Sept. 14, 1948. R. P. SEELIG 2,449,515

METHOD OF FORMING PARTS FROM POWDERED METAL

Filed Nov. 30, 1944 3 Sheets-Sheet 1

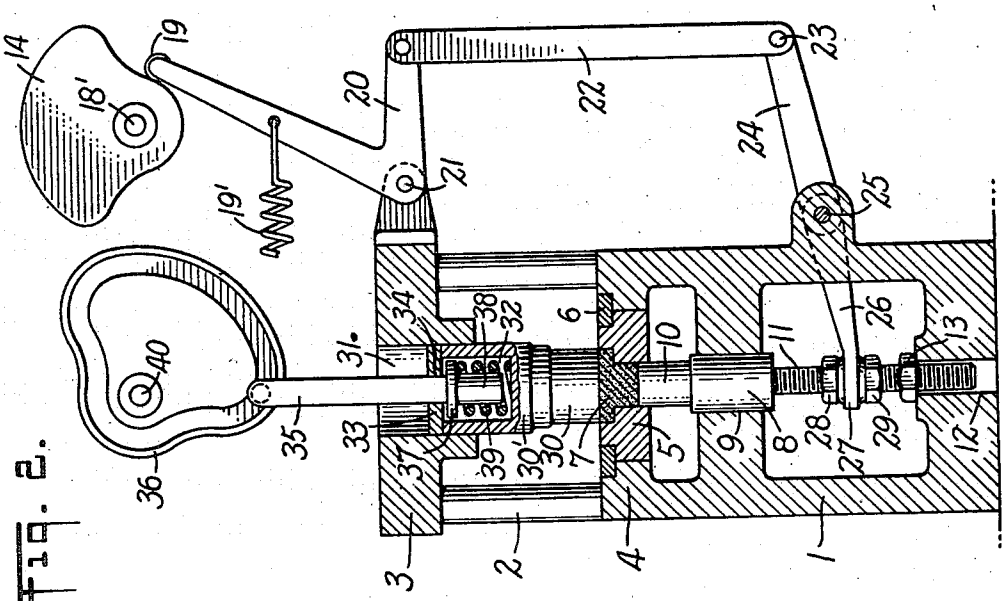


Fig. 2.

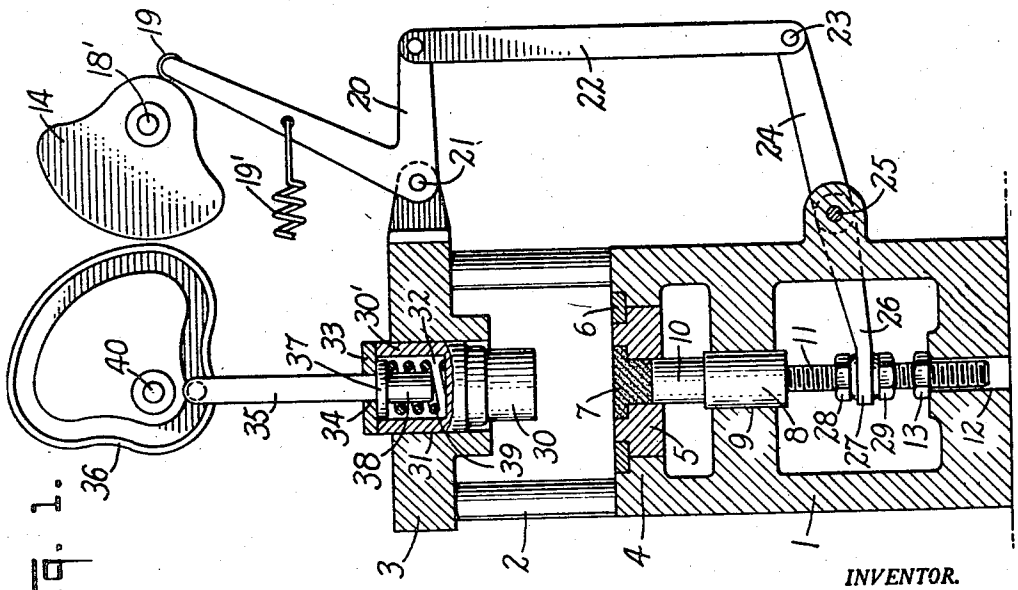


Fig. 1.

INVENTOR.
Richard P. Seelig
BY
Blair, Curtis & Hayward
ATTORNEYS

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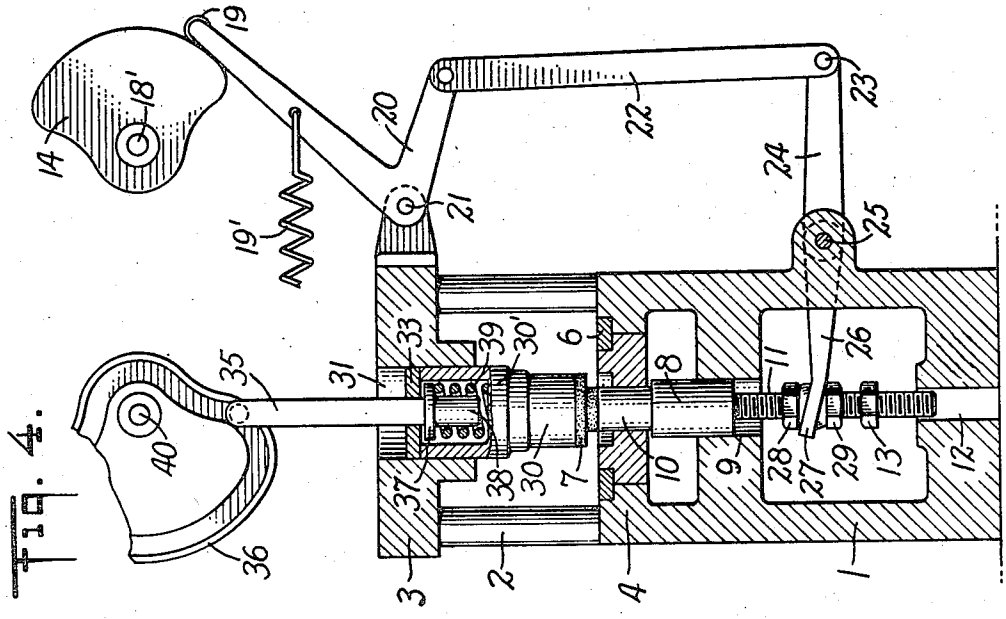


Fig. 4.

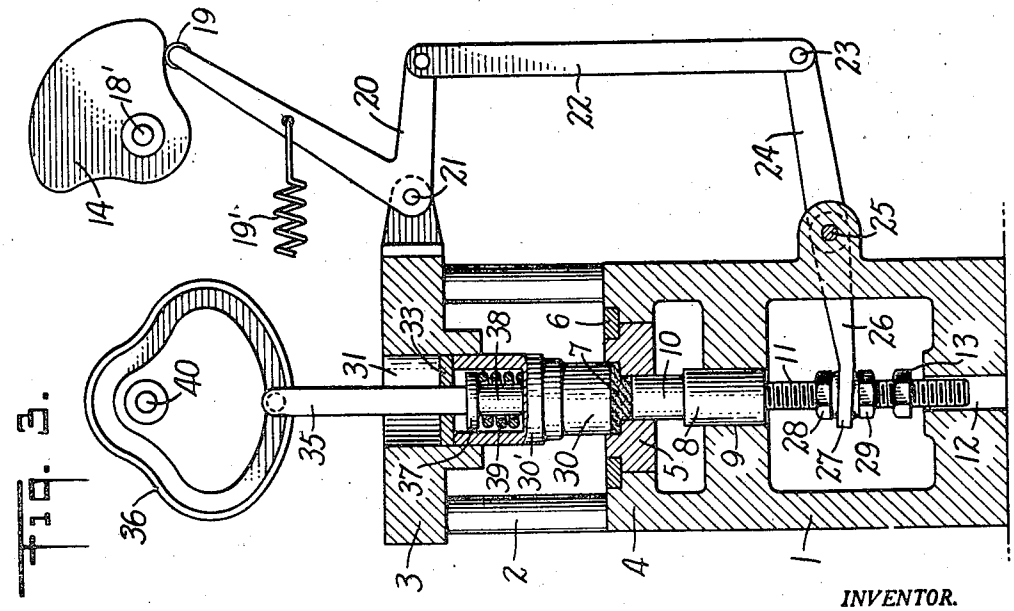


Fig. 3.

INVENTOR.
Richard P. Seelig
BY
Blair, Curtis & Hayes
ATTORNEYS

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Fig. 6.

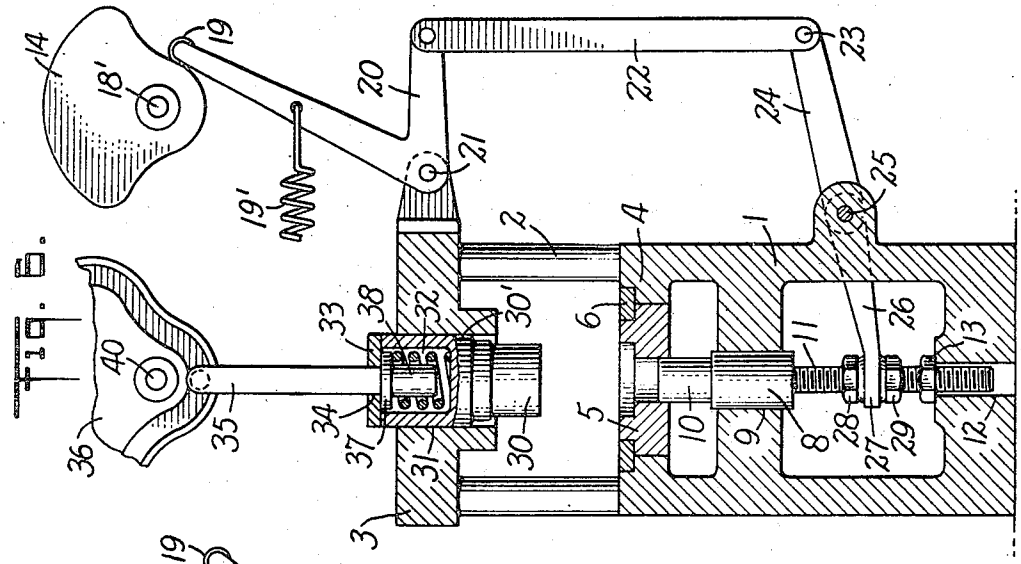


Fig. 5.

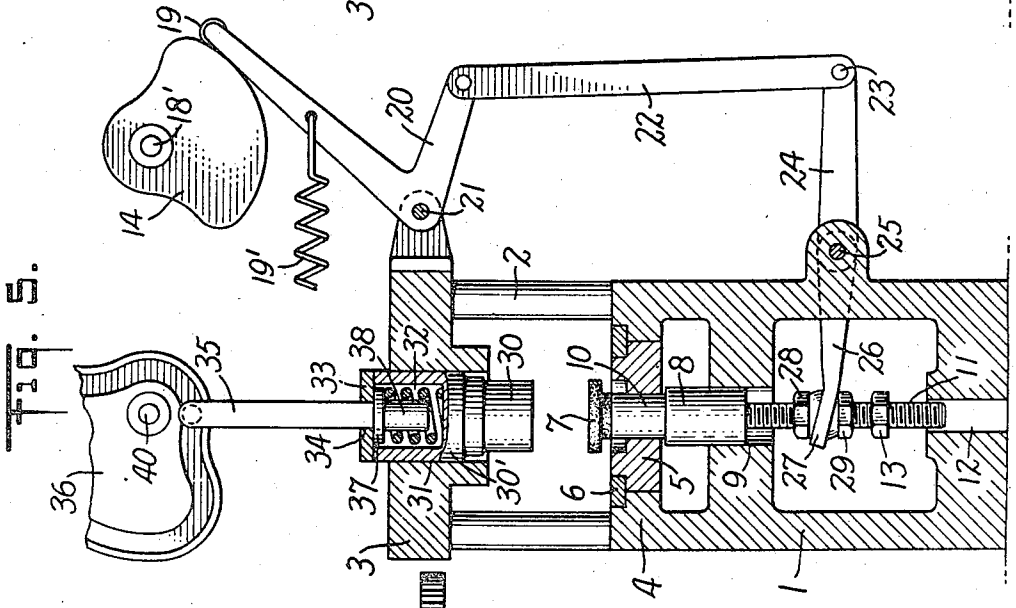
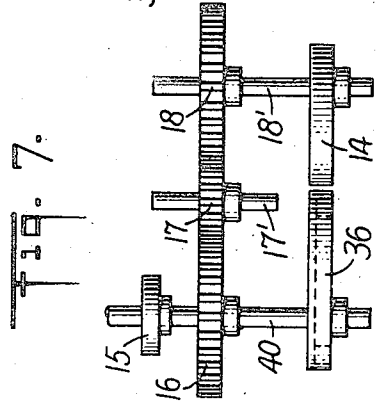


Fig. 7.



INVENTOR.
Richard P. Seelig
BY
Blair, Curtis & Hopgood
ATTORNEYS

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UNITED STATES PATENT OFFICE

2,449,515

METHOD OF FORMING PARTS FROM POWDERED METAL

Richard P. Seelig, Elmhurst, Long Island, N. Y., assignor, by mesne assignments, to Reconstruction Finance Corporation, New York, N. Y., a corporation of the United States

Original application February 15, 1944, Serial No. 522,530. Divided and this application November, 30, 1944, Serial No. 565,874

3 Claims. (Cl. 29—160.5)

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This invention relates to a method of forming powder metallurgy parts of intricate design, and the subject matter is divided out of my copending application Serial No 522,530, filed February 15, 1944.

The invention has for an object to compress metal powders into parts of various shapes so that the parts will have substantially uniform density throughout their mass and which will be substantially free of cracks or laminations.

The invention has for a further object the ejection of the formed and compressed metal parts from the forming die while maintaining the same under such pressure as will prevent any substantial injury to the formed part.

I have illustrated the mechanical phase of my invention as embodied in a mechanically operated press, but it is to be understood that it is not limited to such a press for the press may be operated by hydraulic or other pressure.

In the drawings:

Figures 1 through 6 are views, partly in section and partly in elevation, illustrating the mechanism and successive steps of the operation of the press; and

Figure 7 is a diagrammatic view of the driving means for the cams.

The press includes a base 1 having a table 2 with a cross head 3 and a die supporting portion which is adapted to receive and support a die 5 of suitable form for the powder metal part that is to be formed. This die is secured in place in the table by a clamping ring 6 of conventional design. I have illustrated the powdered metal within the die in Figures 1 through 6 at 7, regardless of its state of compression. A plunger 8 is mounted for vertical sliding movement in a bearing 9 in the base and carries a lower punch 10 at its upper end which is in alignment with and adapted to enter the opening of the die 5.

A plunger extension 11 is rigid with the plunger 8 and may have screw-threaded engagement therewith. This plunger extension projects downwardly therefrom and loosely into an opening 12 in the base 1. The extent of downward movement of the plunger 8 and its punch 10 is limited by a stop nut 13.

The upward and downward movement of the plunger 8 and its punch 10 is caused and controlled by a cam 14 which is driven by any suitable source of power such as a prime mover 15 through gears 16, 17 and 18. A cam roller 19 carried by a bell crank lever 20 rides upon the face of the cam 14, and is held in contact therewith by a spring 19' that is conventionally represented in the drawings. This bell crank lever 20 is pivoted at 21 to the cross head 3 and is pivotally connected to a link 22 which, in turn, is pivoted at 23 to a rocker lever 24. This rocker lever 24 is pivoted at 25 to the base 1. One arm 26 of the lever 24 is loosely connected to the plunger extension 11 as at 27 and is adapted to operate against two adjustable abutments 28 and 29 on the plunger extension 11. I have shown these two abutments in the form of adjustable nuts on the plunger extension and it will be understood that by adjustment of these nuts the punch 10 will be moved either upwardly or downwardly in relation to the arm 26 of the lever 24, with the result that the stroke of the punch may be varied.

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Moreover the plunger 8 and its punch 10 may be removed and replaced by another plunger and lower punch as the occasion requires.

An upper punch 30 is located above the lower punch 10 and the die opening and carried by a slide 30' which is mounted for upward and downward sliding movements in a bearing 31 in the cross head 3. This slide 30' is provided with a chamber 32 which is closed at its upper end by a plate 33 having an orifice 34 therein, which plate is positively attached to the slide. A rod 35, having a roller on its upper end which rides in a groove in a cam 36, extends through the orifice of the plate 33 into the chamber 32. A collar 37, rigid with the rod 35, is located within the chamber 32 and is provided with a boss 38. The distance between the upper face of the collar 37, which is adapted to engage the lower face of the plate 33, and the lower end of the boss 38, which is adapted to engage the lower end of the chamber 32, is less than the distance between these two portions of the slide.

A spring 39 surrounds the boss 38 and, operating against the lower face of the chamber 32 and the lower face of the collar 33, normally urges the rod 35 upwardly and the end of the boss 38 out of contact with the adjacent end of the chamber 32 of the slide 30'.

The cam 36 is mounted on a shaft 40 which is connected to the prime mover 15 and carries the gear 16. By this arrangement the cam 36 is driven in a definite relation to the cam 14 through the relationship of gear 16, the gear 17 carried by the shaft 17' and the gear 18 which is carried by the shaft 18' of the cam 14.

Describing now the operation of this embodiment of the mechanical phase of my invention, and referring to Figures 1 through 6, when the

parts are in the positions illustrated in Figure 1, with the lower punch 10 closing the lower end of the die cavity, and the upper punch 30 in its raised position, the die cavity is filled with the metal powder indicated at 7. When the cams 14 and 36 are set in motion they both turn clockwise, as shown in the drawings, and because of the fact that the roller 19 contacts a concentric face during the initial part of the movement of the cam, the lower punch remains stationary. However, the upper slide with its punch 30 will immediately start to move downwardly. Due to the increasing distance of the cam track from the center of rotation of the cam 36, the cams are so timed in their rotation that as soon as the upper punch 30 enters the die the lower punch 10 begins to move upwardly.

In the embodiment illustrated the die 5 is of such form that the flange of the part 7 that is being formed of the powdered metal is less deep than the lower shank of the part. Because of this the upper punch 30 will travel more slowly into its portion of the die cavity than will the lower punch 10 as soon as the upper punch enters the die.

As the upper punch meets the resistance of the powdered metal within the die cavity, the continued rotation of the cam 36 will compress the spring 39 so that the lower end of the boss 38 will engage the lower face of the chamber 32 and there will be a positive connection between the rod 35 and the upper slide with its punch 30.

The parts in this relationship are illustrated in Figure 3 of the drawing.

The relative movements of the upper and lower punches described above are such that both punches will reach their maximum pressure simultaneously in the position shown in Figure 3 of the drawings and the powdered metal will be completely compressed into a part having a flange and a shank as illustrated in this figure.

As soon as both of the upper and lower punches reach the maximum pressure positions shown in Figure 3, the cam 36 will have rotated to a position such that the rod 35 will move upwardly under the influence of the spring 39, while the upper punch remains in its lowered position. This upward movement of the slide creates a space between the boss 38 and the adjacent face of the chamber 32 of the upper slide so that upward movement of the upper punch 30 is resisted by the spring pressure.

During the upward movement of the upper slide with its punch 30 under the action of the cam 36 and the rod 35, the lower slide 8 with its punch 10 moves upwardly under the influence of the cam 14 and during this movement of the two punches the metal part 7 will be moved upward initially under the lateral pressure of the die and under the longitudinal yielding pressure created by the spring 39.

As the punches continue their upward movement with the metal part 7 thus clamped between them, the pressure is maintained constant until the upper face of the lower punch 10 is flush with the surface of the die and the metal part no longer receives the lateral pressure of the die 5.

The relative positions of the parts when the lower punch reaches the uppermost end of its stroke is illustrated in Figure 4 of the drawings.

When the parts reach this position the cam 36 moves the upper slide upwardly, while the cam 14 permits the lower punch 10 on the plunger 8 to remain in its uppermost position with the metal part supported on the upper end of the lower punch, as shown in Figure 5, so that it may be removed by hand or automatic means.

The continued movement of the cam 14 permits the lower plunger 8, with its punch 10, to move back into its lowermost position, as illustrated in Figure 6, where it will close the lower end of the die cavity and the cavity may be filled for the second cycle of operations.

It is to be noted that the groove of the cam 36 is so formed that when the upper slide is being moved upwardly by the cam and the spring 39 provides a yielding connection between the slide and the rod 35 there will be a gradual drop in pressure on the compressed metal part by the upper and lower plungers until the metal part is completely ejected from the die and ready for removal.

Thus it will be seen that the metal powder is first compressed within the die cavity by pressure exerted from above and below, and when the die cavity is of the form illustrated in the drawings, with a thin flange zone and a deeper shank zone, the maximum pressure on the flange zone will be reached simultaneously with the reaching of the maximum pressure on the shank zone. The result of this will be the production of a powdered metal part having a substantially uniform density.

After this compression the positive pressure exerted on one end of the powdered metal part will be transformed into a yielding pressure. However, the pressure exerted on both ends of the powdered metal part will continue to exist during the removal of the part from the die cavity at which time the pressure on the part will be relieved, but the part will remain supported by one of the pressure creating forces until it has been removed for the sintering operation.

This method insures the production of powdered metal parts which will have substantially uniform density and which will be relieved of the compressive forces in such manner that the part will not be fractured or weakened. The method insures the substantially uniform density of the powdered metal part irrespective of the differences in the depth of the various zones of the part.

I have illustrated the upper and lower punches as being operated by mechanical cams and gearing, and as having a yielding connection between the upper punch and its cam mechanism, but it is to be understood that this mechanical operation may be supplanted by a hydraulic system which is the equivalent of the mechanical system here shown.

Moreover it will be realized that certain of the parts may be hydraulically operated while the others are mechanically operated.

While I have illustrated and described the particular embodiment of the structural phase of my invention, I do not wish to be limited to the details thereof, or to the particular structure of the embodiment except in so far as this is made necessary by the claims.

What I claim is:

1. A method of forming a powdered metal article in a die cavity having opposite open ends which includes the steps of placing a mass of powdered metal in said cavity, applying positive compacting pressure to said mass at the ends of said die cavity to impart to said mass a predetermined shape, applying to said shaped mass a moving force to remove said shaped mass from said die cavity and maintaining on said shaped mass a yielding diminishing pressure of less max-

imum value than that of said positive compacting pressure during the movement of said shaped mass from said die cavity.

2. A method of forming a powdered metal article which includes the steps of applying a positive compacting pressure to a mass of powdered metal confined in a die cavity to impart thereto a predetermined shape, applying to said shaped mass a moving force to remove said shaped mass as a unit from said die cavity and maintaining on said shaped mass a yielding diminishing pressure of less maximum value than that of said positive compacting pressure during said movement of said shaped mass.

3. A method of forming a powdered metal article in a die cavity having opposite open ends and having one portion of said die cavity of greater diameter than the other portion of said die cavity, which includes placing a mass of powdered metal in both said portions of said cavity, applying oppositely acting moving forces to said mass at the ends of said die cavity to apply a positive compacting pressure to said mass at said ends of said die cavity to impart to said mass a predetermined shape in said portions of said

die cavity, applying to said shaped mass a moving force to remove said shaped mass as a unit from said die cavity and maintaining on said shaped mass a yielding diminishing pressure of less maximum value than that of said positive compacting pressure during the movement of said shaped mass from said die cavity, the movement of one of said oppositely acting forces at the die cavity portion which is of greater diameter being less extensive and less rapid than the movement of the other of said oppositely moving forces at the die cavity portion which is of lesser diameter.

RICHARD P. SEELIG.

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