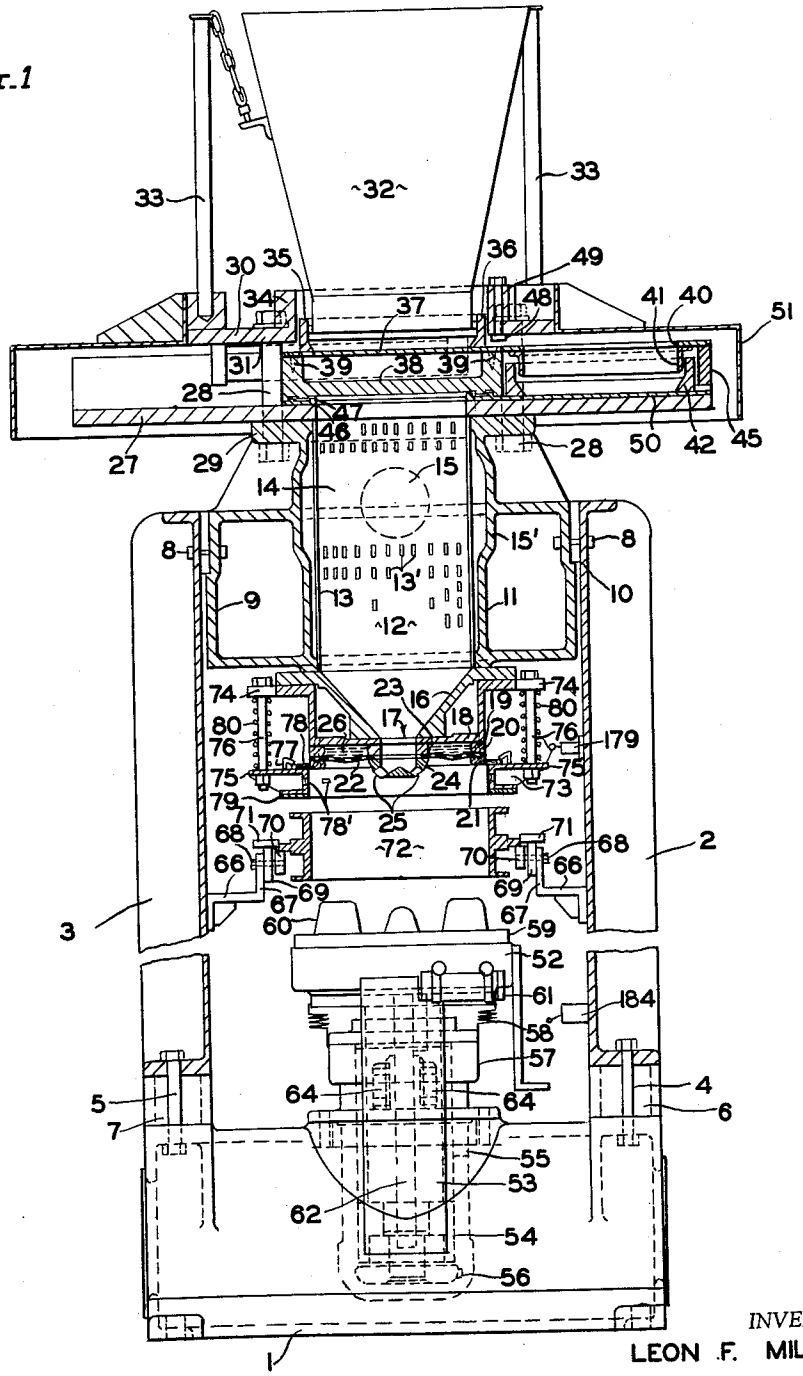
May 14, 1963 L. F. MILLER 3,089,207

BLOW-SQUEEZE MOLDING MACHINE

Filed April 9, 1959 4 Sheets-Sheet 1

Fig. 1



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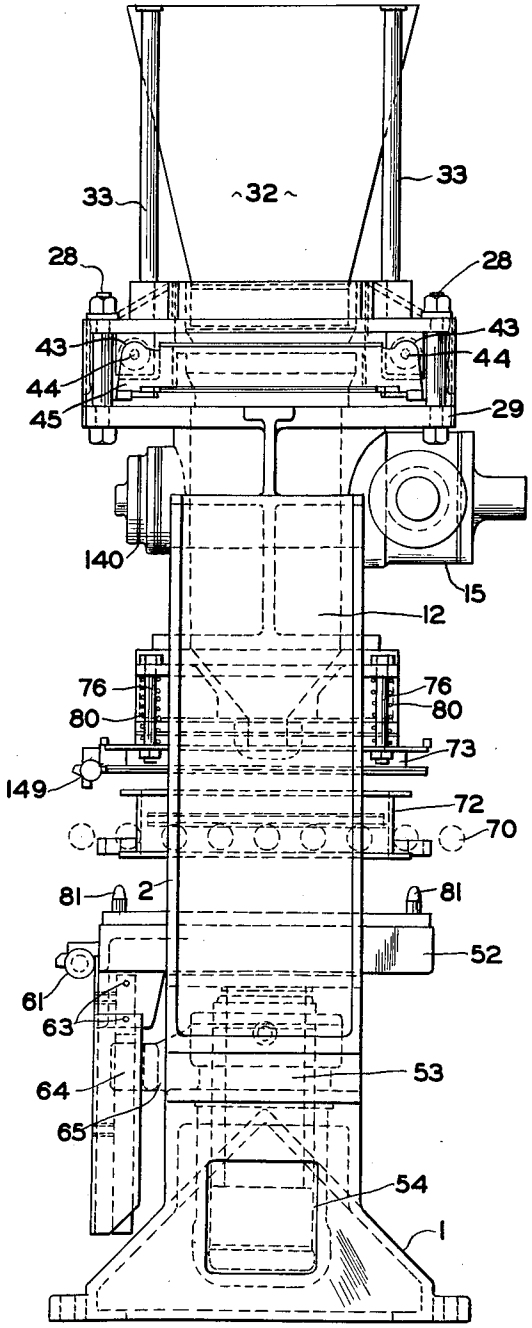
BY
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BLOW-SQUEEZE MOLDING MACHINE

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Fig. 2



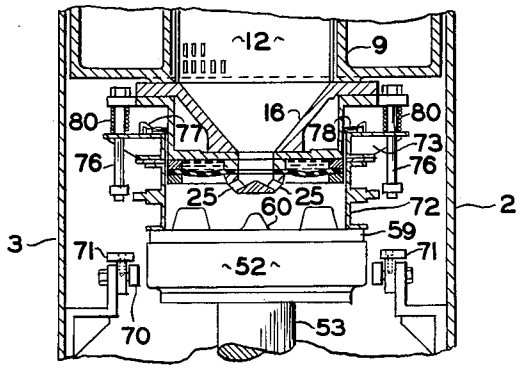
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BLOW-SQUEEZE MOLDING MACHINE

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Fig. 3



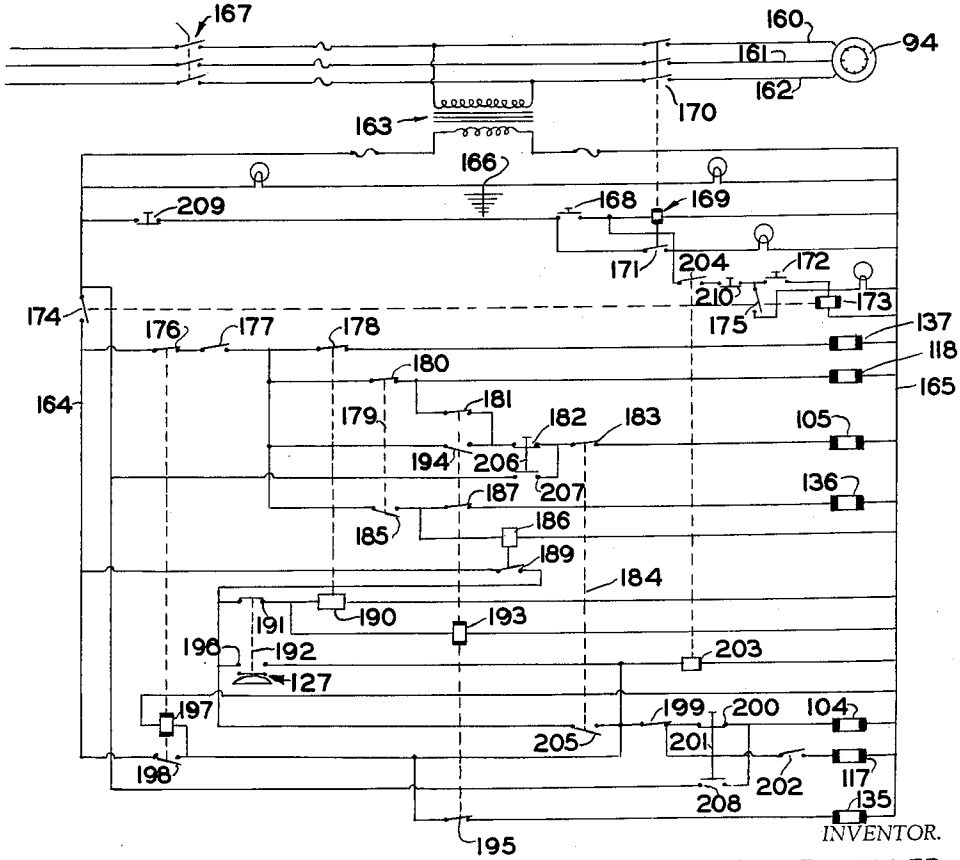


Fig. 4

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BLOW-SQUEEZE MOLDING MACHINE

Filed April 9, 1959 4 Sheets-Sheet 4

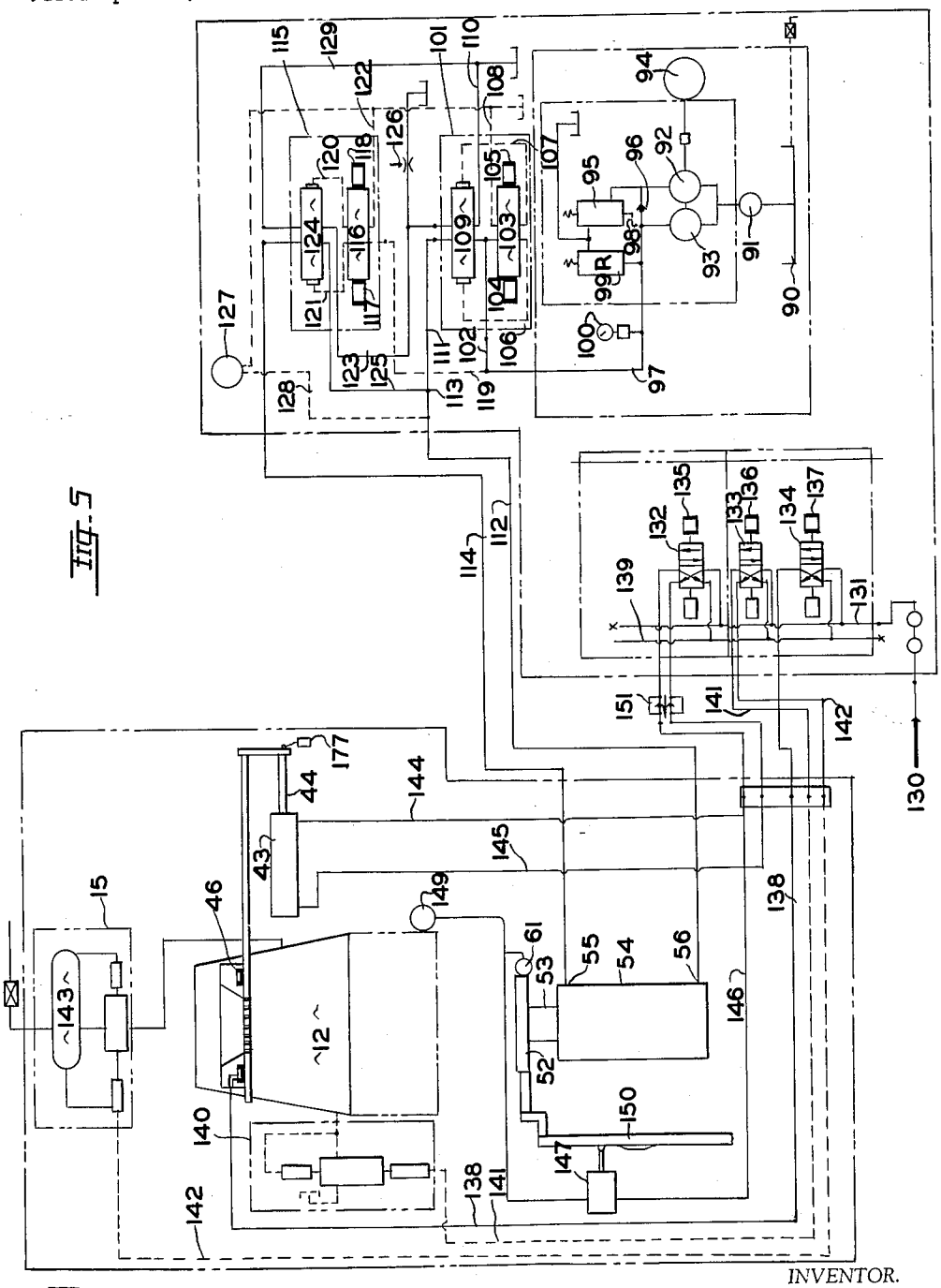


Fig. 5

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United States Patent Office

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3,089,207

BLOW-SQUEEZE MOLDING MACHINE

Leon F. Miller, Rocky River, Ohio, assignor to The Osborn Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Filed Apr. 9, 1959, Ser. No. 805,174
24 Claims. (Cl. 22—36)

This invention relates as indicated to a blow-squeeze molding machine, and more particularly to a machine for efficiently and quickly producing foundry molds by a method wherein particulate molding materials such as foundry sand are blown into a pattern containing mold box or flask and then squeezed against such pattern to achieve desired uniform consistency and surface hardness.

Reference may be had to my co-pending application Serial No. 747,474, "Foundry Molding Machine and Method of Molding," filed July 9, 1958, for a disclosure of a molding machine of this general type, the present invention involving certain modifications and improvements therein. It is difficult to operate a machine of this type rapidly for efficient production of foundry molds and at the same time to achieve the desired uniformity of mold consistency and surface hardness.

It is, accordingly, an important object of this invention to provide a foundry molding machine of the type indicated including a control system achieving automatic operation and thereby eliminating variation in the molds produced likely to be found when the operation is left in the direct control of the machine operator.

Another object of the invention is to ensure operation of the machine in such manner that uniform compacting of the sand within the flask will be achieved despite a certain amount of variation in the amount of sand charged into the flask in successive cycles.

Still another object is to provide such machine which will automatically rapidly assemble and clamp together the pattern and flask beneath a blow-squeeze head, fill such flask with particulate molding material, compress such material to a predetermined degree of compactness, and then draw the pattern from the finished mold.

A further object is to provide such machine with means for regulating performance of the drawing operation.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principles of the invention may be employed.

In said annexed drawings:

FIG. 1 is a front elevation, partially in section, of a blow-squeeze molding machine embodying the principles of my invention with the parts of the sand receiving assembly in unclamped position;

FIG. 2 is a side elevation of said blow-squeeze molding machine as viewed from the right hand side of FIG. 1;

FIG. 3 is a view similar to FIG. 1, partially broken away, illustrating the parts of the sand receiving assembly in the clamped final pressure position;

FIG. 4 is a schematic illustration of the wiring diagram by which automatic operation of the machine is accomplished; and

FIG. 5 is a schematic illustration of the hydraulic and pneumatic controls for my blow-squeeze molding machine.

I. The Blow-Squeeze Molding Machine

Referring now to the drawings and more particularly to FIGS. 1 and 2 thereof, it will be seen that my molding machine generally comprises a base 1 on which is mounted two upstanding channel frame members 2 and 3. These channel frame members are secured to the base by means of elongated bolts or tie rods 4 and 5 which clamp the frame members to the base through interposed shims 6 and 7.

At the top of the channel frame members 2 and 3, there is securely bolted, as shown at 8, a blow head frame 9. Between the blow head frame 9 and the upper portion of the channel frames 2 and 3, there are shoulder connections 10 which it will be seen will, together with the bolts 8, firmly secure the blow head frame against moving upwardly of the base 1. Within the central cylindrical portion 11 of the blow head frame 9 is a particulate molding material reservoir generally shown at 12. Within this reservoir a perforated sleeve 13, having a multitude of vertically elongated perforations 13', is slightly spaced from the periphery of the reservoir 12 as formed by the cylindrical portion 11 of the blow frame head. The vertically elongated perforations within the sleeve 13 extend the length of the sleeve with the exception of an imperforate band 14 positioned opposite the air inlet 15. The air inlet 15 is centrally placed in an enlarged annular portion 15' of the cylinder 11. It will now be seen that the cylindrical sleeve 13 acts as an air diffuser which will effectively fluidize the particulate molding material that is within the reservoir 12 when air under pressure is admitted through the inlet 15.

Pendently mounted from the central portion of the blow head frame 9 is a funnel shaped member 16 leading to the outlet 17 through which the particulate molding material will pass into the mold box. Secured to the funnel shaped member 16 is a generally rectangular member 18 surrounding the circular orifice 17. Around the periphery of the rectangular member 18 there is secured as by bolts 19 passing through two similarly shaped frame members 20 and 21, a flexible diaphragm 22 having a central orifice of the same dimension as the sand orifice 17 around which clamping members 23 and 24 firmly seal the diaphragm 22. The clamping member 24 also serves as a deflector and has two or more, preferably four, diverging outlets 25 through which the particulate molding material will pass into the mold box, and hence be more evenly distributed therewithin. The lower planar surface of the member 24 will also serve as a squeeze biscuit to preclude the sand from being compressed within the orifice 17. Between the flexible diaphragm 22 and the rectangular frame member 18, I prefer to place a fixed amount of fluid under pressure, as shown at 26. It will, of course, be understood that during the final squeeze operation it would be entirely possible to increase the pressure of the fluid behind the diaphragm 22. It will now be seen that the clamping member 24 having the divergent lateral nozzles 25, together with the flexible fluid backed diaphragm 22, generally comprise my blow-squeeze head.

Mounted on the top of the blow head frame 9 is a rigid frame member 27. This frame member is secured to the blow head frame 9 by means of bolts 28 passing through flanges 29 on the top of the blow-head frame. Vertically spaced above the blow frame member 27 is a further frame member 30 which is secured to the frame member 27 by means of the bolts 28 which have reduced portions at the tops thereof, generally shown at 31, on which the frame member 30 is positioned. In this manner it will be seen that the frame members 27 and 30 are rigidly held in spaced apart relation by means of the bolts 28. Above the upper blow slide frame member 30, there is mounted a hopper 32 by means of upstanding supports 33. In the hopper 32, there is placed a supply of particulate molding material such as sand from any suitable source external to the machine, as, for example, a belt conveyor. The mouth of the funnel shaped hopper 32 fits within an annular upstanding frame 34 positioned around an orifice 35 in the upper blow slide frame 30. Within the ring 34 is a sand retaining ring 36 for the hopper 32 which rests upon a chromesteel plate 37 secured to the top of the blow slide 38 by means of suitable fasteners such as screws 39. An orifice 40 of the same diameter as the mouth of the hopper as formed by the sand retaining ring 36 is formed near the right end of the plate 37 as seen in FIG. 1. Depending from the orifice 40 is a flanged shield member 41 fitting within a sand retaining ring 42 identical in form to the ring 36. The blow slide 38 together with the plate 37 and shields 41 and 42 are mounted for horizontal reciprocation on suitable slides by means of two pneumatic cylinders 43, the rods 44 of which are secured to end plate 45 which reciprocates the blow slide parts as a unit. Beneath the heavy central slide member 38 is positioned an annular inflatable rubber sealing ring 46 which is firmly secured to the member 38 by suitable screw fastened clamps 47. When the slide is positioned for blow, as shown in FIG. 1, the inflatable sealing ring surrounds the periphery of the opening into the reservoir 12. When the rubber sealing ring is inflated from a source of air as hereinafter described, the ring 46 will expand raising the entire slide until the plate 37 contacts suitable bearing buttons 48 positioned around the orifice 35 on the lower side of upper blow frame member 30. These bearing buttons 48 are secured thereto by means of bolts passing through the frame member 30 and the annular upstanding member 34, as shown at 49. It will now be seen that when the rubber sealing ring is inflated, the reservoir slide will be slightly raised against the bearing buttons 48 and the sealing ring will be in firm contact with bearing plate 50 surrounding the periphery of the opening into reservoir 12 so that an impermeable seal is provided for the upper orifice of the sand reservoir 12.

In order to admit sand to the reservoir 12 from the hopper 32, the reservoir slide will be moved to the left as shown in FIG. 1. This will position the opening 40 in the plate 37 beneath the mouth of the hopper permitting the particulate molding material to drop through the orifice into the reservoir 12. After a predetermined time the reservoir slide will be returned to the position shown in FIG. 1, the sand within the orifice 40 and above the plate 50 sliding to the right with the reservoir slide and remain in that position until the slide is again moved back so that the sand reservoir may be filled from the hopper. Over the exterior of the reservoir slide there is positioned a hood 51 which extends down over the reservoir slide as a protection from free blowing sand.

Mounted in the base 1 for vertical reciprocation is a clamping table 52. The table 52 is mounted on the rod 53 of an hydraulic cylinder 54 having suitable connection fixtures 55 and 56 for the proper hydraulic control lines. The hydraulic cylinder 54 extends above the base 1, as shown at 57, and between this upper extension of the cylinder and the table 52 there is mounted an annular flexible boot 58 which acts as a seal to preclude sand or dirt from coming into contact with the piston rod 53.

On the top of the table there is placed a pattern plate 59 having a pattern 60 mounted thereon. Secured to the table is a pneumatic pattern vibrator 61 to aid in the withdrawal of the pattern from the completed mold.

In order to keep the table from rotating within the cylinder 54, I provide a guide pin 62 depending from the table 52 and securely mounted thereto as by spaced screws 63. The guide pin passes through shoes 64 which are mounted on a lateral extension 65 of the upwardly extending portion 57 of the cylinder. The guide pin is preferably of square cross section and the guide shoes are of a like configuration enabling the adjustment of the shoes to fit the guide pin regardless of the variations in the transverse dimension of the guide pin due to wear.

Spaced above the table 52 in its lowermost position, as shown in FIG. 1, horizontally aligned elongated angle brackets 66 are secured to the side of each channel frame member 2 and 3. Secured to an upwardly extending flange 67 thereon by means of suitable bolts 68 passing through spacer member 69 are horizontally aligned rollers 70. Secured to the top of spacer member 69 is a guide member 71. In this manner a flask 72 may be positioned above the pattern carrying table 52 by movement from a source external to the machine on the rollers 70. Suitable latches or stops will, of course, be provided so that the flask 72 will be placed in the desired vertically aligned position with respect to the other parts of the sand receiving assembly.

Around the blow squeeze head there is pendently mounted an upset or fillframe 73 of the same configuration as the flask 72. The fillframe is mounted on four elongated bolts or rods extending downwardly from the flanges 74 of the rectangular frame member 18. The fillframe has an outwardly extending flange 75 with suitable openings therein through which the elongated guide bars 76 pass. Clamped to the top of the fillframe 73 by any suitable fastening means, generally shown at 77, is a brush strip sealing member 78, the bristles of which engage diaphragm clamping members 20, 21 and the rectangular frame member 18. The brush seal 78 is preferably of the "brush strip" construction and provides an effective sand or particulate material filter for the escape of air from the sand receiving assembly. It will, of course, be understood that additional suitable vents such as screen vents may be provided in the fillframe or the pattern itself as shown at 78'. The lower side of the fillframe has mounted thereon a bearing plate 79 which may be employed with a gasket and is adapted to form an effective seal with the top of the flask 72. Mounted around the guides 76 between the flange extensions 74 of rectangular frame 18 and the flanges 75 of the fillframe 73 are suitable coil compression springs 80 which are adapted resiliently yieldingly to maintain the fillframe in its lowermost position, as shown in FIG. 1. It will, of course, be understood that suitable air springs could easily be employed in place of the coil springs 80.

It will now be seen that as the table 52 rises with the pattern plate 59 and pattern 60 thereon, the flask 72 will engage the top of the pattern plate 59 with suitable aligning pins 81 mating with corresponding openings in the flask. Further upward motion of the table with the flask now resting on the pattern plate 59 will cause the top of the flask to engage the bottom plate 79 of the fillframe 73. In this manner it will be seen that a sand sealed sand receiving assembly has now been formed enclosing the blow-squeeze head. As soon the flask 72 has contacted the plate 79 of the fillframe 73, the assembly of the parts is completed and the enclosure or sand receiving assembly is now ready to be filled with a particulate molding material through lateral blow orifices 25.

II. Hydraulic Control System

Referring now to FIG. 5, there is schematically shown the hydraulic and pneumatic controls for the operation of my machine. Referring first to the hydraulic controls which operate cylinder 54, it will be seen that hydraulic

fluid is pumped from a suitable tank 90 through suction filter 91 to the inlets of two constant volume pumps 92 and 93 driven through a flexible coupling by a suitable electric pump motor 94, the operation of which will be hereinafter more fully described. Pump 92 is a large volume pump producing a flow generally at the rate of 18 gallons per minute at 250 p.s.i. Pump 93 is a small volume pump pumping fluid at the rate of 12 gallons per minute at a much higher pressure of approximately 1250 p.s.i. for example. The outlet of pump 92 is connected to an unloading valve 95 and through check valve 96 to line 97. The unloading valve is designed to unload the production of pump 92 to the tank 90 when the pressure in line 97 increases above a certain predetermined pressure, as for example 350 p.s.i. For this purpose a pilot line 98 is connected from the unloading valve 95 to the line 97. The production of pump 93 is connected directly to line 97 and is precluded from passing through the unloading valve by check valve 96. Conventionally mounted on line 97 is a relief valve 99 and a pressure gauge 100. Line 97 leads into a clamp direction valve, generally indicated at 101, through line 102. Valve 101 is a four way double solenoid controlled, spring centered, pilot operated hydraulic control valve. The solenoid controlled pilot valve 103 of valve 101 is controlled by solenoids 104 and 105, the actuation of which will hereinafter be more fully described. When the pilot valve 103 is in its centered position, the connections to the pressure line 102 are blocked and the ports connecting both the pilot lines 106 and 107 are opened to the tank 90 through drain line 108. When the hydraulic valve 109 of the clamp direction valve 101 is in its centered position, the pressure line 102 is connected directly to tank 90 through line 110. It will now be seen that when the valve 101 is deenergized and both valves 103 and 109 are in their centered positions, the hydraulic pumps will merely circulate hydraulic fluid from the tank through lines 97, 102 and 110 back to the tank.

In order to cause the table 52 to move upwardly, solenoid 105 is energized to connect the pressure line 102 to the pilot line 106, thereby moving the valve 109 to connect the pressure line 102 directly with the one inch line 111. This line joins a 1½ inch pressure line 112 at a T coupling 113. The line 112 is connected directly to the blind end of hydraulic cylinder 54. Connected to the rod end of cylinder 54 is control line 114 which passes through clamp speed valve 115, which is a four way double solenoid controlled, spring centered, pilot operated hydraulic control valve, the solenoid operated pilot valve 116 of which is controlled by solenoids 117 and 118. A pressure pilot line 119 is connected to pilot valve 116 which in its centered position blocks pressure line 119 and connects pilot lines 120 and 121 to tank 90 through line 122. Fluid passing through valve 109 entering lines 111 and 112 from pressure line 102 will force the cylinder piston upwardly and fluid will be forced from the rod end of the cylinder through line 114 and outwardly to the tank 90 through line 123 when the valve 115 is deenergized since in the centered position of the hydraulic valve 124, hydraulic fluid will pass from line 114 to line 123 and hence to tank 90 through variable choke 126. The resultant back pressure caused by this variable choke 126 can be regulated so that insufficient pressure will be built up in line 97 to unload pump 92.

In order to make the table rise at a more rapid rate, it will be seen that the solenoid 118 of valve 116 need only be energized connecting hydraulic fluid from pilot line 119 to pilot line 121. This will cause the valve 124 to shift connecting the line 114 to line 125, which is a 1 inch line joining line 112 at T coupling 113. The volume of oil now forced from the rod end of the cylinder through line 114 is caused to return to line 112 instead of passing to the tank through line 123. This added volume of oil will cause the table 52 to rise more rapidly since the area beneath the piston of the hydraulic cylinder 54 is approximately twice the area above the piston. In order to raise the table with just the pattern plate and pattern mounted thereon, only a very low pressure need be created in the hydraulic system, as for example approximately 100 p.s.i. As will be seen, the combined volume of the pumps will rapidly raise the table 52 to the desired position for filling the sand receiving assembly with sand.

When the sand is within the flask and the table is again lifted against the blow-squeeze head to compress or compact the sand therewithin, resistance will be met by the hydraulic fluid in line 112 increasing the pressure therein above the unloading pressure of valve 95. Since the line 112 is connected directly to line 97, the increased pressure will unload the production of pump 92 and pump 93 will alone take over the lifting of the table at a low volume and high pressure. When the desired predetermined pressure of the squeeze head upon the sand is reached, pressure switch 127, which is connected to line 112 by means of a pilot line 128, is actuated. This brings the valves 116 and 124 to their centered position and deenergizes solenoid 105 and energizes solenoid 104 which immediately shifts the valve 103 to cause the hydraulic fluid to pass from line 102 through pilot line 107 shifting the hydraulic valve 109 to interconnect the pressure line 102 with line 123. Since the valve 124 is at this time deenergized and in its centered position, the hydraulic fluid will pass from the pressure line 102 through line 123 and into line 114 which passes into the rod end of the cylinder 54. This immediately starts the table downwardly and oil or hydraulic fluid will issue from the blind end of cylinder 54 through line 112 to line 111 through valve 109 to line 110 which is connected directly to the tank 90. Since the line 112 is a 1½ inch line and line 111 is a 1 inch line, the pressure of the oil or hydraulic fluid passing therethrough will be sufficiently great to keep the valve 95 in its unloaded position which will cause the table to move downwardly slowly. In order to cause the table to move downwardly more rapidly, the solenoid 117 may be selectively energized which moves valve 116 to a position connecting pilot pressure line 119 with pilot line 120, shifting the valve 124 so that line 125, which is connected to line 112 at T coupling 113, is now connected directly to tank through line 129. In this position of the valve 124, line 123 is still connected to line 114 in the same manner as they were when the valve was in its centered position to keep fluid moving into the rod end of cylinder 54. With both 1 inch lines 125 and 111 now connecting line 112 directly to the tank 90 through lines 129 and 110, respectively, the pressure in line 112 will drop sufficiently so that unloading valve 95 will close, causing high volume pump 92 to be again connected into the pressure line 97 and in this manner causing the table to descend rapidly. The table will continue to its maximum down position until a suitable limit switch hereinafter described will deenergize both valves 101 and 115.

III. Pneumatic Control System

Referring now to the pneumatic control system also illustrated in FIG. 5, a source of air under pressure 130 supplies main conduit 131. Connected to the pressure line 131 are three 4-way solenoid operated valves 132, 133 and 134. These valves 132 through 134 are controlled by solenoids 135, 136 and 137, respectively. These valves 132, 133 and 134 may employ suitable manual override controls, if desired.

Valve 134 controls the air supply to the ring seal 46 through line 138. In the energized position of the valve 134, the line 138 is connected directly to the pressure line 131. In the deenergized position, the line 138 is connected to line 139 which is in turn connected directly to atmosphere. In this manner it will be seen that the energization of solenoid 137 will connect line 138 for the ring seal 46 to the source of air pressure. Valve 133

operates the blow valve 15 and the reservoir exhaust valve 140. When the valve 133 is energized by solenoid 136, air under pressure is connected to line 141 positioning valve 140 to exhaust the reservoir 12. When the valve 133 is in its deenergized position, line 142 is connected to the air pressure line 131 opening blow valve 15. At the same time, this vents line 141 to atmosphere. It will also be understood that when the valve 133 is energized, line 142 will be vented to atmosphere.

For the blowing operation, air under pressure from a suitable outside source is admitted to an air reservoir 143 and kept therein under pressure, the energization of valve 15 interconnecting the air reservoir and the sand reservoir 12 through a suitable inlet. In this manner it will be understood that either the exhaust valve or the blow valve must always be energized through the valve 133 while the other is vented.

When valve 132 is energized by solenoid 135, line 144 connecting cylinders 43 is opened to air pressure line 131. This causes movement of the reservoir slide to a position sealing the reservoir 12. When the source of air pressure is connected to line 144 by the valve 132, the line 145 is vented to atmosphere, the converse also being true, i.e., when the valve 132 is deenergized, the line 145 will be connected to the source of air pressure 131, and the line 144, connected to the rod end of cylinders 43, will be vented to atmosphere.

Connected to conduit 144 is a conduit 146 delivering air under pressure through a 3-way valve 147 to pattern vibrator 61 and an upset vibrator 149. The valve 147 is a 3-way valve used as a 2-way valve and delivers air to the vibrators during the pattern draw, at which time line or conduit 144 will be connected to source of pressure 131. The valve 147 is operated by an adjustable cam 150 which moves up and down with the table 52. It will, of course, be understood that the vibrators 61 and 149 are optional and, moreover, may be placed at any desired position on the machine parts. It is noted that conventional free flow valve structures may be provided in lines 144 and 145, as shown at 151.

IV. The Electrical Control Circuit and Operation

Referring more particularly to FIG. 4, there is shown the hydraulic pump motor 94, which may preferably be, for example, a 7½ horsepower, 1800 r.p.m., 220/440, three phase, sixty cycle, squirrel cage induction motor, connected to lines 160, 161 and 162. Connected to lines 160 and 162 is a suitable stepdown transformer 163 supplying 110 volts to mains 164 and 165, both of which are connected to ground at 166. It will be understood that suitable ground lights may be employed in the lines between ground connection 166 and the mains 164 and 165 as shown. It will also be understood that suitable fuses will be employed between the mains 164 and 165 and the stepdown transformer 163. The mains 164 and 165 are energized through a suitable disconnect switch shown at 167. After this switch has been closed, the operator then closes start pump switch 168 which is a suitable push button switch to energize motor starter 169, which in turn closes switches 170 in each of the lines 160, 161 and 162 to start hydraulic pump motor 94. This across-the-line starter 169 also energizes or closes switch 171, which closes a holding circuit for push button switch 168. It will be understood that suitable signal lights may be employed as shown to notify the operator that the pump is now operating. It will also be understood that suitable over-load relays may be employed in connection with the hydraulic pump motor 94.

With the hydraulic pump motor 94 running and the hydraulic fluid now circulating from the tank through pumps 93 and 92 through lines 97, 102 and 110, the machine is now ready to commence the cycle of operation, the reservoir 12 having been previously filled with green molding sand and the slide moved to the position shown in FIG. 1. The operator manually closes "start cycle" switch 172 energizing valve circuit relay 173 which closes normally open switch 174 and normally open holding switch 175. The closing of normally open switch 174 permits the energization of valve solenoids 137, 118 and 105 through normally closed switch 176, limit switch 177, which has been closed by the position of the blow slide at the end of the last cycle, and time switch 178 which is closed. Since limit switch 179 is in a position closing contacts 180 and switch 181 is normally closed, the push button contacts 182 are closed and the contacts 183 of limit switch 184 are normally closed, the valve solenoids 118 and 105 will also be energized. Upon the energization of valve 134 through solenoid 137, the ring seal 46 is inflated sealing the particulate molding material reservoir 12. The energization of solenoid 105 moves pilot valve 103 to connect line 102 with pilot line 106 energizing hydraulic valve 109 to connect the pressure line 102 with the line 112 to start the table 52 upwardly. The energization of solenoid 118 moves pilot valve 116 to connect the pilot pressure line 119 with the pilot line 121 moving valve 124 to connect the line 114 from the rod end of the cylinder 54 to line 125. In this manner the table 52 is caused to move upwardly rapidly.

Vertical motion of the table continues past a point where the flask 32 is engaged by the guide pins 81 on the pattern plate moving the flask off the conveyor rollers 70. The continued upward motion of the table trips limit switch 179, opening contacts 180 and closing contacts 185. This limit switch is tripped as soon as the flask contacts the lower plate 79 of the fillframe 73 sand sealing the top of the flask about the lower end of the blow squeeze head. The closing of contacts 185 energizes timer 186 as well as solenoid 136 of the blow pilot valve 133 through normally closed switch 187. At this time the opening of contacts 180 of the limit switch 179 deenergizes solenoids 118 and 105 bringing the table to a halt. The parts of the sand receiving assembly are now ready to be filled with a particulate molding material through the operation of the blow pilot valve 133 controlled by solenoid 136. The operation of this valve admits air under pressure to line 141, closing reservoir exhaust valve 140. Simultaneously line 142 is vented to atmosphere opening the blow valve 15 causing air to issue from the reservoir 143 into the sand reservoir 12. This fluidizes the sand within the reservoir and forces it through lateral orifices 25 into the mold box, compacting it about the pattern therewithin. Since the limit switch contacts 180 are in parallel with the solenoid 137 controlling the inflation of the ring seal 46, the ring seal will remain inflated during this blowing operation.

After a predetermined time interval, that sufficient for the blowing operation, the timer 186 times out, closing the contacts of switch 189. This in turn energizes blow ring seal timer 190 through the normally closed contacts 191 of pressure switch 127. In parallel with timer 190 is squeeze relay 193 which reverses the position of switches 181 and 187 and closes normally open switch 194 and opens normally closed switch 195. When switch 187 is open, the blow pilot valve 133 is deenergized through solenoid 136, reversing the air flow pressurizing line 142 and venting line 141 to atmosphere. This permits the pressurized reservoir 12 to exhaust to atmosphere through valve 140 and stops the flow of air through the blow valve 15. The closing of contacts 194 energizes solenoid 105 through the closed contacts of push button switch 182 and limit switch 183. This energization of solenoid 105 interconnects hydraulic pressure line 25 with pilot line 106 to move the spool of valve 109 so that the pressure line 102 is connected to line 111 causing the piston 52 to rise. The sand within the mold box now compresses against the blow squeeze head and increasing resistance will be met, causing the hydraulic pressure in the system to increase. When the pressure reaches 350 p.s.i., pump 92 will unload through valve 95 to tank 90. At this point the small volume high pres-

sure pump 93 takes over delivering the final squeeze to the sand. Continued upward motion further increases the pressure to the amount desired for squeezing the mold. When this predetermined pressure is reached, arm 192 of pressure switch 127 closes contacts 196 and opens contacts 191. The closing of contacts 196 energizes draw relay 197 which in turn closes the normally open contacts of switch 198 and opens the normally closed contacts of switch 176. Switch 198 acts as a holding circuit for the contacts 196 of the pressure switch 192. The closing of contacts 198 energizes solenoid 104 through the contacts of closed limit switch 199 and the contacts 200 of push button 201. The energization of solenoid 104 interconnects pressure line 102 with pilot line 107 through valve 103 which in turn moves the spool of valve 109 to interconnect pressure line 102 with line 123. Due to the choke 126, the hydraulic fluid will pass through valve 124 in its centered position and into line 114, causing the table to move downwardly. When valve 109 is energized to connect the pressure line 102 with the line 123, the line 111 is also connected to the tank 90 through line 110. Choke or needle valve 126 needless to say may be regulated to vary the amount of fluid passing therethrough to the tank 90, thus controlling the downward speed of the table.

The closing of contacts 198 may also selectively energize solenoid 117 through selector switch 202. The energization of solenoid 117 interconnects pilot pressure line 119 with pilot line 120 through valve 116. This in turn energizes valve 124 to connect line 125 directly to tank through line 129. In this position of the valve 124, line 123 is also connected to line 114 in the same manner that it was in the centered position of the valve 124. It will now be seen that leading from conduit 112, which is connected to the blind end of the cylinder 54, there are now two 1 inch lines, i.e., conduits 111 and 125, connected directly to the tank 90. This increase in the drain flow of the fluid coming from the cylinder 54 will sufficiently reduce the pressure in the hydraulic system so that unloading valve 95 will close and this in turn will again connect the large volume pump 92 to the conduit 97 to produce a rapid lowering of the table 52. When the table has reached this lower limit of travel, limit switch contacts 199 will be opened deenergizing solenoid 104 and, selectively, solenoid 117, the deenergization of these solenoids returning valves 101 and 115 to their centered positions.

When the contacts of switch 198 are closed, cycle timer 203 is energized as well as solenoid 135 through the now closed contacts of switch 195, switch 195 having been closed by the deenergization of squeeze relay 193 when the contacts 191 of pressure switch 127 are opened by means of actuating arm 192. This deenergization of squeeze relay 193 also resets switch contacts 187, 194 and 181 for the next cycle. The energization of solenoid 135 shifts valve 132 to admit air under pressure to line 144 and vent line 145 to atmosphere, causing the movement by means of cylinders 43 of the blow slide to filling position. When the timer 203 times out, contacts 204 open, stopping the cycle by deenergizing cycle relay 173 to open contacts 174.

It is noted that the closing of contacts 196 of the pressure switch, which energize the draw relay 197, opens the contacts 176 deenergizing solenoids 137 and 105 which prohibit any further upward movement of the table when the pressure switch has been actuated. Should, through malfunction of the machine, insufficient sand be blown into the mold box and consequently insufficient pressure between the sand and the blow squeeze head result to actuate switch 127, I provide an upper limit safety switch 184 which when tripped will open contacts 183 and close contacts 205 when the table is at its maximum safe upward elevation. The opening of contacts 183, of course, deenergizes the solenoid 105 to preclude any further upward movement of the table and the closing of contacts 205 performs the same function as the closing of contacts 196 of the pressure switch, immediately energizing solenoid 104 to start the table down.

In order that the operator of the machine may relatively adjust the various parts of the sand receiving assembly when setting up a cycle, I provide jog push buttons 206 and 201 which will connect the solenoids 105 and 104, respectively, directly to the main 164 through contacts 207 and 208. These, of course, permit the manual energization of these solenoids whenever desired.

I also provide pump stop button 209 in series with pump start button 168 and holding switch contacts 171 so that the pump may be stopped whenever desired by the operator. I also provide an emergency stop button 210 connected in series with the start switch 172 and the holding contacts 175 so that the cycle may be interrupted whenever desired by the operator, as, for example, during an emergency. It will, of course, be understood that suitable signal lights and fuses may be employed wherever in the circuit that they may be required.

It will now be seen that I have provided a molding machine which can rapidly produce molds by quickly assembling or clamping together the various parts or components of a sand receiving assembly in the proper relation to a blow squeeze head, filling such assembly with sand or particulate molding material through a blowing operation, and then squeeze the sand within the flask against the blow squeeze head to a final predetermined pressure and produce molds of uniform compactness. It will also be seen that I have provided a control system for this molding machine which will require no more than a single operator and will require very little of his full attention. Moreover, the optional speeds at which the molding machine may be operated make it extremely adaptable to the particular requirements of the casting.

Other modes of applying the principles of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I, therefore, particularly point out and distinctly claim as my invention:

1. A molding machine comprising a vertically movable table, a blow-squeeze head positioned directly above said table, means to position a flask and pattern on the table, an upset frame pendently mounted around said blow-squeeze head, pressure means effective resiliently yieldingly to maintain said upset frame in its lowermost position, said upset frame being of the same transverse dimensions and aligned with such flask, lift means operative to raise said table with such flask and pattern positioned thereon, means responsive to a predetermined elevated position of such flask after contact between such flask and upset frame effective to stop said lift means and to blow sand into such flask and upset frame through said blow-squeeze head, means operative to actuate said lift means after a predetermined time interval again to raise said table with the sand filled flask positioned thereon raising said upset frame against the force of said pressure means and compressing such sand within the flask and upset frame against said blow-squeeze head.

2. In a foundry molding machine having a squeeze head, a flask-supporting table mounted for reciprocation toward and away from said squeeze head, an upset frame adapted to receive and contain molding sand extending above the upper margin of such flask; power means operative to elevate said table and thereby such flask into position spaced beneath said squeeze head with such flask and said upset frame defining a sand-receiving enclosure together with said table and squeeze head, blow means operative to blow molding sand through said

squeeze head to fill such flask and said upset frame, said power means being operative thereafter further to elevate said table to squeeze the sand in said upset frame against said squeeze head, and pressure-responsive means operative to limit the extent of such further elevation upon imposition of a predetermined squeeze pressure on such sand.

3. A molding machine as set forth in claim 2 wherein said power means is an hydraulically operated piston, and including means to operate said hydraulically operated piston initially at a high speed and low pressure and after such sand is deposited within such flask thereafter at a low speed and high pressure.

4. A molding machine as set forth in claim 3 including means to reverse the direction of movement of the table to draw such pattern from such flask and means responsive to the lowermost position of the table to deenergize said power means.

5. A molding machine as set forth in claim 4 including means selectively to draw such pattern from the mold at a fast or slow speed and means operable to adjust such fast and slow speeds.

6. A blow and squeeze molding machine comprising a frame including a base, a blow and squeeze head spaced vertically above said base; a table vertically reciprocably mounted in said base and adapted to support a flask and pattern plate thereon, a fillframe enclosing said blow-squeeze head and mounted for movement relative thereto; low pressure means to move said table rapidly toward said blow-squeeze head to assemble such pattern plate and flask with said fillframe into sand receiving assembly enclosing said blow-squeeze head, means responsive to the movement of such pattern plate and flask into assembled position with said fillframe to stop said low pressure means and to blow sand into such flask through said blow-squeeze head, time responsive means again to move such flask toward said blow-squeeze head at low speed and high pressure; and pressure responsive means to reverse the direction of movement of the table to disassemble such pattern plate, flask and fillframe and draw the pattern from such flask.

7. A blow and squeeze molding machine comprising a vertically reciprocable table, means to position a flask thereon enclosing a pattern therein, means to raise the table, means responsive to an intermediate position of the table to deenergize the means to raise the table for a predetermined time interval, means responsive to the lapse of said interval to reenergize said means to raise the table, means responsive to an increase in resistance to increase the pressure of said means to raise the table; and limit means to deenergize said means to raise the table upon the attainment of a predetermined maximum pressure.

8. In a mold blowing machine having a sand reservoir with an opening for charging with sand, means for closing such openings, a blow valve operative to admit high pressure air to said reservoir, a blow hole through which sand is discharged from said reservoir by such high pressure air, and clamp means operative to hold a pattern containing flask firmly in sand sealing position beneath said blow hole to reseive sand discharged through said blow hole, a fluid backed squeeze head laterally adjacent said blow hole, means to move said pattern containing flask toward said squeeze head after such sand is blown into such flask whereby such sand is compressed between said squeeze head and such pattern, and means responsive to a predetermined pressure on such sand to move such pattern containing flask away from said squeeze head.

9. The machine of claim 8 wherein said blow hole is centrally disposed and said fluid backed squeeze head encircles said blow hole.

10. The machine of claim 9 wherein said squeeze head includes a flexible diaphragm enclosing such fluid backing.

11. The machine of claim 10 wherein said blow hole comprises laterally directed nozzles in a centrally disposed squeeze biscuit.

12. The machine of claim 11 wherein said flexible diaphragm has a fixed constant volume of liquid backing.

13. The machine of claim 8 including safety means responsive to the relative position of the squeeze head and such patern containing flask to stop movement of such pattern containing flask toward said squeeze head.

14. The machine of claim 8 including means selectively to move such pattern containing flask away from said squeeze head at a fast or slow rate of speed.

15. The machine of claim 8 wherein said blow hole comprises laterally directed nozzles adapted more thoroughly to distribute the sand within such pattern containing flask.

16. The machine of claim 13 wherein said safety means moves such pattern containing flask away from said squeeze head.

17. The machine of claim 15 wherein said laterally directed nozzles are enclosed in a squeeze biscuit disposed centrally below said blow hole whereby sand will be precluded from being squeezed upwardly into said blow hole.

18. The method of producing foundry molds comprising the steps of assembling a flask and pattern plate into a sand sealed enclosure beneath a blow and squeeze head, blowing sand within such enclosure, moving such enclosure upwardly against said head after thus filled with sand with the top edge of such enclosure moving beyond such head and applying a predetermined maximum pressure on the sand within such enclosure, reversing the movement of such enclosure and drawing the pattern from the mold.

19. The method of producing foundry molds in a machine having a vertically movable table and a blow and squeeze head thereabove comprising the steps of moving upwardly such table having situated thereon a pattern and pattern plate toward such blow and squeeze head, positioning a flask on such pattern plate, stopping the upward movement of such pattern containing flask when it is contacted by a pendently mounted fillframe surrounding such blow and squeeze head and thereby forming an assembled sand sealing enclosure therebeneath, blowing sand within such enclosure centrally through such blow and squeeze head, again moving such sand filled enclosure upwardly against such blow and squeeze head and applying a predetermined maximum pressure to such sand within such flask, reversing the movement of such sand filled flask after such predetermined maximum pressure has been obtained, and drawing such pattern from such flask.

20. The method of producing foundry molds in a machine having a vertically movable table and a blow and squeeze head thereabove comprising the steps of placing a pattern containing flask upon such vertically movable table, moving such table upwardly toward such blow and squeeze head, stopping the upward movement of such table when the top of such flask has contacted a pendently resiliently mounted fillframe horizontally enclosing such blow and squeeze head, blowing sand into such flask, again moving such table upwardly against such blow and squeeze head and thereby applying a predetermined maximum pressure on the sand within such flask, reversing the movement of such table when such predetermined maximum pressure is obtained, and drawing such pattern from such flask.

21. In a mold blowing machine having a combination blow-squeeze head, a sand reservoir with an opening for charging with sand, means for closing such opening, a blow valve operative to admit high pressure air to said reservoir, an exhaust valve operative to relieve pressure in said reservoir, a blow hole through said blow-squeeze head through which sand is discharged from said reservoir by such high pressure air, means operative to hold a flask or the like firmly in sand-sealing position to receive sand discharged through such blow hole, means operative to elevate such flask after being thus filled with sand toward said blow-squeeze head with the top edge of such flask moving beyond said head, and sand squeeze pressure re-

sponsive means operative to limit such elevation of such flask toward said blow-squeeze head.

22. A blow and squeeze molding machine comprising a vertically reciprocable table, a blow-squeeze head vertically above said table, means to position a flask on said table enclosing a pattern therein, means to blow sand within such flask, means to raise said table against said blow-squeeze head and to lower the table, said means to raise and lower said table comprising a hydraulic system driven by a high pressure and low volume pump and a high volume and low pressure pump, and means responsive to a predetermined maximum pressure in said hydraulic system operative to lower said table.

23. A blow and squeeze molding machine comprising a vertically reciprocable table, a blow-squeeze head vertically above said table, means to position a flask on said table enclosing a pattern therein, means to blow sand within such flask, means to raise said table against said blow-squeeze head and to lower the table, said means to raise and lower said table comprising a hydraulic system driven by a high pressure and low volume pump and a high volume and low pressure pump, and limit means operative to lower said table upon the first attainment of either a predetermined maximum pressure in said hydraulic system or a predetermined maximum elevation of said table.

24. A blow and squeeze molding machine comprising a vertically reciprocable table, a blow-squeeze head vertically above said table, means to position a flask on said table enclosing a pattern therein, means to blow sand within such flask, means to raise said table against said blow-squeeze head and to lower the table, said means to raise and lower said table comprising a hydraulic system driven by a high pressure and low volume pump and a high volume and low pressure pump, said hydraulic system including a pressure responsive valve operative to load and unload said high volume and low pressure pump at a predetermined hydraulic pressure in said system.

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