

United States Patent

Marcovitch

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[54] METAL WORKING

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[30] Foreign Application Priority Data

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[52] U.S. Cl. 72/77, 72/100, 72/107, 72/198, 72/366

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[58] Field of Search..... 72/366, 76, 198, 102, 103, 72/104, 107, 108, 100, 77, 80-84

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[57] ABSTRACT

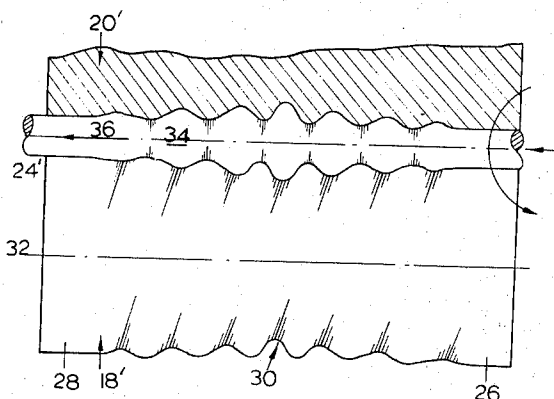
This invention relates to methods of working workpieces to improve their characteristics. The invention provides causing a bulge to be formed in the workpiece and to be moved along the workpiece for any desired number of times. The invention is most applicable to methods of rolling processes.

4 Claims, 9 Drawing Figures

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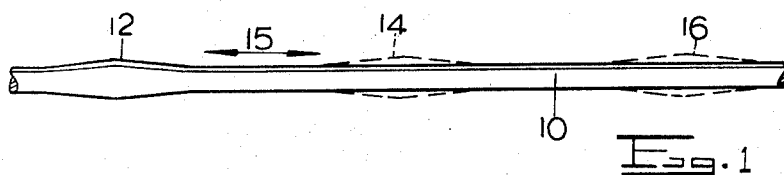


Fig. 1

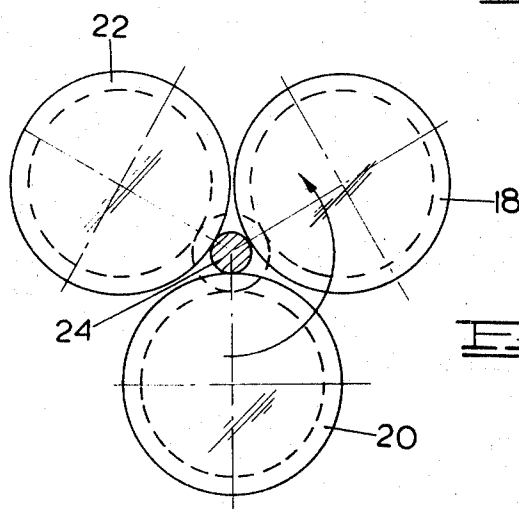


Fig. 2

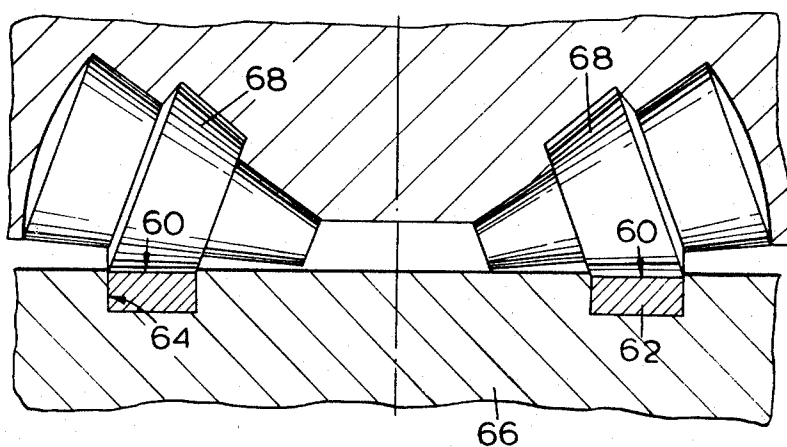
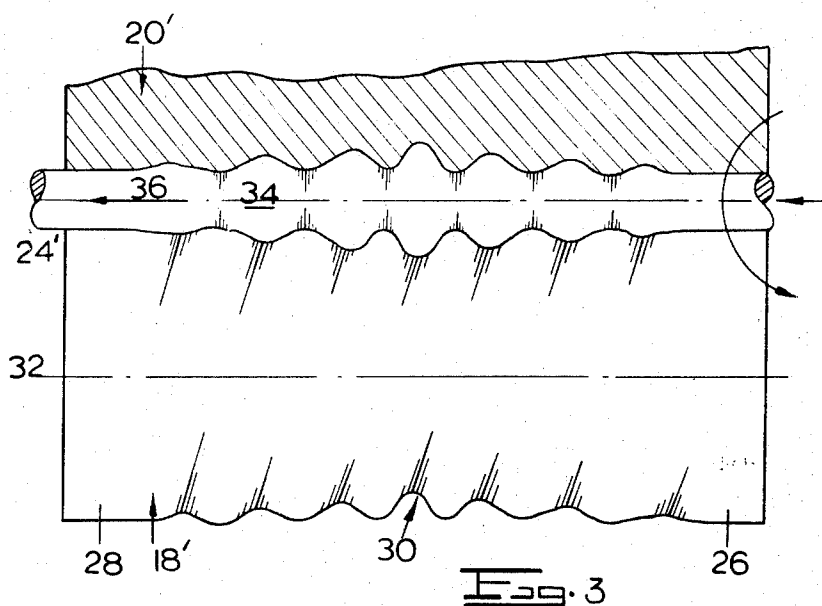
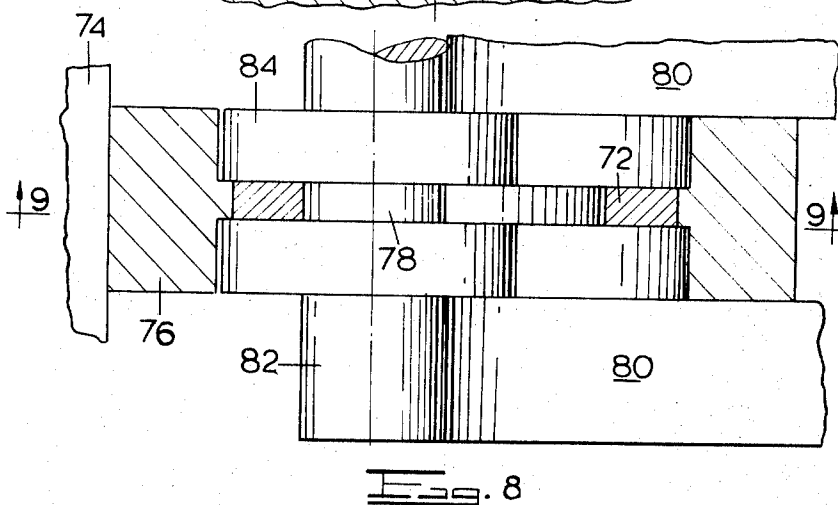
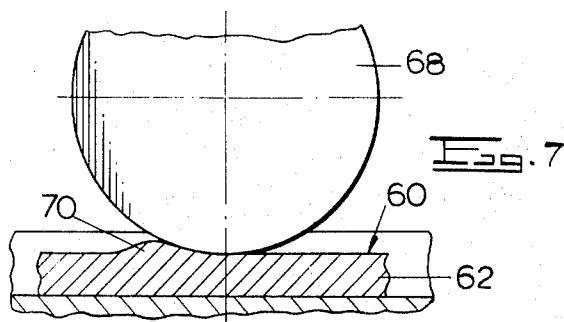


Fig. 6

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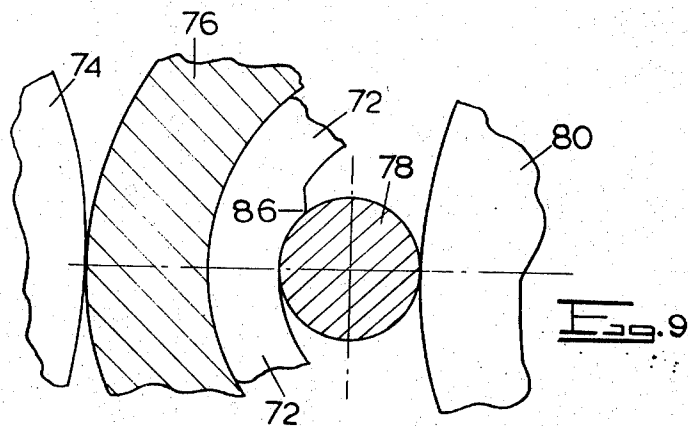
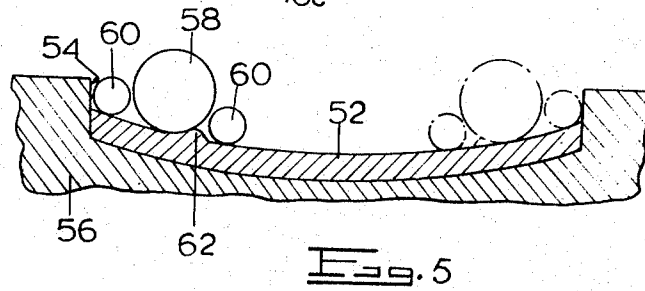
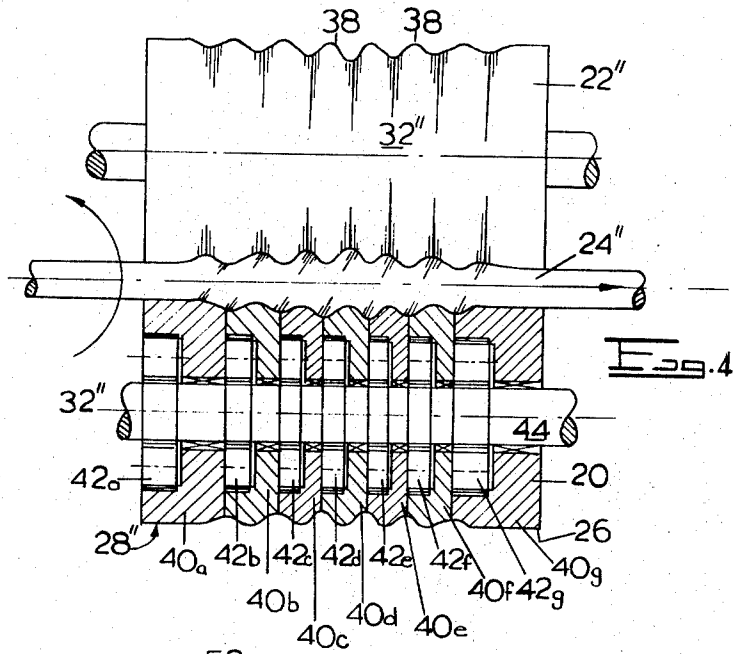
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METAL WORKING

This invention relates to methods of working materials, especially metals, from the surface.

It is known that during the working of metal for example by rolling or forging, the metals acquire certain advantageous characteristics. The extent of the working of the metal is however determined by the amount of reduction of the workpiece that is required. In other words the amount of working is determined by the initial dimensions of the workpiece and its final dimensions. It has not been possible hitherto to provide a greater amount of surface working than is possible within the limits set by these initial and final dimensions. It is an object of this invention to provide a method which enables any desired amount of surface working to take place without final reduction of the workpiece beyond a predetermined thickness.

According to one aspect of this invention there is provided a method of working a workpiece by forming a bulge in the workpiece and moving the bulge along the workpiece. This working may be associated with a forming operation by rolling and may be carried on further after the workpiece has been fully formed with a bulge still persisting and thereafter retracting the rollers to disperse the bulge.

Embodiments of this invention will now be described with reference to the accompanying drawings.

In the drawings:

FIG. 1 is a sketch illustrating how the invention is applied to an elongated workpiece.

FIG. 2 shows an end view of a type of apparatus for working an elongated workpiece.

FIG. 3 is a side view of one apparatus of the type of FIG. 2.

FIG. 4 is a view similar to FIG. 3 of alternative apparatus for working a workpiece in accordance with the invention.

FIG. 5 is a sketch diagrammatically shewing how a relatively flat workpiece may be worked in accordance with the invention.

FIG. 6 is a section through apparatus for use in working a ring from a side in accordance with the invention

FIG. 7 is a side view through the workpiece of FIG. 6 showing how the workpiece material reacts during rolling.

FIG. 8 is a section through apparatus used in working a ring from the inside and

FIG. 9 is a section on line 9 — 9 of FIG. 8.

Referring now to FIG. 1 there is shown a billet in the form of a cylindrical rod 10 of the desired final diameter. A bulge 12 is formed in the rod 10. In the method of the invention, the bulge 12 is made to travel in ripple fashion, or in the manner of wave action, along the length of the billet. Two of the positions which the bulge will occupy are indicated in dotted lines at 14 and 16. The process is repeated several times up and down the length of the billet, as indicated by the arrow 15. Axial pressure is preferably applied to the billet during the operation to maintain it in a state of compression. Care must be taken that the bulge is not rolled out at the ends of the rod until treatment has been completed. The ends of the rod will therefore not be as fully treated as the remainder of the rod.

It is obvious that, with movement of the bulge, the metal in the zone momentarily occupied by the bulge will be displaced both radially and axially relatively to the position it occupied before the arrival of the bulge, and after its departure. This applies to the entire body of the metal in the bulge, except perhaps theoretically at the billet axis. The metal is thus worked substantially throughout its mass. The ends of the rod being not fully rolled will be removed from the rod by parting in any conventional manner.

This surface working process will normally take place with a heated workpiece, the heating being as in conventional processes, i.e. for Ausforming, the workpiece may be in the 1,000° F. range and for Marforming in the 500° F. range, but it may be heated to any desired temperature to give the desired properties or it may be carried out at ambient conditions.

FIG. 2 shews a general form of apparatus for use in carrying out the process described above. The apparatus comprises three rolls 18, 20 and 22 equispaced around a billet 24. These

rolls work the billet 24 as it passes in the direction of its axis through the throat defined between the rolls 18, 20 and 22. The rolls are supported and driven by means (not shewn) but which are known to those skilled in this art.

The operative part of one suitable machine of the general type of FIG. 2 is shewn in FIG. 3. The rolls 18', 20' and 22' have identical diameter cylindrical inlet and outlet portions 26 and 28 and between these portions 26 and 28 helical scrolled surfaces 30. The crests of the scrolls lie on the projection of the cylindrical portions 26 and 28. The bases of the scrolls are arranged so that the scroll is concave and has a nipped waist. In this embodiment the rolls are arranged with their axes 32 parallel to each other and to the billet axis 34. The scrolls are in register where they engage the billet 24' so producing annular grooves and ridges in the billet 24'.

As the rolls have nipped waists, they define a generally bulged zone along their lengths in which the billet 24 is adapted to be confined. The pitch of the scrolls is such that the axial speed of the billet 24, as it is drawn through the space between the rollers in the direction of the arrow 36, tends to be slightly retarded in the outgoing portion of the bulge relative to the incoming portion. There can never be any accumulation of material in the bulge, but establishing this tendency ensures that the space for the bulge is always full. The crests of the scrolls keep the material of the billet in axial compression at the bulged zone. The pitch of the scrolls 30 may decrease towards the center of the scroll from both ends.

The billet is formed initially with a bulged zone which is inserted in the throat space between the rollers; and, with correct feed and driving arrangements, the bulge persists but ripples relatively along the length of the billet as the operation proceeds.

After the billet has almost completed a path through the machine, so that the bulge is not rolled out of the billet, the billet is reinserted for a second pass in which the bulge is moved in the reverse direction along the length of the workpiece. More passes may follow depending on the extent of working required.

For the reasons as discussed above there is a high degree of containment of the workpiece in the bulged zone, so that the metal in that zone is in a state of extreme compression. Great care must therefore be exercised in the design and construction of the components that operate on the billet to ensure that there is no permanent elastic deformation in those components and yet that the billet is readily inserted and removed. Massive backing for the rolls may be necessary to allow the machines to withstand the large forces generated. Thus the rolls 18, 20 and 22 in FIG. 3 will ordinarily not be set in bearings but will be supported along their full length on surfaces that are themselves massively supported.

Another embodiment with three rolls 18'', 20'' and 22'' having skewed axes 32 and identical diameter inlet and outlet cylindrical sections 26 and 28 and between them nipped waists to define a bulged zone is shewn in FIG. 4. In this case the rolls are provided with annular portions 38 that are out of register, so generating a helical scroll on the billet. As shewn in the lower roll, the scroll is made up of individually driven and mounted sections, 40a, 40b, etc., connected to a common driven shaft 44 by individual gearing transmissions schematically indicated at 42a, 42b, etc. The other two rolls are similarly compounded of sections.

The driving arrangements are such that, on the insertion of a suitably bulged end of a billet 24'' into the space between the rolls, driving of the rolls 18'', 20'' and 22'' will cause the scrolled profile to be impressed on the billet, which propels itself through the machine while the bulged zone moves relatively along it, the metal in that zone receiving a severe kneading. The movement of the bulge is aided by a speed differential in the roll sections to the left of the waist of the rolls, and a corresponding reverse differential to the right of the waist. Thus the billet enters and emerges from the machine with a uniform diameter, its helical scrolled bulged zone existing only in the region of the waist of the rolls. Here again the starting

billet may be of the desired final diameter and the crests of the annular portions bite into the material of the billet bulge. Axial input pressure may be provided acting on the ends of workpiece.

The embodiments described above might easily be modified to treat tubular workpieces, either by the insertion of a solid mandrel in the tubular cavity, or of a mandrel on which are mounted rollers with propagate the ripple-like movement of the bulge as the billet is drawn over the mandrel acting against a cylindrical die on the outside, with end entrapment for the billet.

Flat or relatively flat workpieces can also be worked in accordance with the invention. Reference is now made to FIG. 5 in which a slightly bowed workpiece 52 is shewn in position in a correspondingly shaped recess 54 in a die 56. A main pressure roller 58 is flanked by two side rollers 60 which prevent excessive bowing of the workpiece during rolling. The workpiece 52 which may be heated to the temperature ranges mentioned above is rolled down to fill the die and additional pressure is then applied to the main roller 58 and a bulge 62 is maintained. The main roller 58 then moves the bulge 62 from one end of the workpiece 52 to the other. The ends of the recess 54 prevent axial elongation of the workpiece 52. As the roller 58 must be lifted over the bulge to commence rolling it in the opposite direction, it will be apparent that the entire length of the workpiece 52 will not be worked by the main roller 58 and it will be necessary for the ends of the workpiece to be cut off before the workpiece is to be used. It will be noted that the ends of the recess 54 prevent elongation of the workpiece in the direction of rolling. When the workpiece 52 is sufficiently worked, the pressure of the main roller 58 is slackened off and rolling is continued until the workpiece is rolled to its desired thickness and the bulge 62 disappears. If desired the workpiece may be taken from the recess 54, turned over and re-rolled. In this way both sides of the workpiece 52 will be worked according to the invention. The bowed workpiece may be further rolled over a flat platten (not shewn) so that a flat member is produced.

Reference is now made to FIGS. 6 and 7 wherein is shewn apparatus working the sides 60 of a ring 62 which sides are of course endless. The workpiece 62 which is to be produced to the desired final dimensions and properties is inserted into a recess 64 in a die 66. A series of conical rollers 68 now roll over the upper side 60 of the ring 62, so as to fill the die and to work the piece further by the formation of a bulge 70 and moving this bulge 70 around the surface of the side 60. When sufficient working of the workpiece has taken place the pressure of the conical roller 68 is taken off and rolling continued until the workpiece returns to the desired final diameter and the material of the bulge is absorbed in the material of the ring. The temperature at which this operation takes place is as discussed above. It will be noted that as the workpiece is

forced into the die recess, the material of the workpiece will be under lateral pressure throughout and at the roller, the material of the workpiece will be wholly contained by the sides of the recess and the roller. No circumferential elongation of the workpiece takes place during this operation

In FIGS. 8 and 9 there is shewn a set-up for treating an endless bearing race 72 especially its inner surface. The apparatus comprises a pressure roll 74, and anvil ring 76, a mandrel 78 and two pairs of back-up rolls 80 on which the cylindrical continuations 82 of the mandrel 78 respectively roll. The mandrel 78 has two upstanding enlarged diameter cylindrical collars 84 between which the workpiece 72 is trapped

The workpiece 72 is rolled to size between the anvil ring 76 and the mandrel 78. Further pressure is then applied to cause the formation of the small bulge 86 and rolling continues while this bulge 86 moves along the entire inner surface of the workpiece 76. When sufficient working had taken place, the pressure exerted by the mandrel 78 is allowed to slacken off so that the workpiece is allowed to return to its desired dimensions and the bulge is rolled out of the workpiece.

Here again the temperature of the workpiece during the surface treatment is as discussed above.

I have found that in the ways mentioned above I can provide a suitably treated workpiece the working of which is not limited to the reduction in thickness of the workpiece.

The invention is not limited to the precise details hereinbefore described and illustrated. For example, the workpiece may be moved axially when rolling as described with reference to FIG. 5 after each pass so that a relatively wide workpiece may be treated in accordance with this invention.

I claim:

1. A method of working the surface of an elongated metal workpiece having a predetermined initial thickness which is uniform along the length of said workpiece, comprising deforming a surface of the workpiece beyond its elastic limit to form a bulge therein, and moving said bulge lengthwise along said workpiece a plurality of times so that said bulge passes a given point on said workpiece a plurality of times, and then removing said bulge to restore said workpiece to said predetermined thickness.

2. A method as claimed in claim 1, in which said workpiece is straight and said bulge reciprocates lengthwise along said workpiece.

3. A method as claimed in claim 1, in which said workpiece is annular and said bulge moves in a plurality of circuits about said workpiece.

4. A method as claimed in claim 1, in which said bulge is moved by passing said workpiece between rollers, and said bulge is removed by increasing the distance between the rollers so as to roll the material of the bulge back into the workpiece.

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