Nov. 17, 1931. A. E. GEDDES 1,832,626

FOUNDRY APPARATUS

Filed March 9, 1928 8 Sheets-Sheet 1

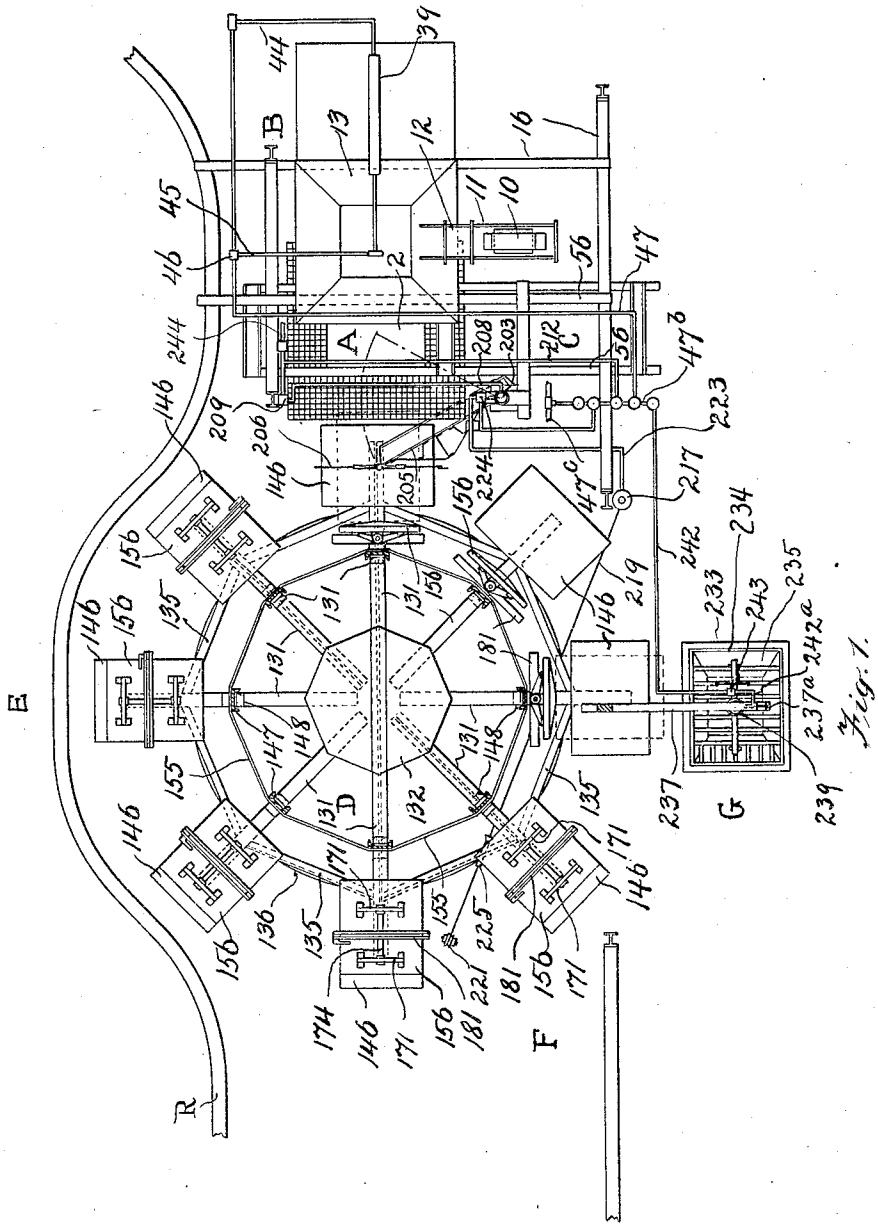


Fig. 1.

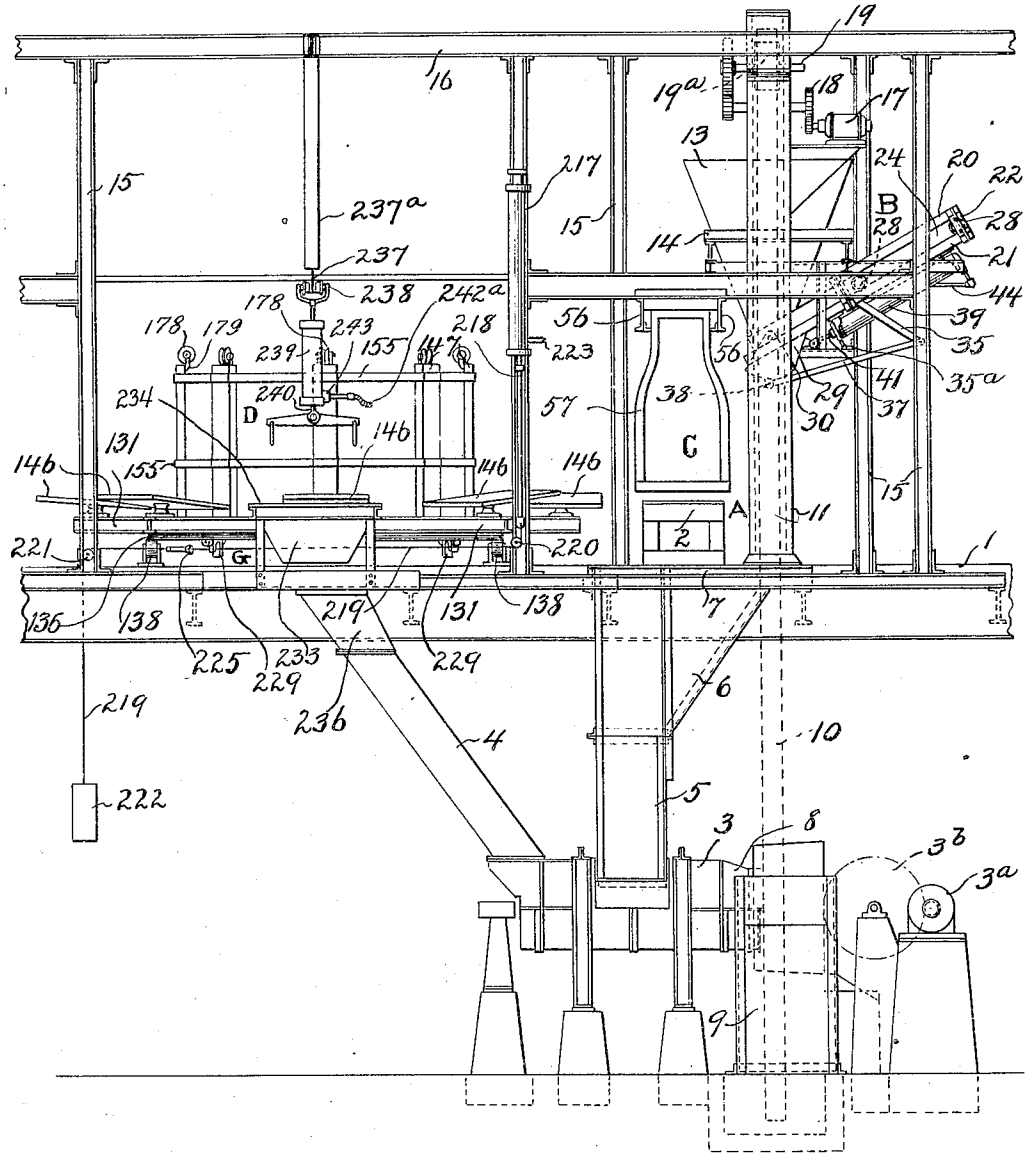
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FOUNDRY APPARATUS

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Fig. 2.



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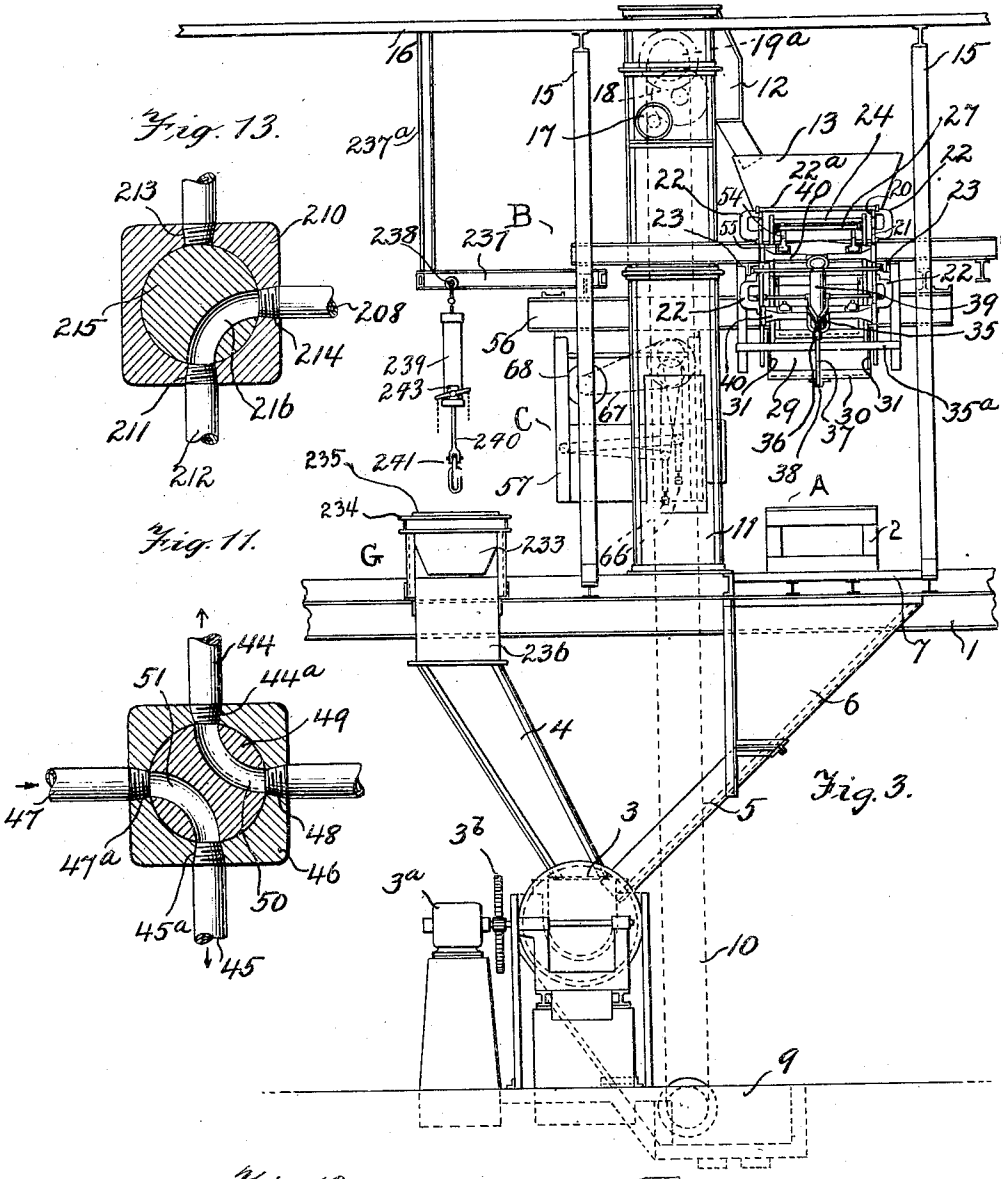
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FOUNDRY APPARATUS

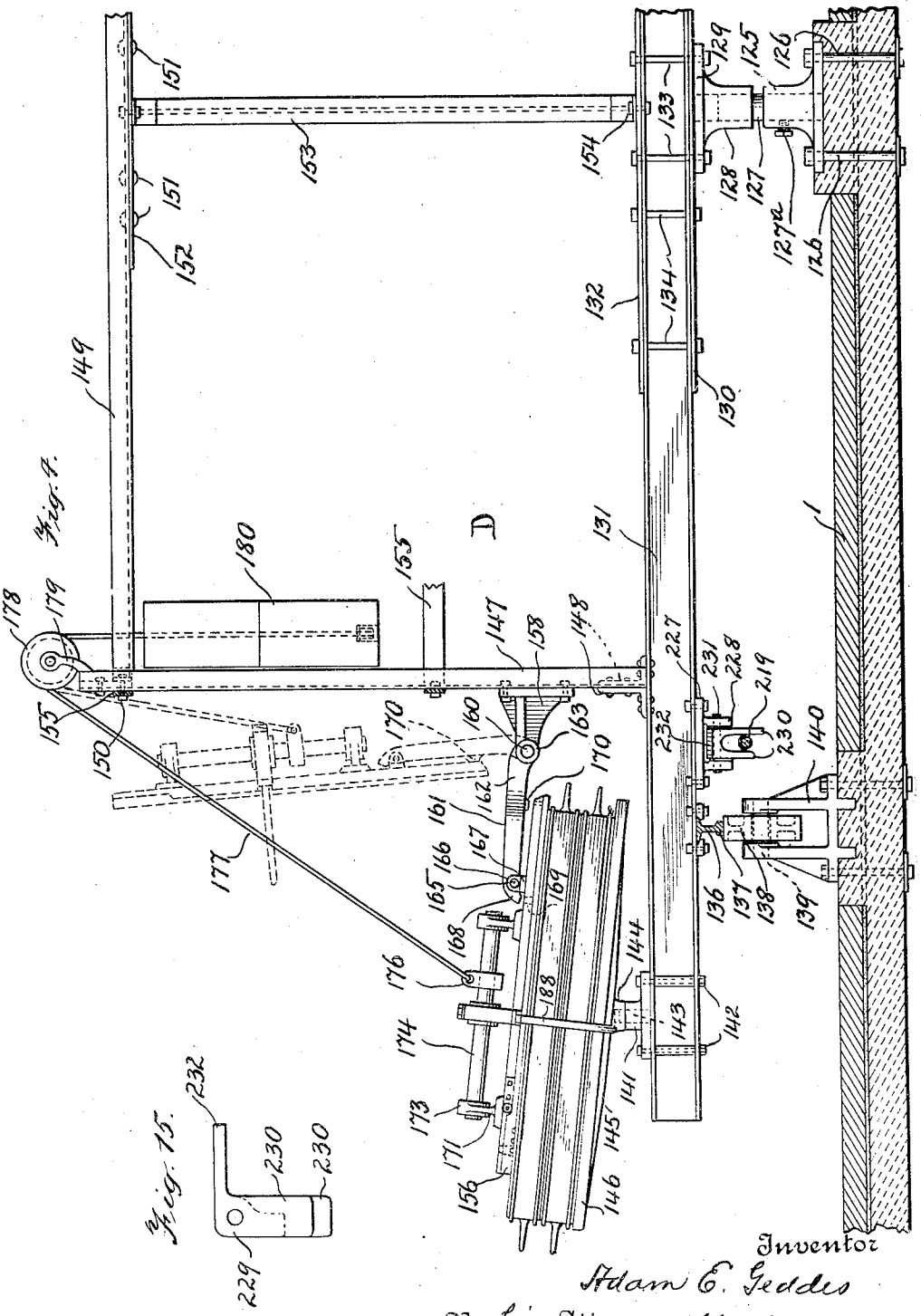
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FOUNDRY APPARATUS

Filed March 9, 1928 8 Sheets-Sheet 4



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Nov. 17, 1931. A. E. GEDDES 1,832,626

FOUNDRY APPARATUS

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Fig. 5.

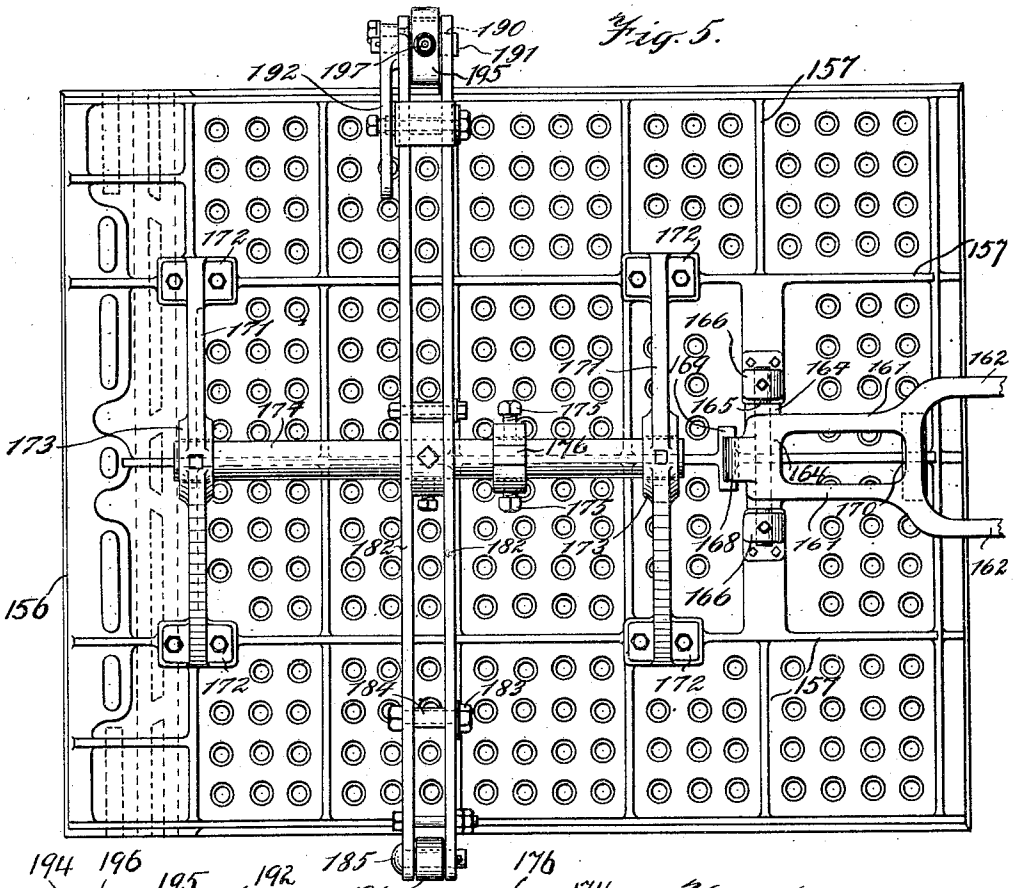


Fig. 6.

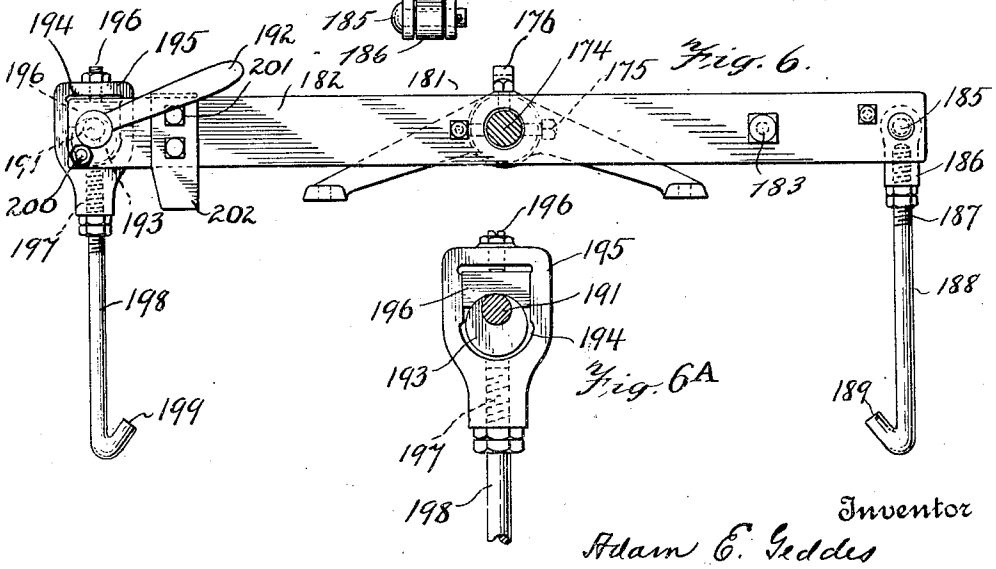


Fig. 6A

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FOUNDRY APPARATUS

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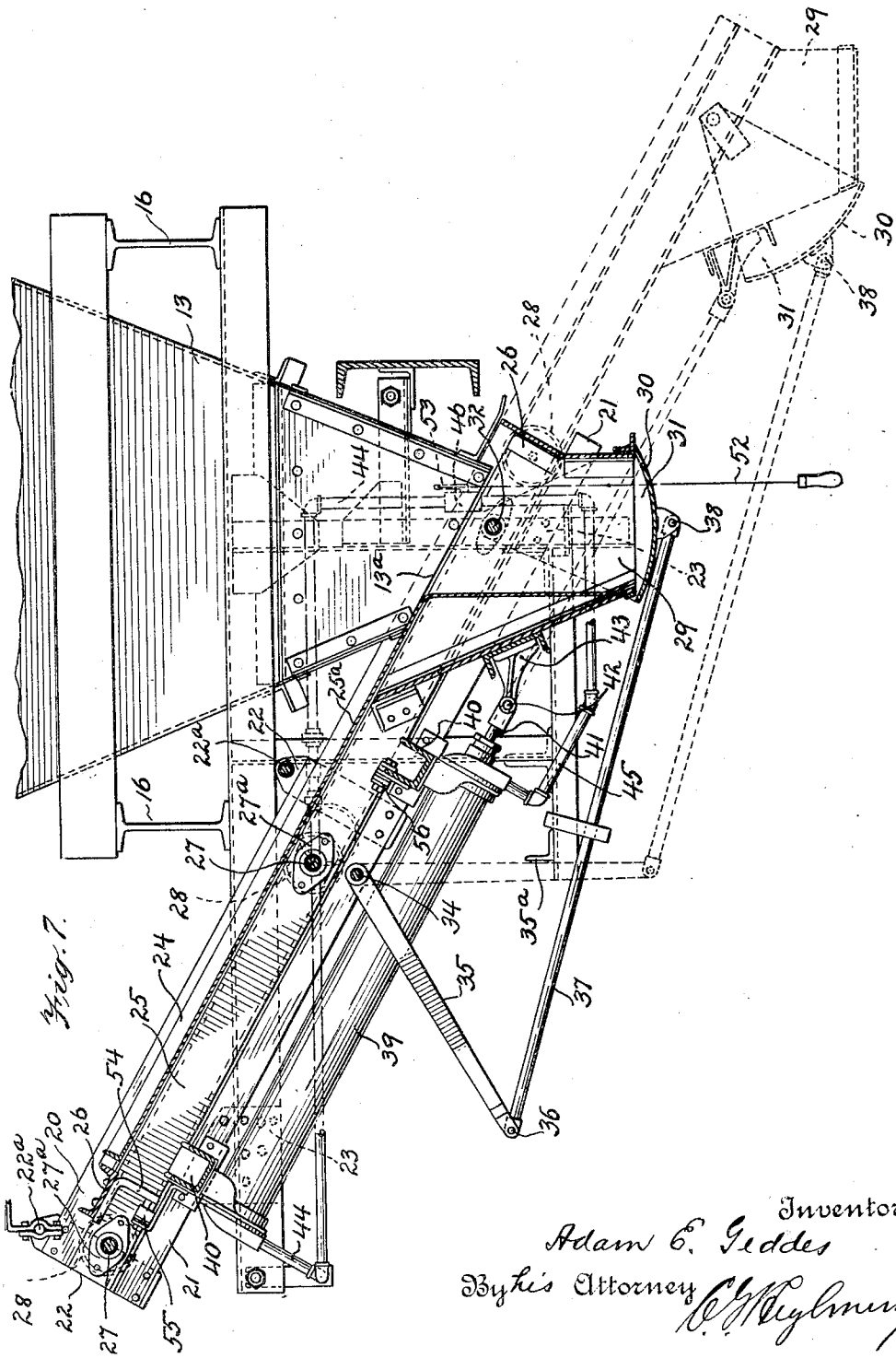


Fig. 7.

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FOUNDRY APPARATUS

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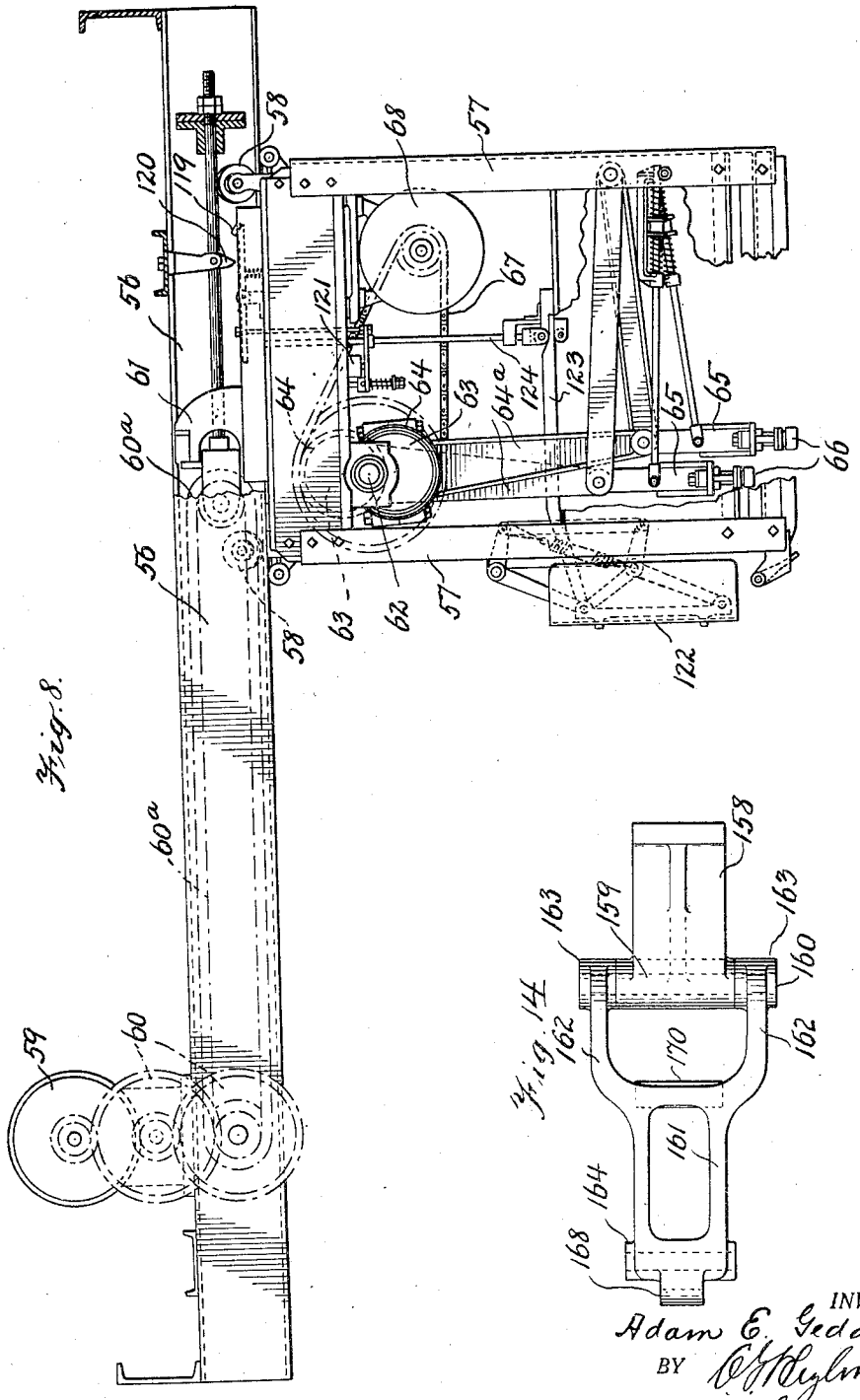


Fig. 8.

Fig. 9.

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Nov. 17, 1931. A. E. GEDDES 1,832,626

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Fig. 9.

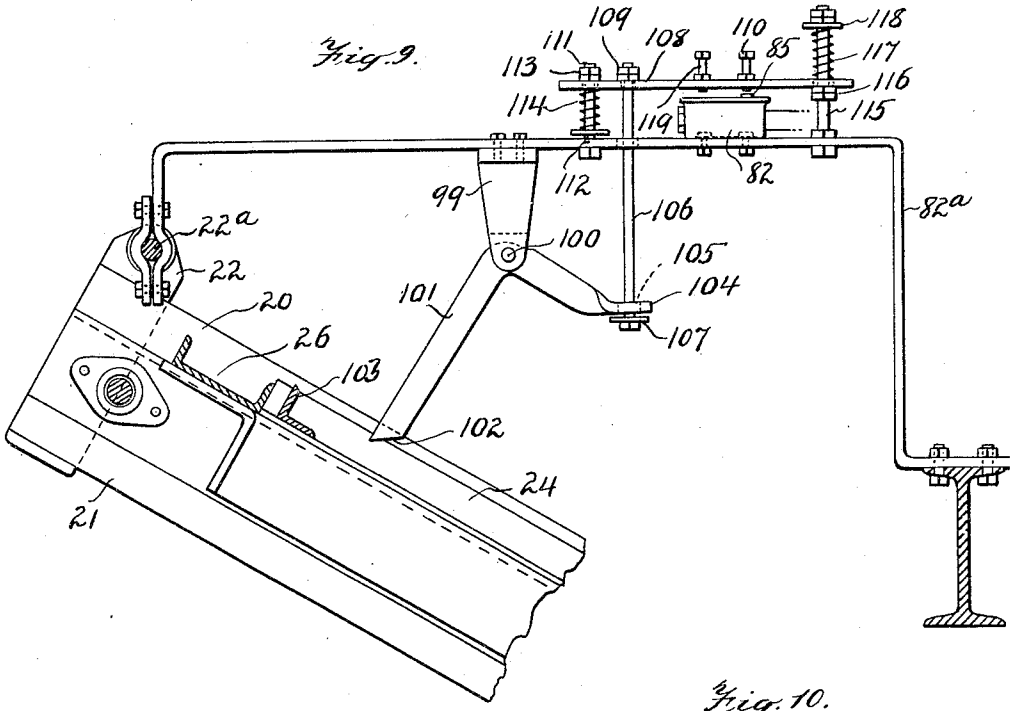


Fig. 10.

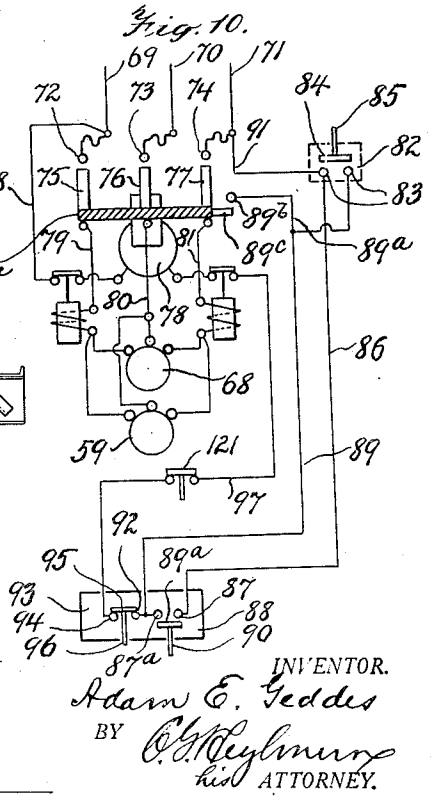
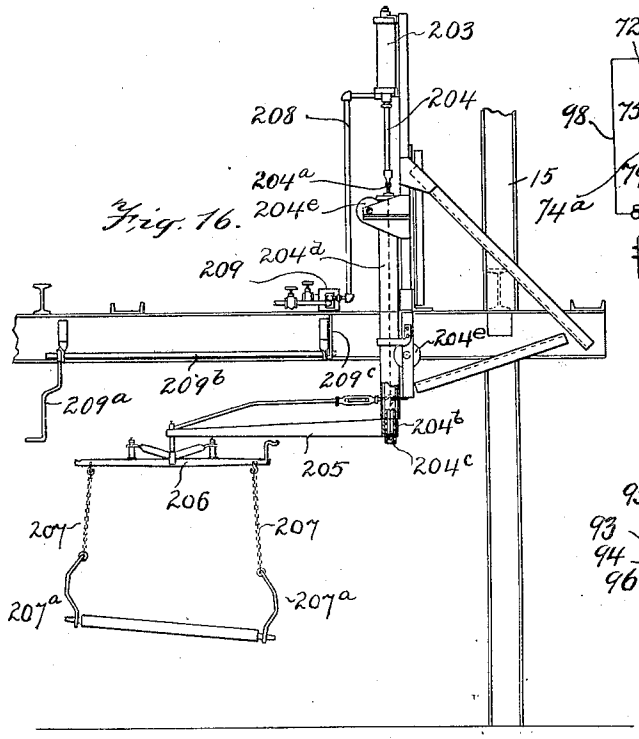


Fig. 16.



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Patented Nov. 17, 1931 1,832,626

UNITED STATES PATENT OFFICE

ADAM E. GEDDES, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN RADIATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY

FOUNDRY APPARATUS

Application filed March 9, 1928. Serial No. 260,324.

This invention relates broadly and generally to new and useful improvements in foundry apparatus, and more particularly of that character or type whereby a sand mold may be formed in a flask, or succession of flasks, at a suitable point or station, then transferred from such station to or through a succession of stations or zones in which the mold is poured with molten metal, then carried through a cooling period in which the casting sets, to a shake-out station at which the mold and casting are removed from the flask, and the latter is then returned to the mold-making station to again have a sand mold formed therein.

One of the objects of the invention is to provide an apparatus of the character mentioned which will be comparatively simple and compact in construction, and by which the various mold-forming and casting operations may be performed economically and expeditiously.

A further object is to provide an apparatus of the character described with improved and simplified means for supplying a flask with mold-forming sand, and for ramming or packing such sand to form a mold conforming to a desired pattern.

A further object is to provide an apparatus of the character described with improved means for transferring the mold-containing flask or flasks through pouring, cooling, shake-out and return passes or zones.

A further object is to provide a unitary structure, which will require a minimum number of workmen, but which will be capable of efficiently and expeditiously producing castings of satisfactory commercial quality.

Other objects and advantages will be apparent from the following description.

The invention consists in the novel construction and combination, to be more fully described hereinafter, and the novelty of which will be particularly pointed out and distinctly claimed.

A preferred embodiment of the present invention is fully and clearly illustrated in the accompanying drawings to be taken as a part of these specifications, and wherein—

Figure 1 is a top plan view, to some extent diagrammatic, of an apparatus embodying the present invention, certain parts, shown in detail in other figures, being only indicated generally for the sake of clearness;

Fig. 2 is a view in elevation looking toward the lower side of Fig. 1, and also showing certain sand-handling apparatus arranged beneath the floor or other support upon which the apparatus shown in Fig. 1 is mounted;

Fig. 3 is a view in elevation of the sand-handling apparatus, looking at the same from the right of Figs. 1 and 2;

Fig. 4 is an enlarged detail view in side elevation of a portion of a flask transfer apparatus in the form of a turn-table constituting one of the elements of the invention;

Fig. 5 is a plan view of a flask or mold top-plate forming part of the turn-table shown in Fig. 4;

Fig. 6 is a view in elevation of a top-plate clamp, also shown in Figs. 4 and 5;

Fig. 6A is a detail view, partly in section, of the left-hand end of the clamp shown in Fig. 6;

Fig. 7 is a view in side elevation and in central longitudinal section of a sand delivery apparatus forming part of the sand-handling apparatus shown in Figs. 2 and 3;

Fig. 8 is a view in side elevation of a mold-ramming machine, which per se is not of the present invention, but which constitutes one of the elements in combination of the invention;

Fig. 9 is a detail view of a circuit control means for controlling relative operation of the sand delivery means shown in Fig. 7, and the ramming machine shown in Fig. 8;

Fig. 10 is a diagrammatic view of a circuit for energizing and controlling operation of the ramming machine;

Fig. 11 is a detail sectional view of a control valve for controlling supply of fluid pressure to certain of the operative parts of the apparatus;

Fig. 12 is a longitudinal sectional view of a cable stop button;

Fig. 13 is a detail sectional view of another control valve;

Fig. 14 is a detail view of a hinge bracket shown in Fig. 4;

Fig. 15 is a detail side view of a trip pawl shown in Fig. 4; and

Fig. 16 is a detail view in elevation, and partly in section, of a flask-hoisting device.

Referring to the drawings by characters of reference, A designates, generally, a mold-forming station at which sand molds may be formed in the cope and drag sections of a flask. B designates, generally, a sand supply apparatus for furnishing sand from which molds are to be formed in the flask sections at the station A. C designates a sand-ramming mechanism for ramming the sand in the flask sections at the station A, said ramming mechanism specifically not being of my invention. D designates, generally, a turn-table for receiving the mold-containing flasks from the station A and transferring said flasks through a pouring zone E, a cooling zone F, to a shake-out station G, and then return the empty flasks to the mold-forming station A. The foregoing brief description is given so as to make clear the several functions in mold-making and casting performed by the preferred embodiment shown.

At the mold-making station A and upon the floor 1, is located a pattern stand 2, which may be of any well known form carrying a mold pattern, for example that for making a loop or section of a house-heating radiator. This stand is adapted to support the cope or the drag of a two-part flask, and which when in position on said stand is adapted to receive molding sand which is rammed in the flask and upon the pattern to form one-half of a sand mold having a print formed by the pattern and adapted to form one-half of a complete mold cavity to receive the casting metal. The cope and drag parts of the flask after the application of a suitable core, are then brought together with the sand mold prints matching to form a mold cavity for producing the desired external contour for the article to be produced, for example, a radiator section for heating purposes. It will be understood that the present invention is not limited to the specific structure of this pattern stand, as it may be of any of the well known forms of the type mentioned, which is well known in the art, and for this reason it is not necessary to more specifically illustrate or describe the same. All of the apparatus above described, with the exception hereinafter mentioned, is supported upon a suitable foundation or floor 1.

Means for furnishing sand to the pattern stand to fill a flask element thereon and form a mold part conforming to the pattern on said stand will now be described: Beneath the floor 1 is a horizontally rotatable sand treating or mixing drum 3, which may be of any well known form adapted to mix or treat molding sand to render it capable of use for forming green sand molds, said drum being driven by a suitable motor 3^a and gearing 3^b. This drum receives sand through a chute 4 leading from the shake-out station G, and also sand from a spill chute 5 which receives the excess spill sand from a hopper 6 located under a floor grating 7 upon which the pattern stand is located. The treated sand is delivered from the end 8 of the drum 3, into a receptacle 9, in which is located the lower end of an endless bucket conveyor 10, which passes upward through an opening in the floor 1 and through a boot 11 above said floor. The upper end of said conveyor discharges the sand into a chute 12 which empties into a distributing or supply hopper 13 which is supported overhead on a suitable framework or superstructure 14. The superstructure is built up of suitable vertical columns 15 and cross-members 16 of structural steel elements of any suitable design. The conveyor 10 is driven by a suitable motor 17 and intermediate gearing 18 geared to the driven shaft 19, upon which the conveyor drive pulley 19^a, or its equivalent, is mounted.

The hopper 13 is open-bottomed and discharges into a sand delivery apparatus which deposits the sand into a flask element located on said pattern stand, which delivery apparatus will now be described, referring particularly to Figs. 2, 3 and 7: Supported on said superstructure or frame are oppositely disposed pairs of upper and lower guide rails 20, 21 maintained in spaced parallel relation by spacer brackets 22 riveted to said rails and connected by cross bars 22^a, said rails being supported from the superstructure or frame by brackets 23 riveted to the frame and to the lower rail 21 of each pair, as shown in dotted lines in Fig. 7. These pairs of rails incline downwards and extend parallel to the oblique or inclined lower end 13^a of the hopper 13. Arranged to be reciprocated between the rails 20, 21 is a rectangular carrier frame 24, made up of longitudinal members 25 and transverse members 26 rigidly connected, said frame carrying two transverse shafts 27 in bearings 27^a on the members 25, upon which shafts are journaled flanged running wheels 28 located between the rails 20, 21 and serving to guide the carrier frame in its reciprocations. At its lower end portion the carrier frame carries a hopper or bucket 29 which is substantially rectangular in horizontal cross-section, and is open at its top and bottom. When the carrier frame is in its retracted or upper position, as shown in full lines in Fig. 7, this hopper or bucket 29 is located directly beneath the lower open end of the sand supply hopper 13 to receive sand from the latter. Cooperating with the lower open end of the bucket 29 is closure valve 30 suspended by side members 31 from pivots 32 on the sides of the hopper 29, the arrangement being such that the valve normally tends to swing or gravitate to the closed position shown in full

lines in Fig. 7. When in the position shown in full lines, the bucket receives and retains sufficient sand to form a cope or drag mold at the pattern stand. In rear of the bucket 29 the space between the frame members 25 of the carrier frame is closed by a plate 25ª which serves a purpose to be presently described, and which is suitably secured to said members 25.

Pivoted, as at 34, on the stationary main frame is one end of a lever 35, the other end of which is connected, as at 36, to one end of a link 37, the other end of which is connected pivotally, as at 38, to a bracket 39 on the bottom of the valve or movable bottom 30 of the hopper 29. When the carrier is in upper position, the valve 30, link 37, and lever 35 are in the position shown in full lines in Fig. 7, but when the carrier is moved downwards to carry the hopper 29 to the position shown in dotted lines, the lever 35 strikes a stop member in the form of a horizontal bar 35ª, rigidly supported on the main frame, just before the carrier reaches its lowest point, so that movement of the valve will be arrested and further movement of the carrier will cause the valve to swing to the position shown in dotted lines, whereby the sand in the bucket will be deposited by gravity into a flask supported on the pattern stand. The plate 25ª bridges the space between the side members 25 of the reciprocable carrier frame and is so arranged that the forward edge thereof, when the frame is in retracted position, is located approximately at the lower edge of the rear wall of the hopper 13, said plate being of such length that when the frame descends to the position shown in the dotted lines, the plate will pass under and close the lower end of the hopper 13, thereby preventing fall of sand therefrom during reciprocation of the frame.

The carrier frame is reciprocated by means of a double acting power cylinder 39 supported by the cross-members 40 riveted to the side rails 21. This cylinder contains a piston (not shown), which is mounted on a piston rod 41 pivotally connected, as at 42, to a bracket 43 fixed on the rear wall of the hopper or bucket 29. Power fluid under pressure, such as compressed air, is supplied to the opposite ends of the cylinder and on opposite sides of the piston by means of supply pipes 44, 45 connected to oppositely disposed ports 44ª, 45ª in the casing of a four-way valve 46 of any suitable type, for example as shown in Fig. 11. This valve is located at the mold-making station A and is supplied with pressure fluid through a pipe 47 and port 47ª, and has an exhaust port 48 exhausting to atmosphere. The pipe 47 is connected to a branch pipe 47ᵇ which is connected to and receives compressed air from a supply pipe line 47ᶜ. The valve ports may be controlled by a turn-plug 49 having passages 50, 51 so formed and arranged that pipe 44 may be connected to the supply port, and the pipe 45 be connected to the exhaust 48, or pipe 44 may be connected to the exhaust 48 and pipe 45 to the supply. When pipe 44 is connected to the supply 47 and pipe 45 to the exhaust, the carrier is caused to descend to the position shown in dotted lines in Fig. 7, and when pipe 44 is connected to the exhaust, and pipe 45 to the supply, the carrier is returned to the position shown in full lines and held in this position by the air pressure beneath the piston. The valve plug may be manually operated by a pull-line 52 connected to a lever 53 on the plug. Upward movement of the carrier is limited by lugs 54 on the carrier striking stop-buffers 55 fixed to the cross-member 40, while downward movement is arrested by the lugs 54 striking against stop-buffers 56 fixed to the lower cross-member 40. When the operator desires to supply sand to a flask on the pattern stand, the valve 46 is operated to admit fluid pressure to the upper end of cylinder 39, and to connect the lower end of the cylinder to the exhaust, whereupon the carrier and bucket 29 moves downward toward the position indicated in dotted lines in Fig. 7. When the carrier has moved to a position where the bucket is approximately over the pattern stand, lever 35 strikes against stop 35ª, and continued travel of the carrier causes the bucket-valve 30 to be held back and assume the position shown in dotted lines, whereby the charge of sand is discharged by gravity into the flask.

The sand-ramming apparatus C is preferably of the construction shown by U. S. Patent Number 1,536,031 to Redpath and Bliss, granted April 28, 1925. This construction is illustrated in some detail in Fig. 8, so that the manner in which it cooperates in the combination constituting the present invention will be clear. The mechanism comprises overhead parallel flanged trackways 56, from which is suspended a carriage frame 57 having running wheels 58 travelling on flanges on said rails. This carriage is adapted to be reciprocated on the track rails by any suitable means which may be that described in said patent to Redpath and Bliss, and including an electric motor 59 transmitting motion through gearing 60 to an endless drive chain 60ª having projections (not shown) adapted to cooperate with an abutment device 61 on said carriage to reciprocate the same. On the carriage is a horizontal shaft 62 carrying eccentrics 63 upon which are eccentric straps 64 connected to pitmen rods 64ª. Each rod 64ª has pivoted thereto a hanger member 65 supporting at its lower end a rammer foot 66. The shaft 62 is driven by a power chain 67 from an electric motor 68 suitably supported on the carriage frame. All of the elements thus briefly de-

scribed are fully described in said patent to Redpath and Bliss, to which reference is made, and it is believed further specific description is unnecessary.

The rails upon which the carrier frame for the sand bucket travels, and the rails upon which the rammer carrier travels, are arranged at right angles to each other, as will be apparent from Figs. 1, 2 and 11, and are of such length that the sand-supplying bucket 29 may first take position over the pattern stand to deliver sand thereto, at which time the rammer carriage will be withdrawn from ramming relation to the pattern stand, and the sand-supply bucket may then be withdrawn from position over the stand, and the rammer carriage moved forward to cause the rammer feet to ram the sand which has previously been deposited from the bucket 29 in a flask element on the pattern stand.

I will now proceed to describe means constituting a feature of the present invention, whereby the relative operation of the sand-supplying apparatus and the ramming apparatus in the manner just described, may be accomplished: The rammer motors 59 and 68 are of any suitable three-phase alternating current type supplied with current from current supply conductors 69, 70, 71 (see Fig. 10), both motors being on the same circuit so that they may be driven simultaneously. This motor circuit is suitably and preferably controlled so that it will be closed to start the motors by movement of the sand bucket carrier 24, so that the rammer motors will be energized simultaneously when the sand bucket carrier moves upward or away from the pattern stand after a charge of sand has been delivered to the flask, the energization taking place after the bucket 29 has cleared the pattern stand. The leads 69, 70, 71 are connected respectively to the fixed contacts 72, 73 and 74 of a magnetically operated switch 74^a of well known commercial design, and including movable contacts 75, 76, 77 adapted to close simultaneously the circuit at the contacts 72, 73, 74. The contacts 75, 76, 77 are actuated simultaneously by the core of a solenoid 78. The contacts 75, 76, 77 are connected respectively to leads 79, 80, 81 connected to the motors 59 and 68. When the magnetic switch circuit is closed to the supply line, both motors are supplied with current and simultaneously drive the propelling chain 60 and the shaft 62. The switch 74^a may be that known on the market as an "Allen Bradley across line magnetic starting switch J 1552."

Mounted on the main frame is a push-button starting switch 82 of well known form and including spaced contacts 83 (see Fig. 10) with which cooperates a movable contact member 84 operated by a push-button 85. The contact 84 is normally held by a spring (not shown) out of contact with the contacts 83. One of the contacts 83 is connected by a lead 86 to a contact 87 of a manually operable starting switch 88 located at the station A, and which also includes a contact 87^a which is connected by a lead 89 to the other contact 83. The switch 88 includes a contact member 89^a operable by a push-button 90 to connect the contacts 87, 87^a. The member 89^a is normally maintained out of contact with the contacts 87, 87^a by means of a spring (not shown). The left hand contact 83 of switch 82 is connected directly by a lead 91 to the supply conductor 71. The contact 87^a and the lead 89 is connected to a contact 92 of a normally closed push-button switch 93 which also includes a contact 94. The contacts 92 and 94 are normally closed by a contact member 95 adapted to be operated by a push-button 96, the contact member 95 being held normally closed by means of a spring, not shown. The switches 88 and 93 are of well known commercial form obtainable on the market, and therefore it is not believed further detailed description thereof is necessary. The contact 94 is connected by a lead 97 to the solenoid 78, which is in turn connected by a lead 98 to the current supply line 69. The circuit is such that when the switch 82 is operated to close the circuit at the contacts 83, the current will flow from the lead 71 through the switch 82, lead 89, closed switch 93, lead 97, the solenoid 78 and lead 98 to the supply line 69, which energizes the magnetic switch to close the circuit through the motors 68 and 59. As heretofore stated, the switch 82 is mounted on the main frame, for example, by means of a bracket member 82^a adjacent the upper end of sand-supplying apparatus. On the bracket 82^a is a bracket 99, upon which is fulcrumed, as at 100, a trip member, preferably in the form of a bell-crank lever 101, one member of which is arranged with its end 102 in the path of movement of the carrier frame 24, preferably an angle bar 103. The end 104 of the other member of the bell-crank lever is provided with an aperture 105, through which projects a vertical rod 106, which is provided on its end with a stop collar 107 beneath the end 104 of the bell-crank lever, so that when the member 102 of the bell-crank lever is swung toward the left of Fig. 9, the downward pull will be exerted upon rod 106. The rod 106 at its upper end passes upward through an opening in the bracket 82^a and through an opening in a floating lever 108, said rod carrying on its upper end above the lever 108 a stop collar 109, which when rod 106 is moved downward will impart a downward movement to said floating lever. This lever 108 overlies the push-button 85 of the switch 82 and carries an adjustable contact screw 110 adapted to engage the push-button 85 when the lever 108 is moved down. One end of

the lever 108 is apertured to receive guide bolt 111 rigidly connected to the member 82ª, as at 112, and having at its upper end stop collars or nuts 113. Surrounding the bolt 111 and beneath the lever 108, is a cushion spring 114 which abuts said lever and the member 82ª to normally hold the lever 108 in engagement with the stop nuts 113. At its opposite end the lever is apertured to slide upon a guide bolt 115, said bolt being provided with an adjustable stop abutment, consisting of a nut 116 threaded on said bolt and serving to limit the downward movement of that end of lever 108 which is mounted on the bolt 115. The lever 108 is yieldingly held against the stop 116 by means of an expansion spring 117 arranged on the bolt and above said lever, the ends of said spring abutting the upper side of the lever and the underside of an adjustable spring abutment 118 on the bolt. The arrangement is such that when the carrier frame 24 of the sand-supplying apparatus is moved downward, the member 103 will strike the lower end of the bell-crank lever to raise the end 104 of the latter, but due to the loose connection between the end 104 and the rod 106, the latter will not be operated to cause actuation of the switch push-button 85 of switch 82. After the sand has been deposited in the flask at the pattern stand, the return movement of the carrier frame 24 will cause the member 103 to strike the end 102 of the bell-crank lever 101, which will move the end 104 downward to exert a downward pull on rod 106. The downward pull on rod 106 will pull down the left-hand end of lever 108 against the tension of spring 114, the abutment 116 on bolt 115 acting as a fulcrum for said lever 108, whereupon the bolt 110 will strike against the push-button 85, causing the contact 84 to connect the contact 83, thus energizing the solenoid 78 and supplying current to motors 59 and 68. The floating lever 108 may be provided with an adjustable stop bolt 119 adapted to limit downward movement of lever 108, so as to prevent too great thrust of bolt 110 upon the push-button, with consequent injury to the switch.

When the motors 59 and 68 are energized, the ramming apparatus will traverse a flask on the pattern stand and ram the sand in the flask and will then return to its starting position, due to the drive arrangement by the endless chain which is fully set forth in said patent to Redpath and Bliss. It will thus be seen that the sand-supplying apparatus serves to control or initiate reciprocation of the ramming apparatus across the mold. When the ramming apparatus has returned to its starting position, a pivoted trip device 119 thereon strikes a trip latch 120 on the trackway 56, which serves to open a switch 121 on the rammer carriage and located in the lead 97 to break the circuit through the latter and the solenoid to open the magnetic switch to stop the rammer carriage at its starting or initial position. The switch 121 is of a commercial push-button type normally held closed by a spring (not shown) which automatically closes the switch after the trip 119 has passed the trip latch 120. As shown in said patent to Redpath and Bliss, the rammer carriage will be provided with a safety buffer 122, which upon contact with an obstruction, such as a workman, will exert a rearward thrust on an operating member 123 which will cause an upward movement of a plunger rod 124 to actuate the lever 120ª to break the current at the switch 121. If the current be broken at the switch 121, the carriage comes to rest, but may be again set in motion by closing manually the starting switch 88, the current to the solenoid 78 to close the magnetic switch then being from supply 71 through lead 91, lead 86, switch 88, switch 93 lead 97, solenoid 78 and lead 98, to current supply line 69, thus closing the magnetic switch. The carriage may be stopped manually at any time by breaking the current at the stop switch 93, which will open the circuit through the solenoid and break contact at the magnetic switch. The lead 89 is connected by a conductor 89ª to a contact 89ᵇ in the magnetic switch and adapted to be engaged by a contact 89ᶜ when the magnetic switch closes. It will be understood that the push-button switch 82 automatically opens as soon as the member 103 has passed the bell-crank lever, but that the current through the solenoid 78 will be maintained through the leads 71, contacts 77, 89ᶜ, 89ᵇ, leads 89ª, 89, switch 93, lead 97, the solenoid 78 and lead 98 to line 69.

It will be seen that during normal operation, the ramming mechanism is under control of the sand delivery mechanism, and unless set in motion by the starting switch 88, cannot traverse the pattern stand until a charge of molding sand has been delivered by the sand delivery mechanism to the pattern stand.

The turn-table D for receiving mold-containing flasks from the pattern stand and conveying them through the path heretofore mentioned, will now be described: On the floor 1, preferably in line with the transverse center line of the pattern stand is a bearing socket or step 125 (see Fig. 4) suitably anchored to the floor by bolts 126 and receiving a vertical pivot pin or axle 127, the upper end of which is located in a bearing sleeve 128 having at its upper end a horizontal flange 129. The pin is held in place by a set screw 127ª. Upon the flange 129 is a center plate 130 upon which are supported radiating horizontal members 131 preferably of structural steel I-beams equally spaced circumferentially about the pin 127, and being of equal length radially from the said pin which

serves as the center bearing or turning axis of the turn-table. The members 131 constitute the arms or spokes of the turn-table. Overlying the inner ends of the spokes or arms is an upper center plate 132, said arms and the plates 130, 132 being fixed to the flange 129 by means of bolts 133 extending through said plates, the flanges of the I-beams and said flange 129. The outer portions of the plates 130, 132 are further secured to said I-beams by bolts 134 passed through said plates and the flanges of the I-beams. It will be noted that the sleeves 125 and 128 do not contact each other so that there is no friction between the same, the table resting on the center pin upon which it turns freely.

The outer ends of the arms 131 are connected to each other and held in proper spaced relation by means of bracing members 135 (see Fig. 1), the ends of which are riveted rigidly to the respective arms.

Adjacent the outer end portions of the arms or spokes 131, and on the under side thereof, is rigidly secured a circular T-rail 136 arranged concentric with the axis of rotation of the table. The tread 137 of the rail 136 travels upon a plurality of bearing rollers 138 (see Fig. 4) arranged to rotate on horizontal journals 139 supported by bearing bracket 140 rigidly bolted to the floor 1. The weight of the turn-table is supported by the rollers 138, the pin 127 merely serving as an axis of turning movement for the table and not supporting the same.

In the preferred embodiment illustrated, there are eight of the arms 131, as shown in Fig. 1, so as to provide for the operating stations or zones previously mentioned.

Supported on the outer end portion of each of the arms 131 is a bearing socket 141 rigidly bolted to the arm, as at 142 and supporting a vertical pivot pin 143 which enters a bearing socket sleeve 144 on the bottom of a platform 145 constituting a bottom plate or board 146 to receive flasks from the pattern stand. The bottom board is inclined at an angle to the vertical central axis of the bearing pin 143, as shown in Figs. 2 and 4, for a purpose to be presently described, and maintains this position at all points in its rotation on the vertical pivot pin.

On each of the arms 131 at a point between the bottom board and the center of rotation of the table, is a standard or upright 147 rigidly secured to the arm by angle members and rivets, as at 148. These standards are braced and held in vertical position by means of upper radial members 149, the outer ends of which are riveted to the upper ends of the uprights, as at 150, and the inner ends of which are riveted, as at 151, to the upper side of a center-plate 152 which is supported rigidly by a center-column 153 bolted, as at 154, to the center of the plate 132. The standards 147 are also held by braces 155 connecting the standards laterally to each other.

Adapted to cooperate with each bottom board to hold a flask in position on the latter, is a top-plate 156, shown in Figs. 1, 4 and 5 but omitted from Fig. 2 for the sake of clearness.

Each top plate 156 consists preferably of a flat rectangular plate member braced on its upper or back face by longitudinal and transverse ribs 157. This top plate is pivotally or hingedly connected to the adjacent standard 147 in the following manner: On the standard 147 is a bracket member 158 having on its outer end an apertured ear 159, in which is fixed a bearing pin 160, the ends of which project on opposite sides of said ear, as indicated in Fig. 14 of the drawings. 161 designates a hinge member having rearward arms 162 which straddle ear 159, and are provided with ears 163 pivotally mounted on the projecting ends of the pin 160, the forward or swinging end of which hinge member is provided with a cross-bearing 164 to receive a bearing pin 165 mounted in ears 166 on brackets 167 bolted on the top side of the top plate. The hinge member is provided with a forwardly and downwardly projecting stop 168 adapted to cooperate with a bearing face 169 on the top plate, and said hinge member is also provided at a point between the bearing pins 160 and 165 with an engaging lug 170 adapted to cooperate with the top face of the top plate, all in a manner to be presently described.

Also mounted on the upper surface of the top plate are bridge pieces 171 bolted rigidly, as at 172, to the top plate, and each provided at an intermediate point with an apertured hub 173 to receive a cross-shaft 174 held in place by set screws 175. Connected to this shaft member is a loop 176, to which is connected one end of a flexible connection 177 which passes upward from the top plate and over a guide pulley 178 mounted in a bracket 179 suitably secured to the top of the standard 147. The rear end of the connection 177 passes downward from the pulley 178 and supports a suitable counter-balancing weight 180 which acts by gravity to assist in raising of the top plate to the position shown in dotted lines in Fig. 4. When the top plate is to be raised from the position shown in full lines in Fig. 4 from the top of a flask, the engaging member 169 first strikes the projection 168, and the plate, together with the hinge member, is then swung on the pivot 160 to the position shown in dotted lines in Fig. 4, in which the plate will engage the stop lug 170 on the hinge member 161. When the top plate is to be lowered and the forward end thereof is grasped by an operator to pull the plate down to the position shown in full lines, the rear of the plate strikes the lug 170 to limit swinging movement of the plate

and to cause the same to be in substantial parallelism to the top surface of the flask when it is about to engage the latter. When the plate is moved upward toward the dotted line position, the engagement between surface 169 and lug 168 prevents further relative movement between the plate and the hinge member 161, and causes the rear end of the plate to be lifted clear of the flask without danger of dragging into the sand mold contained in the flask and injuring the mold and casting.

Each top-plate 156 is provided with an equalizing clamp (see Fig. 5), by means of which the top-plate may be clamped down on the flask so that the latter will be held securely between the top-plate and the bottom board. This clamp comprises a beam member 181 consisting of side-bars 182 held in rigid spaced relation by cross-bolts 183 and spacer sleeves 184. At one end of said beam is a cross-bolt 185, upon which is pivoted a hanger-piece 186 in which is adjustably threaded, as at 187, a clamping bar 188 having at its lower end a hook 189 adapted to engage under the edge of the bottom-board, as shown in Fig. 4. The opposite end of the beam from the hook 188 is provided with bearing apertures 190 (Fig. 5), in which a shaft 191 is mounted rotatably, said shaft having fixed suitably to one end a hand-lever 192 by means of which the shaft may be rotated manually. On the shaft 191 and between the members 182, is an eccentric cam 193, which is located in an opening 194 in a shackle frame 195, also located between members 182. In the opening 194 is slidably arranged a bearing block 196 resting on the upper side of cam 193 and limited in its upward movement in said opening by a set-screw 196 let through the upper cross-bar of the frame 195. Threaded adjustably into the lower end of the shackle frame 195, as at 197, is one end of clamping bar 198, the lower end of which is provided with a hook 199 adapted to engage under the edge of the bottom-board in the same manner as hook 189. When a flask is placed on the bottom-board and the top-plate lowered into the position shown in full lines in Fig. 4, the hooks 189 and 199 are engaged manually with the opposite edges of the bottom-board, whereupon the workman moves hand-lever 192 toward the left of Fig. 6, thereby causing the cam 193 to lift on shackle 195 and hook 199. When the upward pull is exerted on hook 199, the beam 181 fulcrums on shaft 174, the end adjacent hook 199 moving downward, and the opposite end moving up, thereby pulling up on hook 189 and causing the same to strongly engage the bottom-board. By this means the top-plate is clamped to the flask, and the latter is clamped to the bottom-board or platform. When the top-plate is to be lifted, the lever 192 is moved to the position shown in Fig. 6, thereby loosening the hooks 189, 199 sufficiently to permit them being disengaged from the bottom-board. The movement of the hand-lever may be arrested by stop-bolts 200, 201, the former to stop movement of the cam within limits applying pull on bar 198, and the latter limiting the releasing movement of the cam. The beam may have a depending stop-plate 202 bolted thereto and adapted to engage the top-plate to limit movement of beam 181 toward said plate.

On the main frame on the opposite side of the rammer rails 56 from the pattern stand, is rigidly mounted a vertically disposed hoisting cylinder 203 (see Figs. 1, and 16), the piston (not shown) of which actuates a piston rod 204 connected to a flexible connection 204^a which extends downward through a vertical tube 204^b, and is anchored to the lower end of said tube, as at 204^c. The tube is housed in a cylindrical shell 204^d guided between rollers 204^e fixed to the supporting structure, so that the tube and shell may move up and down, and also rotate on said rollers. The lower end of tube 204^b has fixed thereto a horizontal crane arm 205, to which is loosely connected a sling, including a beam 206 with flexible connections 207 provided with loops 207^a adapted to engage the gudgons on a flask. This hoisting apparatus is arranged so that the crane arm may be swung horizontally over the pattern stand to permit attachment of the loops 207^a to a flask to lift the same and transfer it to a platform or bottom-board on the turntable. It will be understood that the tube 204^b may be rotated to permit swinging of the crane arm and sling. Fluid pressure to move said piston and piston rod to raise the load, is supplied by a pipe 208 connected to the cylinder below the piston, and to a control valve 209 located adjacent the molding station for convenient operation by workmen at that point. The valve may be operated by a hand-lever 209^a and a shaft 209^b suitably connected by an arm 209^c to the valve spindle. This valve, as shown in Fig. 13, may be of simple turn-plug type, including a casing 210, having a supply port 211 connected by a pipe 212 to the branch pipe 47^b leading to the main air supply 47^c. This valve also has an exhaust port 213 and an outlet and return port 214 to which pipe 208 is connected. The turn plug 215 has a cross port 216, the ends of which are so located that the supply port 211 may be connected to pipe 208 to supply compressed air to the cylinder to raise the piston, or port 211 may be cut off and port 213 connected to port 214 to permit the fluid in the cylinder to pass to the exhaust and the piston to descend. The connections 207 are preferably of different lengths so that the flask part will be supported in an inclined position substantially parallel to the supporting surfaces of the bottom-boards 146.

The specific crane shown and described is

not my invention, and is merely illustrative of one type of horizontally swinging crane arm which may be employed in comb nation with the other elements and apparatus constituting my invention. It is to be noted that the crane arm is located overhead out of the way of the molders, but it is arranged so as to swing under the rails 56 upon which the rammer travels. It will also be seen upon reference to Fig. 1, that the crane support and the axis upon which the crane pivots is located between the path of movement of the rammer and the path of movement of the turn-table.

I will now describe novel means for rotating the turn-table to bring the platform or bottom-boards singly in line with the pattern stand to receive flask sections from the stand. 217 designates a vertically disposed power cylinder containing a piston (not shown) on a depending piston rod 218, to the lower end of which is connected one end of a pull line 219. The pull line is guided around and beneath a guide sheave 220 and thence passes horizontally between the floor 1 and the turntable, and then over a guide sheave 221 mounted on the main frame and down through an opening in the floor, the lower free end of the line carrying a weight 222 which opposes the power stroke of the piston rod 218. Connected to the cylinder 217 beneath the piston therein is a pipe 223, the other end of which is connected to the branch pipe 47b to receive compressed air therefrom, and in said pipe 223 is a manually operable control valve 224 located at a point for convenient operation by a workman at station A. This valve may be of the same type shown in Fig. 13, and is operable to admit fluid pressure to the cylinder to cause the piston rod to exert a pull in one direction on the line 219, or to cut off the supply and exhaust the fluid from the cylinder to thereby permit the weight 222 to exert a pull in the other direction on said line. On the horizontal portion of the pull line is a pull-button 225 which is held against longitudinal movement on the pull line by means of cable clamps 226 (Fig. 12) located at opposite ends of said button.

Secured to the bottom flange of each of the arms or spokes 131 is a bracket plate 227 (see Fig. 4) having depending spaced bearing ears 228 between which is arranged a trip lever or pawl 229 having spaced lugs 230 which straddle the pull line 219, said lever being hung on a transverse pivot pin 231 fixed in said legs. The pawl is provided with a stop lug 232 adapted to abut the plate 227 to limit swing of the pawl in the direction of travel of the turn-table, but the pawl is free to swing in the opposite direction. The lug 230 which is further from the axis of the turn-table is shorter than the other lug, so as to facilitate entry of the line by lateral movement into the space between the lugs. By the arrangement described, when pressure fluid is admitted to the cylinder 217, the piston therein exerts a pull on the line, bringing the pull-button 225 against the lugs 230 of pawl 229, which is held against swinging movement by engagement of the lug 232 against the plate 227, continued pull on the line serving to rotate the turn-table for the desired distance. When pressure is exhausted from the cylinder, the weight 222 pulls the line in the opposite direction, the button striking the pawl in rear thereof, but the pawl swings on its pivot to permit the button to pass in rear of said pawl and take position to engage the pawl when the table is to be rotated again. Should the line be displaced from the pawl when the button trips the pawl, the line readily passes under the shorter leg 230 and assumes operative position relative to the pawl.

The shake-out station is located preferably adjacent the seventh bottom-board, counting in sequence in the direction of rotation from the board adjacent the pattern stand. At this station is a shake-out hopper 233, including a frame 234 and grill 235, adapted to receive a flask part containing a sand mold to support the flask while the sand is being removed. The hopper 233 discharges into a boot 236, which in turn discharges into the chute 4 heretofore described. Over the hopper and in line with the diameter of the turntable and overlying the path of the platforms, is an overhead flanged horizontal rail 237 supported by a hanger member 237a supporting a trolley carriage 238 (see Fig. 2) adapted to travel from a point over an adjacent bottom-board 146 to a point over said hopper 233. The trolley carriage supports a pneumatic hoist cylinder 239 containing a piston (not shown) operating a piston rod 240 supporting a flask sling 241 adapted to be attached to flask parts on an adjacent turntable platform to transfer said parts to the shake-out grid, and also to return the flasks to the turn-table. The hoist cylinder piston is supplied with fluid pressure through a pipe 242, receiving air under pressure from the pipe 47b, said pipe 242 being connected to the lower end of the cylinder by means of a flexible hose coupling 242a. In pipe 242 is a manually operable control valve 243 of any suitable type adapted to be operated by the shake-out workman to pass air to said cylinder to hoist a flask, or to disconnect the cylinder from the supply and connect the cylinder to the exhaust when the load is to be lowered. The valve 243 may be of the same form or type as valve 209, and further description thereof is not necessary, its operation being readily apparent upon reference to valve 209 (Fig. 13).

The various parts and mechanisms being as shown and above described, the operation

thereof may be summarized as follows: It will be understood that in the preferred embodiment the system or plant will be furnished with a quota of two-part flasks, for efficient operation the quota being at least equal to the number of bottom-boards or platforms 146 on the turn-table. There will also be a sufficient supply of molding sand to keep the hopper 13 substantially filled. When a mold is to be made in a flask or flask section, the molder at the mold-making station A cleans the pattern on the stand 2, this being done preferably by a blast from the usual air hose 244, which may be connected to the pipe 212. If chaplets are to be employed for supporting a core, they are then applied to the pattern and the crane arm 205 and sling 206 is operated to lift a flask section, for example, the drag from the next adjacent platform 146, and transfer it to the pattern stand upon which it is set and alined by any of the usual guide-pins or other devices employed for the purpose in foundry practice. The molder then operates the valve 46 to cause forward movement or descent of the sand delivery receptacle from the position shown in full lines in Fig. 7 to the position shown in dotted lines in said figure, this operation serving to deliver into the flask a sufficient amount of sand to form a mold. Previous to delivering the sand the molder may apply facing sand to the pattern in the flask. The molding sand having been delivered, the valve 46 is manually operated to return the sand delivery bucket 29 to the position shown in full lines in Fig. 7. As the carrier frame 24 descends, the plate 25^a closes the lower end of the hopper 13. When the frame 24 approaches its upper position, the cross-bar or piece 103 strikes the end 102 of lever 101, causing the bar 108 to engage button 85 to close automatically the circuit through motors 59, 68, whereupon the rammer carriage and rammer feet are set in motion and reciprocated across the pattern stand to ram the sand in the flask. The molder at station A then strikes the mold with a hand strike in the usual manner, and by means of the valve 209 causes the hoist crane 205 and sling 206 to lift the drag section of the flask from the stand, then rolls the section over to bring the mold print uppermost, and deposits the drag on the platform or bottom-board 146 which is adjacent and in line with the pattern stand, and which has been previously turned on its pivot to the position shown in Fig. 1. The steps heretofore set forth are then repeated for the formation of the cope section of the mold, one molder setting the core, if any, in the drag on the platform while another molder is striking the cope and setting sprues. The crane 205 is operated to set the cope on the drag previously made, and this having been done, the bottom-board is turned ninety degrees on its axis so as to incline downwards toward the axis of rotation of the turn-table. The top-plate 156 is then lowered onto the cope of the flask and the clamp on the top-plate clamped to the bottom-board to hold the top-plate on the cope, and the cope and drag on the bottom-board.

The molder at the molding station A then operates valve 224 to supply air to the cylinder 217 which causes the line 219 to be pulled to bring button 225 against the trip pawl 229 on the sixth arm 131 in sequence from the molding station, and thereby rotate the turn-table one step in a direction counter-clockwise of Fig. 1, taking the platform at the molding station to the second position. This operation also brings the eighth board in sequence, and carrying an empty flask to the first position at the molding station A to supply an empty flask to the molders and receive the flask after a mold has been made therein, as previously described.

The step by step operation of the turn-table brings bottom-boards carrying flasks containing molds to the second, third and fourth positions in the zone E in which the molds may receive the molten metal to form a casting. The molds may be poured from a ladle (not shown) suspended from a trolley travelling on an overhead rail R. Continued rotation of the table brings the molds into the fifth and sixth positions embraced in the cooling zone F. When rotation of the table brings a mold containing a casting to the shake-out station G, the shake-out workman unclamps the top-plate and raises it from the flask, and by means of hoisting cylinder 239 lifts the cope from the turn-table and transfers the cope to a position over hopper 233 and shakes the sand out into the hopper. The drag is then lifted and transferred in the same manner, and the casting shaken out over the hopper 233, whereupon the cope and drag are replaced on the adjacent bottom-board to be returned to the molding station.

The system or plant has many advantages, among which the following may be mentioned:

The structure is unitary, and is conveniently operable by its individual molding team and a single shake-out workman, thus requiring not more than three men to expeditiously make molds and shake out the castings.

A number of the units may be arranged so as to be independently operable of each other, so that a possible break down of one will not affect the others in any way.

There is a close check on the efficiency of the equipment, and also on the quality of product, as the shake-out workman can immediately notify his molder of any defect in the product.

It is to be noted also that the sand delivery device, the ramming means, and the travel of the turn-table are under control of the mold-

er at the molding station A, due to the fact that the manual controls for these mechanisms are all located at station A in convenient access to the molder. Furthermore, the molder can regulate the time of travel of the turn-table so as to transfer completed molds to the turn-table and through the successive zones at a proper rate to keep in step with the molds produced at station A to ensure commercial castings. The foregoing is important because in a foundry employing a number of such units, each unit can be operated to the best advantage by its particular crew of three workmen without affecting or being affected by the capabilities of the screw operating another unit.

What I claim and desire to secure by Letters Patent of the United States is:—

1. An apparatus of the character described comprising a mold-making device, a reciprocable sand delivery device having a retracted position relative to said mold-making device, and movable toward the mold-making device to deliver sand thereto, a reciprocable ramming mechanism movable in a path at an angle to the path of movement of the sand delivery device and operable to traverse the mold-making device when the sand delivery device is in retracted position, and a turn-table adjacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move the same through pouring, cooling and return zones to the mold-making device.

2. An apparatus of the character described comprising a mold-making device, a reciprocable sand delivery device having a retracted position relative to said mold-making device, and movable toward the mold-making device to deliver sand thereto, a reciprocable ramming mechanism movable in a path at an angle to the path of movement of the sand delivery device and operable to traverse the mold-making device when the sand delivery device is in retracted position, a turn-table adacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move the same through pouring, cooling and return zones to the mold-making device, and means adjacent the mold-making device for transferring molds from the mold-making device and depositing said molds on said platforms.

3. An apparatus of the character described comprising a mold-making device, a reciprocable sand delivery device having a retracted position relative to said mold-making device, and movable toward the mold-making device to deliver sand thereto, a reciprocable ramming mechanism movable in a path at an angle to the path of movement of the sand delivery device and operable to traverse the mold-making device when the sand delivery device is in retracted position, a turn-table adjacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move the same through pouring, cooling, shake-out and return zones to the mold-making device, a shake-out apparatus at said shake-out zone, and means for transferring molds from the platforms to said shake-out apparatus.

4. An apparatus of the character described comprising a mold-making device, a reciprocable sand delivery device having a retracted position relative to said mold-making device, and movable toward the mold-making device to deliver sand thereto, a reciprocable ramming mechanism movable in a path at an angle to the path of movement of said sand delivery device and operable to traverse the mold-making device when the sand delivery device is in retracted position, a turn-table adjacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move each of the molds in succession through a pouring zone, a cooling zone, a shake-out station and a return zone, a shake-out receptacle at the shake-out zone, a track overlying the turn-table and said receptacle, a mold-transferring device travelling on said track and movable to positions over a mold-receiving platform and over said receptacle respectively, and means for rotating said turn-table to bring the platforms successively into position at said mold-making device and in operative relation to said hoisting device.

5. An apparatus of the character described comprising a mold-making device, a sand delivery device movable toward and from a position to deliver sand to said mold-making device, a turn-table adjacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move the molds through pouring, cooling, shake-out and return zones to the mold-making device, a shake-out receptacle at said shake-out zone, means to deliver molds from said platforms to said shake-out receptacle, and means to convey sand from said receptacle to said sand delivery device.

6. An apparatus of the character described comprising a mold-making device, a sand delivery device movable toward and from a position to deliver sand to said mold-making device, a sand receptacle to receive spill sand at said mold-making device, a turn-table adjacent the mold-making device and comprising a plurality of mold-receiving platforms to receive molds from said mold-making device and move the molds through pouring, cooling, shake-out and return zones to the mold-making device, a shake-out receptacle at said shake-out zone, means to deliver molds

from said platforms to said shake-out receptacle, and means to receive sand from said sand receptacles and deliver the same to said sand delivery device.

7. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a support adjacent each platform, and a flash top-plate movably connected to each support and adapted to be moved into and away from position on a flask carried by the platform.

8. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a support adjacent each platform, a flask top-plate pivotally connected to each support and adapted to be raised and lowered relative to a flask carried by the platform.

9. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a support adjacent each platform, a flask top-plate pivotally connected to each support and adapted to be raised and lowered relative to a flask carried by the platform, and means associated with each support for elevating said top-plate.

10. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a support adjacent each platform, a flask top-plate pivotally connected to each support and adapted to be raised and lowered relative to a flask carried by the platform, and counter-balancing means for elevating each top-plate.

11. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a standard adjacent each platform, and a flask top-plate pivotally connected to each standard and adapted to be raised and lowered relative to a flask on an adjacent platform.

12. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a standard adjacent each platform, a flask top-plate pivotally connected to each standard and adapted to be raised and lowered relative to a flask on an adjacent platform, a flexible connection connected to the top-plate and extending over a guide on the standard and means operable on said flexible connection to elevate the top-plate.

13. An apparatus of the character described comprising an apparatus for making sand molds in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of flask-receiving platforms, a support adjacent each platform, a flask top-plate movably connected to each support, means associated with each support for elevating the top-plate, and clamping means adapted to secure a top-plate in position on a flask on a platform.

14. A molding apparatus comprising an apparatus for making a sand mold in a flask, a turn-table rotatable relative to said mold-making apparatus, said turn-table carrying a plurality of inclined flask-receiving platforms, and a flask top-plate for each platform, the flask top-plate being connected to the turn-table by means for automatically adjusting said plate to the top plane of a flask carried by the platform.

15. A molding apparatus comprising an apparatus for forming a sand mold in a flask, a turn-table rotatable relative to said mold-forming apparatus, said turn-table carrying a plurality of flask-receiving platforms inclined downwards toward the center of the turn-table, and a top-plate for each platform, each top-plate being pivotally connected to the turn-table adjacent the inner end of the platform.

16. A molding apparatus comprising an apparatus for forming a sand mold in a flask, a turn-table rotatable relative to said mold-forming apparatus, said turn-table carrying a plurality of inclined platforms each rotatably mounted on the turn-table, and a flask top-plate for each platform, and means for pivotally connecting each top-plate to the turn-table.

17. A molding apparatus comprising an apparatus for forming a sand mold in a flask, a turn-table rotatable relative to said mold-forming apparatus, said turn-table carrying a plurality of inclined platforms each rotatably mounted on the turn-table, a flask top-plate for each platform, means for pivotally connecting each top-plate to the turn-table, and clamping means carried by each top-plate and adapted to engage a platform to clamp a flask thereto.

18. A molding apparatus comprising an apparatus for forming a sand mold in a flask, a turn-table rotatable relative to said mold-forming apparatus, said turn-table carrying a plurality of inclined platforms each rotatably mounted on the turn-table, a flask, top-plate for each platform, means for pivotally connecting each top-plate to the turn-

table, an equalizing clamp carried by each top-plate and adapted to engage said platform to clamp a flask thereto, and a compensating connection between each top-plate and the turn-table whereby the top-plate is adjusted to the top plane of a flask carried by the platform.

19. A turn-table for foundry operations comprising a frame including a center-bearing, radial members extending from said center-bearing, a flask-receiving platform on each of said members, an upright adjacent each of said platforms and supported by the frame, and a flask top-plate pivoted to each of said uprights to swing into and out of position on a flask supported on a platform.

20. A turn-table for foundry operations comprising a frame including a center-bearing, radial members extending from said center-bearing, a flask-receiving platform on each of said members, an upright on each of said members, and a flask top-plate pivoted to each of said uprights to swing into and out of position on a flask supported on a platform.

21. A turn-table for foundry operations comprising a frame including a center-bearing, radial members extending from said center-bearing, a flask-receiving platform rotatable on each of said members, an upright on each of said members, and a flask top-plate pivoted to each of said uprights to swing into and out of position on a flask on a platform.

22. A turn-table for foundry operations comprising a frame including a center-bearing, radial members extending from said center-bearing, a flask-receiving inclined platform mounted to turn on a vertical axis on each member, an upright on each of said members, and a flask top-plate pivoted to each of said uprights to swing into and out of position on a flask on a platform.

23. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of trip-dogs arranged in circular series on the frame and concentric therewith, and means adapted to engage said trip-dogs individually to rotate the turn-table.

24. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of trip-dogs arranged in circular series on the frame and concentric therewith, each trip-dog being free to move in one direction but having a stop to limit movement in the other direction, and means adapted to engage said trip-dogs individually to swing the dog in said other direction to thereby rotate the turn-table.

25. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of trip-dogs arranged in circular series on the frame and concentric therewith, and reciprocable means adapted to engage said trip-dogs individually to rotate the turn-table.

26. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of trip-dogs arranged in circular series on the frame and concentric therewith, each of said trip-dogs being pivoted to swing free in one direction and having means to limit swinging movement in another direction, and reciprocable means adapted to engage said trip-dogs to cause the same to engage the limiting means to rotate the turn-table.

27. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of bifurcated trip-dogs arranged in circular series on the frame and concentric therewith, each of said trip-dogs being pivoted to swing free in one direction and having a stop to limit movement in another direction, a reciprocable member cooperable with said trip-dogs and movable in the bifurcation thereof, said member having means adapted upon movement of said member in one direction to engage a trip-dog to thereby rotate the turn-table, and upon movement of said member in the other direction to swing the trip-dog on its pivot to clear said means.

28. A turn-table of the character described comprising a frame, a center-bearing for the frame, a plurality of mold-receiving platforms arranged in circular relation on said frame, a movable flask top-plate associated with each platform and pivoted to the frame, a plurality of bifurcated trip-dogs arranged in circular series on the frame and concentric therewith, each of said trip-dogs being pivoted to swing free in one direction and having a stop to limit movement in another direction, a reciprocable flexible member cooperable with said trip-dogs and movable in the bifurcation thereof, said flexible member having a projection adapted upon movement of said member in one direction to engage a trip-dog to thereby rotate

the turn-table, and upon movement of said member in the other direction to swing the trip-dog on its pivot to clear said projection.

29. An apparatus of the character described comprising a mold-making device, sand-delivering means to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, and means whereby the traverse of the ramming means is controlled by said sand-delivering means.

30. An apparatus of the character described comprising a mold-making device, sand-delivering means movable to a position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, and means whereby the traverse of the rammer means is controlled in accordance with the position of said sand-delivering means.

31. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, and means whereby the traversing movement of the rammer means is automatically controlled in accordance with the position of the sand-delivering means.

32. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, and means actuated by movement of the sand-delivering means for controlling traversing movement of the ramming means.

33. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, and means actuated by movement of the sand-delivering means from projected to retracted position to cause the ramming means to traverse said device.

34. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, a power device for driving said rammer means, controlling means for said power device, and means actuated by said sand-delivering means for operating said controlling means.

35. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, an electric motor for driving said rammer means, and controlling means for said motor, said controlling means being actuated by movement of said sand-delivering means.

36. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, an electric motor for driving said rammer means, means for controlling the electric circuit for said motor, and means actuated by said sand-delivering means for operating said controlling means.

37. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device, rammer means adapted to traverse said device to ram sand delivered thereto, a power device for driving said rammer means, controlling means for starting said power device to drive the rammer means, and means actuated by movement of the sand-delivering means from projected toward retracted position to operate the controlling means to start said power device.

38. An apparatus of the character described comprising a mold-making device, a sand-delivering means movable over said device to deliver sand thereto, rammer means movable over said device to ram sand delivered thereto, and means under the control of one of said movable means whereby the other of said movable means can move toward the said device only when the said one movable means is out of position over said device.

39. An apparatus of the character described comprising a mold-making device, a sand-delivering means movable over said device to deliver sand thereto, rammer means movable over said device to ram sand delivered thereto, and means under the control of said sand-delivering means whereby said rammer means can move toward the said device only when the sand-delivering means is out of position over said device.

40. An apparatus of the character described comprising a mold-making device, a reciprocable sand-delivering means movable over said device to deliver sand thereto, rammer means reciprocable over said device to ram sand delivered thereto, said delivering means and ramming means moving in inter-

secting paths, and means controlled by movement of one of said reciprocable means for controlling the travel of the other of said reciprocable means.

41. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device and to resume said retracted position, rammer means adapted to traverse said device to ram sand delivered thereto, power means to project and retract said sand-delivering means, means to control said power means, power means to traverse said rammer means, controlling means for said last-named power means, and means actuated by retraction of said delivering means to operate said controlling means to cause the traversing movement of the rammer means.

42. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device and to resume said retracted position, rammer means adapted to traverse said device to ram sand delivered thereto, power means to project and retract said sand-delivering means, manually operable means to control said power means, power means to traverse said rammer means, controlling means for said last-named power means, and means actuated automatically by retraction of said delivering means to operate said controlling means to cause the traversing movement of the rammer means.

43. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device and to resume said retracted position, rammer means adapted to traverse said device to ram sand delivered thereto, power means to project and retract said sand-delivering means, a second power means to traverse said rammer means, and controlling means including means to cause said first power means to project and retract said sand-delivering means, and means actuated by retraction of said sand-delivering means to cause said second power means to traverse said rammer means.

44. An apparatus of the character described comprising a mold-making device, sand-delivering means having a retracted position with relation to said device and movable to a projected position to deliver sand to said device and to resume said retracted position, rammer means adapted to traverse said device to ram sand delivered thereto, power means to project and retract said sand-delivering means, a second power means to traverse said rammer means, and interrelated control means for said first-named and second-named power means operable to cause the first-named power means to project and retract the sand-delivering means, and then cause the second-named power means to traverse said rammer means.

45. An apparatus of the character described, comprising a mold making device, a shake-out device, a plurality of separate and equally spaced mold receiving and supporting platforms positioned in fixed circular arrangement, said platforms being so spaced from each other that one of said platforms will be positioned at said mold making device when another of said platforms is positioned at said shake-out device, a turn-table carrying said platforms, and means to advance said turn-table in equal step-by-step movements, each step being equal to the distance between said platforms whereby each step will accurately position a platform at each of said devices as said platforms are advanced by said turn-table.

46. An apparatus of the character described, comprising a turn-table having a center bearing and having circularly arranged thereon a plurality of separate and equally spaced mold receiving and supporting platforms, each of said platforms being mounted for substantially horizontal rotation relative to said turn-table and having its mold supporting surface inclined to the horizontal.

47. An apparatus of the character described, comprising a turn-table having a center bearing and having circularly arranged thereon a plurality of separate and equally spaced mold receiving and supporting platforms, each of said platforms being mounted for substantially horizontal rotation relative to said turn-table and having its mold supporting surface inclined to the horizontal, and means to rotate said turn-table in step-by-step movements.

In testimony whereof I have hereunto subscribed my name.

ADAM E. GEDDES.