May 10, 1966 B. W. SMITH 3,250,163

RULE DIE HAVING A POWDERED METAL BODY

Filed April 6, 1964 2 Sheets-Sheet 1

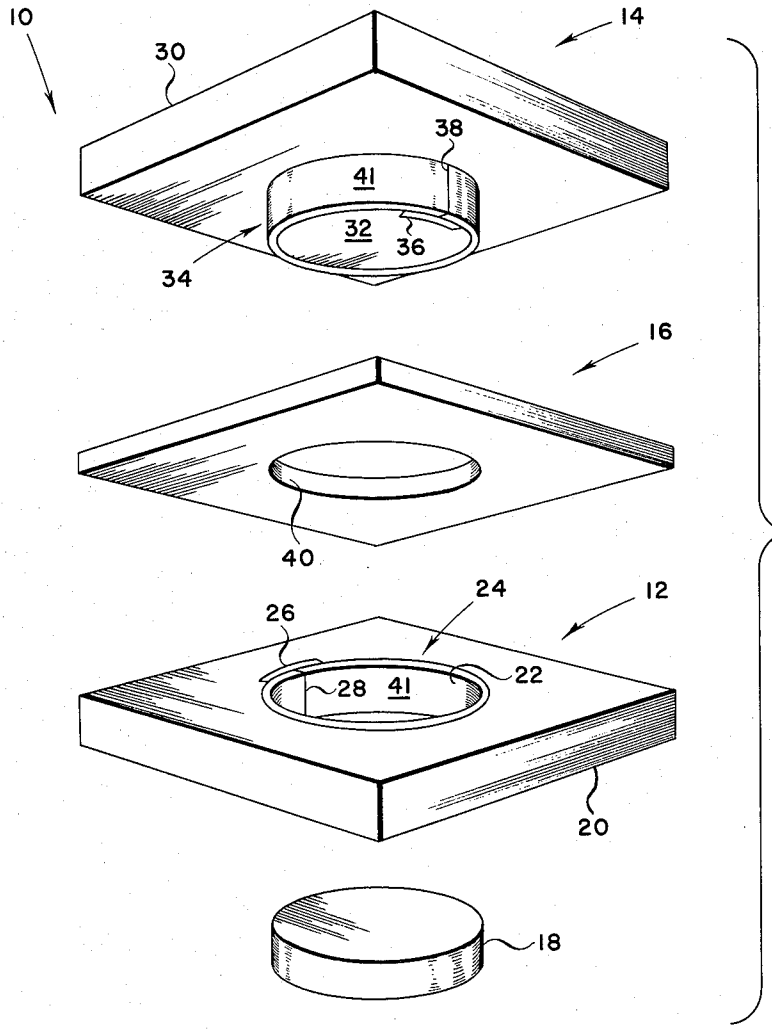


FIG. 1

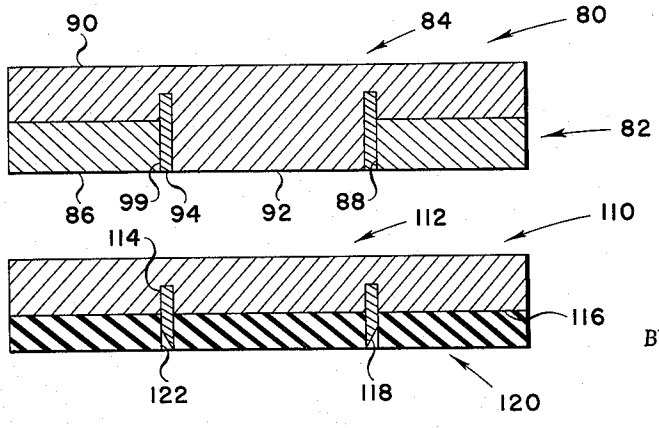


FIG. 6

FIG. 4

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FIG. 2

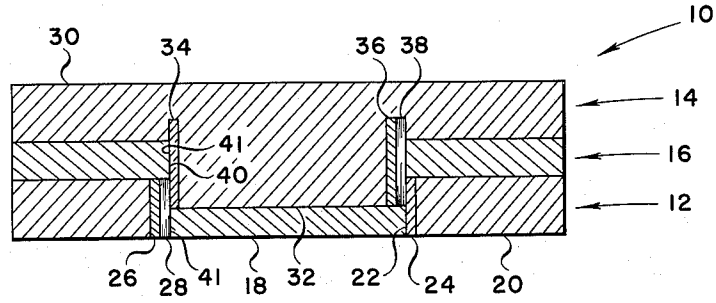
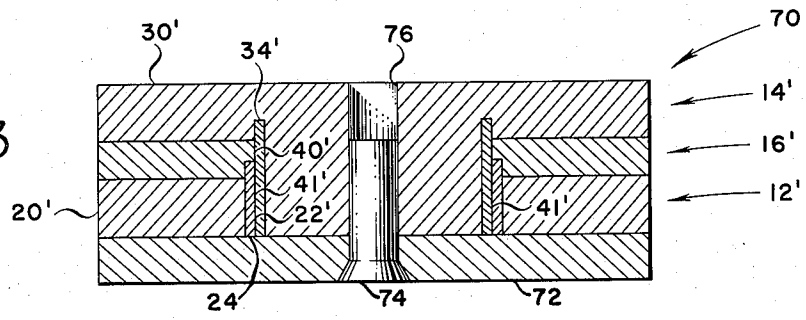



FIG. 3



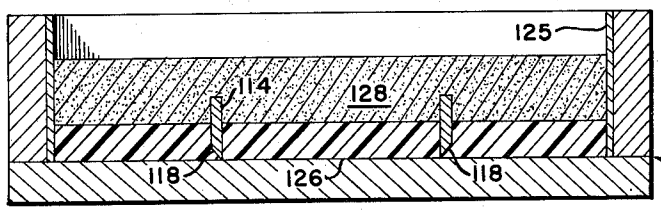




FIG. 5

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# RULE DIE HAVING A POWDERED METAL BODY

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7 Claims. (Cl. 83—139)

This invention pertains to new and improved dies and die sets of the so-called "rule" type. This invention also pertains to new and improved methods of producing such dies and die sets.

At the present time it is normally considered that so-called "rule" dies are advantageous for use in many different types of operations because of their cost, effectiveness and longevity. In different industries the terms "die" and "die sets" are frequently used with respect to so-called rule type dies in a somewhat confusing manner. Thus, in metal working fields the term "die" is frequently utilized to designate an element having an opening formed therein, and such an element is utilized with a punch which fits within the opening. If the perimeter of the punch is surrounded by a steel rule like element the punch and die are normally referred as a "rule type" die set in these fields. In such a die set the opening in the die part may be surrounded by such a rule like strip, and various auxiliary elements or parts can be employed. In other fields such as the paper industry a "rule type" die is considered to consist essentially of a steel rule like strip mounted on a support.

Such a rule type die set or die is normally formed by bending a relatively hard strip of metal or rule such as steel to a desired shape, and then mounting the strip of metal upon a block of wood cut to a corresponding shape. This procedure is considered to be unnecessarily time consuming and expensive, particularly when it is followed in the manufacture of die or die set having an intricate shape. A number of efforts have been made to provide other methods for the manufacture of so-called rule type dies. As an example of this, it has been suggested to cast with respect to a rule having a desired shape a support out of any one of a number of various different materials. It is considered that dies resulting from this generalized procedure are relatively undesirable because of factors such as die-life and the like.

An object of the present invention is to provide new and improved rule type dies and die sets which overcome various limitations and disadvantages of known rule type dies and die sets such as are briefly described in the preceding discussion. Another object of the present invention is to provide rule type dies and die sets in which desired dimensions such as clearance between a metal working die and punch can be achieved without difficulty. A further object of the present invention is to provide dies and die sets as herein indicated which are relatively inexpensive and which are capable of being used for prolonged periods without difficulty.

An object of this invention is also to provide new and improved methods for producing so-called rule type dies and die sets. A related object of this invention is to provide methods of this purpose which are relatively inexpensive to carry out, which may be practiced with a minimum amount of difficulty and which produce satisfactory dies and die sets capable of being handled without breakage and capable of being used over prolonged periods.

These and various other objects of this invention as well as many specific advantages of it will be more apparent from a detailed consideration of the remainder of this specification, the appended claims and the accompanying drawings in which:

FIGURE 1 is an exploded view showing various parts of a die set of this invention in perspective;



FIGURE 2 is a cross-sectional view of the die set shown in FIGURE 1 with the parts of this die set in an assembled position;

FIGURE 3 is a cross-sectional view similar to FIGURE 2 of a modified die set of this invention;

FIGURE 4 is a cross-sectional view similar to FIGURE 2 of a die of this invention; and

FIGURE 5 is a cross-sectional view showing a step in the manufacture of the die shown in FIGURE 4.

Those skilled in the art of the manufacture and design of rule type dies and die sets will realize from a consideration of the drawings that these drawings are primarily intended so as to illustrate for explanatory purposes the principles of this invention. For this reason the accompanying drawings are not to be considered as limiting the scope of the present invention. The essential features of the present invention are considered to be defined or summarized by the appended claims forming a part of the present disclosure.

In order to facilitate an understanding of this invention it can be indicated in a summary manner that it concerns dies or die sets in which rule type cutting, shearing or blanking elements are supported and bonded to what may be termed "powder metal" supports. In accordance with this invention metal powder is located with respect to a rule type die element or part and is then compacted with respect to this part and then both the compacted body and the rule type element together are treated so as to bond the metal powder into a metallic, rigid assembly.

The invention is best more fully explained with reference to drawings. In FIGURES 1 and 2 there is shown a rule type die set **10** of the present invention which consists of a die element **12**, a punch element **14**, a stripper plate **16** and a knockout plate **18**. The die element **12** includes a rigid unitary "powdered metal" body **20** having an internal opening **22** formed therein. This opening **22** is bounded by a metal strip or rule **24** as a steel "rule," all parts of which are parallel. A splice plate **26** of the same material as the rule **24** is preferably welded to the exterior of this rule so as to hold its ends **28** with respect to one another. The rule **24** and the plate **26** are bonded to the body **20** in the die element **12** as hereinafter described.

The punch element **14** includes a punch plate **30** from which there projects a punch core **32**. Both the plate **30** and the core **32** are formed of the same material as the body **20**. This core **32** is surrounded by a rule **34** corresponding to rule **24**. The rule **34** is welded to a plate **36** which is used to secure its (the rule **34**) ends **38** to one another. The plate **36** thus corresponds to and is of the same character as the plate **26** previously described. The rule **34** is formed so as to have a parallel sided exterior which is capable of fitting closely within the interior of the opening **22** along the rule **24**. The rule **34** extends a short distance into the punch plate **30** and is bonded to both this punch plate and the punch core **32** as hereinafter indicated.

The stripper plate **16** forming a part of the die set **10** is of a flat configuration and is provided a centrally located opening **40** capable of fitting around the rule **34** on the punch element **14**. This stripper plate **16** is preferably of a thickness which is less than the distance the rule **34** projects from the punch plate **30** so as to be capable of being located as shown in FIGURE 2 between the punch element **14** and the die element **12** when the punch core **32** is positioned within the opening **22**. The knockout plate **18** employed with the die set **10** is of a disc-like shape, and is capable of being inserted through the opening **22** in the die element **12**.

The complete die set **10** can be manufactured by first creating the rules **24** and **34** to a desired shape in ac-

cordance with conventional practice. The surfaces **41** of the rules **24** and **34** which are located opposite one another are then preferably coated with a release agent (not numbered on the drawings) such as titanium dioxide. This or various equivalent oxides can be secured in place through the use of a conventional "clear" lacquer such as a lacquer consisting of nitrocellulose dissolved in a suitable solvent. Such agents prevent bonding during subsequent sintering.

At the present time it is preferred to utilize finely divided iron or steel powder entirely in forming a die set such as the set **10** indicated. Such powder is of the type commonly used in the so-called "powder metal" field and is described in detail in a great number of technical publications. This type of material is preferred because of its availability, the fact that it can be easily utilized in the process and because of the strength of a body or plate produced from it. If desired however, various other powder metal type elements or alloys can be utilized.

The compaction step employed should, of course, utilize a pressure which is sufficiently great so that the various quantities of powder metal indicated are rendered sufficiently strong to withstand handling prior to sintering as a result of this step. In general it is preferred to utilize pressures which will eliminate as many of the voids within each of the bodies indicated as reasonably possible. With the use of powdered iron as indicated in the preceding pressures of from 30 to 70 tons per square inch have been found to give satisfactory results.

With this same type of material the sintering operation used in completing the die set **10** is preferably carried out in accordance with standard metallurgical practice as a temperature of from 1900° F. to 2250° F. in an inert or reducing atmosphere. Such a sintering step is, of course, carried on for a sufficiently long period so as to develop as much strength in a "powdered metal" body as is reasonably possible, and after it is finished the body is, of course, cooled to room temperature under conventional conditions in the powdered metal art. These generalized conditions apply if other powdered metals than powdered iron are used with this invention.

The die set **70** differs from the die set **10** by omitting the knockout plate **18** previously described. It includes a conventional metal such as steel die plate **72**. This die plate **72** carries a conventional piece punch **74** formed out of rigid metal. The punch **74** extends from the die plate **72** into the interior of the opening **22'**. The die plate **72** is secured to the body **20'** of the die element **12'** as hereinafter described. The punch plate **30'** and the punch core **32'** are formed so as to include an opening **76** into which the pierce punch **74** closely fits.

In FIGURE 8 of the drawing there is shown a die **110** of the rule type such as is employed in paper and other industries in cutting cardboard or various sheet materials having somewhat analogous physical characteristics. This die **110** consists of "powdered metal" die base **112** which is bonded to a die type rule **114** of steel or other material. This die **114** extends from the surface **116** of the base **112**. If desired the projecting end of it may be provided with a beveled cutting surface **118**. To the surface **116** there is bonded a conventional resilient rubber polyurethane or similar resilient layer **120** serving as a stripper element. This layer **112** is bonded in place by conventional adhesive (not shown), it is provided with openings **122** in the nature of slits which accommodate portions of the rule **114** extending from the base **112**.

During the manufacture of the die **110** the rule **114** is inserted within a mold **124** lined with sheets **125** of parting material as shown in FIGURE 9 of the drawings. This rule **114** is then secured in place by casting an incompressible material capable of being easily removed into a layer **126** corresponding approximately in depth to the desired thickness of the layer **120**. Various common waxes such as beeswax can be used in creating the layer **126**; various other comon commercial casting preparations capable of being easily broken or removed by melting or by being placed in solution can be used in order to form the layer **126**. After the layer **126** becomes hard a quantity **128** of powder metal is located upon it as shown.

After these operations the quantity **128** is compacted as previously described, and then is removed from the mold **124**. At this point the layer **126** may be removed in any manner appropriate to the composition of this layer; if it is of a volatile character capable of being volatilized at an elevated temperature it may be left in place. Next the structure removed from the mold **124** is sintered as described in the preceding. After such sintering the complete die **110** may be finished by coating the surface **116** with an adhesive and pressing the layer **120** into it. During such pressing, the openings **122** will be automatically created.

From a detailed consideration of this specification those skilled in the art of the manufacture and design of rule type dies and die sets will realize that dies and die sets as herein described can be produced relatively inexpensively and that these die sets are capable of being employed for prolonged periods without difficulty. They will also realize that the methods herein described are relatively inexpensive to carry out and that they may be practiced with a minimum of difficulty.

I claim:

1. A die set including:
(a) die element and a punch element;
(b) said die element comprising:
(c) a powdered metal unitary body having a centrally located opening formed therein;
(d) said punch element comprising:
(e) a "powdered metal" punch plate having an integral punch core extending therefrom and
(f) a die rule extending into said punch plate and surrounding said core;
(g) said rule being bonded to said punch plate and said core;
(h) said rule fitting closely within the interior of said opening in said body.

2. A die set including:
(a) a die element and punch element;
(b) said die element comprising:
(c) a "powdered metal" body having an opening formed therein;
(d) a die type die rule bounding the interior of said opening, said die rule being bonded to said body;
(e) said punch element comprising:
(f) a rigid unitary "powdered metal" punch plate having an extending punch core;
(g) a die type punch rule surrounding the periphery of said core and extending into the interior of said punch plate;
(h) said punch rule being bonded to said core and said punch plate;
(i) said punch rule being capable of fitting closely within said die rule.

3. A die set as defined in claim **2** including a stripper plate having an opening formed therein capable of being located between said body and said punch plate with said punch core and said punch rule extending through the opening in said stripper plate.

4. A die set including:
(a) a die element, a punch element and a knock-out plate;
(b) said die element comprising:
(c) a rigid, unitary "powdered metal" body having an opening formed therein;
(d) a die type die rule bounding the interior of said opening;
(e) said die rule being bonded to said body;
(f) said punch element comprising:

(g) a rigid, unitary "powdered metal" punch plate having an extending punch core;
(h) a die type punch rule surrounding the periphery of said core and extending into the interior of said punch plate;
(i) said punch rule being bonded to said core and said punch plate;
(j) said punch rule capable of fitting closely within said die rule;
(k) said knock-out plate being capable of fitting within said opening.

**5.** A die set as defined in claim **4** including a stripper plate having an opening formed therein, said stripper plate being capable of being located between said body and said punch plate with said punch core and said punch rule extending through the opening in said stripper plate.

**6.** A die set including:
(a) a die element and a punch element;
(b) said die element comprising:
(c) a die plate;
(d) a punch mounted on said die plate so as to extend from one side thereof;
(e) a "powdered metal" die body having an opening formed therein;
(f) located on said side of said die plate so as to extend therefrom with said opening being located around said punch;
(g) a die type die rule located on said die plate so as to bound the interior of said opening;
(h) said die body being bonded to said die plate and said die rule;
(i) said punch element comprising:
(j) a punch plate having a punch core, said punch plate and said punch core being integral with one another and being of "powdered metal";
(k) a die type punch rule extending around the periphery of said core and into the interior of said punch plate;
(l) said punch rule being capable of fitting closely within said die rule;
(m) said punch rule being bonded to said punch plate and said core;
(n) a hole formed in said core and said punch plate for receiving said punch when said core is located within said opening in said die element.



**7.** A die set as defined in claim **6** including a stripper plate having an opening formed therein, said stripper plate being capable of being located between said body and said punch plate with said punch core and said punch rule extending through the opening in said stripper plate.


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