July 27, 1965 A. P. JOHNSTON 3,196,656

WIRE CONDITIONING APPARATUS

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Fig. 4

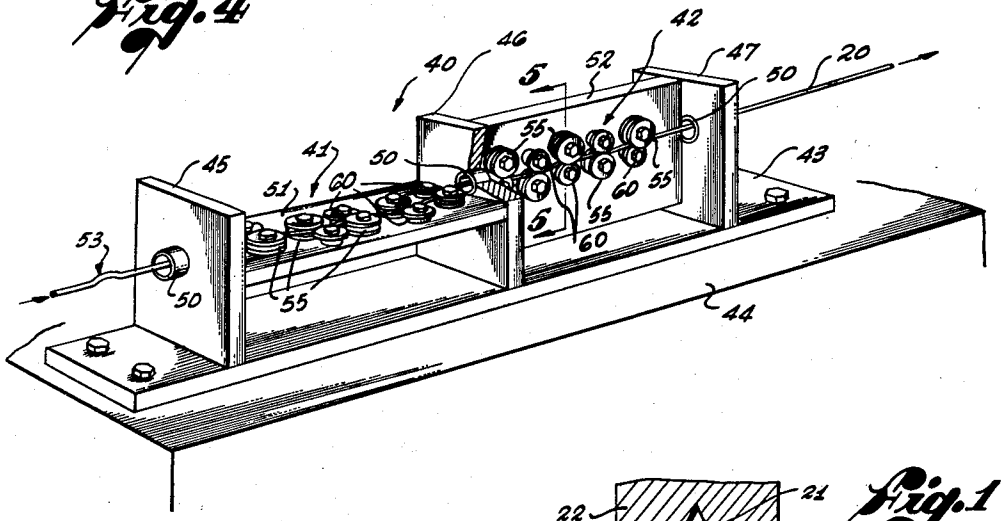


Fig. 1

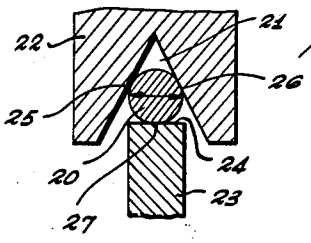


Fig. 5

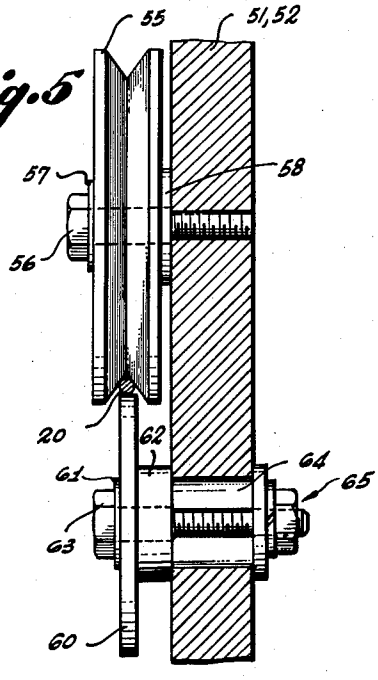


Fig. 2

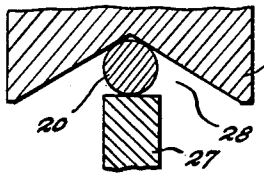
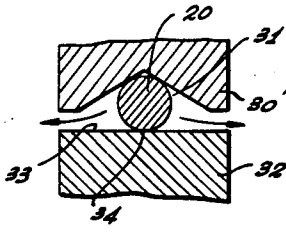


Fig. 3



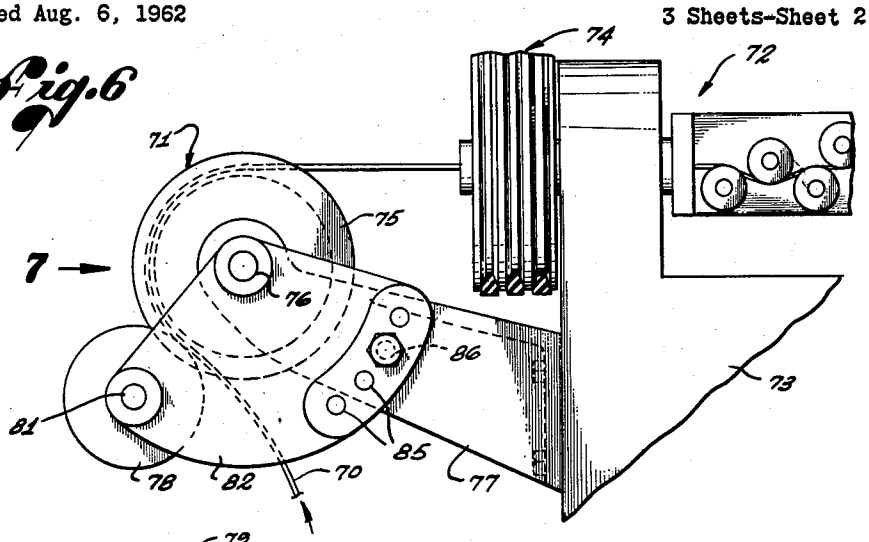
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WIRE CONDITIONING APPARATUS

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Fig. 6



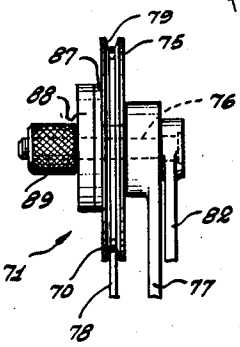
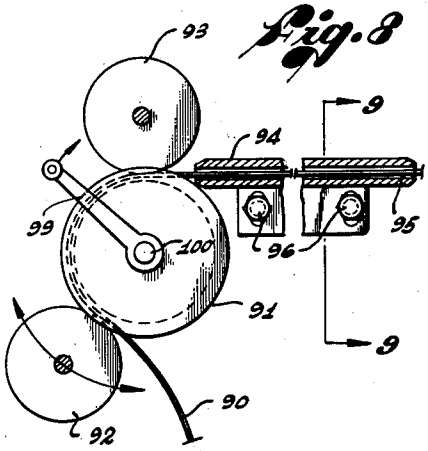


Fig. 7

Fig. 8



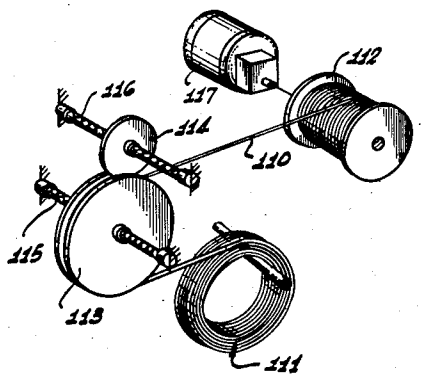
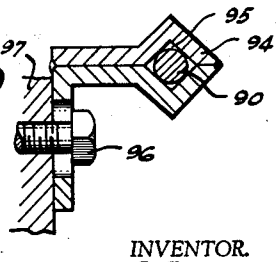


Fig. 10

Fig. 9



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WIRE CONDITIONING APPARATUS

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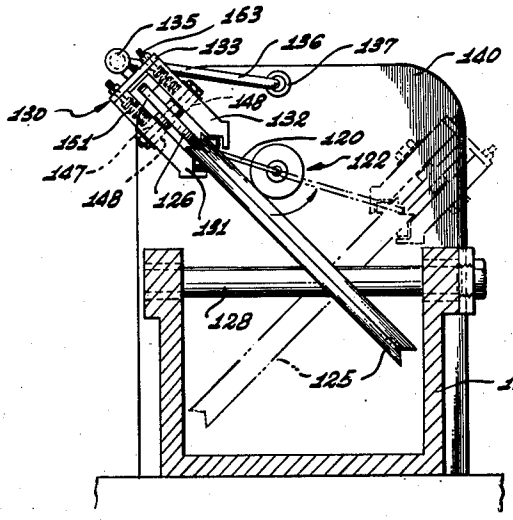


Fig. 11

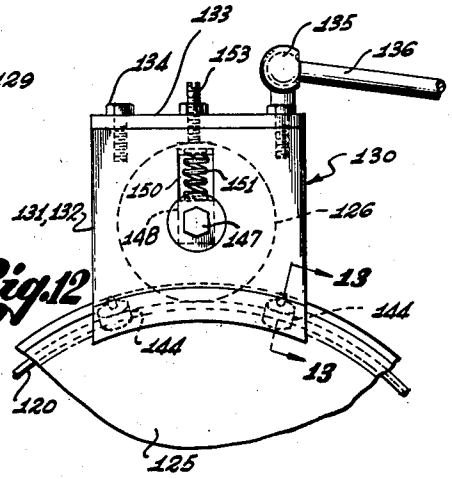


Fig. 12

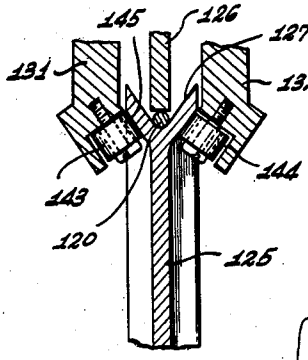
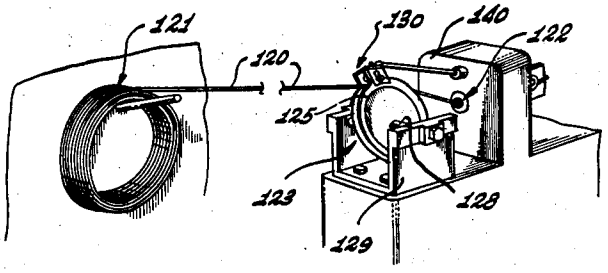


Fig. 13

Fig. 14



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United States Patent Office

3,196,656
Patented July 27, 1965

3,196,656

WIRE CONDITIONING APPARATUS

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Filed Aug. 6, 1962, Ser. No. 214,878
17 Claims. (Cl. 72—162)

This invention relates generally to devices for conditioning round or near-round wire and tubing for a variety of subsequent uses, and more particularly to novel apparatus adaptable to serve any of a multiplicity of wire conditioning functions including wire guiding, straightening, tensioning, and/or the prevention of twist. In this regard, the term "wire," wherever employed throughout the specification and claims, is deemed to include any round or near-round cylindrical body.

In the past, a number of problems have been encountered in connection with the design and use of conventional wire processing apparatus, especially in the fields of wire straightening and guiding, and wherever high speed operation is desired for processes requiring frequent interruption of wire travel.

In many wire straightening situations, i.e., as in the manufacture of nails or coat hangers, the wire straightening apparatus must be capable of high speed wire discharge, for practical processing volume output, yet must also be capable of frequent stopping and starting for intermediate processing, such as the heading of nails, with minimum delay and without deforming the wire. Unfortunately, the wire straightening apparatus heretofore available, and especially those of the rotary type, have generally proven to be too cumbersome and heavy for such straightening applications at high speeds. In this regard, such heavy straighteners possess too high a moment of inertia to enable acceleration to and deceleration from such high operating speeds in the extremely short interruption time intervals permitted.

Various attempts have been made to improve the rapid stopping capabilities of straighteners having high moments of inertia by means of improved braking expedients. However, such breaking expedients, while successful to some degree in rapidly stopping the straightening apparatus, have generally resulted in deformation of the wire passing through the apparatus, as well as shortened over-all equipment life. Hence, the use of high moment of inertia straightening machines carries with it the requirement of low speed operation and the consequence of reduced wire processing output.

The relatively few low moment of inertia wire straightening devices heretofore available have generally fallen into disuse for a number of reasons, particularly the inability to provide the same quality of straightening as the larger straightening machines, especially with wire having sharp kinks or bends.

Another difficulty encountered with conventional wire straighteners has been the inability to prevent "roll over" or rotation of the wire about its own cylindrical axis during the straightening process. Such lack of rotational restraint not only reduces the efficiency of the straightening process, but the rotation of the wire may also be transmitted back to the wire supply source. The attendant buildup of twist may result in dangerous "wire throw" or whipping, knotting and sufficient binding to eventually stop the flow of wire to the straightening apparatus. The latter conditions not only present a hazard to operating personnel, but may also result in time-consuming and costly shut-downs.

In contrast to the aforedescribed wire straightening requirements, some wire guiding situations, as where limed or annealed wire must be directed from a non-rotating coil supply to a draw die or like device, call for a complete absence of rotational restraint by the wire guiding system to prevent the build-up of twist and enable uniform uncoiling of the wire being guided. Moreover, the rotation of the wire in such situations is desirable both from the point of view of more uniform draw die wear, as well as the even distribution of an appropriate lubricating compound over the wire prior to its entering the draw die.

However, in the past, wire conditioning expedients which were useful for wire straightening were not also useful for wire guiding and vice versa. This is particularly true in some precision coil-winding procedures where it is desirable to accomplish a combination of single plane straightening, for wire issuing from a coil supply, while simultaneously imparting a fixed "cast" or curvature in another plane and guiding the wire to successive coil positions upon a winding spool. This type of wire winding is particularly useful in preparing welding rod supply reels.

Additional difficulties encountered with the various wire conditioning expedients have included the complexity and cost of manufacture of the mechanisms, the difficulty of adjustment by unskilled or semi-skilled labor, the inability of many straighteners to handle short lengths of wire, as well as the inability of many wire guiding expedients to prevent "jumping" or sidewise slippage of sharply kinked wire out of the intended wire flow path.

Accordingly, it is an object of the present invention to provide new and improved wire-conditioning apparatus overcoming the above and other disadvantages of the prior art.

Another object is to provide a wire-conditioning expedient adapted for improved wire straightening and/or wire guiding functions.

A further object of the invention is the provision of simplified wire conditioning apparatus which eliminates the susceptibility of the wire to sidewise slippage or jumping out of the intended wire flow path.

Still another object is to provide a new and improved apparatus for preventing the transmission of twist between a wire straightening apparatus and a wire supply source.

Yet another object of the present invention is the provision of a new and improved wire conditioning expedient for restraining wire against rotation about its own cylindrical axis and/or introducing controlled tensioning of the wire during wire travel.

A still further object of the invention is to provide a novel wire guiding arrangement which imposes no rotational restraint upon the wire being guided and improves the uniformity with which the wire uncoils from a non-rotating coil supply.

Another object is the provision of an improved wire conditioning means, characterized by simplicity of structural arrangement, ease of adjustment, and low moment of inertia.

Still another object of the invention is the provision of a new and improved wire conditioning apparatus for straightening wire in one plane while simultaneously imparting a controlled cast to the wire in another plane during a precision wire winding procedure.

The above and other objects and advantages of this invention will be better understood by reference to the following detailed description when considered in con-

nection with the accompanying drawings of illustrative embodiments thereof, wherein:

FIGURES 1 and 2 illustrate two embodiments of groove roll and edge roll wire conditioning apparatus in accordance with the present invention;

FIGURE 3 illustrates a groove roll and edge roll combination which differs in edge roll design from that of the present invention, and serves to illustrate the manner in which sidewise slippage of the wire is avoided by the embodiments shown in FIGURES 1 and 2;

FIGURE 4 is a perspective view illustrating one embodiment of a dual plane wire straightening apparatus embodying the groove and edge roll wire conditioning expedients of the present invention;

FIGURE 5 is a sectional view, taken along the line 5—5 of FIGURE 4, and illustrates one manner in which the groove and edge rolls may be mounted for relative spacial adjustment therebetween;

FIGURE 6 is an elevational view of a wire anti-twist and tensioning arrangement adapted to prevent the transmission of wire rotation between a rotary-type wire straightener and a wire supply source;

FIGURE 7 is a partial elevational view, taken substantially in the direction 7 of FIGURE 6, and illustrates the structural details of a drag clutch arrangement for the apparatus of FIGURE 6;

FIGURE 8 is an elevational view, partially in section, of a simplified wire straightening apparatus employing the groove and edge roll conditioning expedients of the present invention;

FIGURE 9 is a sectional view, taken along the line 9—9 of FIGURE 8, and shows the structure of a straightening tube for use with the straightening apparatus of FIGURE 8;

FIGURE 10 is a perspective view of a precision wire winding apparatus employing the groove and edge roll expedients of the present invention for accomplishing single plane straightening and the introduction of controlled cast for the wire being processed;

FIGURE 11 is an elevational view, partially in section, of a wire guiding apparatus using a modified form of the groove and edge roll expedients of the present invention, for providing uniform uncoiling of wire from a non-rotated coil supply in directing the wire to a draw die;

FIGURE 12 is a partial right-side elevational view of the carriage mechanism for mounting the edge roll in the apparatus of FIGURE 11;

FIGURE 13 is a sectional view, taken along the line 13—13 of FIGURE 12, and illustrates the manner in which the edge roll carriage is constrained to ride along the outer periphery of the groove roll; and

FIGURE 14 is a perspective view of the wire guiding apparatus of FIGURES 11–13 and illustrates the manner in which the wire is received from a coil supply.

Referring now to the drawings, and particularly to FIGURE 1 thereof, there is shown one embodiment of a novel device, in accordance with the present invention, for conditioning a wire 20. The embodiment of FIGURE 1 is particularly well adapted for such wire conditioning functions as straightening, tensioning, and the prevention of rotation of the wire 20 about its own cylindrical axis.

The wire 20 is pressed, during its longitudinal travel, within a triangular peripheral groove 21 upon the circumference of a rotatable sheave or groove roll 22. The wire is maintained within the groove 21 due to the pressure exerted upon it by a rotatable edge roll 23. The edge roll 23 has a wire contacting face 24 of less width than the maximum width of the groove 21 at the outermost periphery of the groove roll 22, so that the edge roll can extend into the groove.

The groove roll 22 and edge roll 23 may be fabricated of any appropriate structural material, such as steel or the like, so long as the tendency of the rolls to deform under pressure is less than that of the material constituting the wire 20 being conditioned. Moreover, the contact pressure between the edge roll 23 and the wire 20 in the groove 21 may be supplied by any suitable adjustment means well known in the art, such as spring mounting or the like.

As shown in FIGURE 1, the wire 20 is contacted at three discrete points in passing through a single groove roll and edge roll combination and the wire cannot bottom in the groove. For example, the wire 20 is contacted by the walls forming the groove 21 at points 25 and 26, and the wire is also contacted by the edge roll surface 24 at the point 27. Because of this contact at the points 25, 26, the arrangement of FIGURE 1 tends to remove bends, kinks, or other irregularities of the wire 20 in planes extending crosswise of the groove 21, as generally indicated by the doubleheaded arrow. Hence, the groove roll and edge roll arrangement of FIGURE 1 provides an effective single plane straightening expedient for conditioning wire.

With sufficient pressure between the contacting surface 24 of the edge roll 23 and the wire 20, irregularities in the plane passing through the center of the groove 21 and the edge roll are also reduced, the extent of straightening in this plane being controlled somewhat by the distance between the surface of the wire 20 and the apex of the groove.

In this connection, FIGURE 2 shows a wire 20 maintained by an edge roll 27 within the groove 28 of a groove roll 29. It will be apparent from a comparison of FIGURES 1 and 2, that the groove 28 in FIGURE 2 is shallower and has a greater groove angle than the groove 21 of FIGURE 1. In this regard, the arrangement of FIGURE 1 is more suitable for removing irregularities of the wire 20 in the plane crosswise of the groove, whereas the arrangement of FIGURE 2 is less effective than that of FIGURE 1 for this purpose but is more effective in straightening irregularities in the plane through the center of the groove.

The angle of the groove in the groove roll is chosen, in accordance with the structural characteristics of the wire being conditioned, to avoid objectionable wedging or squashing of the wire, yet of such an angle as to cause adequate forming of the wire without too great a pressure by the edge roll. In this regard, the deep, acute angle groove 21 of FIGURE 1 would be more prone to wedging of the wire in the groove than the groove 28 of FIGURE 2 which would be less prone to wedging but more prone to squashing of the wire. Hence, the groove angle is selected so as to provide adequate forming for the straightening process, but without deformation of the cross-sectional configuration of the wire.

It will be noted in FIGURE 1 that the edge roll 23 extends into its respective groove 21, so that it contacts the wire 20 at points inward of the outer peripheral edges of the groove roll. This is often important, as will be apparent from an examination of FIGURE 3.

FIGURE 3 shows a wire 20 in a groove 31 of a sheave 30, the wire being maintained in the groove by an edge roll 32. However, the edge roll 32 in FIGURE 3 has a wire contacting surface 33 of greater width than the widest portion of the groove 31 and, therefore, contacts the wire 20 at a point 34 which is beyond the outer peripheral edges of the sheave 30. Hence, there is a tendency for the wire 20 to "jump" or experience sidewise slippage out of the groove 31 (in the directions indicated by the arrows) whenever wire irregularities in the plane crosswise of the groove pass between the rolls. In contrast, since the edge roll 23 of FIGURE 1 extends inboard of the outer peripheral edges of the groove roll 22, the wire 20 is effectively restrained against such "jumping" or sidewise slippage.

As previously indicated, a major problem encountered in straightening apparatus has been the difficulty in preventing "roll over" or rotation of the wire about its own cylindrical axis when forces are applied to straighten the

wire. In this regard, the three-point contact configurations of FIGURES 1 and 2 effectively restrain the wire **20** against such rotation so long as the wire does not bottom in the groove. Hence, the arrangements of FIGURES 1 and 2 are not only effective single plane straightening expedients, but also provide simple means for the prevention of "roll over" and wire twist. This prevention of "roll over" further enhances the efficiency of the wire straightening accomplished by the edge roll and groove roll combination. Again, however, it is essential for such anti-rotational applications that the shape of the groove be such that the wire will not bottom in the groove.

FIGURE 4 shows one embodiment of a complete wire straightening apparatus using a plurality of groove roll and edge roll arrangements of the type shown in FIGURES 1 and 2.

Basically, the straightening apparatus **40** of FIGURE 4 comprises two mutually perpendicular banks **41, 42** of groove rolls and edge rolls through which the wire **20** is passed for the removal of irregularities. The groove rolls and edge rolls of each bank are coplanar. The first bank of rolls **41** removes all irregularities of the wire in a first plane, and the subsequent bank of rolls **42** removes all wire irregularities in a second plane perpendicular to the first plane. This arrangement for removing just the wire irregularities existing in a pair of mutually perpendicular planes serves to effectively remove all irregularities, regardless of their orientation with respect to any one of the two straightening planes. The reason for this latter result is that any irregularity can be completely resolved into two mutually perpendicular components, one component extending in each of the straightening planes. Removal of all such component irregularities in the two mutually perpendicular planes effectively removes the entire irregularity.

The straightening apparatus **40** comprises a baseplate **43** secured in any appropriate manner to a desirable working surface **44**. The baseplate **43** carries three upstanding flange members **45–47** spaced at uniform intervals along its length. Each of the flanges **45–47** embodies a suitable guideway or passage **50** so that the wire **20** may pass therethrough. In this connection, all of the passages **50** have a common central axis representing the mean flow path of the wire **20** as it passes through the straightening apparatus. The first bank of rolls **41** is positioned, as shown, upon a horizontal plate **51** supported between the upstanding flanges **45, 46**. The second bank of rolls **42** is mounted upon a vertical plate **52** supported between the flanges **46, 47**.

It will be noted in FIGURE 4 for each of the banks of rolls **41** and **42**, that the groove and edge roll combinations are spaced so that the contact points with the wire **20**, proceeding from one groove roll-edge roll combination to another in the same bank, are further from the mean flow path of the wire near the entrance to the bank than at the exit from the bank. This arrangement causes the wire to undulate or oscillate about the mean flow path in passing through the straightening apparatus **40**, and thereby destroys the bending memory of the wire molecular structure. Essentially, therefore, the path of the wire **20** through each of the roll banks **41, 42** is that of an oscillatory pattern with diminishing amplitude, or a damped sinusoidal wave, about the mean flow path as an axis. In this regard, the maximum amplitude of the oscillatory pattern decreases to values which avoid exceeding the elastic limit of the wire being proceessed.

Hence, the apparatus **40** of FIGURE 4 enables a wire **20** to enter with any number of kinks, bends, or other irregularities, such as the bend **53**, and to exit from the apparatus completely straight and with no tendency to return it to its previous state by virtue of wire molecular memory.

FIGURE 5 illustrates a typical groove roll and edge roll arrangement which may be used in either of the roll banks **41, 42** of FIGURE 4. The groove roll **55** may be secured to the mounting plate **51** or **52** by any well known means, as by a mounting bolt **56** in threaded engagement with the mounting plate. The groove roll is held between a pair of collar members or washers **57, 58** and is adapted for rotation about the shaft of the bolt **56**, the degree of drag upon such rotation being dependent upon the pressure exerted by tightening of the mounting bolt.

Similarly, the edge roll **60** is supported between a washer **61** and collar member **62** for rotation about the shaft of a mounting bolt **63**. The shaft of the mounting bolt **63** extends through an elongated slot **64** in the mounting plate **51** or **52**, and terminates in a conventional nut and washer fastening arrangement **65** on the opposite side of the mounting plate. Hence, the position and contact pressure of the edge roll **60** against the wire **20** positioned within the groove of the groove roll **55** may be readily adjusted by altering the position of the mounting bolt **63** along the adjustment slot **64**.

It will be apparent that, in processing the wire **20** through the apparatus **40** of FIGURES 4 and 5, the only rotating members are the edge and groove rolls in the banks **41** and **42**. Each of these edge and groove rolls is a relatively light element, rotating about a relatively short radius of gyration, so that the moment of inertia of the entire system is very low. In this regard, the straightening apparatus **40** is particularly well adapted for high speed, interrupted wire travel operation since starting and stopping of the apparatus is rapidly accomplished without deforming the wire **20**. A typical application for such a straightening apparatus is in the manufacture of nails embodying "cold heading" procedures.

FIGURE 6 shown another embodiment of the invention using the groove roll and edge roll wire conditioning expedient of FIGURES 1 and 2. The arrangement of amount of tension between the wire supply and subsequent FIGURE 6 facilitates the introduction of a controlled straightening apparatus, i.e., of the rotary type, and simultaneously restrains the wire against "roll over" and twist build-up.

As will be apparent from FIGURE 6, a wire **70** is directed from a coil or other supply (not shown) to a wire conditioning station **71**, and thereafter to a rotary straightener **72**. The rotary straightener **72** is of the conventional type, well known in the art, and is supported in a bearing block **73** for rotation by a pulley wheel drive arrangement **74**.

As will be apparent from FIGURES 6 and 7, the wire conditioning station **71** includes a novel edge roll and groove roll arrangement, in accordance with the invention, and wherein the angular orientation of the edge roll with respect to the circumference of the groove roll is adjustable. The reason for this angular adjustability between the groove roll and the edge roll is the fact that the twist resistance of the wire **70** increases not only with the pressure of the edge roll upon the wire **70**, but also with the length of wrapping of the wire around the groove roll. Since it was previously pointed out that the amount of pressure which can be safely exerted by the edge roll upon the wire **70** is limited by the tendency of the wire to squash or wedge in the groove of the groove roll, variation of the length of wrapping around the groove roll provides a more versatile expedient for adjusting the twist resistance of the wire.

The wire conditioning apparatus of FIGURES 6 and 7 includes a groove roll **75** mounted for rotation about a shaft **76** which is supported in a projecting arm **77** carried by the bearing block **73**. An edge roll **78** abuts the wire **70** seated within the groove **79** of the groove roll **75**. This edge roll **78** is mounted for rotation about a shaft **81** carried by a supporting collar **82**. The collar **82** is, in turn, journaled for rotation about the same shaft **76** as the groove roll **75**. The end of the adjusting collar **82** remote from the shafts **81** and **76** carries a plurality of apertures **85**, any one of which may be aligned in registry with an aperture **86** in the projecting arm **77**. By so aligning one

of the apertures 85 with the aperture 86, and bolting the adjusting collar 82 to the projecting arm 77 through these apertures, the angular position of the edge roll 78 with respect to the groove roll 75 is established. Hence, the adjusting collar 82 affords a means of selectively contacting the wire 70 at a number of points along the periphery of the groove roll 75, and thereby provides an effective means for varying the length of wrapping of the wire 70 about the groove roll.

The arrangement of FIGURES 6 and 7 is also useful in imparting a controlled amount of tension to the wire 70 for subsequent processes. In this regard, the tension of the wire 70 depends upon the pressure exerted upon it in the groove, the length of wrapping around the groove roll, and the frictional resistance to rotation of the groove roll 75 about the shaft 76. Insofar as the latter is concerned, FIGURE 7 illustrates one manner in which the frictional drag upon the groove roll 75 may be varied. To this end, the groove roll 75 carries a drag clutch arrangement including a friction plate 87 adapted to engage a second friction plate 88. The pressure between the plates 87 and 88 is controlled by an adjustment nut 89 in threaded engagement with one end of the shaft 76.

FIGURE 8 illustrates a modified version of the apparatus of FIGURE 6 to provide a very simple, yet highly efficient, hand-operated straightening device.

In the arrangement of FIGURE 8, a wire 90 is fed around a groove roll 91. The wire 90 is initially engaged by an edge roll 92, the angular position of which may be adjustable in the same manner as the edge roll 78 of FIGURE 6. However, a second edge roll 93 also engages the wire 70 at a second point along the periphery of the groove roll 91. The addition of the second edge roll 93 further reduces the tendency of the wire 90 to rotate about its own cylindrical axis or, alternatively, may be used to maintain the same rotational resistance with lower contacting pressures between the wire and the rolls. The latter approach is especially useful where soft, easily deformed wire is being processed.

It will be apparent that single plane straightening is accomplished by the arrangement of FIGURE 8 at each of the high resistance points of contact between the edge rolls 92, 93 and the wire 90 wrapped around the groove roll 91. As the wire 90 exits from the point of contact between the edge roll 93 and the groove roll 91, it enters an elongated tube 94 having a central longitudinal orifice or aperture 95 extending its full length. The aperture 95 is sized to provide a reasonably snug fit about the wire 90 and thereby effects removal of those wire irregularities not previously removed by the single plane straightening action of the groove and edge rolls 91–93. The elongated straightening tube 94 may be mounted by any appropriate means 96 upon a suitable supporting surface 97.

Wire travel through the apparatus of FIGURE 8 may be accomplished by directly driving the groove roll 91. This may be readily accomplished by securing a handle 99 to the shaft 100 about which the groove roll 91 rotates. In this manner, the simplified straightening apparatus of FIGURE 8 may be hand operated. In the alternative, of course, a motorized drive may be employed for rotating the groove roll 91.

The arrangement of FIGURE 10 illustrates a groove roll and edge roll combination, in accordance with the present invention, for a precision wire winding procedure wherein wire 110 from a supply coil 111 is wound upon a spool 112.

A groove roll 113 and an edge roll 114, of the type shown in FIGURES 1 and 2, are supported for rotation about the fixed shafts 115 and 116, respectively. The wire 110 is directed from the supply coil 111, around the groove roll 113, and thereafter to the supply spool 112. The wire 110 is held within the groove of the groove roll 113 by the contact pressure of the edge roll 114.

The groove and edge roll combination 113, 114 accomplish single plane straightening in a direction extending crosswise of the groove. Simultaneously with the straightening of the wire 110, a controlled curvature or "cast" is introduced into the wire to facilitate subsequent winding upon the spool 112. The desired degree of cast may be controlled by selecting the diameter of the groove roll 113.

In precision winding procedures, i.e., such as those used to prepare welding rod supply reels, each successive coil, proceeding from one side of the spool to the other side, must be devoid of sidewise wire irregularities and must precisely abut adjacent winding coils in the same winding layer. The elimination of such sidewise irregularities is readily accomplished by the rolls 113, 114 due to the single plane straightening action previously described.

It will be apparent from FIGURE 10 that the plane through the center of the rolls 113, 114 must be moved from side to side along the shafts 115, 116, in order to guide the wire 110 for proper winding upon the spool 112 in proceeding from one side of the spool to the other side of the spool. This may be accomplished by a number of mechanisms, well known in the art. By way of example, the shafts 115, 116 are both provided with endless loop grooves in which the rolls 113, 114, respectively, ride by means of pins (not shown) in an arrangement similar to that conventionally employed in fishing reels and like apparatus.

Alternatively, the endless loop groove may be provided only upon one or the other of the shafts 115, 116 so as to guide only one of the rolls 113, 114. In such an instance, the roll which rides upon a non-grooved shaft would follow the sideways movement of the guided roll by virtue of the engagement between the two rolls. Moreover, the winding sequence may be controlled at or near the spool 112, in which case the groove and edge rolls 113, 114 would move sideways in accordance with the changing direction of pull of the wire 110 as it is wound upon the spool.

As shown in FIGURE 10, the winding spool 112 is rotatably driven by a motor 117. However, if desired, the groove roll 113 may also be powered to reduce tension in the issuing wire directed to the spool 112.

Referring now particularly to FIGURES 11–14, there is shown another embodiment of the groove and edge roll expedient of the present invention, for enabling uniform uncoiling of wire from a non-rotated coil supply and directing such wire to a draw die or other processing apparatus.

The wire 120 uncoils from a non-rotated supply coil 121 which may be hung from an arm or hook or merely situated upon a horizontal supporting surface. The wire 120 is non-regular, angularly bent wire, such as limed or annealed wire preparatory to drawing. It is important, in directing such wire to a draw die 122, that the wire be guided to the draw die with minimum rotational restraint, to avoid build-up of twist in the entering wire. The turning of the wire 120 as it enters the draw die 122 is considered advantageous since the continuously varying approach of the rotating wire to the draw die improves the pick-up of an appropriate lubricating compound (not shown) with reduced channeling within the compound. Moreover, such wire rotation also improves the uniformity of wear of the draw die opening, since wire entry is essentially uniformly distributed about all directions of entry to the die. Essentially, these ends are accomplished by directing the wire 120 from the uncoiling supply 121 to an eccentrically mounted edge roll and groove roll guiding arrangement at a conditioning station 123.

As will be apparent from FIGURE 13, the primary distinction between the groove roll 125 and edge roll 126 and the embodiments of the invention shown in FIGURES 1 and 2 resides in the shape of the groove 127 of the groove roll. In this regard, the shape of the lower portion of the groove 127 closely conforms to the round cross section of the wire 120, so that the wire bottoms in the groove and rotational restraint upon the wire is minimal. How-

ever, it will be noted that the edge roll **126** extends deep within the groove **127**, beyond the outer peripheral ends thereof, to prevent jumping or sidewire slippage of the wire **120** within the groove. In this regard, the arrangement of FIGURES 11–14 is similar to the wire conditioning expedients of the present invention previously described.

The contact pressure between the edge roll **126** and the wire **120** in the groove **127** is reduced to a level satisfying the minimum requirements for preventing the wire **120** from jumping the groove. By virtue of the rolling contact between the wire **120** and the walls forming the groove **127** in the groove roll, as well as the minimal contact pressure of the edge roll **126** against the wire, resistance to wire roll-over is minimized. This is in contrast to the use of the edge roll and groove roll combination for wire straightening purposes where it is desired to prevent roll-over.

As best observed in FIGURES 11 and 14, the groove roll **125** is mounted for rotation about a shaft **128** appropriately supported within a frame or bearing block **129**. The groove roll **125** is eccentrically mounted with respect to its center and is pierced by the shaft **128** in a manner such that the plane through the center of the groove roll intersects the shaft at an angle other than **90** degrees.

The edge roll **126** is supported in a carriage arrangement **130** adjacent the groove roll **125** so that the edge roll is maintained in contacting engagement with the wire **120** in the groove **127** and follows the upper end of the outer periphery of the groove roll. This is accomplished by mounting the edge roll **126** in the carriage **130** such that the carriage is secured to the peripheral edges of the groove roll **125**, and follows along therewith, while simultaneously spring-biasing the edge roll into the groove **127**.

In this regard, the carriage arrangement **130** includes a pair of side members **131**, **132** which are maintained in spaced relationship by top plate **133** affixed by any appropriate means **134** to each of the side members. The top plate **133** also carries at its end nearest the draw die **122**, a ball and socket device **135**. A rod **136** is swivelly secured at one end to the ball and socket **135**, and is swivelly secured at the opposite end to a second ball and socket **137** carried by a fixed vertical member **140**. The member **140** also supports the draw die **122**.

The lower ends of each of the side members **131**, **132** carry resilient rollers **143**, **144** which abut the outer flared flange surfaces **145** of the groove roll **125**, and are thereby constrained for movement therealong.

The edge roll **126** is supported for rotation about a shaft **147**. The shaft **147** is, in turn, supported at its ends within a pair of rectangular blocks **148** positioned within and slidingly engaging a pair of elongated vertical slots **150** within each of the members **131**, **132**. The blocks **148** are biased to the lowermost positions within the slots **150** by a pair of springs **151**, one for each of the slots **150**. Each spring **151** abuts a shaft carrying block **148** at one end and an adjustment screw **153** at the other end. The adjustment screw **153** extends through the top plate **133** and may be used to control the contact pressure between the edge roll **126** and the wire **120** in the groove **127**.

The operation of the wire guiding arrangement will be most apparent from FIGURES 11 and 14. As the wire **120** uncoils from the supply coil **121**, the position of the wire shifts from the top of the coil to the bottom of the coil. To accommodate this shifting wire position, rotation of the groove roll **125** about the shaft **128** causes a change in vertical level of the uppermost outer peripheral end of the groove roll, as will be apparent from the phantom position shown in FIGURE 11. Moreover, the carriage arrangement **130** follows along the flange surfaces **145** of the groove roll so that the edge roll **126** effectively constrains the wire **120** to the groove **127** as the position of the groove roll **125** is altered. The effect of the oscillating arrangement of FIGURES 11–14 is to guide the wire **120** to the draw die **122** with minimal restraint imposed upon the natural uncoiling action of the wire and rotation about its own cylindrical axis. As previously indicated, such an arrangement prevents the build-up of twist in the wire **120** while simultaneously improving wire lubrication and draw die wear characteristics.

The groove roll and edge roll wire conditioning arrangements of the type herein described satisfy a long-existing need in the wire processing field for simplified, low-cost, easily adjusted, wire conditioning devices possessing sufficient versatility to effectively serve a number of wire conditioning functions including wire guiding, straightening, tensioning, and the control of wire rotation.

It will be apparent from the foregoing that, while particular forms of my invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of my invention. Accordingly, I do not intend that my invention be limited, except as by the appended claims.

I claim:

1. A wire conditioning device comprising:

at least one circular groove roll adapted for rotation about a selected axis, said groove roll having an outer peripheral triangular groove extending about the full circumference of said groove roll and adapted to receive a wire to be conditioned;

and a circular, rotatable edge roll for each groove roll, said edge roll having an end face for contacting the wire within said triangular groove, the width of said end face being less than the maximum width of said groove, said edge roll extending into said groove, whereby said end face will contact wire within said groove only at points inward of the outer peripheral edges of said groove roll.

2. In an apparatus for conditioning wire, the combination comprising:

a pair of coplanar conditioning rolls, one of said rolls having an outer peripheral triangular groove, the other of said rolls having an outer end extending into said groove, whereby wire being conditioned is maintained within said groove by contact pressure applied to the wire by said other of said rolls and said wire will not bottom in said groove.

3. An arrangement for conditioning wire comprising:

a first rotatable roll having end surfaces defining a triangular peripheral groove extending about the circumference of said roll;

and a second rotatable roll, coplanar with said first roll, said second roll having an end face width which is less than the maximum width of the groove in said first roll, said second roll extending into the groove of said first roll, whereby the end face of said second roll will contact wire within the triangular groove of said first roll at points inward of the outermost peripheral edges of said first roll.

4. A wire conditioning arrangement as set forth in claim **3** wherein the included angle at the apex of the triangular groove in said first roll is less than 90 degrees.

5. A wire conditioning arrangement as set forth in claim **3** wherein the included angle at the apex of the triangular groove in said first roll is at least 90 degrees.

6. In a wire straightening apparatus, the combination comprising:

a first bank of coplanar rolls;

a second bank of rolls lying in a plane which is perpendicular to the plane of said first bank of rolls;

each of said banks including at least one groove roll having an outer peripheral triangular groove about its circumference;

and an edge roll for each groove roll, each edge roll extending into the triangular groove of its respective groove roll.

7. Apparatus for straightening wire comprising:
a first bank of rolls lying in a first plane;
a second bank of rolls lying in a second plane perpendicular to said first plane;
each of said banks including a plurality of groove rolls and an edge roll adjacent each of said groove rolls, each groove roll having a peripheral end surface defining a triangular groove extending about the circumference of the groove roll, and each edge roll having a wire contacting end surface of less width than the maximum width of its respective groove roll.

8. A wire straightening apparatus comprising:
a first bank of rolls lying in a first plane;
and a second bank of rolls lying in a second plane, said second plane being perpendicular to said first plane;
each of said banks including a plurality of groove rolls and an edge roll for each of said groove rolls, each groove roll having end surfaces defining a triangular peripheral groove extending about the circumference of the groove roll, each edge roll having an end face width which is less than the maximum width of the groove in its respective groove roll, each edge roll extending into the groove of its respective groove roll such that the end face of the edge roll will contact wire within the groove of the groove roll only at points inward of the outermost peripheral edges of the groove roll, the groove rolls and edge rolls of each of said banks being positioned such that wire passing through each bank follows a path within the plane of each bank such that the wire oscillates with diminishing amplitude about the mean flow path of the wire.

9. In a wire straightening apparatus, the combination comprising:
a plurality of groove rolls and edge rolls arranged in successive pairs within a first plane, each pair including a groove roll and an edge roll, the groove roll within each of said pairs having a triangular peripheral groove extending about its circumference, and the edge roll within each of said pairs extending into the groove of its respective groove roll to contact a wire seated therein;
a plurality of similarly oriented groove rolls and edge rolls lying in a second plane perpendicular to said first plane;
the groove rolls and edge rolls being oriented within each of said planes such that the locus of wire being straightened within each plane is a damped oscillatory pattern about the mean path of the wire;
and means for varying the contact pressure between the wire and each of the edge rolls.

10. An apparatus for straightening wire comprising:
first means for straightening wire in a first plane;
and second means for straightening wire in a second plane;
each of said first and second means including at least one pair of wire conditioning rolls, each such pair of rolls including a groove roll and an edge roll extending into a triangular groove of said groove roll.

11. An apparatus for controlling tension and twist build-up in wire comprising:
a rotatable groove roll having end surfaces defining a triangular peripheral groove extending about the full circumference of said groove roll;
a rotatable edge roll, lying in the same plane as said groove roll, said edge roll having an end face width which is less than the maximum width of the groove in said groove roll, said edge roll extending into the groove of said groove roll;
and means for adjusting the angular orientation of said edge roll with respect to the circumference of said groove roll, whereby the length of wrapping of a wire about said groove roll may be selectively controlled.

12. Apparatus as set forth in claim 11 including means for imposing a frictional drag which resists the rotation of one of said rolls.

13. A wire straightening apparatus comprising:
a rotatable groove roll having a triangular peripheral groove extending about the full circumference of said groove roll;
at least one edge roll, coplanar with said groove roll, each edge roll having an end face width which is less than the maximum width of the groove in said groove roll, each edge roll extending into the groove of said groove roll, at least one edge roll being adjustable as to angular orientation about the circumference of said groove roll;
and a tube for receiving wire issuing from said groove and edge rolls, said tube having a longitudinal orifice for removing irregularities still remaining in the wire issuing from said groove and edge rolls.

14. Apparatus for conditioning wire for precision winding upon a spool comprising:
a groove roll having a triangular peripheral groove and adapted to rotate about a first axis; and
an edge roll, coplanar with said groove roll and adapted to rotate about a second axis, said edge roll having an end face width which is less than the maximum width of the triangular groove in said groove roll, said edge roll extending into the groove of said groove roll;
and means for causing said groove roll and said edge roll to move laterally along said first and second axes, respectively, in synchronism with the winding of wire passing between said rolls upon a spool.

15. An arrangement for guiding wire from a non-rotating coil supply to a processing station comprising:
a groove roll mounted for rotation about an eccentric axis intersecting the plane of said groove roll at an angle other than a right angle, said groove roll having end surfaces defining a peripheral groove extending about the full circumferenec of said groove roll;
an edge roll, coplanar with said groove roll and adapted to rotate about an axis which is always perpendicular to the plane of said groove roll, said edge roll having an end surface which is less than the maximum width of the groove in said groove roll, said edge roll extending into the groove of said groove roll to contact wire within said groove only at points inward of the outermost peripheral edges of said groove roll;
and means for constraining the path of said edge roll such that said edge roll always encounters said groove at the uppermost end of said groove roll.

16. A wire guiding arrangement comprising:
a circular groove roll mounted for rotation about a horizontal eccentric axis intersecting the plane of said groove roll at an angle other than 90 degrees, said groove roll having a peripheral groove extending about the circumference of said groove roll, the shape of said groove conforming closely to the shape of the wire to be guided thereby;
a circular edge roll, coplanar with said groove roll and adapted to always rotate in the plane of said groove roll;
carriage means for carrying said edge roll adjacent said groove roll, said carriage means being adapted to ride along the outer peripheral end of said groove roll;
and means for guiding the path of motion of said carriage to maintain said carriage in contacting engagement with the uppermost end of said groove roll at all times.

17. A wire guiding arrangement as set forth in claim 16 wherein said carriage means includes adjustable spring-bias means for controlling the contact pressure between

said edge roll and the wire in the groove of said groove roll.

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