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Krafft et al.

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[54] **WIRE FINISHING METHOD AND APPARATUS**

[75] Inventors: **Erich Krafft**, Solingen; **Bodo Missmahl**, Erkrath; **Hans Pfeiffer**, Solingen-Wald; **Alfons Goeke**, Solingen; **Karl Gustav Weck**, Solingen-Wald, all of Germany

[73] Assignee: **Kieserling & Albrecht**, Solingen, Germany

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[51] **Int. Cl.** **B21b 1/00**

[58] **Field of Search** ..... 72/203, 235, 234; 29/33 F, 33 P

[56] **References Cited**

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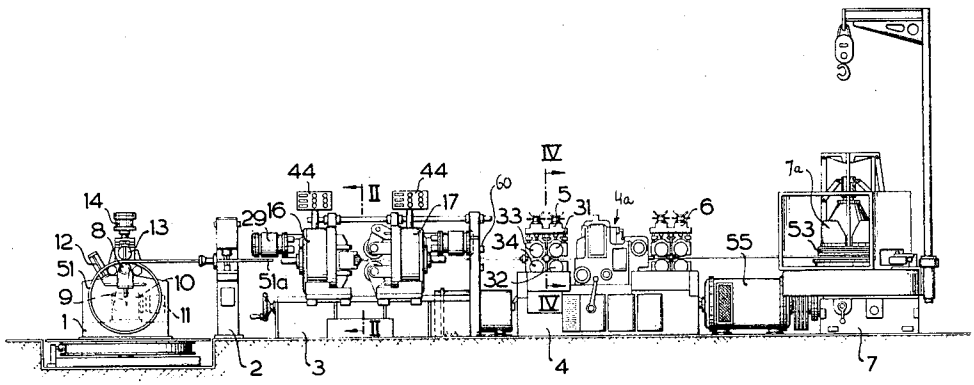
Primary Examiner—Milton S. Mehr

Attorney—Michael S. Striker

[57] **ABSTRACT**

Wire finishing apparatus wherein the leader of a supply of convoluted wire is threaded through a combined straightening and calibrating unit and into the range of feed rolls in a shaving unit. The rolls of the calibrating unit are moved apart during such threading but engage and calibrate the wire when the latter is pulled by the feed rolls so that it passes through the revolving shaving head and the leader reaches and is connected to the drum of a collecting unit. The drum is thereupon started to withdraw the wire at a higher speed whereby an overrunning clutch allows the feed rolls to rotate at the speed which is determined by the motor which rotates the drum. The rolls of the calibrating unit are adjusted to furnish a more pronounced calibrating action when the wire begins to advance at the higher speed.

15 Claims, 6 Drawing Figures



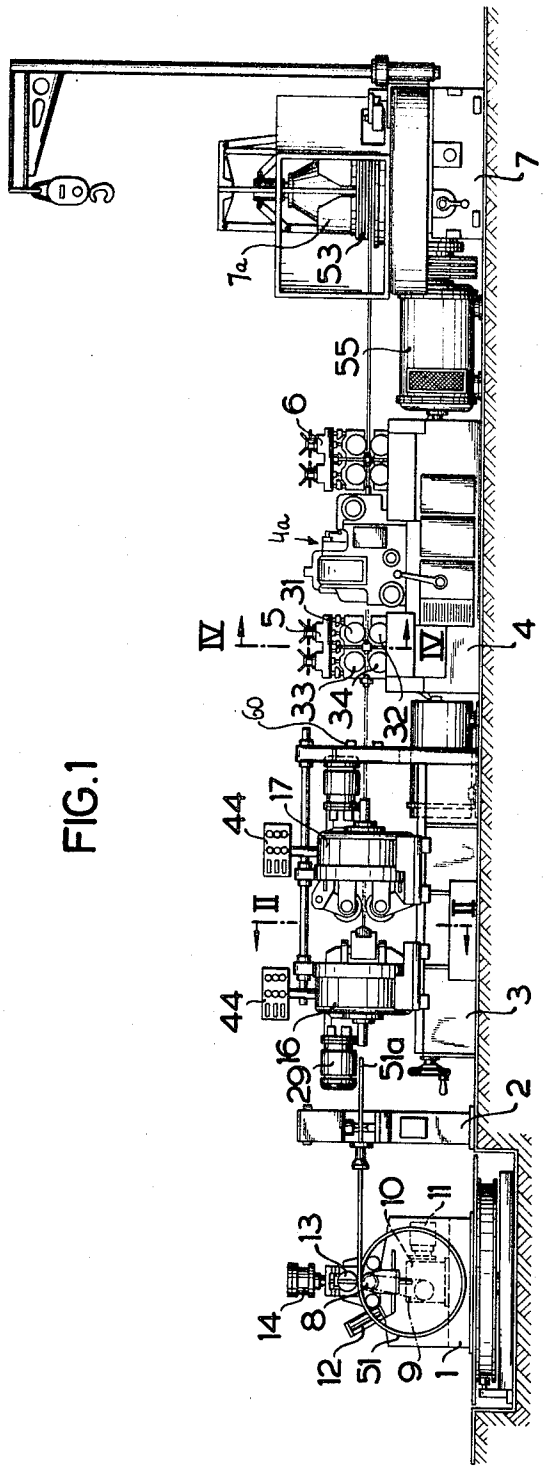

7
7a
53
55
6
4a
31
5
IV
IV
4
33
34
32
60
17
44
II
II
3
44
16
29
51a
2
10
11
13
14
8
12
51
9
1

FIG.1

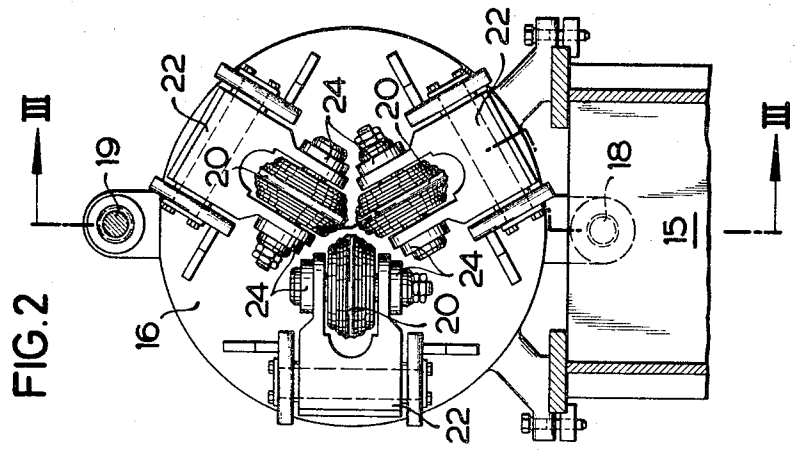

III
III
19
22
20
24
18
15
16

FIG.2

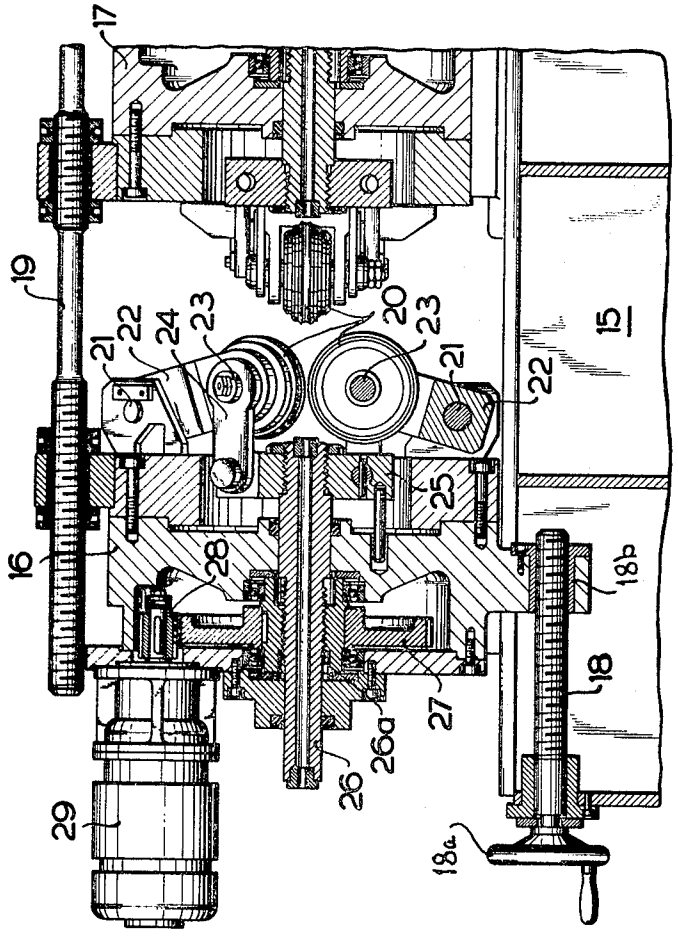

17
19
20
21
22
23
24
15
25
16
28
18b
18
27
26a
26
29
18a

FIG.3

FIG. 4

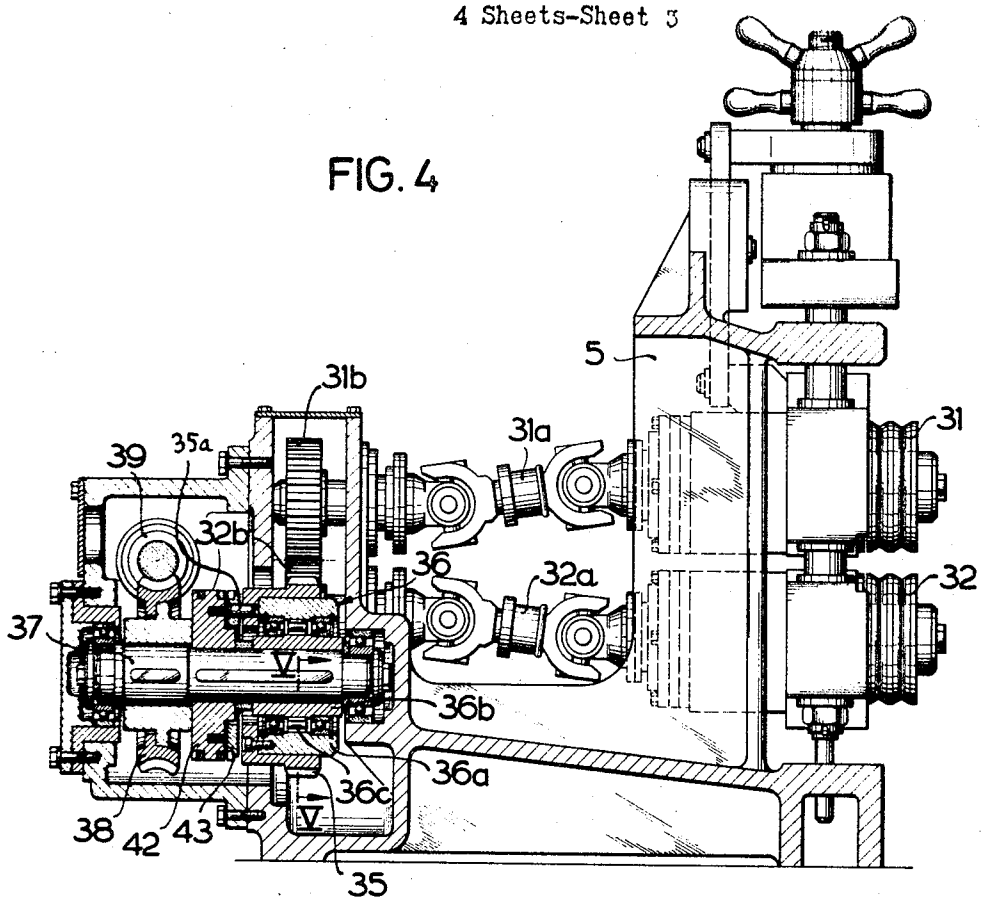

5
31b
31a
31
39
35a
32b
36
32a
32
37
36b
36a
36c
38
42
43
35

FIG. 5

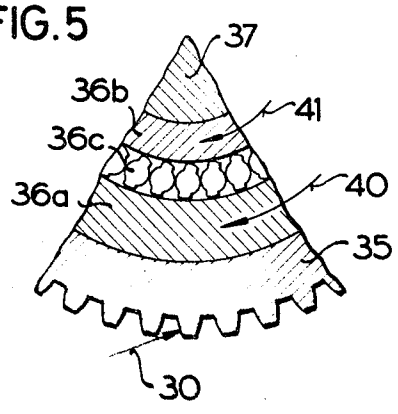
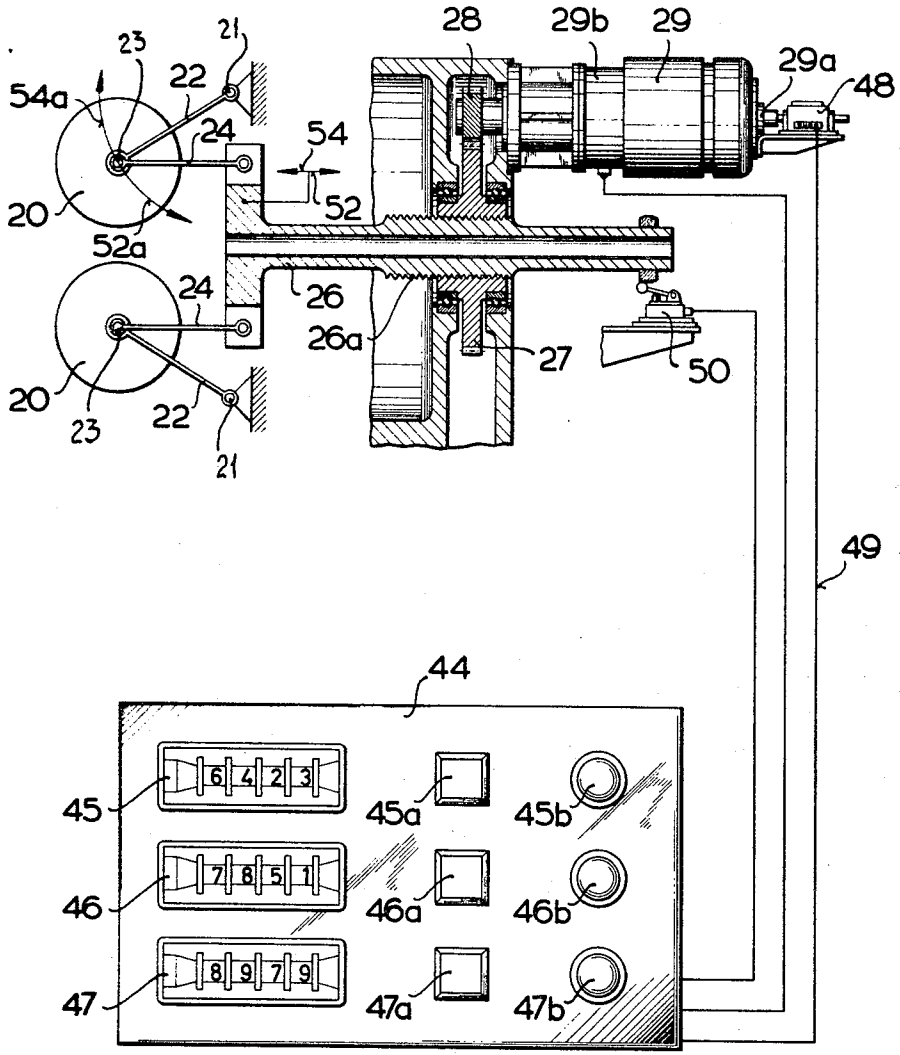

37
36b
41
36c
36a
40
35
30

FIG.6


28
29b
29
29a
48
23
21
22
54a
24
54
20
52
52a
24
26
26a
27
50
20
23
22
21
49
44
45
6 4 2 3
45a
45b
46
7 8 5 1
46a
46b
47
8 9 7 9
47a
47b

WIRE FINISHING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a method and apparatus for finishing wire, and more particularly to an automatic method and apparatus for straightening, calibrating and shaving rolled wire or analogous elongated rod-like metallic stock.

It is already known to treat metallic wire in an apparatus wherein the material is being withdrawn from a supply reel to be convoluted on a takeup reel and passes through a shaving unit. Prior to entering the shaving station, successive increments of the wire are calibrated by passing through a die, and the shaving station is followed by a straightening and polishing unit. In certain instances, the freshly shaved, straightened and polished increments of wire are caused to pass through a second die prior to reaching a collecting station where the finishing material is convoluted on the takeup reel.

A drawback of the above outlined conventional apparatus is that a certain length of wire immediately behind the leader is not subjected to any shaving action because the motor which drives the takeup reel furnishes the force which is necessary to pull the wire through successive treating stations. Thus, the shaving operation can begin only after the leader of a fresh supply of wire is securely fastened to the takeup reel and the latter begins to rotate to draw the wire off the supply reel. The knife or knives of the shaving unit are set in motion only when the leader of the wire is secured to the takeup reel in a manner to insure that the latter can readily advance the wire during removal of material at the shaving station and while the rolls of the straightening unit perform their straightening action.

It was already proposed to connect the leader of a fresh supply of wire with a thin threading wire which is passed through the first die, the shaving unit, the straightening and polishing unit and the second die to be secured to the clamping device of the takeup reel. Such thin wire serves to draw the leader of material to be treated through successive processing stations. A drawback of this proposal is that the changes in setup and/or the introduction of the leader of a fresh supply of wire into the apparatus invariably consume much time because the leader of each fresh supply must be secured to a threading wire and also because a single type of threading wire might not be satisfactory for use in connection with relatively thin or relatively thick wires. Another drawback of the aforedescribed apparatus is that the straightening and polishing units are mounted in rotating frames which are likely to cause a twisting of wire. Moreover, a wire which is to be passed through one or more dies must undergo extensive preliminary treatment. Reference may be had to U.S. Pat. No. 2,394,381 to Hoern.

Another conventional wire finishing apparatus wherein the shaving unit is located between a supply reel and a takeup reel also employs a straightening unit wherein the straightening rolls are mounted in a rotating frame. Such apparatus are incapable of calibrating the wire and, furthermore, the wire must be subjected to an extensive preliminary treatment, such as pickling, in order to reduce the wear on the shaving tools and the straightening rolls. Moreover, such apparatus are suited mainly for finishing of certain types of wire, particularly small-diameter wire of relatively low strength and high ductility so as to insure that the increase in strength during drawing reduces the likelihood of twisting during passage through the rotating straightening frame. The preliminary treatment, particularly pickling and drawing, constribute significantly to the cost of the finished product. In the event of failure of a single unit in such finishing apparatus, the portion of wire between the supply and takeup reels must be severed from the remainder of the supply of wire whenever the apparatus is brought to a standstill. This is due to the fact that, owing to its inertia, the rotating straightening frame cannot be arrested within a short interval of time and causes rapid localized heating and twisting of the adjacent portion of the wire. Since such apparatus cannot subject the wire to a desirable calibrating action, the shaving tools must remove substantial quantities of material which is undesirable for a number of reasons, such as relatively low speed of wire transport, excessive wear on shaving tools, losses in valuable material, and others. Reference may be had to the publication entitled "Draht" (1964, No. 2, pages 57–60).

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel and improved method of finishing wire, particularly rolled wire, and analogous rod-like materials in such a way that the straightening action which precedes the shaving operation need not be preceded by preliminary treatment of the material.

Another object of the invention is to provide a finishing method according to which the rod-like material can be properly treated substantially all the way from its leader to its trailing end.

A further object of the invention is to provide a method according to which the length of material which extends between a source of supply of untreated material and the station which collects finished material need not be severed and discarded in the event of malfunction of one or more units which necessitates an interruption in the feed of material through various finishing stations.

An additional object of the invention is to provide a simple, rugged and versatile finishing apparatus for wire or analogous rod-like materials which can properly finish various types and gauges of wire, whose operation is fully automatic, wherein the leader of a fresh supply of material can be properly threaded through various finishing stations without resorting to auxiliary equipment, and which can treat practically each and every increment of a supply of rod-like material, starting at the leader and all the way to the trailing end.

Still another object of the invention is to provide a finishing apparatus for wire or the like which can be rapidly converted for the finishing of different types and gauges of wire.

An additional object of the invention is to provide the finishing apparatus with novel and improved means for regulating the action of calibrating and straightening elements and with novel and improved means for threading the leader of wire or like rod-shaped material into the range of withdrawing means which pulls the material through the apparatus in the course of the normal finishing operation.

An ancillary object of the invention is to provide the finishing apparatus with novel and improved means for terminating the withdrawing action of a first withdraw-

ing device when the withdrawing action is to be taken over by a second withdrawing device.

The method of the present invention is utilized for the finishing of wire or analogous rod-like materials which are susceptible of a calibrating, straightening and shaving treatment. The method comprises the steps of establishing a source of supply of convoluted rod-like material, advancing the leader of such material along a predetermined path through a first station and on to a second station (such advancing step preferably comprises pushing successive increments of the material toward the first station by a pair of cooperating advancing rollers or the like, thereupon withdrawing the material from the source by exerting a pull upon successive increments of the material at the second station whereby the leader of the material advances along the path toward a third station, subjecting successive increments of the material at the first station to a first calibrating and straightening action while the leader advances toward the third station and simultaneously subjecting successive increments of the material at the second station to a shaving action (preferably by resorting to one or more orbiting knives), terminating the pull upon the material at the second station when the leader of the material reaches the third station and thereupon withdrawing the material from the source of supply by exerting a pull upon the material at the third station so that the material advances continuously along the path (the second withdrawing action preferably comprises advancing the material at a speed which exceeds the speed of material in the course of the first withdrawing step), and subjecting successive increments of the material at the first station to a second calibrating and straightening action while continuing the shaving action upon successive increments of the material at the second station in the course of the second withdrawing step.

The second calibrating and straightening action is preferably more pronounced than the first calibrating and straightening action so that the rate of material removal at the second station in the course of the first withdrawing step (when the material is advanced at a lower speed) is at least substantially the same as the rate of material removal in the course of the second withdrawing step (when the material is advanced at a higher speed).

The calibrating and straightening steps preferably include subjecting the material to the action of at least one group of idler rolls whose orientation with respect to the path for the material is constant, i.e., the rolls need not orbit about the path along which the material moves through the first station and on toward the second station.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved wire finishing apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevational view of a wire finishing apparatus which emodies the invention;

FIG. 2 is an enlarged transverse vertical sectional view as seen in the direction of arrows from the line II—II of FIG. 1;

FIG. 3 is a fragmentary longitudinal vertical sectional view as seen in the direction of arrows from the line III—III of FIG. 2;

FIG. 4 is a fragmentary transverse vertical sectional view as seen in the direction of arrows from the line IV—IV of FIG. 1;

FIG. 5 is an enlarged fragmentary sectional view as seen in the direction of arrows from the line V—V of FIG. 4; and

FIG. 6 is an enlarged diagrammatic partly elevational and partly longitudinal vertical sectional view of a detail in the apparatus of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, the wire finishing apparatus comprises a threading unit 1 which can receive a supply of convoluted wire 51 and includes means for rotating such supply so as to transport the leader 51*a* of wire along a predetermined path (this path is shown as being horizontal) whereby the leader first passes through a cutoff 2 and thereupon enters a combined straightening and calibrating unit 3 on its way into a material removing or shaving unit 4. The shaving unit 4 comprises a wire feeding device 5 located upstream and a wire withdrawing device 6 located downstream of a rotary shaving head 4*a*. The apparatus further comprises a collecting unit 7 serving to convolute finished wire so as to form a reel 53 which can be transferred to a further station by a crane or the like.

The wire threading unit 1 comprises a first advancing roller 8 which is rotated by an endless chain 9 receiving motion from an electric motor 11 by way of a variable-speed transmission 10. Two separating rollers 12 on the frame of the threading unit 1 serve to segregate the reel whose wire 51 is engaged by the advancing roller 8 from the next following reel or reels. The driven advancing roller 8 cooperates with an idler advancing roller 13 which is biased by an adjustable fluid-operated cylinder and piston assembly 14 so that the peripheral surfaces of the rollers 8 and 13 can engage and advance the wire 51 with a desired force.

The cutoff 2 serves to sever the leader 51 of the wire 51 if the leader is deformed to such an extent that it cannot be properly introduced into the combined straightening and calibrating unit 3. This cutoff is provided with shears which is actuated after the unduly deformed leader passes beyond the cutting plane so that the leader is severed and discarded whereby the freshly formed leader behind the separated leader can readily enter the calibrating and straightening station. For example, the cutoff 2 will sever a leader which comprises one or more strongly twisted, overly bent or otherwise deformed portions.

The combined calibrating and straightening unit 3 (hereinafter called calibrating unit for short) is shown in detail in FIGS. 2 and 3. It comprises a base 15 which supports two frames 16, 17 for groups of three calibrating and straightening rolls 20. The frames 16, 17 are movable toward and away from each other along suitable ways which are provided in or on the base 15. The means for moving the frames 15, 16 relative to each other comprises a hand wheel 18*a* which is rotatably mounted in the base 15 and is connected with a feed

screw 18 meshing with a spindle nut 18b on the frame 16. The latter is coupled with the frame 17 by means of a threaded spindle 19 in such a way that the frames 16, 17 move toward each other when the wheel 18*a* is rotated clockwise and away from each other in response to counterclockwise rotation of the wheel 18*a*.

The rolls 20 of each group are angularly offset relative to each other through 120° (see particularly FIG. 2). Thus, the axes of the three rolls constitute the sides of an equilateral triangle whose center is located in the path for lengthwise movement of wire 51 through the calibrating station. The shafts 23 of the rolls 20 are mounted on levers 22 (see also FIG. 6 which, for the sake of clarity, merely shows two of a group of three cooperating rolls 20) which are pivotable on pins 21 secured to the respective frame 16 or 17. The rolls 20 are free to rotate on the respective shafts 23 and such shafts are further coupled to pairs of links 24 which are articulately connected with axially movable disk-shaped holders 25 to thereby move the rolls 20 of the respective group toward or away from each other (see the arrows 52*a* and 54*a* in FIG. 6). Each holder 25 is fixedly secured (preferably threadedly connected) to an adjusting sleeve 26 whose axial bore defines a portion of the path for the wire 51 and which is mounted in the respective frame 16 or 17 for axial movement to thereby pivot the corresponding pairs of links 24 and thus move the peripheral surfacrs of the associated rolls 20 nearer to or further away from each other. The external threads 26*a* of each sleeve 26 mate with the internal threads of a gear 27 which is rotatably mounted in the respective frame 16 or 17 and can be rotated by a pinion 28 on the output shaft of an electric adjusting motor 29. The gears 27 are held against axial movement in the repsective frames 16, 17 so that the sleeves 26 and the holders 25 thereon are compelled to move axially when the motors 29 rotate the corresponding pinions 28 in a clockwise or counterclockwise direction. Each motor 29 is provided with a built-in brake 29b which can arrest the pinions 28 in immediate response to stoppage of the motor to thus insure that the rolls 20 of each group can be positioned with a high degree of accuracy.

FIG. 3 shows that the rolls 20 on the frame 16 are angularly offset with reference to the rolls 20 on the frame 17. The mutual inclination of the axes of the two groups of rolls 20 is 60° so that the rolls of one group alternate with and are equidistant from the rolls of the other group, as considered in the circumferential direction of the wire 51 which passes through the calibrating station.

The control means for initiating and effecting the operation of motors 29 of adjusting means for the groups of rolls 20 on the frames 16 and 17 comprises two signal storing devices 44 each of which includes three selector switches 45, 46, 47 (see FIG. 6), three scanning devices or detectors 45*a*, 46*a*, 47*a* which scan the positions of rolls 20, and three indicating devices 45*b*, 46*b*, 47*b* here shown as signal lamps which provide visible indications when the rolls 20 reach the positions selected by the switches 45—47, A discrete signal storing device 44 is provided for each of the two frames 16, 17. The lamps 45*b*—47*b* may light up when the adjustment is completed or they remain lighted during the making of an adjustment so that the operator knows that the adjustment has been completed when the visible signals disappear. Each motor 29 receives impulses by way of an impulse transmitting device 48 which is connected with the signal storing device 44 by conductor means 49. The signal transmitting device 48 is further connected with the shaft 29*a* of the respective motor 29. A limit switch 50 (shown in the upper part of FIG. 6) produces a signal to terminate the axial movement of the respective sleeve 26 when the rolls 20 of the corresponding group are moved apart to a maximum permissible extent.

The details of the shaving unit 4 are shown in FIGS. 1, 4 and 5. The aforementioned wire feeding and withdrawing devices 5, 6 flank the rotary shaving head 4*a* and the device 5 comprises two pairs of feed rolls 31, 32 and 33, 34. The shaft of the feed rolls 31 to 34 are rotatable by discrete cardan shafts (see the shafts 31*a*, 32*a* in FIG. 4) which receive torque from pairs of mating gears (see the gears 31*b*, 32*b* in FIG. 4). The illustrated gear 32*b* (and the non-illustrated gear for the cardan shaft of the feed roll 34) meshes with a ring gear 35 which is secured to the outer race 36*a* of an overrunning clutch 36 which further includes an inner race 36*b* and an annulus of sprags 36*c* or analogous motion transmitting elements between the two races. The inner race 36*b* is driven by a shaft 37. The shaft 37 carries a worm wheel 38 in mesh with a worm 39 on the output shaft of an electric motor, not shown.

The overrunning clutch 36 can rotate the ring gear 35 only in the direction indicated by the arrow 40 (FIG. 5). Thus, the sprags 36*c* can entrain the outer race 36*a* (and hence the ring gear 35) only when the shaft 37 rotates the inner race 36*b* in the direction indicated by the arrow 41 shown in FIG. 5. The arrow 30 indicates the direction of action of a force which opposes the rotation of ring gear 35 in the direction indicated by the arrow 40. If the rotational speed of the gear 35 in the direction indicated by the arrow 40 exceeds the rotational speed of the shaft 37 and inner race 36*b* in the direction indicated by the arrow 41, the force 30 disappears and the sprags 36*c* are incapable of transmitting torque to the outer race 36*a*. Thus, the gear 35 and the outer race 36*a* are then free to rotate relative to the inner race 36*b* and shaft 37. When the direction of rotation of the shaft 37 and inner race 36*b* is reversed, the sprags 36 *c* cannot transmit torque and the outer race 36*a* remains idle. The shaft 37 is fixedly secured to a disk-shaped electromagnet 42 which is energizable to rotate the ring gear 35 in a counterclockwise direction (as viewed in FIG. 5) by way of a motion transmitting ring 43 which is coupled to the gear 35 by one or more axially parallel studs 43*a* (one shown in FIG. 4).

The construction of the withdrawing device 6 in the shaving unit 4 is preferably identical with that of the feeding device 5. The apparatus can operate properly with a simplefied withdrawing device whose rolls need not be driven; such rolls then merely serve to take up moments which develop as a result of the material removing action of one or more orbiting knives in the rotary head 4*a*.

The collecting unit 7 for finished wire comprises a suitable clamping device for the leader of wire and comprises a drum 7*a* which is rotated by a motor 55 to collect the convolutions 53 of finished wire and to furnish the force which is needed to draw the wire 51 through the units 2, 3 and 4.

THE OPERATION

The convolutions of wire 51 which rest on the driven

advancing roller 8 are rotated when the motor 11 is started whereby the roller 8 cooperates with the downwardly biased idler advancing roller 13 to transport the leader 51*a* of the wire 51 lengthwise toward and through the cutoff 2 and into the space between the rolls 20 in the frames 16 and 17 of the calibrating unit 3. The rolls 20 of each group of rolls are moved to spaced-apart positions before the leader 51*a* of the wire reaches the calibrating station. Such movements of rolls 20 in each group are effected by the control system including the signal storing devices 44. More particularly, the extent to which the rolls 20 move apart prior to entry of the leader 51*a* into the calibrating station is determined by the setting of the selector switches 45. The spacing between the rolls 20 of each group (as determined by the selector switches 45) is such that the leader 51*a* is free to pass through the spaces between such groups of rolls. Thus, the force which is furnished by the advancing rolls 8 and 13 suffices to move the leader 51*a* through the calibrating unit 3 and into the nip of feed rolls 33, 34 of the wire feeding device 5 in the shaving unit 4. Once the leader 51*a* is properly engaged by the feed rolls 31, 32 and/or 33, 34 the calibrating rolls 20 in the unit 3 are caused to move nearer to each other and to engage the wire 51. At the same time, the motor 11 can be arrested because, from there on, the wire 51 is fed lengthwise by the rolls 31—34 and later on by the motor 55 of the collecting unit 7 as soon as the leader of the wire is engaged and held by the aforementioned clamping means which secures the leader to the drum 7*a*.

The adjustment of the calibrating rolls 20 depends on the force which the feed rolls 31—34 can furnish to draw the wire 51 in a direction to the right, as viewed in FIG. 1, and also on the desired extent of calibrating action. As a rule, the rolls 20 will be adjusted to such an extent that, in carrying out a desirable straightening action, the rolls 20 will at least slightly reduce the diameter of the wire 51.

The adjustment of rolls 20 subsequent to threading of the leader 51*a* into the shaving unit 4 can be initiated manually or automatically. A manual adjustment will be initiated by depressing the pushbuttons 46a whereby the motors 29 are started simultaneously with deactivation of the respective brakes 29*b*. While the motors 29 rotate, the pinions 28 rotate the respective gears 27 whereby the sleeves 26 move axially in the direction indicated by the arrow 52 (FIG. 6) so that the respective pairs of links 24 pivot the the associated levers 22 and move the rolls 20 in the direction indicated by the arrow 52*a*. When the number of impulses which the shafts 29*a* of the motors 29 furnish to the corresponding impulse transmitting devices 48 matches the number which is selected by the switches 46 of the signal storing device 44, the motors 29 are arrested and their brakes 29*b* engaged ro arrest the sleeves 26 in accurately determined positions corresponding to the desired calibrating action of the respective groups of rolls 20. The lamps 46*b* light up when the number of impulses furnished by the shafts 29*a* matches the number which is selected by the corresponding switches 46. The devices 48 can furnish impulses in response to each revolution of the respective shafts 29*a*, and each such revolution entails a predetermined axial movement of the respective adjusting sleeve 26.

The rolls 31—34 of the feeding device 5 thereupon feed the wire 51 into and through the revolving head 4a of the shaving unit 4 whereby the knife or knives in the head 4*a* remove material from the wire and impart thereto a desired diameter. The knife or knives are adjustable in a manner not forming part of the present invention so as to insure that the diameter of successive increments of the wire 51 can be reduced to an accurately determined value. When the leader 51*a* of the wire 51 reaches the clamping device of the collecting unit 7, the finished wire 53 begins to form convolutions on the drum 7*a*. The arrangement is preferably such that the clamping device comprises a normally open tongs which receives the leader 51*a* and is automatically closed to clamp the leader in response to further lengthwise transport of the wire. The leader 51*a* can also actuate a starter switch (not shown) for the motor 55 which thereupon begins to rotate the drum 7*a* so that the latter can draw the wire all the way from the threading unit 1 and through the units 2, 3 and 4. Still further, the just discussed starter switch for the motor 55 (or another switch which is actuated by the leader 51*a* when the latter reaches the collecting unit 7) furnishes a signal which starts the motors 29 again so that the rolls 20 are moved to their final positions determined by the setting of selector switches 47. A time delay relay (not shown) can be energized in response to entry of the leader 51*a* into the collecting unit 7 to arrest the motor for the worm 39 of FIG. 4 so that the feed rolls 31—34 cease to receive torque and merely rotate in response to lengthwise transport of wire 51 by the motor 55 and drum 7*a*. The normal operating speed of the drum 7*a* is preferably much higher than the peripheral speed of the feed rolls 31–34 so that the wire 51 is thereupon transported through the apparatus at a relatively high speed. The overrunning clutch 36 insures that the rolls 31–34 can rotate at a very high speed because the ring gear 35 is free to rotate relative to the inner race 36*b* as soon as the speed of the outer race 36*a* exceeds the speed of the shaft 37.

The apparatus then continues to draw wire 51 from the unit 1 and to subject successive increments of such wire to a straightening, calibrating and shaving action. When the trailing end of a supply of wire 51 moves beyond the calibrating unit 3, a suitable detector 60 of the control means (e.g., a mechanical scanner or a photoelectric scanning device which monitors the path downstream of the frame 17 for the presence or absence of wire 51) furnishes a signal which disengages the brakes 29*b* and starts the motors 29 to move the sleeves 26 in the direction indicated by the arrows 54 of FIG. 6. The movement of sleeves 26 is terminated when the limit switches 50 are closed. This results in stoppage of the motors 29 and in renewed application of the brakes 29*b*. The positions of the rolls 20 (which were moved in the direction indicated by arrow 54*a*) then correspond to the selected setting of the switches 45.

When the trailing end of the wire 51 moves beyond the shaving unit 4, the knife or knives in the head 4*a* and the rolls of the devices 5, 6 can be moved to their idle positions.

A feature of the present invention resides in the recognition that the drawbacks of conventional wire finishing apparatus and methods can be avoided in a simple way by utilizing a calibrating unit with idler rolls which need not be mounted in a rotating frame and by equipping the means for supporting a fresh supply of wire with a threading device which can push the leader

of a fresh supply of wire to the shaving station or even all the way to the collecting station for the finished product while the elements of the straightening and claibrating unit are held in open or spaced-apart positions. As explained above, the calibrating rolls **20** can be moved nearer to each other to furnish a certain calibrating and straightening action as soon as the leader of the wire reaches the feeding device **5** of the shaving unit **4**, and the calibrating rolls **20** are moved to their normal operating positions as soon as the leader is properly attached to the drum or reel of the collecting unit. Thus, the calibrating action of the rolls **20** is less pronounced when the wire is being drawn by the rolls **31—34** of the feeding unit **5** while the rolls **31—34** are positively driven at a relatively low speed (shaft **37**) and the calibrating action is more pronounced as soon as the transport of wire is taken over by the motor **55** in the collecting unit **7**. The clutch **36** insures that the rolls **31—34** can rotate at a speed which exceeds the maximum speed of these rolls when the clutch **36** transmits torque to the gear **35**.

Since the leader of the wire **51** advances through the shaving station at a relatively low speed (rolls **31—34**), the shaving head **4a** can immediately begin to rotate at full or normal operating speed because the rate of material removed per unit of time is at least substantially the same as when the wire is being transported at full speed. Thus, when the calibrating action of the rolls **20** is less pronounced, the wire is transported at a lesser speed and the wire moves lengthwise at full speed only when the rolls **20** furnish a more pronounced calibrating action whereby the knife or knives in the orbiting head **4***a* remove a substantially constant quality of material per unit of time irrespective of the speed of transport of wire toward the collecting unit **7**.

Another very important advantage of the improved finishing method and apparatus is that the wire need not be subjected to any preliminary treatment. It was found that, even if the material to be treated is not rolled wire and requires a very pronounced straightening treatment to elimniate pronounced bends or the like, the rolls **20** are capable of furnishing the necessary straightening and calibrating action and at the same time remove substantial amounts of scale. The calibrating treatment further insures that the knife or knives of the shaving unit **4** must remove very small quantities of material. In presently known wire finishing apparatus, the quantity of material which is being removed at the shaving station is reduced by drawing the wire through a die; however, such mode of operation necessitates a costly and time-consuming preliminary treatment of the starting material. Furthermore, the die must be replaced by a different die whenever a particular starting material is replaced with wire having a larger or smaller diameter, whereas the calibrating rolls **20** can be readily adjusted to furnish a satisfactory calibrating and straightening action for a wide range of starting materials.

Still another advantage of the improved finishing apparatus is that the calibrating rolls **20** need not be mounted in rotating frames and that these rolls need not be driven. Thus, in the event of malfunction of any one of the units, the rolls **20** come to a standstill as soon as the lengthwise movement of wire is terminated. This prevents localized overheating of wire and contributes to the simplicity and longer useful life of the calibrating and straightening unit.

The provisions of several groups of calibrating rolls wherein the rolls of one group are angularly offset with respect to the rolls of the other group or groups brings about the advantage that a relatively small number of rolls can properly calibrate a wire with several sharp bends or kinks and with a cross-sectional outline which is out of round.

The signal storing devices **44** with their adjustable selectors **45–47** allow for rapid changes in the setting of rolls **20** for treatment during transport of wire at a lower speed or at full operating speed. Thus, an operator can rapidly reset the signal storing devices **44** when the wire to be treated is different from the previously treated wire or when a particular wire is to be subjected to a more or less pronounced calibrating and straightening action.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that otherscan, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations sould and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended:

1. A method of finishing wire or analogous rod-like materials, comprising the steps of establishing a source of supply of convoluted material; advancing the leader of such material along a predetermined path through a first station and on to a second station; withdrawing the material from said source by exerting a pull upon successive increments of the material at said second station whereby the leader of material advances along said path toward a third station; subjecting successive increments of the material at said first station to a first calibrating and straightening action while the leader advances toward said third station and simultaneously subjecting successive increments of the material at said second station to a shaving action; terminating the pull upon material at said second station when the leader of such material reaches said third station and thereupon withdrawing material from said source by exerting a pull upon the material at said third station so that the material advances continuously along said path; and subjecting successive increments of the material at said first station to a second calibrating and straightening action while continuing the shaving action upon successive increments of material at said second station in the course of said second withdrawing step.

2. A method as defined in claim **1**, wherein said second calibrating and straightening action is more pronounced than said first calibrating and straightening action.

3. A method as defined in claim **2**, wherein said second withdrawing step includes advancing the material at a speed which is higher than the speed of material in the course of said first withdrawing step.

4. A method as defined in claim **1**, wherein each of said calibrating and straightening steps includes subjecting the material to the action of at least one set of idler rolls whose orientation with respect to said path is constant.

5. A method as defined in claim **1**, further comprising the step of convoluting the shaved material at said third station.

6. A method as defined in claim 1, wherein said advancing step comprises pushing successive increments of the material of said source toward said first station.

7. Apparatus for finishing wire or analogous rod-like materials, comprising a threading unit arranged to support a supply of convoluted wire-like material and having means for advancing the leader of such supply along a pre-determined path; a combined calibrating and straightening unit adjacent to said path and including a plurality of idler calibrating rolls distributed circumferentally about the material in said path and adjusting means for moving said rolls toward and away from said path so as to move said rolls away from and into more or less pronounced calibrating engagement with the material in said path; a shaving unit located downstream of said rolls and having a rotary shaving head as well as at least one set of feed rolls and drive means for rotating said feed rolls whereby the feed rolls engage and entrain the leader of the material to advance such leader beyond said shaving unit at a first speed; and a collecting unit located downstream of said shaving unit and having means for withdrawing the material from said supply at a second speed higher than said first speed.

8. Apparatus as defined in claim 7, further comprising overrunning clutch means interposed between said drive means and said feed rolls to allow for rotation of said feed rolls independently of said drive means during withdrawal of material at said higher second speed.

9. Apparatus as defined in claim 7, further comprising control means for said adjusting means, said control means being actuatable to maintain said calibrating rolls away from the material in said path during movement of the leader of material toward said feed rolls, to maintain said calibrating rolls in less pronounced calibrating engagement with successive increments of the material while the material is being advanced at said first speed, and to maintain said calibrating rolls in more pronounced calibrating engagement with successive increments of the material while the material is being advanced at said second speed.

10. Apparatus as defined in claim 7, wherein said calibrating rolls form several groups including a first group and a second group, the rolls of said first group being angularly offset relative to the rolls of said second group.

11. Apparatus as defined in claim 10, wherein each of said first and second groups consists of three equidistant calibrating rolls and the rolls of said first group are angularly offset through 60° with reference to the rolls of said second group.

12. Apparatus as defined in claim 7, wherein said combined calibrating and straightening unit further comprises control means for said adjusting means, said control means including means for selecting the extent of movement of said calibrating rolls toward and away from said path and means for indicating the positions of said calibrating rolls.

13. Apparatus as defined in claim 12, wherein said adjusting means comprises at least one motor having a rotary output member and means for moving said calibrating rolls in response to rotation of said output member, said control means further comprising impulse generating means operated by said output member and means for arresting said motor in response to generation of a preselected number of impulses.

14. Apparatus as defined in claim 13, further comprising braking means for said output member, said control means including means for disengaging said braking means in response to starting of said motor and for engaging said braking means in response to stoppage of said motor.

15. Apparatus as defined in claim 7, wherein said calibrating rolls form a plurality of groups and said combined straightening and calibrating unit further comprises discrete frames for said groups of calibrating rolls and means for moving said frames with and relative to each other lengthwise of said path.

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