May 29, 1956 H. P. REINHARDT 2,747,231

METHOD OF PRESSING POWDER COMPACTS

Filed Jan. 26, 1953

Fig. 1

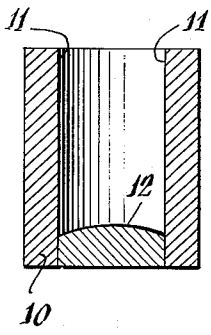


Fig. 2

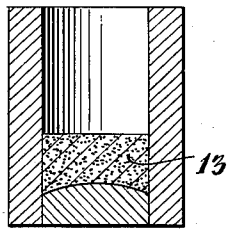


Fig. 3

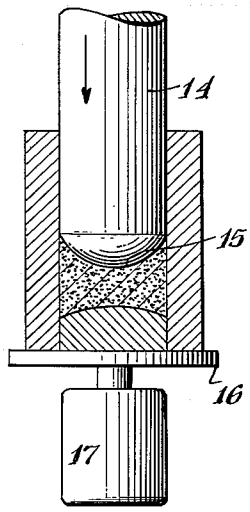


Fig. 4

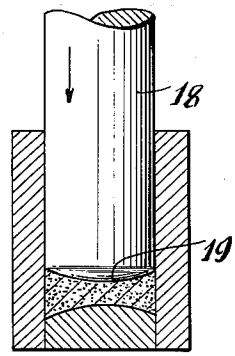


Fig. 5

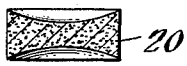
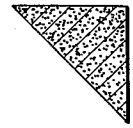


Fig. 6

Fig. 7

Fig. 8



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METHOD OF PRESSING POWDER COMPACTS

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4 Claims. (Cl. 18—59.3)

The present invention relates to the art of powder metallurgy and, more particularly, to a novel method of molding or pressing coherent bodies, or compacts, from metallic powder.

As is known, the manufacture of parts by pressed powder techniques is relatively simple when the part is of a simple, uniform or symmetrical shape. Considerable difficulties are experienced, however, when the part has an irregular or complicated shape, the thickness of which, measured in the direction of pressing, is greatly different in different regions. Parts of this character, when made by the conventional procedure of filling the die with metallic powder and striking off the excess powder will display a more or less non-uniform pressed density, depending upon the configuration incorporated in the die. Various expedients have been used to produce compacts of complicated shape to substantially uniform pressed density. These include pressing in several stages, spring-loaded punches, multiple punch motions, rubber dies, and the like. None of these prior procedures, however, is capable of satisfactorily producing on an industrial scale parts of continuously varying cross section of such configurations as will be described in the following.

It has been discovered that the outstanding problem may be solved in a remarkably simple manner.

It is an object of the present invention to improve the methods of molding compacts from powders, specifically from metallic powders.

It is another object of the present invention to provide a novel and improved method of pressing coherent bodies of complicated shape and having uniform pressed densities.

It is a further object of the present invention to provide a simple and efficient method of producing pressed compacts characterized by uniform densities throughout and having such complex shapes that they cannot be efficiently produced by any conventional method.

Other and further objects and advantages of the invention will appear from the following description and from the accompanying drawing, in which

Figures 1 to 4 are diagrammatic views, somewhat fragmentary in character, illustrating step-by-step the preferred manner in which the method of the invention may be practiced;

Figure 5 is a vertical sectional view of the finished compact made by the method of invention; and

Figures 6 to 8 are similar views of other complicated shapes which may be made by the method of the invention.

Broadly stated, in accordance with the principles of the present invention, the powder is prepositioned in the containing member or die in such a manner that upon subsequent pressing or compacting the pressed density will be substantially uniform throughout the compact. The correct amount of powder is placed in the containing member or die and then a preform member or punch is placed in the die on top of the powder.

The powder will then assume the shape of the cavity

defined by the die and the preform member, if it can be made to flow. According to the invention, this flow is accomplished by subjecting the die or container to mechanical vibrations. Light pressure, exerted by hand or other means, on this preform punch, while the die is being vibrated produces the desired positioning of the powder which will be caused to accurately conform to the shape of the cavity. The preform punch is then removed and the final compacting is made preferably by the use of a second pressing member or punch. Thus, the prepositioning of the powder in conjunction with the final pressing produces a finished compact which will have uniform pressed density throughout.

In general, the shape of the preform punch is so determined as to "pile" the powder to the proper depth prior to pressing or, in other words, that the powder prepositioned thereby, upon subsequent compression, establishes the desired final and uniform pressed density. Of course, the proper fill ratio of the powder must be known and in some cases it is desirable to make a few simple preliminary tests to determine the configuration of the preform punch that is most suitable for the purpose. Thus, depending upon the shape of the compact to be pressed, the shape of the preform punch may be similar to that of the pressing punch or may be completely different therefrom. In some rare instances the shapes of the preform and pressing punches may be identical although this is a rather remote possibility.

A great variety of vibrators available on the market may be used, such as so-called electronic vibrators, and the like. The frequency of the mechanical vibrations imparted to the die and thus to the powder is quite low, generally between 20 and 400 cycles per second although certain advantages are obtainable by subjecting the die or powder to high frequency vibrations where the increased cost of the equipment is not objectionable. While light hand pressure exerted on the preform punch is sufficient to cause the powder to flow and fill out the vibrated die cavity, mechanical means may be provided for producing such moderate pressure. Of course, the pressed compacts are subjected to further powder metallurgical operations, such as sintering and, in some cases, repressing, as those skilled in the art will readily understand.

Referring now to Fig. 1 of the drawing, reference numeral **10** denotes a die having straight side walls **11** and a convex bottom punch **12** inserted therein. As shown in Fig. 2, a measured amount of metallic powder is poured into the die to constitute a body **13** of loose powder therein having a substantially level top surface. A preform punch **14**, having a convex face **15** is now inserted into the die (Fig. 3) and the entire assembly is subjected to mechanical vibrations. As diagrammatically illustrated in the drawing, this is accomplished by placing the assembly on a table or platform **16** maintained in vibration by means of a vibratory motor **17**. Of course, the same result may be accomplished by various other types of conventional vibrators.

The vibration causes the powder to be set into motion, particularly adjacent to the die walls. As a result of this motion, assisted by light hand pressure applied to the preform punch, the cavity is completely filled with the powder **13** which is lightly compacted. The shape of the preform punch is so predetermined that the powder, as now prepositioned, upon subsequent compression, establishes the final pressed density. The preform punch **14** is then removed and a pressing punch **18**, having a convex pressure exerting face **19** is inserted (Fig. 4) whereby the final high pressure compacting of the part is accomplished. The finished compact **20** is shown in section in Fig. 5 and has concave top and bottom surfaces, which accurately conform to the corresponding surfaces **12** and **19** of the bottom punch and pressing punch respectively.

It has been found that a compart made according to the method of the invention is characterized by as nearly uniform pressed density as is commensurate with unidirectional or bidirectional pressing. The pressed compact may now be subjected to the usual sintering and possibly to a repressing operation. Of course, the method of the invention may be applied to the production of a great variety of irregular or complicated shapes, other than the one described in the foregoing, such as are shown in Figs. 6–8 of the drawing. For example, to press a compact having the shape shown in Fig. 6, it is preferred to use a die with straight side walls, similar to die **10** shown in Fig. 1 in combination with a bottom punch having a concave face. The preform punch is likewise of concave shape so that the prepositioned powder is confined between the straight side walls of the die and two concave punch surfaces. The pressing punch is provided with a flat pressing face so that the finished pressed compact will be characterized by a flat top surface combined with a convex bottom surface.

Although the present invention has been disclosed in connection with a preferred embodiment thereof, variations and modifications may be resorted to by those skilled in the art without departing from the principles of the present invention. All of these variations and modifications are considered to be within the true spirit and scope of the present invention, as disclosed in the foregoing description and defined by the appended claims.

What is claimed is:

1. The method of pressing from metallic powder a coherent body which comprises introducing a measured amount of the powder into a die, applying a preform punch of predetermined configuration against the top surface of said powder in the substantial absence of pressure, vibrating said die to cause the powder to flow and to assume the shape of the cavity defined by said die and punch, replacing said preform punch with a pressing punch of the desired configuration, and then pressing said powder into a coherent body, the shape of said preform punch being so determined with respect to that of said pressing punch as to "pile" the powder in each region of said preform punch in accordance with the fill ratio of the powder and the thickness of the pressed body in such region measured in the direction of pressing.

2. The method of pressing from metallic powder a coherent compart the thickness of which varies considerably in the direction of pressing which comprises introducing a measured amount of the powder into the die,

applying a preform punch against the top surface of said powder at a pressure not exceeding light hand pressure, subjecting the die to mechanical vibration to cause the powder to flow and to conform to the shape of the cavity defined by said die and punch, replacing said preform punch with a pressing punch having a shape corresponding to that of the desired compact, and then pressing said powder into a coherent compact of substantially uniform density, the shape of said preform punch being so determined with respect to that of said pressing punch as to "pile" the powder in each region of said preform punch in accordance with the fill ratio of the powder and the thickness of the pressed body in such region measured in the direction of pressing.

3. The method of pressing from metallic powder a coherent compact the thickness of which varies considerably in the direction of pressing which comprises filling the die with a measured amount of powder, placing a preform punch on the top surface of said powder, subjecting said die to mechanical vibration while applying pressure not exceeding light hand pressure to the punch to cause the powder to flow and to conform to the shape of the cavity defined by said die and punch, the shape of said preform punch being so correlated to the desired shape of the compact and to the proper fill ratio of the powder as to "pile" the powder in each region to the correct depth prior to pressing corresponding to the thickness of the finished compact in such region measured in the direction of pressing, replacing said preform punch with a pressing punch having a shape accurately corresponding to that of the desired compact, and then pressing said powder into a coherent compact of substantially uniform density.

4. The method of claim 3 wherein the frequency to which the die and powder is subjected is between 20 and 400 cycles per second.

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