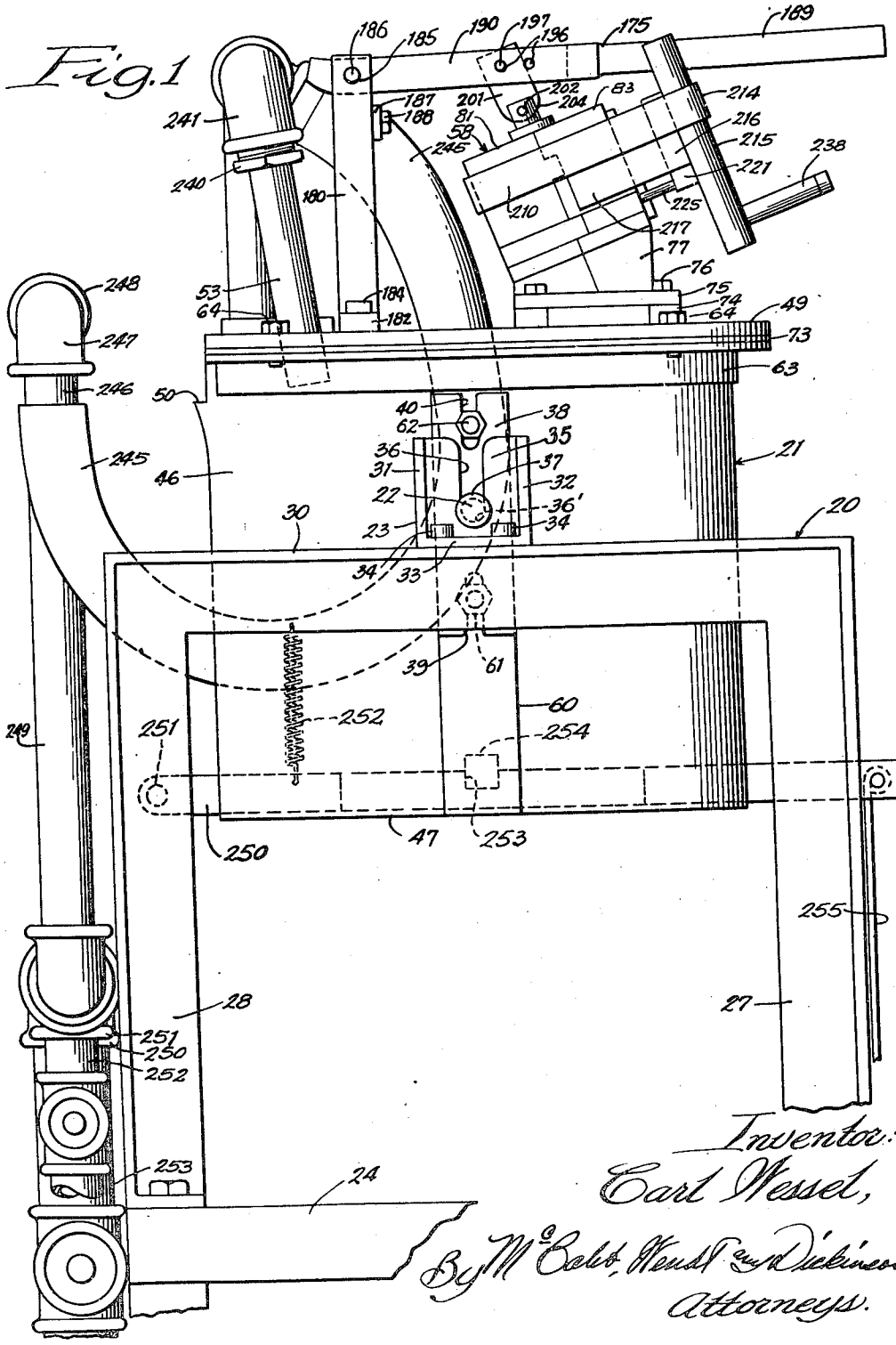
Oct. 14, 1947. C. WESSEL 2,429,146

MOLD AND CORE STRUCTURE

Filed Dec. 11, 1942 6 Sheets-Sheet 1

Fig. 1



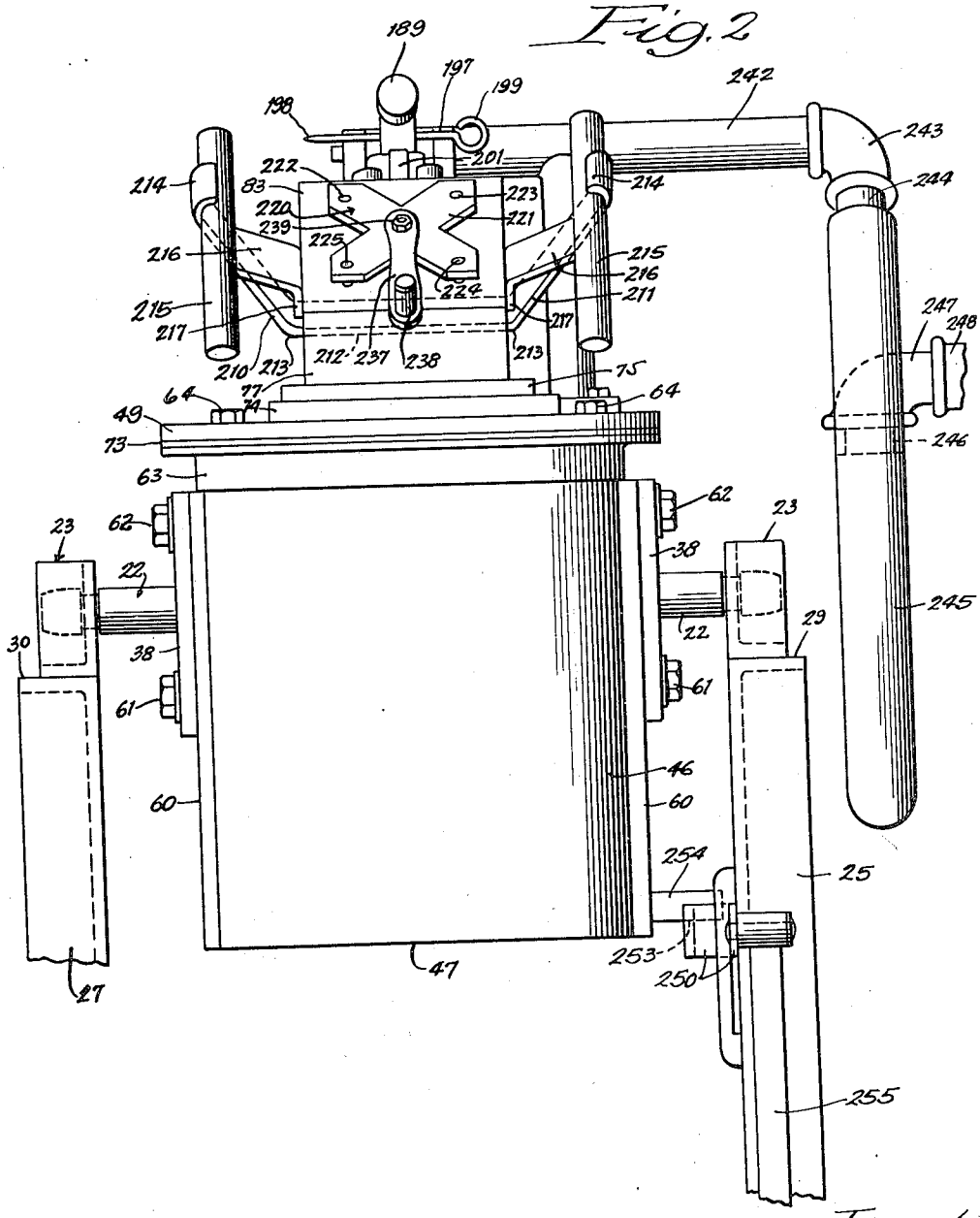
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Oct. 14, 1947. C. WESSEL 2,429,146

MOLD AND CORE STRUCTURE

Filed Dec. 11, 1942 6 Sheets-Sheet 2

Fig. 2



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Oct. 14, 1947. C. WESSEL 2,429,146

MOLD AND CORE STRUCTURE

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Fig. 3

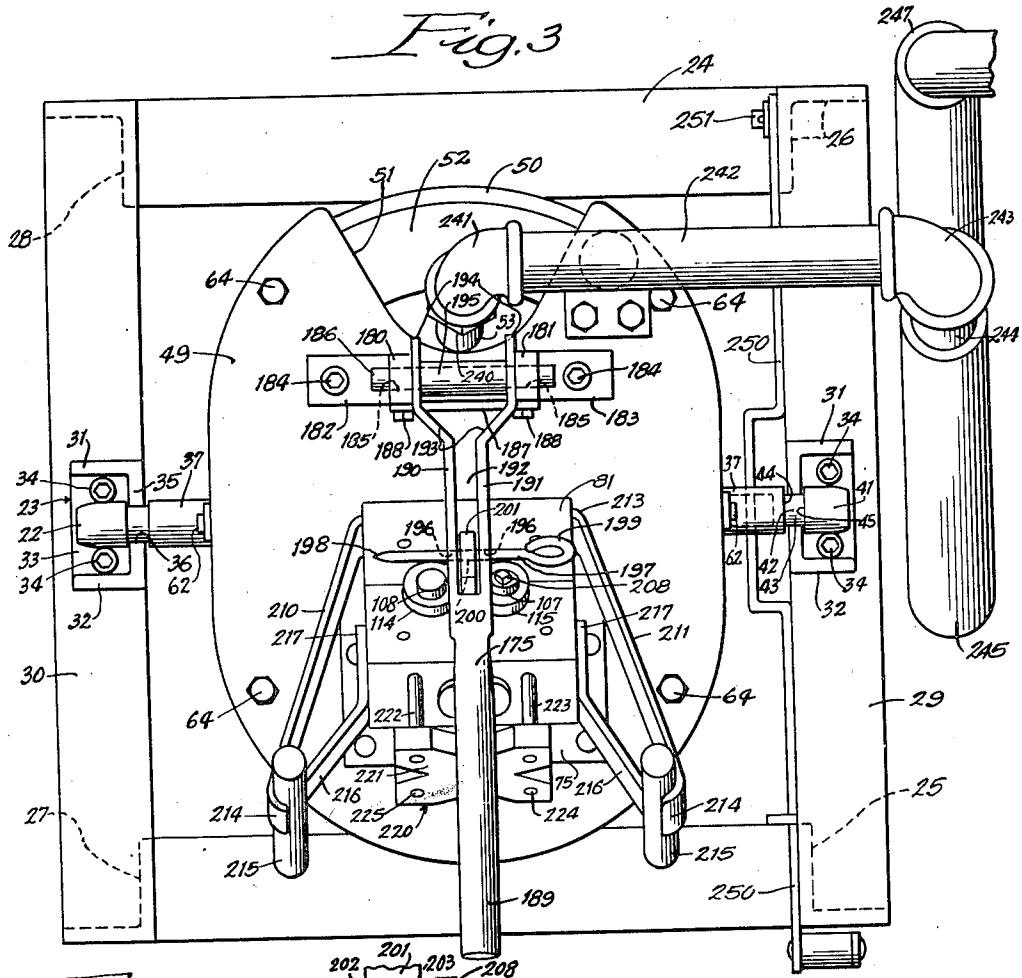


Fig. 4

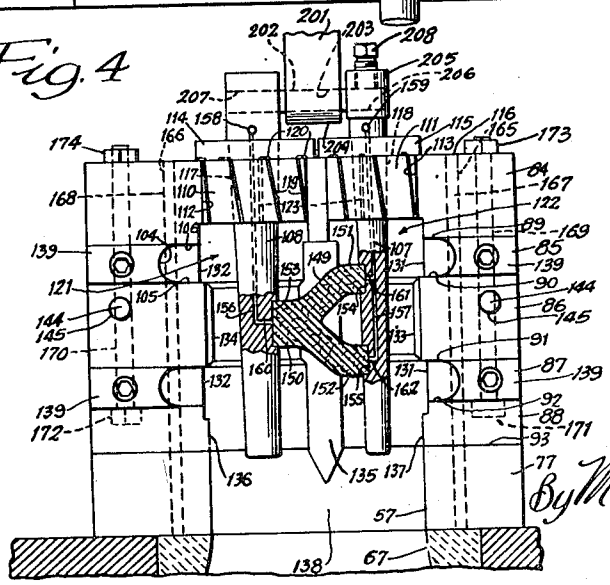
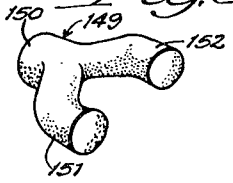


Fig. 5



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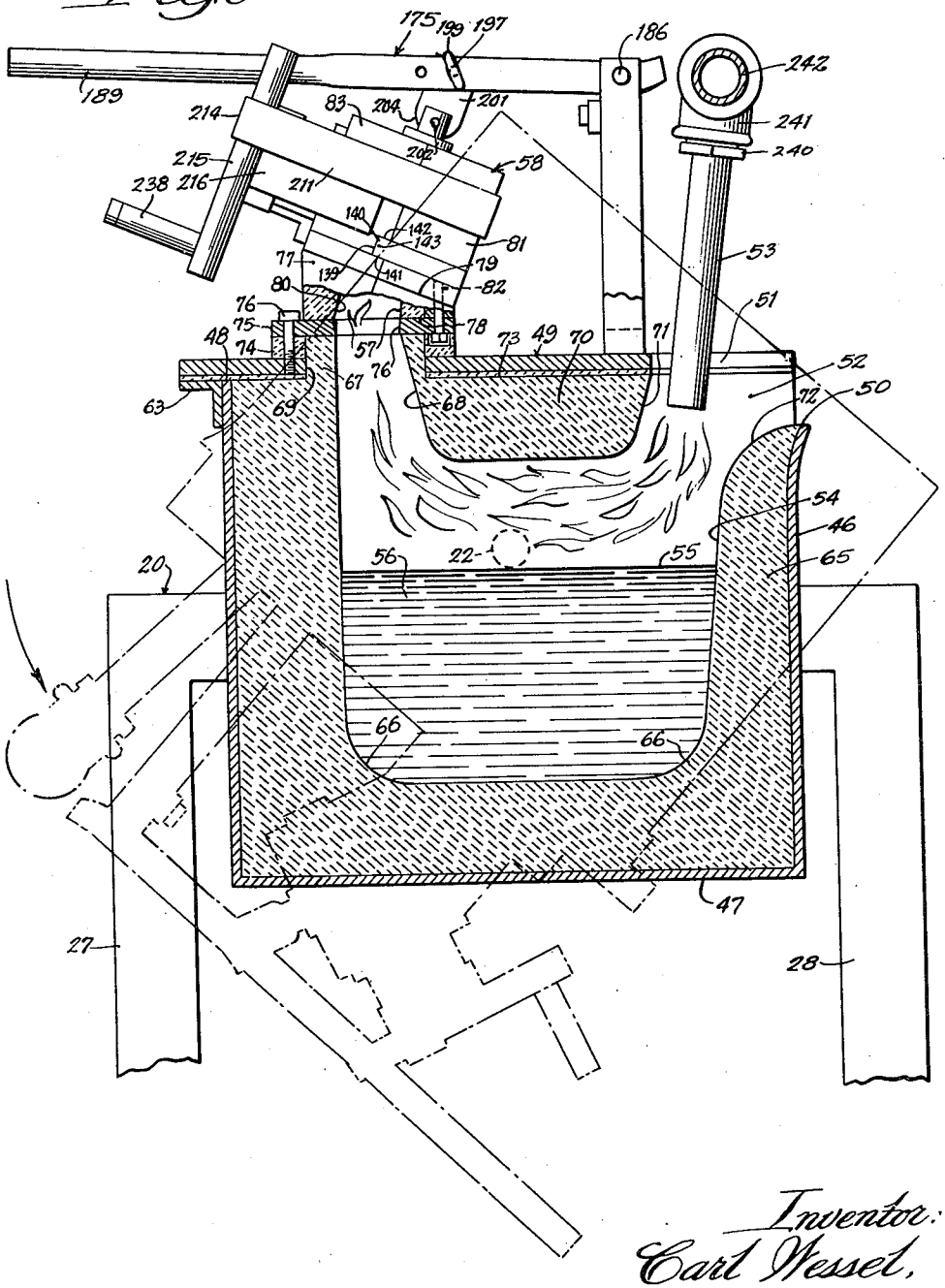
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MOLD AND CORE STRUCTURE

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Fig. 6



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MOLD AND CORE STRUCTURE

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Fig. 7

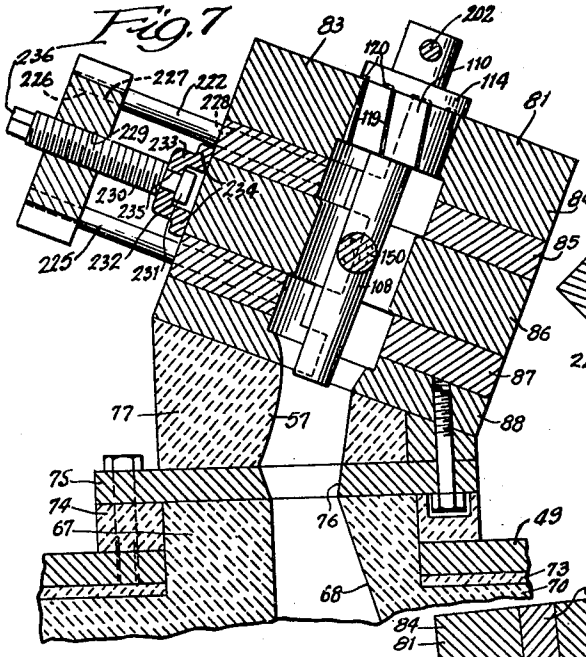


Fig. 8

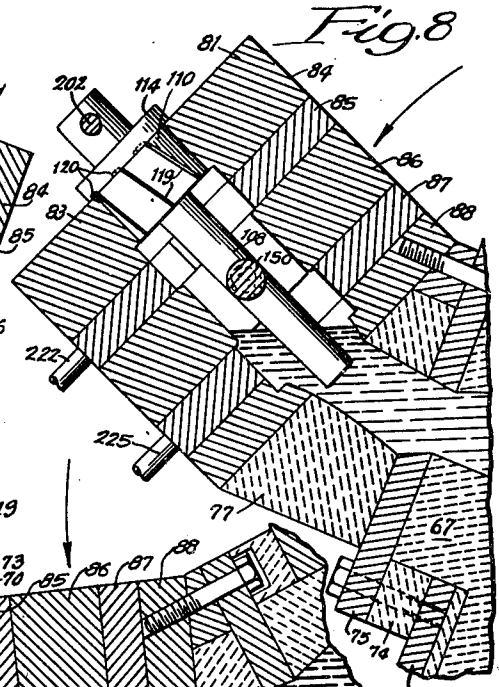


Fig. 9

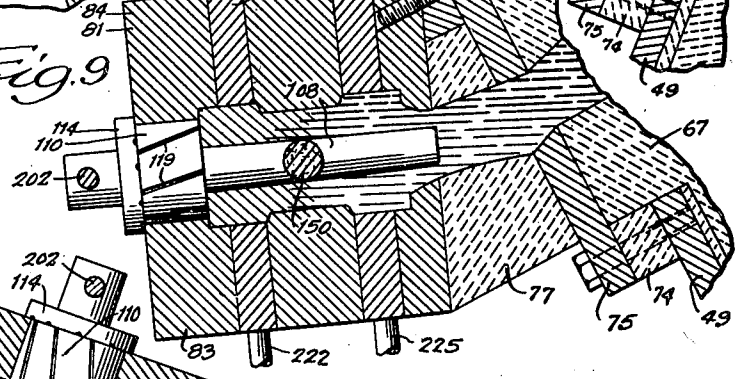
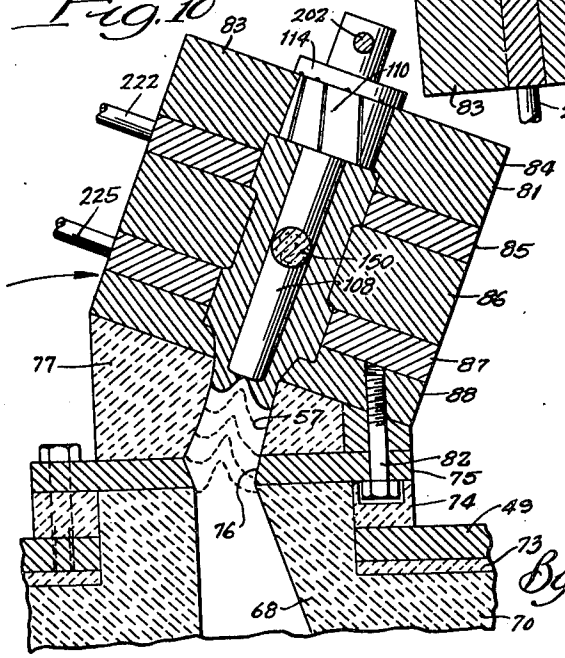


Fig. 10



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Oct. 14, 1947. C. WESSEL 2,429,146

MOLD AND CORE STRUCTURE

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Fig. 11

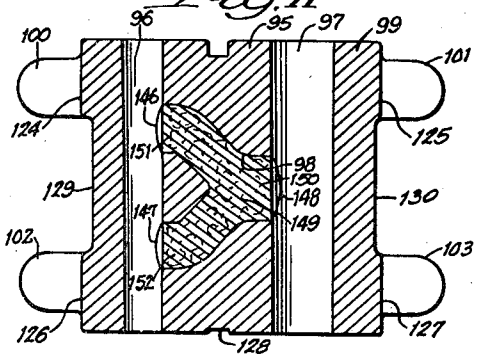


Fig. 12

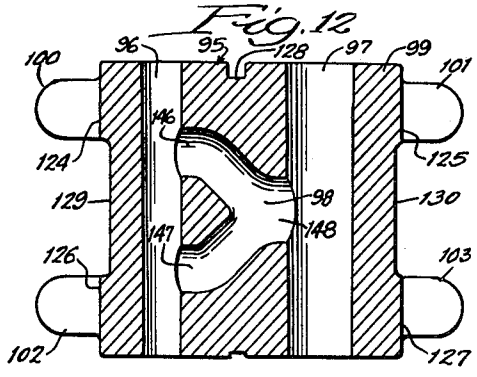


Fig. 13

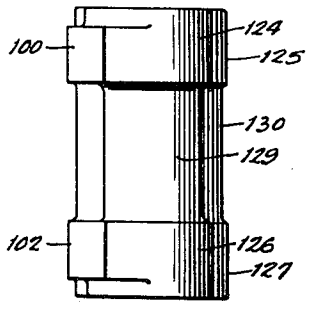


Fig. 14

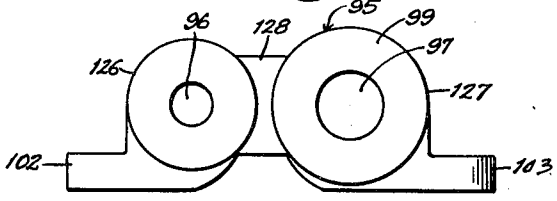


Fig. 15

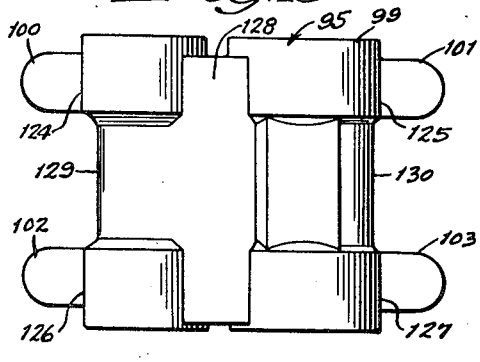
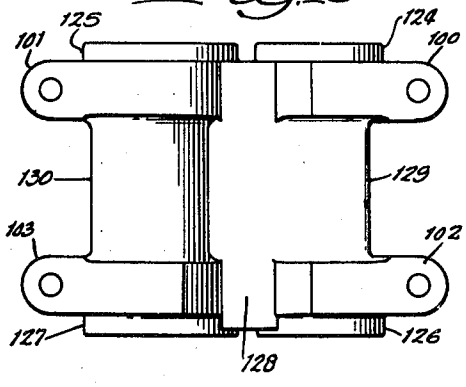


Fig. 16



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Patented Oct. 14, 1947

2,429,146

UNITED STATES PATENT OFFICE

2,429,146

MOLD AND CORE STRUCTURE

Carl Wessel, Chicago, Ill., assignor to Carl Wessel and Lew W. Cleminson, Chicago, Ill.

Application December 11, 1942, Serial No. 468,621

12 Claims. (Cl. 22—151)

1

The present invention relates to castings, machines, and methods of casting, and is particularly concerned with improvements in the subject-matter disclosed in my prior application, Ser. No. 251,092, filed January 16, 1939, which has issued as United States Letters Patent No. 2,287,848, June 30, 1942, Method of casting.

One of the objects of the invention is the provision of an improved casting machine and improved method of casting, which is adapted to produce better castings and better metal stock of various shapes, more efficiently and more economically than can be done by the methods and apparatus of the prior art.

Another object of the invention is the provision of an improved tilting machine adapted to carry out the methods covered by my prior patent and certain improved methods of casting.

Another object of the invention is the provision of an improved method and apparatus for casting, by means of which the difficulties of removing the mold from the casting, and the casting from the machine, are greatly reduced so as to expedite the making of castings.

Another object of the invention is the provision of an improved mold by means of which the mold parts may be more quickly separated or assembled and by means of which the casting may be more easily removed from the mold and machine.

Another object of the invention is the provision of an improved machine of the tilting type, in which provision is made for tilting the ladle on its axis so as to secure special results in the flow of metal into particular parts of the mold, and also for the purpose of leveling up the machine.

Another object of the invention is the provision of an improved mold and improved cores by means of which cored apertures of any desired shape may be made in the casting and the core is very conveniently removed when the casting is finished.

Another object of the invention is the provision of an improved method of making cores for castings, and the provision of a method of making molds.

Another object of the invention is the provision of an improved casting or metal stock having a higher degree of uniformity of crystal structure, a better finished surface, so as to eliminate the necessity for machining, the elimination of the undesirable results of shrinkage, flaws, pipes, and the perfect filling of the mold.

Other objects and advantages of the invention

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accomplished by this method and apparatus are substantially the same as those enumerated in prior patent, the methods of which this apparatus is adapted to carry out with even better results.

Further objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views, and of which there are five sheets.

Fig. 1 is a side elevational view of a casting machine embodying the invention;

Fig. 2 is a front elevational view of the casting machine;

Fig. 3 is a top plan view of the casting machine;

Fig. 4 is a sectional view, taken on a plane passing through the axis of the casting, showing the open half of the mold and the cores in place for the formation of a casting, after the application of the other mold half;

Fig. 5 is a view in perspective of a special core of the type used in Fig. 4;

Fig. 6 is a vertical sectional view, taken on a plane passing through the axis of the ladle, showing the mold in elevation and illustrating the application of a burner flame to the surface of the metal and to the mold. The dotted line position illustrates one of the extreme positions to which the ladle may be tilted, although it is not necessary to tilt the ladle in every case to this extent.

Fig. 7 is a fragmentary sectional view, taken through the mold, showing the position of the mold parts before the beginning of the mold filling operation;

Fig. 8 shows the position of the mold parts and the molten metal as the mold filling operation begins;

Fig. 9 is a similar view, showing the mold after it has been filled and is being subjected to the pressure of a head of metal in the ladle, while the metal casting is congealing;

Fig. 10 is a similar view, showing the mold and casting after the ladle and mold have been tilted back to the position of Fig. 7, but before the mold has been removed;

Fig. 11 is a sectional view, taken through the casting made with the mold illustrated, the section being taken on a plane passing through the axes of the two bores of the casting, with the destructible core still in place;

Fig. 12 is a similar view of the casting after the destructible core has been removed;

Fig. 13 is a side elevational view of the casting;

Fig. 14 is an end plan view of the casting;

Fig. 15 is a front elevational view of the casting;

Fig. 16 is a rear elevational view of the casting.

Referring to Figs. 1 to 3, these are illustrations showing the outside of a suitable form of apparatus for carrying out the present method.

The apparatus preferably includes a supporting framework (Fig. 1), indicated in its entirety at 20, for pivotally supporting a ladle 21 by means of trunnions 22 carried by the bearing members 23.

Other modes of tiltably supporting the ladle 21 may be employed, but I prefer to utilize trunnions 22, which are located so that the ladle is normally held in upright position when it is charged with a suitable charge of molten metal.

The framework 20 may consist of a plurality of angular metal members, four of such members forming a rectangular base 24, the base members being secured together by welding at the corners.

At each of the corners of the base 24, the framework 20 is provided with upwardly extending columns 25, 26, 27, and 28. At their upper ends the vertically extending frame members 25 and 26 are joined by a horizontal frame member 29, also made of angle stock, and the upper ends of the vertical frame members 27, 28 are joined by a horizontal frame member 30.

The bearing members 23 may each consist of cast metal members in the form of a channel, having side flanges 31, 32, and a base flange 33, which is provided with apertures for receiving the screw bolts 34, which secure these bearing members to the horizontal frame members 29 or 30.

The web 35 of each bearing member is provided with a vertically extending slot 36, the lower end of the slot being provided with a half circular border 36' so that it is adapted to serve as a bearing for the trunnion 22. The trunnion members 22 are identical in shape and construction, but are oppositely disposed on the ladle 21.

Each trunnion may comprise a substantially cylindrical shaft 37, which is fixedly secured to a supporting strap 38, which may be of substantially rectangular shape and provided with inwardly extending slots 39 and 40 at its upper and lower ends.

The trunnion 37 may be provided with a head 41, which is formed by means of a groove 42 located between the end of the trunnion and the supporting strap 38. The groove 42 may be of rectangular cross section so that the trunnion has a portion of reduced cylindrical size at 43 for engaging in the bearing slot 36 against the bearing surface 37.

The annular thrust surfaces 44 and 45, which form the walls of the slot 42, serve to engage the two faces of the web 35 of the bearing member 23 and prevent endwise motion of the trunnions in the bearings.

The two upwardly extending portions of the frame 20, which are formed by the vertical parts 27, 28 and horizontal member 30, and the vertical parts 25, 26 and horizontal member 29, are spaced from each other, leaving the framework open at the front and back so that the ladle and its associated parts may be tilted freely between these upwardly extending bearing supporting portions.

The ladle 21 may consist of a metal shell, and the metal shell may take various different forms, but is preferably made with a cylindrical body

portion 46 and a flat bottom portion 47. The cylindrical portion 46 of the shell may terminate with the upper edge 48 of its wall in substantially the same plane for engagement with a cover member 49, except that the cylindrical wall 46 is provided with a partially circular cut-out portion at 50, the groove 50 also registering with a cut-out portion 51 located in the cover 49, forming a burner opening 52.

The burner opening is of sufficient size (Fig. 6) to permit the burner discharge pipe 53 to be directed into the inner chamber 54 of the ladle at the various different angles and to be so oriented that its flame may impinge upon the free surface 55 of the molten metal 56 and be reflected upward toward the opening 57 in the mold 58.

In addition to this, the opening 52 is of sufficient size so that it may serve as an aperture for filling or emptying or cleaning the ladle, and it also serves to discharge the gases of combustion which issue from the ladle as a result of the action of the burner 59.

At diametrically opposite sides the shell 21 is provided with the longitudinally extending frame member comprising a metal strap 60, such as steel, which is welded, or otherwise permanently secured to the metal shell 21 and provided with the outwardly extending threaded screw bolts 61, 62.

These screw bolts are spaced from each other such a distance relative to the location of the slots 39, 40 that a considerable vertical adjustment is permitted with respect to the location of the trunnion member 22 upwardly or downwardly on the side of the ladle 21.

The trunnion members are clamped in place by means of nuts on the bolts 61, 62; and by means of this adjustment the ladle and its mold may be tilted in a lateral direction so as to level up the machine, where a laterally symmetrical casting is to be made in the mold.

In the event casting is being made in a mold which is not symmetrical laterally, and it is desirable to facilitate the flow of the metal toward one side of the mold before it reaches the other, these adjustable trunnions may be used to tilt the entire ladle from the vertical axis, and to facilitate the flow of the metal to the desired points in the mold.

Except at the opening 52, the upper edge of the shell 21 is provided with an angle iron 63, the vertical flange of which is curved cylindrically to fit the outside of the shell wall 46. The horizontal flange of the angle 63 provides an extended bearing surface for the cover 49. All of the metal parts of the ladle 21, frame 20, and mold 58 are preferably made of a metal of high melting point, such as steel, or steel alloy, although in some cases the mold parts may be made of cast metal.

The cover 49 may consist of a circular plate of sheet metal (Fig. 2) adapted to cover the upper end of the shell 21 and to have its border coincide with the outer edge of the horizontal flange of the angle 63, except that the cover is provided with the cut out portion at 51, bordered by two substantially radially extending lines and providing an opening 52.

The cover may be secured to the shell 46 by a plurality of through screw bolts 64, passing through apertures in the cover, and threaded into apertures in the angle 63. In some embodiments of the invention the cover may be riveted in place or welded.

The frame preferably supports a latching lever

250, which is pivotally mounted at 251 and urged into latching position by a spring 252. It has a notch 253 for engaging a keeper 254, which is carried by the ladle and may be actuated by a foot pedal connected to a connecting link 255.

The ladle 21 is preferably heat-insulated by having its shell 46 lined with a relatively thick wall 65 of heat-insulating and heat-resisting refractory.

The refractory 65 covers the inside of the cylindrical wall 46 and the bottom 47, and forms a substantially cylindrical chamber 54, which has its lower corners rounded at 66 for effective cleaning and complete discharge of the ladle in use or during the cleaning operations.

The wall of refractory 65 may be built up in the lower part of the shell 46 by using a suitable inner core, after which the core is withdrawn, and additional upper sectional cores are used to form the upper wall surfaces.

The refractory not only extends up to the cover 49 at the outer walls of the shell 46, but it is provided with an upwardly extending tubular neck 67, surrounding a ladle discharge conduit 68 and passing through a circular opening 69 in the cover plate 49.

The neck 67 may be formed integrally with the side wall of refractory 65, and an additional upper wall portion 70 may be formed integrally with the side walls and neck of refractory. The upper wall portion 70, being supported from the side walls of refractory 65, at the open mouth 52 the refractory is gradually curved outward, as indicated at 71 and 72.

Another layer 73 of refractory of the same or of a different kind may extend over the upper wall surface 74 and over the horizontal flange of the angle 63 to insulate the cover plate 49 from the shell 21 and angle iron 63.

The tubular neck 67 (Fig. 6) may be surrounded by an insulating collar 74 of refractory, which supports a metal plate 75, having a tapered aperture 76 registering with the discharge conduit 68.

The plate 75 is secured to the cover plate 49 by a plurality of screw bolts having their heads located above the plate 75, the bolts passing through plate 75 and through the insulating axle 74, and being threaded into the cover plate 49.

Thus the plate 75 is heat-insulated from the cover plate of the ladle, except for the heat that is transmitted through the securing bolts 76.

The member 77 comprises a collar of refractory having a lower plane surface 78 for engagement with the plate 75 and having its upper plane surface 79 at an acute angle to the lower plane surface 78 so as to locate the axis of the mold at an angle to the horizontal free surface 55 of the molten metal.

The refractory member 77 also has a conduit 80 passing through it, and registering with the discharge conduit 68 and aperture 76 of the ladle and plate 75. The conduit 80 communicates with the inlet to the mold, and the refractory member 77 serves as additional heat insulation for insulating the mold from the ladle.

The fixed half 81 of the mold 58 may be fixedly secured to the plate 75 and refractory member 77 by a plurality of screw bolts 82, having their heads located below the plate 75, the bolts passing upward through the plate 75 and through the refractory 77 and being threaded into the mold half 81.

Thus this portion of the mold is heat-insulated from the ladle by the refractory 77, except for the bolts 82, which transmit some heat to the plate 75.

The two halves of the mold 58 are indicated by numerals 81 and 83, and these members are substantially similar in shape and construction, each having half of a cavity formed therein to provide the casting cavity. The mold halves are each preferably built up of a plurality of metal layers of laminations, the laminations engaging each other with lapped and ground plane surfaces, and the separate sections or laminations of the half mold member 81 are indicated by the numerals 84—88.

The joints between these sections are indicated by the numerals 89—92, and the lower plane surface of the section 88, which engages the refractory member 77, is indicated by numeral 93. The joints between the sections are preferably located at such points with respect to the casting as are desirable, from the fact that the casting changes its contour abruptly at such points.

For example, Figs. 11–16 are illustrations showing the casting, which is indicated by the numeral 95, and comprises a double barreled member having the two axially extending bores 96, 97 communicating by means of a Y-shaped conduit 98.

The body of the casting is indicated by the numeral 99, and it is provided on its rear side with four laterally projecting attaching flanges 100, 101, 102, and 103.

The borders of the mold portions, which form the ends of these attaching flanges, are indicated at 104, 105, 106. Thus it is desirable to have the first section 84 terminate along the line 106, which is the upper edge of attaching flanges 100, 101. The next section 85 may be of the same width as the attaching flanges 100, 101. The next section 86 of the mold forms that portion of the casting which is between the attaching flanges, and it may terminate at its lower plane surface 91, which is on the same plane as the upper edge of the attaching flanges 102, 103.

The next section 87 of the mold may be of the same vertical width as the attaching flanges 102, 103, and the lowermost section 88 is of sufficient depth vertically to form the lower barrel portion of the casting 95 and to make these barrel portions of sufficient length so that when the sprue is cut off only perfectly formed barrel portions of sufficient length are left.

The two bores 96 and 97 in the casting 95 are formed by suitable permanent cores 107, 108. These permanent cores are almost cylindrical in shape, but have a very slight taper, such as four thousandths of an inch on a seven inch core.

This makes the cores frusto-conical so that they may be removed from the casting by being withdrawn axially; and after the casting is completed, it is only necessary to ream out the bores 96, 97 to make them of cylindrical shape, before the bores are threaded at each end.

In order to hold the permanent cores 107, 108 in place, they are supported by the cylindrical plugs 110, 111, which fit in the circular bores 112, 113 in the mold. These circular bores are, of course, formed by half cylindrical grooves in each half of the mold. Each plug 110, 111 is provided on its upper plane side with a metal washer 114, 115, the washer having a greater diameter so that it engages the upper plane side 116 of the mold and limits the inward movement of the plugs 110, 111 into the mold.

The plugs 112, 113 and washers 110, 111 are provided with tapered bores 117, 118 for receiving the tapered permanent cores 107, 108 so that the plugs and washers have a forced fit, and are frictionally held in predetermined position on the permanent cores.

Each plug is preferably provided with a plurality of longitudinally extending external grooves 119 extending the full length of the groove and communicating with radially extending grooves 120 located either at the lower side of the washer 114, 115 or in the top wall of the plugs 110, 111.

If located in the top wall of the plug 110, 111, the grooves also extend radially into the upper surface 116 of the mold so as to provide communication between the external atmosphere and the interior chambers 121, 122 of the mold through grooves 119, 120.

These grooves are from two thousandths to eight thousandths of an inch in depth and thickness, and in some cases grooves smaller than two thousandths of an inch in depth may be provided in greater number to permit the slow passage of the air out of the mold and effect a perfect filling of the mold.

The grooves are too small relative to the condition of the molten metal to pass the molten metal, and for this purpose the size of the grooves depends on the liquidity of the molten metal.

When the mold is filled at a temperature of molten metal close to the melting point, the liquidity of the metal is low, and the grooves have a lesser tendency to form a disfiguration on the end surface of the casting.

Similar grooves are also provided at 123 on the inside of each plug 110, 111 for venting the air from the mold at the corners adjacent the permanent cores 107, 108.

The grooves 123 also communicate with radial grooves 120 to permit the communication of the grooves with the atmosphere.

The casting in question is formed with a pair of barrels comprising enlarged cylindrical portions 124, 125, 126, 127 at each end, joined by a flat and thick central rectangular portion 128 and by intermediate substantially cylindrical portions 129 and 130 (Fig. 16).

In order to provide this shape, the mold has the cylindrical bores 112, 113, and cylindrical bores of a slightly larger size 131, 132 at each end of the mold. The intermediate bores 133, 134 in the mold are smaller to form the smaller portions 129, 130. Each half mold has a flat wall portion 135 between the permanent cores and cavities, and the flat wall portions are spaced from each other on the separate halves of the molds, to provide a thick central body portion 128, which joins the two barrels.

At its lower end the mold is provided with a pair of bores 136, 137 (see Fig. 4) of the same size as the bores 112, 113, and the two bores 136, 137 may merge into a single oval opening 138 at the lower end of the mold, and communicating with the conduit 57 in the refractory member 77.

The present casting is adapted to be formed with the laterally projecting ears 100—103, and the mold sections 85 are formed with the recess surrounded by the walls 104, 105, 106 to form these ears. The rest of the surface of each section 85 is indicated by the numeral 139, and the sections 85, 87 of the mold are utilized to form ribs 140 on the fixed half of the mold.

The ribs 140 (Fig. 6) are bound by the face surface 139 and the two side walls 141, 142. They

fit into corresponding recesses 143 in the movable half 83 of the mold. These ribs 140 and recesses 143 serve to align the two halves of the mold in a vertical direction, further alignment being accomplished by means of dowel pins 144 (Fig. 4) located in the apertures 145 which extend above halves of the mold.

The present casting is intended to have a pair of conduits joining the two barrels or bores 96, 97, the conduit being indicated by the numeral 98 in Fig. 11. Such a Y-shaped conduit may be used for a two-way valve in order to direct fluid in one direction or another into the bore 96. When one port 146 (Fig. 11) is closed by a cylinder, another port 147 may be opened, and both ports may be controlled by means of a cylinder in the bore 97, closing port 148.

This Y-shaped conduit extends across the intermediate body portion 95 of the casting from one bore 96 to the other bore 97; and for this purpose I prefer to use a destructible core 149 of the type illustrated in Fig. 5.

This destructible core has a larger cylindrical stem portion 150, which forms the port 148, and two smaller cylindrical stem portions 151, 152 for forming the ports 146, 147 and the connecting conduits.

The destructible core is made by means of a special method, fully to be disclosed hereinafter; and it is preferably of such construction that it may be dissolved by means of a suitable solvent passed through the casting after the casting has been completed.

I prefer to construct the core of such materials and construction that it is destructible merely by the use of water as a solvent, so that the core may be dissolved at the same time that the casting is quenched in water.

In other embodiments of the invention it may be made soluble in certain quenching oils or other solvents.

In order to support the core 149 in the mold I prefer to provide a cylindrical socket 153 for the cylindrical end 150 of the destructible core in the permanent core 108. Similar cylindrical sockets 154, 155 are formed in the permanent core 107 for receiving the end portions 151, 152 of the destructible core 149.

Each of the permanent cores 107, 108 is provided with an axially extending air escape bore 156, 157 extending at its upper end to a radially extending bore 158, 159 for communicating with the atmosphere.

At its lower end the bore 156 communicates with a radial bore 160 extending into the socket 153. At its lower end the bore 157 in the permanent core 107 communicates with radially extending bores 161, 162, which communicate with sockets 154 and 155.

The axially extending bores 156 and 157 may extend the full length of the permanent cores, if desired, for purposes of convenience, as no harm is done by having the bore at the lower end of the permanent core. These bores and conduits 156 to 162, inclusive, may be of any suitable size for permitting the escape of air and other gases from the destructible core 149, when heat is applied to it.

For example, they may be of the proportions shown in the drawing, or they may be made considerably larger for freer passage of the gases from the interior of the mold.

The separate sections 84—88 of the mold are held in axial alignment by means of metal dowel pins, preferably two in number, one being located

in each of the side portions of the mold on each side of the cavity, in Fig. 4.

The dowel pins and the bores extend through all of the mold sections. The dowel pins have a frictional fit in the bores. For example, the bores for the dowel pins are indicated by the numerals 165 and 166 (Fig. 4), while the dowel pins are indicated by the numerals 167, 168.

In addition to the dowel pins for aligning the sections of the mold 85—88, these dowel pins may extend downward into the refractory member 77 in the case of the fixed portion of the mold 81, but in the movable portion of the mold 83, the dowel pins terminate short of the lower surface of the mold half 83.

The mold sections are also preferably secured together by through bolts, comprising at least one on each side of the mold, and the through bolts pass through aligned bores in the separate mold sections 84—87.

The through bores are indicated by the numerals 169, 170 (Fig. 4), and the through bolts by the numerals 171, 172. The clamping nuts 173—174 at the top engage the threaded portions of the bolts and draw the bolt sections tightly together. The separate mold sections are, of course, accurately lapped and ground at their engaging surfaces and provided with inner mold cavity formations, which are accurately aligned, as indicated, by the bolts and dowel pins.

The machine is preferably provided with means for withdrawing the permanent cores, and this may comprise a suitable lever 175 and its associated parts. For this purpose the cover plate 49 may be provided with a pair of columns 180, 181 for pivotally supporting the rear end of the lever 175.

The columns 180, 181 have laterally turned attaching flanges 182, 183, through which the screw bolts 184 pass, to be threaded into threaded bores in the cover 49.

At their upper ends these columns are provided with aligned bores 185 for receiving the shaft 186, which may have a tight frictional fit in the bores. The columns 180 and 181 may be braced by a transverse frame member 187 secured to each column by screw bolts 188 adjacent the top.

The lever 175 may be constructed out of a tubular pipe, the cylindrical portion 189 at the front end serving as a handle. Above the mold the pipe of which the lever 175 is formed may be split into a pair of parallel legs 190, 191, separated by a slot 192.

The legs 190, 191 may be bent diagonally outward at 193, and may be provided with pivot flanges 194 at each end, the pivot flanges having apertures providing bearings for the pivotal movement of the lever on the shaft 186. A tubular spacer 195 may be placed on the shaft 186 between the pivot flanges 194.

The legs 190, 191 may be provided with a pair of aligned apertures 196 for receiving the removable pivot pin 197, having a pointed end 198 and a finger loop 199.

The pivot pin 197 also passes through a bearing bore 200 in the link 201. The link 201 comprises a short strap of metal pivotally secured to the lever 175 at the pin 197, and also pivotally secured to a shaft 202 (Fig. 4) which is adapted to support the two permanent cores 107, 108.

For this purpose the link 201 has a through bore 203 at its lower end, and the lower end is rounded, as indicated at 204, to prevent interference with the mold parts.

If the permanent cores are not large enough to provide a sufficient body, they may be provided with a head 205 at the top, as shown in Fig. 4 on the core 107, or the head may be omitted, as shown, at the upper end of core 108. The upper end of each core is provided with a through bore 206, 207 for receiving the shaft 202, which also passes through the bore 203 of the link 201.

The shaft 202 preferably has an easily removable fit in the bores, and is secured in one of the bores by means of a set screw 208, such as that shown, threaded into the upper end of the core 107. Thus the cores may be readily disconnected from their operating linkage, if desired; but usually the cores are disconnected by withdrawing the pin 197 when it is necessary to change them or clean them or make some other adjustment.

The lever 175 withdraws the cores by means of the application of an upward force to its rounded end 189, and by reason of the taper of the permanent cores, they may be withdrawn. Those portions of the destructible core 149 which are in the sockets 153—155 are readily sheared off.

The destructible core 149 is made by molding this core in a suitable mold, having a cavity corresponding in shape to the external area, and consisting of two parts. Such a mold may be wood or of any suitable material, including metal.

The core may be made of a mixture of fuller's earth and kaolin in the proportions of 50 percent of fuller's earth and 50 percent of kaolin, moistened by means of a suitable solvent, such as kerosene, to a moldable condition.

When a core has been molded out of this composition, as shown in Fig. 5, it is then placed on a sheet of blotting paper, and the excess of kerosene is then taken up by the paper, while the molded core is permitted to dry at room temperature. The length of time in which drying is necessary depends upon the humidity and temperature of the room; but in ordinary summer weather the cores will dry in about an hour under these conditions.

After the cores have dried at room temperature, they are relatively rigid, and they are then dipped in a solution of water and silicate of soda.

This solution is sufficiently thick to serve as a coating solution, and it may be of the consistency of paint. The strength of the resulting destructible core depends upon the consistency of the solution of sodium silicate and the period of time of immersion. The cores are preferably dipped in quickly, and then removed by means of pins or needles in order to make a thin shell of sodium silicate on the outside of the core.

The dipped cores are then baked at a maximum temperature of about 500 degrees F. The temperature is raised slowly to 500 degrees and baking carried on for a period of about two hours. During the baking and as the temperature is raised, the kerosene is volatilized, and driven out at a temperature of about 230 degrees F.

The water of combustion and of solution in the sodium silicate solution is driven out, and the sodium silicate is caused to harden, forming a destructible core, with a hard outer shell; and the interior of the core is soft and fluffy. Such a sodium silicate shell is supported against the external pressures which are applied to it by the head of metal in the mold and in the ladle by means of the body of fuller's earth and kaolin,

which also excludes most of the air from the destructible core.

However, the core is destructible; and when the metal goes into the mold, the air expands in the core and escapes through the conduits 160—162 and conduits 156, 157, 158, 159, through the permanent cores.

The castings may be quenched in water at about 1,000 degrees F., and the core may be removed at once by soaking the casting in the quenching water.

Cleaning out of the core may be effected by means of the flow of water under pressure, leaving the through conduit 98 in the casting, with its outlet ports 146—148.

The mold is preferably provided with spring means for securing the two halves of the mold together and maintaining the removable mold half in the casting position. For example, each side of the fixed half 81 of the mold may be provided with a pair of spring arms 210, 211, which may take the form of a strap of metal.

The strap may have a flat attaching portion or yoke 212, which is welded, screwed, or otherwise secured to the rear side of the mold half 81. At each side of the mold, such as, for example, the points 213, the strap is bent forwardly, and extends diagonally outward from the mold, forming the spring arms 210, 211.

These spring arms are provided at their ends with partially cylindrical inwardly curved latching portions 214, which are complementary in shape to the pipe handles 215 carried by the movable mold section 83. The curved portions 214 may extend over approximately one-fourth of a revolution, that is, they may extend far enough about the handles 215 to have a portion of their curved surface in position to oppose directly any movement of the handles 215 and the movable mold half 83 away from the fixed mold half 81.

The handles 215 comprise short sections of tubular stock or pipe, which are fixedly secured, as, for example, by welding, to the ends of the spring arms 216. For example, the pipe may be slotted, and the end of each spring arm inserted in the slot and welded in place.

The spring arms 216 also are provided with attaching flanges 217, which extend parallel to the sides of the movable mold half 83, and are secured to this mold half by welding, riveting, or screws, preferably the former.

The length of the spring arms 216 and the direction in which they extend relative to the spring arms 210, 211 is such that the latching shoulders 214 engage outside the tubular handles 215 and so that the arms 210, 211, 216 are in substantial alignment with each other when he mold halves are in closed position.

The arms 216 may be swung toward each other by means of lateral pressure applied to the handles 215, and thus the removable mold half may be removed. The arms 216, however, tend to swing out into the latching position and to hold the mold halves together in the closed position.

Referring to Figs. 1, 2, and 7, the mold is preferably provided with means for ejecting the casting from the movable half of the mold, indicated in its entirety by the numeral 220 (Fig. 2). This may consist of a cross head 221 of cruciform shape, the four arms of which carry four pins or plungers 222—225.

Each of these plungers may consist of a cylindrical rod, having a portion of reduced size, as indicated at 226 (Fig. 7), the reduced end portion [illegible] in a bore 227 in the cross head 221. It may be secured by a tight frictional fit or by riveting over the end, or in any other suitable manner. The plungers 222—225 are slidably mounted in the mold half 83, which is provided with through bores 228 for receiving these plungers, the bores being parallel and having a sliding fit with the plungers.

The plungers are provided on their inner ends with surfaces complementary to that portion of the mold into which they may happen to project so that the ends of the plungers form a continuation of the mold surface in the cavity.

The plungers 222—225 and bores 228 are preferably symmetrically located with respect to the parts of the casting, and a lesser or a greater number of plungers may be used, as required, to assure the ejection of the casting from the movable half of the mold and its retention in the fixed portion of the mold.

In other words, the plungers remove the movable mold half 83 from the casting and fixed mold half.

The plungers preferably engage the casting at some point where the casting will not be marred by the engagement of the plungers. In the present case the plungers are so arranged that they engage the casting at the attaching flanges 100—103. The molds being cylindrical and the surfaces of these attaching flanges being plane or flat, the ends of the plungers may be flat, and they form corresponding circular marks in the attaching flanges 100—103, which serve as marks for determining the location of the drill in drilling the apertures in these attaching flanges.

The cross head 221 is provided with a centrally located threaded bore 229 for receiving the threaded shaft 230, which is provided with a cylindrical head 231. The cylindrical head 231 is rotatably mounted in a socket 232 provided by a metal stirrup 233, which has attaching flanges 234 welded to the outer surface of the mold half 83.

The stirrup 233 has a bore 235 for rotatably supporting the shank of the threaded shaft 230. The stirrup 233 serves as a thrust bearing for preventing the axial movement of the shaft 230 relative to the mold half 83. The shaft 230 is provided with a reduced noncircular portion 236 adapted to receive the complementary bore in the end of a crank 237, having a handle 238.

A nut or other suitable means is provided at 239 for securing the crank arm 237 on the reduced portion 236 of the shaft 230. When the crank is rotated by means of the handle 238, it rotates the shaft 230, and the threads on the shaft and in the bore 229 cause the cross head to progress along the shaft in one direction or another. When the cross head is driven inward, the plungers engage the attaching flanges 100—103 on the casting, and the shaft utilizes its head 231 to withdraw the mold half 83 from the casting and the fixed mold half 81.

The plungers react against the casting to remove the movable portion of the mold. The length of the shaft is preferably such that when the plungers are withdrawn to the flush position inside the cavity, the cross head hits the lower side of the crank arm 237, thus assuring the continuity of the cavity at the point where the plungers are located.

The burner 59 may comprise an arrangement having a nozzle 53, which is directed into the opening 52 of the ladle, but which is of such length that it may be rotated out of the aperture 52, or it may be directed at different angles.

In the present embodiment, nozzle **53** comprises a pipe secured in a bushing **240**, which is in turn secured in an elbow **241**. The elbow **241** is carried by a horizontally extending pipe **242**, and leads to a second downwardly turned elbow **243**, which is connected to a short section of pipe **244** leading to a flexible rubber hose **245**.

The flexible rubber hose **245** is of sufficient length to form a substantially U-shaped curved portion which is adapted to be bent when the ladle is tilted. The opposite end of the hose is secured on another short pipe section **246** carried by the elbow **247**.

The elbow **247** is connected by additional elbows **248** to a downwardly directed pipe **249**, which has two inlets **250**, **251** to the air pipe **253** and the gas pipe **252**. The two pipes **253**, **252** are connected to appropriate supplies of air and illuminating gas, and are provided with valves so that the two gases may be mixed in proper proportion to be conducted to the nozzle **53**, where they are burned upon issuing from the nozzle.

The assembly of pipes extending downward from the pipe **249** may be fixed and secured to the framework or to the floor while thus located, and connected to the opposite end of the hose **245**.

Another modified form of destructible core for casting may be constructed and handled as follows: Asbestos fibers and kaolin may be mixed together in the proportions of equal parts by volume of asbestos and kaolin. The asbestos fibers may be of the chrysotile type or the Amosite type.

The mixture of kaolin and asbestos may be moistened with kerosene, which has the advantage that it does not cause the core to adhere to the mold; but, on the contrary, makes it easily separable from the mold.

This plastic mixture may then be molded into the proper shape for the destructible core, and pressure is applied to squeeze out the excess of kerosene, after which the cores are laid out upon a blotting paper, or similar material, to dry, the cores being handled by means of pins or needles, which may project into portions of the core and provide handles. The blotting paper takes up such of the kerosene as will separate by gravity from the relatively dry and hard cores; and in the proper use of such cores they may be produced in a continuous series, if possible, so that they may be used from one end of the stream and built at the other end.

It is also possible, however, to let the cores stand for a considerable length of time after they have been molded, as the presence of kerosene in the core at this stage prevents it from absorbing moisture from the air.

After the cores have dried on the blotting paper, they may then be dipped in a solution of sodium silicate of such a consistency that it provides a coating composition. The sodium silicate coats the exterior of the cores. Instead of baking the cores, as previously described, the operator may then ignite the cores a little while before it is necessary to use them, by applying a match. The kerosene will cause the cores to be burned so that the kerosene will be burned out of the core, even though the core is covered by the sodium silicate. The water will then be evaporated out of the sodium silicate, leaving only the salts, and the core will be free of all liquid when it has finished burning, and will be provided with a relatively hard exterior surface.

Such cores after being burned, remain hot for a considerable length of time so that they can be used as desired, if the casting is proceeding uniformly and the hot cores are used in the casting in the usual way.

There are a number of different ways of removing the cores after the casting has solidified and cooled:

1. The cores may be picked out by means of a picking tool, which effectively tears them to pieces and withdraws them from the cavity which the core has formed.

2. They may be drilled out or removed by any other mechanical tool.

3. The castings may be placed in water, whereupon the cores will absorb the water and disintegrate so that their removal can be expedited by picking at them mechanically.

4. The cores may be dissolved by immersion of the casting in water, and forced out by water under the pressure.

The advantages of these cores are as follows:

1. They form relatively perfect cavities in the castings, and they may be made of any desired shape.

2. There is no tendency to absorb moisture in the air if the cores are used quite promptly after having been burned out.

3. They do not tend to stick to the walls of the cavity.

4. They form a relatively smooth cavity, due to the outer crust of the salts from the sodium silicate solution.

5. The destructible cores are easily removed from the casting.

6. They have the advantage over permanent cores that they do not have to be preheated like permanent cores, and they do not have to be tapered or otherwise shaped so that they can be retracted from the cavity which they are to form.

Referring to Figs. 7 to 10, these are views which show the mold and a part of the ladle in the different positions which they assume during the making of the casting.

In Fig. 7 the mold is shown on top of the ladle, with the mold halves closed, and the cores in proper position. The mold is empty, but has been preheated by the application of the flame from the burner **53**, which projects a flame into the ladle, the flame being reflected from the free surface of the metal into the mold. After the first casting has been made, the mold is maintained in heated condition by the heat which it takes from the molten metal as the metal congeals.

Assuming the metal and the mold to be at the proper temperatures, the ladle may be tilted from the full line position of Fig. 6 to a position where the major axis of the mold extends substantially horizontally, that is, until the mold is filled and the head of metal in the ladle is located above the mold cavity.

This tilting motion may be suitably timed, and should be carried out steadily and gradually, depending on the size of the casting.

As the ladle and mold tilt toward the left from the position of Fig. 7 to that of Fig. 8, the molten metal will well up into the mold cavity about the ends of the permanent cores **107**, **108**, gradually filling the cavity as shown in Fig. 8.

The free surface of the metal in the mold cavity is, of course, always at the same level as that in the ladle. The metal wells up without any separation, splashing, or spurting until the mold is filled and the tilting may be continued to raise the free surface of the metal in the ladle sub-

stantially above the mold cavity to the position shown in Fig. 9.

This places a predetermined head of metal on the molten metal in the cavity of the mold, and the pressure assures the filling of the mold at all points.

As the filling of the mold cavity progresses, the air passes out of the grooves 123 and 119 at the edges of the mold cavity, and any gases that are generated by the heating of air or volatilization of any of the constituents of the destructible core 109 may pass out through the apertures 160 and apertures 156, 158 or apertures 162, 157, 159 in the permanent cores 108, 107. The tilting may be continued, if desired, until the mold is substantially inverted, as the invertion of the mold may be desirable by reason of the fact that the position of the casting corresponds to the natural heat gradient of heated bodies. Under these conditions the castings will be cooler at the bottom.

The casting congeals from the outside surfaces of the casting inward and from the surfaces of the permanent cores outward, forming an inner and outer shell first, after which further congelation progresses from that part of the casting that is most remote from the ladle, down toward the filling opening.

As this congelation takes place, there is a shrinkage of the casting, which, however, is taken up by the supply of additional metal to the space between these two initial shells. The point to which congelation takes place may be indicated by any of the dotted lines seen at the bottom of the casting in Fig. 10, depending upon the time when the mold and ladle are tilted back to the initial position.

Fig. 10 shows the casting after the casting has congealed and the mold is ready to be opened. Thus the sprue may be made long or short, but as long as the perfect part of the casting extends to the point where the sprue is to be cut off, no harm is done.

The molten portion of metal in the filling conduit which is not congealed flows back into the ladle. The portions of sprue which are cut off may also be thrown back into the furnace to be remelted and used over. The amount of sprue is so small that the characteristics of the molten metal are not materially changed by remelting and using these small sprues.

The casting having congealed, the permanent cores may be removed by pulling upward on the lever 189. This lever is adapted to apply a substantial lifting force to the permanent cores 107, 108 by reason of its length; and it may be necessary to jar the lever upward initially by means of a blow with the heel of the hand, after which the lever may be moved up steadily until the cores are removed.

During this motion of the permanent cores the ends of the destructible core 149, which are in the sockets 153, 154, 155, will be sheared off.

The mold halves may then be separated by turning the crank arm 237 in a clockwise direction, which will cause the cross head 221 to approach the mold half 83, and the plungers 222—225 will bear against the casting, while the threaded member 230 withdraws the mold half 83. The springs 210 are forced apart by the threaded member 230, portions 214 acting as cams.

The ends of the plungers 222—225 make marks on the attaching flanges 100—103 which serve to indicate where holes should be drilled, and after the crank 237 and threaded member 230 have been used to initiate the removal of the mold half 83 from the casting and the mold half 81, the handles 215 may be sprung together, and the entire mold half 83 removed by hand.

The filling opening 76 in the plate 75 preferably tapers downward, and the filling conduit 57 in the refractory member 77 also tapers downward so that any sprue which is located either in the openings 57 or 76 can be removed in an upward direction without difficulty. Where these conduits are not tapered downward, arrangements may be made for separating the refractory member 77 into two halves also.

The casting and sprue are then pried out of the fixed mold half 81, and the casting may be quenched at once by being placed in water, which will initiate the dissolution of the destructible core. Then the removal of the destructible member may be completed according to any of the methods described, such as flushing with water or mechanically picking away to remove it, and the sprue may be cut off.

The mold is then ready to be re-assembled with destructible and permanent cores, and the two halves placed together, with the plungers 222—225 withdrawn, and the permanent cores inserted in their proper place. The destructible core 149 can be inserted in the sockets 153, 154, 155, just before the plugs 110, 111 are moved downward into their sockets or bores 112, 113.

If this is not done, the permanent cores will be in such position that there is no room to get the ends of the destructible core in the sockets. Therefore, the destructible core and the permanent cores must first be assembled, and then the assembly of cores moved down into the mold.

The method of making destructible cores has already been described herein in several different ways. The method of casting may be briefly summarized as follows:

The ladle is preferably supplied with metal from a plurality of furnaces which hold the metal in batches, and batches are successively supplied to the ladle from the furnaces in rotation. The temperature of the furnace is maintained at a higher degree than the ladle in order that the heat which is supplied to the metal in the furnace may be used to elevate and maintain the temperature of the ladle and mold.

The temperatures which are given herein are exemplary and vary with the different alloys or metals to be cast. For example, the alloy No. 356 of the Aluminum Company of America having a composition of 7% silicon, 0.03% magnesium and the rest aluminum may be used for casting; and in this case I prefer to keep the temperature of the furnace within a range of not less than 1250 degrees F. and not more than 1300 degrees F. The temperature of the metal in the ladle will depend upon the type of casting being produced; and when the present castings are produced I prefer to maintain the metal in the ladle between 1175 degrees F. and 1200 degrees F.

For casting thin plates of this alloy the temperature in the ladle might be maintained between 1225 degrees F. and 1250 degrees F.

The characteristics of this alloy are given in certain standard tables as having a solidifying temperature ranging from 1075 degrees F. to 1130 degrees F. Thus the temperature of the metal in the ladle is preferably maintained as close as possible to the melting temperature of the metal used in casting, that is, slightly above the solidifying temperature, so that when cast the metal solidifies quickly in the mold.

Less time is required for casting, and any tendency toward segregation is minimized by quicker congelation.

Segregation ordinarily takes place during congelation. Quicker congelation reduces or substantially prevents the segregation of impurities or of the ingredients of an alloy.

This "close to congelation" temperature is maintained by frequent measurement, and constant observation of indicated temperature of the molten metal in the ladle and of that in the furnace; by adjustment of the furnace and ladle temperature, by regulating the heating arrangements of the furnace, or of the ladle; and by replenishing the ladle supply at proper time and temperature.

The ladle gas burner can be adjusted to higher or lower heat, or if the metal or ladle or furnace is too hot, a small solid piece of clean metal can be thrown in to absorb heat by reason of the fact that it will be heated and melted.

With the metal in the ladle and the mold at the proper temperature, and the flame blowing on the filling opening of the mold, by reflection from the free surface of the metal, and all of the parts in proper position for casting, the casting operation may then be started.

The ladle should be provided with a clean supply of molten metal, and any dross or scum should be skimmed off by using a skimming member through the opening **52**, and the oxygen should be excluded from the space above the molten metal by means of the flame and gases from the burner **53**.

The operator may use the pipe **242** as a handle, and the ladle and mold are tilted forward, that is, toward the left in Fig. 6, causing the free surface of the metal to approach the filling opening.

Since the metal is clean and has been skimmed, nothing but clean metal wells up into the conduit **68**, leading to the mold; and as the ladle and mold are tilted, the metal gradually wells up into the mold cavity, as shown in Fig. 8.

While this is going on, the air is being discharged through the grooves around the top of the mold and through the air bleeders in the permanent cores, and the tilting is continued until the mold is completely filled.

The arrangement of the mold with respect to the incoming stream of metal is preferably such that at no time does the metal, which is filling the mold, separate from the main body of the metal, but in some cases it may be necessary, with complicated castings, to diverge slightly from this preferred procedure. In any event, the complete mold is filled with molten metal when the mold reaches the position of Fig. 9, and the ladle has a head of molten metal above that in the mold.

The casting is then caused to congeal from the point most remote from the ladle, inward toward the ladle; and it also congeals inward from the sides of the mold cavity and outward from the permanent cores.

This results in this particular casting in the formation of a double shell, the walls of the shell being separated by molten metal, which continues to congeal backward, toward the ladle. As the casting congeals, there may be shrinkage, which is taken up by the supply of additional molten metal from the ladle under pressure, due to gravity. When the metal has congealed to the desired point to form a complete casting, with a minimum amount of sprue, the mold and ladle are tilted back to the position of Fig. 10, and the dotted lines of lower pipe formations in the sprue indicate possible lengths of the sprue.

The sprue is preferably kept as short as possible, and the timing may be gauged in a few minutes by making a few castings. The rest of the molten metal flows back into the ladle, and the mold is now preferably promptly removed from the casting, as follows:

The permanent cores are withdrawn by means of the handle **175**. The mold half **83** is withdrawn from the casting and mold half **81** by means of the threaded member **230**. The casting is then pried out of the mold half **81**, taking with it such sprue as may remain on the casting; and due to the downward taper of the opening, extending downward from the mold cavity to the ladle, the sprue can be removed with the casting.

The casting is then preferably quenched in water, or some other suitable liquid which will dissolve the destructible core. The destructible core may be removed by picking with a mechanical tool or by flushing it out with water under pressure.

The sprue is then cut off at an appropriate point, and holes may be drilled in the attaching flanges of the casting.

It will be observed that I have invented an improved casting machine and a casting method by means of which castings of better characteristics and finish may be made than in any of the prior art devices. By means of my destructible cores, various types of apertures or conduits may be formed in the casting during the casting operation, thereby saving a great deal of machining; and due to the finished surface of the castings, there is no machining necessary on the outside.

In the present casting it is, of course, necessary to ream out the bores **96** and **97** because of their slight taper; and these bores are later threaded at each end for the purpose of attachment of pipes. In some embodiments of the invention, by means of the mold halves having threaded formations, the threads may be formed directly in the casting during the casting operation.

The present castings are adapted to withstand a higher pressure per square inch than any of the castings made according to prior art methods. They are nonporous and absolutely sound. They are free from flaws, fissures, segregations, surface defects and other defects.

While I have illustrated a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:

1. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially

the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting.

2. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting, the said cores being formed with sockets for receiving the ends of a substantially Y shaped destructible core member adapted to form a conduit leading from the bore of one barrel to the bore of the other barrel.

3. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting, the said cores being formed with sockets for receiving the ends of a substantially Y shaped destructible core member adapted to form a conduit leading from the bore of one barrel to the bore of the other barrel, the said cores being provided with vents leading from said sockets to the external atmosphere for venting any gas resulting from the heating of the said destructible core.

4. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting, the said plugs being formed with annular limiting flanges for engaging the outside of the mold assembly and determining their final position.

5. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting, the said plugs being formed with annular limiting flanges for engaging the outside of the mold assembly and determining their final position, and the said plugs being formed in their external cylindrical surface with a plurality of longitudinally extending grooves also located in the under-side of said annular flange for venting air from the upper part of said mold at the outside corners of the cavity.

6. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold being formed at its upper end with a pair of cylindrical apertures for receiving a pair of substantially cylindrical plugs, and each of said plugs having centrally located therein a core member for forming a through bore in each of the barrels of said casting, the said plugs being formed with annular limiting flanges for engaging the outside of the mold assembly and determining their final position, and the said plugs being formed in their external cylindrical surface with

a plurality of longitudinally extending grooves also located in the under-side of said annular flange for venting air from the upper part of said mold at the outside corners of the cavity, and the said plugs also having internal grooves forming vents in connection with their cores at the inner upper corner of the mold adjacent the cores.

7. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, the said mold having its lower end open and being secured to a substantially wedge shaped insulating body which is carried by a metal plate, and means for insulating said metal plate for a ladle.

8. A permanent mold comprising a member of steel which is formed of a plurality of steel plates having upper and lower plane surfaces, the said steel plates being secured together in alignment by means of a plurality of dowel members, said mold comprising two halves, each of which is formed with a mold cavity, the said cavities, when the molds are assembled, having a recess for a pair of substantially cylindrical barrels arranged substantially parallel to each other and provided with a joining body between said barrels, the said cylindrical barrels being of larger cross section at each end and provided with an intermediate portion of smaller cross section, and the said plates including a central plate of substantially the same thickness as the length of said central portion of reduced size, one of the halves of said mold having a plurality of plungers extending through it into engagement with a casting formed in the cavity, and force multiplying means for withdrawing said latter half of the mold while causing said plungers to react against a casting in the cavity.

9. In a mold of the permanent type, the combination of a pair of mold members, each of said mold members being formed with a portion of a cavity, means for maintaining the proper alignment of said mold members and for securing the said mold members together, the said mold members being provided with substantially plane engaging surfaces bordering the cavity portions formed in them and the said mold being closed at its outer end and provided at its inner end with a filling opening for direct communication with a member containing a supply of molten metal, the cracks between the mold members being of such size as to permit air to escape between them, one of said mold members being fixed, and the other one being movable, and force multiplying means for actuating a plurality of plungers, the said plungers passing through one of said mold members and engaging the casting to separate the mold members and cause the casting to be retained by the other mold member, said force multiplying means including a screw acting on a cross head supporting said plungers.

10. In a mold of the permanent type, the combination of a pair of mold members, each of said mold members being formed with a portion of a cavity, means for maintaining the proper alignment of said mold members and for securing the said mold members together, the said mold members being provided with substantially plane engaging surfaces bordering the cavity portions formed in them and the said mold being closed at its outer end and provided at its inner end with a filling opening for direct communication with a member containing a supply of molten metal, the cracks between the mold members being of such size as to permit air to escape between them, the closure of the outer end of said mold being accomplished by means of a removable slidable closure, and force multiplying means for removing said outer end closure, the said closure supporting a longitudinally extending core located in said cavity, and said core being removable with said closure, said core having a laterally extending recess, and a second core extending laterally from the first-mentioned core and located in said recess to form a laterally extending passage inside a portion of said casting, one of said cores being destructible to facilitate the withdrawal of the first-mentioned core by shearing action.

11. In a mold for casting, the combination of a pair of mold members, each of which is formed with a portion of the cavity, the said mold members having opposed engaging plane faces, said mold having a pair of openings at the outer end of its cavity for receiving a pair of cores, whereby the casting is formed with a pair of bores, a core in each opening and said cores being provided with opposed recesses for receiving the ends of a destructible core forming a transverse conduit between said bores, a destructible core carried in said recesses, whereby the said destructible core is sheared off at said recesses by the withdrawal of either of the first-mentioned cores when the casting is completed.

12. In a mold for casting, the combination of a pair of mold members, each of which is formed with a portion of the cavity, the said mold members having opposed engaging plane surfaces, said mold having a pair of openings at the outer end of its cavity for receiving a pair of cores, whereby the casting is formed with a pair of bores, a core in each opening and said cores being provided with opposed recesses for receiving the ends of a destructible core forming a transverse conduit between said bores, a destructible core carried in said recesses, whereby the said destructible core is sheared off at said recesses by the withdrawal of either of the first-mentioned cores when the casting is completed, the said recesses communicating through air apertures in said cores with the external atmosphere to discharge any gases formed in the vicinity of said destructible core.

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