ABSTRACT: Wire stock is unwound from a supply reel and wrapped in an opposite angular sense about a brake wheel which is frictionally retarded. After passing several times about the brake wheel the wire enters a traction drive comprising a pair of toothed drive belts which grip the wire therebetween under adjustable pressure, with the portion of the wire between the brake wheel and the traction belts being stretched beyond its yield point to remove the curl. Upon emerging from the traction drive the wire is fed continuously into a two-sided reciprocating shear device which cuts the wire into discrete lengths.
APPARATUS FOR STRAIGHTENING AND CUTTING COILED WIRE

FIELD OF THE INVENTION

This invention relates to apparatus for the fabrication of articles from recoiled wire stock, and is particularly concerned with straightening such wire and cutting it to discrete lengths.

THE PRIOR ART

A variety of articles such as wire leads, harness sections and the like are manufactured from metal wire stock. Such wire stock is almost invariably manufactured in the form of very long continuous filaments, which cannot be handled practically unless they are wound on reels and delivered to the fabricator in that form.

Therefore coiled wire is the starting point for almost every wire fabricating process. But after being wound and stored on reels, the metal wire takes a set, resulting in a permanent curvature. Before it can be fed into any of the various devices for fabricating metal articles from wire stock, the wire must first be straightened.

The prior art has developed a number of approaches to the problem of straightening coiled wire prior to fabrication. Basically, these approaches fall into two general categories. One type of machine, known as a roll straightener, attempts to straighten the wire by curling it in the opposite angular sense, carrying the deformation beyond the yield point of the wire so as to introduce a substantially equal counter-curl, resulting in a wire which is permanently deformed back into a substantially straight condition. This type of equipment is difficult to adjust so that it results in zero curl.

The other type of device, known as a rotary straightener, passes the curled wire through a die which provides a sinusous path comprising alternate opposite deflections. The die is rotated so that each deflected segment of wire revolves conically, and is thus spun past its yield point to eliminate the previously set curvature. This method does not always produce satisfactory results, particularly with small diameter wire, which has been known to break and jam the straightening machinery. Also, the straightening die and the traction drive which pulls the wire through the straightening die have a tendency to impose undesirable markings and scratches upon the wire, particularly if the wire is in the smaller diameter range.

Upon emerging from the straightening apparatus the wire must be cut to discrete lengths. Prior art mechanisms for accomplishing this have required that the wire be advanced intermittently, and that the cutting operation be performed in the interval between advances of the wire, since continuous movement of the wire filament during the cutting step would cause the wire to crumple against the edge of the cutting die unless a "flying shear" device is used.

SUMMARY AND OBJECTS OF THE INVENTION

A principal object of the present invention is to provide apparatus for straightening and cutting off predetermined lengths of wire in high speed, continuous flow operation, utilizing either conventional roll straightening or rotary straightening techniques or a unique form of stretch straightening technique for elongating a portion of the wire in longitudinal tensile stress beyond its tensile yield point.

Another object of the invention is to provide subcombinations and apparatus for utilizing such stretch straightening techniques in the straightening of wire traveling longitudinally from wire stock. In addition, a pressure foot 64 pressing downwardly upon the lower stand of belt 32 cooperates with an anvil 66 below the confronting strand of belt 34 to press the two belts together into engagement with the wire 22 from opposite sides thereof. Consequently, the two belts 32 and 34 grip the wire 22 therebetween and drag it longitudinally to the right as seen in FIG. 4 in response to the pull of a wire traction drive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the entire apparatus of this invention.

FIG. 2 is a top plan view of the same apparatus.

FIG. 3 is a sectional view of the brake mechanism of the apparatus of the previous figures, taken along the lines 3-3 of FIG. 1 looking in the direction of the arrows.

FIG. 4 is a sectional view of the wire traction drive mechanism of the apparatus of the previous figures, taken along the lines 4-4 of FIG. 2, looking in the direction of the arrows.

FIG. 5 is a sectional view of the wire traction drive taken along the lines 5-5 of FIG. 4, looking in the direction of the arrows.

FIG. 6 is another sectional view of the wire traction drive taken along the lines 6-6 of FIG. 4 looking in the direction of the arrows.

FIG. 7 is a sectional view of the wire cutting portion of the apparatus of the previous FIGS., taken along the lines 7-7 of FIG. 2, looking in the direction of the arrows.

FIG. 8 is another sectional view of the wire cutting unit, this time taken along the lines 8-8 of FIG. 7.

FIG. 9 is still another sectional view of the wire cutting unit, taken along the lines 9-9 of FIG. 7, looking in the direction of the arrows.

The same reference characters refer to the same elements throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In general terms, the wire straightening apparatus of this invention comprises a wire traction drive 20 which pulls a wire 22 off a rotatable supply reel 24 and through a brake mechanism 26. In the process, the wire is straightened, and then delivered continuously to a wire cutting mechanism 28 which shears the advancing wire 22 into discrete lengths which it deposits in an output tray 30.

As best seen in FIG. 4, the wire traction mechanism 20 comprises a pair of endless belts 32 and 34, which are looped about respective pairs of wheels 36, 38 and 40, 42. The belts 32 and 34 are of the type which comprise a plurality of teeth 44 around the inner periphery thereof. Such belts are commonly used in industry for timing and other precision belt drive applications, the teeth 44 thereof being designed to mesh with cooperating teeth 46 on the wheels 36, 38, 40 and 42.

As seen in FIGS. 1 and 2, a motor 48 drives an output shaft 54 by means of a gear box 50 and a coupling 52. Referring again to FIG. 4, the wheel 36 which meshes with belt 32 is keyed to this shaft 54 by key 55, as is gear 56. The gear 56 drives another gear 58 which in turn is keyed to a shaft 60 by key 61, along with wheel 40 which meshes with belt 34. Consequently, the shaft 54 drives the belt 32 by means of wheel 36, and also drives the belt 34 by means of gears 56 and 58, shaft 60 and wheel 40.

The lower strand of belt 32 stretching between wheels 36 and 38 confronts the upper strand of belt 34 stretching between wheels 40 and 42, thus defining a portion of a feed path 62 for the wire 22. In addition, a pressure foot 64 pressing downwardly upon the lower strand of belt 32 cooperates with an anvil 66 below the confronting strand of belt 34 to press the two belts together into engagement with the wire 22 from opposite sides thereof. Consequently, the two belts 32 and 34 grip the wire 22 therebetween and drag it longitudinally to the right as seen in FIG. 4 in response to the
For convenience in counteracting part of the curl which wire 22 has when it comes off the supply reel 24, the wire is wound about the brake wheel 68 in the opposite angular sense relative to the direction of winding upon reel 24. However, this does not straighten the wire completely, since it would be difficult to introduce exactly the right amount of counter-curl. In order to eliminate the curl completely it is necessary to deform the wire 22 beyond its yield point.

This is accomplished in that part of the wire feed path 62 where the wire 22 is pulled off the brake wheel 68 by the traction drive mechanism 20. As this occurs, the brake wheel 68 revolves slowly, continuously releasing some of the wire 22 to the traction drive 20, and at the same time reeling on a similar amount of wire from the supply reel 24. However, the rotation of the wheel 68 is retarded by the brake shoe 76 just enough so that the resulting tensile stress exerted on the wire 22 stretches it past its yield point and permanently eliminates the curl. It will be appreciated that this result is achieved as a result of pure tensile stress, without any lateral flexure or conical rotation as in prior art methods of straightening wire.

The traction drive mechanism 20 is mounted upon a frame 126 comprising an upstanding wall 127 from which extend a pair of vertical members 128 and 130, and three horizontal members 132, 134 and 136. The latter two member 134 and 136 are secured to the table 76 by bolts 138, thus securing the entire frame 126 in place. An upper cover plate 140 is secured to the frame 126 by bolts 142, and a lower cover plate 144 is similarly secured in place by bolts 146. Between the upper and lower cover plates is a longitudinal space 148 through which the wire 22 can be passed when it is initially inserted into that portion of wire feed path 62 which lies between the confronting surfaces of drive belts 32 and 34. Notches 150 and 151 are similarly formed in the vertical members 128 and 130 to permit passage of the wire 22. On the surface of the wall 127 is mounted another electrical contact sensor 153 of the type discussed above, which detects whipping of the wire end to warn the operator of the wire straightening machine of a break in the wire 22.

The drive shaft 54 which carries the gear 56 and wheel 36 is journaled upon the wall 127 and the front plate 140 by means of suitable bushings 155. In a similar manner the shaft 60 which carries the gear 58 and wheel 40 is journaled on the wall 127 and the lower cover plate 144 by bushings 157.

The anvil 66 which supports the lower drive belt 34 in its tractive engagement with the wire 22, rests upon an abutment 154 projecting laterally from the wall 127 immediately above a thickened section 156 thereof. The thickened section 156 does not extend all the way forward to the cover plate 144, in order to leave a space 158 for the lower cover plate 144. The other end of the spring 102 is connected to an adjusting bolt 106 having a threaded upper end which passes through an opening in the arm 98. A hand wheel 108 is threaded to the bolt and may be turned manually for adjusting the tension on the coil spring 102, thus giving a coarse adjustment of the braking pressure exerted by the shoe 74 upon the wheel 68. Fine adjustment can be achieved by means of weights 110 which are slidable along the arm 98 and locked in position by means of winged nuts 112 once they are properly located.

The wire 22 is pulled off the supply reel 24 and wound about three times without the rubber insert 70 on the periphery of the brake wheel 68. An electrical contact sensor 114 is positioned upon the vertical plate 96 and the wire 22 passes through an opening therein. When the supply of wire 22 upon the reel 24 is exhausted, the trailing end of the wire droops or wips into electrical contact with the walls of the opening and triggers the sensor 114. A wire guide 116 is also mounted upon the plate 96 to control the path of the wire 22 from the reel 24 to the brake wheel 68. Below the wheel 68 are similar wire guides 118 and 120 and electrical contact sensors 122 and 124. Sensor 122 is not used with the supply reel 24, but is provided in case an alternative supply of wire is fed in from the left side of FIG. 1. Both it and sensor 124 are of the same type as sensor 114, and serve to detect the electrical contact made by the whipping of the wire when a break occurs.
pressure contact with the wire 22, so as to avoid pinching the wire, which would result in a permanent lateral deformation. Moreover, the pressure exerted by the screw jack mechanism is distributed across the entire length of the wire 22 which is in contact with the drive belts 32 and 34, a factor which further deters any excessive local deformation in the lateral direction. Finally, the level of squeezing pressure applied to the wire 22 is manually adjustable by means of the knob 162 of the screw jack mechanism, so that it can be set at the lowest level which is sufficient to exert the required tractive force on the wire 22, in order to minimize lateral deformation of the wire. This lack of lateral wire deformation stands in sharp contrast to prior art wire straightening approaches, particularly the rotary approach in which the dies designed to force the wire into a sinuous configuration were likely to cause permanent lateral deformation of the wire.

As the wire 22 emerges from the slot 150 of the traction drive mechanism 20, it is cut into discrete lengths by the mechanism 28 which is mounted on a pedestal 168 atop the table 76. As best seen in FIG. 9, this mechanism includes a block 170 secured to the pedestal 168 by means of a pin 172. A end 174 thereof in the block 170 to receive a tumbler wire guide 176 which is secured in place by means of a set screw 178 threaded engaged in a tapped hole through the upper surface of the block 170. The wire 22 emerging from the traction drive mechanism 20 enters a central bore 180 formed axially through the wire guide 176 via the flared mouth thereof, it enters through a constricted passage 184 having a diameter just slightly larger than that of the wire 22, and emerges through an end face 186 of the wire guide 176. The end face 186 is one of the elements which cooperates in shearing the wire 22 during the repeated cutting operations performed by the mechanism 28.

The other shearing element which cooperates therewith is an end block 190. The shearing block 190 reciprocates left and right as seen in the view of FIG. 7, within a horizontal slot 192 formed in the block 170. The block 190 is formed at either end with a pair of upstanding lugs 194 and 196 which embrace the upper portion of block 170 and strike alternately against stop pins 198 and 200 respectively which are frictionally received within a horizontal bore 202. In this way the lugs 194 and 196 cooperate with the stop pins 198 and 200 to define two opposite limiting positions to the reciprocating shearing block 190.

In one of its limiting positions, lug 196 contacts stop pin 200 and a first wire exit hole 204 is then aligned with the wire passage 184 as seen in FIGS. 7 and 8. In the opposite limiting position, the lug 194 contacts the stop pin 198 and another wire exit hole 184 is then aligned with the wire passage 184. As seen in the view of FIG. 7, the wire 22 emerging from passage 184 passes out through exit hole 204, through a large oval opening 208 formed in the shearing block 190, and out through an opening 210 formed in a cover plate 212 secured to the mounting block 170 by means of bolts 213. However, after a predetermined length of wire 22 has escaped from the passage 184 and extends through the openings 204, 208 and 210 to overhang the tray 30 on the table extension 78, the shearing block 190 is suddenly shifted to the right as seen in FIG. 7 and 8. This causes the wire 22 to be sheared off as surfaces 188 and 186 slide across each other.

The motion is very abrupt and very quick, with the result that the wire 22 emerging from the passage 184 is neatly and quickly severed, and before the continuously advancing wire has a chance to buckle objectionably against the surface 188 the exit hole 206 is immediately brought into line with passage 184. As a result the next succeeding segment of wire 22 emerges through exit hole 206 and the opening 208 and 210 to overhang the tray 30. After a predetermined length of wire has emerged in this way, the shearing block 190 is again abruptly shifted, returning to its original position of FIGS. 7 and 8. When this happens the wire 22 is again sheared off, and the initial conditions are restored. Cyclical repetition of this operation results in the repetitive severing of successive discrete lengths of the wire 22 as the wire advances continuously into the cutting mechanism 28 under the influence of the traction drive 20.

The reciprocating motion of the shearing block 190 is imparted thereto by a pair of oppositely located solenoids 214 and 216, operating armatures 218 and 220 respectively. Electrical leads 222 and 224 passing through opening 223 and 225 respectively are provided to energize the solenoids, and a conventional energizing circuit (not shown) is provided to energize the leads 222 and 224 in the proper timed alternating relationship so that the shearing block 190 reciprocates at the correct intervals to sever the desired lengths of wire 22. The solenoids 214 and 216 are mounted upon side brackets 226 and 228 respectively which are integral with the pedestal 168, and the armatures 218 and 220 operate the shearing block 190 by means of plungers 230 and 232 respectively which are received within appropriate bores formed within these side brackets. Within the bores are also located respective biasing springs 234 and 236 for the plungers 230 and 232. These plungers act against stop pins 238 and 240 respectively frictionally received within suitable openings at the sides of the block 190 to reciprocate the block when the respective solenoids are energized.

In order that the two alternative positions of the shearing block 190 may be sharply defined, and the shearing block snapped quickly and cleanly between those positions, an over-center detenting mechanism 242 is provided. This comprises a tubular member 244 which passes upwardly through a recess 246 formed in the pedestal 168, and is threaded upwardly into a tapped hole 248 in the underside of the mounting block 170. The upper end of the tubular member 244 protrudes into a well 250 extending down from the lower surface of the horizontal slot 192 which is formed in the mounting block 170. A small operator 252 protrudes partway in an upward direction from the interior of the tubular member 244 into the well 250. An appropriate biasing spring (not shown) within the tubular member 244 biases the operator 252 upwardly to the illustrated position, but the operator is too large to escape entirely through its opening in the tubular member 244. A steel ball 254 is received within a socket 256 formed in the underside of the shearing block 190, and has a large enough diameter to interfere with the upwardly projecting tip of the operator 252.

When the reciprocating shearing block 190 is shifted to the left as seen in FIGS. 7 and 8, the steel ball 254 is positioned to the left of center of the operator 252 as seen in those FIGS. As the shearing block 190 snaps to the right of those FIGS. it carries the steel ball 254 with it, and the steel ball then depresses the operator 252 as shown in FIG. 7. In the illustrated position, the tubular member 244, snapping overcenter, and coming to rest to the right of center. When the opposite motion of the shearing block 190 is performed, the ball 254 snaps to the left, and initial conditions are restored. Thus the detenting mechanism 242 provides the shearing block 190 with two sharply defined positions, and has an overcenter feature which causes it to snap sharply between those two positions. The tubular member 244 can be reached through the notch 246 and threaded within the path opening 248 to adjust the spring force between the operator 252 and steel ball 254, until optimum operation of the detenting mechanism 242 is obtained.

In order to keep the mounting block 170 securely in place within a depression 255 formed in the pedestal 168, there is provided a bolt 258 which is threaded downwardly through a crossarm 260 to bear against the top of the mounting block 170. The bolt is secured in place by a nut 262, and the arm 260 is formed at one end with a longitudinal slot 265 to receive a binding post 266, the lower end of which is threaded engaged with the tapped opening 268 below a recess 270 in the side bracket 226. At its opposite end, the arm 260 is received within a recess 274 of the side bracket 228, and pivotally secured thereto by a pin 272. The arm 260 can thus be rotated upwardly about pivot pin 272 to the dashed line position of FIG. 7 in order to permit removal of the mounting
block 170 so that the shearing block 190 can be extracted from its opening 174 when it becomes necessary to substitute a new shearing block and a new tubular guide for use with a different size wire 22. The enlarged head of the binding post 266 can be turned from the crosswise position of FIGS. 2 and 7 to a position of alignment with slot 265. This permits the slotted end of the arm 260 to escape past the head of binding post 266. After reassembly of elements 170 and 190, the arm 260 is rotated back down into the recess 270 (the solid line position of the drawings) and the head of binding post 266 is turned crosswise to the slot 265 (the position seen in the drawings) so as to secure the arm 260 in place and thus hold the shearing block 170 within its recess 255.

Generally, in conventional shearing devices, a shearing edge has to pass through the material that is being cut, and then has to come to a stop, accelerate in a reverse direction and retract past the material cut, returning to its original position before it is ready for the next shearing operation. My shearing edge of each shearing aperture 204 and 206 passes through the material, but does not retract. Instead, this invention automatically brings a second shearing edge into position to cut the edge of the opposite shearing aperture 206 or 204.

Stretch straightening in the manner described herein is useful with a wide variety of materials in which the "plastic range" or difference between the tensile yield stress and the ultimate tensile stress is not too narrow. Examples of such materials are copper and copper alloys, low carbon steel, brass, nickel-iron and alloys of that nature.

On the other hand, ultimate tensile stress and tensile yield stress may be very close together in such materials as aluminum and stainless steel. With such materials, lack of precision in controlling the amount of stretch straightening stress imposed may risk breaking the wire. Furthermore, the available power may be insufficient to stress such wire beyond its yield point. In order to avoid these limitations of the stretch straightening technique in such cases, either roll straighteners or rotary straighteners may be used. Any of these straighteners may be employed in the combinations of this invention, feeding wire directly into the traction drive 20 and thence into the dual-shearing cutoff device 28.

It will now be appreciated that the preferred mechanism of this invention illustrated in the drawings continuously unwinds curved wire from a supply reel, draws it through a dynamic braking mechanism and stretches it in pure tension, past its yield point, by means of an adjustable traction drive, in order to remove the curl without imposing any lateral deformation on the wire, a feature which is particularly important when dealing with small diameter wire stock. In addition, the mechanism continuously feeds the straightened wire into a snap-acting cutter which accepts a continuous feed from the traction drive as the wire proceeds to predetermined lengths, without the necessity for intermittent stoppage of the traction drive.

Since the foregoing description and drawings are merely illustrative, the scope of protection of the invention has been more broadly stated in the following claims, and these should be liberally interpreted so as to obtain the benefit of all equivalents to which the invention is fairly entitled.

I claim:

1. A machine for straightening coiled wire comprising means defining a feed path for said wire a yieldable brake means in said wire feed path for dynamically retarding said wire as it moves along said path, and a traction drive downstream from said brake means for pulling said wire along said feed path from said brake means whereby said wire is stressed in tension beyond its yield point between said traction drive and said brake means while moving along said feed path.

2. A machine as in claim 1 further comprising means downstream from said traction drive for cutting said wire into discrete lengths as it emerges from said traction drive.

3. A machine as in claim 2 further comprising means on said wire feed path upstream from said brake means for rotatably supporting a coil of wire whereby to unreel said wire therefrom for passage down said feed path.

4. A machine as in claim 1 wherein said brake means comprises a brake wheel, means rotatably mounting said wheel, a material on the periphery of said wheel having a relatively high coefficient of friction whereby said wire may be wrapped around said wheel in frictional engagement with said peripheral material, and a brake shoe bearing frictionally against said wheel to retard the rotation thereof in response to the tractive force exerted on said wire.

5. A machine as in claim 4 further comprising means for adjusting the force exerted by said brake shoe upon said wheel.

6. A machine as in claim 5 further comprising a supply reel of wire on which said wire is wound in a first angular sense, said wire being wrapped around said brake wheel in the opposite angular sense.

7. Continuous-flow wire straightening traction drive apparatus comprising continuously operating wire straightening means including a brake wheel, means rotatably mounting said wheel, a material on the periphery of said wheel having a relatively high coefficient of friction whereby said wire may be wrapped around said wheel in frictional engagement with said peripheral material, and a brake shoe bearing frictionally against said wheel to retard the rotation thereof in response to the tractive force exerted on said wire and a pair of traction drive belts having respective surfaces formed of a yieldable material, said belts being positioned with said yieldable surfaces in confronting relationship with each other, means defining a wire feed path leading from said straightening means between said confronting surfaces, opposed means pressing said belts together so that said confronting surfaces frictionally engage said wire therebetween, and means providing a drive to at least one of said belts whereby to exert tensile stress on said wire beyond its yield point.

8. A traction drive as in claim 7 further comprising a wheel at each end of each of said belts, at least one of said wheels drivingly engaging its associated belt, said belt driving means being connected to rotate said drive wheel whereby to revolve said belt thereabout.

9. A traction drive as in claim 8 wherein said driving wheel is toothed, and its associated belt has mating teeth on the inside surface thereof.

10. A traction drive as in claim 9 further comprising a pair of cooperating pressure means located between the wheels of each pair associated with each of said belts, said pressure means pressing said belts together whereby to grip said wire therebetween.

11. A traction drive as in claim 10 further comprising means for adjusting the pressure exerted upon said belts by said pressure means.

12. A traction drive as in claim 11 wherein said adjusting means comprises a spring jack, and an elastomeric foot coupling said screw jack to said pressure means whereby to equalize the pressure exerted thereon by said screw jack.

13. A device for cutting discrete lengths from the leading end of a continuous advancing wire, comprising: a shearing block formed with an entrance face and two wire passages leading from said face through the body of said block, a wire guide having a passage for leading said advancing wire to said entrance face, the two wire passages and the wire guide passage closely embracing the advancing wire coaxially on opposite sides of the shearing block entrance face and thereby forming elongated lateral support for the wire during the shearing operation and means causing abrupt, nonharmonic cyclical intermittent relative motion between said shearing block and said guide wire between two relative positions, said wire guide passage aligning with one of said two shearing block wire passages in one of said relative positions and with the other of said shearing block wire passages in the other of said relative positions, whereby to deliver said wire to each of said passages for a limited time and thereafter to shear off said wire between said guide wire and said shearing block and deliver said wire to the other passage as a result of said relative motion.

14. A device as in claim 13 wherein said means for producing relative motion comprises a pair of solenoids at opposite
sides of said device, said solenoids having respective armatures spaced from and laterally aligned for abutting impact against the lateral sides of the shearing block in response to energization of said solenoids for producing oppositely directed phases of said cyclical relative motion, a means for energizing said solenoids alternately.

15. A device as in claim 14 wherein said shearing block is movable in response to lateral impact of each of said solenoid armatures, said device further comprising means mounting said shearing block for reciprocation to perform said movement relative to said wire guide.

16. A device as in claim 15 further comprising overcenter means engaging said shearing block to cause it to toggle between its two positions relative to said wire guide.