

Feb. 13, 1951

S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 1

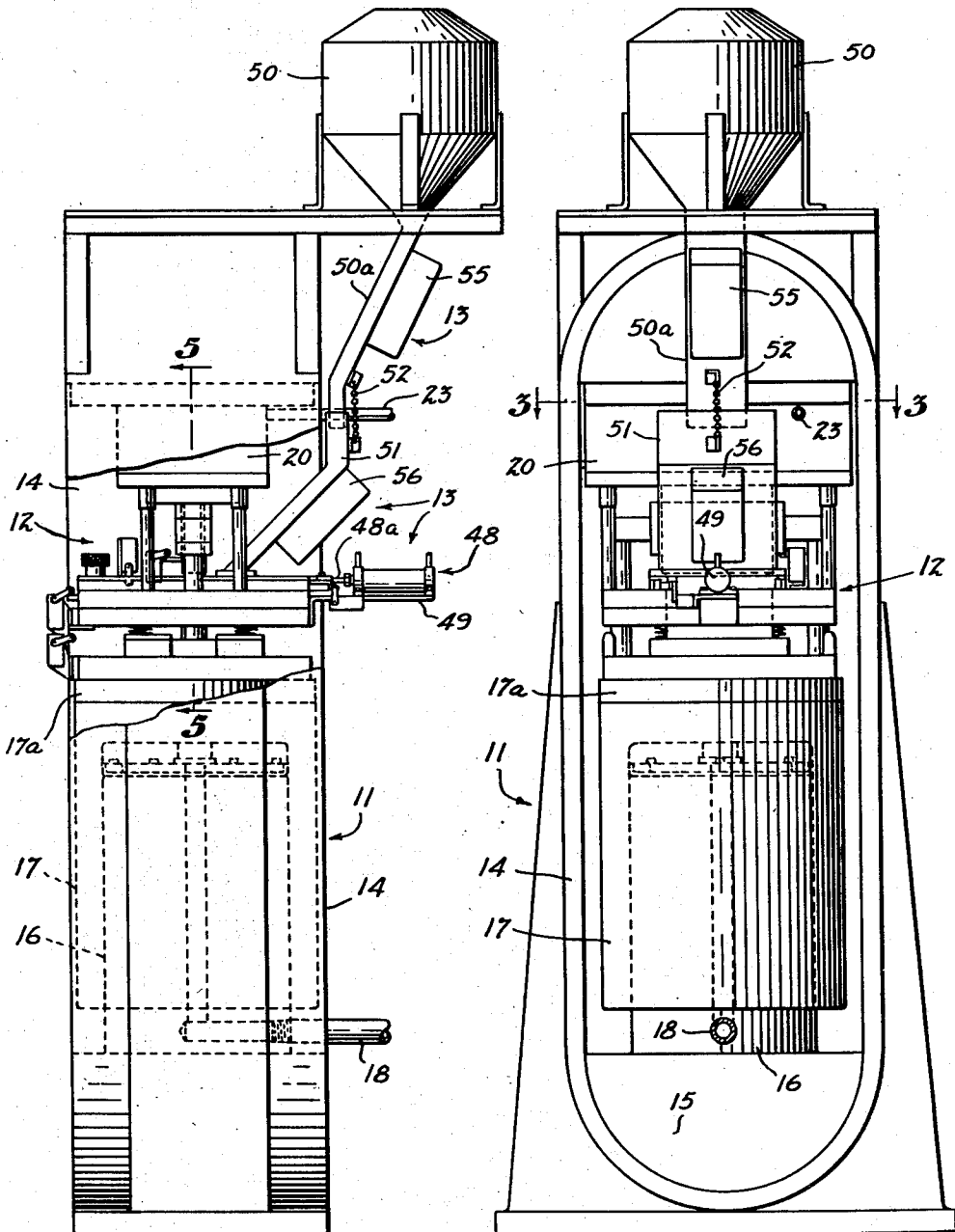


Fig. 1

Fig. 2

INVENTOR
S. K. Wellman
BY Ray P. Gehr
ATTORNEY

Feb. 13, 1951

S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 2

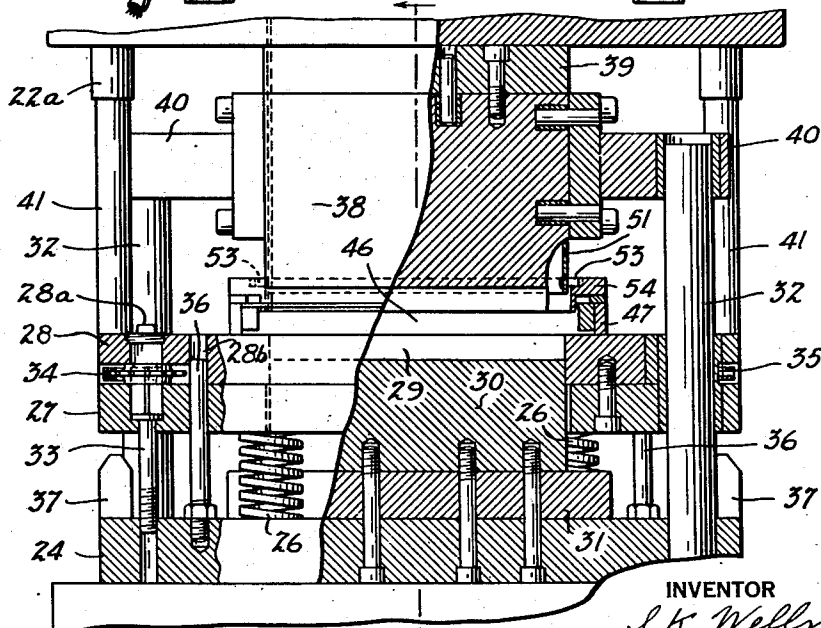
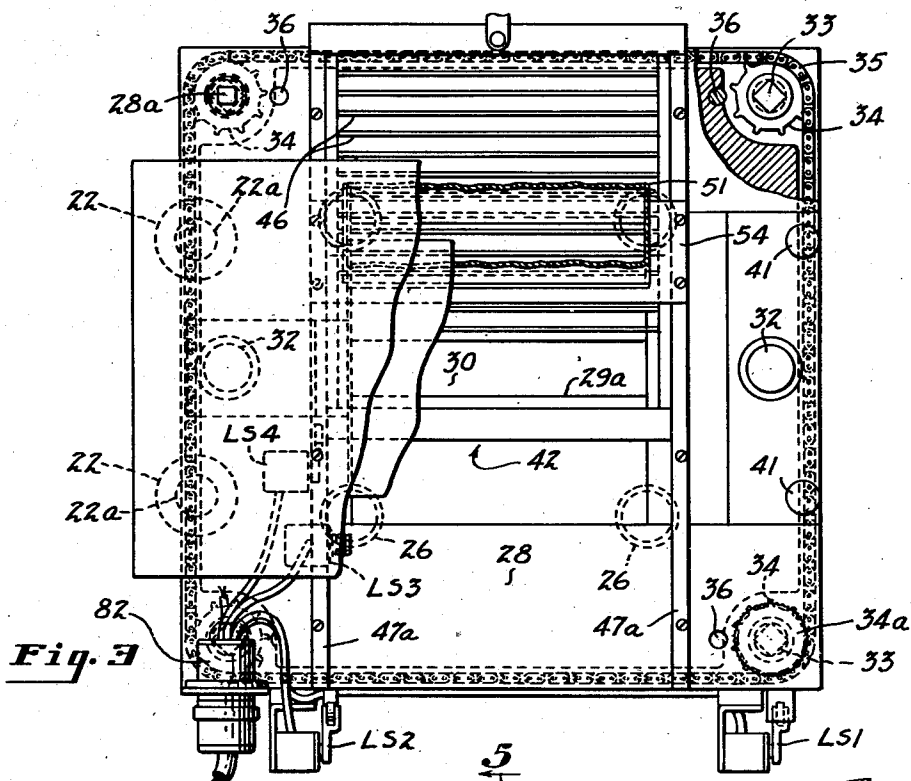


Fig. 4

INVENTOR
S. K. Wellman
BY Ray P. Lehr
ATTORNEY

Feb. 13, 1951

S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 3

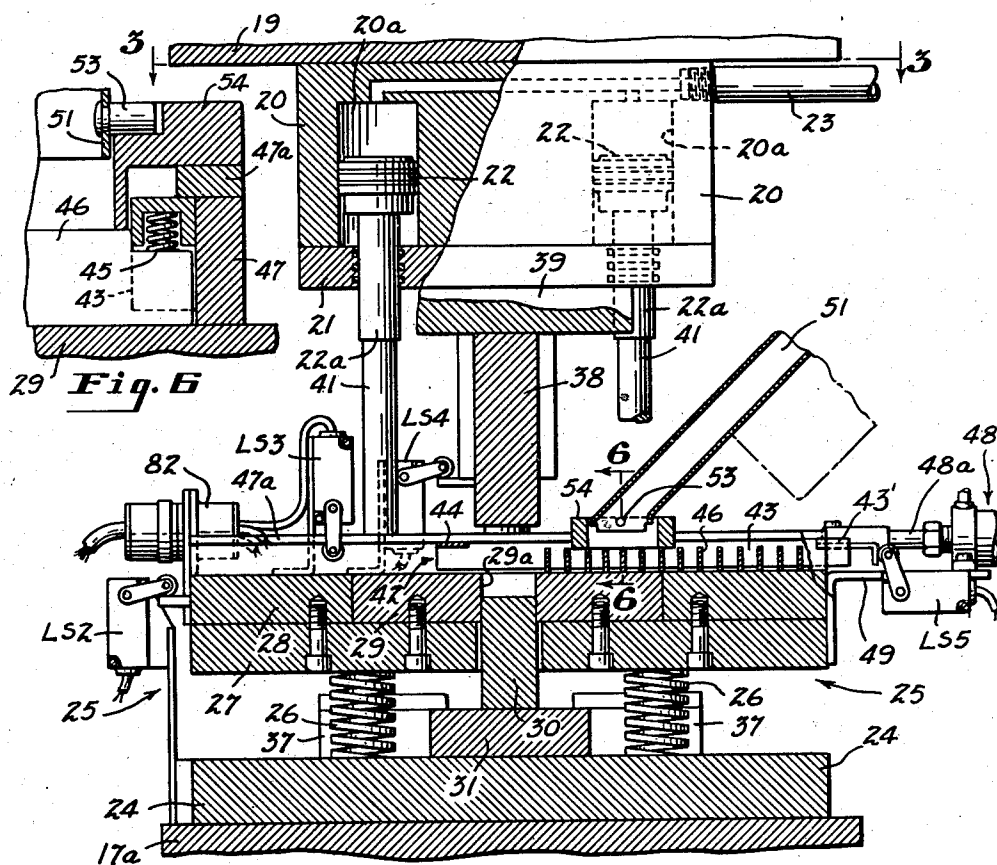


Fig. 5

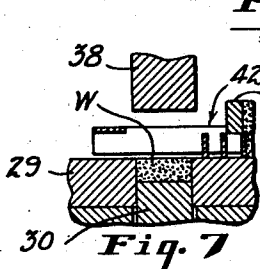


Fig. 7

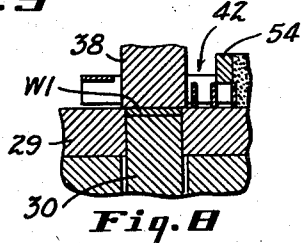


Fig. 8

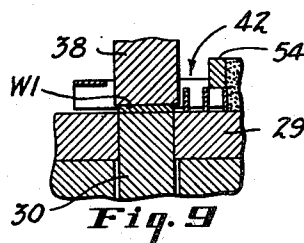


Fig. 9

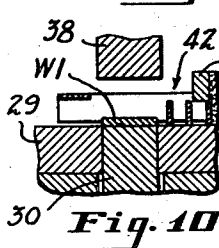


Fig. 10

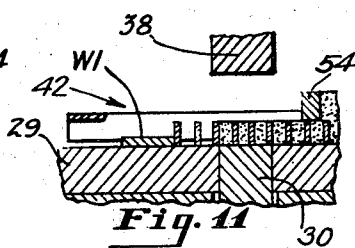


Fig. 11

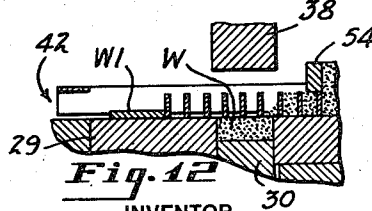


Fig. 12

INVENTOR
S. K. Wellman
BY Ray S. Gehr
ATTORNEY

Feb. 13, 1951

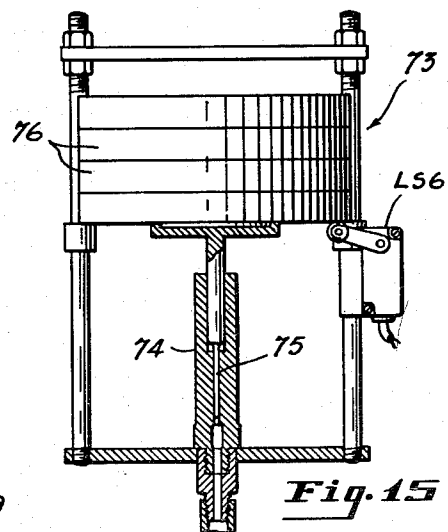
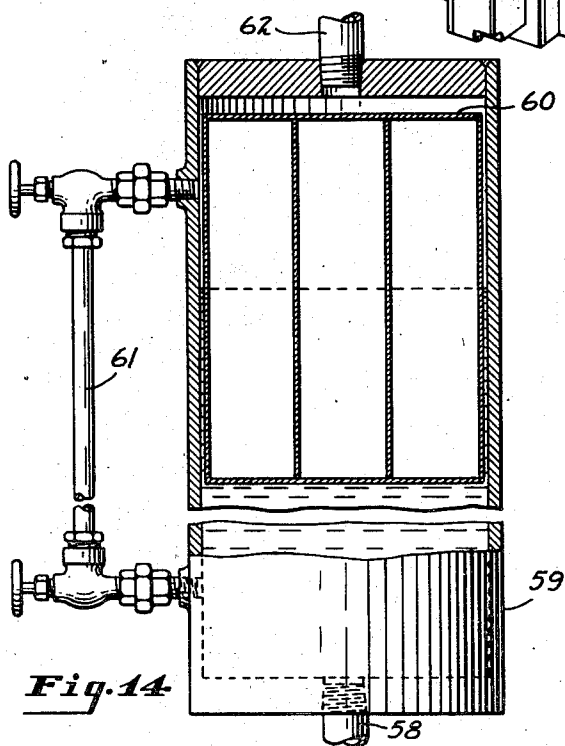
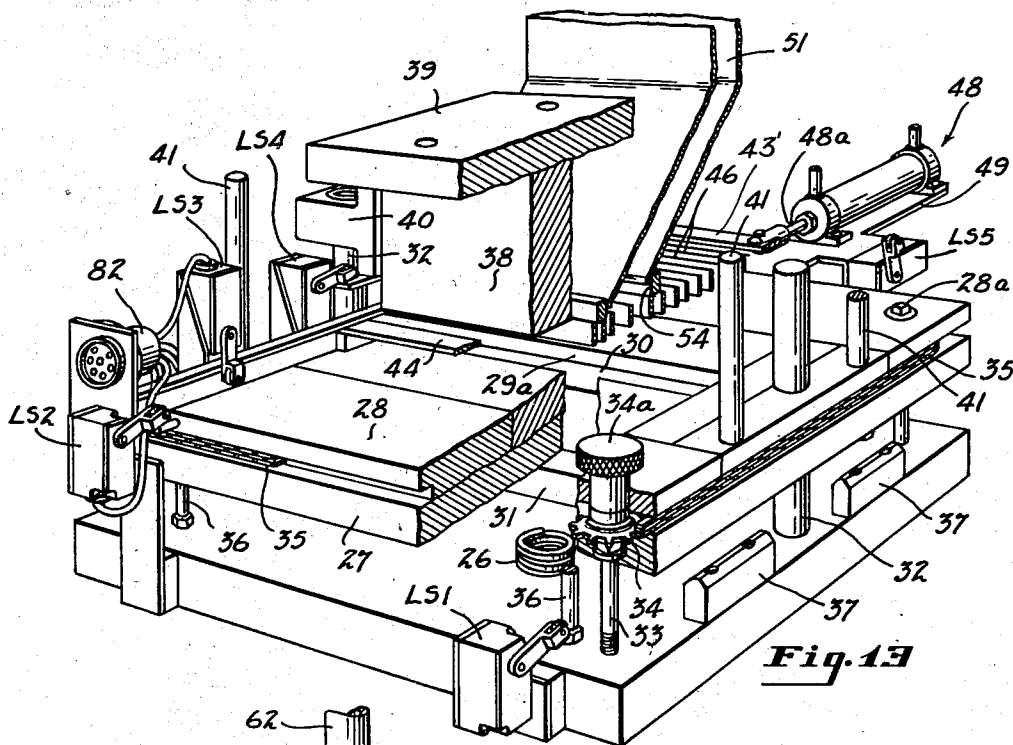
S. K. WELLMAN,

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 4



INVENTOR
S. K. Wellman
BY Ray S. Gehr
ATTORNEY

Feb. 13, 1951

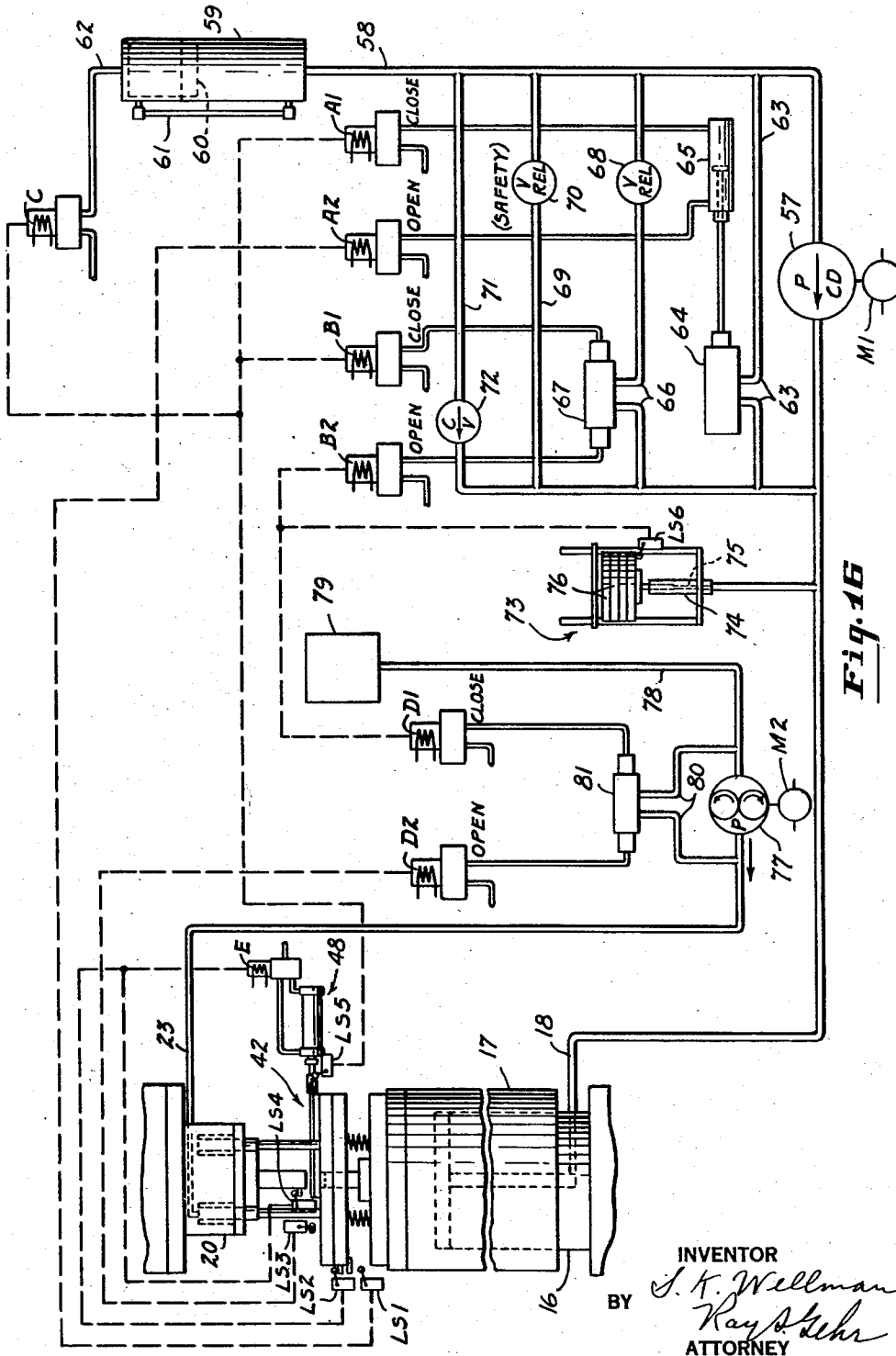
S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 5



Feb. 13, 1951

S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 6

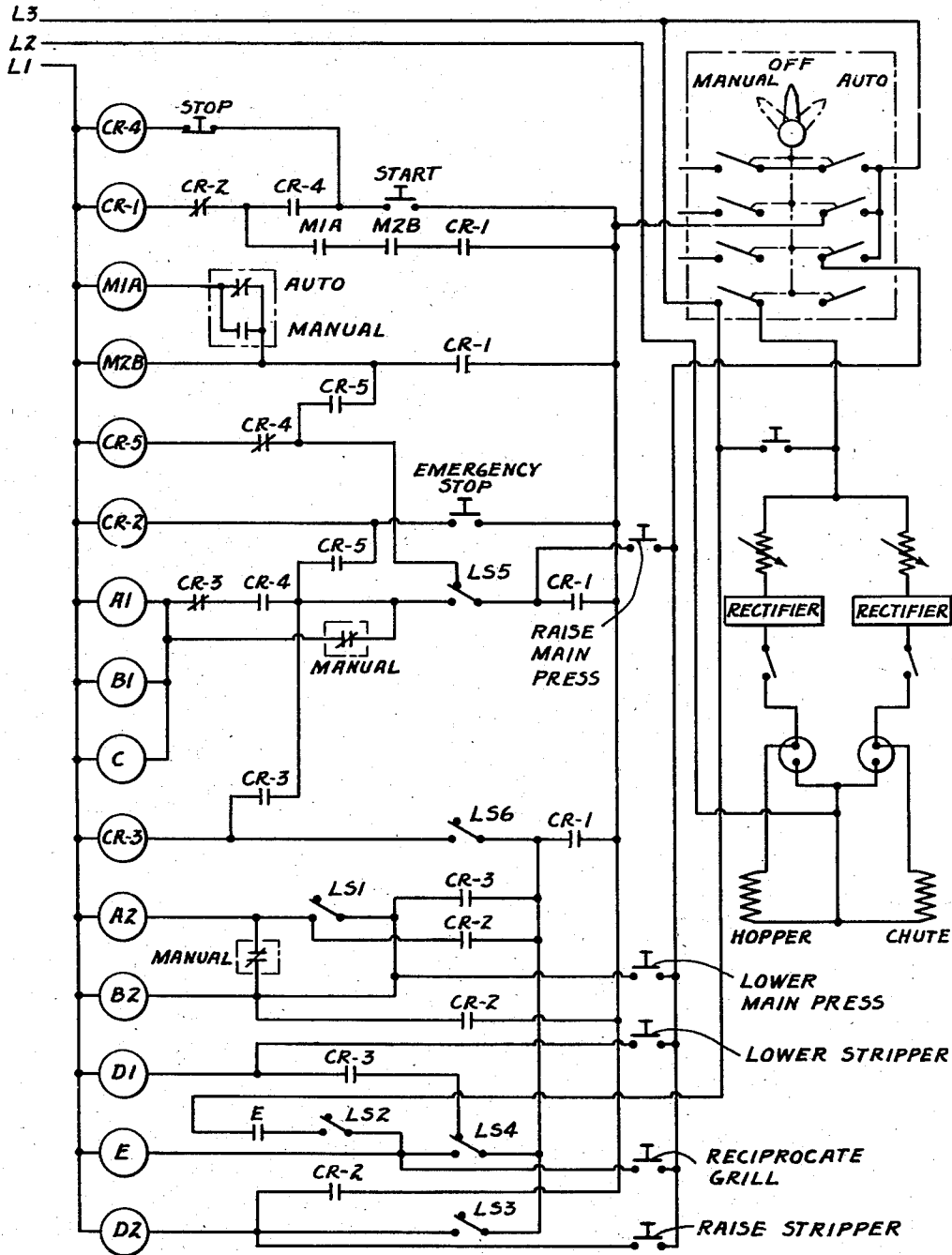


Fig. 17

INVENTOR
S. K. Wellman
BY
Ray S. Gehr
ATTORNEY

Feb. 13, 1951

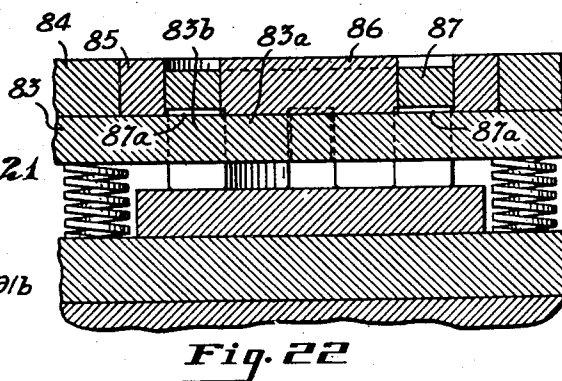
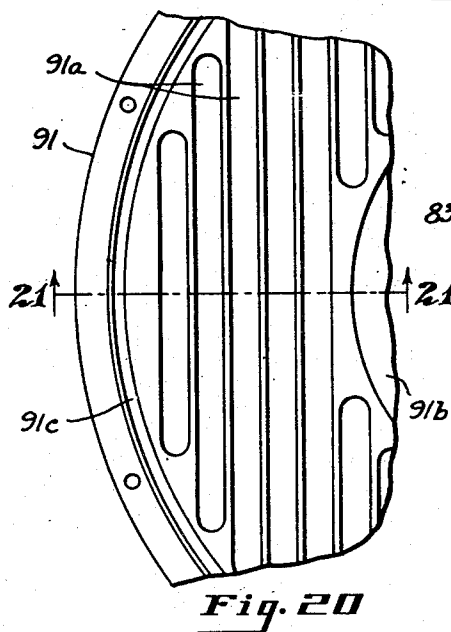
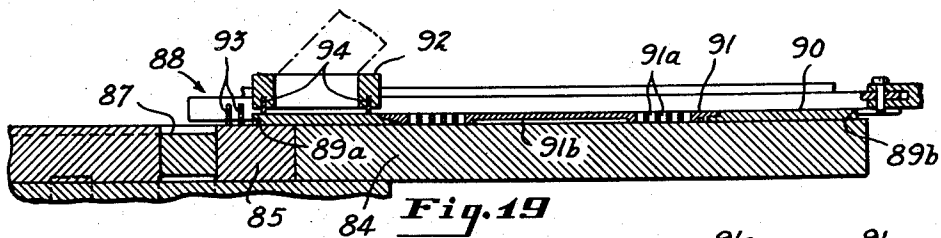
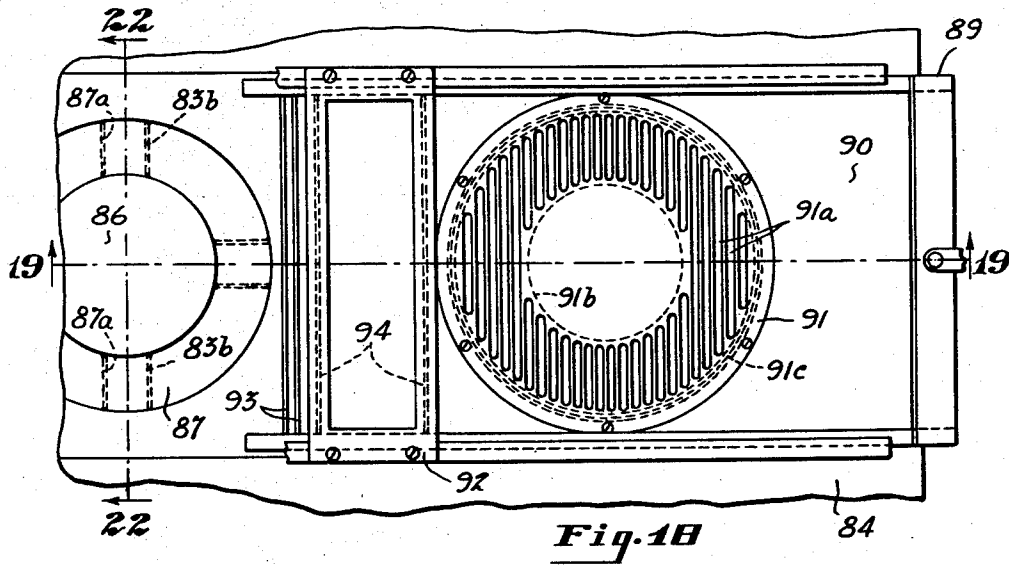
S. K. WELLMAN

2,541,899

METHOD AND APPARATUS FOR FORMING BRIQUETTES

Filed April 1, 1947

7 Sheets-Sheet 7



INVENTOR
S. K. Wellman
Ray A. Gehr
ATTORNEY

UNITED STATES PATENT OFFICE

2,541,899

METHOD AND APPARATUS FOR FORMING
BRIQUETTES

Samuel K. Wellman, Cleveland Heights, Ohio, as-
signor to The S. K. Wellman Company, Cleve-
land, Ohio, a corporation of Ohio

Application April 1, 1947, Serial No. 738,677

10 Claims. (Cl. 18—16)

1

The invention relates to the briquetting of loose materials and particularly of finely divided granular materials.

In the production of briquets of certain types, such for example, as metallic or partly metallic facings for bearings, clutches and brakes, it is important that the density of each briquet be highly uniform throughout planes parallel to the surface of the facing and also that the densities of briquets having related uses, as in the case of a multiple segment clutch or brake disk, should be uniform throughout the lot. Prior to the present invention the production of such briquets involved much hand work in charging weighed portions of the loose material into the briquetting die or mold and spreading it uniformly in the die cavity preparatory to compression. The method and apparatus disclosed in United States Patent No. 2,240,971 represents the best practice available prior to the present invention.

It is an object of the invention to provide an improved method of charging briquetting dies capable of producing briquets of highly uniform density and susceptible of being carried out by automatic apparatus of high production capacity.

Another object of the invention is to provide improved automatic briquetting apparatus for the practice of the novel method.

More specifically with respect to the apparatus, it is a further object of the invention to provide automatic briquetting apparatus having press mechanism and coacting die mechanism which, together with control devices peculiar to it, is removable as a unit from the press, so that the apparatus can readily be converted, by interchange of dies, to produce briquets of many different sizes and shapes.

The invention has for another object the provision of automatic briquetting apparatus capable of operating at high speed to produce briquets of highly uniform character.

With the last stated object in view, the invention has the further object of providing hydraulic press apparatus which is capable both of developing high unit pressures and of high speed operation.

Still another object of the invention is the provision of a method of control for high speed high pressure hydraulic press mechanism capable of accurately regulating the maximum unit pressure developed by the press.

Other objects of the invention more or less incidental or ancillary to those stated above will

2

become apparent as the further description proceeds.

For the attainment of the stated objects the invention consists in certain method steps and apparatus which will be pointed out and explained in connection with a preferred form of apparatus shown in the accompanying drawings and finally defined in the claims.

In the drawings,

Figs. 1 and 2 are side and front elevations, respectively, of a press and die mechanism constructed in accordance with the invention, a portion of the press frame being broken away in the case of Fig. 1 to better disclose the die mechanism.

Fig. 3 is a view on an enlarged scale partly in plan and partly in section of the cylinder block of the stripper press and of the die mechanism together with some associated parts, the top plane of the view being indicated by the line 3—3 on Figs. 2 and 5.

Fig. 4 is a view on an enlarged scale partly in rear elevation and partly in vertical section of the die mechanism and some associated parts.

Fig. 5 is an enlarged vertical section of the stripper press and the die mechanism, the section being taken on the line 5—5 of Fig. 1 and Fig. 4.

Fig. 6 is a fragmentary section on the line 6—6 in Fig. 5.

Figs. 7 to 12, inclusive, are fragmentary sectional views of main parts of the die and charging mechanism illustrating sequential movements of the mechanism in its operation.

Fig. 13 is a perspective view of the die mechanism with some of the associated cavity-charging devices.

Fig. 14 is a view partly in side elevation and partly in section of an hydraulic surge tank employed in connection with the main press of the apparatus, a portion of the structure being broken away to permit larger scale illustration.

Fig. 15 is a side elevation, partly in section, of press regulating mechanism employed.

Fig. 16 is a diagram showing the main and stripper hydraulic presses and the die mechanism together with the associated pressure and control devices employed in the operation of the apparatus.

Fig. 17 is an electrical wiring diagram suitable for the control devices of the apparatus.

Fig. 18 is a plan view of an alternative form of die and charging grid.

Fig. 19 is a vertical section on the line 19—19 of Fig. 18.

3

Fig. 20 is an enlarged fragmentary plane view showing a portion of the grid structure of Figs. 18 and 19.

Fig. 21 is a section on the line 21—21 of Fig. 20.

Fig. 22 is a vertical section on the line 22—22 in Fig. 18.

Referring in detail to the construction illustrated and at the outset particularly to Figs. 1-5 and 13, the numeral 11 designates generally hydraulic press mechanism fitted with die mechanism designated generally by the numeral 12 and die charging devices generally designated by numeral 13 (Figs. 1, 2).

Press mechanism

The press mechanism has a frame structure 14 with a base block 15 supporting a fixed ram 16 which cooperates with the movable cylinder 17, the ram and cylinder constituting the main press of the mechanism. The ram 16 is formed with a central passage to which is connected a liquid supply and exhaust pipe 18. Cylinder 17 carries on its top a platen block 17a.

The fixed head of the press comprises a plate 19 to which is secured a cylinder block 20 which is bored out to form four cylinders 20a closed by head plate 21 and accommodating the four pistons 22 with stub piston rods 22a which extend downward through the head plate 21 (Fig. 5). Pressure liquid is supplied and exhausted through conduit 23 which is suitably connected to the four cylinder chambers. As will later appear the four cylinder head press performs the function of stripping briquets from the forming die.

Die mechanism

The die mechanism 12 comprises a base plate 24 which rests upon the platen 17a of the main press. A built-up die body structure generally designated by numeral 25 is yieldingly supported from base 24 by four coil springs 26, 26 (Figs. 4, 5). The body structure 25 comprises a main plate 27 and a plate 28 secured on top thereof. Plate 28 is interrupted to receive a removable or interchangeable plate 29 which is recessed or apertured to form the side wall 29a of the die cavity. It will be appreciated that the die body structure thus constructed may be adapted to produce a variety of briquet shapes by simply changing the single insert 29. The bottom wall of the die cavity is formed by plunger 30 which is fixedly secured on a block 31 which in turn is similarly secured to base 24.

The yielding support of the structure 25 provides for a telescoping movement between the die body and the plunger bottom wall 30. Such telescoping movement is guided by a pair of heavy upright rods 32, 32 carried by the base and slidably engaged by bushed apertures of the body structure 25. Upward movement of the body 25 relative to base 24 is determined by limit stops in the form of four bolts 33 each adjacent one corner of the die structure. Each bolt 33 is threaded into base 24 and has its head engaging a counter-sink in plate 27, the head having a square section to engage a similarly shaped hole in the hub of a sprocket wheel 34. A sprocket chair 35 passes over the four sprocket wheels 34 and serves to simultaneously turn all of the bolts 33 to equally adjust the limit stops. An operating knob 34a is provided to engage any one of the sprocket wheels or its bolt 33 to facilitate such adjustment, access to the said wheels and bolts being afforded through apertures in

4

plate 28 by removal of screw plugs 28a that are provided to exclude dirt. Adjacent each corner of the die body is a gauge rod 36 adjustably threaded to base 24 and slidably engaging a hole 28b in the die body. The gauge rods 36 have their tops adjusted to the same heights as the die plunger 30 and the depth of holes 28b thus always indicate the depth of the die cavity. Gauge rods 36 also serve as guides in the initial adjustment of limit bolts 33. Downward movement of the die body 25 in relation to base 24 is limited by a series of blocks 37 carried by the base.

The top wall of the die cavity is formed by block 38 which is rigidly secured to plate 39 which in turn is bolted to the cylinder plate 21. Block 38 is somewhat larger in horizontal section than the die cavity. Thus there is obviated a considerable amount of accurate machine work on part 38 that would be necessary in accordance with the usual practice of forming both top and bottom walls of the die to telescope with nice fits in the die cavity and of accurately aligning the telescoping parts. With the present construction it is only necessary that the bottom of block 38 and the top of the die body have cooperating flat and parallel surfaces. Apertured bracket arms 40 carried by block 38 (Fig. 4) slidably engage the rods or posts 32 and the latter thus serve to maintain alignment of parts 24, 25 and 38 of the die mechanism.

In vertical alignment with the piston rods 22a of the stripping press are four thrust rods 41 which are carried by die body structure 25 and serve to transmit downward movement of the pistons 22 to the structure 25.

Die-charging devices

The die charging devices 13 comprise a grid structure generally designated by 42 which is slidably mounted on the top surface of die body 25. The grid comprises a rectangular frame having side bars 43, a front transverse bar 44 and a similar rear transverse bar 43' (Figs. 5, 6 and 13). The side bars 43 are drilled and slotted to receive light coil springs 45 and the ends of smoothly polished blades, 46, the springs serving to press the ends of the blades yieldingly downward in relation to the rectangular frame. The resultant upward thrust on the frame is resisted by guide rails 47 having flanges 47a which overlie the tops of the frame bars 43. A compressed-air reciprocating motor 48 is provided to reciprocate the grid structure, said motor being mounted on a bracket 49 carried by the body of the die and the piston rod 48a of the motor being suitably connected to the rear bar 43' of the grid.

The finely divided material to be briqueted is supplied from a large hopper 50 carried on the superstructure of the press and having its hopper bottom connected with a downwardly inclined chute 50a which in turn delivers, with automatic regulation, into the open upper end of a second inclined chute 51 which is supported from chute 50a by chain 52. The lower end of chute 51 is pivotally connected at 53 to a rectangular discharge frame 54 which is screwed to guide rails 47 and has its lower side arranged to just clear the upper edges of the grid blades 46. The chutes 50a and 51 are provided with electrically energized vibrators conventionally shown at 55 and 56, respectively. With rheostat control for the vibrators the intensity of the vibration applied to the chutes can be varied at will.

It will be seen that the blades 46 of the grid 42 divide the latter into a series of cells which can be filled from the supply chute 51 when the grid is moved beneath the discharge frame 54 and that by forward movement of the grid thus charged with finely divided material that material can be transferred to the die cavity. The peculiar manner in which this is accomplished and the significance of the cellular structure of the charging grid will be pointed out in connection with the operation of the apparatus in the later description.

Fluid pressure supply and control devices

Suitable hydraulic pressure supply and control devices are provided for the main and stripping presses as shown diagrammatically in Fig. 16. The supply conduit 18 of the main press leads to a reciprocating piston contant delivery pump 57 driven by electric motor M1, the suction inlet of this pump is connected by conduit 58 with an upright cylindrical surge tank 59 (also shown in Fig. 14). This tank is fitted with a hollow float 60 which substantially covers the liquid surface in the tank 59 but has sufficient clearance so that oil will rise around it and permit it to function as a float. The tank is provided with a gauge glass 61 to indicate the liquid level in the tank and the top of the tank is connected to a compressed air supply conduit 62 controlled by a valve actuated by solenoid C.

Pump 57 is bypassed by conduit 63 controlled by hydraulic valve 64 which is opened and closed by a compressed air motor 65 which, in turn, is controlled by air valves actuated by solenoids A1 and A2. Pump 57 is also bypassed by conduit 66 which is controlled by valve 67 actuated by air valves controlled by solenoids B1 and B2. Conduit 66 also is fitted with an adjustable spring-pressed relief valve 68 adapted to permit flow from the main press to surge tank 59. Another bypassing conduit 69 is fitted with relief valve 70 simply as a safety measure. Finally pump 57 is bypassed by a conduit 71 fitted with a check valve 72 permitting flow from the surge tank 59 to the main press cylinder. To limit the working pressure of the main press cylinder a control device generally designated by 73 is provided. This device, which is also shown in Fig. 15, comprises a cylinder 74 fitted with an exceedingly slender plunger 75 which may be variably loaded with weights 76 which determine the pressure at which plunger 75 and weights 76 will rise and cause actuation of a controlling spring-biased limit switch (LS6).

The stripping press has its cylinder 20 supplied through conduit 23 by a relative low pressure pump 77 driven by electric motor M2. The intake of the pump 77 is connected by conduit 78 with surge tank 19. Pump 77 may be bypassed by conduit 80 which is controlled by valve 81 which in turn is controlled by air valves actuated by solenoids D1 and D2. The air motor 48 which actuates the charging grid of the die is controlled by a biased air valve actuated by solenoid E.

The various solenoids which have been referred to are controlled by a number of limit switches LS1, LS2, LS3, LS4, and LS5 carried by the die mechanism, as shown in Figs. 13 and 16, and LS6 which is associated with the pressure control device 73. Switch LS1 is supported on die base 24 and switches LS2, LS3, LS4 and LS5 are supported on die body 25 (Figs. 5 and 13). The five limit switches mounted on the die mechanism

(Fig. 13) are wired to a common coupling plug 82 which facilitates changing of dies. In fact a die can be removed from the press without disturbing the timing adjustments of the controls. In Fig. 16 the dashed lines are intended only to indicate the solenoid devices with which the respective limit switches are cooperatively related. The main features of a suitable electric wiring system for the apparatus are shown in the electrical diagram of Fig. 17. From the foregoing description it is believed that this diagram will be clear without detailed description. It may be noted, however, that single letters A, B, C, etc., refer to solenoids (in accordance with Fig. 16), the letters CR followed by a numeral refer to control relays, and the letters LS followed by a numeral refer to the limit switches already mentioned. Other switches shown in the diagram are manually operated. By throwing the selector switch to "Manual" various movements (indicated by legends in Fig. 17) of the apparatus can be carried out under manual control by selecting suitable switches.

Operation

In the operation of the apparatus, with the charging hopper 50 suitably supplied with the loose material to be compacted, the mechanism is started by moving the selector switch (Fig. 17) from the "Off" to the "Auto" position. Assuming that the apparatus has been stopped in its prior operation with the charging grid in its fully retracted position (Fig. 5) the die cavity will have been charged as indicated in Fig. 7. Also the limit switch LS5 will have been actuated at the end of the grid retraction so that at the outset of the operation the hydraulic valves 64 and 67 will be closed through the operation of solenoids A1 and B1 and compressed air, preferably at about 100 pounds per square inch pressure, will have been admitted into the top of the tank 59 by the energizing of solenoid C.

The effect of these valve actuations is to cause the supplying of pressure liquid to the main press cylinder from tank 59 simultaneously through conduit 58 by pump 57 and through bypass conduit 71 by the air pressure. The air pressure acts to supply a large volume of liquid through the bypass 71 to effect a relatively rapid traverse of the main press cylinder until the pressure in said cylinder rises to that of the compressed air source, whereupon the check valve 72 closes and the remaining movement of the main press cylinder is effected by high pressure, supplied by pump 57. The upward movement of the main press cylinder lifts the entire die mechanism until the top surface of the die body engages the bottom surface of the stationary die block 38. This arrests the upward movement of the die body 25 whereupon its supporting springs 26 are compressed and the plunger 30 is moved upward in the die cavity to compress the charge W shown in Fig. 7 and form the briquet W' as shown in Fig. 8.

During the compression of the charge the pressure applied to it gradually increases and when it reaches a predetermined desired intensity, say 22,000 pounds per square inch, the weighted plunger of the control device 73 rises and permits actuation of biased limit switch LS6 with the result that hydraulic valve 67 is opened and the pressure in the main cylinder lowered to a suitable point determined by the adjustment of relief valve 68. Preferably this valve is adjusted to maintain a pressure of not less than 1000

pounds per square inch. The actuation of limit switch LS6 also energizes solenoid D1 to close hydraulic valve 81 and apply pressure to the stripping cylinders. This causes lowering of pistons 22 which, acting through thrust rods 41, force the die body 25 downward against the tension of springs 26 to strip the briquet from the die cavity as shown in Fig. 9. The downward stripping movement of the die body 25 actuates limit switch LS1 which energizes solenoid A2 to open hydraulic valve 64 and completely release the pressure in the main press, allowing its cylinder, and the die body thereon, to fall. At or about the time this lowering of the die body reaches the stage shown in Fig. 10, limit switch LS4 is actuated (by engagement of its arm with stationary dog supported by blocks 38, 40) to energize solenoid E and cause air motor 48 to move the charging grid forward. The first part of this grid movement starts ejection of the briquet by the forward blade 46 and as the grid movement continues the loaded cells thereof are brought directly above the top of plunger 30 so that the material above said plunger is supported on the top surface of the plunger. Fig. 11 shows the position of the parts at the completion of the forward movement of the grid and the downward movement of the die body. Near the end of the forward movement of the grid it engages and actuates limit switch LS3 which energizes solenoid D2 to open hydraulic valve 81 and release the pressure in the cylinders of the stripping press thus permitting the tension of springs 26 to raise the die body 25 from the position indicated in Fig. 11 to its fully raised position indicated in Fig. 12. This upward movement of the die body carries the charging grid upward with it and the grid blades 46 are lifted out of the uncompacted material supported on the top of plunger 30. In this way the uncompacted charge material is introduced into the die cavity as shown in Fig. 12 while the material is at all times supported by the plunger 30. Thus there is no falling of the charge into the cavity and substantially no rearrangement of different portions of the charged mass. In other words, the density of the charge throughout the die cavity is uniform. Also, with uniform operating conditions maintained, the densities of successive charges is also maintained equal.

At the end of the upward movement of the mold body it actuates limit switch LS2 which deenergizes solenoid E and causes the air motor 48 to retract the charging grid and cause its strike-off blades 46 at the front end of the grill to remove excess material and leave the die cavity evenly filled to the top. As the charging grid reaches its fully retracted position it again actuates limit switch LS5, thus starting a repetition of the cycle which has been described.

The operation of the apparatus which has been described is carried out at relatively high speed, it being possible to produce up to 750 briquets per hour, and such high working speed has important significance with respect to the design of the apparatus. The high speed possibilities of the type of electrical controls employed is known by those familiar with such devices; but the attainment of speed such as that noted involves additional considerations of importance.

The design of the charging apparatus is of primary importance in this connection. The supply of loose material to the charging grid must be free and effective at all times in order to insure prompt filling of the grid cells as they move

beneath the discharge frame 54. At the same time the working conditions at the point of discharge to the grid must be kept uniform in order that the loose material shall have a substantially uniform density from moment to moment and from hour to hour. This condition is attained by maintaining a substantially uniform head on the lower feed chute 51 and by the further fact that the inclination of the chute is such that flow of material is attained only by vibration of the chute structure, thus making possible a nice control of the flow by controlling the intensity of the vibration.

The design of the cellular structure of the grid is also important in meeting the conditions referred to. An important factor is the width of the individual cell in the direction of the grid movement. The width must be large enough so that the cell will fill freely and quickly without bridging under the relatively low effective supply head which has been referred to. At the same time the stated width of the cell is to be kept small enough so that in the relatively rapid movement of the grid in the die-charging operation the mass of the material in the individual cells will not be great enough to cause material to be thrown from the cells or to cause localized compacting of the material by inertia effect. The width of cell which is most suitable may vary somewhat with the character of the material to be briqueted, but generally speaking it has been found satisfactory to make the stated width of the cell approximately equal to its depth. The depth, in turn, will depend upon the thickness of the briquet to be produced and the intensity of the compacting pressure. In the production of friction facing briquets such as were referred to at the outset a typical material is of the following composition:

	Per cent
Cu	70.9
Pb	10.9
Sn	6.3
Graphite	7.4
Air-blown silica	4.5

In the compacting of such material under a pressure of 22,000 pounds per square inch, with the loose material supplied to the charging grid under the conditions above described, it is found that the compacting ratio is about 3 to 1, that is, the depth of the die cavity should be approximately three times the thickness of the briquet produced. Thus, for such material and such working pressures, we have the practical rule that the width and depth of the grid cell and the depth of the die cavity should be approximately equal and about three times the thickness of the briquet. It follows that for friction facing briquets, which commonly have much greater width than thickness, the charge for the die cavity will be supplied by a plurality of grid cells. It should be borne in mind, in connection with the filling of the die cavity, that space is occupied by the grid blades overlying the cavity. Allowance should be made for this, and a small excess of charging material may well be provided to be removed by the strike off blades as the grid is retracted.

Since the blades forming the cell walls of the grid occupy space at the expense of the loose material, the blades should be made as thin as may be without loss of substantial rigidity under the operating conditions. Obviously the surfaces of the blades should be smooth to favor free entry of material into the cells and insure ready

separation of the blades from the loose material as the latter is introduced into the die cavity, and to this end the blades are given a smooth and highly polished finish.

Another factor affecting speed of operation is the attainment of rapid movement of the relatively heavy main press cylinder. This is achieved by the combined action of low pressure air and high pressure liquid, which has been described. The air pressure on the surge tank 59 insures a fast traverse of the main press cylinder during the first part of the compression movement and is automatically replaced by the high liquid pressure to complete the compression. The rapid air action is made practical by the use of the surge tank float which blankets the surface of the liquid and prevents excessive and troublesome foaming of the oil which would otherwise occur.

Still another important factor in the attainment of the high speed operation is the method of regulating the maximum compacting pressure by the use of the weight-loaded control device. Under rapidly changing pressures at intensities as high as 22,000 pounds per square inch, conventional pressure gauges of the Bourdon tube or diaphragm type flutter or hunt badly and are wholly impractical for the close regulation of pressure required to attain uniform density of product. The weight-loaded regulator, however, has proven highly successful for this purpose.

The above described method of stripping the briquet from the die cavity has not been specially commented upon since it has heretofore been disclosed and claimed in United States Patent No. 2,259,094, granted October 14, 1941.

It will be understood that the design of the die and charging mechanism will vary with the character of the briquets to be produced. Thus one piece annular briquets suitable for facing disc clutches or brakes call for special application of the principles of the invention, particularly in the design of the charging grid. This is shown in Figs. 18-22 of the drawings which illustrate a die and charging grid which have been found satisfactory for the production of such annular briquets. Here the spring-supported die body has a lower plate 83 formed with four segmental apertures leaving a central block 83a supported by four radiating "spokes" 83b. An upper plate 84 is interrupted to receive outer cavity wall section 85 and inner circular wall section 86, both sections being removably supported on lower plate 83. The bottom cavity wall or plunger 87 is in tubular form with four slots 87a to pass over the "spokes" 83b and permit support of the plunger on the base of the die.

For this type of die the grid, designated generally as 88, comprises a U-shaped frame 89 which has its side rails resting upon a plate 90 that is held against endwise displacement in relation to the frame by frame shoulders 89a, 89b that engage the front and rear ends of the plate. The plate 90 has a circular aperture which is counter-sunk to receive a circular insert 91 which is secured in position by screws. Insert 91 has an annular portion corresponding to the die cavity which is formed with slots 91a that constitute cells to receive the finely divided material from the discharge frame 92 of the supply chute. As will be noted from Figs. 18 and 19 the elongated slots or cells 91a are disposed perpendicular to the longitudinal axis of the grid, as are the cells of the grid previously described. The central imperforate surface of the insert 91 has its lower

portion relieved at 91b (Figs. 19 and 21) as does also an annular portion at 91c surrounding the slotted portion of the insert. Furthermore the slotted portion of the insert 91 is thicker than the plate 90 and as a result the said slotted portion is the only part of the grid which rests upon the flat top surface of the die, except for a pair of spring-pressed wiper blades 93 attached to the front end of the frame 89. The rectangular mouth 92 of the chute also is fitted with a pair of wiper blades 94 to engage the top of the plate 90 and insert 91.

With the grid constructed in the manner described its weight is sufficient to maintain good wiping engagement between the upper sides of the slotted portion of the insert 91 and the top surface of the die body. This modified grid is reciprocated, in the same manner as the grid earlier described, from the loading position shown in Figs. 18 and 19 to the discharge position over the annular die cavity and functions generally in the same manner as the other grid. However, it is to be observed that the cell structure of the first described grid is not as well adapted to cooperate with the annular form of die cavity as is the second grid because with the first form a considerable mass of the finely divided material in the central portion of the grid does not enter the die cavity but remains in the grid to be dragged back over the material delivered into the cavity with resultant disturbance of the material charged into the cavity, and some unevenness in the filling of different portions of the cavity. In the second form of grid by keeping the central zone imperforate this result is avoided. Furthermore, by relieving the under side of the grid so that only the slotted portions rest upon the die, the metal parts between the slots or cells act effectively as wiping blades and any slight amount of the fine material that may find its way beneath the unslotted section of the grid is accommodated by the relief previously referred to so that there is no tendency for the grid to be lifted out of contact with the top of the die.

Aside from the specific features which have been referred to in connection with the annular cavity charging grid, the design and operational features which were pointed out in connection with the first described grid apply to the annular cavity grid construction. Accordingly it is believed that the operation of the apparatus with annular type cavity will be clear without further description.

It is to be understood, in connection with the appended claims, that the specific procedures and forms of apparatus which have been described and explained are subject to modification in various respects within the bounds of equivalency.

What is claimed is:

1. In the briquetting of finely divided material the method of charging the open-topped cavity of a flat-topped die body having a cavity bottom wall movable vertically within the side walls of the cavity, the said method comprising delivering such material into the cells of a charging grid slidably supported on the top of the die body and having a plurality of cells open at their tops and bottoms, while the bottom wall of the die cavity is level with the top of the die body sliding the grid over the die cavity, while the grid is at rest in the latter position with the material contents of a plurality of grid cells supported on the bottom wall of the die cavity effecting a lowering of the said bottom wall relative to the die body

and grid to cause a simultaneous gravity discharge and merging of material from the said plurality of grid cells into the die cavity, and thereafter sliding the grid over the top of the die body to leave the die cavity level full of merged material.

2. Apparatus for briquetting finely divided material to form wide bodies of uniform density, said apparatus comprising a flat-topped die body structure shaped to form the side walls of a die cavity; means operable in cooperation with the side walls of the cavity to compress material therein, said means comprising a bottom cavity wall relatively movable within the cavity side walls between the top thereof and a position corresponding to the full depth of the cavity; a charging grid slidably mounted on the top of the die body for reciprocation from a loading zone at one side of the die cavity to a discharge position overlying the cavity and return, the grid having a plurality of cells open at top and bottom and with a width in the direction of the reciprocation much less than the width of the die cavity in the same direction so that a plurality of grid cells overlies the entire die cavity when the grid is in its said discharge position; means for delivering uncompact material into the grid when it is in the loading zone; means constructed to effect the reciprocation of the loaded grid to its discharge position over the die cavity while the bottom wall of the cavity is level with the top of the die body structure and thereafter return the grid to the loading zone; and means constructed to effect the lowering of the cavity bottom wall in relation to its side walls while the grid is at rest in its discharge position.

3. Apparatus as claimed in claim 2 in which the means for delivering the uncompact material into the grid is constructed and controlled to deliver the material to the grid at a substantially uniform velocity and pressure.

4. Apparatus according to claim 2, in which the die body structure and cavity bottom wall and the charging grid are operable in relation to a press mechanism comprising fixed base and head parts and a power actuated movable platen, said die body structure and bottom wall and charging grid being removable from the press mechanism as a unit, and in which the relative movements of the die body structure, bottom wall, charging grid and press mechanism are controlled by a plurality of limit switches mounted on the die body structure and electrically connected to a separable connector plug.

5. In briquetting apparatus, the combination with press mechanism comprising fixed base and head parts and a power actuated movable platen; of a combined die and charging mechanism supported on and movable with the press platen and removable therefrom as a unit, said combined mechanism comprising a base, a flat-topped die body shaped to form the side walls of a die cavity, springs yieldingly supporting the die body on the die base, a die bottom wall supported by the base and slidably fitting the side walls of the die cavity, a charging grid slidably mounted on the top of the die body, power means for reciprocating the grid, and a plurality of limit switches mounted on and operable by movements of the said combined mechanism and electrically connected to a separable connector plug carried by the said mechanism, the said switches constituting parts of means for controlling movements of the press platen and mutual relative movements of the parts of the die and charging mechanism.

6. In apparatus for briquetting finely divided material to form wide bodies of uniform density, the combination of die mechanism comprising a flat-topped die body structure shaped to form the side walls of an open-topped die cavity and means operable in cooperation with the side walls of the cavity to compress material therein; a charging grid slidably mounted on the top of the die body for reciprocation from a loading zone at one side of the die cavity to a discharge position overlying the cavity and return, the grid having a plurality of cells open at top and bottom with a width in the direction of reciprocation much less than the width of the die cavity in the same direction and great enough to receive uncompact material under gravity flow without bridging and to discharge said material by gravity; means for effecting the said reciprocation of the charging grid; and controllable means at the loading zone for delivering the uncompact material into the grid cells at a substantially uniform predetermined rate of flow.

7. Apparatus as claimed in claim 6 in which the means for delivering the uncompact material into the grid cells comprises a feed chute inclined upward at an angle smaller than will induce flow of the material under treatment and controllable means for vibrating the chute and causing flow of the material.

8. Apparatus as claimed in claim 6 in which the means for delivering the uncompact material into the grid cells comprises a feed chute inclined upward at an angle smaller than will induce flow of the material under treatment, supply means for maintaining a uniform head of material in the chute, and controllable means for vibrating the chute and causing flow of the material.

9. Apparatus as claimed in claim 2 in which the die cavity is annular in horizontal section and the charging grid comprises a plate having an annular zone corresponding to the die cavity in size and slotted to form the grid cells, the said plate being relieved on its under side so that only its slotted zone and a circular rib surrounding the zone bear against the top of the die body.

10. Apparatus as claimed in claim 6 in which the die cavity is annular in horizontal section and the charging grid comprises a plate having an annular zone corresponding to the die cavity in size and slotted to form the grid cells, the said plate being relieved on its under side so that only its slotted zone and a circular rib surrounding the zone bear against the top of the die body.

SAMUEL K. WELLMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
456,656	Leavitt	July 28, 1891
989,211	Updegraff	Apr. 11, 1911
1,460,287	Stevenson	June 26, 1923
1,503,619	Zeh	Aug. 5, 1924
1,790,041	Crossley	Jan. 27, 1931
2,028,021	Shippy	Jan. 14, 1936
2,075,992	Lux et al.	Apr. 6, 1937
2,214,816	Harrington	Sept. 17, 1940
2,232,103	Ernst et al.	Feb. 18, 1941
2,348,197	Ernst et al.	May 9, 1944
2,398,227	Hubbert	Apr. 9, 1946