ABSTRACT

The specification discloses an apparatus for compacting granular material utilizing a die and a lower punch and an upper punch. The upper punch is mounted on a press slide to be reciprocated into and out of the upper end of the die, while the die is floatingly supported and guided in the press and the lower punch mounting is movable in the press between an uppermost ejection position in which a punch mounted thereupon would have its upper end flush with the top of the die and a lowermost fill and compacting position wherein the lower punch is solidly supported on the press bed. A crankshaft in the press has angularly related throws connected to the slide which supports the upper punch and to a bridge that engages the lower punch mounting from beneath. Resilient cushions are employed for floating the die table that carries the die and for controlling relative movement between various parts of the press.

31 Claims, 22 Drawing Figures
APPARATUS FOR COMPACTING GRANULAR MATERIAL

RELATED U.S. APPLICATION

This is a continuation of application Ser. No. 41,354, filed May 28, 1970, now abandoned.

This invention relates to an apparatus for producing workpieces by compacting granular materials and to a press for compacting the materials.

The compacting of granular materials is well known in the ceramic art and also in the powdered metal art. Many types of compacting presses, both mechanical and hydraulic, have been devised for compacting the granular materials but, heretofore, the presses have been relatively complex to set up and operate, and the prior art presses have not been sufficiently reliable in operation, and have lacked the precision and rigidity necessary to produce precisely sized workpieces at high speed.

Furthermore, many such presses involve the use of mechanical latches and releasing devices therefor and auxiliary motors or actuators to insure the proper relative positioning of the parts during operation of the press.

Still further, many of the presses employ multiple motors for actuating various parts of the dies that are being used in the press and both the use of latches and the use of multiple motors causes complexity in operation and control of the press. Through this complexity of construction precision is lost and rigidity of the press structure is often impaired.

When a press is compacted from granular or powdered material, it usually requires considerable force to remove the compacted workpiece from the die in which it is formed and, heretofore, either "ejection" or the part from the die or "withdrawal" of the die from the workpiece is resorted to in removing the workpiece from the die. When ejection is employed in some existing presses the lower punch requires adjustment for effecting the filling of the die cavity. When withdrawal of the die from the workpiece is employed in other existing presses a fixed lower punch is employed, but difficulties are sometimes encountered when flanged parts are to be removed from a die.

With the foregoing in mind, it is a primary object of the present invention to arrive at a press configuration which combines the advantages of both of the aforementioned ejection and withdrawal methods.

A salient object of the invention is the achievement of precise alignment between the reciprocating slide that carries the upper punch and the floating table that carries the die by aligning and guiding both members on precise guide ways on the press structure.

A further object of this invention is the provision of a press in which the lower punch of the die is fixed and solidly supported on the press bed for compaction, but wherein no adjustment of the lower punch is required to establish the fill depth of the die cavity.

In addition, it is an object of the invention to provide a more rigid and hence more precise structural configuration for a press by conveying the high compaction loads only through major structural members and over short distances.

Another object of this invention is the provision of a press in which the compacted workpiece is ejected upwardly out of the die using a fixed stroke of the press actuating mechanism thereby eliminating the need for removable stops for the die which are employed when a die is pulled downwardly to release a workpiece therefrom.

Another object of this invention is the achievement of the high reliability and durability of a crank-type actuating mechanism in place of the less durable cams that are used in prior art mechanical presses, while at the same time achieving the desired dwell positions in the movement of the lower punch mounting and floating die table through the use of resilient cushions and stops.

Still another object is the provision of a press arrangement which is easy to set up and simple to operate and in which all of the press movements are precisely timed relative to each other without the necessity of complex controls or cams.

Still another object of the invention is the provision of a press which will operate rapidly and which is extremely rigid to provide for the production of precision parts at high rates of speed.

Still another object of the invention is the provision of a press arrangement in which a workpiece having stepped contours can be fabricated by compaction and ejected from the die cavity without breakage.

Still another object of this invention is the provision of a modular fill shoe and fill shoe actuating mechanism adaptable to a variety of production requirements through the use of a readily interchangeable and adjustable fill shoe actuating cam, a fill shoe mounting that permits easy interchange of fill shoes of various sizes and shapes adapted to the needs of the particular part being manufactured, and an adjustable mechanism to provide for changing the dwell time of the fill shoe at the fill position.

The foregoing objects as well as still other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification, taken in connection with the accompanying drawings, in which:

FIG. 1 is a schematic view showing an arrangement of machines for practicing the process of the present invention;

FIG. 2 is a perspective view of the press forming the principal machine utilized in the practice of the invention;

FIG. 3 is a fragmentary perspective view showing the drive crankshaft of the press of FIG. 2;

FIG. 4 is a schematic fragmentary view, partly in section, showing other parts of the press structure;

FIG. 5 is a fragmentary perspective view showing a powder feed mechanism for use with the press;

FIG. 6 is a fragmentary view looking in from the right side of FIG. 5 showing adjustments pertaining to the powder feed mechanism and the actuating cam for the powder feed mechanism;

FIG. 7 is a fragmentary perspective view showing a typical adjustment utilized in the press structure;

FIG. 8 is a schematic vertical sectional view through the press with the parts thereof displaced from true position for the sake of clarity;

FIG. 9 is a view of the press partly in section at the point in the press cycle where the die cavity commences to fill with powder;

FIG. 10 shows the relative positions of the throws of the crankshaft for the FIG. 9 position of the press parts;

FIG. 11 schematically shows the press at the end of the fill cycle.
FIG. 12 shows the positions of the throws of the crankshaft pertaining to the FIG. 11 position;
FIG. 13 is a view showing the press parts when the fill shoe has been retracted from filling position;
FIG. 14 shows the crankshaft throw positions pertaining to the FIG. 13 position;
FIG. 15 is a view showing the press parts at the end of a compaction cycle;
FIG. 16 shows the positions of the crankshaft throws pertaining to the FIG. 15 position;
FIG. 17 is a view showing the press parts during the ejection of a compacted workpiece therefrom;
FIG. 18 shows the crankshaft throw positions pertaining to the FIG. 17 position;
FIG. 19 is a view showing the press at the end of the workpiece ejection stroke;
FIG. 20 shows the crankshaft throw positions pertaining to the FIG. 19 positions;
FIG. 21 is a schematic vertical sectional view through a modified construction with the parts of the press displaced from the true position thereof for the sake of clarity; and
FIG. 22 is a view from the front of the press of FIG. 21 and partly in section.

BRIEF SUMMARY OF THE INVENTION

The press of the present invention is constructed with a head and a bed and uprights extending therebetween with a slide guided on the uprights and with a lift out bridge vertically reciprocable in the press bed. A crankshaft in the press head has angularly related throws connected to the slide and to the bridge for reciprocation thereof in timed relation.

A die table is floatingly supported above the bed guided upon the same press uprights as is the slide, and is adapted for supporting a tubular die. A lower punch support beneath the die table supports a lower punch extending into the die from below. An upper punch for the die is mounted on the slide and is adapted to enter the die from above.

Resilient cushions provide a floating support for the die table. Other cushions urged the lower punch support toward the upper position wherein it abuts the die table; while the die table also engages a stationary abutment when in an upper position.

Filling of the cavity of the die is accomplished by moving the lower punch support downwardly to a stopped position against the press bed where it remains while material is compacted against the lower punch by the upper punch. The exact amount of fill is controlled by moving the die table downwardly at the same time as the punch support but a lesser distance.

Ejection of the compacted workpiece is accomplished when the lower punch supports and the die table are in their uppermost positions at which time the upper end of the lower punch and the upper end of the die are coplanar with the upper side of the die table. With the die table and lower punch in their uppermost positions, a fill shoe reciprocates into position over the die to displace the compact from its ejected position over the die area and deliver powder thereto when the lower punch moves downwardly. The fill shoe moves out from over the die when the upper punch descends for compaction.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, in FIG. 1, 10 is a press for the compacting of powdered, or granulated materials, such as metal, or ceramic, or the like, and 12 is a sintering or curing oven. Reference numeral 14 designates a sizing or coining press and 16 is a receiver for finished parts.

The press 10 is adapted for cycling continuously and material is fed thereto on each cycle from a supply hopper 18 via a feed, or fill shoe 20, which moves into the work space when the press slide 22 retracts and moves out of the work space when the slide advances. The shoe 20 is arranged to reciprocate into the work space at the time that a workpiece compacted on the previous press cycle has been ejected from the die and is resting on top of the die so that it will be pushed out of the working space by the inward movement of the feed shoe and be delivered, as by sliding down an incline 24 to a bin or to a conveyor 25 by means of which it is conveyed through sintering or curing oven 12.

The cured, or sintered, workpiece may then be placed between the die members 28 of the coining, or sizing, press 14 and struck, or pressed, or trimmed, to the desired final size and/or configuration. The completed workpiece is delivered to receiver 16, which may be a box, or the like.

The press, generally indicated at 10 in FIG. 1, will be seen in FIG. 2 to comprise a head 30, a bed 32 and uprights 34 extending therebetween. On top of head 30 is a drive motor 36 which drives a fly wheel 38 as by means of belt 40. Fly wheels 38 and 39 are mounted on a shaft 42, together with a pinion 44. Pinion 44 meshes with a gear 45 on a counter shaft 46. Mounted on counter shaft 46 is a clutch-brake mechanism 48, which is employed for interrupting or establishing the drive train in the press. The output side of the clutch-brake device 48 is connected in a suitable manner with a crankshaft 50 rotatably mounted in the press head.

Turning now to FIG. 3, it will be seen that a fixed stroke actuating means is provided. The crankshaft 50 has gears 52 thereon which are driven by suitable gearing from the output side of clutch-brake device 48. The crankshaft 50 may have one gear 52 at one end but, preferably, is provided with a gear 52 at each end.

The crankshaft is supported in bearings 54 fixed in the press head and has a center throw 56 and two side throws 58. The two throws 58 are the same size and are identically located circumferentially on the crankshaft while throw 56, which is usually of a different size than throws 58, is located on the crankshaft in about the middle of the length thereof and in circumferentially trailing relation to throws 58. In the present case, throw 56 trails throws 58 at an angle of 75°.

Throw 56 is connected to slide 22 by connecting means which includes the connecting rod 60 embracing throw 56. Slide 22, as will be seen hereinafter, is advantageously adjustable in length to determine the lower limit position of an upper punch member mounted on the underside of slide 22.

Each of throws 58 is connected with a respective pull rod 64 by way of connecting rods 66 and connector members 68, with each connector member being attached to the upper end of a respective pull rod 64 and pivotally connected to the respective connecting rod. FIG. 4 shows some of the press parts below the press head. In this view it will be seen that pull rods 64, at their lower ends, are connected to a lift out bridge member 70 which extends transversely of the press beneath the upper flange 72 of press bed 32. Lift out
bridge 70 is thus arranged to reciprocate in the vertical direction as crankshaft 50 rotates and by an amount which is determined by the throw of crankshaft throws 58. Furthermore, the reciprocation of lift out bridge 70 and the reciprocation of slide 22 will be in precisely timed relation to each other in conformity with the angular relation of throws 56 and 58.

The slide 22 is guided on uprights 34 and between slide 22 and upper bed flange 72 is the working space of the press. Disposed in this space is a die table 74 which is guided on the press uprights 34. Die table 74 is adapted for being entered from the top by an upper punch member carried on the underside of slide 22. The die in space 76 of table 74 is adapted for being entered from below by a lower punch member supported on a punch support structure which includes a post 78 located on the axis of the press. Support connected

Connected with die table 74 are four rods 80 which extend downwardly through upper bed flange 72 and two of which have rod extensions 101 which abuttingly engage a flange plate 82 secured to the lower end of the lower punch support post 78. Rods 80, as will be seen hereinafter, are adaptably connected to die table 74.

Also connected to die table 74 are adjustable abutment rods 84 adapted to abut the upper ends of cushion rods 86 which extend downwardly through bed flange 72 and lift out bridge 70 to pneumatic cushion cylinders 88.

FIG. 4 will also show cushion cylinders 90 carried on the underside of lift out bridge 70 and biasing pins 92 in the downward direction. Pins 92 are adapted for engaging flange plate 82 and for pushing the flange plate downward against other pneumatic cushions 94.

The aforementioned fill shoe 20 and the actuation thereof is shown more in detail in FIGS. 5 and 6. In FIGS. 5 and 6, it will be noted that the fill shoe is in the form of a generally rectangular metal outer frame having a relatively thin sheet metal cover 102 on top and may have an optional screen 104 at adjustable levels inside. The downwardly opening box 20 thus formed is connected by side links 106 to shaft 108 carried by a reciprocating plate 110 which is guided in its motion into and out of the working space in the press by guides 112 and guide rods 113. The box is adapted for being drawn out of the working space of the press by a link 114 pivoted at one end to plate 110 and at the other end to the lower extremity of a swinging arm 116.

Arm 116 at its upper end is pivotally mounted on a shaft 118 secured to the adjacent upright of the press in any suitable manner. Close to the pivot axis of arm 116, the arm carries an actuating roller 120 facing the press. Cam follower 120 is adapted for engagement by a cam 122. Adjacently carried on the adjacent portion of slide 22. It will be evident that as slide 22 goes downward, arm 116 will be cammed in a direction to retract the fill shoe from the working space of the press while, upon retraction of slide 22, air cylinder 111 will act on arm 116 so as to keep roller 120 against cam 122 and will thus return the fill into the work space as soon as roller 120 runs off the high part of cam 122. Adjustment of the cam 122 on slide 22 provides for timing of the movement of the fill shoe with respect to the slide movement.

At the lower end of arm 116 the connection thereof with link 114 is by way of block 124 and adjustable stop screw 126. The block 124 may be freely slidable in slot 128 of link 114 thereby to provide for dwell periods of the fill shoe at each limit of its travel.

Acting between plate 110 and levers 131 which are fixed to shaft 108 are the spring means 130 which maintain the fill shoe pressed downwardly against die table 74, thereby to prevent loss of material from the fill shoe.

The fill shoe also embodies a bumper element 132 on its outer end which pushes the workpiece compacted on the previous cycle of the press out of the work space when the fill shoe advances.

It will be seen that the fill shoe can readily be replaced by another of a different size if so desired, so that the opening in the bottom of the fill shoe can be made to match the fill shoe to the die cavity. Leading from hopper 18 is a flexible fill tube 134 that connects with the space in the fill shoe through the top wall of the fill shoe so that the fill shoe is always supplied from the hopper with the granulated material which is to be supplied to the die cavity.

It has been mentioned as shown in FIG. 4 that rods 80 are adaptably connected to die table 74 to adjust the upper limiting stroke position of the die table, and that abutment rods 84 are adjustable in die table 74 to adjust its lower limiting stroke position. A typical adjusting arrangement comprises threaded portion 85 on rods 84 engaged by nuts 87 rotatable in table 74 but held against axial movement therein. Nuts 87 are rotated in any suitable manner, as by a worm and wheel structure of the nature illustrated in FIG. 7. In FIG. 7, worm gear 89 is adapted for rotation by worm 91 which may be adjusted by hand wheel 93 or by a motor. Worm gear 89 is connected to a nut 87. The nut in turn carries a gear 95 meshing with a gear 97 rotatable in table 74 and meshing with another gear 99 attached to another nut 87. The adjustment described and illustrated is typical of adjustments employed in the press for the adjustment of various rods so that two, or more, rods can be adjusted in unison and by the same amount, merely by adjusting a selected one thereof.

Substantially the entire press is schematically shown in vertical cross section in FIG. 8. Certain parts of the press displaced for the sake of clarity in comprehending the structure and operation of the press.

The press of FIG. 8 also shows a certain construction located beneath the bed of the press which can form a part of the press structure as manufactured or which can be added thereto subsequent to the press manufacture. The equipment shown below the press bed in FIG. 8 is operative for certain modes of operation of the press but, on other occasions, is inoperative.

Wherever applicable, the same reference numerals have been employed in FIG. 8 that have been employed in connection with the figures previously described. FIG. 8, however, shows certain parts of the press structure that are difficult to ascertain from FIGS. 1 to 7.

In particular, FIG. 8 shows an alternate adjustable connection of rods 80 with table 74. This adjustable connection is represented by threads at 140 but it will be understood that the adjustable connection of rods 80 with table 74 would be of the type illustrated in FIG. 7.

An alternate connection of abutment rods 84 with table 74 is indicated as adjustable by the threads 142.

FIG. 8 will show that rods 80 have abutment means 144 thereon in the form of collars which abut the un-
derside of upper flange 72 of bed 32 in a certain uppermost position of the said table.

FIG. 8 will also show that the die carried by the die table, and designated at 146, is a tubular member with the upper surface substantially flush with the surface of table 74. FIG. 8 also shows that there is supported on the lower punch support member 78, a spacer block 148 and a lower tubular punch member 150 which extends upwardly into die 146 from below. The upper punch member is shown at 152 mounted on the underside of slide 22.

The lift out bridge 70 connected to the lower ends of pull rods 64 will be seen to have an upwardly facing abutment at 154 which engages the punch support structure 78 to lift it to its uppermost position in which it is illustrated in FIG. 8. It will also be noted in FIG. 8 that the flange plate 82 which is connected to the lower end of the punch support structure 78 is engaged by downwardly facing abutment means 156 on rods 101 so that the die and lower punch 150 are fixed in a predetermined uppermost position when crankshaft throws 58 are at top dead center and, furthermore, with the upper surfaces of the die and the lower punch flush so that fill shoe 20 can freely slide thereacross and also so that the previously made compact can be displaced from the die area by the inward movement of the fill shoe.

Two of the rods 80 in FIG. 8 have extension rods 103 which extend downwardly through lower bed flange 160 of bed 32 and through a first upper floating table 162. Floating table 162 has attached to the lower side thereof an adjustable nut arrangement 164 which is threaded on a rod 166 that extends upwardly completely through punch support structure 78 and into punch 150 and carries a core element 168 on the upper end. In the arrangement illustrated in FIG. 8, rods 103 are fixedly connected to upper floating table 162. Rod 166 is also fixed to table 162 so that the die table 74 and core element 168 move together maintaining the upper end of core element 168 flush with the upper surface of die 146. When crankshaft throws 58 are at top dead center the top surface of lower punch 150 also becomes flush with the top surfaces of die table 74 and core element 168.

Upper floating table 162 is provided with pneumatic cushions 170 between it and the lower flange 160 of bed 32 and is also provided with pneumatic cushions 172 between it and a lower floating table 174. Between floating table 174 and a lowermost table structure 176 are further pneumatic cushion means 178. Lowermost table 176 is adjustably mounted on rods 180 carried by and descending from lower bed flange 160. For connection of table 176 to rods 180, the rods are threaded and carry nuts 184 beneath the table 176. Nuts 184 may be connected by a chain 186 adapted for adjustment by hand wheel 188 or motor so that all of the nuts 184 can be adjusted at one time.

The cushions 170, 172 and 178 can be provided with air under pressure to provide for collapsing thereof upon the exertion of a certain axial force thereon, or they can be exhausted of pressure in which case they will collapse under the application of substantially no force. In FIG. 8, as illustrated, cushions 170, 172 and 178 are not pressurized. For various modes of operation, as will be explained hereinafter, the cushions 170, 172, and 178 will be pressurized in certain combinations.

In FIG. 8, as mentioned, crankshaft throws 58 are at top dead center and crankshaft throw 56 is 75° behind dead center. Under these circumstances, the previously compacted workpiece 151 has been ejected and is resting on top of the lower punch member 150 and will be pushed out of the die area when fill shoe 20 enters the working space. As the crankshaft continues to rotate, lift out bridge 70 will commence to move downwardly and when it does move downwardly, the combined weight of die table 74 and the punch supporting structure 78 will being about collapsing of pneumatic cushions 94 which are acting upwardly on flange plate 82.

When, however, rods 84 engage the upper ends of rods 86, the weight of the die table 74 becomes supported on its cushions 88 and the weight of the punch support structure 78 is not large enough to continue the collapsing of cushions 94. The lift out bridge 70, however, continues to move downwardly and pins 92 carried thereby will engage flange plate 82 and cause it to move downwardly, together with the punch support structure and to cause collapsing of cushions 94.

This movement of the punch supporting structure 78 will continue until the downwardly facing abutment 190 thereon engages member 192 supported on bed flange 72, causing the punch support structure to come to a halt in a solidly supported position. During this downward movement of the punch support structure, lower punch 150 is drawn downwardly in die 146 and forms a cavity which fills with granular material from the fill shoe. Fill shoe 20 was advanced inwardly into filling position by upward movement of slide 22 prior to the initiation of the downward movement of punch 150 in the die means.

After the punch support structure 78 comes to a halt, lift out bridge 70 continues to move downwardly and, during this further movement, cushion means 90 pertaining to pins 92 will yield to permit the lift out bridge to overtravel in the downward direction.

The slide 22 commences to advance downwardly when throws 58 are 75 degrees beyond their top dead center position so that after punch support structure 78 bottoms on member 192, fill shoe 20 will be retracted and upper punch member 152 will enter the die from above and will compact material therein. After throw 56 has passed its bottom dead center position and slide 22 commences to retract, lift out bridge 70 will be back to the position where it engages abutment means 154 of the punch support structure 78 which will cause vertical movement of punch 150 in the die to eject the compacted workpiece from the die.

During the pressing operation, cushions 88 yield in conformity with the downward force exerted on die 146 by frictional engagement of the material being compacted therein and this downward movement is accompanied by corresponding downward movement of core element 168 which, in this mode of operation of the press, is fixed to the die.

During ejection, the die table 74 and, therefore, the die 146 and core element 168 will be returned to their uppermost positions by engagement of abutment means 156 on rods 101 with flange plate 82 connected to the lower punch support structure 78.

The arrangement provides for full press tonnage to be exerted on the compact with the lower punch firmly supported and with the die floating. The arrangement also provides for the application of about half the full press tonnage for ejection of the compact. It will be
noted that no latches, cams, or auxiliary drive arrangements are required, but the entire operation of the press is carried out by availing of a single crankshaft having two throw arrangements thereon angularly related to provide for reciprocation of the slide 22 and the lift-out bridge 70 in timed relation to each other.

In the foregoing description of a cycle of the press, the core rod 166 was fixed to die table 74 by the nuts 81 an 83 threaded on rod 103 and on opposite sides of upper floating table 162.

Other modes of operation of the press, however, are possible where the core rod and floating die table move independently of each other. In one case, the core rod may take a greater floating movement than the die table and in another case, the core rod may take a floating movement less than that of the die table. In one case of independent movement of the core rod and die table, the core member, represented by numeral 168 in FIG. 8, must be in place for the filling of the cavity and then be out of the powder fill before compaction commences.

According to the present invention, an upper core member mounted on the slide is employed to force the lower core member downwardly prior to compaction. The adjustable nut 164 is availed of for this type of operation to insure that the upper end of core member 168 is flush with the floating die table after ejection. The upper position of the core member is, in this case, determined by movement of the lower floating table 174 upwardly by the pneumatic diaphragms 178.

The table 174 is forced by the diaphragms 178 against the shoulders 181 on rods 180 which are fixed to and descend from lower flange 160 of the press bed 32. Nuts 81 are adjusted down against the top of upper floating table 162 when it is in its uppermost position, while nuts 83 are adjusted downwardly away from table 162 a sufficient distance to permit the table to float.

In this manner, the core member 168 is held flush with the upper surface of the floating table after ejection of the workpiece and until completion of the filling of the die cavity but when the upper core member carried on the press slide, enters the die cavity, it will force lower core member 168 downwardly against the bias of cushions 178. In the event the core rod 166 is to float more than the floating die table 74, adjustments as mentioned before are made so that the core member 168 is in the proper position for ejection of a compact and for filling of the cavity. Nuts 83 are adjusted up against the bottom of floating table 162 while nuts 81 are adjusted upwardly away from floating table 162. Fluid diaphragms 170 are maintained under pressure to press table 162 against the lower nuts 83. Diaphragms 170 in this case insure that the core member will be pulled out of compacts after the compacts are ejected.

In case the situation is such that it is not important for core member 168 to be flush with the die table during ejection and filling, both nuts 81 and 83 can be adjusted away from upper floating table 162.

A still further mode of operation of the press requires core rod 166 to be held stationary during connection. This type of operation is obtained by movement of the bottom adjustable table 176 upwardly until it abuts the lower end of core rod 166 at 177. Adjustable nut 164 can be adjusted to insure that the upper end of the core member is flush with floating die table at the fill level. Lower nuts 83 are then adjusted up against the bottom of upper floating table 162, while the upper nuts 81 are adjusted upwardly away from the said table. The air diaphragms 170 serve to pull the core member out of the compact and hold upper floating table 162 firmly against the lower nuts 83.

In still another type of operation, core rod 166 floats downwardly during compaction to a positive stop. In this case, with the floating table at the fill level, nut 164 is adjusted until the upper end of core member 168 is at the desired level. The air diaphragms 178 are pressurized and hold lower floating table 174 up against the shoulders 181 on rods 180. The lower adjustable table 176 is adjusted for the desired gap between the lower end 177 of the core rod and the upper surface of bottom adjustable table 176.

Upper nuts 81 are adjusted downwardly against the top of upper floating table 162 to serve as an upper limit for the core rod and core member, while lower nuts 83 are adjusted downwardly away from floating table 162.

During compaction, core rod 166 floats downwardly against the bias of diaphragms 178 until the lower end 177 of the core rod abuts bottom adjustable table 176 which halts movement of the core rod and core member and solidly supports these elements during further compaction. Bottom adjustable table 176 is designed so that it will sustain at least one half or more of the rated press tonnage. If it is desired for the upper end of core member 168 to be flush with the floating die table during ejection and at the start of the cavity fill, the diaphragms 170 and 172 are employed.

In this case, the upper nuts 81 are adjusted so that diaphragms 172 hold upper floating table 162 against the said upper nuts 81 and adjustment of nuts 164 insures that the upper end of core member 168 is flush with the upper surface of the die table.

If the floating die table moves downwardly to its fill level, the core rod and core member on the upper end thereof also moves downwardly thereby to maintain the aforementioned flush condition. When the lower punch starts downwardly for filling the die cavity, a valve is actuated and pressure is thereby released from diaphragms 172, while diaphragms 170 are at this time pressurized. This deenergization of diaphragms 172 and energization of diaphragms 170 forces upper floating table 162 and core rod 166 downwardly to a stopped position against lower floating table 174 which establishes the fill level for the core member mounted on the upper end of the core rod.

It will be appreciated that all of the modes of operation of the press described above are carried out without the use of cams, mechanical latches, and release mechanisms therefor, and that, when necessary, the core rod can be solidly supported for compaction at high tonnage thereagainst.

A modification of the press is shown in FIGS. 21 and 22, wherein a floating table is provided carrying a second lower punch. The purpose of this modification is to aid the ejection of flanged parts from the die. Under the high compaction pressures developed by the press, all vertical surfaces of the compacted part are forced into tight frictional contact with the walls of the die, outer punch, and core member. To prevent breakage of thin flanges during part ejection, it is necessary that the outer punch members move upward with the part to provide support for the flanges against frictional resistance. This function may be accomplished through
the addition of moving members to the tooling used, or it may be accomplished within the press itself. The following discussion discloses the manner in which this compacting press may be built to accomplish the desired support of flanged parts through the use of a floating die support table, a floating outer punch support table, and a movable inner punch support member.

In FIG. 21, a somewhat simplified representation of the press is made and in this Figure the core rod is connected with the floating die table to move therewith. The structure of the previously described press members disposed beneath the press bed could, however, be associated with the press of FIG. 21, if so desired. In FIG. 21, floating die table 200 carries a tubular die 202 and extending upwardly into die 202 from beneath is an outer punch 204 and an inner punch 206 with a core member 208 reciprocally mounted in inner punch 206. Core member 208 is mounted on a core rod 210 connected by flange 212 with rods 214 which are extensions of rods 262.

Upper floating die table 200 has adjustable abutments 218 adapted for abuttingly engaging the upper side of a floating punch support table 220 which carries outer punch 204.

The upper floating die table is adapted for floating against cushion means 222 which is engaged by adjustable pin 224 carried by the upper floating die table when the upper floating die table moves downwardly a predetermined amount from its FIG. 21 position.

Floating table 220 has abutment rods 226 adjustably carried thereby and adapted for abutting the upper ends of rods 228 which are supported by pneumatic cushions 230 mounted on lower flange 232 of the press bed.

Floating table 220 also has adjustably connected thereto rods 234 which extend downwardly through the upper flange 236 of the press bed and also extend through the lift out bridge member 238, abutting lower punch mounting flange 244 at the lower ends of rods 234 to provide a flush ejection position of the top surfaces of the lower punches 204 and 206 with respect to one another. Mounted on flange 236 of the bed there are adjustable stops 242 which determine the lowermost solidly supported position of table 220 and punch 204.

The lower ends of rods 234 abut a flange 244 fixed to the lower end of inner punch supporting member 246 which, at its upper end, is fixed to inner punch 206. Flange 244 is biased upwardly by pneumatic cushions 248 and is adapted for being moved downwardly by pins 250 carried by lift out bridge 238 and resiliently biased downwardly thereon by pneumatic cushions 252.

Surrounding support member 246, and resting on the upper flange 236 of the bed is a stop ring 254 against which support member 246 bottoms in the lowermost solidly supported position of inner punch 206.

In operation, core member 208 and punches 204 and 206 and die table 200 occupy their FIG. 21 position for ejection. Filling of the die cavity is initiated by downward movement of lift out bridge 238 when pull rods 256 commence to be moved downwardly by the respective throws on the press crankshaft.

the initially downward movement of the lift out bridge is accompanied by downward movement of die table 200, outer punch 204, inner punch 206 and core member 208. When, however, adjustable pin 224 on die table 200 engages cushion 222, downward movement of die table 200, core member 208, punches 204 and 206 ceases. Support member 246 also dwells at this time because cushions 248 support the weight thereof.

Further downward movement of lift out bridge 238 will bring pins 250 into engagement with flange 244 and thereby pull inner punch support member 246, inner punch 206, floating table 220, and punch 204 down, with collapsing of cushions 248. When abutment rods 226 contact rods 228 floating table 220 and punch 204 cease moving downward. Support member 246 continues downward until it bottoms in stop ring 254, thus providing for a lowest solidly supported position of inner punch 206. Further movement downwardly of lift out bridge 238 causes collapsing of cushions 252.

The fill of the die cavity is now complete and immediately thereafter the upper punch 250 enters the upper end of die 202 and carries out a compacting operation.

During compaction, floating die table 200 and core member 208 float downwardly due to the friction of the material being compacted against the axial surfaces of die 202 and core member 208, while outer punch 204 and its table 220 yield downwardly against the thrust of cushions 230 until collars 242 abut lower moving table 220 and provide for a stopped solidly supported position of the table 220 and punch 204 resting thereon.

Following compaction, and after the press slide and upper punch 258 commence to retract, lift out bridge 238 will commence the ejection operation. During ejection, the lift out bridge 238 first engages and commences to lift inner punch supporting member 246 and inner punch 206 while the die table and core member move upwardly due to the friction of the material thereon. When the floating die table 200 reaches an upper stopped position, as determined by the engagement of the nuts 260 on rods 262 with the underside of upper bed flange 236, die table 200 dwells and the compact is forced out of die 202. The floating table 220 is supported at ejection position by engagement of flange 244 with the lower ends of rods 234.

the aforementioned rods 262 are adjustably connected tofloating die table 200 as at 264.

It will be appreciated that the press of FIG. 22 is arranged to operate with a crankshaft having circumferentially related throw means connected to the press slide and to the lift out bridge 238 and that, by providing the pneumatic cushions and the variously disposed abutments between the stationary and moving parts of the press, the need for cams, latches, and releasing devices therefor is entirely eliminated.

In every case, the press is relatively easy to set up and adjust, thereby representing a substantial economy of time over previous press arrangements. The simplicity of the setting up of the presses substantially decreases chances for error and the damage that might be done to expensive die arrangements because of improper set ups. The press structure is basically a straight forward mechanical press with simple pneumatic cushions associated therewith so that initial cost of the press is within reasonable limits and maintenance problems and the expense of maintenance is substantially reduced. Furthermore, relatively simple die arrangements can be employed, thereby reducing tooling costs.

The present construction is such that a high degree of precision can be maintained due to the rigidity of all of the press parts and due to the fact that the parts of
the dies which determine the final workpiece size are in solidly supported position during compacting.

Modifications may be made within the scope of the appended claims.

We claim:

1. A press for compacting granular materials comprising, in combination, a fixed mechanical stroke actuating means for providing two reciprocating motions having a fixed displacement relationship to each other, a floatable die table provided with a number of dwell positions, cushion means for controlling an adjustable stroke for said die table and lower punch means operable by said fixed mechanical stroke actuating means, stop means for providing fixed dwell positions for said die table, and upper punch means actuated by said fixed mechanical stroke actuating means for reciprocating said upper punch means in a predetermined non-variable sequence with said die table and lower punch means.

2. A press for compacting granular material comprising, in combination, fixed mechanical stroke actuating means including a first and a second reciprocating mechanism with a predetermined displacement relationship, a floating die table provided with a number of dwell positions, cushion means for controlling adjustable strokes for said die table and lower punch means carried by said press, said lower punch means operable with respect to said die table to support compacting loads, said cushion means, and lower punch means actuated by said first reciprocating mechanism of said fixed mechanical stroke actuating means, stop means cooperating with said cushion means for providing dwell positions for said die table and lower punch means, and upper punch means actuated by said second reciprocating mechanism for cooperation with said die table and lower punch means.

3. A press according to claim 2 wherein the lower punch means is reciprocated over a fixed stroke length wherein said length is established by cooperating cushion and stop means so that the lower punch stroke is less than the stroke of the fixed stroke actuating means.

4. A press according to claim 2 wherein an additional surrounding punch means is provided in association with said lower punch means for supporting flanged parts and supported independently from said lower punch means.

5. A press according to claim 4 wherein the additional surrounding punch means is operable by the said first reciprocating mechanism in cooperation with additional cushion and stop means.

6. In a press for compacting granular materials and having a head and a bed and uprights extending therebetween, a die table adapted to support a die on a vertical axis, punch support means beneath said die table adapted to support lower punch means extending into said die from below, a vertically reciprocable slide above said die table adapted to support upper punch means for entering said die from above, said die table and punch support means having uppermost positions wherein the upper ends of said die and lower punch means are disposed in the plane of the top of said die table, a downwardly facing stationary first abutment means operatively engaging said die table in its uppermost position and a downwardly facing second abutment on said die table operatively engaging said punch support means when said die table and punch support means are both in the uppermost positions thereof, a lift out bridge beneath said punch support means vertically reciprocable between uppermost and lowermost positions, an upwardly facing third abutment engageable with said punch support means for raising the punch support means to the uppermost position thereof, upwardly acting first cushion means associated with said die table and permitting the die table to yield downwardly during compaction, second cushion means acting upwardly on said punch support means, a downwardly facing fourth abutment on said bridge engageable with said punch support means upon a predetermined downward travel of said bridge from its uppermost position and third downwardly acting cushion means supporting said fourth abutment on said bridge, an upwardly facing stationary fifth abutment engageable with said punch support means in a predetermined lowermost position thereof spaced from the said uppermost position thereof a distance less than the distance between said uppermost and lowermost positions of said bridge, and drive means connected to said slide and said bridge operable to effect reciprocation thereof in timed relation to each other.

7. A press according to claim 6, in which said first cushion means yields at a load greater than the weight of said die table and parts carried thereby while said second cushion means yields at a load greater than the weight of said punch support means and parts carried thereby and less than the combined weights of said die table and said punch support means and the parts carried thereby.

8. A press according to claim 7, wherein a sixth abutment means is spaced upwardly from said first cushion a predetermined first distance to establish the fill level of said die table.

9. A press according to claim 8, in which said fourth abutment is spaced upwardly from said punch support means a second predetermined distance to provide dwell time for positioning the fill shoe over the die.

10. A press according to claim 9, in which said punch support travels upward from said fifth abutment to a predetermined upper position for work product ejection.

11. A press according to claim 6, in which said drive means comprises a crankshaft having first throw means operatively connected to said bridge and second throw means angularly related to said first throw means connected operatively connected to said slide.

12. A press according to claim 11, in which said first throw means leads said second throw means by an angular interval that depends upon the relative strokes of the two throw means and the predetermined timing relationship within the press mechanism.

13. A press according to claim 6, which includes a supply hopper for material to be compacted, a fill shoe open on the bottom and pressed against the top face of said die table and connected to said hopper to receive material therefrom by gravity, means for advancing said full shoe into fill position over said die during upward movement of said slide and after upper punch means thereon is out of the vertical range of said fill shoe and said die table and punch support means are in said uppermost positions thereof, and means for retracting said fill shoe from fill position during downward movement of said slide after said punch support means reaches said lowermost position thereof and before the upper punch means comes within the vertical range of said fill shoe.
14. A press according to claim 13 in which said means for advancing and retracting said fill shoe comprises an arm pivotally supported at one end on the press and operatively connected at the other end to said fill shoe, a cam of said slide, and a cam follower on said arm engaging said cam.

15. A press according to claim 14, which includes actuating means continuously urging said fill shoe toward fill position, said cam and cam follower acting in opposition to said actuating means.

16. A press according to claim 15, in which said cam is adjustable and easily replaceable with another cam of modified contour on said slide to adjust the timing of said fill shoe movements.

17. A press according to claim 13, in which said fill shoe is readily interchangeable with other fill shoes of different size.

18. A press according to claim 111, in which said die table includes sixth abutment means adapted to engage said first cushion means, said sixth abutment means being adjustable on said die table to adjust the length of the travel of the die table from the uppermost position thereof downwardly to the position where it is supported by said first cushion means.

19. A press according to claim 11, in which said first abutment comprises the bed of the press, said die table having rod means adjustable carried thereby and extending downwardly into said bed and having collar means thereon for engagement with the bed in said uppermost position of said die table to establish the dwell position of said die table for ejection of the work product.

20. A press according to claim 19, in which said second abutment comprises a flange on said lower punch support means extending laterally beyond said rod means and said rod means having downwardly facing shoulder means for engagement with said flange to maintain said lower punch support means in fixed relationship to the die table as said die table descends from a dwell position for ejection of the compacted material to a dwell position for fill.

21. A press according to claim 19, in which said fifth abutment comprises said press bed whereby said punch support means is solidly supported in the said lowermost position thereof to receive compaction loads.

22. A press according to claim 15, which actuates a lower core rod within said lower punch support means, said core rod extending downwardly through said punch support means and through said bed, said core rod having an uppermost position wherein the upper end of the core member carried thereon is disposed in said plane of the top of said die table, and means beneath said bed connected to said core rod for adjusting the axial position of said core member.

23. A press according to claim 22, in which the said means connected to said core rod comprises means adjustable connecting the core rod to said die table for movement in controlled relation therewith.

24. A press according to claim 22, in which the said means connected to said core rod comprises an adjusting nut threaded thereon, an upper table beneath said bed to which the adjusting nut is rotatably connected, rod means connected to said die table and extending therefrom through said bed and said upper table, stop nuts adjustable on the rod means on opposite sides of said upper table, fourth cushion means disposed between said bed and said upper table, said fourth cushion means being adapted to be supplied with air under pressure to bias said upper table downwardly, fifth cushion means operable when energized to urge said upper table upwardly, said cushion means to be exhausted to remove said bias from the said upper table.

25. A press according to claim 24, in which said core rod extends completely through said adjusting nut, and a bottom table adjus\tably suspended from said bed disposed below the lower end of said core rod a fourth distance and is adapted to abut the said lower end of the core rod and halt the said core rod in a predetermined lower position thereof.

26. A press according to claim 25, which includes a lower table between said upper table and bottom table and through which said core rod extends, stationary rods dependent form said bed and extending through said upper and lower and bottom tables, shoulders on said stationary rods above said lower table for abutment therewith, and sixth cushion means acting between said bottom table and said lower table for providing a floating action for said core rod during compaction.

27. A press according to claim 2, which includes a punch support table beneath said die table upon which a second lower punch can be mounted, said second lower punch extending upwardly into said die, punch support table having an uppermost position wherein the upper end of said second lower punch is disposed in the said plane of the top face of said die table and also having a lowermost position and floating against a further condition when moving downwardly toward said lowermost position, said die table is floating on cushion supports while punch support table is forced down against adjustable stops on said bed flanges, and abutment rod means adjustable mounted on said die table and engaging said punch support table with rod elements adjustable connected to said punch support table and extending downwardly through the bed and against the lower punch mounting flange when both said die table and said punch support table are in the uppermost positions thereof, so that the punches mounted on the lower punch support member and on the lower punch support table will be disposed in said plane of the top of said die table.

28. A press according to claim 22, in which said first cushion is disposed so that said die table moves downwardly a predetermined first amount from its said uppermost position before it engages said first cushion to establish its fill position and to provide floating resistance during compaction.

29. A press according to claim 22, in which said punch support means moves downwardly a predetermined second amount after said first amount before engaging said second cushion means for establishing the fill position of said punch support means, and to provide floating resistance during compaction.

30. A press according to claim 5, wherein said additional surrounding punch means is carried by a floating table.

31. A press according to claim 6 provided with a fill shoe mechanism and with an actuating linkage and having an adjustable stop in said actuating linkage for mechanically controlling a variable dwell time of the fill shoe over the die.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,764,244 Dated October 9, 1973

Inventor(s) Donald L. Hurley and Charles R. Talmage

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 3, line 18, "positions" should be --- position ---
Col. 3, line 63, "downwardly" should be --- downwardly ---
Col. 4, line 17, "25" should be --- 26 ---
Col. 5, line 17, "support connected" after "press" should be deleted.
Col. 5, line 22, "support" should be --- support ---
Col. 5, line 23, "connected" should be --- connected ---
Col. 5, line 60, "shoe" omitted between "fill" and "into"
Col. 7, line 10, "he" should be --- the ---
Col. 8, line 11, "being" should be --- bring ---
Col. 9, line 9, "an" should be --- and ---
Col. 9, line 56, "situation" should be --- situation ---
Col. 9, line 67, "he" should be --- the ---
Col. 10, line 1, "uppwr" should be --- upper ---
Col. 10, line 13, "adjusted" should be --- adjusted ---

Col. 11, line 64, "the" first occurrence, should be --- The ---
Col. 12, line 42, "the" should be --- The ---
Col. 12, line 56, "th" before "presses" should be --- the ---
Col. 13, line 44 (Claim 3) "mans" should be --- means ---
Col. 14, line 38 (Claim 9) "the" second occurrence, should be --- a ---
Col. 14, lines 46 & 47 (Claim 11) "connected" should be deleted
Col. 14, line 46 (Claim 11) "and" omitted after "means" second occurrence
Col. 14, line 47 (Claim 11) "conducted" should be --- connected ---
Col. 14, line 58 (Claim 13) "full" should be --- fill ---
Col. 15, line 5 (Claim 14) "of" should be --- on ---
Col. 15, line 9 (Claim 15) "In" should be --- in ---
Col. 15, line 18, (Claim 18) "lin" should be --- 11 ---
Col. 15, line 22, (Claim 18) "the", first occurrence, should be deleted
Col. 16, line 17, (Claim 26) "form" should be --- from ---
Col. 16, lines 21 & 22 (Claim 26) "providing" should be --- providing ---
Col. 16, line 27 (Claim 27) "said" omitted between "die," and "punch"
Col. 16, line 32 (Claim 27) "condition" should be --- cushion ---
Col. 16, line 64 (Claim 31) "variable" should be --- variable ---

Signed and sealed this 16th day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.  C. MARSHALL DANN
Attesting Officer  Commissioner of Patents