March 11, 1952 W. M. VENNER ET AL 2,588,898

APPARATUS FOR MOLDING PISTONS

Filed May 27, 1950 3 Sheets-Sheet 1

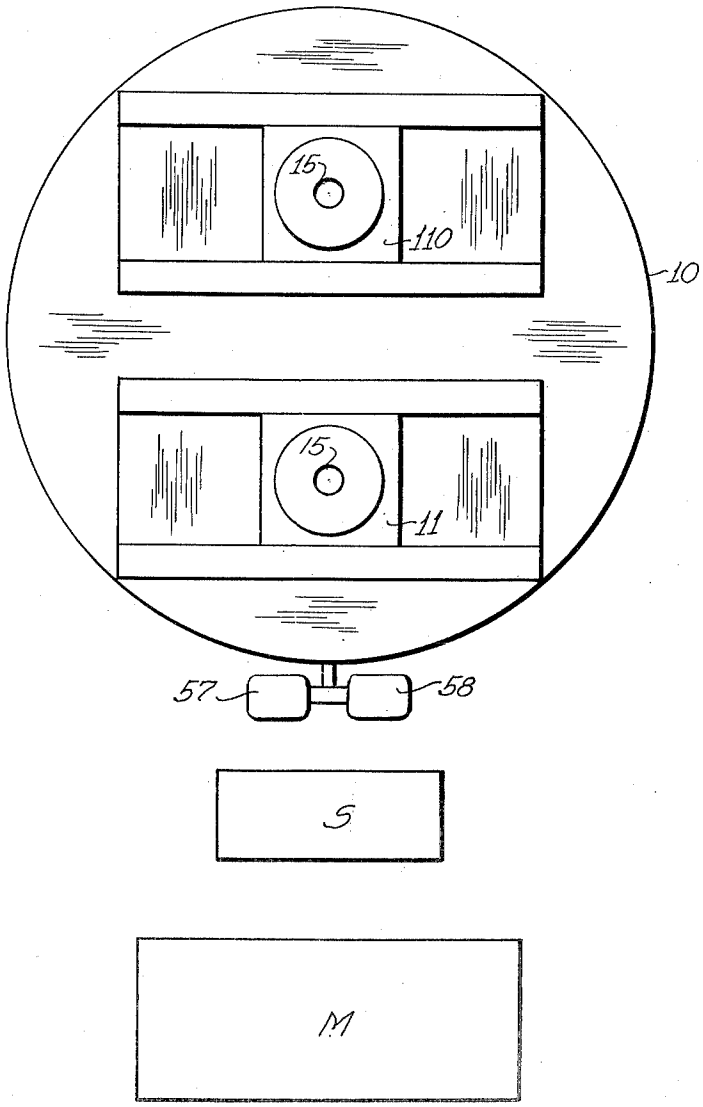



Fig. 1.

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Fig. 2.

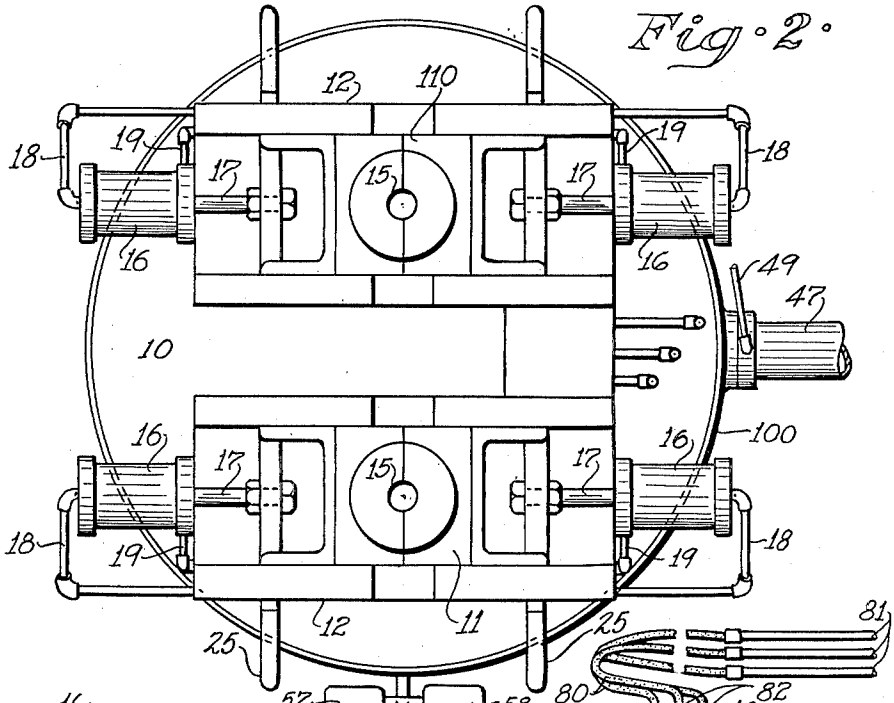



Fig. 3.

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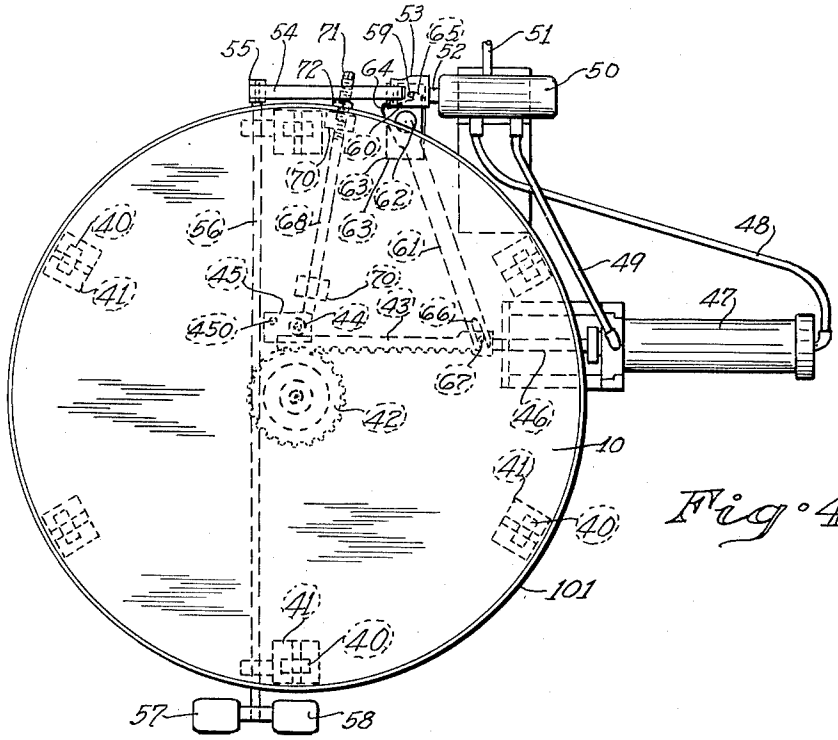



Fig. 4.

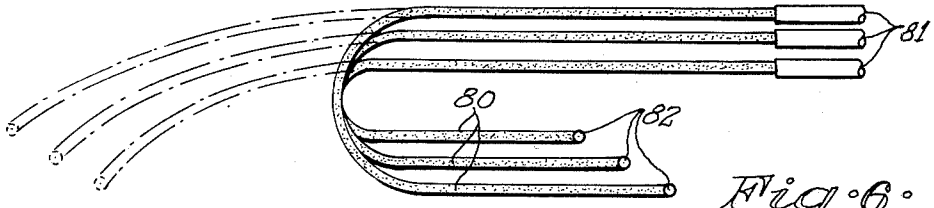



Fig. 6.

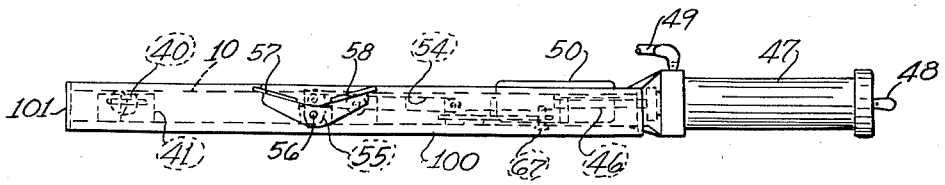



Fig. 5.

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# UNITED STATES PATENT OFFICE

2,588,898

## APPARATUS FOR MOLDING PISTONS

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Application May 27, 1950, Serial No. 164,812

2 Claims. (Cl. 22—77)

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This invention relates to an apparatus for molding pistons, and particularly aluminum and magnesium alloy trunk pistons. This application is a continuation of application Ser. No. 620,571, filed October 5, 1945, now abandoned, as to common subject-matter. Processes and apparatuses of this character, adapted for this purpose, are disclosed in the following patents: No. 1,551,193, August 25, 1925; No. 1,952,199, March 27, 1934; No. 2,129,351, September 6, 1938; No. 2,204,407, June 11, 1940.

An apparatus of the character described in the above patents comprises generally a pair of mold sections formed externally to shape the outside of the piston and a series of relatively collapsible core sections formed to shape the inside of the piston. In the apparatus of the character described in the above-noted patents the piston is cast with the head up and the gate is therefore at the top, and mechanism is provided for shifting the mold sections and the cores of the molds manually, hydraulically, pneumatically, or by cam mechanism.

Aluminum and magnesium alloys have relatively high crystallization shrinkages and co-efficients of expansion. A trunk piston embodies a head of relatively thick cross section and a skirt of relatively thin cross section. Where such a piston is cast with the head up and with the gate at the top, crystallization shrinkage is first compensated for in the skirt drawing from the metal in the head and the latter is then compensated for by drawing from the metal in the gate. More or less complete compensation for crystallization shrinkage finally in the head is indicated by a dropping of the gate in the center and coloration of that gate. The molder can therefore determine by observation when crystallization shrinkage has been compensated for. There is, however, also shrinkage due to the high co-efficient of expansion of aluminum and magnesium alloys. The thin skirt will, of course, chill first followed by chilling of the head and finally followed by chilling of metal in the gate. Where the alloy is cast over a core usually collapsible in form which must be withdrawn after casting, the skirt will contract on the core materially before it begins to contract at the head part. If, of course, the metal contracts on the core before the core is withdrawn to such extent as to seize the core, then it will be impractical or impossible to withdraw the core so that usually the casting must be brought to such a high temperature as to ruin it before it can be withdrawn from the core. Where the core is a part of a

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machine that of course represents great difficulties. Such conditions are not so outstanding where the piston is cast with the head down because in such a case, the gate will extend along the skirt and will remain in molten or plastic condition perhaps even after the head has set. A proceeding, however, in which the piston is cast with the head up has great advantages over a proceeding in which the piston is cast with the head down because the former permits the casting to be performed in a machine.

We want to observe here that it is not so important to time the opening of the outside mold for unless that mold has parts going into the casting, which is very rare, it may be left closed an extended period after the metal has set because any shrinkage will be away from the mold and moreover the mold is made up of halves. The important consideration in casting a piston employing a core, particularly casting with the head up, is to release or extract the core from the casting as soon as possible in order to prevent any seizure of the casting on the core. The practice, therefore, is to watch the gate closely and as soon as crystallization shrinkage has been substantially compensated for, indicated by the appearance of the gate, the core is immediately withdrawn; thereafter the mold can be opened in a more or less leisurely fashion determined by the speed with which the casting operation is to be completed. Of course, the core should not be withdrawn too early because if that is done, the casting will be ruined. It should be really withdrawn at the right time.

The above will show the disadvantage of an apparatus for casting a piston with the head up and with the gate on top, and thereafter inverting the mold with its core in order to take the cores out by an upward movement. Even if the gate is closely observed, there is liability in two directions: first, if the mold is inverted too soon even before crystallization shrinkage of the head has been compensated for, the casting will be deficient, if not ruined; second, if, however, the mold with its core is inverted for too long a period after casting, then the skirt may seize the core and render it difficult and even impossible to extract the same without ruining the casting. This will show the importance of always maintaining a mold core assembly with the gate up at all times but withdrawing the cores from the bottom thereby avoiding the two above possibilities mentioned.

In view of the fact that the metal must be set after pouring, it has been possible for a single

molder to operate a number of mold assemblies, and these are arranged adjacent a supply of molten metal, with the molder stationed between the molds and the supply, and for this purpose the molds are arranged side-by-side facing the source of supply. This, however, not only takes up space but requires that the molder direct practically his entire attention visually and manually to one mold assembly while pouring, requiring the molder to distract his attention from the other mold assembly in which the metal may be setting.

One of the objects of this invention, therefore, is to provide an apparatus for molding pistons in which a plurality of mold assemblies is arranged adjacent a supply of molten metal with the molder between the supply and the mold assemblies; but the apparatus is such that the molder, while pouring, can have the mold assembly, in which the metal is setting, under close observation.

Another object is to provide an apparatus of the character described in which the floor space required is materially reduced.

Further objects will appear from the detail description, taken in connection with the accompanying drawings, in which will be described and shown an illustrative embodiment of this invention. It is to be understood, however, that various changes may be made in details, within the scope of the appended claims, without departing from the spirit of this invention.

In the drawings, Figure 1 is a plan view, generally diagrammatic in form, embodying this invention;

Figure 2 is a detail plan of the mold assembly of Figure 1, again somewhat diagrammatic in form;

Figure 3 is a front view of the mold assembly again somewhat diagrammatically in form;

Figure 4 is a plan of the top of the carrier with the molds omitted;

Figure 5 is a front view of the carrier; and

Figure 6 is a plan showing flexible operating connections to the mold-operating means.

Generally stated and in accordance with the illustrative embodiment of this invention, a plurality of piston molds, each provided with a gate at the top and with a core movable downwardly from the bottom, are arranged adjacent a supply of molten metal with the molder stationed between the molds and the supply, and power operated mechanism under control of the molder at the molder's station is provided for rapidly shifting the molds alternately and in succession contiguous the molder's station for pouring the metal into the top of the mold away from the station for setting of the metal, then back to the station for removal of the casting from the top of the mold. The molds are, however, so arranged that when one mold with its core is away from the molder's station, it is with its gate within the unobstructed view of the molder at the station at which the molder is pouring the mold from its core at that station.

The apparatus comprises a carrier 10, which is supported for movement on a sub-base 100, a plurality of piston molds 11, 110, arranged oppositely on the carrier, and means 40, for mounting the carrier 10 for movement on the sub-base 100 to permit shifting of the molds alternately and in succession contiguous to the molder's stations for pouring of the metal into the top of the mold and away from the station for setting of the metal, then back to the station



for removal of the casting from the top of the mold. Means 42—47 is provided for moving the carrier to so position the molds. The molds may comprise sections, together with means for moving the sections relatively. Flexible operating connections 80, may be provided for the mold-operating means, and where they are of the fluid-operated type, whether hydraulic or pneumatic, these flexible operating connections may be in the form of hose.

Referring now to the accompanying drawings, and particularly to Figures 1 and 2, 10 designates a carrier on which is mounted a pair of molds or mold assemblies designated as 11 and 110 and which are arranged oppositely on the carrier. Each mold or mold assembly comprises a base 12 supported on the carrier by uprights 13. Mounted to slide laterally on the base 12 are a pair of mold sections 14 so as to be movable to the open and closed positions, with the mold sections when closed forming a gate 15. A pair of cylinders 16 provided with pistons (not shown) are connected by rods 17 to the mold sections, and each of these cylinders is provided with fluid - connections 18 and 19, respectively. Another cylinder 20 is supported by a bracket 21 from the base 12 and is provided with a piston (not shown) connected with a rod 22, and the cylinder is further provided with fluid-connections 23 and 24. The rod 22 is connected with the central part of a core (not shown) within the mold sections 14, while the side core parts (not shown) are connected to levers 25 moving in slots 26 on the base.

The parts so far described, with the exception of the carrier 10, may be of any suitable construction as shown in the various patents enumerated above. In molds of the character described and as shown in the patents enumerated, the mold is provided with a gate at the top, with a center core which moves downwardly from the bottom, with side cores movable into the space previously occupied by the center core and with mold sections which move laterally to open the mold. As shown in these patents, the various parts of the mold and of the core may be operated by fluid pressure or manually. It is also to be understood that in the broadest aspects of this invention the mold sections, as well as the core sections or parts, may be operated manually. The core may further be a 3-part core or a 5-part core, as is also shown in the above-enumerated patents.

Referring now to Figures 3, 4, and 5, the carrier 10 is mounted on rollers 40 mounted on brackets 41 arranged on the floor or on a flanged sub-base so that the carrier rests on the rollers within the flange 101. This carrier may be shifted rotatably in any suitable manner and by any suitable mechanism other than herein described. With this particular embodiment, the carrier 10 is provided with a gear 42 fixed thereon with which meshes a rack 43 held against the gear by a roll 44 on a bracket 45 on the sub-base. This rack is connected with a rod 46 of a piston (not shown) working in a cylinder 47 supported on the floor or on the sub-base. This cylinder is provided with fluid-connections 48 and 49 for hydraulic or pneumatic fluid, leading from a 4-way valve 50 on the sub-base of any suitable construction, and to which the fluid is supplied by a connection 51. This valve is provided with a stem 52 having a head 53 connected by link 54 with an upstanding arm 55 on a rock shaft 56 on the sub-base 100 provided with pedals 57 and

58. The head 53 is also provided with a pin 59 working in an arcuate recess 60 in one end of a lever 61 pivoted at 62 on bracket 63 on the floor or on the sub-base. The arcuate recess terminates with shoulders 64 and 65 for engagement with the pin 59. The other end of the lever has a slot 66 engaging the pin 67 on the rack 43. The bracket 45 may be pivoted at 450 on the floor or on the sub-base and is engaged by a bar 68 moving in guide brackets 70 on the sub-base. This bar may be adjusted lengthwise by an adjusting nut 71 screwed into the bracket 70 and provided with a lock nut 72.

Assuming the carrier to be in the position shown in Figures 2 and 3 at which time one of the mold assemblies is adjacent to and near the molder's station, indicated at S of Figure 1, the procedure of shifting the carrier to bring the opposite mold assembly in a position for pouring is as follows:

The molder will depress the left treadle 57 thereby shifting the valve 50, Figure 4, through the connections 56, 55, 53, and 52. This will admit fluid through the connection 48 to the cylinder 47, causing its piston to move to the left, Figures 2 and 4, causing the rack 43, by engagement with the gear, to shift the entire carrier 10 through 180°. In doing so, the lever 61 will be carried along with the rack and cause the shoulder 64 to engage the pin 59 so as to shift the head 53 and thereby the valve rod 52 in order to close the valve. The carrier will therefore come to rest after rotation of 180°. In order to shift the carrier back, the molder will depress the right treadle 58, which, by the connections previously described, will cause the valve to admit fluid to connection 49 and to the left end of the cylinder 47 so as to move the rack 43 back to the position shown in Figure 4, and at the end of the 180° rotation of the carrier the lug 65 will engage the pin 59 to again close the valve.

Referring again to Figure 1 in connection with Figure 3, it will be seen that the molder's station S is between a mold assembly 11 and a source of supply of molten metal M, while the opposite mold assembly 110 will be opposite the mold assembly 11 but in the direct line of vision of the molder at his station. The molder will fill his ladle from the supply M and pour the metal into the mold assembly 11. After pouring is completed the molder will step on the left pedal 57, causing the carrier 40 to rotate in order to shift the mold assembly 110 to the position contiguous the molder's station while the mold assembly 11 is now moved away from the molder's station. The molder will then pour the metal into mold assembly 110 (assuming it to be empty). The procedure then is as before, the molder now depressing the right pedal 58 after he has completed pouring of the mold assembly 110. Whenever a mold assembly such as 11 and 110 arrive contiguous the molder, he will shift the various mechanisms to open the mold, collapse the core, and remove the piston.

Assuming in Figure 1 that the mold assembly 11 is adjacent the station S and that the metal in mold assembly 110 is setting, the molder, in opening the mold assembly 11, collapsing its cores removing the casting, and subsequently closing the mold assembly and expanding the cores followed by pouring, will at all times have the mold assembly 110 under his direct observation as it is directly opposite. Accordingly, any disturbance in the proper functioning of the mold assembly 110 will be always under direct observation. This is important because the functioning will be noted by the dropping of the gate and the change of color of the metal in the gate. This feature therefore is of great advantage in securing efficient and reliable metallurgical functioning of the entire apparatus. Moreover, since the mold in which the metal has set is moved back to the station for the removal of the casting, the same molder is able to further check upon the functioning of the entire process and apparatus. All of this can be accomplished by a single molder under whose control is the entire functioning of the apparatus.



The time allowed for the molder to fill his ladle from the source of supply M is very short, so that even if the molder's attention is then distracted, thereafter while he is pouring the mold at the molder's station, he can observe what is taking place in the gate of the mold diametrically opposite. It should be observed here that when the molder has stepped on treadle 58 or 57 after the completion of the pouring of the mold, the mold itself is rapidly moved by mechanism away from the molder's station to a diametrically opposite position. In other words, the time required for a poured mold to travel from the molder's station to the diametrically opposite position is accomplished in a short space of time so that actually the mold will be at the setting position during substantially the entire time required for setting. Likewise the travel of the mold from the setting position back to the molder's station is accomplished rapidly by treadle control. This is again of importance because if the molder should observe something not functioning properly at the setting position, he can immediately shift that mold back to him. That is important because if the metal should solidify, the piston will be ruined and seize on the core unless the core is withdrawn. Actually, the center core can be withdrawn before complete solidification because the side cores remain in position, but can move towards one another upon shrinking of the metal.

Referring again to Figure 1, it will be seen that the mold assembly is presented for pouring and again is disassembled directly contiguous the molder so that he need only move a minimum amount, as distinguished from an arrangement in which the mold assemblies are arranged side-by-side. Furthermore, the floor space required is materially reduced by this arrangement of the mold assemblies.

It will be seen that where the mold and core operating mechanisms are mounted on a shiftable carrier, operating connections must be provided in order to supply the mechanism with fluid, for instance such as hydraulic or pneumatic fluid. Referring now to Figure 6, in accordance with this invention, flexible operating connections 80 in the form of a rubber hose are provided from conduits or pipes 81 from the main source of fluid supply to the fluid connections 82 to the mold and core operating mechanisms. Provision of this flexible hose furnishes means whereby the connections may be maintained during the shifting of the carrier without liability of breakage of connections or leakage. This is particularly true of the embodiment shown in Figure 3 because the rubber connections may be made directly to the pipes by suitable hose clamps and even cemented to provide for permanence.

It will thus be seen that the invention accomplishes its objects. An apparatus is provided in which the steps and the elements are so com-

bined as to work together in harmony to not only speed up production of aluminum magnesium alloy trunk piston castings, but also to avoid defective castings and seizure of the casting on the core. By casting the piston with the head up and the gate on top and with cores moving downwardly to withdraw them from the mold, it is possible to shift the mold from pouring to setting position while the molder at the molding station can keep the gate of the mold which has been poured under constant observation. This observation is not only permitted because the cores are out of the way and below the gate, but even the connections to the mechanisms are so made as to not obstruct that view. As soon as the condition of the gate indicates that the alloy in the mold which is in setting position away from the station, the mold can be quickly moved back to position where the molder can quickly release the core. Thereafter, he can open the mold and remove the casting in a more or less leisurely fashion, depending more or less upon the speed of output desired.

The invention having thus been described, what is claimed is:

1. An apparatus for molding trunk pistons of aluminum and magnesium alloys having relatively high crystallization shrinkages and coefficients of expansion and embodying a head having a relatively thick cross section and a skirt of relatively thin cross section, in which a molder's station is arranged adjacent a supply of molten metal, comprising, a plurality of piston molds, each shaped to cast the piston with the head up, each provided with a gate at the top and with a core movable downwardly from the bottom, a carrier for said molds and their respective cores which are maintained thereon with their gates up and with their cores below, said molds and their respective cores being arranged in diametrically spaced relation on said carrier so that when one mold and its core is at the molder's station, the other mold and its core will be away from that station but diametrically opposite the first mold and its core and with its gate within the direct and unobstructed view of the molder at the station while pouring the mold at that station, mechanism for opening and for closing each mold and for withdrawing and for replacing its core while at that station, means for mounting said carrier for movement, and power-operated mechanism under control of the molder at the molder's station for rapidly shifting said carrier and with it said molds and their respective cores in synchronism while maintaining their relative positions with each mold and its core to positions: first contiguous the molder's station for pouring of the metal into the top of the mold, second away from the station for setting of the metal, and third back to the station for downward withdrawal of the core, opening of the mold, removal of the casting from the top of the mold and closing of the mold and core for repouring.

2. An apparatus for molding trunk pistons of aluminum and magnesium alloys having relatively high crystallization shrinkages and coefficients of expansion and embodying a head having a relatively thick cross section and a skirt of relatively thin cross section, in which a molder's station is arranged adjacent a supply of molten metal, comprising, a plurality of piston molds, each shaped to cast the piston with the head up, each provided with a gate at the top and with a core movable downwardly from the bottom, a carrier for said molds and their respective cores which are maintained thereon with their gates up and with their cores below, said molds and their respective cores being arranged in diametrically spaced relation on said carrier so that when one mold and its core is at the molder's station, the other mold and its core will be away from that station but diametrically opposite the first mold and its core and with its gate within the direct and unobstructed view of the molder at the station while pouring the mold at that station, mechanism for opening and for closing each mold and for withdrawing and for replacing its core while at that station, and means for mounting said carrier for movement, and power-operated mechanism under control of the molder at the molder's station for rapidly shifting said carrier and with it said molds and their respective cores in synchronism while maintaining their relative positions with each mold and its core to positions: first contiguous the molder's station for pouring of the metal into the top of the mold, second away from the station for setting of the metal, and third back to the station for downward withdrawal of the core, opening of the mold, removal of the casting from the top of the mold and closing of the mold and core for repouring, flexible operating connections to said mechanism but constructed to leave direct view of the molder at the molder's station unobstructed of the gate of the mold when away from and opposite that station.

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