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METHOD OF FORMING SHEET METAL WITH LOW-MELTING DIES

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2 Claims. (Cl. 113—51)

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This invention relates to diemaking generally and more specifically to a method of fabricating expendable dies from soft metal alloys having low-melting characteristics.

An urgent need has long been apparent—especially in the automotive and aircraft industries—for a method whereby limited quantities of experimental sheet metal parts could be formed by using dies that could be rapidly and economically fabricated. Experimental engineering often requires the production of sheet metal parts in limited numbers for testing purposes. The most desirable type of die would be one that could be rapidly and economically fabricated, and which would be capable of producing the required quantities of experimental parts.

The use of steel dies to make experimental parts is often impractical, because the cost of producing a satisfactory steel die does not warrant its production when at the most only a few hundred parts are to be formed. The contouring and finishing of a steel die is a long and expensive process and is justified only where tremendous quantities of a sheet metal article are desired. A further disadvantage inherent in the use of steel dies to form experimental parts is the impossibility of changing the contours of the part being formed by altering the die faces. Advancement of experimental projects often requires minor changes in the contour of the parts. Therefore, a die having working faces that are not readily altered would be impractical in experimental production of sheet metal parts.

The method most commonly used in the automotive industry in producing small experimental parts is by hand formation of the part over hardwood patterns. This method involves the employment of skilled craftsmen in the formation of the hardwood pattern and also skilled metal workers to obtain a satisfactory part from the pattern.

For large experimental parts such as hoods, fenders, and doors, the general practice is to use a cast iron pattern over which the sheet steel is drawn to approximate form. The part must then be placed on a hardwood pattern and finished much as the smaller parts are.

As may easily be understood, the formation of experimental parts by hand formation is unsatisfactory in that it is costly and requires a considerable amount of time. The patterns are not readily changed and if a major change is contemplated, the general practice is to discard the old patterns and begin anew. This method of experimental production seriously curtails experi-

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mentation that could be carried on if the desired parts could be produced more rapidly and economically by dies capable of easy alteration to facilitate necessary changes as the experimental work progresses.

It is therefore an object of this invention to provide a method whereby experimental work may be expedited by the use of dies that are easily and economically produced, and which may be easily altered to meet the requirements of experimental production.

This has been accomplished by casting the die from a soft metal alloy, preferably from the well-known series of bismuth base low-melting alloys. These alloys are composed primarily of bismuth, tin, and lead. Cerrobend—one of these alloys—is composed of 50% bismuth, 13.3% tin, 10% cadmium, and 26.7% lead. Cerrobend has proven to be the most satisfactory of these low-melting alloys in the casting of dies to produce experimental sheet metal parts, because of its characteristic growth upon solidification and its favorable reaction to super-cooling. Cerrobend has the extremely low-melting point of approximately 260° F., which permits melting of the alloy with only the simplest of equipment. The alloy may be kept in the molten state by immersing a container of the molten alloy in water having a temperature above 160° F. The low temperature of the alloy in the molten state has the added advantage that it may be readily handled without fear of burns.

Many attempts have been made to utilize these bismuth base alloys in the fabrication of experimental dies. In recent years the aircraft industry has done considerable work on dies made from these bismuth base alloys. Some success was obtained in the forming of aluminum parts and other soft sheet metals. The dies as prepared by the aircraft industry are not suitable for use in forming experimental automotive parts, inasmuch as the parts formed for automotive testing are ordinarily fabricated from sheet steel, and these soft metal dies are not capable of producing steel parts in sufficient quantity or quality because of the inherent softness of the low-melting alloys. Dies formed from bismuth base alloys quickly blunted and deformed when attempts were made to form experimental steel parts. This obstacle to the use of soft metal dies has been overcome by the applicant's method of preparing the die for use.

The general procedure used in making soft metal dies is to obtain a model or surface development of the part to be formed. The model, or surface development, is preferably produced from material which can be easily and rapidly worked. Models formed from soft woods have proven satisfactory for smaller parts, while aluminum or other easily formed metals have been successfully used to form models for larger parts.

A plaster or clay cast is then made of the model, or surface development, after the model or surface development has been built up with modeling clay to provide the clearances required for an accurate die surface. The plaster or clay cast is then baked to drive off any moisture. It has been found that dies produced from a thoroughly dry plaster or clay cast require considerably less finishing than those dies formed in molds that are not baked dry. The molten alloy is then poured into the cast to form one-half of the die. Plaster molds have proven very satisfactory in the fabrication of the soft metal die, because of the extremely low temperature of the molten metal.

In producing dies from smaller patterns, it has been found possible to pour the molten metal directly on the pattern thereby forming one portion of the die. There is no apparent distortion to the model so used. Soft metal dies have also been satisfactorily produced by casting the molten alloy directly on the clay model as prepared by the automotive designers. The ability to cast the molten alloy in the methods above described results in a considerable saving in time and expense.

After one section of the die has been formed, its surfaces are cleaned and it is covered with a thin coating of plasticine modeling clay which protects the die surface and also serves to allow the necessary clearance between the dies. A piece of aluminum of a thickness corresponding to the part to be formed is then placed on the die face and is formed to the die contour by pressing it to shape by a heavy rubber pad. The aluminum part thereby formed is left on the die face to act as a separator when the other half of the die is cast and also serves as a conductor of the heat when the molten metal is poured. After casting the other section of the die on the first section, the die is faced off to assure perfectly parallel bearing surfaces. The ability to face the dies while they are together permits rapid and exact locating of the two dies when they are assembled in the presses.

After separating the two sections of the die, the faces are finished by hand. Flaws and blow holes are easily repaired with a soldering iron and a piece of the alloy. The surface is finished by rasping off the working faces until the exact contour desired is obtained. It has been found that minor alterations of the die contours may be made by fusing more of the metal to the die or by removing part of the metal with a rasp or other tool. The free cutting characteristics of the metal permit such timesaving operations. If major changes to the die are contemplated, the old dies may be completely salvaged by melting them in hot water and recasting into the desired new form.

Dies formed by the described process are rapidly produced at an extremely low cost, but it was found that such soft metal dies were incapable of producing sheet steel parts because the dies were too soft. Applicant has overcome this deficiency by the expedient of supercooling the soft metal dies. For smaller dies, this has been accomplished by immersing the finished dies in liquid nitrogen, or a similar coolant which is capable of lowering the die temperature to about minus 320° F. and gives the die surfaces the necessary hardness to form sheet steel parts. Reimmersion of the die is necessary when the die temperature rises above a safe maximum. It has been found that the maximum temperature for satisfactory part formation from a bismuth base die is about minus 200° F. When the temperature of the die rises to this point, the die must be recooled.

Maintaining the dies in a supercooled state still proved difficult because of the heat conducted to the die faces from the sheet steel used in the fabrication of the parts. This difficulty has been overcome by cooling the sheet steel to be formed to the maximum degree permitted by the required deformation of the sheet steel.

Dies fabricated by the described method have generally proven satisfactory in the production of sufficient quantities of experimental parts. Experimental projects may, however, require large quantities of sheet steel parts than can be accurately formed by the supercooled die. Production of experimental parts from a supercooled bismuth base die can be materially increased by chrome plating the working surfaces of the die. Chrome plating the working surfaces is easily and rapidly accomplished by utilizing conventional chrome plating processes. The chrome plated working surfaces reflect a large portion of the heat that normally would be conducted to the die, as well as providing a harder working surface. Dies that are chrome plated may be more easily kept in the supercooled state because of the heat reflecting characteristics of the chrome plated surfaces.

Compression tests on the bismuth base alloy show that the unchilled alloy begins plastic deformation well below 7500 pounds per square inch; the same test piece after immersion in liquid nitrogen will withstand stresses in excess of 25,000 pounds per square inch without plastic deformation. Brinell hardness tests show less than one-fourth the ball impression on the supercooled piece as compared with one at normal temperature. Control of the die temperature by reimmersion in, or circulation of, liquid nitrogen permits the accurate production of hundreds of parts formed from S.A.E. 1020 sheet steel.

The method of forming the above dies has effected considerable savings in time and money which, in turn, permits a larger amount of experimental work. Small steel dies for experimental work generally take six or more weeks to produce, and any changes in design result in complete loss of the die and the highly skilled labor that has gone into its production. The soft metal dies described above can be made from a wooden or clay sample, and may be produced in a matter of hours instead of weeks.

It will be understood that this invention is not to be limited to the exact method described, but that various changes and modifications may be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. The process of die forming sheet metal products comprising fabricating a die from an alloy melting below the boiling point of water, supercooling the die prior to use to a temperature at least as low as −200° F. and maintaining the die below the temperature of −200° F. during the forming operations.

2. The process of die forming sheet metal parts comprising fabricating a die from an alloy

composed predominately of bismuth, tin and lead, supercooling the die to a temperature at least as low as −200° Fahrenheit and maintaining the die below the temperature of −200° Fahrenheit during the forming operation.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
669,330	Thurber	Mar. 5, 1901
1,243,471	Willis	Oct. 16, 1917
1,431,041	Rees	Oct. 3, 1922
1,632,928	Shaw	June 21, 1927

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Number	Name	Date
2,366,487	Burgess	Jan. 2, 1945
2,418,874	Gary	Apr. 15, 1947

FOREIGN PATENTS

Number	Country	Date
113,485	Germany	1900

OTHER REFERENCES

"Impact Resistance and Tensile Properties of Metals at Subatmospheric Temperature," August, 1941.

"Modern Core Practices and Theories," 1942.

"Chemical and Metallurgical Engineering," June, 1945.

"Machinery," April, 1947.