April 7, 1936. K. F. DAILEY 2,036,401

CENTRIFUGAL CASTING MACHINE

Filed July 15, 1933 5 Sheets-Sheet 1

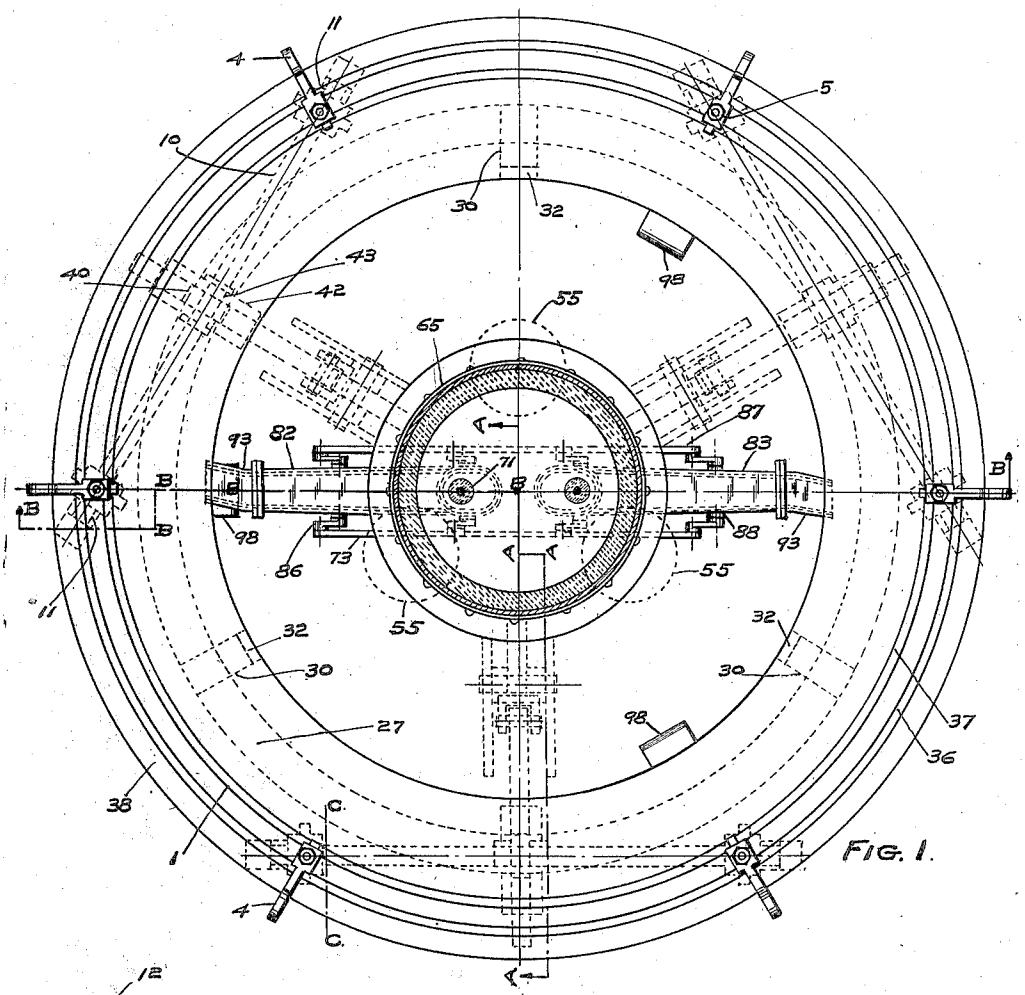


FIG. 1.

FIG 2.

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CENTRIFUGAL CASTING MACHINE

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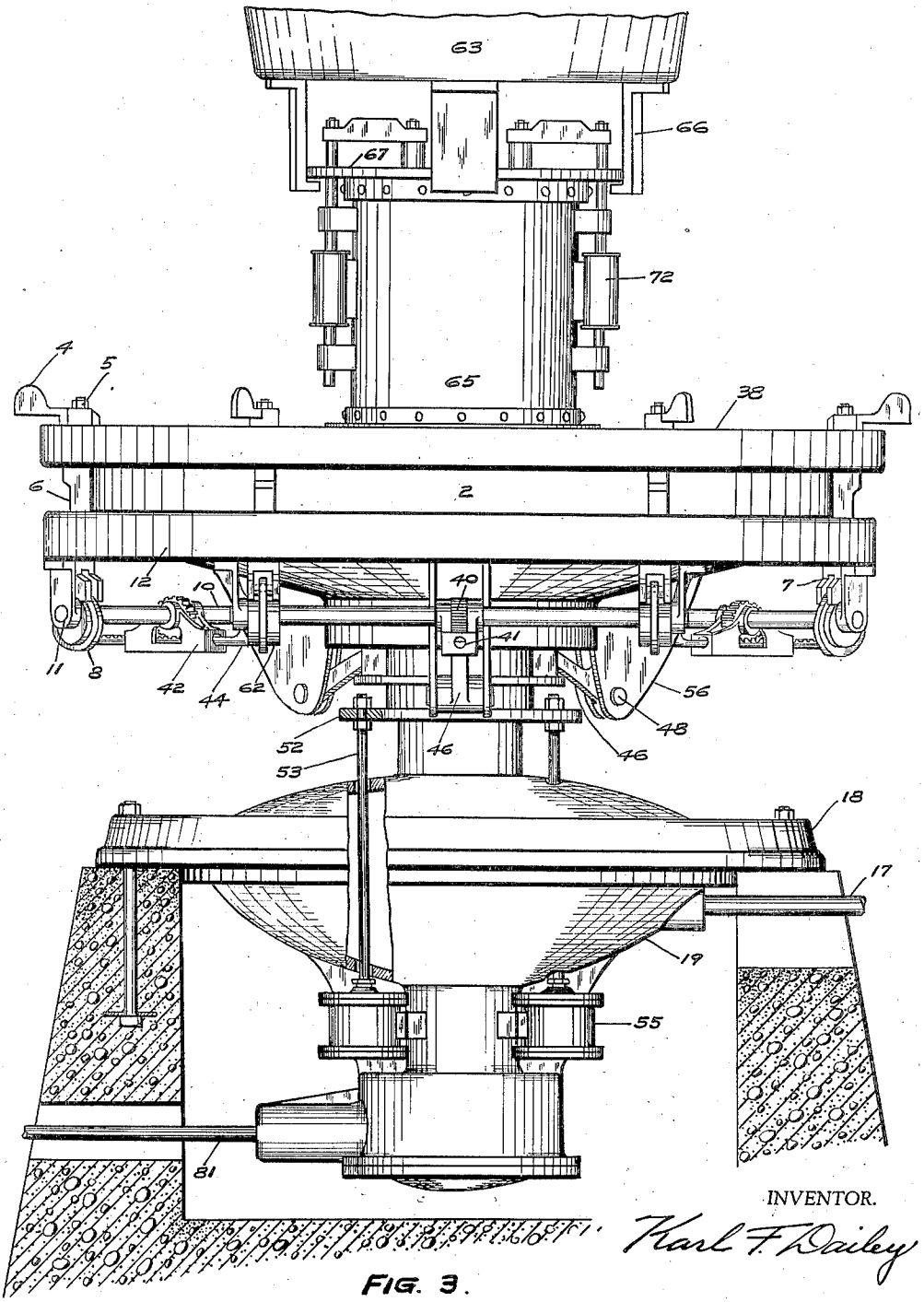


FIG. 3.

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CENTRIFUGAL CASTING MACHINE

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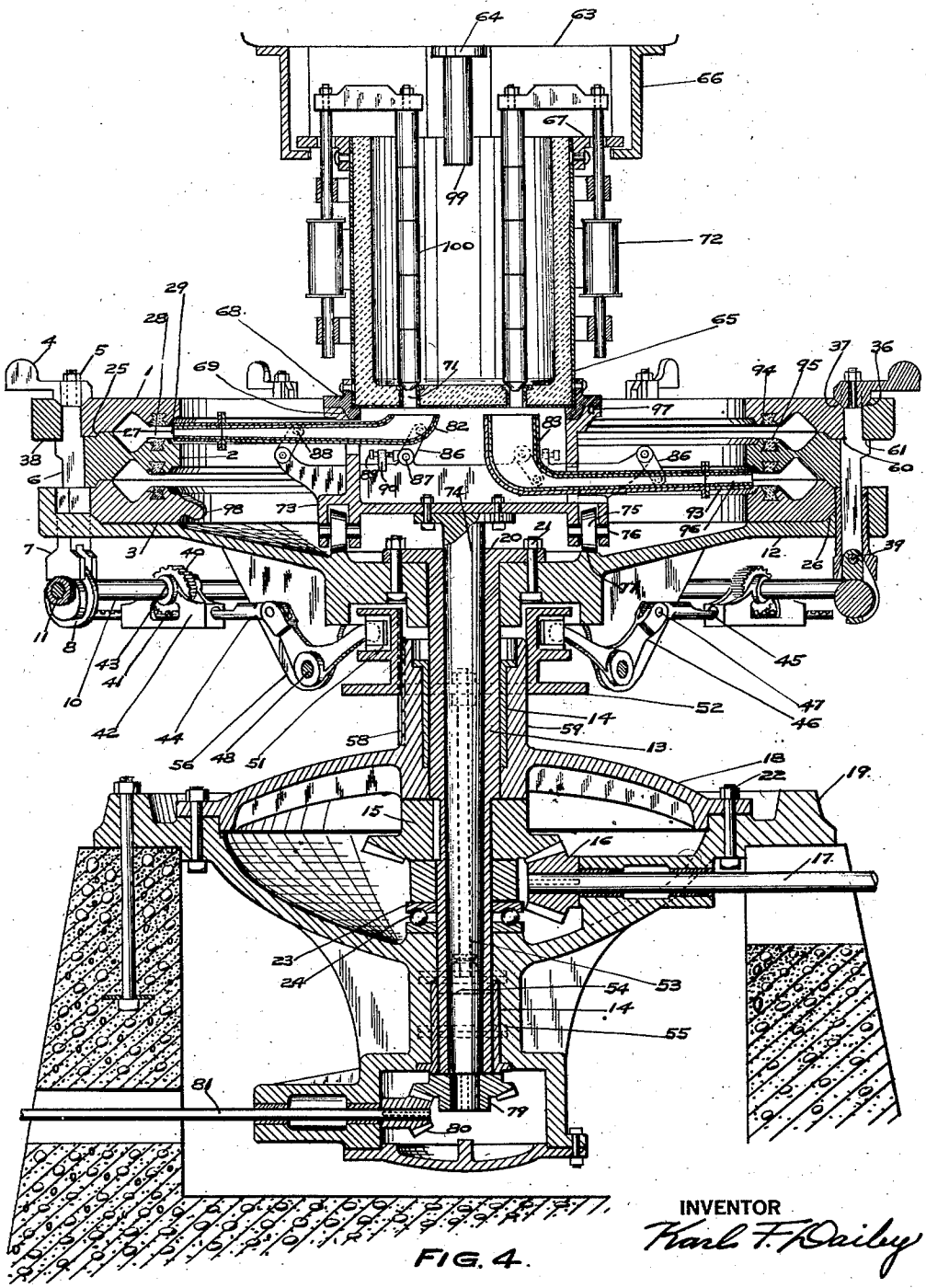


FIG. 4.

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CENTRIFUGAL CASTING MACHINE

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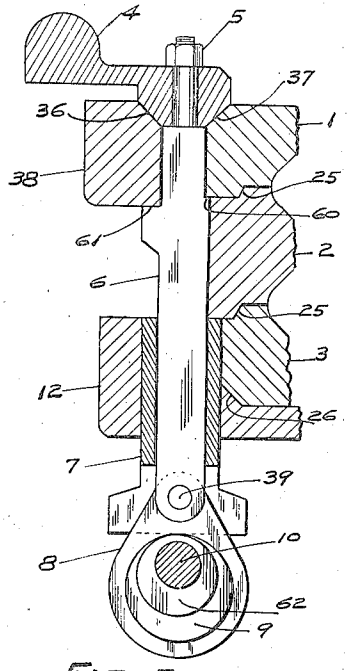


FIG. 5

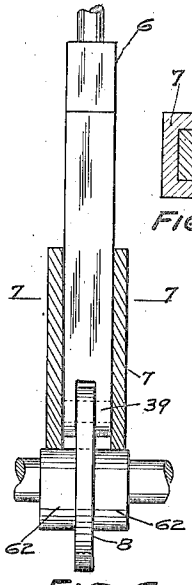


FIG. 6.

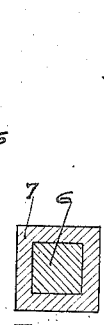


FIG. 7.

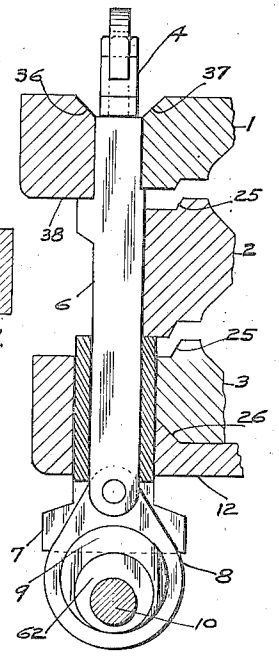


FIG. 8.

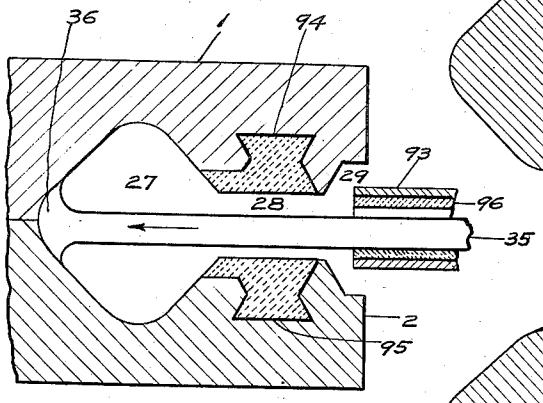


FIG. 9.

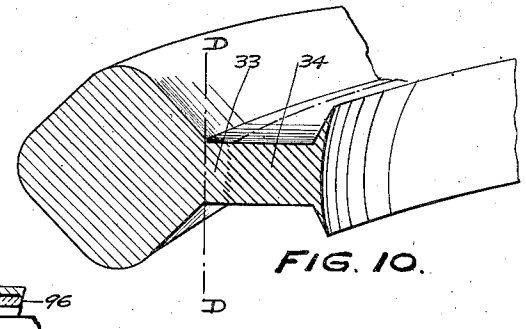


FIG. 10.

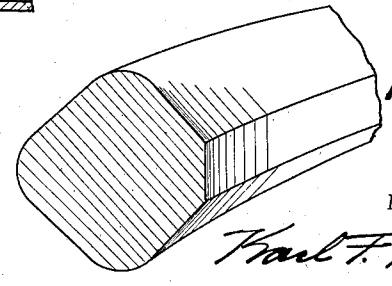


FIG. 11.

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CENTRIFUGAL CASTING MACHINE

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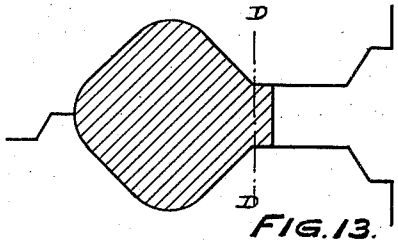


FIG. 13.

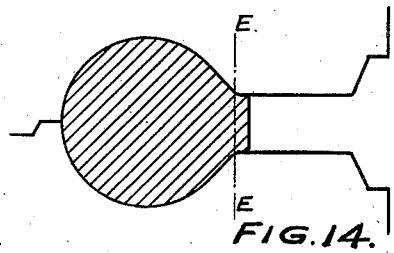


FIG. 14.

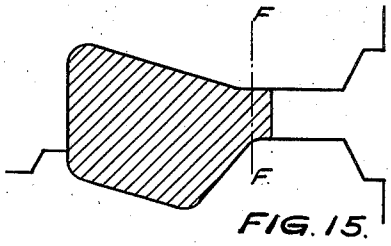


FIG. 15.

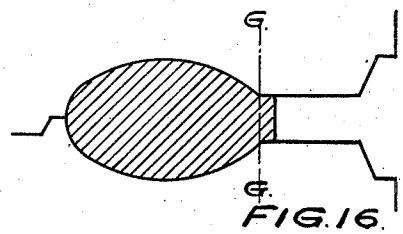


FIG. 16.

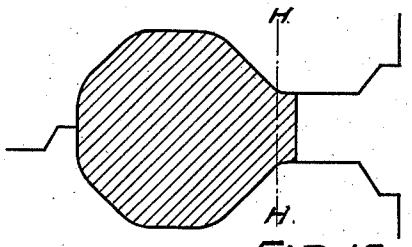


FIG. 17.

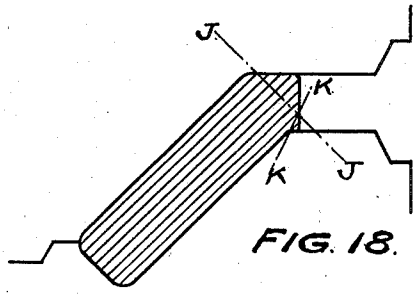


FIG. 18.

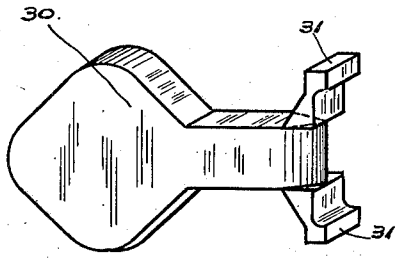


FIG. 12.

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Patented Apr. 7, 1936

2,036,401

UNITED STATES PATENT OFFICE

2,036,401

CENTRIFUGAL CASTING MACHINE

Karl F. Dailey, Cleveland, Ohio, assignor to Francis B. Douglass, Cleveland, Ohio

Application July 15, 1933, Serial No. 680,564

13 Claims. (Cl. 22—65)

The invention relates to machine designed for the making of arcuated, segmental, individual formed castings, ring and band castings and the like by the centrifugal process through the pouring of molten metal into rotating molds, and has for its object the provision of an improved machine which shall enable castings to be made in greater quantities, more rapidly, with a greater uniformity of quality as well as an improved quality of the metal as to contaminations, granular disintegration, impurities, with a minimum crop of scrap loss and with less labor than is possible with machines heretofore known.

The type of machine to which the invention relates is that in which a mold, or series of molds, is permitted to rotate about an axis, preferably a vertical one, the metal being poured into the mold through a stationary runner adjacent to mold or a spout which may rotate about an axis coincident with the axis of rotation of the mold.

A machine according to my invention has for its object the adaptability of a plurality of molds arranged in annular circular sections forming a series of individual pockets or circular ring molds held securely, concentrically together through bevel seats and against a rotating table, mold sections being held securely together and against said rotating table by means of pressure cylinders, or may be effected by an electric motor, and this pressure, holding force, may be applied while molds are rotating or at rest, the object being the rapid removal and displacement of molds as a unit bank and the elimination of loss of time attending clamping means dependent on manual screwed, wedge or cam devices.

According to my invention, the molds have an enclosed type of cavity of any practical cross sectional form, such as square, octagonal, trapezoidal, rectangular, oval or round, and is entered through an annular flat port leading from a secondary cavity at the inner radial portion of mold.

The object of this arrangement is to segregate clean metal, contaminated metal, slag and impurities into definite positions and forms so that they may be readily separated from each other by a subsequent shearing, sawing or other suitable process.

It is generally known that in casting metal in centrifugal machines it is difficult to produce a definite distinct line of demarkation between clean metal on one side and defective metal, slag and impurities on the other.

Another object of the invention embodied herein is characterized in that the annular flat port provides sufficient volume for the accumulation through centrifugal force of undesirable contaminated metal, slag and impurities and an excessive amount may overflow into the secondary cavity at the inner radius of molds. This flat port, much smaller in cross section than the major cavity of mold permits of a deposit of defective metal therein that would be one-fifth or less than the amount necessary to remove from conventionally cast ingots in the form of a scrap crop.

This minimized crop bead formed in the flat annular port may be removed from the major casting at a plane at a relatively substantial distance from the plane at which the innermost radial surface of crop bead meets the accumulation of slag and impurities, thus resulting in perfect metal throughout major casting, and under variable conditions which attend melting and pouring of metals.

The molten metal in flat port, while under centrifugal action produces an accumulated pressure at the inner radius of the major casting and a heavier pressure at the outer radius but the pressure at the inner radius and particularly at a plane on which the crop is removed, is sufficient to produce compact metal of close granular structure, without the additional centrifugal pressure of slag and impurities against the innermost radial surface of crop bead.

The rotation of molds must be done at a high rate of speed to effect the separation of slag and impurities as is customary with all types of centrifugal casting machines. This rate of speed may reach 90 feet per second at the radius of mold cavity while metals flowing by gravity from orifices in the bottom of ladles and spouts attain only a small fraction of that velocity and when poured into rapidly rotating molds, produces turbulence of metal, thin laminations, excessive oxidation, particularly during the short period elapsing before metal reaches circumferential velocity and subsequently centrifugal functions. To maintain fluidity of metal under above conditions requires higher temperatures of molten metal. The object of the invention is that balanced spouts, runners, or means for admitting metal into rotating molds, are themselves rotated about an axis coincident with the axis of rotating molds and at a controlled rate of rotation independent of the rotation of molds and this controlled rotational movement of spouts flows metal into radially, balanced streams, through the flat port and impinges metal directly against the radially outermost surface of mold cavity.

The controlled ratio of velocities between molds and spouts permits the flowing of metal into molds with minimized turbulence, thick laminations, and in a form producing greater cross sectional areas in relation to peripheries thus resulting in conserving heat and will permit pouring molten metal at lower temperatures and more in conformity to temperatures prevailing in conventional types of melting furnaces.

Molten metal is poured into a master ladle from any conventional melting furnace. This master ladle carries below it a smaller auxiliary ladle on hooks engaging a flange around the top of auxiliary ladle affording sufficient clearance to permit rotation about its axis when contact between hooks and flange is broken by the lowering of the master ladle effecting engagement of and aligning of auxiliary ladle on a table rotated independently of the mold table but whose axis is coincident with it.

The equal distribution of molten metal to mold or molds in different planes is effected by the two openings in auxiliary ladle being opened or closed, during rotation or at rest by electric solenoids operating stoppers.

Characteristics of certain metals may present conditions in which it would be advantageous to not permit auxiliary ladle to make contact with rotating table but to pour from the then non-rotating ladle into rotating spouts equipped with annular basin and cylindrical mouth both concentric with axis of molds.

After the pouring of the metal has been completed and the castings have cooled to a plastic state, circumferential shrinkage takes place and may be of no importance when molds are arranged in a series of individual molds or pocket molds in a circular group but when mold cavities are full circular rings or when the individual pocket mold has considerable length with pronounced arcuated effect the circumferential or longitudinal shrinkage effects a reduction in the radius of the casting and unless the casting is free to conform to the reduced radius disintegration of metal takes place. A further object of the invention is to permit the free movement of castings and prevent stresses therein and to effect this the mold sections are moved away from each other, providing clearance between castings and mold sections to permit an unretarded movement of castings in a radial or circumferential direction. When the change of form is radial castings make contact at the lower inner radial surface of mold cavity and climb upward thereon.

The movement of mold sections away from each other is effected while mold sections are rotating or at rest and by the same stationary pressure cylinders or motor that produces the binding of mold sections together and against the rotating table.

After the molten metal in molds has cooled to a rigid state with mold sections in a separated position, the rotating table is brought to rest, clamping dogs are turned 90 degrees or a suitable amount from radial position and mold bank is free to be removed upwardly from machine by a tripod of hooks engaging lugs on lower mold section.

In the accompanying drawings to which reference will now be made and in which a centrifugal casting machine and relevant parts are embodied in one form,

Fig. 1 is a plan view.

Fig. 2, a partial cross sectional view of Fig. 1 at a plane AAAA looking in the direction of the arrows.

Fig. 3, a vertical elevation and a partial cross section.

Fig. 4, a sectional elevation of Fig. 1 in a plane BBBBBB.

Fig. 5, a partial cross section at CC of Fig. 1 showing molds closed.

Fig. 6, a partial cross sectional elevation of Fig. 5.

Fig. 7, a cross section of Fig. 6 at 7—7.

Fig. 8, a partial cross section at CC of Fig. 1 showing molds open.

Fig. 9, a partial cross section of Fig. 1 at a plane BBB.

Fig. 10, a perspective view of a portion of a casting before trimming.

Fig. 11, a perspective view of a portion of a casting with crop and slag removed at a plane DD of Fig. 10.

Fig. 12, a perspective view of a mold partition.

Figs. 13, 14, 15, 16, 17, 18, cross sectional views of castings, with crop beads, of respectively square, round, trapezoidal, oval, octagonal and rectangular forms and planes DD, EE, FF, GG, HH, JJ, KK, at which crop beads are removed.

Referring to the drawings; **12** represents a table carried by a hollow shaft **13**, which is rotated by bevel gears **15** and **16** and a shaft **17** from any external source. Table **12** is attached to shaft **13** in any suitable manner as by flange **20** and bolts **21**. Shaft **13** is journalled through bushings **14** to casings **18** and **19** attached together by bolts **22**. A thrust bearing **23**, **24**, is mounted on shaft **13** between faced hub of bevel gear **15** and casing **19** to carry the weight of shaft **13** and all parts directly or indirectly attached thereon.

Annular circular mold sections represented by **1**, **2**, **3**, internally faced by refractory material **94** and **95**, are adapted to retain concentric relationship between each other and table **12** through beveled annular seats **25**, **26** and comprises an annular major cavity **27** entered by a flat annular port **28** from a secondary annular cavity **29**.

Partitions **30** Fig. 12 radially adapted to cavities **27**, **29** and port **28** are provided with lugs **31** meshing with notches **32** in **1**, **2** and **3** to hold said partitions in assembled relation. The spacing of partitions **30** about the periphery of **27**, **28** and **29** effects the length of segmental, arcuated castings.

Fig. 10 shows perspective view of a portion of typical casting as taken from mold cavity and the same casting shown in Fig. 11 having crop bead **33** and slag **34** removed at a plane DD.

Fig. 9 represents an enlarged sectional view of a mold section **1** and **2** showing a major cavity **27** port **28** and secondary cavity **29** and a stream of metal **35** passing through secondary cavity **29** port **28** and depositing same against the outer radial surface of cavity **27** in a laminated deposit **36** that has a centralized cross sectional area and minimized periphery.

To effect the binding together of mold sections **1**, **2** and **3** and against rotatable table **12** a plurality of clamping dogs **4**, trunnioned and held on posts **6** by nut **5** are moved downward, contacting bevel surfaces **37**, **36** of respectively section **1** and ring **38** and said posts **6** actuated by each being provided with, and attached to its lower end by pin **39**, an eccentric pitman **8** in which is disposed an eccentric **9** fast to shaft **10** journalled to table **12** in bearings **11** and said

shaft 10 adapted to turn eccentrics 9 downward.

There are three shafts as shown in plan view 1, each operable with two eccentrics 9. Shafts 10 each carry a toothed pinion 40 and these pinions mesh with racks 41 formed on round bars 44 and are held in mesh by housing 42 journalled to shaft 10 at 43 and provided with slidable bearings 45.

Rack bars 44 are reciprocated by oscillatory movement of bell cranks 46 pinned to 44 by 47 and carried on shafts 48 supported in bosses 56 fast to table 12, and said movement effected by engaging of bell crank end 49 in block 50 slidable radially in recess 57 in thrust ring 51 turnable in groove of cross-head 52 keyed by 58 to and guided by bearing surface 59 of casing 18 and said cross head 52 moved by pressure applied to pistons 54 and rods 53 attached to cross head and operable in cylinders 55 attached to casing 19.

In Fig. 4 the mold sections are shown in a downward position held against each other and against table 12 and it will be apparent that on a downward movement of pistons 54 eccentrics 9 will turn upward and lift posts 6 ring 38 and mold section 1 by contacting lip extensions 60 and 61 of 6.

On each side of eccentrics 9 are eccentrics 62, fast to shafts 10, having a throw one half of that of eccentrics 9 and engage lifter posts 7, slidable on posts 6, said lifters 7 engaging mold section 2 at its under side. It is apparent that the turning of shaft 10 to produce upward throw of eccentrics, will move mold section 2 half the distance that section 1 moves, and that the distance apart of 1 and 2 will equal that of 2 and 3. Lugs 98 provide means for lifting sections 1, 2, 3, from machine by overhead crane hooks.

Referring to Fig. 4, 63 represents a master ladle having an outlet 64 in the bottom thereof which may be manually opened or closed by any ordinary stopper, controlling the flow of metal 99 into the auxiliary ladle 65 carried below 63 and supported by hooks 66 attached to 63 and engaging flange 67 of 65 and providing sufficient clearance between hooks 66 and 67 to permit rotation of 65 when its bevel ring 68 contacts bevel seat 69 of rotatable table 73 when master ladle 63 and ladle 65 are lowered. Pin 97 effects the necessary register of flows from 71 with mouth of 82 and 83.

The auxiliary ladle is provided with openings or outlets 71 and their respective stoppers 100 are actuated, while in rotation, by solenoids 72 or other suitable means fast to ladle 65 and receiving electric current through cables leading to suitable collector rings.

Table 73 is attached to a vertical shaft 74 in the usual way and is supported on rollers 75, journalled to pins 76 in 73, riding on track 77 fast to table 12.

Shaft 74, journalled to shaft 13, is rotated by bevel gears 79 and 80 and a shaft 81 from any external source. 82, 83 represent spouts carried on yokes 86 trunnioned to table 73 at 87 and to spouts at 88 and are adapted to outward movement effected by centrifugal action.

The outermost position is adjustable by set screws 89, in lugs 90 fast to 73, contacting yokes 86.

An inward movement of spouts 82, 83, is effected by gravity when centrifugal action ceases.

Spouts 82 and 83 may be adapted to receive metal from a non-rotating ladle by the use of axial and annular formed mouths concentric with axis of rotation.

Operation will be as follows, the mold sections being clamped together in the position shown Fig. 4, and the mold parts being in rotation by application of power to the shaft 17.

The power is applied to the shaft 81 to drive the spouts or nozzles, the latter being shifted against gravity, by centrifugal force, so that the mouth of each is closely adjacent the port of its mold cavity, as shown in Fig. 4. Molten metal is then supplied to the spouts from the outlets 71 in the auxiliary ladle by suitable energization of the solenoids 72 for control of their stoppers 100.

The molten metal is delivered from the spouts substantially directly into the mold cavities, without contact with the walls of the mold ports, as shown in Fig. 9, the spout speed being sufficient for the purpose. If the spouts are driven in the same direction as the molds, but at a different speed, there will be a slow spout progression relative to the molds along the endless ports, and a relatively thick layer of metal will thus be deposited in the mold cavities, and with a minimum of turbulence. If the spouts be driven in the opposite direction a series of relatively thin layers of metal will be deposited in rapid succession in the mold cavities.

The mold and port cavities being ultimately filled, the spout streams and spout drive are cut off but the molds are preferably continued in rotation until solidification of their contents. Prior to solidification the mold contents are compacted by centrifugal force, forcing impurities from the metal into the mold ports. The ports having considerable radial dimension relative to their dimensions longitudinal of the axis of rotation, the port contents have enhanced hydrostatic effect upon the mold contents to compress the latter.

As the castings cool, shrinkage occurs and the mold sections are correspondingly released by manipulating their locking means under the control of the member 52 and its actuating cylinders 55, the castings having cam action upon the mold sections to separate the latter.

After the castings are solidified the clamping dogs for the mold sections are removed, and the sections and castings lifted from the machine by a crane; the drive of the molds having previously been cut off.

93 shows detachable nozzles, containing orificed refractory sleeves 96 of suitable cross section adapted to direct flow of metal away from the radial and in the same direction molds rotate.

The details of construction and arrangement of parts employed in carrying out the invention may be varied from the particular embodiment described and illustrated in many ways other than those specifically mentioned.

Have thus described my invention, what I claim as new, and desire to secure by Letters Patent is;

1. A centrifugal casting machine for making arcuated, segmental, individual formed castings, rings and band castings and the like from molten metal poured from a master ladle into an auxiliary ladle adapted to controlled rotation, including openings through bottom of auxiliary ladle and means for opening and closing said openings, while auxiliary ladle is in rotation, and means for receiving molten metal passing through openings and running same molten metal outward to and into rotating mold cavity, means for rotating said last named means inde-

pendently of rotating molds, with said auxiliary ladle and concentrically with mold cavity.

2. A centrifugal casting machine for making arcuated, segmental, individual formed castings, ring and band castings and the like from molten metal poured into one or more rotating circular molds or circular group of molds, comprising a forming cavity at an outer radial position of molds, a secondary cavity at an inner radial position of molds and a port at an intermediate radial position, connecting the secondary cavity to the forming cavity, including a means for moving mold sections together and against a table in a state of rest or rotation and said means for moving mold sections in a state of rest or rotation away from each other and producing clearances in controlled and equal amounts between the upper surface of metal castings and the upper surface of forming cavities of a circular mold or circular group of molds arranged in one or a plurality of planes at right angles to and cutting the axis of rotation and the amount of said clearance between upper surface of castings and upper surface of forming cavities of mold or molds in one plane to be simultaneously equal to the amount of clearance between upper surface of castings and upper surface of forming cavities of mold or molds in parallel planes cutting the said axis of rotation.

3. In a machine for centrifugally casting circular steel ingots of large diameter, an annular mold arranged to provide an annular major cavity and an annular port directed outwardly to said cavity at that part of the latter nearest the mold axis, said cavity having a wall part adjacent said port, disposed to permit the casting, upon shrinkage in cooling, to have cam action radially inwardly against said wall part, said mold being parted at said port and transversely of said axis to provide a pair of sections separable by said cam action, and locking means for said sections capable of holding said sections together sufficiently to prevent outflow of molten metal under centrifugal forces, but capable of yielding under shrinkage forces during rotation.

4. In a machine for centrifugally casting circular steel ingots of large diameter, a rotatably mounted mold arranged to provide a major cavity concentric about the axis of mold rotation, and an annular port directed toward said cavity at that part of the latter nearest said axis, said port being of width lengthwise of said axis, substantially less than said cavity, and said port being short relative to said diameter but extending from said cavity sufficient to contain the entire scrap crop of the casting after pouring, and nozzle means movable relative to said mold to feed a molten metal stream of compact section into said mold cavity by way of said port but without contacting the sides of the latter.

5. In a machine for centrifugally casting steel ingots or the like, a rotatably mounted mold arranged to provide an annular major cavity of uniform section about the axis of mold rotation and an annular port directed outwardly to said cavity at that part of the latter nearest said axis, said port extending, longitudinally of said axis, substantially less than said cavity, and being of volumetric capacity sufficient to contain the entire scrap crop of the casting after pouring, and a plurality of partitions uniformly spaced about said axis, to provide a corresponding number of similar individual arcuate castings, each partition extending longitudinally of said axis and radially through the combined sectional area of said major cavity and port, and means securing each partition to said mold adjacent the mouth of said port, the uniformity of the major mold cavity being uninterrupted at the partition.

6. In a machine for centrifugally casting circular steel ingots of large diameter, a rotatably mounted mold arranged to provide a major cavity concentric about the axis of mold rotation, and an annular port directed toward said cavity at that part of the latter nearest said axis, said port being of width lengthwise of said axis, substantially less than said cavity, and said port being short relative to said diameter but extending radially from said cavity sufficient to contain the entire scrap crop of the casting after pouring, and nozzle means arranged for rotation about said axis and relative to said mold to feed a molten metal stream of compact section into said major cavity by way of said port but without substantial contact with the walls of the latter.

7. In a machine for centrifugally casting circular steel ingots of large diameter, an annular mold mounted for rotation about its axis and arranged to provide an annular major cavity and an annular port directed outwardly to said cavity at that part of the latter nearest said axis, said cavity having a wall part adjacent said port, disposed to permit the casting, upon shrinkage in cooling, to have cam action radially inwardly against said wall part, said mold being parted at said port and transversely of said axis to provide a pair of sections separable by said cam action, and means providing controlled opposition to said separation of said mold sections during said mold rotation.

8. In a machine for centrifugally casting circular steel ingots of large diameter, annular mold means mounted for rotation about an upright axis and arranged to provide a plurality of longitudinally spaced annular major cavities, each concentric with said axis and each having an annular port directed radially outwardly thereto at that part of the cavity nearest said axis, said mold means being parted transversely of said axis at each port, whereby the mold means comprises a plurality of sections in stacked relation, means for supporting the lowermost section, each cavity having a wall part adjacent its port disposed to permit a casting therein, during shrinkage in cooling, to have cam action radially inwardly against said wall part, whereby each cooperative pair of the mold sections may be separated by cam action of the castings thereagainst, each intermediate section rising more than the one therebelow and less than the one thereabove, and means associated with the uppermost of said sections and providing opposition to said separation of mold sections, and arranged to permit variation in said opposition during said rotation.

9. In a machine for centrifugally casting steel ingots or the like, mold means mounted for rotation about an upright axis and arranged to provide a pair of similar major cavities concentric with said axis, each with an annular port directed outwardly at that part of the cavity nearest said axis, said mold means being parted transversely of said axis at each cavity, whereby the mold means comprises three sections in stacked relation, means supporting the lowermost mold section, each major cavity having a wall conically disposed approaching its port, whereby upon shrinkage of the castings in cooling, the mold sections will be separated by cam action of the castings against the mold means, the uppermost

mold section being caused to rise twice as far as the intermediate section, means associated with said mold sections and providing for positive limitation to said separation thereof in proportion to their said rising characteristics.

10. In a machine for centrifugally casting circular steel ingots of large diameter, rotatably mounted mold means arranged to provide a major cavity distributed about the axis of mold rotation, and having an annular port with a mouth directed toward said axis, and means, including a rotating element, for delivering to the mouth of said port, a stream of molten metal under pressure centrifugally produced independently of rotation of said mold.

11. In a machine for centrifugally casting steel ingots or the like, a rotatably mounted mold arranged to provide cavity distribution about the axis of mold rotation, and having an annular port directed toward said axis, spout means for delivery of metal to said port, mounted for rotation about said axis, and means providing for adjustment of said spout means toward and from the mouth of said port.

12. In a machine for centrifugally casting steel ingots or the like, a rotatably mounted mold arranged to provide cavity distribution about the axis of mold rotation, and having an annular port directed toward said axis, spout means for delivery of metal to said port, mounted for rotation about said axis, means for driving said spout means, and means mounting said spout means for automatic radial adjustment into and from the mouth of said port dependent upon spout rotation.

13. In a machine for centrifugally casting steel ingots or the like, rotatably mounted mold means arranged to provide a plurality of longitudinally spaced cavities each having distribution about the axis of mold rotation, said mold means having for each cavity an annular port directed toward said axis, spout means comprising a plurality of spouts, at least one for each port, and means for controlling the relative delivery of said spouts to their respective ports.

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