Aug. 18, 1931. J. G. C. MANTLE 1,819,254

ART OF EXTRUDING COLD MATERIALS

Filed March 31, 1924

Fig. 1.

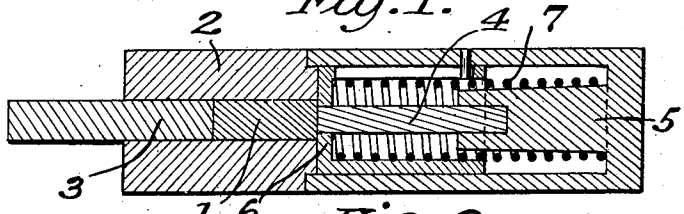


Fig. 2.

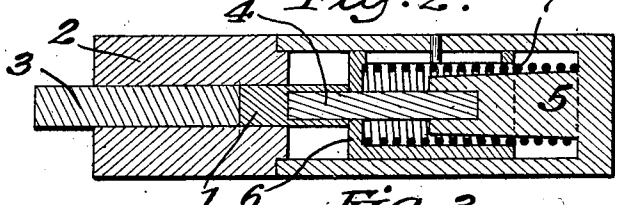


Fig. 3.

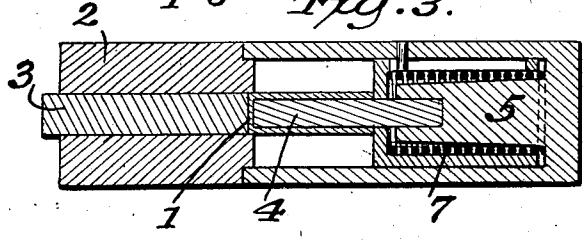


Fig. 4. Fig. 5.

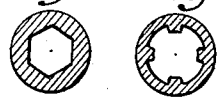


Fig. 6. Fig. 7



Fig. 8. Fig. 9.

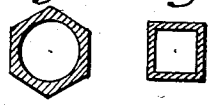


Fig. 10. Fig. 11.

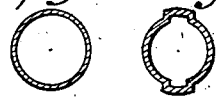


Fig. 12. Fig. 13. Fig. 14. Fig. 15. Fig. 16.

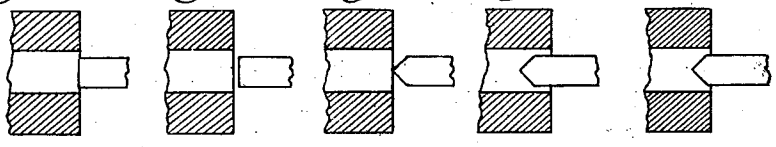


Fig. 17.

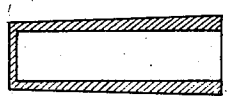


Fig. 18.

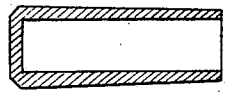


Fig. 19.



Fig. 20.

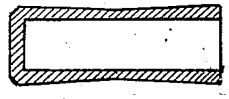


Fig. 21.

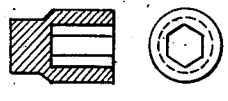
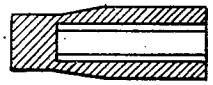


Fig. 22.



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UNITED STATES PATENT OFFICE

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ART OF EXTRUDING COLD MATERIALS

Application filed March 31, 1924. Serial No. 703,060.

This invention refers to the extrusion of metals in a cold condition, and comprises a method and apparatus by which steel, brass, and similarly hard metals, can be extruded without preliminary heating to soften the same. Hitherto, only the softer metals, such as lead or tin, and other soft materials, could be extruded without softening by heat. Moreover, in many instances where certain harder metals could be extruded by preliminary heating it was found more economical, on account of the slowness and cost of the operation, to machine the cold material rather than extrude it.

In the drawings,—

Figure 1 is a sectional view of an apparatus for carrying my invention into practice, with the die, the ram and the punch in the positions they assume at the beginning of the operation.

Figures 2 and 3 are views similar to Figure 1 with the several parts in relative positions as the extrusion progresses.

Figures 4 to 11, inclusive, are cross sectional views illus rating different forms which may be imparted to the material by the procedure and apparatus of my invention.

Figures 12, 13 and 14 are diagrammatic views of the positions the punch may take relative to the material exit of the die.

Figures 15 and 16 are views of a die and a punch showing positions wherein the material becomes packed around the punch at the material exit from the die resulting in a practically inoperative mode of procedure.

Figures 17 to 20, inclusive, are views illustrating in longitudinal section different forms of extruded metal objects.

Figure 21 illustrates in longitudinal section and in end elevation another form of extruded metal object, and

Figure 22 is a view similar to Figures 17 to 21 of still another form of metal object.

In explaining this method reference will be made to drawings, more particularly Figures 1, 2 and 3.

1 is a piece of non-preheated steel, brass or other similarly hard metal and will be called the "stock".

2 is a member for containing the stock to be extruded; it has a corresponding inner form and its size should be such that the stock may slide therein. This member will be called the "die".

3 is a member having a cross section, corresponding to, and a close sliding fit in the die and its use is to push the stock from within the die. This member will be called the "ram".

4 is a rod-like member, very hard and strong, and which may have a cross section of any desired form. This member will be called the "punch".

5 is a member for holding and supporting the punch. This member will be called the "holder".

6 is a member slidably mounted in the holder and having a close sliding-fit in the holder and on or around the punch. Its main use is to steady and support the punch in strict alignment with the die. This member will be called the "guide".

7 is a spring for pressing the guide against the extruded stock.

Now suppose the stock 1 to be within the die 2, as shown in Figure 1. The stock may be slid into the die either by withdrawing the die 2 from the holder 5, or, by withdrawing the ram 3. The ram being moved in direction towards the punch 4, forces the stock 1 from within the die, against and around the punch, as shown in Figure 2. The further movement of the ram forces the stock still further around the punch as shown in Figure 3. There need be no pause in this movement of the ram, and its total movement may be a very quick one, for the operation may be performed in a press, or, in a header, or, in other powerful suitable machine. The movement of the ram may continue until there is but a thin layer of material between the ram and the punch, as in Figure 3, or, the movement may stop at any time before, so that this depth of the recess or hollow within the extruded stock is as desired. Stock of any desired cross section may be extruded, the inner form of the die corresponding to the outer form of the stock, see Figures 4 to 10, inclusive, wherein differ-

ent cross sectional shapes of stock are shown.

With this method when the stock passes from within the die and around the punch, or, which is the same thing, when the punch is passing into the stock, the outer surface of the stock surrounding the punch is not in contact with the die, and the stock is not surrounded by the die, see Figures 2 and 3; otherwise, if so surrounded, it is not possible, with non-preheated steel, brass or similarly hard metal, for the punch to enter except to a depth amounting to but a fraction of the diameter of the punch. In the making of hollow steel set screws many attempts have been made to punch a sufficiently deep recess in the cold metal, but drilling and broaching had to be resorted to. Even in softer material, such as lead or tin, the depth of penetration was very limited, this was in great part due to the material packing and gripping the punch. In this method of operation, not only the outer surface of the material surrounding the punch is free, but the punch is also free. In fact, during any stage of the operation the stock may be slid from off the punch, or the punch from within the stock.

There may be any desired combination of die and punch cross sections giving any required form of extruded material, the punch being an internal former for imparting the desired internal contour to the product, some of which are shown in Figures 4 to 11, inclusive, and consequently this method of cold extrusion is useful for very varied purposes, for instance, hollow-set-screws, hollow-rivets, shells, tubes, internal gears, socket wrenches, nipples, etc. The cheaper commercial bar-stock may be used, instead of tubing and sheet material; also it may replace many machine operations such as drilling, drifting, milling, etc., and avoid much of the scrap.

The form of the free end of the punch and its position relative to the exit of the die affects both the durability of the punch and the outside size of the extruded material. A punch having a rounded or pointed end and a parallel portion appreciably extending into the die, as shown in Figure 15, is useless when dealing with non-preheated steel, brass and similarly hard metals, for the reason that the material packs in the die and grips the punch, and the punch is crippled. The form and position shown in Figure 16 is better, yet the punch is insufficiently durable for the operation to be commercially successful.

There is far less resistance with a flat ended punch shown in Figures 1, 2, 3, 12 and 13, positioned adjacent the exit of the die. But the best all-around results have been obtained with a flat-ended punch its sharp corners beveled off a few thousandths of an inch and the flat end projecting into the die for about one sixteenth of the diameter of the punch. With this form of punch, so positioned, stock varying in size from five to eighteen thousandths of an inch below that of the inside diameter of the die was extruded uniformly of size within two thousandths of an inch of the diameter of the die, and with stock measuring up to four thousandths of an inch below the inside diameter of die the diameter of the extruded material was within one thousandth of an inch, as also the thickness of the wall surrounding the punch, both transversely and longitudinally, the die thus serving as a former for imparting the desired external size or contour to the product. Also, the outside and inside surfaces were exceedingly smooth, in fact, the inside surface much smoother than could be obtained by internal grinding. Apparently there is a slight packing of the material as it approaches the exit of the die. If the punch is positioned relatively to the exit of the die as in Figure 13, the extruded material has its outside size larger than the inside diameter of the die. If the position of the die be varied relative to the punch (as from that shown in Figure 12 to Figure 13) during the movement of the ram, then the outside sizes of the extruded stock will also vary throughout its length on the punch. Examples are shown in Figures 17–22.

For Figure 17, the die relative to the punch is as in Figure 13 when the ram commences its stroke and passes to, during, and is as in Figure 12 at the end of the stroke. For Figure 18 it is reversed. For Figure 19 the die relative to the punch is as in Figure 12 when the ram commenced its stroke and passes to, during, and is as in Figure 13 at the middle, and returns to as in Figure 12 by the end of the stroke. For Figure 20 it is reversed. For Figure 21 and Figure 22 the die relative to the punch is as in Figure 13 when the ram commences its stroke and after any desired time changes, more or less abruptly as desired, to as in Figure 12 and so remains till the end of the stroke. It is apparent that by such means, a very great variety of outside forms of the extruded material may be obtained. A very convenient way of giving any required movement to the die would be by use of a cam for each particular form of extruded material similarly as is done in automatic screw-machines. The cam could be given one revolution for each out and return stroke (two strokes) of the ram. The cam could operate one long arm of a lever and a short arm of the lever operate the die. The manner of connecting such parts, and the making and applying of such parts are understood by those skilled in the arts to which this invention pertains.

In describing this method, the punch and die has been generally assumed to be stationary and the ram moving, but this is merely relative movement; the ram might be sta-

tionary and the punch and die moving. This may be readily seen by inspection of Figures 1, 2 and 3, assuming the ram as stationary and the movement being given to the holder 5 containing the punch.

When using a punch of short length, when a depth of recess of one diameter of the punch, or less, is required, the guide 6 is not essential, nevertheless, it is a useful adjunct for it serves as a stripper for the extruded stock from the punch. Also it serves to square up or impart other desired shapes to the end of the extruded material, in which case the yielding member 6 is fashioned for that purpose. When a long punch is used for deep penetration, the guide is necessary to keep the punch from springing sidewise, especially when the stock is a loose sliding-fit in the die. When extruding such material as steel, bronze or brass, the free or working end of the punch, as also the inside of the die (especially near the exit), must be thoroughly hard. Attention is directed to Figures 1, 2 and 3, wherein it may be seen that the die 2 is separably connected to the punch holder 5. On account of this separability, neither the die 2 nor the punch 4 has to slide on or in any part of the holder 5 in order to insert the blank into the die or to remove the extruded material from the punch; and, as the contacting surfaces of the punch and holder as also the male and female contacting surfaces of the die and holder are slightly conical, they are in such intimate contact that, during the entire period of the extrusion, any relative lateral movement, whatsoever, is impossible.

Also, attention is directed to Figure 11 which shows a section of extruded material the external contour of which, apart from mere size, differs from that of the blank. To obtain this form which is obtained from blanks of round form, the end of the punch is positioned in relation to the exit of the die as shown in Figure 13 and not as in Figure 12. As already herein stated, the form of the interior of the die, apart from a slight difference in size, always corresponds to that of the blank.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. In an apparatus for making hollow articles from a blank of metal a receptacle for the blank, means for extruding material of the blank from the receptacle, and two members opposing the extrusion of said material, one of said members serving as an internal former and the other of said members yieldably opposing the extrusion during the entire period of said extrusion.

2. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, means for extruding material of the blank from the receptacle, and two members comprising an inner member and an outer member, both members opposing the extrusion of said material, the inner member serving as an internal former for said extruding material and the outer member serving as an end former for shaping the end of said extruding material.

3. In an apparatus for making hollow articles from a blank of metal; a receptacle for the blank, means for extruding material of the blank from the receptacle, a member serving as an internal former for the extruded material, and a lateral-support in direct contact with said member during the entire period of said extrusion.

4. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, means for extruding material of the blank from the receptacle, a member serving as an internal former for the extruded material, and a lateral-support adjacent the advancing end of the said extruded material on the said member and also in direct contact with the said member during the entire period of said extrusion.

5. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, means for extruding material of the blank from the receptacle, a member serving as an internal former for the extruded material, and a lateral-support in contact with the advancing end of the said extruded material on the said member and also in sliding contact with the said member during the entire period of said extrusion.

6. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, the receptacle having an exit for the extrusion of material of the blank, means for extruding the said material through the said exit, a member serving as an internal former for the extruded material, the said member having a flat end in contact with the said material, and the said flat end being adjacent the said exit during the entire period of said extrusion.

7. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, the receptacle having an exit for the extrusion of material of the blank, means for extruding the said material through the said exit, a member serving as an internal former for the extruded material, the said member having a flat end in contact with the said material, and the said flat end adjacent the said exit and stationary in relation to said exit during the entire period of said extrusion.

8. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, the receptacle having an exit for the extrusion of material of the blank, means for extruding the said material through the said exit, a member yieldably opposing the said extrusion and also serving as a lateral-support to, and in direct contact with, a second member during the entire period of the ex-

trusion, the said second member serving as an internal former for the extruded material and also having an end in contact with the said material and adjacent the said exit during the entire period of said extrusion.

9. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, the receptacle having an exit for the extrusion of material of the blank, means for extruding the said material through the said exit, a member yieldably opposing the said extrusion and serving as a lateral-support to a second member during the entire period of the extrusion, the said second member serving as an internal former for the extruded material and having an end adjacent the said exit and being in contact with the said material, said second member being stationary in relation to said exit during the entire period of said extrusion.

10. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, means for extruding material of the blank from the receptacle, a member serving as an internal former for the extruded material, a holder serving as a support and holder for the said member, and a connecting means for separably connecting the said receptacle to the said holder and serving, when connected, to prevent all relative lateral movement of the same.

11. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank, means for extruding material of the blank from the receptacle, a member serving as an internal former for the extruded material, a holder serving as a support and holder for the said member, and a connecting means for separably connecting the said receptacle to the said holder and serving, when connected, to prevent all relative lateral movement of the same, the said connecting means comprising a male and female surface pressed into contact for the entire period of the said extrusion.

12. In an apparatus of the character described, a receptacle for a blank, means for extruding material of the blank, a stationary member of substantially uniform cross-section and serving as an internal former for the extruded material and having a flat end adjacent said receptacle and a lateral support encircling said former and in sliding contact therewith during the entire period of said extrusion.

13. The method of making tubular metal articles which comprises positioning a cold metal blank in a confined space, exerting a pressure on one end of the blank so as to cause the other end of the blank to be pressed against the flat end of a stationary punch to extrude the material of the blank into tubular form and exerting a resilient pressure on the end of the extruded material during the entire extruding operation.

14. The method of making tubular metal articles which comprises positioning a cold metal blank in a confined space, exerting a pressure on one end of the blank so as to cause the other end of the blank to be pressed against the end of a punch to extrude the material of the blank into tubular form, varying the position of the punch with respect to the blank during the extruding operation in order to obtain a tubular element having a wall of different thicknesses.

15. The method of making tubular metal articles which comprises positioning a cold metal blank in a confined space, exerting a pressure on one end of the blank so as to cause the other end of the blank to be pressed against the end of a punch to extrude the material of the blank into tubular form, exerting a resilient pressure on the end of the extruded material during the entire extruding operation, and removing the tubular element from the punch by the stored energy of the end resilient pressure.

16. In an apparatus for making hollow articles from a blank of metal, a receptacle provided with an opening therethrough, a ram fitting within said opening and adapted to extrude material from said receptacle, a flat ended member adjacent said opening in said receptacle and having a smaller diameter than the said opening, said flat ended member serving as an internal former, and a lateral support in sliding contact with said flat ended member.

17. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank and provided with an opening therethrough, means for extruding material from said receptacle, a flat ended member adjacent said opening in said receptacle and adapted to serve as an internal former, a lateral support in sliding contact with said flat ended member, and means for yieldingly pressing said lateral support against the end of the extruded material.

18. In an apparatus for making hollow articles from a blank of metal, a receptacle for the blank and provided with an opening therethrough, a ram fitting within said opening and adapted to extrude material from said receptacle, a former adjacent said opening in said receptacle and having smaller diameter than the said opening, and a lateral support in sliding contact with said former during the extruding operation.

19. In an apparatus of the character described, a receptacle for a blank of metal, means for extruding material of the blank from the receptacle, a stationary member of substantially uniform cross section and serving as an internal former for the extruded material, and having a flat end adjacent said receptacle, a lateral support encircling said

stationary member and in sliding contact therewith during the entire period of said extrusion, and means for yieldingly pressing said lateral support against the end of the extruded material.

In testimony whereof I have hereto signed my name this 26th day of March, 1924.

JOSEPH G. C. MANTLE.