Nov. 26, 1963 A. A. FORNATARO 3,112,087

BELT TYPE WRAPPING APPARATUS

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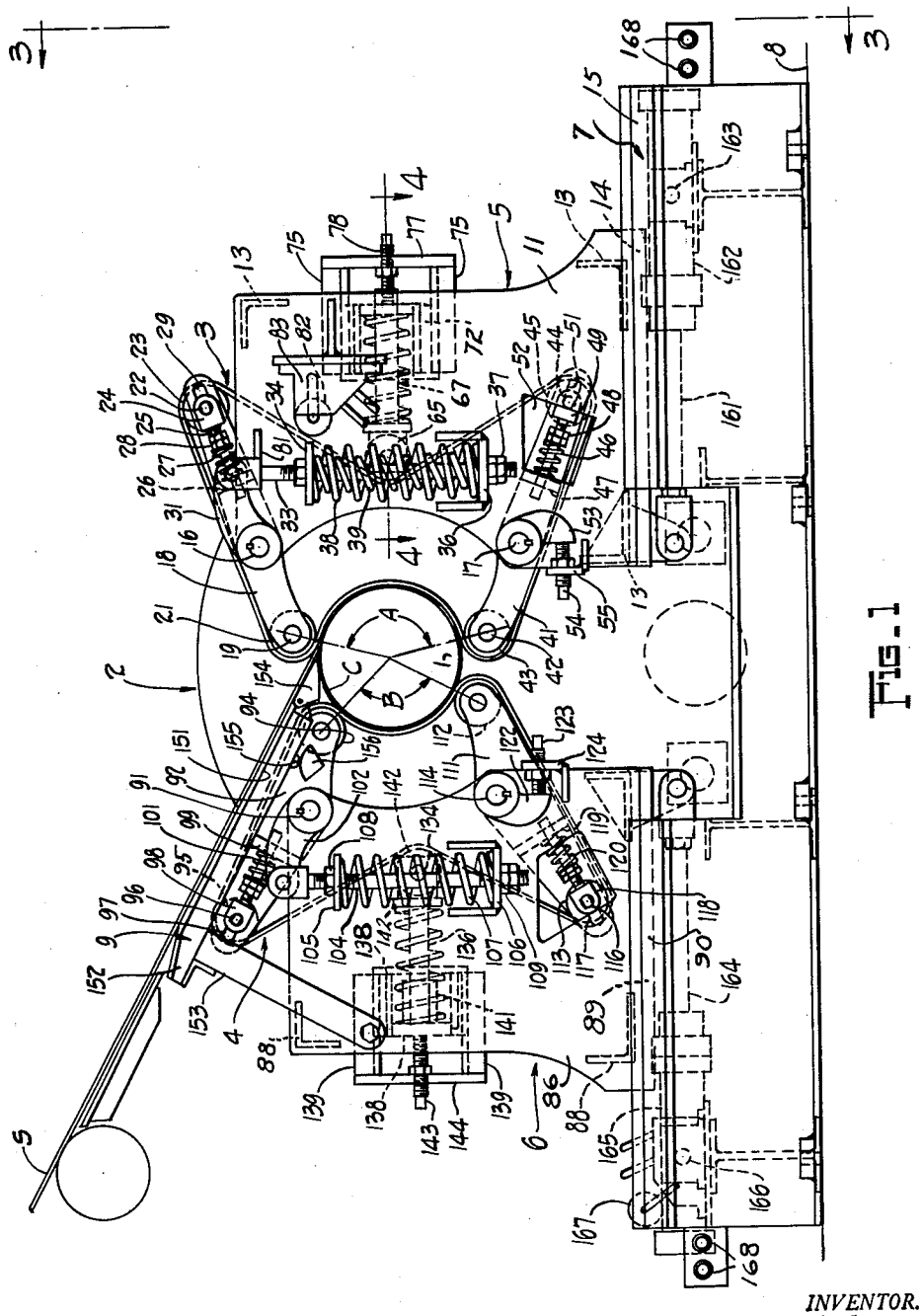


FIG. 1

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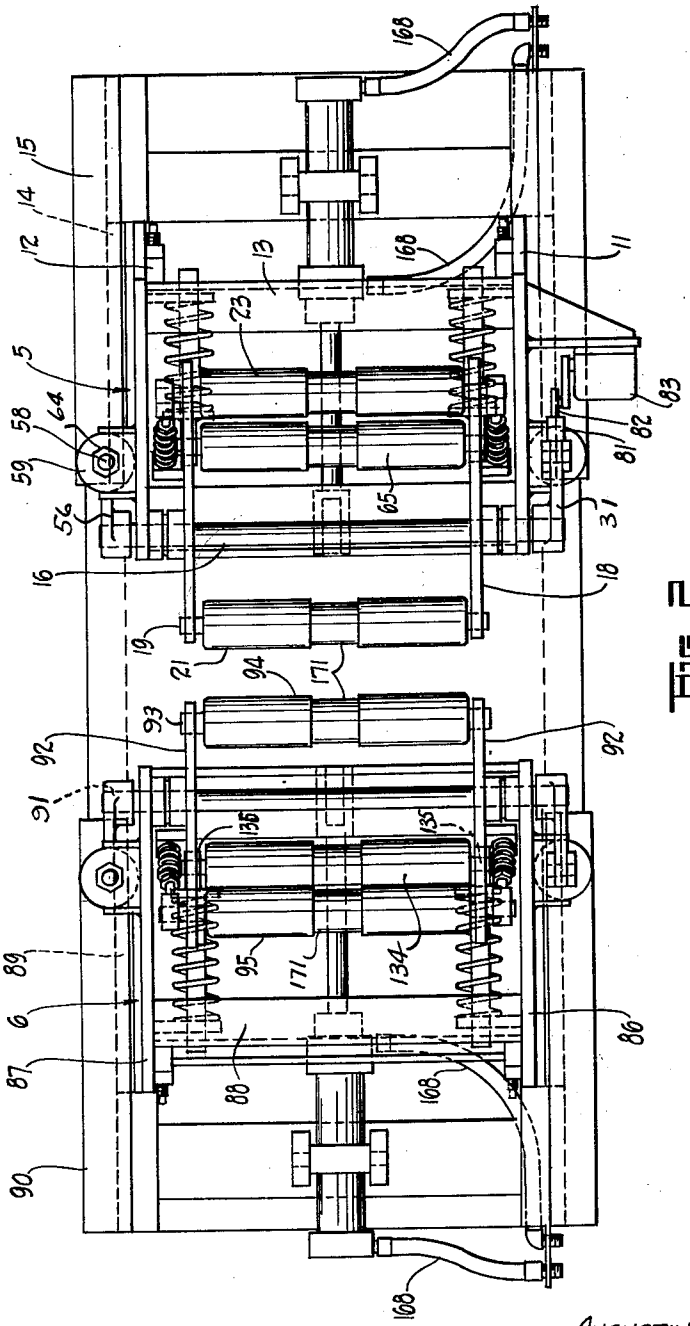


FIG. 2

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BELT TYPE WRAPPING APPARATUS

Filed Aug. 9, 1960 5 Sheets-Sheet 3

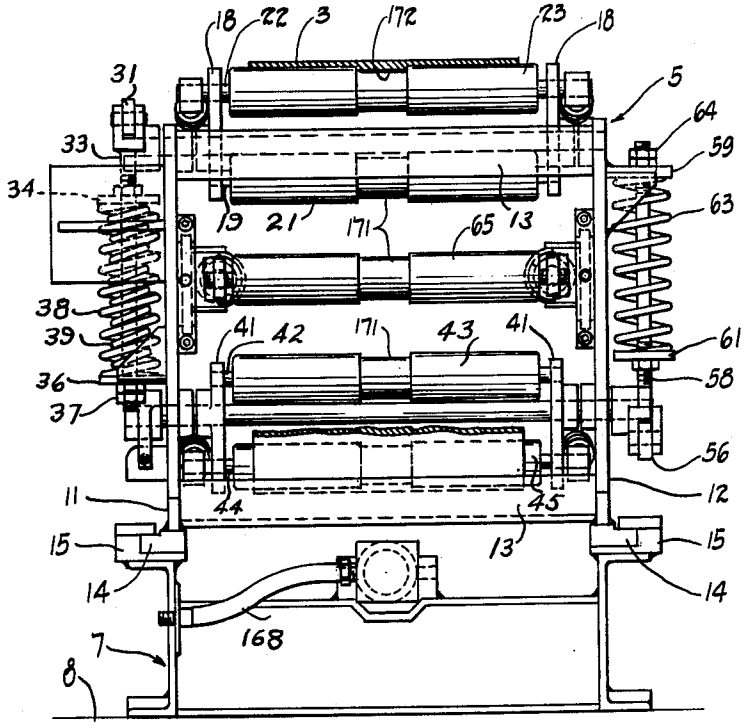


FIG. 3

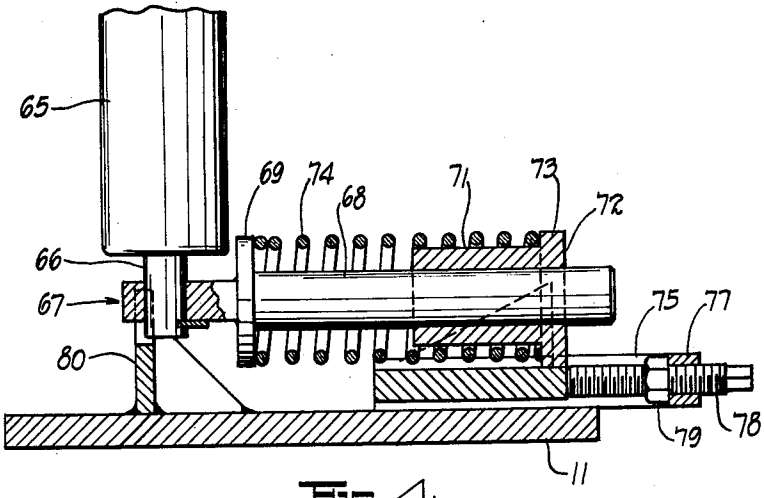


FIG. 4

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Nov. 26, 1963 A. A. FORNATARO 3,112,087

BELT TYPE WRAPPING APPARATUS

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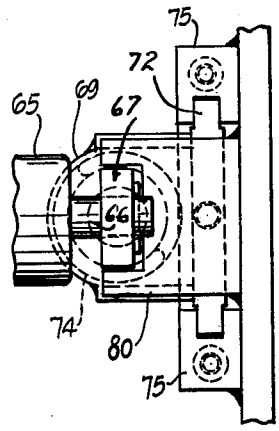


FIG. 6

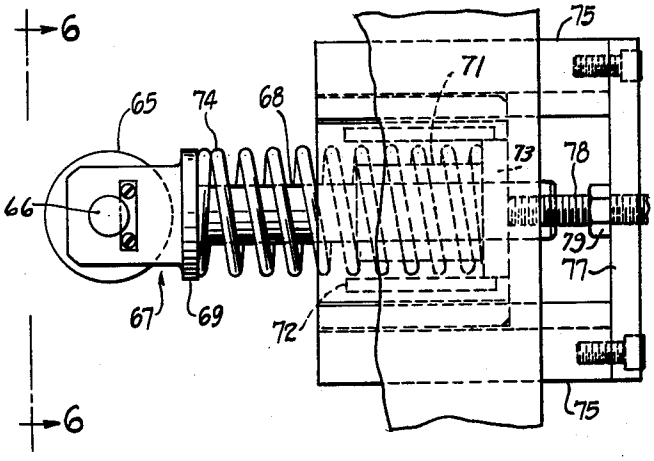


FIG. 5

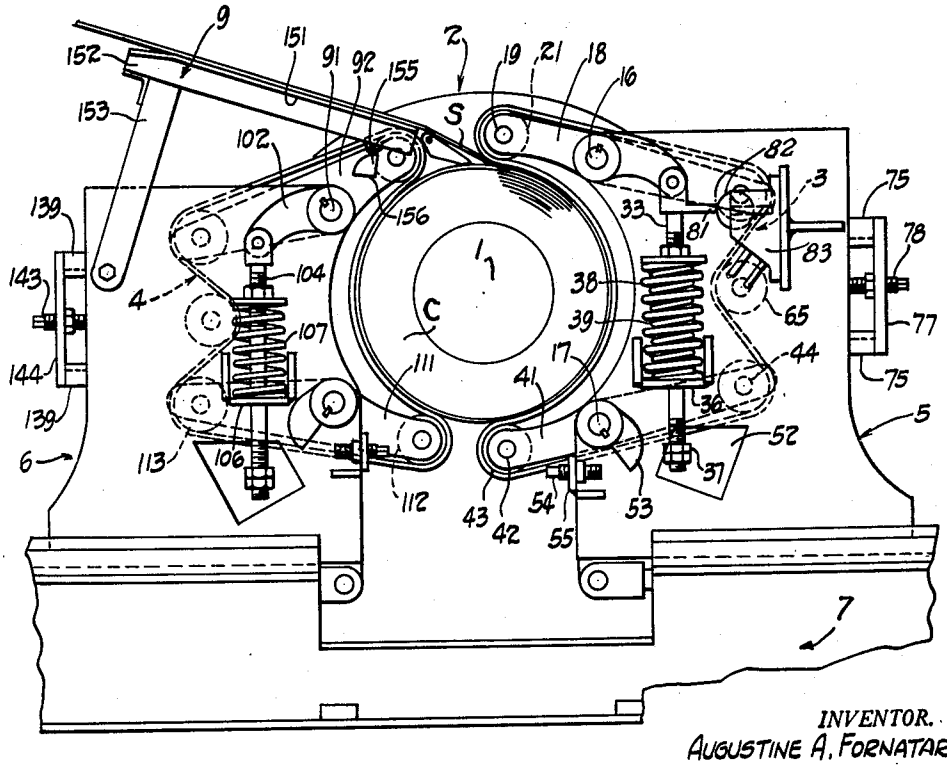


FIG. 7

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BELT TYPE WRAPPING APPARATUS

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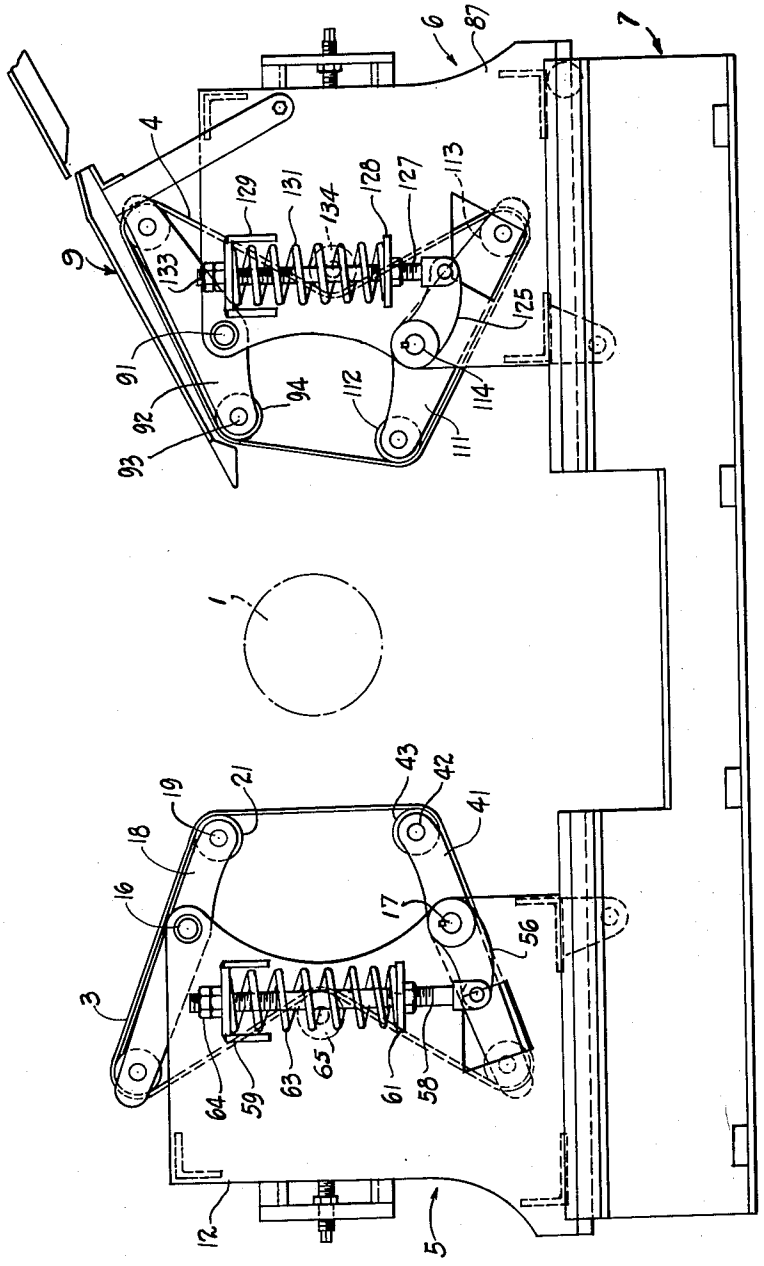


FIG. 8

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United States Patent Office 3,112,087 Patented Nov. 26, 1963

3,112,087

BELT TYPE WRAPPING APPARATUS

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Filed Aug. 9, 1960, Ser. No. 48,426
6 Claims. (Cl. 242—78.5)

This invention relates to apparatus for winding or coiling sheet material on a mandrel, and more particularly to a belt wrapper for winding the material on the rotating mandrel of a tension reel or the like by frictionally engaging the material between one side of a belt and the outer curved surface of the mandrel or a coil thereon.

In general, belt wrappers have been used heretofore to wind only a very few turns of sheet material on a rotating mandrel. Examples of such uses occur in the production or processing of continuous metal strip in which a belt wrapper is employed to start the leading end of the strip on the winding mandrel; in such prior use, the belt of the wrapper is caused to frictionally engage the strip only until enough turns have been wrapped on the mandrel to prevent slippage, after which the belt is withdrawn. Coiling of the strip is thereafter continued merely by rotating the coil on the mandrel until a coil of the desired size is formed, after which the strip is cut and the coil is removed. Since only a very few turns of continuous strip metal need be wound on the mandrel by the belt wrapper to achieve the desired non-slipping engagement of the strip with the mandrel, there is only a negligible increase in the diameter of the coil over that of the mandrel during the time the belt wrapper is engaged. Therefore, there has been no problem of maintaining the belt in wrapping relation while compensating for greatly increased coil size, and prior belt wrappers in general are incapable of so compensating.

However, this problem arises when it is desired to wind short lengths of strip metal or the like on a mandrel to form coils which are substantially greater in diameter than the mandrel. For example, in lines for high speed processing, such as annealing, of strip steel or other metal originating in coils, it is usually necessary to cut off the leading end portion of a coil to remove material which is off gage or otherwise rejectable; then, after the metal of the coil has been largely unwound and processed, a portion containing substandard material usually must be cut from the tail end of the coil; defective material must then be cut off the leading end of another full coil to form a new leading edge which can be welded to the cut tail end of the first expended coil to form a continuation of the strip which is to be processed, and so on as desired. The disposition of such cut off leading and tail portions presents serious problems, particularly because of their lengths which may vary from a few feet to many feet, and because of the relatively high rate at which such end portions accumulate in operation of high speed continuous strip processing lines. Unless the end portions are quickly disposed of, they obstruct aisles and work spaces around the machines, impeding productivity and creating work hazards. On the other hand, transporting them away individually is costly, as is individual cutting of these pieces into scrap before they are so transported.

The present invention provides belt wrapping apparatus which possesses the advantages, among others, that it can solve such problems by winding the cut off leading and tail end portions of varying lengths onto the mandrel of a tension reel to form a coil which has a diameter substantially greater than that of the mandrel. Thus a considerable quantity of such scrap material can be safely temporarily stored in the form of a compact coil which requires removal only at relatively infrequent intervals and which can be easily handled by standard available

equipment during and after removal from the mandrel. The belt wrapping apparatus of the present invention operates so that the coil is continuously contacted by the belt. The length of belt wrap increases as the coil diameter increases, thus maintaining substantial belt tension and providing effective wrapping action throughout the build-up of the coil. The cut-off portions of strip metal are readily wound into the coil as they are fed to the wrapper even though their ends overlap; there is no need for special precautions to butt their ends. Therefore, these scrap portions can be easily and individually disposed as fast as they are made, and with elimination of obstructions or hazards to working conditions. The apparatus of the invention thus differs from, and possesses important advantages over, prior belt wrappers that cannot operate throughout the operation of forming a coil of substantially larger diameter than that of the mandrel which it is wound, that cannot compensate to maintain effective belt wrapping relation as the coil increases to a size substantially greater than that of the mandrel, and that cannot form a coil from a number of short lengths of material.

A general object of the invention is the provision of a belt wrapping apparatus adapted to provide effective belt wrapping action throughout the formation of a coil having a diameter substantially greater than that of the mandrel. Another object is to provide belt wrapping apparatus which is adapted to form a number of relatively short lengths of strip material into a coil which may have a diameter substantially greater than that of the mandrel, even though the ends of such lengths overlap. Further objects and advantages of the invention will become apparent from the following description of a preferred form thereof, reference being made to the accompanying drawings in which:

FIGURE 1 is a front elevation of a belt wrapper embodying my invention, shown as beginning the winding of a coil;

FIGURE 2 is a plan of the apparatus of FIGURE 1, the belts, feed table and mandrel being omitted to show the structure more clearly;

FIGURE 3 is an end elevation, from line 3—3 of FIGURE 1;

FIGURE 4 is a detail view, to an enlarged scale and along line 4—4 of FIGURE 1, showing a portion of one of the belt tension rollers and its adjustable resilient supporting means;

FIGURE 5 is a side elevation of the parts of FIGURE 4, to the same scale, a portion of the wall of the supporting frame being broken away for clarity;

FIGURE 6 is an end elevation from line 6—6 of FIGURE 5;

FIGURE 7 is a front elevation of the belt wrapping apparatus, shown as completing the winding of a coil; and

FIGURE 8 is a rear elevation of the apparatus, but with the belt supporting housings fully retracted.

In the drawings, as shown to advantage in FIGURES 1 and 2, reference numeral 1 indicates a rotatable mandrel of a tension reel, the mandrel being supported and driven by conventional means generally indicated by numeral 2. Strip metal S is formed into a coil C about such mandrel by endless belts 3 and 4 of the belt-type wrapping apparatus illustrated as embodying the invention. Belt 3 is supported by a housing 5 and belt 4 is supported by a housing 6, both housings being slidably supported on a base 7 so that when desired they may be moved toward and away from a mandrel 1 in a horizontal path perpendicular to the mandrel axis. The base 7 rests on and is fixed to the floor 8. The left housing 6 also supports an adjustable feed table 9 over which passes the strip S which is formed in the coil C. The strip S may be supplied from any suitable source; for example, it may be

a leading or tail portion cut from a coil of steel strip which is passed through an annealing or other type of steel-conditioning or processing line.

When the device is ready to form a coil on mandrel **1**, the housings **5** and **6** are positioned on base **7** to their closest positions relatively to the mandrel as shown in FIGURE 1; the leading end of a strip S is caused to pass over the table **9** and is introduced between the mandrel and the belt **3** so that the strip is frictionally engaged between the underside of the belt and the curved outer surface of the mandrel. As the mandrel rotates, the leading end of strip S is carried around the mandrel until it enters between the underside of the belt **4** and the mandrel, then between the underside of the belt **3** and the outer surface of the strip coiled on the mandrel, and so on, to form a coil, the operation continuing while the mandrel is rotated and strip material is supplied until the coil reaches a predetermined diameter. It is not necessary that a continuous strip be supplied, since as mentioned above, the apparatus provides particular advantages in forming a coil of a number of short lengths of strip material, such as those cut from the leading or tail ends of coils.

As the coil increases in size, the rollers supporting the belt move against resilient resistance to increase belt wrap and maintain substantial tension in the belt so that a compact coil is formed. After the coil formed on mandrel **1** has reached the predetermined size (as shown in FIGURE 7), the coiling operation is automatically halted and the housings **5** and **6** are retracted on base **7** away from the mandrel **1** to positions where the belts **3** and **4** can clear the coil C (as shown in FIGURE 8), after which the coil may be removed from the mandrel in the usual manner with or without prior banding of the coil.

Housing **5** comprises two spaced upright side frames **11** and **12** (see FIGURES 2 and 3), rigidly connected together by cross members **13**. The lower edge of each side frame has a slide member **14** which is slidably supported and guided by one of the guide members **15** fixed on the upper portion of base **7**. At its side nearest mandrel **1** the housing **5** rotatably supports an upper shaft **16**, which extends between the frames **11** and **12** about an axis located parallel to and above the axis of mandrel **1**. At the same side the housing **5** also rotatably carries a lower shaft **17** extending between the frames **11** and **12** about an axis located below and parallel to the axis of mandrel **1**.

The upper shaft **16** carries two arms **18** which are respectively located near and between the frames **11** and **12**. Intermediate their ends, these arms are rigidly fixed to the shaft **16** in identical angular relation. The ends of the arms **18** nearest the mandrel **1** rigidly carry an axle **19** supporting an elongated belt-carrying roller **21** for rotation about an axis parallel to that of the mandrel **1**. At their outer ends remote from the mandrel, the arms **18** slidably resiliently support an axle **22** on which an elongated belt-carrying roller **23** is mounted for rotation about an axis parallel to that of the mandrel **1**. For this purpose each arm **18** near its outer end slidably supports a member **24** carrying a projecting end of the axle **22**. The member **24** has a stem **25** which passes through a lug **26** fixed to the arm **18** and through a compression spring **27** located between the lug **26** and lock nuts **28** adjustably threaded on the stem. Each projecting end of the axle **22** has flat sides which slidably but non-rotatably engage the sides of an elongated slot **29** located in the outer end portion of one of members **18**. The springs **27** on the arms **18** thus exert a predetermined force urging the axle **22** of roller **23** away from the mandrel in a guided path determined by slots **29**.

The arms **18** pivotally supported on housing **5** are biased toward the positions in which their rollers **21** most closely approach the mandrel **1** by a spring-pressed lever arm **31** fixed to the end of shaft **16** projecting from frame **11** of housing **5**. The lever arm **31** is pivotally connected to the upper end of a plunger rod **33**, which also adjustably carries near its upper end a spring stop member **34**. The lower end of plunger rod **33** passes through a lug **36** projecting outwardly from the side frame **11** of the apparatus, and has adjustable lock nuts **37**. Nested compression springs **38** and **39** surrounding plunger rod **33** and located between the fixed lug **36** on the frame **11** and the spring stop member **34** on plunger rod **33** urge the rod **33** upwardly, and through lever arm **31** and arms **18** thus resiliently bias the belt-supporting roller **21** toward the mandrel **1**. As is apparent, the lock nuts **37** limit upward travel of rod **33** and hence movement of roller **21** toward the mandrel.

Similarly, two roller-carrying arms **41** are rigidly mounted on the lower shaft **17** in identical angular relationship between the frames **11** and **12** of the housing **5**, one of the arms being located near each of the frames. The inner ends of the arms **41** nearest the mandrel **1** rigidly carry an axle **42** on which is rotatably mounted an elongated belt-carrying roller **43**. The outer or remote ends of arms **41** slidably resiliently support an axle **44** rotatably carrying an elongated belt-carrying roller **45** about an axis parallel to that of the mandrel **1**, the structure being similar to that supporting roller **22** on the upper arms **18**. Thus, axle **44** is resiliently urged away from mandrel **1** by a compression spring **46** operating between lug **47** on each arm **41** and lock nuts **48** on a stem of a slidable member **49** supporting an end of axle **44**; each projecting end of the axle has flat portions slidably contacting an elongated slot **51** in the outer end portion of each lower arm **41**. An opening **52** in the frame **11** provides access to these points for adjustment.

The distance that belt roller **43** can move toward mandrel **1** is limited by a stop member **53** that is rigidly fixed to the end of shaft **17** projecting from frame **11** and contacts the end of adjustable bolt **54** threaded in lug **55** welded to the inner edge of frame **11**. Furthermore, as shown in FIGURES 2, 3 and 8, the opposite end of shaft **17** projecting from frame **12** rigidly carries a lever arm **56**, similar to the lever arm **31** fixed to upper shaft **16**, pivotally connected to the lower end of a plunger rod **58**. The upper end of rod **58** slidably passes through a lug **59** fixed near the top of the outer surface of frame **12**, and the lower portion of the plunger rod **58** adjustably carries a spring stop member **61**. A compression spring **63**, located between such stop member **61** on rod **58** and lug **59** on frame **12**, resiliently urges rod **58** downwardly and thus biases toward mandrel **1** the roller **43** carried by the inner ends of the lower arms **41**. Adjustable lock nuts **64** threaded on the upper end of plunger rod **58** prevent escape of the rod end through fixed lug **59** and also aid stop member **53** in limiting the inward travel of the lower arms **41** and the roller **43** carried by them.

The housing **5** also resiliently supports an elongated belt tension control roller **65** (see FIGURES 1, 2, 4, 5 and 6) to aid in controlling the tension in the endless belt **3** carried by rollers **21**, **23**, **43** and **45** and passing between the frames **11** and **12** of the housing. This roller **65** is rotatable about an axis substantially parallel to the axis of the mandrel **1** and it is resiliently urged against the belt **3** and toward the mandrel **1** in a generally horizontal plane. To this end, the roller is rotatably mounted between the frames **11** and **12** of the housing **5** on an axle **66** each end of which is rigidly carried by a supporting member **67** having a horizontal plunger rod **68**. At its end near the axle **66**, the rod **68** carries a spring stop member **69**, and at its other end is slidably supported in the cylindrical bearing portion **71** of a slidable carriage member **72**. A compression spring **74**, surrounding the plunger rod **68** and the bearing portion **71** bears against a spring stop member **69** on rod **68** and a stop member **73** on the carriage member **72**. Spaced guide members **75** fixed to inner surface of the associated frame **11** or **12** and engaging slide portions on the upper and lower edges of carriage member **72** slidably support each

such member 72. The outer ends of each pair of guide members 75 rigidly carry a retaining member 77 which has threaded in its central portion an adjusting bolt 78, the inner end of which bears against the associated carriage member 72. By these bolts 78 and their lock nuts 79, it is possible to adjust the positions of the carriages 72 longitudinally of the guide members 75 fixed to the frame of the housing 75, so that the positions of springs 74 and hence the force exerted by the springs can be adjusted to control properly the pressure exerted by the roller 65 on the belt 3 and the resulting tension in the belt. Preferably, a guiding lug 80 is provided on each associated frame 11 or 12 to slidably engage and aid in guiding the end of each supporting member 67 and to prevent the supporting member 67 from escaping from the carriage member 72 by force of spring 74, in the event of rupture of belt 3.

As the diameter of the coil C on the mandrel 1 increases, the inner ends of the arms 18 and 41 carrying the rollers 21 and 43 move outwardly away from the mandrel 1, while the outer ends of the arms carrying the rollers 23 and 45 move inwardly toward each other and toward the horizontal plane containing the axis of the mandrel 1, as shown in FIGURE 7. This movement increases the length of the belt 3 between the rollers 21 and 43 and concurrently decreases the length of belt between the rollers 23 and 45 at the outer ends of the arms 18 and 41; compensation for this decrease in belt length is affected by lateral movement of the tension control roller 65 away from the mandrel 1 against the pressure of spring 74. In the illustrated apparatus as shown in FIGURES 1 and 7, one of the upper arms 18 is employed to halt the rotation of the mandrel 1 when the coil C has reached a predetermined size, this being accomplished by a projecting actuating member 81 rigidly fixed to the upper end of plunger rod 33 in such manner that when the arm 18 reaches the position corresponding to the predetermined coil size the member 81 contacts and moves a roller 82 to actuate an electrical limit switch 83 mounted on housing 5.

The means for supporting the cooperating belt 4 from the other housing 6 are similar to those for supporting belt 3 from housing 5, although the parts are somewhat differently dimensioned, shaped and positioned to provide for the support and operation of the adjustable table 9. More specifically, as shown in FIGURES 1, 2 and 8, the housing 6, which is somewhat lower in height than the housing 5 to provide room for the adjustable table 9, comprises two spaced vertical frames 86 and 87, between which belt 4 passes, rigidly connected by cross members 88. At its lower edge, each vertical frame has slide member 89 which is slidably supported in and guided by a guide member 90 on the base 7. At its upper side nearest the mandrel 1, the housing 6 supports an upper shaft 91 for rotation about an axis parallel to and spaced above the axis of mandrel 1. Rigidly mounted on the shaft 91 in the same angular relation are two upper spaced belt-supporting arms 92 located between and adjacent the frames 86 and 87. The arms 92 support at their inner ends an axle 93 which rotatably support an elongated belt-supporting roller 94 in the same manner as roller 21 is carried by arms 18. At their outer ends the arms 92 carry an elongated belt-supporting roller 95 which is resiliently urged outwardly in a guided path, similarly to the roller 21 on arms 18 of housing 4, by an axle 96 that rotatably supports roller 95 and has projecting ends each of which is movable in a slot 97 in one of the arms 92 and is carried by a supporting member 98 slidably mounted in lug 99 fixed to the arm 92 and urged outwardly by a compression spring 101. The arms 92 are resiliently biased to urge the inner roller 94 toward the mandrel axis by a lever arm 102 fixed to the end of shaft 91 projecting from frame 86 and is pivotally connected to a plunger rod 104 carrying near its upper end a spring stop member 105 and at its lower end passing through a lug 106 rigidly fixed

to the frame 86. A compression spring 107 surrounding plunger rod 104 between lug 106 and stop member 105 serves to exert the resilient biasing hereon; this force can be adjusted by lock nuts 108 and 109, the latter of which also determine the closest location when the roller can achieve relatively to the axis of the mandrel 1.

The housing 6 also carries lower belt-supporting arms 111, which rotatably support inner roller 112 and outer roller 113 by arrangements similar to those by which lower arms 41 and rollers 43 and 44 are carried by the other housing 5. Thus, the lower arms 111 are rigidly mounted in the same relative angular positions on a lower shaft 114 journalled in the frames 86 and 87 at the side of housing 6 nearest the mandrel 1, for rotation about an axis located parallel to but below the axis of mandrel 1, each of the lower arms 111 being located adjacent one of the frames 86 or 87. The inner roller 112 is mounted at the inner ends of arms 111 for rotation about an axis fixed relatively to the arms the mounting means being identical to that previously described for the other inner rollers. The outer ends of arms 111 rotatably support the roller 113 by means resiliently urging the roller outwardly in a guided path. Such means, which is similar to that supporting roller 44 on lower arms 41 of housing 5, comprises an axle 116 on which the roller 113 is rotatably mounted and which has projecting ends each of which passes through a slot 117 in the end of one of the lower arms 111 and is fixed in a supporting member 118 one end of which is slidably mounted in a lug 119 rigidly fixed to the arm 111; compression springs 120 disposed between the lugs 119 and adjusting nuts 121 on the supporting members 118 resiliently urge the axle 116 outwardly so that the roller 113 mounted on the axle presses outwardly against the belt 4. Similarly to arms 41 on housing 5, the lower arms 111 are limited in their inward movement toward the mandrel 1 by a stop member 122 rigidly fixed to the end of axle 114 projecting from frame 86 and adapted to contact an adjustable stop bolt 123 threaded into a lug 124 fixed to such frame.

The lower arms 111 are biased toward the position in which the inner roller 112 is closest to the axis of mandrel 1 by means similar to that biasing the lower arms 41 carried by housing 5. Such means, shown in FIGURE 8, comprises a lever arm 125 rigidly mounted on the end of axle shaft 114 projecting from frame 87 of housing 5; the arm 125 is pivotally connected to the lower end of a plunger rod 127 which at its lower portion also adjustably carries a spring stop member 128 and at its upper end slidably extends through a projecting lug 129 rigidly fixed to the frame 87 of the housing 5. A compression spring 131 located between spring stop member 128 and lug 129 causes the above-mentioned biasing action; the force exerted by the spring can be adjusted by adjustable stop member 128 and lock nuts 133 threaded on the end of plunger rod 127; such end lock nuts also cooperate with stop member 122 to limit the inward travel of the lower arms 111.

An elongated belt tension control roller 134 is mounted on the housing 5 between the frames 86 and 87 to be resiliently biased toward the mandrel 1 to maintain tension in the belt 4 as the rollers 94 and 112 and rollers 95 and 113 change positions relatively to each other as the diameter of coil C changes. The roller 134 is supported similarly to the corresponding roller 65 on housing 5, by an axle shaft 135 each end of which is rigidly mounted in a supporting member 136 slidably supported in a slidable carriage member 138. This carriage member is slidably supported for movement toward and away from the mandrel 1 by guide members 139 fixed to the associated frame member. A compression spring 141 located between the carriage member 138 and a stop member 142 on supporting member 136 provides resilient force urging the roller 134 toward the mandrel; this force can be adjusted by a screw 143 threaded through a retaining member 144 fixed to the ends of the guide members 139 and bearing

against the central rear portion of carriage member 138.

The adjustable feed table 9 comprises a top plate 151 fixed, as by welding, to two spaced longitudinally extending frame members 152, as shown in FIGURE 1. At the outer end of the table remote from the mandrel 1, these members are rigidly connected to two spaced downwardly extending supporting members 153 by which the table is pivotally mounted on the housing 6. At its inner end nearest the mandrel, the table 9 pivotally supports a gate member 154 the free edge of which is adapted to rest on the mandrel or coil. Near its inner end the table also has two spaced downwardly extending supporting legs 155 which are adapted to rest on projecting lugs 156 fixed to the outer surfaces of the upper belt-supporting arms 92 carried by the housing member 6; preferably, the upper surface of each such lug 156 is shaped in the form of a cam surface which permits the associated supporting leg 155 to slide smoothly over it and which maintains the proper clearances between the table and the belt 4 when the inner end of the table moves upwardly with the inner ends of arms 92 as the coil on the mandrel increases in diameter.

At its bottom portion nearest the mandrel, the housing 5 is connected to a piston rod 161 of the hydraulic cylinder 162 pivotally mounted by trunnion 163 on the base 7. The cylinder 162 is adapted to move the housing 5 and the belt 3 carried by it toward the mandrel 1 at the commencement of the coiling operation, to hold it in such position during the coiling operation, and to move housing 5 and the belt 3 away from the coil C on the mandrel at the conclusion of the coiling operation. Similarly, housing 6 is pivotally connected to the piston rod 164 of the hydraulic cylinder 165 mounted on the base 7 through pivotal trunnion mounting 166, so that this cylinder can move housing 6 toward mandrel 1 prior to coiling, hold it there during the operation of coiling, and withdraw it from the coil on the mandrel at the end of the coiling operation. Preferably a limit switch 167 is provided on base 7 to be engaged by housing 6 when it is withdrawn a predetermined distance from the mandrel 1; when the switch is thus engaged it causes the hydraulic cylinders 162 and 165 to cease operation and thus limit the movement; if desired a similar switch may be provided to be activated by and individually limit movement of the housing 5. Pipes 168 conduct hydraulic liquid under suitable pressure to the cylinders 162 and 165 from a suitable source not shown; suitable controls, not shown, are also provided to control manually the operations of mandrel 1 and cylinders 162 and 165.

As shown in FIGURES 2 and 3, each of the various rollers which contacts the belt is provided with a wide groove or depression 171 centrally located around the periphery of the roller. On its side which contacts its supporting rollers, each of the belts 3 and 4 is provided with a raised ridge portion 172 which fits into the grooves 171 of the rollers and serves to guide the belt by preventing movement of the belt axially of the rollers. The belt itself preferably is a known type made of fabric-reinforced rubber-type material. Other means may be provided for locating the belt axially of the rollers. A plurality of belts may be employed in side-by-side relation on the rollers of each housing in place of the single belt shown and described, and the term "belt" in the description and in the following claims is intended to include such plurality of side-by-side belts.

One preferred method of operation is as follows, beginning with the housings 5 and 6 retracted to their extreme positions away from the mandrel 1. When the housings are in these positions, as shown in FIGURE 8, on housing 5 the inner belt-supporting rollers 21 and 43 are in their closest relative positions, the outer belt-supporting rollers 23 and 45 are in their most widely separated positions, and the belt tension control rollers 65 bearing against the belt 3 is in its closest position relative to the inner side of housing 5, the springs 38 and 39, and 63 urging arms 18 and 41, and springs 74 urging the carriage members 72, to so locate these rollers; on housing 6 the inner belt-supporting rollers 94 and 112 are in their closest relative positions, the outer belt-supporting rollers 95 and 113 are in their most widely separated positions, and the belt tension control roller 134 bearing against the belt 4 is in its closest position relative to the inner side of housing 6, the arms 93 and 111 being resiliently urged by springs 17 and 131 and the carriage members 138 being moved by springs 141 to the positions where these rollers are so located.

By actuation of suitable control means, the cylinders 162 and 165 are then caused to move the housings 5 and 6 simultaneously toward the mandrel 1 to the position shown in FIGURE 1 where the belts 3 and 4 contact and partially wrap around the empty mandrel, the rollers on the belt-supporting arms being substantially in the positions described above in connection with FIGURE 8, but the belt tension control rollers 65 and 134 being positioned further away from the mandrel to compensate for the decrease in belt length between each outer pair of rollers arising from the increase in belt length between each inner pair of rollers as it contacts the curved mandrel. Positive rotation of the mandrel 1 is started, either before or after the mandrel is engaged by the belts. As the mandrel rotates, the surfaces of the belts 3 and 4 contacting the mandrel move with the surface of the mandrel, thus causing the belts to travel over their rotatable supporting and tensioning rollers.

The leading edge of a strip S of steel is then passed over the table 9 and the inner pivoted gate member 154 into the juncture formed by the outside of the mandrel 1 and the mandrel-contacting surface of the belt 3 carried by the housing 5. The frictional gripping action provided by the moving belt pressing the strip S against the mandrel causes the edge of the strip to be carried around and under the mandrel until it reaches the belt 4, which similarly grips the strip between the mandrel and the belt. The strip is then carried further around the mandrel and so on until the strip is entirely wound or rotation of the mandrel is halted.

During the winding operation, the increase in size of the coil causes the belt supporting inner rollers 21 and 43 carried by the roller arms 18 and 41 to separate and the outer supporting rollers 23 and 45 carried by such arms to move toward each other against the resistance of springs 38 and 39, and 63. A substantial tension is maintained at all times in the belt 3 from this action and by tension control roller 65 which moves away from the mandrel 1 against the force provided by springs 74. Similarly, the innermost belt supporting rollers 94 and 112 carried by the arms 93 and 111 on the housing member 6 move away from each other as the coil diameter increases, while the outer belt supporting rollers 95 and 113 move toward each other against the resistance of springs 107 and 131, a substantial tension being maintained in belt 4 by this action and by the tension control roller 134 which is urged toward the mandrel 1 by springs 141 as the belt 4 causes the roller 134 to move away from the mandrel. In the illustrated apparatus, the biasing springs 38 and 39 acting together also provide a substantially greater biasing force on arms 18 than the corresponding springs 63, 107 and 131 exert on arms 41, 92 and 111, thus making possible the greater pressure which must be exerted by the roller 21 to initially engage and bend the strip S as it passes from the table 9 to the coil C.

As the coil size increases, table 9 swings about its pivotal connections at the lower ends of the supports 153, the legs 155 sliding over the lugs 156 to maintain the proper clearances between the table parts and the roller 94 and the belt thereon. The actuating member 81 on plunger rod 33 also moves downwardly as the coil increases in size until, when the predetermined coil size is reached, member 81 depresses the roller 82 and actuates the limit switch 83 as shown in FIGURE 7; by suitable

means not shown, such actuation halts rotation of the mandrel **1** and preferably causes the housings **5** and **6** to retract their extreme positions away from the mandrel where their movement is halted when the housing **6** engages the limit switch **167** and where the belts **3** and **4** no longer contact the coil on the mandrel. The coil is thus available for banding and removal from the mandrel by conventional equipment and method.

As is apparent from FIGURES 1 and 7, the total angle of belt contact, i.e., the sum of angles A and B in these figures, does not decrease as the coil diameter increases; preferably it increases substantially as shown; also, each of angle A through which the belt **3** contacts the coil, and angle B through which belt **4** contacts the coil, remains at least as great during as at the commencement of the coiling operation, and preferably increases substantially as the coil size increases. Consequently, the total belt length in contact with the coil, as well as the length of each individual belt in contact with the coil, increases as the size of the coil increases so that the coil-forming wrapping action of the apparatus increases during the winding operation. The above described movable and resiliently biased mountings of the belt supporting and tension rollers prevent decrease in belt tension as the coiling proceeds and preferably maintain substantially uniform tension in each belt throughout the coiling operation. The resilient mountings of the outer rollers on the pivotally mounted roller supporting arms also aid the above described roller mountings in compensating for minor irregularities in the thickness of the strip material, particularly when short lengths of strip material are being coiled with their ends in overlapping relation. These factors cooperate to cause the apparatus of the invention to operate effectively throughout the winding of a coil as it increases to a diameter substantially larger, and even about twice as large or more, than the diameter of the mandrel. These same factors make it possible to disengage the belts **3** and **4** from, and reengage them with, a partially wound coil on the mandrel **1**, by moving the housings **5** and **6** away from and toward the mandrel, should such disengagement and re-engagement of the belts be desirable or necessary in operation. They also make possible the use of belt wrapping apparatus embodying the invention, in association with mandrels of various diameters, ranging in size from the smallest diameter to the largest diameter of cylindrical member which the belt wrapper is designed to engage.

For these reasons the belt wrapping apparatus of the invention is well adapted to the coiling of a continuous strip on the mandrel until a predetermined large coil size is reached, but it provides exceptional advantages in the coiling of short lengths of strip material, such as those cut from the leading or tail ends of coiled strip material, since the large amount of belt wrap provided by the belts throughout the winding operation permits these short lengths to be engaged by the belt wrapper and wound into a coil considerably larger in diameter than the mandrel, without difficulty or the need of any special precautions to prevent overlapping of the ends of successive short lengths. The previously indicated problems of disposing of such short lengths of metal are thus completely solved by the apparatus of the present invention.

Other advantages and other modifications of the apparatus of the invention than those indicated above will be apparent to those skilled in the art. It is, therefore, to be understood that my patent is not limited to the preferred form of the invention disclosed herein or in any other manner than by the scope of the appended claims.

I claim:

1. Belt wrapping apparatus for coiling sheet material to form a coil on a rotatable mandrel having a substantially horizontal axis, said apparatus comprising a base; two housings slidably mounted on said base on opposite sides of said mandrel and adapted to be moved substantially horizontally at right angles to said mandrel axis toward said mandrel to coiling positions and away from said mandrel axis to noncoiling positions; a separate endless belt carried by each of said housings; means on each of said housings for carrying said belt comprising upper arm means rotatably supporting at its ends a pair of belt carrying rollers and pivotally mounted intermediate its ends on said housing above the mandrel axis, lower arm means rotatably supporting at its ends another pair of belt carrying rollers and pivotally mounted intermediate its ends on said housing below the mandrel axis, means biasing said arm means so that the innermost rollers on the ends of said arm means nearest said mandrel are urged toward said mandrel and the outermost rollers on the ends of said arm means remote from said mandrel are urged away from said mandrel, and means for maintaining substantial tension in said belt, whereby when said housings are in their coiling positions nearest said mandrel the lengths of the belts between said innermost rollers are substantial and increase as the coil size increases; a table for feeding and guiding sheet material to said belt wrapping apparatus comprising a table surface having a front end adapted to feed strip material to said mandrel, means pivotally supporting said table surface from one of said housings at a point remote from said front end, and means supporting the front end of said table surface from said upper arm means of said housing so the front end of said table surface moves with said arm means in response to changes in the size of the coil on said mandrel.

2. Belt wrapping apparatus for coiling sheet material to form a coil on a rotatable mandrel having a substantially horizontal axis, said apparatus comprising a base; two upright housings slidably mounted on said base on opposite sides of said mandrel and adapted to be moved substantially horizontally at substantially right angles to the mandrel axis toward said mandrel to coiling positions and away from said mandrel to noncoiling positions; a separate endless belt carried by each of said housings; means on each of said housings for carrying said belt comprising a pair of upper arms rotatably supporting at their ends a pair of belt carrying rollers and pivotally mounted intermediate their ends on said housing above said mandrel axis, a pair of lower arms rotatably supporting at their ends another pair of belt carrying rollers and pivotally mounted intermediate their ends on said housing below said mandrel axis, means biasing said arms so that the innermost rollers on the ends of said arms nearest said mandrel are urged toward said mandrel and the outermost rollers on the ends of said arms remote from said mandrel are urged away from said mandrel, a rotatable tension roller contacting the length of belt between said outermost rollers, and means for slidably supporting said tension roller from said housing for movement toward and away from said mandrel and for urging said tension roller toward said mandrel, whereby when said housings are in their coil-forming positions nearest said mandrel substantial lengths of belts between said innermost rollers contact a coil on said mandrel during the coiling operation and such lengths increase as the coil size increases; and a table carried by one of said housings for feeding and guiding sheet material to said mandrel, said table including a table surface member having a front end adapted to be positioned adjacent said mandrel, supporting means remote from said front end of said table and pivotally supporting said table from said housing, and supporting means including cam surfaces supporting said table near its front end from the ends of the arms on said housing so that the table clears the innermost roller carried by the inner ends of said arms and the belt carried by said roller, as the coil size changes.

3. Belt wrapping apparatus for coiling sheet material comprising a positively driven rotatable mandrel on which a coil of sheet material is formed, said mandrel having a substantial horizontal axis; a base; two upright housings slidably mounted on said base on opposite sides

of said mandrel and adapted to be moved substantially horizontally and substantially at right angles to the mandrel axis toward said mandrel to coiling positions and away from said mandrel to noncoiling positions; a separate endless belt carried by each of said housings; means on each of said housings for carrying said belt comprising a pair of upper arms rotatably supporting at their ends a pair of belt carrying rollers and pivotally mounted intermediate their ends on said housing above said mandrel axis, a pair of lower arms rotatably supporting at their ends another pair of belt carrying rollers and pivotally mounted intermediate their ends on said housing below said mandrel axis, means biasing said arms so that the innermost rollers on the ends of said arms nearest said mandrel are urged toward said mandrel and the outermost rollers on the ends of said arms remote from said mandrel are urged away from said mandrel, a rotatable tension roller contacting the length of belt between said outermost rollers, and means for slidably supporting said tension roller from said housing for movement toward and away from said mandrel and for urging said tension roller toward said mandrel, whereby when said housings are in their positions nearest said mandrel substantial lengths of belts between said innermost rollers contact a coil on said mandrel during the coiling operation, and such lengths increase as the coil size increases; and means actuated by movement of at least one of said arms for halting rotation of said mandrel when the coil size reaches a predetermined size.

4. The belt wrapping apparatus of claim 3 in which said last mentioned means also retracts said housings from said mandrel to their noncoiling positions after a coil of predetermined size is formed.

5. Belt wrapping apparatus for coiling sheet material on a mandrel which rotates about a fixed axis during the coiling operation, said apparatus comprising a base; two housings mounted on said base at positions angularly spaced around said mandrel for movement toward said mandrel to coiling positions and away from said mandrel to noncoiling positions; a separate endless belt carried by each of said housings; a pair of rotatable belt supporting rollers carried by each of said housings; means supporting such rollers from each housing for rotation about axes substantially parallel to the mandrel axis, so that said rollers are located at positions angularly spaced around said mandrel when the housing is in its coiling position, resilient means for urging said rollers toward said mandrel during coiling of sheet material on said mandrel to cause said belt to contact the coil on the mandrel throughout the coiling operation by a belt length which increases during said coiling operation; means for compensating for changes in the belt length between said rollers and for maintaining substantial tension in the belts during the coiling operation as the size of the coil increases, a table for feeding and guiding sheet material to said belt wrapping apparatus comprising a table surface having a front end adapted to feed strip material to said mandrel, means pivotally supporting said table surface from one of said housings at a point remote from said front end, and means supporting the front end of said table surface so that the front end of said table surface moves with one of said roller supporting means in response to changes in the size of the coil on said mandrel.

6. Belt wrapping apparatus for coiling sheet material to form a coil on a mandrel which rotates about a fixed, substantially horizontal axis during the coiling operation, said apparatus comprising a base; two upright housings slidably mounted on said base on opposite sides of said mandrel and adapted to be moved substantially horizontally at substantially right angles to the mandrel axis toward said mandrel to coiling positions and away from said mandrel to noncoiling positions; a separate endless belt carried by each of said housings; and means on each of said housings for carrying said belt comprising a pair of upper arms rotatably supporting at their ends a pair of belt carrying rollers comprising an inner belt carrying roller and an outer belt carrying roller, said arms being pivotally mounted intermediate their ends on said housing at a level above said mandrel axis, a pair of lower arms rotatably supporting at their ends another pair of belt carrying rollers comprising an inner belt carrying roller and an outer belt carrying roller, said arms being pivotally mounted intermediate their ends on said housing at a level below said mandrel axis, means biasing said arms so that the inner rollers on the ends of said arms near said mandrel are urged toward said mandrel and the outer rollers on the ends of said arms remote from said mandrel are urged away from said mandrel, a rotatable tension roller contacting the length of belt between said outer rollers, and means for supporting said tension roller from said housing for movement toward and away from said mandrel, whereby when said housings are in their coil forming positions nearest said mandrel substantial lengths of belts between said inner rollers contact a coil on said mandrel during the coiling operation and such lengths increase as the coil size increases.

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