Sept. 26, 1967 C. H. HAAS ETAL 3,343,430

METHOD OF MAKING METAL FORMING DIES

Filed Dec. 15, 1965

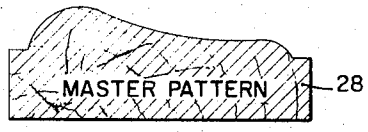

Fig. 7

Fig. 2

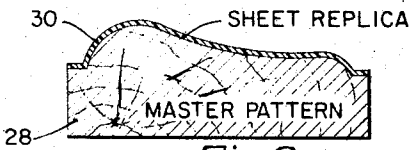

Fig. 8

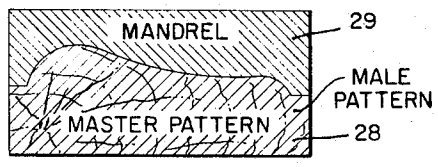

Fig. 3

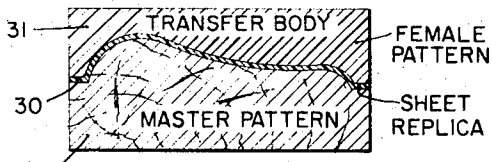

Fig. 9

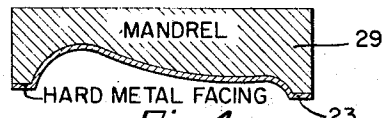

Fig. 4

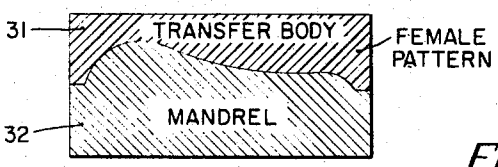

Fig. 10

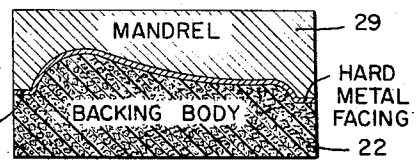

Fig. 5

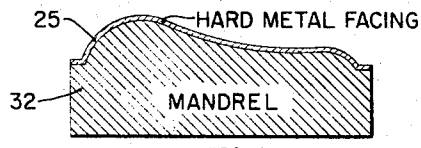

Fig. 11

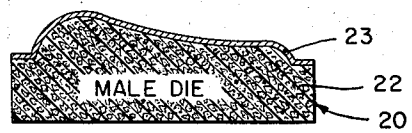

Fig. 6

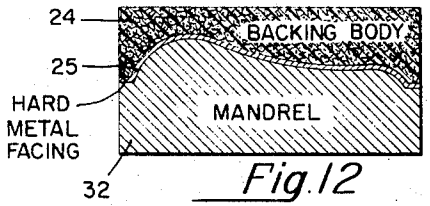

Fig. 12

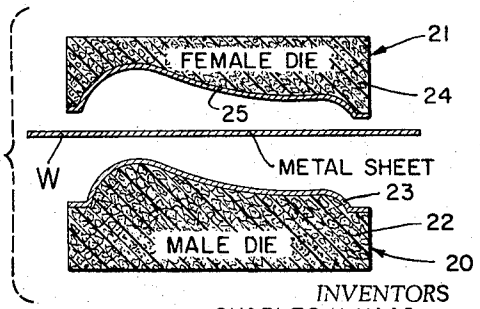

Fig. 1

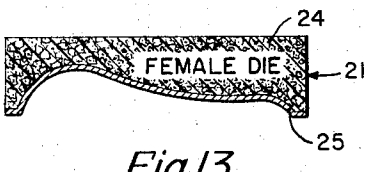

Fig. 13

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United States Patent Office 3,343,430
Patented Sept. 26, 1967

3,343,430

METHOD OF MAKING METAL FORMING DIES

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Filed Dec. 15, 1965, Ser. No. 514,093
1 Claim. (Cl. 76—107)

ABSTRACT OF THE DISCLOSURE

A process for fabricating a thin shelled die upon a backing body, in which a master pattern is utilized to form a mandrel of disposable material. A thin shell of material is conformed to the mandrel and while the same is in place thereon a flowable hardenable back-up material is applied to the thin shell. Upon hardening of the latter back-up material the mandrel is removed from the shell. The shell secured on the backup member may be used as a die.

This invention relates to a method of making metal forming dies, particularly for making metal-faced body-backed dies, and has for an object the provision of improvements in this art.

It has heretofore been established that metal sheet-forming dies can be made of a plastic backing body faced with a hard metal shell or jacket which will give satisfactory production service, particularly when relatively small lots of articles are required, thus avoiding the need to provide costly tool-formed or sculptured dies of solid metal which are normally used for large volume work.

However, as heretofore produced, such plastic-backed metal-faced dies have required an undesirable amount of work and have not given as satisfactory service as desired.

One prior method has included the steps of machining a plastic body to the die shape, coating it with a conductive material, electro-depositing a metal shell or jacket on it, and then finishing the outer surface of the metal jacket to final form. One difficulty with that method is that there is a tendency to separate at the conductive coating. Another is that the cost of finishing the plastic backing body is considerable. Another is the cost of finishing the metal jacket on the deposit side. And another is that each item has to be tool-shaped separately without the use of a common pattern so that exact duplication is difficult and expensive.

Another prior method has included the carbonyl deposit of a surface jacket directly on a shaped plastic backing member; and while this avoids the conductive coating, the method requires elaborate and very expensive equipment which is also potentially dangerous to personnel. Preforming of the plastic backing member and the final shaping of the surface layer are about the same as with the electroplating method.

Another method is to deposit on a shaped plastic body a layer of hard metal from a spaced shape-matching metal body in a dielectric liquid by electro-spark transfer. The difficulties inherent in this method will be apparent from the very title of the process.

It is not the intention here to describe all prior processes and their problems at length but merely to indicate some of the difficulties which are avoided by the present process.

It is a particular object of the present invention to provide a very simple and inexpensive method of producing metal-faced body-backed dies.

Another object of the invention is to provide a method which requires no pre-forming of the jacket-backing body and a minimal amount of final forming of the facing metal layer.

Another object is to provide a method which employs a single pattern for all dies produced so, in kind, they will all be substantially identical.

Another object is to provide a method which employs a single basic master pattern for both male and female dies of an operating set of dies.

The above and other objects of the invention, as well as various novel features and advantages, will be apparent from the following description of an exemplary embodiment, reference being made to the accompanying drawings, wherein:

FIG. 1 is a vertical section through a set of mating sheet forming dies showing a flat sheet between them ready to be shaped;

FIGS. 2 through 6 show the steps of forming a male die member, and wherein:

FIG. 2 is a section through a shaped master or starting pattern;

FIG. 3 shows the pattern of FIG. 2 with a shape-retaining, face-shaping body or mandrel flow-formed thereon;

FIG. 4 shows the face-shaping body separated from the pattern and with a hard metal facing layer or jacket formed thereon, as by electro-deposition;

FIG. 5 shows the assembly of FIG. 4 with a final flow-formed, rigid, shape-stable backing body supporting the metal facing layer;

FIG. 6 shows the assembly of FIG. 5 with the face-shaping body or mandrel removed;

FIGS. 7 through 13 show the steps of forming a female die member from the same pattern used for forming the male die member and wherein:

FIG. 7 shows the same starting master pattern as shown in FIG. 2;

FIG. 8 shows the pattern of FIG. 7 coated with a layer of material or replica of the same thickness as that of the metal sheet shown in FIG. 1 which is to be formed by the dies;

FIG. 9 shows the assembly of FIG. 8 with a transfer body, as of plaster or other suitable material, flow-formed thereon, this body being the pattern for the female die member corresponding to the pattern of FIG. 2 for the male die member;

FIG. 10 shows the pattern of FIG. 9 with a face-shaping body or mandrel flow-formed thereon, this view corresponding to FIG. 3 for the male die member;

FIG. 11 shows the face-shaping body or mandrel separated from the pattern and with a hard metal facing layer formed thereon, the view corresponding to FIG. 4 for the male die member;

FIG. 12 shows the assembly of FIG. 11 with a final flow-formed, rigid shape-stable backing body supporting the metal facing layer, the view corresponding to FIG. 5 for the male die member;

FIG. 13 shows the assembly of FIG. 12 with the face-shaping body or mandrel removed, the view corresponding to FIG. 6 for the male die member.

FIG. 1 shows the end product. namely a male die member **20** and a female die member **21** ready to be brought together to shape a metal sheet or workpiece W between them.

The male die member comprises a flow-formed, rigid, shape-stable backing body **22** and a hard metal facing layer, shell, or jacket **23** firmly bonded thereto. The female die member comprises a flow-formed, rigid, shape-stable backing body **24** and a hard facing layer, shell, or jacket **25** firmly bonded thereto.

Suitable flow-formed, rigid, shape-stable backing materials and suitable facing materials are well known but, by way of example, it may be noted that they are of such a nature that they will provide a hard, firm but non-fragile shape-stable backing support and a hard shape-stable facing and will adhesively bond firmly together. The facing layer may be a hard material, such as electro-deposited nickel, which will hold its shape when sup-

ported and rigidified by the backing body and will accurately form a sheet in the press.

Good results have been obtained by electro-depositing from a nickel sulfamate bath, preferably with a stress reducer such as naphthalene trisulfonic acid, para-toluene sulfonamide, and saccharin, but the invention is not to be limited by these examples or necessarily limited even to electro-deposition as a method of forming the hard facing layer.

It would be possible to have both a male and a female starting pattern, but greater accuracy and some economy is obtained by using a single master pattern. This is designated by the reference character **28** in FIGS. 2, 3, 7, 8 and 9.

The final steps of forming the male and female dies are alike and all steps would be alike if male and female master patterns were provided; but since a single master pattern is used, the making of the female die member requires some additional starting steps—as would the making of a male die member if the master pattern were female—and the making of a male die member from a male master pattern is simpler, so that will be described first, reference being made to FIGS. 2 through 6.

The master pattern **28** of FIG. 1 may be of suitable hard stable wood, as is usual. As shown in FIG. 2, it has had flow-formed against its shaped surface a body or mandrel **29** of suitable material, such, for example, as a low melting point metal which will not harm the pattern and which can easily be melted away later. Many low melting point metals are known, as see "Fusible Alloys" in Webster's unabridged dictionary. An alloy known as "Cerrobend" which is similar to Wood's metal or Rose's metal, which melts near the boiling point of water, and which is very hard when solidified has been found to be very suitable for the described purposes. These fusible alloys usually contain bismuth, lead, tin, cadmium, mercury, and the like. The present invention is not dependent on the use of any particular metal or even upon any other particular material, the important point being that it can be flow-formed to exactly conform to the pattern shape; that it will be rigid and shape-stable; and that it has a suitable facing jacket formed on it.

As shown in FIG. 4, the hard metal facing layer **23**, as of electro-deposited nickel, is formed on the surface of the body of mandrel **29** after it has been removed from the pattern **28**. If the mandrel is of cast metal, as mentioned above, it will take a metal plating directly; if it is of a nonconductive material and a conductive surface is needed for depositing the jacket electrolytically or otherwise, a metal coating can be applied at the start.

As shown in FIG. 5, the backing body **22** has been flow-formed on the outer surface of the facing layer **23**. The rough surface of the electro-deposited layer **23** greatly aids the adhesive bonding of the plastic body thereto. The plastic may, if desired, be reinforced by stronger materials, such as concrete, metal, or the like, or may even be flowed in a space provided between a backing body of solid material and the facing jacket, the important feature being that the material immediately backing the work-engaging facing or jacket will have sufficient flowability to completely conform to the back of the jacket and will be permanently bonded thereto—and to the solid reinforcement, if used.

As shown in FIG. 6, the mandrel **29** has been removed to expose the surface opposite that attached to the backing body **22**. Since this surface of the jacket was formed against a smooth surface of the mandrel **29** which, in turn, was formed against the smooth surface of the master pattern **28**, this die-active or working surface of the facing layer of the die will be very smooth. If any rough or irregular spots are noted, these can easily be dressed before the die is used.

The formation of the female die member from the single master pattern, as shown in FIGS. 7 through 13, is different from that for the male die member in that the thickness of the sheet W to be formed must be provided for and a surface reversal must be provided to change from a male working surface to a female working surface.

FIG. 7 shows the start with the master pattern **28**, which is the same as in FIG. 2.

As shown in FIG. 8, a sheet replica **30**, of the same thickness as the sheet W to be formed, is deposited on the pattern **28**. This is a known process termed "packing" and may employ wax, plastic, or other suitable easily-shaped, flowable material which will temporarily adhere to the pattern and permit later stripping therefrom. The thickness of this layer will depend upon the thickness, etc. of the sheet material to be drawn or formed and may, for example, be .030" to .040", more or less.

As shown in FIG. 9, a transfer body or female pattern **31** of suitable material, such as plaster, plastic, or the like, is next formed, as by flow-forming or casting, on the sheet replica **30**.

As shown in FIG. 10, the transfer body or female pattern **31** has been removed from the assembly **28**, **30** and has had formed thereon a mandrel **32**, the same corresponding to the mandrel **29** for the male die member shown in FIG. 3.

Next, as shown in FIG. 11, the pattern or transfer body **31** has been removed from the mandrel **32** and the mandrel has had formed on it a hard metal facing layer or jacket **25**.

Next, as shown in FIG. 12, the backing body **24** has been formed on the back of the facing layer **25**.

FIG. 13 shows the die member **21**, comprising the elements **24**, **25**, after the mandrel **32** has been removed therefrom.

As for the male die member **20**, the backing body **24** is flow-formed on the rough surface of the facing layer **25** and the smooth opposite surface of the facing layer is presented as the working die surface, suitable finishing being given to it if needed.

It will be seen that the method of forming the dies is relatively simple and economical and requires a minimum of hand finishing, flow-forming as contrasted to tool-shaping being used at all stages, yet obtains great accuracy of shape and perfect matching of the die members for the particular thickness of sheet to be formed in the dies.

While one embodiment of the invention has been described for purposes of illustration, it will be understood that there may be various embodiments and modifications within the general scope of the invention.

We claim:

The method of forming a die member with a hard metal facing layer or jacket and a rigid, shape-stable, backing body which comprises, providing a master pattern, conforming a sheet replica to the master pattern, applying a flow-forming hardenable body to the sheet replica conformed to the master pattern, removing the hardened transfer body from the sheet replica and master pattern and applying to the transfer body a flowable, disposable, hardenable material to form a rigid shape-stable mandrel body, forming a hard metal facing layer on the mandrel body, forming a body of flowable hardenable material on the back of the metal facing layer to form a rigid, shape-stable, adherent, backing body thereon, and removing the mandrel body from the backing body.

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