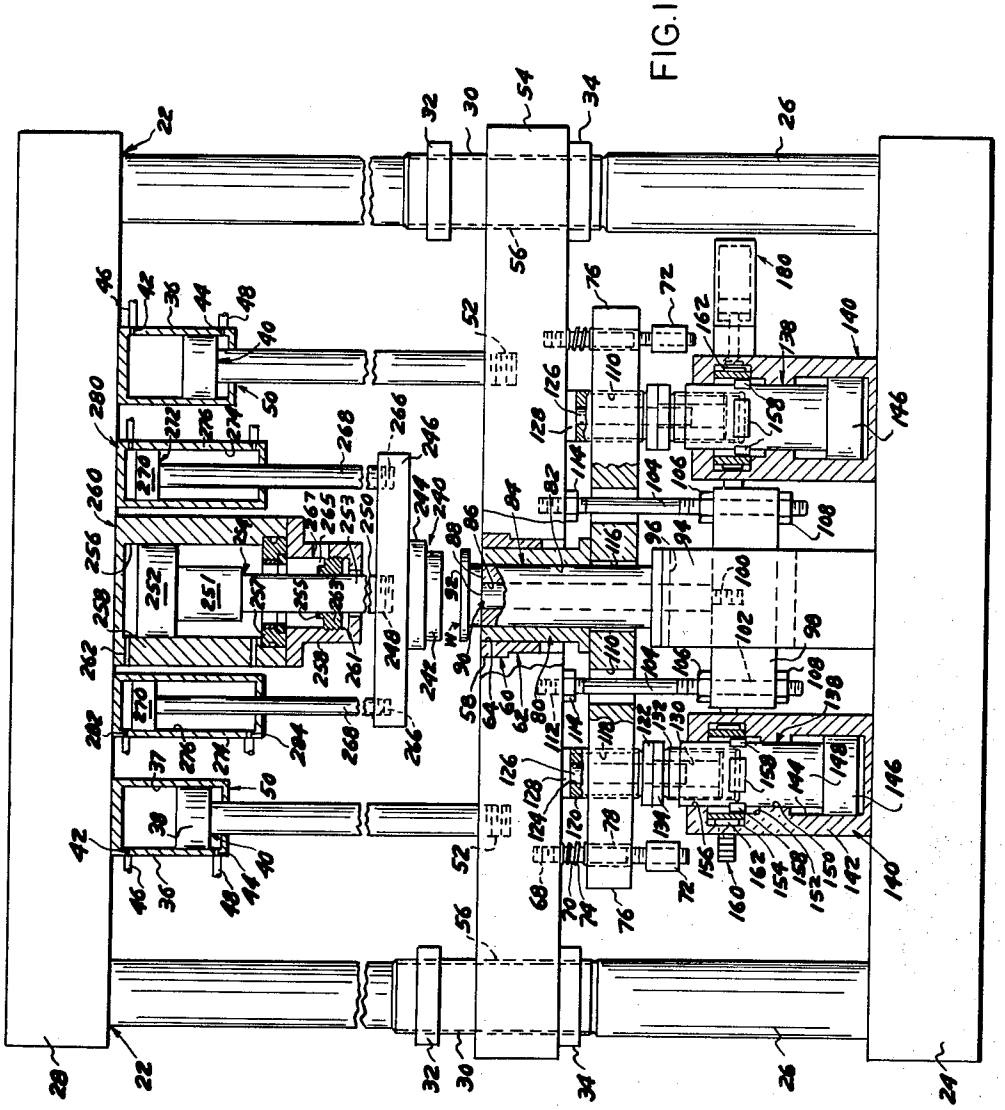
June 29, 1965 J. HALLER 3,191,232

HYDRAULIC COMPACTING PRESS

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FIG. 1



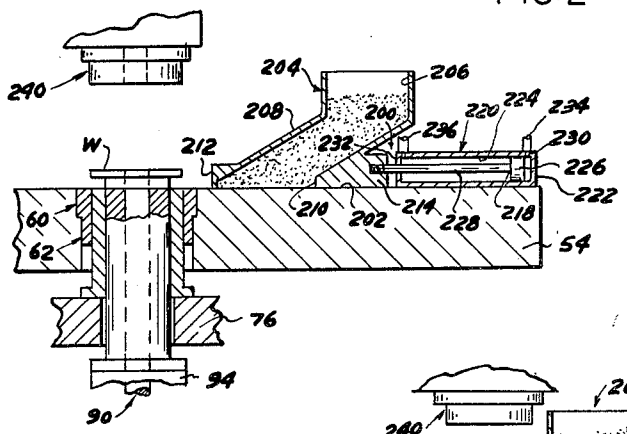
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HYDRAULIC COMPACTING PRESS

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FIG. 2



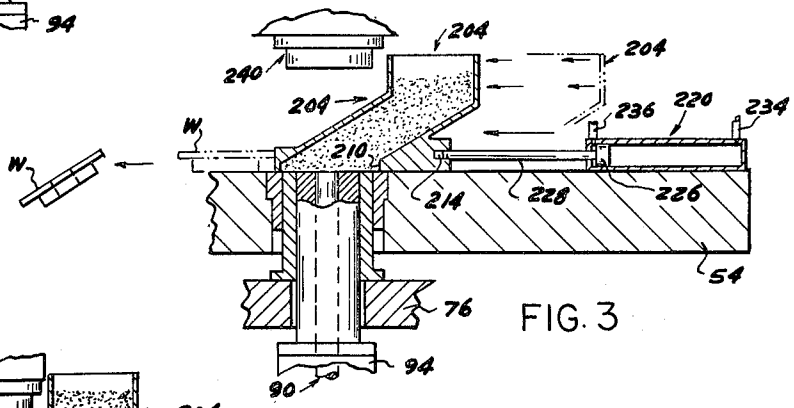


FIG. 3

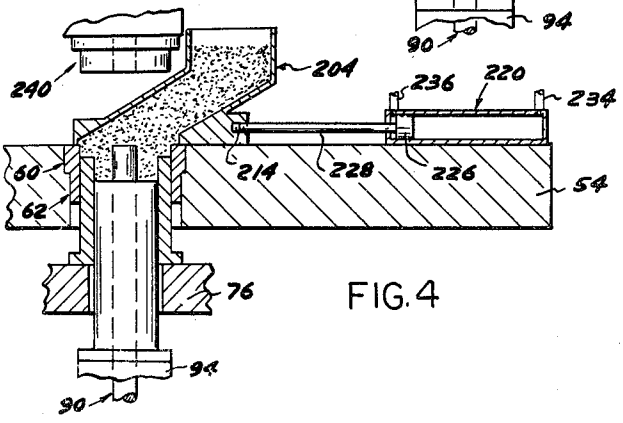
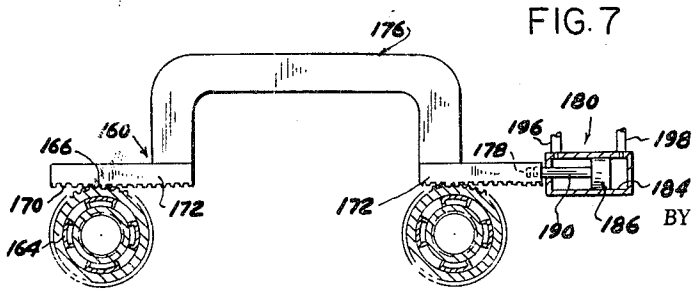


FIG. 4

FIG. 7



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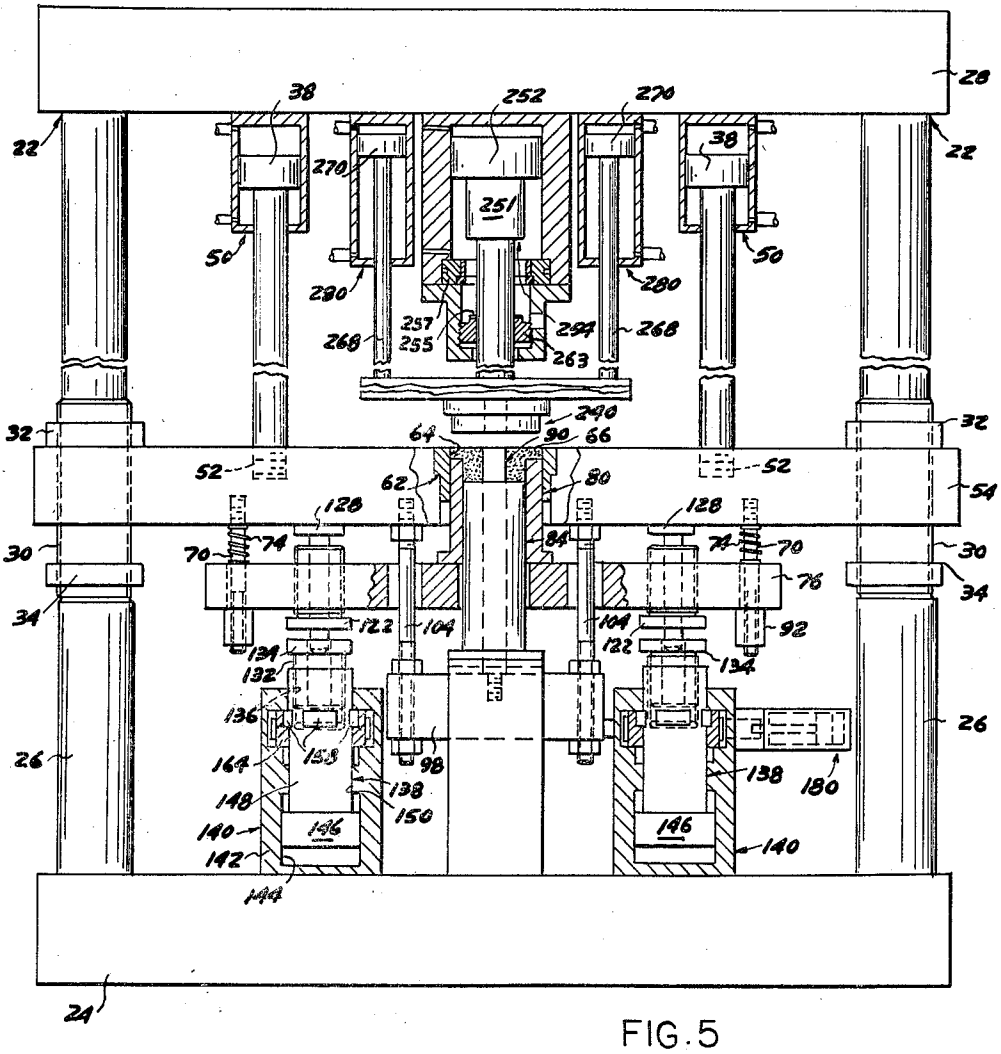


FIG. 5

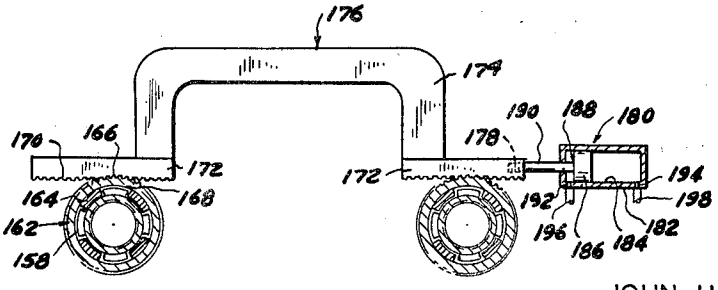


FIG. 6

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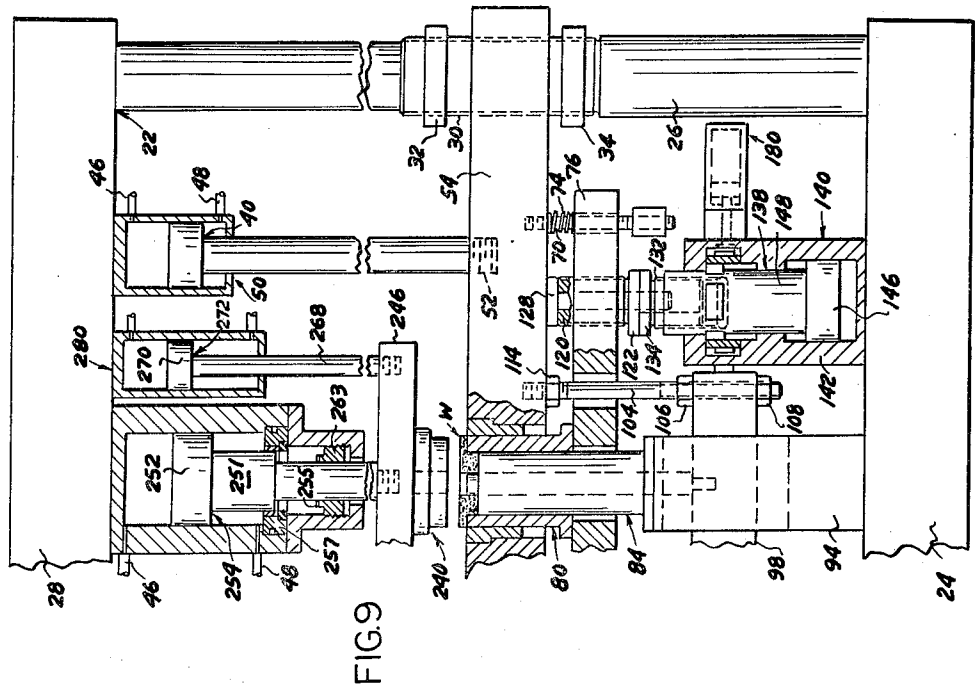


FIG. 9

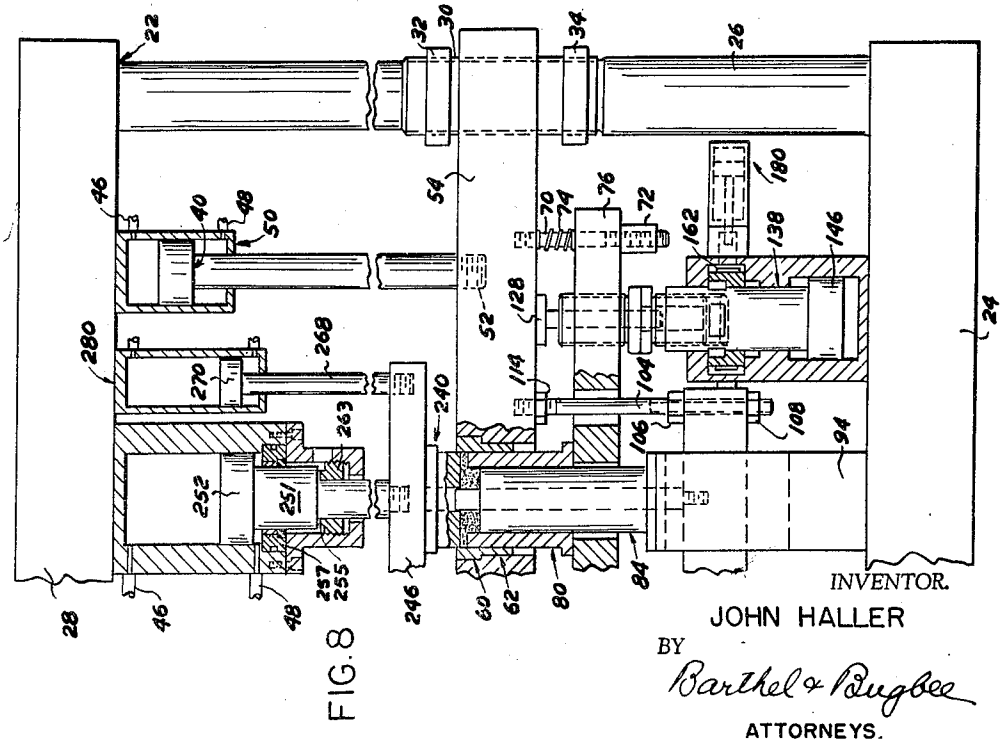


FIG. 8

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3,191,232

HYDRAULIC COMPACTING PRESS

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Filed Dec. 7, 1961, Ser. No. 157,780
4 Claims. (Cl. 18—16.7)

This invention relates to hydraulic presses, and, in particular, to hydraulic compacting presses for producing shouldered or flanged workpieces from powdered materials either metallic or non-metallic.

Hitherto, it has been very difficult to produce shouldered or flanged workpieces from sintered powdered metal or non-metallic materials such as sintered powdered nylon plastic, for the reason that during ejection of the workpiece, the slightest departure from a common speed for all the moving parts caused a crack to develop between the thick and thin portions of the workpiece. Such workpieces in which this problem arises include thin discs with central hubs or with thickened marginal flanges, thin gears, sprockets or cams with axially thicker hubs, and other workpieces having sudden and considerable differences in thickness existing between adjacent portions thereof. The present invention provides a hydraulic compacting press which insures even and uniform motion of the various parts in a predetermined sequence whereby ejection of the finished flanged workpiece is carried out by successively accomplished reverse stripping without the occurrence of such breakage.

Accordingly, one object of the present invention is to provide a hydraulic compacting press for producing compacts or briquettes of powdered metal or non-metallic powdered materials which are to be subsequently sintered, which have axially thin portions bordering upon axially thick portions, such as, for example, an axially thin disc having an axially-thick hub, wherein ejection is effected by moving the die and shoulder punch relatively to the core rod in an even and uniform manner to accomplish reverse stripping.

Another object is to provide a hydraulic compacting press, as set forth in the object immediately preceding, wherein ejection of the flanged workpiece is accomplished sequentially, the die being first withdrawn downward from the side surface of the flange so as to release lateral pressure on the flange while the shoulder punch or tubular plunger is maintained temporarily stationary relatively to the lower punch which supports the bottom of the workpiece, after which the tubular punch or plunger is retracted downwardly to leave the entire workpiece exposed for expulsion by the lateral motion of the filling box or shoe.

Another object is to provide a hydraulic compacting press of the foregoing character wherein the die table is adapted to be supported upon hydraulic cushioning cylinders which can be temporarily locked in immovable positions by mechanically-actuated positive locking devices, which can thereafter be released to permit hydraulic cushioning and pressure-responsive yielding henceforth to take place.

Another object is to provide a hydraulic compacting press of the foregoing character wherein the core rod which supports the central hub or axially-thicker portion of the workpiece is fixedly and immovably mounted upon the press frame or other stationary supporting structure so as to be substantially as unyielding as an anvil during the operation of the press.

Other objects and advantages of the invention will become apparent during the course of the following description of the accompanying drawings, wherein:

FIGURE 1 is a diagrammatic front elevation, mainly in central vertical section, of a hydraulic compacting press for producing flanged workpieces, according to one form of the invention, showing the relative positions of the moving parts at the conclusion of one pressing operation, ready for expulsion of the workpiece after ejection, and ready for the start of a new filling and pressing cycle and with the secondary die table supporting plungers in their mechanically-unlocked positions;

FIGURE 2 is a fragmentary vertical section taken along the line 2—2 in FIGURE 1, showing the feed box of powdered material in its retracted position ready to move forward and expel the ejected workpiece and position the feed box for subsequent filling of the die cavity with powdered material;

FIGURE 3 is a view similar to FIGURE 2 but showing the feed box moved to its advanced position over the die after having expelled the previously formed workpiece;

FIGURE 4 is a view similar to FIGURES 2 and 3, showing the formation of the die cavity and its simultaneous filling with powdered material in response to the upward motion of the main and secondary die tables and the die and shoulder punch carried by them;

FIGURE 5 is a view similar to FIGURE 1, but showing the relative positions of the parts of the press with the die cavity filled and the feed box retracted from the position shown in FIGURE 4, and with the secondary die table supporting plungers in their mechanically locked positions;

FIGURE 6 is a diagrammatic horizontal section taken along the line 6—6 in FIGURE 1, showing the mechanical locking device for the secondary die table supporting plungers in their mechanically unlocked positions;

FIGURE 7 is a view similar to FIGURE 6, but with the supporting plungers shown in their mechanically locked positions;

FIGURE 8 is a fragmentary central vertical section, partly in front elevation, of the central portion of the press with the moving parts in the positions immediately following their positions of FIGURE 5, with pressing of the die cavity charge of powdered material having just terminated; and

FIGURE 9 is a view similar to FIGURE 8, but showing the upper pressing ram and the upper punch being retracted and the secondary die table moving upward to eject the compacted workpiece to the position of FIGURE 1.

Referring to the drawings in detail, FIGURE 1 shows diagrammatically a hydraulic compacting press, generally designated 20, according to one form of the invention, in the relative positions of the various moving parts at the end of one operating cycle which has produced a finished compact or briquette ready to be expelled, and therefore also at the beginning of the next operating cycle wherein the feed box or filling shoe expels the previously made compact or briquette W immediately prior to moving over the die set to fill the die cavity with powdered material for producing the next workpiece. The workpiece W consists of a central hub H of considerably greater thickness than the annular flange F which surrounds its upper portion. The press 20 of the present invention prevents cracks or other evidence or results of breakage from occurring at the junction J between the flange F and core H of the workpiece W, in the manner and by reason of the construction explained below.

The press 20 is provided with a press frame, generally designated 22, consisting of a rectangular press bed 24 adapted to rest upon the floor or upon a concrete foundation (not shown), and having longitudinal frame members or strain rods 26 rising from the four corners of the bed 24 and terminating at their upper ends in a press head 28. Ordinarily, the strain rods 26 are provided with reduced diameter threaded portions at their upper and lower ends and pass through holes in the press bed 24

and press head 28, beyond which they are provided with threaded retaining nuts (not shown) by which the bed 24 and head 28 are held in assembly with the strain rods 26. The construction has been shown as simplified and diagrammatic in the present drawings in order to clarify the disclosure. The press head 28 normally serves as a platform to support the hydraulic pressure fluid operating circuit including a driving motor, hydraulic pump, hydraulic fluid reservoir for the working fluid, generally oil, and the necessary valves, electrical control devices and other components conventionally present in such circuits. The hydraulic pressure fluid operating circuit and these components are familiar to hydraulic engineers and are available upon the open market, hence these components, apart from the hydraulic devices shown in the drawings, are beyond the scope of the present invention.

The strain rods 26 intermediate their opposite ends are provided with intermediate threaded portions 30 (FIGURE 1) carrying upper and lower threaded stop collars or nuts 32 and 34 respectively. Secured to and depending from the press head 28 are auxiliary cylinders 36 spaced laterally away from the center line or main axis X—X of the press 20 and having cylinder bores or chambers 37 containing the piston heads 38 of auxiliary plungers 40. The cylinders 36 are provided with upper and lower service ports 42 and 44 to which pipes 46 and 48 are connected respectively. The pipes 46 and 48 are connected to the hydraulic circuit (not shown) located mainly on top of the press head 28, by way of a conventional four-way valve (not shown) by which hydraulic pressure fluid is simultaneously supplied to one of the service pipes 46 and its port 42 while being withdrawn from the other service pipe 48 and service port 44 and vice versa, as explained below in connection with the operation of the invention. The assembly of the auxiliary hydraulic cylinders 36, their piston heads 38 and plungers 40 forms auxiliary hydraulic reciprocatory motors, generally designated 50.

The lower ends of the auxiliary hydraulic plungers 40 are threaded as at 52 into a generally horizontal rectangular main die table 54 (FIGURE 1) which is provided at its four corners with smooth bores 56 to receive and slidably engage the threaded portions 30 of the strain rods 26 between the upper and lower stop collars or nuts 32 and 34. The main die table 54 is also provided with a stepped central vertical bore 58 containing the correspondingly-flanged tubular die 60 of a compacting die set, generally designated 62. The tubular die 60 is fixedly mounted in the bore 58 against relative motion and contains a bore 64 constituting the outer bore of the die cavity, generally designated 66 (FIGURE 5) formed by the die set 62 during the pressing step of the press 20.

Threaded as at 68 into the lower side of the main die table 54 at laterally-spaced locations relatively to the main center line or axis X—X of the press 20 are the upper ends of secondary die table suspension rods 70 (FIGURE 1), the lower ends of which are also threaded to receive secondary die table carrier nuts 72. Mounted on the upper portions of the secondary die table suspension rods 70 adjacent the main die table 54 are compression springs 74, the lower ends of which engage the top of a rectangular secondary die table 76 which has bores 78 therethrough at its four corners. The bores 78 loosely and slidably engage the suspension rods 70 so that the secondary die table 76 can rise and fall relatively to the main die table 54 in guided relationship therewith while suspended at least part of the time therefrom. The compression springs 74 urge the secondary die table 76 downward toward the secondary die table carrier nuts 72, the downward motion of the secondary die table 76, however, being resisted by other components described below.

Mounted upon the central portion of the secondary die table coaxial with the main axis X—X of the press 20 (FIGURE 1), is a tubular shoulder punch or flange punch 80 which telescopes with the tubular die 60 and slides relatively thereto vertically in the die bore 64. The tubular shoulder punch 80 in turn contains a bore 82 which slidably receives a tubular lower or bottom punch 84 also coaxial with the main press axis X—X and containing a central bore 86 and having an annular top surface 88. Mounted in the central bore 86 for sliding motion relatively thereto is a core rod 90 having a top surface 92. The tubular bottom punch 84 is stationary throughout all of the operations of the press 20, and rests upon the upper end of a pedestal or pillar 94, which in turn rests upon the stationary press bed 24.

The pedestal or pillar 94 is provided with a vertically-extending horizontal slot 96, which in turn receives a horizontal core rod supporting member or bar 98, the slot 96 being higher than the vertical height of the bar 98, so as to permit a considerable movement relatively thereto. The bar 98 is bored and threaded centrally as at 100 to receive the reduced-diameter threaded lower end of the core rod 90; the outer ends of the bar 98 are bored as at 102 to receive the threaded lower ends of bar suspension rods 104 carrying middle and lower retaining nuts 106 and 108 engaging the upper and lower sides of the bar 98. The suspension rods 104 pass loosely through vertical bores 110 in the secondary die table 76 and are threaded at their upper ends into laterally-spaced threaded sockets 112 on the lower side of the main die table 54 and held in place by lock nuts 114. The secondary die table 76 contains an enlarged bore 116 through which the bottom punch passes to permit relative rise and fall of the secondary die table 76.

The secondary die table 76 between the bores 78 and 110 (FIGURE 1) is provided with laterally-spaced threaded bores 118 threadedly receiving correspondingly-threaded flanges or headed stop bushings or shoulder ejection adjustment bushings 120 having stop heads 122 and central guide pin bores 124. Slidably mounted in the guide pin bores 124 are headed guide pins 126, the stop heads 128 of which are secured to the lower side of the main die table 54. The shank of each guide pin 126 passes through the bore 124 in its respective stop bushing 120 into the central bore 130 of a headed main die table float adjustment bushing or lower stop bushing 132 (FIGURE 5) which has a stop head 134 and in turn is threaded into a correspondingly threaded bore 136 in a cushioning plunger 138 forming the moving part of a hydraulic cushioning motor, generally designated 140, of which there are two, each having a cylinder 142 containing a cylinder bore 144 within which is reciprocably mounted the piston head 146 of the cushioning plunger 138, the stem or piston rod 148 of which passes slidably through a bore 150 coaxial with the cylinder bore 144.

Each cylinder 142 above the bore 150 (FIGURE 1) is provided with an enlarged bore 152 above which is a counterbore 154, above which in turn is a continuation portion 156 of the bore 150. The stem or piston rod 148 of each cushioning plunger 138 immediately within the counterbore 154 is provided with circumferentially-spaced radially-projecting arcuate stop lugs or locking lugs 158 which are selectively engaged by a rotary locking device, generally designated 160 (FIGURES 6 and 7). The rotary locking device 160 is provided with a pair of geared annular piston rod stop collars 162, each containing inwardly-projecting radial arcuate stop lugs 164 and outwardly projecting gear teeth 166, the stops 162 being rotatably mounted in the counterbores 154. The inwardly-projecting locking or stop lugs 164 are spaced apart from one another and are so proportioned as to lie between the outwardly-projecting stop lugs 158 in the unlocked (FIGURE 6) positions, so as to permit vertical motion of the cushioning plungers 138. The inwardly-projecting locking or stop lugs 164 are separated from one another by radial grooves 168 in which the outwardly-projecting stop lugs 158 in the cushioning plungers 138 slide vertically in the unlocked position of the locking device 160 (FIGURE 6). The inwardly-projecting stop

lugs 164 on the annular geared stop collars 162 are located on a lower level than the plunger rod stop lugs 158 in the raised and locked position of the cushioning plungers 138 (FIGURE 5) so that upon rotation of the geared stop collars 162, the inwardly projecting segmental stops 164 thereof pass beneath the outwardly-projecting segmental stop lugs 158 on the plunger rods 150 so as to temporarily prevent downward motion of the cushioning plungers 138.

Meshing with the gear teeth 166 on the geared stop collars 162 (FIGURE 6) are rack teeth 170 on spaced aligned rack bars or racks 172 (FIGURES 6 and 7) which in turn are interconnected by a U-shaped bridge member 174 to form a dual rack assembly, generally designated 176. One of the racks 172 is bored and threaded at its outer end as at 178 for connection to a reciprocatory hydraulic operating motor, generally designated 180. The latter consists of a hydraulic cylinder 182 containing a cylinder bore 184 in which the head 186 of an operating piston 188 is reciprocably mounted and which has a piston rod 190 threaded into the threaded bore 178 in the rack bar 172. The operating cylinder or locking cylinder 182 is provided with service ports 192 and 194 (FIGURES 6 and 7) to which are connected service pipes 196 and 198 respectively connected in turn to the hydraulic circuit located on the press head 28 (FIGURE 1) and reciprocated thereby to lock or unlock the locking devices 160, as explained below in connection with the operation of the invention.

Mounted on the main die table 54 and movable upward and downward therewith as a unit is a powdered material filling and workpiece ejecting device, generally designated 200 (FIGURE 2) located on the top surface 202 of the main die table 54 and at the rear of the die cavity 66. The filling and ejection device 200 includes a feed box or feed shoe 204 in the form of an inclined hopper with an upright receiving portion 206 and an inclined feeding portion 208 with an outlet 210 at the bottom thereof. Mounted on the forward end of the feed box or feed shoe 204 is an expulsion box or shoe 204 to encounter and expel the finished compacted workpiece W upon completion of the pressing cycle.

The feed box or feed shoe 204 (FIGURE 2) is reciprocably mounted on the top surface 202 of the main die table 54 and is provided with a rearwardly-projecting coupling boss 214 (FIGURE 2) which is bored and threaded as at 216 to receive the threaded forward end of the piston 218 of a feed operating reciprocatory hydraulic motor, generally designated 220. The motor 220 includes a hydraulic cylinder 222 provided with a cylinder bore 224 within which the piston head 226 of the piston 218 is reciprocable, the piston rod 228 thereof being threaded at 216 into the coupling boss 214. Service ports 230 and 232 at the opposite ends of the cylinder 222 are connected to pressure fluid supply pipes 234 and 236 respectively for supplying pressure fluid to the opposite ends of the cylinder 222 in order to reciprocate the piston 218 and consequently move the feed box or feed shoe 204 back and forth over the top surface 202 of the main die table 54 to positions in line with and out of line with the die cavity 66.

Pressing of the charge of powdered material within the compacting die set 62 is accomplished by a stepped upper punch, generally designated 240 (FIGURE 1), which, as its name suggests, consists of a reduced diameter lower portion 242 adapted to telescope with the bore 64 within the tubular lower die 60 (FIGURE 9) and an enlarged-diameter upper or base portion 244 which is attached in any suitable manner to a vertically-reciprocable main pressing ram or platen 246. The ram or platen 246 is bored and threaded as at 248 coaxial with the central axis X—X of the press 20 to receive the correspondingly-threaded reduced diameter lower end of the piston rod 250 having a piston head 252 constituting the main pressing plunger 254 reciprocably mounted in the bore 256 of a main hydraulic cylinder 258 of the main reciprocatory hydraulic pressing motor, generally designated 260. The hydraulic motor 260 is likewise double-acting having upper and lower service parts 262 and 264 to which are connected service pipes (not shown) leading to the hydraulic pressure fluid supply circuit mounted on the press head 28.

The piston rod 250 of the main pressing ram 254 is provided with an intermediate diameter portion 251 adjacent the head 252 and connected to a reduced diameter lower portion 253 at an annular shoulder 255. The lower end of the cylinder bore 256 is closed by an annular closure gland 257 held in place by a main pressing cylinder extension head or stop bracket 259 bolted thereto and containing a reduced diameter threaded bore 261 engaged by a correspondingly-threaded stop ring or bushing 263 loosely and relatively rotatably surrounding the reduced diameter lower portion 253 of the piston rod 250. The stop bushing 263 is provided at its upper end with wrench and spanner recesses 265, access to which is gained through an access opening 267 in the extension head or stop bracket 259. By rotating the stop bushing 263 by means of a suitable wrench engaging the recesses 265 through the access opening 267, the stop bushing 263 is moved upward or downward to change the halting location of the main ram 254 and consequently to predetermine the depth to which the reduced diameter lower portion 242 of the upper punch 240 will enter the bore 64 in the tubular lower die 60. This in turn regulates the thickness of the flange F of the workpiece W.

The main pressing ram 246 near its opposite ends is also bored and threaded to provide sockets 266 which threadedly receive the correspondingly-threaded reduced diameter lower ends of piston rods 268 terminating in their upper ends in piston heads 270 and collectively forming secondary upper plungers 272. The piston heads 270 are reciprocable in cylinder bores 274 formed in hydraulic cylinders 276 and collectively forming secondary upper hydraulic motors, generally designated 280. Each of the secondary reciprocatory hydraulic motors 280 is provided with upper and lower service ports 282 and 284 respectively which are likewise connected to the hydraulic pressure fluid supply circuit mounted on the press head 28 by pipes (not shown).

Operation

In the operation of the hydraulic compacting press 20, let it be assumed that the press 20 is at the end of a pressing cycle with the moving parts in their relative positions shown in FIGURE 1 and with the flanged workpiece W ejected from the die set 62 but not yet expelled from the main die table 54. This terminating position of one cycle of operations is thus the starting position of the next cycle of operations wherein the pressing ram 246 and upper punch 240 are retracted into their raised or "up" position (FIGURE 1), and the powdered material feed box or feed shoe 204 of the powdered material filling and workpiece ejecting device 200 is retracted to its rearward position (FIGURE 2). The main die table 54 is in its lowered position against the die table lower stop nuts 34 and the secondary die table 76 is held down by the main die table 54 through the agency of the stop heads 128 engaging the upper ends of the threaded ejection adjustment bushings 120 (FIGURE 1).

In the starting position of the press 20, the geared annular stop collars 162 are in their unlocked positions (FIGURE 6). The cushioning plungers 138 carrying the locking lugs 158 are urged upwardly by hydraulic pressure fluid standing in the portions of the cylinder bores 144 beneath the piston heads 146, but are held down because of the greater weight of the main die table 54 and its associated parts pressing downward upon the threaded bushings 120 which have heads 122 engaging heads 134 on lower stop bushings 132 threaded into the upper ends of the cushioning plungers 138.

Assuming that the operator has filled the feed box or feed shoe **204** with a charge of suitable powdered material, such as powdered iron, powdered bronze or alloys thereof, or suitable powdered non-metallic materials, such as the polyamide plastic commercially known as nylon, the operator starts the hydraulic system in operation to cause the automatic pressing cycle to commence. When this occurs (FIGURE 2), hydraulic pressure fluid passes through the service pipe **234** into the rearward end of the hydraulic feed cylinder **222**, causing the piston **218** of the hydraulic motor **220** to advance to the left upon its forward stroke, carrying with it the feed box **204** and the workpiece expulsion abutment **212**. When the latter encounters the flanged workpiece W resting upon the top surface **88** of the bottom punch **84**, it expels the workpiece W, as shown in FIGURE 3, while it moves into its filling position with its outlet **210** over the die cavity **66**. The thus-expelled finished workpiece W falls off the main die table **54** into a collection box (not shown).

Hydraulic pressure fluid is now directed into the pipes **48** leading to the ports **44** beneath the piston heads **38** of the auxiliary plungers **40** (FIGURE 1), causing the latter and the main die table **54** to move upward, carrying with it the tubular outer die **62** and the core rod **90** through the raising of the member **98** by the rods **104**, until the main die table **54** encounters the upper die table stops **32** on the strain rods **26**, halting the die table **54** (FIGURE 5). The upward motion of the main die table **54** carries with it the secondary die table **76** when the die-table-carried nuts **72** on the suspension rods **70** thereof encounter the die table **76**. The foregoing actions have now caused the moving parts to assume the relative positions shown in FIGURE 5, with the tubular outer die **62** raised to its highest position to expose the upper end of its bore **64** for formation of the workpiece flange F, while at the same time the raising of the secondary die table **76** has caused the tubular flange punch or shoulder **80** to rise relatively to the stationary lower or bottom punch **84** so as to expose the entire die cavity **66** (FIGURE 5). When this occurs, the powdered material within the feed box or feed shoe **204** (FIGURE 4) falls through the outlet **210** thereof into the die cavity **66** and fills it, as shown in FIGURE 5.

With the downward pressure from the weight of the main and secondary die tables **54** and **76** thus removed by the rising thereof, the cushioning plungers **138** of the reciprocatory hydraulic cushioning motors **140** are forced upward by the pressure of the hydraulic pressure fluid in their cylinder bores **144** beneath their piston heads **146**, causing their radially-projecting locking lugs **158** to rise through the slots or grooves **168** between the inwardly-projecting locking or stop lugs **164** (FIGURE 5), coming to a halt against the upper ends of the cylinders **142**, thereby attaining their raised positions wherein they can be locked.

Hydraulic pressure fluid is now supplied to the service pipe **196** (FIGURE 6) and port **192** at the forward end of the cylinder **182** of the reciprocatory hydraulic locking motor **180**, urging the piston head **186** and piston rod **190** to the right (FIGURE 7), carrying with it the rack bars **172** and consequently rotating the geared annular stop collars **162** in a clockwise direction so as to move the inwardly-projecting stop lugs **164** thereof beneath the outwardly-projecting stop lugs **164** of the cushioning plungers **138**, locking the latter positively and mechanically in their raised positions (FIGURES 5 and 7).

Hydraulic pressure fluid is now supplied to the pipe **236** and port **232** (FIGURE 4) of the feed box shifting hydraulic motor **220**, shifting or retracting the feed box **204** from its forward or filling position of FIGURE 4 to its rearward or retracted position of FIGURE 2. As the feed box **204** thus moves rearwardly, it wipes the surplus powdered material off the top of the die cavity

66, leaving the charge or "fill" therein flush with the top of the die cavity **66** (FIGURE 5).

The operator now supplies hydraulic pressure fluid to the ports **262** and **282** at the upper ends of the main pressing cylinder **258** and secondary cylinders **276** of the main and secondary hydraulic motors **260**, causing their respective plungers **254** and **272** to move downward, carrying with them the main ram **246** and the stepped upper pressing punch **240**. The latter moves downward until the reduced diameter portion **242** reaches and engages the charge or fill in the die cavity **66**, and continues downward into the die cavity **66** (FIGURE 8). As the upper punch **240** moves downward into the die cavity **66**, compressing the powdered material charge therein, the pressure transmitted therethrough to the main die table **54** forces the secondary die table **76** and the tubular flange or shoulder punch **80** carried thereby to "float" downward with the pressing ram **246**, as the immovable bottom punch **84** takes the thrust of the bottom of the charge.

Meanwhile, the downward motion of the secondary die table **76**, brought about by the thrust of the upper punch **240** upon the powdered material charge in the die cavity **66** (FIGURE 8) pulls the main die table **54** downward with it by its engagement with the stop or carrier nuts **72** upon the lower ends of the rods **70**. It will be recalled that hydraulic pressure fluid was previously supplied to the lower ends of the die table cylinders **36** of the reciprocatory motors **50** to raise the main die table **54** into engagement with the upper strain rod stops **32**, and this pressure still acts as a counter pressure to resist the downward floating of the main and secondary die tables **54** and **76**.

As the main pressing ram **246** and upper punch **240** continue to move downward, the stop bushings **122** (FIGURE 8) engage the stop bushings **132** on the upper ends of the piston rods **148** of the cushioning plungers **138**, halting the downward travel of the secondary die table **76** because the plungers **138** are still solidly locked to the cylinders **142** resting upon the press bed **24** against downward travel by the interengagement of their locking lugs **158** and the stop lugs **164** beneath them (FIGURES 7 and 8). The main pressing ram **246** and upper punch **240** however continue to move downward to predetermined positions against a preset stop bushing **263**. (FIGURE 8). The workpiece W is now completely formed and finish-compacted to the desired predetermined density.

Pressure fluid is now supplied to the ports **264** and **284** at the lower ends of the main and secondary hydraulic cylinders **258** and **276** (FIGURE 8), causing the main and secondary plungers **254** and **40** to be retracted upward (FIGURE 9), carrying with them the main pressing ram **246** and upper punch **240**, removing the downward pressure previously exerted by them upon the main and secondary die tables **54** and **76**. Hydraulic pressure fluid is now supplied to the service pipe **198** and port **194** at the rearward end of the lock-operating cylinder **182** of the lock-operating motor **180** (FIGURE 7), causing the plunger **188** thereof to move to the left (FIGURE 6), consequently rotating the geared stop collars **162** so that their inwardly-projecting lugs **164** move counterclockwise from beneath the outwardly-projecting lugs **158** on the piston rods **148** of the cushioning plungers **138**. With the cushioning plungers **138** thus unlocked and free to move downward, they are nevertheless held up to exert a back-up pressure by hydraulic pressure fluid in the lower ends of the cylinder bores **144** of the cylinders **142** of the reciprocatory cushioning motors **140**. This "back-up" hydraulic fluid is retained within the cushioning cylinders **142** by a pressure relief valve in the hydraulic circuit (not shown) which has a release pressure set above the pressure required to strip the flange F of the workpiece W from

the side wall of the bore **64** within the tubular die **62**, as explained below.

While the plungers **138** of the cushioning motors **140** are held up in this manner through the hydraulic "back-up" fluid within the lower ends of the cushioning cylinders **142**, the engagement of the stop bushings **122** of the secondary die table **76** with the stop bushings **132** on the upper ends of the cushioning plungers **138** prevent the secondary die table **76** and the flange or shoulder punch **80** temporarily from descending (FIGURE 9). Hydraulic pressure fluid is now supplied to the service pipe **46** and port **42** at the upper ends of the die table cylinders **36** of the reciprocatory die motors **50**, causing the main die table **54** and die **60** to move downward in telescoping relationship to the shoulder or flange punch **80**, exposing and thereby ejecting the flange F of the workpiece W from the die cavity **66** of the die set **62** while at the same time, by this reverse stripping, the core rod **90** has been carried downward through its connection by the bar **98** and suspension rod **104** to strip the bore B in the workpiece W from the core rod **90** (FIGURE 9).

By reason of the guide pin stops or heads **128** with the bushings **120** threaded into the secondary die table **76** (FIGURE 9) and the engagement of the heads **122** on the lower ends of the bushings **120** with the heads **134** on the upper ends of the stops **132**, the above-named stops transmit the downward thrust of the die table plungers **40** and main secondary die tables **54** and **76** through the hydraulic cushioning plungers **138** to the hydraulic fluid in the lower ends of the cylinder bores **144** of the hydraulic cushioning cylinders **142**. This action overcomes the set pressure of the relief valve (not shown) connected thereto so as to release back-up hydraulic fluid from the lower ends of the hydraulic cushioning cylinders **142** (FIGURE 9), permitting the main and secondary die tables **54** and **76** to continue to move downward from the position of FIGURE 9 wherein only the flange F or upper portion of the workpiece has been ejected or "stripped" to the FIGURE 1 position where the shoulder or flange punch **80** carried by the secondary die table **76** has telescoped downward relatively to the bottom punch **84**. The latter it will be recalled, has been held immovable upon the pedestal **94** rising from and resting upon the press bed **24**. This action strips or ejects the hub portion H of the flanged workpiece W (FIGURE 1), exposing the entire workpiece W.

The above-described sequential reverse stripping action completes the operating cycle of the press. The electro-hydraulic system or circuit of the press then automatically starts a new operating cycle, repeating the foregoing sequence of operations commencing with the forward motion of the feed box **204** from its retracted position of FIGURE 2 to its advanced position of FIGURE 3, expelling the thus-ejected workpiece W into the collection box (not shown), as shown in FIGURE 3, and positioning the feed box **204** ready to fill the die cavity **66** as soon as it is again formed by the upward motion of the main and secondary die tables **54** and **76** from their positions of FIGURE 1 to their positions of FIGURE 5, as described above.

What I claim is:

1. A hydraulic compacting press for producing flanged workpieces, comprising

a press frame,

a main die table mounted for reciprocation on said press frame, a tubular die mounted on said main die table,

a secondary die table connected to said main die table for reciprocation relatively thereto, a tubular flange punch mounted on said secondary die table in telescoping relationship with the tubular die,

a bottom punch support mounted on said press frame, a bottom punch mounted on said bottom punch support in telescoping relationship with the flange punch,

a hydraulic main die table reciprocatory motor operatively connected to said main die table,

a main pressing platen mounted for reciprocation on said press frame above said main die table, a main pressing punch mounted on said main pressing platen,

a main hydraulic reciprocatory pressing motor operatively connected to said platen,

a hydraulic reciprocatory cushioning motor disposed adjacent said secondary die table and having a reciprocable cushioning plunger yieldingly engageable thereby in response to motion of said secondary die table toward said cushioning motor during the compacting stroke of said main pressing platen,

and a movable locking device anchored to said press frame and movable into and out of locking engagement with said cushioning plunger into and out of immobilizing relationship therewith.

2. A hydraulic compacting press, according to claim **1**, wherein axially adjustable coacting stops are disposed between said plunger of said cushioning motor and said secondary die table.

3. A hydraulic compacting press, according to claim **1**, wherein means is provided for selectively moving said locking device into and out of locking engagement with said plunger.

4. A hydraulic compacting press, according to claim **1**, wherein said cushioning plunger has a locking projection thereon, and wherein said locking device has a locking element selectively movable into and out of locking engagement with said locking projection.

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