United States Patent

Nakamura et al.

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[54] **APPARATUS FOR MECHANICALLY REMOVING THE SCALE FROM THE PERIPHERAL SURFACE OF A HOT ROLLED WIRE MATERIAL**

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[52] **U.S. Cl.**.....**15/88,** 51/80 A, 134/9

[51] **Int. Cl.**.....**A46b 13/02**

[58] **Field of Search** .....15/88, 77, 181, 97; 134/9; 29/81, 90; 51/80 R, 80 A

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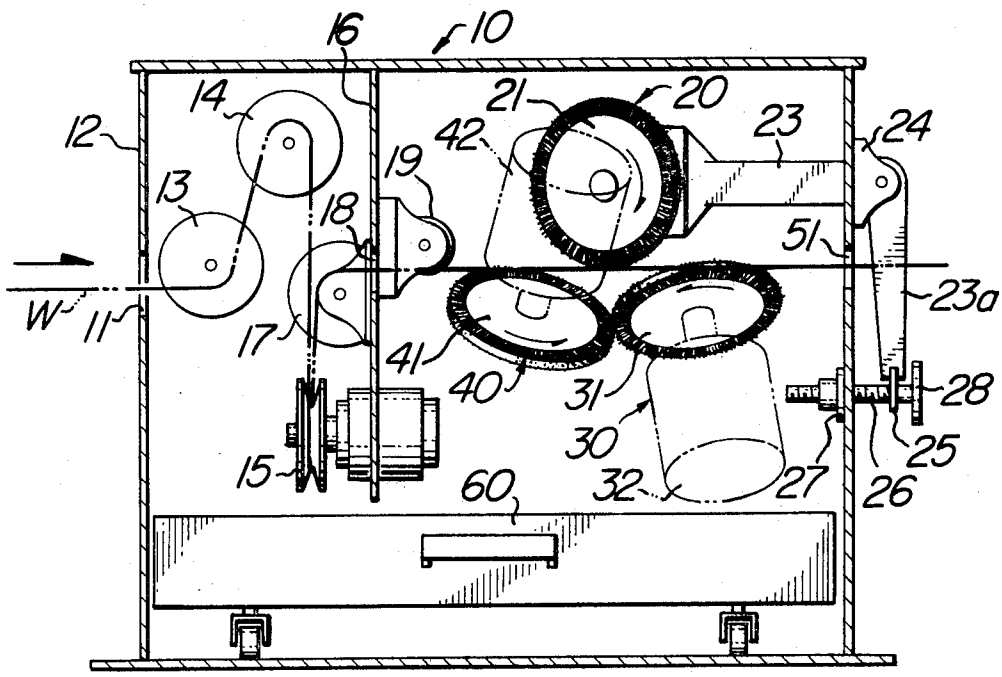
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[57] **ABSTRACT**

A hot rolled wire material is first moved along a meandering path of travel defined by a plurality of sheaves to remove loose scale particles and is then brought into rubbing contact with rotating brushing wire wheels arranged around the run of the wire material in angularly and axially spaced relationship with each other with respect to the axis of the wire material so that the remaining scale is substantially completely removed. Each wire wheel has its plane of rotation inclined at an angle with respect to the run of the wire material.

1 Claim, 5 Drawing Figures



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FIG. 1

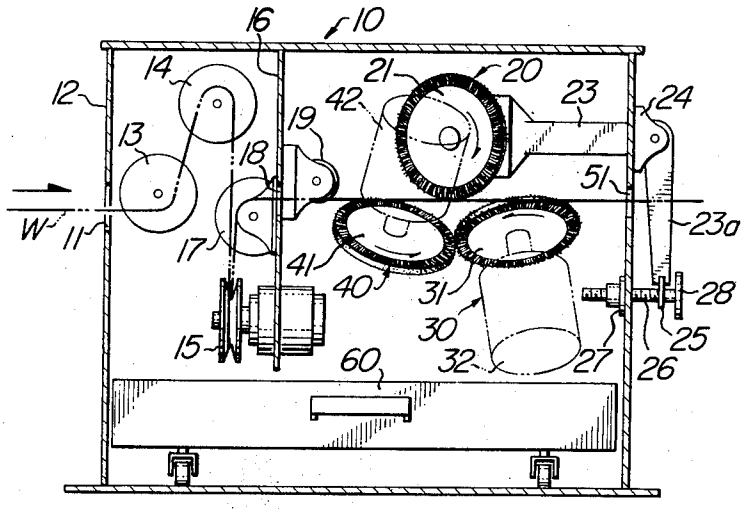


FIG. 2

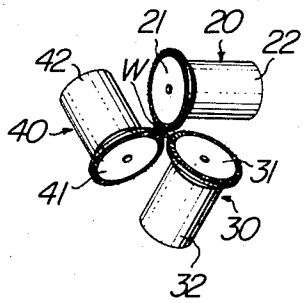


FIG. 3

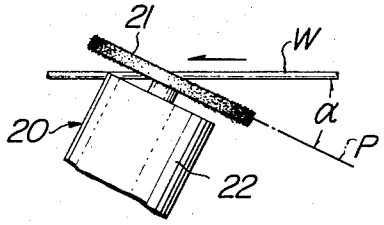


FIG. 4

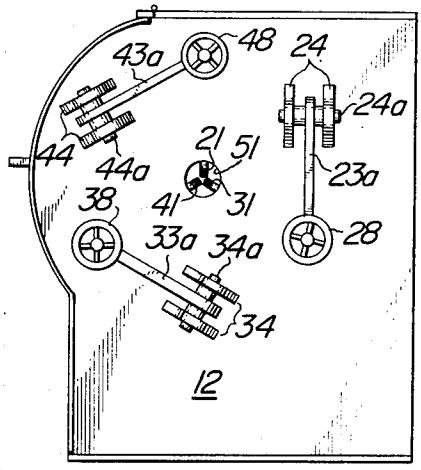
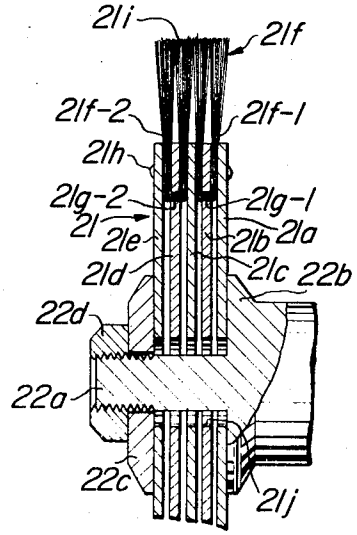


FIG. 5



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APPARATUS FOR MECHANICALLY REMOVING THE SCALE FROM THE PERIPHERAL SURFACE OF A HOT ROLLED WIRE MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of mechanically removing the scale produced on the peripheral surface of a wire material during the hot rolling thereof and also to an apparatus for performing the method.

2. Description of Prior Art

Heretofore, a descaling of a hot rolled wire material is generally performed with a chemical process such as by use of a quantity of hydrochloric acid or sulfuric acid which must be disposed of as a waste material after use for a certain amount of time. The disposal of the wasted materials such as the mentioned acids and a neutralizing agent such as lime is recently governmentally regulated in the viewpoint of environment sanitation or public health. In addition, the chemical processes require bulky equipments which inevitably increase the cost of the manufacture of the products.

Mechanical descaling methods have therefore been recently spotlighted for the reason primarily that these methods are entirely free from the problem of environment sanitation and that smaller apparatus may be sufficient for these methods. Conventional mechanical descaling methods are classified into:

i. A descaling method including the steps of subjecting a hot rolled wire material to repeated bendings by means of a plurality of sheaves, directing jets of air against the bent portions of the wire material and/or bringing the wire material into rubbing contact with a polishing material such as a sheet of steel wool wound around the peripheral surface of the run of the wire material;

ii. A descaling method including the steps of subjecting a hot rolled wire material to repeated bendings by means of a plurality of sheaves and, thereafter, bringing the wire material into rubbing contact with a brush which is not only rotated about its axis but also moved around the wire material while the brush is held in contact with the wire material; and

iii. A descaling method including the steps of subjecting a hot rolled wire material to repeated bendings by means of a plurality of sheaves and, thereafter, causing the wire material to pass through a polishing box or so-called "scouring box" or "rotating barrel". However, all of the conventional mechanical descaling methods have shortcomings. Namely, the mechanical descaling method (i) fails to perform a complete descaling. With the descaling method (ii), the peripheral speed of the brush in contact with a wire material to be descaled is limited by the design of the apparatus for performing the method. In order to obtain a peripheral speed of the brush large enough to sufficiently descale the wire, a complicated mechanism is required for the apparatus. Thus, it is difficult to manufacture a satisfactory apparatus. Furthermore, it has been found that the descaling method (iii) also fails to perform a complete descaling of a wire material. It will therefore be appreciated that, while the conventional mechanical descaling methods are satisfactory in the viewpoint of environment sanitation, these methods are inferior to the chemical methods with respect to the quality and degree in the performance of descaling, with a result that the residual scale particles on the wire material treated with any of the mechanical descaling methods cause serious problems in subsequent working of the wire material. For example, if the mechanically descaled wire material is formed into nails, the dies and knives used in the nail manufacture become damaged in a shorter period of operation. For the reasons above-stated, the conventional mechanical descaling methods have not widely been employed into practical use.

SUMMARY OF THE INVENTION

In order to eliminate the above-discussed shortcomings and difficulties, the present invention contemplates a method of mechanically removing the scale produced on the peripheral surface of a wire material during the hot rolling thereof, which method includes the step of causing the wire material to come into successive rubbing contact at the peripheral surface thereof with at least three wire wheels which are arranged around the periphery of the wire material in angularly spaced relationship with each other with the plane of rotation of each wire wheel being inclined at an angle with respect to the run of the wire material. In a preferred embodiment of the invention, the wire wheels may be driven to rotate in directions substantially opposite to the direction in which the wire material is advanced. Prior to the rubbing contact with the brushing wire wheels, the wire material may preferably be subjected to repeated bendings by means of a plurality of sheaves so that loose scale particles are removed.

The present invention also contemplates an apparatus for use in performing the method set forth above which comprises at least three wire wheels disposed around the wire material in angularly spaced relationship with each other for rubbing contact with the peripheral surface of the wire material, each of the wire wheels having its plane of rotation inclined at an angle with respect to the run of the wire material, means for supporting respective wire wheels in the above-mentioned positions, and means for rotating the wire wheels. Preferably, the wire wheels may be rotated in directions substantially opposite to that of the wire advancement. Each of the wire wheels may preferably be arranged such that the wire wheel is to be in contact with the peripheral surface of the wire material substantially at the central point of the thickness of the wire wheel, or in other words, the width of the common peripheral surface of the wire wheel and that the radius of the wire wheel included in a transverse plane and passing through the point of contact between the wire material and the wire wheel is in alignment with the radius of the wire material passing through said point of contact, said transverse plane extending radially through said central point.

In a preferred embodiment of the invention, a plurality of sheaves may be disposed upstream of the brushing wire wheels and so arranged as to define a meandering path of travel along which the wire material is caused to move. The path of travel may advantageously be curved in at least two radial directions of the wire material for subjecting the wire material to repeated bending in such directions so that loose scale particles are removed at the point upstream of said brushing wire wheels.

The rotating means may be conventional electric motors upon the output shafts of which the wire wheels are rigidly mounted for rotation therewith, respectively. The electric motors may advantageously be mounted on a supporting means in such a manner that the wire wheels on the motor shafts are positioned in the above-stated arrangement, respectively. In addition, means may be provided for adjusting the radial position of at least one of said wire wheels with respect to the axis of the wire material to thereby adjust the pressure at which the wire wheels are in brushing contact with the wire material.

The supporting means may preferably be rod members which extend substantially in parallel with the run of the wire material. Each of the rod members has its inner end rigidly secured to one of the electric motors and an outer end portion pivotally mounted on a machine frame of the apparatus. An arm, which is rigidly connected at one end to the outer end of the rod member, extends substantially in parallel with the machine frame. The adjusting means may preferably be adjusting screw members each threadably mounted on the machine frame and having a portion operatively connected to the other end of the arm so that screwing or rotation of the screw member is effective to pivotally move the corresponding rod member with respect to the wire material whereby the pressure at which the brushing wire wheels are in rubbing contact with the wire material is advantageously adjusted.

In a preferred embodiment of the invention, the wire wheels are arranged in spaced relationship also in the direction of the wire advancement. This arrangement conveniently eliminates any interference between respective wire wheel units.

Each of the wire wheels may advantageously comprise a plurality of disc-like members assembled in substantially laminated relationship with each other and a brushing bristle firmly secured to the outer peripheral edge portion of the disk-like assembly. In a preferred embodiment of the invention, the bristle is formed of a plurality of bundles of wire rods each of which bundles is of substantially U-shaped configuration having the immediate or base portion of the U extending through one of a plurality of circumferentially spaced axial apertures formed in each of the disc-like members, excepting the opposite outer ones, adjacent the peripheral edge thereof. The leg portions of each U-shaped wire bundle extend radially outwardly through the space or gap between the adjacent pair of disc-like members and are firmly held therebetween by means of conventional fastening means, such as rivets or bolt and nut assemblies.

Other objects and features of the present invention will become apparent from the following description of a preferred embodiment of the invention with reference to the accompanying drawings.

DESCRIPTION OF DRAWINGS

FIG. **1** illustrates, partly in side elevation and partly in longitudinal section, an embodiment of the descaler according to the present invention with a part of the descaler being omitted for the simplification of illustration;

FIG. **2** is a schematic fragmentary perspective view of brushing wire wheels and motors thereof as viewed from an upstream point along the run of a wire material being treated;

FIG. **3** illustrates the angular arrangement of the plane of rotation of one wire wheel with respect to the run of a wire material;

FIG. **4** is an end view of the apparatus; and

FIG. **5** is a fragmentary radial sectional view of one wire wheel and the output shaft of the corresponding motor.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring first to FIG. **1** of the drawings, a wire material W delivered from a hot rolling mill (not shown) is introduced into a descaling apparatus **10** of the present invention. The wire material W is passed through an inlet opening **11** in a machine frame **12** of the apparatus to a first sheave **13** mounted on the frame within the housing of the apparatus adjacent the inlet opening **11**. The wire material is partially wound around the sheave **13** and then directed to a second sheave **14** mounted above the first sheave **13**. The wire is wound around the second sheave **14** substantially over 180° and then is directed downwardly to a third sheave **15** mounted on an inner frame member **16** at a level lower than that of the first sheave **13**. In the illustrated embodiment, the inner frame member **16** terminates short of the base of the apparatus for reasons which will become apparent later in this description.

The wire material W is then wound around the third sheave **15** substantially over 180° (not illustrated) and then again upwardly directed to a fourth sheave **17** which is also mounted on the inner frame member **16** generally at the same level as that of the first sheave **13**. The wire material is wound around the fourth sheave **17** substantially over 90° and is advanced therefrom through a passage of opening **18** in the frame member **16** into substantially tangential rolling contact with a fifth sheave **19** which is mounted on the side of the frame member **16** opposite to the side on which the sheaves **15** and **17** are mounted. The fourth and fifth sheaves **17** and **19** are arranged such that these sheaves guide the wire material W along a path of travel which is generally axially aligned with the path of travel of the wire material up to the first sheave **13**.

In the illustrated embodiment, the fourth sheave **15** is arranged such that the axis thereof is substantially perpendicular to the axes of other sheaves. It will, however, be appreciated that any other arrangement of the sheaves may be employed as far as they are disposed to cause the wire material W to be advanced along a meandering path which is advantageously curved in at least two radial directions, e.g. vertical and horizontal directions, for subjecting the wire material to repeated bending so that loose scale particles on the wire material are removed therefrom by the bending.

The wire material W is further advanced and brought into rubbing contact with brushing wire wheels of wire wheel units **20**, **30** and **40** which are generally arranged around the run of the wire material in angularly spaced relationship to each other as will be seen in FIG. **2**. In the illustrated embodiment of the invention, the wire wheel units **20**, **30** and **40** are arranged in spaced relationship to one another also in the direction of the wire travel as shown in FIG. **1**. This arrangement advantageously ensures that each of the units is prevented from otherwise interfering with the operation of the other units.

As will be seen in FIG. 2, the unit 20 includes a wire wheel 21 and an electric motor 22 for driving the wire wheel. Advantageously, the wire wheel is rotated in the direction substantially opposite to the direction in which the wire material W is advanced. Similarly, the units 30 and 40 have wire wheels 31 and 41, respectively, which are driven by electric motors 32 and 42, respectively. These wire wheel units are arranged in substantially the same manner with respect to the run of the wire material W and, for this reason, it will be sufficient to describe the arrangement of only one of the units 20 in this concern.

As best shown in FIG. 3, the wire wheel 21 of the unit 20 is positioned such that the plane of rotation of the wheel 21 represented by P is inclined at an angle with respect to the run of the wire material. In a preferred embodiment of the invention, moreover, the wheel 21 is positioned with respect to the peripheral surface of the wire material such that the radius of the wire wheel included in a transverse plane and passing through the point of contact between the wheel and the wire material is coincident with the radius of the wire material passing through the point of contact with the wire wheel, said transverse plane extending radially through the central point of the thickness of the wire wheel or, in other words, the width of the common peripheral surface of the wire wheel 21. The angle α may be variable in accordance with the number and speed of rotation of the brushing wire wheels, the linear velocity and diameter of the wire material W being advanced, etc. It has been found that, in dealing with wire materials having diameters ranging from 5.5 to 9.5 mm, a better result is obtainable when the angle α is in the order of 15°.

The motors 22, 32 and 42 are mounted on their supports, only one of which 23 for the motor 22 is being illustrated in FIG. 1, so that the supports enable their wire wheels to be positioned in the afore-described arrangement with respect to the run of the wire material W. In the illustrated embodiment, the supports as represented by numeral 23 are in the form of rod members extending generally in parallel with the run of the wire material and having one or the inner ends thereof rigidly secured to the motors 22, 32 and 42 (FIG. 1) while the other or outer end portions of the rod members extend rearwardly or outwardly through the rear wall of the machine frame 12 and are pivotally mounted thereon by means of pairs of brackets 24, 34 and 44, respectively, as will be seen in FIG. 4.

At its outer end extremity, the rod member 23 is rigidly connected with an arm 23*a* extending substantially in parallel with the outer surface of the rear wall while the rod member 23 is pivotally mounted on the machine frame adjacent the connection with the arm 23*a* by means of a pair of brackets 24 and a pin 24*a* (FIGS. 1 and 4). The other end of the arm 23*a* is operatively connected with a disc member 25 which is rigidly mounted on a screw member 26 threadably rotatably extending through the rear wall of the machine frame into a nut 27 rigidly mounted on the inner surface of the wall, as will be seen in FIG. 1. The screw 26 has a handle or wheel 28 rigidly mounted on the outer end thereof. It will be appreciated that the wheel 28 may be rotated in either direction to pivotally move the arm 23*a* about the pivot pin 24*a* so that the angular position of the rod member 23 with respect to the axis of the wire material is adjusted whereby the pressure at which the brushing wire wheels are in rubbing contact with the wire material is also adjusted.

The other wire wheel units 30 and 40 are substantially similarly supported by their supporting rod members (not shown) which in turn are pivotally and adjustably mounted on the machine frame by means of pairs of brackets 34 and 44, pivot pins 34*a* and 44*a* and arms 33*a* and 43*a*, as shown in FIG. 4, and adjusting screws (not shown), respectively. It will be appreciated that the rod members for supporting the wire wheel units 30 and 40 are different only in the length or axial dimensions thereof because, as described hereinabove, the three wire wheel units are spaced in the direction of the travel of the wire material W.

Referring now to FIG. 5 of the drawings which is an enlarged fragmentary radial sectional view of the wire wheel 21 of the wire wheel unit 20, the wire wheel 21 comprises a plurality of disc-like members 21*a* to 21*e* assembled substantially in laminated or stacked relationship with each other and a brushing bristle, generally represented by 21*f*, rigidly secured to the outer periphery of the assembly of the disc-like members. The bristle 21*f* is composed of a large number of bundles represented by 21*f*–1 and 21*f*–2 of generally U-shaped wire rods. The wire bundles have their intermediate or base portions of the U extending through axial apertures 21*g*–1 and 21*g*–2 formed in the disc members 21*b* and 21*d* along concentric circles on the disc members adjacent the outer peripheral edges thereof. The wire bundles then extend radially outwardly through the narrow gaps between adjacent pair of the disc members 21*a* to 21*e* beyond the outer peripheral edges thereof. The portions of the wire bundles 21*f*–1 and 21*f*–2 adjacent said intermediate portions of U are firmly held between the adjacent disclike members by means of conventional fastening means such as bolt and nut assemblies or rivets 21*h* which firmly fasten the marginal portions of the disc-like members together while the portions of the wire rods outward of the outer peripheral edges of the disc members extend generally radially outwardly while somewhat diverging axially outwardly and circumferentially of the disc members and terminate in a common peripheral surface 21*i*.

It will be appreciated that, while the disc members 21*b* and 21*d* only are illustrated as being formed with axial apertures 21*g*–1 and 21*g*–2 for the wire bundles, the central disc member 21*c* may also be formed with similar apertures, in which case the apertures in the central disc member 21*c* may conveniently be disposed in circumferentially staggered relationship with the apertures in the disc members 21*b* and 21*d* for the reasons which will be self-explanatory to those skilled in the art.

The disc member assembly 21 has a central throughhole 21*j* for receiving an output shaft 22*a* of the motor 20. The output shaft 22*a* has a flange 22*b* against which the assembly 21 is firmly urged by means of a washer 22*c* and a nut 22*d* which is tightened to urge the washer 22*c* against the disc assembly 21.

After the wire material W has been treated by the wire wheel 21, 31 and 41, the wire material is delivered out of the apparatus through an outlet opening 51

formed in the rear wall of the machine frame for a further treatment such as stretching.

In the above-described and illustrated embodiment of the invention, each wire wheel has a brush-like construction. It is, however, to be understood that any other construction may alternatively be employed.

Lastly, the apparatus **10** is provided adjacent the base thereof with a box or drawer **60** for receiving the scale particles removed off the wire material W. For this purpose, the above-mentioned inner frame member **16** terminates in its bottom end which is positioned above the top of the drawer **60**.

The present invention is remarkably advantageous over the prior art chemical and mechanical descaling methods and apparatuses in that:

a. The method and apparatus of the invention are completely free from the environment sanitation problem caused by the disposal of wasted acids used in chemical descaling processes;

b. The apparatus of the invention may be disposed directly in front of the apparatus for the next treatment, such as a wire stretcher so that the layout of the plant can be simplified;

c. The method and apparatus of the invention provide a highly improved descaling efficiency which provides the finished wire material with a fine surface and presents the tools for working the resultant wire material from becoming damaged in shorter operation;

d. The apparatus may be positioned so as to directly receive the wire material delivered from a hot rolling mill so that the productivity is remarkably increased as compared with a chemical descaling process with which it is required to once displace the hot roller wire material out of the streamline of the successive treatments;

e. The apparatus and method of the invention are entirely free from the problem of hydrogen brittleness as caused by chemical descaling processes;

f. The apparatus may be operated at the linear velocity of the wire material of up to 200 meters per minute;

g. The brushing wire wheels can be so adjusted that they are not of contact with the wire material in the case where the latter is one which has been treated by a chemical process; and

h. The apparatus utilizes a simplified construction so that the apparatus can be economically manufactured.

What is claimed is:

1. An apparatus for removing the scale produced on the peripheral surface of a wire material during the hot rolling thereof, comprising:

at least three brushing wire wheels disposed in angularly spaced relationship with each other for brushing contact with the peripheral surface of the wire material and in spaced relation with each other in the direction of wire advancement;

each of said wire wheels being disposed with its plane of rotation inclined at an angle with respect to the run of the wire material and arranged such that the wire wheel is in contact with the peripheral surface of the wire material substantially at the central point of the width of the common peripheral surface of the wire wheel and that the radius of the wire wheel included in a transverse plane and passing through the point of contact between the wire wheel and the wire material is in alignment with the radius of the wire material passing through said point of contact, said transverse plane extending radially through said point of contact;

electric motors for rotating said wire wheels, each having an output shaft on which one of said wire wheels is rigidly mounted for rotation thereby;

rod members for supporting the respective wire wheels in the above-stated positions, said rod members extending substantially parallel to the run of said wire material, and each of said rod members having an inner end rigidly secured to one of said electric motors in an outer end portion extending through a machine frame of said apparatus, said outer end portion being pivotally mounted on said machine frame and having an arm rigidly connected to the outer end of said outer end portion and extending substantially parallel with said machine frame;

means for adjusting the radial position of said wire wheels with respect to the axis of the wire material to thereby adjust the pressure at which the wire wheels are in brushing contact with the wire material comprising screw members each being threadably mounted on said machine frame and operatively connected to said arm for pivotally moving said arm to thereby adjust the angular position of the corresponding rod member with respect to the run of said wire material;

a plurality of sheaves disposed upstream of said brushing wire wheels and arranged so as to define a meandering path of travel along which the wire material is caused to move, said path of travel being curved in at least two radial directions of said wire material for subjecting the wire material to repeated bending in such directions so that loose scale particles are removed at the point upstream of said brushing wire wheels; and

each of said wire wheels comprising a plurality of disc-like members arranged substantially in laminated relationship with each other, the disc-like members with the exception of the opposite outer ones thereof being formed therein with a plurality of circumferentially spaced axial apertures adjacent the outer peripheral edges thereof, a plurality of substantially U-shaped bundles of wire rods each having its intermediate portion of the U-shape extending through one of said axial apertures, the leg portions of each bundle extending radially outwardly through the gap between each adjacent pair of said disc-like members and beyond the outer peripheral edges thereof and terminating in said common peripheral surface of the wire wheel, means for firmly fastening said disc-like members together so that said wire bundles are firmly held in radially outwardly extending positions between adjacent disc-like members, and a central through-hole formed in the assembly of said disc-like members for receiving the output shaft of one of said electric motors.

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