Jan. 2, 1951 H. L. KREBS ET AL 2,536,689

METHOD OF MAKING SMALL METAL BODIES

Filed June 22, 1946

Fig. 1

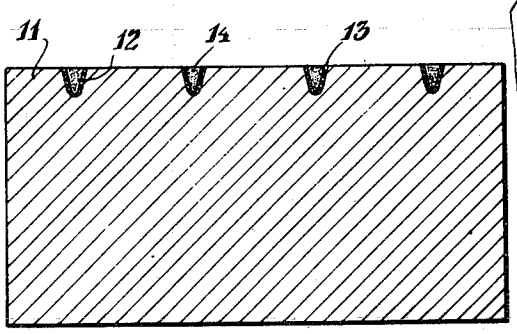


Fig. 2

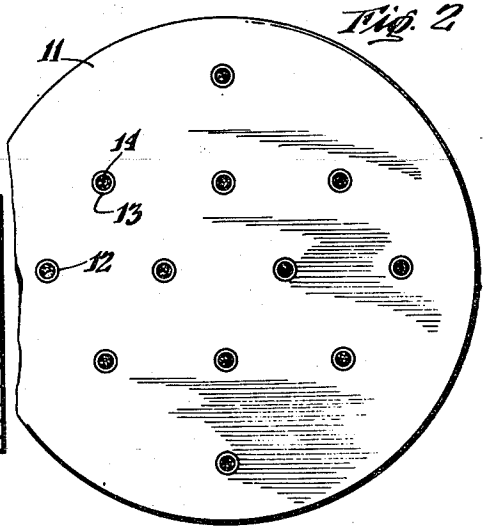


Fig. 3

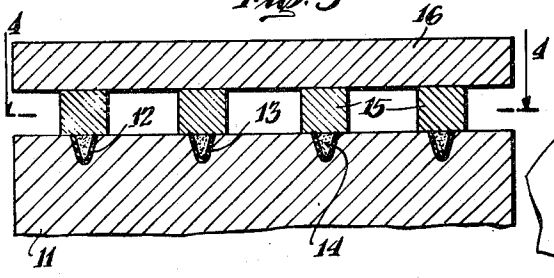


Fig. 4

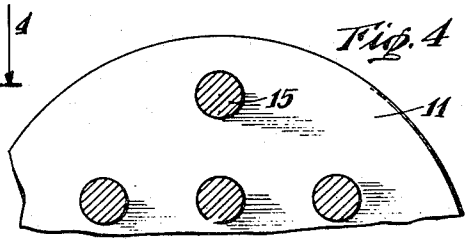


Fig. 5

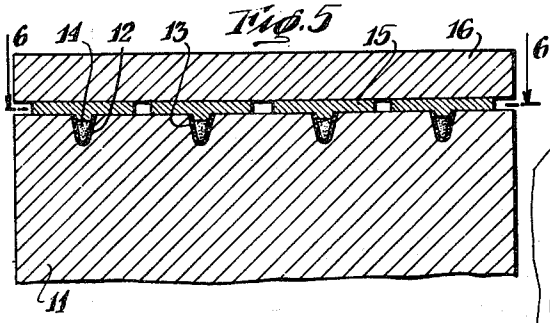


Fig. 6

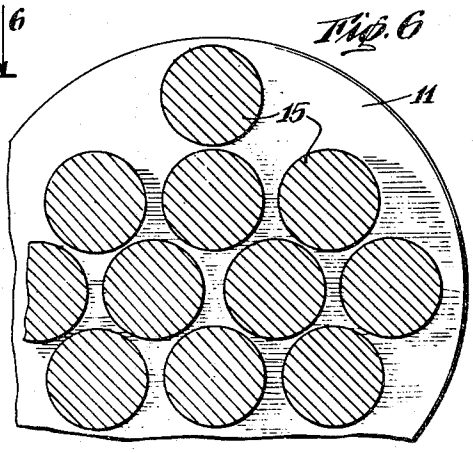
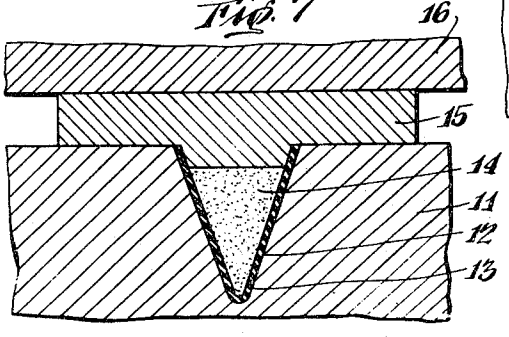


Fig. 7



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METHOD OF MAKING SMALL METAL BODIES

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Application June 22, 1946, Serial No. 678,610

6 Claims. (Cl. 29—160.5)

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This invention relates to a method of making small pressed parts such as phonograph needle tips, pen points, pivot bearings and points, cutting tips, contacts, and the like, and to an apparatus for carrying such method into practice.

This application is related to a copending application by Franz R. Hensel, Serial No. 637,032, filed December 22, 1945, entitled Method and Apparatus for Making Small Pressed Parts. In the said copending application, there is disclosed a method of and apparatus for the manufacture of small metal bodies which utilizes a soft metal layer to simultaneously transmit pressure onto several die recesses filled with metal powders whereby a large number of such bodies may be pressed or compacted in a single operation.

It is an object of the present invention to improve the method and apparatus disclosed in the said copending application.

It is another object of the invention to provide a method and apparatus for making small compacted and sintered metal bodies of predetermined size and shape having substantially uniform density and structure.

The invention also contemplates a novel and improved method of making small metallic parts by means of a powder metallurgical procedure which may be carried out on a quantity production scale at a low cost.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawing, in which:

Figure 1 is a vertical sectional view of a die provided with a plurality of die cavities adapted to carry the principles of the invention into practice;

Figure 2 is a top plan view of the die sectionally represented in Figure 1;

Figure 3 is a vertical sectional view of the complete pressing apparatus and is illustrative of an intermediate step in the method of the present invention;

Figure 4 is a horizontal sectional view, having parts in elevation, of the apparatus, taken on line 4—4 of Figure 3;

Figure 5 is a vertical sectional view of the apparatus when carrying out the final pressing step of the invention;

Figure 6 is a horizontal sectional view of the apparatus taken on line 6—6 of Figure 5; and

Figure 7 is an enlarged sectional detail view of a single die cavity and pressure slug as they appear after the final pressing operation.

In all the drawings the size of the die cavities has been greatly exaggerated for reasons of clarity.

Broadly stated, in accordance with the principles of the present invention, there is provided a lower die member or die plate made of a material having substantial strength and wear resistance such as tool steel. A plurality of die recesses or cavities is provided in the upper surface of the die, the said cavities having shapes corresponding to those of the bodies to be pressed but being slightly larger in size in order to compensate for the shrinkage occurring during the sintering operation.

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When carrying the method of the invention into practice the die cavities are coated with a suitable lubricant and are filled with the metal powders to be compacted. The powder-filled cavities are covered by individual tough and ductile metal slugs or pellets having diameters larger than those of the cavities and a plane and substantially non-deformable pressure platen is placed over the said slugs. Upon pressure being applied to the platen, such pressure is transferred to the individual slugs which are deformed or flattened and are caused to protrude to some extent into the die cavities. The lower portion of each slug will act as an independent and individual pressure plunger, automatically conforming to the surface of the die cavity and exerting powerful compacting pressure upon the metal powder mixture therein.

The compacted metal bodies may be readily removed from the die cavities by moderately heating the die thereby melting the lubricant coating and causing the bodies to drop out upon turning the die upside down. Thereafter, the compacted bodies are subjected to the usual powder metallurgical operations such as sintering, and the like. It has been found that metal bodies made in accordance with the described method are characterized by uniform density, microstructure and physical properties in general and that such properties can be accurately controlled and maintained in quantity production.

As shown in Figures 1 and 2, the apparatus of the present invention comprises a die plate 11 formed of an annealed tool steel blank into which cavities 12 of the desired shape are pressed by punches or other means. After the cavities have been formed, the die blank is heat treated to a hardness of about 60 Rockwell C and the cavities are polished and lapped to a mirror finish. This is necessary as rough surfaces in the cavities tend to give a rough surface to the pressed bodies and also make the removal of the said bodies after pressing more difficult.

The finished die cavities are preferably coated with a suitable fusible lubricant 13, for example with a 1% to 5% paraffin or stearic acid solution in carbon tetrachloride or other volatile solvent. The die is then tamped face down on a paper towel or other absorbent material and wiped free of excess lubricant.

After lubrication, the die cavities are filled with the required amount of metal powder mixture 14 by sifting the powder through a fine sieve into

the cavities with an alternate tapping and shaking motion and wiping off the excess powder. The resulting structure will clearly appear from Figure 2 which is a top view of the apparatus in Figure 1 showing an arrangement of die cavities coated with lubricant and filled with metal powder.

The filled die is now ready for pressing. As illustrated in Figure 3, over each die cavity there is placed a slug or pellet 15 of copper or any other tough and ductile metal which is readily extrudable. The slugs are preferably made of heavy copper wire, having a hardness of at least 50 Rockwell B, cut into short pieces. The hardness characteristics of the slug are quite important because the portion of the slug which is extruded into the die cavity must conform exactly to the shape of the die, and for best results, the surface of the slug in contact with the powder must be flat. In addition to copper, other metals or alloys which can be readily extruded may be used as the pressing medium; for example, aluminum, nickel, cold rolled steel, lead or silver. The necessary hardness, of course, depends upon the material used, but the metal should be about "three-fourths to full hard," as it is sometimes expressed in metallurgy.

After placing a slug in position over each of the powder filled cavities, a common pressure platen 16 is positioned over the slugs. The complete assembly is then inserted into a hydraulic press and pressure is applied ranging from about 50 to 100 tons per square inch.

As it will appear from Figures 5 and 6, during the pressing operation, the individual slugs 15 are flattened out and their lower portions are extruded into the corresponding cavities. The extruded portions of the slugs act as individual plungers which exactly conform to the shape of the die cavity and cause the metal powder to be pressed to the desired density. This is best shown in Figure 7 which is a greatly enlarged view of a single die cavity and cooperating slug after the pressing operation. From this figure the plane bottom surface of the extruded slug portion is clearly apparent.

It has been found that in order to obtain best results, it is desirable to prevent the circumferential surfaces of the slugs from touching each other during or after the pressing operation. This will be readily understood if it is considered that direct contact of adjoining slugs during pressing would interfere with further spreading of the slugs and with uniform extrusion of the slugs into the cavities. Direct lateral contact of the slugs may be easily avoided by proper spatial arrangement of the die cavities and by selecting suitable initial dimensions of the slugs. For the same reasons, the preferred initial shape of the slugs is cylindrical although various other shapes such as shapes of a square or hexagonal cross section could be used with equal or similar results. In general, the slugs are used only for a single pressing operation and the flattened and extruded slugs are discarded for scrap. This, however, does not appreciably affect the cost of practicing the invention in view of the low cost of the slugs which may be readily and inexpensively made in large quantities, for example, by chopping off short pieces from a wire of the proper diameter.

After pressing, the die with the pressed pieces still in the cavities is heated to about 50° C. to 100° C. to soften the lubricant which coats the surfaces of the cavities. The die is then inverted

and tapped lightly against a flat surface whereupon the pressed pieces fall out readily. The pressed compacts are then sintered by any one of several methods well known to those skilled in the art.

The size, shape and number of the cavities in the die will be determined by the type of the compact or pressed body and other manufacturing considerations. Thus, in the case of phonograph needle points, for example, a cone shape of the proper angle and height is required. In a practical die for making phonograph needle points the number of cavities was 21 and they were spaced $\frac{1}{2}\frac{1}{2}$'' (0.344'') apart from each other. The top diameter of the cone-shaped cavities was 0.064'' and their total depth was 0.081''. The side walls of the cavities enclosed an angle of 39 degrees and the bottom of the cavities was rounded out to a radius of 0.005''.

The composition of the metal powders is likewise subject to considerable variations in accordance with the specific application. A composition which was found to be very satisfactory for phonograph needle tips and similar small articles comprised 50% osmium, 34% tungsten carbide and 16% cobalt. The preferred sintering temperature for this composition was about 1450° C. A great variety of other metal compositions suitable for practicing the present invention is disclosed in the copending applications of Franz R. Hensel and Earl I. Larsen, Serial Nos. 637,031, and 663,954, filed December 22, 1945 and April 22, 1946, respectively, and entitled Metal Composition for Phonograph Needles and Hard Metal Compositions, respectively, both of said applications now abandoned.

It will be noted that the present invention provides various important advantages. Thus, the invention provides a method and an apparatus of great simplicity for making small pressed parts, such as phonograph needle tips, pen points, pivot bearings and points, cutting tools, and the like, characterized by great uniformity of density, microstructure and other desirable physical properties.

It is also to be observed that the method of the invention employing individual pressure slugs or pellets for each of a large plurality of die cavities represents a substantial advance over methods employing a single pressure layer for all of the die cavities in requiring lower compacting pressures and in compensating for small differences in the size and shape of the cavities and in the quantity of metal powder introduced into such cavities which are unavoidable in pressing metal bodies of greatly reduced dimensions.

Moreover, the invention is readily adaptable to pressing metal bodies of minute dimensions on a quantity production scale and at a very low cost. Practicing the method involves a minimum of manual handling of the individual bodies and yields compacts of heretofore unobtainable structural and dimensional uniformity.

While the present invention, as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

What is claimed is:

1. The method of forming powdered metal compacts which comprises providing a plurality of die recesses in a die plate conforming in shape to that of the compacts to be formed, filling said recesses with metal powder, covering each of said

powder filled recesses with a ductile metal pellet, and simultaneously applying pressure to said pellets to cause partial extrusion of said pellets into the recesses and compacting of the metal powder therein.

2. The method of forming powdered metal compacts which comprises providing a plurality of spaced die recesses in a plate, coating said recesses with a lubricant, filling said coated recesses with metal powder, covering each of said powder filled recesses with a slug of ductile metal having a diameter larger than the surface diameter of the recesses, placing a common pressure platen over said slugs, and applying pressure to said platen to cause progressive flattening of said slugs and their partial extrusion into the die recesses resulting in compression and compacting of the metal powder therein, the spacing of the die recesses being so determined with respect to the final diameter of the flattened slugs that direct lateral contact of adjoining slugs is effectively prevented during the pressing operation.

3. The method of forming small objects of powdered metals which comprises coating die recesses in a hard metal plate with a lubricant, filling said coated recesses with metal powder, placing a ductile copper slug having a hardness of 50 to 65 Rockwell B over each of said powder filled recesses, covering said slugs with a common pressure platen, and applying pressure to said platen to cause said slugs to be extruded into and the metal powder to be compacted in said recesses.

4. The method of forming powdered metal compacts which comprises providing in a plate at least one dies recess conforming in shape to that of the compacts to be formed and having a smooth inner surface, filling said recess with metal powder, covering said powder filled recess with a ductile metal pellet, applying pressure to the top face of said pellet to cause it to flow and to protrude to a limited extent into said recess and to accurately conform to the side walls thereof thereby to compact the metal powder in said recess, and then removing the compact from said recess for further treatment.

5. The method of forming powdered metal compacts which comprises providing in a substantially non-deformable die plate a plurality of recesses spaced from each other and having

shapes conforming to those of the compacts to be formed, filling said recesses with metal powder, covering each of said powder filled recesses with a metal slug of generally cylindrical character, simultaneously forcing a substantially plane pressure surface against the exposed faces of said slugs to cause their material to flow and to protrude to a limited extent into the respective recesses thereby to compact the powder therein, said slugs having such ductility and hardness as to accurately conform to the walls of the recess and to retain a substantially plane plunger-like surface in contact with the powder, and then removing the finished compact from said recesses for further treatment.

6. Apparatus for making compacts of powdered metals which comprises a hard metal die containing a plurality of recesses adapted to receive said powdered metal, a ductile copper slug positioned over each of said recesses, the diameter of said slugs being slightly larger than the surface diameter of the recesses and said recesses being disposed on the hard metal body so that the copper slugs, after being enlarged by compression against said die and said powdered metal, will not touch each other, a common pressure platen covering said slugs, and a coating of fusible lubricant on the walls of said recesses to facilitate removal of the pressed compacts from the recesses upon said die being heated.

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