P. J. CULHANE, JR.

PROCESS OF SEVERING BARS.

APPLICATION FILED NOV. 29, 1915.

1,366,063. **Patented Jan. 18, 1921.**

3 SHEETS—SHEET 1.

Fig. 1

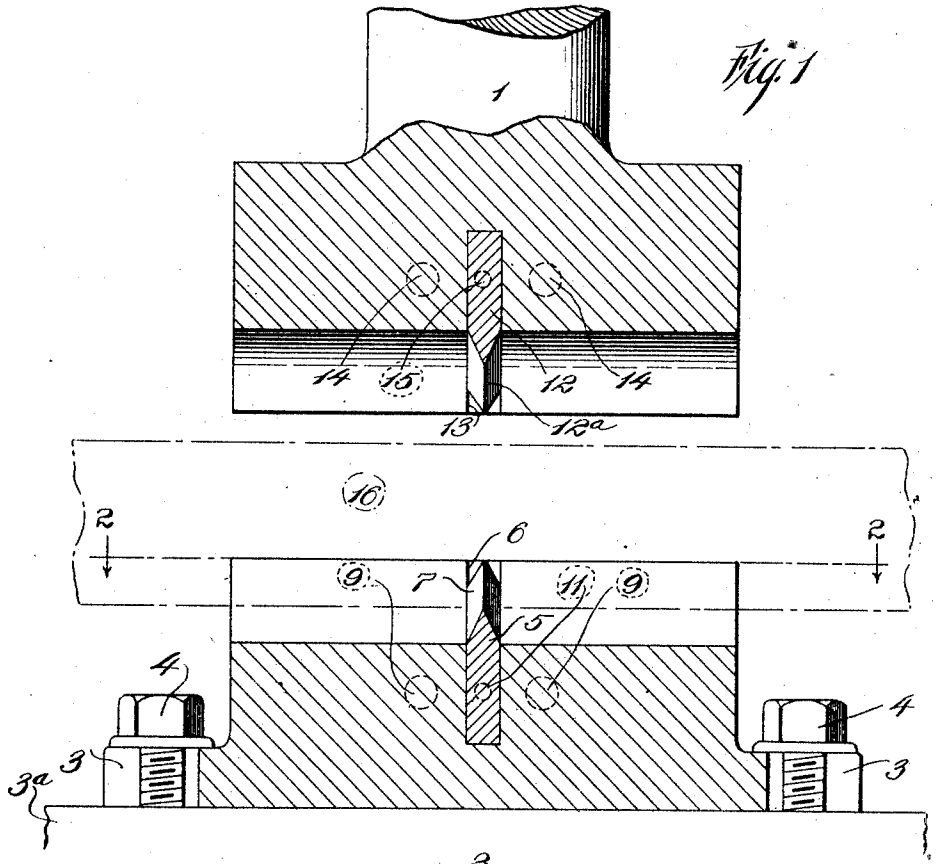
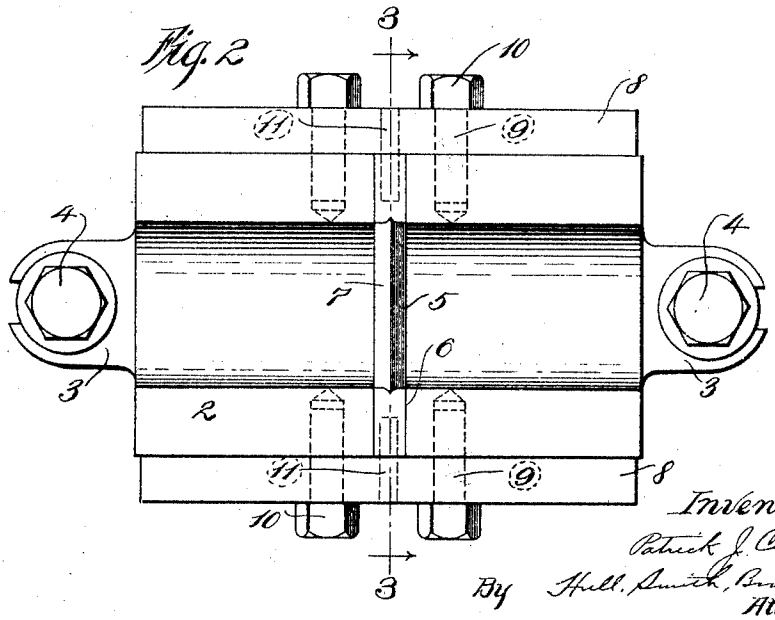


Fig. 2



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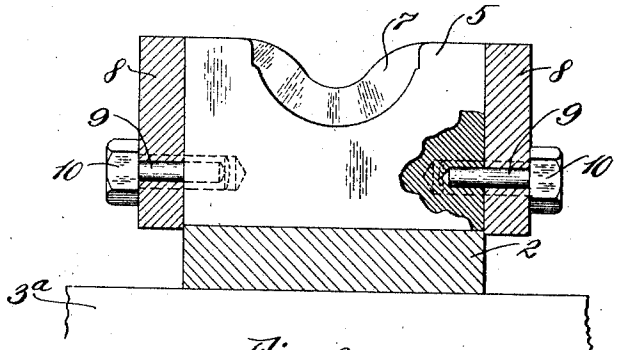


Fig. 3

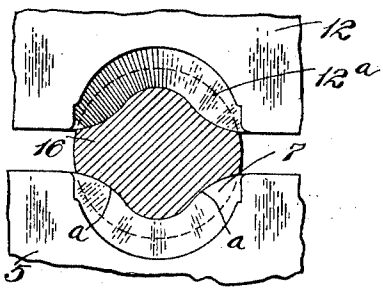


Fig. 5

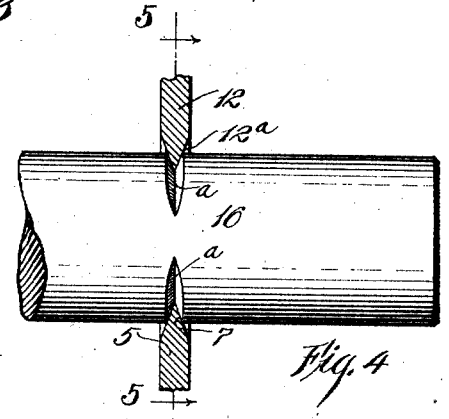


Fig. 4

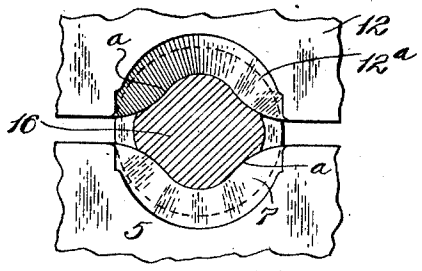


Fig. 7

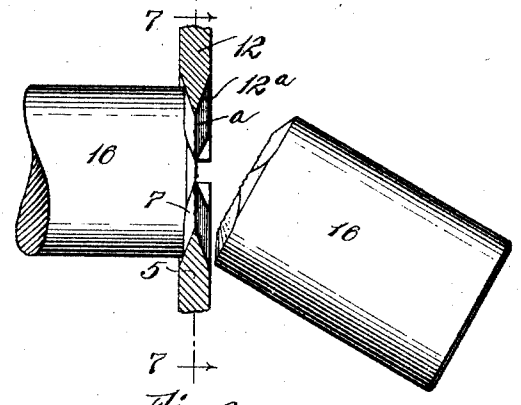


Fig. 6

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3 SHEETS—SHEET 3.

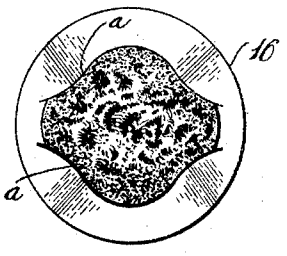


Fig. 9

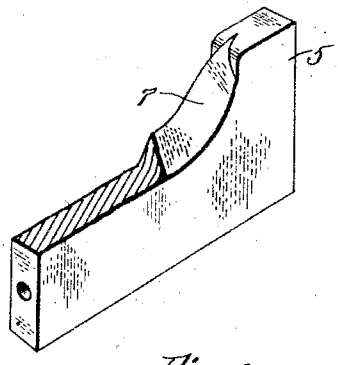


Fig. 8

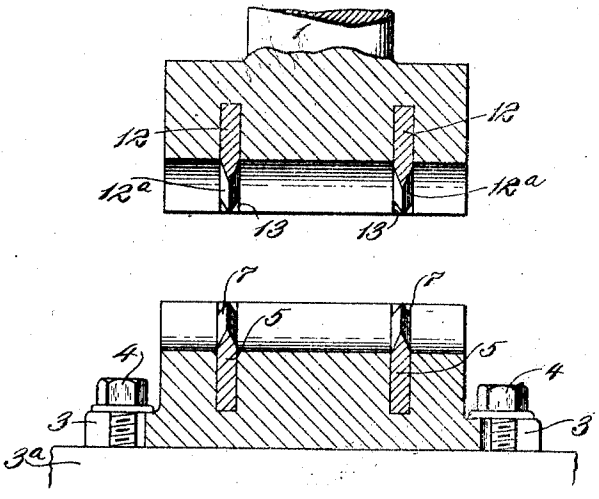


Fig. 10

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UNITED STATES PATENT OFFICE.

PATRICK J. CULHANE, JR., OF CLEVELAND, OHIO, ASSIGNOR TO THE HYDRAULIC PRESSED STEEL COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

PROCESS OF SEVERING BARS.

1,366,063. Specification of Letters Patent. Patented Jan. 18, 1921.

Application filed November 29, 1915. Serial No. 64,034.

To all whom it may concern:

Be it known that I, PATRICK J. CULHANE, Jr., a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvements in Processes of Severing Bars, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to a process of and apparatus for severing metal bars, and has for its general object to accomplish this severing operation in a particularly efficient and economical manner. The commercial methods in ordinary use whereby such bars have been cut or severed heretofore may be classified as follows:—

(*a*) Nicking the bars and subsequently breaking them by the action of a sledge, drop or power hammer.

(*b*) Hot-sawing; that is, severing the bar by sawing through the same while heated to a temperature which will materially lessen the resistance to the sawing action;

(*c*) Cold sawing; that is, sawing through the bar while at ordinary atmospheric temperature.

(*d*) Severing by means of shears.

The objection to the first method of severing bars is that it requires, for heavy bars, the installation of a power hammer; also that it necessitates the employment of two operations. Furthermore, in the case of bars of large cross section, the break is apt to be irregular, requiring a still further operation upon the ends of the severed portions or blanks.

A serious objection to both of the sawing operations is that they involve a considerable loss of metal by the saws, and this loss is a material one where the bar is to be cut into short lengths. Furthermore, the sawing operation (whether performed hot or cold) generally results in producing a flange or "flash bur" projecting from the side of the metal from which the edge of the saw emerges at the completion of the cut. This necessitates the subsequent operation of grinding or otherwise removing this projecting bur or flange. Furthermore, the saws are relatively slow in operation and the cost of upkeep is high.

The operation of ordinary shears is necessarily limited to bars of relatively small cross-sectional area, thereby eliminating this operation so far as bars of large cross-sectional area are concerned, for instance, in connection with bars of three inches or more in diameter.

In the present process, the bar is subjected to a combined severing and wedging action. This action is secured by means of one or more wedge-shaped cutters and, where a pair of such cutters are used, one being opposed to the other, the cutting edges are preferably in the same plane, which plane is transverse to the axis of the bar or stock being severed. The action of these cutters differs from that of the ordinary shears, not only in having the cutting edges arranged in the same plane transverse of the axis of the bar, but also in the wedge shape of the cutters, the ordinary shear blades neither requiring nor possessing such shape. These cutters, while penetrating the bar and thus reducing its cross section, force the metal which is contacted by the inclined sides of the cutters lengthwise of the bar. During this cutting action, the metal is thus forced lengthwise or longitudinally of the bar and, to a certain extent, is compressed radially. Where the process is realized in and through a second cutting operation in substantially the same plane as the first, the net result of this first cut is a decrease in the cross section of the bar in the plane of the cutters, a radial compression of the bar, and a tension stress in the unsheared section of the bar due to the squeezing of the metal in a direction lengthwise of the bar by the wedged or tapered sides of the cutters. If there are any stresses in the surface metal, as is usually the case in hot rolled, unannealed steel, they will be relieved locally by this first cut.

Assuming that the longitudinal tension stress produced by the first cut is insufficient to sever the bar, the bar may then be given a partial turn on its axis whereby another portion of the bar in the same transverse plane may be subjected to a second cutting action, whereupon the second stroke of the press will sever the bar. This second cut duplicates the first up to a certain point, the metal being forced in a direction parallel to the axis of the bar and the section of the bar in the plane of the cutters being still further reduced. The squeezing out of the metal by the tapered sides of the cutters in a direction lengthwise of the bar sets up a tension

stress in the unsheared section of the material, which stress increases as the section is reduced in area by the shearing action until the unit tension exceeds the tensile strength of the material, provided that the cutting stroke be made with sufficient rapidity to prevent such flowing or deformation of the metal on opposite sides of the cutters, in a direction longitudinal of the bar, as will enable the metal to absorb a material portion of the available pressure. When the tensile strength of the unsheared portion of the cross-section of the bar is thus exceeded, this portion is pulled apart by a pure tension stress. In operating upon a cylindrical bar of about 3¼ inch diameter and cutting the same into blanks approximately six inches long, the reaction of the metal on the cutter blades when the bar is thus pulled apart has been sufficient to cause the blanks to be thrown a considerable distance from the cutters with a like reaction upon the main body of the bar on the opposite sides of the cutter blades.

The foregoing operation has been performed with a 156 ton press having concaved blades projecting approximately three quarters of an inch beyond their carriers, the faces of the cutters being inclined about 23° each way from the center line. As used with great advantage, these blades have been constructed so as to produce as nearly as possible a uniform amount of deformation of the bar for each unit of movement of the cutters, thereby utilizing in the most efficient manner the uniform pressure available in the press cylinder.

In the drawings forming part hereof, which illustrate two embodiments of a means or apparatus for realizing the process, Figure 1 represents a vertical sectional view through a pair of die members, certain parts being shown in elevation and the bar to be severed being indicated in dot-and-dash lines; Fig. 2 a sectional view corresponding substantially to the line 2—2 of Fig. 1, the bar being omitted; Fig. 3 a transverse sectional view corresponding substantially to the line 3—3 of Fig. 2; Fig. 4 a diagrammatic view illustrating the first operation performed on the bar by the apparatus; Fig. 5 a transverse sectional view corresponding to the line 5—5 of Fig. 4; Fig. 6 a diagrammatic view, similar to Fig. 4, illustrating the second operation performed on the bar by the apparatus; Fig. 7 a sectional view corresponding to the line 7—7 of Fig. 6; Fig. 8 a perspective view of one of the knives or cutters of the apparatus, a part being broken away; Fig. 9 an end view of one of the blanks or of the corresponding end of the bar from which the blank has been removed; and Fig. 10 a view, similar to Fig. 1, showing a modification of the apparatus.

Describing by reference characters the various parts illustrated in the drawings, 1 denotes the punch member and 2 the stationary or bed member of a pair of cutting or shearing dies. Each of these die members has a concave interior, the two parts together providing when closed, in the embodiments shown herein, a substantially cylindrical opening or bore. The bed or base member 2 is shown as provided with ears 3 whereby it may be bolted to a suitable support 3^a, the bolts being indicated at 4. The punch member will be operated by a suitable press in a manner well understood by those skilled in the art.

5 denotes a blade of suitable material (such as tool steel) which is carried by the lower die member. This blade may be conveniently and removably applied and secured to the member 2, as by inserting the blade into a vertically extending slot 6 in said member. This slot may extend entirely across the die member 2 and to a considerable depth therewithin. The blade projects within the cavity of the die member 2, the blade being beveled approximately equally on its opposite sides, and the amount of the bevel or inclination may increase slightly from the central portion of the blade toward the ends thereof. Thus, the faces 7 may form with the center line an angle of somewhat less than the 23° at the center of the blade while this angle may increase somewhat toward the ends of the blade. The blade may be conveniently secured in place by means of a pair of side or cheek plates 8 which are fastened to opposite sides of the base member 2, as by means of the screw bolts 9 having caps 10. Each of these plates is shown as provided with a dowel pin 11 which is adapted to enter a corresponding hole in the side of the blade whereby the blade will be firmly anchored.

The punch member 1 is also provided with a blade 12 arranged directly opposite the blade 5 and secured in its die member in like manner, the recess for the blade being indicated at 13, the bolts which secure the cheek plates in place being indicated at 14, one of the dowel pins at 15, and the edge of the blade being provided by and between the two beveled faces 12^a, which are preferably given the same amount of bevel as the faces 7.

With the parts arranged and constructed as illustrated and described, when it is desired to sever a bar of metal (such as steel) into lengths, the bar (indicated at 16) is inserted between the die members. The bar being inserted in proper position and resting upon the lower blade 5, the punch member of the die is brought down, with the result that the blades first enter diagonally opposite sides of the bar, as indicated at *a*,

thereby shearing the bar, and that further movement of these cutters inwardly or toward the center of the bar results in the gradual application of the entire cutter to each side of the bar and the subsequent gradual penetration of the bar by each entire or complete cutter. As stated, this tends to produce in the bar a uniform amount of deformation for each unit of movement of the cutters, or opposes to the cutters, moving at a uniform speed, a uniform resistance whereby the cyclic efficiency of the apparatus is high. With cutters having their faces making an angle of about 23° each with the center line and assuming 50% of the pressure to be employed in overcoming the friction of the cutter and in pressing the metal on opposite sides of the same we will then have (with a 156-ton press) about three hundred fifty thousand pounds tension exerted longitudinally of the bar or about forty-two thousand pounds per square inch on the original section of the bar. With the cutters operating at a speed not substantially less than three-eighths inch per second (whereby the first cut will be made in about one second) and with the faces beveled or inclined at the angle specified, a bar of soft steel can be severed by making the first cut (extending about one half way around its circumference) to a depth of about three-eights inch and then, by turning the bar about 90° on its axis and subjecting it to a second cut, the bar will be severed with considerable force by the time the cutters have entered from one-fourth to three-eighths inch on the second cut.

The speed at which the cutters operate is an important factor in the severing operation, it being necessary that the cutting operation shall be performed so rapidly that the metal on opposite sides of the cutter blades cannot have sufficient time to deform or flow in a longitudinal direction to such an extent as to absorb any appreciable portion of the available pressure. Given cutters having their faces inclined at the angle stated and operating on a circular bar of about the diameter specified, at the end of the first cut the tension exerted longitudinally of the bar will amount to about fifty-six thousand five hundred pounds per square inch on the section remaining at the end of the first cut. The unit stress thus produced is not sufficient to sever a soft steel bar having a tension strength of, say sixty-five thousand pounds per square inch. But, when the section is still further reduced by the second cut, this stress then considerably exceeds the tension strength of sixty-five thousand pounds per square inch (because of the reduction of the cross sectional area of the bar), and this results in the rupture of the bar by tension. It has been found that, if the press be operated at a speed of much less than that specified, the bar can be nicked to the full depth of the cutters and entirely around its circumference without producing the tension break. On the other hand, if the press be operated excessively fast, the bar may be, and sometimes has been, broken by the first cut, although this necessarily subjects the press to a considerably greater stress than if operated at the speed indicated hereinbefore.

It will be evident that, in operating upon bars of different shape, corresponding changes will be made in the shape of the cutters, the best results (from an efficiency standpoint) being secured however by so inclining the sides of the cutters as to secure to a uniform amount of deformation of the bar for each unit of movement of the cutters. Also, the inclination of the faces of the cutter blades may be varied.

For instance, if the stock from which the cutters are made will stand up under the work, by employing a sharper angle (say 15° or 16° for each side instead of about 23°) the bar may be severed by a single stroke of the cutters by cutting slightly deeper and without exceeding the pressure applied to the first described blades.

A further and important advantage which resides in operating the cutters at about the speed specified is that, because insufficient time is given the metal on each side of the cutters to flow laterally, no projecting burs are produced at the outer sides of the cuts, the diameter of the stock at the junction of the cut with the body thereof being the same as the diameter of the body.

It will also be observed that the edges of the cutters are diametrically opposed to each other. It is believed that this is an important factor, from a commercial standpoint, since it insures a practically smooth break extending at right angles to the axis of the bar, thus rendering unnecessary any subsequent finishing operation on the ends of the blanks such as must be resorted to in connection with the other severing operations referred to hereinbefore. A further advantage in having the cutters in the same plane is that all of the available pressure, being exerted at right angles to the plane of severance, acts longitudinally on the bar and sets up no unbalanced stresses in the punch or die members.

In Fig. 10 there is shown a modification of the invention wherein the die member 2 is provided with a pair of longitudinally spaced blades 5 and the punch member 1 is provided with a similar pair of blades 12 opposed to the blades 5. The distance between one set of blades 5 and 12 and the other set of blades 5 and 12 will be equal to the length of the blank which is to be cut from the stock. In the operation of this apparatus, the bar to be treated will be inserted between

the die members with one end in substantially the plane of one set of blades and the body of the bar between the other set. By closing the dies, the first cut will be made by the pair of blades adjacent to the operator. The die will then be opened and the bar be given a quarter revolution and moved forward so as to bring the cuts therein in the plane of the edges of the blades farthest away from the operator. The dies will then be closed with the result that, while one pair of blades is making the first cut in the bar, the other pair will accomplish the severing of the bar in the manner shown in Fig. 6. It will be understood, of course, that the power of the press must be correspondingly increased to accomplish the two cuts simultaneously and that the blades must have sufficient lateral strength to take up the residual "kick" when the bar is severed.

While I have illustrated and described in detail the particular construction of the cutter blades and have set forth a particular speed of operation of such blades, I do not thereby propose to limit myself to such details except as such limitations may be rendered necessary by the state of the prior art or may be positively included in the claims hereto annexed.

Having thus described my invention, what I claim is:—

1. The process of severing a metal bar which consists in subjecting the same to a combined cutting and wedging action whereby the cross sectional area of the bar is reduced and the bar is simultaneously subjected to a longitudinal tension sufficient to rupture the bar across a reduced area of material extent.

2. The process of severing a round metal bar which consists in simultaneously reducing the cross sectional area of said bar throughout the major portion of the peripheral extent thereof and subjecting it to a longitudinal tension sufficient to rupture the same across a reduced section of material extent.

3. The process of severing metal bars which consists in simultaneously penetrating the major part of the peripheral portion thereof and exerting upon said bar a longitudinal tension sufficient to disrupt the same.

4. The process of severing a metal bar which consists in preliminarily reducing the cross sectional area of the same and then subjecting the reduced section of the bar to a combined cutting and wedging action including the major peripheral portion thereof and serving to reduce further the cross sectional area of the bar and to exert upon such bar a longitudinal tension, the cutting and wedging action being performed at such speed as to prevent a material absorption of such longitudinal tension due to the movement of the metal, whereby the tension will be operative to rupture the bar across such reduced area.

5. The process of severing a metal bar which consists in reducing the cross-sectional area of the bar and then applying sufficient force between the walls extending outwardly from said reduced section to effect rupture of said bar under tension at said section prior to any material elongation thereof.

6. The process of severing a metal bar which consists in reducing the cross-sectional area of the bar from diametrically opposite points on the bar's periphery and applying sufficient force between the walls extending outwardly from said reduced section to effect rupture of said bar under tension at said section prior to any material elongation thereof.

7. The process of severing a metal bar which consists in reducing the cross-sectional area of the bar along diametrically opposite arcs embracing the major portion of the bar's periphery and applying sufficient force between the walls extending outwardly from the section thus reduced and at opposite sides thereof to effect rupture of said bar under tension at said section prior to any material elongation thereof.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

PATRICK J. CULHANE, JR.

Witnesses:

ARCHER W. RICHARDS,

SPENSLEY S. DAYKIN.