J. H. BAMBERG.

METAL MOLD.

APPLICATION FILED MAR. 7, 1916. RENEWED JAN. 9, 1919.

1,296,588.

Patented Mar. 4, 1919.

5 SHEETS—SHEET 1.

Fig. 1.

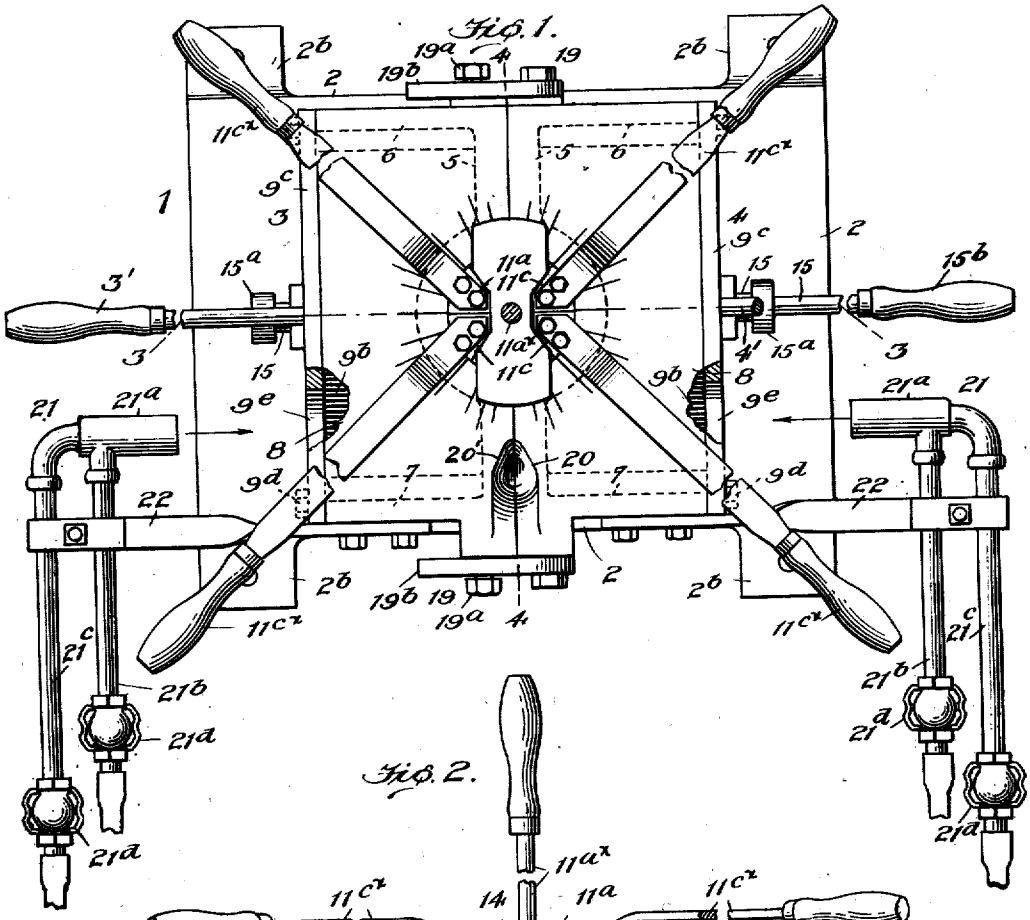
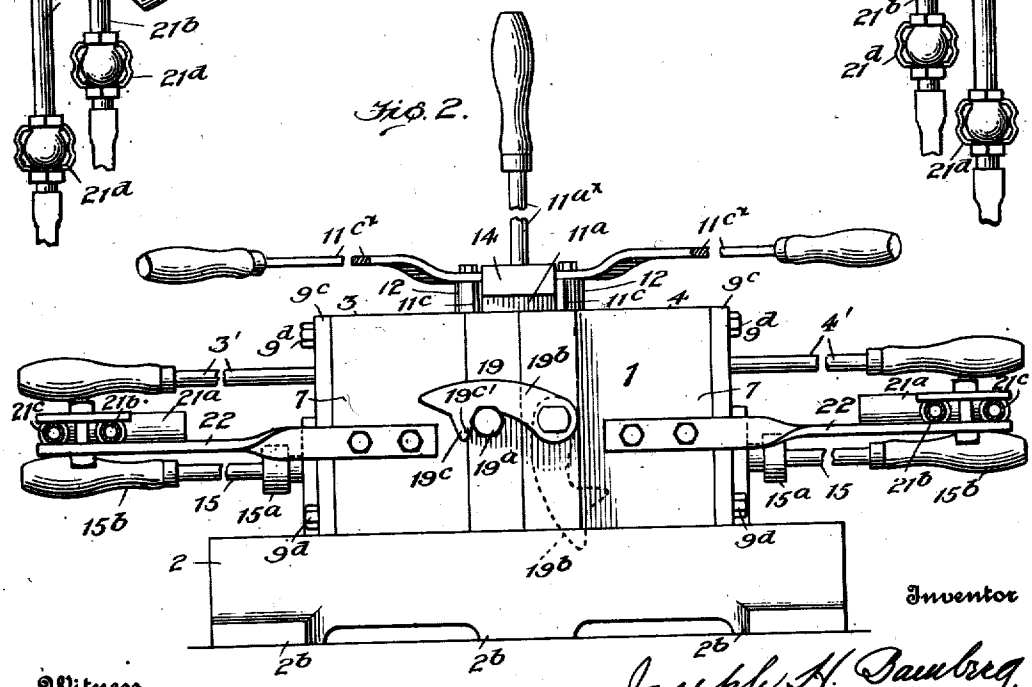


Fig. 2.



Witness

Edwin L. Bradford

Inventor

Joseph H. Bamberg.

By Edward B. Alexander

Attorney

J. H. BAMBERG.

METAL MOLD.

APPLICATION FILED MAR. 7, 1916. RENEWED JAN. 9, 1919.

1,296,588. Patented Mar. 4, 1919.

5 SHEETS—SHEET 2.

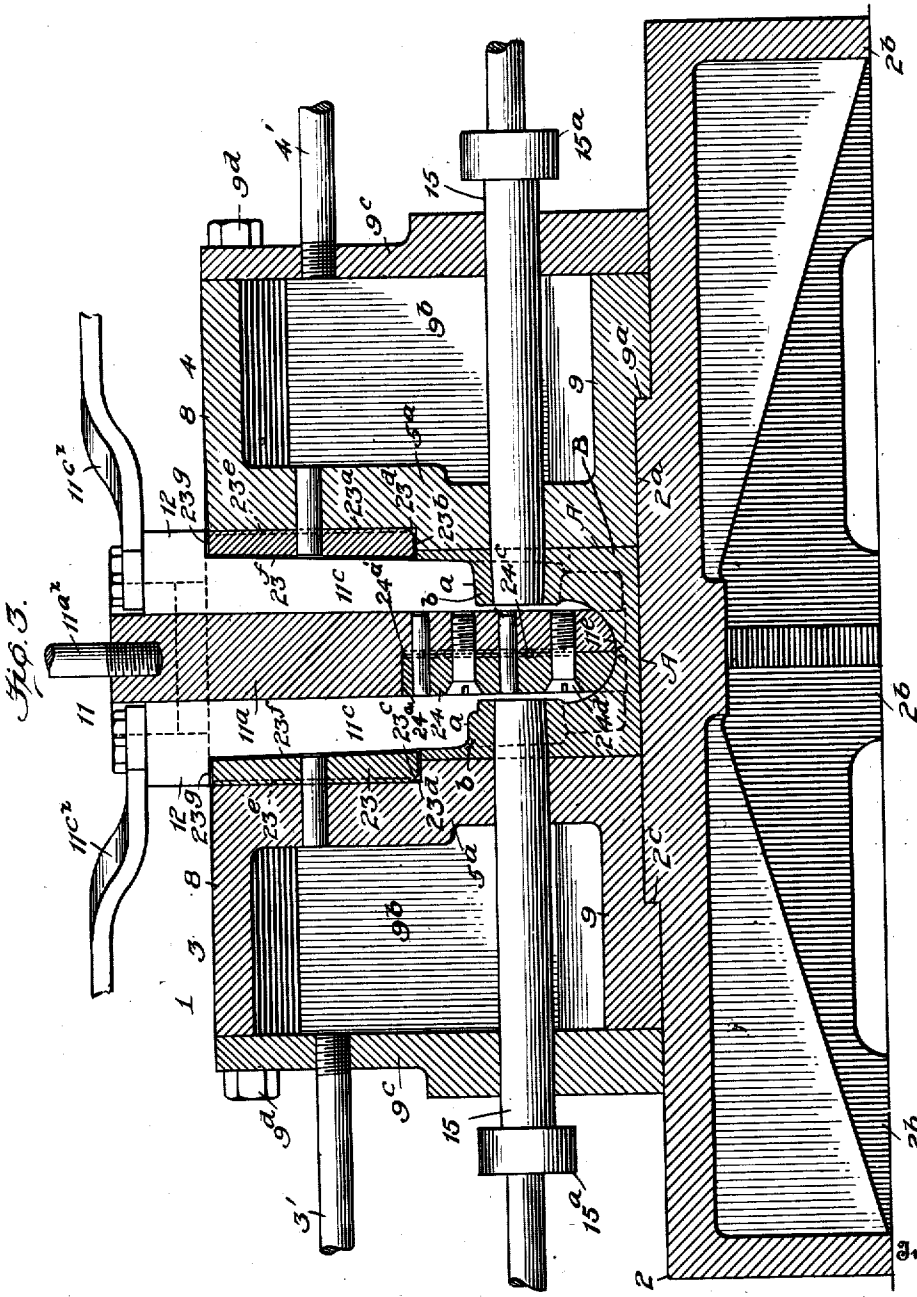


Fig. 3.

Witness

Edwin L. Bradford

Inventor

Joseph H. Bamberg.

By Edward R. Alexander

Attorney

J. H. BAMBERG.

METAL MOLD.

APPLICATION FILED MAR. 7, 1916. RENEWED JAN. 9, 1919.

1,296,588. Patented Mar. 4, 1919.

5 SHEETS—SHEET 3.

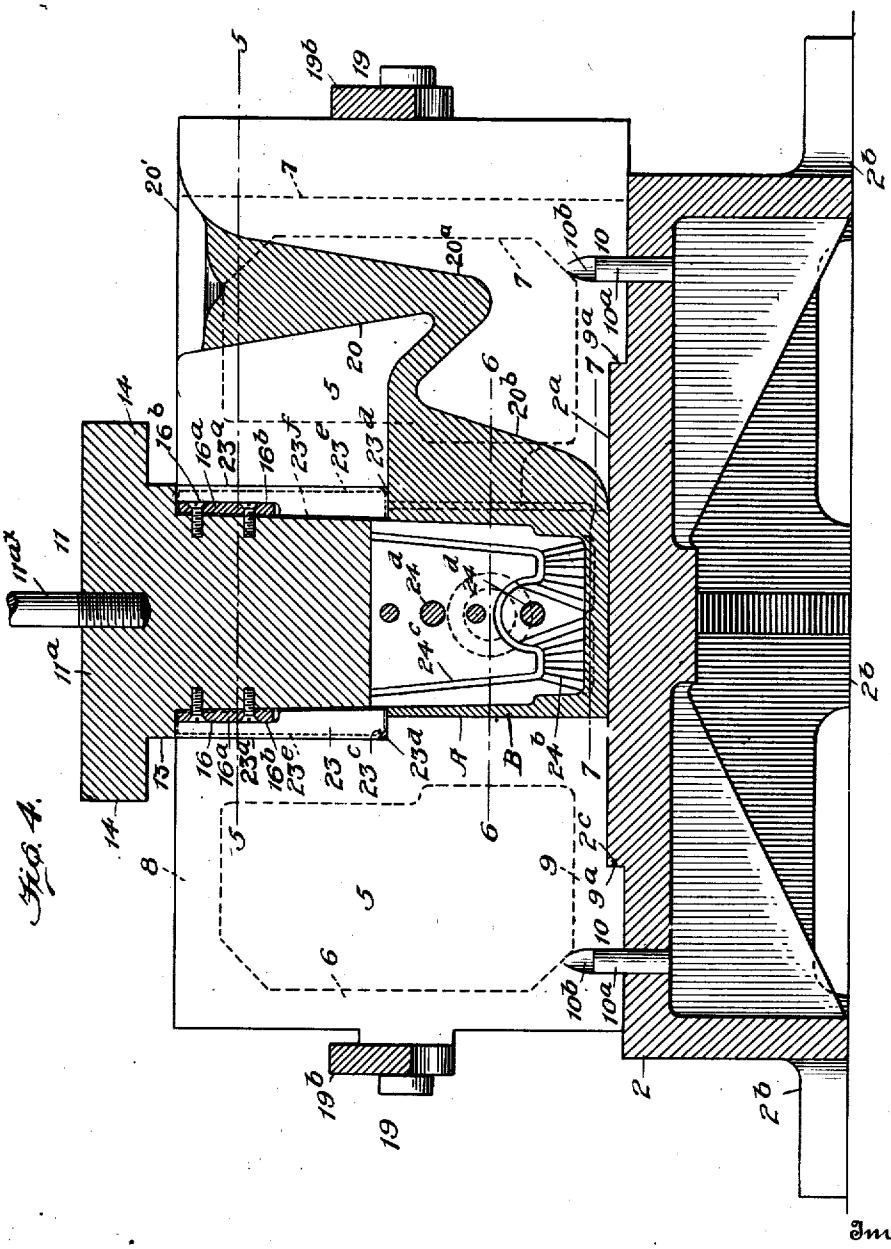


FIG. 4.

Inventor

Witness

Edwin L. Bradford

By Joseph H. Bamberg.

Edward R. Alexander

Attorney

J. H. BAMBERG.

METAL MOLD.

APPLICATION FILED MAR. 7, 1916. RENEWED JAN. 9, 1919.

1,296,588.

Patented Mar. 4, 1919.

5 SHEETS—SHEET 4.

Fig. 5.

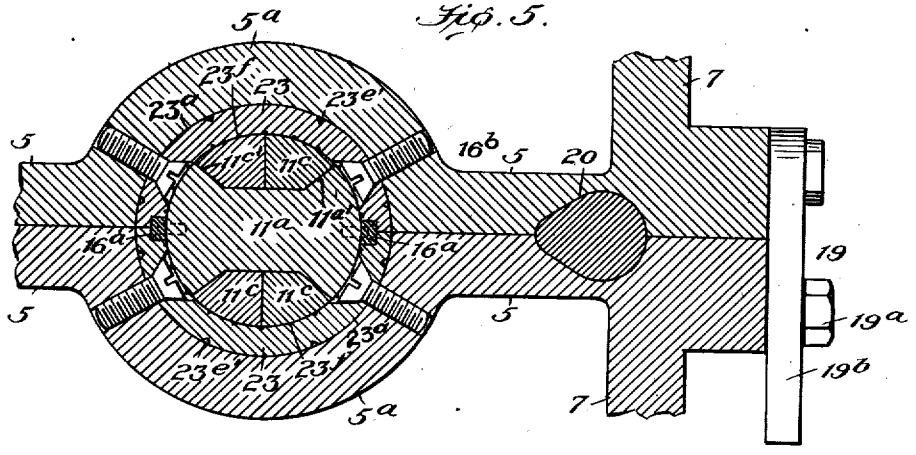


Fig. 6.

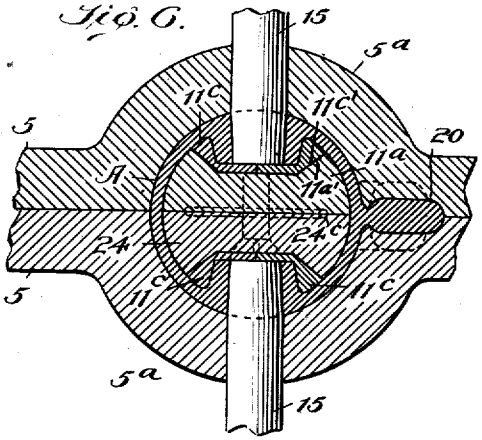


Fig. 8.

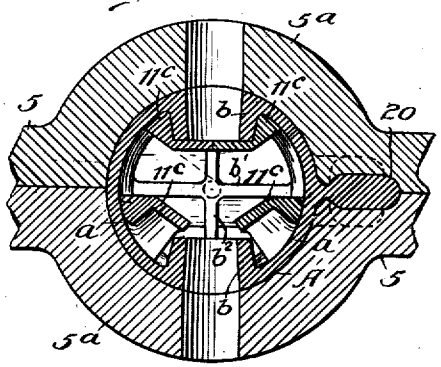


Fig. 7.

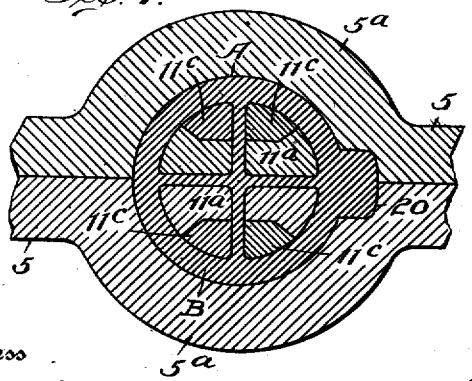
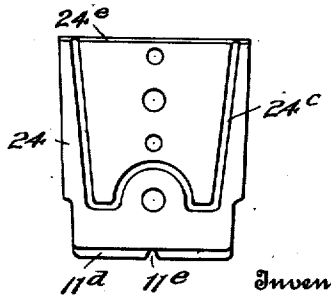


Fig. 9.



Witness

Edwin L. Bradford

Inventor

Joseph H. Bamberg,

By Edward B. Alexander

Attorney

J. H. BAMBERG.

METAL MOLD.

APPLICATION FILED MAR. 7, 1916. RENEWED JAN. 9, 1919.

1,296,588.

Patented Mar. 4, 1919.

5 SHEETS—SHEET 5.

Fig. 10.

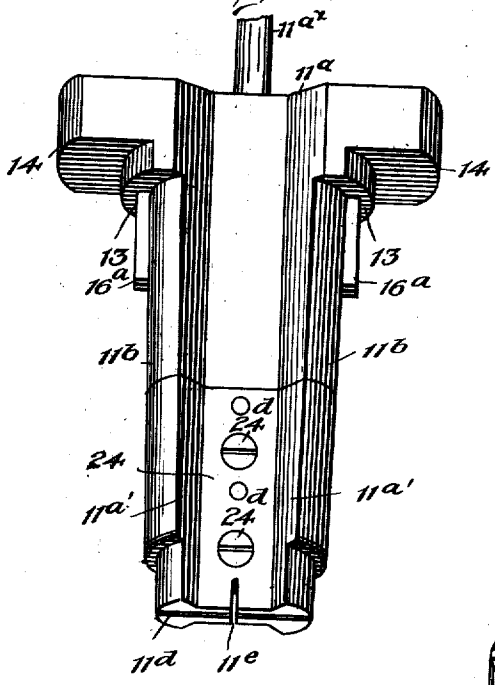


Fig. 12.

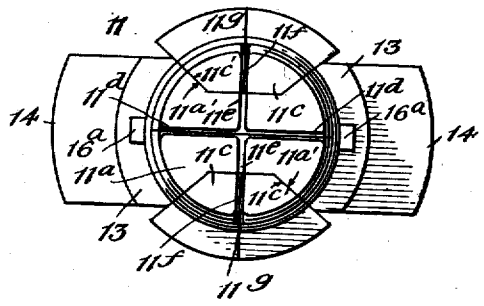


Fig. 13.

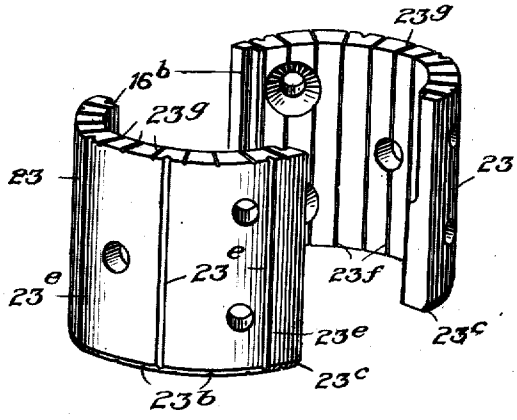


Fig. 11.

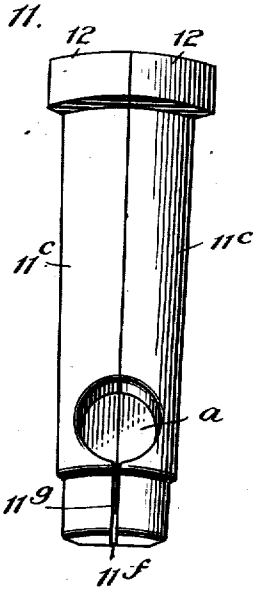
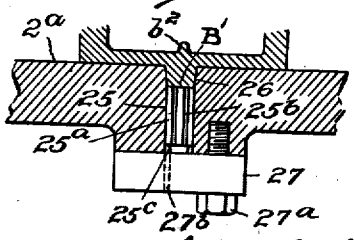


Fig. 14.



Witness

Edwin L. Bradford

Inventor

By Joseph H. Bamberg,

Edward R. Alexander

Attorney

UNITED STATES PATENT OFFICE.

JOSEPH H. BAMBERG, OF TONAWANDA, NEW YORK, ASSIGNOR TO THE ALUMINUM CASTINGS COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

METAL-MOLD.

1,296,588. Specification of Letters Patent. Patented Mar. 4, 1919.

Application filed March 7, 1916, Serial No. 82,528. Renewed January 9, 1919. Serial No. 270,446.

To all whom it may concern:

Be it known that I, JOSEPH H. BAMBERG, a citizen of the United States, residing at Tonawanda, in the county of Erie and State of New York, have invented certain new and useful Improvements in and Relating to Metal-Molds, of which the following is a specification.

This invention relates to molds adapted to receive molten metal or metallic alloys, such as aluminum or aluminum alloys, and more particularly the invention relates to permanent molds each comprising a plurality of sections or parts constructed and correlated to form a complete mold cavity.

One object of my invention is to provide an improved permanent mold including the core, adapted for the easy and rapid casting of cup-shaped articles (such as pistons for operation within engine cylinders) which may be equipped with inwardly extending bosses, ribs, extensions, etc., and the sections of which may be so constructed and correlated that in casting, the metal will quickly flow through and to all parts of the mold cavity, and which may be readily and quickly separated to permit the removal of the casting without damage thereto.

Other objects of my invention are to provide a sectional core to facilitate its insertion into and ready removal from the mold cavity, the sections being readily and quickly withdrawable to free the casting and its projections, etc., by the combined lateral and axial movement of the sections relative to the casting. These core sections and the mold body are constructed and correlated to insure control of the setting of the metal as desired throughout the casting, and the core sections are so arranged that should any fins be formed in casting, they may be readily removed without damage to the walls of the castings.

Other objects of the invention are to provide improved means for venting the mold cavity to facilitate the elimination of gases and air therefrom during the casting operation, and also for the circulation of heat through a chamber about the mold cavity, by which the mold parts are maintained at a desired temperature.

Other objects of my invention are to provide an improved mold in which (*a*) the setting of the casting will take place progressively, and (*b*) at substantially all times during the solidification period, the portions of the freezing metal still liquid will be in communication with a source of liquid metal, so that the cavities which would normally be formed by crystallization shrinkage in the casting are filled up, and porosity of the metal is prevented.

Other objects of my invention are to provide an improved mold in which to cast a metallic alloy of the character of aluminum alloys which will produce a relatively small quantity of eutectic in the casting, and which eutectic will be caused substantially to surround the excess substance in the casting, the construction of the mold being such as to insure freedom from porosity due to crystallization shrinkage and to cause the casting to be chilled or set with sufficient rapidity to produce a relatively fine grain structure.

Another object of my invention is to provide an improved mold in which to cast a metallic alloy having a relatively low specific gravity and a relatively high coefficient of heat conductivity and in which the casting made will contain a relatively small volume of metal for the desired product and will require substantially no cleaning and a minimum amount of machining.

Another object of my invention is to provide an improved mold in which to cast a metallic alloy, all of the walls of which mold, including core parts, which constitute the mold cavity, being shaped and disposed so that they may be easily and readily coated or treated, in any well known manner, to prevent undesirable agitation of the molten metal when it flows into contact therewith, thus insuring proper setting of the metal within the mold cavity.

With these and other objects in view, the invention consists in the parts and combination or combinations of parts herein selected for the purposes of illustration and hereinafter described in the following specification and set forth in the appended claims.

For the purpose of illustration, I have, in the accompanying drawings, shown and herein described one form of apparatus embodying my invention.

Figure 1 is a plan view of a mold embodying my invention, parts of the mold being broken away.

Fig. 2 is a side elevation of the mold.

Fig. 3 is a cross-section on the line 3—3 of Fig. 1.

Fig. 4 is a cross-section on the line 4—4 of Fig. 1.

Figs. 5, 6 and 7 are fragmentary horizontal sections on the lines 5—5, 6—6, and 7—7 of Fig. 4, respectively.

Fig. 8 is a view similar to Fig. 6 but showing the center core section removed and two of the side sections swung laterally to illustrate the manner of freeing the same for removal.

Fig. 9 is an insert for the main core section.

Fig. 10 is a perspective view of the main core section.

Fig. 11 is a perspective view of two side sections of the core.

Fig. 12 is a bottom plan view of the assembled core.

Fig. 13 is a perspective view of the devices, detached and separated, which are used for venting of the upper end of the mold cavity.

Fig. 14 is a fragmentary sectional view of a portion of a mold slightly modified to provide for venting in casting certain types of cup-shaped articles.

In the drawings, 1 indicates as an entirety a permanent mold comprising a series of members constructed to form a casting of the desired shape, such as a skirted or cup-shaped piston for an internal combustion motor. The mold illustrated in the accompanying drawings may be formed from cast iron or other suitable material. The main part or body of the mold preferably comprises a base member 2, and complementary members 3, 4, movable on the base member 2 toward and from each other. The base member 2 may comprise a platform or base plate 2^a, the central portion of which is suitably surfaced to form the bottom of the mold cavity A. The base member 2 is by preference mounted on feet or standards 2^b.

Each of the complementary members 3, 4, may comprise a side wall 5, end walls 6, 7, and top and bottom walls 8 and 9, respectively. These walls may be integrally formed, as shown in the drawings. The walls 6, 7, 8 and 9 of each member project outwardly from the rear face of the wall 5 to form a heating chamber 9^b, the outer side of which is formed by a plate 9^c fixed in a well-known manner to the end edges of the walls 6, 7 and 8 by bolts 9^d.

3', 4', indicate handles, connected in any well known manner to the plates 9^c for the respective mold members 3, 4, whereby the latter can be conveniently moved to and from the operative position.

The wall 5 of the mold member 3 is adapted to engage with the wall 5 of the member 4 when said members are moved together, as shown in Fig. 1. The wall 5 of each mold member 3, 4, is provided between its ends with a semi-circular portion 5^a which in coöperation with the similar semi-circular portion of the other mold member, and the surfaced portion of the base plate 2^a, forms the outer wall of the mold cavity A. The wall 5 is, in the preferred from of the invention, relatively thick in order that it may be capable of retaining sufficient heat to make the mold efficient for casting pistons or other cup-shaped articles from various metals and alloys, such as aluminum alloys.

At 2^c, the base plate 2^a is provided with an annular shoulder and the bottom walls 9 of the mold members 3, 4, are recessed at 9^a to receive the shoulder 2^c, whereby the mold members 3, 4, are properly alined relatively to each other and also centered on the base plate 2^a when moved together, as shown in Fig. 1.

10 indicates auxiliary devices for alining and centering the mold members 3, 4. The auxiliary devices 10 may be used in connection with and auxiliary to the devices 2^c and 9^a, or as a substitute therefor. The auxiliary devices 10 preferably comprise a pair of upwardly projecting stationary pins 10^a arranged near opposite sides of the base plate 2^a and recesses 10^b formed in the opposing faces of the walls 5 of the mold members 3, 4. The pins 10^a and recesses 10^b coöperate to cause the positioning of the mold members 3, 4, at a predetermined position each time they are moved together, it being necessary to so position the members 3, 4, that their recesses 10^b will receive the pins 10^a to bring them face to face to form the mold cavity A.

11 indicates as an entirety a permanent sectional core adapted to removably fit within the mold cavity A. The sides of the core may be slightly tapering to facilitate its removal.

The core 11 preferably comprises a plurality of parts made of steel, though other suitable material may be used; in the illustrated example it consists of a main or center section 11^a having curvilinear end walls 11^b, and pairs of segmental sections 11^c arranged at opposite sides of the center section 11^a. Each section of each pair of side core sections 11^c at either side of the center section is bodily laterally movable after the center section 11^a has been removed, as illustrated in Fig. 8, to permit its disengagement from inwardly projecting parts on the casting prior to its endwise or axial movement upwardly for withdrawal purposes. Each core section 11^a, 11^c, may be provided with a handle 11^{ax}, 11^{cx}, respectively, to facilitate handling thereof in assembling and disassembling the core.

The construction of the core in sections, as herein disclosed, provides for the easy and rapid removal of the sections where the casting has inwardly extending tubular or

hollow bosses, ribs or other inwardly projecting members, desired for any purpose. As shown in Fig. 11, the cavity *a* for each wrist pin boss is formed in the adjacent side core sections 11ᶜ, one-half of the cavity being formed in each section by cutting away a portion of the core section wall. As will be understood, this construction permits these sections 11ᶜ to be swung away from each other in order to move their lower ends from beneath the adjacent boss of the casting in the mold cavity, and to do this, where inwardly extending ribs are carried by the casting, without defacing or mutilating such ribs.

In the form of construction shown, I have made provision for two heat dissipating ribs which extend across the inner face of the piston head preferably at right angles to each other. Such ribs may also be used for strengthening purposes. One rib is provided for on the casting by a groove 11ᵈ formed in and extending longitudinally of the lower end of the center core section 11ᵃ; the other rib is provided by a groove 11ᵉ formed in the lower end of the center section 11ᵃ and extending transversely to the groove 11ᵈ and by cut-away portions 11ᶠ which aline with the groove 11ᵉ and are formed in the opposing faces between and adjacent to the lower ends of each pair of side core sections 11ᶜ. Where it is desired to have the transverse rib extend upwardly to the bosses, as shown in the drawings, the opposing faces of the side core sections may be cut away as indicated at 11ᵍ.

In Fig. 8 I have shown a circle of substantially the diameter of the thickness of the inwardly extending ribs or webs. The walls of the core sections 11ᶜ which extend toward this circle are preferably formed on lines tangential to the circle, as are also the walls of the section 11ᵃ which engage therewith. This construction insures that when the sections 11ᶜ are swung bodily to remove them from the adjacent boss *b* their lower ends will practically engage flat with the side of the rib or web toward which they are moved rather than make a point engagement therewith. The purpose of this construction is twofold; first, it permits of maximum lateral swinging movement of the side core sections to facilitate their withdrawal from a casting in the mold; second, in the event any molten metal flows in between the opposing faces and forms a fin (which may happen if the sections do not fit tightly together or become worn) the fin is caused to project from the inner face of the casting at substantially right angles to a plane extending tangentially of the casting at the point of union of the fin therewith. When so disposed the fin may be broken or sheared off without injury to the adjacent walls of the casting; whereas I have found in practice that fins extending in other directions away from the inner face of the casting due to the construction of the core sections and disposition of their opposing or engaging faces, have a stronger union on one side of the fin with the adjacent wall of the casting than on the other, so that when such a fin is removed by breaking or shearing it off, it will carry with it portions of the metal forming the casting wall to which it was most strongly connected instead of making a clean break or shear. Under such circumstances the removal of the fin will materially damage the casting.

In carrying out this feature of my invention, it will be noted that the opposite side faces of the center section 11ᵃ are provided with walls 11ᵃ′ which extend in a direction approximately radially of the axis of the core and that the opposite side walls 11ᶜ′ of each side core section are shaped to fit against each other and the walls 11ᵃ′, respectively.

12 indicates devices for swingably supporting the side core sections 11ᶜ on the mold members 3, 4. These devices preferably comprise flanges, one for each section, extending around the outer edges thereof. When the core sections 11ᶜ are assembled in the mold cavity A, the flanges 12 engage the top walls 8. As the latter are flat, they permit the flanges 12 to slide thereon when the sections 11ᶜ are swung laterally as shown in Fig. 8, and thus guide the sections 11ᶜ bodily laterally.

13 indicates devices, preferably flanges, secured to or formed integrally with the center section 11ᵃ. These flanges extend around the curved end walls 11ᵇ of the core section 11ᵃ and rest upon the top walls 8 to support the said section in proper position.

14 indicates projecting members carried by and preferably formed integrally with the main or center core section 11ᵃ. The members 14 are arranged above the flanges 13 and extend beyond their free edges so as to leave a space between each projecting member and the adjacent top wall 8. In actual practice, the core sections 11ᵃ, 11ᶜ, are usually wedged together very tightly within the mold opening above the cavity A. The purpose of this construction is therefore to provide devices with which a tool or lever may be engaged to pry out the core section. I prefer to provide a projecting member 14 at either curved end of the core section 11ᵃ.

15 indicates a pair of permanent core sections or core pins arranged to project into the mold cavity A to form openings in or through the bosses formed by the cavities *a* in the core sections 11ᶜ. The core pins 15 preferably comprise rods, each of which extends through a pair of alined openings formed in a wall 5ᵃ and adjacent plate 9ᶜ. At their inner ends the rods pref-

erably engage the core sections 11^c to limit their inward movement when positioned as shown in Figs. 1, 2 and 3. Near their inner ends, the core pins 15 may be slightly tapered to permit ready removal and disengagement from the casting. 15^a indicates a collar fixed in any suitable manner to each rod 15. The collar 15^a is spaced from the adjacent plate 9^c to permit the use of a prying tool to be used to force the rod outwardly and remove it when necessary. Each rod 15 is provided on its outer end with a handle 15^b of any suitable form.

16 indicates devices which coöperate to aline the core 11 relative to the opening in or between the mold members 3, 4, so that the inner and outer walls constituting the cavity A will be properly correlated to form the desired castings. The alining devices preferably comprise a key or rib 16^a fixed to and extending longitudinally of the core section 11^a and a groove 16^b formed in the walls of the opening through which the core 11 is moved. The key 16^a may be connected to the core section 11^a by counter-sunk screws, as shown in Fig. 4. The groove 16^b may be formed by cutting away the adjoining faces of the walls 5^a, said faces, in the construction shown, being formed by bushing members 23 (see Fig. 13) which will be later described.

19 indicates devices for locking the mold members together so that they may be held in rigid relationship while casting takes place. I may provide a set of locking devices at either side of the mold. Preferably, each set of devices 19 comprises a lug or projection 19^a, fixed in any suitable manner to one of the mold members, such as the member 3, and a member 19^b pivotally mounted on the other mold member and swingable into latching engagement with the lug 19^a. The member 19^b carries a hook or arm 19^c which engages the pin 19^a. The pivoted member is adapted to be driven downwardly against the pin 19^a and the pin engaging face of the arm 19^c is wedge shaped, as shown at $19^{c'}$, so that when the member 19^b is struck with a hammer or equivalent tool, the inclined face $19^{c'}$, will serve to force the mold members 3, 4, tightly together and maintain them in such position.

In operation, the walls of the mold, including core parts, which constitute the wall for the mold cavity are suitably coated or treated in any well known manner to reduce as much as possible agitation of the molten metal as it flows into contact therewith and to insure proper setting of the metal within the mold cavity. The mold members 3, 4, are usually moved together, then the locking devices 19 are moved into operative position ready to be driven or forced into latched position and the pairs of side sections and the center of the core 11 are assembled in the mold, after which the members 19^b are hammered to draw and lock the mold members together. The core sections 15, 15 are then introduced into place.

20 indicates the gate for the mold; it may be of any desired form. The gate is preferably formed by cutting away the adjoining faces of the opposing walls 5, so that when the members 3, 4, are assembled together the cutaway portions form a gate of the desired shape. The shape and construction of the gate 20 herein shown for illustrative purposes I believe to be the sole invention of A. B. Norton, of Detroit, Michigan. As such invention will form the subject-matter of a separate application, further description of the gate herein will not be necessary.

Where the character of the castings, the mold parts and the metal poured, or either thereof, make it necessary or desirable to heat the mold in carrying out the casting operation, I provide means, indicated as an entirety at 21, for heating the mold parts or walls to and keeping them at the desired temperatures. The heating means 21 may comprise suitable burners 21^a to which are connected gas and air supply pipes 21^b, 21^c, respectively. Each supply pipe has a flexible connection and is provided with a valve 21^d of any suitable construction. The open or free end of the burner 21^a is preferably spaced from the adjoining mold member but is arranged to project the flame into and through an opening 9^e formed in the adjacent plate 9^c, whereby it may impinge against the wall 5 within the chamber 9^b. I have for illustrative purpose shown heating means 21 for each mold member 3, 4, and so arranged that the flame will impinge directly on the portions of the adjacent wall 5 in which the gate 20 is formed. As a result of this construction, the metal flowing through the gate 20 to the mold cavity A will be kept from premature setting.

22 indicates a bracket for supporting each heating means 21. The bracket is fixed in a well known manner to one wall of the adjacent mold member, such as the wall 7. Being connected to and movable with the mold members, the brackets maintain the burners 21^a in fixed relationship to the mold members and thus permit the latter to be operated in carrying out the casting operations.

I provide improved means for venting the mold cavity A to permit the ready escape of air or gases as the molten metal flows into the cavity and to effect the run of the metal to all parts of the cavity. The sectionality of the mold structure lends itself admirably to the carrying out of this feature of my invention, since it permits the mold cavity to be vented without regard to the shape and construction of the casting.

I have chosen to illustrate three different examples of venting means. One of these examples is shown in Figs. 3, 4, 5 and 13. Referring to these figures, 23 indicates an insert and 23^a indicates a recess formed in the wall 5^a of each mold member 3, 4, to receive an insert 23. The inserts 23 are mounted above the mold cavity A in the opening formed by the semi-circular walls 5^a. They are of curvilinear shape and, as shown, form the upper walls of the opening through which the sections of the core 11 are inserted into and removed from the mold cavity A. The inserts are preferably arranged to project inwardly beyond the outer wall of the cavity A (see Fig. 3), whereby their lower ends form the upper end walls for said cavity. 23^b indicates a plurality of grooves formed on the lower ends of the inserts. These grooves may extend in a direction radially relative to the axis of the mold cavity. The grooves 23^b are preferably etched or otherwise formed in the surface of the insert so that they will be small enough to preclude molten material from flowing through them but large enough to permit the free escape of air or gases from the mold cavity A. At 23^c the lower outer corners of the inserts 23 are cut or beveled away to form in coöperation with the walls of the recess 23^a a channel 23^d into which the outer ends of the grooves 23^b lead. 23^e indicates recesses or grooves formed in the outer surfaces of the inserts 23. The recesses 23^e extend from end to end of the inserts and in coöperation with the adjacent walls of the recesses 23^a form outlets or vents leading from the channel 23^d to the outside atmosphere.

23^f indicates air escape grooves which may be formed on the inner surfaces of the inserts 23. The grooves 23^f are connected at their upper ends with grooves 23^g formed in the upper end walls of the inserts 23. The grooves 23^g permit the escape of the air or gases from the recesses 23^f which might otherwise be prevented by the flanges 12, 13, on the core sections 11^a, 11^c, respectively, when the latter are in position. It will be noted that the vents 23^b and 23^f lead from the upper outer and inner corners of the cavity A. This construction permits air and other gases to escape from both of these points as the metal is poured, and insures that the metal will run into and completely fill the cavity and form a casting of the desired shape. The inserts 23 may be fixed in the recesses 23^a in any suitable manner, preferably by screws, the heads of which are countersunk as shown in Fig. 5.

Another form of venting is shown in Figs. 3, 4, 6, 7, and 9. By this latter form, I illustrate means for venting a cavity formed in a core section or sections. In these figures, 24 indicates an insert which fits into a recess or cutaway portion 24^a in the main core section 11^a. This insert is of a size and shape to complete the core section, as will be readily understood from Figs. 3 and 10. On the face of the lower end of the main core section 11^a, opposing the inner wall of the insert 24 are formed a plurality of fine grooves 24^b to permit the escape of air or gases from the cavities 11^d and 11^e and to insure the formation of the inwardly extending ribs on the casting. The grooves 24^b lead to a conduit 24^c preferably formed by coöperating grooves in adjoining faces of the insert 24 and center section 11^a, through which conduit the air and gases escape to lateral passageways $24^{a'}$, Fig. 3, between the upper end of the insert and adjacent shoulder of the center section 11^a formed by chamfering or beveling the upper inner edge of the insert 24, as indicated at 24^e. The passageways $24^{a'}$ communicate at their outer ends with the vents 23^f.

The insert 24 is preferably fixed to the adjacent portion of the core section 11^a by screws 24^d.

The other form of venting means (see Fig. 14) is illustrated in connection with a slightly modified form of mold, wherein the bottom of the casting, that is, the outer face of the piston head in this example, is provided with a work spot B'. In this construction, the base plate is formed with an opening 25 and this opening has inserted in it a pin 25^a. The upper end of the pin terminates at a point below the upper surface of the plate 2^a in order to form the cavity 26. 25^b indicates a series of grooves formed in the outer wall of the pin 25^a and leading downwardly from the cavity 26. At its lower end, the pin 25^a is reduced or cut away to form an annular channel 25^c into which all of the grooves 25^b lead. 27 indicates a plate removably fixed to the under surface of the base plate by a bolt 27^a or equivalent means. The plate 27 serves to close the lower end of the opening 25. The plate 27 is formed with a conduit 27^b the inner end of which is in communication with the channel 25^c to permit the escape of air and gases therefrom.

The operation of a mold embodying my invention will be readily understood by one skilled in the art. The temperature at which the parts 3, 4, and supporting structure therefor is maintained, will depend largely upon the nature and character of the metal or alloy to be cast. Assuming that the burners 21 have been operated to heat up the parts of the mold to the desired temperature and that the mold complete, including core sections, is assembled, as illustrated in Figs. 1 and 2, the molten metal to be cast is brought to the mold in any suitable manner, as by a ladle and is poured into the inlet port 20' of the gate 20. It descends through

the gate and enters the mold cavity A. I prefer to use a gate 20 such as illustrated in the drawings because of the peculiar advantages which it possesses in connection with the casting of a cup-shaped article having inwardly extending bosses and ribs or either of them. The construction of the gate is such that a liquid seal is formed at 20^a as the metal flows through the gate. This seal after it is formed tends to preclude the passage of air and gases into the mold cavity A and also to materially reduce splashing of the metal within the gate during the pouring. Splashing further is substantially eliminated by forming the wall 20^b in such way that the metal flows smoothly along it and thence into the cavity A. Air and gases within the mold cavity escape in the well-known manner through the vents provided as hereinbefore described. The metal rises from the bottom of the mold cavity upwardly until it engages with the lower end of the inserts 23, when the casting B is completed, having in this example two inwardly extending tubular bosses, b, b, and two inwardly extending ribs b', b^2, disposed at right angles to each other. The weight of the metal in the upper portion of the gate serves to force the metal into the mold cavity to complete the casting, the upper end wall of the casting being substantially in line with the upper portion of the gate which directly feeds it. In addition to trapping out the air this construction of gate in actual operation serves to prevent oxids of the metals poured and other foreign materials from entering the mold cavity. Preferably, I next remove the core sections 15, 15, by pulling endwise each of them out of the mold, or at least out of engagement with any part of the casting. Next, preferably, I ease off the lock devices 19 and then remove the main or center section 11^a of the core by withdrawing it axially or longitudinally upward and away from the rest of the mold. Then by grasping the handles 11^{ex} I move bodily laterally each of the core sections 11^c so as to free it from alinement with any part of the adjacent casting boss b, see Fig. 8, and then withdraw each of the said core sections 11^c axially or longitudinally from the mold. Then the mold sections 3, 4, are entirely unlatched and moved away from each other a sufficient distance to permit the casting to be withdrawn therefrom, whereupon the mold parts are reassembled and the operation repeated.

In assembling the mold parts it is preferable to first move the mold members 3 and 4 together, then before tightly securing them by the locking devices 19, lower the sections of core 11 into position and thereafter tighten the lock devices 19. This order of procedure obviates the wear on the core parts that would result from driving them home after the mold members 3 and 4 were locked tightly together.

To one skilled in the art of casting metals and their alloys, the many advantages of my improved mold should be obvious; among others:

It will be noted that the elements of my mold construction may be so shaped and correlated as to lend themselves admirably to the making of cup-shaped castings, and particularly of cup-shaped castings like skirted pistons having inwardly extending bosses and ribs, or either of them. Each of the core sections is correlated to each of the others in such manner as to have merely a sliding or surface engagement with the adjacent section or sections; that is, none of the core sections when in operation is attached to any other core section but merely has a sliding contact or engagement therewith. Again the core sections are so shaped, disposed and correlated that they with great rapidity may be withdrawn from the casting so as to require a minimum amount of time within which all sections of the core may be removed or freed from the casting. In the casting of skirted pistons having inwardly projecting bosses this is of material advantage. The core sections 15 may be withdrawn rapidly merely by pulling them outwardly from the mold. The center section 11^a may be withdrawn quickly by pulling it outwardly, longitudinally of the axis of the casting, and each of the sections 11^c may be quickly disengaged from the casting by swinging it bodily laterally inwardly and then withdrawing it outwardly axially of the casting and the mold sections 3, 4. The mold sections 3, 4, may be then quickly unlatched and separated so as to free the casting. Where the period of time that the casting remains in the mold is essential in the production of the character of casting desired, my improvements will be found to be of large advantage in enabling the operator or operators to produce one after the other in rapid succession castings which have been permitted to remain in the mold the prescribed time.

The nature and construction of the venting illustrated herein, possesses great advantage in its simplicity and efficiency and in insuring against defective castings.

It will be further noted that the elements of my improved mold are so constructed as to facilitate and insure the production of cup-shaped articles, such as skirted pistons, having relatively thin walls and relatively thin strengthening and radiating or heat dissipating webs or ribs, thereby reducing to a minimum the amount of metal in the casting.

It will be further noted that for the casting of skirted pistons having internally projecting bosses I am enabled to dispose the gate for the casting intermediate of the

bosses and at one side of the casting B so as to insure substantial uniformity of distribution of the metal from the gate with reference to each side of the casting carrying one of the bosses, *b*, *b*. My improved mold is also peculiarly adapted for controlling to advantage, as desired, the chilling or rate of setting of different parts of a cup-shaped casting including internal bosses and extensions. For example, I have found it desirable in making piston castings, particularly of alloys such as above mentioned, to chill the wrist pin bosses *b* to a greater extent than any other part of the casting. To do this with my improved mold all that is necessary is to maintain the core pins 15 cooler than any other parts of the mold which come into contact with the cast metal and of sufficient mass to insure the proper heat capacity. I have found that if the temperature of the core pins is not properly maintained imperfect castings result. Since the volume of metal at the bosses is greater than at adjacent portions of the casting, I have found it advisable to chill these bosses to a greater extent than any other portion of the casting. Incidentally this produces somewhat finer grain structure in the bosses which is of advantage in the mounting and operation of the wrist pins therein. Ordinarily when the mold is in operation and the core sections removed, I have found it advantageous to apply heat to all sections of the core other than the core pins 15, and these core pins I preferably maintain at a lower temperature than the other parts of the core. It will be understood that the respective core sections can readily be maintained at temperatures differing from each other and from the temperatures of the other parts of the mold, by reason of the fact that the core parts are periodically removed from the mold and while removed can be subjected to any suitable temperature conditions; as, for example, to the cooling action of water or the atmosphere, or to the moderate heat of a torch or furnace.

While the use of my improved mold is not limited to any particular metal, I have found that it is peculiarly adapted for use in connection with the making of castings of an aluminum alloy containing copper, magnesium and iron, in that it enables me to control to advantage the arrangement of the eutectic portion of such alloy within the cast structure, it being understood that it is the composition of the alloy that determines whether or not any eutectic will be present in the casting, and it is the method of casting the alloy that determines what will be the structural relation of the eutectic to the excess substance.

I believe that progressive setting of the metal in the casting is one of the important factors in reducing porosity, due to crystallization shrinkage, which is especially marked in aluminum alloys, and I have had in mind to have the setting take place progressively within the mold with that object in view. It is my opinion that when any liquid metal becomes completely surrounded with solid metal, during freezing, its solidification will be accompanied by a contraction of about three to six per cent. of its total volume, porosity accordingly resulting. In my improved mold the mold cavity and gate are so correlated that at no time is liquid metal allowed to be isolated in any part of the casting, during the greater portion of the solidification period. At substantially all times during the solidification period, the portions of the freezing metal still liquid are in communication with a source of liquid metal from the gate, so that cavities which would normally form by crystallization shrinkage in the casting are filled up.

The existence of an eutectic in a metallic alloy for casting purposes is peculiarly advantageous in reducing the amount of porosity in the casting, particularly where the liquid portions of the freezing metal are in direct communication with other liquid metal, for instance in the gate, as provided by my invention, thus permitting the crystallization shrinkage within the casting to be filled up or to be taken care of from molten metal without the mold cavity proper. During the freezing of the metal in the mold cavity in my improved mold, at substantially no time is any liquid metal isolated from other liquid metal by solid portions.

It will be noted that I make the main core section 11^a slightly longer than the side core sections 11^c, as shown in dotted lines in Fig. 3, so that that portion of the inner surface of the cast piston head between the side core sections will be slightly lower than the other portions of such surface. In the event any fins are formed on the head of the casting between the main and side core sections, this form of construction will permit the side core sections, when moved bodily laterally for removal purposes, to readily bend over and shear off any fins that may be so formed on the cast head.

It will be noted that the gate at its port of communication with the mold cavity is relatively narrow, insuring the forming of a relatively narrow section of metal between the gate and casting, which facilitates the removal of the gate from the casting proper.

While I have shown this port of communication between the gate and the mold cavity to extend from the bottom to the top of the mold cavity, it will be understood that it does not necessarily have to extend the entire length of the mold cavity in an unbroken line so long as it does extend to the top of the mold cavity and has sufficient area between the top of the mold cavity and the

bottom of the mold cavity to fill the mold cavity progressively from the bottom upwardly by continually introducing metal on top of that which has already entered the mold cavity until the top of the cavity is finally reached.

I appreciate the fact that my inventions herein disclosed probably constitute subjects-matter for different applications for Letters Patent, and accordingly of even dates herewith I have executed and filed an application relating to my improved process and product herein disclosed. (See application Ser. No. 82,529, filed March 7, 1916.)

To those skilled in the art many modifications of and widely differing embodiments and applications of my invention will suggest themselves, without departing from the spirit and scope thereof. My disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

What I claim is:

1. In a mold for casting pistons, the combination of a permanent base member, a pair of permanent mold members movably supported on said base member and formed with complementary walls coöperable with a portion of the upper wall of said base member to form the outer walls of a mold cavity for casting a cup-shaped article having a head end with a skirt extending therefrom, and a permanent core movable relative to and spaced from said outer cavity walls to form the inner walls of the cup-shaped cavity.

2. In a mold for casting pistons, the combination of a permanent base member, complementary side permanent mold members movable on said base member and coöperable therewith to form the outer walls of a cup-shaped mold cavity for a piston casting having a head and a skirt extending therefrom, and a sectional permanent core insertible within said complementary members to form the inner wall of the said mold cavity of which said base and complementary side members form the outer walls.

3. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt with internal piston pin bosses, and a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a center section and pairs of sections arranged upon opposite sides of the center section with each pair formed to provide the cavity for one of the said pin bosses.

4. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt, and a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a center section and pairs of sections arranged upon opposite sides of the center section and the abutting side walls of said sections being disposed in planes extending substantially radially of the axis of the cavity.

5. In a mold for casting pistons, the combination of a permanent mold body having an opening the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt, and a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a removable center section and pairs of sections arranged upon opposite sides of the center section and swingable relative to each other after the removal of the center section and then withdrawable longitudinally.

6. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt with internal piston pin bosses, a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a removable center section having lateral walls forming opposite parts of the external core wall and side sections arranged upon opposite sides of the center section and formed to provide the cavities for the said pin bosses, said side sections being movable laterally relative to each other after said center section has been removed, and means for supporting the side sections of the core for lateral movement in the mold after the said center section has been removed.

7. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt with internal piston pin bosses, a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a removable center section having lateral walls forming opposite parts of the external core wall and pairs of sections arranged upon opposite sides of the center section and movable relative to each other after said center section has been removed, each pair being formed to provide the cavity for one of said pin bosses, and means for supporting said pairs of core sections for lateral movement in the mold after the said center section has been removed.

8. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt with internal piston pin bosses, a permanent sectional core

insertible within said mold body to form the inner wall of the cavity, the said core comprising a removable center section having lateral walls forming opposite parts of the external core wall and pairs of sections arranged upon opposite sides of the center section and movable relative to each other after said center section has been removed, means for supporting said pairs of core sections for lateral movement in the mold after said center section has been removed, and independent means for moving each of said sections into and out of its operative position within the mold.

9. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt, a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a center section having lateral walls forming opposite parts of the external core wall and pairs of sections arranged upon opposite sides of the center section, and means for supporting said sections in said mold members with their free ends spaced from the bottom wall of the cavity and their adjacent walls in sliding engagement with each other.

10. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt, a core insertible within said members to form the inner wall of the cavity, and a tubular part mounted in the said opening and extending inwardly therefrom to form the upper end wall of the skirt cavity.

11. A mold for casting pistons comprising in combination complementary permanent side members movable toward and from each other and coöperable to form the outer lateral wall of a piston mold cavity, a core insertible within said members to form the inner wall of the cavity, and inserts mounted in recesses in said complementary mold members and arranged to extend inwardly relative to the outer cavity walls to form the upper end wall of the cavity.

12. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a trunk piston mold cavity, and a core comprising relatively movable sections insertible within said opening to form the inner wall of the cavity, the adjacent walls of certain of said sections having correlated recesses to form an internal projecting member on the piston casting.

13. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a trunk piston mold cavity, a core comprising relatively movable sections insertible within said opening to form the inner wall of the cavity, the adjacent walls of certain of said sections having correlated recesses, and core pins insertible through openings in the mold body and coöperating with the walls of said recesses in the core sections to form internally projecting hollow wrist pin supports on the piston casting.

14. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a trunk piston mold cavity, and a sectional core insertible within said opening to form the inner wall of the cavity, the said core comprising a main section and pairs of sections arranged at opposite sides of the main section, the side sections being formed with complementary recesses in their abutting surfaces to form internally projecting members on the casting.

15. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a piston mold cavity, a sectional core insertible within said opening to form the inner wall of the cavity, the said core comprising a main section and pairs of sections arranged at opposite sides of the main section, the side sections being formed with complementary recesses in their abutting surfaces, and core pins insertible through openings in the mold body walls and coöperable with the walls of said recesses to form hollow wrist pin supports on the casting.

16. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a piston mold cavity, a core comprising relatively movable sections insertible within said opening to form the inner wall of the cavity, the walls of certain of said sections having recesses, and core pins insertible through openings in the mold body and coöperating with the walls of said recesses in the core sections to form internally projecting hollow wrist pin supports on the piston casting.

17. The combination of a base permanent mold member and side permanent mold members movable thereon and shaped and coöperating therewith to form the outside cavity walls for a piston casting having a head cast against said base member and a skirt cast against said side members, means interposed between one of said members and each of the remaining members for causing alinement and registry of all of said members, and a sectional permanent core insertible between said side members through the open end of the cavity to form the inner cavity walls for the piston head and skirt.

18. The combination of a base permanent mold member and side permanent mold

members movable thereon and shaped and coöperating therewith to form the outside cavity walls for a piston casting having a head cast against said base member and a skirt cast against said side members, a sectional permanent core insertible between said side members through the open end of the cavity to form the inner cavity walls for the piston head and skirt, and means interposed between certain of said mold members and the core for causing alinement of the core therewith during its insertion into position.

19. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent mold members movably mounted on said main member and provided with complementary walls forming the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent sectional core removably mounted within and spaced from the walls of said mold members to form the inner cavity walls for the piston head and skirt, certain of said core sections being recessed to form internally extending wrist pin bosses on the casting.

20. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member serving as the end wall of that portion of the cavity in which the piston head is formed, a pair of permanent side mold members movably mounted on said main member and provided with complementary walls serving as the outside wall of that portion of the cavity in which the piston skirt is formed, a main permanent core removably mounted within and spaced from the walls of said mold members to form the inner cavity walls for the piston head and skirt, certain of said core sections being recessed to form internally extending wrist pin bosses on the casting, and core pins, each extending through one of said side mold members, and movable into and out of said recesses in said main permanent core.

21. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent side mold members movably mounted on said main member and provided with complementary walls forming the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent sectional core removably mounted within and spaced from the walls of said mold members to form the inner cavity walls for the piston head and skirt, said permanent core sections having merely surface engagement with each other and being held together and properly positioned within said side mold members by surface engagement between portions of said side mold members and portions of said core sections.

22. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent side mold members movably mounted on said main member and provided with complementary walls forming the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent core, comprising a plurality of relatively movable sections, removably mounted within and spaced from the walls of said mold members to form the inner cavity walls for the piston head and skirt, said section being maintained in proper position within said side mold members and so held by surface engagement between portions of said sections and portions of said members.

23. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent side mold members movably mounted on said main member, the last mentioned members being provided intermediate their ends with complementary walls forming the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent core removably mounted within and spaced from the cavity walls of said mold members to form the inner cavity walls for the piston head and skirt and having a pair of diametrically disposed wrist pin boss recesses.

24. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of similarly shaped permanent side mold members movably mounted on said main member, each of said side members being provided with a relatively wide abutting wall formed intermediate its ends with a complementary wall forming with the other complementary curved wall the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent core removably mounted within and spaced from the cavity walls of said mold members to form the inner cavity walls for the piston head and skirt.

25. In a mold for casting a piston having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of similarly shaped permanent side mold members movably mounted on said main member, each of said side members being provided with a relatively wide abutting wall formed

intermediate its ends with a complementary curved wall forming with the other complementary wall the outside wall of that portion of the cavity in which the piston skirt is cast, and a permanent core, comprising a plurality of relatively movable sections, removably mounted within and operatively supported on the side mold members and spaced from the cavity walls of the mold to form the inner cavity walls for the piston head and skirt.

26. A piston mold comprising in combination, a pair of permanent side mold members formed with complementary portions cooperable to form the outer lateral wall of a trunk piston mold cavity, and a permanent core removably mounted between said complementary walls to form the inner wall of the cavity, each of said side mold members comprising an abutting wall, and side, top and bottom walls, and a plate secured to the free edges of said side, top and bottom walls and coöperating therewith to form a chamber.

27. A piston mold comprising in combination, a pair of permanent side mold members formed with complementary portions coöperable to form the outer lateral wall of a cup-shaped trunk piston mold cavity, a permanent core removably mounted between said complementary walls to form the inner wall of the cavity, each of said side mold members comprising an abutting wall, and side, top and bottom walls, and a plate secured to the free ends of said side, top and bottom walls coöperating therewith to form a chamber, and means for supplying heat to said chambers.

28. A piston mold comprising in combination, a pair of permanent side mold members formed with complementary portions coöperable to form the outer lateral wall of a cup-shaped trunk piston mold cavity, a permanent core removably mounted between said complementary walls to form the inner wall of the cavity, each of said side mold members comprising an abutting wall, and side, top and bottom walls, and a plate secured to the free ends of said side, top and bottom walls and coöperating therewith to form a chamber, and means, movable with each of said side mold members, for supplying heat to the said chambers.

29. A piston mold comprising in combination, a pair of permanent side mold members formed with complementary curved portions coöperable to form the outer wall of a cup-shaped trunk piston mold cavity, a permanent core removably mounted between said complementary walls to form the inner wall of the cavity, each of said side mold members comprising an abutting wall, and side, top and bottom walls, and a plate secured to the free ends of said side, top and bottom walls and coöperating therewith to form a chamber, and means comprising a flame jet injecting burner extending in line with an opening through each of said plates, for supplying heat to said chambers.

30. In a mold for casting pistons having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent complementary mold members movably mounted on said main member and forming the outside wall of that portion of the cavity in which the piston skirt is cast, the cavity formed by said complementary members being open at its upper end, and a permanent core insertible within the cavity opening and having a portion spaced from the cavity forming walls of said main and complementary mold members to form the inner cavity walls for the piston head and skirt, and a flange bearing upon said complementary mold members properly to support said permanent core in longitudinal relation thereto.

31. In a mold for casting pistons having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent complementary mold members movably mounted on said main member and forming the outside wall of that portion of the cavity in which the piston skirt is cast, the cavity formed by said complementary members being open at its upper end, and a permanent sectional core insertible within the cavity opening and having a portion spaced from the walls of said main and complementary mold members to form the inner cavity walls for the piston head and skirt and another portion having surface engagement with the adjacent walls of said complementary mold members to properly position and support said core sections relative to each other and to said mold members.

32. In a mold for casting pistons having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent complementary mold members movably mounted on said main member and forming the outside wall of that portion of the cavity in which the piston skirt is cast, the cavity formed by said complementary members being open at its upper end, and a permanent core, comprising a plurality of relatively movable sections, insertible within the cavity opening and having parts spaced from the walls of said main and complementary mold members to form the inner cavity walls for the piston head and skirt and other parts which removably engage said complementary mold sections and are thereby properly supported and positioned

relatively to said mold members and to each other.

33. In a mold for casting pistons having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent complementary mold members movably mounted on said main member and forming the outside wall of that portion of the cavity in which the piston skirt is cast, the cavity formed by said complementary members being open at its upper end, a permanent sectional core insertible within the cavity opening and spaced from the walls of said main and complementary mold members to form the inner cavity walls for the piston head and skirt, and means interposed between said core and complementary mold members for causing the proper alinement of the core in the mold cavity.

34. In a mold for casting pistons having a head and a skirt, the combination of a main permanent mold member forming the end wall of that portion of the cavity in which the piston head is cast, a pair of permanent complementary mold members movably mounted on said main member and forming the outside wall of that portion of the cavity in which the piston skirt is cast, the cavity formed by said complementary members being open at its upper end, a permanent sectional core insertible within the cavity opening and spaced from the walls of said main and complementary mold members to form the inner cavity walls for the piston head and skirt, and means for securing the complementary members together.

35. A core for a mold having a cutaway portion and an insert mounted in said cutaway portion, one of the opposing walls between said insert and cutaway portion being formed with vents.

36. A core for a mold having a cutaway portion and an insert mounted in said cutaway portion, the opposing walls between said insert and cutaway portion being formed with a groove for conveying away air, and one of the opposing walls being formed with vents which lead from the end of the core to the groove.

37. A core for a mold having a recessed portion and an insert mounted in said recessed portion, the opposing walls of the core and insert being cut away to form a mold cavity for forming a projection on the internal wall of the casting.

38. A core for a mold having a recessed portion and an insert in said recessed portion, the opposing walls of the core and insert being cut away to form a mold cavity for a projection on the internal wall of the casting, and one of the opposing walls between said insert and recessed portion being formed with vents leading from the mold cavity.

39. A core for a mold having a recessed portion and an insert mounted in said recessed portion, the opposing walls of the core and insert being cut away to form a mold cavity for forming a projection on the internal wall of the casting and grooved to form vents for conveying away air, and gases, and one of the opposing walls between said insert and recessed portion being formed with vents leading from the mold cavity to the groove.

40. A cylindrical core for a mold comprising a main center section and a plurality of side sections, the main section having its opposite end walls enlarged and the side sections being arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections being disposed in planes extending substantially radially of the axis of the core.

41. A cylindrical core for a mold comprising a main center section and a plurality of side sections, the main section having its opposite end walls enlarged and the side sections being arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections and the abutting side walls between said side sections being disposed in planes extending approximately radially of the axis of the core.

42. A cylindrical core for a mold comprising a plurality of side sections and a main section independently insertible in and removable from between the side sections, the main section having its opposite end walls enlarged and the side sections being arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections being disposed in planes extending approximately radially of the axis of the core, in combination with means carried by said sections arranged to engage a mold and support the core as a unit from one end.

43. The combination with a mold having a main opening for a core and side openings for core pins, of a core insertible in the main opening and comprising a main section enlarged at its opposite end walls and a plurality of side sections arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections being disposed in planes extending approximately radially of the axis of the core

and the side sections at each side of the main section being formed with recesses which coöperate to form a boss mold cavity adjacent one of the side openings in the mold, and a core pin insertible through one of said side openings and arranged to project into the adjacent boss mold cavity.

44. The combination with a mold having a main opening for a core and side openings for core pins, of a core insertible in the main opening and comprising a main section having its opposite end walls enlarged, and a plurality of side sections arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections being disposed in planes extending approximately radially of the axis of the core and the side sections at each side of the main section being formed with recesses which cooperate to form a boss mold cavity adjacent one of the side openings in the mold, and core pins, each insertible through one of said side openings and arranged to project into the adjacent boss mold cavity, the inner wall of each boss cavity serving as a stop for the adjacent core pin.

45. The combination with a mold having a main opening for a core and side openings for core pins, of a cylindrical core insertible in the main opening and comprising a main section having its opposite end walls enlarged and a plurality of side sections arranged on opposite sides of said main section and between the said enlargements thereof, the abutting side walls between the enlargements of the main section and the side sections being disposed in planes extending approximately radially of the axis of the core and the side sections at each side of the main section being formed with recesses which coöperate to form a boss mold cavity adjacent one of the side openings in the mold, and core pins, each insertible through one of said side openings and arranged to project into the adjacent boss mold cavity, the main section being removable independently of the side sections to permit the latter to swing laterally and inwardly prior to their endwise removal.

46. In a mold for casting a piston having a head and a skirt, the combination of a permanent mold base having a wall adapted to form the outer wall of that portion of the cavity in which the piston head is cast, a pair of permanent hollow mold members having top, bottom, side and end walls arranged to be moved together with side against side, the abutting side walls of said members having complementary portions adapted to form the outer wall of that portion of the cavity in which the piston skirt is cast, and a permanent core insertible within the opening formed by the complementary portions and supported by said hollow mold members and arranged with its lower free end and sides adjacent thereto spaced from the outer walls of the cavity to form the inner walls thereof.

47. In a mold for casting a piston having a head and a skirt, the combination of a permanent mold base having a wall adapted to form the outer wall of that portion of the cavity in which the piston head is cast, a pair of permanent hollow mold members having top, bottom, side and end walls arranged to be moved together with side against side, the abutting side walls of said members having complementary portions adapted to form the outer wall of that portion of the cavity in which the piston skirt is cast, a permanent core insertible within the opening formed by the complementary portions, and means at the outer end of said core for supporting the core within said opening with its lower free end and sides adjacent thereto spaced from the outer walls of the cavity to form the inner walls thereof.

48. In a mold for casting a piston having a head and a skirt, the combination of a permanent mold base having a wall adapted to form the outer wall of that portion of the cavity in which the piston head is cast, a pair of permanent hollow mold members having top, bottom, side and end walls arranged to be moved together with side against side, the abutting side walls of said members having complementary portions adapted to form the outer wall of that portion of the cavity in which the piston skirt is cast, and a permanent core insertible within the opening formed by the complementary portions and arranged with its lower free end and sides adjacent thereto spaced from the outer walls of the cavity, and means for supplying heat to the interior of each of said hollow mold members.

49. In a mold for casting a piston having a head and a skirt, the combination of a permanent mold base having a wall adapted to form the outer wall of that portion of the cavity in which the piston head is cast, a pair of permanent hollow mold members having top, bottom, side and end walls arranged to be moved together with side against side, the abutting side walls of said members having complementary portions adapted to form the outer wall of that portion of the cavity in which the piston skirt is cast, a permanent core, comprising a plurality of relatively movable sections, insertible within the opening formed by the complementary portions, and means for supporting said core sections within said opening with their lower free ends and sides adjacent thereto properly spaced from the outer walls of the cavity to form the inner walls

thereof and for holding the adjacent walls of said sections in slidable surface engagement.

50. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of separable permanent mold sections having surfaces which cooperate to form the outer walls of the mold cavity, and a permanent core composed of a plurality of separable sections, each merely having surface engagement with the adjacent walls of an adjoining section, said sections normally being held together when constituting walls of the mold cavity from points entirely outside the mold cavity, and adjoining side sections being recessed at their adjacent surfaces to form a cavity for an inwardly extending boss.

51. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of separable permanent mold sections having surfaces which cooperate to form the outer walls of the mold cavity, and a permanent core comprising a main section and side sections having merely slidable surface engagement with said main section when the casting is formed in the mold, the main section being removable by sliding it longitudinally relative to the side sections and the casting, and the side sections being removable by movement bodily laterally relative to the casting and then longitudinal withdrawal from the casting.

52. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of separable mold sections having surfaces which cooperate to form the outer walls of the mold cavity, and a permanent core comprising a main section and side sections having merely slidable surface engagement with said main section, the adjoining side sections being recessed at their adjacent surfaces to form a cavity for inwardly extending bosses, when the casting is formed in the mold, the main section being removable by sliding it longitudinally relative to the side sections and the casting, and the side sections being swingable bodily laterally away from the casting and the adjacent boss and then removable from the casting by outward endwise movement.

53. In a mold for casting cup-shaped articles, the combination of permanent mold sections shaped and correlated to form the outer walls of the mold cavity, a permanent core made of a plurality of sections certain of which are separable from each other in a diametrical plane and have formed in them at either side of said plane recesses which cooperate to form in the casting diametrically opposed inwardly extending bosses, and a gate for the mold cavity having an opening into said mold cavity arranged intermediate said diametrically opposed boss recesses.

54. In a mold for casting cup-shaped articles, the combination of permanent mold sections shaped and correlated to form the outer walls of the mold cavity, a permanent core made of a plurality of sections certain of which are separable from each other in a diametrical plane and have formed in them at either side of said plane recesses which cooperate to form in the casting diametrically opposed inwardly extending bosses, core pins insertible through said mold sections and movable to and fro within said mold sections into and out of said boss recesses, and a gate for the mold cavity having an opening into said mold cavity arranged intermediate said diametrically opposed boss recesses.

55. In a mold for casting cup-shaped articles, the combination of permanent mold sections shaped and correlated to form the outer walls of the mold cavity, a permanent core made of a plurality of sections certain of which are separable from each other in a diametrical plane and have formed in them at either side of said plane recesses which cooperate to form in the casting diametrically opposed inwardly extending bosses, and a gate for the mold cavity having an opening into said mold cavity arranged midway between said diametrically opposed boss recesses.

56. In a mold for casting cup-shaped articles, the combination of a plurality of permanent mold sections shaped and correlated to form the walls against which the head end, sides and annular bottom walls of the cup-shaped article are cast, and a permanent core made of separable sections, the inner ends of which constitute the walls of the mold cavity against which the inner walls of the casting are formed.

57. In a mold for casting cup-shaped articles, the combination of a plurality of permanent mold sections shaped and correlated to form the walls against which the head end, sides and annular bottom walls of the cup-shaped article are cast, and a permanent core consisting of a central section insertible and withdrawable from the assembled mold sections by endwise movement and having flared end walls at diametrically opposite sides thereof, and side sections disposed between said end walls of the center section and having walls separable from said center section along lines approximately radial to the axis of the center section, said side sections being removable from the casting after the center section has been withdrawn by bodily lateral and then endwise longitudinal movements.

58. In a mold for casting cup-shaped articles, the combination of a plurality of permanent mold sections shaped and correlated to form the walls against which the head end, sides and annular bottom walls of the cup-shaped articles are cast, and a permanent core consisting of a central section in-

sertible and withdrawable from the assembled mold sections by endwise movement and side sections disposed at either side of said center section and having walls separable from said center section along lines approximately radial to the axis of the center section, said side sections being removable from the casting after the center section has been withdrawn by bodily lateral and then endwise longitudinal movements and said center section extending at its lower end slightly beyond the side sections, whereby when the center section is removed and the side sections are moved bodily laterally they will tend to sever any fin which might have been formed between them and the center section.

59. In a mold for casting cup-shaped articles, the combination of a permanent mold body shaped to form the walls against which the head end, sides and annular bottom walls of the cup-shaped articles are cast, and a permanent core consisting of a central section insertible and withdrawable from the mold body by endwise movement, and side sections disposed at either side of said center section and having walls separable from said center section along lines approximately radial to the axis of the center section, said side sections being removable from the casting after the center section has been withdrawn by bodily lateral and then endwise longitudinal movements, and said center section at its lower end being recessed to cause an inwardly extending web to be formed in the casting on the head thereof.

60. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of a mold body having surfaces which form the outer walls of the mold cavity, and a permanent core comprising a main section and side sections having merely slidable surface engagement with said mold body, the adjoining side section being recessed at their adjacent surfaces to form a cavity for inwardly extending bosses, when the casting is formed in the mold, the main section being removable by sliding it longitudinally relative to the side sections and the casting, the side sections being swingable bodily laterally away from the casting and the adjacent boss and then removable from the casting by outward endwise movement, and the side and center sections being recessed between said bosses to provide a cavity for the forming of a connecting web between the bosses on the casting.

61. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and skirt with internal piston pin bosses, and a permanent sectional core insertible within said mold body to form the inner wall of the cavity, the said core comprising a center section and side sections arranged upon opposite sides of the center section and formed to provide the cavities for the said pin bosses.

62. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a mold cavity for a piston casting having a head and a skirt with internal piston pin bosses, and a permanent core insertible within said mold body to form the inner wall of the cavity, the said core comprising a main member and members movably related to the main member and formed to occupy the spaces directly under the pin boss cavities when the parts of the mold are assembled in operative relation.

63. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of a permanent mold body having surfaces which form the outer walls of the cup-shaped mold cavity, and a permanent core composed of a plurality of separable sections, each having merely surface engagement with the adjacent walls of an adjoining section, said sections normally being held together when constituting walls of the mold cavity from points entirely outside the mold cavity and adjoining side sections being recessed at their adjacent surfaces to form a cavity for an inwardly extending boss.

64. In a mold for casting cup-shaped articles having inwardly extending projections, the combination of a permanent mold body shaped to form the outer walls of the cup-shaped mold cavity, a permanent sectional core comprising a main section having opposite lateral walls shaped to form parts of the internal walls of the cup-shaped cavity and side sections on opposite sides of the main section, said side sections being recessed to form in the casting diametrically opposed inwardly extending bosses and being adapted for withdrawal from the mold by lateral and then endwise movement after the main core section has been removed, and a gate for the mold cavity having an opening into the said cavity arranged intermediate the said diametrically opposed bosses.

65. In a mold for casting cup-shaped articles, the combination of a permanent mold body shaped to form the outer walls of the cup-shaped cavity, and a permanent core divided longitudinally into a plurality of sections and shaped to form the inner walls of the cup-shaped mold cavity, said core comprising a section insertible and withdrawable from the mold cavity by endwise movement and additional sections removable from the mold body and casting, after the first named section has been withdrawn, by bodily lateral and then endwise movement, and said first named section being extended at its lower end slightly beyond the other

sections, whereby when the said extended section is removed and the other sections are moved bodily laterally they will tend to sever any fin which may have been formed between them and the extended section.

66. A permanent mold core comprising a plurality of sections having adjacent end surfaces shaped to form one of the walls of the mold cavity, one of said core sections being withdrawable from the mold in advance of the others by endwise movement and having its end surface extended beyond the adjacent end surfaces of the other core sections, whereby when it is removed and said other sections are moved bodily laterally they will tend to sever any fin which may have been formed between them and the extended section.

67. In a mold for casting cup-shaped articles, the combination of coöperating separable mold body sections having surfaces forming the outer walls of the cup-shaped cavity and also the walls of a core cavity above the mold cavity proper, a permanent core divided longitudinally into a plurality of sections which are longitudinally movable in relation to each other, said core having its upper part engaging the side walls of said core cavity and its lower part forming the inner side and bottom walls of the cup-shaped cavity of the mold, means for positively limiting the inward movement of all of the core sections into the mold cavity, and means for locking the mold body sections together and tightly clamping the core sections in operative position.

68. In permanent molds for casting skirted pistons, the combination of a support, a pair of permanent mold members mounted on said support and movable bodily upon said support toward and away from each other, said mold members being formed with walls comprising complementary outer curved walls of a mold cavity for casting a piston having a head end with a skirt extending therefrom, and a permanent core movable relative to and spaced from said outer cavity walls to form inner walls of the mold cavity.

69. In a mold for casting pistons, the combination of a permanent mold body having an opening, the walls of which form the outer wall of a piston mold cavity, a core insertible within said opening to form the inner wall of the cavity, the said core having its walls formed with recesses, and permanent core pins insertible and withdrawable through openings in the mold body and coöperating with the walls of said recesses in the core to form internally projecting hollow wrist pin supports on the piston casting.

In testimony whereof I affix my signature in the presence of two witnesses.

JOSEPH H. BAMBERG.

Witnesses:

VERNON E. GARDNER,

WM. R. LAIRD.

Corrections in Letters Patent No. 1,296,588.

It is hereby certified that in Letters Patent No. 1,296,588, granted March 4,1919, upon the application of Joseph H. Bamberg, of Tonawanda, New York, for an improvement in "Metal-Molds;" errors appear in the printed specification requiring correction as follows: Page 2, line 70, for the word "from" read *form;* page 10, line 115, claim 24, page 11, line 2, claim 25, and same page, line 56, claim 29, strike out the word "curved;" page 11, line 36, claim 27, after the word "walls" insert the word *and;* same page, line 57, claim 29, after the word "outer" insert the word *lateral;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of May, A. D., 1919.

[SEAL.]

R. F. WHITEHEAD,
Acting Commissioner of Patents.

Cl. 22—136.