Nov. 18, 1947. W. R. TUCKER 2,431,095

APPARATUS FOR HOT PRESSING POWDERED METAL

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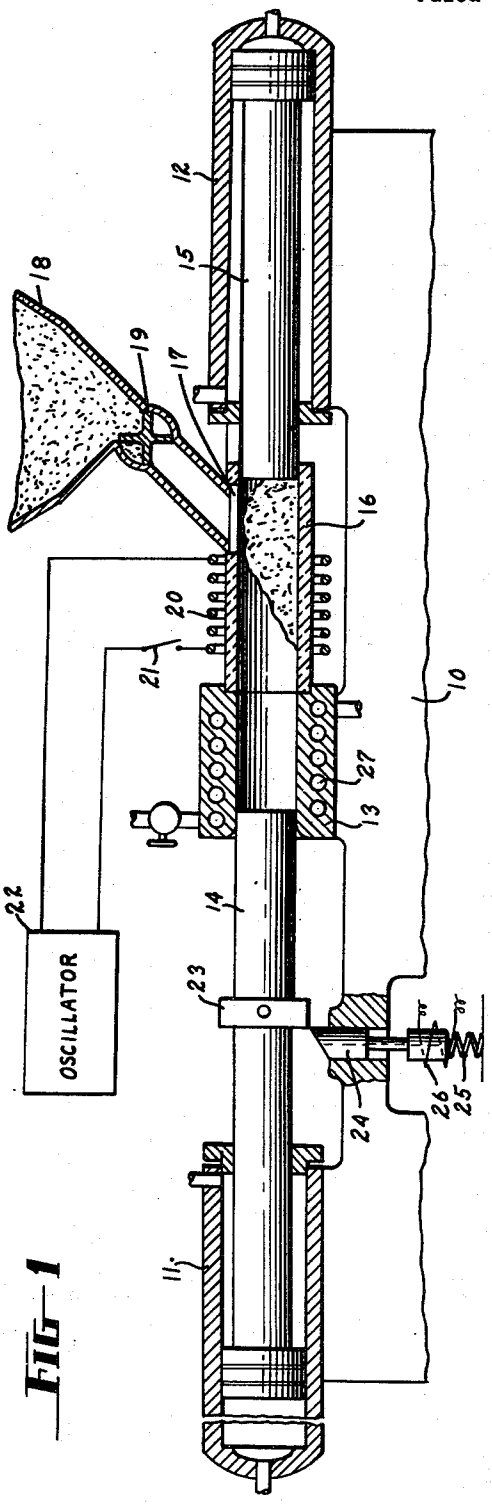


FIG. 1

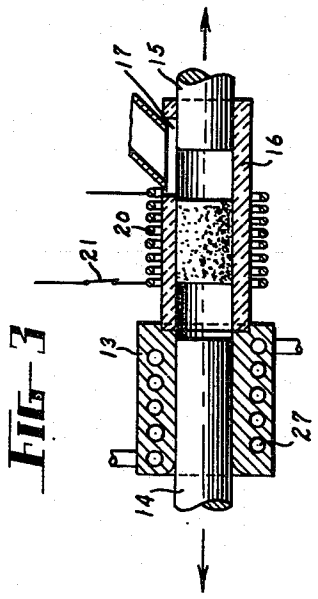


FIG. 3

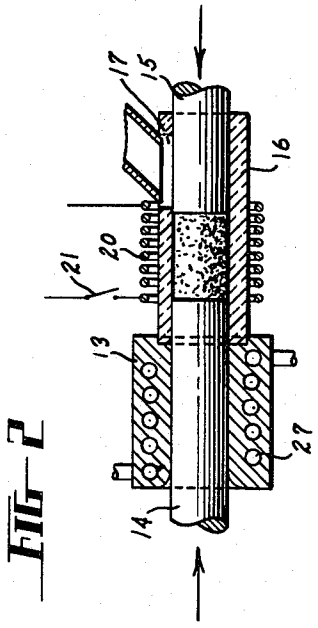


FIG. 2

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FIG-4

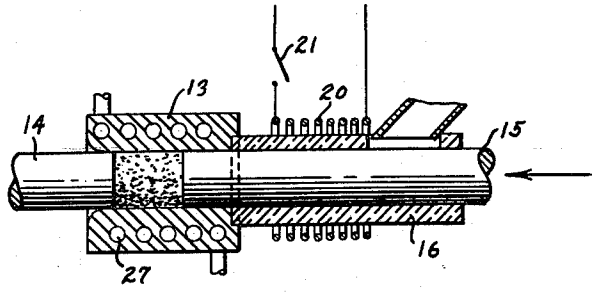


FIG-5

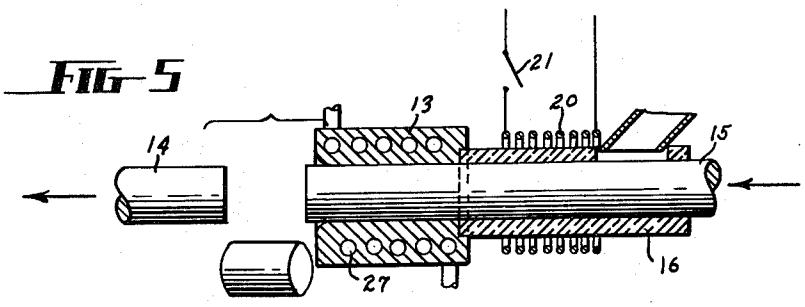


FIG-6

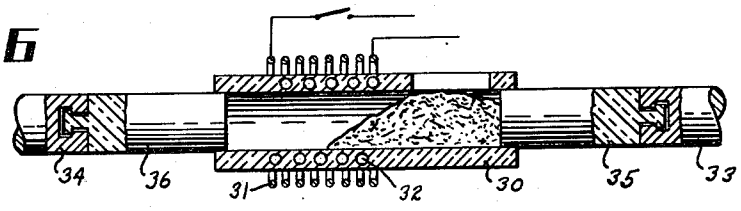


FIG-7

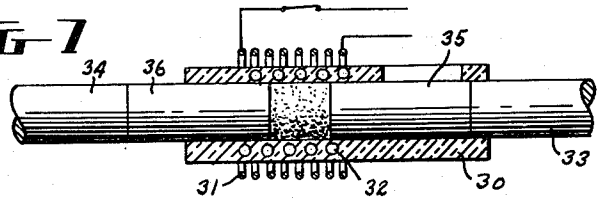


FIG-8

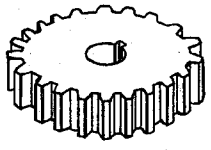
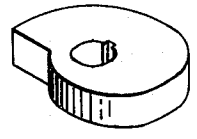


FIG-9



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APPARATUS FOR HOT PRESSING POWDERED METAL

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Application November 6, 1944, Serial No. 562,091

7 Claims. (Cl. 219—3)

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This invention relates to the art of forming workpieces from finely divided metallic particles or mixtures thereof with plastics or other binders.

This invention has for its particular object an improved method of heating and pressing the powdered material and includes the use of a high frequency electromagnetic field.

This invention will be clearly understood upon reference to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a press embodying the features of this invention;

Figures 2, 3, 4 and 5 are fragmentary views of the press of Figure 1 showing the operating part thereof during various stages of the pressing cycle;

Figure 6 is a view showing a modified construction;

Figure 7 is a view of the apparatus of Figure 6 in a different stage of the pressing cycle; and

Figures 8 and 9 are perspective views of typical workpieces adapted to be formed according to this invention.

General arrangement

According to this invention there is provided a die or mold within which the powdered metal is to be compacted. A pair of pressing members are adapted to be reciprocated relative to said die so as to accomplish the aforementioned compacting.

Associated with the die and at least one of the plungers is a heating chamber of insulating material such as ceramic or plastic within which the powdered metal is placed and heated. The heating is accomplished by an induction coil arranged around the heating chamber and connected to a suitable source of high frequency alternating current.

Optionally, the heating chamber may also be used as the die or mold, this being possible when the tensile strength of the insulating material used therein is sufficiently high to withstand the compacting force of the pressing plungers.

Structural arrangement

Referring to Figures 1 to 5, inclusive, there is shown, diagrammatically, a press comprising a bed 10 which has mounted on either end thereof the motors 11 and 12 and intermediate the said motors the die or mold member 13. The motor 11 is adapted to reciprocate a plunger 14 which enters the said die from the left end thereof, while the motor 12 is adapted to reciprocate the plunger

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15 which enters the said die from the right end thereof.

Arranged in coaxial alignment with the die 13 is a chamber 16 of electrical insulating material such as plastic or ceramic and preferably possessing high resistance to heat. The chamber 16 has a feed opening 17 which is adapted to receive material from the hopper 18 positioned above the said opening. The hopper 18 may include a means 19 for measuring the material into the feed opening 17 so that a predetermined charge of material may be placed within the heating chamber. The means 19 may measure the material by weight or volume as desired.

Arranged around the chamber 16 in any suitable manner is an induction coil 20 which is connected through a switch 21 with an oscillator 22 of suitable frequency and capacity for heating the material in the time desired. The coil 20 may comprise a hollow conductor which is water cooled or may comprise a solid conductor adapted to be air cooled, the particular job determining which type of coil will be used.

Attached to the plunger 14 is a collar 23 which is adapted, when the said plunger moves to the right, to cam over the plunger 24 which is spring urged toward the plunger 14 by the spring 25. A solenoid 26 is adapted, when energized, to withdraw the plunger 24 from engagement with the collar 23.

Referring now to Figure 6, there is shown a modified arrangement wherein the material is compacted within the heating chamber. In Figure 6 the heating chamber is constructed of a high strength plastic or ceramic material capable of withstanding the compacting force of the press plungers. The chamber 30 in Figure 6 may have associated therewith, in addition to the induction coil 31, the cooling passages 32 by which means the heating chamber and workpiece may be cooled following the pressing operation. The pressing plungers 33 and 34 may comprise end portions of insulating material indicated at 35 and 36 which are constructed of a material sufficiently strong to withstand the pressing force.

Referring to Figure 7, there is shown the apparatus of Figure 6 with the material compacted within the chamber 30 between the plungers 33 and 34 while the induction coil 31 is energized. It will be apparent that the portions 35 and 36 of the plungers 33 and 34 together with the chamber 30 provide an enclosure for the material which is completely electrically insulated.

In Figures 8 and 9 are shown typical workpieces which may readily be formed according to this

invention. Figure 8 is a gear or similar toothed member, while Figure 9 represents a cam or other similarly shaped workpiece.

Operation

The operation of the apparatus illustrated in Figure 1 is as follows:

Assuming the parts to be in the position shown in Figure 1, a predetermined charge of powdered metal or powdered metal mixed with a binder is fed into the chamber 16 from the hopper 18 by actuating the measuring means 19. After the material is placed within the chamber the motors 11 and 12 are actuated to move the plungers 14 and 15 into the heating chamber so that they occupy their Figure 2 position thus compacting the powder as indicated.

Following the compacting of the powder the plungers 14 and 15 are withdrawn and the switch 21 is closed thus energizing the coil 20 from the oscillator 22 and creating an electro-magnetic field through the compacted material as indicated by the dashed lines on Figure 3.

When the material has reached the proper temperature for the particles thereof to be alloyed together or sintered, the switch 21 is opened and the motor 12 is actuated to move the heated material into the die 13 and compact it therein against the plunger 14. The compacting step is illustrated in Figure 4. At this time the plunger 14 is retained in position by the engagement of the plunger 24 and collar 23.

After a predetermined time, during which, if desired, the die 13 may be cooled by passing a cooling medium through the passages 27, the solenoid 26 is energized to withdraw the plunger 24 from engagement with the collar 23 and the motor 11 is actuated to retract the plunger 14 leftwardly. The motor 12 is then effective to move the plunger 15 to the left thus ejecting the workpiece from the die 13. This stage of the pressing cycle is indicated in Figure 5.

Following the ejection of the workpiece the press parts may be returned to their Figure 1 position and a new cycle of operations commenced.

The operation of the apparatus indicated in Figures 6 and 7 is substantially the same as described in connection with Figures 1 to 5, inclusive, except that the plungers 33 and 34 are not retracted during the heating cycle but remain in pressing engagement with the workpiece so that the latter is compacted, heated and sintered in a single step. The chamber 30 may be cooled during or subsequent to the heating and sintering step by passing a suitable cooling medium through the passages 32 should it be desired.

The completed workpieces produced according to this invention have uniform density, are of substantially the correct size when ejected, are relatively free from scale and thus require a minimum of machine work to produce a high quality finished workpiece.

It will be apparent that various modifications could be made in the structure and arrangement without in any way departing from the spirit of this invention and, accordingly, I desire to comprehend such modifications and substitution of equivalents as may be considered to come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An apparatus for heating and compacting powdered metal comprising, a mold having a cavity therein, a heating chamber of electrical insulating material arranged in alignment with said mold cavity, a pair of pressing members adapted to enter said mold cavity and said heating chamber, an induction coil arranged around said heating chamber, means for actuating said pressing members so as to compact said powder within said heating chamber and thereafter to transfer the same into said mold cavity and compress it therein, and means for supplying electrical energy to said coil for heating said powder in said heating chamber.

2. In a press for compacting granulated metallic materials, a ceramic chamber for receiving said material, means for introducing a predetermined quantity of said material into said chamber, opposed plunger means operable at least partially to compact said material within said ceramic chamber, means including an induction coil arranged around said chamber energizable for inductively heating said granulated material to working temperature, a mold having a cavity therein adjacent said chamber, said plunger means being operable to transfer said material from said chamber to said cavity and to compact said material within said cavity, and means for ejecting the finished workpiece.

3. In a press for compacting divided materials at least a portion of which is metal, a mold of electrical insulating material, a pair of opposed pressing members of electrical insulating material reciprocable in said mold from opposite ends to compress material therein, feeding mechanism operable to introduce a predetermined quantity of said material into said mold between said members, means to actuate said members to apply working pressure on said material, and means comprising an induction coil arranged around said mold energizable for heating said material therein to sintering temperature while the said pressing members continue the said working pressures.

4. In a press for compacting divided materials a substantial portion of which is metal, a mold, a chamber of electrical insulating material adjacent said mold, said mold and said chamber having coaxial passages therethrough, a first and a second plunger adapted to enter said passages from opposite ends thereof, means for introducing a predetermined quantity of said material into said chamber, means selectively operable for actuating said plungers so as to compress said material within said chamber, means for heating said material to working temperature within said chamber comprising an induction coil arranged around said chamber and means of supplying electrical energy thereto, means selectively operable for actuating said plungers to transfer said heated material into said mold, and means for halting one of said plungers so as the same forms a bottom for said mold while moving the other of said plungers theretoward.

5. In a press for forming workpieces from granulated metals, a heating chamber and mold chamber of electrical insulating material for receiving charges of said granulated metals, an induction coil energizable to establish a field of electromagnetic induction in one of said chambers to heat the metal therein, and opposed pressing members movable in one of said chambers for exerting forming pressure on the granulated material therein, said pressing members being movable from opposite ends of said chambers.

6. Mechanism according to claim 5 in which the workpiece is ejected from the enclosure by the pressing members.

7. Mechanism according to claim 5 in which the pressing members have at least their end portions formed of electrical insulating material whereby they may exert forming pressure on the metal during the heating thereof without subtracting energy from the field of the coil.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,380,250	Reymond	May 31, 1921
2,355,954	Cremer	Aug. 15, 1944
2,362,701	Koehring	Nov. 14, 1944