June 15, 1954 H. J. B. HERBRUGGEN 2,680,889

CORE BLOWING APPARATUS

Filed April 9, 1952 2 Sheets-Sheet 1

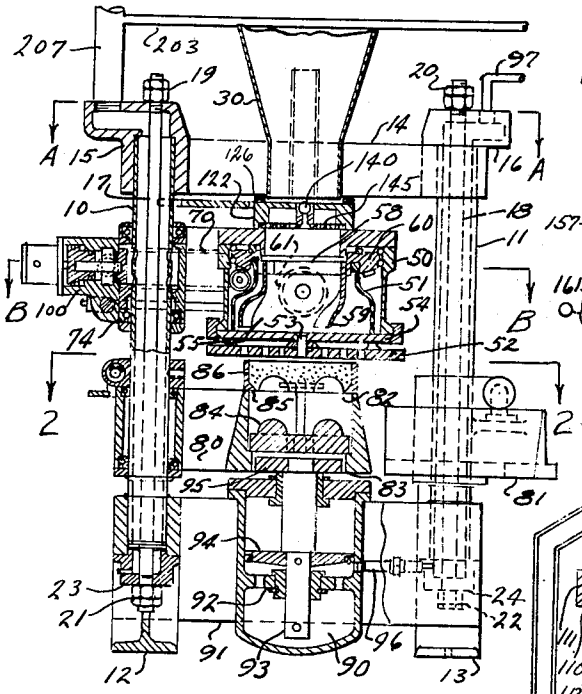


Fig. 1

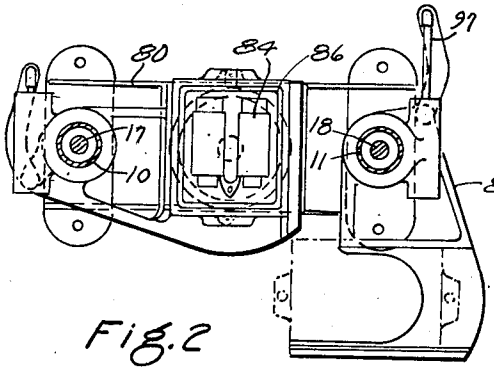


Fig. 2

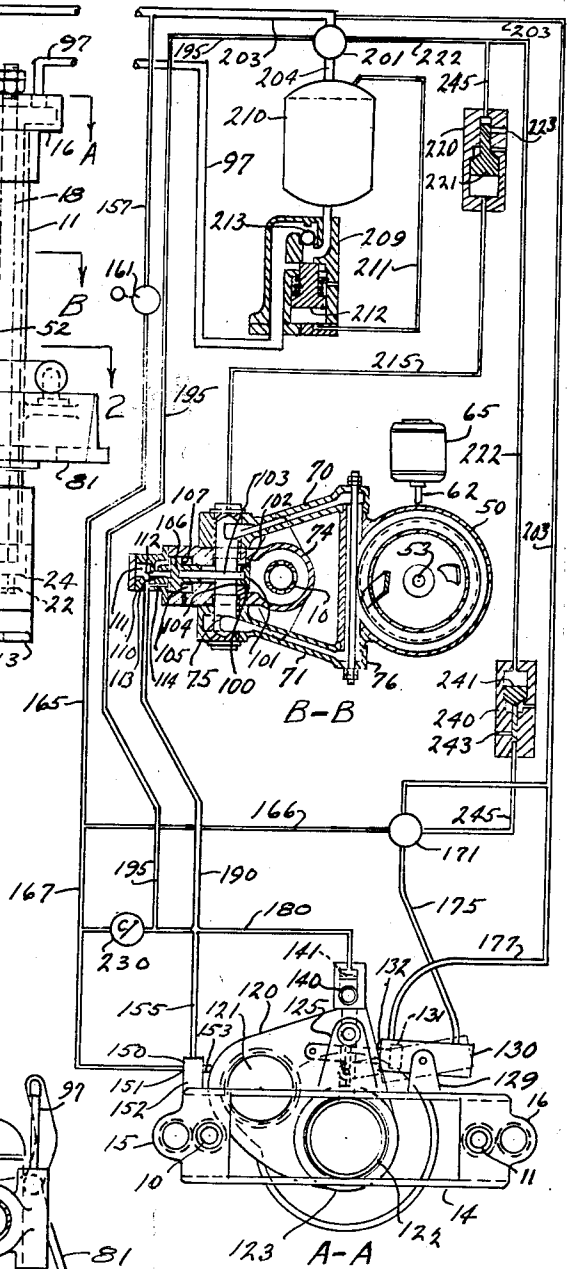


Fig. 3

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2 Sheets-Sheet 2

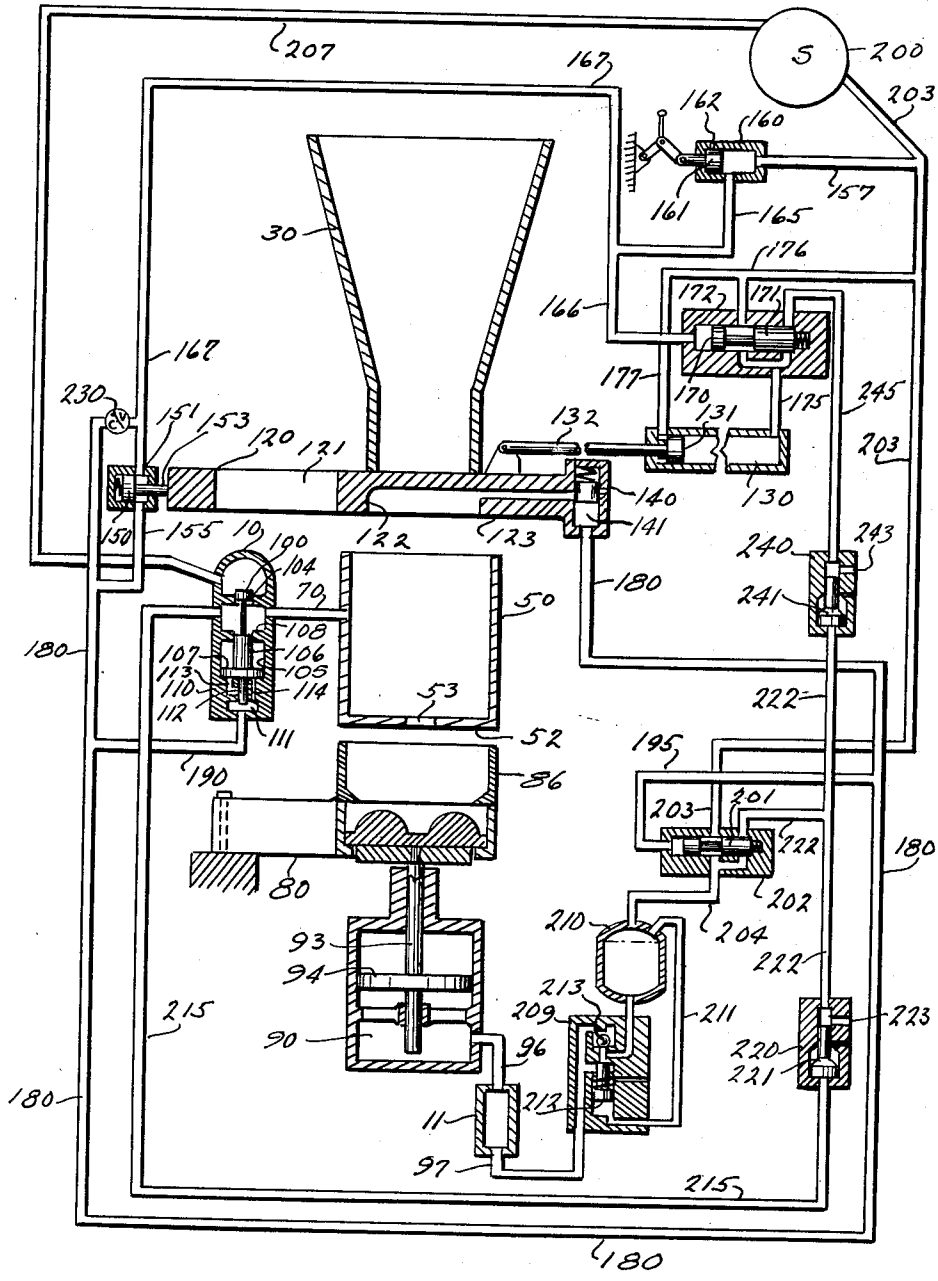


Fig. 4

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CORE BLOWING APPARATUS

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Application April 9, 1952, Serial No. 281,371

16 Claims. (Cl. 22—10)

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This invention relates to a system and apparatus for blowing cores and molds and, more particularly, is concerned with a core blowing apparatus having a controlled fluid pressure operating system.

Basically, the core blowing apparatus of the type under consideration embodies a sand transfer chamber supported in operative relation to a core or mold box which may be positioned in core blowing relation to the sand chamber by means of a clamp or lift arrangement. The positioning and blowing operations may be controlled individually or automatically in successive related stages. Among the difficulties attending such operations is the proper sequential control of such related successive operations. Improper sequential control of the operations or inadequate safeguards against individual functional operation of some apparatus component which is unrelated to the overall core blowing operation present a number of difficult problems.

By way of example, the usual sequence of operations contemplates that the core or mold box be securely and properly in position before the core blowing operation takes place. Likewise, optimum operation requires that the sand chamber be exhausted after the blowing operation is completed sufficiently to prevent the escape of sand under pressure into the surrounding environment should the core or mold box be removed from operative position. Such improper operating sequence may create unfavorable working conditions and endanger the operation, as well as decrease the output of the apparatus and increase wear and tear to such an extent as to offset reasonable maintenance.

Accordingly, it is an object of this invention to provide a core blowing apparatus having a controlled fluid pressure operating system which will automatically insure proper sequential operation of the respective core blowing functions of the apparatus.

Another object of the invention relates to the utilization of the frame and supporting members as fluid pressure conduits in the operating system.

Briefly, in accordance with this invention there is provided a core blowing apparatus including a sand transfer chamber which has provision for the admission and discharge of air and sand and, also including a fluid pressure operated removable cover cooperating as a gate between the chamber and a sand storage hopper. The sand transfer chamber is operatively supported relative to a movable core or mold box support that

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is positioned into operative core blowing relation by means of a fluid pressure controlled lift mechanism while the supporting frame and intermediate supporting structures are utilized advantageously as fluid pressure conduits in the operating system.

The invention further embodies a common fluid pressure operating system for positioning the cover in operative relation over the sand chamber which positioning automatically applies operating pressures to pneumatic controls for the lift mechanism and for the admission of air to the sand transfer chamber. The pneumatic controls automatically delay the admission of the operating pressure within the chamber until after the lift mechanism has initially moved the core box or mold into core blowing relation with respect to the chamber and, after the core blowing operation is completed, automatically delays the return or release of the lift mechanism to separate the core box or mold from the blow chamber until and in response to a predetermined reduction of the operating pressure within the sand transfer chamber. The system also automatically provides for the removal of the cover into sand charging position in response to a predetermined reduction of fluid operating pressure within the lift mechanism, thereby insuring that the cover is not removed from the chamber until after the lift mechanism has been released.

In the drawings,

Fig. 1 is a vertical view of the core blowing apparatus structure illustrating in partial cross section the interior construction of the principal operating members;

Fig. 2 is a horizontal view taken along the lines 2—2 in Fig. 1, illustrating in plan view one of the pneumatically positioned core or mold box supporting arms;

Fig. 3 is a schematic illustration of a portion of the operating system connected in plan view with the cover operating mechanism as shown at A—A, which is a partial view of the apparatus taken along the lines A—A in Fig. 1, and with the sand transfer chamber as shown at B—B, which is a partial view of the apparatus taken along the lines B—B in Fig. 1 of the drawings; and,

Fig. 4 is a diagrammatic illustration of a combined pneumatic and hydraulic operating system for the apparatus of Fig. 1 schematically illustrating only the basic operating members essential to such operation.

Referring now to the preferred embodiment in

Fig. 1 of the drawings, there is shown a rigid frame for supporting the operating members of the core blowing apparatus of this invention which frame embodies a pair of spaced vertical pillars 10 and 11, each of which are hollow tubular like members adapted to serve as conduits in the operating system as will be hereinafter more fully described. Each of the pillars are supported by base members 12 and 13 and are rigidly secured together at the top by a cross member 14. The cross member 14 has suitable spaced coupling members 15 and 16, each of which are hollow so as to provide communicating reservoirs between each of the hollow pillars 10 and 11 and the corresponding connecting conduits 207 and 97 to the operating system respectively. Connecting rods 17 and 18 extend through the corresponding coupling members and pillars and are each provided at the top end with nuts 19 and 20, which threadingly engage the top end of the corresponding connecting rod, and at the bottom end with nuts 21 and 22, which engage corresponding bearing surfaces 23 and 24 on the base members 12 and 13. Thus, when the respective nuts at the ends of the connecting rods are tight, the entire structure is made rigidly secure to provide a rigid rectangular frame for the operating elements or members of the core blowing apparatus.

The cross member 14 carries a sand hopper 30 which communicates through the cross member to feed sand into a sand transfer chamber 50 operatively disposed therebelow. The sand transfer chamber 50 is in the form of a hollow cylindrical member open at the top and having an annular baffle 51, of lesser diameter, concentrically mounted therein. The transfer chamber is provided with a removable base in the form of a blow-plate 52 having a central core blowing opening 53 which is adapted to communicate with a core or mold box cavity that may be operatively supported therebelow. The removable blow plate 52 may be coupled to the cylindrical chamber 50 through an externally accessible coupling spider 54. The baffle 51 forms a sand chamber 55 within the transfer chamber and the space between the baffle and the external cylindrical wall of the transfer chamber provides an air space about the sand chamber by means of which air under pressure may be admitted through a plurality of openings in the baffle 51 to the sand chamber 55.

The sand chamber 55 is provided with an agitating member 58 having annular spaced stirring elements 59 which are secured to a ring gear 60 operatively positioned in bearings within the air space in the chamber for rotation along the top edge of the baffle 51. A pinion 61, shown in dotted lines in Fig. 1, coacts with the ring gear 60 within the air space to drive the ring gear and rotate the stirring elements 59. The pinion 61 may be carried on a shaft 62 extending through the external cylindrical wall of the transfer chamber 50 and in turn coupled to a source of driving power such as a motor 65.

Referring now to Fig. 3 of the drawings, and particularly to the portion designated B—B therein, the sand transfer chamber 50 is shown supported from the pillar 10 by hollow arms 70 and 71 which extend from opposite sides of the cylindrical chamber wall towards the pillar 10. The extended ends of the supporting arms are pivotally coupled to a rotatable sleeve 74 on the pillar 10 through a hollow horizontal shaft 75 which communicates interiorly with the hollow interior of the respective supporting arms 70 and 71. The ends of the supporting arms adjacent the transfer chamber 50 are likewise coupled through another hollow horizontal shaft 76 with the air space in the transfer chamber 50. The hollow shaft 75 also communicates intermediate its ends through a pneumatically controlled valve with the hollow interior of the pillar 10, thereby providing continuous valve-controlled communication from the interior of the pillar 10, through the hollow shaft (75), thence through the supporting arms 70 and 71 and the hollow shaft 76 to the air space of the transfer chamber 50, as will be hereinafter more fully described in connection with Fig. 4 of the drawings.

The apparatus is intended to blow either cores or moles and is provided with a pair of supports 80 and 81 therefor which enables a high number of blowing operations per working hour. The core or mold supports 80 and 81 are each mounted for pivotal movement about a corresponding supporting pillar of the apparatus frame, as shown in Figs. 1 and 2 of the drawings. Each supporting arm has an opening 82 therethrough with an inwardly turned lower flange 83 upon which a pattern plate 84 may be supported. The size of the opening through the arm is such that a flask or core box 86 may be supported on its upper edge. The flask or core box is preferably provided with an inwardly turned lower flange 85 which partially extends transversely into the opening 82 for engagement by the marginal edges of the pattern plate 84 or by a hydraulic lift platen, as will be hereinafter more fully described.

The frame carries a self-contained pneumatically-controlled hydraulic lift mechanism which includes a hydraulic fluid piston-chamber 90 supported on a cross member 91 rigidly extending between the base members 12 and 13 of the frame. The hydraulic fluid chamber 90 is provided with an intermediate baffle 92 for supporting a lift piston rod 93 which carries an operating lift piston 94 within the chamber 90 in the area above the baffle 92 and a lifting platen 95 at the end external to the chamber 90. A conduit 96 communicates between the portion of the fluid chamber 90 above the baffle 92 and the hollow interior of the pillar 11 to convey hydraulic fluid through the pillar 11 into the chamber 90, whereby displacement of the fluid within the pillar 11 and chamber 90 will move the operating piston 94 and the lift platen 95 to position the flask or core box 86 in operative core blowing engagement with the blow plate 52 of the transfer chamber 50. It is of course understood that any type of fluid pressure may be utilized to provide the necessary lift action.

The pillar 11 is connected at the top through the coupling member 16 to a conduit 97 which is in turn connected to a compound hydraulic valve mechanism comprising a casing 209 having a ball check valve 213 and a differential slide valve 212 which open separate hydraulic fluid paths through the casing 209 to a hydraulic fluid reservoir 210 depending upon whether pneumatic operating pressure is applied to or released from the surface of the hydraulic fluid within the reservoir 210, as will be hereinafter more fully described in connection with Fig. 4 of the drawings. The application of pneumatic pressure to the hydraulic fluid within the reservoir 210 will cause a displacement of fluid through the compound valve mechanism in a direction to move the operating piston 94 upwardly and thereby lift the platen 95 and the flask or core box 86 into operative engagement with the blow plate 52.

Further displacement moves the entire assembly of the platen 95, flask or core box 86, and transfer chamber 50, into operative core-blowing engagement with a cover 122, as will be hereinafter more fully described.

Referring again to Fig. 3, where like numerals designate like parts, there is schematically illustrated a portion of the operating system connected in plan view at B—B with the transfer chamber 50 through the pneumatic pressure conveying supporting arms 70 and 71 which are operatively coupled through the pneumatically controlled valve 100 to the interior of the supporting pillar 10.

The pneumatically controlled valve 100, which opens the transfer chamber 50 through the hollow supporting arms 70 and 71 to a source of pneumatic pressure 200 (Fig. 4) which is in turn connected to the pillar 10 through coupling member 15 and conduit 207 consists of a valve body which has an overhanging head 101 on the pillar side of the port 104 with a shank portion 102 that extends for a small distance parallel to the sides of the port and then is bevelled inwardly toward the valve rod 103 which threadedly engages the shank 102 of the valve body at one end and extends at the other end into a chambered extension of the hollow shaft 75. The chambered extension of this hollow shaft 75 forms a chamber 105 which carries a T-shaped piston 106 which is supported at the extended end of the valve rod 103 so that the piston 106, rod 103, and valve 100, move axially as a unit. Such movement is limited in one direction by interlocking engagement between the underside of the head 107 of the T-shaped piston 106 and the inturned marginal edges 108 of the piston chamber 105.

The piston chamber 105 is provided with a further extension 110 which has a pneumatic pressure inlet 111 adapted to receive a pin 112 that is fixedly carried by the head 107 of the T-shaped piston 106. A sinuous opening 113 is formed in the chamber extension 110 to connect the inlet 111 with the piston chamber 105. This sinuous opening 113 is normally blocked from the inlet 111 when the T-shaped piston 106 is in a position to close the valve 100.

A bleeder opening 114, of much smaller cross section than the sinuous opening 113, communicates separately and distinctly from the inlet 111 with the piston chamber 105, so that when pneumatic operating pressure is admitted to the inlet 111 from a connecting conduit 190, it passes through the bleeder opening 114 to the piston chamber 105 and slowly moves the T-shaped piston 106 in a direction to open the valve 100.

The bleeder 114 and sinuous opening 113 provide a compound, successively acting inlet for admitting pneumatic operating pressure to the piston chamber 105 which results in a delayed opening of the valve 100. The distance that the piston 106 and its pin 112 must move before opening the sinuous opening 113 to communication with the inlet 111 is equivalent to the axial length of the shank portion 102 of the valve 100 so that the valve 100 does not establish communication between the hollow shaft 75 and the pillar 10 until the T-shaped piston 106 has moved a sufficient distance to open communication between the inlet 111 and the sinuous opening 113. Then, since the sinuous opening 113 is of larger cross section than the bleeder opening 114, the rate of opening movement of the valve 100 will consequently increase to open communication between the hollow shaft 75 and the pneumatic operating pressure

within the pillar 10. This construction enables a delayed opening of the valve 100 after application of pneumatic operating pressure to the inlet 111 for a length of time sufficient to allow the hydraulic lift mechanism to operate to move the core or mold box into operative core blowing engagement with the transfer chamber 50, thereby preventing admission of core blowing pneumatic pressure within the transfer chamber 50 before the apparatus is ready, as will be hereinafter more fully described in connection with the operating system schematically illustrated in Fig. 4 of the drawings.

Referring again to Fig. 3 of the drawings there is also schematically illustrated a portion of the operating system connected in plan view at A—A with the top of the frame and the combined gate and cover assembly 120 and associated operating mechanism. The combined gate and cover assembly 120 is in the form of a sector of a circle having a circular gate opening 121 angularly spaced from a depending circular annular flange 122 forming a cover 123 and air exhaust chamber for the transfer chamber 50. The combined gate and cover assembly 120 is pivoted at its apex to a horizontal extension 125 from the cross member 14 so that either the opening 121 or the cover portion 123 may be alternately positioned coincident with the opening in the sand transfer chamber 50.

The hopper 30 is carried by the cross member 14 in axial vertical alignment with the transfer chamber 50 so that when the combined gate and cover assembly 120 is positioned with the opening 121 coincident therewith, the sand will be guided into the transfer chamber 50 and, when the combined gate and cover assembly 120 is positioned so that the depending annular flanged closed portion 122 surmounts the opening in the transfer chamber 50, it acts as a closure for the hopper 30 as well as a cover 123 for the transfer chamber 50. A floating annular ring 126 loosely surrounds the discharge end of the hopper 30 so that it rests on the combined gate and cover assembly 120 and acts as a scraper across the gate opening 121 during closing movement of the cover portion 123.

The cross member 14 is provided with another horizontal extension 129 which pivotally supports a piston chamber 130 with a piston 131 movably supported therein. A piston rod 132 extends outwardly from the chamber 130 towards pivotal engagement with the combined gate and cover assembly 120 and the piston 131 is pneumatically operated for reciprocation within the chamber 130 to move the combined gate and cover assembly 120 into open and closed position relative to the transfer chamber 50.

As previously indicated, the depending annular flanged portion 122 of the cover acts as an air exhaust chamber for the transfer chamber 50 and has a valve controlled exhaust port 140. A suitable screen and filter 145 is supported within the annular depending flange portion 122 to prevent sand from the transfer chamber 50 from exhausting through the cover and port 140 to the atmosphere.

Fig. 3 of the drawings also illustrates at A—A the mechanically positioned slide valve 150 which may be positioned to establish communication between a pneumatic pressure inlet conduit 151 and a connecting conduit 155 which is in turn connected to other pneumatically operated pistons, as will be hereinafter more fully described in connection with Fig. 4 of the drawings. A valve casing 152 for the slide valve 150 may be sup-

ported as shown on the cross member 14 or on the pillar 10. The slide-valve 150 is in the form of a piston having a piston rod 153 extending externally towards the movable combined gate and cover assembly 120 so that whenever the assembly 120 is positioned by the pneumatically controlled piston 131 to close the transfer chamber 50, the adjacent end of the assembly engages the piston rod 153 to shift the piston 150 and to open communication between pneumatic pressure inlet 151 and the connecting conduit 155.

A common operating system is diagrammatically illustrated in Fig. 4 of the drawings, wherein the pertinent operating members of the apparatus are schematically shown. Thus, as shown in Fig. 4, a source of pneumatic air pressure 200 is connected through conduits 203 and 157 to the casing 160 of the hand-operated toggle slide valve 161 for communication with the connecting conduit 165. The connecting conduit 165 has a branch 166 communicating with the operating piston 170 of a spring-pressed slide valve 171 and another branch 167 communicating with the inlet 151 of the mechanically positioned spring-pressed slide valve 150.

The application of pneumatic pressure to the operating piston 170 positions the spring-pressed slide valve 171 in its casing 172 to connect the conduit 175, which communicates with the piston chamber 130, directly with the source 200 through conduit 176. The slide valve 171 also isolates the casing 172 from communication with an atmospheric release valve casing 240, as will be hereinafter more fully described.

There is a difference in area on opposite ends of the piston 131, and the conduit 175 has a branch 177 communicating directly with the chamber 130 on the reduced area side of the piston 131, while the conduit 175 connects the source 200 from the slide valve casing 172 to the enlarged area side of the piston 131. Thus, due to the difference in piston area, with like pneumatic pressures acting on each side of the piston 131 after the toggle valve 161 is opened, the piston 131 is moved in a direction to close the cover 123 over the opening in the transfer chamber 50 whereupon the assembly 120 engages the piston rod 153 to move the slide valve 150 to a position establishing communication between the inlet 151 and connecting conduit 155.

The conduit 155, on the other side of the slide valve casing 152 has a branch 180 communicating with a spring-pressed transfer chamber exhaust controlling piston 141 and another branch 190 communicating with the inlet 111 of the pneumatically controlled valve 100 of the transfer chamber 50. Thus, when the gate and cover assembly 120 is positioned to close the transfer chamber 50, the slide valve 150 is mechanically positioned to apply the source pressure to close the exhaust port 140 and to initiate the opening movement of the valve 100.

The conduit 180 has another branch 195 which applies the pneumatic air pressure from the slide valve casing 152 to the operating piston of a spring-pressed slide valve 201, which controls the admission of pneumatic pressure from the source 200 through the conduit 203 and connecting conduit 204 to the hydraulic fluid reservoir 210. The slide valve 201 also isolates the casing 202 from communication with the atmospheric release valve casing 220, as will be hereinafter more fully described. Thus, consequent upon the mechanical positioning of slide valve 150 to apply pneumatic pressure to the conduit 155, there is a simultaneous application of pneumatic pressure to the transfer chamber exhaust piston 141, to the inlet 111, and to the operating piston of the slide valve 201.

When the slide valve 201 is pneumatically positioned to admit air pressure from the source 200 to the hydraulic fluid reservoir 210, a branch conduit 211 applies this pressure to the large area side of another spring-pressed slide valve 212 which, due to the dissimilar areas of the valve body ends, closes the return hydraulic path from the pillar 11 to the reservoir 210. At the same time, the pneumatic pressure in the reservoir 210 acting on the surface of the incompressible hydraulic fluid displaces such fluid through the ball check valve 213, the pillar 11, and the piston chamber 90 to move the operating piston 94 and lift platen 95 to position the core box or flask 86 into operative engagement against the blow plate 52. Further displacement of hydraulic fluid in this direction moves the entire assembly of the flask or core box 86 and the transfer chamber 50 into operative engagement with the cover 123. Since the slide valve 212 maintains the return path for the hydraulic fluid closed under the action of pneumatic pressure from conduit 211 and the ball check valve 213 acts as a stop to prevent a reverse displacement of hydraulic fluid through its path, the operative members of the apparatus will remain in clamped engagement until the pneumatic operating pressure is released.

As previously described, the mechanical positioning of the slide valve 150 applied pneumatic pressure to the inlet 111 at the same time as it was applied to the operating piston of the spring-pressed slide valve 201. The distance that the T-shaped piston 106 must move under bleeder pressure from the bleeder opening 114 before full pneumatic pressure is applied from the sinuous opening 113 is such that the valve 100 will not open until the core box or flask 86 and transfer chamber 50 have been securely clamped together with the cover 123 in operative core blowing position. Thus, the delayed application of pneumatic pressure from the pillar 10 to the transfer chamber 50 insures that no sand will be forced into the surrounding environment to the detriment of the operator and apparatus and, after the valve 100 has opened, the pneumatic pressure enters the transfer chamber 50 through the hollow supporting arms 70 and 71 and passes through the openings in the baffle 51, thence through the blow opening 53 and into the flask or core box 86. During the blowing operation, the stirring elements 59 are rotated by the motor 65 and a uniform transfer of sand is effected from the transfer chamber 50 into the flask or core box.

At the same time as pneumatic pressure is admitted to the transfer chamber 50 from the pillar 10, pneumatic operating pressure is also admitted to the conduit 215 through the hollow shaft 75 and is applied to the casing 220 of a differential slide valve 221 at the large area end of the valve. The reduced area side of the differential valve 221 is coupled through a conduit 222 to the slide valve casing 202 and, since at this stage of the operation the slide valve 201 is positioned under pneumatic pressure to isolate the casing 202 from the casing 220, the only pneumatic pressure acting on the slide valve 221 is at the enlarged end and it moves the slide valve 221 to a position to close an atmospheric vent 223 in the casing 220.

After the core blowing operation is completed, the toggle slide valve 161 is hand positioned to isolate the connecting conduit 165 from the source 200 and to connect it to an atmospheric vent 162 in the valve casing 160, thereby releasing to atmosphere the pneumatic operating pressure from the branch conduits 166 and 167 through the connecting conduit 165 and also from the branch conduits 155, 180, 190 and 195 through the one way check valve 230 and the connecting conduit 165. This release removes pneumatic operating pressure from the spring-pressed exhaust piston 141 which opens the transfer chamber 50 to the atmosphere through the exhaust port 140 and also removes pneumatic operating pressure from the inlet 111, allowing the pneumatic pressure in the pillar 10, acting against the valve 100, to close that valve and isolate the transfer chamber 50 from the source of pneumatic operating pressure 200. Likewise, the release of the pneumatic operating pressure from the branch conduit 195 through the check valve 230 allows the spring-pressed slide valve 201 to isolate the hydraulic fluid reservoir 210 from the source 200 and also to establish communication from the reservoir 210 through the casing 202 to the atmospheric release valve casing 220. However, since the opposite end of the slide valve 221 is of larger area, the slide valve 221 remains stationary and continues to block the release of pneumatic pressure from the reservoir 210 through the atmospheric vent 223. Thus, the hydraulic fluid in the reservoir 210 remains under pneumatic operating pressure and maintains all of the operating members of the apparatus in secure clamped core blowing relation.

In the meantime, pneumatic pressure has been exhausting through the port 140 from the transfer chamber 50 and has consequently been reducing the pneumatic operating pressure in the conduit 215. For illustrative purposes, if the ratio of areas of the slide valve member 221 were 4 to 1, the slide valve 221 would not move to uncover the atmospheric vent 223 until the pneumatic pressure in the transfer chamber 50 and the conduit 215 were reduced to one-quarter of that acting at the other end of the slide valve 221, which latter is substantially the entire operating pneumatic pressure within the reservoir 210. Thus, it is readily seen that by suitable choice of differential areas for the valve member 221, the pneumatic operating pressure will not be released from the hydraulic lift mechanism until after the pneumatic pressure within the transfer chamber 50 has been reduced to a predetermined safe amount so as not to be sufficiently strong to force sand out of the chamber into the surrounding environment.

After the atmospheric vent 223 has been opened in response to the predetermined reduction of pneumatic pressure within the transfer chamber 50, the hydraulic lift mechanism will still not release the operating members until the pneumatic pressure within the reservoir 210 and the conduit 211 is reduced a predetermined amount depending upon the ratio between the differential end areas of the slide valve 212 which, again for exemplary purposes of illustration, may be in the ratio of 4 to 1, resulting in an opening of the return hydraulic path when the pneumatic pressure in the reservoir 210 and branch conduit 211 has been reduced to one-quarter of that of the source. The release of the slide valve 212 to open the return path for the hydraulic fluid allows a return displacement of hydraulic fluid acting under the weight of the operating members through the operating lift piston 94.

The release of the pneumatic pressure from the branch conduit 166 allows the spring-pressed slide valve 171 to isolate the conduit 175 from the source 200 and connects it through the casing 172 to the atmospheric release valve casing 240. The valve casing 240 and slide valve 241 therein are similar to the casing 220 and slide valve 221 and the enlarged end portion of the casing 240 is connected through the conduit 222 and valve casing 202 to the branch conduit 204, which at this stage of the operation is in communication with the hydraulic reservoir 210. The smaller end area of the valve casing 240 is in communication with the piston chamber 130 on the enlarged side of the piston 131 through the valve casing 172 and conduit 175. However, due to the differential end areas of the slide valve member 241, the valve member 241 will be positioned within the casing 240 to isolate casing 240 from the atmosphere vent 243, thereby preventing the release of the pneumatic operating pressure from the chamber 130. The valve member 241 operates similarly to the slide valve 221 and will not move to open the casing 240 to the atmosphere until the pneumatic pressure in line 222 is reduced a predetermined amount, which in accordance with the foregoing illustrative examples, may be when such pressure is reduced to one-quarter of that of the source.

It is readily apparent that the pneumatic pressure in line 222 is substantially the same pneumatic pressure that exists within the hydraulic reservoir 210 and branch conduit 211. Thus, the pneumatic pressure in the piston chamber 130 will not be released to amosphere until the hydraulic lift has been released and at that time the pneumatic pressure from the source acts through the conduit branch 177 against the smaller area end of the piston 131 to open the cover 123 and position the opening 121 under the hopper for a re-charge of sand, thereby insuring that the combined gate and cover assembly 120 is not positioned for re-charging of the transfer chamber 50 until the hydraulic lift mechanism has completely released the operating members of the apparatus and returned them to re-charging position for a new core blowing cycle.

Thus, the core blowing apparatus and operating system of this invention automatically insures proper sequential operation of the respective core blowing functions of each component of the apparatus so as to safeguard the operator and maintain favorable working conditions with a minimum of maintenance and an optimum production. The apparatus and system also efficiently utilizes the structural components to their maximum extent wherever possible by combining their functions operatively in the structural positioning and support of the components and in the functions of the operating system.

I have shown and described what I consider to be the preferred embodiments of my invention along with similar modified forms and suggestions and, it will be obvious to those skilled in the art, that other changes and modifications may be made without departing from the scope of my invention as described by the appended claims.

I claim:

1. In a core blowing apparatus adapted for op-

eration from a source of fluid pressure and provided with a movable core box operatively supported below a sand transfer chamber having a sand discharge opening adjacent the core box and open at the other end to receive sand therein, a fluid pressure operated lift for moving said core box into operative engagement with the transfer chamber, a removable cover for said transfer chamber, valve means adapted to be positioned by said cover in the closed position to automatically apply operating fluid pressure from the source to said lift and to said transfer chamber, and fluid pressure controlled valve means adapted to be positioned by the applied pressure for coaction in said transfer chamber to delay admission of fluid pressure thereto until after said lift has moved the core box into operative engagement with said transfer chamber.

2. In a core blowing apparatus provided with a sand transfer chamber having a sand receiving opening and a sand discharge opening and surmounting a movable core box, a fluid pressure controlled lift for moving said core box into operative core blowing engagement with the discharge opening of said sand transfer chamber, said sand transfer chamber having a fluid pressure controlled inlet for admitting fluid pressure therein, a removable cover for the sand receiving opening of said transfer chamber, said cover being provided with a fluid pressure controlled exhaust for said transfer chamber, fluid pressure controlled means supported adjacent said cover and adapted to be positioned by said cover in the closed position to automatically apply fluid operating pressure to operate said lift, to open said chamber inlet, and to close said fluid pressure controlled chamber exhaust, valve means within said chamber inlet for delaying the admission of fluid pressure therethrough until after said lift has moved the core box into operative engagement with the discharge end of said transfer chamber, means for opening said fluid pressure controlled chamber exhaust after the core blowing operation is completed, and a second fluid pressure controlled means for automatically releasing the operating pressure from said lift in response to a predetermined reduction of fluid pressure within said transfer chamber.

3. In a core blowing apparatus provided with a sand transfer chamber having a sand receiving opening and a sand discharge opening and surmounting a movable core box, a fluid pressure controlled lift for moving said core box into operative core blowing engagement with the discharge opening in said sand transfer chamber, said sand transfer chamber having a valve controlled inlet for admitting fluid operating pressure therein and a controlled exhaust therefor, a fluid pressure operated removable cover for the sand receiving opening, means for applying fluid operating pressure to open and close said cover, valve means adapted to be positioned by said cover in the closed position to apply fluid operating pressure to operate said lift, to open said chamber inlet and to close said chamber exhaust, said valve controlled chamber inlet including means for delaying the admission of fluid pressure therethrough until after said lift has moved the core box into operative engagement with said chamber, means for opening said chamber exhaust after the core blowing operation is complete, fluid pressure controlled means for automatically releasing the operating pressure from the lift in response to a predetermined reduction of fluid pressure within the sand transfer chamber, whereby said core box is separated from operative engagement with the chamber, and a second fluid pressure controlled means for automatically reversing the fluid operating pressure acting on the cover to move the cover to open position in response to a predetermined reduction of fluid operating pressure in the lift.

4. In a core blowing apparatus adapted for operation from a source of fluid pressure and having a sand transfer chamber and a movable core box operatively supported relative thereto, a fluid pressure controlled lift adapted to be coupled to the source to move said core box into core blowing engagement with said sand transfer chamber, valve means for successively applying fluid operating pressure from the source to said lift and to said sand transfer chamber, means for exhausting said sand transfer chamber after the core blowing operation is completed, and a fluid pressure controlled valve coacting therewith to automatically release the operating fluid pressure from said lift in response to a predetermined reduction in the fluid pressure within said sand transfer chamber.

5. In a core blowing apparatus adapted for operation from a fluid pressure source and having a sand transfer chamber and a movable core box operatively supported relative thereto, a fluid pressure controlled lift adapted to be coupled to the source to move the core box into operative core blowing engagement with the sand transfer chamber, a fluid pressure operated removable cover for said sand transfer chamber, fluid pressure controlled means adapted to be coupled to the source to successively apply fluid operating pressure to close the cover, to operate the lift, and to admit fluid pressure to said chamber, means for exhausting said sand transfer chamber after the core blowing operation is completed, fluid pressure controlled means coacting therewith in response to a predetermined reduction of pressure in the chamber for removing the fluid operating pressure from said lift, and other fluid pressure controlled means for reversing the fluid operating pressure to open said cover in response to a predetermined reduction of the fluid operating pressure acting on said lift.

6. In a core blowing apparatus adapted for operation from a source of fluid pressure and having a sand transfer chamber with a sand receiving opening and a sand discharge opening operatively supported relative to a movable core box, a fluid pressure controlled lift adapted to be coupled to the source to move said core box into operative core-blowing engagement with said sand discharge opening, a fluid pressure operated removable cover for said sand receiving opening, means for successively applying fluid operating pressure from the source to close said cover, to operate said lift, and to admit fluid pressure to said transfer chamber, other means for exhausting said transfer chamber after the core blowing operation is completed, and fluid pressure controlled means coacting therewith to successively release the operating pressure from said lift and from said removable cover in response to a predetermined reduction of fluid pressure in said transfer chamber.

7. In a core blowing apparatus adapted for operation from a fluid pressure source and having a sand transfer chamber with a sand receiving opening and a sand discharge opening, a sand storage hopper operatively supported adjacent said sand receiving opening, a combined cham-

ber cover and hopper gate member movably supported intermediate said hopper and said chamber, a first fluid pressure controlled means adapted to be coupled to the source to move said combined gate and cover member to open or close said sand receiving opening, means responsive to the closure of said combined cover and gate member to apply fluid pressure from the source automatically to said chamber, other means for exhausting said chamber, and a second fluid pressure controlled means coacting therewith in response to a predetermined reduction of fluid pressure in said chamber for releasing the fluid operating pressure from said first fluid pressure controlled means to open said combined cover and gate member.

8. In a core blowing apparatus having a vertically disposed hollow support, a sand transfer chamber, a hollow supporting arm for said sand transfer chamber and extending towards said vertical hollow support, means coupling the extended end of said hollow supporting arm to said vertical hollow support, the hollow interior of said supporting arm communicating with the interior of the hollow support at the extended end and communicating at the other end through the corresponding side of the sand transfer chamber with the interior thereof, means for applying fluid operating pressure to said hollow vertical support, and valve means normally isolating the interior of said vertical hollow support from the hollow interior of said supporting arm, whereby upon opening of said valve, fluid operating pressure from the hollow vertical support is conveyed through the hollow supporting arm and into the interior of said sand transfer chamber.

9. In a core blowing apparatus having a source of fluid pressure and a sand transfer chamber, a first conduit connecting said chamber to said source, a valve member in said conduit, a piston having a piston rod extending in opposite directions from each end thereof, said valve member being carried at the extended end of one of said rods, a first fluid pressure inlet for said piston, a second conduit connecting said source to said first inlet, said other piston rod normally blocking said inlet for a predetermined axial rod distance, said valve member having means normally blocking said first conduit until said other piston rod has moved an axial distance sufficient to unblock said fist inlet, and a separate fluid pressure inlet of reduced size maintaining constant communication from said second conduit to said piston, whereby said piston initially moves slowly in a direction to unblock said first inlet and thereafter moves rapidly to move said valve member out of blocking position in said first conduit to admit fluid pressure to said sand transfer chamber.

10. In a core blowing apparatus adapted for operation from a fluid pressure source and having a sand transfer chamber and a movable core box operatively supported relative thereto, fluid pressure controlled means for applying and releasing fluid pressure to and from said transfer chamber, a fluid pressure controlled lift adapted to be coupled to the source to move said core box into operative core blowing engagement with said sand transfer chamber, said lift including a fluid chamber having a lift piston operatively disposed therein, a fluid reservoir, a conduit interconnecting said fluid piston chamber with said reservoir, a second means for applying fluid pressure to said reservoir, compound valve means in said connecting conduit to permit displacement of fluid in the piston lifting direction and at the same time prevent displacement in the opposite direction, other fluid pressure controlled means for releasing the fluid pressure from said fluid reservoir in response to a predetermined reduction of fluid pressure in said transfer chamber, said other fluid pressure controlled means including means for reversing the operation of said compound valve, whereby said valve permits displacement of fluid in the operating piston return direction to lower the lift piston and core box out of core blowing position.

11. A lift for a core blowing apparatus comprising in combination, a piston chamber, a lift piston operatively disposed therein, a fluid reservoir, conduit means connecting said piston chamber with said reservoir, means for applying fluid pressure to displace the fluid from said reservoir into said piston chamber, a compound valve mechanism in said conduit means providing a double path for fluid therethrough, a ball check valve freely supported in a first fluid path to permit fluid displacement therethrough in a piston lifting direction and to prevent displacement in the piston return direction, a differential slide valve in the second fluid path and having a small valve area at one end exposed to the fluid pressure in said first path, said slide valve having a large valve area at the other end exposed to the fluid pressure in said reservoir, whereby said slide valve is moved to open said second fluid path to permit fluid displacement in a return piston direction in response to a predetermined reduction of fluid pressure in said reservoir in a ratio to said applied fluid pressure equivalent to the ratio of the small valve area to the large valve area.

12. In a core blowing apparatus having a sand transfer chamber and a movable core box operatively supported relative thereto, a supporting frame therefor comprising a pair of spaced hollow vertical members, a lift operatively supported by said members below said movable core box to move the core box into operative core blowing engagement with said sand transfer chamber, a hollow arm communicating with said sand transfer chamber and supporting said chamber in spaced vertical relation above said movable core box from one of said hollow vertical supports, means for connecting said one hollow vertical support with a source of fluid pressure, a fluid pressure controlled valve for operatively connecting fluid pressure from said one hollow vertical support through the interior of said hollow arm to said sand transfer chamber, an exhaust for said chamber, means for connecting a source of fluid to said other hollow vertical support, other means connecting said other hollow vertical support with said lift mechanism, and fluid pressure controlled means for displacing the fluid from said other hollow vertical support through said lift mechanism in a direction to move said core box into operative core blowing engagement with said sand transfer chamber, and other fluid pressure controlled means for automatically reversing said fluid displacement in response to a predetermined reduction of fluid pressure in the chamber to return the core box out of operative engagement with the chamber after the core blowing operation is completed.

13. In a core blowing apparatus provided with a sand transfer chamber having a fluid pressure inlet and outlet and fluid pressure controlled means for positioning a member in operative core blowing relation to said chamber, a fluid

pressure operating system therefor comprising, means for applying fluid operating pressure to said member positioning means and to said transfer chamber, a differential valve having a casing and a valve member freely supported therein, each end of said valve member having a different area, an inlet at each end of the casing communicating respectively with a different end of said valve member, an atmospheric vent through the casing adjacent the small end of said valve member and adapted to be covered and uncovered thereby, means connecting the casing inlet adjacent the large valve member end to fluid pressure in said chamber, and other means connecting the casing inlet adjacent the small valve member end to the fluid operating pressure in the member positioning means, whereby the latter pressure is released through the atmospheric vent in response to a predetermined reduction in pressure in the chamber proportional to the ratio of the small end area to the large end area of said valve member.

14. In a core blowing apparatus provided with a sand transfer chamber having fluid pressure and sand inlets and outlets with a removable cover for the sand inlet having fluid pressure controlled positioning means and a movable core box having a fluid pressure controlled lift, a fluid pressure operating system therefor comprising, means for successively applying fluid operating pressure to close the cover, to operate the lift, and to blow sand from the chamber into the core box, a pair of differential valves each having a casing with a valve member having dissimilar sized ends therein, each casing having an atmospheric vent adjacent the small end of the corresponding valve member, means exposing the large end of one valve member and the small end of the other valve member to the fluid operating pressure for said lift, other means exposing the small end of said one valve member to the fluid operating pressure in said cover positioning means and exposing the large end of said other valve member to the fluid pressure in said chamber, and means for releasing the fluid pressure from said chamber, whereby the fluid operating pressure is first released from the lift through the vent in said other valve member casing in response to a predetermined reduction of pressure in the chamber and the fluid operating pressure is next released from said cover positioning means through the vent in said one valve member in response to a predetermined reduction of operating pressure from said lift, the predetermined reduction in each case being proportional to the corresponding ratios of the small end area to the large end area of the corresponding valve member.

15. In a core blowing apparatus adapted for operation from a source of fluid pressure and provided with a sand transfer chamber having a discharge opening surmounting a movable core box, a fluid pressure controlled lift for moving the core box into operative core blowing engagement with the discharge opening of the transfer chamber, a first fluid pressure controlled means adapted to be coupled to the source to successively apply operating pressure to the lift and to the transfer chamber a fluid pressure controlled atmospheric vent adapted to be opened consequent upon uncoupling of said means from the source to exhaust the transfer chamber after the core blowing operation is completed, and a second fluid pressure controlled means adapted to be positioned in response to a predetermined reduction of fluid pressure within the transfer chamber to release the operating pressure from the lift.

16. In a core blowing apparatus adapted for operation from a source of fluid pressure and having a sand transfer chamber with an open end and a discharge end and a movable core box operatively supported relative to the discharge end, a removable cover for the open end of the transfer chamber, a fluid pressure controlled lift adapted to be coupled to the source to move the core box into operative engagement with the discharge end of the transfer chamber, fluid pressure controlled means adapted to be coupled to the source to close the cover, valve means actuated by the cover closure for automatically applying fluid operating pressure from the source to the lift and to the sand transfer chamber, means for exhausting fluid pressure from the transfer chamber after the core blowing operation is completed, fluid pressure controlled means coacting therewith to automatically release the fluid operating pressure from the lift in response to a predetermined reduction of fluid pressure within the transfer chamber, and other fluid pressure controlled means coacting in response to a predetermined reduction of the fluid operating pressure within the lift to automatically remove the cover from the chamber.

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