July 29, 1941. C. A. WITTER 2,251,094

SHELL BODY AND METHOD OF MAKING THE SAME

Filed Jan. 5, 1940 2 Sheets-Sheet 1

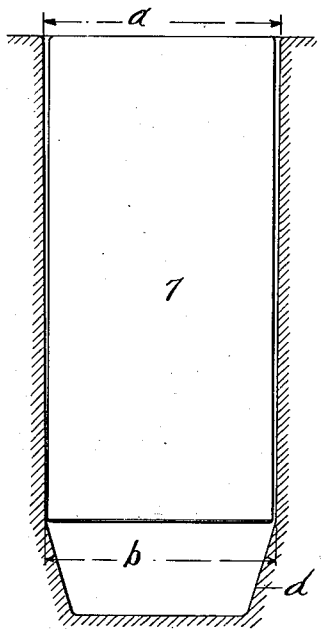


Fig. 1

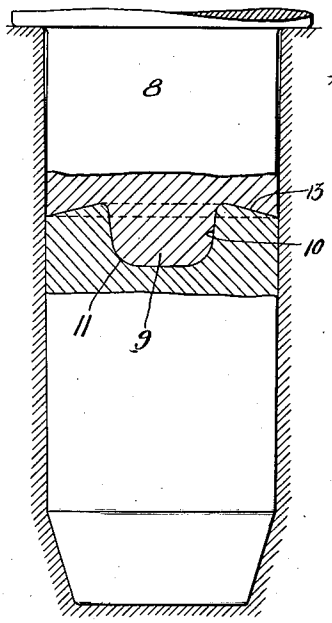


Fig. 2.

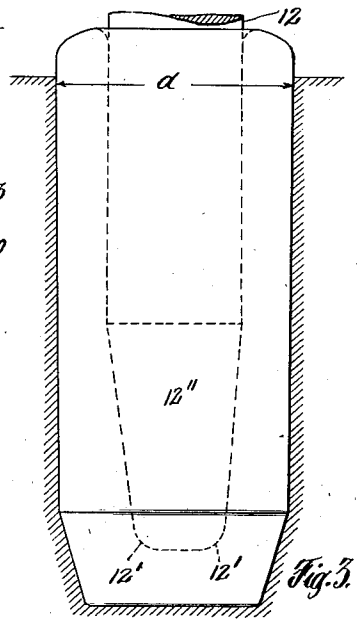


Fig. 3.

Fig. 4.

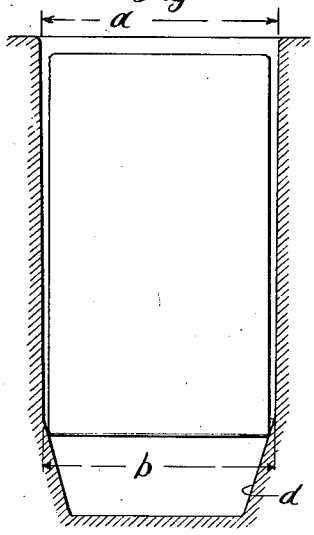


Fig. 5.

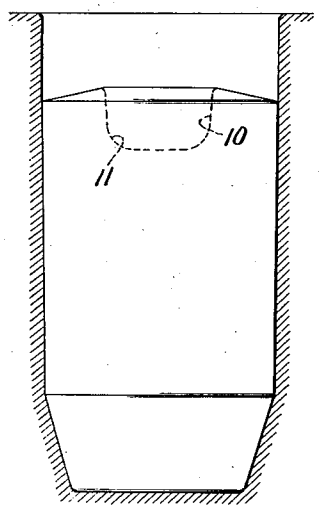
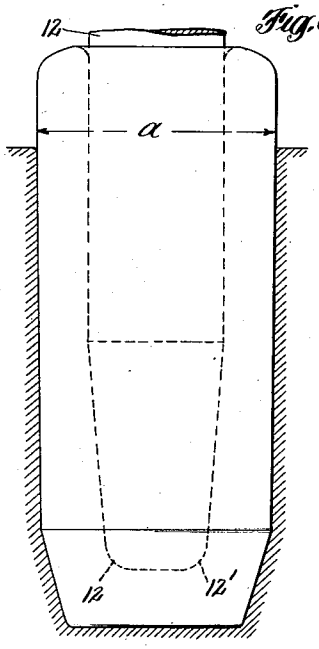


Fig. 6.



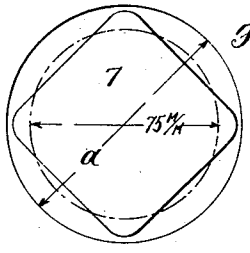


Fig. 7.

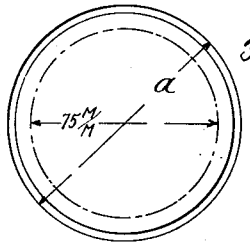


Fig. 8.

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July 29, 1941. C. A. WITTER 2,251,094

SHELL BODY AND METHOD OF MAKING THE SAME

Filed Jan. 5, 1940 2 Sheets-Sheet 2

Fig. 9.

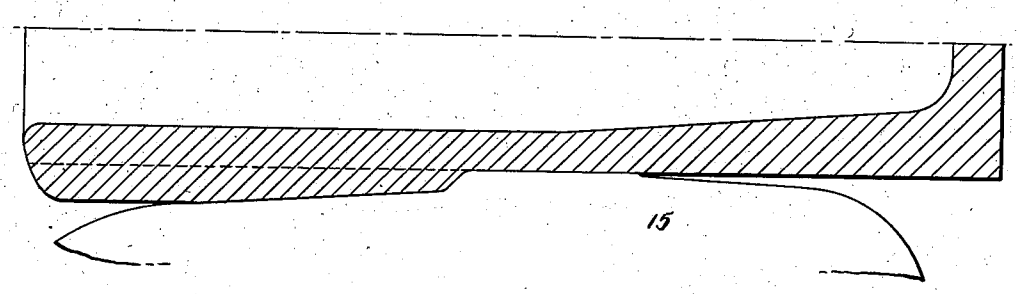
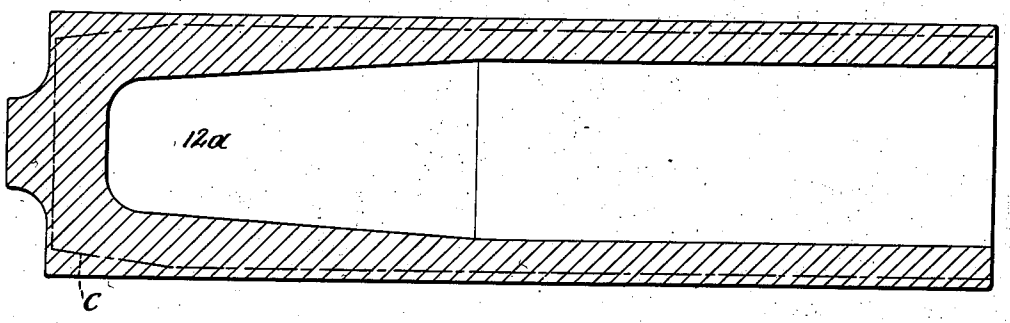


Fig. 10.



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SHELL BODY AND METHOD OF MAKING THE SAME

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Application January 5, 1940, Serial No. 312,499

7 Claims. (Cl. 29—1.21)

This invention relates to improvements in shell bodies (such as H. E. shell bodies) and method of making the same.

Insofar as the shell body is concerned, the primary object of the invention is economically to produce a worked metal shell body of improved characteristics, such for example as uniform density of metal annularly of the shell, whereby, among other things, more perfect balance is obtained.

Insofar as the method is concerned, the primary object of the invention is to provide a simple, rapid and economical method of manufacture in which, among other things, the plant investment required is relatively small as compared with that required in standard practice for the same output on large scale unit production.

The nature and advantages of my invention will be best under stood from the following brief description of standard practices in producing shell forgings. One method is known as the upsetting method, in which a succession of upsetting operations (with intermittent longitudinal movement of metal) are performed to produce a cylindrical shell body having a contoured bore and a closed end. The other conventional method most widely followed is to pierce a so-called "slug" or billet, cut to predetermined weight, by a piercing operation, the depth of pierce being about 75% or more of the depth of the bore in the finished shell, the length of the pierced blank being proportionally long. The closed-end blank thus produced is now sized in a conventional draw bench (with intermittent longitudinal movement of metal), having a long mandrel and a series of reducing ring dies, which serve to remove the die draft needed for forging and to gain the length of shell body and depth of bore needed for the particular shell being produced.

In commercial production by both of these and other methods now in use, it is impossible to avoid eccentricity, which usually is very marked, for which, and other reasons, it is necessary to provide sufficient excess metal to permit of machining to finished outside diameter requirements, concentric with the bore. To illustrate, for a 75 mm. H. E. shell, in which the finished outside diameter is 2.94", the Government specifications for the forgings when produced by the conventional method just above described, require an outside diameter of 3.25" plus .03, and for the supsetting method, an outside diameter of 3.17" plus .03. In other words, in the conventional method, the diameter of the finished forging is $\frac{5}{16}$" greater than that of the finished shell, and in the upsetter method, the outside diameter of the forgings is ¼" larger than that of the finished shell, in order to make it possible to correct for the eccentricity, external fins, and markings and other deficiencies incident to such methods of production. To remove this excess metal requires both a rough and a final finish machining operation, which involves a heavy cost in labor and equipment investment.

By my improved method I avoid eccentricity, and moreover, should eccentricity occur it is automatically corrected for in the process, so that I am enabled to produce a forging so close to outside diameter requirements that only a commercial grinding operation or a light finish machining operation is required.

Broadly considered, my process comprises cutting slugs of appropriate weight from either commercial polygonal or round bar stock, piercing the slug to provide a closed end blank, and cross-rolling sizing the blank thus produced in a way to secure a substantial reduction in outside diameter which is automatically converted into the required length.

The process will now be set forth in greater particularity, reference being had to the accompanying drawings, wherein

Figure 1 is a diagrammatic cross-sectional view illustrating a slug of round corner square bar stock in the die, ready for the first operation;

Figure 2 is a similar view illustrating the condition of the slug at the end of the first operation;

Figure 3 illustrates the blank produced by the next or piercing step;

Figures 4, 5 and 6 are views corresponding to Figures 1, 2 and 3, but illustrating the use of slugs cut from round stock;

Figure 7 is a plan view of Figure 1, the full circular line indicating the die cavity, and the dot and dash circle indicating the outside diameter of the finished shell;

Figure 8 is a plan view of a circular slug in position in the die, the dot and dash line again indicating the outside diameter of the finished shell;

Figure 9 is a fragmentary view, partially in section, showing the contour of the diagonal rolls which I prefer to use in the cross-rolling operation and the reducing of the pierced blank as produced in Figures 3 and 6; and

Figure 10 is a cross-sectional view of the shell forging as produced by either of the standard

methods hereinbefore referred to, the dotted lines indicating the excess metal necessary to correct for eccentricity.

I have illustrated and will describe my invention as applied to the manufacture of a 75 mm. H. E. shell body. Whether the slug be of polygonal or round bar stock, the diameter of the die cavity is substantially greater than that of the finished shell body. For example, in Figures 1 to 8 inclusive, the diameter of the cavity of the dies at *a* is approximately 3¾", and the diameter at *b* is approximately 3⅝", the difference being provided to afford draft. Since the closed (or cartridge) end of the finished shell is to be tapered as indicated at *c* in Figure 10, the lower end of the die cavity is tapered as indicated at *d* in Figure 1.

Referring to Figure 1, the slug 7 (in this case of round corner square stock) is preferably of the largest size which will go into the die, in which case it will not bottom, but will be supported by the inclined wall *d*.

Of course, the slug 7 is heated to a temperature suitable for forging before insertion in the die.

The next operation is to fill the die cavity and to shape the lower end of the slug, if desired. This is done by means of the centering punch 8 which is brought down upon the top of the slug, forcing the metal to conform to the die cavity. The punch has a central boss 9 and of course it is to be understood that the punch is concentric with the die cavity and is guided. This boss forms a centering cavity 10 in the upper portion of the blank, the corners of the centering cavity being rounded as indicated at 11. It will be seen that a relatively short stroke is all that is required to produce the blank of Figure 2 from the slug of Figure 1, which affords economy in power consumption.

The blank of Figure 2, either left in the die in which it has been formed or placed in a similar die, is now pierced by the piercing punch 12, as indicated in Figure 3. It will be seen that the work end of the piercing punch 12 is rounded as indicated at 12' so as to insure that it will center in the centering cavity 10 of the blank. With the piercing stroke, the displaced metal results in increase in the length of the blank as compared with the blank of Figure 2.

It will be seen that the stroke of the piercing punch is relatively short, about 50% of that required for the conventional method. (This is because the process permits of the use of stock of large cross section, the slug and blank having large diameter and short length.) In addition, contrary to usual practice, the diameter of the piercing punch is substantially greater than the bore of the finished shell, and moreover, the contour of the piercing punch does not have to coincide with the contour of the bore in the finished shell. For example, the tapered end 12'' of the piercing punch can be substantially shorter in length than the length of the tapered portion 12*a* of the finished shell (see Figure 10). Because the piercing punch is sturdy due to its relatively large diameter and to the shortness of its tapered end, and due to the fact that the piercing stroke is short, and that the piercing punch is centered by the cavity 10, and to the fact that a relatively short piercing punch can thereby be employed, the punch does not deflect but remains in alignment, and concentricity is thus maintained. (It is of course understood that the piercing punch is properly supported and guided.)

Another advantage of using a piercing punch the diameter of which is substantially greater than the bore of the finished shell, is that punch maintenance is greatly reduced, because the punch can be permitted to wear to a substantial extent before it is necessary to replace it. Moreover, for reasons which will subsequently appear, surface imperfections on the punch present no difficulty.

Depending upon the size of the shell, it is unnecessary to re-heat the blank in the operations thus far described.

The same steps described in connection with Figures 1 to 3 are followed when using the round bar slug of Figures 4, 5, 6 and 8.

The pierced blank, produced either from the square bar or the round slug, is now subjected to the cross-rolling sizing operation hereinbefore mentioned. Re-heating is ordinarily not required between the piercing and the sizing operation.

The cross-rolling sizing mill should be one which effects a substantial reduction in outside diameter. The mill reduction is such as to reduce the outside diameter of the blank to the point where, as above indicated, only a commercial grinding or a finish machining operation is required. By way of illustration, the outside diameter of the pierced blank, for a 75 mm. shell, at *a* is preferably 3¾".

In the cross-roll sizing mill, the pierced blank is of course mounted on a mandrel and both the mandrel and the blank are supported and guided concentrically with the pass of the mill. The mandrel has the finished bore dimensions and contour of the shell plus allowance for shrinkage. As hereinbefore pointed out, the bore in the pierced blank is larger and need not conform to the finished contour. Now I have discovered that by the reduction in the cross-roll sizing mill the shell body is not only sized as to outside diameter, but that the bore is sized and contoured to finished requirements. The cross-rolling, as it were, irons in the metal to the finished contour mandrel (without wear on the mandrel) and removes bore surface imperfections in the blank.

It will also be seen that, in the cross-roll sizing there is a great gain in length from the relatively short, large diametered pierced blank and this is obtained in my process by a continuous flow of the metal in a single operation, whereas in previous practices the length has been obtained by a series of intermittent sizing, reduction operations, which of course breaks up the continuity of flow of the metal.

I have moreover discovered that the cross-roll sizing practically eliminates eccentricity if present in the blank to be rolled. In fact, I have deliberately produced eccentric blanks, and by cross-roll sizing have practically eliminated the eccentricity, thereby proving that should eccentricity develop in the production of the blank, due to carelessness or inefficient shop practice, the cross-roll sizing adds a corrective medium, enabling me, as hereinbefore pointed out, to produce a finished forging to tolerances so close as to approximate finished outside contour dimensions and to specified inside contour dimensions of the shell.

The reduction in the cross-roll sizing is a variable but should always be sufficient to iron in the metal to the finished mandrel and to correct eccentricity due to careless or inefficient shop practice.

The shell body produced by my proces has

uinform density of metal, cross-sectionally considered, in consequence of which the shell is in inherent balance, which is not the case where the eccentricity is machined off.

It will be obvious from what has been said that the process is very simple, requires a relatively small investment in both forging plant and finishing equipment on a comparable production basis, and that the power requirements are relatively small. In this connection, by the upsetting method, it is possible to produce about sixty shell bodies per hour in the 75 mm. size, and by the conventional method the peak is about 120 per hour, per unit. By my process I am enabled to produce 240 to 300 shell bodies per hour, with a unit very much less extensive and expensive than would be required by standard practice for the same output. On a comparative weight basis, the finished forging for a 75 mm. H. E. shell when produced according to Government specifications by the conventional method weighs from 18 to 20 pounds, and when produced according to the upsetter method approximately 17 pounds or more, whereas the forging for the same shell produced according to my process will weight 14½ pounds, a 15% to 30% weight saving. Moreover, because of avoidance of eccentricity, what are known as "fish tails" are avoided. When there is eccentricity in the conventional method, the thick or heavy side naturally produces greater length than the thin or light side, producing waste metal which must be cut off. Waste metal is greatly reduced in my process.

In this connection, it is also to be observed that dishing of the centering punch at 13 has the advantage that the inward rounding or chamfering of the open end which occurs in conventional practice is largely reduced, the end surface coming out substantially normal to the longitudinal axis of the body. The amount of cut-off is thus much reduced.

One form of cross-roll sizing mill suitable for my process is that shown in the patent to Assel, No. 2,060,768, of November 10, 1936, in which the piece is drawn through the mill pass by the rolls.

In Figure 9, I have illustrated a fragment of a contoured roll 15 with which I have produced the shell forgings as set forth hereinbefore. It is to be understood that three or more of such rolls are employed.

While I have described the production of blanks for the cross-rolling by a forging operation, it is to be understood that I may, for example, in some instances, centrifugally cast the blanks and then size them in the cross-rolling mill.

Moreover, my invention is useful in connection with closed end tubular members other than shells, requiring contoured inside and outside dimensions.

What I claim is:

1. In the fabrication of a closed-end hollow shell body from a solid slug of length appreciably less than that of the finished shell body, the method which includes piercing the slug to form a hollow blank of length appreciably less than that of the finished shell body, and cross-rolling the blank with diagonal rolls to extend the hollow blank to the length of shell body desired.

2. A method in accordance with claim 1, in which approximately one-half of the desired length of cavity in the shell body is secured by piercing, and the other half by cross-rolling.

3. A method in accordance with claim 1, characterized by a piercing operation providing a cavity in the blank of diameter greater than that desired in the finished shell body, and further characterized by reduction of the diameter of the cavity to that desired in the finished shell body by the cross-rolling operation.

4. In the fabrication of a closed-end hollow shell body from a solid slug of length appreciably less than that of the finished shell body, the method which includes piercing the slug to form a hollow blank the internal diameter of which is appreciably greater than that desired in the finished shell body, and reducing the internal diameter of the blank approximately to that desired in the finished shell body by cross-rolling the blank with diagonal rolls.

5. A method in accordance with claim 4, in which the cross-rolling is effected with the shell body on a mandrel dimensioned and contoured to the final finished requirements of the internal cavity of the shell body.

6. A method for manufacturing shell bodies including shaping and piercing a slug in a die to form a short tubular closed-end blank having appreciably greater external and internal diameters and wall thickness than that of the finished body, and cross-rolling the blank to reduce the external and internal diameters and wall thickness to a point approximately that desired in the finished body and to lengthen the blank to a point approximating the desired length of the finished body.

7. A method for manufacturing shell bodies including placing a solid slug in a die, shaping the slug to the die cavity shape and providing a centering cavity in an end of the slug by a punch having a relatively short stroke and having its end surface annularly dished, piercing the slug to form a hollow blank of length appreciably less than that of the finished shell body, and cross-rolling the blank with diagonal rolls to extend the hollow blank to the length of the shell body desired.

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