Sept. 14, 1965 L. F. MILLER ETAL 3,205,542

JOLT-SQUEEZE MOLDING MACHINE WITH SQUEEZE PISTON SUPPORTED ON BODY OF HYDRAULIC FLUID

Filed Jan. 21, 1963 3 Sheets-Sheet 1

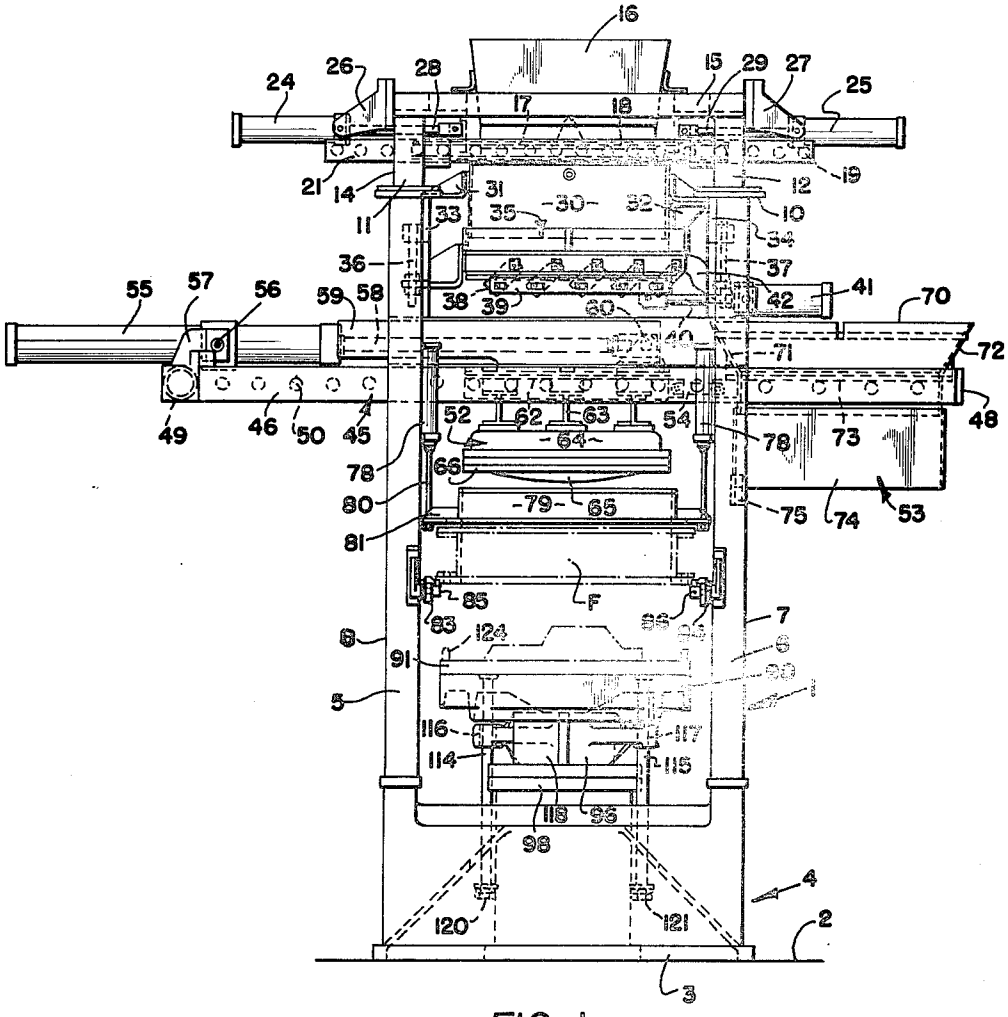


FIG. 1

INVENTORS
LEON F. MILLER,
WARREN A. BLOWER,
EDMOND K. HATCH &
ROBERT W. ELLMS

BY Merlin, Maky & Donnelly
ATTORNEYS

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Filed Jan. 21, 1963 3 Sheets-Sheet 2

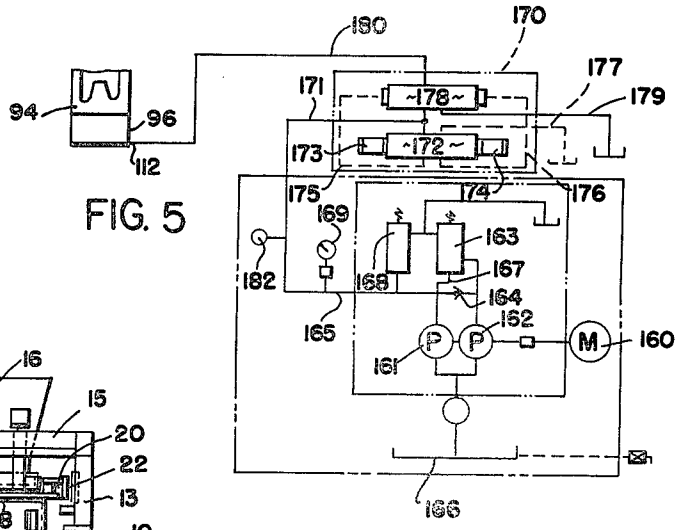


FIG. 5

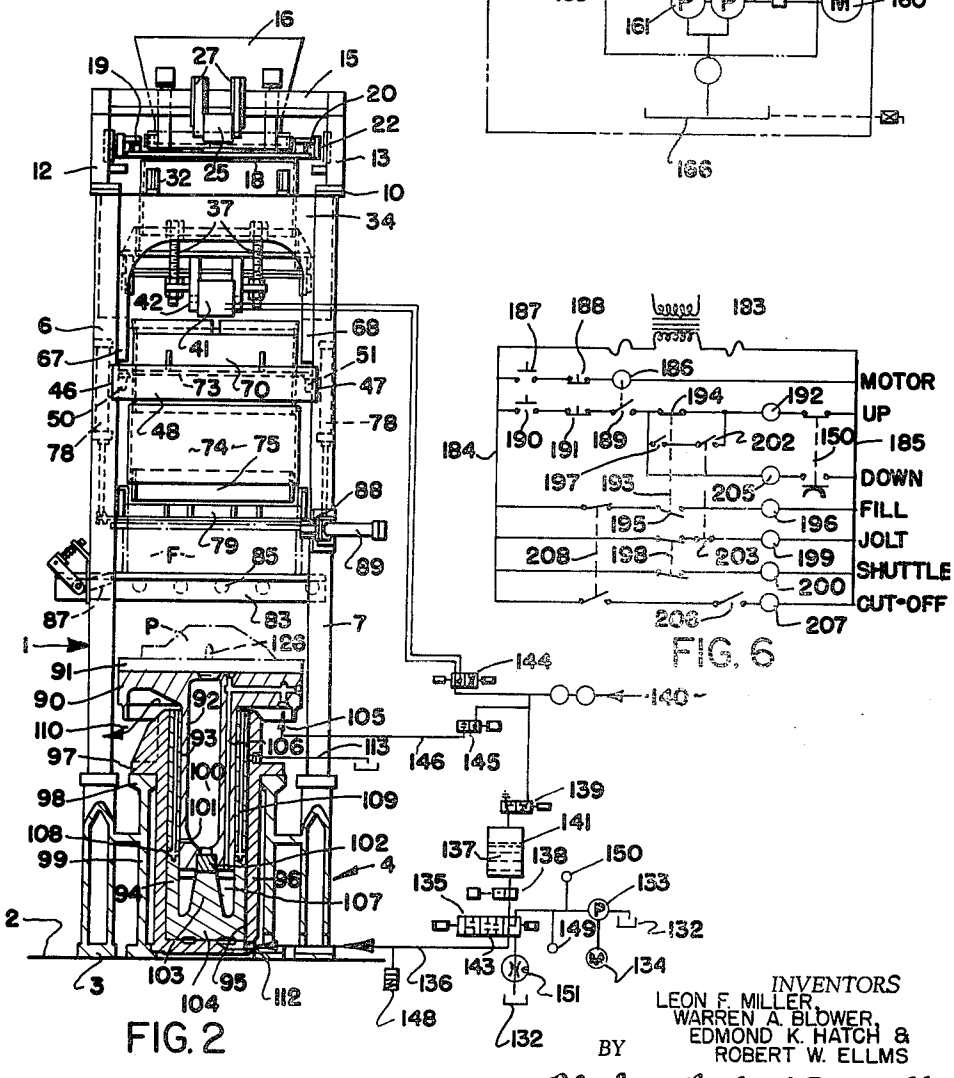


FIG. 2

FIG. 6

INVENTORS
LEON F. MILLER,
WARREN A. BLOWER,
EDMOND K. HATCH &
ROBERT W. ELLMS

BY

Oberlin, Maky & Donnelly
ATTORNEYS

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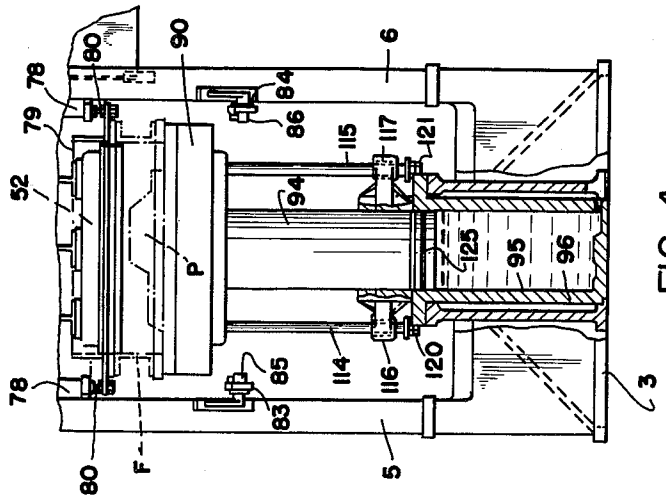


FIG. 4

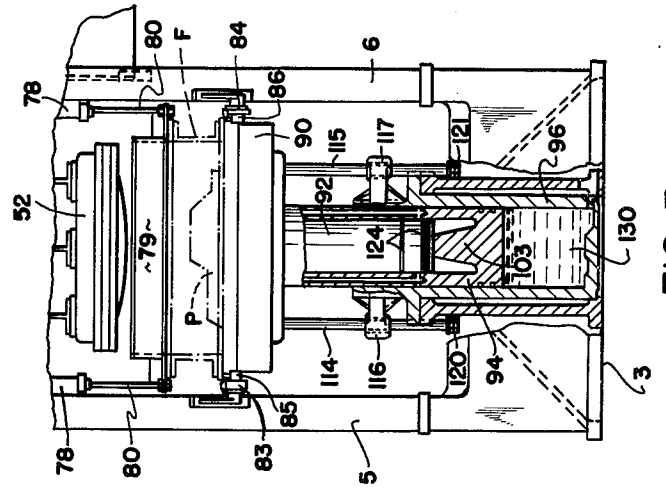


FIG. 3

INVENTORS
LEON F. MILLER,
WARREN A. BLOWER,
EDMOND K. HATCH &
ROBERT W. ELLMS

BY Oberlin, Maky & Donnelly
ATTORNEYS

United States Patent Office 3,205,542 Patented Sept. 14, 1965

3,205,542

JOLT-SQUEEZE MOLDING MACHINE WITH SQUEEZE PISTON SUPPORTED ON BODY OF HYDRAULIC FLUID

Leon F. Miller, Rocky River, Warren A. Blower, Cleveland, Edmond K. Hatch, Brecksville, and Robert W. Elms, North Olmsted, Ohio, assignors to The Osborn Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Filed Jan. 21, 1963, Ser. No. 252,644
10 Claims. (Cl. 22—45)

This invention relates generally as indicated to a molding machine and more particularly to a jolt and squeeze foundry molding machine for quickly and efficiently producing foundry sand molds. Specifically, foundry molds with the present invention are produced by a method wherein particulate molding materials such as foundry sand are gravity dumped into a pattern containing mold box or flask which is then jolted initially to compact the sand and the sand is then mechanically squeezed against such pattern to achieve the desired uniform consistency and surface hardness.

It is difficult to provide a jolt and squeeze molding machine which will cycle rapidly and efficiently to produce foundry molds and at the same time achieve the desired uniformity of mold consistency and surface hardness. For example, the pattern and pattern plate must be assembled with the flask to form a mold box or sand enclosure. The flask must then be filled with sand and the sand filled mold box then firmly supported for the subsequent jolt operation. After the jolt operation, the flask with the sand therein must then be moved relatively to a squeeze head to compress the sand against the pattern. Atfer the sand is properly compressed, the pattern and pattern plate must then be drawn from the sand mold. A machine which will then accomplish all of the above steps to produce a sand mold of the desired uniformity and surface hardness and yet rapidly cycle for efficient production is highly to be desired.

It is therefore a principal object of the present invention to provide a jolt and squeeze foundry molding machine which will accomplish all of the above functions with but a single complete stroke of a hydraulic cylinder.

A further important object is the provision of a jolt action at the most efficient point in the aforementioned complete stroke of the hydraulic cylinder.

A still further important object is the provision of such jolt action while the sand filled flask is firmly substantially inelastically supported by the hydraulic cylinder.

Another object is the provision of a jolt and squeeze molding machine not requiring the usual complex drawing mechanisms for removing the pattern from the mold.

Yet another object is the provision of a jolt foundry molding machine having an enlarged shock contact area.

Still another object is the provision of a firmly substantially inelastically supported jolt mechanism having a bottom strike eliminating the problems inherent with top strike jolts.

A still further object is the provision of a jolt mechanism having an air exhaust directed especially to protect the exposed surfaces of the hydraulic piston supporting the same.

A yet further object is the provision of a jolt machine for producing foundry sand molds which will have reduced shock in the housing and foundation, such shocks always being an inherent problem in jolt foundry sand molding.

And a further object is the provision of a jolt and squeeze molding machine which constitutes certain improvements in a molding machine of the type disclosed in the copending application of Edmond K. Hatch and Leon F. Miller, Serial No. 133,700, now Patent No. 3,169,285, filed August 24, 1961, entitled Overhead Squeeze Molding Machine.

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 certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

In said annexed drawings:

FIG. 1 is a front elevation of a jolt and squeeze molding machine in accordance with the present invention;

FIG. 2 is a side elevation of such machine with the bottom part of such machine broken away and in section and also illustrating schematically one form of control mechanism that may be employed to operate the machine;

FIG. 3 is a fragmentary side elevation similar to FIG. 2 on a somewhat enlarged scale illustrating the machine in its intermediate jolt position;

FIG. 4 is a view similar to FIG. 3 illustrating the machine in its mechanical squeeze position;

FIG. 5 is a schematic hydraulic diagram of another control mechanism for the present invention; and

FIG. 6 is a schematic wiring diagram illustrating more clearly the sequence of operation of the present machine.

Referring now to the annexed drawings and more particularly to the machine shown in FIGS. 1 and 2, it will be seen that such machine comprises a vertically extending frame 1 which is mounted on the floor 2 by means of heavy duty fasteners such as nut and bolt assemblies passing through the bottom flange 3 of a triangular section heavy duty base 4. Extending upwardly from the base 4 are four corner columns 5, 6, 7 and 8, columns 7 and 8 being behind columns 6 and 5, respectively in FIG. 1. Pedestals 10 on the top of the columns 5 through 8 support the legs 11, 12, 13 and 14 of a top rectangular frame 15 which surrounds and supports a hopper 16 adapted to be supplied with foundry sand from an overhead conveying system or the like.

The bottom of the hopper 16 is closed by two cut-off plates 17 and 18 mounted for reciprocation on horizontally aligned rows of rollers 19 and 20. These rollers are inwardly directed from roller bars 21 and 22 which are mounted on the insides of the legs 11 through 14 of the frame 15. The cut-off plates 17 and 18 are provided with marginal or side channel edges which enclose the rollers and the cut-off plates are then firmly held for reciprocation in the plane defined by the rollers 19 and 20. Movements of the cut-off plates are obtained by pitson-cylinder assemblies 24 and 25, the rod ends of the cylinders being pivotally mounted on clevises 26 and 27, respectively, secured to the frame 15. The rods 28 and 29 of the assemblies 24 and 25 are connected to the plates 17 and 18, respectively, so that as the assemblies retract, the plates will be pulled from beneath the hopper 16 to allow sand to drop therefrom. Extension of the rods will move the plate beneath the hopper to cut-off the sand supply.

Situated directly beneath the hopper 16 is a sand measuring box 30 supported by pairs of brackets 31 and 32 from cross plates 33 and 34 extending between the columns 5 and 8 and 6 and 7, respectively. The bottom of the box 30 is closed by a louver assembly 35 adjustably vertically supported on screws 36 and 37 which are in turn supported on the plates 33 and 34, respectively.

Louvers 38, shown as five in number, are opened and closed in unison by means of a bar 39 operated by the rod 40 of louver piston-cylinder assembly 41. The rod end of such assembly is pivotally mounted on brackets 42 extending from the louver assembly 35 and it will be seen that the entire assembly 35 including the piston-cylinder assembly 41 is vertically adjustable by means of the screws 36 and 37 to control the depth of the box 30 and thus the amount of sand to be charged in the machine. When the rod 40 is retracted, the louvers will open gravity discharging the sand within the box 30. After the sand has thus been discharged, the rod 40 will be extended closing the louvers and thus the box 30.

Secured to the inside of the columns 5 through 8 is a conveyor frame 45 which includes two longitudinally extending side frame bars 46 and 47 interconnected at one end by an end frame member 48 and at the opposite end by a tubular cross frame member 49. On such longitudinally extending side bars 46 and 47, there is mounted horizontally aligned rows 50 and 51 of inwardly projecting conveyor rollers supporting for horizontal shuttling movement squeeze head 52 and sand chute 53. The sand chute and squeeze head are interconnected by a link 54 for movement in unison obtained by a piston-cylinder assembly 55, the cylinder of which is pivoted at 56 to bracket 57 connected to the tubular cross frame member 49. The rod 58 of such assembly underlies a sand shield 59 and is connected at 60 to the squeeze head 52. The sand shield reciprocates with the squeeze head so as to cover completely the rod 58 in its extended position to protect the exposed surfaces thereof from falling sand.

The squeeze head 52 is comprised of a top support plate 62 which overlies the rows of rollers 50 and 51 supporting the squeeze head for such shuttling movement and three transverse I-beams 63 beneath such top plate support the chamber 64, the lower end of which is closed by a diaphragm 65 clamped to the chamber by clamping rings 66. The chamber 64 may be filled with fluid, liquid or gas, a combination of the two, rubber blocks, etc. backing up the diaphragm 65 so that it will conform to the top of the to be produced sand mold applying a uniform squeeze pressure over the entire top surface. Whereas the illustrated machine is shown with a diaphragm squeeze head, it will be understood that a multiple piston type squeeze head or a plain squeeze board may equally well be employed. The present machine with its shuttling squeeze head and chute facilitates the interchangeability of squeeze heads and other types may equally well be employed as well as squeeze heads of different size and configuration. The squeeze head 52 in the position shown in FIG. 1 underlies longitudinally extending relatively heavy plates 67 and 68 so that the top squeeze head plate 62 will then be confined between the rollers 50 and 51 and the plates 67 and 68 and restrained from vertical movement as the squeezing operation proceeds.

The sand chute 53 comprises a top hopper 70 having inclined longitudinal end plates 71 and 72 which ensure reception of the sand from the box 30 into the chute 53 when the chute is shuttled to the left as seen in FIG. 1 replacing the squeeze head 52 in the position shown. The peripheral horizontally extending flange 73 supports the chute upon the horizontal row of rollers 50 and 51 and an apron 74 extends from the top hopper 70 to guide the sand into the flask and fill frame as hereinafter described. The trailing edge of the apron 74 is provided with a scraper 75 to level the sand charge within the mold box.

Pneumatic cylinder assemblies 78, one secured to each of the columns 5 through 8, support a fill frame 79. The cylinder assemblies 78 resiliently bias the fill or upset frame 79 to its lowermost position, i.e., that shown in FIG. 1, and the pressure of the squeeze cylinder

elevating the flask will move the fill frame upwardly against the air pressure in the cylinder assemblies 78 to telescope about the clamping rings 66 of the squeeze head chamber 64. In other words, the upset frame 79 comprises an open bottom and top box dimensioned closely to telescope about the squeeze head. The downwardly extending rods 80 of the cylinder assemblies 78 are connected to brackets 81 mounted on the fill upset frame.

Extending transversely of the machine frame just below the fill or upset frame 79 are conveyor rails 83 and 84 provided with inwardly projecting horizontal rows of conveyor rollers 85 and 86, respectively. These conveyor rails may be secured directly to the machine columns 5 through 8 and, of course, constitute merely one section of a much larger conveyor for a flask handling system. A flask F, again an open bottom and top box or like container of similar peripheral configuration to the fill frame 79, may be shuttled into the machine from the left as seen in FIG. 2 riding over a spring loaded latch member 87 and coming to rest against a stop 88 operated by a piston-cylinder assembly 89. In the properly centered position against the stop, the spring latch 87 will then pop up confining the flask against horizontal movement in the proper position. The flask F is then ready to be assembled with a pattern and pattern plate and the fill frame 79 to be filled with sand for production of the foundry sand mold therein and the next flask coming into the machine will shuttle the completed mold off to the right as seen in FIG. 2 upon release of the stop 88 by the cylinder assembly 89.

Situated beneath the flask F is a table 90 supporting a pattern plate 91 and a pattern P thereon. The table 90 is provided with a centrally disposed downwardly projecting hollow piston 92 which projects into the bore 93 of a hollow cylinder 94. The hollow cylinder 94 is itself closed at the bottom and acts as the squeeze piston reciprocating in the bore 95 of cylinder 96. Such cylinder is seated in the bottom flange 3 of the base 4 and is provided with a top flange 97 seated on a buttress top edge 98 of cylinder 99 projecting centrally upwardly through the triangular section base 4. The cylinder 96 for the piston or hollow cylinder 94 is firmly secured to the base 4 as by suitable heavy duty fasteners passing through the flange 97 and the top edge 98 of the enclosing cylinder 99. The chamber 100 in the piston 92 is generally filled with waste and oil and constitutes an oil reservoir with oil seeping through small passageway 101 to lubricate the piston 92 within the bore 93 of the hollow piston or cylinder 94. The bottom of the chamber 100 is closed by a striking plug 102 which is force-fitted into a bore in the bottom of the jolt piston 92 abutting a shoulder in such bore and the bottom of the jolt piston is provided with an annular lip surrounding and supporting firmly such striking plug.

The striking plug 102 is supported on a centered frusto-conical projection 103 projecting from the bottom 104 of the hollow squeeze cylinder or piston 94. The jolt piston 92 is elevated within the squeeze piston 94 by means of air supplied through inlet 105 and through the passage 106 leading through the table and down along the chamber 100 to the bottom of the jolt piston and into a compression space 107. Air entering the passageway 106 under suitable pressure will then elevate the striking plug 102 and the jolt piston 92 off the projection 103 until the bottom of the jolt piston rises above the inlets 108 for the jolt air exhaust passages 109. Whereas only two exhaust passages 109 are illustrated in the sectional portion of FIG. 2, it will be understood that four, six or eight may be employed. When the bottom of the jolt piston 92 rises above the ports 108, the piston will then fall and the plug 102 will strike the projection 103 jolting the table 90 and whatever it supports. The exhaust passages 109 are directed vertically within the cylinder 94 and the exhaust air from the jolting action will be emitted

in the direction of the arrow shown at 110. The air under pressure being emitted by reason of the jolt action will then serve to maintain any exposed surfaces of either the jolt piston 92 or the squeeze piston 94 clear of loose sand or other particulate debris. This then materially reduces the wear normally encountered in such close fitting parts and lengthens the life of the machine.

The end of the bore 95 beneath the bottom wall 104 of the squeeze piston 94 is provided with a hydraulic oil inlet 112 so that hydraulic fluid under pressure admitted through the inlet 112 beneath the bottom of the squeeze piston will elevate the same and, of course, the jolt piston 92 and the table 90 supported thereby. An oil overflow or by-pass outlet 113 is provided in the bore 95 to limit the height that can be obtained by elevation of the squeeze piston. A line from the outlet 113 leads back to the hydraulic tank. The hydraulic outlet 113 may be used with or in lieu of vertically extending guide bolts 114 and 115 as shown in FIG. 1. These bolts are secured to the bottom of the table 90 and extend down through guide bushings 116 and 117 which project from the top 118 of the cylinder 96. Stop nut assemblies 120 and 121 are provided on the bottom of each guide bolt 114 and 115, respectively, and such will engage the respective bushings 116 and 117 to limit the elevation of the table 90.

As seen perhaps more clearly in FIGS. 3 and 4, O-ring seals 124, three in number, are employed to seal the jolt piston 92 within the cylindrical bore of the squeeze piston 94, and O-ring seals 125 are employed to seal the squeeze piston 94 within the cylindrical bore 95 of the cylinder 96.

As should now be apparent, hydraulic fluid is supplied to the bottom of the squeeze piston 94 through the inlet 112 to elevate the same and thus the table with the pattern and pattern plate 91 supported thereon. Guide pins 126 which enter holes in the flask F are employed properly to center and align the pattern with the flask as the pattern plate engages the flask. With reference to FIG. 3, the squeeze piston is shown elevated to a position wherein it has picked up the flask lifting the same slightly from the conveyor rollers 85 and 86. The flask F will be picked up to such an extent as to cause engagement between the flask and fill frame 79 so that there is thus formed a mold box comprised of the fill frame 79, the flask F, which is now bottom closed by the pattern plate 91. The pattern P will then properly be positioned within such enclosure or sand container. The air within cylinders 78, of course, will maintain the fill frame 79 firmly against the top of the flask F.

At this time, the cylinder 55 will be retracted and the sand chute 53 will be positioned over the thus formed sand enclosure. A charge of sand within the measuring box 30 will then be dumped within such enclosure by opening of the louvers 38 by retraction of the louver cylinder assembly 41. It will, of course, by understood that the cut-off plates 17 and 18 will have been extended to their closed position to block further flow of sand from the hopper 16 into the measuring box 30. After the sand charge is dumped into the sand enclosure, the louvers 38 will then be closed by extension of the rod 40 and the cut-off plates can then be retracted to dump another charge of sand within the sand measuring box 30.

Sand will fall from the box 30 through the louvers 38 through the chute 53 into the sand enclosure formed by the fill frame flask and pattern plate and the apron 74 will maintain sand spillage to a minimum. With the sand enclosure thus filled with sand, the cylinder 55 is extended and the rod 58 thereof will shuttle the chute 53 and the squeeze head 52 to the position shown in FIG. 1. In the meantime, the sand filled enclosure supported on the table 90 will be jolted by reason of an air pressure supply through the inlet 105 and the inlet passage 106 to the pressure chamber 107 at the bottom of the jolt piston 92. A jolting action is accordingly obtained which will cause the jolt piston to elevate and drop with the striking plug 102 striking the projection 103 and the number and frequency of the jolts thus obtained can be closely regulated by the pressure and time duration of the air supply to the jolt piston. At this time, the jolt mechanism as well as the table, pattern plate, sand enclosure formed therewith and the sand itself will be supported on a substantial body of inelastic fluid, i.e., the hydraulic fluid which caused the elevation of the table to the FIG. 3 position. This body of fluid is shown at 130 in FIG. 3.

The bottom of the striking plug 102 is generally slightly rounded so that it contacts a relatively small area on top of the projection 103. A bottom strike jolt is usually preferable in that it eliminates wear problems and subsequent misalignment, etc., involved in a top strike or one where the top of cylinder 94 would absorb the jolt shock. A point shock, however, has been found to be detrimental not only to the machine frame and components, but also to the machine foundation. But, the oil base 130 beneath the bottom 104 of piston 94 better distributes and absorbs this shock. A large area interface is provided between the top of the column of oil 130 and the bottom 104 of the supporting squeeze piston. In the illustrated embodiment, the diameter of the column of hydraulic fluid may be from 16 to 18 inches whereas the diameter of the contact between the rounded plug 102 and projection 103 may be 1 inch or less. Thus the body 130 of hydraulic fluid dampens or absorbs the shock normally created in a metal-to-metal shock contact. The peak hydraulic pressure at impact may reach 4000 p.s.i., but such is well within the load of the system.

After the jolt portion of the cycle, which may last a few seconds and impart as many as ten substantial jolts to the sand filled container, hydraulic fluid is again supplied beneath the squeeze piston 94 elevating the piston to the FIG. 4 position wherein the flask and fill frame 79 will telescope about the squeeze head 52 causing the top surface of the sand within such container to be compressed against the vertically fixed squeeze head 52. The diaphragm 65 in the squeeze head will engage the top surface of the sand and will equalize the pressure of the squeeze over the entire top surface of the sand mold.

When a predetermined maximum pressure has been reached in the hydraulic system elevating the sand filled flask, the cycle of operation will reverse and the squeeze piston 94 will descend. As the table is thus lowered, the flask and fill frame will telescope away from the squeeze head 52 and the fill frame 79 will then separate from the flask F as the piston rods 80 reach their maximum extent. The flask will then be lowered further and placed upon the rollers 85 and 86. Continued lowering of the table 90 will then draw the pattern P from the sand mold within the flask and during the draw cycle of the machine, the table may be vibrated to facilitate the drawing of the pattern. The flask with the thus produced sand mold is then placed upon the horizontal rows of conveyor rollers 85 and 86 and the table is then lowered to the position shown in FIGS. 1 and 2. The cycle of the machine is then substantially complete and a flask entering the machine from the left in FIG. 2 will push the completed sand mold within the flask F off to the right when the latch 38 is released.

The complete cycle of operation of the machine is accordingly accomplished on a two stage up stroke of the squeeze piston 94 with an intermediate halt for the jolt operation on the substantial body of an inelastic fluid, and a one stage down stroke of the same squeeze piston 94 to draw the pattern from the mold after the same has been mechanically squeezed against the squeeze head. Accordingly, the machine accomplishes the steps of assembling the sand container, filling the container, jolting the sand within the container, mechanically squeezing the sand after jolting, and drawing or disassembling all on one complete reciprocatory stroke of the squeeze piston 94.

Rapid cycling of the machine may be obtained by the controls shown diagrammatically in FIG. 2 wherein hydraulic fluid under pressure is supplied from reservoir **132** to a pump **133** driven by motor **134**. The output of the pump **133** is supplied to a solenoid operated control valve **135**. The valve in the up position shown will supply the pump output to the line **136** leading to the port **112** in the bottom of cylinder **96**. However, the output of the pump **133**, which is preferably a high pressure, low capacity pump, is insufficient to supply the volume of fluid **130** in a time interval short enough for the efficient and fast operation of the machine. Therefore, in order to elevate the table rapidly to the position wherein the flask and fill frame will be picked up whereby sand can be dumped on top of the pattern on the table, an additional supply of hydraulic fluid **137** is connected to the control valve **135** through shut-off valve **138**. With the shut-off valve **138** opened, solenoid operated valve **139** may be shifted to supply air from source **140** to the surface of the fluid **137** in container **141**. The air pressure then acting on the relatively large upper surface of the body of fluid **137** will force such fluid through the control valve **135** to add to the output of pump **133** to elevate the squeeze piston **94** rather rapidly through the initial assembling part of its up stroke.

When the proper height of the table **90** has been obtained and the flask and fill frame are assembled, this height being at least the necessary extent of the subsequent draw plus the distance required to lift the flask from rollers **85** and **86**, e.g., ½ inch, the control valve **135** may be shifted to the center blocking position **143**. This will then lock the squeeze piston **94** in the position shown in FIG. 3 wherein it will be supported on a substantial body **130** of inelastic hydraulic fluid. At this time, the valve **144** will be opened supplying air to the louver piston-cylinder assembly **41** allowing sand to drop from the measuring box **30** into the thus formed sand enclosure onto the pattern P. The louvers will then be closed to close the bottom of the measuring box **30** for reception of the next sand charge. While the table is still locked in its elevated intermediate position, the valve **145** is now opened for a predetermined short interval to supply air through line **146** to the inlet **105** of the jolt mechanism. Air under pressure will now be supplied to the compression space **107** elevating the jolt piston **92** until the vent openings **108** are exposed and the table will then drop with the striking plug **102** hitting the truncated top of the projection **103** transmitting the jolting force evenly to the body of hydraulic fluid **130** and thus to the machine frame. When the jolt piston **92** drops, the vents **108**, of course, will be closed causing the jolt action to proceed through a predetermined number of cycles depending upon the duration that the valve **145** is open.

If desired, a spring loaded plunger **148** may be provided in the hydraulic fluid supply line **136** to obtain a controlled cushion for the jolt. In certain types of sand molding operations, it may be desirable not to have the normal sharp impact resulting from jolting operations. However, the body **130** of the hydraulic fluid and the construction of the projection **103** and the striking plug **102** will reduce the shock in the housing and foundation sufficiently without the controlled cushion mechanism **148**. Selective control of the extent of the cushion may be obtained by selecting the desired spring or by controlling the excursion of the spring loaded piston by means of an adjusting screw or the like.

In lieu of the spring loaded plunger, a trapped air cushion may be employed. It may have, for example, a 1/16 or 1/32 inch displacement and the amount of the cushion of the jolt can be controlled simply by bleeding off trapped air which can be supplied from the usual foundry source. It must be understood that the jolt action here is not necessarily to ram the mold as hard as possible, but to get the sand properly positioned around the pattern for the subsequent mechanical squeeze.

When the jolt portion of the cycle is complete, the valve **145** will be closed and the control valve **135** will be shifted from its center blocking position **143** back to the position shown in FIG. 2. The high pressure pump **133** and the air-over-oil supply will now supply fluid through the line **136** to elevate the table **90** from the FIG. 3 to the FIG. 4 position causing the container formed by the fill frame **79** and the flask F on top of the pattern plate **91** to telescope about the squeeze head **52** causing engagement between the diaphragm **65** and the top surface of the jolted sand within the flask. It will, of course, be understood that after the flask is filled, the piston-cylinder assembly **55** will be extended to position the squeeze head in the position shown in FIG. 1. As the diaphragm engages and conforms to the upper surface of the sand within the flask, increasing resistance is met and the pressure in line **136** will accordingly increase and a pressure switch **149** will be employed to shift the valve **138** to allow the high pressure pump alone to lift the table to provide a high pressure mechanical squeeze. When a predetermined high pressure is obtained in line **136**, pressure switch **150**, of course, set higher than switch **149**, will be employed to shift control valve **135** to the extreme right as seen in FIG. 2 to permit then the fluid to drain from the bottom of the squeeze piston **94** through the line **136**, the valve **135**, through flow regulator **151** to tank **132**. Valve **138** may be opened here to replenish the supply **137**. The spill line **113** or the bolts **114** and **115** may also be employed to limit the upward extent of the table. The table will now descend due to the weight of the jolt and squeeze pistons with the sand filled flask thereon forcing the fluid outwardly through the line **136**. During such lowering of the table, the flask will automatically be deposited on the rollers **85** and **86** and the pattern drawn from the mold.

Referring now more particularly to FIG. 5, there is illustrated a slightly modified form of hydraulic control mechanism for obtaining the same aforementioned cycle of the squeeze piston encompassing one complete vertical stroke thereof. Hydraulic pump motor **160** drives two constant volume pumps **161** and **162**. The pump **162** is a large volume pump and the pump **161** is a small volume pump pumping fluid at a lesser rate at a much higher pressure. The outlet of pump **162** is connected to an unloading valve **163** and through check valve **164** to line **165**. The unloading valve is designed to unload the production of pump **162** to the tank **166** when the pressure in line **165** increases above a certain predetermined pressure. For this purpose, a pilot line **167** is connected from the unloading valve **163** to the line **165**.

The production of pump **161** is connected directly to the line **165** and is precluded from passing through the unloading valve by check valve **164**. A relief valve **168** is mounted on the line **165** and a pressure gauge **169** may also be mounted on such line.

Line **165** leads to a directional valve, generally indicated at **170** through line **171**. The valve **170** may, for example, be a four-way double solenoid controlled, spring centered, pilot operated hydraulic control valve. The solenoid controled pilot valve **172** of valve **170** is controlled by solenoids **173** and **174**. When the pilot valve **172** is in its centered position, the connections to the pressure line **171** are blocked and the ports connecting both the pilot lines **175** and **176** are opened to the tank **166** through the drain line **177**. When the hydraulic valve **178** of the directional valve **170** is in its centered position, the pressure line **171** is connected directly to tank **166** thorugh the line **179**. It will now be seen that when the valve **170** is deenergized and both valves **172** and **178** are in their centered positions, the hydraulic pumps will merely circulate hydraulic fluid from the tank through the lines **165**, **171** and **179** back to the tank.

In order to cause the table **90** to move upwardly, solenoid **174** is energized to connect the pressure line **171** to

the pilot line 175, thereby moving the valve 178 to connect the pressure line 171 directly to the supply line 180. This supply line is connected directly at 112 to the blind end of the squeeze cylinder 96. In order to raise the table 90 with the pattern plate and pattern thereon, only a very low pressure need be created in the hydraulic system and it will be seen that the combined volume of the pumps 161 and 162 will rapidly raise the table 90 to the desired position to assemble the fill frame 79 and flask with the pattern plate 91. When the table has reached its intermediate position as shown in FIG. 3, the solenoids 173 and 174 may be deenergized centering the valves 178 and 172 causing the output of the pumps 161 and 162 to circulate to the tank 166 and blocking the line 180. At this position, the filling and jolt operations will occur.

When the sand is within the flask and has been jolted, the table is again lifted by again energizing the solenoids 173 and 174 in the manner above indicated causing the output of both pumps 161 and 162 to be supplied to the line 180 lifting the jolted sand against the squeeze head 52. The piston-cylinder assembly 55 will in the interim, of course, be extended properly to position the squeeze head as shown in FIG. 1. As the diaphragm contacts the top surface of the sand mold, resistance will be met by the hydraulic fluid in line 180 increasing the pressure therein above the unloading pressure of valve 163. Since the line 167 is connected directly to the line 165, the increased pressure will unload the production of the pump 162 and the pump 161, the high pressure low volume pump, will alone take over the lifting of the table at such low volume and high pressure. When the desired predetermined pressure of the squeeze head upon the sand is obtained, pressure switch 182 is actuated bringing the valves 172 and 178 to the proper position opening line 180 to the drain line 179 to tank 166 permitting the table now to descend. Thus the combined output of the pumps 161 and 162 will elevate the table rapidly at low pressure and when the higher pressure is encountered as the result of the mechanical squeezing operation, the pump 162 unloads by reason of the unloading valve 163 and the high pressure pump 161 alone will move the sand against the squeeze head.

Referring now to FIG. 6, there is illustrated a schematic simplified wiring diagram whereby the components of the machine utilizing either the hydraulic controls of FIG. 2 or 5 can be cycled with the cycle of operation either commencing manually or automatically. The electric current is supplied from a step-down transformer 183 to two mains 184 and 185, between which are the relay controls of the illustrated machine embodiments. A motor starting relay 186 is employed to start the motor driving the hydraulic pumping system. Push button switches 187 and 188 may be employed to energize and deenergize, respectively, the relay 186. The motor start relay 186 also closes contacts 189 preparing a circuit for the start of the cycle of the machine. The cycle can then be started or stopped, respectively, by the push button switches 190 and 191. Although push button or manual switches are shown, it will readily be understood that limit switches may readily be substituted which are responsive to the proper positioning of the flask F within the machine so that the machine will operate completely automatically in an automated foundry line. With the switches 189 and 190 closed, the up relay 192 will now be energized controlling the directional valves 135 or 170, as the case may be, to supply hydraulic fluid to the blind end of the cylinder 86 containing the squeeze piston 94. In the case of the FIG. 2 embodiment, the relay 192 will also control the operation of valves 138 and 139 so that the table will rise relatively rapidly to assemble the flask and fill frame in the fill position. When such fill position is obtained, limit switch 193 will open contacts 194 and close contacts 195 deenergizing relay 192 and energizing relay 196, respectively. Relay 196 will operate the valve 144 causing the louver piston-cylinder assembly 41 to retract opening the louvers 38 to dump the sand charge in the measuring box 30 into the assembled flask, fill frame and pattern plate.

The relay 196 will, on delay, close contacts 197 and also the set of contacts 198, the latter energizing both the jolt relay 199 and the shuttle relay 200. The shuttle relay 200 will, of course, cause the extension of piston-cylinder assembly 55 to move the chute 53 to the right after the sand filling operation and to replace the same in the machine frame by the squeeze head 52. The energization of the relay 199 will operate valve 145 to supply air through line 146 to the jolt piston. On delay, switch 201 will now be energized closing contacts 202 and opening contacts 203 again energizing the up relay 192 and deenergizing the jolt relay 199, respectively. The table will now again move up elevating the sand filled flask against the squeeze head to apply an equalized mechanical squeezing operation to the entire top surface of the sand within the flask.

When a predetermined maximum pressure is reached in the hydraulic system, the pressure switch 150 will deenergize the up relay 192 and energize the down relay 205 which now shifts the directional valve 135 or 170, as the case may be, to cause the table to descend. The table will now descend past the conveyor rollers 85 and 86 depositing the flask F thereon with the mold therein and further lowering of the table will draw the pattern from the mold.

A limit switch 206 will close upon the completion of the operation of the louver cylinder assembly 41 preparing a circuit to the cut-off relay 207 so that the cut-ofl cylinder assemblies 24 and 25 will retract when the louvers are closed as dictated by interlocking limit switch 208. The contacts of this latter limit switch ensure that the cut-off cylinder assemblies 24 and 25 cannot be retracted while the louvers 38 are opened. Suitable holding circuits will be provided for the various relays in the conventional manner ensuring their timely deenergization throughout the cycle of operation. When the table descends, the cycle will be completed when the latch 88 is released by the piston-cylinder assembly 89 and the flask F is replaced by an empty flask shuttled in from the left as seen in FIG. 2. When such second flask obtains its proper position, the cycle may then be repeated.

It can now be seen that there is provided a simplified jolt and squeeze foundry molding machine wherein a single hydraulic piston-cylinder assembly on one complete stroke accomplishes the following functions:

(1) Assembles the pattern plate, flask and fill frame to form a sand enclosure;

(2) supports such enclosure after filled with sand on a substantially inelastic fluid base for a bottom strike jolting operation, such fluid base reducing the shock in the housing and foundation which is always an inherent problem in jolt molding machines;

(3) further elevates the sand filled flask to squeeze mechanically the top surface of the sand mold;

(4) lowers the flask and fill frame to disassemble these components; and

(5) further lowers the flask to deposit the mold on a mold discharge conveyor while further lowering the pattern plate and pattern to draw the latter from the mold.

It can also be seen that with the striking plug 102 in the bottom of the jolt piston engaging the projection 103 in the bottom 104 of the squeeze piston 94, especially when the latter is elevated on the body 130 of hydraulic fluid, the shock contact area of the jolt is enlarged and, of course, the shock in the housing and foundation is reduced. Moreover, with the top strike eliminated, i.e., a strike about the top of the supporting cylinder or piston 94, the problems of uneven wear in an annular strike surface are avoided. The exhaust of the jolt, which is directed through the top of the squeeze piston 94, serves then to direct dirt and sand away from the exposed surfaces of the jolt and squeeze pistons. Accordingly, a

simplified sand molding machine is provided eliminating complex draw mechanisms and overhead hydraulics for mechanical squeezes.

Other modes of applying the principle 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.

We, therefore, particularly point out and distinctly claim as our invention:

1. A jolt-squeeze molding machine comprising a squeeze head, a horizontally extending flask supporting conveyor beneath said head, a flask supporting table vertically reciprocably mounted beneath said head, means operative to elevate said table to lift such flask from said conveyor and firmly support the same on a body of hydraulic fluid, means operative to fill such flask with sand, means operative to jolt such sand within such flask while thus firmly supported on such hydraulic fluid, and means further to elevate said table to move the sand within such flask against said squeeze head.

2. A jolt-squeeze molding machine as set forth in claim 1 including means responsive to a predetermined squeeze pressure on such sand operative to move said table away from said squeeze head to deposit such flask on said conveyor for discharge from the machine.

3. A jolt-squeeze molding machine comprising a squeeze head, a horizontally extending flask supporting conveyor beneath said head, a table having a pattern thereon vertically reciprocably mounted beneath said head, means operative to elevate said table to lift such flask from said conveyor and firmly support the same on a body of hydraulic fluid, means operative to fill such flask with sand, means operative to jolt such sand within such flask while thus firmly supported on such hydraulic fluid, means further to elevate said table to move the sand within such flask against said squeeze head, and means responsive to a predetermined squeeze pressure on such sand to move said table away from said squeeze head to deposit such flask on said conveyor and to draw the pattern from the sand mold within such flask.

4. A jolt-squeeze molding machine comprising a frame including a base, a squeeze head spaced vertically above said base, an upwardly extending hydraulic cylinder in said base, a squeeze piston in said cylinder thus vertically reciprocably mounted in said base, a table on said piston adapted to support a pattern plate thereon, means operative to elevate said squeeze piston and thus said table to engage and support a flask on a body of hydraulic fluid, means to fill such flask with sand, means within said squeeze piston operative to jolt the sand in such flask while thus supported on such hydraulic fluid, and means further to elevate said squeeze piston and thus such sand filled flask against said head mechanically to squeeze the sand therein.

5. A jolt-squeeze molding machine as set forth in claim 4 including means responsive to a predetermined squeeze pressure on such sand operative to lower said squeeze piston and thus such flask away from said head.

6. A jolt-squeeze molding machine as set forth in claim 4 including a jolt piston in said squeeze piston, a bottom striking plug on said jolt piston, an upwardly extending central frusto-conical projection in the bottom of said squeeze piston operative to distribute the shock of said jolt piston against the bottom of said squeeze piston to distribute the jolt strike to such body of hydraulic fluid beneath said squeeze piston and to said machine.

7. A jolt-squeeze molding machine comprising a frame including a base, a squeeze head spaced vertically above said base, an upwardly extending hydraulic cylinder in said base, a squeeze piston in said cylinder thus vertically reciprocably mounted in said base, a table mounted on said piston adapted to support a pattern plate thereon, means operative to supply said hydraulic cylinder with hydraulic fluid under pressure to elevate said squeeze piston and thus said table to engage and support a flask thereon on a body of such hydraulic fluid, means to fill such flask with sand, means within said squeeze piston operative to jolt the sand within such flask while said squeeze piston is thus supported on such body of hydraulic fluid, and means further to elevate said squeeze piston and thus such sand filled flask against said squeeze head mechanically to squeeze the sand therein.

8. A jolt-squeeze molding machine as set forth in claim 7 including a jolt piston within said squeeze piston supporting said table thereon, a striking plug in the bottom of said jolt piston, a frusto-conical projection in the bottom of said squeeze piston operative to absorb the jolt shock between said squeeze and jolt pistons, and a compression chamber surrounding said projection operative to be supplied with air under pressure to cause said jolt piston to strike said projection.

9. A jolt-squeeze molding machine as set forth in claim 8 including vents for said jolt piston extending longitudinally upwardly of said squeeze piston whereby the exhaust of said jolt piston will be directed from beneath said table to protect the exposed surfaces of said jolt and squeeze pistons.

10. A jolt-squeeze molding machine comprising 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, means operative to move said table toward said squeeze head to assembly said fill frame and flask to form a sand receiving enclosure and firmly substantially inelastically to support the same, means to fill said enclosure with sand, means operative to jolt the sand within such enclosure, means operative to move said sand filled enclosure against said head mechanically to squeeze the sand therein, said means operative to move said table toward said squeeze head comprising a vertically extending squeeze piston-cylinder assembly, said means to jolt the sand within such enclosure comprising a jolt piston within said squeeze piston supporting said table thereon, and a frusto-conical projection in the bottom of said squeeze piston operative to engage said jolt piston and distribute the shock contact area between said jolt and squeeze pistons to said machine, said squeeze piston being supported on a body of hydraulic fluid thus to distribute the jolt shock to the machine enlarging the shock contact area.

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MARCUS U. LYONS, *Primary Examiner.*

ROBERT F. WHITE, *Examiner.*