

July 23, 1963

J. J. LITTLE ET AL

3,098,261

POWDERED METAL COMPACTING PRESS

Filed Jan. 6, 1961

4 Sheets-Sheet 1

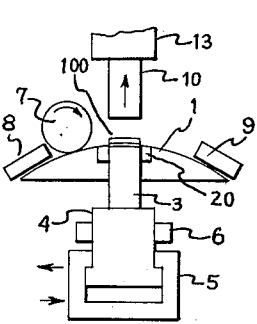


Fig. 1a.

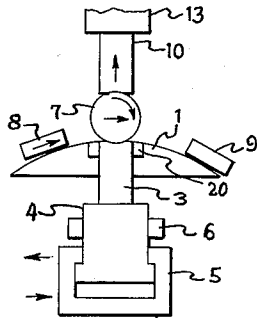


Fig. 1b.

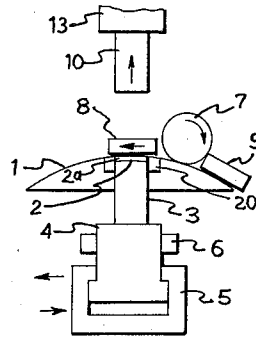


Fig. 1c.

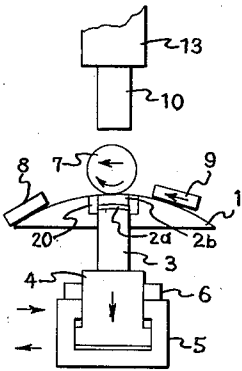


Fig. 1d.

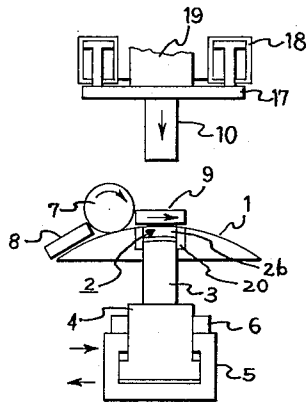


Fig. 1e.

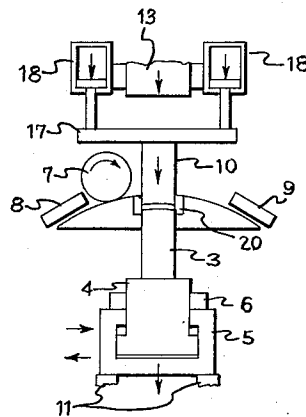


Fig. 1f.

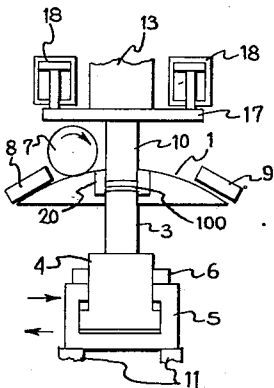


Fig. 1g.

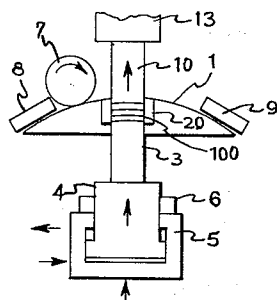


Fig. 1h.

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POWDERED METAL COMPACTING PRESS

4 Sheets-Sheet 2

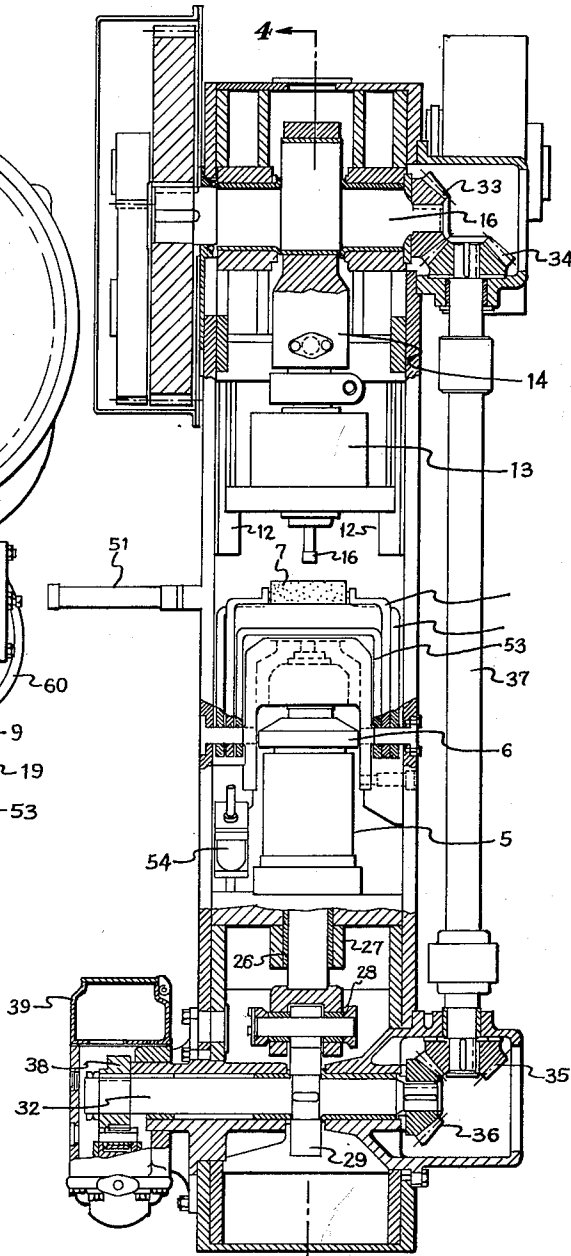
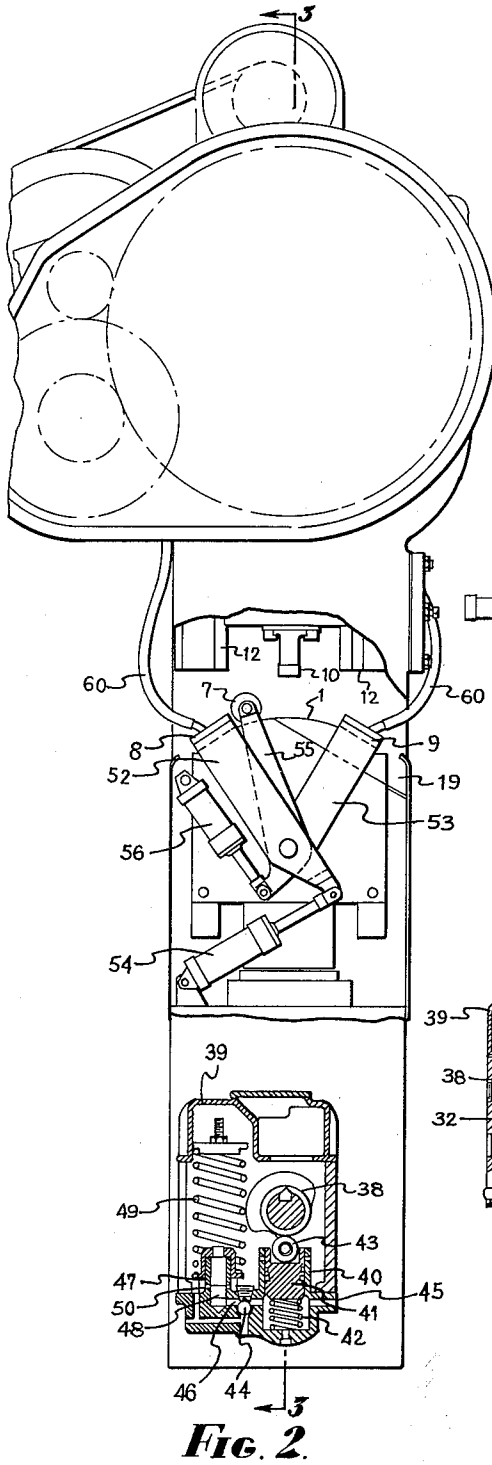


Fig. 3.

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4 Sheets-Sheet 3

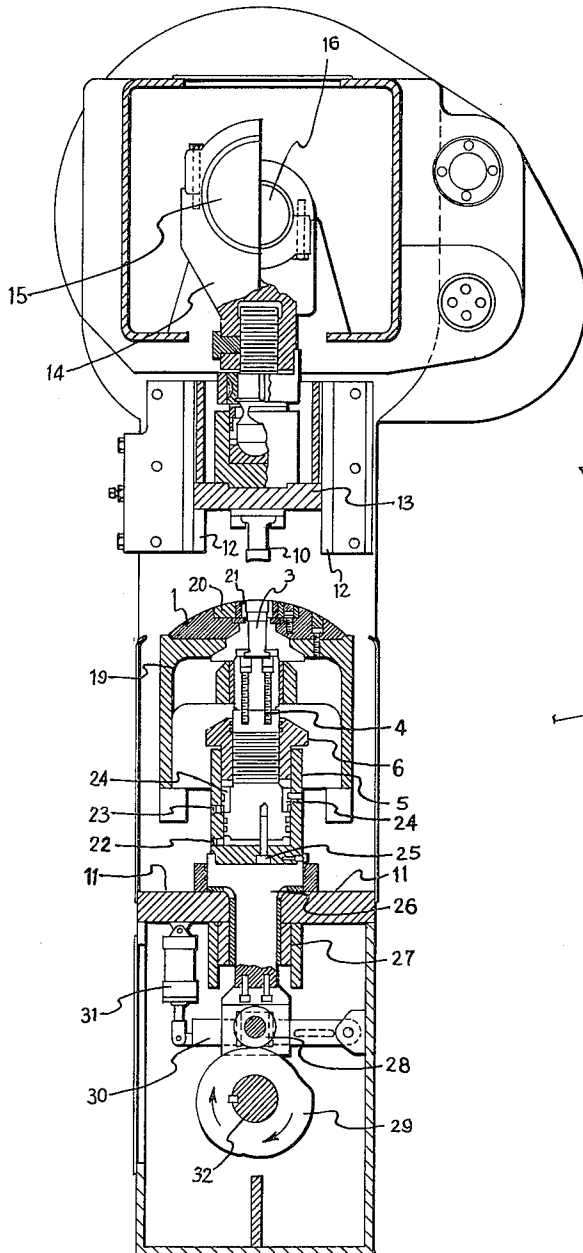


FIG. 4.

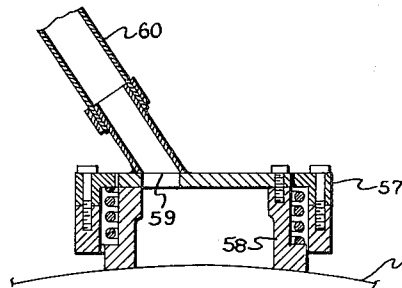


FIG. 5.

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4 Sheets-Sheet 4

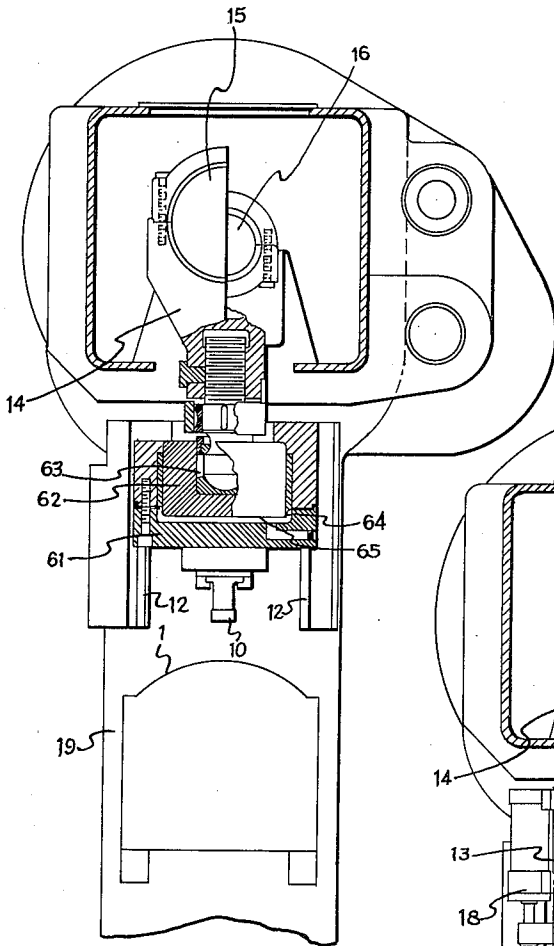


Fig. 7.

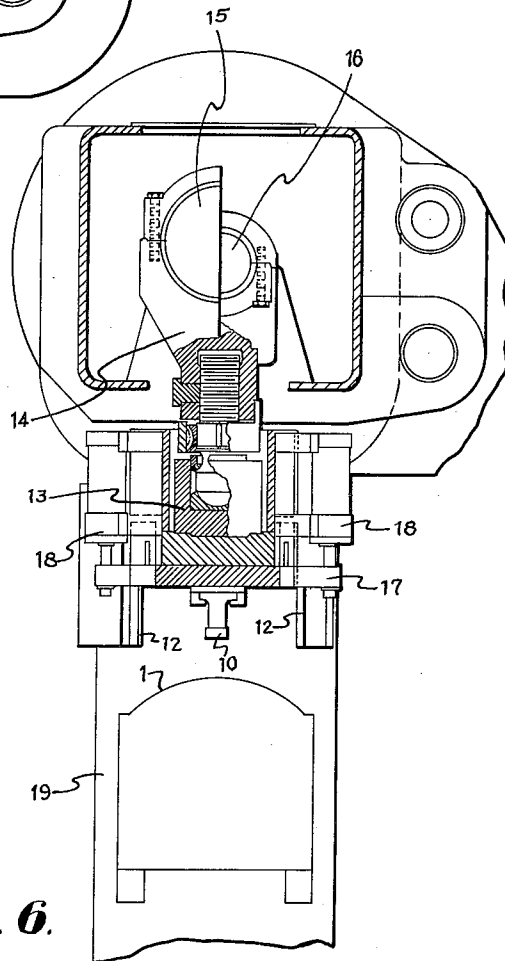


Fig. 6.

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3,098,261

POWDERED METAL COMPACTING PRESS

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Filed Jan. 6, 1961, Ser. No. 81,036

13 Claims. (Cl. 18—16.5)

This invention relates to a press for compacting powdered material such as powdered metal into a finished product having a curved surface, and is especially useful for forming curved brake linings consisting of two separate and distinct layers of material.

Brake linings are generally used in conjunction with drum type brakes of both the internal-expanding and external-contracting type. In either case, the brake linings must be curved; for example, with an internal-expanding brake, the curve is such that the outer radius is equal to the radius of the inside of the brake drum, and the inner radius matches that of the brake shoe. Furthermore, to promote maximum life of the drum and shoe, the lining must be securely fastened to the shoe, and at the same time the portion which bears against the brake drum must have a high coefficient of friction, without causing permanent damage to the drum. For this reason, brake linings are composed of a thin and relatively hard backing layer which may be conveniently bonded to the brake shoe, and a thicker layer of material having suitable friction characteristics.

It has been found possible to manufacture such brake linings by compacting two layers of suitable powdered metals in conventional presses, but this presents several problems. In the first place, since the material used in forming the backing layer is quite hard, it is important that the two layers of material be kept separate and distinct. Also, to promote maximum brake lining life, it is desirable that the line formed by the junction of the two layers be essentially concentric with both the outer and inner radii of the lining itself, so that the wearing away of the friction layer takes place evenly, and no one portion of the backing layer will be exposed before the rest of that surface.

In the conventional compacting press a feeder or other source of powdered material passes over a cavity, the side walls of which are formed by an appropriately shaped die and the bottom of which is formed by a curved lower punch, and dispenses its contents. As the feeder moves away, it strikes the surface of the powder in the cavity flat and even with the top of the die; the second or friction layer is then deposited in a similar fashion on top of the first or backing layer. The upper punch, which is also curved, then presses down compacting the two layers and forming a brake lining. Linings made in this fashion suffer from several disadvantages; in the first place, the line at the junction of the two separate layers is almost flat rather than concentric with the inner and outer radii, and secondly the outer or friction layer has a greater density at its two ends than at its center.

Furthermore, from a mechanical standpoint, some conventional compacting presses use a large flat, horizontal die table which embodies twelve sets of tools. In operation, the entire die table rotates, and is capable of production of perhaps 72 pieces per minute. The die table rotates under the feeders, and leakage and wear are great problems. Lubrication and sealing are also difficult, and tooling costs are quite high. For example, in a press which produces 72 pieces per minute with twelve sets of tools, average production is only 6 pieces per minute per set of tools; while the total production of our machine may be somewhat lower, the rate per minute per tool is higher, and a saving in tooling costs will result. Finally, such conventional devices seem to have an inherent tendency

2

to get out of adjustment, so that while only one set of tools may need an hour of maintenance, twelve sets of tools are idle for that entire hour, whereby twelve hours of production time are lost.

We have now invented a novel compacting press which utilizes only a single set of tools having a single cavity or a small number of cavities, and is capable of producing one piece per cavity per stroke, and greatly reduces maintenance costs and lost time due to maintenance, leakage due to wear, and tooling costs.

Accordingly, it is a principal object of our invention to provide a compacting press for powdered metals which is suitable for production of finished products having two concentrically curved layers with a constant density throughout the article.

It is a further object of the instant invention to provide such a press which reduces tooling costs, maintenance costs, and time lost due to maintenance.

A further object of the instant invention is the provision of a novel feeding operation for a powdered metal compacting press which deposits an evenly curved layer of the desired powdered metal.

Another object of our invention is to provide a feeding mechanism which largely eliminates leakage and mixing of the separate materials.

Still a further object of our invention is to provide such a feeding operation in which the depth of fill of the second layer is variable.

Another object of our invention is the provision of an ejection means which will always return the lower punch to die table level regardless of the variable depth of fill, and which provides overload protection for the entire system.

We accomplish these objects of our invention, and others which will be set out hereinafter, or which will be apparent to the worker skilled in this art upon reading these specifications, by that certain construction and arrangement of parts of which we shall now illustrate by means of an exemplary embodiment.

Reference is made to the accompanying drawings wherein:

FIGURES 1a to 1h inclusive are a series of eight schematic representations of stages in the operation of our machine;

FIGURE 2 is a side view of the machine of our invention;

FIGURE 3 is a sectional view taken along the line 3—3 of FIGURE 2;

FIGURE 4 is a sectional view taken along line 4—4 of FIGURE 3;

FIGURE 5 is a greatly enlarged sectional view of the feeder assembly of our invention;

FIGURE 6 is a sectional view similar to the upper portion of FIGURE 4 showing a modification of our invention; and

FIGURE 7 is a sectional view similar to FIGURE 6 showing still another modification of our invention.

Referring now to the schematic drawings of FIGURE 1, we provide a die table 1 curved to almost the desired radius of the finished product. In the center of the table is a cavity indicated generally at 2 which is formed by coaction of the die 20 and the lower punch 3. The lower punch is securely fixed to the piston 4 of a hydraulic cylinder 5. At 6 we have indicated a nut by means of which the total movement of the hydraulic piston is regulated. As will be described more completely later in these specifications, the entire assembly consisting of the hydraulic cylinder 5, the piston 4, and the lower punch 3 is reciprocated up and down by means of a cam action shown in the other figures.

Above the curved die table we have indicated a brush member generally at 7, a first feeder assembly generally

3

at 8, and a second feeder assembly generally at 9; these members will also be described in more detail hereinafter.

When the parts are in the position shown in FIGURE 1a, the lower punch has been moved to its uppermost position, in which it is exactly level with the die table, by means of the combined action of the cam and the hydraulic cylinder, and an extractor mechanism removes the finished article 100. At this time, the brush 7 begins moving to the right, immediately followed by the first feeder 8; the brush cleans the die table, the lower punch, and the upper punch 10 as seen in FIGURE 1b. After the brush has passed over the lower punch, the entire cam operated assembly 3-5 including the lower punch makes its first drop (fixed distance), and as shown in FIGURE 1c the first feeder 8 passes over the cavity 2a thereby formed and deposits the material for forming the backing layer. As the first feeder 8 returns to its starting position, it strikes the powder in the cavity to the same arc as the die table, and to an arc which is approximately equal to the desired arc of the final product as will be explained later.

Then as shown in FIGURE 1d, the action of the hydraulic cylinder causes the lower punch 3 and the piston 4 to drop to form a cavity 2b for the deposition of the second layer of material. The distance of this second drop is controlled by the large nut 6 on the piston. The brush 7 then follows the feeder 8 and cleans the die table, as shown in FIGURE 1d. The second feeder 9 then starts its arcuate motion to the left, and as shown in FIGURE 1e, deposits the material for the friction layer. As was the case with the first feeder, when this second feeder returns to its starting position, it again strikes the powder in the cavity to the same arc as the die table.

When the second feeder has returned to its original position, the entire cam operated assembly 3-5 drops to its lowermost position in which it is supported by the positive press stops 11 which bear the full pressure of the upper punch. This third drop permits entry of the upper punch into the cavity without displacing the powdered layers. In FIGURES 1e, 1f and 1g, we have shown a modification of our invention which will be described in detail later, but basically consists of attaching the upper punch 10 to a back-up plate 17 supported by air cylinders indicated generally at 18, rather than directly attached to the eccentric operated ram. By means of this arrangement, the upper punch is accelerated downward ahead of the ram as is clearly shown in FIGURE 1f; when the punch contacts the powder in the cavity, it meets resistance, and so is forced upward against the slight resistance of the air cylinders. Therefore, only light pressure is maintained on the powdered layers momentarily to allow any air entrained in the powder to escape. Full press tonnage is then applied when the ram 13 reaches the plate 17 as shown in FIGURE 1g. In FIGURE 1h, the parts are shown returning to the original position shown in FIGURE 1a; the lower punch is moved upward by the combined action of the cam and the hydraulic cylinder, and the upper punch is moving upward under the influence of the eccentric operated ram. When the finished article is level with the die table, an air operated extractor (not shown) withdraws it across the die table to a discharge chute.

Having schematically described our invention, we shall now turn to a detailed description of its embodiment. The upper punch 10 is conventionally mounted to reciprocate in guide members 12. It is attached to a ram 13 having a collar 14 surrounding an eccentric 15 mounted on the main drive shaft 16. The remaining features of the drive are entirely conventional and form no part of our invention. The die table 1 is mounted securely to the frame 19. A suitably shaped die 20 (rectangular in the case of drum type brake linings) having an insert 21 is mounted in the center of the table. The lower punch 3 which reciprocates within the die insert with tolerance as close as mechanically practicable, is securely mounted

4

to the piston 4 through a guided adapter 4a of the hydraulic cylinder 5. Port 22 is connected to the outlet 45 from the hydraulic pump (FIGURE 2), and provides a means of raising the piston 4. Port 23 is connected to a suitable air supply (not shown) and is used to force the piston down to allow the deposition of the friction layer of powder. The distance of this drop is controlled by the large nut 6 threaded on the piston 4; stops 24 inside the cylinder limit the upward motion of the piston. We also provide a long pin 25 extending through the base of the cylinder and into the piston itself to prevent rotation.

The hydraulic cylinder just described is in turn supported on a member 26 reciprocating within guide members 27 and fastened on its other end to cam follower 28. The cam follower is urged against the cam 29 by means of the bar 30 and the small cylinder 31. The profile of the cam 29 is shown in FIGURE 4; it will be seen that it consists of a high section, a first drop followed by a constant and rather long dwell, a second drop followed by a short dwell, and then a constant rise to the high position. This provides the relative motion called for in the schematic description. It will be noted that in the lowest cam position, the flanged member 26 rests on the press frame members 11 which act as a positive press stop, and bear the full press tonnage. The cam 29 is secured to the cam shaft 32 which is driven by a power take-off from the main drive shaft 16. The power take-off is conventional and comprises the matched bevel gears 33, 34, 35 and 36, and the vertical shaft 37, and serves to drive the cam shaft 32 at the same speed as the main drive shaft 16. By this arrangement, we are able to maintain the exact timed relation between the action of the upper and lower punches.

At the other end of the cam shaft 32 is mounted a second and slightly smaller cam 38 which serves to actuate the hydraulic pump. A co-worker disclosed, in U.S. Letters Patent No. 1,881,185, a hydraulic pump which we have found highly satisfactory. As best seen in FIGURE 2, all the component parts are maintained within an oil housing 39. The pump comprises a cylinder 40 with a piston 41 normally urged upwardly by the spring 42, and having a roller 43 at its upper end which follows the cam. Oil enters the cylinder through a check valve 44, and when the cam forces the piston down, oil leaves the cylinder via port 45 and goes directly (piping not shown) to the port 22 in the hydraulic cylinder below the lower punch. When the upward motion of this latter cylinder is contained by the stops 24, excess oil flows from the cylinder 40 through the passage 46 into the relief cylinder 47 and urges the relief piston 48 upward against the pressure of the spring 49. When the relief piston is forced up far enough, it uncovers relief ports 50, and the oil flows back into the reservoir. As explained earlier, the combined action of this hydraulic pump and the main cam 29 bring about the ejection of the finished product. Shortly after the upper punch starts up, the ejection cam 29 starts the upward travel of the lower punch; immediately thereafter, the second cam 38 actuates the hydraulic pump and forces a controlled amount of oil to the hydraulic cylinder 5 causing a further upward ejection action. The combination of mechanical and hydraulic ejection is a very important and novel feature of our invention. By means of this combination, there is no lost motion on the ejection stroke, regardless of the fill adjustment of the second layer of material. In other words, the whole step is accomplished in one smooth stroke with no excess travel by any component and the resulting impact as that excess is taken up. Also, the lower punch always returns exactly to the level of the die table, again regardless of the fill adjustment. This, of course, prevents maladjustment of the extraction system, reduces wear on the lower punch, and prevents damage to a finished article caused by failure of the lower punch to return to a position

5

level with the die table. Furthermore, since the hydraulic system has an overload protection inherent in its design, the combination also has an overload protection.

At 51 we have shown a conventional air operated extractor which pulls the finished article across the die table at a suitable discharge chute.

The operation of the feeder assemblies is clearly shown in FIGURE 2. The feeders 8 and 9 respectively are connected to arms 52 and 53 which are pivoted at the center of the die table arc. The motion of feeder 8 is controlled by the small cylinder 54, while a similar cylinder on the other side of the machine and hence not shown in the drawings operates the feeder 9. Since the feeders pivot about the center of the table arc, they have no tendency to lift or shift as often occurs in conventional operations, and so leakage is reduced.

Similarly, the brush 7 is connected to an arm 55 and air cylinder 56, and also pivots in an arcuate path. The brush may be conveniently mounted on a hollow shaft which is connected to a light vacuum to further the efficiency of the cleaning operations.

In FIGURE 5 we have shown the feeder assemblies 8 and 9 (they are substantially identical) in more detail. They comprise a housing 57 and a rectangular spring loaded free seating bronze shoe 58 which is ground to fit the die table surface. This construction further reduces leakage caused by wear on the table since the bronze shoe would show a similar pattern of wear, and still be spring urged to a close fit. At the top of the housing, an opening 59 is provided, along with appropriate connections to a powder supply feed 60.

In FIGURE 6 we have illustrated a modification in the construction of the upper punch which was briefly mentioned earlier in these specifications. Therein the upper punch 10 is mounted on a large guided punch back-up plate 17, which is in turn supported by the pistons of four small air cylinders 18. This pre-tamp assembly is accelerated ahead of the ram on its down stroke into the die cavity and places light pressure on the powder allowing air to escape prior to the main compacting.

In FIGURE 7 we have illustrated another modification of our invention. It is understood that in a press of this size, the finished products will have a constant size, regardless of the small variations in the amount of powder deposited in the die cavity. Furthermore, if the size remains constant with varying quantities of material, density must vary. However, for many uses, it is desirable to maintain a constant density; this is especially true if certain finishing operations are to be performed after the article comes from the press. To accomplish this result, we provide a special slide 61 and a guided ball seat retainer 62, fastened to the ram as at 63. A diaphragm 64 of any suitable material is fastened to the special slide. The diaphragm chamber 65 may be charged with any suitable material, such as, but not restricted to, nitrogen under pressure. The gas is completely enclosed, and will not be lost unless leakage occurs or the pressure is adjusted down. With this arrangement, the upper punch will move downward with the ram until the resistance of the powder against the upper punch equals or exceeds the pressure of the nitrogen or other material in the diaphragm chamber; at this point, the nitrogen is more easily compressed than the powder, and so the guided ball seat retainer 62 can continue downward while the ram with the punch remains stationary. In actual practice, we have found that a maximum stroke of $\frac{1}{4}$ inch is sufficient for normal operation. This unit, in addition to controlling the pressure applied, acts as an overload protection for both the press and dies.

The embodiments described are exemplary only, and numerous other modifications will occur to those skilled in the art which do not depart from the spirit of our invention; therefore, we intend to limit ourselves in no way except as delineated in the claims which follow.

6

What we claim as new and what we desire to secure by Letters Patent is:

1. A compacting press for compacting powdered material into a finished product of arcuate form, comprising an eccentric driven ram, a curved upper punch secured to said ram, a die table curved to an arc approximately equal to the desired arc of the finished product, a die mounted in said table, a curved lower punch adapted to be reciprocated within said die, means for reciprocating said lower punch, feeder means mounted for arcuate travel over said curved die table and die, and means for effecting the arcuate travel of said feeder means, said feeder means thus filling said die with said powdered material and leaving a curved top surface on said powdered material prior to compacting between said curved upper and lower punches.

2. The device claimed in claim 1, including a fluid cylinder having a reciprocating piston operatively connected to said lower punch, a source of fluid for said cylinder, a cam driven in timed relation to said eccentric driven ram for reciprocating said fluid cylinder, whereby the coaction of said cam and said fluid cylinder lower and raise the lower punch.

3. The device claimed in claim 2, including brush means mounted for arcuate travel over said die table and die in timed relation to the motion of said eccentric ram and said feeder means.

4. A press for forming brake linings from powdered material comprising an eccentric driven ram with a curved upper punch attached thereto, a die table having a die centrally mounted therein, said die table being curved to an arc substantially equal to the desired arc of the finished brake linings, a curved lower punch adapted to be reciprocated within said die, a fluid cylinder having a reciprocating piston operatively connected to said lower punch, a source of fluid for said cylinder, a cam driven in timed relation to said eccentric driven ram for reciprocating said piston, a first feeder secured to an arm pivoted at the center of said die table arc, means for moving said first feeder arcuately from one side of said curved die table to said die and back to its starting position, a second feeder also secured to an arm pivoted at the center of said die table arc, and means for moving said second feeder arcuately from the opposite side of said curved die table to said die and back to its starting position, said cam and said piston coacting to raise and lower said lower punch in timed relation to the motion of said feeders and said eccentric driven ram, and each of said feeder means filling said die with said powdered material and leaving a curved interface between the powdered material fed by said two feeders, and a curved top surface on said powdered material prior to compacting between said curved upper and lower punch members.

5. The device claimed in claim 4, wherein said cam comprises a high portion, a sudden drop followed by a relatively long dwell period, a second sudden drop followed by a shorter dwell period, and a gradual rise back to the high portion.

6. The device claimed in claim 5, wherein said supply of fluid is operatively connected to said cam whereby said piston, and therefore said lower punch, is moved downwardly between said cam drops, and is moved upwardly during said gradual cam rise.

7. The device claimed in claim 6, wherein adjustable means are provided to limit the downward motion of said piston.

8. The device claimed in claim 7, wherein said first and second feeders are substantially identical and comprise a housing in communication with a supply of powdered metal, said housing surrounding a fully enclosing shoe member conforming to the curvature of said die table, and spring means urging said shoe member against said die table.

9. The device claimed in claim 8, wherein said arm

mounting said first feeder and said arm mounting said second feeder each extend beyond their respective pivot points, and wherein said means for moving said feeders arcuately across said die table comprise a pair of fluid cylinders each having a movable piston and a supply of fluid for said cylinder, said pistons respectively being secured to said arm extensions.

10. The device claimed in claim 9, including brush means mounted on an arm pivoted at the center of said die table arc, and means for moving said brush means arcuately from one side of said die table to the other and back to its starting position.

11. The device claimed in claim 10, wherein said arm mounting said brush means extends beyond its pivot point, and wherein said means for moving said brush means arcuately across said die table comprises a fluid cylinder having a movable piston, and a supply of fluid for said cylinder, said piston being secured to said arm extension.

12. A press for forming brake linings from powdered material comprising an eccentric driven ram with a plurality of small fluid cylinders secured thereto, said cylinders having movable pistons, a supply of fluid for said cylinders, a back-up plate secured to all of said pistons, a curved upper punch secured to said back-up plate and extending downwardly therefrom, a die table having a die centrally mounted therein, said die table being curved to an arc substantially equal to the desired arc of the finished brake linings, a curved lower punch adapted to be reciprocated within said die, a fluid cylinder having a reciprocating piston operatively connected to said lower punch, a source of fluid for said last named cylinder, a cam driven in timed relation to said eccentric driven ram for reciprocating said piston, a first feeder secured to an arm pivoted at the center of said die table arc, means for moving said first feeder arcuately from one side of said curved die table to said die and back to its starting position, a second feeder also secured to an arm pivoted at the center of said die table arc, and means for moving said second feeder arcuately from the opposite side of said curved die table to said die and back to its starting position, said cam and said piston coacting to raise and lower said lower punch in timed relation to the motion of said feeders and said eccentric driven ram, and each of said feeder means filling said die with said powdered material and leaving a curved interface between the powdered material fed by said two feeders, and a curved top

surface on said powdered material prior to compacting between said curved upper and lower punch members.

13. A press for forming brake linings from powdered material comprising an eccentric driven ram, a slide having a diaphragm chamber positioned below said eccentric driven ram, a curved upper punch secured to said slide and extending downwardly therefrom, a die table having a die centrally mounted therein, said die table being curved to an arc substantially equal to the desired arc of the finished brake linings, a curved lower punch adapted to be reciprocated within said die, a fluid cylinder having a reciprocating piston operatively connected to said lower punch, a source of fluid for said cylinder, a cam driven in timed relation to said eccentric driven ram for reciprocating said piston, a first feeder secured to an arm pivoted at the center of said die table arc, means for moving said first feeder arcuately from one side of said curved die table to said die and back to its starting position, a second feeder also secured to an arm pivoted at the center of said die table arc, and means for moving said second feeder arcuately from the opposite side of said curved die table to said die and back to its starting position, said cam and said piston coacting to raise and lower said lower punch in timed relation to the motion of said feeders and said eccentric driven ram, and each of said feeder means filling said die with said powdered material and leaving a curved interface between the powdered material fed by said two feeders, and a curved top surface on said powdered material prior to compacting between said curved upper and lower punch members.

References Cited in the file of this patent

UNITED STATES PATENTS

532,186	Rolf et al.	Jan. 8, 1895
532,500	Thomann	Jan. 15, 1895
661,236	Chisholm	Nov. 6, 1900
819,005	Crichfield	Apr. 24, 1906
835,737	Simmons et al.	Nov. 13, 1906
994,349	Updegraff	June 6, 1911
1,599,085	Gibson	Sept. 7, 1926
2,145,096	Schutz	Jan. 24, 1939
2,275,592	Menihan	Mar. 10, 1942
2,350,971	Pecker et al.	June 6, 1944
2,482,342	Hubbert et al.	Sept. 20, 1949
2,675,584	Frienberg et al.	Apr. 20, 1954
2,900,664	Hampel et al.	Aug. 25, 1959