Dec. 29, 1970 T. A. FOX ET AL 3,550,419

METHODS AND APPARATUS FOR METAL ROLLING

Filed March 4, 1968

Fig. 1.

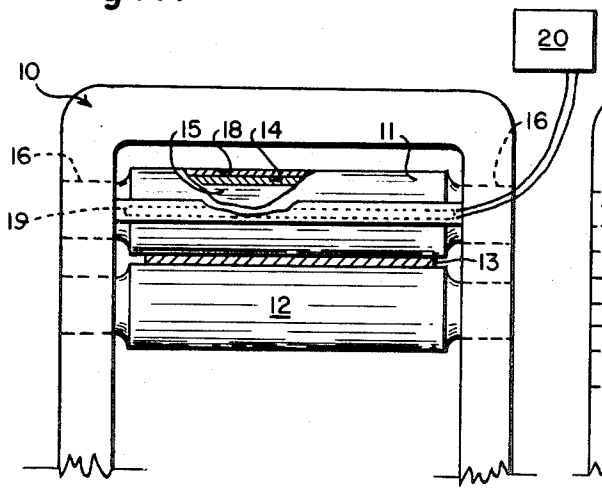


Fig. 2.

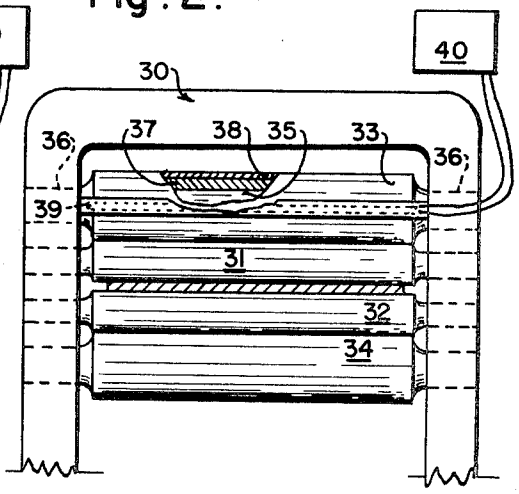


Fig. 4.

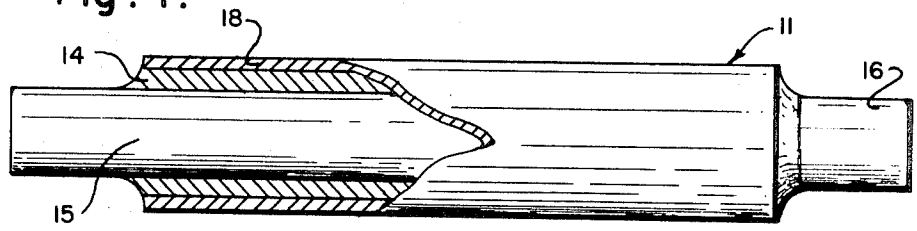
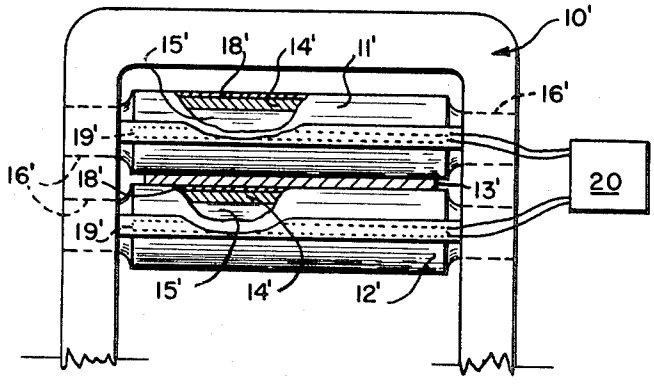


Fig. 3.



INVENTORS
Thomas A. Fox &
Joseph Zentko

Fidel, Black & Kleinkauf
Their Attorneys

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METHODS AND APPARATUS FOR METAL ROLLING

Thomas A. Fox and Joseph Zentko, both % Fox Industries, Inc., Box 358, Youngstown, Ohio 44401

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U.S. Cl. 72—199 4 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for metal rolling by introducing vibrational force into at least one roll outside the bearings.

This invention relates to methods and apparatus for metal rolling and particularly methods and apparatus for introducing vibrating force into the working rolls of a metal rolling mill to improve the rate of reduction and the quality of the product.

The art of rolling metals has been faced with the constant problem of increasing the speed and the quality of rolling. These two desired ends are frequently inconsistent and the industry has been continually beset with problems in its attempts to attain these ends.

We have discovered that we can improve both the speed and quality of the rolling by imparting a vibrating force into the mechanism of the rolling mill or roll forming line. We have found that when one or both of the work rolls is vibrating, the work moves more freely and the resistance in the mill is reduced. This means that a greater reduction of metal can be achieved by any given unit of force. The quality of the product is improved because of greater uniformity in thickness and a reduction in the strains induced by the mill.

We believe that the surprising effectiveness of our invention resides in an effect similar to that of forging combined with the rolling operation, thus with a prearranged frequency of vibration in a work roll, the metal being rolled is not only rolled in the conventional way, but is simultaneously hammered into itself. This we believe reduces the resistance and strain in both the mill and the work by reducing the pulling and stretching action of the mill required to produce a given reduction.

We have found that the manner of introduction of the vibrating force is important. We have found that the vibrating force cannot be introduced into the mill through the roll journals and bearings because the bearings are destroyed and the net efficiency is low. We have found that the vibration can be best introduced through the use of a roll of magnastrictive material operating in a pulsating magnetic field thus causing the roll to expand and contract as it rolls.

In a preferred embodiment of our invention we provide in a rolling mill having a housing, a plurality of rolls journaled for rotation in said housing, at least one of said rolls being on each side of a pass line, and means for introducing vibrational force into at least one of said rolls outside the bearings to impart the same to a work piece in said pass line. Preferably, at least one of said rolls is formed at least in part of magnastrictive material operated in a pulsating magnetic field from a source adjacent the mill. In the practice of our invention it is preferred that the vibrational force be introduced in such manner as to cause successive rapid expansion and contraction of the roll as it rotates in contact with the work.

In the foregoing general description of our invention we have set out certain objects, purposes and advantages. Other objects, purposes and advantages will be apparent

from the following description and the accompanying drawings in which:

FIG. 1 is a front elevation of a two high mill embodying our invention;

FIG. 2 is a front elevation of a four high mill embodying our invention;

FIG. 3 is a front elevation of a second embodiment of a two high mill embodying the subject of our invention; and

FIG. 4 is an enlarged fragmentary view of a preferred form of roll and field inducing device.

Referring to the drawings we have illustrated in FIGS. 1 and 4 and a two high mill and roll therefore made up of a housing **10** of conventional design with rolls **11** and **12** on opposite sides of a strip **13** forming a pass line. Roll **11** is formed of magnastrictive material **14** surrounding a central shaft **15** carrying bearing journals **16** at each end. A hardened and ground alloy steel sleeve **18** surrounds the magnastrictive material **14** and provides the actual working surface of the roll. An electrical coil **19** capable of providing a pulsating field is provided adjacent the roll **11**. A frequency generator **20** or like electrical control is connected to coil **19** and provides the electrical power to operate said coil. The operation of the frequency generator causes a magnetic field of pulsating character to be produced by the coil **19**. This in turn acts on the magnastrictive material **14** of the roll causing it to change its physical dimensions by enlarging and contracting on the diameter.

In FIG. 2, we have illustrated a second embodiment of our invention applied to a four high mill. Here a housing **30** of usual shape is provided with work rolls **31** and **32** on opposite sides of a pass line and back up rolls **33** and **34** on opposite sides of the work rolls. One of the back up rolls **33** is formed in precisely the same manner as roll **11** of FIG. 1. Roll **33** is made up of a core **35** having journals **36** at each end. A magnastrictive material **37** surrounds the core **35** and an outer sleeve **38**. A magnetic coil **39** and frequency generator **40** are placed adjacent the roll **33** as in FIG. 1.

In FIG. 3, we have illustrated a mill identical with that of FIG. 1 except that both work rolls are formed as shown in FIG. 4. The construction and operation of the mill is identical with that of FIG. 1 and like numerals with the prime sign are applied to like parts. The only difference between the mills is that both work rolls vibrate to work on the metal.

It will be obvious that in four high mills and the like, multihigh mills, all back up rolls, all work rolls, or one back up roll or one work roll might be vibrated to produce a desired result and these combinations are contemplated by this invention.

The principal working functions of this invention are believed to reside in our theory that when a magnetic field is placed with the magnetic lines of force penetrating a magnastrictive material, this material will expand and/or contract with the variance of this force, thereby when a frequency is passed through the coil a varying magnetic field will ensue in and about this coil, and since the magnastrictive material is in this field it will also be governed by the magnetic force, expanding and contracting in unison with this field, thereby when the magnastrictive material is in the core of the roll and a sleeve of suitable rolling material is placed on this core the sleeve will expand and contract due to the magnastrictive material forcing it to expand and its own elasticity will cause it to contract when the magnastrictive material contracts.

With the expansion and contraction of the magnastrictive material and the sleeve material in unison, we have accomplished the desired effect of vibrating the rolls.

This method is unique in the fact that the roll itself is pulsating and does not put undue strain on the bearings

or bushings causing deterioration. The amount of expansion can be governed by the magnetic flux and by the diameter of the core, since the magnastrictive material expands or contracts in one direction only and the amount of expansion and contraction is greater with the greater length along its magnetic axes.

Another form of increasing the length of expansion and contraction is by polarization of the material. This is done by applying a direct magnetic field of sufficiently high intensity for the value of the magnetic field to remain above zero.

Various other means for inducing vibration into the roll may be used such as by direct coupling of a transducer to the roll end. The important thing to be observed is that the vibrational energy be introduced to the roll through some means other than the bearings, i.e. outside the bearings and journals.

While we have illustrated and described certain preferred embodiments and practices of our invention in the foregoing specification, it will be understood that this invention may be otherwise embodied within the scope of the following claims.

We claim:

1. In a metal rolling mill having a housing, a plurality of rolls journaled for rotation in said housing, at least one work roll being on each side of a pass line, and means for introducing vibrational force into at least one of said rolls within the body of the roll, said means expanding and contracting the roll radially to apply periodic pressure perpendicular to the plane of said pass line.

2. A rolling mill as claimed in claim **1** wherein the said one of said rolls is formed at least in part by magnastrictive material providing a pulsating magnetic field.

3. A rolling mill as claimed in claim **1** wherein more than one work roll is vibrated.

4. The method of rolling comprising the steps of:

(a) passing a body of metal between two rolls under pressure, and

(b) subjecting at least one of said rolls to vibrational force introduced into the roll within the body of the roll expanding and contracting said roll radially to apply periodic pressure perpendicular to the plane of the pass line.

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MILTON S. MEHR, Primary Examiner