3,669,582
DIE AND PUNCH ASSEMBLY FOR COMPAKTING POWDER MATERIAL HAVING DEFLECTION COMPENSATOR
Joseph E. Smith, Birmingham, Mich., assignor to
Filed Jan. 25, 1971, Ser. No. 109,376
Int. Cl. B30b 11/02, 15/72
U.S. Cl. 425—78

16 Claims

ABSTRACT OF THE DISCLOSURE
A die and punch assembly for use on a powder compaction press for making articles compacted from a powder and including a deflection compensator which allows the punch to remain engaged with and support the compacted article after the compacting pressure applied to the article is relieved. The assembly comprises a die plate appropriately mounted to the press and includes one or more die cavities, each of which has a punch slidable and snugly disposed therein. The punch is actuated by a punch upper support which, in turn, is slidable carried by a pair of posts extending below the die plate to permit reciprocable movement of the punch within the die cavity. A second punch support slidable carried by the posts is positioned below the punch upper support and operatively connects the punch upper support to an actuating ram which selectively causes reciprocation of the punch within the die cavity. A core rod is provided having one end disposed within a longitudinal bore formed in the punch, while the other end of the core rod is fixedly mounted to a core rod support which, in turn, is fixedly supported between the punch upper and lower supports by the pair of posts. The punch lower support carries the deflection compensator which comprises a bushing fixedly mounted within a centrally disposed bore in the punch lower support and in which the upper end of the actuating ram is slidable mounted for relative reciprocable movement. The actuating ram has an end portion extending through the bushing and carries an axially adjustable enlarged head adapted to engage the upper surface of the punch lower support to move the punch supports and thus the punch downwardly in the die cavity, while an enlarged axially adjustable intermediate portion of the actuating ram is adapted to engage the lower portion of the bushing to impart an upwardly directed force to the punch supports to drive the punch upwardly into the die cavity to compact the powder material into a compacted article. The punch actuating mechanism is provided with a spring loaded lost motion link to bias the punch end into engagement with the compacted article to prevent damage thereto when the punch actuating ram is retracted to relieve the compacting pressure applied to the article during compaction.

BACKGROUND OF THE INVENTION

(I) Field of the invention
This invention relates to powder compacting presses, and more particularly to an improved die and punch assembly for use in such presses and specifically to a deflection compensator which maintains the punch end in contact with the underside of the compacted article to support the article after compaction, while allowing the applied compaction pressure to be relieved.

(II) Description of the prior art
The present invention is an improvement over an apparatus of the character provided as part of a powder compacting press disclosed in U.S. Pat. Nos. 3,328,840 and 3,414,940 and co-pending U.S. patent application Ser. No.
49,800 filed June 25, 1970. The powder compacting presses described and claimed in the aforementioned patents and patent application consist generally of a machine for the purpose of manufacturing memory cores, heads, pellets, tablets and the like made of powder ferrite, glass, alumina, metal powders, pharmaceutical and other powder substances capable of forming a substantially solid article upon the application of a pressure in a confined molding cavity. The primary purpose of such presses is the manufacture of computer memory cores, porous bearings and bushings, transistor headers, microcircuit substrates, and the like. Such computer memory cores, porous bearings and bushings and the like may have a toroidal, cylindrical, square, or rectangular shape which often requires a high degree of dimensional control.

In the several embodiments of the powder compacting presses as disclosed in the aforementioned patents and patent application, the articles are compacted and formed in a multi-cavity die plate. Finished articles are automatically ejected from the die plate, picked up by a suitable mechanism such as a vacuum suction head, and delivered into vials or bottles. A flipper assembly, which is part of the press, is mounted movable transversely over the die plate and carries an anvil, a vacuum pick-up head and a secondary powder hopper which is supplied with powder from a primary hopper connected thereto by means of a flexible tubing. The hopper is first positioned over the die cavities which are filled with powder as the punches are displaced downwardly to draw a predetermined amount of powder into the die cavities. The hopper may be vibrated to aid in filling each die cavity. The hopper is removed as a result of a subsequent motion of the flipper assembly while wiping the die plate surface clean from excess powder, and replaced by the anvil which, in turn, is clamped into position on the upper surface of the die plate and over the die cavities.

The powder in each die cavity is then compacted against the anvil by means of the punches. The punches are then lowered to remove pressure from the compacted articles to permit the anvil to be removed from its position over the die cavities and replaced by the vacuum pick-up head. The punches are then raised to bring their upper end substantially flush with the surface of the die plate so that the finished compacted articles are ejected from the die cavities and picked up by the vacuum pick-up head. The vacuum pick-up head is then moved from over the die cavities and disposed over a series of apertures arranged in a disposition similar to the arrangement of the die cavities in the die plate and the finished articles are dropped through the apertures into separate vials or bottles.

Although the die and punch assemblies disclosed in the aforementioned patents and patent application have functioned in a very acceptable manner, the present invention provides an improved die and punch assembly which eliminates a certain disadvantage associated with such high production automatic powder compacting presses in the manufacture of very thin articles. As hereinafore mentioned, after the powder has been compacted the punches are withdrawn slightly to relieve the pressure so that the anvil may be unlatched and removed from its position over the die cavities and replaced by the vacuum pick-up head. During the manufacture of relatively small and thin articles compacted of powder material, the initial withdrawal of the punch force from the underside of the compacted article while the anvil is unlatched and removed from above the die cavity, may cause the very thin and fragile compacted part to buckle or otherwise become damaged under the suction effect created by the downward movement of the punch away from the compacted article.
In addition, in the powder compacting presses of the type hereinbefore described, the compaction pressure is transmitted from a cam mounted on a shaft to an end of a lever-like assembly. The other end of which is operatively connected to the punch actuating ram with the result that a considerable load is exerted on diverse internal components of the machine, causing some elements to elastically deflect a sufficient amount so that the punch escape is interrupted from engagement with the underside of the compacted article as soon as the compaction pressure is relieved, thus causing the aforementioned damage to the compacted article.

It would therefore be desirable to provide a die and punch assembly for use in the powder compacting presses of the type hereinbefore described which has all the advantages of such previously described die and punch assemblies, but which has a deflection follower for maintaining the punch in a supporting contact with the underside of the compacted articles after compaction, while allowing the compaction pressure to be relieved.

**SUMMARY OF THE INVENTION**

The present invention comprises a die and punch assembly for a powder compacting press for making articles compacted from a powder material and including a deflection follower which allows the punch to maintain a supporting contact with the underside of a compacted article while relieving the compaction pressure which is exerted on the article during the compacting process.

It is therefore and object of the present invention to provide a die and punch assembly for use with a powder compacting press which insures a more reliable and more repetitive control of the dimensional characteristics of a compacted article, and in particular a die and punch assembly which provides means for supporting the underside of the compacted article to prevent deformation thereof after compaction.

Other objects, advantages, and applications of the present invention will become apparent to those skilled in the art of powder compacting presses when a description of an example of the best mode contemplated for practicing the invention is read in conjunction with the accompanying drawing.

**BRIEF DESCRIPTION OF THE DRAWING**

The description herein makes reference to the accompanying drawing wherein like reference numerals refer to like parts throughout the several views, and in which:

FIG. 1 represents a fragmentary sectional view of a die and punch assembly illustrated in FIG. 1; and

FIG. 2 represents a fragmentary sectional view of the die and punch assembly illustrated in FIG. 1.

FIG. 3 represents a fragmentary sectional view of the die and punch assembly illustrated in FIG. 1 with an anvil disposed over the die cavity and the assembly shown in a press position; and

FIG. 4 represents a fragmentary sectional view of the die and punch assembly illustrated in FIG. 1 with the punch being maintained in a supporting contact with the underside of a compacted article and with the anvil being removed from position over the die cavity and about to be replaced by a vacuum pick-up head.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

Referring to the drawing and, in particular, to FIGS. 1 and 2, there is shown an example of the present invention in the form of a die and punch assembly having a die plate 12 adapted to be seated in a counterbore 13 of a table 15, which, in turn, forms a portion of a powder compacting press (not shown). The die plate 12 preferably has a flat upper surface 14 and is held to the table 15 by any suitable means such as clamps, screws or the like (not shown). The die plate 12 is provided with a cylindrically shaped aperture 18 formed about an axis 20 (FIG. 1) which is disposed normal to the flat upper surface 14 of the die plate 12. A cylindrically shaped die bushing 22, preferably formed of a hard material such as a carbide, is retained within the aperture 18 by a suitable adhesive material disposed between the outer periphery of the die bushing 22 and the surface of the aperture 18. The manner in which the die bushing 22 is retained within the aperture 18 is described in the aforementioned patent specification and a further description thereof is not necessary as the same forms no part of the present invention. As can best be seen in FIG. 1, the die bushing 22 is disposed in the aperture 18 such that the upper surface of the die bushing is flush with the upper surface 14 of the die plate 12.

The die bushing 22 has a centrally disposed bore 24 which, for illustration purpose, is shown as circular, although it is obvious that the bore 24 may be rectangular, square, oval, or any shape having an outer cross-section according to the peripheral shape of the article compacted therein. The bore 24 extends normal downwardly from the upper surface 19 of the die bushing 22 and is provided with a chamfered portion 26 at the lower end thereof.

Although only one bore 24 is shown, it is to be understood that the die bushing 22 may be provided with a plurality of mutually parallel bores disposed, for example, in a circular arrangement around the axis 20 of the die bushing 22 and having a regular peripheral spacing with each of the parallel bores extending normal downwardly from the upper surface 19 of the die bushing 22 and each bore being provided with a chamfered portion 26 at the lower end thereof.

The die plate 12 is further provided with a pair of diametrically opposed longitudinal bores 28 (only one of which is shown) radially spaced from the axis 20 by predetermined equal distances. Associated with each bore 28, there is one of a pair of downwardly extending support posts 32 and 34 (FIG. 2). The support posts 32 and 34 are of an elongated cylindrical shape and are retained within their bores 28 by any suitable adhesive, or otherwise fastened into the bores 28 such as by a press-fit assembly or by means of set screws.

The die and punch assembly 10 further comprises a core rod support 36 of a generally cylindrical shape. The core rod support 36 is provided with a central aperture 38 in which a core rod insert 40 is bonded by a suitable adhesive. The core rod support 36 is also provided with a pair of diametrically opposed longitudinal bores 42 (only one of which is shown) which are radially spaced from the axis 20 by the same distance as the die plate bores 28. Core rod support 36 is positioned at a selected distance from the lower surface of the die bushing 22 by means of a sliding engagement between the bores 42 and the support posts 32 and 34. A pair of threaded passages (one of which is shown in FIGS. 1, 3 and 4) radially extend from the outer periphery of the core rod support and terminate at the bores 42, the threaded bores 44 accommodating set screws 46. The cylindrically shaped core rod support 36 may be adjusted up and down on the support posts 32 and 34 at a selected distance from the lower surface of the die bushing 22 and is locked in place by means of the set screws 46.

The die and punch assembly 10 includes a punch upper support 48 which is provided with a centrally disposed bore 50 supporting a cup-shaped support member 52 having an outer periphery complementary to the bore 50 of the punch support 48 and including a shoulder 54 mating with a similar shoulder 56 formed in the bore 50. The cup-shaped support member 52 supports a punch insert 58 having a centrally disposed bore 60 in which the end 61 of an elongated cylindrically shaped punch 62 is received. The punch insert bore 60 and the punch 62 have a suitable adhesive applied between their engaged
surfaces to secure the punch 62 within the insert bore 60, while the punch insert 58 is bonded to the cup-shaped support member 52. The support member 52 is in turn bonded to the punch support 48 by a suitable adhesive. The punch support 48 has a pair of diametrically opposed longitudinal bores 64 which are radially spaced from the axis 20 by the same distance as the die plate bores 28 to permit a sliding engagement between the punch support 48 and the posts 32 and 34 to align the upper end 66 of the punch 62 with the die bore 24 such that the punch 62 extends axially upward from the punch support 48 to register with the die bushing bore 24 which is in axial alignment therewith.

The punch 62 has an outer diameter and contour to accurately and slidably fit the inner diameter and contour of the die bushing bore 24, and the punch defines a die cavity 67 (FIG. 1). Each punch 62 has a longitudinal bore 68 closely fitting the outer diameter of a core rod 70 which is disposed within the punch longitudinal bore 68 for relative sliding movement such that the punch 62 is slidably guided over the core rod 70 and the punch 62 is free for upward and downward movement relative to the core rod 70. The punch support 48 functions to transmit an upwardly directed force from an actuating ram 72 to the powder material within the die cavity 67 as will be described hereinafter.

The core rod 70 extends through a centrally disposed bore 74 in the lower surface of the cup-shaped support member 52 and is fixedly mounted within a bore 76 in the core rod insert 40 by any suitable means such as an adhesive. The longitudinal bores 64 of the punch upper support 48 are adapted to slidably engage the support posts 32 and 34 such that upon reciprocating motion imparted thereto by the actuating ram 72, in a manner to be described, the punch support 48 will move toward and away from the die bushing 22 in a sliding relationship with respect to the support posts 32 and 34, whereby a sliding registration of the elongated punch 62 in the die bushing bore 24 is achieved.

The punch upper support 48 is coupled to the actuating ram 72 by means of a punch lower support 78 and a deflection compensator 80 which will be described in greater detail hereinafter. The punch lower support 78 has a pair of diametrically opposed longitudinal bores 79 which slidably receive the support posts 32 and 34 to support 78 during reciprocal movement thereof and to maintain the punch lower support 78 in proper axial alignment with the punch upper support 48. The punch lower support 78 is connected to the punch upper support 48 by a pair of threaded fasteners 82 (only one of which is illustrated in FIGS. 1, 3 and 4). Each threaded fastener 82 extends axially upward through a bore 84 in the punch lower support 78 and threaded engages the punch support 48 as shown at 86. A sleeve member 88 surrounds each fastener 82 with the upper and lower surfaces of each sleeve member 88 being respectively in abutment with the lower and upper surface of the punch supports 48 and 78 respectively. Thus, as the fasteners 82 are threaded into the punch upper support 48, the supports 48 and 78 are fixedly secured to one another and reciprocate as a unit under the motion of the actuating ram 72. Bores 90 disposed in the core rod support 36 slidably receive the outer periphery of the sleeve members 88 and, as can best be seen in FIG. 2, the fasteners 82 are angularly disposed to the support posts 32 and 34 by 90°.

The punch lower support 78 has a centrally disposed bore 92 which is axially aligned with the die bushing bore 24 and in which the deflection compensator 80 is fixedly secured by a suitable adhesive or the like. The deflection compensator 80 comprises a bushing insert 94 having a lowered increased portion 96 forming a shoulder 98 which abuts a portion of the lower surface of the punch lower support 78 to aid in transmitting the upwardly directed force from the actuating ram 72 to the punch supports 48 and 78. The bushing insert 94 has an enlarged bore 100 opened at its lower end and connected to a bore 102 of a decreased diameter opened at the upper end of the bushing insert 94. The bores 100 and 102 respectively receive complementary shaped upper and lower stem portions 106 and 104 of the actuating ram 72 for relative sliding movement. The end of the upper stem portion 106 threadedly engages an adjusting nut 108 which, as shown in FIG. 1, engages the upper surface of the punch lower support 78 to displace the punch supports 48 and 78 and the punch 62 downwardly as the actuating ram 72 is moved downwardly.

A plurality of superimposed Belleville springs 110, disposed within the enlarged bore 100 of the bushing insert 94 and surrounding the upper stem portion 106, abuts the lower stem portion 104 and biases the punch lower support 78 into engagement with the adjusting nut 108. The amount of bias or pre-load of the springs 110 is determined by the relative engagement of the adjusting nut 108 onto the thread on the end of the upper stem portion 106. The actuating ram 72 has an enlarged intermediate threaded portion 112 on which a cylindrical collar member 114 is threaded. The collar member 114 has an upper surface 116 which is adapted to abut the lower surface 118 of the bushing insert 94 to transmit the upwardly directed force from the actuating ram 72 to the punch lower support 78. The amount of axial travel of the actuating ram 72 prior to engagement of the surfaces 116 and 118 may be adjusted by varying the relative axial position of the collar member 114 and the intermediary threaded portion 112 of the actuating ram 72 as a result of rotating the collar member in the appropriate direction of an appropriate amount.

A suitable adhesive which may be used between the bonded elements described hereinafter may be of a commercial quick-setting bonding compound such as an anaerobic adhesive which will securely maintain the die bushing 22 within the aperture 18 when subjected to pressure during the compacting operation. An example of one such bonding compound is known under the name of "Locite" manufactured by the Loctite Corporation, Newton, Conn. The compound, partially useful in the bonding of cylindrical parts, is an anaerobic adhesive having unusually high shear strength exceeding that of conventional press-fitted parts by up to five times.

The "Locite" retainer compound is fast curing and has excellent heat and solvent characteristics as well as providing the high shear strength between adjoining interfaces. A more detailed description of the "Locite" retaining compound may be had by reference to U.S. Pat. No. 3,621,534.

For purposes of illustration, a typical powder compacting cycle includes a powder filling step, a compacting step, and an ejection step. Briefly, the filling step is diagrammatically shown in FIG. 1 and comprises a powder supply device, or what is commonly referred to as a hopper 120, which is disposed over the die plate 12 completely encompassing the die bushing 22 and which fills the die cavity 67, defined by the bore 24 and the upper end 66 of the punch 62, with a powdered material 122. The punch 62 may be displaced slightly downward from the upper surface 19 of the die bushing 22 by the action of the adjusting nut 108 abutting the top surface of the punch lower support 78 when the actuating ram 72 is moved downwardly so as to insure that the cavity 67 is filled with the powdered material 122. The hopper 120 may be vibrated to insure a complete filling of the die cavity 67. After the filling operation illustrated in FIG. 1, the hopper 120 is removed by means (not shown) and the upper surface 19 of the die bushing 22 wiped clean of any excess powder which can be accomplished by the hopper 120 being moved transparently across the upper surface 19 of the die bushing 22. The upper surface 19 of the die bushing 22 is preferably polished to a superfinish so that there is no possibility of any grain of powder remaining on the surface 19 after the wiping step.
Referring to FIG. 3, an anvil 124, supported by means (not shown), is transferred over the filled die cavity 67 and dropped into position, and the punch supports 48 and 78 are actuated by means of the actuating ram 72 moving upwardly until the surface 116 of the collar member 114 abuts the lower surface 118 of the insert 94 to thereby force the punch 62 upwardly so as to compact the powder 122 contained within the die cavity 67 against the anvil 124 to form a very thin wafer-shaped compacted article 126. FIGS. 3 and 4, while simultaneously further compressing the Belleville springs 110.

In order to remove the anvil 124 from over the die cavity 67, the anvil is first unlatched while the punch 62 is simultaneously displaced slightly downwardly so as to relieve the pressure applied by the punch end 66 on the bottom surface of the compacted article 126. As hereinbefore mentioned, this initial downward movement of the punch in assemblies wherein the punch is rigidly supported by an actuating ram results in a suction effect on the underside of the compacted article 126 causing the compacted article to buckle or deflect inwardly toward the top end 66 of the punch 62. This deflection may cause a complete collapse of thin articles compacted of poorly adhering powder. Once the anvil 124 has been removed, it is replaced by a suitable pick-up such as the vacuum pick-up head 128 schematically illustrated at FIG. 4, wherein when the insert 94 is ejected from the die cavity 67 as a result of an upward motion of the punch 62 having only its end 66 flushed with the upper surface 19 of the die bushing 22 picked up by the pick-up head 128, and is deposited in a suitable container. Even though the wafer-shaped article 126 may have been only deflected downwardly by the initial downward movement of the punch, the article may very likely be broken or otherwise damaged when the punch 62 is moved upwardly to eject the article from the die cavity.

In order to prevent the initial downward deflection of the compacted article 126, or complete collapse and disintegration, use of the pick-up head 128 results in the compacting pressure exerted on the compacted article 126, while still maintaining the upper end 66 of the punch 62 in a supporting contact with the underside of the compacted article 126, without exerting any appreciable force on the compacted article 126, thereby permitting removal of the anvil 124 and replacement thereof by the pick-up head 128.

As can best be seen in FIGS. 3 and 4, as the actuating ram 72 is initially moved downwardly after the article 126 has been appropriately compacted in the die cavity, the collar member upper surface 116 becomes disengaged from the bushing insert lower surface 118 as soon as the compacting pressure exerted on the compacted article is relieved. The Belleville springs 110, disposed within the bushing insert bore 100, continue to bias upwardly both the punch lower support 78 and the punch upper support 48 rigidly connected thereto, thus causing the upper end 66 of the punch 62 to remain engaged with the underside of the finished article 126. Since the bias of the springs 110 is relatively small, the compacted article 126 is held within the die cavity 67 by the friction between the article 126 and the surface of the die bushing bore 24. The supporting contact between the punch 62 and the underside of the finished article 126 is had without exerting an upwardly directed force on the article. Thus, the anvil may be removed from over the die cavity without damage to the compacted article.

As can best be seen in FIG. 4, the actuating ram 72 is lowered a sufficient distance to cause disengagement of the surface 116 and 118 without displacing the punch 62 downwardly. This position is maintained until the pick-up 128 is positioned over the die cavity 67, whereupon the actuating ram 72 is actuated to slightly displace the punch 62 upwardly and eject the finished article from the die cavity 67 for removal therefrom by the pick-up 128 for deposit in a suitable container as described hereinbefore. The actuating ram 72 is then moved downwardly, whereupon the adjusting nut 108 engages the upper surface of the punch lower support 78 to bring the punch 62 into the filled positioned illustrated in FIG. 1, whereupon the fill, compaction and ejection cycle may be repeated.

While the form of the example of the present invention as disclosed herein constitutes one preferred form, it is to be understood that other forms might be adopted all coming within the spirit of the invention and the scope of the appended claims.

I claim:

1. An apparatus for making an article of compacted powder material comprising:

a die plate having at least one die cavity;
mean for dispensing powder material into said die cavity;
lower and upper compacting members aligned with said die cavity and operable with relative movement toward and away from each other to exert a compacting pressure on said powder material to compact said powder material within said die cavity to form said article; and
deflection compensating means for maintaining one of said compacting members in contact with a face of said article to support said article when said compacting pressure is released.

2. The apparatus defined in claim 1 wherein said one of said compacting members has an end engaged in one end of said die cavity, and further comprising means operatively coupling said one compacting member to said deflection compensating means for moving said one compacting member relative to said die cavity, a reciprocal actuating member movable between a first position wherein it engages said deflection compensating means to exert a force thereon to move said one compacting member to compact said powder material and a second position wherein said reciprocal actuating member disengages said deflection compensating means, and biasing means disposed between said deflection compensating means and said actuating member for maintaining said one compacting member in contact with the one side of said article after said actuating member disengages said deflection compensating member.

3. The apparatus defined in claim 1 further comprising a reciprocal actuating member, a support plate operatively coupled to one of said compacting members and slidably mounted for reciprocable movement toward and away from said die cavity, said support plate having a bore through which said actuating member is slidably disposed for relative movement, said actuating member having an end portion extending through to one end of said support plate and including means abutting a portion of said support plate when said actuating member is moved away from said die cavity to move said last mentioned one compacting member away from the other of said compacting members; biasing means disposed in said bore between a portion of said support plate and a portion of said actuating member to bias said support plate and said actuating member away from one another, said actuating member having means for engaging and another portion of said support plate after an amount of movement of said actuating member toward said die cavity to move said support plate and thus said last mentioned one compacting member toward said die cavity.

4. The apparatus defined in claim 3 wherein said last mentioned means is adjustable such that the engagement between said actuating member and said support plate may be selectively varied with respect to the amount of relative movement between said actuating member and said die cavity.

5. The apparatus defined in claim 1 wherein said deflection compensating means comprises a support plate coupled to said lower compacting member, an actuating member disposed for relative sliding engagement with
respect to said support plate, an upper end portion of said actuating member extending through said support plate, and having means carried thereby to engage the upper surface of said support plate when a downward force is exerted by said actuating member to thereby withdraw said lower compacting member away from said upper compacting member, a lower portion of said actuating member having means engaging a lower portion of said support plate after an amount of upward movement of said actuating member to move said lower compacting member into said die cavity and providing axial alignment between said punch and said die cavity, and further comprising post means carried by said die plate, said punch support plate engaging said post means for reciprocal movement relative to said die cavity, an actuating member for reciprocating said punch support plate, and a second punch support slidably engaging said post means and operatively connected to said first punch support plate and said actuating member to move said punch in contact with the underside of said article after said compacting pressure is relieved.

The apparatus defined in claim 1 wherein said actuating means comprising a bore in said second support plate in which said actuating member is disposed for relative sliding engagement, an upper end portion of said actuating member extending through said said bore and having means carried thereby to engage the upper surface of said second support plate when a downward force is exerted by said actuating member to thereby withdraw said punch away from said upper compacting member, a lower portion of said actuating member having means engaging a lower portion of said second support plate after an amount of upward movement of said actuating member to move said punch into said die cavity to compact said powder material, and including means disposed within said second support plate bore and between said second support plate and said actuating member for maintaining said punch in contact with the underside of said article after said actuating member disengages said second support plate.

The apparatus defined in claim 8 wherein said actuating member is movable to a third position and includes means engaging said deflection compensating means to move said lower compacting member away from said upper compacting member.

The apparatus defined in claim 8 further comprising post means; said operatively coupling means comprising said support plate slidably mounted on said post means and reciprocal toward and away from said die cavity, said support plate having a bore through which said actuating member is dislocated for relative movement, said actuating member having an end portion extending through the upper end of said support plate and including means abutting the upper portion of said support plate when said actuating member is moved downwardly away from said die cavity to move said lower compacting member away from said upper compacting member; said biasing means comprising a spring disposed in said bore and having one end in abutment with a portion of said support plate and the other end of said spring in abutment with a portion of said actuating member to bias said support plate and said actuating member away from one another, said actuating member having means engageable with the lower portion of said support plate after an amount of upward movement of said actuating member to move said support plate and thus lower compacting member upwardly into said die cavity.

11. The apparatus defined in claim 10 wherein said last mentioned means is adjustable such that the engagement between said actuating member and said support plate may be selectively varied with respect to the amount of relative movement between said actuating member and said die cavity.

12. The apparatus defined in claim 1 further comprising at least one core rod disposed in one of said compacting members for the provision of at least one core hole in said compacted article.

13. The apparatus defined in claim 1 wherein said lower compacting member comprises a punch having its end engaging one end of said die cavity and reciprocal therewithin, a punch support plate connected to the other end of said punch for reciprocating said punch relative to said die cavity and providing axial alignment between said punch and said die cavity, and further comprising post means carried by said die plate, said punch support plate engaging said post means for reciprocal movement relative to said die cavity, an actuating member for reciprocating said punch support plate, and a second punch support slidably engaging said post means and operatively connected to said first punch support plate and said actuating member to move said first punch support plate, said deflection compensating means cooperating with said second punch support plate and said actuating member to maintain said punch in contact with the underside of said article after said compacting pressure is relieved.

14. The apparatus defined in claim 13 wherein said deflection compensating means comprises a bore in said second support plate in which said actuating member is disposed for relative sliding engagement, an upper end portion of said actuating member extending through said said bore and having means carried thereby to engage the upper surface of said second support plate when a downward force is exerted by said actuating member to thereby withdraw said punch away from said upper compacting member, a lower portion of said actuating member having means engaging a lower portion of said second support plate after an amount of upward movement of said actuating member to move said punch into said die cavity to compact said powder material, and including means disposed within said second support plate bore and between said second support plate and said actuating member for maintaining said punch in contact with the underside of said article after said actuating member disengages said second support plate.

15. The apparatus defined in claim 14 wherein the lower portion of said actuating member is adjustable in opposite directions along the path of movement of said actuating member so as to selectively determine the amount of upward movement of said actuating member before said engagement with said second support plate.

16. The apparatus defined in claim 14 wherein said resilient means comprises a spring, and further comprising means carried at one end of said actuating member for providing an adjustment of the relative position of said actuating member with respect to said bore for varying the compression of said spring to determine the amount of said bias.

References Cited
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3,446,879 5/1969 Atkin -------------- 18—16 R X
L. HOWARD FLINT, JR., Primary Examiner
U.S. Cl. X.R.
425—355, 227, 447
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,669,582       Dated June 13, 1972

Inventor(s)   JOSEPH E. SMITH

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION

Column 6, line 41, change "partially"
to -- particularly --

Column 7, line 7, change "compast" to
-- compact --

Column 8, line 4, change "positioned" to
-- position --

Signed and sealed this 10th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.  ROBERT GOTTSCHALK
Attesting Officer          Commissioner of Patents