July 5, 1927. 1,634,914

L. REICHOLD

CENTRIFUGAL CASTING APPARATUS

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Fig. 1.

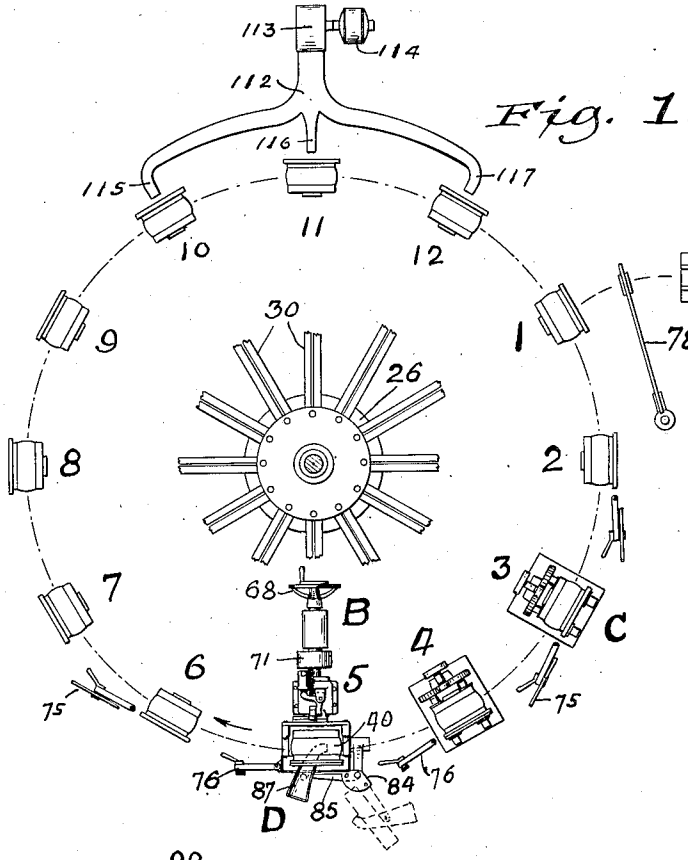


Fig. 1a.

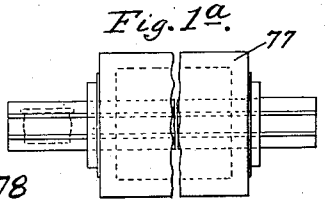


Fig. 1b.

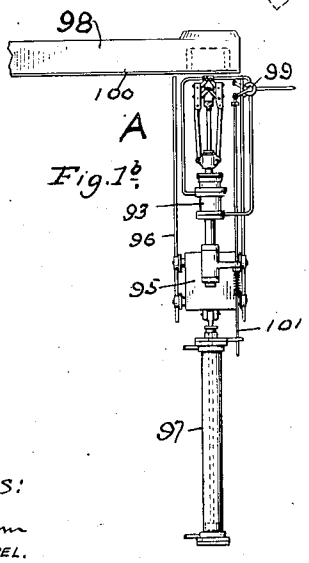


Fig. 10.

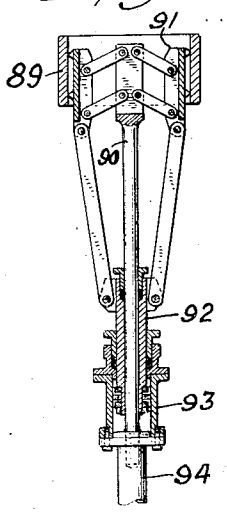


Fig. 5.

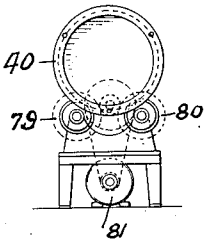
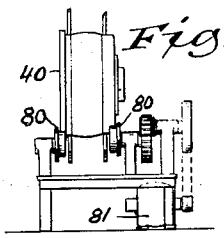


Fig. 6.



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CENTRIFUGAL CASTING APPARATUS

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Fig. 3.

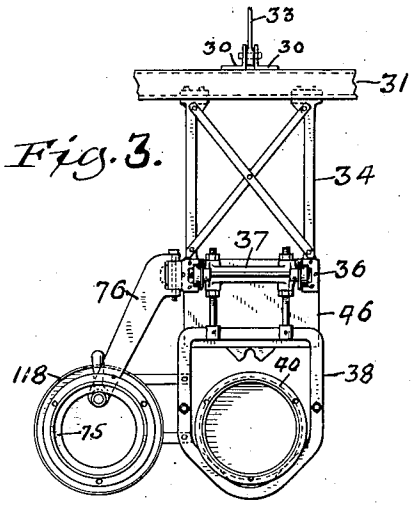


Fig. 2.

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CENTRIFUGAL CASTING APPARATUS

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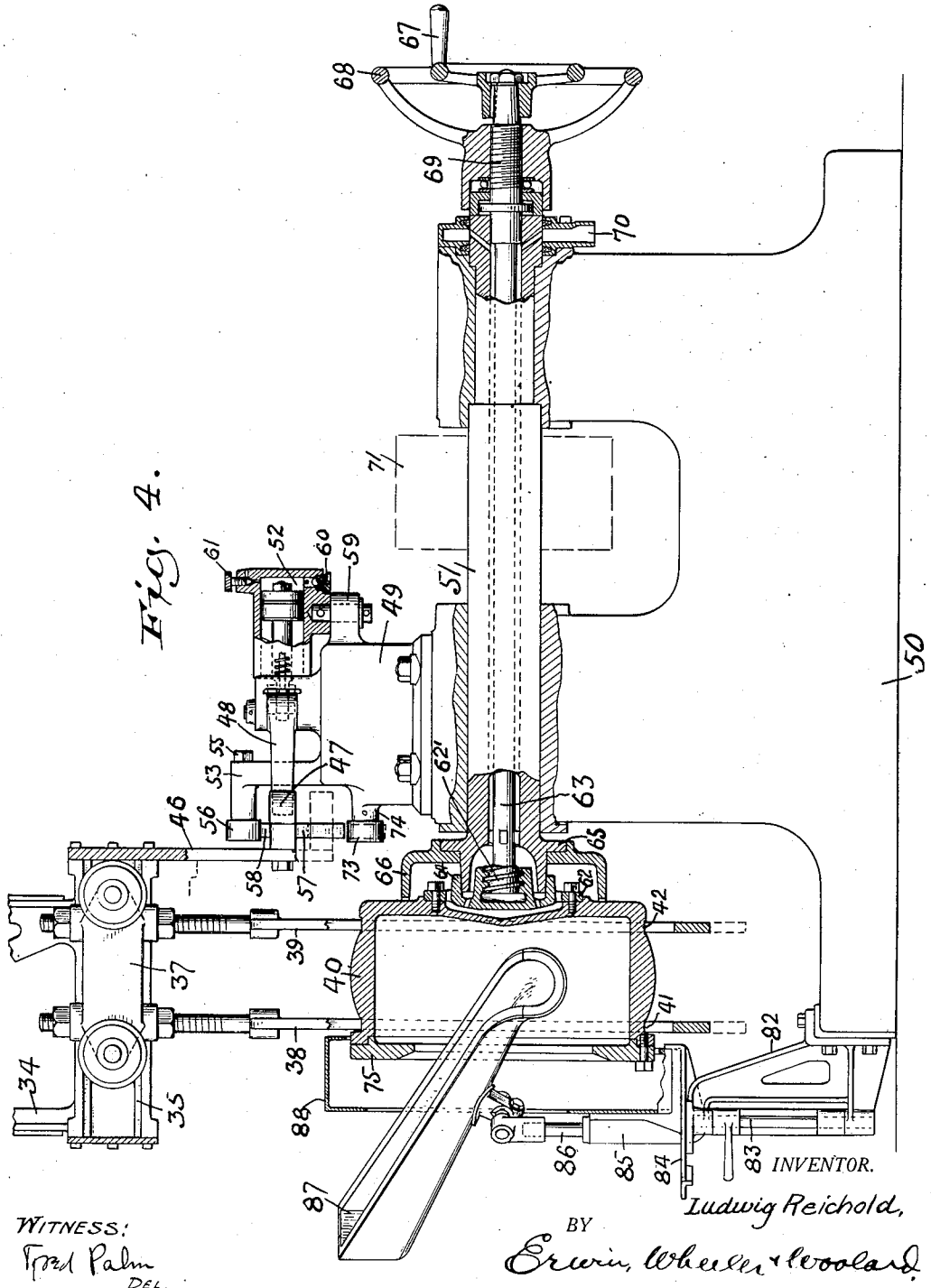


Fig. 4.

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CENTRIFUGAL CASTING APPARATUS

Filed June 20, 1924 4 Sheets-Sheet 4

Fig. 7.

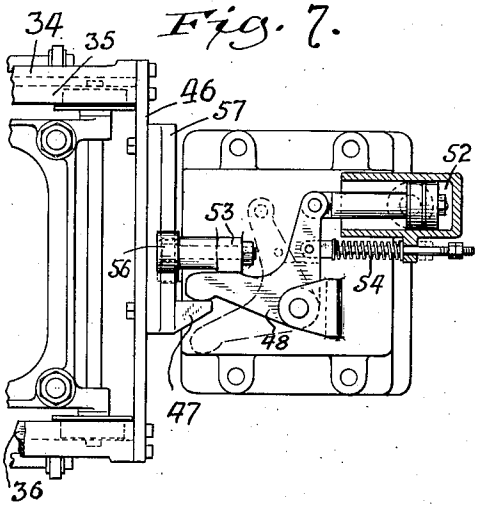


Fig. 8.

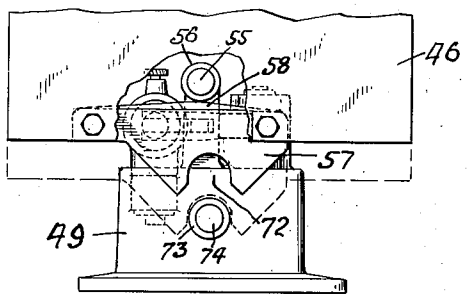
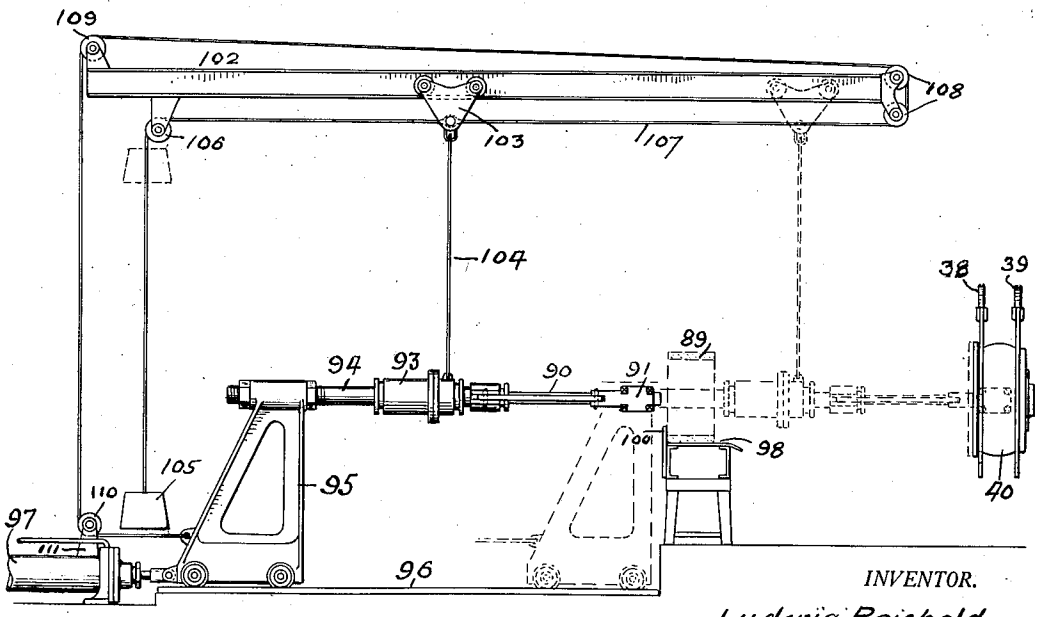


Fig. 9.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL CASTING APPARATUS.

Application filed June 20, 1924. Serial No. 721,200.

The invention relates to centrifugal casting machines, and has been designed primarily for use in producing tubular articles, such as pipe couplings, but is applicable to the production of various other like articles by the same method of casting, and resides in an improvement in the construction and arrangement of such machines, whereby the articles to be produced may be cast in rapid succession.

My invention greatly expedites the operation of centrifugal casting, by reason of the mechanical provisions in the improved apparatus, and enables the production in quantity of tubular articles, all of which are practically uniform as to density and weight, these latter involving conditions the attainment of which is very much to be desired in the production of certain articles of this class, and particularly in the couplings which are used to connect the ends of lengths of tubes of large diameter, such as are used for oil well casings.

The tubing of larger diameter which is used for the purposes stated has an approximate weight of fifty pounds per running foot, and it is therefore of the greatest importance that the couplings used be so constructed as to embody the highest state of perfection and present a maximum degree of strength, so as to support the enormous weight of a casing, which latter frequently has a length of several thousand feet. It is not enough that the couplings sustain the increasing weight of the casing as the same is lengthened by the addition of other tube sections applied at the time of drilling the well, but the couplings should be so constructed as to successfully withstand the much greater strains which are encountered in withdrawing the casing from the well, should the latter operation be found necessary for any reason.

In my experiments looking to the construction of a pipe coupling which will fully meet all of the requirements and surmount all the difficulties which may be encountered in actual use, I have found the centrifugally cast steel pipe coupling to be superior in important particulars to those produced by other methods, by reason of the high state of perfection which can be attained in its manufacture.

These facts having been ascertained by actual practice, my efforts have been directed to the perfection of an apparatus which will enable the expeditious production of pipe couplings by centrifugal casting, and I have in accordance with such studies produced the present apparatus by the use of which such perfected casting may be effected in rapid succession, so that quantity production is possible at a minimum expenditure of time and other costs.

I attain the results desired by providing a plurality of molds which are brought in quick succession to a central casting station, such molds moving intermittently through an endless path to enable them to be progressively conditioned in the intervals of the casting operations and preparatory to such operations.

Having thus generally outlined its nature and purposes, the details of structure comprised in the invention, as well as the operation thereof, will now be particularly described, and the novelty thereof will be pointed out in the appended claims.

In the accompanying drawings:

Figure 1 is a diagrammatic plan view showing in a conventional manner the arrangement of the elements of my improved apparatus.

Fig. 1[a] illustrates the relative location of the furnace employed for initially heating the molds as a preliminary to their insertion in the casting machine.

Fig. 1[b] likewise illustrates the arrangement of the extractor with relation to the machine, the purpose of which extractor is to withdraw the castings from the molds.

Fig. 2 is a view in elevation, with parts in section, showing the general construction and manner of mounting the intermittingly rotating turret or frame which supports the molds, and showing also the devices for rotating or spinning the molds during the casting operations.

Fig. 3 is a view in end elevation of one of the cradles for the mold, together with the means for temporarily supporting the front cover of the mold when removed therefrom.

Fig. 4 is an enlarged view, partly in elevation and partly in section, showing certain details of construction of the devices shown at the left of Fig. 2, and particularly the means for coupling the mold to its rotating means.

Fig. 5 is a view in front elevation and Fig. 6 is a view in side elevation, looking from the right in Fig. 5, of the devices for spinning the molds during the application of the coating thereto, preparatory to the casting operation.

Fig. 7 is a plan view, partly in section, showing the arrangement of the stop devices which will arrest the movement of the rotating turret or frame at the time that the latter brings the molds into position for casting.

Fig. 8 is a front elevation of the devices employed to lock the turret in position during the casting operation, so that the free rotation of the mold without interference may be effected.

Fig. 9 is a view in side elevation showing in a conventional manner the arrangement of the extractor, together with the devices for operating the same.

Fig. 10 is a horizontal sectional view showing the construction and arrangement of the engaging devices forming the extractor, whereby the casting may be engaged and withdrawn from the molds.

In the drawings, the numeral 20 indicates a post arranged at its lower end in a base 21, and sustained at its upper end by a beam 22, so as to maintain the post 20 in a fixed vertical position. A sleeve 23 surrounds the lower end of the post, and is supported upon the base 21, so as to have a free vertical but non-rotative movement upon the post 20, in a manner which will be hereinafter described, the said sleeve being provided at its lower end with a circumferential flange 24, and at its upper end with a like flange 25.

Surmounting the sleeve 23, a flanged hub 26 is arranged loosely about the post 20, and is provided at its lower side with a ball race 27, constituting an anti-friction bearing between the lower face of the hub and the upper face of the flange 25. A second flanged hub 28 is similarly arranged upon the post 20, and is separated from the hub 26 by means of a sleeve 29, encircling the post, and acting as a distance piece to support the hub 28 in elevated, fixed relation to the hub 26. In the structure thus described, the sleeve 23, and the unit comprised of the hubs 26 and 28 and the distancing sleeve 29, are adapted to move as a whole vertically with relation to the post 20, in addition to which the said unit is free to have a rotary movement about the said post, upon the anti-friction bearing 27.

The hub 26 forms the center of a spider composed of a plural number of pairs of radially arranged bars 30, which are preferably constituted as angles for the purpose of securing rigidity against deflection, and are connected at their outer ends by two annular channels 31 and 32, of different diameters, but concentrically arranged. Adjustable tie rods 33 extend diagonally from the points of their connection with the hub 28 in proximity to the post 20, to the outer ends of the radially arranged bars 30 with which they are also connected, so as to support the free ends of the latter at all times in a horizontal circular plane, and thus prevent any deflection from such plane of the said bars under the weight of the load imposed thereon.

I have illustrated the apparatus in Fig. 1 as constructed and adapted to accommodate twelve molds, numbered 1 to 12 inclusive, which numerals may designate stations in the operation of the apparatus, as will be further explained, commencing with the operation performed at station 1.

Attached to the rings 31 and 32 of the turret by any suitable means permitting adjustment around the said rings to properly position them circumferentially, are depending sub-frames 34, twelve in number. Such sub-frames may be of any appropriate construction, and each is provided at its lower end with spaced horizontal tracks 35 and 36 paralleling the radially arranged bars 30. A carriage 37 provided with rollers is adapted to have a limited movement radially of the apparatus upon the said tracks 35 and 36. Depending from each carriage is a cradle composed of two loops 38 and 39, which are adapted to receive and support a mold 40, by engagement with the same near the opposite ends thereof, the said loops 38 and 39 of the cradle being suitably spaced apart for this purpose. Means are provided for adjusting the vertical positions of the loops 38 and 39 of the cradle, at the point of their connection with the carriage 37. In this manner the molds carried by the several cradles may be adjusted in vertical position and accurately aligned, so as to be presented in the same horizontal plane at the central casting station 5. The exterior surface of the mold 40 is provided with slight circumferential depressions 41 and 42, which form seats in which the lower member of the loops 38 and 39 engage, to retain the mold against axial displacement in the abnormal operation of the apparatus. In such abnormal operation, and during the rotation of the turret, the molds are supported solely by engagement of the loops with the undersides thereof, as stated. The turret is freely rotatable, so as to bring the molds in succession to the central casting station 5.

During the periods of intermitting rotation of the turret, the latter is elevated on the supporting post 20 by the fluid pressure means indicated in Fig. 2. Such means comprises a plurality of cylinders 43 formed in the base 21 about the post 20, and opening upwardly for the reception of plungers 44. The length of the plungers is such that they

may be withdrawn entirely within the cylinders so as to permit the lower part of the flange of the sleeve 23 to rest upon the face of the base 21. Relaxation of the pressure in the cylinders 43 will permit the turret to fall to its lowest position, and in this action certain of the molds will be relieved from support by the loops 38 and 39, and will be supported by adjunctive devices which will permit their treatment or manipulation independently of the turret. For the purpose of limiting the upward movement of the turret under fluid pressure, when exerted, I provide adjustable stops 45, which are shown as vertical studs threaded into the base 21 and as extending through openings in the flange 24, with jam nuts threaded upon the opposite ends of the studs, to engage the upper face of the flange, as shown in Fig. 2. It will be understood that when in its abnormal elevated position, the turret may be freely rotated, and that when the turret is in its normal lowered position, it is locked against rotative movement. The casting operation is performed at the time that the turret is in its normal lowered position of rest, so that the particular mold which is to be poured at central station 5 is then out of contact with the loops of the supporting cradle, and is free for rotation without frictional interference by the loops.

Each sub-frame 34 is provided with a depending projection 46 to which is attached a catch 47, which latter is in the rotation of the turret brought into engagement with a horizontally disposed pivoted bell crank 48, mounted in a housing 49, positioned upon the stand 50. In the latter is journalled the shaft 51, by means of which rotative movement about its axis is imparted to the mold 40, to rapidly spin the latter and cause the molten metal in the mold to distribute itself in an even manner over the interior surface of such mold, as usual in centrifugal casting. The shock of the engagement of the catch 47 with the free arm of the bell crank 48 is cushioned by means of dash pot 52, the piston rod of which is connected to the other arm of the bell crank. The dash pot 52 is pivotally mounted upon the casing 49, as at 59, and is provided with an inlet valve 60 and an exhaust control 61, of usual form. Mounted also upon the casing 49 is a fixed stop 53, constituted as an upstanding post.

During the rotation of the turret, the catch 47 moves in the fixed horizontal plane of the bell crank 48. But inasmuch as the catch 47 participates in the lowering movement of the turret when the supporting fluid pressure is withdrawn, the catch 47 will fall to a plane below that of the bell crank, thereby disengaging the parts and freeing the bell crank to the force of an expansion spring 54, which spring will act to restore the bell crank to the dotted line position shown in Fig. 7 and so as to be in position to meet the catch 47 of the following sub-frame and check the next advancing movement of the turret, the catch 47 now being in the plane of the bell crank, but at the rear thereof. Viewing Fig. 7, it will be seen that a clearance is provided to enable the catch 47 to pass the post 53, in the further movement of the turret.

A pin 55, secured in the upper end of the post 53 carries at its outer end a roll 56, which latter is adapted to ride over the top surface of the plate 57, attached to the depending projection 46, and which carries the catch 47, in the arrangement shown. The upper face of the plate 57 is shaped as a cam having a slight elevation, in the manner indicated at 58 in Fig. 8, the purpose of this construction being that with the parts aligned as in Fig. 8, the turret will be positively held in the precise horizontal position necessary to enable proper connection between the mold 40 and the means for imparting rotation about its axis to be made at the casting station.

The mold rotating shaft 51, is tubular and is journalled in a plurality of bearings in the stand 50, to secure its alignment. A socket 62, flanged at its base, is attached to the rear of the mold 40, the said socket being formed with a central boss which is provided with a coarse thread to receive a correspondingly formed thread 62′ upon the end of the locking shaft 63, rotatably mounted in the tubular shaft 51. There is also formed upon the socket 62 an annular wall 64, concentrically arranged with relation to the boss, and which is provided with a cylindrical bore to receive the enlarged adjacent end of the shaft 51, with a sliding fit, and thus insure the true axial relation of the mold 40 and the shaft 51, by means of which latter the mold is supported and rotated during the casting operation. The enlarged end of the shaft 51 is hollowed to receive the boss and is provided with a circumferential flange 65 which supports centrally a cup 66, the diametral opening of which is sufficient to embrace the socket 62 and bear upon the rear side of the mold at points some distance from the center thereof, so as to steady the mold against vibration during the rotation of the latter.

A crank 67 is keyed upon the outer end of the locking shaft 63, by means of which crank the said shaft may be given a movement of rotation so as to engage the corresponding screw thread upon the forward end thereof with the threaded boss upon the mold, a compensating movement of the mold being permitted by the carriage 37 upon the tracks 35 and 36, by which the cradle for the mold is supported. For the purpose of completing the connection just described, a hand

wheel 68 is mounted upon the outer end of the locking shaft 63, the connection being made by means of comparatively fine screw threads 69, upon the shaft engaging like threads in the hub of the hand wheel, so that after the screw at the end of the shaft 63 is fully engaged with the socket 62 on the rear side of the mold, a partial turn of the hand wheel will have the effect of drawing the tapering parts at 64 together and the rim of the cup 66 into a closer engagement with the mold. This action will also serve as a locking means for the coarse screw connection 62′ between the end of the shaft 63 and the mold, whereby there is established a fast connection between the mold and its driving shaft. The rim of the cup 66 is notched and the socket 62 is perforated for the circulation of air, and a duct 70 will permit the flow of air through the hollow shaft 51, to reduce the temperature of the mold at its rear side. A pulley 71 fixed upon the shaft 61 is utilized to transmit rotation to the mold during the casting operation. A thrust bearing may be arranged between the hub of the hand wheel and a collar loose upon the shaft 63 but abutting the end of the tubular shaft 51.

Referring again to the depending projection 46 upon the sub-frame 34, and the plate 57 carried thereby, the latter is provided at its lower edge with a notch 72, in which is received a roll 73, pivoted on a stud 74 fixed in the front face of the casing 49, when the turret is lowered to free the mold at central station 5 from support by the loops 38 and 39 of the cradle. The engagement of the notch 72 with the roll 73, acts in a positive manner to hold the turret against any rotative movement during the casting operation. The mold 40 is formed with a solid bottom, and is open at its front end. Closure is effected by means of a dam or mouth piece 75, formed as a ring, and adapted to be secured in position upon the mold as shown in Fig. 4. The ring 75 is easily detachable, and when detached is carried away from the mold, and supported upon a swinging arm 76 pivoted upon the sub-frame 34, as shown in Fig. 3.

It is desirable to heat the molds to a certain temperature before undertaking the casting, and in order to effect this I provide a mold heating furnace 77, shown as broken out at the center in Fig. 1ª. This heating furnace, however, will be of sufficient length to accommodate the twelve molds used in the machine illustrated, and when such molds have been heated to the temperature desired, they are conveyed singly from the furnace to the cradle at station 1 by means of a swinging crane 78. The turret is then rotated the distance of one station, and another mold is transferred from the furnace to the cradle which awaits it. This operation is repeated until all the molds have been transferred to the cradles carried by the turret. Meanwhile, the first mold has reached station 3. At this point the supporting pressure for the turret will be relaxed and the turret permitted to settle down. At such time the mold will be relieved from support by the loops of the cradle, and will rest upon the separated pairs of rollers 79 and 80, of an independent mold rotating or spinning machine, such as is shown in Figs. 5 and 6. This mold rotating machine may be driven by an independent motor 81, so as to impart a rapid rotation to the mold. At this station the interior of the rotating mold is supplied with a coating of liquid graphite, or other material, which is adapted to alloy with the surface metal of the casting to be subsequently formed, so as to lower the melting point of the molten metal thereat, and retard the cooling of the surface metal to such an extent that the casting will be free from surface cracks. Then the turret will be raised to lift the mold from the spinning devices, and the turret advanced to the next station. At station 4, the arm 76 will be swung toward the mold and the cover 75 will be applied to the mold. This station may likewise be provided with a mold spinning mechanism similar to that at station 3, if it be found expedient to apply a further coating after the cover 75 has been secured in place. At station 4 the temperature of the mold may be taken to ascertain whether suitable conditions for casting have been created.

The turret is then moved to station 5, which is the central casting station. At this station the mold is coupled to the drive shaft 51 in the manner hereinbefore described, and rotation imparted thereto. A bracket 82, attached to the base of the stand 50, is formed with bearings which support a vertically arranged shaft 83, the said shaft supporting at its upper end a platform 84, upon which is mounted an arm 85 in which is socketed a stud 86, supporting in adjustable position at its upper end a pouring trough 87, the lower end of which is adapted to be inserted in the mold, in the manner illustrated in Figs. 1, 2 and 4. A measured quantity of molten steel is conveyed from a nearby furnace and is introduced into the mold by means of the trough 87. The platform 84 and arm 85 are adapted to support a hood 88, having an opening through which the trough 87 is passed, the purpose of the said hood being to confine the sparks which fly during the casting operation. The said hood 88 moves with the trough 87, and when in position for casting, encloses the outer end of the mold. After a brief period of rotation, the mold rotating mechanism is brought to a condition of rest, and the pouring trough 87 and the hood 88 are with-

drawn by swinging these parts away from the mold upon their pivotal support 83. The arm 76 is then swung into position to engage and support the ring 75, and the latter is disconnected from the mold and swung to one side, as indicated in Fig. 3.

The extractor mechanism is now brought into operation, to withdraw the tubular casting 89 from the mold, such extractor mechanism being located with reference to the central casting station 5 as shown in Fig. 1b. The extractor is composed of a rod 90 to which jaws 91, provided with extractor projections to engage the interior of the casting, are connected by a toggle mechanism, the latter being actuated by means of a plunger 92, encircling the rod 90, and working in a cylinder 93, carried by the support 94 for the rod 90. The support 94 is fixed in a carriage 95, which operates over a track 96, actuation of the carriage being effected through the medium of a stationary cylinder 97, the piston of which is connected to the carriage 95, the pistons of cylinders 93 and 97 being actuated by fluid pressure. The carriage 95 is advanced through the action of cylinder 97 as indicated, and when the jaws 91 are entered into the hollow of the casting 89 then in the mold, the piston of cylinder 93 is actuated to spread the said jaws and engage the projections thereon with the interior surface of the casting. When this has been done, the carriage 95 is retracted through reverse action of the piston of cylinder 97 and the casting is withdrawn from the mold and carried to the dotted line position indicated in Fig. 9, where it is shown as resting upon a discharge chute 98. The jaws 91 are then released through reverse action of the piston in cylinder 93, and in the continued movement of the carriage 95 the jaws are withdrawn from the casting which is then free to roll away.

It is highly desirable that the extractor jaws 91, be operated at the proper times, and to achieve this result, I may use devices which automatically control the action of the cylinder 93. A two-way valve 99, is coupled into the pressure lines leading to the cylinder 93, and is adapted to be opened in the forward movement of the extractor when the jaws of the latter have entered the mold, to cause the projections on the jaws to engage the casting. Upon the outward movement of the extractor, and as the casting is brought to the chute 98, the valve will be reversely operated to release the jaws from their contact with the casting, and the latter will be stripped from the extractor by engaging a stop 100 upon the chute. The valve may be operated in both directions by any suitable device, as for instance, rod 101, operated by the carriage 95 in the reciprocations of the latter.

In order to prevent disarrangement of the carriage 95, due to the added weight of the casting 89, when the latter is withdrawn from the mold, I have provided a counterbalancing mechanism, as shown in Fig. 9. Over a fixed horizontal track 102 operates a trolley 103, having a suspending connection 104 attached to the extractor cylinder 93, or to the extractor at some other point distant from the carriage 95. A cable connected at one end to the trolley and at the other to a counterweight 105, is guided over a sheave 106 supported by the track 102, the weight having a vertical movement in consonance with the horizontal movement of the extractor, as will be understood. Movement is imparted to the trolley by means of a cable 107, passing about sheaves 108 at one end of the track 102, over a sheave 109 at the other end of the track, and about a sheave 110 supported upon a bracket 111 fixed to the floor, the other end of the cable 107 being attached to the carriage, so that the forward movement of the extractor and carriage 95 induces a positive parallel movement of the trolley 103, the weight 105 being elevated in such movement. In the reverse movement of the extractor, the weight 105 will move the trolley and hold the cable 107 taut, as the carriage 95 is moved rearwardly.

The turret is now raised to engage the loops of the cradle with the mold; and the mold is uncoupled from its driving mechanism by first turning the hand wheel to release the locking pressure and then by rotating the shaft 63 through the crank 67, to disconnect the mold from the shaft 51.

The turret is rotated to the next station, and the mold following is brought to the central casting station 5 for another casting operation, these operations now being performed in succession. At any station from 6 to 9, the temperature of the mold advanced after the casting has been made at the central casting station 5, may be taken for the purpose of determining the condition of the mold, and calculating the necessary subsequent treatment to effect temperature reduction.

At 112, in Fig. 1, I have indicated a temperature quencher, in the form of a blower with a manifold delivery to a plurality of molds at the same time. The fan 113 is driven by a motor 114, and from the fan casing, ducts 115, 116 and 117 lead to the molds presented in succession thereto, so as to condition such molds. As before stated, a further ascertainment of the temperature of the mold, just preceding the casting operation, will be made at station 4, to determine the extent of the quenching effect and the condition of the mold preparatory to the next casting operation.

An insulating chamber 118, Fig. 3, for

the reception of the heated cover 75 of the mold, may be supported upon the loop 38, when the said cover is swung with the arm 76, to conserve the heat in the cover.

An operating crew of four persons is desirable in connection with the apparatus, such operators being stationed at points indicated A, B, C and D, in Fig. 1. The main operator at station A, will control the vertical movements of the turret, the rotation of the mold in the casting operation, the application of the quenching media, and the extraction of the casting. The operator at station B, will effect the coupling of the mold with its rotating mechanism and the disconnection of the same; he will also move the turret from station to station, and may take the temperatures. The operator at station C will spray the molds for the purposes hereinbefore indicated, and will apply the covers thereto. The operator at station D, will position the pouring spout and hood preparatory to casting, and will remove the cover to the mold. In addition to these, a gang will carry the pots of molten steel from the nearby furnace and pour the castings.

At the conclusion of operations for the day, the molds will be returned to the preliminary heating furnace 77, which will be insulated so as to retain the heat of the molds in a large measure, so that they will be practically in condition for use when the operations are continued the next day, or so nearly so as to require but slight additional heating in order to render them suitable for use in the resumed casting operations.

In the operation of the apparatus, the several detached molds are supported in a state of suspension by the turret only during the step-by-step rotation of the latter, but in a state of equilibrium, and are adapted to be presented singly and in succession at the central casting station. At this point, with the turret at rest, each mold in its turn will be connected to the mold rotating or spinning devices, so that the casting operation may be performed. The withdrawal of a mold from the turret to permit its manipulation in the casting operation, does not in any degree disturb the balance of the turret, for the latter is locked against any rotary movement during the period of such withdrawal. By moving the molds through an endless but fixed circular path, the treatment of the molds, both after a casting operation has been performed and preparatory to another one with the same mold, is easily accomplished. The cooling of the molds progressively by the application of quenching media directed through the manifold enables a controlled reduction of temperature to be accomplished in an easily regulable manner.

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

1. In a centrifugal casting apparatus, a detached mold, means for supporting and presenting it to a casting station, and means at the station for engaging and rotating the mold through the engaging means during the casting operation.

2. In a centrifugal casting apparatus, a plurality of molds adapted to be presented in succession to a central casting station, and means for engaging and rotating the molds through the engaging means as presented to such station.

3. In a centrifugal casting apparatus, a plurality of detached molds adapted to be presented in succession to a central casting station, mold rotating means, and means at the casting station for coupling a mold to the rotating means.

4. In a centrifugal casting apparatus, a plurality of detached molds adapted to be presented in succession to a central casting station, means at such station for rotating the molds, and means for coupling a mold to the rotating means when presented to the station.

5. In a centrifugal casting apparatus, a central casting station, means thereat for rotating a mold, means for presenting detached molds in succession to the casting station, and means for connecting a mold to the rotating means when so presented.

6. In a centrifugal casting apparatus, a plurality of molds, means for moving the molds in succession, means for imparting rotary movement to the molds, and means for coupling the molds in succession to the rotating means.

7. In a centrifugal casting apparatus, a plurality of detached molds, means for supporting such molds and presenting them in succession to a central casting station, means for imparting rotary movement to the molds, and means at the central casting station for coupling the mold to the rotating means.

8. In a centrifugal casting apparatus, a central casting station, a plurality of molds and means for presenting them successively to the casting station, and means at the station for engaging and rotating each mold through the engaging means in the order of its presentation.

9. In a centrifugal casting apparatus, a plurality of molds supported in a state of suspension, means for presenting such molds in succession to a casting station, means at such station for rotating a mold, and means for coupling the mold to its rotating means for a casting operation.

10. In a centrifugal casting apparatus, a plurality of molds supported in a state of suspension, means for presenting the molds in succession to a central casting station,

means at such station for rotating a mold, means for coupling a mold to its rotating means to perform a casting operation, and means for relieving the mold from suspension during the rotation thereof.

11. In a centrifugal casting apparatus, a revolving turret and a plurality of molds carried thereby and adapted in the movement of the turret to be presented in succession to a casting station, means at such station for rotating a mold, and means for coupling the mold to its rotating means.

12. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds, which latter in the movements of the turret are adapted to be presented in succession to the said casting station, means at the station for rotating the molds, means for coupling a mold to the rotating means, and means to relieve the mold of support by the turret during its rotation.

13. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds, which latter in the movements of the turret are adapted to be presented in succession to the casting station, means at the station for rotating the molds as presented, means for coupling a mold to the rotating means, means to relieve the mold of support by the turret, and means for locking the turret against movement during the rotation of the mold.

14. In a centrifugal casting apparatus, a revolving turret supporting a plurality of detached molds, and a central casting station to which the molds are presented in succession by the turret, in combination with means for engaging and rotating the molds through the engaging means when presented at the station.

15. In a centrifugal casting apparatus, a casting station, a revolving turret supporting a plurality of detached molds which are presented in succession to the casting station in the movements of the turret, means for arresting the movement of the turret when a mold has reached the casting station, and means at the station for engaging and rotating the molds through the engaging means as presented.

16. In a centrifugal casting apparatus, a casting station, a revolving turret supporting a plurality of detached molds which are presented in succession to the casting station in the movements of the turret, means for arresting the movement of the turret when a mold has reached the casting station, means at the station for engaging and rotating the molds as presented, and means for locking the turret against movement during the rotation of the mold.

17. In a centrifugal casting apparatus, a casting station, a revolving turret supporting a plurality of detached molds which are presented in succession to the casting station in the movements of the turret, means for arresting the movement of the turret when a mold has reached the casting station, means at the station for engaging and rotating the molds as presented, means for locking the turret against movement, and means for relieving the mold from support by the turret during the casting operation.

18. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds which in the movements of the turret are presented in succession to the casting station, a stop at the casting station having a limited yielding movement in a fixed path and a catch upon the turret adapted to engage the stop to arrest the turret and position a mold at the station, in combination with means for engaging and rotating the mold.

19. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds which in the movements of the turret are presented in succession to the casting station, a stop at the casting station having a limited yielding movement in a fixed path, and a catch upon the turret adapted to engage the stop to arrest the turret and position a mold at the station, in combination with means for engaging and rotating the mold, and means for lowering the turret to relieve the mold from its support by the turret.

20. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds which in the movements of the turret are presented in succession to the casting station, a stop at the casting station having a limited yielding movement in a fixed path, and a catch upon the turret adapted to engage the stop to arrest the turret and position a mold at the station, in combination with means for engaging and rotating the mold, means for lowering the turret to relieve the mold from its support by the turret and disengage the catch from the stop, and means to lock the turret against movement during the casting operation.

21. In a centrifugal casting apparatus, a central casting station, a revolving turret provided with a radially movable cradle supporting a detached mold which by the movement of the turret is adapted to be presented at the casting station, means at the casting station for rotating the mold, and means for effecting radial movement of the cradle in coupling the mold to its rotating means.

22. In a centrifugal casting apparatus, a central casting station, a revolving turret provided with a radially movable cradle supporting a detached mold which by the move-

ment of the turret is adapted to be presented at the casting station, means at the casting station for rotating the mold, means for effecting radial movement of the cradle in coupling the mold to its rotating means, and means for relieving the mold of its support by the cradle during the casting operation.

23. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds adapted to be presented in succession to the casting station, means at the casting station for rotating the mold, and screw connections to couple the mold to its rotating means.

24. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of detached molds adapted to be presented in succession to the casting station, means at the casting station for rotating the mold, screw connections to couple the mold to its rotating means, and additional locking means for such screw connections.

25. In a centrifugal casting apparatus, a casting station, a detached mold having a socket provided with screw threaded boss at its rear side, a tubular driven shaft at the casting station one end of which shaft engages the socket, a shaft working in the said tubular shaft and threaded for engagement with the threaded boss, and additional means for locking the engagement of the parts.

26. In a centrifugal casting apparatus, a central casting station, a plurality of detached molds and means for presenting them in succession to the casting station, means at the casting station for engaging and rotating the molds as presented, and a pouring spout at the casting station which spout is adapted to be positioned in relation to each mold for a casting operation.

27. In a centrifugal casting apparatus, a central casting station, a plurality of detached molds and means for presenting them in succession to the casting station, means at the casting station for engaging and rotating the mold as presented, a pivotally supported pouring spout and a mold covering hood connected therewith and adapted to be positioned in relation to each mold for a casting operation.

28. In a centrifugal casting apparatus, a revolving turret supporting a plurality of detached molds, means to relieve the molds of their support by the turret, and independent means for supporting and rotating the molds when relieved of their said support.

29. In a centrifugal casting apparatus, a revolving turret supporting a plurality of detached molds, means for lowering the turret to relieve the molds of their support, and means for supporting and rotating the molds when unsupported by the turret.

30. In a centrifugal casting apparatus, a rotating turret supporting a plurality of detached molds, means for relieving the molds of their said support, means for supporting and rotating the molds when unsupported by the turret, and means for locking the turret against movement during the rotation of the molds.

31. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of molds which are successively presented to the casting station for a casting operation, and means for engaging and rotating the molds at the station, in combination with means for quenching the temperature of the molds after a casting operation.

32. In a centrifugal casting apparatus, a central casting station, a revolving turret supporting a plurality of molds which are successively presented to the casting station for a casting operation, and means for engaging and rotating the molds at the station, in combination with means to effect a progressive quenching of the temperature of a plurality of the molds following casting operations.

33. In a centrifugal casting apparatus, a casting station, and a revolving turret for supporting a plurality of molds, in combination with a furnace for preliminarily heating the molds, and means to transfer the heated molds from the furnace to the turret to successively present them at the station for a casting operation.

34. In a centrifugal casting apparatus, a casting station, and a revolving turret for supporting a plurality of molds which in the movements of the turret are adapted to be successively presented at the casting station, in combination with a furnace for heating the molds, and means for transferring the heated molds singly from the furnace to the turret.

35. In a centrifugal casting apparatus, a casting station, and means for supporting a plurality of molds and separately presenting them to the casting station, in combination with a furnace for heating the molds, and means for transferring the heated molds singly from the furnace to the supporting and presenting means.

36. In a centrifugal casting apparatus, a revolving turret provided with a plurality of depending cradles disposed in a circle and supporting detached molds in the same number, and a casting station arranged within the circle, in combination with means at the casting station for engaging and rotating the molds in succession when presented thereto, and means for relieving the mold of support by the cradle during the casting operation.

37. In a centrifugal casting apparatus, a revolving turret provided with a plurality of depending cradles disposed in a circle and

supporting detached molds in the same number, and a casting station arranged within the circle, in combination with means at the casting station for engaging and rotating the molds in succession when presented thereto, means for relieving the mold of support by the cradle, and means for locking the turret against movement during the casting operation.

38. In a centrifugal casting apparatus, means for supporting a plurality of molds disposed in a circle, and a casting station arranged within the circle, in combination with means at the casting station for engaging and rotating the molds in succession during the casting operation.

In testimony whereof, I have signed my name at Milwaukee, this 16th day of June, 1924.

LUDWIG REICHOLD.