Jan. 25, 1966 P. B. EYRE ETAL 3,231,648

PROCESS FOR HOT PRESSING POWDER

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FIG. 1.

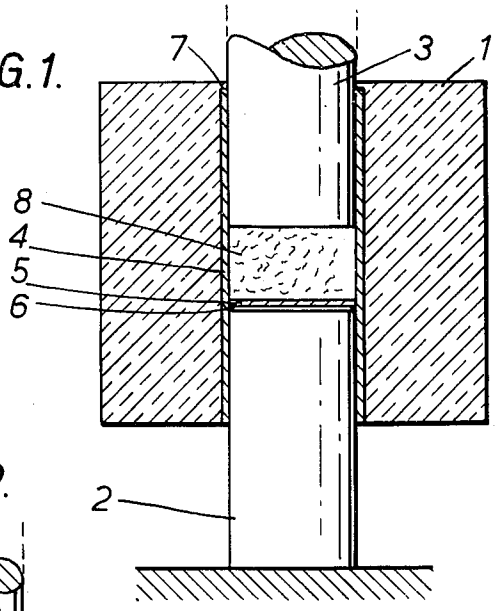
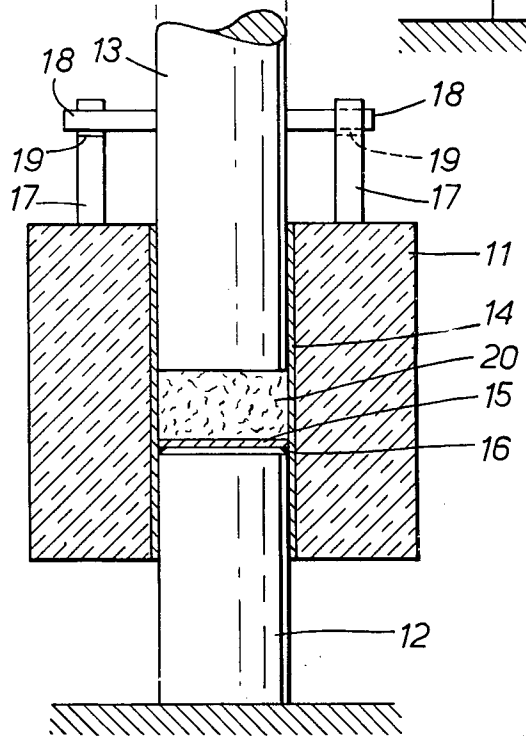


FIG. 2.



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FIG. 4.

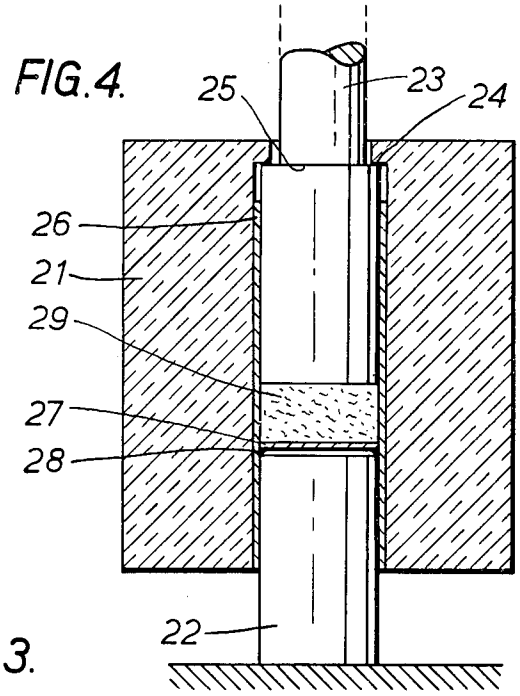
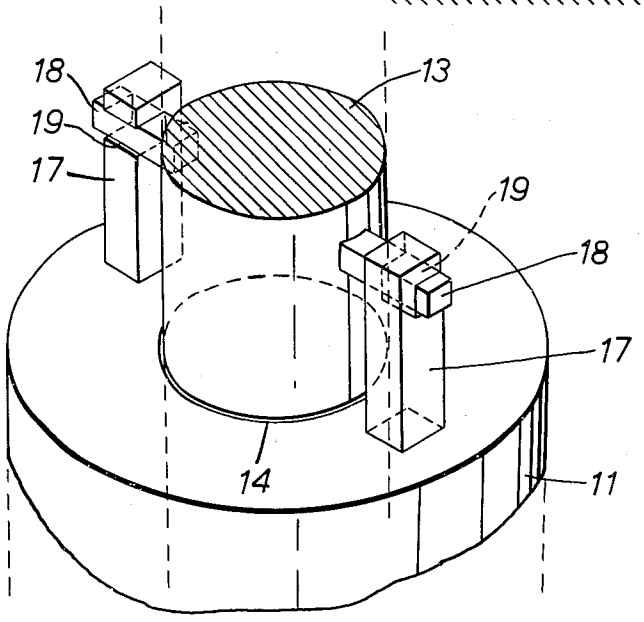


FIG. 3.



United States Patent Office

3,231,648

Patented Jan. 25, 1966

3,231,648

PROCESS FOR HOT PRESSING POWDER

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Filed May 4, 1962, Ser. No. 192,485
Claims priority, application Great Britain, May 17, 1961, 18,054/61
1 Claim. (Cl. 264—111)

This invention relates to hot pressing of solid bodies from particulate material.

A technique for hot pressing of solid bodies from powder, known as double ended hot pressing, comprises compacting powder at an elevated temperature in a die between two axially aligned punches, the punches being entered into the bore of the die from opposite ends thereof. During the pressing operation both the punches must be free to move in the die and where the punches are vertically arranged, one being fixed and the other movable, the die must be provided with external support prior to the start of the pressing operation until the initial application of pressure by the movable punch compacts the powder to bind in the die when the external support must be removable or of such a nature so as to allow the die to move relatively to the fixed punch during the remainder of the pressing operation. It has been proposed to support the die by means of a spring prior to commencement of the pressing operation, the necessary movement of the die relative to the fixed punch during the pressing operation being accommodated by deflection of the spring. Where the material being pressed is of an expensive nature the use of a relatively inexpensive expendable component such as a spring, is warranted. However, where the powder is of an inexpensive nature and perhaps for the mass production of components, a spring as a component expendable on each pressing is relatively expensive and its use is therefore to be avoided.

It is also desirable to hold the powder in the die at pressing temperature, prior to application of pressure by the movable punch, for sufficient time to allow outgassing of the powder. Where a spring is employed to support the die outgassing is rendered difficult as pressure must be applied by the movable punch to compact the powder in the die and thus support the die before the spring sags on softening at the elevated temperature.

According to the invention in a process for pressing of powder at an elevated temperature in a die, between vertically arranged upper and lower punches, supporting means are provided for supporting the die from one of the punches prior to and initially during the pressing operation, said die being releasable from said supporting means after application of initial pressure sufficient to compact the powder in the die, such that the die is supported after release of said means by friction with the compressed powder, both punches being subsequently movable relative to the die during the remaining major part of the pressing operation.

In one form of the invention the die is provided with a liner, the die being supported from the liner by engagement therewith, said liner having a transverse partition fixed by tack welds, the die and liner being supported by the transverse partition resting on the upper face of the lower punch, whereby on application of initial pressure to powder in the liner by movement of the upper punch relative to the lower punch the powder is compacted to bind in the liner and to swell the liner in the die whereby the liner and hence the die is forced to move relative to the lower punch, thus breaking the tack welds between the transverse partition and the liner, both punches then being subsequently movable relatively to the die during the remaining part of the pressing operation.

In another form of the invention the die is supported directly from one of the punches by means of arms on the punch engaging with lugs on the die said arms being disengageable from the lugs by rotation of the punch relative to the die after the application of initial pressure sufficient to compact powder in the die between the punches such that the die is supported after release of the arms from the lugs by friction with the compressed powder.

In a third form of the invention the die is suspended from a step on the upper punch so as to be freely movable upwards relative to the upper punch, whereby after the application of initial pressure sufficient to compact powder in the die, such that the die is independently supported by friction with the compressed powder, the upper punch is movable downwards relatively to the independently supported die.

Three embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a longitudinal sectional elevation of one embodiment of the invention,

FIGURE 2 is a longitudinal sectional elevation of a second embodiment of the invention,

FIGURE 3 is a detail, in perspective form, of the embodiment shown in FIGURE 2, and

FIGURE 4 is a longitudinal sectional elevation of a third embodiment of the invention.

In FIGURE 1 there is shown an assembly of a cylindrical graphite die **1**, a lower fixed punch **2** and an upper movable punch **3**. The die **1** is fitted internally with a mild steel liner **4** having a transverse partition **5** which is located, by tack welds **6**, in the liner **4**. The assembly of die **1** and liner **4** is supported from the lower fixed punch **2**, the liner **4** being supported from the transverse partition **5** which rests on the upper end face of the fixed punch **2** and the die **1** having an internal step **7** from which it is supported by the liner **4**.

In use of the arrangement, the assembly of die **1** and liner **4** is fitted over the lower fixed punch **2** and metal powder **8** to be compacted at an elevated temperature is poured into the liner **4** above the transverse partition **5**. The upper punch **3** is inserted into the liner **4** and the assembly mounted in a vacuum furnace between the rams of a hydraulic compression machine. The whole assembly is heated in the furnace until the metal powder **8** reaches pressing temperature (i.e. for beryllium powder about 900 to 1150° C.). Pressure is now applied to force the upper punch **3** down the liner **4** thus compressing the metal powder **8** against the transverse partition **5**. The pressure of the upper punch **3** compacts the metal powder **8** in the liner **4** so that the compressed powder **8** binds in the liner **4** and swells the liner **4** in the die **1**. Thus a downward force is applied to the liner **4** and the die **1** which breaks the tack welds **6** between the transverse partition **5** and the liner **4** thus allowing relative downward movement of the die **1** and liner **4** with respect to the lower fixed punch **2** during the remainder of the pressing operation. Prior to breaking of the tack welds **6** the assembly of die **1** and liner **4** is supported by the transverse partition **5** from the lower fixed punch **2**. After breaking of the tack welds **6** the assembly of die **1** and liner **4** is supported by frictional contact of the liner **4** with the metal powder **8** which has been expanded in the liner **4** by the applied compression.

In the arrangement of FIGURE 1 the die **1** is held in its upermost position by the transverse partition **5** acting through the liner **4**. The tack welds **6** take the initial load and it is necessary to apply pressure by means of the upper punch **3** to expand the liner **4** in the

die 1 early in the heating cycle before the welds 6 shear at the elevated temperature under the weight of the die 1. Thus it is difficult to hold the powder 8 at temperature for outgassing in this arrangement.

In FIGURE 2 there is shown an assembly of a cylindrical graphite die 11, a lower fixed punch 12 and an upper movable punch 13. The die 11 is fitted internally with a mild steel liner 14 having a transverse partition 15 which is located by tack welds 16 in the liner 14. The die 11 is fitted with two diametrically opposed lugs 17 and the upper punch 13 has a pair of radially extending arms 18 engageable with slots 19 in the lugs 17. As shown in FIGURE 3 the slots 19 are on opposite faces of the lugs 17 so that the arms 18 can be disengaged from the slots 19 by rotation of the upper movable punch 13 relative to the die 11 in an anticlockwise sense.

In use of the arrangement the assembly of die 11 and liner 14 is fitted over the lower fixed punch 12 so that the transverse partition 15 rests on the upper face of the lower punch 12. Metal powder 20 to be compacted at at elevated temperature is poured into the liner 14 and the radial arms 18 engaged with the slots 19 in the lugs 17. The assembly is mounted in a vacuum furnace between the rams of a hydraulic compression machine. The whole assembly is heated in the vacuum furnace and pressure is applied to the upper punch 13. The consequent downwards movement of the upper punch 13 is transmitted to the die 11 by virtue of the engagement of the arms 18 with the lugs 17 on the die 11. The metal powder 20 is initially compacted between the lower fixed punch 12 and the upper movable punch 13 swelling the liner 14 in the die 11 so that the liner 14 grips by friction in the die 11. Thus the downwards movement of the die 11 with the upper punch 13 is transmitted to the liner 14 breaking the tack welds 16 between the transverse partition 15 and the liner 14. The upper punch 13 can now be rotated anticlockwise relative to the die 11 thus moving the arms 18 from engagement with the slots 19 in the lugs 17, the die 11 and liner 14 being then supported by frictional contact of the liner 14 with the metal powder 20 compacted between the punches 12 and 13. The remainder of the pressing operation is carried out with the arms 18 disengaged from the lugs 17.

In FIGURE 4 there is shown an assembly of a cylindrical graphite die 21 a lower fixed punch 22 and an upper movable punch 23. The die 21 has an internal step 24 and the upper punch 23 is of reduced section at its upper end to provide an external step 25 from which the die 21 is suspended at the internal step 24. The die 21 is fitted internally with a mild steel liner 26 having an internal transverse partition 27 located by tack welds 28 in the liner 26.

In use of the arrangement the liner 26 is fitted over the lower fixed punch 22 so that the transverse partition 27 rests on the upper face of the lower punch 22. Metal powder 29 to be compacted at an elevated temperature is poured into the liner 26 and the die 21 fitted with the upper punch 23 is fitted over the liner 26 into the position shown in FIGURE 4. The assembly is mounted in a vacuum furnace between the rams of a hydraulic compression machine. The whole assembly is heated

in the furnace and pressure is applied to the upper punch 23 thus compressing the powder 29 against the transverse partition 27. The downwards movement of the upper punch 23 in the liner 26 is followed initially by the die 21 which slides down on the liner 26 until the pressure of the upper punch 23 causes the compressed metal powder 29 to bind in the liner 26 and swell the liner 26 so that it binds in the die 21. Thus a downward force is applied to the liner 26 which breaks the tack welds 28 between the transverse partition 27 and the liner 26 thus allowing relative downward movement of the die 21 and liner 26 relative to the lower fixed punch 22 during the remainder of the pressing operation. Prior to breaking of the tack welds 28 the liner 26 is supported by the transverse partition 27 from the lower fixed punch 22, while the die 21 is supported from the upper punch 23 at the external step 25. After breaking of the tack welds 28 the assembly of die 21 and liner 26 is supported by frictional contact of the liner 4 with the powder 29 which under the applied compression has expanded the liner 26 to bind in the die 21.

In the arrangement of FIGURES 2 and 3 and the arrangement of FIGURE 4 the die is initially supported from the upper punch. Therefore in these arrangements the powder in the die can be held at an elevated temperature for outgassing prior to application of pressure by the upper punch.

We claim:

A process for pressing of powder at an elevated temperature in a die between vertically arranged upper and lower punches comprising the steps of supporting the die from at least one of said punches prior to and during initial application of pressure to the powder in the die, followed by release of the support of the die by the supporting punch after the application of initial pressure to the powder in the die sufficient to compact the powder in the die, such that the die is supported after release of the die from the supporting punch by friction with the compressed powder, both punches being subsequently movable relative to the die during the remaining major part of the pressing operation.

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