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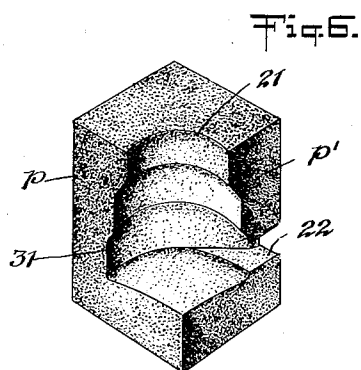
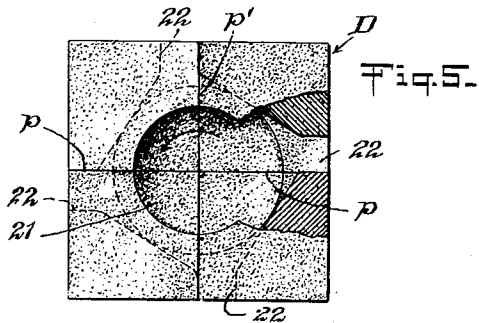
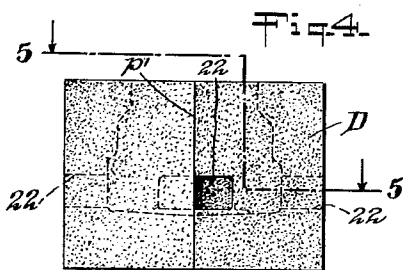
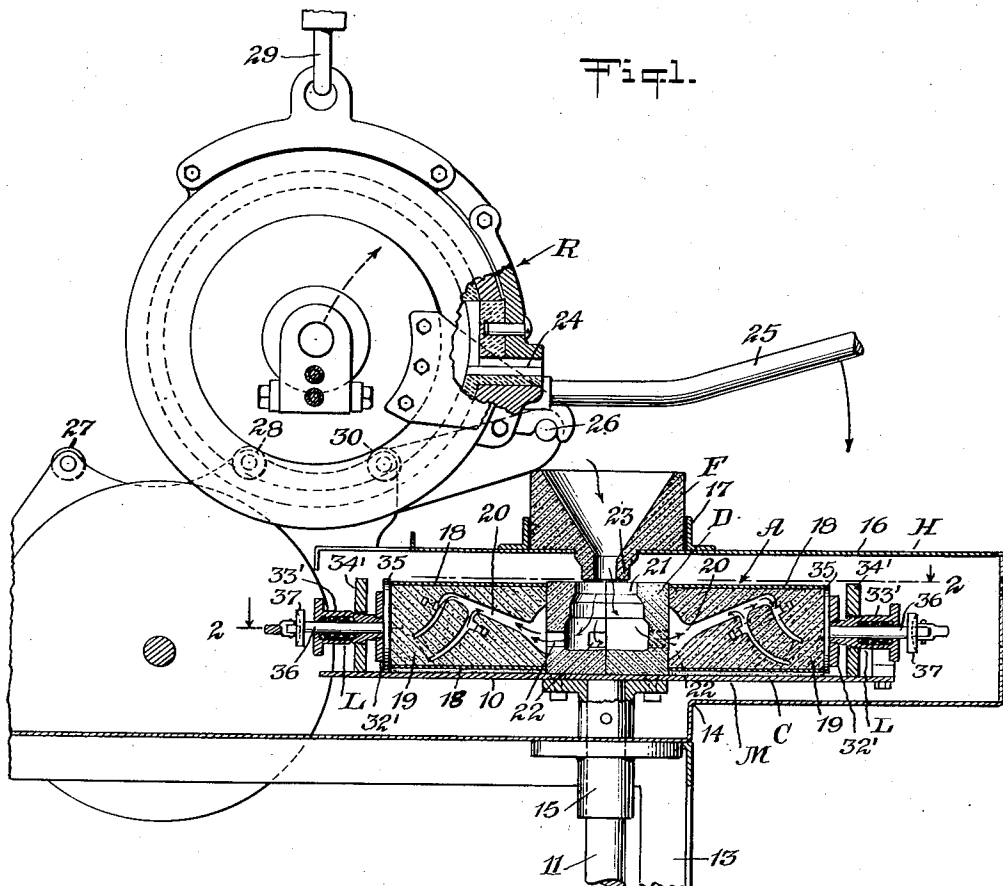
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CENTRIFUGAL CASTING APPARATUS

Filed Jan. 29, 1943

2 Sheets-Sheet 1



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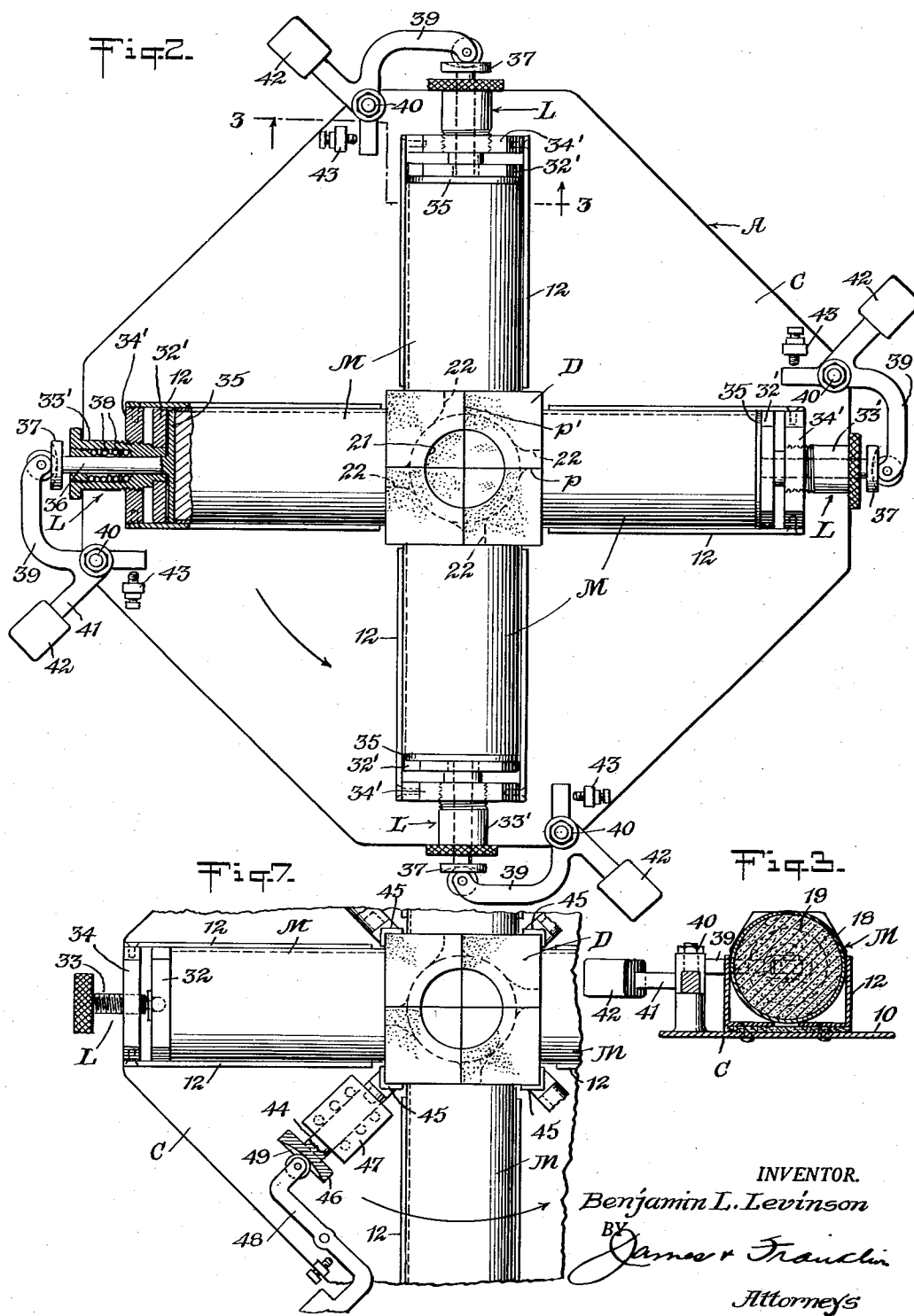
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CENTRIFUGAL CASTING APPARATUS

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UNITED STATES PATENT OFFICE

2,385,631

CENTRIFUGAL CASTING APPARATUS

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Application January 29, 1943, Serial No. 473,897

10 Claims. (Cl. 22—65)

This invention relates to an improved apparatus for centrifugally casting metals and alloys.

The prime object of my present invention centers about the provision of centrifugally cast metal castings which are highly sound in body and accurate in form and which possess great strength. To effectuate this, my present invention relates to an improved apparatus for centrifugally casting metals and metal alloys whereby such castings of substantial soundness, accuracy of shape and strength are produced.

A further prime object of the invention is the provision of a centrifugal casting method and machine for producing such castings which may be practiced or used rapidly and efficiently, so that the castings may be made on a high production basis and with repeated uniformity. It is a further characteristic of the invention that the machine thereof may be used with equal efficacy with any of a variety of metals and alloys of both high and low range melting points.

It is a desideratum in the making of any metal casting to produce one of uniform denseness, devoid of pores, pits or cracks. It is a further desideratum to produce a casting which is an accurate reproduction in shape or form of the mold cavity. The castings made by the method and with the apparatus of the present invention possess both a highly uniform body denseness or body soundness, and an accuracy of form or shape, combining also therewith a finished surface or skin, the combination of which reduces and in fact eliminates the need of any subsequent surface machining. Such castings are also found to possess unusual tensile and compression strengths.

The centrifugal method of casting, being in effect a pressure casting method, lends itself to the making of castings of uniform denseness and accuracy of shape. Difficulties, however, arise in the practice of the method which militates against the production of the desired or possible results. I have found that these difficulties originate mainly from two sources, which are (a) the improper control of the heat cycle from the melting retort or ladle to the mold and (b) the improper control of the physical nature and condition of the path of metal flow from melting retort to mold.

In the making of moderately sized or large castings the melting retort or furnace is external to the centrifugal casting machine, and the molten metal is ladled from the furnace into an axially disposed funnel and distributor and thence flowed centrifugally into the mold. Because of

the relatively long path of metal flow, the metal is usually superheated in the furnace and poured in a superheated state. This superheating is, however, likely to result in burning out desirable constituents of an alloy, or in adding undesirable ingredients (such as carbon in an arc furnace), or in the formation of oxides or in the dissolving of gases, which become occluded in the metal and in the subsequent casting, causing lack of homogeneity and strength. Sudden changes in temperature in the funnel, distributor and mold (due to the large temperature gradient) also add to the difficulties. I have found that these difficulties may be solved by providing a gradual heat gradient in the heat cycle from melting furnace to mold and by thereby at the same time enabling the metal to be melted while avoiding undesirable superheating of the same.

The physical nature and condition of the path of metal flow from ladle to mold is of great importance. The funnel and distributor even when made of the proper refractory material, such as a carbon or graphitic composition, must be properly treated for each operation, lest impurities be imparted thereby to the metal flowing there-through, resulting in a non-homogeneous casting. I have found that the funnel and the distributor should undergo certain heating as well as cleansing operations for each casting cycle, and that if this be properly done, the troubles may be effectively overcome. The heating treatment to properly physically condition these parts also serves to provide the desired heat gradient already referred to.

To practice the method effectively with such control of the heat cycle and the physical nature and condition of the path of metal flow, I have devised a centrifugal casting apparatus which may be used with rapidity and efficiency. Characteristic features of such apparatus are (a) the provision of a multi-mold machine composed of separable funnel, distributor and mold sections which are assemblable and disassemblable with rapidity; (b) the provision of such a machine in which the parts are well balanced mechanically; (c) the further provision of such a machine which after being locked in assembled condition is automatically so maintained by means which takes up for shrinkage of the parts due to cooling; (d) the provision of a sectional distributor which may be disassembled and readily cleansed and then quickly reassembled in the machine; and (e) the provision of a distributor which is designed to permit a smooth and non-turbulent

flow of the metal received and distributed thereby.

To the accomplishment of the foregoing and such other objects as may hereinafter appear, my invention consists of the casting method and apparatus and the parts thereof hereinafter sought to be defined in the claims and described in the following specification taken with the accompanying drawings in which:

Fig. 1 is a vertical elevational view with parts shown in section and other parts broken away, of the centrifugal casting machine of the present invention;

Fig. 2 is a plan view of the essential parts thereof;

Fig. 3 is a detailed view taken in cross-section in the planes of the broken line 3—3 of Fig. 2;

Fig. 4 is a side elevational view of the sectional distributor of the machine;

Fig. 5 is a view of the same taken partly in plan view and partly in cross-section in the planes of the broken line 5—5 of Fig. 4;

Fig. 6 is a perspective view of one of the sections of the distributor; and

Fig. 7 is a fragmentary plan view of a modified form of the machine.

Referring now more in detail to the drawings and having reference first to Figs. 1 and 2 thereof, the centrifugal casting apparatus generally designated as A comprises in its essential parts a rotatable carrier C, a separable distributor D removably mountable centrally on the carrier C, a plurality of separable molds M, M also removably mountable in the carrier C and arrangeable therein radially of the distributor D, and radially adjustable locking means L, L arranged on said carrier C at the outer ends of one or more molds M, having a part adapted to be moved into and out of engagement with said mold end or ends for locking the distributor D and the molds M, M in assembled relation on said carrier. The centrifugal casting apparatus A may be suitably enclosed by a housing H, which housing may fixedly carry a separable funnel F also arranged centrally and axially of the carrier C with which funnel is directly associated a melting furnace or retort R.

The carrier C comprises in its simplest form a platform 10 supported axially on a shaft 11, which latter is adapted to receive motion from a suitable source of power, and on said platform are mounted a plurality of radially arranged cradles 12, 12 for receiving the molds M, M and for supporting the locking means L, L. The housing H may comprise any suitable enclosure supported by the machine framework 13 having a casing part 14 which may provide a suitable bearing 15 for the shaft 11 and having a cover 16 which may be quickly removed to permit access to the centrifugal casting apparatus A which rotates within the housing. This cover 16 may removably carry the funnel F being seated in the angleiron frame 17 arranged centrally thereof.

The molds M as practiced with the present method are of the investment type, each consisting of a flask 18 containing a refractory investment material 19 which has a mold cavity 20 produced therein by the lost wax method. The mold cavity illustrated in Fig. 1 of the drawings is for the making of exhaust motor parts as used in airplane engines. The distributor D comprises a refractory vessel having a charge receiving chamber terminating in an open charging mouth 21 at its top and having generally radially disposed channels 22, 22 at its sides and

bottom, the said distributing channels 22, 22 communicating with the mold cavities 20, 20 of the molds M, M when the distributor and molds are assembled on the carrier, as is clearly depicted in Fig. 1 of the drawings.

The separable funnel F also comprising a refractory unit, has its discharging end 23 in communication with the charging end of the distributor and arranged relatively thereto as shown in Fig. 1 of the drawings to permit the egress of air and gases from the distributor; and communicating directly with the charging end of the funnel is the pouring mouth 24 of the melting furnace or retort R, which latter is adapted to be moved into the position shown in Fig. 1 and manually rotated by means of the handle 25 about the pouring fulcrum 26 for a pouring operation. The path of flow of the molten metal from retort to the plurality of molds is indicated by the arrows in Fig. 1 of the drawings.

As an essential factor in producing castings having the desired soundness of body, accuracy of shape and surface finish and great strength, I have found that the elements in the path of metal flow must be properly heated, thereby providing a suitably gradual heat-gradient in the heat cycle from the melting retort R to the molds M, M. To this end the molds M, M, the distributor D and the funnel F are made as separable elements, each being thereby capable of being removed from the machine and heated to high temperatures (temperatures approaching the melting point of the metal to be cast) outside of the casting machine, and the casting machine is further so designed that these elements may be quickly assembled therein and locked together, as shown in Fig. 1 of the drawings, for a casting operation. By thus preheating to relatively high temperatures all of the elements which partake or enter into the path of the metal flow (funnel F, distributor D and the molds M, M), and by rapidly assembling the same in the casting machine, such superheating in the melting retort as gives rise to the described casting difficulties is avoided, and the troubles usually incident to the sharp temperature drop from retort to casting machine during pouring or charging of the metal are eliminated.

In the practice of the method, the molds M, M, the distributor D and the flask F are removed from the casting apparatus A and are placed in suitable furnaces and heated to high temperatures. The particular temperatures to which these elements are heated depends largely upon the melting point of the metal or alloy to be cast. Taking, for example, a high melting point metal or alloy such as stainless steel having a melting point around 3000° F., the molds M, distributor D and funnel F are heated to temperatures generally approaching this melting point, such, for example, as 1600° F. Taking as another example an alloy in the low melting point range, such, for example, as a magnesium alloy, having say, a melting point of 1100° F., the molds, distributor and funnel are heated in the furnace to temperatures from 450° to 600° F. While these elements are being heated, the metal in the retort R is brought up to its melting point. The retort R at this stage of the method is mounted for oscillation on the rollers 27 and 28. When all these parts are brought to the proper temperatures, the molds M, distributor D and funnel F are removed from the furnace and assembled in the casting machine; and the retort R is lifted by means of the lifting chain 29 over to the position shown in

Fig. 1 of the drawings, resting on the rollers 28 and 30, in which position it is adapted to be rotated by means of the handle 25 about the pouring fulcrum 26 for the pouring operation as described. Because of the preheating of the casting machine elements to the high temperatures described, undesirable preheating in the retort R is avoided, the temperature drop between retort and the elements of the casting machine is considerably reduced, and the temperature gradient for the metal flow path is tempered or graduated, and thereby the above described disadvantages incident to prior methods of this nature are overcome.

As a further essential factor in producing castings having the desired characteristics, I have found that the physical nature and condition of the path of metal flow from ladle to mold is of great importance. The funnel F and distributor D are made of a suitable refractory material such as a carbon or graphitic composition, as, for example, graphite bonded with clay. Unless these elements are properly conditioned, there is the danger of carbon particles thereof being burned off by the metal flowing therethrough and undesirably entering into the metal composition, which, for such metals or alloys as stainless steel, Stellite or Vitallium, is quite detrimental. I have found that when the distributor D and the funnel F are heated to the described high temperatures and particularly in a furnace having an oxygen atmosphere, that there is formed a hard, slagged refractory surface on the distributor and funnel walls which acts as a protecting coating for the flowing metal. To secure the desired results, these elements should be thus furnace heated in preparation for each casting cycle.

I have also found that the path of metal flow should be thoroughly cleansed in preparation for each casting cycle. After each casting cycle, the distributor D and the funnel F are removed and the interior walls thereof thoroughly cleaned of all metal particles or other foreign material. After this cleansing operation, these elements are subjected to the furnace heating described. To enable the distributor D to be quickly and thoroughly cleansed and also to permit the same to be readily assembled as if made in one unit, the distributor is made up of vertically split sections and preferably of the vertically split quadrant sections best shown in Figs. 4 to 6 of the drawings. Referring to these figures, the distributor D comprises four quadrant sections each having a construction best disclosed in Fig. 6 of the drawings, which sections when assembled have the charge receiving chamber 31, the charging mouth 21 at its top and the four generally radially disposed distributing channels 22, 22. When these quadrant sections are disassembled, all of the interior walls of the charge receiving chamber 31, the mouth 21 and the channels 22 are fully exposed as shown in Fig. 6 for a cleansing operation. The quadrant sections are readily assembled to form the distributor unit D as shown in Figs. 4 and 5 of the drawings. While the distributing channels 22, 22 are arranged generally radially of the distributor, they are slightly offset in the direction of rotation of the machine as best shown in Fig. 5 of the drawings (so as to permit smoother flow of the metal into the distributing channels), the arrangement being such that the vertical quadrant dividing planes p and p' intersect the distributing channels 22, 22 so that these planes are coincident with one side wall of each

channel. As a further feature in producing a smooth and non-turbulent flow of the metal received and distributed by the distributor, the interior wall or surface of the charge receiving chamber 31 is recessively stepped from top (mouth 21) to bottom (channels 22), as is most clearly shown in Fig. 1 and Fig. 6 of the drawings; by means of this feature of the construction, back splashing of the metal charged into the distributor is effectively inhibited. The construction of the distributor is, therefore, such that the parts of the distributor may be quickly disassembled and readily cleansed and then quickly reassembled in the machine, and the distributor in operation permits a smooth and non-turbulent flow of the metal received and distributed thereby.

To produce a mechanically balanced apparatus and one assemblable with ease, the separable molds M, M are arrangeable on the carrier C in opposed radial relation. Preferably and for the same reasons, a plurality of sets of such molds are used, one preferred arrangement being that shown in the drawings wherein four separable molds M, M are removably mountable in the carrier C and arrangeable therein radially in quadrangular relation, this being used with the quadrant sectional distributor D described above. For rapidly locking these molds and the distributor D in assembled position in the machine, the radial adjustable locking means L previously mentioned is used, and such locking means may be arranged in the carrier at least at one of the opposite ends of a pair of molds. For the most ideal operation, such locking means is provided at the outer end of each of said molds, so that in the structure shown in the drawings, four such locking means L are used for a machine having four separable molds. Since these locking means are the same for each mold, a description of one of them will suffice for all.

The locking means L comprises in its simplest form (see Fig. 7 of the drawings) a plate part 32 movable radially into and out of engagement with the outer end of the mold M, so movable by means of a knurl headed screw 33 threadedly carried in a bearing 34 mounted on the carrier C to which the cradle 12 is attached, the inner end of said screw being secured as shown to the plate part 32. Simple manual rotation of all the end screws 33 will, of course, move the plates 32 into engagement with the outer ends of all the molds M, M for locking the parts of the machine together, and out of engagement for unlocking the same.

Due to the preheating of the casting machine elements to relatively high temperatures in a furnace outside of the centrifugal casting machine, shrinkage of these elements may take place during a casting operation, resulting in some looseness in the assembly. Means may, therefore, be provided which is automatically movable in response to centrifugal action for moving the elements together to take up for such shrinkage. Such means may be designed to be active only with the sections of the distributor as shown in Fig. 7 of the drawings or may be designed so as to be active against both the molds M and the distributor D as shown in Figs. 1 to 3 of the drawings. In the latter case such means is combined with the manual locking means L.

Referring first to Figs. 1 to 3 of the drawings, the locking means L shown in these figures comprises a knurl headed screw 33' provided with a plate part 32' at its inner end and threadedly

movable in the bearing 34', the structure and mode of operation corresponding to those of the locking means L described in connection with Fig. 7 of the drawings. In the form of the structure shown in Figs. 1 to 3, however, there is provided a second plate part 35 normally in contact with the plate part 32' and movable inwardly therewith when the screw 33' is rotated to effect such motion. The plate part 35, however, is independently movable, forming the inner end of a shank 36 provided at its outer end with a button bearing 37, the said shank being freely slidable in the bore of the screw 33', being assisted therein by the rollers or balls 38 therein. Acting upon the button bearing 37 is a centrifugally responsive arm 39 forming part of a lever fulcrumed at 40, the other arm 41 of which is provided with the weight 42. A suitable stop element 43 may be provided to limit the motion of the lever 41. With this construction, it will be observed after the molds M and distributor D are locked in position by means of the locking screws 33', any shrinkage which may take place radially in the molds or distributor will be taken up during the rotation of the machine by the action of the centrifugally responsive arm 39 acting to move the shank 36 and its inner end plate part 35 against the mold ends.

In the modified arrangement shown in Fig. 7 of the drawings, similar mechanism is used to operate radially against the corners of the quadrant sections of distributor D to hold the quadrant parts locked together, taking up any shrinkage occurring therein. The mechanism shown in Fig. 7 is arranged in the space between the molds whereby the longitudinal and lateral dimensions of the rotating part of the machine are not increased by the added provision of this mechanism. In this modified construction, the radially movable shank 44 having at its inner end the right angle bearing piece 45 and at its outer end the button bearing 46, is radially movable in a sleeve support 47 and is movable inwardly in response to the centrifugally acting lever 48 having a structure and operation corresponding to the lever 39 shown in Fig. 2. The outer surface 49 of the button bearing 46 is so contoured that the force of the lever arm is directed always in the same direction.

It will be noted that this centrifugally responsive mechanism, either in the form of the invention shown in Figs. 1 to 3 or that shown in Fig. 7, does not interfere with the ability to quickly assemble and disassemble the parts of the centrifugal machine to carry out the other operations described.

The manner of practicing the method of the present invention and of operating the apparatus thereof will, in the main, be fully apparent from the above detailed description thereof. By carrying out the described method, the castings, devoid of pores, pits or cracks and forming an accurate reproduction in shape of the mold cavity and provided with a finished surface of skin, are produced in repeated operating cycles. Such castings are found to possess unusual tensile and compression strengths, whether made of metals or alloys of relatively high or relatively low melting points. Taking, for example, the high melting point metal such as Vitallium, it is found that the tensile strength cold is from 115,000 to 125,000 pounds per sq. inch, and the tensile strength hot (at 1500° F.) is from 70,000 to 78,000 pounds per sq. inch. The apparatus is so constructed that this method may be carried out

quickly and with efficiency, the parts being readily assemblable and disassemblable for repeated operating cycles. The centrifugal casting apparatus provided forms a well balanced machine, smooth in its rotation, in which the parts once locked in assembled condition may be maintained in such condition despite any shrinkage which may take place during an operating cycle. The elements of the machine are further so devised that a smooth, non-turbulent flow of metal is produced therein.

While I have shown and described the apparatus of my present invention in the preferred manner and form, it will be understood that many changes may be made therein without departing from the spirit of the invention described in the following claims.

I claim:

1. A centrifugal casting machine for casting metals and alloys, comprising a rotatable carrier, a separable distributor removably mountable centrally of said carrier, said distributor comprising a refractory vessel having an open charging mouth at its top and having a generally radially disposed channel at its side, a separable mold removably mountable in said carrier and arrangeable therein radially of said distributor, said mold having a mold cavity communicating with the distributor by way of its said channel, and radially adjustable means arranged in said carrier at the outer end of said mold and having a part adapted to be moved into and out of engagement with said outer mold end for locking the distributor and the said mold in assembled relation on said carrier, said radially adjustable means including a device responsive centrifugally for automatically moving said part into its said engagement to take up for shrinkage of the mold or distributor.

2. A centrifugal casting machine for casting metals and alloys, comprising a rotatable carrier, a separable distributor removably mountable centrally of said carrier, said distributor comprising a refractory vessel having an open mouth at its top and having generally radially disposed channels at its opposite sides, a plurality of separable molds removably mountable in said carrier and arrangeable therein radially of said distributor and in opposed relation, each of said molds having a mold cavity communicating with the distributor by way of one of its said channels, and radially adjustable means arranged in said carrier at at least one of the opposite ends of said molds and having a part adapted to be moved into and out of engagement with said mold end for locking the distributor and the said molds in assembled relation on said carrier, said radially adjustable means including a device responsive centrifugally for automatically moving said part into its said engagement to take up for shrinkage of the molds or distributor.

3. A centrifugal casting machine for casting metals and alloys, comprising a rotatable carrier, a separable distributor removably mountable centrally of said carrier, said distributor comprising a refractory vessel composed of vertically split sections and having when assembled an open charging mouth at its top and generally radially disposed channels at its opposite sides, a plurality of separable molds removably mountable in said carrier and arrangeable therein radially of said distributor and in opposed relation, each of said molds having a mold cavity communicating with the distributor by way of

one of its said channels, and radially adjustable means arranged in said carrier at at least one of the opposite ends of said molds and having a part adapted to be moved into and out of engagement with said mold end for locking the sections of said distributor and the said molds in assembled relation on said carrier, said radially adjustable means including a device responsive centrifugally for automatically moving said part into its said engagement to take up for shrinkage of the molds or the distributor.

4. A centrifugal casting machine for casting metals and alloys, comprising a rotatable carrier, a separable distributor removably mountable centrally of said carrier, said distributor comprising a refractory vessel composed of vertically split sections and having when assembled an open charging mouth at its top and a generally radially disposed channel at its side, a separable mold removably mountable in said carrier and arrangeable therein radially of said distributor, said mold having a mold cavity communicating with the distributor by way of its said channel, radially adjustable means arranged in said carrier at the outer end of said mold and having a part adapted to be moved into and out of engagement with said outer mold end for locking the distributor and the said mold in assembled relation on said carrier, and a device on said carrier responsive centrifugally and active for automatically moving the sections of said distributor together to take up for any shrinkage occurring therein.

5. In a centrifugal casting machine for casting metals and alloys in which separable parts are preheated and then assembled for a casting operation, a rotatable carrier, a separable distributor removably mountable centrally of the carrier, a separable mold removably mountable in said carrier and arrangeable therein radially of said distributor, the distributor and mold being assemblable in said carrier after being preheated to high temperatures outside of the casting machine, and centrifugally acting means on said carrier for forcing the distributor and mold radially in engagement with each other to take up for shrinkage therein due to cooling.

6. In a centrifugal casting machine for casting metals and alloys in which separable parts are preheated and then assembled for a casting operation, a rotatable carrier, separable parts mountable on said carrier, said separable parts being assemblable on said carrier after being pre-

heated to high temperatures outside of the casting machine, and centrifugally acting means on said carrier for forcing the separable parts radially together to take up for shrinkage therein due to cooling.

7. In a centrifugal casting machine for casting metals and alloys in which separable parts are preheated and then assembled for a casting operation, a rotatable carrier, a distributor removably mountable centrally of said carrier, said distributor comprising a refractory vessel composed of vertically split sections, said sections being assemblable on said carrier after being preheated to high temperatures outside the casting machine, and centrifugally acting means on said carrier for forcing the said distributor sections radially together to take up for shrinkage therein due to cooling.

8. In a centrifugal casting machine for casting metals and alloys, a rotatable carrier, a distributor, a separable mold removably mounted in said carrier and arrangeable therein radially of said distributor, and centrifugally acting means on said carrier for forcing the distributor and mold radially in engagement with each other to take up for shrinkage therein due to cooling.

9. In a centrifugal casting machine for casting metals and alloys, a rotatable carrier, a distributor, a separable mold removably mounted in said carrier and arrangeable therein radially of said distributor, radially adjustable means arranged in said carrier at the outer end of said mold and having a part adapted to be moved into and out of engagement with said outer mold end for locking the distributor and the mold in assembled relation on said carrier, said radially adjustable means including a device responsive centrifugally for automatically moving said part into its engagement to take up for shrinkage of the mold or distributor due to cooling.

10. In a centrifugal casting machine for casting metals and alloys, a rotatable carrier, a distributor, a separable mold removably mounted in said carrier and arrangeable therein radially of said distributor, and means on said carrier for locking the distributor and mold in assembled relation on the carrier, said means including centrifugally acting means for forcing the distributor and mold radially in engagement with each other to take up for shrinkage therein due to cooling.

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