March 2, 1948. L. D. RICHARDSON 2,437,127

APPARATUS FOR POWDER METALLURGY

Filed Oct. 1, 1945

FIG. 1.

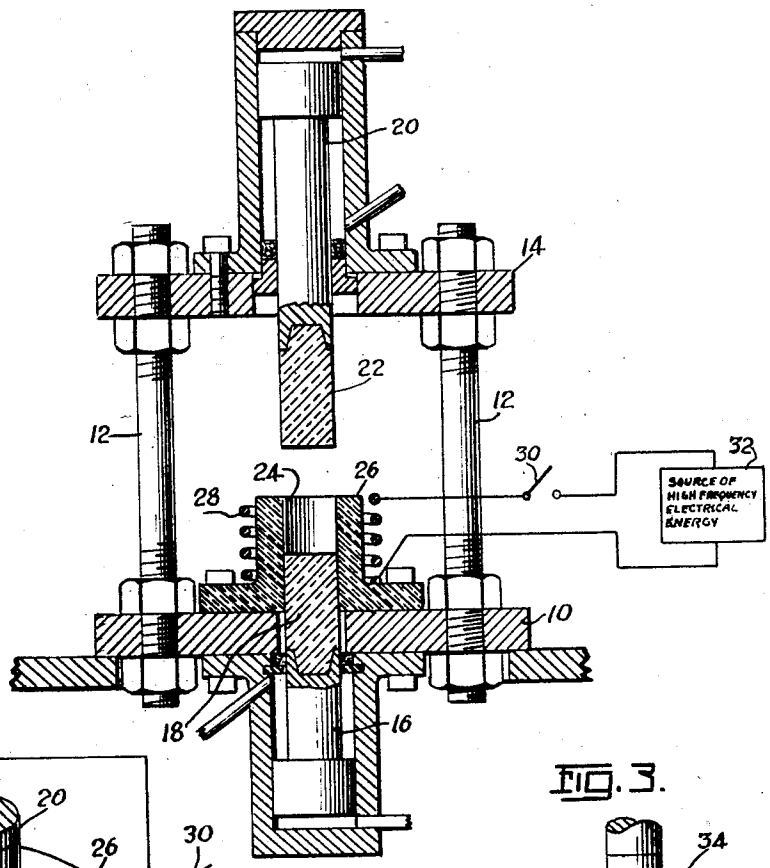


FIG. 2.

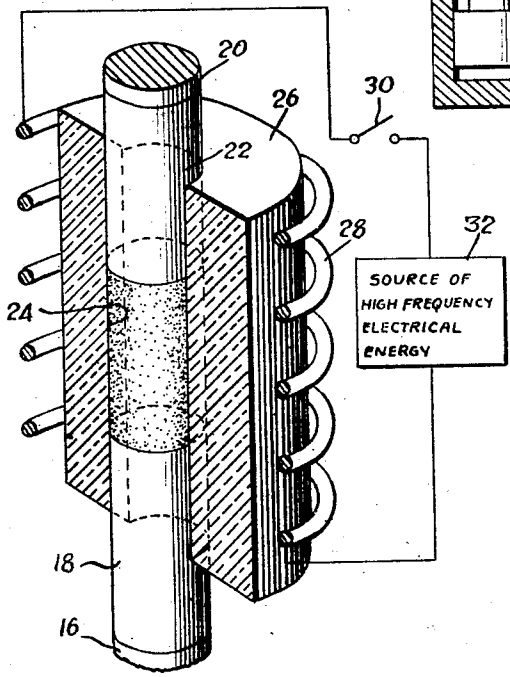


FIG. 3.

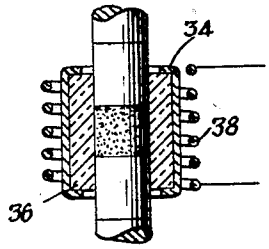
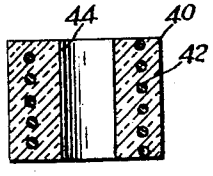


FIG. 4



INVENTOR
LLOYD D. RICHARDSON
BY Toulmin & Toulmin
ATTORNEYS

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APPARATUS FOR POWDER METALLURGY

Lloyd D. Richardson, Dayton, Ohio, assignor to H-P-M Development Corporation, Wilmington, Del., a corporation of Delaware

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3 Claims. (Cl. 219—3)

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This invention relates to powder metallurgy and particularly, to a method of and apparatus for forming workpieces from powdered metal in a single operation.

The particular object of this invention is to provide an improved method for forming and sintering powdered metal workpieces in a single step.

It is another object to provide a method and apparatus for forming workpieces of powdered metal which fully forms the said workpiece thereby eliminating subsequent machining operations.

It is still another object to provide a method and apparatus for sintering powdered metal parts under pressure whereby the resulting workpiece is fully formed and precisely sized.

These and other objects and advantages will become more apparent upon reference to the accompanying drawings in which:

Figure 1 is a diagrammatic, sectional view of a press adapted for practicing the method of this invention;

Figure 2 is a perspective view showing a workpiece in the process of being formed; and

Figures 3 and 4 are modified arrangements of the die member of this invention.

General arrangement

The apparatus for pressing and sintering a workpiece from powdered metal according to this invention comprises a mold or die cell formed of low electrical conductivity and preferably nonmagnetic material which has sufficient strength to withstand the pressures at which the workpiece is formed. The pressing plungers which compress the workpiece within the die have at least their end portions formed of the same material so that the workpiece is completely enclosed thereby. Materials which have been found suitable for this purpose include glass, ceramics and in certain instances graphite.

There is disposed around the die cell a coil which is connected with a source of high frequency electrical energy. The coil establishes a heat producing alternating field in the workpiece and raises it to sintering temperature while under pressure by the plungers. After a predetermined time, the sintering operation is completed and the workpiece is cooled and ejected. A completely finished and accurately sized workpiece is thus produced.

Structural arrangement

Referring to Figure 1, there is shown a press having a bed 10 which is connected by strain rods

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12 with a head 14. The bed 10 mounts an upward acting fluid operable plunger 16 whose end portion comprises the glass or ceramic member 18.

The head 14 mounts the fluid operable plunger 20 which has at its lower end the glass or ceramic member 22. The members 18 and 22 are reciprocable in the cavity 24 of a die cell 26 which is formed of the same material as the said members.

Mounted about the die cell 26 is a coil 28 which is connected through a switch 30 with a source of high frequency eelctrical energy indicated at 32. Closure of the switch 30 will bring about the energization of the coil 28 to establish a high frequency alternating field through the die cell 26. Inasmuch as the die cell 26 and the pressing members 18 and 22 are formed of a nonconducting material, the energy of the field is absorbed by the metal powder within the cavity 24.

While it is apparent that any nonconducting material having sufficient strength is suitable for use as the die cell 26 and pressing members 18 and 22, it is preferred to employ a high strength glass or ceramic. However, in certain instances graphite may be used in which case a certain amount of heat would be generated in the graphite material where it touched the workpiece and the heating effect at the surface of the workpiece would thus be somewhat enhanced.

In Figure 3, there is illustrated a modified form of die cell 34 which is strengthened by the addition of a thin metal shell 36 therearound which, while being heavy enough to add strength to the die, is not heavy enough to absorb an appreciable amount of energy from the field established by the coil 38.

In Figure 4 there is shown a die cell 40 which has imbedded therein a coil 42 for establishing the heating field of electromagnetic induction in the workpiece in the cavity 44. In Figure 4 the coil 42 is disposed nearer to the workpiece than is possible with the arrangements shown in Figures 1 and 3 and in addition provides a support for the die when it is under pressure.

While the method and apparatus of this invention are adapted for forming workpieces from any powdered metal material, it is evident that it is of particular value in connection with the forming of refractory materials which are ordinarily too hard to be machine worked after sintering.

Operation

In operation, a predetermined quantity of powdered material is placed within the cavity 24

and the press members 22 and 18 are advanced into the die cavity to engage the powder with pressing force. Thereafter, the switch 30 is closed to energize the coil 28 thereby to establish an alternating field of electromagnetic induction through the workpiece. The workpiece, being electrically conducting, absorbs energy from the magnetic field and its temperature is thereby raised to the sintering point.

After the temperature of the workpiece has been raised sufficiently high the switch 30 is opened while the pressure of the pressing members on the workpiece is continued. After the workpiece has become fully sintered and is cooled sufficiently to permit its ejection into the atmosphere, the pressing member 22 is withdrawn while the member 18 is actuated to force the finished workpiece from the die. By properly controlling the amount of material placed into the die and by properly shaping the die and plungers, the ejected workpiece may be controlled as to the size and shape so as to require no subsequent machining operation.

While the apparatus disclosed and described herein constitutes a preferred form of my invention, it will be understood that the apparatus is capable of alteration without departing from the spirit of the invention, and that all modifications that fall within the scope of the appended claims are intended to be included herein.

I claim:

1. In an apparaus for forming workpieces from powdered metals; a substantially horizontal bed; a die of substantially electrically non-conductive material supported on said bed; an opposed pair of pressing members reciprocable in the cavity of said die and comprising at least end portions which are substantially electrically non-conductive; and an induction coil encircling the cavity of said die and adapted for being energized by a source of high frequency electrical energy; means for supporting one of said pressing members in spaced relation from said bed comprising strain rods, said bed having means for supporting said other pressing member, and means for reciprocating said pressing members comprising cylinders and pistons mounted on said strain rods and bed respectively.

2. In an apparatus for forming finished workpieces from metal powders; a substantially horizontal bed; a die supported on said bed having a cavity, a pair of plungers reciprocable in said

cavity; motor means for actuating said plungers for compacting the material within said die and for ejecting the finished workpiece from said die, said die and at least the end portions of said plungers being substantially electrically non-conductive; an induction coil adapted when energized for establishing a magnetic fiield through the material within said die; and a source of high frequency electrical energy adapted for connecting to said coil; means for supporting one of said pressing plungers in spaced relation from said bed comprising strain rods, said bed having means for supporting said other pressing plungers, and means for reciprocating said pressing plungers comprising cylinders and pistons mounted on said strain rods and bed respectively.

3. In an apparatus for forming finished workpieces from metal powders; a substantially horizontal bed; a die supported on said bed having a cavity, a pair of plungers reciprocable in said cavity from opposite sides thereof; motor means for actuating said plungers for compacting the material within said die and for ejecting the finished workpiece from said die, said die and at least the end portions of said plungers being substantially electrically non-conductive; an induction coil adapted when energized for establishing a magnetic field through the material within said die; and a source of high frequency electrical energy adapted for connecting to said coil, means for supporting one of said pressing plungers in vertically spaced relation from said bed, said bed having means for supporting said other pressing plunger, said motor means including means for reciprocating said pressing plungers and comprising cylinders and pistons mounted on said supporting means and bed respectively.

LLOYD D. RICHARDSON.

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