Aug. 29, 1944. W. F. HEINEMAN 2,357,110

METHOD OF MAKING BOMB SHELLS

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FIG. 3.

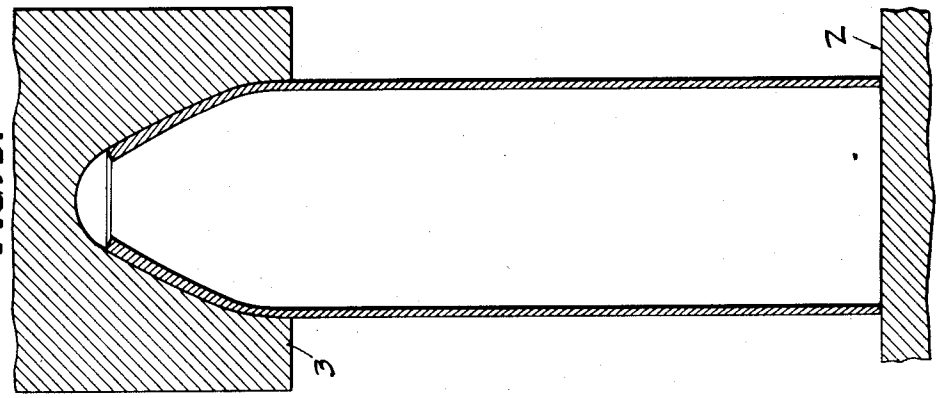

FIG. 2.

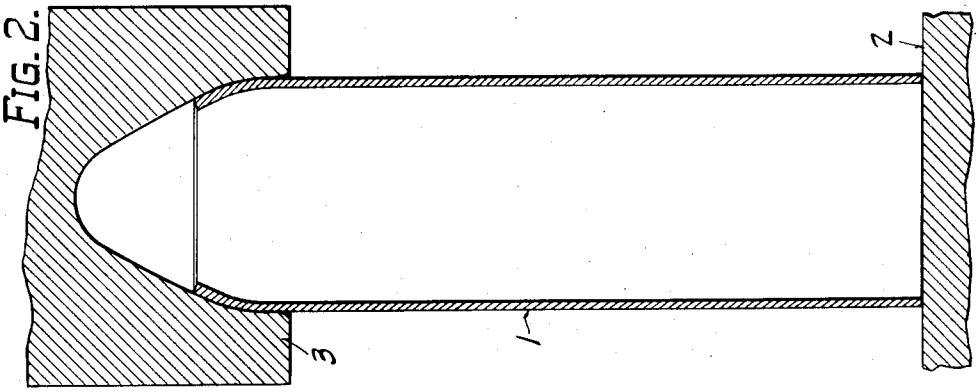

FIG. 1.

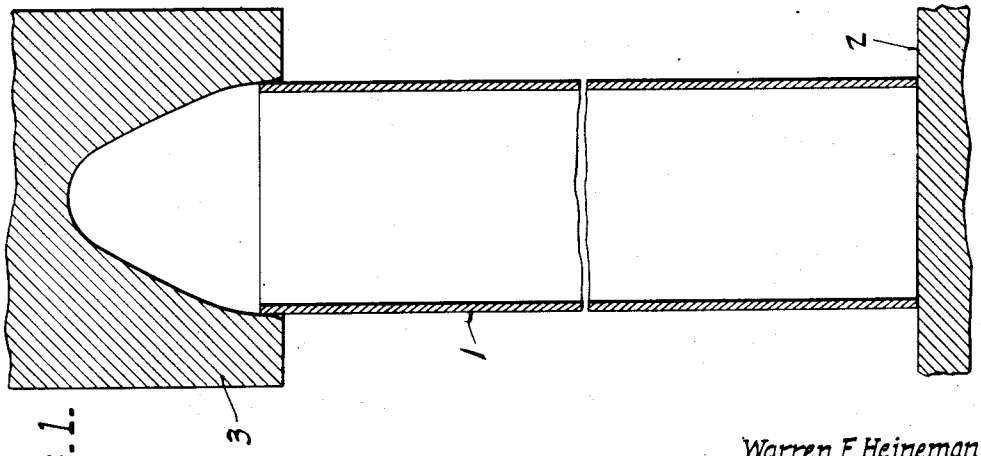

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FIG. 7.

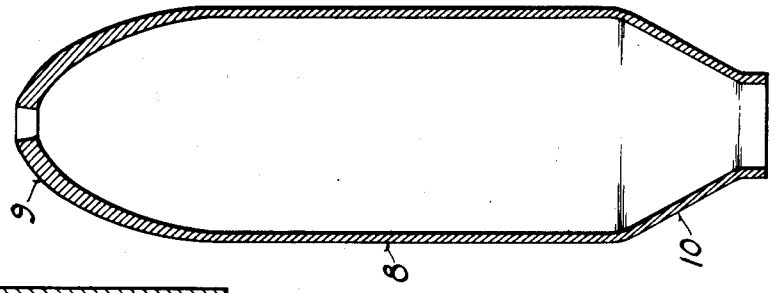


FIG. 6.

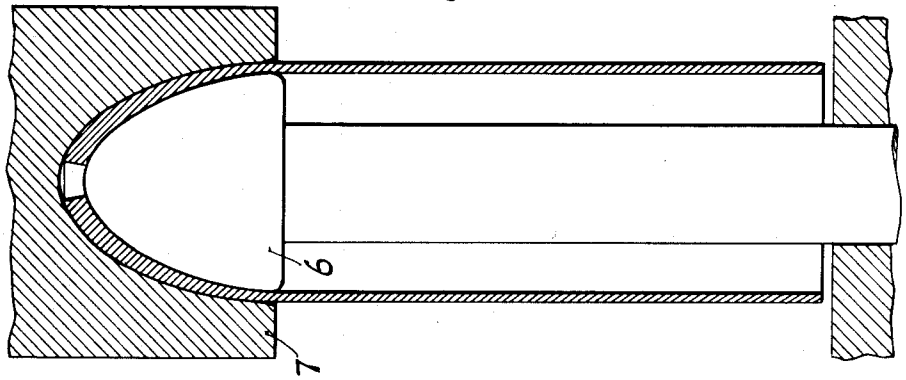


FIG. 5.

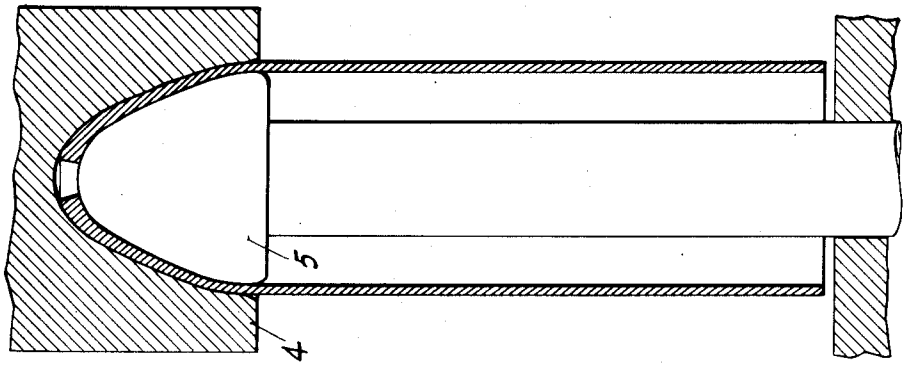
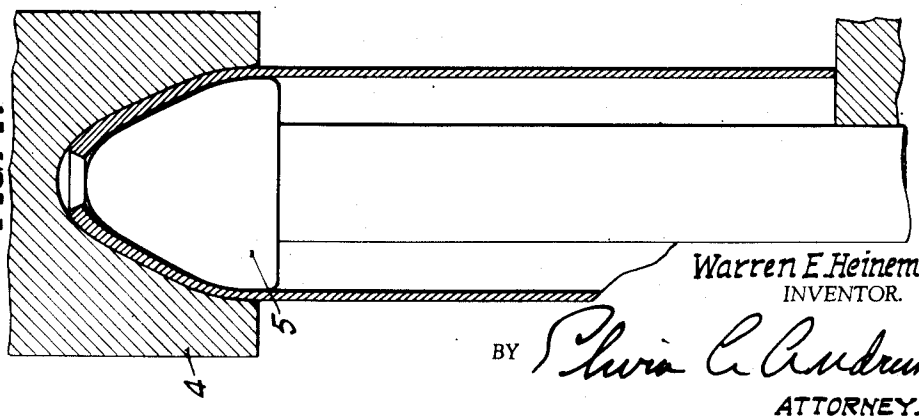


FIG. 4.



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UNITED STATES PATENT OFFICE

2,357,110

METHOD OF MAKING BOMBSHELLS

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Application September 15, 1941, Serial No. 410,833

5 Claims. (Cl. 78—81)

This invention relates to a method of making bomb shells and more particularly to the forging or upsetting of the nose of the bomb from a portion of a cylindrical blank similar to the body section of the bomb.

The design of the nose for bomb shells has had a long history of development due to the developments of modern methods of warfare in which bombs are dropped from increasingly greater heights and strike objects of different resistance to penetration. The present trend for certain types of bombs is to provide thicker and heavier nose sections.

Heretofore, in the manufacture of bombs, it was sufficient to forge the nose from the end of the cylindrical blank by heating the latter and repeatedly hammering the end radially between suitable die sections. Such forging processes are entirely insufficient to produce noses of the relative thicknesses desired at the present time since the mere radial contraction of the end of the tube does not sufficiently thicken the same at the end.

Where, in order to obtain the required thickening, it was attempted to heat the cylindrical blank and then to push it longitudinally into a die having the shape of a finished nose, many difficulties arose.

The present invention has for its principal object the overcoming of these difficulties, and the practical forging of nose sections on bombs having greater thickness relative to the body than heretofore.

The more specific objects will be set forth in the description of one method of carrying out the invention, illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a longitudinal central section of a cylindrical blank from which a bomb shell is to be formed and showing in similar section the support and die for giving it the first forging operation;

Fig. 2 is a similar view showing the bomb shell at the end of the first forging operation;

Fig. 3 is a similar view showing the bomb shell at the end of the second forging operation;

Fig. 4 is a similar view showing the bomb shell with an inside mandrel in position at the end of the third or succeeding forging operation;

Fig. 5 is a similar view of the bomb shell illustrating the ironing operation after the forging step of Fig. 4;

Fig. 6 is a similar view showing the bomb shell in the final forming or sizing operation; and

Fig. 7 is a longitudinal central section of the finished bomb.

In carrying out the invention a combination of hot and cold forming is resorted to in successive steps to gradually work the metal into the thicker portion of the nose. The bomb illustrated utilizes approximately eighteen inches of the original cylindrical blank 1 in length in forming a nose which is approximately twelve inches long.

The first step in forming the nose lies in supporting the lower end of the blank 1 on an abutment 2 and then pushing the other end longitudinally into a circular die 3 having a cavity simulating but somewhat different in shape from the finished bomb nose. By this operation the end of the blank 1 is contracted along a substantially conical surface portion of the die as far as the metal will form satisfactorily in the cold state. In the bomb shell illustrated this cold forming will extend for from four to five inches from the end of the blank and will effect some thickening of the metal in the contracted section.

In the second step the previously formed end of the blank is heated to a suitable forging temperature without heating the metal of the remainder of the blank and the heated end is again pushed into the same die, resulting in a further contraction of the heated portion of the blank and a further cold forming of the metal adjacent thereto to an extent about equal to the amount previously cold formed.

The third operation is carried out in a separate die 4 and preferably employing a mandrel or punch 5 to assist in the shaping of the heated metal at the end of the nose. In this operation the blank is first heated in the previously formed section only without materially heating the remainder of the blank and the heated end is then pushed into the die 4 while the punch 5 is advanced to its place properly spaced from the die walls to provide plenty of space for the thickening of the metal in the nose portion being formed. After this stroke of the forging press the blank is withdrawn at least partially to loosen it in the die and the support 2 is dropped down away from the blank. The stroke of the punch 5 or die 4, depending upon which element of the forging machine is constructed to move, is then adjusted to bring the two relatively closer together, and the blank is squeezed between the punch 5 and die 4 to iron

out any wrinkles or irregularities which may have resulted from the forming step.

The subsequent forming and ironing steps are preferably carried out similarly in different sets of dies and punches, and with alternate heating in each case only of the previously formed section of the nose. As many subsequent steps are employed as may be necessary to form the completed nose.

The final step, illustrated in Fig. 6, is essentially a hot sizing step in which the nose section is heated and pressed between the punch 6 and die 7 to round out the nose to final shape, thereby eliminating the more nearly conical shape of nose employed in the earlier forming steps. The final bomb shell, illustrated in Fig. 7 has a cylindrical body 8 and a forged nose 9 of gradually increasing thickness toward the forward end. After the nose is formed any suitable tail piece 10 may be secured to or forged from the body 8 at the end opposite the nose.

In carrying out the invention several features should be particularly considered. It is important in the successive heating operations to leave practically all straight sections of the blank cold so that the proper forging pressure may be transmitted from the support 2 to the metal engaged by the forging die. If any substantial part of the cylindrical section of the blank were heated to a softened condition it would collapse under the longitudinal pressure being applied through it to the part being forged. Any attempt to support such section against collapse by other means increases the resistance to such an extent as to make the entire operation impractical.

In practice it is preferred to heat the blanks in a liquid bath, such as molten salt, by dipping the lower end of the suspended blank in the bath. Other methods of heating, such as electrical resistance or induction, may be employed. A quick heating should be obtained so that the amount of heat conduction along the blank does not soften the cylindrical portion which must be kept relatively cold.

In general, with a bomb shell of the proportions and dimensions illustrated, the heat gradient from the zone of forging temperature to the zone of relatively cold temperature will extend for about two inches axially of the shell. This heat gradient zone will gradually increase in length during the process until it is in excess of four inches in the last forming step. Too sharp a line of heat gradient tends to create a ridge of thickening on the inside and to prevent the more gradual increase in thickness from the body to the tip of the nose. Too long a zone of heat gradient results in the lack of support for the metal being forged, previously referred to.

It is necessary to keep the cylindrical part of the blank cold in order to prevent its collapse under the forces being transmitted by it during the forming of the end.

In addition to this, by leaving a portion of the metal to be formed in a given step cold, a combination of hot and cold forging is obtained in which the relatively colder metal between the hot end and the cold cylindrical part of the blank serves to support and to transmit substantial upsetting pressures to the hot end of the blank.

The more or less conical shape of the die employed in the forming steps is important in giving a rather straight column effect to the side walls of the formed section for transmitting the forging or forming pressure to the tip of the nose where the greatest thickening is desired. In this way the resistance near the tip of the nose to thickening is readily overcome by the inflowing material, and the friction of the latter with the die is greatly reduced. The metal always has a tendency to hug the surface of the die as it moves forward.

In some instances more than one forming operation may be performed in the same die. In such case it is preferable to employ a separate second punch which gives a little more clearance for thickening in the conical section.

The machine to be employed is relatively unimportant. It has been found that very good results can be obtained by a vertical type machine in which the die 3 is secured to a vertically movable ram and the support 2 constitutes the fixed top of the bed. The punch 5 or 6 extends upwardly through the support 2 in axial alignment with the die 3 and is vertically adjustable relative to support 2 and the die 3 for the ironing step in each instance.

Various modes of carrying out the invention may be employed within the scope of the claims.

The invention is claimed as follows:

1. The method of nosing a cylindrical blank inwardly at one end to provide a curved end of substantially greater cross-sectional area of metal than that of the blank, comprising alternately heating and upsetting the end of the blank by endwise forging action and with the heat softening of the metal restricted substantially to the previously formed portion in each step.

2. In the manufacture of bombs from cylindrical blanks, the steps of endwise forging of a thickened nose on the end of the blank comprising, endwise forming the substantially cold end of the blank in a die cavity having walls of nearly conical shape, then heating the formed portion of the blank to forging temperature while avoiding the heating of the cylindrical portion of the blank, then endwise pressing the heated end of the blank into the die to upset and form it while cold forming a second portion of the cylindrical blank between the heated portion and the body of the blank, repeating similar heating and forming operations with successive dies of shapes progressively nearer to that of the finished nose, and finally hot sizing the formed end of the blank in a die cavity having substantially the shape of the finished nose.

3. In the manufacture of bombs from cylindrical blanks, the steps of endwise forging of a thickened nose on the end of the blank comprising, endwise forming the substantially cold end of the blank in a die cavity having walls of nearly conical shape, then heating the formed portion of the blank to forging temperature while avoiding the heating of the cylindrical portion of the blank, then endwise pressing the heated end of the blank into the die to upset and form it while cold forming a second portion of the cylindrical blank between the heated portion and the body of the blank, repeating similar heating and forming operations with successive dies of shapes progressively nearer to that of the finished nose, and finally hot sizing the formed end of the blank in a die cavity having substantially the shape of the finished nose, and after at least one intermediate forming step, ironing out any wrinkles in the formed portion of the blank by squeezing the same longitudinally between a punch and the die cavity.

4. The method of nosing a cylindrical blank inwardly at one end, comprising alternately heating and upsetting the end of the blank by end-

wise forging action and with the heat softening of the metal restricted substantially to only an outer end portion of the part to be formed in each step.

5. The method of nosing a cylindrical blank inwardly at one end, comprising alternately heating and upsetting the end of the blank by endwise forging action and with the heat softening of the metal restricted substantially to only an outer end portion of the part to be formed in each step, the end of the blank being formed along conical lines, and thereafter forging the conical end to bilge the same to nose shape.

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