Dec. 19, 1961 A. W. SCRIBNER 3,013,451

METAL ROLLING

Filed Feb. 17, 1958 2 Sheets-Sheet 1

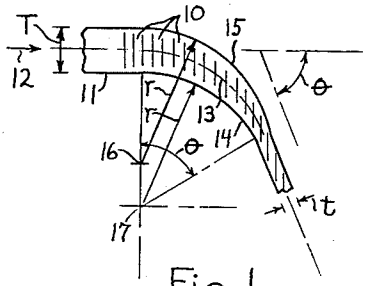


Fig. 1

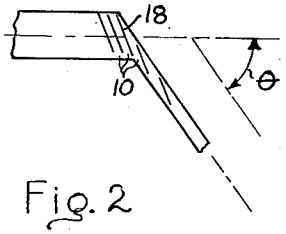


Fig. 2

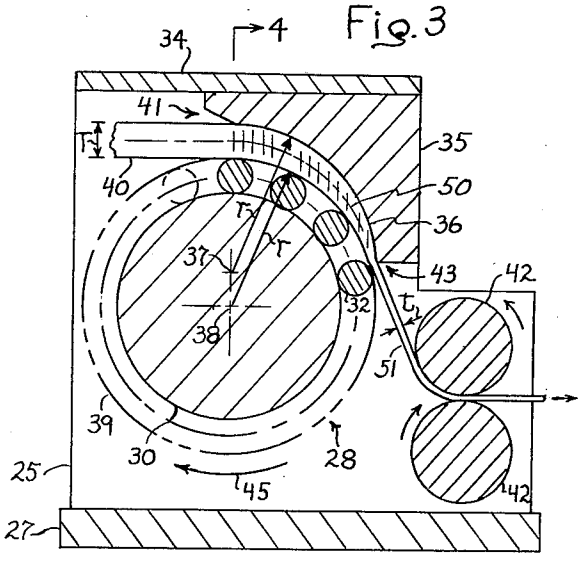


Fig. 3

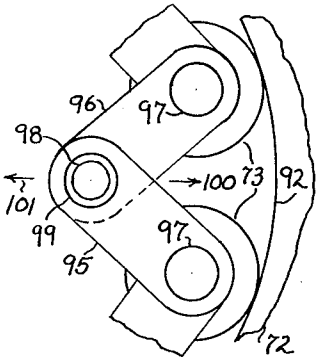


Fig. 9

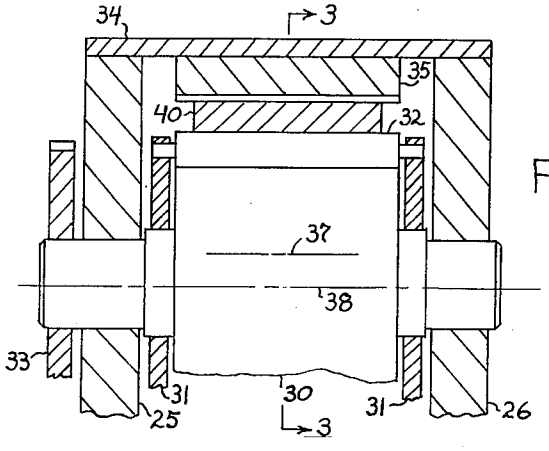


Fig. 4

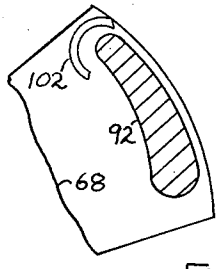


Fig. 10

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METAL ROLLING

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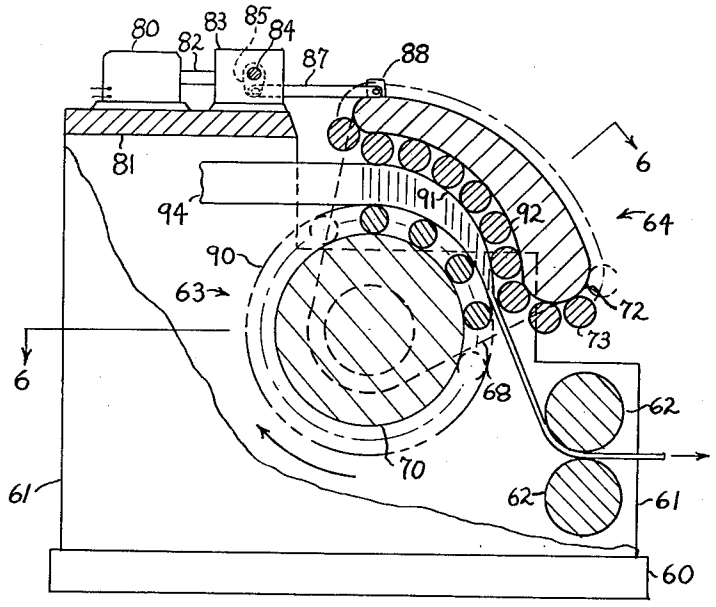


Fig. 5

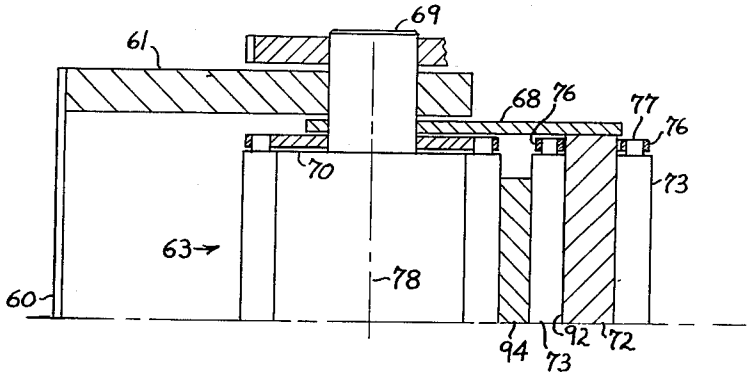


Fig. 6

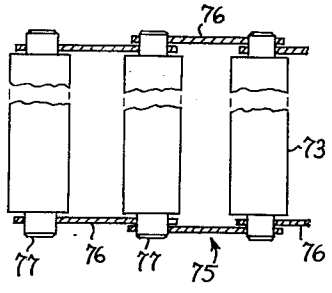


Fig. 7

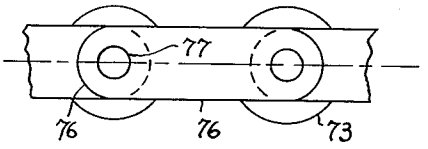


Fig. 8

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3,013,451

METAL ROLLING

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2 Claims. (Cl. 80—18)

This invention relates to an improved method and apparatus for reducing a work blank and more particularly relates to a novel method and apparatus for the planetary rolling of metal.

One object of the instant invention is to provide an improved method and apparatus of reducing metal whereby the work material as a whole is moved through an arcuate path during the reducing operation.

Another object of the invention is to provide an improved method and apparatus for gradually displacing the successive transverse elemental layers of metal in substantially parallel transverse shear planes as the work moves through a work station.

Another object of the invention is to provide a novel planetary rolling mill having one conventional type of planetary roll head cooperating with a concave type tool head.

Another object of the invention is to provide an improved method and apparatus for the impact rolling of metal whereby the work metal is caused to flow in a curved path with the rotating planetary roll head on the concave side of said path and whereby said work metal partakes of circular inner and outer longitudinal sectional profiles during the rolling operation.

Other objects of the invention will become apparent as the disclosure progresses.

In the drawings:

FIGURES 1 and 2 are diagrammatic views illustrating the nature of the instant method.

FIGURE 3 is a central vertical sectional view of one embodiment of the instant apparatus and is taken along section line 3—3 of FIGURE 4.

FIGURE 4 is a vertical sectional view taken along section line 4—4 of FIGURE 3.

FIGURE 5 is a side elevational view taken in partial medial section of a second embodiment of the instant apparatus.

FIGURE 6 is a semi-sectional view taken along section line 6—6 of FIGURE 5.

FIGURES 7 and 8 are top and side views, respectively, and illustrate the construction of a flexible roll cage for the apparatus of FIGURE 5.

FIGURES 9 and 10 illustrate an alternate construction for the roll cage and related structure of the apparatus of FIGURE 5.

In the reducing method illustrated in FIGURE 1 the successive transverse elemental strata or layers 10 of the work metal are progressively displaced downwardly as the work blank 11 is longitudinally fed to the right as shown by arrow 12. The gradual relative displacement of and between said strata occurs in substantially parallel vertical shear planes so that the thickness of the metal, measured in a vertical direction, is always substantially the same. As the metal is being progressively worked in shear the overall movement of the metal follows a curved or arcuate path and the actual thickness thereof measured normal to the curved work axis 13 will continually decrease. The inner profile 14 of the work metal being reduced here defines a circular arc having a radius of r. The outer profile 15 of the work metal being reduced will also be defined by a circular arc having an equal radius of r. The center of curvature 16 of profile 15 however is positioned a distance of T vertically above the center of curvature 17 of profile 14, T being the initial thickness of said horizontally moving work blank 11. The final thickness t of the reduced work will depend on the size of angle θ between the directions of the work axis immediately before and after the reducing operation. In FIGURE 1 the said successive transverse strata 10 are continually being relatively displaced downwardly in shear as the metal progressively flows along said arcuate path, as opposed to the case where the intermittent working of each successive layer 10 occurs all at one time and in substantially a single work plane region 18 as shown in FIGURE 2.

Referring to FIGURES 3 and 4 there is shown a planetary type rolling mill for carrying out the method described in connection with FIGURE 1. The machine frame comprises a pair of spaced vertical side members 25 and 26 which are fixedly mounted on the base 27 and which rotatably support a planetary roll head 28. The roll head 28 is conventionally constructed and may comprise a backing roll 30 which is rotatably mounted in said side members. Rotatably mounted on said backing roll 30 is a roll cage 31, FIGURE 4, which rotatably supports a plurality of circumferentially spaced working rolls 32 which are adapted to planetate around the roll 30 in the usual manner. A gear 33 is fixed to the outer end of said backing roll so as to provide a means for driving roll 30. Any suitable power means may be used to rotate the drive gear 30. A cross member 34 secured between the tops of said side members fixedly supports an anvil or tool head 35 which is formed with a concave cylindrical working surface 36. The radius r and the center of curvature 37 for the working surface 36 respectively correspond to the radius r and the center of curvature 16 for the profile 15 of FIGURE 1. In similar fashion the radius r and the center 38 of the circle 39 circumscribed about the roll head 28 correspond to the radius r and the center of curvature 17 for the profile 14 of FIGURE 1. The vertical distance between the centers 37 and 38 is equal to the thickness T of the work blank 40 which is fed into the arcuately extending roll pass 41 cooperatively defined by the working surface 36 and the planetating work rolls 32. A cooperating pair of planishing rolls 42 are operatively mounted to the right and below the exit 43 of said arcuate roll pass 41.

In operation the work blank 40 is horizontally fed into the pass 41 while the roll head 28 is rotatably driven in a clockwise direction as noted by arrow 45. In that the relative contours and positions of the inner and outer profiles of the work material being reduced will respectively correspond to that for profiles 14 and 15 of FIGURE 1, each successive transverse elemental layer of the work material will be gradually displaced downwardly with respect to the next following layer as said material progressively moves arcuately through the curved roll pass 41. The longitudinal axis of the metal approaching, passing through, and leaving the roll pass 41 defines a smooth continuous curve 50. The arc 50 represents the curved axis of the roll pass and of the metal being reduced, said curve approximating a circular arc having a radius of r. It will be noted that that axis of the roll head 28 and the center of curvature of surface 36 are both on the concave side of the curved roll pass 41. As the work metal moves through the said pass it will be continually reduced in parallel shear planes and when a plurality of work rolls are used as shown in FIGURE 3 the reducing action is continuous rather than intermittent. The reduced work 51 may be finished by being fed through the planishing rolls 42 which when driven effect a forward tension on the metal passing through said roll pass.

A modified form of the instant apparatus is shown in FIGURES 5–8. Here the machine frame comprising a

base 60 and the side members 61, as well as the planishing rolls 62 and the roll head 63 are similar in nature to that described in connection with FIGURES 3 and 4. Here however, instead of utilizing a stationary tool head or anvil a movable concave tool head 64 is provided. Roll head 64 comprises a pair of radially extending arms 68 which are respectively pivotally mounted on the hubs 69 of the backing roll 70. Disposed between and fixedly secured to the outer ends of said arms 68 is a backing member 72 having an inner concave and an outer convex sectional profile as shown in FIGURE 5. A plurality of work rolls 73 are operatively mounted about the periphery of said backing member 72. A flexible roll cage is provided for maintaining the rolls 73 in mutually spaced relation, the nature of said flexible cage being illustrated in FIGURES 7 and 8. Here the cage 75 comprises a plurality of links 76 which are pivotally connected together by the necks 77 of the successive work rolls 73.

The tool head 64 is capable of being oscillated about the axis 78 of the backing roll 70. The means for producing this oscillatory motion of the tool head 64 comprises a motor 80 which is fixed to the cross member 81 secured between the tops of the said side members 61. The shaft 82 of said motor drives a suitable gear transmission 83 which has an output shaft 84 extending therethrough. Rotatably secured to respective outer ends of shaft 84 are cranks 85 whose outer ends are respectively articulately connected by means of a pair of links 87 to the two projections 88 formed on the upper and outer ends of the respective radial arms 68.

The radius and the center of the circle 90 circumscribed about the roll head 63 respectively correspond to that for said circle 39 of FIGURE 3, and the radius and center of the circular arc 91 defined by the motion of the rolls 73 which are in contact with the inner cylindrical surface 92 of said member 72 respectively correspond to that for the said surface 36 of FIGURE 3. Thus an effective curved roll pass, similar to that defined by profiles 14 and 15 of FIGURE 1, is cooperatively defined by the roll head 63 and the movable tool head 64.

In operation the roll head 63 is driven in a clockwise direction and the motor 80 will cause said tool head 64 to be oscillated through a relatively short arcuate distance about the axis 78 of the backing roll 70. The work metal 94 is fed to the right into the curved roll pass and will here again be continually worked in vertically shear planes as it moves around a curved path with the planetary roll head 63 operatively disposed on the concave side thereof. It will be noted that the axis 78 of the roll head 63 and the axis of rotation of the tool head 64 are both disposed on the same side of the curved roll pass. As the tool head 64 is oscillated the work rolls 73 in addition to being oscillatorally planetated will slowly planetate over the inner and the outer surfaces of the backing member 72 in a generally counter clockwise direction due to the progressive elongation of the metal being reduced.

Here the translational movement of the backing member 72 corresponds to the rotary motion of a conventional type backing roll such as 70. The planetary speed of the work rolls 73 during said oscillation may be much less than that for the works rolls on the roll head 63. The arcuate distance through which each roll 73 planetates during each half cycle of said oscillation may be approximately equal to the distance between centers of said rolls 73. It will be noted that as the tool head 64 is being arcuately translated the overall geometric relation, as described in connection with FIGURE 1, between the respective working rolls of said roll head 63 and the tool head 64 never changes and thus the metal will be gradually reduced by being continually worked in shear as above described.

In order to compensate for the increased speed of flow of the work metal as it approaches the exit of the roll pass and to insure a continuous line contact between each work roll 73 and the metal being worked, the flexible roll cage may have an alternate construction which permits the distance between the centers of said rolls to be varied. Referring to FIGURES 9 and 10 two cage links 95 and 96 which are respectively pivotally connected to the necks 97 on each side of each adjacent pair of work rolls may be mutually pivotally connected by a stud 98 which rotatably supports a small roller 99. It will be apparent that as the roller 99 is moved closer to (100) or farther away (101) from the line of centers between said pair of rolls 73, these two work rolls will be respectively moved farther away from or closer to each other. A cam 102, FIGURE 10, is secured to the inner side at the outer end of each radial arm 68. Said rollers 99 are adapted to successively engage the respective outer surface of said cams; the effective shape of said cams being such that the rolls 73 are drawn close together just before they enter the roll pass. As soon as each roll 73 operatively engages the work its associated rollers 99 will move off the lower end of cams 102 respectively and will then be free to move relative to the next following roll 73. As the rolls 73 progressively move down over the concave surface 92 of the backing member 72 the toggle action between said links 95 and 96 will permit the said work rolls to adjust themselves to the particular speed of flow of that portion of the metal which they contact.

Having described the principles of the invention, I claim:

1. A method of reducing metal strip; comprising the steps of longitudinally feeding said metal strip in a first direction and into a work station, progressively relatively displacing the successive elemental layers of the strip material in substantially parallel shear planes which are disposed at an angle with respect to the longitudinal axis of said strip so as to cause the metal being worked to move along a curved path and to have its transverse thickness thereby continually and progressively reduced, and controlling the outer convex and inner concave profiles of the work material as the latter moves along said curved path through said work station during the said displacement of said layers so that said profiles define substantially circular arcs having substantially the same radii of curvature but having centers of curvature which are offset from one another, the reduced metal strip leaving the work station in a second direction which is disposed at an angle with respect to said first direction.

2. The method defined by claim 1 wherein the said relative displacement of said elemental layers is made in parallel shear planes that are disposed substantially normal with respect to said first direction.

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