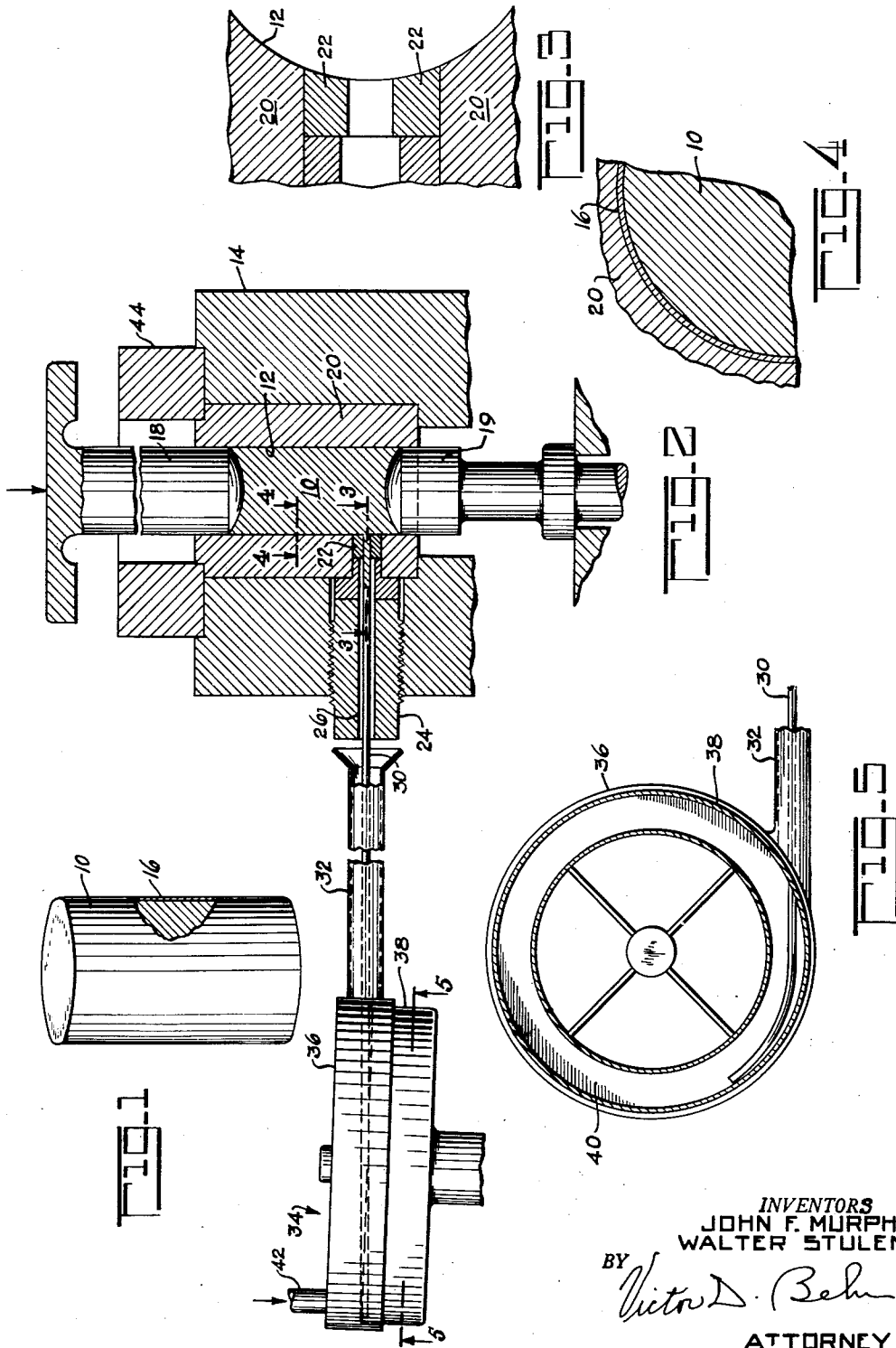


March 14, 1961

J. F. MURPHY ET AL
CROSS-EXTRUSION PROCESS

2,974,790

Filed Jan. 6, 1958



INVENTORS
JOHN F. MURPHY
WALTER STULEN
BY *Victor D. Behn*
ATTORNEY

1

2,974,790

CROSS-EXTRUSION PROCESS

John F. Murphy, Snyder, N.Y., and Walter Stulen, North Caldwell, N.J., assignors to Curtiss-Wright Corporation, a corporation of Delaware

Filed Jan. 6, 1958, Ser. No. 707,340

1 Claim. (Cl. 207—2)

This invention relates to metal forming and is particularly directed to a method and apparatus for extruding metal and to the extruded metal produced thereby.

Metal may be extruded directly from cast ingots of a particular metal or from billets forged as by rolling from ingots of said metal. In the case of an ingot, when the ingot cools and solidifies from its molten state the outer portions of the ingot cool first and the central core is last to cool and solidify. This radially inward cooling of a metal ingot, particularly in the case of certain alloys results in a non-uniform distribution of its constituents and/or other non-uniform internal metallographic structure. Thus, a cast cylindrical ingot generally has a non-uniform internal metallographic pattern across the ingot which pattern runs axially through the ingot. Such non-uniformity or lack of homogeneity in ingots generally is known as segregation. When an ingot having a non-uniform internal metallographic pattern is forged, this non-uniformity causes so-called flow lines to be produced in the resulting billet. Thus a rolled billet will have axial flow lines running through the billet. Hence billets forged from ingots having a non-uniform internal metallographic pattern likewise have a non-uniform internal metallographic pattern. Any non-uniform internal metallographic pattern results in the metal being anisotropic. That is the physical properties of the metal are different in different directions. For example the fatigue strength and ductility of a rolled billet generally are greatest in the direction of its flow lines and are a minimum at right angles to said flow lines.

In conventional extrusion of metals, a metallic blank, which may be a metallic ingot or billet of cylindrical shape, is heated to its proper temperature for extrusion and is placed in a cylindrical chamber of an extrusion press having a co-axial extrusion die opening at one end, the cross section of the die opening being similar to that desired of the extruded metal. Pressure is applied axially to the other end of the blank to force the metal axially out through said die opening. With such axial extrusion, if the above described usual anisotropy exists in the original ingot or billet it will at least to some extent also appear in the extruded metal.

An object of the present invention comprises the provision of a novel extrusion method and/or apparatus whereby anisotropy in the extruded metal is minimized.

A further object of the invention comprises the provision of a novel extrusion procedure such that the extruded metal flow through the extrusion die opening is transverse to any general flow pattern in the ingot or billet being extruded. More specifically it is an object of the invention to extrude a cylindrical ingot or billet through an extrusion die opening having its axis at right angles to the direction of the applied extrusion force.

Other objects of the invention will become apparent upon reading the annexed detailed description in connection with the drawing in which:

Fig. 1 is a perspective view of a billet prepared for extrusion in accordance with the invention;

2

Fig. 2 is a sectional view of extrusion apparatus embodying the invention;

Fig. 3 is an enlarged sectional view illustrating the extrusion die opening and adjacent portion of the extrusion press, this view being taken along line 3—3 of Fig. 2 but with the extrusion press empty of metal to be extruded;

Fig. 4 is an enlarged sectional view taken along line 4—4 of Fig. 2; and

Fig. 5 is a sectional view taken along line 5—5 of Fig. 2.

Referring to the drawing, reference numeral 10 designates a cylindrical metal blank to be extruded, the size of the blank is such as to fit in the cylindrical container 12 of an extrusion press 14 (Fig. 2). In Fig. 2 the blank is already partly extruded. The blank 10 may be an ingot or a billet having, as is common and described above, a non-uniform metallographic pattern across the blank which runs generally in an axial direction substantially through the blank. Before the blank is placed in the extrusion press 14 it preferably is preheated in air or in a suitable salt bath. In the case of steels and heat and corrosion resistant alloys this preheat temperature may be from 1400° F. to 1800° F. The metal blank is then heated to a temperature satisfactory for extrusion preferably by soaking the blank in a bath of molten glass maintained at said temperature. For example in the case of a blank having a composition of steels or other heat and corrosion resistant alloys the blank is heated to a temperature of about 2300° F.

The molten glass not only heats the blank 10 to the extrusion temperature but it also acts to dissolve any oxides from the surface of the blank thereby providing a scale-free surface. Although heating in molten glass is preferred other means may be used to heat the blank to 2300° F. and at the same time provide the blank with a scale-free surface for example by heating the blank in a reducing atmosphere.

Upon removal from the molten glass bath, excess glass is scraped from the blank so as to leave a thin layer 16 of glass, preferably of the order of 1/32 of an inch thick, over the entire surface of the blank. This molten layer or coating of glass protects the surface of the blank from oxidation during the subsequent extrusion of the blank and said layer of glass also functions as a lubricant for the extrusion die as the metal is being extruded through said die.

In lieu of using molten glass as the lubricant coatings of other lubricants, such as graphite or a graphite aluminum mixture, may be applied to the surface of the blank 10 after it has been heated to its extrusion temperature.

The blank 10 is now ready to be placed in the extrusion press 14 which prior thereto has been preheated to approximately 400°–600° F. This temperature should be accurately controlled.

The ram 18 of the extrusion press 14 is then retracted from one end of the extrusion press container 12 and the heated blank 10 with its molten glass layer 16 (or other lubricant coating) is placed within said container. The other end of the cylindrical extrusion press container 12 is closed by a cylindrical ejector member 19. The extrusion press container has an internal liner 20 and a block 22, providing an extrusion die opening, is mounted in said liner. The extrusion die block 22 is mounted adjacent to but slightly spaced from the ejector member end of the extrusion press container 12 and is disposed so that the axis of its opening is directed at right angles to and intersects the axis of the cylindrical extrusion press container 12.

The inner surface of the die block 22 preferably is flush with inner wall of the container as indicated in Figs. 2

3

and 3 whereby said inner die block surface is cylindrical. Cast stellite has proved satisfactory for the die block 22. The inner cylindrical surface of the die block, which is flush with the inner wall of the extrusion press container, preferably is left in its as-cast condition whereby the slight irregularities in said surface function as traps or reservoirs for retaining molten glass lubricant on this surface. The die block 22 is held in position by a breech block 24 having an opening 26 for passage of the extruded metal.

Upon the application of sufficient pressure on the blank 10 by the ram 18, the metal is extruded as indicated at 30 through the extrusion opening of the die block 22. The extruded metal 30 enters a tubular extension 32 of a coiling mechanism 34. The coiling mechanism 34 includes a stationary cover member 36 to which the tubular extension 32 is connected and through which the extruded metal enters. A reel 38 is journaled below the cover, said reel having an annular channel 40 within which the extruded metal is coiled as it is extruded. As illustrated, the extruded metal enters the coiling mechanism cover 36 tangentially and at a small angle to the reel axis so that the metal readily enters the channel 40 of the reel 38.

Means are provided for supplying an inert gas, such as argon, through a passage 42 into the coiling mechanism 34 in order to minimize oxidation of the extruded metal 30 as it cools from the extrusion temperature.

A suitable stop block 44 is provided to limit motion of the ram 18 into the extrusion press container. After completion of the extrusion stroke of the ram 18 it is withdrawn from the extrusion press. The ejector member 19 is then raised to shear off the un-extruded metal remaining in the extrusion press container 12 from the extruded metal in the extrusion die 22. The ejector member 19 is raised sufficiently to permit removal of said un-extruded metal from the extrusion press container 12.

A handle (not shown) preferably is provided on the coiling mechanism reel 38 so that at completion of the extrusion operation the uncoiled portion of the extruded metal can also be coiled on said reel.

With the extrusion procedure described, the external extrusion pressure is applied axially by the ram 18 against the cylindrical metal blank for extruding the metal transversely through the extrusion die 22. With this specific cross-extrusion process the molten glass layer 16 about the metal blank appears to flow more readily to the extrusion die to function as a lubricant for said die as the extrusion proceeds than it would for example if the metal were extruded axially through an extrusion die at the bottom of the extrusion press container 12. This would also be true if another lubricant layer were used in the extrusion press 14 about the blank 10 in lieu of said molten glass layer 16.

With cross-extrusion out through a lateral extrusion die opening, the metal apparently flows primarily from the center of the metal blank laterally to the extrusion die whereas with the conventional type of extrusion through an axial die opening the metal apparently flows to a greater extent from the blank surface to the extrusion die opening. Unless an inert atmosphere is used, the surface of the blank in the extrusion press is subject to oxidation and therefore with said conventional extrusion practice the extrusion die is subject to greater wear from contact with metal oxides. Another advantage of the lateral cross extrusion of this invention is that a plurality of extrusion die openings may be provided, for example in a plant transverse to the axis of the extrusion press 14 and including the axis of the extrusion die 22, with less danger of differences occurring between the extruded metal from the various openings than would be the case of multiple extrusion die openings in a conventional extrusion press in which the extrusion is axial.

Furthermore if, as described, the metal blank 10 has the usual non-uniform metallographic pattern running through it from substantially one end toward the other, this cross extrusion results in the internal metallographic

4

structure of the extruded metal being more uniform or homogeneous than it would be if the metal were extruded in the conventional manner axially through an extrusion die opening at the bottom of the extrusion press. Because of the greater homogeneity obtained in the extruded products with the extrusion process and apparatus of this invention there will be less variation in the physical properties of such extruded products as a result of differences in the flow lines and/or segregation in the starting blanks.

As illustrated, the surface of the ejector member 19 forming the bottom wall of the extrusion press container 12 is convex as viewed from within said container. It has been found that this feature is important for obtaining a homogeneous extruded product possibly because it minimizes axial flow of the metal from the ejector member end of the extrusion press container toward the extrusion die 22. Similarly the inner surface of the ram 18 preferably is made convex as viewed from within the extrusion press container 12.

The extruded metal becomes even more homogeneous at higher extrusion ratios notwithstanding any lack of homogeneity in the blank to be extruded. It is felt that for a given applied pressure higher extrusion ratios are possible with the cross-extrusion process of this invention in which the metal is extruded through a lateral die opening as contrasted with conventional extrusion through an axial die opening. Extrusion ratios of 100 to 1 have been used with the extrusion process described for extruding wire for aircraft engine valve springs. This invention is particularly useful for extruding metals where a high degree of homogeneity is desired in the finished product.

While we have described our invention in detail in its present preferred embodiment, it will be obvious to those skilled in the art, after understanding our invention that various changes and modifications may be made therein without departing from the spirit or scope thereof. We aim in the appended claim to cover all such modifications.

We claim as our invention:

Apparatus for the extrusion of metals comprising: a stationary billet container having a cylindrical cavity therethrough for accommodating a previously prepared metal billet, said container having an opening through the wall thereof near one of said container's ends; an extrusion die seated and held in said opening, the inner end surface of said die being of cylindrical contour which mates with and forms a continuation of said wall, said end surface being of rough cast finish tending to restrain the lubricant employed, and said die having an extrusion orifice therethrough which latter opens through the central part of said end surface; an ejector member having a head portion and a press seating portion, said head portion having a convex end joining an outer cylindrical surface which latter is a sliding fit within said cavity, said seating portion, when seated, holding said convex portion below said die but still closing the lower end of said cavity; means for moving said ejector member in a direction up and along the axis of said cavity to eject an extrusion remnant therefrom; an extrusion ram which is a sliding fit in said cavity, said ram having a convex end similar to and opposed to the convex end on said ejector; means to move said ram back and forth along said axis; whereby, when said ram compresses a billet against said ejector, said billet will extrude through said orifice, and the convex ends of said ejector and said ram, as well as the general orientation of the billet with respect to said orifice, will tend to cause less anisotropy in the product than that caused in and by heretofore conventional extrusion presses.

References Cited in the file of this patent

UNITED STATES PATENTS

2,021	Hanson	Mar. 29, 1841
567,410	Potter	Sept. 8, 1896

(Other references on following page)

5

UNITED STATES PATENTS

907,077	Mereta	Dec. 15, 1908
1,682,399	Mitchell	Aug. 28, 1928
1,739,620	Summey	Dec. 17, 1929
2,080,399	Deibel	May 18, 1937
2,401,235	Farr et al.	May 28, 1946
2,706,850	Sejournet et al.	Apr. 26, 1955
2,731,145	Kritscher	Jan. 17, 1956
2,755,925	Boccon-Gibod et al.	July 24, 1956

6

FOREIGN PATENTS

572,354	Germany	Mar. 16, 1933
829,500	France	Apr. 5, 1938
646,296	Great Britain	Nov. 22, 1950
201,469	Australia	Apr. 11, 1956

OTHER REFERENCES

"Metalworking Lubricants," by E. L. H. Bastian,
McGraw-Hill Book Co., Inc., 1951, pp. 281-282.