May 26, 1953 J. P. DOAN 2,639,810

EXTRUSION OF METAL BILLETS HAVING A TEMPERATURE GRADIENT

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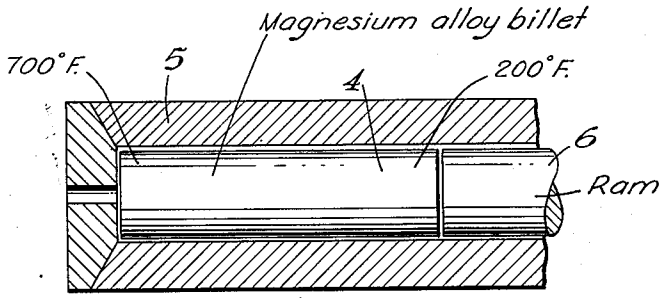


Fig. 1

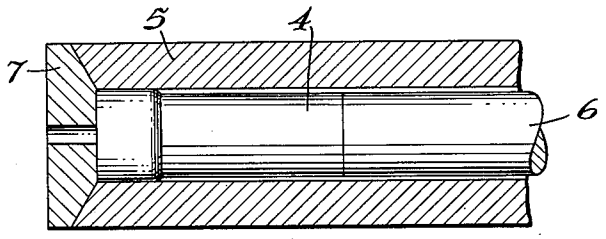


Fig. 2

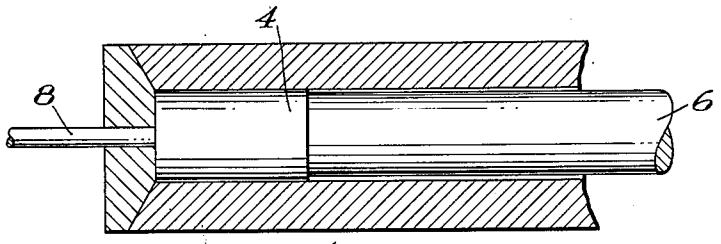


Fig. 3

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EXTRUSION OF METAL BILLETS HAVING A TEMPERATURE GRADIENT

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2 Claims. (Cl. 207—10)

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This invention relates to an improved procedure for producing extruded metal articles.

In the conventional direct extrusion process, billets of the metal to be shaped are cast or otherwise formed to a size only slightly smaller than that of the cylinder of the press to be used. Each billet, after being preheated uniformly throughout to a hot-working temperature, is then placed in the press and is extruded through a forming die at one end of the cylinder by the action of a ram entering the other.

A difficulty frequently encountered in this process is that air unavoidably present in the press cylinder when the billet is introduced tends to become entrapped in the metal being extruded, forming blisters or blowholes when the metal issues from the die. Such entrapment has been minimized by grooving the billets longitudinally to permit rearward escape of air or by using special dummy blocks and rams, but these measures are expensive, in that extra machining operations, or the purchase of highly specialized tools, are required.

It is therefore a principal object of the present invention to provide an effective procedure for preventing air entrapment in metal extrusion processes which can be carried out in very simple manner, using only standard equipment.

According to the invention, this object is realized by pretreating each billet to establish within it a temperature gradient extending from a hot-working temperature at one end to a materially lower temperature at the other. Then, while this gradient still persists, the billet is inserted in the press cylinder with the hotter end toward the die and is subjected to extrusion pressure from the ram. Under these conditions, the billet is upset progressively from the forward end backwards. Consequently, any air in the cylinder is expelled positively from around the billet rearwardly along the ram and out of the press. The air thus has no opportunity to become entrapped in the metal being extruded.

The process of the invention is illustrated diagrammatically in the accompanying drawing, in which

Fig. 1 is a vertical partial cross-section through a direct extrusion press immediately after a new billet has been inserted.

Fig. 2 is a similar view shortly after the start of the press stroke; and

Fig. 3 is a similar view in the middle of the stroke.

The temperature gradient required in the billet according to the invention should be sufficient to insure that the billet is upset progressively from the die end backwards. For this purpose, the forward end of the billet should preferably be at a temperature well above the minimum temperature of hot-working for the particular metal involved, to insure that it will upset easily. The other end of the billet should be materially colder, so that the metal there is much less plastic and is preferably below the minimum hot-working temperature of the metal. In the case of magnesium-base alloys, to which the invention is particularly applicable, the temperature gradient is desirably a least 20° F. per inch, with the hotter end being above 400° F. Optimum results are obtained with the forward end of the billet at 650° to 850° F. and the rear end below 250° F.

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The temperature gradient may be produced in any desired manner, as, for example, by heating one end of the billet intensely while cooling the other. It is advantageous, however, to heat the billet throughout to a uniform hot-working temperature in the conventional manner, and then to chill one end drastically by subjecting it to quenching, as by spraying one end of the billet with water or by standing the billet on one end momentarily in a shallow pool of water.

After the temperature gradient is produced, and before the temperatures of the two ends of the billet have time to equalize, the billet is quickly inserted in the cylinder of the extrusion press and the ram is actuated to start extrusion. The billet upsets progressively and begins to issue from the die. As extrusion proceeds, the heat of mechanical working soon spreads throughout the billet so that all the metal, as it approaches the die, is at a hot-working temperature. The temperature of the press cylinder at the time of inserting the billet is preferably, though not necessarily, close to the desired hot-working temperature.

The progressive upsetting of the billet is shown in the accompanying drawings. In Fig. 1, a magnesium-base alloy billet **4** having one end at 700° F. and the other at 200° F. has just been inserted in the empty press cylinder **5** and the ram **6** is ready to begin the extrusion stroke. In Fig. 2, the ram has advanced and is applying pressure to the billet. The front end of the billet has begun to upset and fill the cylinder **5** to full diameter. Any air present around the billet is being forced rearwardly along the rear portion of the billet, around the ram, and thus backward out of the press. In Fig. 3, the ram has advanced farther; the billet has been upset

completely, and the metal has begun to issue from the die 7 as extruded product 8.

The process of the invention is, as illustrated, applicable in intermittent extrusion, in which the press cylinder is cleaned before each new billet is inserted. It is particularly valuable in the extrusion of continuous product, in which the billets are introduced one after another into the cylinder without removing metal between extrusion strokes of the ram, a procedure described and claimed in an application Serial No. 738,990 by Robert E. Perry et al. filed April 2, 1947.

What is claimed is:

1. In hot-extruding metal billets in an extrusion press having a cylinder, die, and ram, the improvement which comprises pretreating each billet to establish within it a temperature gradient such that one entire end of the billet is at a hot-working temperature and the other entire end of the billet is at a temperature below the minimum hot-working temperature, and while such gradient persists inserting the billet in the press cylinder with the hotter end toward the die and subjecting it to extrusion pressure from the ram, such pressure being applied uniformly over the entire rear face of the billet whereby the billet is upset progressively beginning at the hot end and air around the billet is expelled rearwardly from the cylinder.

2. In a continuous process for the hot-extrusion of magnesium-base alloy cylindrical billets in a direct extrusion press having a cylinder, die, and ram, wherein the billets are introduced into the press one after another without removing metal between successive strokes of the ram, a procedure for minimizing entrapment of air around the billet which comprises pretreating each billet to establish within it a temperature gradient such that one entire end of the billet is at a temperature of 650° to 850° F. and the other entire end is below 250° F., and while such gradient persists inserting the billet in the press cylinder with the hotter end toward the die and subjecting it to extrusion pressure from the ram, such pressure being applied uniformly over the entire rear face of the billet, whereby each billet is upset progressively beginning at the hot end and air around the billet is expelled rearwardly from the cylinder.

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