Oct. 22, 1968 E. W. BRUNS ET AL 3,406,924

APPARATUS FOR WINDING COILS OF METAL STRIP MATERIAL

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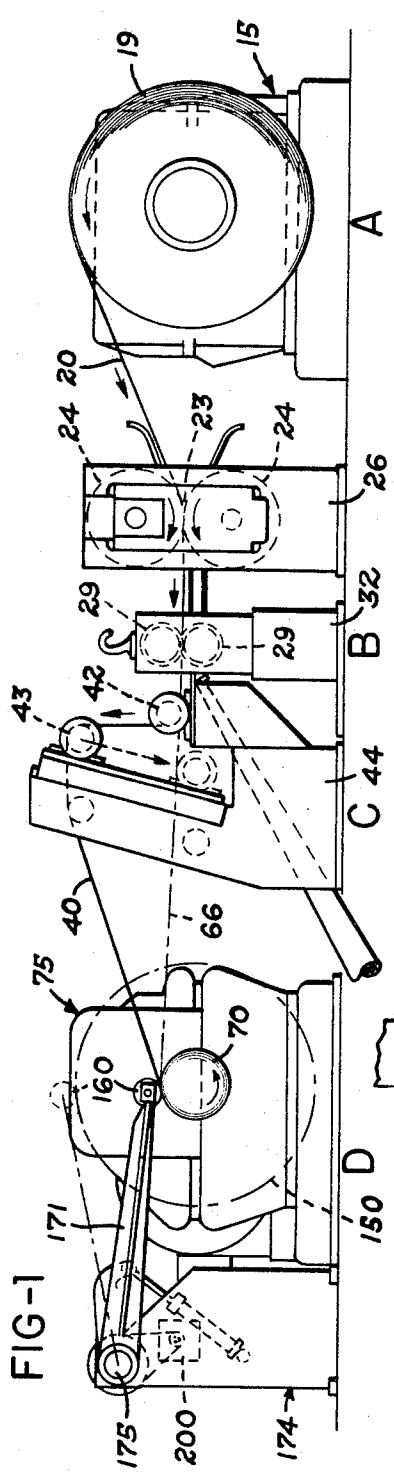


FIG-1

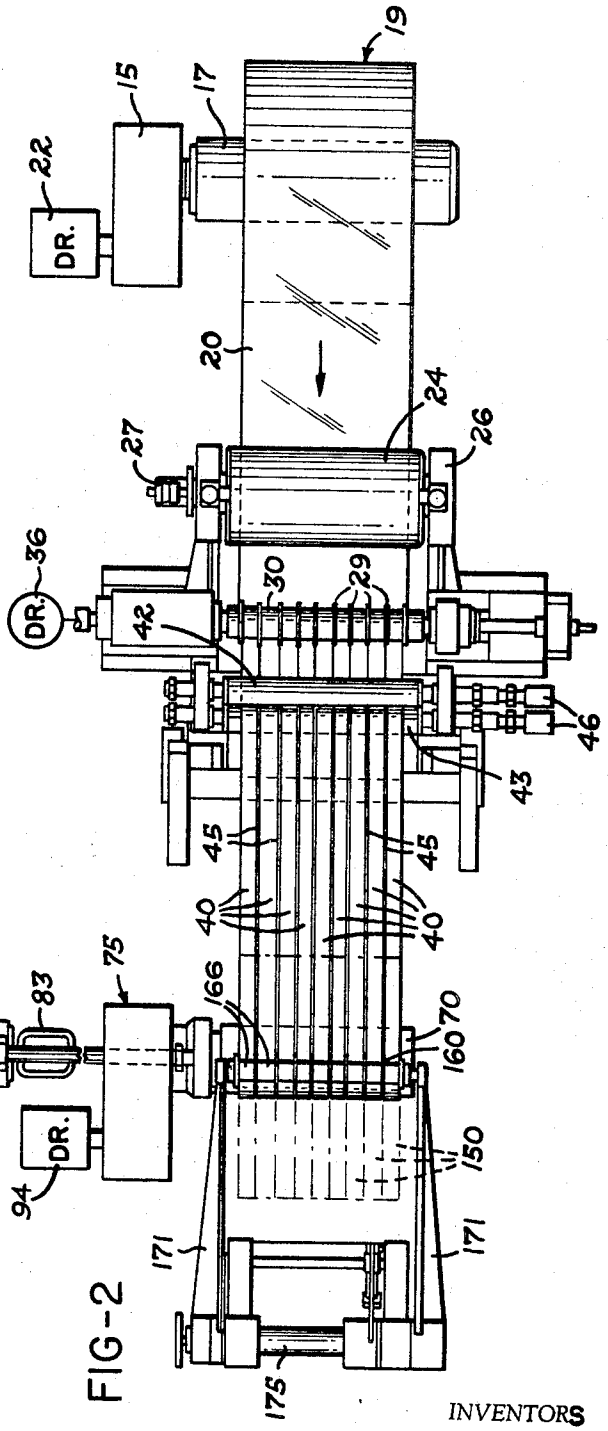


FIG-2

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ATTORNEYS

APPARATUS FOR WINDING COILS OF METAL STRIP MATERIAL

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FIG-3

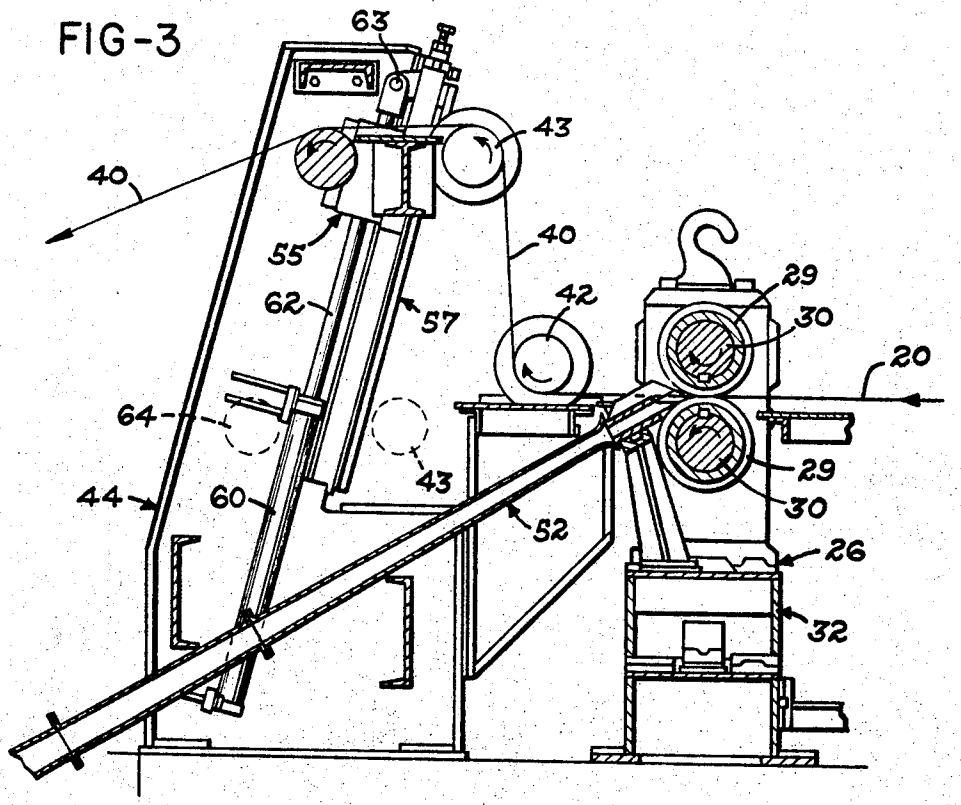


FIG-4

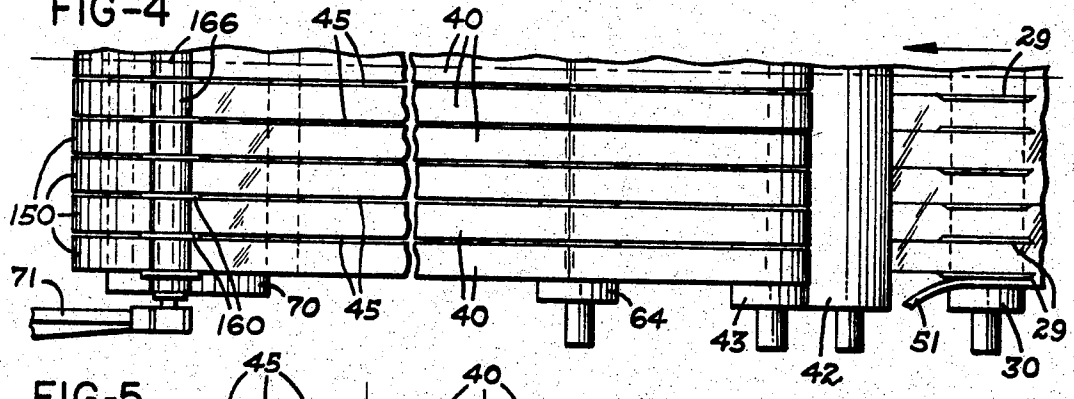
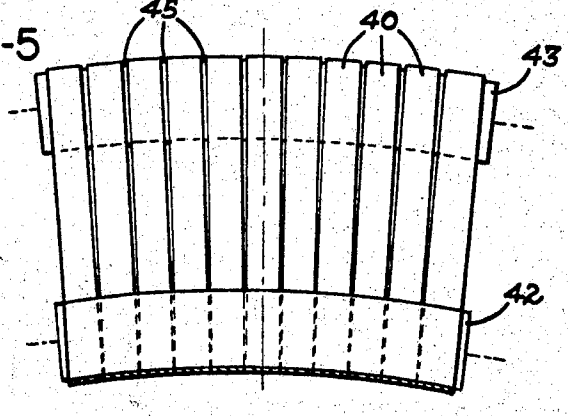


FIG-5



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APPARATUS FOR WINDING COILS OF METAL STRIP MATERIAL

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FIG-6

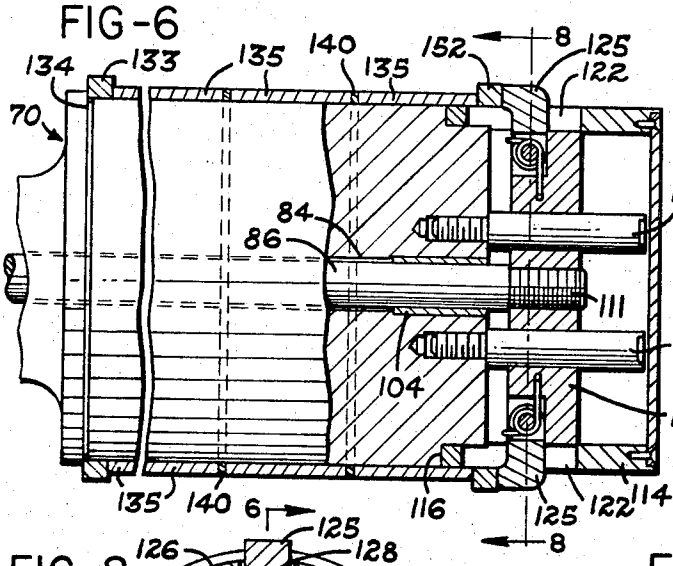


FIG-7

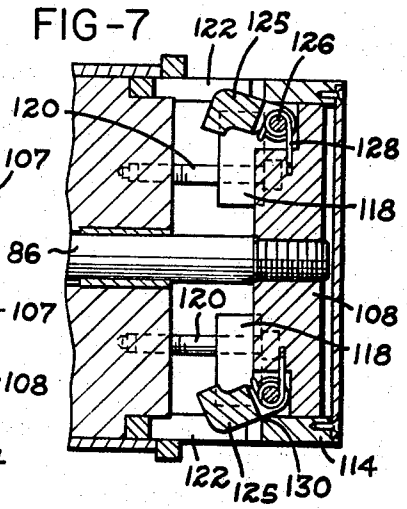


FIG-8

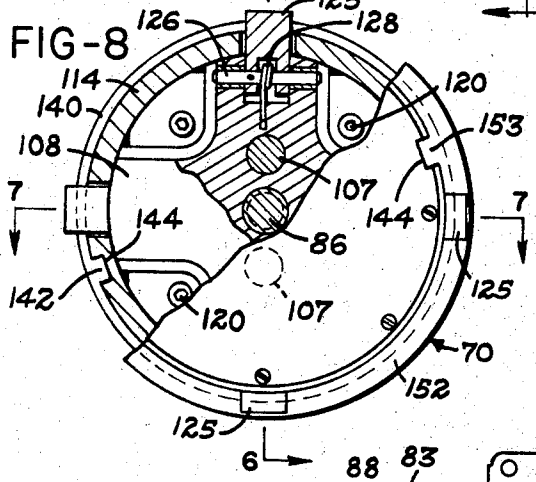


FIG-13

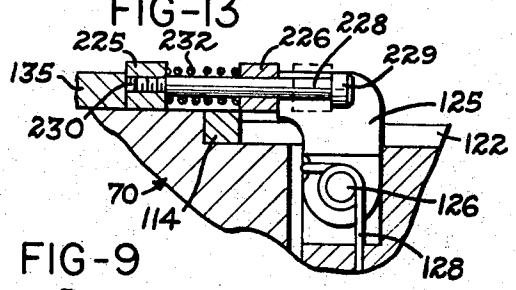
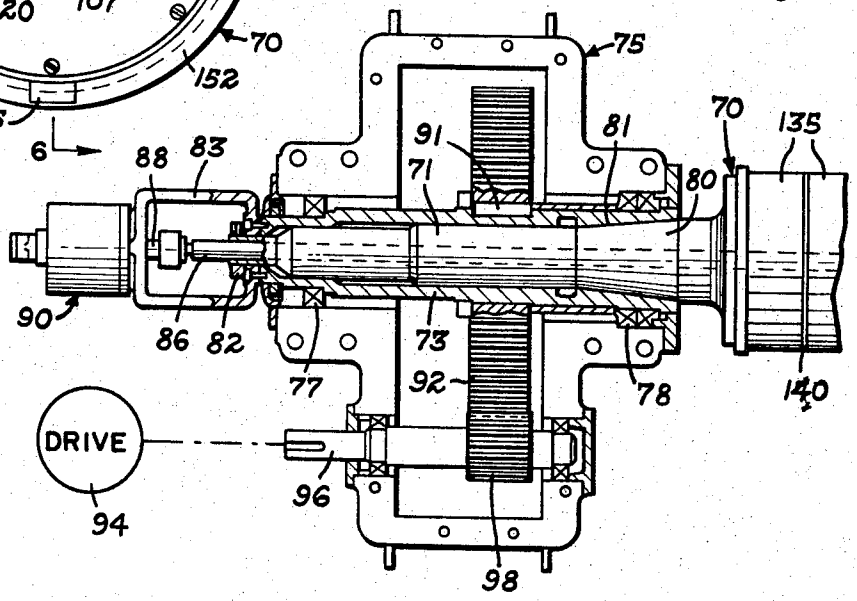


FIG-9



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FIG-10

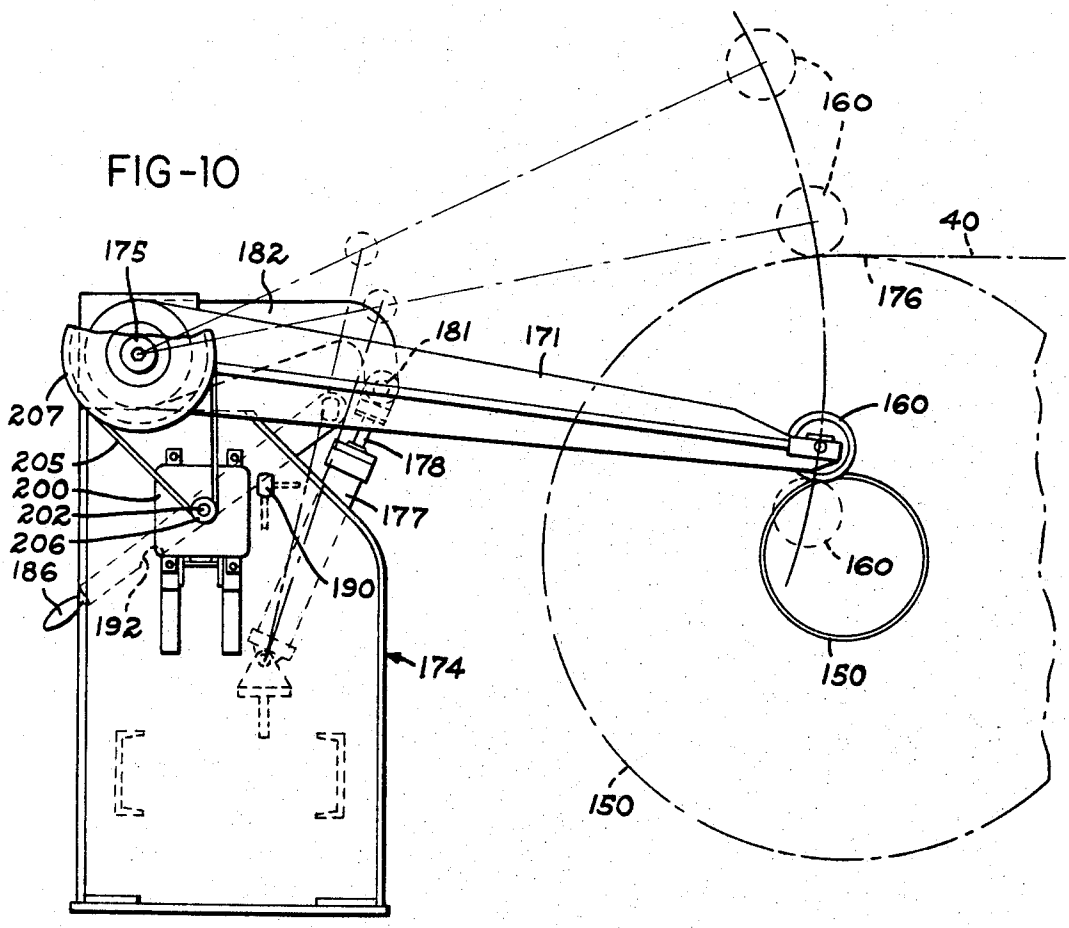


FIG-11

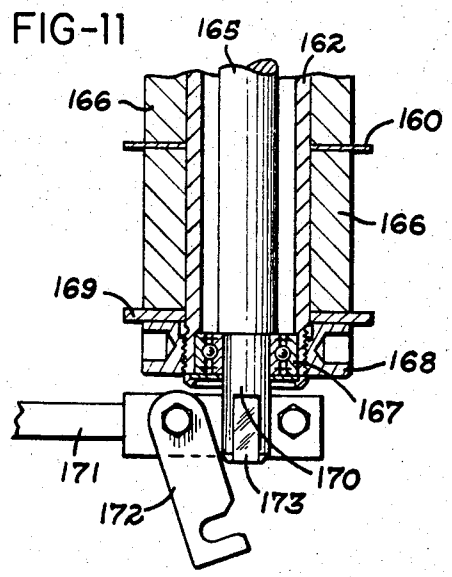
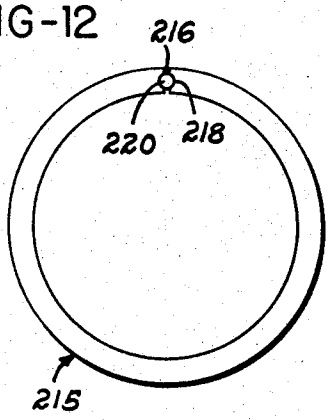


FIG-12



United States Patent Office 3,406,924
Patented Oct. 22, 1968

3,406,924

APPARATUS FOR WINDING COILS OF METAL STRIP MATERIAL

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Filed July 9, 1965, Ser. No. 470,801
10 Claims. (Cl. 242—56.4)

ABSTRACT OF THE DISCLOSURE

A slitter-winder wherein the plurality of separate strips formed by the slitting operation are wound onto corresponding cores mounted on a cantilevered mandrel between flat drive rings fixed for rotation with the mandrel. The drive rings are axially slidable on the mandrel and frictionally engage the ends of the cores by controlled pressure applied axially against the ends of the entire assembly of cores and interspaced drive rings mounted on the mandrel.

This invention relates to apparatus for handling coils of metal strip, and more particularly, to apparatus for unwinding a coil of single metal strip for slitting to form a plurality of separate strips of predetermined width and for rewinding the strips into individual coils while maintaining continuous tension in each strip durng the rewinding operation.

In the continuous production of rolling of metal strip, and especially with wider strips, it is difficult to prevent the forming rolls of a rolling mill from bowing by a slight amount. This is caused in part by the weight of the forming rolls but primarily by the enormous radial loading on the rolls as they progressively compress the metal strip to reduce its thickness. As a result, the metal strip which is formed usually varies in cross-sectional thickness with the center portion of the strip being a few thousandths thicker than the edge portions. Furthermore, as the strips increase in width, usually the differential in thickness across each strip also increases. Thus when the single strip is coiled, the center portion of the single strip has a tendency to increase in diameter at a faster rate than the edge portions which results in producing greater tension in the center portion of the strip within the coil.

When the single coiled strip is subsequently run through a slitting operation to form a plurality of separate strips, it has been found that the stresses within the strip are relieved, and in addition, the strips formed from the center portion of the single strip will have a slightly greater thickness than those strips formed from the edge portion. Thus when each of these separate strips are rewound on a common mandrel into separate coils, the tension in the strips forming the center coils of the mandrel is substantially greater than the tension in the strips forming the outer or end coils.

It is desirable to maintain sufficient tension in each of the strips forming the separate coils during the rewinding operation so that the coils are not loosely formed and will not collapse or telescope after they are removed from the rewinding mandrel. Thus a common procedure is to provide a frictional resistance or drag on each of the separate strips between the slitting and rewinding operations. This drag develops a progressively increasing slack in the strips formed from the edge portions of the single strip, and commonly, a large pit upwards of twenty feet in depth is provided in which to suspended loops of the strips as the slack progressively increases.

In view of the present trend toward larger coil diameters for obtaining more efficient handling of the strips and more efficient use of the machines which subsequently receive the metal strips, it has been found necessary to construct deeper and deeper pits. Furthermore, it is also common procedure to employ a radially expandable mandrel for rewinding the strips into coils. These mandrels are not only complicated in construction, since they must expand and retract radially so that the coils can be removed therefrom, they also commonly employ clamping slots for gripping the leading ends of the separate strips. These slots have been found undesirable since the end portion of each strip must be bent for insertion within the slot, and this bend produces a slight bump in the coil after the first wrap, which tends to mark several successive wraps of the strips.

Another common problem encountered with the rewinding of separate metal strips on a single expandable mandrel is that adjacent strips have a tendency to interweave as the strips are rewound into coils. This causes difficulty in removing the coils from the rewinding mandrel. In an attempt to solve this problem, separating disks have been employed between adjacent coils, but this has been found to result in undesirable rubbing between the disks and the edges of the strips.

In general, the present invention is directed to simplified and less expensive apparatus which maintains continuous tension in each of the separate strips during the rewinding operation, does not require the construction of pits between the slitting and rewinding stations and furthermore eliminates the problem of interweaving between strips.

Accordingly, it is one primary object of the present invention to provide apparatus which slits a single metal strip from an unwinding coil to form a plurality of separate strips each having a predetermined width, and rewinds the separate strips into corresponding coils on a common mandrel while maintaining continuous constant tension in each strip so that all of the separate rewound coils may be conveniently handled without collapsing or telescoping.

It is also an object to provide apparatus which can receive a single metal strip having variations in thickness across its width, slit the single strip to form a plurality of separate strips, and then rewind the separate strips into coils while spacing adjacent strips apart from each other by a slight amount to prevent interweaving between adjacent strips and difficulty in separating the coils.

A further object of the invention is to provide apparatus as outlined above which includes a simply constructed rewinding mandrel for frictionally driving a separate cylindrical core for each rewinding coil by rotatably slipping within the cores to provide relative rotation or slip among the cores as required for maintaining a tension in each of the separate strips according to the difference in average thickness among the strips.

Still a further object of the invention is to provide apparatus as outlined above wherein coils of different widths can be easily formed on a single mandrel at the rewinding station and can be easily removed from the mandrel.

It is also an object of the invention to provide apparatus which is adapted to rewind separate metal strips onto relatively inexpensive cylindrical cores capable of being retained within the coils for handling without damage or may be easily removed, as desired.

As another object, the present invention provides an apparatus as outlined above wherein the frictional drive

of each of the cylindrical cores mounted on the rewinding mandrel is increased proportionally to the increase in diameter of the rewinding coils to provide substantially constant rewinding tension within the strips being rewound.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a general elevational view of apparatus constructed in accordance with the invention and comprising slitting and rewinding stations;

FIG. 2 is a corresponding plan view of the apparatus shown in FIG. 1;

FIG. 3 is a vertical section of the slitting apparatus shown in FIG. 1;

FIG. 4 is a fragmentary plan view showing somewhat schematically the forming, speading and rewinding of the separate metal strips which are rewound into coils at the rewinding station in FIG. 1;

FIG. 5 is a somewhat exaggerated elevational view of the adjustable bow rolls employed for fanning or spreading the separate metal strips leading from the slitting station;

FIG. 6 is a section of the line 6—6 of FIG. 8 showing the mecahnism in the rewinding mandrel for frictionally driving the plurality of rewinding cores;

FIG. 7 is a section on the line 7—7 of FIG. 8 showing the driving mechanism in retracted position for mounting the cores or removing the rewound coils;

FIG. 8 is an end view looking from right to left in FIG. 6 and partially in section on the line 8—8 of FIG 6;

FIG. 9 is a plan view of the supporting and driving device for the rewinding mandrel;

FIG. 10 is a detailed elevational view of the mechanism which assures predetermined slight separation among the metal strips at the rewinding station and for sensing the diameters of the rewinding coils;

FIG. 11 is a detailed sectional view of an end portion of the disk members shown in FIG. 10 for guiding and maintaining the separation among the metal strips;

FIG. 12 is an axial end view of a collapsible core adapted for use when it is desired to remove the core from the rewound coil; and

FIG. 13 is a fragmentary section similar to FIG. 6 and showing a modified friction driving mechanism for rotating the slip cores.

Referring to the drawings, which illustrate a preferred embodiment of the invention, the apparatus shown generally in FIGS. 1 and 2 basically provides four stations, an unwinding station A, slitting station B, spreading station C and a rewinding station D. Positioned at the unwinding station A is a support housing **15** in which are mounted suitable bearings for rotatably supporting a cantilevered unwinding mandrel **17** on which is mounted an unwinding coil **19** of single metal strip **20**. A motor **22** is provided to drive a suitable gear reduction unit enclosed within the housing **15** which in turn drives the unwinding mandrel **17**. As mentioned above, the thickness of the single metal strip **20** commonly varies across the width of the strip by several thousandths of an inch and is usually thicker in the center portion. This single strip **20** is fed from the coil **19** into the nip **23** defined between a pair of guide rolls **24** which are rotatably supported one above the other on the frame member **26**. A tachometer **27** is driven by one roll **24** to determine precisely the speed of travel of the strip **20**.

The rolls **24** guide the single strip **20** into the circular shearing knives or members **29** which are carried on a pair of arbors **30** rotatably supported by a frame **32** at the slitting station B and driven by a suitable drive motor **36**. The plurality of separate metal strips **40** which are sheared from the single strip **20** by the shearing members **29** travel to a pair of bowed rolls **42** and **43** which are supported by a frame **44** at the spreading station C and spread the strips **40** to define slight separations or slots **45** between adjacent strips **40**. The separation is desirable especially during high speed operation of the apparatus to prevent adjacent strips **40** from rubbing together and interweaving at the rewinding station D.

The degree of the bow in the rolls **42** and **43** is variable and is controlled by operation of the corresponding hydraulic jacks **46** which compress the rolls axially to provide the bow. The degree of bow in the rolls **42** and **43** has been exaggerated in FIG. 5 to illustrate the manner in which the separate strips **40** are separated by the bowed rolls. The lower bowed roll **42** provides the initial sperading of the strips **40**, and the upper bowed roll **43** stops the spreading so that the separate strips **40** travel in parallel relationship to the rewinding station D.

Referring to FIGS. 3 and 4, the trimmings **51** sheared from the edge of the single metal strip **20** by the end shearing members **29** are received within a chute **52** which directs the trimmings to a suitable scraping mechanism (not shown) for cutting them into small pieces for further processing. As also shown in FIG. 3, the upper bowed roll **43** is rotatably supported by a carriage **55** which is adapted to travel along the inclined guideway **57** mounted on the supporting frame **44**. The position of the carriage **55** is controlled by a pressure cylinder **60** having a piston rod **62** pivotally connected to the carriage **55** by the pin **63**.

Also rotatably supported by the carriage **55** is a guide roll **64** which provides the desired degree of wrap of the separate strips **40** around the upper bowed roll **43**. Thus the width of the slots **45** between the strips **40** can be controlled both by the relative spacing between the bowed rolls **42** and **43** and by operating the jacks **46** for controlling the degree of bow in the rolls **42** and **43**. With some strips it may not be necessary or desirable to use the bowed rolls **42** and **43**, as for example, when the thickness of the strip **20** exceeds .032 inch. In these situations, the separate strips **40** are directed to the rewinding station D along a path **66** as shown in FIG. 1.

Rotatably supported at the rewinding station D is a cantilevered rewinding mandrel **70** which includes a spindle portion **71** (FIG. 9) removably mounted within a tubular support casing **73** which is in turn rotatably supported in a housing **75** by the bearings **77** and **78**. The spindle portion **71** of the mandrel **70** preferably has a tapered portion **80** which engages and is keyed within a corresponding tapered opening **81** formed within the tubular support casing **73** to provide a tight collet-type fit between the casing and the mandrel **70** when the nut **82** is tightened against the bracket **83** mounted on the end of the casing **73**.

As shown in FIGS. 6 and 9, the rewinding mandrel **70** and its spindle portion **71** are provided with an axially extending opening **84** through which extends a rod **86**. The inner end of the rod **86** (FIG. 9) projects from the end of the spindle portion **71** and is connected to the piston rod **88** extending from a double action fluid pressure cylinder **90**. By operation of the cylinder **90**, the rod **86** is reciprocated a few inches within the opening **84**. Rigidly mounted on the casing **73** by the key **91** and enclosed within the housing **75** is a gear **92** which is driven by a suitable variable speed drive motor **94** through the stub shaft **96** on which is mounted a drive pinion **98**. Thus by controlling the speed of the motor **94**, the speed of rotation of the mandrel **70** is controlled.

As shown in FIG. 6, the elongated mandrel **70** is formed basically as one solid piece and carries a sleeve bearing **104** which rotatably supports the outer end of the rod **86**. Mounted on the outer end of the mandrel **70** are a pair of pins **107** which guide an X-shaped support member **108** mounted on the end of the rod **86** by the threaded connection **111**. Also guiding the support member **108** is a cylindrical sleeve **114** which is retained within a counterbore **116** formed on the outer end of the mandrel **70**.

A series of ears **118** (FIG. 8) are welded to the inner

surface of the cylindrical casing **114** and extend inwardly to receive a series of four bolts **120** which are threaded into the end portion of the mandrel **70** to secure the casing **114** rigidly within the counterbore **116**. A series of four slots **122** are formed radially in the casing **114** adjacent the end of the mandrel **70**. Adapted to extend and retract through the slots **122** are a corresponding series of dogs **125** which are pivotally mounted on the support member **108** by the pins **126**. The torsion springs **128** are provided to bias the dogs **125** outwardly through the slots **122** when the support member **108** is pulled inwardly by the rod **86**. However, when the rod **86** is extended, the support member **108** moves axially within the casing **114** causing the dogs **125** to be cammed inwardly around the edge **130** of the slots **122** and collapse into the casing **114**.

A drive ring **123** (FIG. 6) is mounted on the inner end of the mandrel **70** adjacent the annular shoulder **134** and is adapted to engage the radial end surface of an inner cylindrical core **135** mounted on the outer cylindrical surface of the mandrel **70**. As illustrated in FIG. 6, the number of cylindrical cores **135** mounted on the mandrel **70** corresponds to the number of separate metal strips **40** which lead from the spreading station C to the rewinding station D, and each core **135** is adapted to receive the corresponding leading ends of a strip **40** which preferably is secured to the outer surface of the core **135** as by tape.

Preferably, the cylindrical cores **135** are formed from a relatively inexpensive phenolic impregnated fiber material, but other materials such as paper, wood, cardboard, metal or the like may be used. The inner diameter of each of the cores **135** is slightly greater than the outside diameter of the mandrel **70**, as for example, a clearance of 1/32 on the diameter has been used successfully and enables the cores **135** to be easily mounted on and removed from the mandrel **70**.

Mounted between each adjacent pair of cores **135** is a slip ring **140** having a pair of diametrically opposed tangs **142** (FIG. 8) which are received within a corresponding pair of axially extending slots **144** formed in the outer surface of the mandrel **70** so that the slip rings **140** are positively carried by the mandrel **70** when it is rotated by the drive motor **94**. Preferably, the thickness of each of the slip rings **140** corresponds to the width of the slots **45** defined between the parallel separate metal strips **40**. Thus as the strips **40** are rewound into separate coils **150** on the corresponding cores **135**, a radially extending space is provided between the coils **150** to prevent overlapping and interweaving between the strips during the rewinding operation.

The axial length of each of the cores **135** is selected according to the width of the corresponding strip **40** which is received by the core for rewinding. After the cores **135** are mounted on the mandrel **70** separated by the slip rings **140**, a second drive ring **152** is mounted on the mandrel adjacent the end surface of the end core **135**. The drive rings **133** and **152** are also provided with diametrically opposed tangs **153** (FIG. 8) so that the rings rotate with the mandrel **70** along the slip rings **140**. The cores **135**, slip rings **140** and drive ring **152** are positioned on the mandrel **70** while the dogs **125** are retracted as shown in FIG. 7. After the cores and slip rings are assembled, the pressure cylinder **90** is energized to pull the rod **86** inwardly, causing the support member **108** to shift to the position shown in FIG. 6, whereupon the torsion spring **128** causes the dogs **125** to pivot outwardly and to engage the radial end surface of the end drive ring **152**.

After the leading ends of the separate metal strips **40** are attached to the outer surfaces of the corresponding cores **135**, preferably by a suitable tape, and the strips are given approximately 1½ wraps around the core **135**, the unwinding, slitting and rewinding operations are started by energizing the motors **22**, **36** and **94** respectively, which starts the forming of the rewinding coils **150**. During this rewinding operation, tension is maintained in the rod **86** by the pressure cylinder **90** so that the radial end surfaces of the cores **135** are compressed firmly against the radial surfaces of the slip rings **140** and the end drive rings **133** and **152**. This provides an end friction drive of each of the cores **135** causing the cores **135** to rotate with the mandrel **70**.

As the rewinding coils **150** are formed on the corresponding cores **135** at the rewinding station D, the outer diameter of the center coils on the mandrel **70** will normally increase at a faster rate than the end coils, due to the variations in metal thickness as explained above. It has been found desirable to rotate the mandrel **70** at a slightly higher speed than is necessary to rewind the outside strips **40** on the corresponding outer cores **135** so that all of the cores slip somewhat in relation to the mandrel **70**. This has been found to maintain a continuous tension in all of the separate strips **40**, but it becomes apparent that the inner cores **135** mounted on the mandrel **70** will slip in relation to the outer cylindrical surface of the mandrel **70** more than the outer cores **135**.

As shown in FIG. 10, the precise separation or slots **45** between adjacent strips **40** is held with precision by a series of circular disks **160** (FIG. 11) which are carried on a tubular arbor **162** rotatably mounted on a shaft **165** by the end bearings **167**. The spacing between the disks **160** is determined by the cylindrical spacing members **166** which have axial lengths coresponding to the widths of the separate metal strips **40**. A nut **168** is mounted on the end of the arbor to retain the disks **160**, spacing members **166** and end collars **169**. The thickness of each of the disks **160** preferably corresponds with the thickness of the slip rings **140** and the slots **45** between the strips **40** as provided by the bowed rolls **42** and **43**.

The end portions **170** of the shaft **165** are mounted on the ends of a pair of arms **171** (FIG. 2) and are retained thereon by a plate **172** extending across flats **173** formed on the end portions **160**. The arms **171** are rotatably supported on a frame **174** by the shaft **175**. Thus as the rewinding coils **150** increase in diameter, the arms **171** rotate upwardly so that the disks **160** follow the increasing diameter of the coils **150**. As shown in FIG. 10, preferably the axis of the arbor **162** is maintained slightly in front of the tangent line **176** where the separate strips **40** lead onto the coils **150**. This has been found desirable to maintain the precise separation between the coils **150** without causing binding between the disks **160** and the edges of the strips **40**.

To prevent the weight of the arms **171**, arbor **162**, shaft **165** and disks **160** from resting against the outer surface of the coils **150** as they are wound, these components are counterbalanced by a pressure cylinder **177** (FIG. 10) mounted on the frame **174**. The piston **178** extending from the pressure cylinder is pivotally connected by the pin **181** to a support arm **182** rigidly mounted on the shaft **175** along with the arms **171** by a suitable key (not shown). A hand operated lever **186** is pivotally connected to one of the arms **171** and extends downwardly for engaging a stud **190** within the notch **192** when the arms **171** are moved to their uppermost position. This lever provides a safety catch in case the fluid supply for the pressure cylinder **176** fails, and thereby prevents the arms **171** and disks **160** from dropping.

As the rewinding coils **150** increase in diameter, it has been found desirable to increase the frictional drive forces between each of the slip rings **140**, drive rings **133** and **152** and the adjacent cylindrical cores **135**. Preferably, this increase is provided substantially proportionally to the increase in diameter of the coils **150**. Thus by increasing the pressure within the cylinder **90**, the force of the dogs **125** acting against the drive ring **152** is increased.

For this control, the movement of the arms **171** is sensed by a rheostat **200** (FIG. 10) which is mounted on the frame **174** and is controlled by the rotation of the rheostat spindle **202** connected for direct rotation with the shaft **175** by a timing belt **205** linking the pulleys **206** and **207**. Thus as the arms **170** move upwardly with an in-

crease in diameter of the rewinding coils **150**, the rheostat **202** controls a servo valve system (not shown) which increases the pressure within the fluid cylinder **90**. This increasing pressure, in turn, provides an increasing axial compression force between the end drive rings **133** and **152** causing an increase in the frictional drive of the cores **135** by the slip rings **140**.

After the slitting and rewinding operation is completed, the pressure cylinder **90** is actuated causing the rod **86** to extend outwardly and the dogs **125** to be retracted to the position shown in FIG. 7. The separate coils **150** are then removed from the mandrel **70** along with the drive ring **152** and slip rings **140**.

For some subsequent uses of the separate strips **40**, it is desirable to remove the cores **135** from the rewound coils **150**. For this purpose, a collapsible core **215** (FIG. 12) is used. This core is formed with an axially extending slot **216** and a cylindrical axially extending opening **218** which receives a pin **220**. Thus when it is desirable to remove the core **215** from a coil **150** after the rewinding operation, the pin **220** is driven out of the opening **218**, allowing the core **215** to collapse by the width of the slot **216** which is sufficient for conveniently removing the core **215** from the coil **150**.

A modified embodiment of the present invention is shown in FIGURE 13 where in place of the drive ring **152** shown in FIG. 6, a pair of drive rings **225** and **226** are mounted on the end portion of the mandrel **70** after the cores **135** are placed thereon and are connected by a series of circumferentially spaced bolts **228** having heads **229**. The bolts **228** extend through holes in the ring **226** and are secured within corresponding threaded openings **230** within the ring **225** so that the ring **226** can slide on the bolts **228** relative to the ring **225**.

Surrounding each of the bolts **228** and spaced between the rings **225** and **226** are a corresponding series of compression springs **232** which normally press the ring **226** against the heads **229** of the bolts **228**. After the cores **135** are positioned on the mandrel **70**, the assembled unit of the rings **225** and **226** connected by the compression springs **232** and bolts **228** is mounted on the end portion of the mandrel so that when the dogs **125** are extended, they engage the end face of the ring **226**. Thus when the pressure cylinder **90** (FIG. 9) is actuated to retract the rod **86**, the dogs **125** move the ring **226** towards the ring **225**, thereby compressing the springs **232** which, in turn, exert an axial force against the cores **135**.

It has been found that for rewinding some strips of material, the force exerted by the springs **232** will provide sufficient pressure between the drive ring **225** and the end core **135** without requiring continuous automatic control of the pressure cylinder **90**. Thus with the drive mechanism shown in FIG. 13, it is unnecessary to increase continuously and progressively the pull on the rod **86** as the rewinding coils **150** increase in diameter. Instead, the friction drive of the cores **135** provided by the compression springs **232** will produce a continuous tension in the strips during the rewinding operation. With some strips, however, depending on the type of material and thickness, it may be desirable to make periodical manual adjustments of the pressure within the cylinder **90** to provide incremental or step by step axial movement of the dogs **125** as the coils increase in diameter to increase the force exerted by the drive ring **225** on the slip cores **135** in generally the same manner as automatically provided by the rheostat **200** described above.

From the drawings and the above description it can be seen that the apparatus of the present invention provides several desirable features and advantages. To summarize, the apparatus maintains continuous tension in each of the separate metal strips **40** as they are rewound into coils regardless of variation in metal thickness across the width of the single metal strip **40**. Furthermore, the separate strips **40** are provided with a uniform separation at all times during the rewinding operation so that there is no possibility of rubbing or interweaving of the strips **40** as they are rewound into coils. These advantages are accomplished by an inexpensively constructed rewinding mechanism which includes the solid mandrel **70** and slip rings **140** for frictionally driving the separate cores on which the single metal strips **40** are rewound.

In addition, the cylindrical cores **135** are easily mounted on the mandrel **70** and the rewound coils **150** can be easily removed from the mandrel. It is also an additional feature that the frictional driving force between the cores **135** and the slip rings **140** can be progressively increased corresponding with an increase in diameter of the rewinding coils. Thus a continuous tension can be maintained within the separate strips **40** during the entire rewinding of the coils **150** which, in turn, prevents telescoping or collapsing of the rewound coils.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for unwinding and slitting a single metal strip arranged in a coil to form a plurality of separate strips each having a predetermined width and for rewinding the strips into separate coils while maintaining a continuous tension in each strip regardless of the variation in metal thickness across the width of the single strip, said apparatus comprising means for rotatably supporting the coil of a single strip at an unwinding station, means for slitting the single strip into a plurality of separate strips, drive means for feeding the single strip through said slitting means, a rotatably supported mandrel defining a rewind station, a corresponding plurality of cylindrical core members mounted for relative rotation on said mandrel and adapted to receive corresponding leading ends of the separate strips formed by said slitting means, each said core member having opposite radially extending end surfaces, a drive ring member positively mounted on said mandrel between each adjacent pair of of said core members and having drive surfaces frictionally engaging the corresponding said end surfaces of said core members, power operated means for driving said mandrel at a speed slightly faster than the core member speed required for rewinding the thinnest strip to provide relative rotational slip between each said core member and its corresponding said drive ring members as the rewound coils are formed to compensate for the differences in diameters of the coils caused by the the variation in metal thickness among the strips, and means on said mandrel adjacent the end said core members for pressing said core members axially against said drive ring members as the coils are formed to provide a continuous tension in each of the strips so that the coils formed by the strips are wound with sufficient tightness to enable handling without collapsing or telescoping.

2. Apparatus as defined in claim **1** including a pair of variable bowed rolls spaced between said slitting means and said mandrel to fan out the separate strips and return them to parallel spaced relation so that adjacent coils formed on said core members are spaced apart by a slight amount to prevent interleaving of the strips forming said adjacent coils.

3. Apparatus as defined in claim **1** including a circular spacing disk for each said drive ring member and corresponding said disk and said ring members having substantially equal thickness, and means movably supporting said disk between said strips adjacent the outer surface of the rewinding coils to prevent interleaving of adjacent strips forming said coils.

4. Apparatus for unwinding and slitting a single metal strip arranged in a coil to form a plurality of separate strips each having a predetermined width and for rewinding the strips into separate coils while maintaining con-

tinuous tension in each strip regardless of the variation in metal thickness across the width of the single strip, said apparatus comprising means for rotatably supporting the coil of single strip at an unwinding station, means for slitting the single strip into a plurality of separate strips, drive means for feeding the single strip through said slitting means, a rotatably supported mandrel defining a rewind station, a corresponding plurality of cylindrical core members mounted for relative rotation on said mandrel and adapted to receive corresponding leading ends of the separate strips formed by said slitting means, a ring member positively mounted on said mandrel between each adjacent pair of said core members and having opposite driving end surfaces frictionally engaging the surfaces of the adjacent said core members, power operated means for driving said mandrel at a speed slightly faster than the core member speed required for rewinding the thinnest strip so that the core members slip in relation to said ring members as the rewound coils are formed to compensate for the difference in diameter of the coils caused by the variation in metal thickness among the strips, and means adjacent the end said core members on said mandrel for applying axial pressure between said ring members and adjacent said core members during forming of the coils to provide continuous tension in each of the strips so that the coils formed by the strips are wound with sufficient tightness to enable handling without collapsing or telescoping.

5. Apparatus for slitting a single strip of material to form a plurality of separate strips each having a predetermined width and for winding the strips into separate coils while maintaining continuous tension in each strip regardless of the variation in thickness across the width of the single strip, said apparatus comprising means for slitting the single strip into a plurality of separate strips, a mandrel, means supporting said mandrel in a cantilevered position, power operated means for driving said mandrel, a plurality of cylindrical core members mounted for relative rotation on said mandrel and adapted to receive corresponding leading ends of the separate strips formed by said slitting means, a plurality of generally flat thin drive rings mounted on said mandrel for positive rotation therewith with at least one said ring located between each adjacent pair of said core members, each said ring being axially slidable on said mandrel and having opposite driving surfaces frictionally engaging the end surfaces of the adjacent said core members so that the core members slip in relation to said rings as the coils are formed, and means adjacent the end said core members on said mandrel for applying axial pressure against the entire assembly of said rings and adjacent said core members during forming of the coils to provide continuous tension in each of the strips so that the coils formed by the strips are wound with sufficient tightness to enable handling without collapsing or telescoping.

6. Apparatus as defined in claim 5 including a removable annular collar mounted on the end portion of said mandrel adjacent the end surface of the end said core member, and means including a fluid pressure cylinder for applying a variable axial force against said collar to vary the frictional drive between said driving end surfaces of each said ring member and the adjacent end surfaces of said core members.

7. Apparatus for unwinding and slitting a single metal strip arranged in a coil to form a plurality of separate strips each having a predetermined width and for rewinding the strips into separate coils while maintaining continuous tension in each strip regardless of the variation in metal thickness across the width of the single strip, said apparatus comprising means for rotatably supporting the coil of single strip at an unwinding station, means for slitting the single strip into a plurality of separate strips, drive means for feeding the single strip through said slitting means, a pair of bowed rolls for receiving the strips from said shear means to spread adjacent strips and to return them to parallal spaced relation, pressure cylinder means for varying the degree of bow of said rolls to control the amount of separation between adjacent strips, means for adjustably spacing one of said rolls in relation to the other for also providing control of the amount of separation between adjacent said strips, a rotatably supported mandrel defining a rewind station, power operated means for driving said mandrel, a corresponding plurality of cylindrical core members mounted for relative rotation on said mandrel and adapted to receive corresponding leading ends of the separate strips leading from one of said bowed rolls, each said core member having opposite radial end surfaces, a ring member positively mounted on said mandrel between each adjacent pair of said core members and having opposite radial drive surfaces frictionally engaging said end surfaces of the adjacent said core members and adapted to provide relative rotational slip among said core members as the rewound coils are formed to compensate for the difference in diameter of the coils caused by the variation in metal thickness among the strips, each said ring member having an axial thickness equal to the space betwen the corresponding adjacent pair of strips as produced by said bowed rolls, and means adjacent the end said core members on said mandrel for pressing said core members axially adjacent said ring members to provide continuous tension in each of the strips so that the coils formed by the strips are wound with sufficient tightness to enable handling without collapsing or telescoping.

8. Apparatus for unwinding and slitting a single metal strip arranged in a coil to form a plurality of separate strips each having a predetermined width and for rewinding the strips into separate coils while maintaining continuous tension in each strip regardless of the variation in metal thickness across the width of the single strip, said apparatus comprising means for rotatably supporting the coil of single strip at an unwinding station, means for slitting the single strip into a plurality of separate strips, drive means for feeding the single strip through said slitting means, a rotatably supported mandrel defining a rewind station and having means defining at least one axially extending slot formed in its outer surface, a plurality of cylindrical core members mounted for relative rotation on said mandrel and adapted to receive corresponding leading ends of the separate strips formed by said slitting means, each said core member having opposite end surfaces, a drive ring member mounted on said mandrel between each pair of adjacent said core members, said drive ring members each having means extending into said slot to provide positive rotation of said ring members with said mandrel and axial movement of each said ring members on said mandrel, each said drive ring member including means for frictionally engaging and driving said end surfaces of said core members, power operated means for driving said mandrel at a speed slightly faster than the core members speed required for rewinding the thinnest strip so that the core members slip in relation to said ring members as the rewound coils are formed to compensate for the difference in diameter of the coils caused by the variation in metal thickness among the strips, and means for applying uniform axial pressure between said ring members and adjacent said core members as the coils are formed to provide continuous tension in each of the strips so that the coils formed by the strips are wound with sufficient tightness to enable handling without collapsing or telescoping.

9. Apparatus as defined in claim 8 wherein said means for applying said axial pressure includes a series of dog members adapted to engage an end drive ring mounted on said mandrel, axially movable rod means extending through said mandrel for actuating said dog members from a retracted position for loading and unloading said mandrel to an extended position for applying pressure to said drive ring, fluid cylinder means connected to said rod means, and means for automatically increasing the

pressure within said fluid cylinder means as the coils increase in diameter to provide a substantially constant tension in each said strip.

10. Apparatus as defined in claim **8** wherein said means for applying said axial pressure includes a pair of spaced drive rings mounted on said mandrel, a plurality of annularly arranged compression springs positioned between said drive rings, and means on said mandrel for moving one of said rings toward the other said ring for compressing said springs to provide a continuous axial drive force against said core members during the rewinding of the coils.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,406,924 October 22, 1968

Elton W. Bruns et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 54, "of" should read -- on --. Column 3, line 18, "speading" should read -- spreading --. Column 4, line 5, "interweaving" should read -- interleaving --. line 13, "sperading" should read -- spreading --. Column 5, line 16, "123" should read -- 133 --. Column 12, after line 10, insert

Foreign Reference

11,998	1908	Great Britain

Signed and sealed this 9th day of December 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

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Commissioner of Patents