REWINDING PROCESS AND APPARATUS

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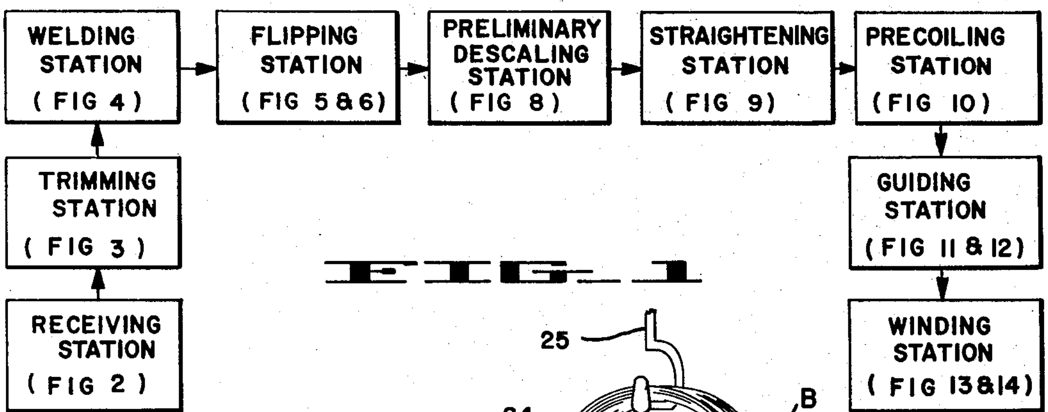

FIG. 1

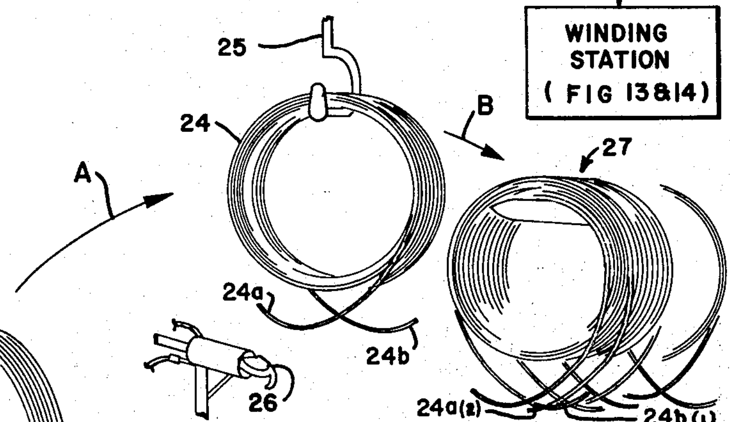

FIG. 3

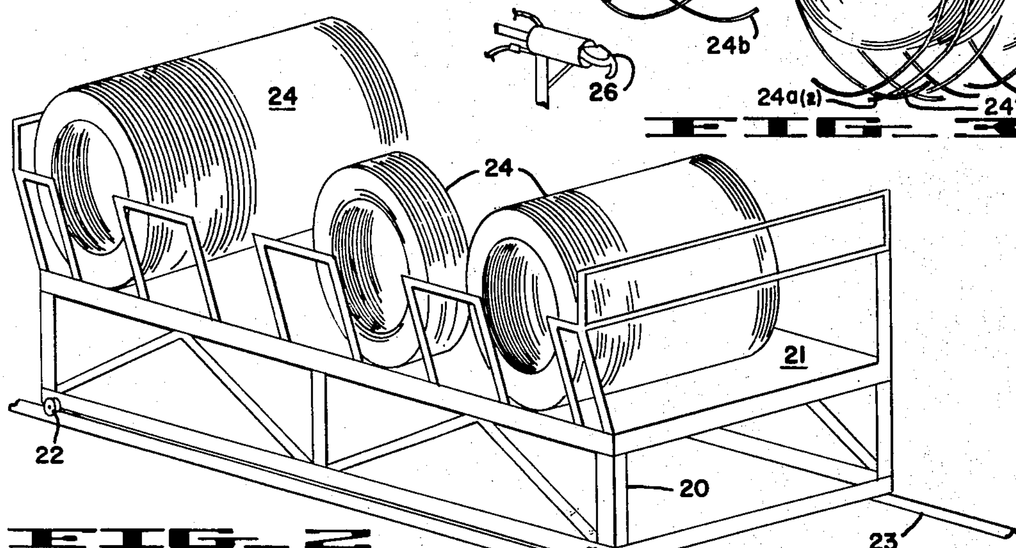

FIG. 2

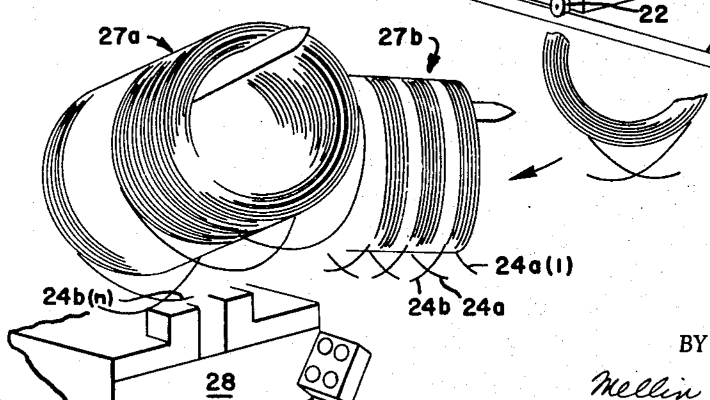

FIG. 4

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REWINDING PROCESS AND APPARATUS

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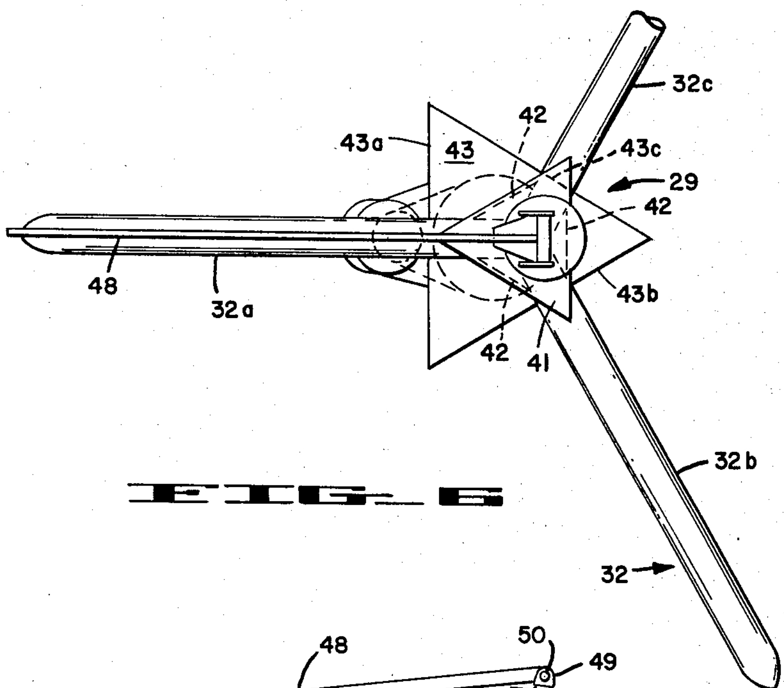

FIG. 6

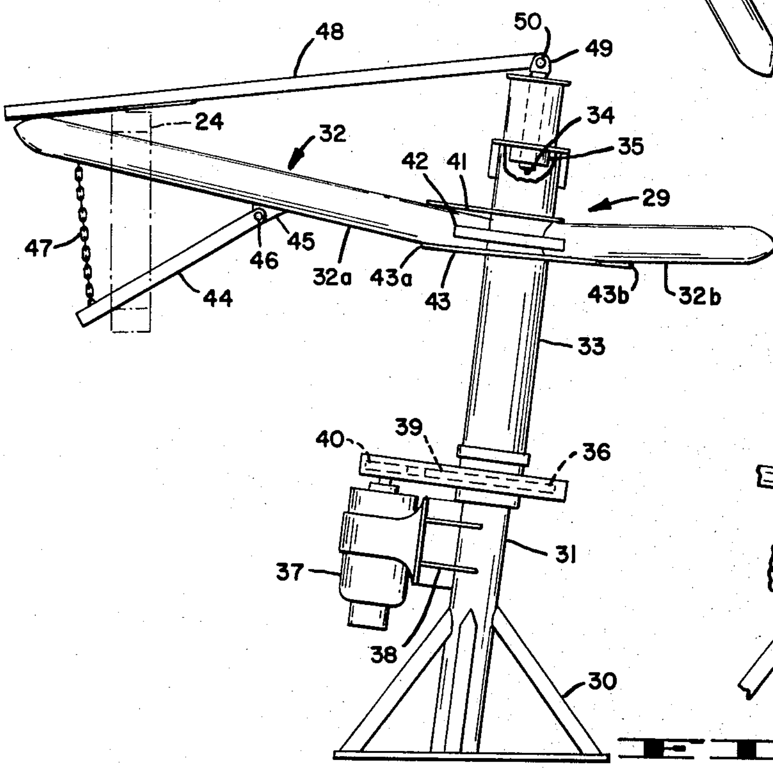

FIG. 5

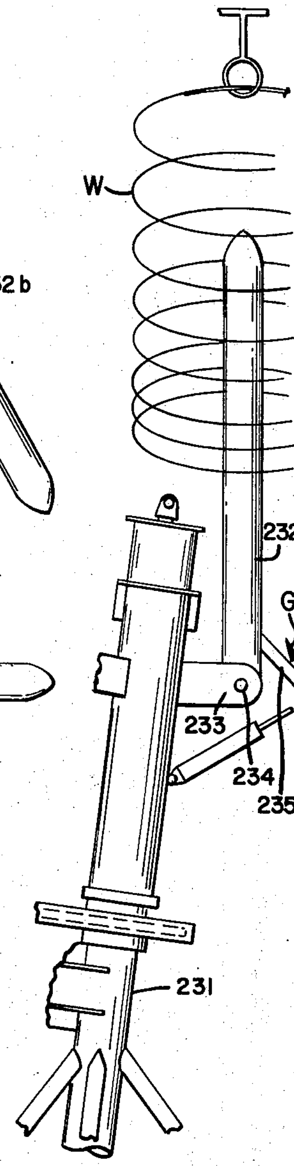

FIG. 7

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REWINDING PROCESS AND APPARATUS

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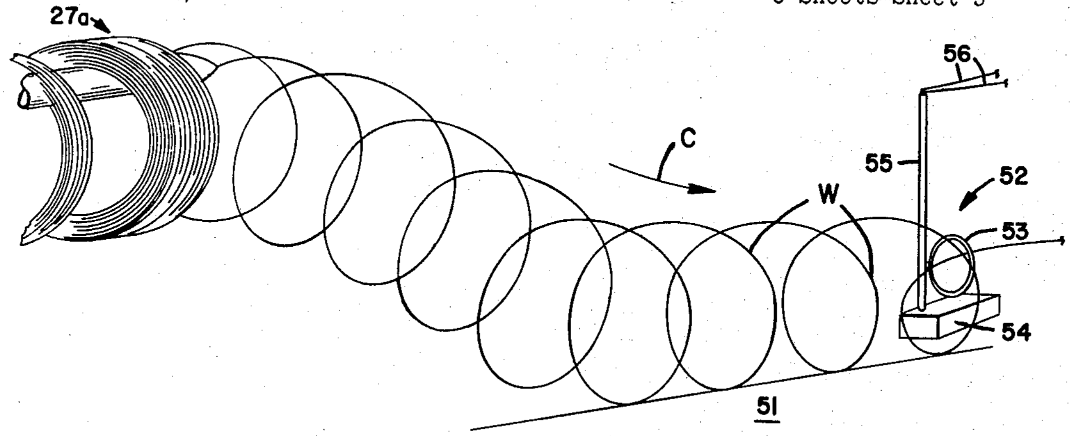

FIG. 8

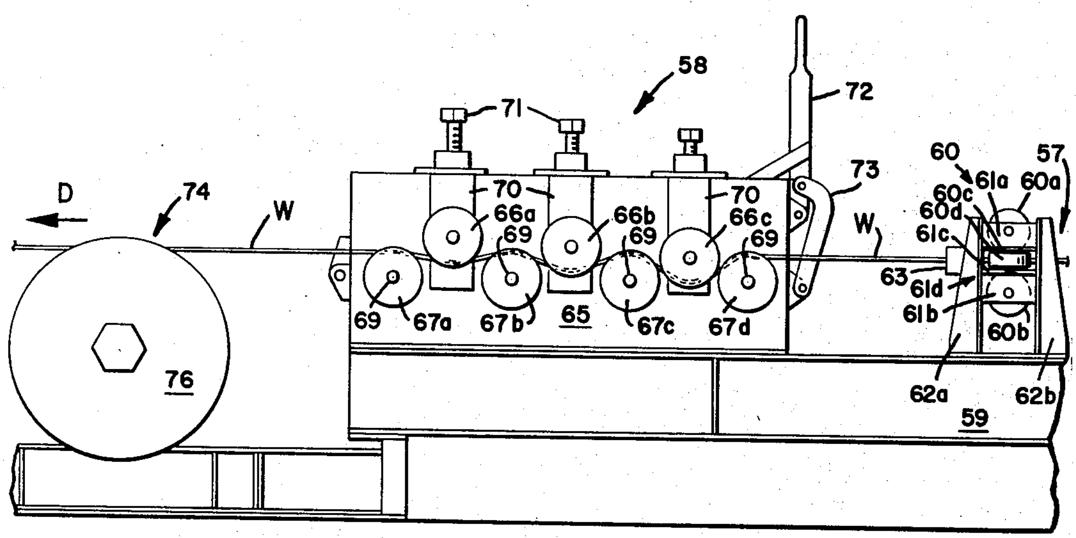

FIG. 9

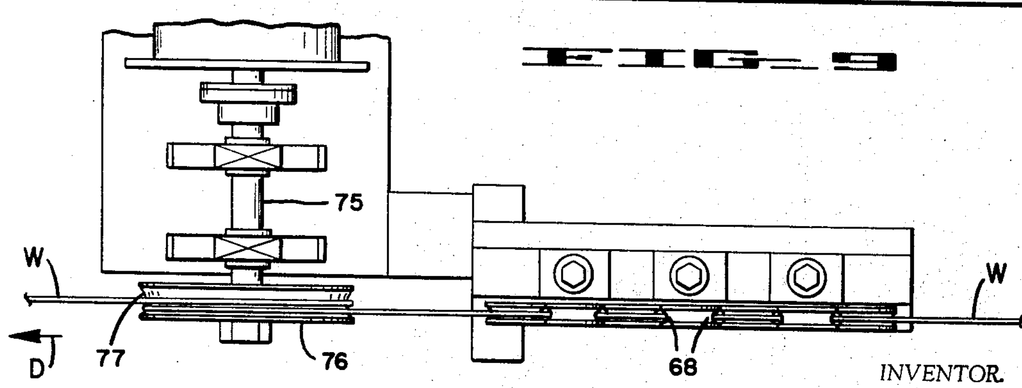

FIG. 10

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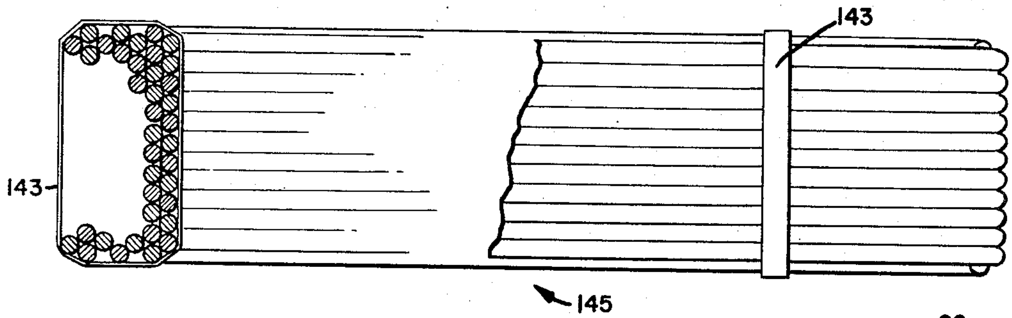

FIG. 15

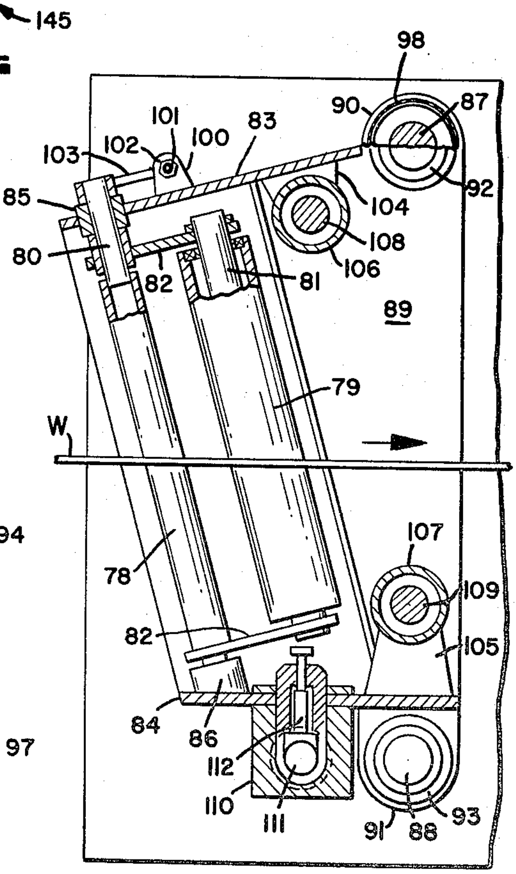

FIG. 12

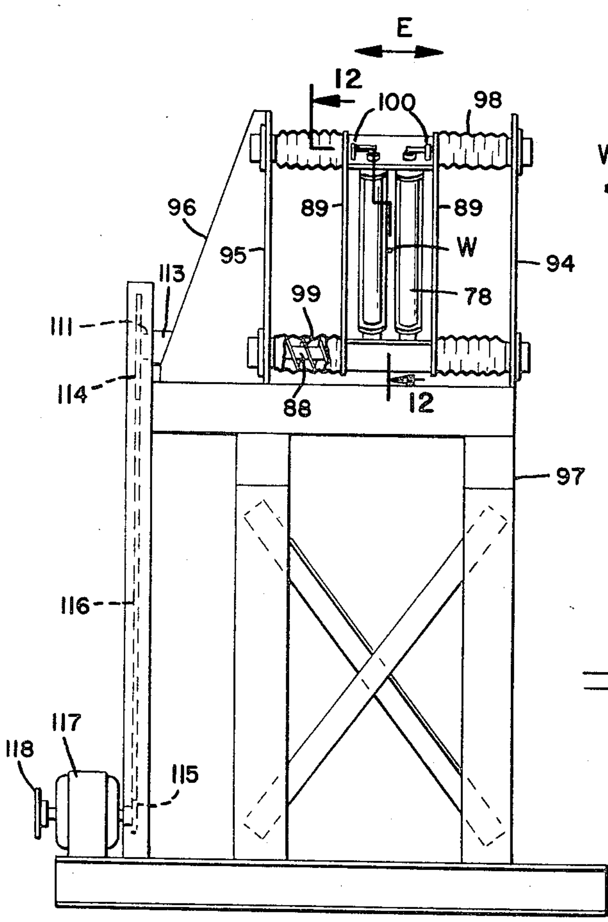

FIG. 11

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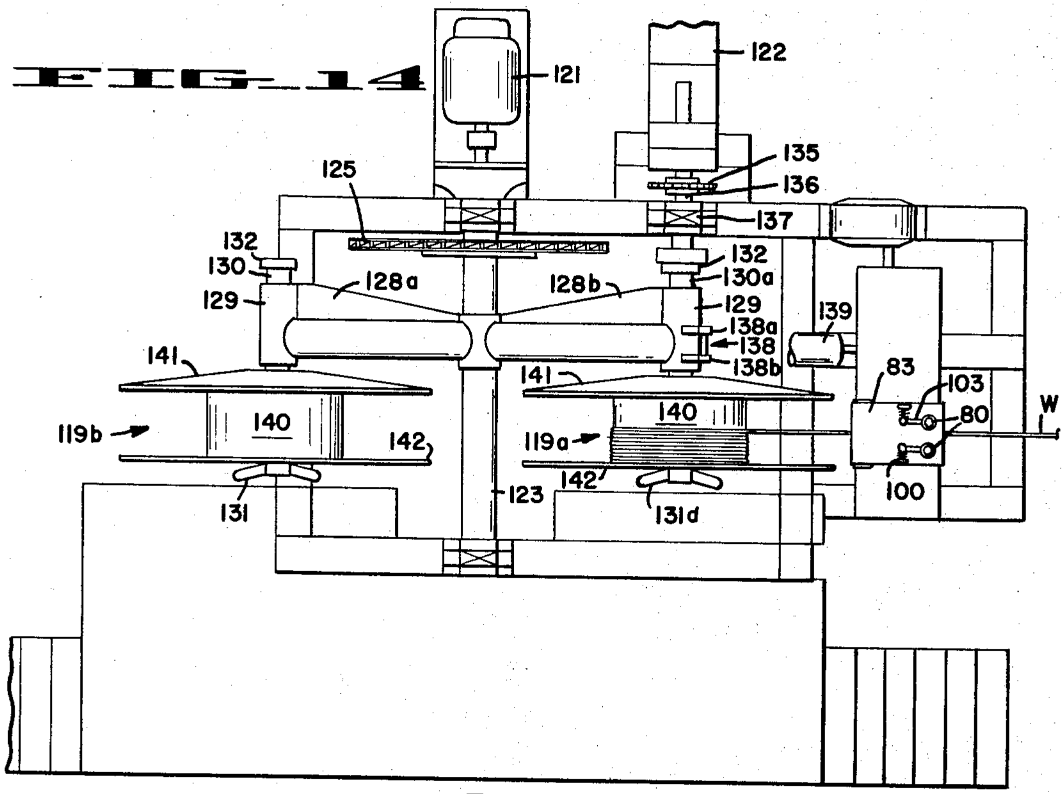
FIG. 14



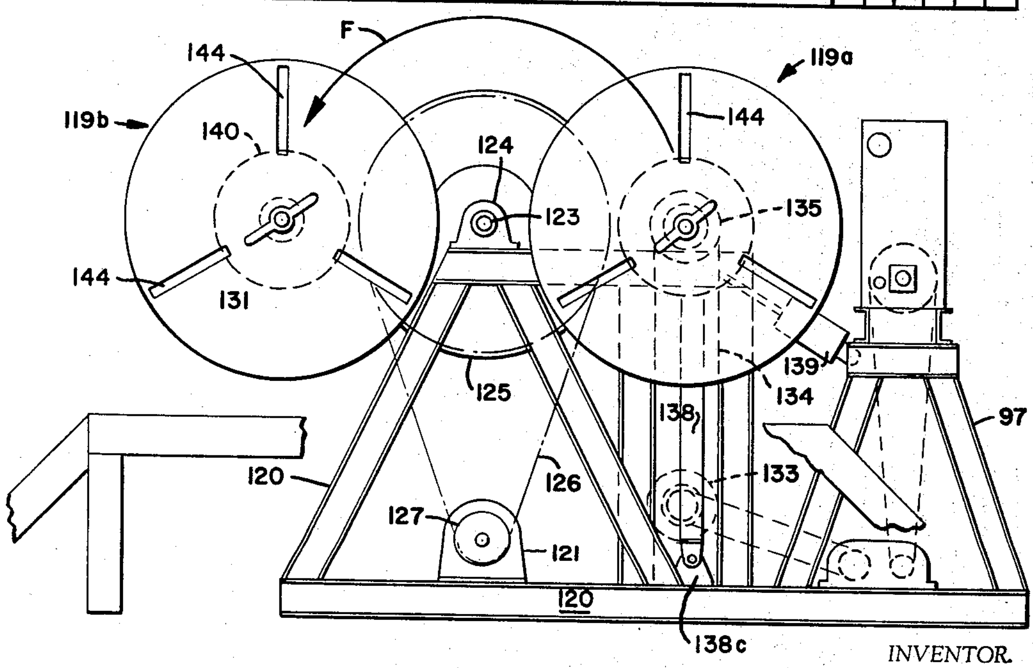


FIG. 13

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United States Patent Office

3,360,016
Patented Dec. 26, 1967

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3,360,016

REWINDING PROCESS AND APPARATUS

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Filed Jan. 6, 1965, Ser. No. 423,721
9 Claims. (Cl. 140—1)

ABSTRACT OF THE DISCLOSURE

A continuous method for making wire coils wherein a number of individual coils are placed adjacent one another, an end of each coil is secured to the compatible end of the adjacent coil to make the individual coil continuous, the coils are uncoiled, the wire is reciprocally bent, precoiled, reciprocally guided for winding about a reel, and then is wound about the reel, the reel being rotated with constant torque.

This invention relates to a method and apparatus for rewinding loosely coiled wire rods (such as those used in reinforcing concrete) into longer continuous compactly wound coils. The invention converts a dead cast mill coil into a longer tightly wound coil having improved shipping, storage, and pay-out characteristics.

In the art of manufacturing reinforcing rods or wire for concrete structures, the rods are customarily made in a rolling mill by passing steel rods at elevated temperatures through rollers which produce a welted rod having, for typical uses of the embodiment of the invention described herein, a diameter of ¼ inch to ½ inch or more. Upon exit from the rolling mill, the hot wire is dead cast (loosely coiled) into coils roughly 3 feet in diameter and weighing about 200 pounds.

The dead cast mill coils have very poor pay-out characteristics and cannot be paid out circumferentially. Stated another way, if an attempt is made to unwind the mill coil circumferentially by rotating it about its axis, the coil snarls and smooth unwinding is impossible. It may not be unwound on an A-frame, which is a material shortcoming because most manufacturing processes require such a method of unwinding. Thus, the mill coil must be paid out in a direction that generally corresponds to its axis by unwinding the coil convolution by convolution.

The dead cast mill coils are also undesirable in storage and shipping because the coil density is low, requiring excessive space. The mill coils also tangle with one another easily. They are coated with a mill scale that must be removed prior to use. The length of individual mill coils is too short for efficient feeding into continuous processes because the spent coil must be too frequently replaced.

Accordingly, the invention has for its objects:

To provide a level and tightly wound coil that may be uncoiled by rotation about its axis smoothly without snarling.

To provide a compactly wound coil having a generally rectangular radial cross section.

To provide a continuous method for connecting loosely wound mill coils, uncoiling the mill coils, cold working the wire, and rewinding it into a tightly and level wound finished coil.

To provide a method for rewinding mill coils which incorporates a cold working of the wire to increase its strength and remove mill scale therefrom.

To provide a novel method and apparatus for continuously forming a plurality of banks of mill coils, connecting adjacent mill coils and adjacent banks, and continuously uncoiling connected coils from a bank.

To provide a continuous method for rewinding uncoiled wire wherein the take-up reel is drawn with constant torque and the wire is fed into the take-up reel at a constant speed to insure a uniformly tightly wound finished coil.

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To provide a method for efficiently removing a finished coil from the take-up position, removing the finished coil from the take-up reel, and placing an unfilled reel in the take-up position.

Each of the objects is fulfilled in the specific embodiment which appears in FIGS. 1–6 and 8–14. FIG. 7 is a variation in the design of one station and FIG. 15 shows the finished coil. With reference to the drawings:

FIG. 1 is a diagram showing the stations in chronological sequence that are provided in the preferred embodiment of the invention.

FIG. 2 is a perspective view of the receiving station.

FIG. 3 is a perspective view showing the trimming station and movement from the receiving station thereto.

FIG. 4 is a perspective view of the welding station.

FIG. 5 is a side view of the flipping apparatus or star-wheel which is included in the flipping station.

FIG. 6 is a top view of the star-wheel shown in FIG. 5.

FIG. 7 is a side view of a variation in the design of the star-wheel and includes vertically pivotal bank arms for vertical pay-out of the connected mill coils as shown.

FIG. 8 is a perspective view showing pay-out of the coil from the flipping station or star-wheel and impact descaling. Thus, it shows the descaling station and in addition shows a snarl actuated switch which stops the process in the event of snarling.

FIG. 9 is a side view of the straightening switch and pre-coiling station.

FIG. 10 is a top view of the straightening and pre-coiling stations as shown in FIG. 9.

FIG. 11 is a side view of the guiding station taken in a direction corresponding to the input of the wire thereto.

FIG. 12 is a sectional side view taken on the line 12—12 of FIG. 11.

FIG. 13 is a side view of the winding station.

FIG. 14 is a top view of the winding station as shown in FIG. 13.

FIG. 15 is a radial sectional view of a finished coil and shows the compact, level wound, and generally rectangular radial cross section of the finished coil.

The process of the present invention includes placing a plurality of individual mill coils adjacent to one another with their ends hanging symmetrically beneath the coil to form a first bank of coils, securing one end of one coil to the compatible end of the adjacent coil, providing a second bank of individual coils and securing one end of one coil in the second bank to the compatible end of the adjacent coil, and securing the end of the first placed individual coil of the first bank to the compatible end of the last placed coil in the second bank, providing a third bank in a manner similar to the provision of the first and second banks, continuously uncoiling the wire from the first bank, applying a tensile force to the wire, reciprocally bending the wire, winding the wire about a precoiler, reciprocally guiding the wire into a take-up reel and continuously winding the wire about the take-up reel to form a finished coil.

The process may be conveniently carried out with the aid of the apparatus appearing in FIGS. 1–6 and 8–14. The apparatus defines the various stations designated in FIG. 1.

The receiving station (FIG. 2) consists of a frame **20** and a platform **21**, mounted for convenient movement on wheels **22** and rails **23**. Individual loosely wound mill coils **24** are placed on frame **20** in any convenient manner such as by a fork lift truck. Frame **20** is then moved into position in close proximity of the trimming station.

The mill coils are then moved from the receiving station by means of monorail hoist **25** as shown by arrow A to the trimming station (FIG. 3). The irregular ends of the mill coils **24** are sheared by hydraulic shear **26** so that they hang symmetrically below mill coil **24** which is apparent with reference to mill coil ends **24***a* and **24***b* (FIG. 3). After shearing or trimming the mill coil **24** is moved by monorail hoist **25** as shown by arrow B and placed adjacent other mill coils to form a first bank of coils referred to generally by reference number **27**. The mill coils **24** are placed in bank **27** so that adjacent ends of adjacent coils are compatible. Compatibility requires that adjacent ends of adjacent coils intersect (as opposed to hanging parallel) so that they may be butt welded to form a continuous wire made up of a number of mill coils. This is best seen with reference to bank **27** of FIG. 3. There mill coil ends **24***b***(1)** and **24***a***(2)** are compatible and adjacent mill coils **24(1)** and **24(2)** must be oriented in bank **27** to achieve this compatibility.

From the trimming station bank **27** is moved to the welding station (FIG. 4). There compatible ends **24***a* of one mill coil and **24***b* of the adjacent coil are butt welded together. Flash butt welder **28** is provided for that purpose. End **24***b*(*n*) is butt welded to the compatible end **24***a***(1)** of the last placed mill coil on bank **27***b* so that uncoiling of bank **27***a* leads continuously to the uncoiling of bank **27***b*. The uncoiling appears best in FIG. 8. If desired the welds may be color-marked at this point for manual or photoelectric rejection in subsequent manufacturing processes in which use of weld-containing sections is undesirable.

The flipping station comprises a star-wheel referred to generally as **29** and best viewed in FIGS. 5 and 6. The star-wheel includes a base **30**, a substantially vertical member **31**, and bank arms **32** radially secured to sleeve **33**. Member **31** is preferably tilted from the vertical so that the bank from which uncoiling is accomplished is inclined upwardly in the direction of the uncoiling. Sleeve **33** is mounted for rotational movement about substantially vertical member **31** and includes pin **34** mounted for rotational movement in sleeve **33** (but not slidable therein) and in bearing socket **35** of member **31**. Sleeve sprocket **36** is fixed to the lower extremity of sleeve **33**. Motor **37** is mounted to member **31** by means of mounting brackets **38**. Chain **39** provides a linkage from the motor sprocket **40** to sleeve sprocket **36** so that rotation of motor sprocket **40** provides a rotational movement of sleeve sprocket **36**, sleeve **33** and bank arms **32**. Triangular gussets **41, 42,** and **43** are rigidly secured to sleeve **33** and bank arms **32** to provide a reinforced rigid joint. Intermediate gussets **42** are three in number and provide a web portion between the bank arms **32** as best seen in FIG. 6. Upper gusset **41** is secured to the upper surface of bank arms **32** and positioned so that its corners extend in the same direction as arms **32** which also can be best seen in FIG. 6. Lower gusset **43** is larger than upper gusset **41** and is positioned out of phase with respect to upper gusset **41**. Thus, lower gusset **43** is oriented so that its edges **43***a, b,* and *c* are perpendicular to the axis of bank arms **32***a, b,* and *c* respectively. The edges **43***a, b,* and *c* provide a surface which aligns banks **27** as the inner mill roll of the bank abuts the edges.

Drop arm **44** is pivotally mounted to the underside of bank arm **32** by means of bracket **45** and pin **46**. It is suspended on chain **47** which is secured at one end to bank arm **32**. The position of drop arm **44** may be changed by lengthening or shortening chain **47** from the dropped position shown in FIG. 5 to a retracted position (not shown) wherein drop arm **44** is parallel and adjacent to bank arm **32**.

An overarm **48** is pivotally connected to pin **34** by means of bracket **49** and pin **50**. Since pin **34** is rotatable about its axis independent of the rotation of sleeve **33**, overarm **48** may be positioned over either bank arm **32***a* (as shown), **32***b*, or **32***c* (not shown). Thus, it may be positioned over whichever bank is being paid out for the purpose of controlling pay-out of the coil convolutions as shown in FIG. 5. There overarm **48** rests against the upper surface of bank arm **32** to control the pay-out of coil **24**. Drop arm **44** is shown in a dropped position to assist in controlling the pay-out as may be readily seen. When mill coils are placed upon the bank arms (as distinguished from being uncoiled from the arms), overarm **48** is pivoted about the axis of pin **34** and associated with another bank arm (from which uncoiling is progressing) and drop arm **44** is retracted to a position adjacent bank arm **32**.

As mill coils **24** are paid out from bank **27** it is desirable, though not essential, to provide a preliminary descaling station as shown in FIG. 8. The descaling station consists merely of a hard rough surface **51** (roughly surfaced concrete, for example), which is abrasive. As the coil convolutions are pulled in the direction of arrow C and drop onto the surface **51**, the impact and abrasion against surface **51** removes a significant portion of the mill scale.

Snarl switch assembly **52** comprises hoop **53** through which the wire is threaded as shown in FIG. 8. Hoop **53** is pivotally mounted to base **54**. Conduit **55** is also mounted to base **54** and conducts leads **56** from a switch (not shown) mounted on base **54** toward the precoiling station (where they are connected to the precoiler drive motor circuit so that opening the switch stops the motor). Hoop **53** is pivoted about its vertical axis whenever a snarl prevents passage of the wire W therethrough. The pivoting opens the switch and stops the precoiler motor. Thus, any snarl automatically stops the rewinding process.

The wire W next passes through the straightening and precoiling stations which appear in FIGS. 9 and 10. The straightening station includes bell mouth entry cone assembly **57**, straightener **58** and base **59**. Entry cone **57** includes entry rollers **60** mounted for rotational movement on four axes respectively which lie in a common plane perpendicular to the direction of travel of the wire W and define a square. Rollers **60***a* and **60***b* are mounted to brackets **61***a* and **61***b* respectively. Rollers **60***c* and **60***d* are mounted to bracket **61***c* and **61***d* respectively. Brackets **61***a–d* are mounted to brackets **62***a* and **62***b* which is in turn mounted to base **59**. Bracket **62***b* contains an input aperture **64** which has a diameter approximately equal to the diameter of the entry rollers **60** and exposes approximately one-half the diameter of each. Thus, an entry cone is provided for the wire W. Entry rollers **60** are spaced such that they define a square passage having dimensions slightly less than the diameter of wire W. An output aperture sleeve **63** is provided in bracket **62***a* through which wire W exits. A drag mechanism (not shown) may be provided to inhibit rotation of rollers **60** to produce tension in wire W between entry cone assembly **57** and straightener **58**.

Straightener **58** includes frame **65**, an upper bank of rollers **66***a, b,* and *c* and a lower bank of rollers **67***a–d* The rollers **66** and **67** contain a concave peripheral surface which is best seen in FIG. 10 at **68**. Rollers **67** are rotatably mounted to frame **65** on shafts **69**. Upper bank **66** is rotatably mounted to mounting plates **70**. Rollers **66** are vertically adjustable by means of rotation of adjusting screws **71**. Mounting plates **70** are connected to a common frame member (not shown) which may be raised or lowered by means of lever **72** and linkage **73** to respectively disengage and engage wire W. The rollers **65** and **66** are horizontally aligned as best seen in FIG. 10. They are vertically staggered as best seen in FIG. 9 to provide a zig-zag passage for wire W. Thus, as wire W is drawn through rollers **66** and **67**, it is reciprocally bent. It will be noted that the degree of bending in successive roller passes may be adjusted by means of adjusting screws **71**. As shown at FIG. 9 bending is more extreme upon entry (see rollers **67***d* and **66***c*) and generally decreases to very little bend in the output rollers **66***a* and **67***a*.

The straightener **58** cold works the steel, removes the remaining mill scale and eliminates the bending-moment resiliency induced by the first coiling as the wire is dead cast from the rolling mill. The cold working also increases the yield point.

Wire W is drawn through straightener **58** by means of precoiler **76** which is mounted to base **59** and forms the precoiling station referred to generally at **74**. Precoiler station **74** includes a precoiling motor (not shown) which drives shaft **75** and precoiler **76**. Like rollers **66** and **67**, precoiler **76** is concave at its circumference which can be best seen at **77** in FIG. 10. It is of sufficient width or thickness **77** to accommodate two diameters of wire. The precoiling motor is driven at an adjustable speed which remains constant regardless of load. Wire W is wound around precoiler **76** for one convolution and paid out in the direction of arrow D. Friction between wire W and precoiler **76** prevents slippage and precoiler **76** pulls wire W through straightener **58** at a constant speed. Thus, upon its entry to precoiler **76**, wire W is under tension. Passage about precoiler **76** induces a bending moment resiliency, and the diameter of precoiler **76** is chosen so that this bending moment resiliency generally tends to hold the wire in a curvature approximately equal to the inner diameter of the finished coil. Precoiler **76** is, of course, aligned with straightener **58** and entry cone assembly **57**.

From the precoiler **76** wire W is fed through the guiding station (FIGS. 11 and 12). It passes first between entry rollers **78** and then between gripping rollers **79**. Both rollers **78** and **79** are mounted for rotation about the respective entry roller shafts **80** and gripping roller shafts **81**. Roller shafts **80** and **81** are mounted in a generally vertical plane but are tilted toward the direction of entry of wire W as best seen in FIG. 12. Gripping roller shafts **81** are mounted at each end to brackets **82** which are in turn rigidly secured to entry roller shafts **80**. Gripping roller shafts **81** therefore pivot about the axis of entry roller shaft **80** on brackets **82** as entry roller shafts **80** are pivoted. Entry roller shafts **80** extend through and are journaled in upper plate **83** and lower plate **84** at **85** and **86** respectively. Upper and lower plate **83** and **84** are mounted for reciprocal movement on bars **87** and **88** respectively. This is accomplished through the use of side plates **89** which are rigidly mounted to upper and lower plates **83** and **84** and contain integral mounting brackets **90** and **91** fixed to sleeves **92** and **93** respectively which are slidable along bars **87** and **88** respectively. Thus, the guide and gripping roller assembly is mounted for reciprocal movement on bars **87** and **88** in the direction of arrows E as shown in FIG. 11.

Bars **87** and **88** are mounted in mounting brackets **94** and **95**. Mounting bracket **94** is reinforced against tilting by web **96**. The mounting brackets **94** and **95** are rigidly secured to frame **97**. Canvas bellows **98** are provided on a coil spring skeleton **99** to serve as a dust cover in the area of bars **87** and **88** not covered by sleeves **92** and **93**.

Studs **100** are fixed to upper plate **83**. Bolts **101** extend through studs **100** and are spring loaded against nut **102**. The ends of bolts **101** opposite nut **102** are pivotally connected to arms **103**. Arms **103** are rigidly connected to entry roller shafts **80**. Thus, as nuts **102** are loosened or tightened, arms **103**, entry roller shaft **80**, brackets **82**, gripping roller shaft **81** and gripping roller **79** is pivoted about the axis of entry roller shaft **80**. The spring mounting of bolts **101** also holds gripping rollers **79** resiliently against wire W and, together with stud **100**, provides a method for adjusting the spacing between gripping rollers **79** to accommoate various wire diameters.

Guide roller brackets **104** and **105** are mounted on upper plate **83** and lower plate **84** respectively. Guide rollers **106** and **107** are mounted for rotational movement on shafts **108** and **109** respectively which in turn are mounted to brackets **104** and **105**. Guide rollers **106** and **107** serve to limit the vertical traverse of wire W to somewhat less than the length of entry and gripping rollers **78** and **79**.

Pawl housing **110** is mounted to the lower side of lower plate **84** and envelops worm gear shaft **111**. Pawl **112** is removably mounted in pawl housing **110** and engages the track of worm gear shaft **111** which is mounted for rotational movement in mounting bracket **94** and bearing **113**. Worm gear shaft sprockets **114** is linked with gear reducer sprocket **115** by means of chain **116**. Gear reducer **117** is mounted to frame **97** and power is supplied to sprocket **118** from a power source not shown. Thus, as worm gear shaft **111** is rotated, pawl **112** follows the worm gear track and as a result, reciprocates pawl housing **110**. The gripping and roller assembly thereby reciprocates on bars **87** and **88** as shown by arrow E in FIG. 11. The traverse of pawl **112** and as a result gripping rollers **79**, is equal to the width of the take-up reel **119** minus the diameter of the wire. The speed of rotation of worm gear shaft **111** is co-ordinated with the speed of rotation of the take-up reel through gear reducer **117**, to insure a level wound finished coil. In addition gear reducer **117** adjusts the speed of worm gear **111** to compensate for a change in the wire diameter due to the winding of various diameter wires from time to time.

After passing through the guiding station, wire W proceeds to the winding station (FIGS. 13 and 14) where it is wound on take-up reel **119*a***. The winding station includes frame **120** to which is mounted turntable motor **121** and take-up reel motor **122**. Turntable shaft **123** is journaled on frame **120** in bearings **124**. A turntable sprocket **125** is rigidly secured to one end of turntable shaft **123** and linked by chain **126** to sprocket **127** of turntable motor **121**. Turntable arms **128*a*** and **128*b*** extend radially from turntable shaft **123** and are rigidly secured thereto. Thus, as turntable shaft **123** is rotated in bearings **124** by motor **121** and chain **126**, turntable arms **128** sweep in the direction of arrow F in FIG. 13.

The ends of turntable arms **128** contain sleeves **129**. They are rigidly secured to arms **128** having their axes parallel to the axis of turntable shaft **123**. Reel shafts **130** are mounted in sleeves **129** for rotation therein and extend beyond one end of sleeves **129** terminating at a threaded engagement with wing nuts **131**. The opposite end of shaft **130** terminates at joint **132**.

Take-up reel motor sprocket **133** is linked by chain **134** to reel drive sprocket **135**. Reel drive shaft **136** extends rigidly from reel drive sprocket **135** and is journaled in bearing **137** and terminates at universal joint **132**, at that point being fixed to reel shaft **130*a***. Joint **132** is capable of quick assembly and disassembly to connect drive shaft **136** to reel shaft **130** and to sever the connection respectively by hydraulically shifting shaft **136** along its axis. When shifted to abut reel shaft **130** as shown in FIG. 14 joint **132** is engaged and the rotation of shaft **136** rotates reel shaft **130**. The joint is hydraulically disengaged when reel **119*a*** is removed from the take-up position and an empty reel takes its place.

Lock arm **138** is pivotally connected to lock arm bracket **138*c*** which is mounted to frame **120**. Lock arm **138** is two-sided as may be seen by reference to side **138*a*** and **138*b*** in FIG. 14. Each side is arcuately notched to a depth equal to the outside radius of sleeve **129**. It therefore accommodates sleeve **129** and locks turntable arms **128** in the position shown in FIG. 13 and prevents sweeping movement in the direction of arrow F. Thus, arms **128** and reel **119*a*** are locked in a take-up position with shaft **130*a*** aligned with reel drive shaft **136**. The positions are simultaneously interchangeable by disengaging lock arm **138** and sweeping turntable arms **128** one hundred eighty degrees. Lock arm **138** is engaged and disengaged with sleeve **129** by means of hydraulically operated jack **139** which is fixed at one end to guiding station frame **97** and at the other end to lock arm **138**.

Take-up reels **119** are mounted for rotation on reel shafts **130**. Reels **119** consist of spool **140**, permanent flange **141** and removable flange **142**. Spool **140** is keyed to reel shaft **130**. Both flanges **141** and **142** as well as spool **140** contain slots **144** which are radially positioned and spaced one hundred twenty degrees from one another. Flange **142** is removable by removing wing nut **131**.

The winding station is aligned with the guiding station so that a line passing through a plane equidistant from reel flanges **141** and **142** perpendicularly bisects the traverse of entry and gripping rollers **78** and **79**.

The description of the apparatus utilized in the specific embodiment is then complete except for the variation in the design of the flipper or star-wheel which appears in FIG. 7. The design shown there differs from the design of FIGS. 5 and 6 because overarm **48** and drop arm **44** are eliminated and a jointed bank arm **232** is added. Bank arm **232** contains joint **233** which is pivotable about pin **234** in the direction of arrow G. Thus, bank arm **232** has two positions with respect to vertical arm **231**. One position is perpendicular to arm **231** for placement of mill coils thereon and the other position is parallel to arm **231** for pay-out. Bank arm **232** is pivoted about pin **234** by means of hydraulic linkage **235** which is pivotally connected at one end to arm **232** and at the other end to vertical member **231** as shown in FIG. 7. Thus, by placing bank arm **232** in a vertical position, mill coil convolutions may be paid out vertically so as to take advantage of gravity to prevent snarling more effectively than is possible with the previously described star-wheel.

Having thus described the apparatus of the specific embodiment the operation is readily apparent. Mill coils are received and passed through the trimming, welding, flipping, descaling, straightening, precoiling, and guiding stations where wire W is handled and processed as previously described. The end is then fixed to spool **140** and take-up drive motor applies a constant torque to reel drive sprocket **135** to turn reel **119** and wind wire W thereon. The take-up reel speed is a function of the precoiler speed and the outside diameter of the finished coil at any given moment. The guiding station operates at a speed which is directly proportional to the speed of take-up reel **119*a***.

After the reel is filled, the coil is steel-strapped by inserting steel straps **143** into slots **144** and circumscribing the radial section of the finished coil **145**. Turntable arms **128** are then actuated and the position of reel **119*a*** is interchanged with reel **119*b***. Reel **119*a*** is thus swept into an unloading position and reel **119*b*** is swept into a take-up position. Winding is begun on reel **119*b*** as previously done on reel **119*a***. On repositioned reel **119*a***, wing nut **131*a*** is removed along with flange **142** to expose finished coil **145**. Coil **145** is removed from spool **140** and the process has produced one unit.

The finished coil which appears in FIG. 15 is tightly and level wound as may be seen with reference to the radial cross-section. It is compact, which is desirable for storage and transport, and free of mill scale. After the retaining straps are cut it may be smoothly paid out by rotation about its axis (on an A-frame for example). It is therefore, unlike the dead cast mill coil, a suitable raw material for subsequent automatic or manual manufacturing processes in various industries.

Having thus described my invention, I claim:

1. A continuous method for making wire coils from shorter individual coils which comprises: placing a plurality of said individual coils adjacent one another, securing an end of one of said individual coils to the compatible end of the adjacent coil thereby making said individual coils continuous, uncoiling said continuous individual coils, reciprocally bending said wire, passing said wire under tension about a precoiler and continuously removing said wire therefrom, reciprocally guiding said wire for level winding about a reel in a take-up position, rotating said reel with constant torque and winding said wire about said reel to form said coil.

2. A continuous method for making wire coils from shorter individual coils which comprises: placing a plurality of said individual coils adjacent one another to form a first bank of coils having a longitudinal axis extending radially from a substantial vertical axis, sweeping said first bank arcuately about said substantially vertical axis, securing an end of one of said coils to the compatible end of the adjacent coil, placing a plurality

of said individual coils adjacent one another to form a second bank of coils having a longitudinal axis extending radially from said vertical axis, sweeping said banks arcuately about said substantially vertical axis, securing one end of the coil in said first bank nearest said vertical axis to the compatible end of the coil in said second bank farthest from said vertical axis, securing an end of one of said coils in said second bank to the compatible end of the adjacent coil, again placing a plurality of said individual coils adjacent one another to form a third bank, securing one end of the coil in said second bank nearest said vertical axis to the compatible end of the coil in said third bank farthest from said vertical axis, securing an end of one of said coils in said third bank to the compatible end of the adjacent coil, uncoiling said first bank, reciprocally bending said wire, passing said wire under tension about a precoiler and continuously removing said wire therefrom, reciprocally guiding said wire for level winding about a reel in a take-up position, rotating said reel with constant torque thereby winding said wire about said reel to form said wire coil.

3. The method of claim **2** further characterized by securing said wire coil about a plurality of radial cross-sections equally spaced on the circumference thereof, severing said wire, removing said reel with said secured coil thereon from said take-up position and simultaneously replacing said reel, removing a flange of said reel and removing said secured coil therefrom.

4. The method of claim **2** wherein said third bank is inclined upwardly in the direction of said uncoiling.

5. The method of claim **2** wherein said first bank is arcuately swept in a vertical plane prior to uncoiling therefrom, said uncoiling proceeding in a substantially vertical direction.

6. A continuous method for making wire coils from shorter individual coils which comprises: placing a plurality of said individual coils adjacent one another with the ends of said coils hanging symmetrically beneath said coils and crossing the adjacent end of the adjacent coil to form a first bank of coils having a longitudinal axis extending radially from a substantially vertical axis, sweeping said first bank arcuately about said substantially vertical axis, abutting and securing an end of one of said coils to the adjacent compatible end of the adjacent coil, placing a plurality of said individual coils adjacent one another with the ends of said coils hanging symmetrically beneath said coils and crossing the adjacent end of the adjacent coil to form a second bank of coils having a longitudinal axis extending radially from said substantially vertical axis, sweeping said banks arcuately about said substantially vertical axis, abutting and securing one end of the coil in said first bank nearest said substantially vertical axis to the compatible end of the coil in said second bank farthest from said vertical axis, abutting and securing one end of said coils in said second bank with the adjacent compatible end of the adjacent coil, again placing a plurality of said individual coils adjacent one another to form a third bank similar to said first and second banks, sweeping said banks arcuately about said substantially vertical axis, abutting and securing one end of the coil in said second bank nearest said substantially vertical axis to the compatible end of the coil in said third bank farthest from said substantially vertical axis, abutting and securing one end of said coils in said third bank with the adjacent compatible end of the adjacent coil, uncoiling said first bank in a direction corresponding to the longitudinal axis of said bank, passing said wire over and in contact with an abrasive surface, reciprocally bending said wire, passing said wire under tension at a constant speed about a precoiler and continuously removing said wire therefrom, reciprocally guiding said wire for level winding about a reel in a take-up position, rotating said reel with constant torque thereby winding said wire about said reel to form said wire coil, securing said wire coil about a plurality of radial cross sections equally spaced on the circumference thereof, severing said wire, removing said reel and coil from said take-up position and simultaneously replacing said reel, and removing a flange of said reel and removing the secured finished coil therefrom.

7. The method of claim 6 wherein said third bank is inclined upwardly in the direction of said uncoiling.

8. The method of claim 6 wherein said first bank is arcuately swept in a vertical plane prior to uncoiling therefrom, said uncoiling proceeding in a substantially vertical direction.

9. Apparatus for making wire coils from shorter individual coils which comprises, in combination: a starwheel having a substantially vertical elongate member mounted for rotation about its axis and three elongate arms equally spaced and radially mounted thereto, an entry cone roller assembly including four rollers mounted with their axes in a vertical plane and defining a square, said rollers forming a square passage having a dimension substantially equal to the diameter of said wire, a straightener having an upper bank of rollers and a lower bank, said rollers being circumferentially concave and horizontally aligned but vertically positioned with said upper bank intermeshed with said lower bank, a precoiler having a circumferentially concave surface and

means for driving said precoiler at a constant speed, a guiding mechanism having a pair of substantially vertically positioned entry rollers and gripping rollers, said entry rollers being spaced a distance substantially equal to the diameter of said wire, and said gripping roller mounted for arcuate movement about said entry rollers and means for urging said gripping rollers toward each other to thereby grip said wire, and means for reciprocally traversing said rollers, a winding station including a turntable arm having a reel rotatably mounted on each end, means for sweeping said arm about an axis perpendicular to its longitudinal axis and means for locking said arm with one of said reels in a take-up position, said entry cone rollers assembly, straightener, precoiler, guiding mechanism, and winding station being horizontally aligned.

References Cited

UNITED STATES PATENTS

2,511,274	6/1950	Kramer	140—1
2,929,569	3/1960	Detrick	242—25
2,971,709	2/1961	Ellis	242—25
3,002,537	10/1961	Kenmore et al.	140—1
3,026,053	3/1962	Sisson et al.	242—25

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