METHOD OF MAKING A SLUG HAVING CONTROLLED GRAIN DIRECTION

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ABSTRACT

A metal slug having an improved grain orientation wherein the individual grains thereof are in substantially parallel relation; and, a method of making such a slug from an inexpensive wrought rod without waste wherein the grain orientation of a rod blank from which the slug is made is altered to provide the completed slug having the improved grain orientation.

2 Claims, 16 Drawing Figures
METHOD OF MAKING A SLUG HAVING CONTROLLED GRAIN DIRECTION

BACKGROUND OF THE INVENTION

It has been found very economical to make extruded articles using metal slugs produced from elongated rod stock. However, these slugs generally tend to have weak spots which are due to the comparatively poor grain orientation of such slugs whereby the occurrence of these weak spots introduces additional inspection costs and scrap costs which tend to reduce the inherent cost advantages of producing slugs from such rod stock.

SUMMARY

This invention provides a metal slug having an improved grain orientation wherein the individual grains thereof are in substantially parallel relation. Further, this invention provides an improved method of making such a slug without waste and from an inexpensive rod blank by altering the rod blank from which the slug is made to produce the desired grain orientation.

Other details, uses, and advantages of this invention will become apparent as the following description of the exemplary embodiments thereof presented in the accompanying drawings proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings show present preferred embodiments of this invention, in which

FIG. 1 is a fragmentary view of an elongated substantially right circular cylindrical rod which may be severed or cut essentially as shown by the dotted lines illustrated to define a plurality of rod blanks each of which may be altered in accordance with the teachings of this invention to define an improved slug particularly adapted to be used in making articles therefrom by extrusion;

FIG. 2 is a view in elevation with parts broken away and parts shown by dotted lines of an exemplary press having a pair of cropping dies which may be used to sever the elongated rod of FIG. 1 and define rod blanks;

FIG. 3 is a fragmentary cross-sectional view illustrating an exemplary forming apparatus which may be utilized to partially form the rod blanks;

FIG. 4 is a perspective view of a partially formed rod blank which has been formed by the apparatus of FIG. 3;

FIG. 5 is a fragmentary cross-sectional view illustrating another exemplary apparatus which may be used to finally form the partially formed blank of FIG. 4 after placing such blank in position so that its predominant grain direction is arranged transverse the direction of forming movement of the apparatus and showing such apparatus at the beginning of the forming movement;

FIG. 6 is a view similar to FIG. 5 illustrating the apparatus of FIG. 5 at the completion of the forming movement;

FIG. 7 is a perspective view of the completed slug after removal from the forming apparatus;

FIG. 8 is a cross-sectional view taken on the line 8--8 of FIG. 7 showing a plurality of spaced dotted lines arranged in parallel relation to indicate the arrangement of the grains in the finished slug of FIG. 7;

FIG. 9 is a perspective view of an exemplary article in the form of a shell casing formed by impact extrusion using a slug made in accordance with this invention;

FIG. 10 is a perspective view of an elongated rod of rectangular cross-sectional configuration which may be used to make rod blanks each having the shape of a parallelepiped and each being used to define an improved slug in accordance with this invention;

FIG. 11 is a fragmentary cross-sectional view of a forming apparatus which may be used to partially form a rod blank of rectangular cross section after placing such blank in its forming position with its predominant grain direction arranged transverse the direction of forming movement and showing such apparatus at the beginning of the forming movement;

FIG. 12 is a view similar to FIG. 11 and showing the apparatus of FIG. 10 at the completion of the forming movement;

FIG. 13 is a perspective view of a partially formed rod blank as formed by the apparatus of FIG. 12;

FIG. 14 is a fragmentary cross-sectional view of another forming apparatus similar to the apparatus shown in FIGS. 11 and 12 which is used to finally form the partially formed blank of FIG. 13 and showing such apparatus at the completion of its forming stroke with the finally formed slug in position therein; and

FIGS. 15 and 16 are fragmentary cross-sectional views of an apparatus and method for forming a rod blank to define a completed slug in one step without first partially forming the rod blank.

DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Reference is now made to FIG. 1 of the drawings which illustrates one exemplary embodiment of an elongated wrought rod of circular cross-sectional configuration which has a predominant grain direction which is substantially parallel to the longitudinal axis thereof. The rod 20 is suitably cut as indicated by a plurality of dotted lines 21 to define rod blanks 22 of substantially right circular cylindrical configuration which may be used to make the improved slug of this invention, and in a manner to be described in detail subsequently.

Any suitable means may be utilized to sever the elongated rod 20 to define blanks 22; however, in this example of the invention the severing action is achieved in a press 23 of conventional construction which has a pair of cooperating cropping dies 24 and 25. The rod 20 is fed into the press 23 utilizing any suitable technique whereupon the cropping dies 24 and 25 sever the rod to define rod blanks 22 which are conveyed by a gravity chute 26 into a container 27. The cropping dies sever the rod 20 in a precise manner so that each rod blank 22 has a precise length or height and hence an exact weight. It will also be appreciated that suitable control devices may be provided in the press 23 to adjust the length of rod blanks 22 severed by dies 24 and 25, as desired.

The rod blanks 22 are formed to define a substantially disc-like slug which is illustrated in FIG. 7 of the drawings and designated generally by the reference numeral 30 and the slug 30 has a smooth exterior which is free of projections such as burrs, ears, flashings, or the like. The slug 30 is particularly adapted to be used in extruding an article therefrom by known impact extrusion techniques and FIG. 9 illustrates an exemplary
shell 31 for a projectile which is made by impact extrusion using a slug 30. Inasmuch as the elongated rod 20 from which each rod blank 22 is made has a predominant longitudinal grain direction, as previously mentioned, it will be apparent that each blank 22 also has a corresponding predominant grain direction. The blank 22 may be supported on a forming apparatus or press 33, see FIG. 3 which illustrates a portion of press 33, and partially formed to define a partially formed blank 34 which is illustrated in perspective view in FIG. 4.

The press 33 may be of conventional construction whereby only a portion thereof has been illustrated. The press 33 comprises a die assembly or die 35 having an outer member 36 provided with a cylindrical surface or bore 37 and an inner member 40 which may be axially moved within the bore 37. The inner member has an outside surface 41 which cooperates with the surface 37 to define a die cavity 42. The press 33 has a punch or ram 43 which is movable toward and away from the die 35 to enable forming of a rod blank 22 placed in the die cavity 42.

The blank 22 in this example is substantially longer than the width across the die cavity 42 and is supported within such cavity so that its predominant grain direction, indicated by a double arrow 44, is arranged substantially parallel to the direction of forming movement of the press 33 and in particular its ram 43. The blank 22 is then partially formed and after this partial forming, it will be seen that the corners of the partially formed blank 34 are rounded as illustrated at 46 whereby undesirable flashing is prevented upon subsequently upsetting the blank 34, see FIGS. 3 and 4, and the vertical height of such blank is substantially reduced by an amount indicated at 47.

The partially formed blank 34 is then placed in a second forming apparatus or press 50 (see FIG. 5) so that its predominant grain direction 44 is arranged transverse of the direction of forming or impacting, also preferably referred to hereinafter as upsetting, movement of the press 50. The press 50 is similar to the press 33 and may also be of conventional construction whereby only a portion thereof has been illustrated in FIGS. 5 and 6. The press 50 has a die assembly or die 51 comprised of an outer stationary die portion 52 provided with a cylindrical bore or surface 53 and a movable inner portion 54 which is supported within the bore 53 and has an outside surface 54A which cooperates with the outer portion of the bore 53 to define a cavity 55. The press 50 also has a punch or ram 56 which has an inwardly concave surface 57 surrounded by a planar surface 60 and the purpose of the surface 57 will be described in detail subsequently.

The partially formed blank 34 is placed within the cavity 55 so that its predominant grain direction 44 is arranged transverse of the direction of forming movement provided by the press 50 and in the illustration of FIG. 5 the predominant grain direction is shown arranged horizontally. The ram 56 and die 51 are then relatively moved together in a high speed forceful manner to impact and thus upset the partially formed blank 34 and define the completed slug 30 with the impacting or upsetting movement being terminated once surface 60 of ram 56 engages a cooperating surface 61 on the outer member 52 of die 51.

Once the upsetting action has been completed, as shown in FIG. 6, the movable member 54 of die 51 may be moved outwardly relative to the outer member 52 and serves as a knock-out device for removing the completed slug 30 from within the cavity 55. Upsetting the partially formed rod blank 34 to define the completed slug 30 improves its grain orientation and in particular the upsetting serves to align the individual grains or what is often referred to as the grain flow direction, of the metal blank so that the individual grains are substantially perpendicular to the direction of upsetting movement provided by relatively moving the ram 56 and the die 51 together whereby in the completed slug 30 the grains are substantially parallel as illustrated by dotted lines 62 in FIG. 8 of the drawings.

In this example of the invention the workpiece-contacting surface 57 has an inwardly concave configuration which results in the forming of a corresponding convex surface 63 on the slug 30. However, it will also be appreciated that either or both surfaces 54A and 57 may be suitably shaped to define a corresponding outside surface of the completed slug 30, as desired.

Thus, it is seen that an elongated metal rod 20 may be severed to define a plurality of rod blanks 22 which are first partially formed in a forming apparatus such as a press 33 to define a partially formed blank 34. The partially formed blank 34 is then finally formed in a forming apparatus or press 50 to define the completed slug 30 having a granular orientation which makes it particularly adapted to be used to provide extruded articles such as by impact extrusion, for example.

As previously indicated, the presses 33 and 50 may be of conventional construction and operation and each may upset its associated workpiece by either gradual or impacting movements with impacting movements being preferred. Further, it will be appreciated that in each press either the ram or die assembly or both may be suitably resiliently supported utilizing mechanical springs, rubber mounts, or the like to assure that these components will not be damaged during upsetting movements.

The improved slug 30 may also be made from an elongated rod which has a non-circular (such as, rectangular, for example) cross-sectional configuration, see FIG. 10, which for ease of presentation and correlation with the description of rod 20 will be designated by the reference character 20A. The rod 20A may be severed along lines 21A utilizing any suitable technique, such as the punch press 23 illustrated in FIG. 2 and described in connection with the severing of the rod 20, to define a plurality of rod blanks 22A and reference may be made to the previous description for an understanding of the operation of the press 23.

The rod 20A is a wrought rod and has a predominant grain direction which is parallel to its longitudinal axis. However, because of the rectangular cross-sectional configuration of the rod 20A, the rod blanks 22A are cut so that they have the general shape of a parallelepiped and in this example the parallelepiped is in the form of a cube. As in the case of the rod 20, the severing action is preferably achieved by cutting the blanks 22A so that each has an exact weight whereby upsetting each blank 22A in a suitable forming apparatus a final slug is defined, which is substantially identical to the slug illustrated in FIG. 7 and such final slug has been given the same reference numeral 30.

The main advantage of utilizing the rod blank 22A is that instead of partially forming the blank 22A to substantially reduce the height thereof as was required in
the case of the rod blank 22, it is possible to provide the forming action with the grain direction properly oriented and without first reducing the height of the blank. In particular, the blank 22A may, at the outset, be placed in an associated forming apparatus or press with its predominant grain direction 44A arranged transverse the direction of forming movement of the press, see FIG. 11. The press of FIG. 11 is very similar in construction (except for its ram) and operation to the press 33 hence, for ease of description, it will be given the identical reference numeral 33 and components thereof will be given the same reference numerals as corresponding components of the previously described press 33.

The blank 22A is partially formed by relatively moving the cooperating ram 43 and die 35 from the position of FIG. 11 to the position of FIG. 12 to effectively round certain corners of the blank 22A, and define the partially formed blank 34A having only its upper corners, which are designated by the reference numerals 46A, partially rounded. This partial rounding of the upper corners assures that upon finally forming the blank 34A the final slug will have the desired grain orientation as well as a smooth exterior free of projections such as burrs and the like, in the manner previously described; and, any tendency for flashing to form on the finally formed slug is substantially eliminated.

In this latter exemplary embodiment of the invention, only the top corners 46A of the partially formed blank 34A have been rounded in the press 33; however, it will be appreciated that in some applications of this invention it may be desirable to round all corners of the severed rod blank 22A to assure the final slug 30 has the desired characteristics.

The partially formed blank 34A is then placed in another forming apparatus or press which is substantially identical to the press illustrated in FIG. 5 and the fragmentary portion of the press illustrated in FIG. 14 will be designated generally by the reference numeral 50 and its component parts will be designated by the same reference numerals as corresponding component parts of the press 50 previously described whereby the detailed construction and operation of press 50 will not be repeated.

The partially formed blank 34A is placed in the press 50 so that its predominant grain direction 44A is again arranged transverse the direction of forming movements of such press and as in the case of blank 34 the final forming of blank 34A is provided by forcefully upsetting the blank 34A to define the completed slug 30 which has an outer appearance and a grain orientation as illustrated in FIGS. 7 and 8 respectively of the drawings, and as previously described.

From the above description it is apparent that a slug particularly adapted for extrusion may be defined from an elongated rod irrespective of the cross-sectional configuration of such rod and that the elongated rod blanks are first partially formed in one apparatus or press 33 and then finally formed in another press 50. However, it will be appreciated that, depending on the detailed dimensions of the final slug and cross-sectional characteristics of the elongated rod employed, it is entirely possible to form a final slug in a one-step operation essentially as shown in FIGS. 15 and 16.

For example, a rod blank 65 may be suitably cut from an associated rod and placed in the press 50 with its predominant grain direction arranged perpendicular to the direction of forming movement whereupon the ram 56 may be moved or impacted forcefully against the blank to define the completed slug 30, as shown in FIG. 16, so that the grains are arranged in substantially parallel relation and in a direction substantially perpendicular the direction of impacting movement of the press 50.

In the above description of presses 33 and 50 the die assembly in each instance has been described as being stationary with the ram being movable relative thereto. However, it is to be understood that either the ram or its associated die or both may be movable to provide the desired forming or upsetting movement such as impacting, for example.

It is well known that wrought rods formed by mechanical action such as by extrusion, for example, may be manufactured comparatively inexpensively. Further, the slugs formed from wrought products generally produce the best extruded articles. This invention enables the provision of an inexpensive high quality slug and a method of providing such a slug which enables an inexpensively produced rod to be utilized without waste material and without sacrificing the quality of the slug and hence of the final article extruded therefrom in a manner heretofore unknown.

The elongated rods 20 and 20A used to make the rod blanks 22 and 22A respectively from which the improved slugs 30 are made may be made by either extrusion or rolling processes. In addition, rods 20 and 20A may be made from any suitable ferrous material, such as steel, or any suitable nonferrous material, such as aluminum or materials containing aluminum. Excellent results have been obtained using 6066 aluminum alloys.

In this presentation of the invention the completed slug 30 has in each instance been formed using a cooperating punch and die wherein the punch is not received within the cavity carrying the workpiece to be formed; however, it will be appreciated that in some applications it may be desirable to form slug 30 using an apparatus which uses an internal punch, i.e., the punch is received within the workpiece cavity.

In this disclosure of the invention the blanks 22 and 22A have been illustrated and described as being formed in the "closed die" apparatus presented in FIGS. 3 and 11 respectively. However, it is to be understood that in many applications it may be preferred to use what are popularly referred to as "open die" arrangements, wherein a particular blank is partially formed or upset with associated portions of a forming apparatus engaging opposed ends thereof and with the central portion of the particular blank which is arranged between the opposed ends remaining unsupported.

In this presentation of the invention the forming movement of each press has been shown as a vertical movement; however, it will be appreciated that the movement in each instance may be horizontal or at some inclined angle, if desired.

While present exemplary embodiments of this invention, and methods of practicing the same, have been illustrated and described, it will be recognized that this invention may be otherwise variously embodied and practiced within the scope of the following claims.

What is claimed is:
1. A method of making a slug having an improved grain orientation wherein the individual grains thereof
are in substantially parallel relation, said method comprising the steps of, severing an elongated wrought rod having a predominant grain direction to define a rod blank having a desired weight, supporting said blank on a first forming apparatus, partially forming said blank with said first forming apparatus to define a partially formed blank, placing the partially formed blank in an extrusion cavity of a second forming apparatus with its predominant grain direction arranged transverse the direction of forming movement of said second forming apparatus in a stationary position relative to said cavity, and relatively moving a die and a cooperating ram of said second forming apparatus against said partially formed blank with said blank in its stationary position to define said slug having the individual grains thereof arranged substantially parallel and with the parallel grains being arranged in a direction which is perpendicular to the direction of forming movement of said second apparatus, said extrusion cavity having a volume which is slightly greater than the volume of said slug and said step of relatively moving comprises the step of impacting said ram and die forcefully against said partially formed blank causing it to fill practically the entire volume of said cavity and define said slug which has a smooth exterior free of projections, said rod comprising a rod of substantially circular cross-sectional outline, said severing step comprising severing said rod to define said blank having approximately the shape of a parallelepiped, said supporting step comprising supporting said blank on said first forming apparatus with its predominant grain direction arranged transverse the direction of forming movement of said first forming apparatus, said step of partially forming comprising rounding certain corners of said blank to assure provision of said slug having said smooth exterior surface.

2. A method of making a slug having an improved grain orientation wherein the individual grains thereof are in substantially parallel relation, said method comprising the steps of, severing an elongated wrought rod having a predominant grain direction to define a rod blank having a desired weight, supporting said blank on a first forming apparatus, partially forming said blank with said first forming apparatus to define a partially formed blank, placing the partially formed blank in an extrusion cavity of a second forming apparatus with its predominant grain direction arranged transverse the direction of forming movement of said second forming apparatus and in a stationary position relative to said cavity, and relatively moving a die and a cooperating ram of said second forming apparatus against said partially formed blank with said blank in its stationary position to define said slug having the individual grains thereof arranged substantially parallel and with the parallel grains being arranged in a direction which is perpendicular to the direction of forming movement of said second apparatus, said extrusion cavity having a volume which is slightly greater than the volume of said slug and said step of relatively moving comprises the step of impacting said ram and die forcefully against said partially formed blank causing it to fill practically the entire volume of said cavity and define said slug which has a smooth exterior free of projections, said rod comprising a rod of substantially circular cross-sectional outline, said severing step comprising severing said rod to define said blank having approximately the shape of a right circular cylinder and having a vertical height which is greater than any dimension of said extrusion cavity of said second forming apparatus measured in a direction perpendicular to the direction of forming movement of said second forming apparatus, said supporting step comprising supporting said blank with its predominant grain direction arranged parallel to the direction of forming movement of said first forming apparatus, said step of partially forming comprising rounding the corners of said blank and simultaneously substantially reducing said vertical height to enable placing the partially formed blank in said second forming apparatus with its predominant grain direction arranged transverse the direction of forming movement of said second forming apparatus.

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