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3,123,910

METHOD OF UPSETTING METAL ABOUT AN OPENING

Filed Sept. 8, 1961

3 Sheets-Sheet 1

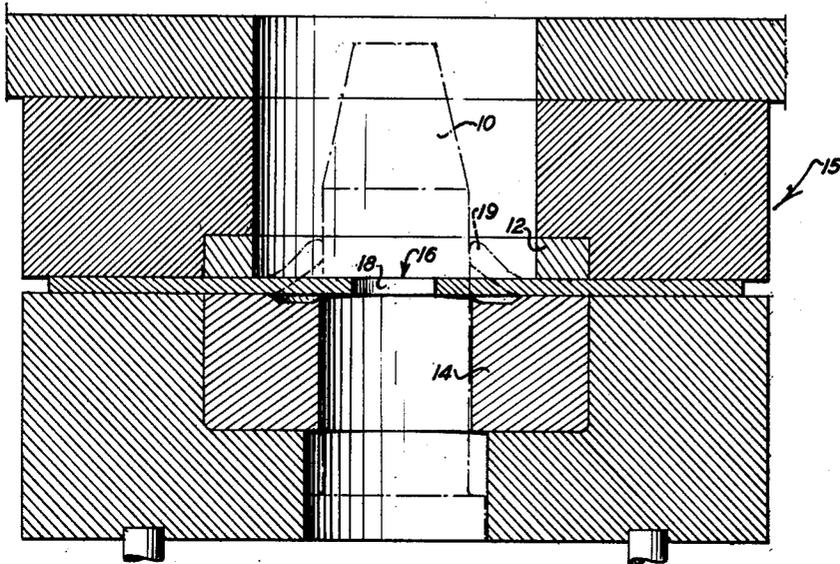


Fig. 1

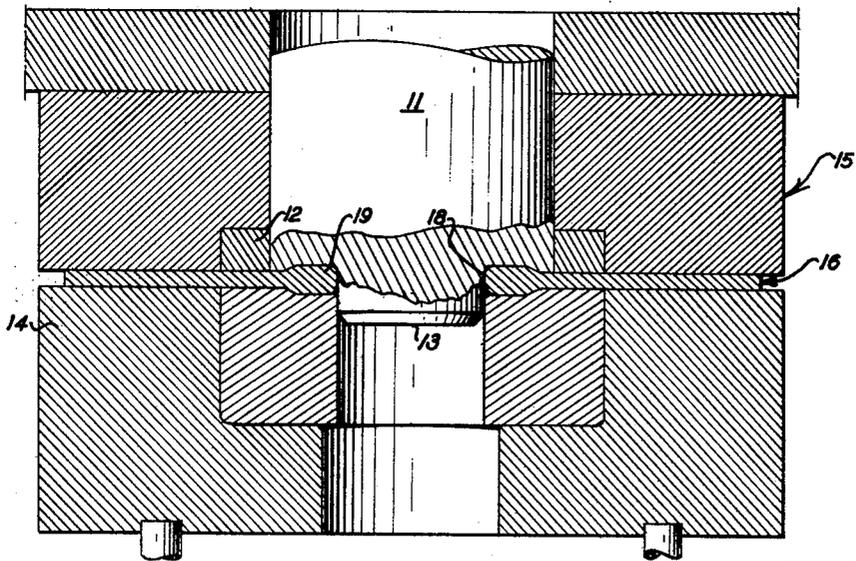


Fig. 2

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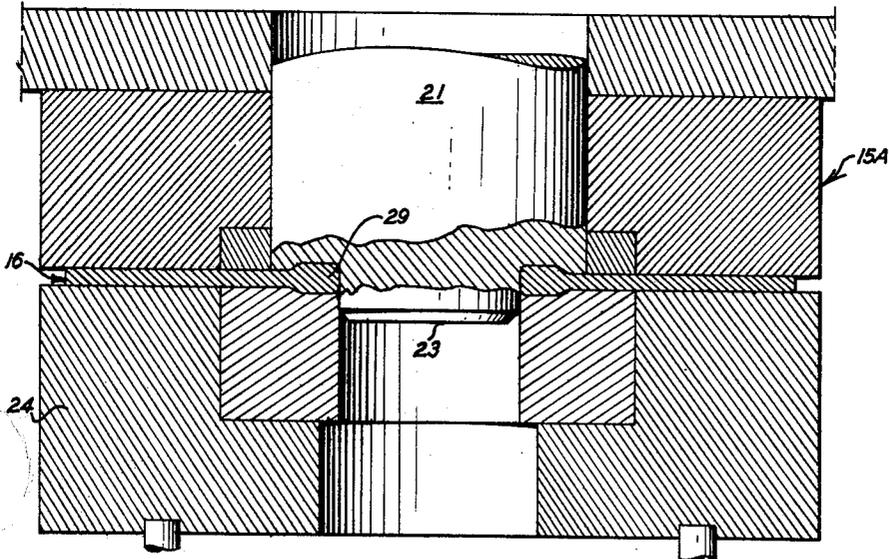
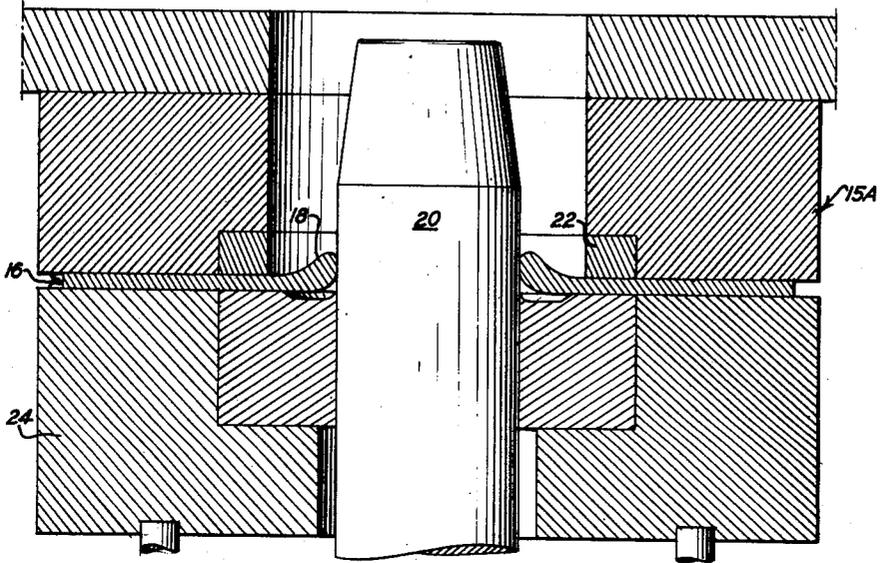
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3 Sheets-Sheet 3

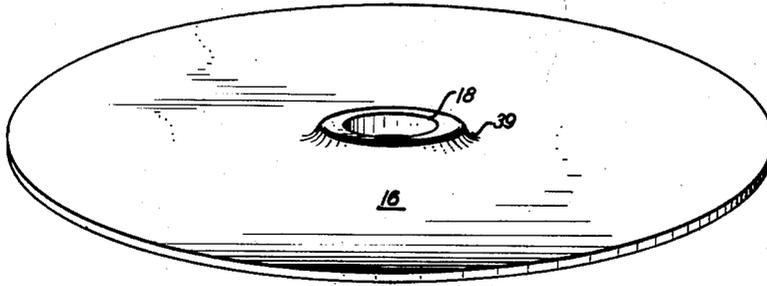


Fig. 5

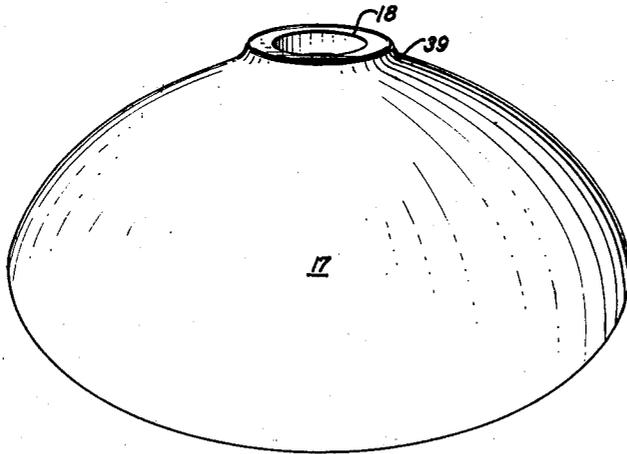


Fig. 6

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6 Claims. (Cl. 29—545)

This invention relates to a method of upsetting metal to produce a flange about an opening. More particularly, it concerns a two-step method for upsetting of metals about an opening in light plate gauge metals such as are used for missile heads.

In recent years, demand has arisen for strong, lightweight, highly reliable heads which contain an opening and require a flange around such opening. Such heads are generally semi-ellipsoidal in shape and are utilized as the forward heads of missiles.

The present method of producing such heads together with their flange is to forge the heads to a uniform thickness and then machine them to produce the flanged section. Alternatively, a thicker section has been welded about the opening to produce the flange. The first method has the disadvantage of being an expensive operation and the process requires removal of an excessive amount of material in a machining operation so that a high percentage of expensive material is lost to scrap. When welding is employed, particularly on newer type materials, the flange section has been a source of failure which cannot be condoned in the art involved.

It has been theorized that a forging method of upsetting metals about an opening would produce a more reliable flange for the igniter boss section. However, conventional forging methods for upsetting have been found inadequate. For example, an opening expanded by the conventional method has been found to flash a significant amount of plate material into the die clearance and is likely to damage the die.

In view of the foregoing, it is the object of this invention to produce a method which may be employed in the upsetting of various types of materials to produce a flange about the igniter boss section of a missile head or the like which is superior to present methods of fabrication.

It is a further object of this invention to produce a missile head with considerable savings of expensive, exotic materials as well as cost saving in machining time.

The invention is illustrated in the accompanying drawings in which:

FIGURE 1 is a vertical section showing a plate secured in the hydraulic press while the fluing step of the first operation is shown in dot-dash lines.

FIGURE 2 shows the flattening step of the first operation.

FIGURES 3 and 4 are similar to FIGURE 1 but showing the fluing and flattening steps of a subsequent operation;

FIGURE 5 shows a plate with the flange formed therein; and

FIGURE 6 shows a finished missile head with a flanged opening produced by the process of the invention.

Prior to the upsetting operations, a steel plate 16 of the type used for missile heads such as SAE-4340 steel of 5/8" thickness is drilled with an opening 18 of modest diameter—say 1 1/4". The plate 16 is then heated about the opening 18 to suitable temperature for workable plasticity which is approximately 2000° F. for this type of metal. The heating may be produced by any known and appropriate means, as for example by electrical induction heating. When the plate has been brought to its proper temperature, it is placed in a hydraulic press 15 having

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interchangeable parts. Within the press 15, the plate is clamped between a retaining ring die 12 and a forming bed 14 which has been fabricated from die material. When clamped in this position, a plug 10 is forced upwardly through the opening 18 as shown in dotted lines in FIGURE 1. Plug 10 tapers downwardly from its upper portion from a diameter smaller than opening 18 to one which is larger. Thus when plug 10 is forced through opening 18, the material about the opening 18 is forced outwardly and at the same time the material is flued, as shown in dotted lines in FIGURE 1. Plug 10 is then withdrawn from the enlarged opening 18 and a forming die plug 11 pushes the flued portion back against the forming bed 14 to flatten plate 18 and form a flange portion 19. Die plug 11 includes a portion 13 which fits into the enlarged opening 18 and maintains it at its size when the flued portion is flattened as shown in FIGURE 2. The new opening is approximately one to two inches larger in diameter than the original opening, depending upon the size of the dies used. In designing the dies for this two-step operation, it has been found important that the angle of the flue be kept at a minimum. It has also been found important for the success of the overall process that the dies be so designed that the flattening dies 11 and 14 in this and each subsequent operation contain only enough void to accommodate the theoretical thickening of the metal.

When the first operation is completed, the plate 16 is removed from the hydraulic press 15. At this time, the dies in the hydraulic press 15 may be interchanged or, preferably, the plate 16 may be placed in a second hydraulic press 15A wherein dies are already set up for the second operation. It is also preferable that plate 16 be turned over for the second operation relative to its position in the first operation or, alternatively, that the die arrangement be reversed.

Between the first and second operation, the metal about the opening is again heated to bring it to a temperature of approximately 2000° F. The second operation is exactly like the first operation except that the fluing plug 20 and portion 23 are of a larger diameter and the forming bed 14 together with the forming die plug 11 and retaining ring die 12 are altered so as to conform to the larger diameter of opening 18. Again it is important that the void between the forming die plug 21 and the forming bed 24 be only sufficient to accommodate the theoretical thickening of the metal in flange portion 29 and that retaining die ring 22 be spaced sufficiently inward to provide a minimal angle of fluing.

Where two hydraulic presses are employed, the previously used dies are removed and new dies are set in the first hydraulic press 15 during the heating and forming of the second operation. The plate 16 is then removed from the second hydraulic press 15A, again heated to bring the temperature of the metal about the opening to approximately 2000° F., and the operation is repeated in the first press with appropriately larger dies. In each operation the opening 18 is increased by one or two inches in diameter and the flange thickness increases proportionately. The operations are repeated until a hole of the finally desired diameter is obtained—for example 7/4". In each operation, the flange is thickened until finally it is brought to the desired thickness—for example 1 1/4".

When plate 16 is removed from the hydraulic press after the final operation, its appearance is illustrated by FIGURE 5 with an igniter boss section 39 about the enlarged opening 18. Plate 16 may then be forged into the shape shown in FIGURE 6 by conventional forging and shaping means.

Following the forging operation, a certain amount of

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machining is normally required to bring the igniter boss section 39 to exactly the proper diameter and to remove from the missile head 17 any excessive material.

It will be appreciated by those skilled in the art that the head may be formed into its semi-ellipsoidal shape first, and the above-described operations illustrated in FIGURES 1-4, performed on the already shaped head to produce a head as shown in FIGURE 6.

The above description and drawings disclose a single embodiment of the invention, and specific language has been employed in describing the process involved in the several figures. It will, nevertheless, be understood that no limitations of the scope of the invention are thereby contemplated, and that various alterations and modifications may be made such as would occur to one skilled in the art to which the invention relates.

I claim:

1. A method of upsetting metal around an opening in a metal body which comprises the steps of heating the metal around said opening to a state of workable plasticity, placing the heated metal body in a press over a die bed, enlarging said opening and fluing the heated metal substantially to coincide with the surface of an obtuse truncated cone around said opening away from said die bed by forcing a tapered die plug through said opening so that the metal around the opening remains substantially unthinned, withdrawing said plug, forming a thickened portion around said opening and flattening said flued portion by forcing said portion against said die bed with a further die plug which includes means to retain said

opening at its enlarged dimension whereby said metal is crowded between the die bed and the further die plug and rollover of the flued portion is prevented.

2. The process of claim 1 wherein a void is provided between said die bed and said further die plug and the void is only enough to accommodate the theoretical thickening of the metal around the opening when said metal is flattened.

3. The process of claim 1 wherein the metal comprises a steel plate and the metal around the opening of said plate is heated to approximately 2000° F.

4. The process of claim 1 wherein the steps are repeated with successively enlarged plugs until an opening of the desired size is obtained.

5. The process of claim 1 wherein the steps are repeated with successively enlarged plugs and the metal body is reversed relative to said die plugs.

6. The process of claim 1 wherein the metal is a steel plate for a missile head and the metal around the opening is heated to approximately 2000° F. and the steps are repeated until an opening of the desired size is obtained.

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