

July 17, 1962

F. A. LESNETT, JR., ET AL

3,044,138

AUTOMATIC TILE PRESS

Filed Jan. 29, 1960

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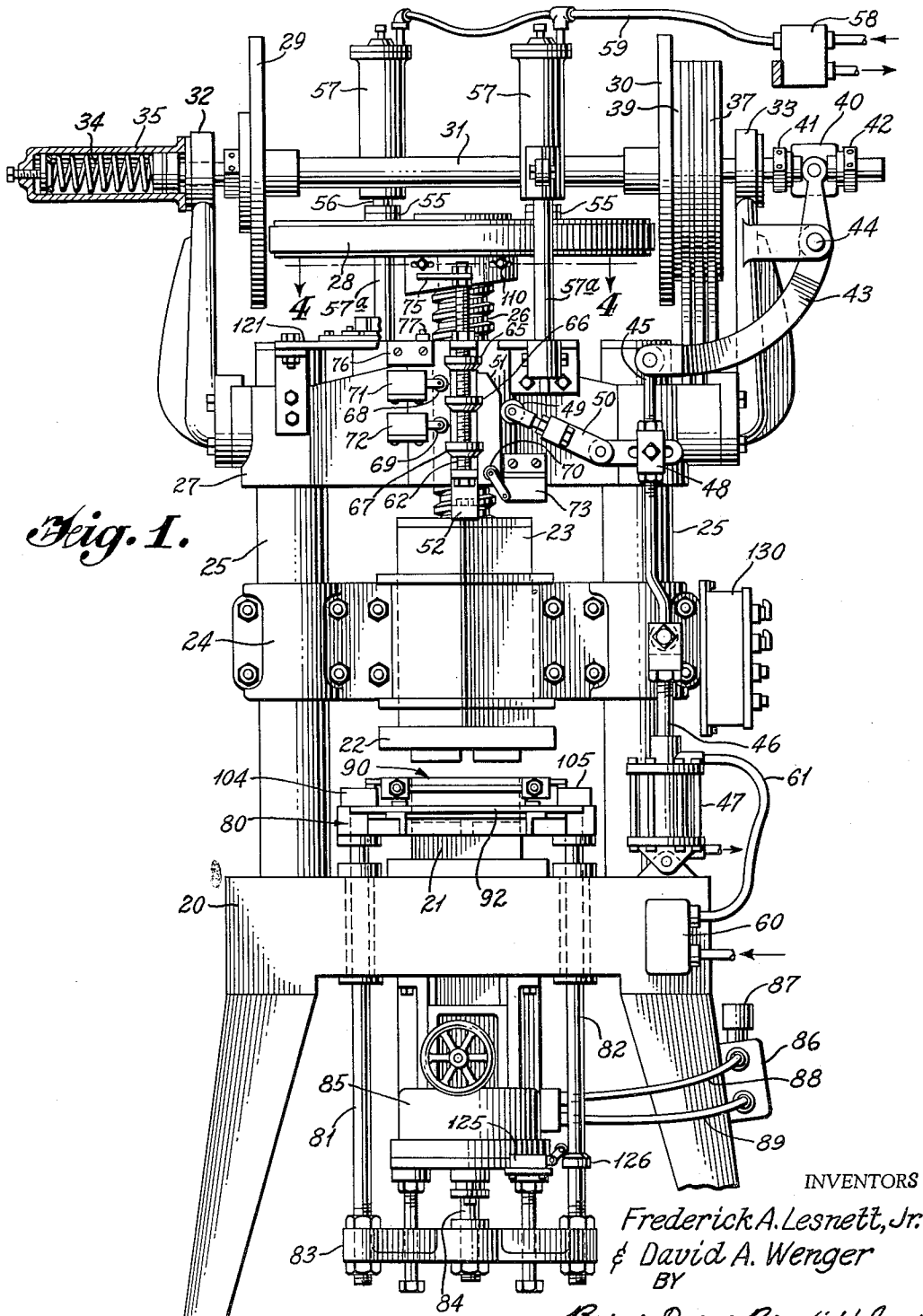


Fig. 1.

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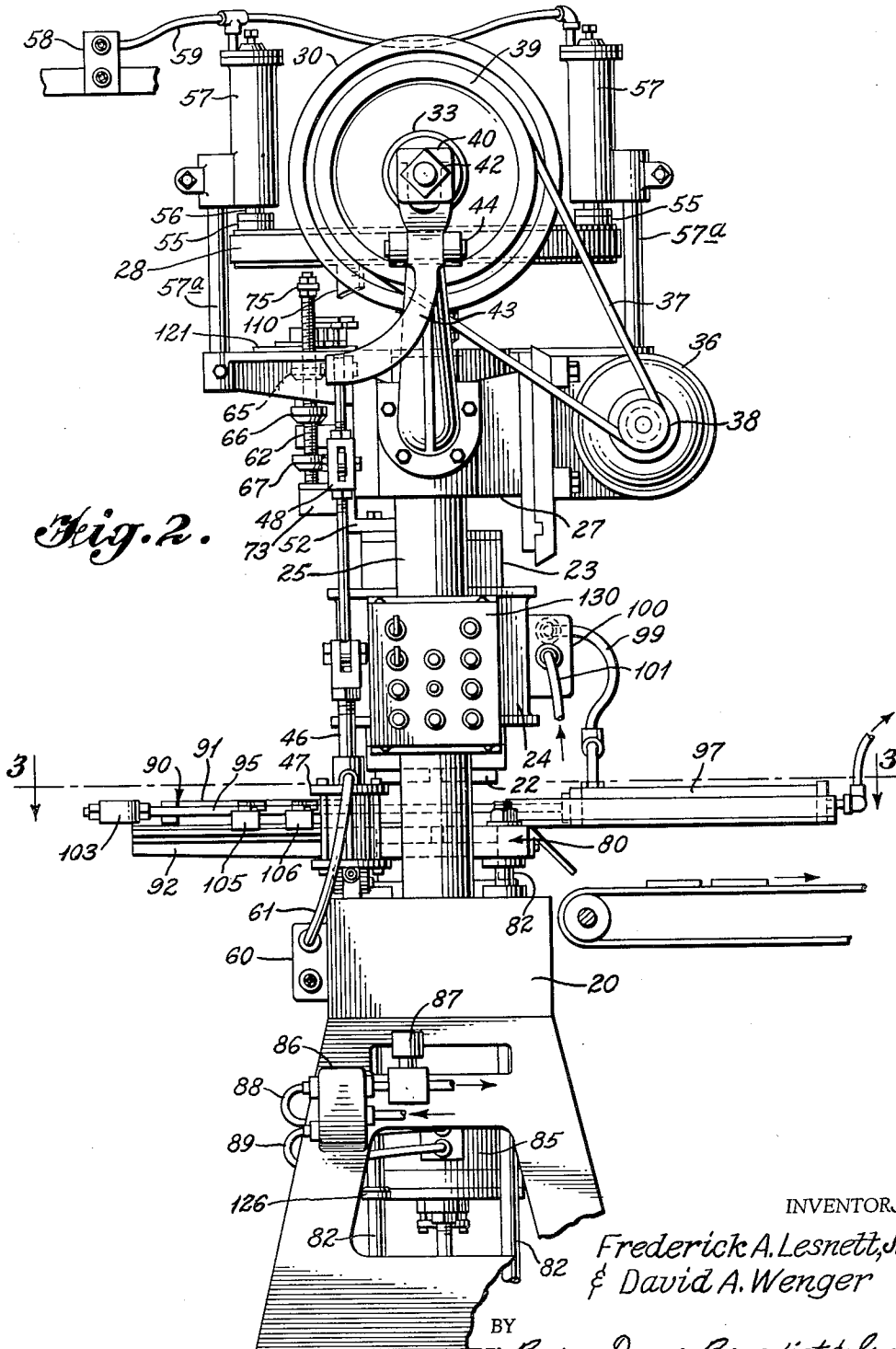
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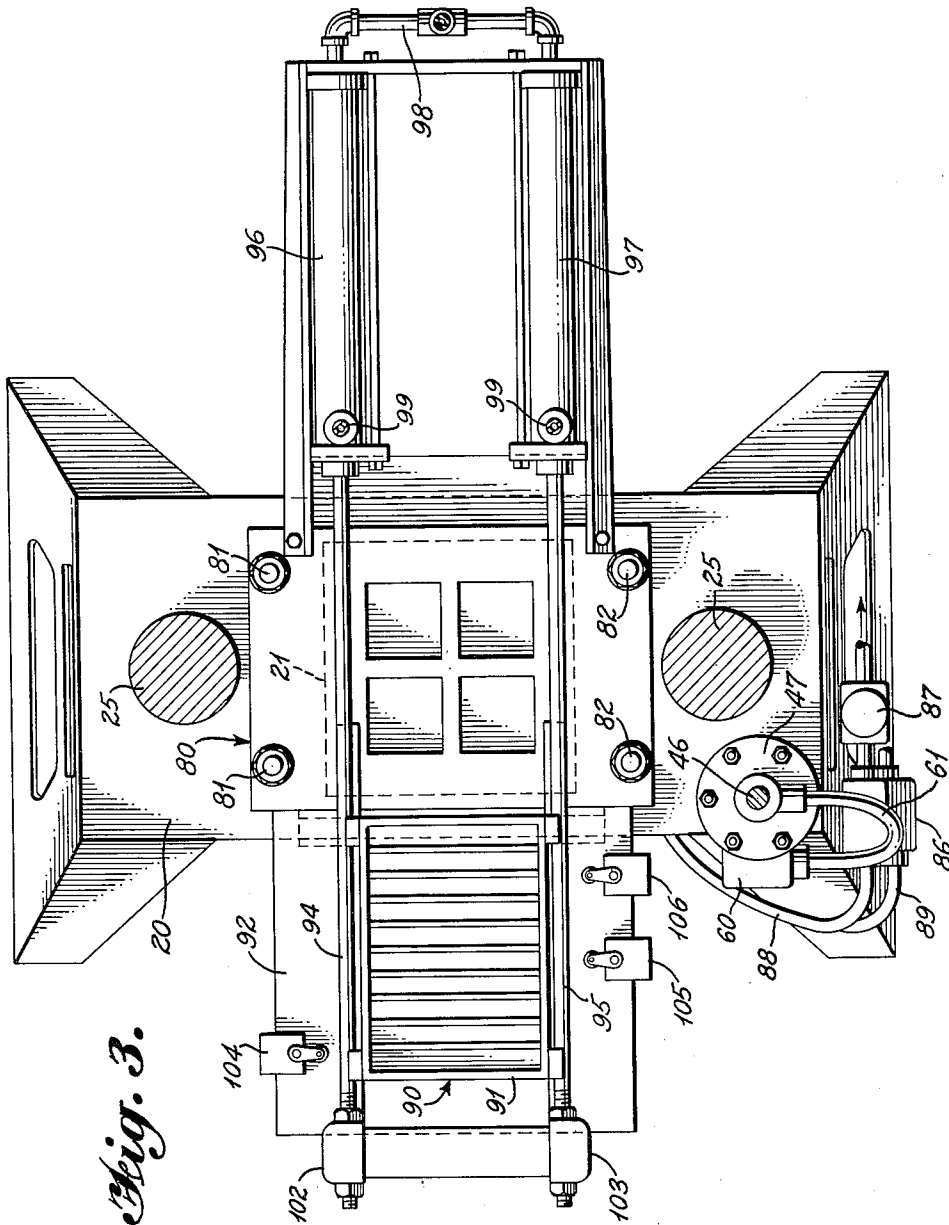
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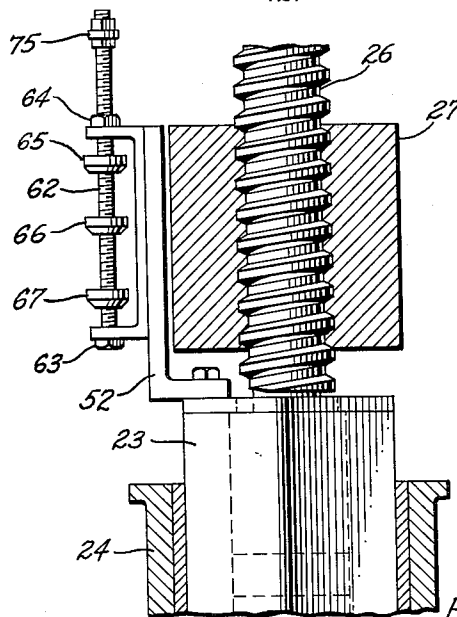
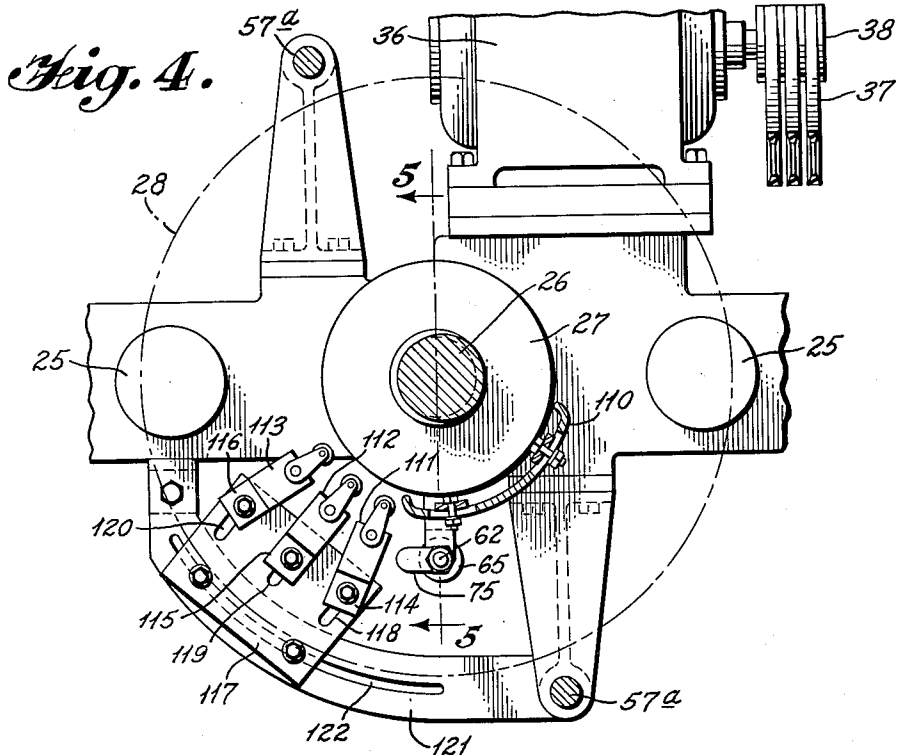


Fig. 5.

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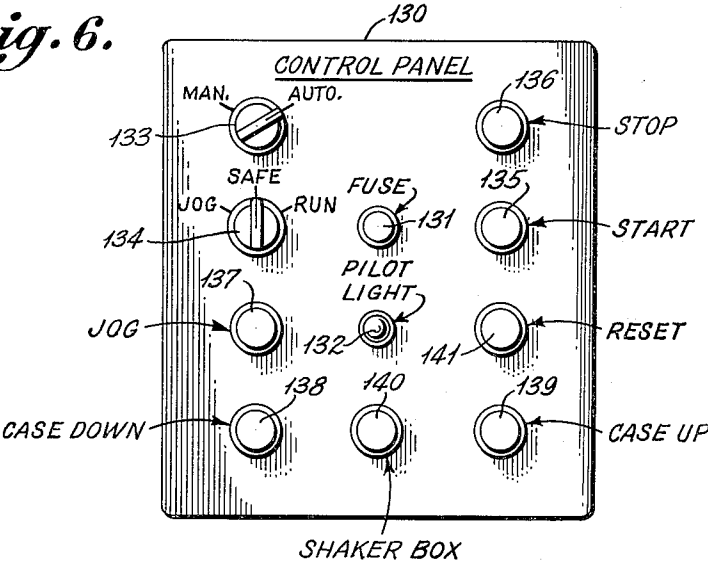
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Fig. 6.



STEP SWITCH CONTACTS CONDITION

☐ = CONTACT OPEN ☒ = CONTACT CLOSED

CONTACT NO.		X*	1*	2	3	4	5	6	7	8	9	10
STEP SWITCH POSITIONS	1	☒	☐	☒	☒	☒	☐	☐	☐	☐	☒	☐
	2	☒	☒	☐	☐	☐	☒	☐	☐	☐	☒	☐
	3	☒	☒	☐	☐	☐	☐	☐	☐	☐	☒	☐
	4	☒	☒	☐	☐	☐	☐	☒	☐	☐	☒	☐
	5	☒	☒	☐	☐	☐	☒	☐	☐	☐	☒	☐
	6	☒	☒	☐	☐	☐	☐	☒	☐	☒	☒	☐
	7	☒	☒	☐	☐	☐	☒	☐	☐	☐	☒	☐
	8	☒	☒	☐	☐	☐	☐	☐	☐	☒	☐	☒

NOTE: * = CONTACTS X AND 1 ARE OPENED EACH TIME STEP SWITCH SOLENOID IS ENERGIZED, WHEN ARMATURE REACHES LIMIT OF ITS TRAVEL.

Fig. 12.

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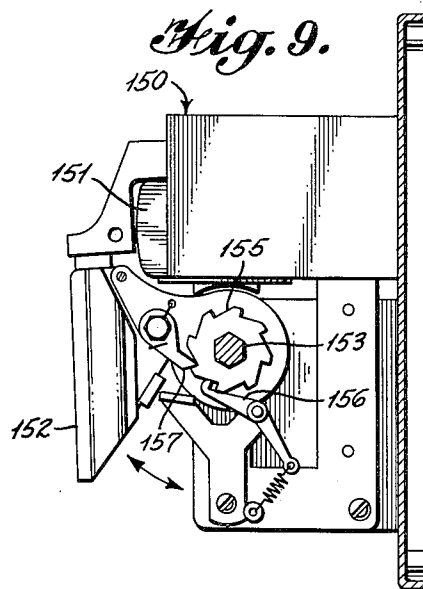
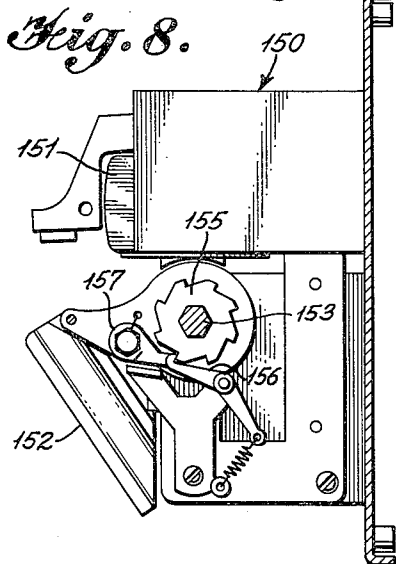
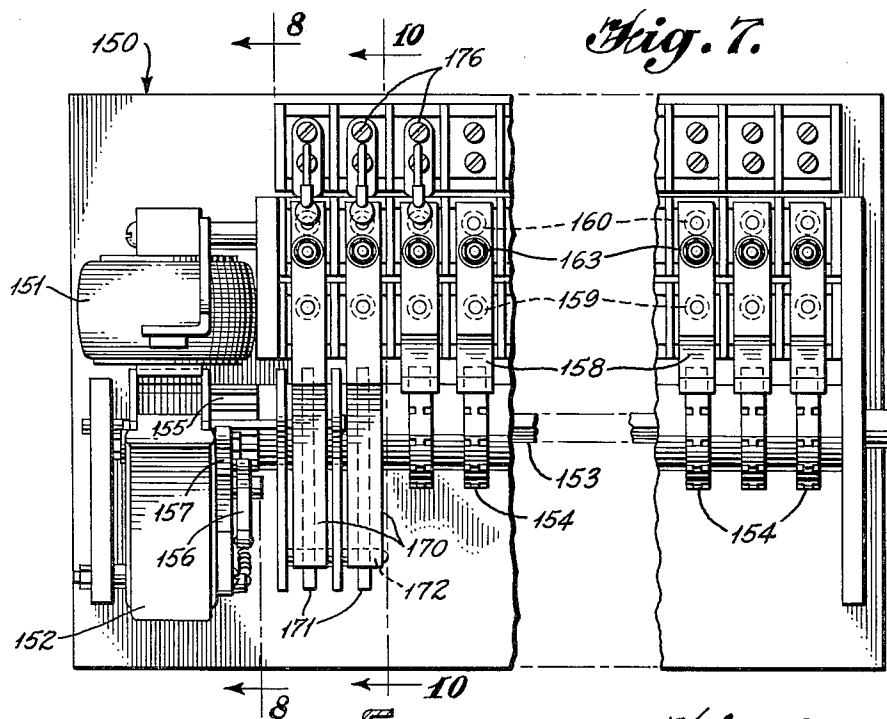
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Fig. 10.

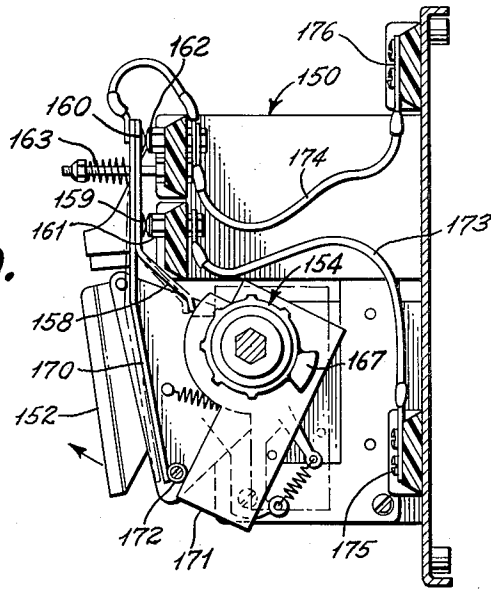
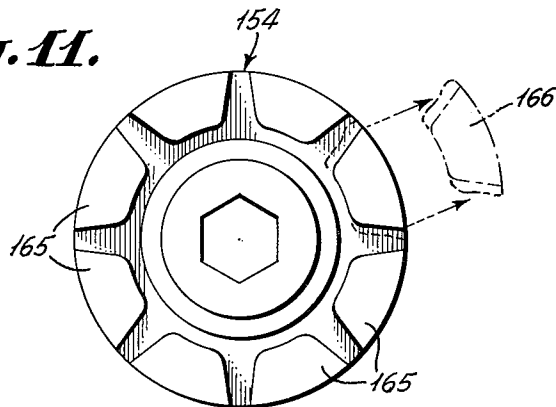


Fig. 11.



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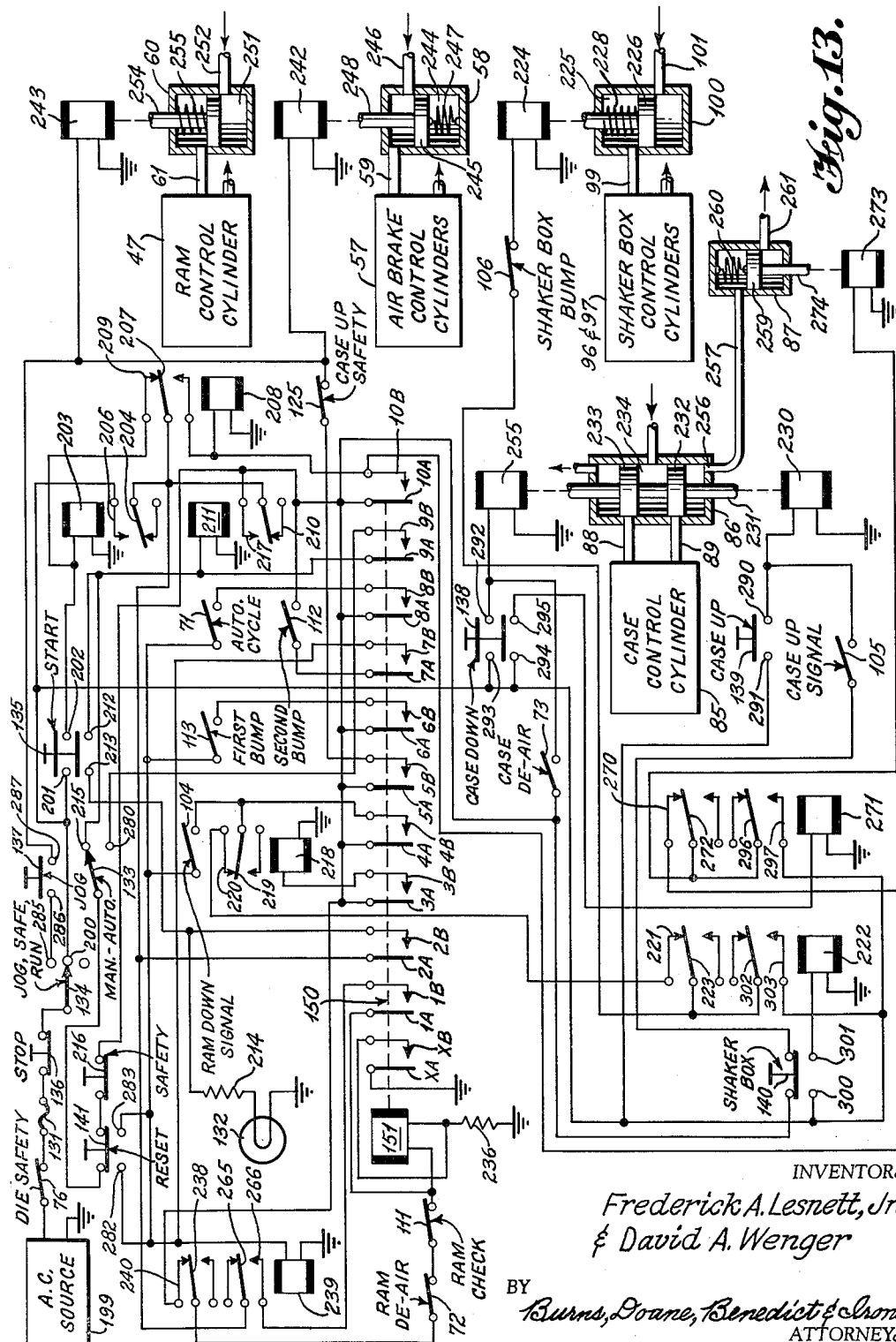
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3,044,138

AUTOMATIC TILE PRESS

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Filed Jan. 29, 1960, Ser. No. 5,418
11 Claims. (Cl. 25—42)

This invention relates to tile presses and, more particularly, to a more satisfactory and efficient system for automatic operation of a friction-drive tile press than has previously been available.

During the process of manufacture of wall tiles, the raw material (called "dust" because of its consistency) is delivered to a press in which it is compacted to the proper density and configuration, before the various trimming, glazing and curing processes take place. One of the most popular types of press adapted for this purpose is identified by the term "friction drive," since it includes a reciprocatory ram which is moved up or down depending upon which of two continuously rotating friction discs is in engagement with a "bull" wheel connected to the ram. The ram carries an upper die and moves it toward or away from a lower die formed by a reciprocatory die case, which defines the sides of the die openings, and a fixed lower die plate.

Raw material or dust is supplied to the lower die by a material conveyor called a "shaker box," which is reciprocated during the material delivery operation to break up lumps in the dust. The die case itself is in upper position to form the tile molds, during the compacting operation, but it must be dropped to a lower position such that its upper surfaces are level with the fixed lower die plate when the tile is compacted, so that the forward end of the shaker box can move the compacted tile away from the die area before a new compacting operation is begun.

Because of the characteristics of the raw material, the usual press provides for three different strokes or "bumps" of the ram and upper die plate, so that the air between the dust particles can be squeezed out and the dust compacted in the best manner. Normally, the first stroke is of less force than subsequent strokes for maximum efficiency in tile formation.

The various operations of the ram, the shaker box and the die case are necessarily interrelated and must be carried out in a definite sequence with careful control. However, until relatively recently, these operations have been controlled by hand, with a single operator operating the shaker box, ram and case in sequence. It is obvious that hand operation is relatively slow and therefore expensive. Moreover, it does not insure absolute uniformity of the product made in different operations of the press, by the same or different operators. It has therefore been proposed that the entire sequence of press operations be controlled, in a repetitive manner, by "automation" of the press.

One of the ways in which automatic press operation can be carried out is disclosed in the patent to Miller, No. 2,770,862, granted on November 20, 1956. The apparatus of the present invention constitutes an improvement over the Miller automatic control to provide for better control over the tile-forming process and to provide for the addition of certain desirable features not employed in the Miller control but known in manual press operation.

In particular, by reason of the relatively-limited distance of reciprocatory travel of the press ram and bull wheel near the lower end of their stroke, it is extremely difficult to obtain the desired control over the adjustment of impact force in the several ram strokes or bumps, if a reciprocatory switch operator such as that suggested by

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Miller is employed. The apparatus of the present invention employs a rotary switch operator for control of the switches associated with these bumps, which operator is fixed to the bull wheel to rotate therewith. The rotary movement of the bull wheel is of course of much greater extent than its reciprocatory movement, so that the bump forces may be more precisely controlled.

Further, since the automatic control of the invention employs relays and solenoids, which, through inexpensive, are relatively slow-acting, and because the ram and associated elements have large inertia, the portions of the apparatus which control the ram strokes are arranged to "lead" the operation of the ram, rather than to attempt to cause ram operations which are coincident with control operations.

In hand-operated presses it is conventional to control the position of the die case in such manner that the case is not held rigidly in position during ram strokes, but rather the case can "float" down with the ram, thereby reducing the danger of destruction of the case. This feature is provided for in the automatic control system of the present invention.

Also, in hand operation, it is conventional to "drop the case" before the upper die is moved upwardly away from the compacted dust at the end of the pressing operation, in order to reduce the danger of fracture of the tile. This feature is also provided for by the automatic control system of the invention.

Provision is also made, in the apparatus to be described, for "jogging" the ram, so that, if it should become stuck in any of its positions, it may be moved downwardly without the necessity of a manual prying operation.

Finally, the control system of the present invention is arranged to insure that the press cycle cannot begin at any but its neutral or initial step, so that danger to personnel and equipment may be reduced. These and other features of the invention will now be described in conjunction with a preferred embodiment thereof shown in the accompanying drawings.

In the drawings,

FIG. 1 is a side elevational view of the tile press, showing the position of various elements of the automatic control system.

FIG. 2 is a front elevational view of the tile press, taken from the operator's position;

FIG. 3 is a plan view, partly in section, of the lower die and shaker box portions of the apparatus, taken along line 3—3 of FIG. 2;

FIG. 4 is a plan view, partly in section, showing the rotary switch operator and associated switches of the invention, taken along line 4—4 of FIG. 1;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is an elevational view of the control panel of the apparatus;

FIG. 7 is a front elevational view of the step switch employed in the automatic control of the invention;

FIG. 8 is a side elevational view, partly in section, taken along line 8—8 of FIG. 7 and showing the step switch in its de-energized condition;

FIG. 9 is a view similar to FIG. 8 but showing the step switch in its energized condition;

FIG. 10 is a sectional view taken along line 10—10 of FIG. 7;

FIG. 11 is a simplified detailed view of one of the cams of the step switch of FIG. 7, showing the manner in which the various segments thereof may be broken out for switch control;

FIG. 12 constitutes a table showing the various conditions of the step switch contact sets in the several positions which the step switch takes during its operation; and

FIG. 13 is a schematic diagram showing the connection of the various switches and actuators of the automatic control system.

Referring first to FIGS. 1 and 2, the tile press is of the well-known type generally shown and described in Miller Patent No. 2,770,862. It includes a base 20 which supports a fixed lower die plate 21. Mounted above the lower die plate is a reciprocable upper die member 22 which is fixed to a ram or plunger 23. The ram is slidably mounted in a bearing 24 which is adjustably mounted on posts or rods 25 at opposite sides of the ram and fixed to the base 20.

The ram is reciprocated by a screw 26 which is connected to the ram, as shown in the Miller patent, in such fashion as to move the ram downwardly and upwardly when the screw rotates in opposite directions. The screw 26 is threadedly engaged with and extends through a fixed journal 27 which is mounted at the upper ends of rods or posts 25, and the screw is rigidly attached to the horizontally mounted bull wheel 28.

Bull wheel 28 is positioned between vertically mounted friction discs 29 and 30 which are mounted for rotation on horizontally extending shaft 31. The shaft 31 is journaled at opposite sides of the bull wheel in bearings 32 and 33 supported by the bearing member 27. The shaft is reciprocable axially with respect to the bearing members, and the shaft is urged toward the right-hand side of FIG. 1 by a spring 34 which is positioned within a spring case 35 fixed to bearing 32. Thereby, the disc 29 is urged toward the frictional surface of bull wheel 28.

The shaft 31 is continuously rotated by an electric motor 36 (FIG. 2) which drives the shaft through a belt 37 coupling together the drive pulley 38 of the electric motor and the pulley 39 mounted on shaft 31. Thereby, the discs 29 and 30 are continuously rotated and the direction of drive of the shaft 31 is such that the disc 29, when in engagement with bull wheel 28 rotates the bull wheel in such direction as to drive the ram 23 upwardly, while the disc 30, when in engagement with the bull wheel, rotates the wheel in such direction as to move the ram downwardly. Since the apparatus is spring-urged in such fashion that disc 29 is in engagement with bull wheel 28, the ram is spring biased upwardly.

The shaft 31 is reciprocated under control of a clutch 40 mounted on the shaft between collars 41 and 42. The clutch is controlled by a lever 43 pivoted at 44 to the support for bearing 33 and carrying at its remote end a rod 45. This rod is fixed to the piston rod 46 of a pneumatic cylinder 47 termed the "ram down cylinder."

Rod 45 is also connected through a double clevis 48 to a roller 49 journaled on a lever 50. The roller 49 cooperates with an actuating member 51 fixed to a bracket 52 (FIG. 5), which bracket in turn is fixedly attached to the ram 23. The upper end of actuating member 51 has a sloping surface and is designed to cause the roller 49 to be moved toward the right-hand portion of FIG. 1 when the ram moves to its upper position. The roller and its associated lever 50, together with the double clevis 48 and the rod 45 then rotate the lever 43 in a generally counterclockwise direction to move the shaft 31 toward the left of FIG. 1. Thereby, the force of spring 34 is counteracted and the friction disc 29 is moved out of engagement with bull wheel 28. In this position of the apparatus, neither of the discs 29 and 30 is in contact with the bull wheel, so that the wheel is stationary.

In order that the bull wheel will stop its rotation substantially immediately upon its reaching the neutral position shown in FIG. 1, the press is provided with a pair of friction brakes including friction discs 55 which are reciprocable with piston rods 56 of pneumatic cylinders 57. The cylinders are supported above journal 27 on posts 57a. These cylinders are provided with air under pressure from solenoid-operated valve 58 through hose connection 59. Similarly, the ram down cylinder 47 is provided with air under pressure from solenoid-operated

valve 60 through hose 61. As will be explained hereinafter, valves 60 and 58 are operated at the same time to release the braking effect on bull wheel 28 and to move rod 45 downwardly to move disc 30 into engagement with the bull wheel and thereby move the ram 23 downwardly, when the compacting portions of the press cycle take place.

As was indicated above, the ram 23 carries a bracket 52 which reciprocates with it. Upon this bracket is mounted a threaded rod 62. This rod 62 is held with respect to bracket 52 by nuts 63 and 64 (FIG. 5) and carries a number of switch-operating cams 65 through 67. These cams respectively cooperate with the operating rollers 68 through 70 of certain switches 71 through 73. Switch 71 is termed the "auto cycle" switch, since it provides for automatic repetition of the cycle of operations of the press. Switch 72 is termed the "ram de-air" switch, since it provides for termination of the positive downward drive of ram 23 during the first stroke or bump of the ram in the cycle. Switch 73 is termed the "case de-air" switch, since it provides for downward movement of the die case during the downward travel of the ram. The functions and operations of these switches will be more fully described hereinafter.

The screw 62 which carries the several switch cams 65 through 67 also carries a lever actuator 75 at its upper end. The lever actuator is designed to cooperate with a switch 76 termed the "thin die safety" switch, since this switch is designed to stop operation of the system in the event that insufficient dust is delivered to the press to form tiles of the desired thickness. When the tile is too thin, the lever 75 will strike switch actuator 77 of the switch 76 and open that switch to open the power circuits of the automatic control apparatus, as will be later described.

The lower die 21 merely forms the bottom wall of the four die cavities used in the pressing operation, the side walls of these cavities being formed by a die case generally identified at 80. This case is mounted on reciprocating rods 81 and 82 journaled in the base 20 and having a cross support 83 at their lower ends. This cross support is connected to a piston rod 84 of a pneumatic cylinder 85 called the "case control cylinder." This cylinder receives its air under pressure from solenoid-operated valves 86 and 87, through hoses 88 and 89. Through operation of these valves, air under pressure is supplied to the case control cylinder 85 to move the case 80 upwardly and downwardly during the press operating cycle.

Referring now particularly to FIGS. 2 and 3, the raw material or "dust" is provided to the die cavities through a conveyor or "shaker box" generally indicated at 90. The shaker box is a rectangular frame which is open at its top and its bottom but which carries a plurality of horizontal rods 91. The shaker box is reciprocable with respect to an extension 92 of the die case 80 and, in the position shown in FIG. 3, is ready to accept a load of dust for supply to the die cavities. The shaker box moves upwardly and downwardly with the die case 80.

The rectangular frame of the shaker box is connected to spaced piston rods 94 and 95 respectively connected to pistons (not shown) in the pneumatic cylinders 96 and 97 extending longitudinally with respect to the direction of shaker box travel at the opposite side of the press from the shaker box. The cylinders 96 and 97 are connected together at their remote ends by a hose 98 which is exhausted to atmosphere. The opposite ends of the cylinders are similarly connected together and are supplied with air under pressure through hose 99 connected to solenoid-operated valve 100. The valve 100 receives its supply of air under pressure from hose 101. The cylinders are preferably of the spring-return type such that, if the air under pressure is released from hose 99, when the pistons are to the right of FIG. 2 with respect to the position shown therein, the pistons are returned toward

the left to the position shown in the figure, by the operation of the bias springs (not shown). Thereby, when air under pressure is supplied through hose 99 to the left-hand ends of the cylinders 96 and 97 (in FIG. 2), the pistons are urged toward the right to move the shaker box from the position shown in FIG. 2 to a position underneath the top die 22 of the press. Then, when the pressure is released from hose 99, the pistons return to move the shaker box out from under the die.

Referring particularly to FIG. 3, the rods 94 and 95 carry cams 102 and 103 which form switch-operating members. The operating member 102 is designed to co-operate with a switch 104 identified as the "ram down signal" switch. This is a normally-open switch which is operative when closed to cause the ram and the upper die to move downwardly. However, as will be discussed hereinafter, this operation only takes place when the shaker box returns to the position shown in FIG. 3.

Switch-operating member 103 cooperates with switches 105 and 106 which are respectively termed the "case up signal" switch and the "shaker box up" switch. The "case up signal" switch is a normally open switch which is closed during the initial movement of the shaker box toward the area between the movable upper die and the fixed lower die. The "shaker box bump" switch 106 is a normally closed switch which, in conjunction with the step switch to be described, provides for movement of the shaker box toward the die cavities when the switch is closed, and, when the switch is open, provides for the spring return of the shaker box to the initial position shown in FIG. 2. The operation of these switches will be described hereinafter in conjunction with the schematic drawing.

It has been indicated hereinabove that one of the features of the present invention is the use of a rotary switch actuator for control of certain switches which can be adjusted to control the "bumps" or strokes of the ram.

Referring now to FIGS. 1 and 4, the rotary switch actuator referred to is a cam surface 110 which is fixed to the lower side of the bull wheel 28 and therefore reciprocates and rotates with the bull wheel. The cam surface 110 is designed to cooperate with three switches respectively identified at 111, 112, and 113, in FIG. 4. These switches are each fixed to support plates 114 through 116 which are in turn mounted on an adjustable switch support 117. The adjustable support 117 has slots 118 through 120 extending generally radially inwardly and along which the several switches are designed to be moved, so that the positions of the individual switches may be independently adjusted with respect to the adjustable switch support 117. The adjustable switch support is in turn adjustable with respect to a fixed switch support 121 which itself is fixed with respect to the fixed bearing 24 of FIG. 1. The fixed switch support 121 has a slot 122 extending arcuately along its surface and the adjustable switch support 117 is designed to be adjustable with respect to the fixed support along that arcuate slot.

The switch 111 is termed a "check" switch and is a normally-closed switch which is opened by movement of the cam surface 110 past the switch during the motion of the ram downwardly and which controls the step switch to be described. The switch 112 is termed the "second bump" switch and is employed in the second operation of the ram to set up the circuits for later causing the ram to move downwardly during its third stroke. Similarly, switch 113, identified as the "first bump" switch is a normally-open switch which is employed to prepare the circuits for the second bump stroke of the ram.

As will be evident, switches 111 through 113 are employed to control the operation of the ram, particularly in the lower portion of its travel. If they were operated through a reciprocatory plunger which was attached to the bull wheel, it would be quite difficult to provide for any range of adjustment of switch positions which would effectively vary the force of the bumps or strokes of the upper die. However, since they are controlled by an

actuator which is rotatable with the bull wheel, it is possible to provide for a relatively wide range of adjustments of switch positions, so that the forces of the strokes may be varied to correspond to different types of dust or raw material.

Referring to FIG. 1 again, it will be apparent that it would not be desirable for the ram to be permitted to move downwardly toward the lower die if the case were not in its upper position. The apparatus is therefore provided with a "case up safety" switch 125 which is controlled by a cam surface or switch actuating surface 126 on the rod 82 connected to the die case 80. The switch 125 must be closed in order that the ram can be driven downwardly toward its lower position. When the case is in its upper position, the safety switch is closed, but when it moves toward its lower position, the switch opens so that the ram cannot descend.

The automatic control system described herein is operated from a control panel 130 shown in detail in FIG. 6. This panel includes an appropriate fuse 131, a pilot light 132, whose operation will be described hereinafter, and various control switches for the apparatus. Referring to the left-hand upper corner of the control panel, the switch 133, termed the "Man-Auto" switch is a two position hand-operated switch which provides alternatively for continuous automatic operation of the press, and for single cycle operation of the press. The three-position switch 134, termed the "Jog-Safe-Run" switch, is in the run position for operation of the apparatus, but can be turned to the "Jog" position to return the ram to its initial upper condition. In the "Safe" position of the switch the apparatus is not running. The functions of the start switch 135 and stop switch 136 are self-explanatory.

The "Jog" switch 137 is operative in conjunction with the "Jog" position of switch 134 to move the ram upwardly. The "Case Down" switch 138 is provided so that the die case may be moved down when the apparatus is not in its operating cycle. The "Case Up" switch performs the opposite function and is identified by the numeral 139. The "Shaker Box" switch is employed to move the shaker box from its normal retracted position to its position beneath the upper die, and that switch is identified by the numeral 140. The "Reset" switch 141 is employed to reset the apparatus to its initial step in the cycle of its operations, if for any reason the apparatus should stop at some other step.

Referring now to FIGS. 7 through 11, the step switch 150 which is employed to control the cycle of operations of the apparatus is therein shown in detail. The step switch is a commercial item which has been modified to a limited extent for operation of the apparatus of the invention and is identified by the Eagle Signal Corporation of Moline, Illinois, its manufacturer, by the legend "MT Series Step Switch" in its bulletin 780C, issued August 1957. The step switch includes a rotary solenoid having an operating coil 151 which is to be energized by alternating current. The solenoid armature 152 of the step switch constitutes a weight which in the operation of the switch returns the solenoid to the position shown in FIG. 8 when current supply to the solenoid coil is interrupted. The armature weight 152 is oscillatable about a cam shaft 153 which carries a plurality of switch operating cams 154 spaced along its length. The cam shaft 153 carries a ratchet 155 at the left-hand end of the shaft in FIG. 7 and is rotatable thereby. This ratchet is controlled by a stop pawl 156 and a feed pawl 157.

The cam shaft and associated pawls and ratchet are shown in FIG. 8 in the de-energized condition of the solenoid. There the stop pawl and the feel pawl hold the cam shaft ratchet against movement. When the solenoid coil 151 is energized, the armature 152 moves clockwise to the position shown in FIG. 9. The stop pawl however prevents movements of the ratchet, and therefore of the cam shaft, during this energized stroke of the switch. When the current supplied to the solenoid coil is inter-

rupted, however, the weight of the armature causes it to return to the position of FIG. 8, thereby moving the feed pawl 157 counterclockwise to advance the ratchet 155 in the same direction, by one step. When the ratchet has advanced by one step, the stop pawl again engages the ratchet to prevent movement thereof in the opposite direction. Thereby, the step switch advances one position or one step each time the solenoid is de-energized, so that the various cams 154 are all simultaneously advanced one step.

Referring now to FIGS. 10 and 11 in conjunction with FIG. 7, the various cams 154 of the step switch are each employed to control the positions of contact levers 158, there being one such contact lever for each cam. Movable contacts 159 and 160 are mounted on the contact lever and are movable toward and away from fixed contacts 161 and 162, respectively. A spring 163 biases the contact lever toward the fixed contacts so that the switch formed by each section of the step switch is closed except when opened by the cam surface. As shown in FIG. 11, each one of the cams is formed by a number of sections 165 which each can be removed from the cam independently, so that the cam may have any desired number of operating surfaces. Specifically, the step switch shown in conjunction with the preferred embodiment of the invention employs cams having eight separate sections or segments. As indicated by the dotted line segment 166 in FIG. 11, a segment may be taken out to leave the cam blank at this position. As is shown in FIG. 10, it is possible to take out seven of the eight segments and leave only the single segment 167 for operation of the switch contact lever 158. With such a cam configuration, the switch formed by the contacts 159 through 162 would not be opened by the cam 154 except in that position of the step switch (the first position) in which the segment 167 moved the lever 158 to its dotted line position shown in FIG. 10.

The switch contact sets identified in FIG. 12 by the numerals 2-10 contain the elements so far described and operate in the manner detailed in conjunction with FIG. 10. The cam corresponding to contact set 9, however, is somewhat different in that its single segment consists of a half segment for each of switch positions 1 and 8, these half-segments being contiguous. The purpose of this arrangement will be described hereinafter.

The switch contact sets identified in FIG. 12 by the letter "X" and the numeral 1 have an additional feature now to be described. These switch sets have, in addition to the contact lever 158, an interrupter contact lever 170 attached to contact lever 158 and an interrupter cam 171. Further, the armature 152 carries a small roller 172 which, when the armature is moved toward its energized position, moves the interrupter contact lever 170 in a clockwise direction to the position shown in dotted lines so that the interrupter cam 171 can move under it. The interrupter contact lever functions like the contact lever 158 to disengage the switch contacts, when moved to this position. The result is that the switch contacts are always opened when the step switch moves to its energized condition. Therefore, the contact sets "X" and 1 are interrupted each time the step switch solenoid is fully energized, whether or not there is a cam surface segment which would cause the contacts to be open at this time.

Referring to FIG. 10, the stationary contacts 161 and 162 are respectively connected by leads 173 and 174 to terminals 175 and 176. These terminals form the sides of the respective switches of the step switch, and are connected to the external portions of the circuit.

Referring now to FIG. 13, the combination of the various switches and other circuit elements will be described in conjunction with operation of the apparatus.

The apparatus is provided with an alternating current source 199 which has one of its terminals connected to ground. The other terminal is connected through the

normally-closed contacts of die safety switch 76 and the fuse 131 to normally-closed stop switch 136. The stop switch is in turn connected to the movable contact of the Jog-Safe Run switch 134. The stationary contact 200 corresponding to the "Run" position of that switch is connected to one terminal 201 of the Start switch 135. When the Start switch is depressed, its contact 201 is connected to contact 202 which is in turn connected to one side of the operating coil of a first line relay 203. This operating coil has its other side grounded. Relay 203 has a movable contact 204 which, when the relay is energized, engages a fixed contact 206 which is connected to contact 201 of the Start switch. Thereby, when the line relay 203 is energized, the contact 204 of the relay has high voltage applied thereto.

This contact is connected to a movable contact 207 of a delay relay 208. In the normal condition of this delay relay, contact 207 engages a fixed contact 209 which is connected to the ungrounded side of the operating coil of relay 203. A holding circuit is thus provided for the relay 203 to keep it energized once it is supplied with operating voltage, as long as contacts 207 and 209 of delay relay 208 remain disengaged.

Movable contact 204 of relay 203 is connected to a movable contact 210 of a second line relay 211 which has one side of its operating coil grounded. The other side of the operating coil is connected to terminal 212 of Start switch 135. When the Start switch is engaged, contact 212 is connected to a contact 213 which in turn is connected through a resistor 214 to one side of pilot light 132. The other side of the pilot light is grounded. The ungrounded side of the operating coil of relay 211 is also connected through the Start switch 135 to fixed contact 2B of step switch 150. The corresponding movable contact 2A is connected to movable contact 204 of line relay 203, so that, when the Start switch button is depressed and relay 203 is energized, relay 211 is in turn energized if contacts 2A and 8B are engaged. Referring to FIG. 12, it is seen that these contacts are engaged only in position 1 of the step switch, which is the initial position in the operating cycle of the apparatus. Therefore, when the step switch is in its initial position, line relays 203 and 211 are energized, as is the pilot light 132.

The ungrounded side of the operating coil of line relay 211 is also connected to stationary contact 215 of Man-Auto switch 133. The movable contact of that switch is connected through the normally-closed contacts of the Reset switch 141 and the normally-closed contacts of a safety switch 216 to the contact 217 of line relay 211 which is engaged by contact 210 when the relay is energized. There is thus provided a holding circuit for line relay 311.

The stationary contact of relay 211 is also connected to movable contacts 10A, 8A, 6A, 5A, 4A and 3A of the step switch 150, so that operating voltage is available at all of these contacts when line relays 203 and 211 are energized.

In the first position of the step switch a delay relay 218 is energized. One side of the operating coil of this relay is connected to ground and the other side thereof is connected to contact 3B of the step switch. As is indicated in FIG. 12, the contacts 3A and 3B are engaged in the first position of the step switch, and contact 3A is supplied with operating voltage as above described. Delay relay 218 has a movable contact 219 which normally engages fixed contact 220 and remains in engagement therewith until a predetermined time period after energization of the relay. The contact 220 is connected to a stationary contact 221 of a shaker box relay 222 which is provided for manual operation of the shaker box and whose function will be discussed hereinafter. The contact 221 is normally in engagement with fixed contact 223, because the relay 222 is not energized dur-

ing the normal operating cycle of the apparatus. The contact 223 is connected through the normally-closed shaker box bump switch 106 to the operating coil 224 of solenoid valve 100. The other side of this coil is grounded. As is indicated in FIG. 13, the solenoid valve may consist of a conventional valve chamber 225 having piston 226 therein and which is movable by a piston rod 227. The rod is mechanically connected to the solenoid coil 224 so that the piston is urged upwardly when the solenoid is energized. However, a spring 228 normally urges the piston to its lower position shown in the figure. Air under pressure is supplied through hose 101 to the lower portion of the chamber 225 and, when the solenoid 224 is energized and the piston is in its upper position, air under pressure is directed through hose 99 to the shaker box control cylinders. Thereby, the shaker box 90 is moved toward the area beneath the upper die 22 to deliver material, which was previously deposited in the shaker box by any suitable means, to the mold-forming cavities.

During this motion of the shaker box, the case up signal switch 105 is closed by movement of the switch actuating surface 103 (FIG. 3) into engagement with the signal switch. One side of this switch is connected to one side of the operating coil 230 of solenoid valve 86 associated with the case control cylinder 85. The other side of this coil is grounded. The other side of case up signal switch 105 is connected through the normally-closed contacts of the Shaker Box switch 140 to contact 10A of the step switch. As was indicated above, this contact is supplied with operating voltage when the line relays 203 and 211 are energized. Thereby, the solenoid 230 of the valve 86 is energized and moves its associated valve piston rod 231 downwardly. This piston rod carries a pair of pistons 332 and 333 mounted in a valve chamber 234. A hose 235 supplies air under pressure to the central portion of this chamber, and the pistons 232 and 233 normally block-off communication between this central portion and hoses 88 and 89 connected to the case control cylinder. When the solenoid 230 is energized, however, air under pressure is supplied through hose 89 to the lower side of the case control cylinder 85 to urge the case upwardly.

During the forward movement of the shaker box, its switch actuating surface 103 (FIG. 3) opens the shaker box bump switch 106. The solenoid 224 is therefore de-energized and the piston 226 returns to the position in which it blocks communication between the air source (not shown) and the shaker box control cylinders. The shaker box therefore returns toward its initial position.

During the rearward movement of the shaker box, the shaker box bump switch 106 is again closed, and during the subsequent forward movement the switch is once more opened. This reciprocating motion takes place until the delay relay 218 finally moves its contact 219 away from stationary contact 220, thereby breaking the energizing circuit for the solenoid 230.

Returning to the initial energization of line relays 203 and 211 for the moment, the solenoid coil 151 of the step switch is energized at this time in a manner now to be described. One side of that coil is connected to ground through resistor 236 and is also connected to contact XB of the step switch. The corresponding movable contact XA is connected to ground, so that resistor 236 is shorted whenever contacts XA and XB are engaged. The other side of solenoid coil 151 is connected through the normally-engaged contacts of ram check switch 111 and ram de-air switch 72 to a movable contact 238 of a step switch control relay 239. When that relay is de-energized, contact 238 engages a stationary contact 240 which is connected to movable contact 3A of the step switch. As explained above, this contact is supplied with operating voltage when line relays 211 and 203 are energized, so that solenoid coil 151 of the step switch is energized at this time. When the armature weight moves toward its

energized position, contacts XA and XB are disengaged to remove the short from resistor 236 so that current through the solenoid coil is reduced to an appropriate operating level.

In its final return to its retracted position, the shaker box causes its switch operating surface or cam to close ram down signal switch 104. One side of this switch is connected to contact 4B of the step switch, which is engaged with contact 4A in the initial position of the step switch, which contact is supplied with operating voltage. The other side of ram down signal switch 104 is connected to one side of the operating coil of step switch control relay 239, the other side of the coil being grounded. Thereby, the relay is energized and disengages contacts 238 and 240 thereof to break the energizing circuit for step switch solenoid 151. The step switch armature thereupon moves to de-energized position, advancing the cams of the step switch to their second positions. In this position, however, contacts 4A and 4B of the step switch are disengaged (FIG. 12), so that the energizing circuit for relay 239 is interrupted and its contacts engage once more to re-energize the step switch solenoid 151. The step switch however remains in position 2, as described above in conjunction with FIGS. 7 through 9.

In the second position of the step switch contacts 3A and 3B thereof are disengaged, so that delay 218 de-energizes. However, contacts 4A and 4B are also open in this switch position, so the shaker box control solenoid 224 cannot be re-energized to move the shaker box to its forward position.

In the second step switch position its contacts 5A and 5B are engaged, so that operating voltage is available at contact 5B. This contact is connected through the now-closed contacts of case up safety switch 125 to the operating coils 242 and 243 associated with the solenoid valves 58 and 60 connected to the air brake control cylinders 57 and the ram control cylinder 47, respectively.

The solenoid valve 58 has a valve chamber 244 which is divided into an upper and a lower portion by a piston 245. This piston is urged by a spring 247 to the position shown in which it allows communication between an air supply hose 246 and the hose 59 connected to the upper sides of the air brake control cylinders. The other sides of the control cylinders are exhausted to atmosphere, so that the pistons (not shown) of the cylinders are normally in such position as to brake the bull wheel. However, when the solenoid 242 is energized, it moves a piston rod 248 connected to piston 245 upwardly to block the supply of air under pressure to the air brake control cylinders and therefore release the brakes.

The solenoid valve 60 associated with the ram control cylinder 47 similarly has a valve chamber 250 divided into upper and lower portions by a piston 251. A hose 252 supplies air under pressure to the lower portion and the hose 61 communicates between the upper portion of the ram control cylinder 47 and the upper portion of the chamber. The piston 251 is urged to the position shown by a spring 253 to block communication between hoses 252 and 61, but, when solenoid 243 is energized, it pulls piston rod 254 and attached piston 251 upwardly to supply air under pressure to the upper side of the ram control cylinder. Thereby the bull wheel and ram are caused to move downwardly.

During the downward movement of the ram the case de-air switch 73 is closed. One side of this switch is connected to one side of the operating coil 255 of solenoid-operated valve 86 associated with the case control cylinder 85. The other side of the coil is grounded. The other side of the switch is connected to step switch contact 10A which is provided with operating voltage, so that solenoid coil 255 is energized. The armature thereof (not shown) raises attached piston rod 231 to move valve pistons 232 and 233 toward the upper end of valve chamber 234. Air under pressure is therefore delivered to the upper portion of case control cylinder 85 to urge

the die case downwardly. However, the lower exhaust port 256 of the valve chamber, which is then in communication with the lower portion of the case control cylinder through hose 89, is not exhausted to atmosphere but rather is connected by hose 257 to the upper portion of the valve chamber 258 of solenoid-operated valve 87. A piston 259 is biased to the position shown by a spring 260 to block communication between hose 257 and the exhaust port 261 of the valve, so that the lower portion of the case control cylinder is not exhausted to atmosphere and the case does not drop down but rather is yielding held in its upper position by the air trapped beneath the piston of the case control cylinder.

During the downward movement of the ram the ram de-air switch 72 is opened to interrupt the energizing circuit for step switch solenoid coil 151. The step switch therefore advances to its third position. In that position step switch contacts 5A and 5B are disengaged (FIG. 12) to de-energize solenoid coil 243 associated with the ram control cylinder and stop downward drive of the ram. However, the ram's inertia causes it to continue to move ("drift") downwardly. The ram de-air switch is then reclosed and the solenoid coil 151 is re-energized. Then, the rotary switch actuator associated with the ram first opens check switch 111 and then closes successively the second bump switch 112 and the first bump switch 113. When the check switch opens, the energizing circuit for step switch solenoid 151 again opens to cause the step switch to advance to its fourth position. The first bump switch has one of its contacts connected to ungrounded side of the operating coil of step switch control relay 239 and its other contact connected to step switch contact 6B. In the fourth position of the step switch, contacts 6A and 6B are engaged and operating voltage is supplied to contact 6A through the line relays 203 and 211. Therefore the relay 239 is energized. Its second movable contact 265 is connected to movable contact 204 of the first line relay and is therefore supplied with operating voltage. When the control relay is energized, movable contact 265 thereof engages a fixed contact 266 which is connected to step switch contact 1B. In the de-energized condition of the step switch solenoid 151, contacts 1A and 1B are engaged and, since contact 1A is connected to the ungrounded side of the solenoid coil, the solenoid is once more energized. When the step switch armature moves toward its fully energized position, however, contacts 1A and 1B disengage and the coil 151 is again de-energized. The step switch therefore advances to its fifth position.

In the fifth position of the step switch its contacts 6A and 6B are disengaged, so that control relay 239 is de-energized. Therefore when the movable upper die strikes the die case to compress or compact the dust and the upper die and the ram rebound and move upwardly so that the ram check switch is again closed, an energizing circuit is again established for solenoid coil 151.

In the fifth position of the step switch its contacts 5A and 5B are engaged so that coil 243 of solenoid valve 60 is again energized to cause the ram to be driven downwardly. During this second movement downwardly, the check switch is again opened to cause the step switch to advance to position "6," whereupon the coil 243 is de-energized to stop downward drive. The second bump switch 112 is then closed. One side of this switch is connected to contact 10A of the step switch and is therefore supplied with operating voltage, while the other contact is connected to contact 7A. In the sixth position of the step switch, contacts 7A and 7B are engaged. Contact 7B is connected to the ungrounded side of the operating coil of step switch control relay 239, so that the relay is energized. Contacts 265 and 266 thereof and contacts 1A and 1B of the step switch again complete an energizing circuit for the step switch coil 151, which, however, is then interrupted by disengagement of contacts 1A and 1B. The step switch therefore advances to position "7."

The coil 151 is immediately re-energized upon closing of the check switch 111 during upward movement of the ram, because contacts 6A and 6B of the step switch are opened in its seventh position, so that control relay 239 de-energizes.

In the seventh position of the step switch, its contacts 5A and 5B are once more engaged and the ram control solenoid 243 is energized to return the ram downwardly. During this third movement or "bump" of the ram the check switch again opens to cause advancement of the step switch to position "8" and ram down drive is again stopped. In position "8," step switch contacts 10A and 10B are engaged. Contact 10A is supplied with operating voltage and contact 10B is connected both to the operating coil of delay relay 208 to energize the relay and to a stationary contact 270 of a case control relay 271. That relay is de-energized during automatic operation of the press and the movable contact 272 which engages stationary contact 270 is connected to the ungrounded side of the operating coil 273 of the solenoid valve 87 associated with the case control cylinder 85. The armature of this solenoid coil is mechanically connected to the piston rod 274 attached to piston valve 259 and this piston is moved downwardly when the coil 273 is energized, to place the hose 257 in communication with exhaust port 261. The lower portion of the case control cylinder is thereby exhausted to atmosphere and the die case drops down.

The ram once more rebounds upwardly and the check switch 111 re-closes to complete an energizing circuit for the step switch solenoid 151. Then, as the ram continues upwardly, the auto cycle switch 171 is closed. One side of this switch is connected to the ungrounded side of the operating coil of step switch control relay 239, while the other side of the switch is connected to step switch contact 8B. In the eighth position of the step switch, contacts 8A and 8B are engaged and, since contact 8A is supplied with operating voltage, the step switch control relay is energized. The control relay then interrupts the energizing circuit for step switch coil 151 and the step switch advances to position "1." In that position the step switch is ready for repetition of the cycle of operations of the press described above.

It was indicated above that delay relay 208 was energized when the step switch was in position "8." The contacts 207 and 209 thereof complete the holding circuit for the first line relay 203, so that this relay is de-energized and all operations of the press are stopped if the contacts are disengaged. However, the delay relay has a delay period of the order of 45 seconds before the contacts disengage, and this period is much longer than the dwell of the step switch in position "8" during normal operation, so that the delay relay is normally de-energized well before it can open its contacts 207 and 209. If, however, the press should "hang up" in the eighth position of the step switch, the contacts disengage.

The operation described above corresponded to the "Auto" position of Man-Auto switch 133. When that switch is in its "Man" position its movable contact engages a fixed contact 280. This contact is connected to contact 9B of the step switch which engages contact 9A thereof in every position of the step switch except when the switch is fully in its eighth position and when it is moving back toward its first position. Contact 9A is connected to the ungrounded side of the operating coil of the second line relay 211, and the contacts 9A and 9B, together with the Man-Auto switch 133 (when that switch is in its "Man" position), the Reset switch 141, the safety switch 216 and contacts 210 and 217 of line relay 211 and contacts 204 and 206 of line relay 203, form a holding circuit for the second line relay. Thereby, with the switch 133 in "Man" position, the press goes through one complete cycle of operations whereupon the line relay 211 de-energizes and the cycle stops.

If for any reason the press should stop or be stopped

in any position of its cycle other than that corresponding to the first position of the step switch, the switch must be returned to the first position before a new cycle of operations can begin, since the second line relay 211 has its energizing circuit completed through contacts 2A and 2B of the step switch and these contacts are engaged only in the first position of the step switch. This feature is provided in order to protect against danger to personnel or equipment that might exist if the press could be re-started in some other position. The step switch must therefore be returned to its first position and such return is provided for by Reset switch 141. Contact 282 thereof is connected to the ungrounded side of the operating coil of step switch control relay 239, while contact 283, which engages contact 282 when the Reset switch is depressed, is connected both to movable contact 265 of the relay and to contact 204 of the first line relay 203. Since that contact is provided with operating voltage when the Start switch is depressed and relay 203 is energized, the step switch control relay 239 is energized. Contact 265 thereof then engages contact 266 and step switch solenoid 151 is provided with energizing voltage through contacts 1A and 1B. These contacts, however, are engaged only when the solenoid is in its completely de-energized condition, so that the contacts are alternately opened and closed and the step switch steps around until it reaches its first position in which contacts 1A and 1B are disengaged.

During the cycle of operations of the press the ram, shaker box, and die case automatically go through the various operations described above. However, it is also desirable that movement of these parts be accomplished when the press is not running. For instance, if the ram becomes stuck in its upper position, it is desired that it be moved out of that position without the necessity of prying it out, as has been required with previous automatically-controlled presses. For this purpose, the Jog-Safe-Run switch 134 is moved to its "Jog" position in which its movable contact engages fixed contact 285. That contact is connected to contact 286 of Jog switch 137. When the Jog switch is depressed, contact 286 is connected to contact 287 thereof which is connected to the ungrounded side of the operating coil 243 of the solenoid valve 60 associated with the ram control cylinder 47. Air under pressure is therefore delivered to the upper side of that cylinder and the ram is urged downwardly.

It may also be desirable to move the die case up. For that purpose, the ungrounded side of the operating coil 230 of the solenoid valve 86 associated with die case control cylinder 85 is connected to terminal 290 of Case Up switch 139, while the other terminal 291 is connected to "Run" terminal 200 of the Jog-Safe-Run switch 134. With that switch in its "Run" position and the Case Up switch depressed, solenoid 230 is energized and the case is moved up.

In order that the case may be moved down, the ungrounded side of solenoid coil 255 of the same valve 86 is connected to terminal 292 of the Case Down switch 138. When the switch is depressed, terminal 292 is connected to a terminal 293 which is in turn connected to terminal 200 of the Jog-Safe-Run switch. Terminal 294 of the Case Down switch is connected to terminal 293 and corresponding terminal 295 is connected to the ungrounded side of the operating coil of case control relay 271. This relay therefore energizes along with solenoid 255, when the Case Down switch is depressed. The second movable contact 296 of relay 271 is connected to the ungrounded side of the operating coil 273 of solenoid valve 87, while the corresponding stationary contact 297 is connected to contact 200 of the Jog-Safe-Run switch 134. When that switch is in its "Run" position, therefore, and the Case Down switch 138 is depressed, the case is moved down.

The shaker box may also be moved forwardly by de-

pression of the Shaker Box switch 140. Terminal 300 thereof is connected to terminal 200 of the Jog-Safe-Run switch 134, while corresponding terminal 301 is connected to the ungrounded side of the operating coil of shaker box control relay 222. Movable contact 302 of that relay is connected through the now-closed contacts of shaker box bump switch 106 to the ungrounded side of the operating coil 224 of shaker box control valve 100. The corresponding stationary contact 303 of relay 222 is connected to contact 300 of the Shaker Box switch. Therefore, when the Jog-Safe-Run switch is in its "Run" position and the Shaker Box switch is depressed, the shaker box moves forwardly.

The operation of the apparatus has been generally described in conjunction with the description of the schematic of FIG. 13. In order that the operation of the mechanical elements of the press may be more easily understood, a short description thereof, together with reference to the various positions of the step switch, will now be given. When the step switch is in position "1," and the line relays are energized, the delay relay 218 has its normally closed contacts engaged, despite the fact that the relay is energized and the shaker box solenoid valve 100 is energized to move the shaker box 90 from its retracted position, with a load of clay dust to a position beneath the upper die 22. During this movement, the shaker box bump switch 106 is opened to de-energize the solenoid and the springs of the shaker box control cylinders 96 and 97 cause the shaker box to be moved rearwardly. The bump switch is again closed by this rearward motion and the shaker box is returned beneath the upper die. By this time, the case up signal switch has closed and energized the solenoid valve 86 in such direction as to move the case 80 to its upper position. The clay dust is therefore delivered by the shaker box to the mold cavities formed by the die case 80 and the lower die 21. The shaker box bump switch again opens to cause return of the shaker box toward its retracted position, but the bump switch once more closes during this movement. The shaker box therefore moves once more to the box beneath the upper die plate and then returns toward its retracted position. These reciprocations of the shaker box cause the dust to be broken up into fine particles, as is well known in the art.

By this time, the delay relay 218 has opened its contacts 219 and 220 so that the shaker box cannot be returned toward the die area. During its last rearward motion, the shaker box causes the ram down signal switch 104 to close to set up an energizing circuit for the step switch control relay 239. Energization of this relay causes interruption of the energizing circuit for the step switch solenoid 151 thereby causing advance of the step switch to position "2." In the second position of the step switch, the fourth contact step of the step switch is disengaged so that the energized circuit for step switch control relay 239 is opened and the energizing circuit for solenoid 151 is once more completed.

In the second position of the step switch, its contacts 5B and 5A are closed to complete an energizing circuit for the valve solenoid 243 and move the friction disc 30 into engagement with the friction or bull wheel 28. The bull wheel and therefore the ram 23 begin their downward movement. During this movement, the case de-air switch 73 is closed to energize the solenoid 255 associated with the case control cylinder. The die case 80 is therefore urged toward its lower position, but the solenoid 273 is not energized at this time so that the lower side of the case control cylinder 85 is not exhausted to atmosphere and the case is yieldingly held in its upper position.

During continued downward movement of the ram, the ram de-air switch 72 is opened to open the energizing circuit for the step switch solenoid 151. The step switch therefore advances to position "3." In this position, step switch contacts 5A and 5B are not engaged, so that solenoid valve 60 reverses its position and downward drive

of the ram is stopped. However, the ram has considerable inertia and continues its downward movement. The switch actuating cam 66 moves past the operating element of ram de-air switch 72, and the switch again closes to complete an energizing circuit for the step switch solenoid 151.

During its continued downward movement, the switch actuator 110 associated with bull wheel 28 first opens the ram check switch 111 and then closes successively the second bump switch 112 and the first bump switch 113. Opening of the ram check switch causes the energizing circuit for step switch solenoid 151 to open once more, so that the step switch advances to position "4." Closure of the first bump switch causes energization of the step switch control relay 239 which completes a new energizing circuit for the step switch solenoid through the now-closed contacts 1A and 1B of the step switch. These contacts however, open when the switch reaches its fully energized position, so that the step switch advances to position "5." In that position, step switch contacts 6A and 6B are disengaged, so that control relay 239 is de-energized.

In the meantime, the upper die 22 has struck the dust in the mold cavities to compact the dust and force the air out. The die case 80 moves downwardly with the ram, compressing the air in the lower side of the case control cylinder 85. Then, the spring 34 associated with the bull wheel drive takes over to move the friction disc 29 into engagement with the bull wheel 28 and move the upper die, ram 23 and bull wheel 28 upwardly. During this movement, the ram check switch 111 closes to re-complete the energizing circuit for step switch solenoid 151. In position "5" of the step switch, its contacts 5A and 5B are engaged so that solenoid 243 is once more energized and friction disc 30 is moved into contact with the bull wheel to move the ram 23 downwardly. The ram has not by this time reached an upper position such as to open the ram de-air switch 72. In this second downward movement of the ram, the check switch 111 is once more opened to cause advance of the step switch to position "6." The second bump switch is immediately closed to energize the step switch control relay 239 through contacts 7A and 7B of the step switch, so that the step switch solenoid 151 is again energized. Contacts 1A and 1B of the step switch thereupon operate in the manner described above to cause advance of the step switch to position "7." In that position, the contacts 7A and 7B are opened so that the energization circuit for the control relay is opened and, when the ram rebounds and closes check switch 111, the step switch solenoid re-energizes.

In position "7" of the step switch, its contacts 5A and 5B are engaged so that the ram is again driven downwardly. Actuator 110 once more opens check switch 111 to cause advance of the step switch to position "8." Then, the ram is driven upwardly. In this final upward movement of the press cylinder, the ram closes the auto-cycle switch 71 to set up a new energizing circuit for control relay 239 and advance the step switch to position "1." However, while the step switch was in position "8," its contacts 10A and 10B engaged to cause energization of solenoid 273 and exhaust the lower side of case control cylinder 85. The case 80 therefore dropped to its lower position.

In position "1" of the step switch the automatic control is ready for a new cycle of operations which is identical to the cycle just described. During the forward movement of the shaker box the box pushes the compacted tiles out from under the upper die 22 and the tiles may be appropriately moved away for subsequent operations by a conventional conveyor.

It will be noted particularly that in the first stroke or bump of the ram and its associated movable die the ram is driven downwardly for a relatively short stroke and it "drifts" downwardly to its compacting position. This is accomplished through opening of ram de-air switch 72.

In the second and third strokes of the ram, however, ram drive continues until the switch actuator 110 reaches nearly the limit of its downward movement to open the ram check switch 111. Therefore, the second and third strokes or bumps of the upper die are with greater force than the first stroke. Also, the forces of these three strokes may be adjusted by adjustments of the positions of switches 111, 112 and 113, associated with rotary actuator 110 and by adjustment of reciprocable switch actuator 66 associated with the ram de-air switch 72. Also it will be noted that the operation of the first and second bump switch is not coincident with the ram down drive which they control but rather leads that drive by one operation of the step switch.

It will be appreciated that many minor changes could be made in the apparatus of the preferred embodiment of the invention without departure from the scope of the invention. In particular, the shaker box control cylinders 96 and 97 could be controlled only through a spring-return solenoid valve to speed up operation of the shaker box. Also, the shaker box could be mechanically operated, rather than pneumatically operated, by substitution of an appropriate mechanical linkage for the pneumatic cylinders and valves disclosed in this application.

The scope of the invention, accordingly, is to be measured, not by limitation to the preferred embodiment disclosed herein but rather only by the scope of the appended claims.

We claim:

1. In a friction drive tile press of the type including a base, a pair of power driven horizontally shiftable friction disks journaled with respect to said base, a horizontally arranged friction wheel mounted on said base between the opposed faces of said disks and carrying a screw threadedly mounted for rotary and vertical reciprocatory movement with respect to said base, a ram mechanically connected to said screw for vertical reciprocatory movement therewith, a movable die member fixed to said ram, die members on said base in the path of movement of said movable die member and cooperable therewith to form tiles from clay dust supplied to said second-mentioned die members, means connected to said friction disks for alternately shifting the disks in opposite directions to cause one and the other of said disks to engage said friction wheel to alternately drive the wheel in such directions as to move said ram alternately up and down, said means including a fluid pressure cylinder mounted on said base and having therein a piston operable when moved in one direction to move said friction disks in such direction as to cause the ram to be driven downwardly, and a source of fluid under pressure for operation of said cylinder;
- an automatic control system for said press operable to move the ram downwardly a plurality of times during each cycle of its operations, said automatic control system including:
 - a solenoid valve connected to said fluid source and operable when the solenoid thereof is energized to deliver fluid under pressure to said cylinder to move the piston thereof in said one direction,
 - means connected to and operable to alternately energize and de-energize said solenoid a plurality of times during each cycle including means for first establishing an energizing circuit for the solenoid and then interrupting that circuit at the beginning of each cycle to begin and then stop downward movement of the ram,
 - said energizing means further including:
 - a switch actuator connected to said friction wheel to rotate and reciprocate therewith,
 - and a plurality of switches each having an operating element respectively arcuately spaced apart in the path of movement of said actuator to be successively operated during each downward and rotary movement of said friction wheel,

one of said plurality of switches being operable subsequent to interruption of said energizing circuit to establish an energizing circuit for the solenoid to cause a second downward drive of the ram, another one of said plurality of switches being operable subsequent to operation of said one switch to interrupt said energizing circuit established by said one switch to stop downward drive of the ram.

2. In a fraction drive tile press of the type including a base, a pair of power driven horizontally shiftable friction disks journaled with respect to said base, a horizontally arranged friction wheel mounted on said base between the opposed faces of said disks and carrying a screw threadably mounted for rotary and vertical reciprocatory movement with respect to said base, a ram mechanically connected to said screw for vertical reciprocatory movement therewith, a movable die member fixed to said ram, die members on said base in the path of movement of said movable die member and cooperable therewith to form tiles from clay dust supplied to said second-mentioned die members, means connected to said friction disks for alternately shifting the disks in opposite directions to cause one and the other of said disks to engage said friction wheel to alternately drive the wheel in such directions as to move said ram alternately up and down, said means including a fluid pressure cylinder mounted on said base and having therein a piston operable when moved in one direction to move said friction disks in such direction as to cause the ram to be driven downwardly, and a source of fluid under pressure for operation of said cylinder;

an automatic control system for said press operable to move the ram downwardly a plurality of times during each cycle of its operations, said automatic control system including:

a solenoid valve connected to said fluid source and operable when the solenoid thereof is energized to deliver fluid under pressure to said cylinder to move the piston thereof in said one direction,

switch means connected to and operable when in any one of a plurality of positions to supply energizing current to said solenoid to cause downward drive of said ram,

means connected to and operable at the beginning of each cycle to first position said switch means in one of said positions to start downward drive of the ram and then to position said switch means in a position different from said plurality of positions to stop downward drive of the ram,

a switch actuator connected to said friction wheel to rotate and reciprocate therewith,

and a plurality of switches each having an operating element respectively arcuately spaced apart in the path of movement of said actuator to be operated during each downward and rotary movement of said friction wheel,

one of said plurality of switches being connected to and operable subsequent to positioning of said switch means in said different position to position the switch means in one of said plurality of positions to energize the solenoid to cause downward drive of the ram, another one of said plurality of switches being connected to and operable when operated subsequent to operation of said one switch to position said switch means in a position different from said plurality of positions to stop downward drive of the ram.

3. In a friction drive tile press of the type including a base, a pair of power driven horizontal shiftable friction disks journaled with respect to said base, a horizontally arranged friction wheel mounted on said base between the opposed faces of said disks and carrying a screw threadably mounted for rotary and vertical reciprocatory movement with respect to said base, a ram mechanically connected to said screw for vertical reciprocatory movement therewith, a movable die member fixed to said ram, die members on said base in the path of

movement of said movable die member and cooperable therewith to form tiles from clay dust supplied to said second-mentioned die members, means connected to said friction disks for alternately shifting the disks in opposite directions to cause one and the other of said disks to engage said friction wheel to alternately drive the wheel in such directions as to move said ram alternately up and down, said means including a fluid pressure cylinder mounted on said base and having therein a piston operable when moved in one direction to move said friction disks in such direction as to cause the ram to be driven downwardly, and a source of fluid under pressure for operation of said cylinder;

an automatic control system for said press operable to move the ram downwardly a plurality of times during each cycle of its operations, said automatic control system including:

a solenoid valve connected to said fluid source and operable when the solenoid thereof is energized to deliver fluid under pressure to said cylinder to move the piston thereof in said one direction,

switch means connected to and operable when in any one of a plurality of positions to supply energizing current to said solenoid to cause downward drive of said ram,

means connected to and operable at the beginning of each cycle to position said switch means in one of said positions to start downward drive of the ram, a first switch actuator reciprocable with said ram, a first switch having an operating element in the path of movement of said first actuator during downward movement thereof, said first switch being connected to and operable when its operating element is contracted by said first actuator to position said switch means in a position different from said plurality of positions,

a second switch actuator connected to said friction wheel to rotate and reciprocate therewith,

and a plurality of switches each having an operating element respectively arcuately spaced apart in the path of movement of said second actuator to be operated during each downward and rotary movement of said friction wheel,

one of said plurality of switches being connected to and operable when operated subsequent to operation of said first switch to position said switch means in another one of said positions to energize the solenoid to cause downward drive of the ram,

another one of said plurality of switches being connected to and operable when operated subsequent to said operation of said one switch to position said switch means in a position different from said plurality of positions to de-energize the solenoid to stop downward drive of the ram.

4. The apparatus of claim 3 in which said one switch is operable when operated during downward drive of the ram to position said switch means in said other position only after a time delay subsequent to operation thereof, whereby downward movement of the ram in a second stroke is controlled by movement of the ram downward in a first stroke.

5. The apparatus of claim 3 in which said one switch is normally open and is closed during downward movement of the ram and said other switch is normally closed and is opened during downward movement of the ram, and in which said switch means comprises a step switch having a solenoid actuator operable each time it is de-energized to advance the step switch by one position thereof,

said step switch having a pair of contacts connected to and operable when closed to furnish energizing current to the solenoid of said solenoid valve, said pair of contacts being closed in each of said plurality of positions,

said step switch having a control relay associated therewith which has a set of normally-closed contacts, an energizing circuit for said solenoid actuator including the series combination of said other, normally-closed, switch and said normally-closed contacts of said control relay, said energizing circuit being operable to energize the solenoid actuator when said other switch and said control relay contacts are closed, whereby the step switch is advanced one position each time said other switch is opened during downward movement of said ram and each time said control relay is energized,

an energizing circuit for said control relay including the series combination of said one, normally-open, switch and a second set of contacts of said step switch, said second energizing circuit being operable to energize the control relay when said one switch and said second set of step switch contacts are closed,

said step switch being constructed to have at least three successive positions and operable to close said first-mentioned set of step switch contacts in the first and third of said positions to energize the solenoid of said valve to cause the ram to be driven downwardly,

said step switch being operable to close said second set of step switch contacts in a second position to cause advance of the step switch from its second to its third position when said one, normally-open, switch is closed by downward movement of the ram.

6. The apparatus of claim 3 in which said one switch is normally open and is closed during downward movement of the ram, said other switch is normally closed and is opened during downward movement of the ram and in which said plurality of switches includes a third normally-open switch which is closed during downward movement of the ram,

and further in which said switch means comprises a step switch having a solenoid actuator operable each time it is de-energized to advance the step switch by one position thereof,

said step switch having a pair of contacts connected to and operable when closed to furnish energizing current to the solenoid of said solenoid valve, said pair of contacts being closed in each of said plurality of positions,

a control relay associated with said step switch,

an energizing circuit for said solenoid actuator including the series combination of the normally-closed contacts of said other switch and a set of normally-closed contacts of said control relay, said energizing circuit being operable to energize the solenoid actuator when said other switch and said control relay contacts are closed, whereby the step switch is advanced one position each time said other switch is opened during downward movement of the ram and each time said control relay is energized,

a first energizing circuit for said control relay including the series combination of said one, normally-open, switch and a second set of contacts of said step switch, said second energizing circuit being operable to energize the control relay when said one switch and said second set of step switch contacts are closed,

a second energizing circuit for said control relay including the series combination of said third, normally-open, switch and a third set of contacts of said step switch, said second energizing circuit being operable to energize the control relay when said third switch and said third set of step switch contacts are closed,

said step switch being constructed to have at least five successive positions with said first-mentioned set of contacts thereof closed in the first, third and fifth positions to energize the solenoid of said valve to cause the ram to be driven downwardly,

said second and third sets of step switch contacts being respectively closed in the second and fourth positions of the step switch to cause advance thereof when the step switch is in its second position and said one switch is closed by downward movement of the ram and when the step switch is in its fourth position and said third switch is closed by downward movement of the ram.

7. The apparatus of claim 6 including a voltage source, a selector switch operable in one of its positions to connect all of said energizing circuits across said voltage source, a hand-operated switch, a second energizing circuit for said first mentioned solenoid valve including said hand-operated switch and said selector switch when in another of its positions, whereby the operating cycle may be interrupted and the ram may be moved downwardly by closure of said hand-operated switch and movement of said selector switch to said other position when the ram becomes stuck in any position.

8. The apparatus of claim 3 in which the friction drive tile press further includes a die case movable between an upper position in which it forms the side walls of the tile molds and a lower position in which its upper surfaces are level with said fixed die member, means for delivering clay dust to the mold cavities defined by the die case and fixed die member, a case control fluid pressure cylinder mounted on said base and having therein a piston operable when moved in one direction to move the die case upwardly and operable when moved in the opposite direction to move the die case downwardly, said automatic control system further including

a second solenoid valve connected to said fluid source and having a pair of solenoid coils therein, said second valve being operable when one of said coils is energized to supply fluid under pressure to the case control cylinder to move the piston thereof in said one direction and operable when the other coil is energized to supply fluid under pressure to the upper side of the case control cylinder to urge the case downwardly,

a third solenoid valve having an exhaust port connected to atmosphere and a piston valve normally blocking communication between said exhaust port and a second port connected to said second solenoid valve, said third solenoid valve being operable to block communication between the lower side of said case control cylinder and atmosphere except when the solenoid thereof is energized, whereby the die case is yieldingly held in an upper position when said other coil of the second solenoid valve is energized until the third solenoid valve is energized, means for energizing said one solenoid coil of said second solenoid coil to move the case upwardly when dust is delivered to said mold cavities,

means responsive to the first downward movement of the ram in a cycle to energize said other coil of said second solenoid valve to yieldingly hold the die case in its upper position,

and means connected to and operable to energize said third solenoid valve when the ram is compacting the dust during its last downward stroke of said cycle to drop the case to its lowermost position before upward movement of the ram.

9. The apparatus of claim 8 in which said switch means comprises a step switch having a solenoid actuator operable each time it is de-energized to advance the step switch by one position thereof,

a control relay for the step switch,

a first energizing circuit for the solenoid of said step switch including the series combination of said other, normally-closed, switch, said first switch and a normally-closed set of contacts of said control relay, said first energizing circuit being operable to energize the step switch solenoid when said other switch,

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said first switch and said step switch contacts are closed,
 said step switch having at least 8 positions and at least 7 sets of contacts, the first contact set being engaged in all positions but the first switch position but being disengaged when the step switch solenoid is energized, the second contact set being engaged only in the first switch position, the third contact set being engaged only in the second, fifth and seventh switch positions, the fourth, fifth, sixth and seventh contact sets being engaged only in the fourth, sixth, eighth and eighth switch positions, respectively,
 said means for delivering dust to the dies being operable when the step switch is in its first position,
 said means for energizing said one coil of said second solenoid valve to move the case up being operable when the step switch is in its first position,
 said means operable to start downward movement of the ram including a fourth switch which is closed when said dust has been delivered,
 a first energizing circuit for said step switch control relay including the series combination of said fourth switch and said second contact set of the step switch operable when completed to energize the control relay to advance the step switch to its second position,
 a fifth normally-open switch having an actuator member attached to the ram to close the switch during the first downward movement of the ram,
 an energizing circuit for said other coil of said second solenoid valve including said fifth switch operable to urge the case downwardly when the switch is closed,
 said first switch being normally closed but momentarily opened by said first switch actuator during the first downward movement of the ram,
 means for moving said friction disks in such direction as to cause the ram to be driven upwardly when said first-mentioned solenoid valve is not energized,
 a second energizing circuit for the solenoid of said step switch including the series combination of said first contact set of the step switch and a normally-open set of contacts of said control relay, said second energizing circuit being operable when completed to energize the step switch solenoid,
 a second energizing circuit for said control relay including the series combination of said one switch and said fourth contact set of the step switch operable when closed to energize the control relay and thereby first energize and de-energize the step switch solenoid to advance the switch to its fifth position after said one switch is closed during the first downward movement of the ram,
 said plurality of switches further including a third, normally-open, switch which is closed during downward movement of the ram,

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a third energizing circuit for said control relay including the series combination of said third switch and said fifth contact set of the step switch operable when closed to energize the relay when the step switch is in its sixth position and said third switch is closed during downward movement of the ram,
 an energizing circuit for said third solenoid valve including said seventh contact set operable to energize the valve and cause the case to move to its lowermost position when the step switch is in its eighth position,
 a sixth normally-open switch having an actuating member attached to the ram to close the switch during the third upward movement of the ram in each cycle,
 and a fourth energizing circuit for said control relay including said seventh switch and said sixth contact set of the step switch operable to energize the relay and advance the step switch to its first position when both switches are closed, whereupon a new cycle of press operations begin.
 10. The apparatus of claim 9 in which said dust-delivery means includes a shaker box, means for reciprocating the shaker box between a retracted dust-receiving position and a forward position for delivery of dust to said mold cavities, an electrical energizing circuit connected to said reciprocating means to move the shaker box in the forward direction and including: a seventh normally-closed switch which is opened during forward movement of the shaker box, the normally-closed contacts of a delay relay which is operable to open its contacts after a predetermined interval, and said second contact set of the step switch; said reciprocating means being operable to move the shaker box in the rearward direction when said energizing circuit is opened, whereby the shaker box is moved back and forth a plurality of times while the step switch is in its first position until said delay relay opens its contacts, said fourth switch having an actuating member attached to said shaker box to close the switch during the last rearward movement of the shaker box in a cycle.
 11. The apparatus of claim 9 including a hand-operated reset switch, and a fifth energizing circuit for said control relay including said reset switch, whereby the step switch may be stepped automatically to its first position when the reset switch is depressed, through cyclic disengagement and engagement of said first contact set of the step switch.

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