

[54] **PROCESS AND APPARATUS FOR STRETCH FORMING METAL**

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[56] **References Cited**

**UNITED STATES PATENTS**

2,153,839	4/1939	Liebergeld.....	72/189
2,709,934	6/1955	Platzer.....	72/190
3,425,253	2/1969	Saxl.....	72/189

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[57] **ABSTRACT**

A device for stretch forming a metal particularly a steel piece which is still in the hot or cold working range and whose texture shows a casting or rolling structure comprises a support which carries a working roller and which is located on a respective side of the workpiece to be moved backwardly and forwardly therealong in a deformation path. The support is articulated by a thrust rod which is driven from a drive disk or shaft to which it is eccentrically connected in order to produce a reciprocating motion of the support. The support carries a shaft which eccentrically carries an eccentric disk which is rotated through an intermediate roller which is in contact with the drive disk. The eccentric disk moves around with its shaft to revolve the support with the working roller in respect to the workpiece.

The process of the invention is characterized by moving the working roller over a length of the deformation working path on a reducing surface of the workpiece and with varying velocity of the workpiece and with an adjustable movement of the working roller which is produced by the driving connection of its support. The movement is a swinging movement back and forth and a revolving movement is advantageously performed by single working rollers upon respective sides of the workpiece.

7 Claims, 2 Drawing Figures

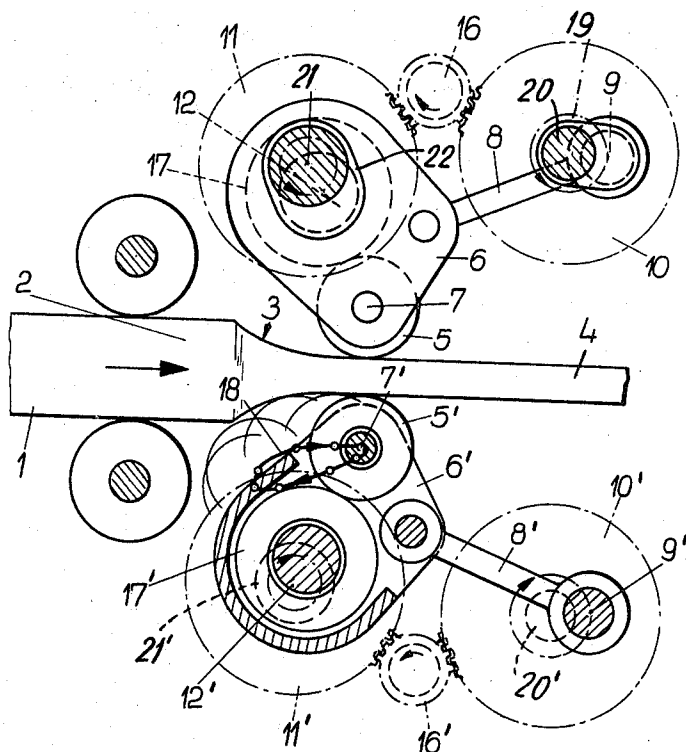
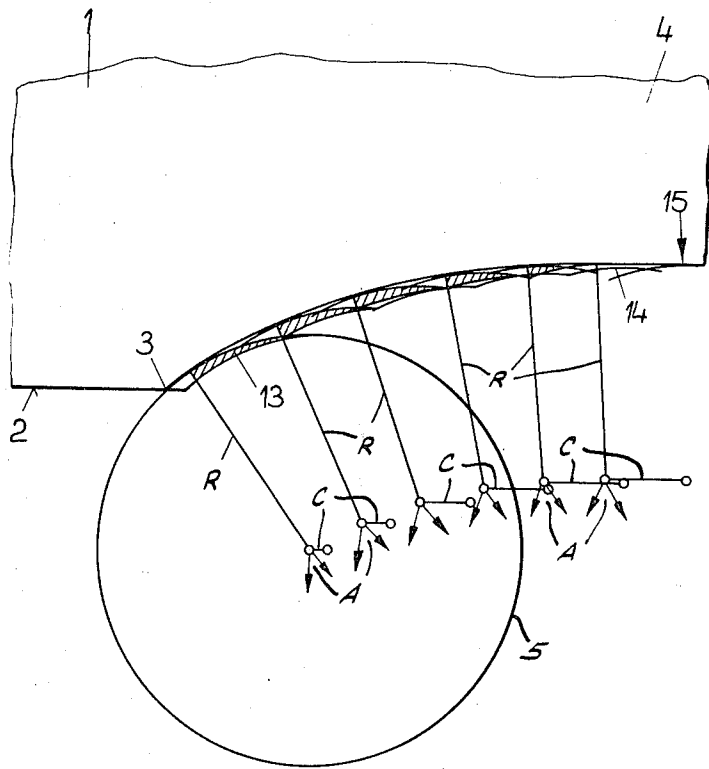


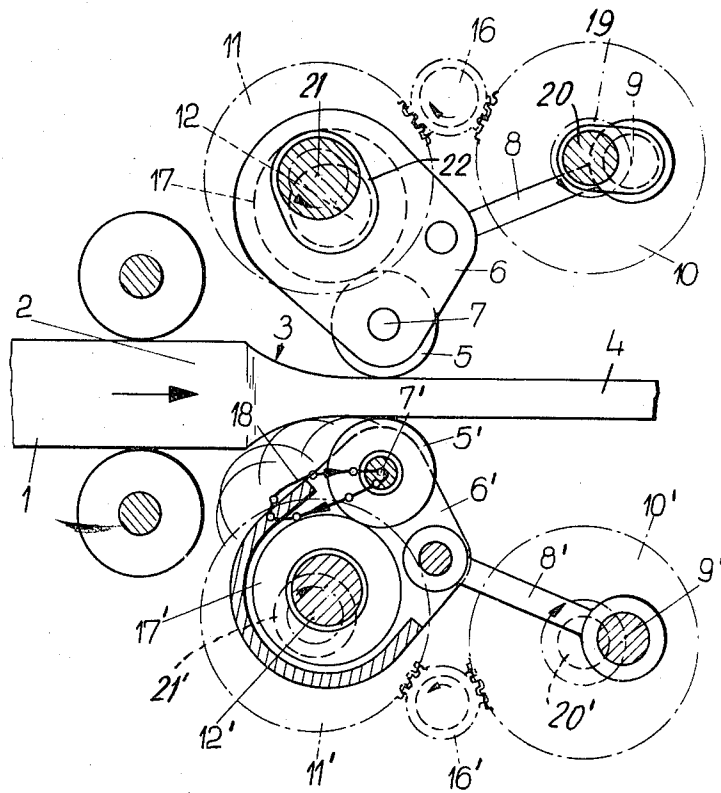
Fig. 1



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Fig. 2



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## PROCESS AND APPARATUS FOR STRETCH FORMING METAL

This application is continuation of Ser. No. 734,591, filed June 5, 1968, now abandoned. SUMMARY OF THE INVENTION

This invention relates in general to a process and apparatus for a stretch forming metal and particularly to a new and useful device and method for stretch forming a steel piece in the hot or cold working range, particularly a steel having a texture having a casting or rolling structure.

The process of forming a bloom into a billet which is processed in a finishing rolling mill to a bar or wire material requires the presence of a blooming mill train, that is, heavy and medium rolling stands. A finishing rolling mill must thus have a corresponding number of roughing stands if the starting material is to be available in sufficient quantities for semi-finished products, which requires a large investment. However, it does not always pay to produce billets in one's own mill and the production is not very economical. The technical prerequisite favorable for the production of billets are not always present. For example, a blooming mill train requires considerable space which must be supplemented by further installations such as vertical ingot heating furnaces, continuous heating furnaces, and the like. If the rough material is in the form of hot metal pieces, as is the case in a continuous casting plant, it is not always possible to arrange a bloom milling train behind the extracting device because of the different velocities which may be required for feeding. It is advisable in some instances to roll material for small section mill trains without double heating, but heretofore the great reduction per path and the resulting high rolling pressures were an obstacle to this. However, to accomplish this, a great driving power of the machine is required with corresponding high power motors.

In still another known process molding jaws can be applied to the workpiece surface to be reduced and developed. These jaws can be displaced because of the curve form of any corrugation formed in the material.

The development of molding jaws obviates some of the disadvantages of the rolling technique. The stretching process can generally take place, however, only by pushing the material toward the center of the workpiece and moving it at a correspondingly high velocity under superimposition of the contact pressure in the direction of motion of the workpiece. Under such an operation a stretching exists which is not given in the usual rolling process, particularly one which has a great reduction per pass. This leads to previously unobserved stretching velocities so that a displacement of the material causes rapid wear of the molding jaw surface. In addition to the increased friction resistance, a high material pressure must be accepted which is partly favorable but partly undesirable. For example, such a pressure may be admitted in case pieces only within certain limits.

In accordance with the present invention, the workpiece is given a high reduction per pass and the stretching of the material is facilitated in such a way that the rolling of a material corrugation is improved with free elongation of the workpiece per minute. In addition, as little rolling pressure as possible is expended and with the use of a relatively low driving power so that the inconveniences of the prior art are eliminated.

In accordance with the method of the invention, a single revolving working roller is moved over at least the length of the deformation working path on a reduced surface with a varying velocity of the workpiece as it is simultaneously adjusted. With such a method there is an elimination of rolling pressure peaks and the reduction per pass is controllable as a function of the velocity of the workpiece and the distance available for the deformation of the material in the working process. The method and apparatus insures that no sliding friction between the workpiece and the roller will result since the circumferential speed is automatically imparted to the working roller in dependence on the stretching velocity.

A fundamental concept of the present invention is that only a single material layer is displaced without sliding friction. A particular advantage, however, is the fact that depending on the quality of the material and of other properties of the workpiece, the form of the pass zone can be determined dynamically according to the optimum design. This permits an optimum reduction of the necessary driving power or a greater reduction per pass with the same driving power.

The apparatus of the invention includes the mounting of a working roller on a support and the drive of the support through a crank and connecting rod connection from a drive shaft so that it may move over a relatively short deformation working path along the reducing surface under adjustment and then be returned to its starting position in a swinging movement. Such a closed deformation cycle repeated in regular sequences permits the working of different types of workpieces in dependence on their velocity of feed. Both pure rolled pieces and also cast pieces can be worked true to form and measure. In addition, a smooth regular surface of the workpiece is formed avoiding any transitions.

According to another procedure of the invention, several working rollers are moved under equal or unequal adjustment movements on the circumference of the cross section of the workpiece. The stretching of the workpiece can be accelerated or decelerated in individual zones depending on the form of the cross section as it corresponds to the volume of the workpiece.

A feature of the apparatus for the process is that the support bearing the working roller or rollers can be easily replaced. Only a relatively small mass has to be moved, namely that of the working roller support together with the roller. A considerable part of the weight is absorbed in the bearing and only acceleration and deceleration forces have to be expended to move the support. The weight of the working roller support with the roller can be compensated in a vertical direction toward the adjusting force so that the driving power has to be used only on the underside in the most unfavorable case. The two drives for moving the working roller support and for adjustment on the workpiece can be either separate or connected drives so that there are ample constructional possibilities for realizing the invention. The drive using a single thrust rod having its ends articulated in an eccentric disk on the working roller support forms a simple and safe solution for carrying out the process according to the invention. All of the elements can be accommodated in a closed housing which can be arranged on the workpiece and can be rapidly exchanged as a unit or moved out of range of the workpiece.

A further feature of the invention is the drive of the working roller support which is mounted with its pivot eccentrically on a driving pulley. The support position is continuously adjusted in relation to the workpiece by the continuous revolution of an eccentric disk which is eccentrically mounted on the support. This positioning is effected in dependence on the swinging movement of the working roller. The entire drive may be accommodated in a single housing and thus provide a machine which can be easily installed in any place. In a preferred arrangement, the adjustment of the workpiece and its support and the following movement of the workpiece is effected from a single drive. In this instance, a driving shaft which carries a crank and connecting arm for driving the support and a drive disk which drives through an intermediate roller the eccentric disk. In this manner a single drive is provided for both movements.

Accordingly it is an object of the invention to provide an improved process for stretch forming a metal, particularly a steel piece which is still in the hot or cold working range and particularly one having a texture showing a casting or rolling structure and using a revolving working roller comprising moving the roller over the length of the deformation working path of the workpiece on a reducing surface while the velocity of feed of the workpiece is varied and the roller position is simultaneously adjusted.

A further object of the invention is to provide a process of stretch forming a metal wherein a working roller is moved over a relatively short deformation working path and is adjusted along a reducing surface as it is moved and returned to its starting position in a swinging movement and wherein a single roller on one side or two rollers working on respective opposite sides are provided.

A further object of the invention is to provide a stretch forming apparatus which includes a self-contained support having a working roller mounted eccentrically in respect to a driving connection of the support and wherein the support carries an eccentric disk which is supported for eccentric movement in respect to the support and is adapted to be driven to provide for the controlled adjustable movement of the support with the working roller.

A further object of the invention is to provide an apparatus for stretch forming a metal which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a schematic partial side elevational view showing the kinematics of the rolling off of a single work roller on the workpiece to be reduced in accordance with the invention; and

FIG. 2 is a partial side elevational view and partial sectional view of an apparatus for stretch forming a metal constructed in accordance with the invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular, the invention embodied therein as indicated in FIG. 2 comprises apparatus for stretch forming a metal such as a workpiece 1 which may, for example, be delivered from a continuous casting plant or a bloom, plate, billet, etc. heated in a preheating furnace, and which is subject to a reducing process. The workpiece 1 has an initial cross section 2 and it is formed over a long deformation path or zone 3 to the final size 4.

In accordance with the invention, the reduction of the workpiece is accomplished by apparatus working on respective opposite sides of the workpiece which includes working rollers 5 and 5', respectively. The working rollers 5 and 5' are mounted in respective supports 6 and 6' for rotation on shafts 7 and 7', respectively. Each support 6 and 6' receives a swinging drive from a thrust rod 8 and 8', respectively, which is respectively articulated on an eccentrically positioned journal or shaft 9 or 9'. The journals 9 and 9' are eccentrically carried on a drive disk 10 and 10', respectively. The construction provides a reciprocating or to and fro movement of the thrust rod 8, 8' and associated support 6, 6'. The drive disks 10 and 10' are carried on respective drive shafts 20 and 20' which are driven at a controlled rate in accordance with the requirements for operation on the particular workpiece which is involved.

In accordance with a feature of the invention in addition to the to and fro movement imparted to each support 6 and 6' by the respective connection with the thrust rods 8 and 8', there is also imparted an adjustable movement on the respective working rollers 5 and 5' by imparting an additional movement to its associated support 6, 6' through the action of an eccentric disk 11, 11'. The disk 11 is rotatably supported on a crank shaft 21 which is carried on a crank arm 22 so that it is eccentric to a shaft 12 journaled on the support 6. The eccentric disk 11 is driven from the drive disk 10 through an intermediate roller or drive member 16. When the disk 11 is rotated in dependence on the movement of the drive disk 10, the working roller 5 thus performs a movement in the direction of motion of the workpiece and also transverse thereto which causes a reduction of the cross section of the workpiece.

The operation is such that individual cross section reductions of material 13, as indicated in FIG. 1, are effected. The development of this single layer of cross section reduction in a stretching direction is shown in FIG. 1 on the reduction surface. Each circumferential part of the working roller 5 rolls off on the surface of the workpiece 1 under displacement of the material of the workpiece and determines according to the discharge of the region 14 the last cross section 15 of the finished workpiece. The material which is displaced, or the reductions of material 13, schematically represent, relatively equal large surface parts or portions over the entire pass reduction so that a constant driving power can be achieved during the period of the deformation work. The material reductions 13 are

transformed into stretching of the workpiece and the showing of FIG. 1 is merely to give a conceptual view of the material reductions 13 which are of equal magnitude over the entire reduction pass.

The long lines R in FIG. 1 indicate schematically the radius of the working roller 5 and the shorter lines C indicate the positions of the effective crank arms with the mechanism such as shown in FIGS. 6 for positioning the roller 5 in each phase of its movement from an initial cross section 3 to a reduced cross section 15. The arrows A indicate the vector force reaction of the pivot to the deforming pressure acting at each position.

The dependence of the drive for the eccentric disk 11 to the driving pulley 10 is such in the embodiment illustrated that the driving roller 16 will be arranged between the two drives and transmit the necessary opposite movement simultaneously to the to and fro movement of the working roller 5. It is of course possible to provide additional smaller single drive units in addition to the roller 16 or in replacement thereof from the drive disk 10 to the eccentric disk 11 or to separately drive the eccentric disk from the drive shaft 20.

In the embodiment illustrated, the shaft 12 which eccentrically supports the eccentric disk 11 also supports a backing roller or supporting roller 17 which is maintained in constant contact with the working roller 5 during its working movement.

In some instances it is also desirable to provide a gear connection for the reducing drive movement of the working roller 5 and the particular arrangements or connections of the support 6 to the drive may be selected in order to obtain the desired reducing movement. The course of the curve 18 indicated in FIG. 2 can also be made adjustable. In some instances it is also desirable to mount the shaft 7 for the working roller so that it can be moved by means in a fixed or variable track. The disk 10 may include or comprise driving gears for this purpose or linkage connections to the shaft to provide the desired working movement.

In the embodiment shown, the eccentricity of the mounting of the thrust rod 8 to the drive disk 10 can be varied in a simple manner by means of an adjustable bearing bush or sleeve mounting 19 for the shaft 9 on the disk 10.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. Apparatus for stretch forming a metal comprising a support, a work roller rotatably mounted on said sup-

port in a position to project outwardly therefrom to engage a workpiece, a thrust rod having one end pivotally connected to said support at a spaced location from the rotatable mounting of said work roller, drive means connected to the opposite end of said thrust rod to move said thrust rod in a reciprocal to and fro movement, an eccentric disk, means mounting said disk on said support for eccentric revolving movement in relation to said support, and eccentric drive means for driving said eccentric disk to cause revolving movement of said support with said working roller as said eccentric disk revolves in an eccentric path relative to said support.

2. Apparatus according to claim 1, wherein said eccentric drive means and said drive means comprise a single drive disk.

3. Apparatus according to claim 1, including a support roller rotatably mounted on said support in rolling supporting engagement with said working roller.

4. An apparatus for stretch forming a metal particularly a steel piece which is still in the hot or cold working range and which has a texture showing a casting or rolling structure, comprising a work roller support having a first end and an opposite end, a first crank drive connected to said work roller support adjacent said first end, a work roller rotatably mounted on said support adjacent the opposite second end, said first crank drive moving said support with said work roller in a reducing direction for contacting and reducing the workpiece, a thrust rod having one end pivotally connected to said support at a spaced location from the rotatable mounting of said work roller and having an opposite second end, and a second crank drive connected to said thrust rod adjacent its second end to move said thrust rod in a reciprocal to and fro movement along which said support member and said working roller for shifting the working roller generally in the direction of feed of the steel piece which is being formed.

5. An apparatus according to claim 4 including a support roller carried on said support and in continuous rolling contact with said work roller.

6. An apparatus according to claim 4 wherein said support roller includes a support roller axle connected to said first crank drive.

7. An apparatus according to claim 4 wherein said first and second crank drives include first and second crank shafts having first and second crank gears thereon, and a synchronizing gear in meshing engagement with said first and second gears for synchronizing the movement of said first and second crank drives.

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