

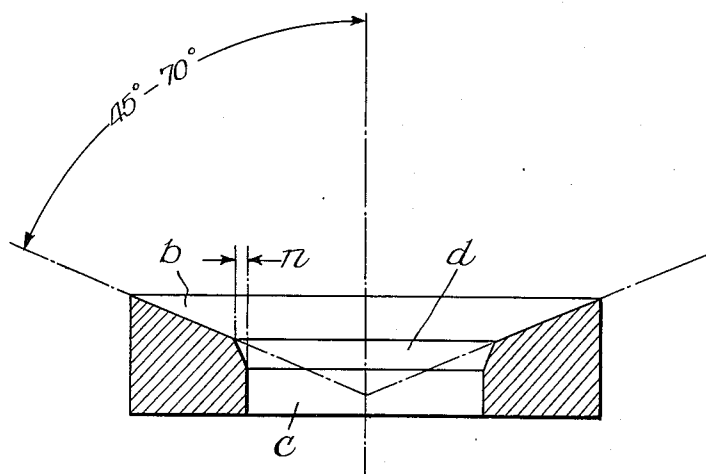
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F. SINGER

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MANUFACTURE OF ARTICLES FROM LIGHT METAL ALLOYS

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Inventor
Fritz Singer,

By Richard Spencer atty

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MANUFACTURE OF ARTICLES FROM LIGHT METAL ALLOYS

Fritz Singer, Soecking, Germany

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4 Claims. (Cl. 207—10)

This invention relates to a new and improved method of producing articles of manufacture such as, for example, bars, rods, tubes and the like, from duraluminum and other light metal alloys by means of extrusion. In using the term "other light metal alloys" as employed herein, particular reference is made to such materials as aluminum alloys containing up to 12% magnesium, magnesium alloys and the like.

It is generally known today that alloys of the light metals can be formed into pipes, rods, bars and the like by extrusion, although in accordance with present day knowledge it is absolutely essential that the rate or speed of extrusion be very slow. Thus, according to Dr. Alfred Zeerleder's "Technology of Aluminum and its Alloys," Academic Publishing Society, Leipzig, 1934, page 156, the extrusion of certain light metal alloys may require up to thirty minutes. The ram speeds used in present light metal alloys extrusion practice vary, depending upon the section, the kind of alloy to be extruded, the size of the cylinder and other conditions, between one inch and forty inches per minute. Furthermore, although it was known that the extrusion operation produced a noticeable temperature increase of the billet so that the temperature of the article extruding from the die was, depending upon the rate of deformation, by 30° to 50° C. higher than that of the billet at the beginning of the operation, it was considered necessary as indicated by the treatise above mentioned to maintain the pressing temperature of the billet at a constant level during the whole extrusion operation by applying external heat to the billet container.

Inasmuch as the extremely slow mode of operation heretofore obtained in the production of articles of light metal alloys resulted in an extraordinarily high cost of production, it has repeatedly been attempted to increase the extrusion speeds in the production of such articles, but in each instance it has been found that the article leaving the die either cracked or was subject to imperfections upon its outer surface, or in the case of tubes, to cross cracks upon their inner and outer surfaces, as to render such efforts futile. Even when maintaining the customary low present day extrusion speeds, tubing, for instance, is often obtained which, due to the increase of temperature resulting from the deforming process, is rendered unsuitable for use owing to the presence of transverse fissures or cross cracks on the inner and outer surface of the tube.

With the foregoing considerations in mind, the importance of the present invention, which

aims toward the extrusion of articles from these metals at high speeds and without defects, will be appreciated. Additionally, in accordance with the practice of the present invention, articles of substantial size and length may be extruded with the same degree of ease as short articles. Thus, valve stems may be satisfactorily produced which may be deemed to be of small size, and likewise tubing many feet in length may similarly be obtained. Through practice of the invention in accordance with the disclosure hereinafter to be revealed, the production of articles from light metal alloys may be greatly increased and the attendant cost of production substantially lowered.

In accordance with the knowledge of the prior art those skilled in the art might have been inclined toward the view that heating the container in which the billet is placed for purposes of extrusion or heating the punch and other tools employed in the extrusion operation was superfluous, owing to the fact that even when operating at low press speeds the emerging metal was of a considerably higher temperature than that of the billet at the beginning of the operation. However, when operating at the customary low extrusion speeds heretofore in use and with which those skilled in the art were acquainted, the elimination of the heating of the receptacle would only have led to a freezing of the billet within the receptacle due to heat losses caused by the long protracted duration of the extrusion operation.

In accordance with the present discovery it has been found that these metals may be satisfactorily extruded at substantially higher up to what might be termed very high extrusion speeds, and by this is meant such speeds as are customary in the production of steel and brass pipe by extrusion in accordance with my process which forms the subject matter of some thirty odd patents which have previously been granted in the United States. Thus, I have discovered that through the employment of high speeds the step of constantly heating the receptacle or container for the billet may be entirely eliminated, and indeed it may become necessary if a rapid succession of extrusion operations are to be performed to cool either intermittently or constantly both the container and the other tools used in the operation, such, for example, as the mandrel and punch.

In further accordance with my discovery, I propose to employ such low billet temperatures that the heat of deformation which occurs dur-

ing the extrusion operation shall not occasion excessive heating of the emerging article which may lead to the formation of fissures or other defects. The determination of the proper temperature of the billet depends, first, on the properties of the alloy of which the billet is composed, second, on the speed of extrusion, and third, on the temperature conditions of the container and extrusion tools. If the tools, such as the piercing mandrel and punch, are practically cold, a small degree of deformation is desired, and a comparatively small billet is employed, the temperature of extrusion may go up practically as far as the lower limit of extrusion temperatures which are employed today in connection with these alloys, namely 380° centigrade. On the other hand, if heavier billets are to be extruded and greater degrees of deformation are desired, the billet temperature must be reduced according to the speed of extrusion and the characteristics of the heated alloy down to as low as 300° centigrade, and if necessary the tools, in particular the piercing mandrel, must also be cooled.

In the case of alloys that are very brittle when hot, to which belong the alloys of the duraluminum group, it will be found practical to use an extrusion die, the billet-supporting surface of which forms an angle of from 45° to 70°, approximately, with the axis of the tool, as illustrated in Figure 1 of the drawing. Furthermore, it will be found desirable that the bearing face *b* of the die should not directly merge with the cylindrical or approximately cylindrical throat *c* of the die, but that there should be an intervening short steep bevel *d*, which, in the case of round pieces of work, such, for example, as tubes, rods and the like, assumes the shape of a truncated cone, the parallel boundary surfaces of which show a difference of radii amounting to less than one-fifth of the radius of the billet. The effect of this beveled area in the extrusion of hollow tubes apparently results in the prevention of uneven stresses being set up between the outer and inner surfaces of the tube.

Referring once more to the drawing, the distance *n* which represents the difference between the radii of the parallel boundary surfaces of the truncated cone *d* amounts to less than one-fifth of the radius of the billet which is to be extruded.

Turning now to a specific practice of the improved process described herein, a billet of duraluminum having a diameter of $2\frac{1}{4}$ inches and a length of $4\frac{17}{32}$ inches may be placed into a container having a slightly greater diameter and a height in excess of the billet length. A piercing mandrel having a diameter of approximately .78 inch may be employed in connection with a die having an interior throat opening of approximately .936 inch to form a tube with a wall thickness of about .078 inch. If the container and the die, as well as the mandrel, are about the temperature of the operator's hand or body temperature, the temperature of the billet may be about as high as 380° centigrade. If, however, the tool and container temperature is about 250° to 300° centigrade, no matter if the tools have been brought to this temperature by the application of external heat or have been heated to this temperature owing to the rapid succession of operations without the application of cooling means, then the billet temperature may have to be lowered as far down as 300° centigrade.

Immediately after insertion of the duraluminum billet the vertical mechanical press, which is of the preferred type, may be started and the

billet extruded at an average press speed of three to four inches of billet length per second. If the lower face of the punch is given a shape corresponding to the upper surface of the die or billet-supporting surface the billet may be extruded until only a thin-walled residue remains, which may be removed from the extruded tube after completion of the extrusion operation in any known manner, such, for example, as by means of a chisel, manually, or by means of a shearing apparatus, mechanically.

Thus, it will be seen that the temperature of the billet and the cooling action of the tools are regulated inversely in proportion to the speed of extrusion and the rapidity of the sequence of operations. If, in the production of tubing or other articles, the tools, including the container, become too hot, it only becomes necessary to reduce the billet temperature. In many instances it will be seen that the reverse of the process of the prior art is employed in carrying out the instant invention. High speeds of extrusion are employed instead of low, low billet temperatures are employed instead of high, and the tools are cooled instead of heated. By balancing and regulating these factors to bring about an effective medium of temperature control it is possible to extrude articles from these alloys at speeds infinitely greater than have ever been employed or contemplated heretofore.

Before concluding this disclosure it may be pointed out that it is difficult to fix definitely the ram speeds that are employed today in extruding aluminum alloys. By ram speed is meant the speed of the plunger moving in the container, or expressed in another way, ram speed indicates the speed of extrusion as expressed in terms of the length of billet extruded per second. Smaller sections can be extruded with higher extruding speeds than can be done with thicker sections due to the increased cooling which small sections undergo while passing through the matrix die opening. The ram speed may be exactly the same in both cases. Also pure aluminum and certain comparatively soft alloys of aluminum can be extruded with almost the same speeds as brass or iron. Generally speaking, the harder the alloy the lower is the maximum speed at which it can be extruded. In general the ram speed decreases with the content of alloying metals.

Thus, the extrusion speeds on an alloy like duraluminum vary quite widely because of a variety of conditions. Likewise, the ram speeds vary even more widely because the speed for extruding any one particular shape will naturally vary with the diameter of the cylinder from which the metal is being extruded. For example, the forward movement of the ram will vary with the square of the radii of the diameter of the cylinder or container. However, a general idea of the ram speeds for extruding duraluminum can be given by stating that depending upon the section, the size of cylinder, and other conditions, the ram speed will be substantially greater than one inch of billet length per minute.

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

1. That improvement in extruding solid and hollow articles from duraluminum and other light metal alloys characterized in that the ram speeds at present being used and which vary depending upon the section, the kind of alloy to be extruded, the size of the cylinder and other conditions, between one inch and forty inches per minute, are

substantially increased up to those used in extruding copper alloys, which speeds vary between one inch and several inches per second, and the billet temperatures at which extrusion is started as well as the cooling action of the tools are balanced and regulated in such a manner as to prevent the heat formed by the rapid extrusion from causing excessive heating of the emerging article which results in the formation of cracks and other defects therein.

2. That improvement in methods of extruding according to the method of claim 1, characterized by the fact that in the extrusion of light metal alloys that are particularly brittle when hot, the billet is supported upon a surface forming an angle of from about 45° to 70° with the axis of the extrusion container and is joined with its extrusion outlet or opening by means of an intervening steep bevel which, in the case of pieces having circular cross section, assumes the shape of a truncated cone, the parallel boundary surfaces of which have a difference of radii amounting to less than one-fifth of the radius of the billet being extruded.

3. That improvement in methods of manufacturing solid and hollow articles from duraluminum and other light metal aluminum alloys which consists in extruding said alloys at a speed in excess of one inch of billet length per second, and balancing and regulating the billet temperatures at which extrusion is started as well as the cooling action of the tools in such a manner as to prevent the heat formed by the rapid extrusion from causing excessive heating of the emerging article which results in the formation of cracks and other defects therein.

4. That improvement in methods of manufacturing solid and hollow articles from duraluminum and other light metal alloys which comprises the steps of placing in a container a billet of such metal, controlling the temperature of the billet and of the tools so as to offset the effects of excessive heat caused by extrusion of the metal, and applying pressure thereto by means of an extruding tool moving at an average speed in excess of 40 inches of billet length per minute.

FRITZ SINGER.

CERTIFICATE OF CORRECTION.

Patent No. 2,218,459.

October 15, 1940.

FRITZ SINGER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 33, after the word "extruding" insert --aluminum and--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of December, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.