

[54] METAL TREATMENT APPARATUS FOR STEEL ROD HAVING AN OSCILLATING PLATFORM BELOW THE LAYING HEAD

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[51] Int. Cl. B21f 23/00

[58] Field of Search 140/1, 2; 266/3 R; 198/111, 112

[56] References Cited

UNITED STATES PATENTS

3,603,355 9/1971 Geipel et al. 140/2

FOREIGN PATENTS OR APPLICATIONS

1,214,635 4/1966 Germany 140/2

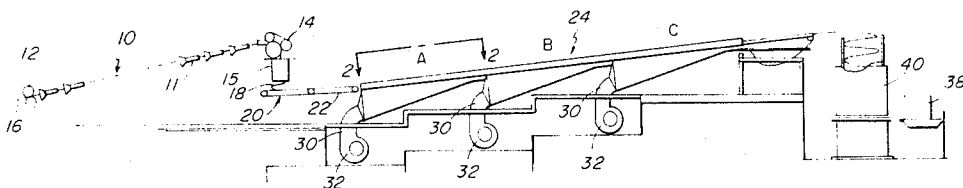
Primary Examiner—Lowell A. Larson

[57] ABSTRACT

A conveyor system for transporting objects sequentially deposited thereon is described in which a portion of the conveyor has imparted thereto an oscillation

which is in the plane of the conveyor and transverse to the conveyor motion. The oscillating conveyor is described in the context of a heat treatment apparatus for hot rolled steel rod. In such heat treatment apparatus, the rod is first shaped by a laying head into a series of rings, and the rings are then deposited upon the moving oscillating conveyor. The rings on the conveyor form a flat overlapping, non-concentric orientation. The oscillation of the conveyor reduces the edge packing effect. The rings are then transported by another conveyor through a series of cooling chambers where they are cooled, such as by forced air convection. The oscillating conveyor includes a flat, wire-woven, endless belt, a portion of the belt, and preferably the oscillating part, being disposed below the laying head. The belt is supported upon a series of shafts having sprockets mounted thereon which engage the belt; one or more of these shafts is driven by a motor assembly. A cam mechanism is associated with the driven shaft to cause that shaft to oscillate along its longitudinal axis, the oscillation being approximately one inch in both directions from center. The belt in turn oscillates, and as the rings are deposited upon the belt, the rings are displaced transversely to the direction of the conveyor motion. The transverse displacement of the rings reduces the edge packing and assists in cooling the rings uniformly.

8 Claims, 6 Drawing Figures



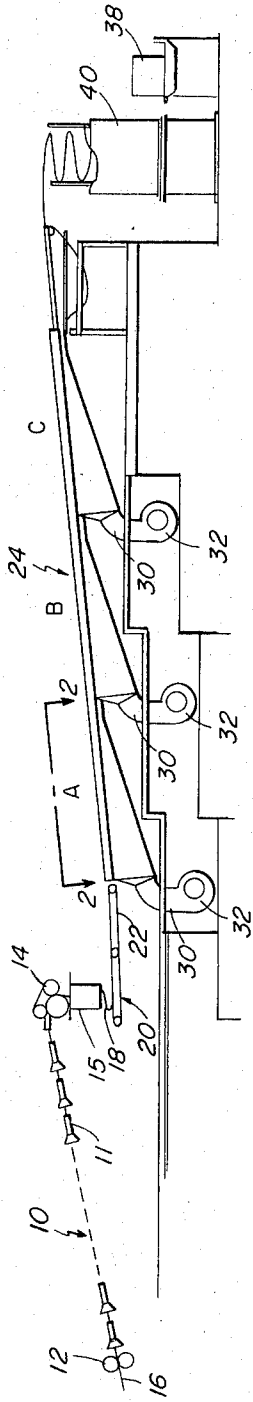


FIG. 1

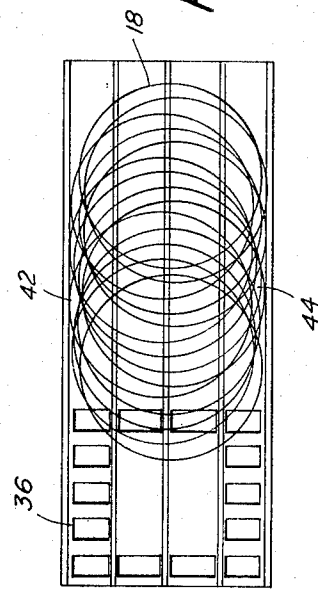


FIG. 2

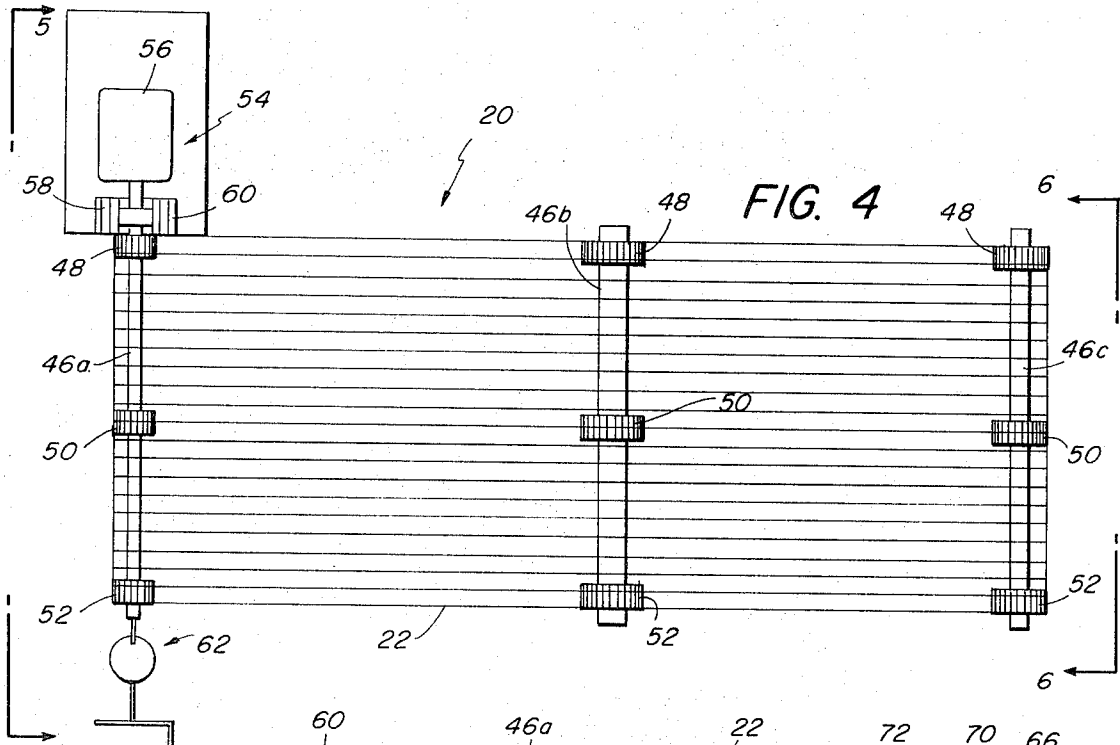


FIG. 4

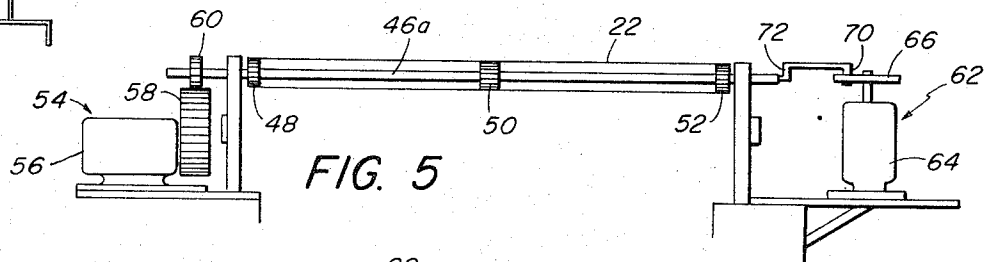


FIG. 5

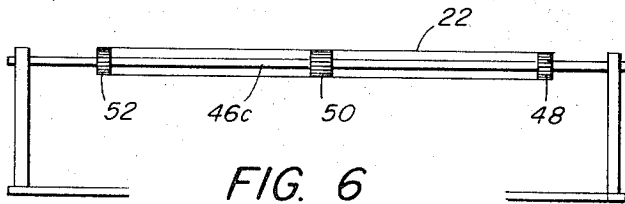


FIG. 6

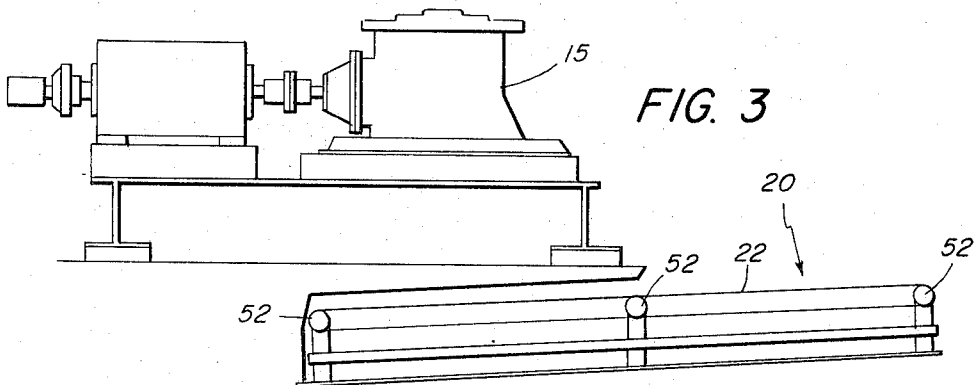


FIG. 3

**METAL TREATMENT APPARATUS FOR STEEL
ROD HAVING AN OSCILLATING PLATFORM
BELOW THE LAYING HEAD**

BACKGROUND OF THE INVENTION

The present invention relates to the metal working industry and more particularly to an improved apparatus operable in direct sequence with rod forming means such as a rolling mill for preparing hot rolled steel rod for subsequent cold working operations such as wire drawing.

Technological advances in the art of rolling steel rod have successfully demonstrated that substantial benefits may be gained by uniformly quenching hot rolled steel rod at a controlled rate in direct sequence with the rolling operation. The process is described in U.S. Pat. No. 3,231,432, the teachings of which are incorporated herein by reference. By this process, a billet of steel is first rolled by conventional means into a length of rod. As the rod leaves the final finishing stand of the mill, it is passed through a delivery pipe equipped with water quenching nozzles which operate to cool the rod from the high temperatures maintained during rolling down to about 1,450°F. Following this initial water quenching step, the rod is then directed into a laying head where it is formed into a continuous series of rings. The rings fall from the laying head under the influence of gravity directly onto an open moving conveyor, the surface of which is made up of laterally spaced support tracks and conveyor chains. The continuous motion of the conveyor causes the rings being deposited thereon to assume a non-concentric overlapping relationship. While moving along the conveyor, the rings are cooled by forced air convection through the transformation range defined by the continuous cooling transformation diagram for the particular grade of steel being processed at a rate appropriate to achieve substantially complete allotropic transformation of the austenite in a manner which will enable the rod to be subsequently cold worked without an intervening patenting step. To compensate for the fact that there is a greater mass of steel at the portions of the rings near the sides of the conveyor than at the center, a larger amount of forced air is directed to the portion of the rings near the conveyor sides. Thereafter, the rings are collected from the conveyor into bundles ready for further processing steps, such as descaling and wire drawing.

Experience has indicated that by cooling the rod in a controlled manner as described above in direct sequence with the rolling operation, more uniform metallurgical properties are developed along the entire length of the rod, which properties are at least equal to and in many instances better than the properties developed by conventional air patenting. The need for a separate patenting step prior to cold working is thus eliminated, making it possible to realize substantial savings in production costs. Moreover, it has been found that by cooling the rod in the aforementioned manner, a thin uniform friable surface scale is formed, which scale may be removed easily with a minimum resulting metal loss while the rod remains in bundle form. However, even with this arrangement, rod cooled at the edge of the ring pattern tends to show a lower average tensile strength, particularly in the high carbon grades, than rod cooled at the center.

Several devices are known which attempt to reduce the edge packing effect to obtain more uniform proper-

ties throughout the rings. U.S. Pat. Nos. 3,460,777 and 3,469,798 disclose systems for deflecting some of the rings transversely after they leave the laying head and before they are deposited on the conveyor. These systems include cam wheels and several deflector flap arrangements; in all these systems a force is applied to certain rings which displaces them in one of two directions transverse to the direction in which the rings are conveyed.

While the above-mentioned systems for transversely displacing the rod rings do reduce edge packing, these systems may create other difficulties. Whenever one of these ring deflector systems is used, there is a risk that the rings will become snagged. This problem is even more important in mills which operate at high speeds of up to 11,000 feet per minute or higher. Furthermore, these known systems for transversely displacing the rings are not ideally suited for mills wherein the rings leaving the laying head are in a horizontal plane and fall under the influence of gravity onto a moving conveyor.

SUMMARY OF THE INVENTION

According to the present invention, an apparatus is provided which overcomes the problems previously mentioned. More particularly, such apparatus reduces the problem of non-uniform cooling of overlapping, non-concentric rod rings by reducing the edge packing effect at the sides of the rings. More importantly, the apparatus does not interfere with the passage of the rings from the laying head even when the mill operates at very high speeds. The invention provides for a metal treating apparatus wherein the rings from the laying head are deposited on a flat platform which oscillates transversely to the direction in which the rings are conveyed through a series of cooling chambers. In accordance with the present invention, the metal treating apparatus, which is capable of handling hot metal rod travelling at speeds as great as 11,000 ft/min or higher, includes a device for shaping a length of hot metal rod into a series of rings. The rings are then sequentially and continuously deposited upon a flat oscillating platform. The rings are continuously transported from the platform and form a flat overlapping, non-concentric orientation. The platform has imparted thereto an oscillatory motion transverse to the direction in which the rings are transported from the platform. Thus, oscillating motion causes the overall width of the ring pattern to increase. Thus, the mass of the ring pattern at the side edges is distributed over a larger region.

The major problem which the present invention solves is reducing the side edge packing effect while also reducing the risk of interference with the laying head operation, even at the high speeds at which modern mills operate. In the rod mill industry, great care must be taken to insure that the rings do not become snagged as they leave the laying head and are deposited on a conveyor system. In the present invention, the rods leave the laying head and are deposited upon an oscillating platform, thus eliminating any provision of an apparatus which could interfere with mill operation.

An important feature of the present invention is the concept of depositing the rings on a flat oscillating surface, instead of, as in known prior art systems, utilizing a mechanism which exerts a transversely directed force at one location on the ring circumference. In the present invention, and in the known systems, a transverse force is exerted on the ring because without this force

the rings would not undergo transverse displacement. In the present invention the force is not exerted on the ring until the ring is deposited upon a flat surface. Since the entire flat surface is oscillating transversely, the forces on the ring are distributed evenly throughout the circumference of the ring. In the prior art systems, the force is concentrated on one part of the ring.

In a preferred embodiment of the present invention, the oscillating platform is a short conveyor having one end disposed below the laying head and the other end arranged to deliver the rod to the longer, conventional cooling conveyor. The end of the short conveyor under the laying head is oscillated transversely while the end of the short conveyor adjacent to the cooling conveyor remains positionally fixed in alignment with the cooling conveyor. This type of "parallelogram" motion is accomplished without buckling the surface of the short conveyor or opening gaps between it and the cooling conveyor by the use of a wire mesh belt having its warp strands parallel to the longitudinal axis and its weft strands transverse thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, reference may be made to the following descriptions of the exemplary embodiments taken in conjunction with the following drawings, in which:

FIG. 1 is a side elevational view of a rod cooling apparatus embodying the concepts of the present invention;

FIG. 2 is a view taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged side elevational view of the laying head and an oscillating conveyor system according to the present invention;

FIG. 4 is a plan view of the oscillating conveyor system;

FIG. 5 is a view of the oscillating conveyor system taken along line 5—5 in FIG. 4; and

FIG. 6 is a view of the oscillating conveyor system taken along line 6—6 in FIG. 4.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring initially to FIGS. 1 and 2, an apparatus for quenching hot rolled steel rod in direct sequence with a rod mill is shown having a delivery pipe 10 which includes a plurality of water spray nozzles 11, extending from a final finishing stand 12 of the rolling mill to a chain guide assembly 14 of known construction overlying a laying head 15. Hot rolled rod 16 issuing from the finishing stand 12 at mill delivery speeds, which may be as high as 11,000 ft/min or higher, enters the pipe 10 where the rod is immediately subjected to the cooling action of the water spray nozzles 11. The temperature of the rod as it leaves the finishing stand 12 is approximately 1,800°F., and as it emerges from the delivery pipe 10, it is down to about 1,450°F. It is important to note, however, that at this point the rod temperature is still above that at which allotropic transformation of austenite begins.

After being subjected to this initial water cooling step, the rod 16 is directed downwardly through an angle of approximately 90° by the chain guide assembly 14 into the laying head 15 where the rod is formed into a continuous series of rod rings indicated typically by the reference numeral 18. As each ring is formed, it drops under the influence of gravity directly onto an oscillating conveyor indicated generally at 20, one em-

bodiment of which can best be seen by additional reference to FIGS. 3 to 6. While the term oscillating conveyor is used, it is to be understood that the invention is not intended to be limited to a conveyor. The invention includes any oscillating platform with which there is associated appropriate means for transporting the rings away from the platform. The oscillating conveyor 20 is driven continuously during mill operation. As the rings 18 fall by gravity onto the moving conveyor 20, the rings assume a flat overlapping, non-concentric orientation as best shown in FIG. 2. The conveyor 20 is positioned adjacent to the receiving end of an elongated upwardly inclined cooling apparatus 24. The cooling apparatus 24 has a conveyor (not shown), and the speed of this conveyor is the same as that of the conveyor 20. The conveyor for the cooling apparatus preferably may include one or more endless chains driven by an arrangement of sprocket wheels mounted on rotating shafts.

The cooling apparatus 24 has a group of plenum chambers A, B and C, through which the rod rings 18 are conveyed. The plenum chambers are each connected by means of ducts 30 to powerful fans 32. The fans 32 supply cooling air through the plenum chambers and onto the steel rings passing therethrough.

As shown in FIG. 2, transverse slots, collectively referred to by the reference numeral 36, in the upper surface of plenums A, B and C of the cooling apparatus 24 provide a means for allowing the cool air to pass upwardly from the plenum chambers to contact the exposed surfaces of the non-concentric, overlapping rod rings. While in FIG. 2 only the left side of the plenum A is shown having slots, it is to be understood that the entire upper surface of the plenum has similar slots. There are a greater number of slots at the sides of the cooling apparatus than at the center. Thus, there is greater cooling at the sides than at the center. The greater side cooling compensates for the fact that the ring pattern has a greater mass density at the side than at the center.

Transformation of the austenite of all parts of the rod rings 18 occurs as the rings pass through the cooling apparatus 24. The cooling rate is selected with regard to the continuous cooling transformation diagram for the particular grade of steel being processed so as to provide the desired metallurgical properties required for subsequent cold working without an intervening patenting step. This cooling rate must be sufficiently slow to avoid the formation of quench hardened areas, such as areas that contain martensite, yet sufficiently rapid to avoid the growth of undue amounts of coarse pearlite.

It will be understood that the number and size of the plenum chambers A, B and C, the arrangement and configuration of slots 36, and the size and capacity of the fans 32 may be varied at will to produce the desired volume of air that is to be passed over the moving rod rings as they travel continuously along the apparatus 24. It should also be understood that a cooling medium other than air may be used, and that the cooling medium may be delivered at selected temperatures above or below atmospheric temperature.

After cooling through the transformation range, the rod rings 18 leave the delivery end of apparatus 24 to be collected into bundles 38 by a coil collecting apparatus 40.

In accordance with the present invention, the oscillating conveyor 20, as shown in FIG. 2, increases the overall width of the pattern of rings. The increased width of the ring pattern reduces the edge packing effect as shown at 42 and 44 in FIG. 2. In the preferred embodiment, the conveyor oscillates ± 1 inch from center. Thus, rod rings laid with a nominal 40 inch ring diameter would have an overall pattern width of at least 42 inches plus the normal pattern variation of approximately 2 inches, thereby reducing the amount of edge packing, and increasing the uniformity of controlled cooling between the edges and the centers. This uniform cooling in turn results in greater uniformity of mechanical, physical, and metallurgical properties throughout a coil of controlled cooled rod.

FIGS. 3 to 6 show the details of the oscillatory conveyor 20. In FIG. 3, an endless belt 22 of the oscillatory conveyor 20 is partially disposed under the laying head 15. The belt 22 is preferably made of woven wire rope. While FIG. 3 shows the wire strands extending only the length of the belt and not along the width, it is to be understood that a series of wires do extend across the width. The wires across the width of the belt are shown partially in FIGS. 5 and 6. The belt 22 is supported on a series of shafts 46a, 46b and 46c, each shaft having sprockets 48, 50 and 52 mounted thereon. The shaft 46a is driven by an appropriate drive system indicated at 54. The sprockets are formed with a suitable arrangement of teeth which engage the inner surface of the wire-woven belt 22. The drive system 54 includes a motor 56, a gear 58 mounted on the motor output and a gear 60 mounted on the shaft 46a. The gears 58 and 60 transmit the rotation of the motor output to the shaft 46a. The width of the gears 58 and 60 and their relative positions with respect to each other is such that the gears remain interlocked even though the gear 60 undergoes translation of ± 1 inch in the direction of the longitudinal axis of the shaft 46a.

The oscillation of the belt 22 is accomplished by a cam mechanism indicated at 62 in FIG. 4 and FIG. 5. A motor 64 rotates a disk 66. A cam arm 68 is eccentrically mounted at one end 70 to the disk 66 and mounted at the other end 72 to the end of the shaft 46a. The output rotation of the motor causes the shaft 46a to oscillate along its longitudinal axis. The shaft 46a is simultaneously rotating about its longitudinal axis. Preferably, the belt 22 oscillates ± 1 inch from its nominal orientation. While in the preferred embodiment the shaft 46a is oscillated, it is to be understood that the shafts 46b or 46c may be oscillated instead of or in addition to the shaft 46a.

The theory of operation of the preferred embodiment of the present invention is as follows. It is desirable, though not necessary, that the frequency of the belt oscillation have a fixed relationship to the rate at which the rings are deposited upon the belt. As the portion of the belt below the laying head oscillates through a ± 1 inch excursion from center, each ring is deposited at a different location with respect to the center of the belt than the preceding ring. The rings do not move relative to the belt after they are deposited thereon because of the high frictional contact between the rings and the wire-woven belt.

There are several advantages in the oscillating conveyor system according to the present invention. The main purpose is to reduce the edge packing in a manner which does not interfere with the rod rings as they fall

from the laying head. This purpose may be accomplished by any substantially horizontal platform below the laying head which oscillates transversely to the direction in which the rings are to be conveyed. An important aspect of the invention is that the rings are not displaced transversely until their descent from the laying head is terminated. Another important feature is that the means for displacing the rings transversely does not present any chance of snagging the rings. In the known systems, a transverse force is applied to one part of the ring by several possible mechanisms, such as cams, deflector arms, etc. With such mechanisms, it is necessary that their operation be more stringently synchronized to the delivery rate of the rings from the laying head. The mechanism is likely to cause a snag if the delivery speed is not uniform or if the motion of the rings, as they leave the laying head, is not uniform. This problem becomes more critical at higher mill speeds at which modern mills operate.

There are several modifications which may be made to the embodiments in FIGS. 1 to 6. First, the concept of the invention is to deposit the rings on an oscillating platform and then to transport the rings from this platform to the cooling chamber. Thus, other forms of oscillating platforms may be used instead of the oscillating conveyor 20. For example, an oscillating flat plate may be located under the laying head. Drive rollers may be associated with the plate for moving the rings off the plate and onto the main ring conveyor. Also, the oscillating motion need not be limited only to motion at a right angle to the direction of ring movement; it is only necessary that a component of this oscillatory motion be transverse to the ring movement. Also, the extent of and frequency of transverse oscillation is variable within wide limits. In addition, the invention is not limited to use with a laying head in which the rings are formed in a horizontal plane as in FIG. 1 of the drawings. The oscillating platform of the present invention may be used in conjunction with rod mills wherein the rings are formed in either a vertical or an inclined plane.

The embodiments of the present invention described previously are intended to be merely exemplary and those skilled in the art will be able to make numerous variations and modifications without departing from the spirit of the present invention. All such variations and modifications are intended to be in the scope of the invention as defined in the appended claims.

What is claimed is:

1. An apparatus for depositing a continuous series of rod rings upon a continuously moving conveyor at its input end in such a way as to form the rings into a flat overlapping non-concentric pattern on the conveyor including

- a. means for providing a continuous length of rod,
- b. means for shaping the rod into a continuous series of rings,
- c. a platform having a discharge end for receiving the rings from the shaping means maintained such that the discharge end of the platform and the input end of the conveyor are in close and parallel relation,
- d. means for oscillating the platform transversely to the conveyor as the rings are deposited on the platform to decrease the edge packing effect of the ring pattern, and
- e. means for continuously transporting the rings from the platform to the conveyor.

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2. The apparatus according to claim 1 wherein the platform is disposed below the ring shaping means and wherein the shaping means forms the rings in a generally horizontal plane.

3. The apparatus according to claim 2 wherein the platform includes an endless belt and means for supporting the belt in a generally horizontal plane.

4. The apparatus according to claim 3 wherein the transporting means includes means for moving the endless belt.

5. The apparatus according to claim 4 wherein the supporting means includes an arrangement of shafts having sprockets mounted thereon which engage the belt and wherein the oscillating means includes means

for oscillating at least one of the shafts along its longitudinal axis.

6. The apparatus according to claim 3 wherein the endless belt is made of woven wire mesh such that the warp strands are parallel to the longitudinal axis of the belt and the weft strands are transverse thereto.

7. The apparatus according to claim 1 wherein the oscillation of the platform has a constant relationship to the speed of the moving conveyor.

8. The apparatus according to claim 6 wherein the discharge end of the platform is maintained permanently fixed in substantially end to end relation with the input end of the conveyor.

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