slot 14, so that the vacuum is built up at the proper time.

Experience has shown that with the improved die it is possible to make castings of definitely higher density than were previously made on the same machines using conventional dies. It was noted that in the castings made in the improved dies porosity had been substantially eliminated.

Experience has also shown that, when the improved dies are used, extremely high injection pressures are of no substantial advantage. The castings produced in the improved dies used on relatively low pressure machines are of substantially the same quality as those made on the improved dies on high pressure machines.

It is apparent that, not only does the improved apparatus result in sound castings having substantially no porosity, but that high quality castings having these characteristics can be made on relatively low pressure machines. By using low pressure machines the parting line, which is formed by the extremely high injection pressures of the high pressure machines, is appreciably reduced. In addition, since the improved die does not have conventional vents, there is no "flash" resulting from metal forced out thereof.

Elimination of porosity greatly reduces the amount of material scrapped, not only because of leakage (where the castings are to be used to contain fluids under pressure), but also because of poor polishing qualities. The elimination of the parting line and of the flash which results when die vents are used, greatly reduces the trimming cost of the finished casting. In addition to the above features, the elimination of the need for extremely high injection pressures permits the use of relatively inexpensive die casting machines having relatively low die locking pressures. This greatly reduces the investment in equipment which must be made by a manufacturer and reduces the cost of the castings accordingly.

Fig. 3 is a view similar to Fig. 2 looking at the face of one half 19' of a multiple cavity side-gated die 18' constructed in accordance with the

invention. The die 18' has a sprue hole 22' which communicates with four cavities 24' through four runners 25'. Cores 37 have portions extending into the cavities 24'. The die 18' is provided with three evacuating plungers 28' positioned in suitably placed bores 26' which communicate with the cavities 24' by means of passages 27' as shown. The numeral 38 indicates the nozzle of a conventional metal chamber or gooseneck of either the air or the plunger type.

Fig. 4 is a view similar to Figs. 2 and 3 looking at the face of one half 19'' of a multiple cavity center-gated die constructed in accordance with the invention. The die 18'' has a sprue hole 22'' communicating with cavities 24'' through runners 25''. A pair of oppositely disposed evacuating plungers 28'' are slidably positioned in the bores 26'' which communicate with the cavities 24'' through grooves 27'' and the interposed enlargement thereof 38. The latter is for the purpose of equalizing the suction effect of the evacuating plungers among all of the cavities communicating therewith.

Any type of die can be constructed in accordance with this invention, and any suitable number of evacuation plungers may be employed depending upon the number and positioning of the cavities, the number and positioning of movable cores and slides used, and upon the interference with parts of the die casting machine. An important feature common to all dies constructed in accordance with the invention is that each evacuating plunger and the passage or passages connecting it with one or more cavities be formed in the die faces, so that any molten metal which might follow a plunger can be ejected as an integral part of the gate. Any suitable and practical means may be employed for effecting a seal as between the two die blocks.

Generally speaking the passages or grooves 27, 27' and 27'' should be large enough to allow air and gases to readily flow therethrough but they should be small enough to somewhat restrict the flow of molten metal therethrough.

While the invention has been shown and described with respect to the art of die casting, the concept of the invention is applicable to principles of permanent mold casting, to the molding of plastic articles, and to sand mold casting.

Various other changes and modifications may be made without departing from the spirit of the invention and all of such changes are contemplated as may come within the scope of the claim.

What I claim is:

In combination: a die formed with a cavity and with a molten metal inlet passage opening into said cavity, said die being separable into two sections along a plane through the die, and said die being formed with a socket remote from said cavity and said inlet passage which socket is positioned with its axis in the plane of separation of said die, said socket extending inwardly from one side of the die and having a closed end, and said die being formed in one of its meeting faces with a single air evacuating passage remote from said inlet passage and extending between the closed end of the socket and said cavity, said pair of passages being the only passages leading to and from said cavity, said air evacuating passage being of considerably less cross-sectional area than said socket; an air-evacuating piston slidably positioned in said socket for withdrawing air from said cavity via

said single-evacuating passage, said piston having a cubic displacement at least as great as the combined volume of said die cavity and the pair of passages within the die communicating with said cavity; pressure means cooperable with the molten metal inlet passage for injecting molten metal into the cavity; and means for moving said piston away from the closed end of said socket in timed relationship with the injection of molten metal into the die to thereby create a vacuum in said cavity during an injection operation.

HENRY F. SCHROEDER.

REFERENCES CITED

The following references are of record in the file of this patent:

Number	
937,477	
1,153,220	
1,607,677	5
1,697,741	
1,960,992	
2,181,157	
2,209,882	10
2,210,544	

UNITED STATES PATENTS

Name	Date
Shonberg	Oct. 19, 1909
Grey	Sept. 14, 1915
Korsmo	Nov. 23, 1926
Vaughan	Jan. 1, 1929
During et al.	May 29, 1934
Smith	Nov. 28, 1939
Galloway	July 30, 1940
Galloway	Aug. 6, 1940

FOREIGN PATENTS

Number	Country	Date
507,036		
331,518	Great Britain	June 8, 1939
66,914	Germany	Jan. 8, 1921
	Denmark	May 31, 1948