April 6, 1937. G. F. TAYLOR 2,076,356

METHOD FOR MAKING WIRE DRAWING DIES

Filed Jan. 29, 1932

Fig. 1.

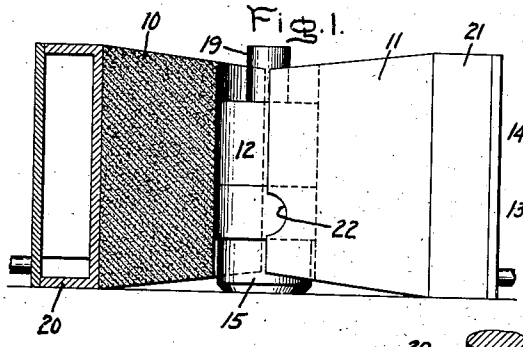


Fig. 2.

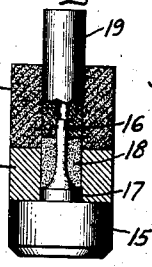


Fig. 3.

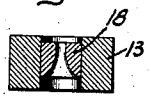


Fig. 4.

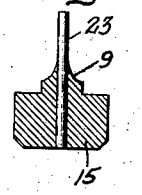


Fig. 5.

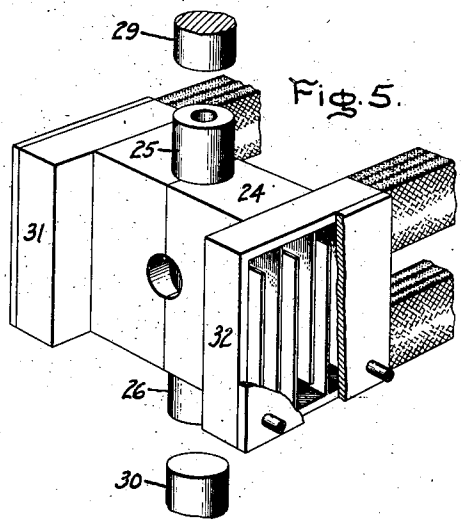


Fig. 6.

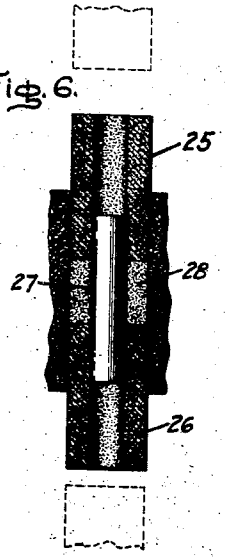


Fig. 7.

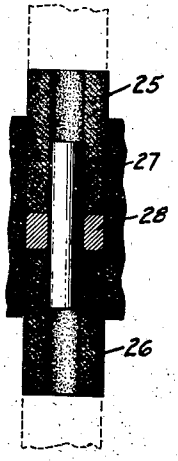


Fig. 8.

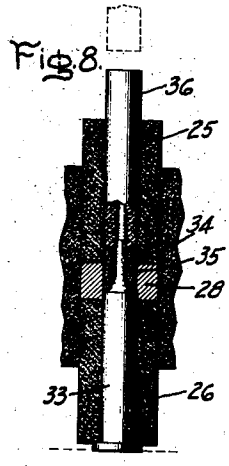
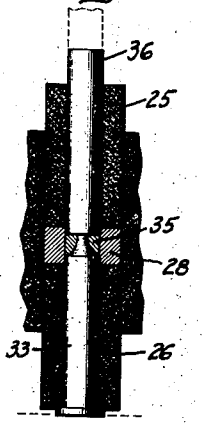


Fig. 9.



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METHOD FOR MAKING WIRE DRAWING DIES

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Application January 29, 1932, Serial No. 589,755

6 Claims. (Cl. 76—107)

The present invention relates to a method for fabricating wire drawing dies from powdered materials.

A wire drawing die usually comprises a central portion called the nib which is supported in a relatively heavy surrounding band of metal called the die-holder. Heretofore if the nib was made of cemented tungsten carbide or like material it was customary first to form the nib into a desired exterior shape by pressing a powdered mixture of a refractory carbide and binder element therefor, for example about 94% tungsten carbide and 6% cobalt, in a steel mold and under pressure of about 20–30 tons per square inch. The exterior shape of the pressed material was made slightly conical to permit easy removal from the mold. The shaped mass was sintered together at a temperature of about 900° C. for one-half hour to give it sufficient strength to permit handling. An opening was then drilled along the axis of the nib. The latter operation was accomplished by means of steel twist drills. Since cemented carbide is very hard material, even when sintered at a temperature as low as 900° C., the drilling operation was slow and the drills lost their edge quickly thereby necessitating frequent resharpening.

After the drilling operation the nib was usually sintered in a hydrogen atmosphere for about 1½ hours at 1400° C. This latter treatment formed the nib into an extremely hard product ready to be mounted in the die-holder. The latter was provided with a central opening of slightly greater diameter than the nib, the lower part of the opening being contracted to form a ledge or support for the nib. The nib was placed on the ledge and surrounded by a quantity of copper sufficient to substantially fill the gap between the nib and holder. The die was then placed in a hydrogen furnace and heated to about 1100° C. to braze the nib to the die-holder. Thereafter the die was removed from the furnace and placed in a lapping machine. By means of a mixture of abrasive materials and oils and the use of forming tools having suitable angles, the axial opening through the die was gradually worn away to a shape suitable for wire drawing purposes.

The prior process of manufacturing cemented carbide dies is a long one and must be carried out by experienced operators having special skill since the dimensions and contour of the opening through the die must be minutely accurate. Furthermore, it is not unusual to wear out several forming tools in providing the proper shaped opening through each die, the forming tools usually being made of relatively soft material such as iron.

It is one of the objects of the present invention to provide a simple, cheap and efficient process for manufacturing wire drawing dies from powdered materials and particularly from powdered materials consisting of a refractory carbide and a binder metal therefor. Other objects of the invention will appear hereinafter.

The novel features which are characteristic of the present invention are set forth with particularity in the appended claims. The invention itself however will best be understood from reference to the following specification when considered in connection with the accompanying drawing in which Fig. 1 represents a view partly in section and partly in elevation of an apparatus whereby my invention may be carried into effect; Fig. 2 is a view partly in section and partly in elevation of a portion of the mold disclosed in Fig. 1; Fig. 3 is a cross sectional view of a wire drawing die formed in accordance with the present invention; Fig. 4 is a cross sectional view of a modification of a portion of the apparatus disclosed in Fig. 2. Fig. 5 is a perspective view partly broken away of a modified form of apparatus which may be employed in carrying out my invention, while Figs. 6, 7, 8 and 9 are cross sectional views of a portion of a carbon mold disclosing successive steps employed in manufacturing both a die-holder and die nib from powdered materials.

Referring more particularly to the drawing, I have indicated at 10 and 11 a pair of graphite blocks each provided with cooperating semi-circular openings extending longitudinally therethrough to provide a cylindrical opening adapted to accommodate a mold designated as a whole by the numeral 12. The mold 12 comprises a hollow cylindrical metal die-holder 13 and a hollow graphite cylinder 14 the external and internal diameters of which are equal respectively to the external and internal diameters of the die-holder 13. A graphite plug or core member 15 closes the lower portion of the die-holder 13. The core 15 is provided with a stem 16 which is curved adjacent its lower end to have the exact contour of the opening desired in the die nib. Stem 16 is long enough to extend completely through the die-holder 13 and is enlarged at its lower end to provide a short cylindrical portion 17 having substantially the same diameter as the internal diameter of the die-holder 13.

In fabricating the die nib, the die-holder 13, graphite cylinder 14 and core 15 are assembled as

disclosed in Fig. 2. A mixture of powdered materials 18, for example tungsten carbide and cobalt or any desired mixture, is then placed in the mold. A graphite plunger 19 provided with a central longitudinal opening therethrough to accommodate stem 16 is then positioned in the cylinder 14 to apply pressure to the powdered mixture 18. The assembled mold is then placed between the carbon blocks 10 and 11 as indicated in Fig. 1. An electric current is supplied to the mold through a pair of water cooled terminals 20 and 21 connected to a suitable source of electric current supply. A current is employed which is sufficient to heat the powdered mixture 18 to its sintering temperature which in general is above 1000° C. With the apparatus disclosed the temperature of the powdered material cannot be observed directly but may be determined approximately from the temperature of the die-holder 13. For this purpose each of the blocks 10 and 11 is provided with a semi-circular opening 22 which openings cooperate to form a circular opening through which the temperature of the die-holder may be read directly with an optical pyrometer. As the powdered mixture is heated, pressure is simultaneously applied thereto through the graphite plunger 19 to thereby compress the powdered mixture 18 into a hard dense mass substantially free from voids. The pressure and heat are supplied for a few minutes only. During this time the powdered material comprising the nib becomes securely welded to the die-holder 13. After the sintering operation is completed the mold is taken apart and the die, after a simple polishing operation on the nib, is ready for use.

It is particularly desirable in a wire drawing die that the nib portion be non-porous and free from voids. This may be accomplished by employing graphite plunger 19, as heretofore pointed out, to compress the powdered mixture while it is heated at its sintering temperature. If, however, it is desired to insure the production of an extremely dense product this may be accomplished by employing higher pressures than may be employed with a carbon plunger. Under such circumstances the plunger 17 may be made of molybdenum, tungsten or any hard and refractory material such as quartz, alumina, magnesia, etc. When a metal plunger is employed it is necessary to prevent the plunger from becoming welded to the sintered material. This may be done by inserting a thin disc of fine grade carborundum paper between the powdered material and the plunger.

It is preferable to apply initially a gentle pressure to the powdered materials to prevent rupture of the graphite cylinder 14. As soon however as plunger 19 has entered the opening in the die-holder 13 the graphite cylinder 14 merely serves as a guide for the plunger 19 and great pressures can thereafter be applied to the heated materials since the force tending to rupture the mold is then applied directly to the metal die-holder 13.

After the die has been in use for some time and the nib has worn away so that the opening therethrough is too large it can be shrunk to a smaller size by placing the die between the graphite core 15 and graphite plunger 19, inserting the assembled members between blocks 10 and 11 and applying pressure to the die nib by means of the plunger 19 while the nib is heated to a temperature above 1000° C.

Although I have illustrated my invention in connection with tungsten carbide and cobalt the invention is not limited to these materials. Other refractory carbides, for example molybdenum carbide, tantalum carbide or columbium carbide or mixtures of carbides may be substituted for tungsten carbide. Furthermore other binder metals having a lower melting point than the carbide employed therewith, for example nickel or iron, or metals of the iron group in combination with metals such as molybdenum, tungsten, chromium or aluminum, may be substituted for cobalt.

I have illustrated the present invention in connection with a die having a circular opening therethrough. My invention however is not limited to dies having this particular opening. In accordance with my invention, dies with square, hexagonal or other shapes may be formed readily by employing a graphite or quartz core, corresponding to core 15, and shaped to have the contour desired in the finished die nib.

The graphite core 15 disclosed in Fig. 2 is made in one piece. In certain cases however, where the diameter of the opening through the nib to be fabricated is very small, for example about 60 mils or less, it may be desirable to form the stem portion of the core from quartz. A core of this character is disclosed in Fig. 4 in which a quartz stem 23 extends through the core 15 and cooperates with the lower curved portion 9 of the stem portion thereof.

The die-holder 13 is preferably made of molybdenum or an alloy thereof and may be fabricated in several ways. It may for example be made from a sintered bar. The latter may be swaged into a round shape and cut into portions having the desired thickness. These portions are then drilled to provide a ring shaped structure such as shown at 13 in Figs. 2 and 3. I prefer to form the die-holder from powdered molybdenum or a mixture of powdered molybdenum with other metal. This may be accomplished with the apparatus disclosed in Figs. 5–9 inclusive. In these figures I have disclosed a split graphite mold 24 the opposite contacting portions of the mold being provided with semi-circular openings which cooperate to provide a central opening in which hollow cylindrical graphite plungers 25 and 26 may be inserted.

In manufacturing the die-holder 13 from powdered material, plunger 26 is first inserted in a graphite mold and a graphite rod 27 inserted in the opening in the plunger 26 as indicated in Figs. 6 and 7. Enough powdered material 28 to form the die-holder is then placed on top of the plunger 26 and around the rod 27. Graphite plunger 25 is then slid over the rod 27 and into contact with the powdered material. Pressure is then applied to the hollow plungers 25 and 26 by means of movable pressure members 29 and 30 indicated in Fig. 5. At the same time that pressure is applied to the powdered material an electric current of sufficient intensity to sinter the powdered material is supplied to the carbon mold through water cooled terminals 31 and 32.

When the powdered material has been pressed and sintered as indicated in Fig. 7 the assembled plungers 25 and 26 and rod 27 are removed from the mold 24 and the rod 27 pushed out of the plungers 25, 26 and die-holder 28. A graphite plug or core 33, similar to core 15 and the upper end of which has a projecting stem 34, is then inserted through the graphite cylinder 26 and the sintered die-holder 28. The lower end of the projecting stem 34 is shaped to have a contour

similar to that desired in the finished die nib. Powdered material **35**, which may be a mixture of tungsten carbide and cobalt or other suitable material, is now inserted on top of plug **33** and around stem **34** and a plunger **36** inserted in the graphite cylinder **25**. The assembled cylinders and die-holder and powdered material are then placed within the mold **24** and pressure applied to the plunger **36** while the powdered material **35** is simultaneously heated to its sintering temperature by means of current supplied through the terminals **31** and **32**.

When the die-holder is made from powdered material, it is not only possible to carry out the manufacturing operation quickly and efficiently but there is an added advantage in that the die-holder may be made from combinations of various powdered materials which will provide a die-holder having substantially the same coefficient of expansion as the nib portion of the die. For example, a die-holder consisting of molybdenum and tungsten may be employed with a die nib having a composition of about 87% tungsten carbide and 13% cobalt, or a composition of 94% tungsten carbide and 6% cobalt. The 13% cobalt composition has a coefficient of expansion slightly higher than that of molybdenum while the 6% cobalt composition has a coefficient slightly below that of molybdenum. The addition to the molybdenum of a suitable amount of tungsten powder, which has a coefficient of expansion below either of the above compositions of tungsten carbide and cobalt, would give any desired coefficient between these two extremes. This is particularly important since the die nib may crack at the boundary betwen the nib and die-holder unless the coefficient of expansion of the two are substantially identical.

A die made in accordance with my process has several advantages, for example a great saving may be effected in the time required to make the die due to the elimination of many operations heretofore necessary in the fabrication of cemented carbide wire drawing dies. Furthermore the angular contour of the die nib may be formed exactly so that very little lapping is necessary to prepare the die for wire drawing operations. The hole through the nib is exactly concentric and coaxial with the holder and the nib is made an integral part of the holder so that copper brazing or shrinking is not necessary. Moreover, the nib does not require a supporting ledge on the holder since it is integrally joined to the latter member.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of forming a wire drawing die comprising a die holder and nib which comprises compressing the powdered ingredients comprising said nib within said die holder and between a plunger and a non-metallic plug while said ingredients are heated to their sintering temperature, said plug being provided with a central non-metallic stem extending through said die holder and having substantially the contour desired in the finished nib and removing said plug and stem.

2. The method of forming a wire drawing die comprising a die holder and nib which comprises compressing the powdered ingredients comprising said nib within said die holder and between a plunger and a non-metallic plug while said ingredients are heated to their sintering temperature, said plug being provided with a central non-metallic stem extending through said die holder and having substantially the contour desired in the finished nib and removing said plug and stem, said powdered ingredients consisting substantially of a refractory carbide and a cementing metal therefor, said cementing metal having a lower melting point than said carbide.

3. The method of forming a wire drawing die comprising a die-holder and nib which comprises inserting within a die-holder of uniform internal diameter a non-metallic core provided with a stem having substantially the contour desired in the finished nib, said core serving as a closure member for one end of the die-holder and pressing a powdered composition positioned within said die-holder and around said stem while said composition is heated at a temperature above 1000° C.

4. The method of forming a wire drawing die comprising a holder having a bore of substantially uniform diameter and a nib portion which comprises positioning a non-metallic plug in one end of said bore to form a closure therefor, said plug being provided with an upwardly extending stem having substantially the contour desired in the finished nib, placing powdered material within said bore and on said plug, applying pressure to said powdered material, heating the pressed material to its sintering temperature, and removing said plug from the sintered nib.

5. The method of forming a wire drawing die comprising a holder having a bore of substantially uniform diameter and a nib portion which comprises positioning a non-metallic plug in one end of said bore to form a closure therefor, said plug being provided with an upwardly extending stem having substantially the contour desired in the finished nib, placing powdered material within said bore and on said plug, heating said holder and powdered material to an elevated temperature, simultaneously applying pressure to the powdered material only to thereby weld it to said holder, and then removing said plug.

6. The method of forming a wire drawing die comprising a molybdenum holder having a bore of uniform diameter and a cemented carbide nib portion which comprises positioning a non-metallic plug in one end of said bore to form a closure therefor, said plug being provided with an upwardly extending stem having substantially the contour desired in the finished nib, placing mixed powdered ingredients comprising said cemented carbide nib within said bore and on said plug, simultaneously applying heat and pressure to said mixed powdered ingredients to simultaneously sinter the mixture and weld it to said holder, and removing said plug from the sintered nib.

GEORGE F. TAYLOR.