Aug. 29, 1961 J. CROSSLEY 2,997,741

ROTARY COMPACTING MACHINES

Filed Jan. 20, 1959 4 Sheets-Sheet 1

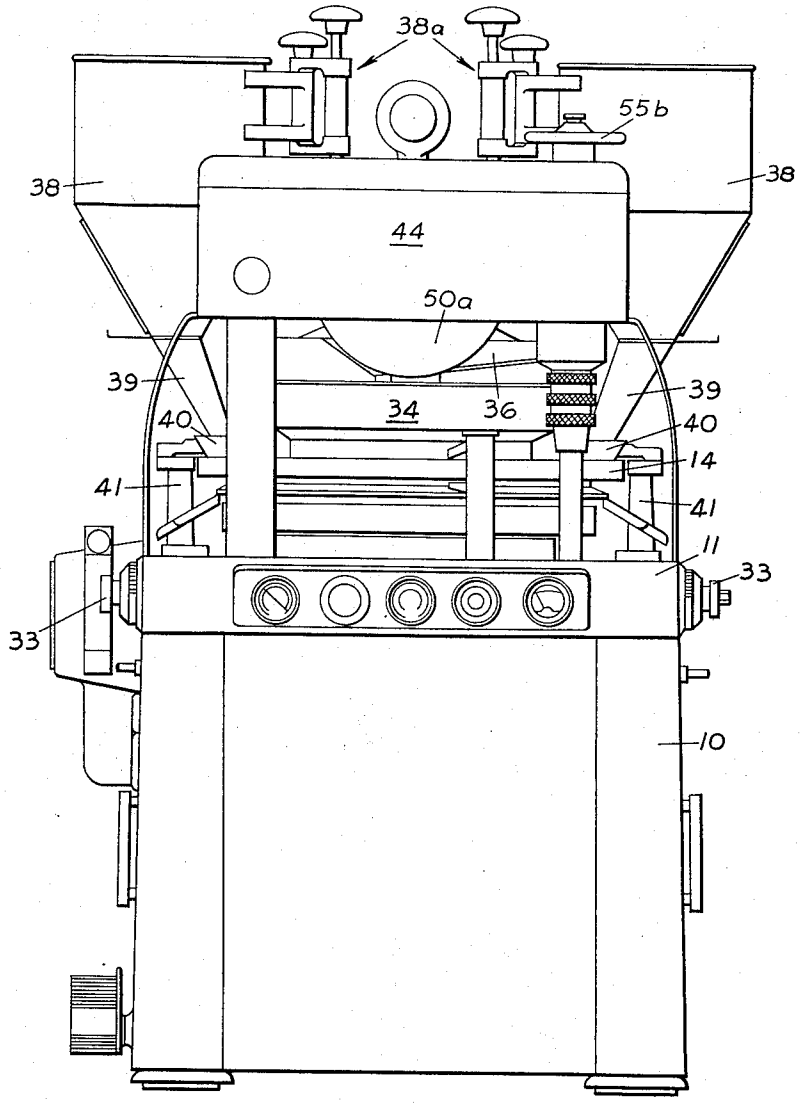


Fig. 1.

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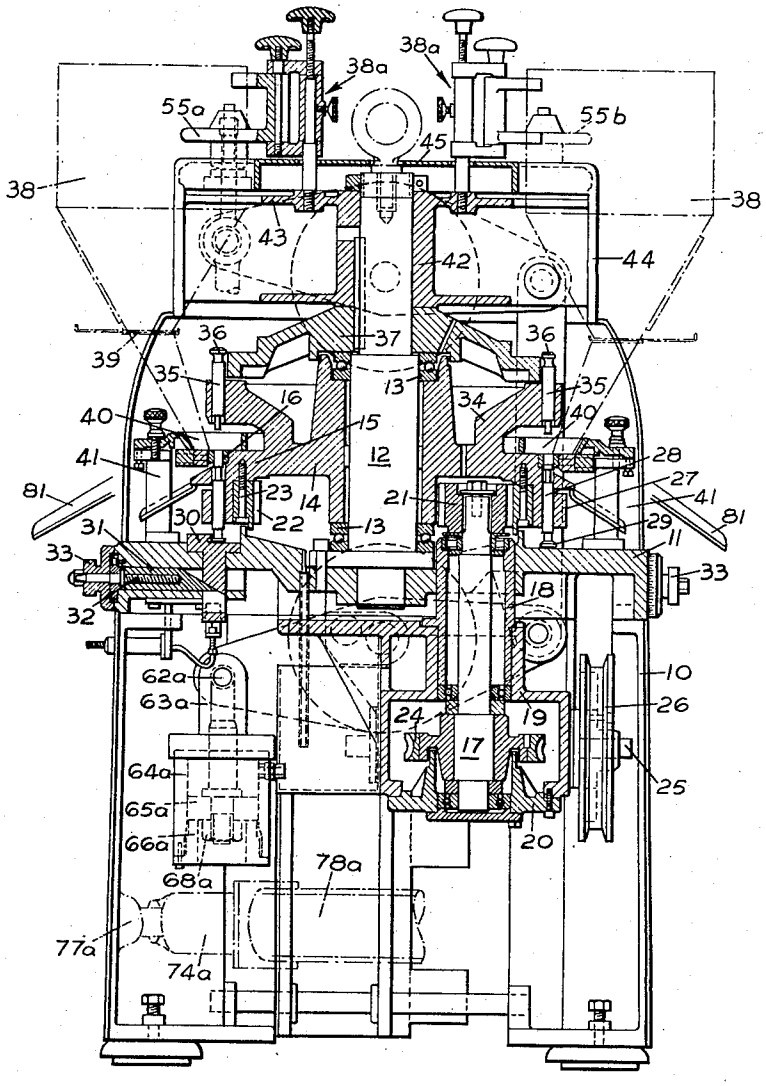


Fig. 2.

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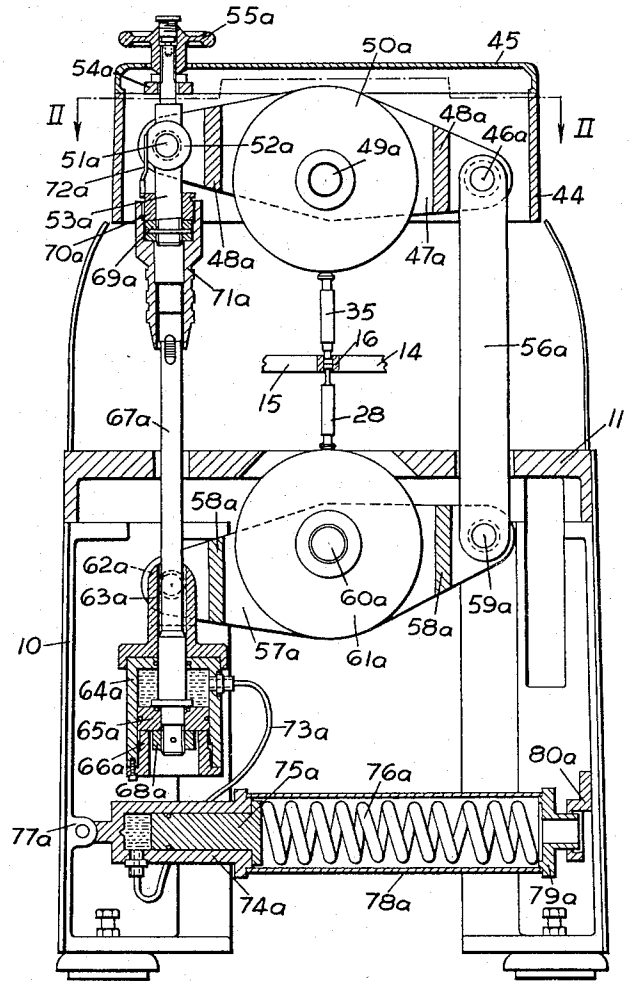


Fig. 3.

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ROTARY COMPACTING MACHINES

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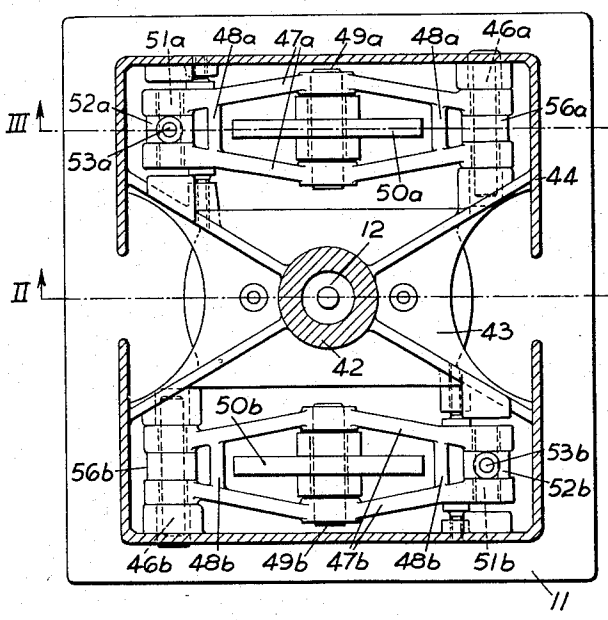


Fig. 4.

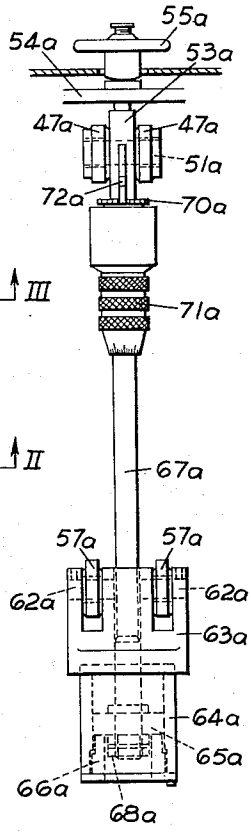


Fig. 5.

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United States Patent Office 2,997,741 Patented Aug. 29, 1961

2,997,741

ROTARY COMPACTING MACHINES

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Filed Jan. 20, 1959, Ser. No. 787,997
3 Claims. (Cl. 18—20)

This invention concerns rotary compacting machines of the type including a rotary die table having one or more dies therein and, associated with each die, upper and bottom punches which upon rotation of the table, engage pressure rolls and are caused thereby to enter into the dies and to compress material in the dies. Such machines (which hereinafter will be referred to as "compacting machines of the type described") are employed, for example, in the manufacture of pharmaceutical tablets from powdered medicinal ingredients, or for making metal and ceramic articles, and like purposes.

Hitherto, it has been usual to mount one of the two rolls stationarily on the machine and, as a safety measure against overloading, to mount the second roll, again on the machine, so as to be displaceable when a predetermined loading is exceeded, so as to prevent damage to the machine.

Certain disadvantages arise out of this prior roll arrangement. Firstly, the machine itself has to be constructed so as to withstand the pressures resulting from engagement of the rolls with the punches both during normal compression and when overloading occurs. In practice, considerable stresses are developed, and machines of even robust construction vibrate considerably during use. Secondly, the mounting of one roll so as to be displaceable safe-guards effectively only against the event that an overloading occurs requiring one only of the punches to be relieved of pressure. Thus, if the roll associated with the bottom punch is displaceable, an overloading requiring relieving movement of the upper punch may occur, and this is not allowed for since the roll associated therewith is stationary, and damage to the machine could occur. Thirdly, where one roll is stationary and the other is movable, defective compacted articles (e.g. tablets) can be produced. This is because such articles are usually made from powdered materials, and such materials do not readily transmit stresses applied thereto, and with the arrangement such as has been described the resulting articles are unevenly compacted and compressed, and parts thereof are liable to crumble very easily, particularly when deep filling.

It is an object of this invention to provide a machine wherein the disadvantages arising from making one roll only displaceable are eliminated, and which enables, if desired, the rolls to be mounted in such a manner that substantially no stresses therefrom are transmitted to the rest of the machine.

According to the present invention a compacting machine of the type described is characterised in that the pressure rolls associated with both the lower and upper punches are displaceable when a predetermined loading is exceeded.

Such arrangement permits displacement of either or both rolls when overloading occurs and consequently guards fully against damage to the machine and tools whilst at the same time ensuring that firmly and evenly compressed articles are produced.

To relieve the machine of stresses from pressure applied by the rolls, the arrangement aforesaid is preferably further characterised in that the two rolls are suitably mounted on and coupled together by a framework or the like substantially independent of the rest of the machine, and which will resist separation of the rolls except when a predetermined load occurs at the rolls.

Preferably such framework or the like includes a pair of roll mountings which are pivoted with respect to one another and connected by tie means which normally resists separation of the rolls, such tie means including a hydraulic accumulator which can be preset to a predetermined load and which will permit separation of the rolls when such load is exceeded.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:

FIG. 1 is a side elevation of a preferred embodiment of machine according to the present invention,

FIG. 2 is a cross-sectional side elevation of the machine of FIG. 1, the section being taken approximately on line II—II of FIG. 4,

FIG. 3 is a cross-sectional side elevation similar to FIG. 2, but taken on the line III—III of FIG. 4,

FIG. 4 is a cross-sectional plan view of the machine, taken on the line IV—IV of FIGS. 2, and 5,

FIG. 5 is a detached elevation showing part of the mechanism of the machine.

In the various figures, certain parts of the machine have been omitted, for the sake of clarity.

The machine illustrated comprises a frame 10 supporting a horizontal bed 11 whereon is mounted a stationary central vertical pillar 12. Journalled on this pillar 12, by bearings 13, is a rotatable die table 14 having a flat portion 15 wherein dies 16 are located at regular intervals.

Means for rotating the die table 14 comprises a vertical shaft 17 extending through the bed 11 and journalled in a housing 18, 19, 20 supported from the horizontal bed 11, a gear wheel 21 on the shaft 17 meshing with a toothed annulus 22 secured to the underside of the die table 14 by bolts 23. A worm wheel 24 is secured to the shaft 17 within the housing part 19 and this meshes with a worm (not visible) mounted on a drive shaft 25 to which a pulley wheel 26 is secured. The pulley wheel 26 is belt driven from a layshaft which in turn is belt driven from an electric motor (not shown).

The die table 14 is thickened at 27 and such thickened part accommodates vertically slidable lower punches 28, one punch 28 being provided for each die 16. Upward and downward movement of the punches 28 other than compressive movement thereof is controlled by engagement with heads 29 of the punches with the surface of the bed 11 or with adjustable cam tracks 30 secured to the bed 11. As can be seen at the left-hand side of FIG. 2, the underside of the cam track 30 is inclined and rests upon a wedge shaped thrust bar 31 which is displaceable by a screw 32 rotatable by a knob 33 to raise and lower the cam track 30.

The die table 14 is also provided with an upper flange 34, and this provides a mounting for upper punches 35, one being aligned with each die 16. Each upper punch 35 has a head 36 co-operating with a cam track 37 mounted stationarily on the pillar 12, the cam track 37 serving to raise and lower the punches 35 except when compressive forces are applied thereto.

Various feed means can be provided for feeding pulverulent or granular material to the flat part 15 of the die table 14. The means described comprises a pair of feed hoppers 38 disposed at diametrically opposed positions relative to the table 14 upon adjustable supports 38*a*. Each hopper 38 has a chute 39 whereby the material is fed to filling shoes 40 adjustably mounted upon pillars 41 on the bed 11 so as to touch lightly onto the flat part 15 of the die table 14. Thus, as the table 14 rotates, the dies 16 pass, in turn, under the filling shoes 40, and will receive material therefrom, the lower punches 28 being lowered for this purpose.

Mounted on the upper end of the pillar 12 by a boss 42 is a crosshead 43 having an integral outer casing 44

and a detachable cover 45. This crosshead 43 serves as a mounting for a pair of pressure roll assemblies which serve, as the die table 14 rotates, to press the upper and lower punches 35, 28 of the dies 16 towards one another to compact or compress material in the dies 16. Since the two pressure roll assemblies are substantially identical, one only thereof will be described, and the reference numerals employed will be given the suffix *a*. For identification purposes, the corresponding parts of the other assembly have been given similar reference numerals in the drawings, but with the suffix *b*, but such reference numerals are not referred to in detail in the text, it being understood that a part having a suffix *b* in the said other assembly is identical to the corresponding part having suffix *a* in the described assembly.

Secured into the crosshead 43 is a heavy horizontal pivot pin 46*a* to which is pivoted an upper roll mounting comprising a pair of adjacent metal plates 47*a* connected by webs 48*a* and supporting a horizontal upper pressure roll shaft 49*a* whereon an upper pressure roll 50*a* is rotatably mounted with its axis horizontal and radially disposed relative to the pillar 12. The pivot pin 46*a* is arranged at one end of the plates 47*a*, so that the latter are capable of swinging up and down relative to a roughly horizontal position.

At their ends remote from the pivot pin 46*a*, a pin 51*a* passes horizontally through the plates 47*a* and an eye 52*a* provided on a vertical rod 53*a* which extends upwards through a stationary support plate 54*a* which is integral with or mounted in the casing 44. The upper end of the rod 53*a* is screw threaded and a hand wheel 55*a* threadedly located thereon from outside the cover 45 engages the support plate 54*a*.

Also mounted upon the pivot pin 46*a* is a depending connecting rod 56*a* and this serves to connect a lower pressure roll mounting to the upper pressure roll mounting just described. The lower pressure roll mounting comprises a pair of adjacent plates 57*a* connected by webs 58*a* and pivotally mounted at one end on the connecting rod 56*a* by a pivot pin 59*a*.

A lower pressure roll shaft 60*a* is supported by the plates 57*a* and a lower pressure roll 61*a* is mounted thereon so as to be disposed in alignment below the upper pressure roll 50*a*.

Pins 62*a* extend through the plates 57*a* and serve to connect the ends of the plates 57*a* remote from the pivot pin 59*a* with a bracket 63*a* provided upon a hydraulic cylinder 64*a*. The cylinder 64*a* houses a slidable piston 65*a* which is held captive by an end plug 66*a* in the cylinder, this end plug 66*a* defining the lowermost position of the piston 65*a*.

Connecting the piston 65*a* and the rod 53*a* is a tension rod 67*a*, this being secured to the piston by a nut 68*a* and extending through a suitable clearance in the bracket 63*a*. The rod 53*a* is screwed at its lower end and is provided with a locknut 69*a* which holds an externally threaded retaining nut 70*a* is provided with external serrations and is screwed and fixed into the adjusting sleeve nut 71*a* on the upper end of the tension rod 67*a*.

The effective length of the rod 53*a* and tension rod 67*a*, and consequently the relative position of the lower roll 61*a* can be adjusted by screwing the adjusting sleeve nut 71*a* on or off the tension rod 67*a*, a spring finger 72*a* engaging the serrations on the retaining nut 70*a* to prevent unintentional rotation thereof of sleeve nut 71*a*.

Rotation of the hand wheel 55*a* raises or lowers through the tension rod assembly 53*a*—67*a*—71*a*, the pressure rolls 50*a* and 61*a*, by raising or lowering the pressure roll shafts 49*a* and 60*a* relative to their pivot pins 46*a* and 59*a* respectively. This adjustment maintains the preset distance between the tips of the punches 28 and 35, but enables the entry of the tips of the punches 28 and 35 to be altered in relation to the die 16.

The hydraulic cylinder 64*a* is connected, by a flexible tube 73*a* to a pre-loading device comprising a cylinder 74*a* (to which the tube 73*a* is connected) and a piston 75*a* which is loaded by a heavy compression spring 76*a*. The pre-loading cylinder 74*a* is connected to a bracket 77*a* in the frame 10 and a tubular casing 78*a* which is secured to the cylinder 74*a* and encloses the compression spring 75*a* has an end cap 79*a* engaging a second bracket 80*a* in the frame 10 whereby the device is located in the machine frame.

The operation of the machine will now be described.

As two feed means for feeding pulverulent or granular material and two sets of upper and lower pressure rolls are provided, the machine will serve to fill each die 16 and to compress the material therein twice upon each revolution of the die table 16. The following description explains the operations occurring as one die is moved when the die table 14 performs a half revolution it being understood that these operations are repeated in relation to the same die as the die table 14 performs a subsequent half revolution, and that the operations occur for each die 16 in succession.

Assuming the die 16 to be empty and approaching a filling shoe 40, the cam track 37 raises the upper punch 35 and the lower punch 28 rests by its head 29 upon the bed 11 so that it is in its lowermost position. The die, as it passes under the shoe 40 receives material from the shoe 40 and is filled therewith.

From this point the lower punch 28, supported by its head 29, passes onto the cam track 30 which can be adjusted by wedge 31 to bring the punch up in the die 16 to a predetermined position when excess material can be ejected out of the die 16 back into the filling shoe 40. The lower punch then returns to its lowest position, taking with it the material remaining in the die.

Thereafter, the cam track 37 causes the upper punch 35 to be lowered onto the material in the die 16, and the table continues to rotate, moving the die 16 and punches 35, 28 so that these punches pass between the upper and lower pressure rolls 50*a*, 61*a*, engaging with the latter by their heads 36, 29 respectively. Therefore, the rolls 50*a*, 61*a* act to force the upper and lower punches 35, 28 towards each other under pressure as defined by the pressure prevailing in the hydraulic cylinder 64*a*, to compress the material in the die 16 to the form of a tablet or the like.

After the die 16 and punches 35, 28 have passed the pressure rolls, the cam track 37 acts to raise the upper punch 35 completely clear of the die 16, whereafter the lower punch 28 engages a cam track 30 which acts to raise the lower punch 28 so that the compressed tablet or the like is brought flush with the flat part 15 of the die table 14.

Continued movement of the die table causes the tablet to engage an inclined guide (not shown) which deflects the tablet laterally outwards of the die table 14, to fall into a delivery slide 81 (see FIG. 2). As the die 16 now passes from the inclined guide towards the second feed shoe 40, the cam track 30 lowers the lower punch 28 to its lowermost position, and when the die 16 reaches the second feed shoe 40 the sequence of operations just described is recommenced.

Whilst the pressure roll frameworks constituted by the connecting rods 56*a*, 56*b* tension rods 67*a* and 67*b* and the roll mountings are pivotally connected to the crosshead each at one side and are suspended from the crosshead by the hand wheels 55*a*, 55*b* on the other side, such connection is not such that stresses arising from normal or abnormal loading of the punches 35, 28 will be transmitted to the machine. Any stresses which do occur are confined to the framework, the rolls and the punches, and the framework is substantially an isolated unit independent of the machine frame or bed.

Under normal loading of the punches, the frameworks, under the influence of the hydraulic cylinders, act to resist any separational movement of the rolls and their

mountings. However, should overloading occur, the pistons or the cylinders can move to permit either or both roll mountings to move, thus relieving overload from either or both punches.

It will be apprecated that the arrangement aforesaid is effective for minimising stresses which arise in the frame or body of the machine due to punch operation, and consequently machines according to the invention can be constructed less robustly than was necessary hitherto. Moreover, damage due to overloading a punch whose roll is not displaceable is completely avoided.

The invention is not confined to the precise details of the foregoing example and variations may be made thereto if desired. For example, the framework may be of any suitable form enabling a hydraulic cylinder and accumulator or like means to be employed to resist separation of the rolls until a predetermined loading occurs. Pneumatic, spring or other means may be incorporated into the apparatus in place of a hydraulic arrangement.

I claim:

1. In a rotary compacting machine including in combination, a machine frame, a rotary die table having a plurality of dies therein, an upper and lower punch associated with each of said dies and displaceable to enter said dies, a floating framework suspended from said machine frame comprising, upper and lower pressure roll mountings pivotally placed respectively above and below said die table, primary tie means suspended from said machine frame coupling together one end of each of said pressure roll mountings so as to resist separating displacement thereof, secondary tie means coupling the opposite ends of said pressure roll mounting so as to oppose separating displacement thereof except when a predetermined punch load is exceeded, and upper and lower pressure rolls carried within said floating framework by said pivotal mountings so as to be disposed in the path of and adapted to be engaged respectively by said upper and lower punches to cause displacement of said punches into said dies whereby material in said dies is compacted.

2. A rotary compacting machine as set forth in claim 1 and including a pillar, a rotary die table rotatable around said pillar, and a crosshead on said pillar with said upper pressure roll mounting connected to said crosshead so as to be disposed above said die table.

3. In a rotary compacting machine comprising in combination, a machine frame, a pillar, a rotary die table rotatable around said pillar, a plurality of dies in said die table, upper and lower punches associated with said dies and displaceable to enter into said dies, a crosshead on said pillar, a floating framework suspended from said machine frame comprising, an upper pressure roll mounting connected to said crosshead and disposed above said die table, a lower pressure roll mounting pivotally disposed below said die table, primary tie means suspended from said machine frame coupling one end of said lower pressure roll mounting with the corresponding end of said upper pressure roll mounting so as to prevent separating displacement thereof, secondary tie means depending from said crosshead and coupling the opposite ends of said pressure mountings, and upper and lower pressure rolls carried respectively by said pressure roll mountings so as to be disposed in the paths of and adapted to be engaged repectively by said upper and lower punches to cause displacement of said punches into their respective dies whereby material in said dies is compacted, said secondary tie means being adjustable to vary the spacing between said pressure rolls and the vertical positions thereof relative to said crosshead.

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