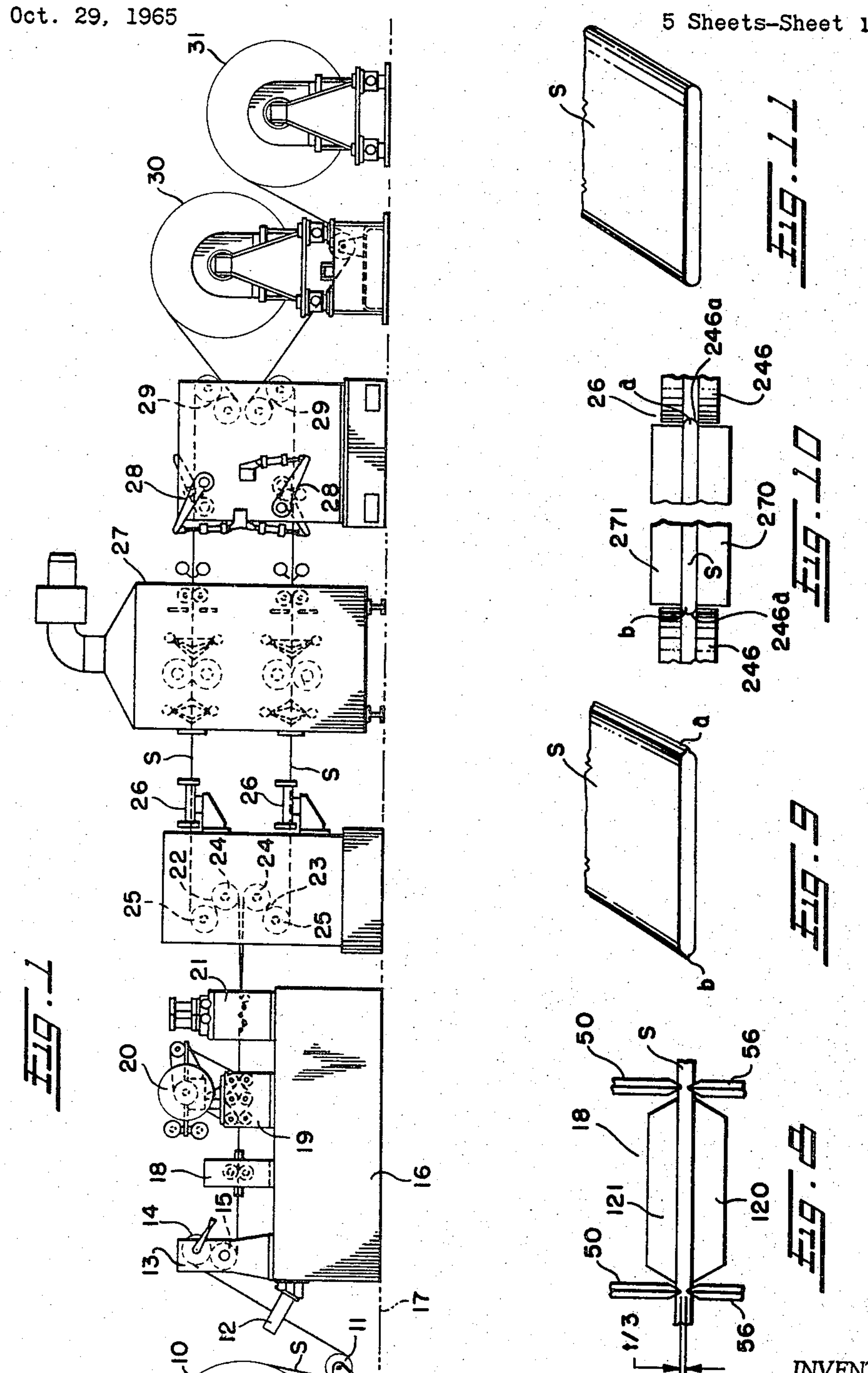
Dec. 17, 1968 J. S. WALSH ETAL 3,416,347

SLITTING AND EDGE CONDITIONING MEANS

Filed Oct. 29, 1965 5 Sheets-Sheet 1



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SLITTING AND EDGE CONDITIONING MEANS

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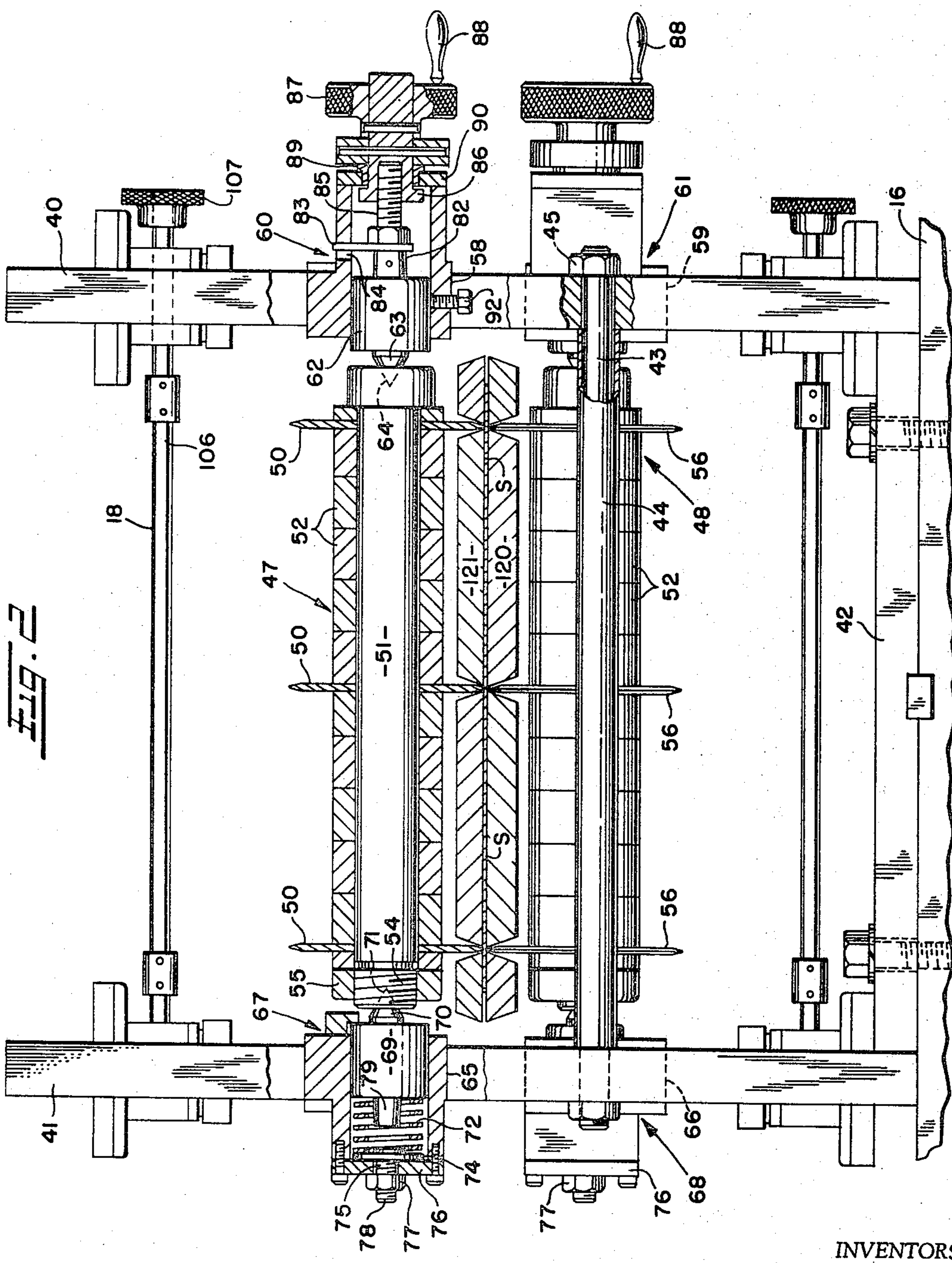

FIG. 2

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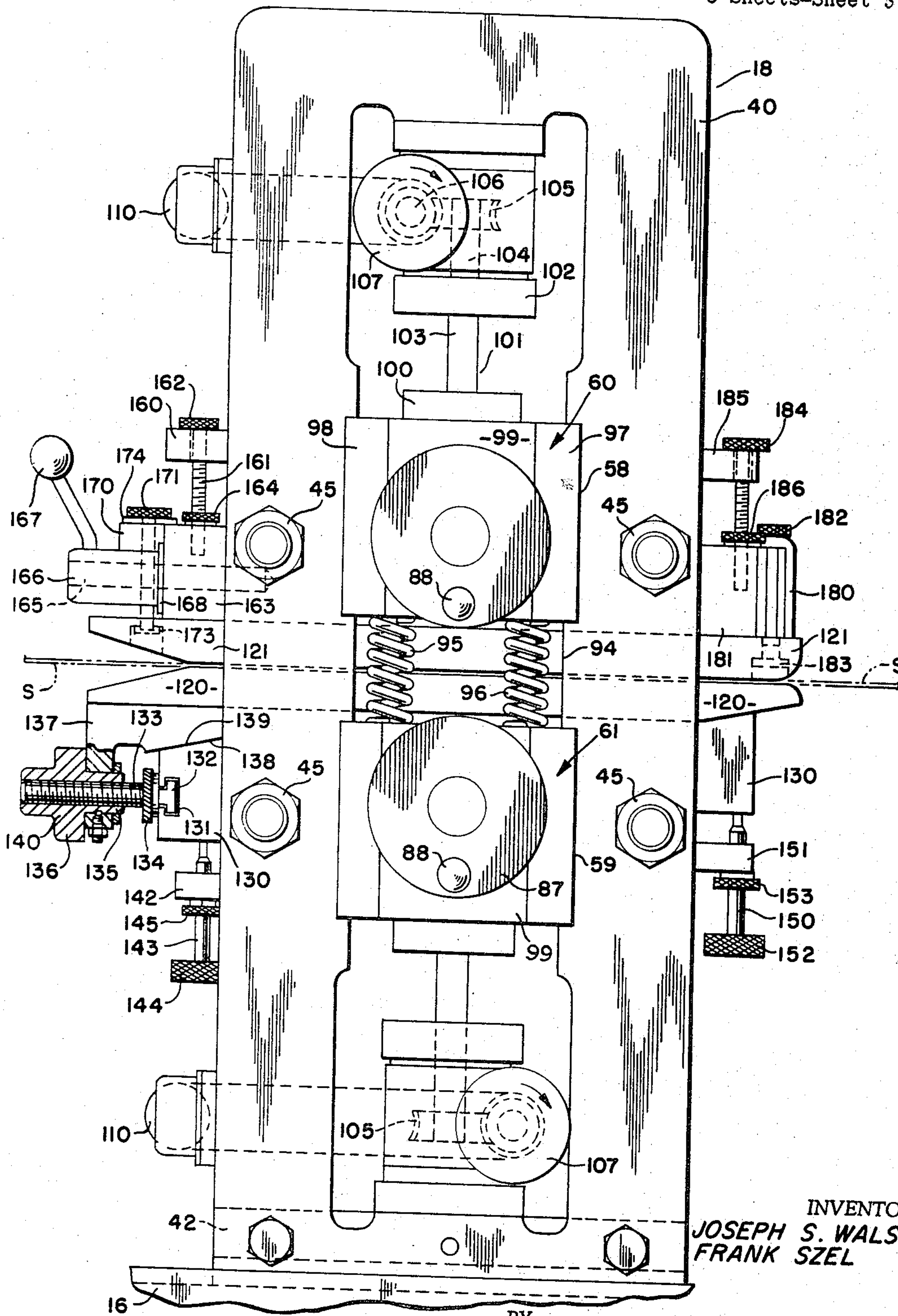

FIG. 3

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SLITTING AND EDGE CONDITIONING MEANS

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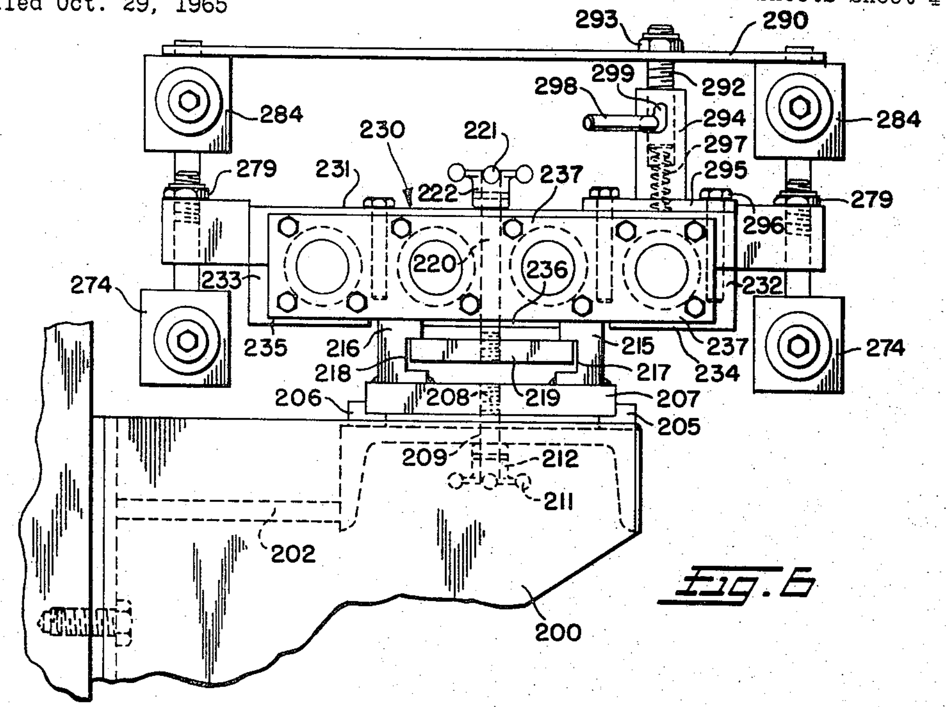

Fig. 6

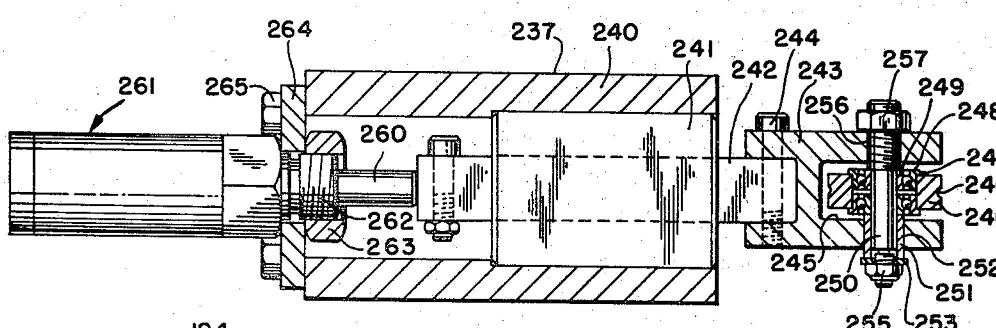

Fig. 7

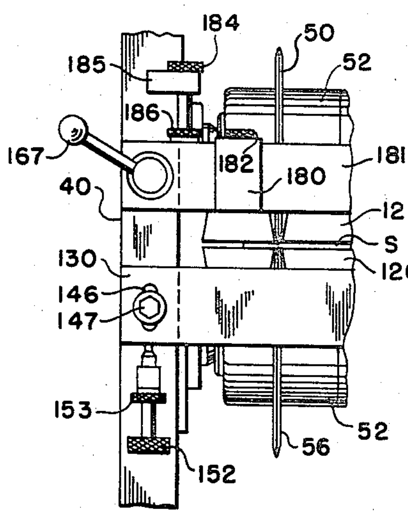

Fig. 3A

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SLITTING AND EDGE CONDITIONING MEANS

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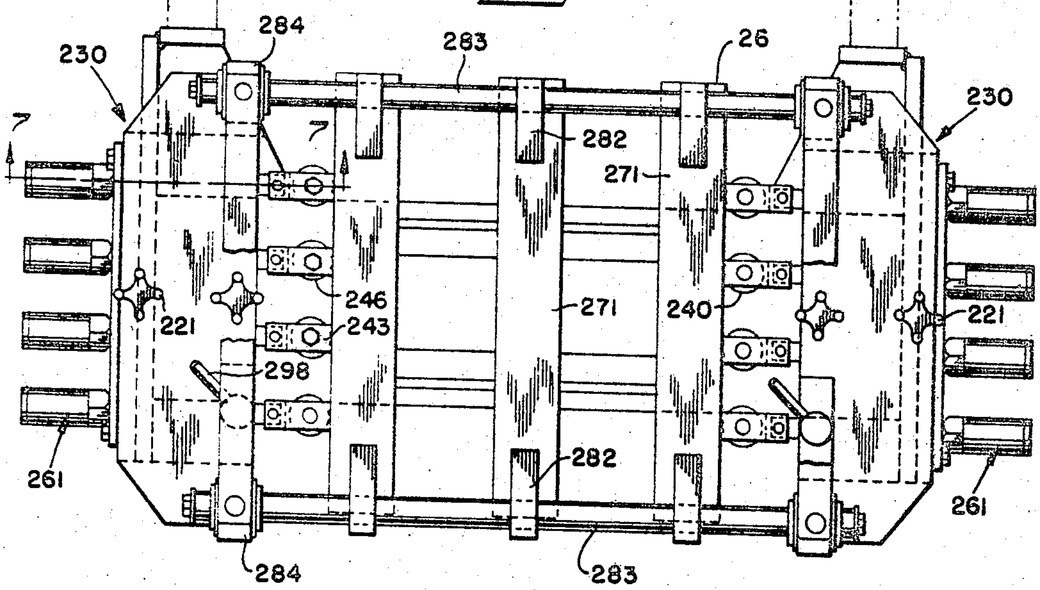

Fig. 4

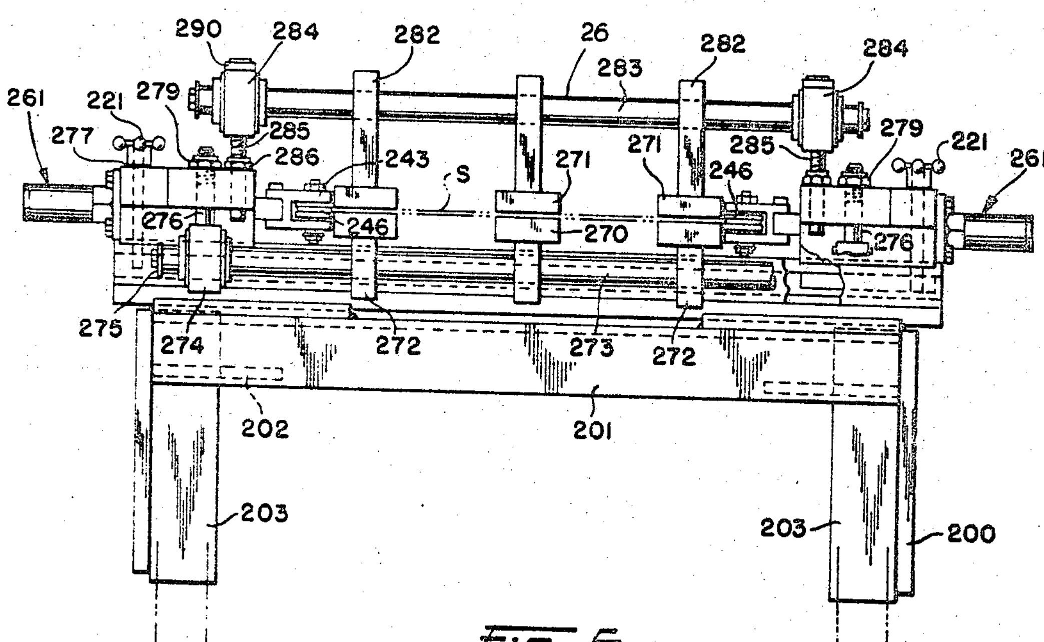

Fig. 5

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3,416,347

SLITTING AND EDGE CONDITIONING MEANS

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Filed Oct. 29, 1965, Ser. No. 505,709
15 Claims. (Cl. 72—203)

ABSTRACT OF THE DISCLOSURE

Apparatus and method for forming electrical strip and the like which includes a pinch slitter partially severing such strip while simultaneously partially forming the edges, such strip being drawn under controlled tension through the slitter between adjustable pressure pads, and then edge conditioning the split strip by drawing such strip through an edge conditioner, the latter including a plurality of edge conditioning rolls each independently urged into contact with the strip edge, such strip in the edge conditioner passing through pressure pads having lateral floating movement.

This invention relates to novel means for slitting and separating coiled strip into a plurality of relatively narrow strips and thereafter conditioning the edges of each thus formed strip to achieve rounding thereof.

In conventional coil strip slitting methods and apparatus, the strip is slit by means of circular blades which penetrate the thickness of the traveling coil thereby to sever the coil into two or more relatively narrow strips. The edges of the thus formed strip are generally flat and burring is unavoidably formed on such edges. Where the strip material is to be used in electrical applications, for example in the making of strip-wound electrical coils, the flat and burred edges are clearly undesirable. The flat edges and sharp corners have a relatively high voltage gradient thereby creating stresses in the insulation and substantially reducing coil life. The flat edges and burring are also detrimental to the uniform packing of the strip and the subsequent application of insulating material. Attempts to condition the flat edges formed by present slitting techniques to improve the use thereof in electrical applications of the type noted have not met with any degree of success.

With the above in mind, a primary object of the present invention is to provide a novel means for and method of partially slitting and thereafter separating the strip coil into a plurality of narrower strips, and then edge conditioning each of the thus formed strips to form rounded edges having predetermined, reasonably true radii.

A further object of the present invention is to provide a novel means for and method of slitting metal strip material comprising first partially severing the material on both sides thereof, with such partial severing forming generally V-shaped grooves in the top and bottom of the strip material, and thereafter completely severing the strip material by essentially tearing the same in the partially severed areas thereof.

A still further object of the present invention is to provide a novel edge conditioning unit comprising a plurality of edge conditioning rolls mounted adjacent each edge of the strip traveling through the unit, with each conditioning roll being formed with an edge-engaging surface generally complemental to the desired radius of the strip edge, the rolls resiliently engaging the opposed strip edges for rounding the same.

Another object of the invention is to provide means associated with the slitting and edge conditioning units for supporting and vertically controlling the strip while

traveling through the slitter and edge conditioner units to provide optimum conditions for strip formation and edge conditioning.

Yet another object of the present invention is to provide an edge conditioning unit wherein the conditioning rolls and means for vertically controlling the strip traveling through the unit are laterally movable to accommodate lateral deviation of the strip as it passes through the unit.

These and other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following descripition and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is a side elevational view of the entire processing line, which line includes the slitting and edge conditioning means of the present invention;

FIG. 2 s an enlarged end view of the pinch slitter unit;

FIG. 3 is an enlarged side elevational view of the pinch slitter unit;

FIG. 3A is a fragmentary side view taken from the right side of FIG. 3;

FIG. 4 is a top plan view of the edge conditioning unit;

FIG. 5 is an end elevational view of the edge conditioning unit;

FIG. 6 is a side elevational view of the edge conditioning unit;

FIG. 7 is an enlarged, sectional view taken on line 7—7 of FIG. 4;

FIG. 8 is a schematic view of the strip traveling through the pinch slitter unit;

FIG. 9 is a schematic perspective view of the strip after passing the strip separating unit;

FIG. 10 is a schematic view of the strip traveling through the edge conditioning unit, and

FIG. 11 is a schematic perspective view of the finally conditioned strip.

Referring now in more detail to the drawings, wherein like parts are indicated by like reference numerals, and initially to the entire process line shown in FIG. 1, the feed strip S is unwound from a conventional drag-type uncoiler **10** under roll **11** and through an edge guide sensor unit **12**. By way of example but not limitation, the strip material S may comprise an aluminum strip approximately .030 inch thick and 14 inches in width, although it will be understood, and will become apparent as the description proceeds, that strip materials other than that mentioned could be used having thicknesses other than that indicated.

The strip S after passing through the edge guide sensor **12** passes through an entry bridle unit **13** having a top roll **14** and a bottom drive roll **15**. The entry bridle unit is supported, as are the next several units mentioned, on frame **16** which is in turn mounted on the supporting surface **17**.

The strip S is driven from the entry bridle unit **13** to the pinch slitter unit **18** which forms an important part of the present invention and which will be described in more detail hereinbelow when specific reference is made to FIGS. 2, 3 and 6. It will suffice here merely to briefly note that at the slitting station the strip S is vertically scored along transversely spaced lines on the top and bottom thereof, with the strip being thereafter severed along such scored lines during passage through a strip separating unit **19**. In accordance with the present invention, two relatively narrower strips, between 6 and 7 inches in width, are formed from the original feed strip, with relatively narrow scrap pieces which include the opposed edges of the original feed strip being also formed and wound on a pair of scrap winders **20** disposed, in the form shown, above the strip separating unit.

The thus formed strips next pass through a stretcher leveler unit **21** which functions effectively to de-camber each of the metal strips. From the stretcher leveler unit **21** the strips pass respectively to tension bridle roll units **22** and **23**, each of which includes a load measuring roll **24** and a drive roll **25**. The latter provide the tension in the strips between the entry bridle unit **13** and the units **22** and **23**, with the rolls **24** being provided with means to measure such tension for setting thereof as desired.

The now vertically spaced strips S pass from the tension bridle roll units **22** and **23** to edge conditioning units **26** of identical construction. While passing through such units, as will be hereinafter described in more detail when particular reference is made to FIGS. 4, 5 and 7, the strip edges are smoothed and rounded to provide a strip having the above-noted desirable characteristics.

The conditioned strips S thereafter pass through a brush and spray cleaning station **27** to clean the strips and rid the same of any undesirable material which may have adhered to the strip surfaces while passing through the previous stations. From the cleaning station **27** the strips are passed through edge flattener units **28** which insure that the thickness of the edge is restored to the approximate thickness of the rest of the strip. It will be noted that although the edge flattener units are shown following the brush and spray cleaning station **27**, the same could be mounted as well preceding such station.

Following edge flattening, the strips S pass through recoiler tension roll units **29** to driven recoilers **30** and **31**, respectively. Means are preferably provided associated with the recoiler tension roll units for reading the tension between the tension bridle roll units **22** and **23** and the driven recoilers **30** and **31**.

Referring now to FIGS. 2 and 3, which show the structural detail of the pinch slitter unit **18**, the unit comprises a generally U-shaped frame which includes side plates **40** and **41** and a base plate **42**. The side plates can be rigidly interconnected to the base plate in any suitable manner, with the latter in turn being suitably rigidly attached to the supporting frame **16**. To additionally rigidify the frame and to space the side plates **40** and **41**, a plurality of tie bars commonly designated at **43** are provided extending vertically adjacent each end of the side plates **40** and **41**, as seen in FIG. 3, with sleeves **44** extending over the bars **43** and serving to uniformly space the side plates **40** and **41** vertically throughout. The opposed ends of each of the tie bars **43** are threaded and extend through openings provided therefor in the side plates **40** and **41**, with the bars being rigidly clamped to the plates by nuts **45**.

Upper and lower pinch slitter blade assemblies generally indicated at **47** and **48**, respectively, are mounted for rotation between the spaced side plates **40** and **41**. Each of the blade assemblies **47** and **48** is identically constructed and mounted in and between the side plates **40** and **41** and the following description, relating to the construction and mounting of the upper blade assembly **47** is applicable to the lower blade assembly as well. Pinch slitter blades commonly designated at **50** are mounted on arbor **51**, with the blades being suitably spaced by cylindrical spacing sleeves **52**. The arbor is enlarged at one end thereof, the right end as viewed in FIG. 2, as indicated at **53**, with such enlarged portion serving as a stop for the adjacent spacer **52**. The opposite end of the arbor **51** is threaded as indicated at **54** for receiving a clamping nut **55** by means of which the entire blade assembly including the spacers and blades themselves can be firmly clamped on the arbor **51**. It will be apparent that the blades **50** can vary in number and spacing as desired, with there being three such blades provided in the form shown.

The bottom pinch slitter blades **56** are mounted and spaced in the same manner, and are aligned vertically with the upper blades **50**, as can be seen in FIG. 2. The blades **50** and **56** can be adjusted vertically through adjustment of the mountings therefor, as will be presently described, to vary the distance between the blade peripheries. As shown in FIG. 2, the blades **50** and **56** are vertically positioned so as to penetrate the strip S a distance approximately equal to one-third of the thickness of the strip thereby to form longitudinally extending grooves therein. It will be seen that the outer blades **50** and **56** sever the feed strip S relatively closely adjacent the opposed edges thereof, with the relatively narrow strip portions subsequently formed being separated and wound on the scrap winders **20** as previously noted.

The side plate **40** is formed with openings **58** and **59** for receiving upper and lower bearing boxes generally indicated at **60** and **61**, respectively. The bearing boxes are identically constructed, with the upper bearing box **60** being longitudinally bored for receiving a spindle bearing carrier **62** which rotatably mounts a spindle dog **63**. The latter is generally cone shaped and adapted to be received in a complemental opening **64** formed in the adjacent enlarged end **53** of the arbor **51**. The bearing carrier **62** can be adjusted along its axis normal to the side plate **40** by means to be presently described thereby to vary the position of the upper pinch slitter blades **50**.

The side plate **41** is similarly provided with openings **65** and **66** for receiving upper and lower bearing boxes generally indicated at **67** and **68**, respectively. The boxes are identically constructed and mounted, with the upper box **67** being longitudinally bored for receiving a spindle bearing carrier **69** which rotatably mounts a spindle dog **70**. The latter is generally cone shaped and is adapted to be received in a similar opening **71** formed in the adjacent end of the arbor **51** whereby the latter is rotatably mounted at such end. The bearing carrier **69** is resiliently biased inwardly toward the arbor by means of a compression spring **72** the inner end convolution of which contacts the bearing carrier and the opposite end convolution of which contacts the enlarged cap end **74** of an adjusting screw **75**. The latter is retained in such position by means of a retaining plate **76** which is suitably bolted or otherwise movably secured to the bearing box and threaded for receiving the adjusting screw **75**. A lock nut **77** is also received around the adjusting screw for maintaining the same in its adjusted position. The screw **75** is formed in its outer end with a slot **78** by means of which the same can be axially adjusted to vary the preloading of the spring **72** against the bearing carrier **69**. For positioning the spring **72** at the inner end thereof, a generally cylindrical hub **79** is mounted on the bearing carrier **69** and extends within the spring convolutions. It will thus be seen that the arbor **51** is continually biased to the right, with the biasing force being controlled through the preloading of the spring **72**.

As above noted, the bearing carrier **62** mounted in the side plate **40** is adjustable axially in the bearing box **60** thereby to vary the positioning of the arbor **51** and thus the blades **50** carried thereby. The carrier **62** has mounted thereto a generally cylindrical outer hub **82** which in turn carries a vertically directed pin or arm **83**. The latter extends upwardly through a slot **84** formed in the bearing box, which arrangement prevents rotation of the bearing carrier during axial adjustment thereof.

A threaded stud **85** is adapted to contact or be suitably connected to the pin **83** and is in turn threadedly received in a collar **86**. The latter is carried by a micrometer collar **87** having a handle **88** extending outwardly therefrom to facilitate rotation thereof. A washer **89** and sleeve **90** are positioned around the collar **86** and between the micrometer collar **87** and the end of the bearing box housing. It will thus be seen that when the collar handle **88** is rotated, the threaded stud **85** can be axially adjusted inwardly or outwardly relative to the collar depending upon the direction of rotation of the collar. The positioning of the arbor **51** and thus the blades **50** carried thereby can accordingly be finally adjusted by the micrometer collar, with such adjustment being against the bias of the spring **72** mounted in the bearing box **67** at the opposite end of the arbor. A lock screw **92** is preferably provided extending upwardly through the threaded opening in the bearing box **60** into engagement with the bearing carrier **62** for maintaining the same in its adjusted position.

The arbor carrying the bottom pinch slitter blades **56** is axially adjustable in the same manner, whereby the upper and lower blades can be precisely laterally adjusted relative to the strip S and vertically aligned.

Referring to FIG. 3, intermediate the openings **58** and **59** formed in the side plate **50** is a relatively smaller opening **94** which is adapted to receive compression springs **95** and **96** the opposed end convolutions of which respectively contact the adjacent ends of the upper and lower bearing boxes **60** and **61**, respectively. As clearly shown in FIG. 3, each of the bearing boxes **60** and **61**, referring to the upper bearing box **60**, is comprised of three united sections **97**, **98** and **99**, the latter such section mounting the bearing carrier **62** previously described. The bearing box **60** is vertically adjustable in the opening **58** to vary the vertical positioning of the slitter blades **50** and **56**.

The springs **95** and **96** bias the intermediate section **99** of the upper bearing box **60** upwardly into contact with the bottom plate **100** of an adjustment member which additionally includes a top plate **102** and a connecting section **103**. The top plate **102** is adapted to be vertically adjusted by shaft **104** the upper end of which is threaded for vertical adjustment by a worm nut **105**. The latter is adapted to be rotated by a worm gear carried by worm shaft **106** to which is mounted a hand knob **107** which extends outwardly from the side of the plate **40**. The worm nut **105** is vertically fixed whereby adjustment of the worm gear carried by the hand knob **107** will vertically raise or lower the plate **100** and thus the bearing box **60** to vertically position the slitter blades **50**. The springs **95** and **96** continually upwardly bias the bearing box against the plate **100**. The bottom slitter blades can be vertically adjusted in the same manner.

The control knobs **107** are preferably operatively connected to counters or scales **110** mounted at the adjacent edge of the side plate **40** at the top and bottom thereof, which scales can accurately indicate the vertical positioning of the pinch slitter blades **50** and **56**.

An important feature of the present invention resides in the manner in which the strip S is vertically controlled and supported as it passes through the pinch slitter unit **18**. To provide such support, a series of lower support pads commonly designated at **120** are vertically adjustably mounted on the side plates **40** and **41** and extend longitudinally past the back and front ends of such plate so as to support the traveling strip during its entire travel through the pinch slitting unit. The pads **120** are preferably formed of nylon or like material so as to reduce the friction between the same and the strip traveling thereover to a minimum. A series of upper pressure pads commonly designated at **121** are disposed above and in pressure engagement with the top surface of the strip S and are similarly vertically adjustably carried by the side plates **40** and **41**. In the form shown, there are four such vertically aligned pairs of support and pressure pads **120** and **121**, respectively, with two such pairs being disposed between the center and the respective outer slitter blades, and two pairs being disposed laterally outwardly of the outer slitter blades for supporting and applying pressure to the relatively narrow scrap portions at the opposed edges of the strip.

Referring to FIG. 3, the lower support pads are supported at the strip inlet side of the pinch slitter unit by a bar **130** which is adjustably mounted on the side plates **40** and **41** and extends therebetween. The bar **130** is provided with a generally T-shaped slot **131** adapted to receive the head **132** of a locking screw member **133**. The screw **133** is movable along the slot **131** and can be maintained in its adjusted position by means of a lock nut **134**.

The adjusting screw **133** extends through a threaded bushing **135** integral with a micrometer adjustment knob **136**. A support pad shoe **137** is mounted on the bushing **135** and adapted to be carried thereby, with the shoe in turn supporting the lower support pads **120**. The shoe preferably extends laterally between the side plates **40** and **41**. The bar **130** is provided with a top bevel surface **138**, with the pad shoe **137** being formed with a complemental bottom bevel surface **139**. It will thus be seen that when the micrometer adjustment knob **136** is rotated, the knob, bushing **135**, and the pad shoe **137** carried thereby will be axially threaded along the fixed adjusting screw whereby the pad shoe may be vertically raised or lowered by virtue of the described beveled surfaces. In this manner, the support pads **120** can be vertically positioned as desired for supporting the strip S passing through the pinch slitter unit. The knob **136** is provided with a micrometer scale **140** to measure the fine adjustment of the shoe and support pad. A plurality of micrometer adjustments of the type described are preferably provided extending between the side plates **40** and **41** for uniformly raising and lowering the pad shoe and the support pad carried thereby.

The bar **130** as above noted is vertically adjustably mounted relative to the side plates **40** and **41**. An internally threaded collar **142** is mounted on the side plate **40**, referring to FIG. 3, and receives an elongated set screw **143** having a knurled end **144** for rotating the same. The lead end of the set screw **143** is adapted to contact the bottom of the bar **130** for vertically positioning the same. A lock nut **145** is provided for maintaining the set screw in its adjusted position. As can be seen in FIG. 3A, the bar **130** is provided with vertically elongated slots **146** at opposite ends thereof to accommodate the described vertical adjustment, with a clamping bolt **147** extending through each slot into a tapped opening formed in each of the side plates **40** and **41** to maintain the bar **130** in its vertically adjusted position. To realize such vertical movement of the bar **130**, the clamping bolt **147** is merely loosened and the set screw rotated. This adjustment provides in effect a coarse vertical adjustment of the bar **130**, and thus the support pads **120**, with the fine adjustment being realized through the micrometer adjustment described above.

The bar **130** provided at the opposite end of the pinch slitter unit, or at the right as viewed in FIG. 3, is mounted for vertical adjustment on and between the side plates **40** and **41** in the same manner as above described. Thus, set screw **150** is vertically movable in an internally threaded collar **151** mounted on the side plate **40**, with the set screw having a knurled end portion **152** for rotating the same and thereby vertically raising or lowering the bar **130** and the support pad **120** carried thereby. A lock nut **153** is similarly provided for retaining the set screw in its vertically adjusted position. It will be noted that the bar **130** and pad **120** are formed with complemental beveled surfaces in such area whereby the previously described adjustment of the pad shoes **137** at the opposite end of the unit will simultaneously provide the same vertical adjustment at the opponite end of the unit. To achieve the same vertical movement at both ends of the support pads, the beveled angles described are made equal.

The upper pressure pads **121** are also vertically adjustably supported on the side plates **40** and **41**. As shown at the upper left in FIG. 3, a collar **160** is secured to the side plate **40** and an adjusting screw **161** having an upper knurled turning portion **162** is supported by such collar. A bar **163** which preferably extends between the side plates **40** and **41** is internally threaded to receive the bottom end of the adjusting screw **161** whereby rotation thereof will effectively raise or lower such bar. A clamp nut **164** is provided to retain the bar **163** in its adjusted position.

A stud **165** is pinned to the frame and held against rotative or axial movement. The stud extends through the bar **163** outwardly thereof and receives an internally threaded sleeve **166** which carries a handle **167**. A clamping washer **168** is disposed around the stud between the bar and the sleeve. It will thus be seen that when the sleeve **166** is drawn toward the bar **163** through tightening of the handle **167**, the sleeve will tightly clamp the bar against the side plate **40**. There is a similar clamping arrangement at the opposite end of the unit for clamping such bar end to the opposite side plate **41**.

The top pressure pads **121** are clamped to the bar **163** by means of a pad shoe **170** which carries the adjacent end of the pressure pads. The shoe **170** is bored for receiving a clamping bolt **171** which extends downwardly through the shoe and through an aligned opening **172** formed in the pressure pad **120** immediately therebelow. A nut **173** is adapted to be threaded on the end of the clamp bolt for securing the assembly. A relatively thin plate **174** is positioned on top of the shoe **170** and extends over the bar **163** for clamping the shoe and pad to the bar.

The means for vertically adjustably supporting the top pressure pad **121** at the opposite end of the unit, shown at the upper right in FIG. 3, is generally similar to that just described. Thus, the pad **121** is carried by a pressure pad shoe **180** which is clamped to the bar **181** by a clamping bolt **182** and nut **183**. The bar **181** is vertically adjustable relative to the side plate **40** by means of an axially fixed adjusting screw **184** which is supported by collar **185** suitably attached to the side plate **40**. A lock nut **186** is similarly provided for retaining the adjusting screw **184** in its vertically adjusted position. Although not appearing in FIG. 3, a handle and sleeve similar to sleeve **166** and handle **167** just described are provided for clamping the bar **181** to the side plate **40**. Although not shown, it will be understood that a series of such upper pressure pad mounting assemblies are provided for vertically adjusting each of the upper pressure pads **121**.

It will thus be seen that both the upper and lower pads **121** and **120**, respectively, and the pinch slitter blades **50** and **56** can be adjusted relative to the strip to afford controlled grooving of the feed strip at the slitting station. The slitter blades are laterally as well as vertically adjustable so as to penetrate the strip on opposed sides thereof the desired depth. The strip is continually supported by the lower pressure pads with the upper pressure pads **121** contacting the strip from above so as to maintain the same in the same horizontal plane while passing through the unit, thereby effectively minimizing the vertical vibration tending to develop in the strip due to the strip being under tension.

Referring now to the detailed construction of the edge conditioning unit **26**, as shown in FIGS. 4–7 each unit is mounted on the housing mounting the bridle roll units **22** and **23** by means of laterally spaced bracket **200** which in turn supports a channel beam **201** which extends therebetween. A reinforcing plate **202** is additionally provided which interconnects the transverse channel beam **201** and the brackets **200**, with the plate being in the form shown welded to flanges **203** of the brackets **200**.

As best seen in FIG. 6, generally L-shaped bars **205** and **206** are mounted on the top of the transverse channel beam **201** and are adapted to slidably receive a plate **207**. The latter is provided with a transverse, threaded opening for receiving a clamping bolt **208** which extends downwardly through a slot **209** formed in the transverse channel beam to permit lateral movement of the plate relative thereto. The clamping bolt **208** has mounted at the exposed end thereof a handle **211** having a bushing portion **212** keyed or otherwise secured to the bolt **208**. The plate **207** can thus be laterally adjusted relative to the bars **205** and **206** and clamped in adjusted poistion by the handle **211**.

Generally U-shaped guide members **215** and **216** are mounted on the plate **207** and provide ways or channels **217** and **218**, respectively, for slidably receiving a generally T-shaped bar **219**. The latter is provided with a transverse opening threaded to receive an upper clamping bolt **220**. A handle **221** is carried by the upper end of the adjusting screw **220** and includes a bushing portion **222** preferably keyed to the adjusting bolt for turning the same.

A housing generally indicated at **230** is clamped to the frame by the bar **219** and bolt **220** and comprises a top plate **231**, side plate sections **232** and **233**, and bottom sections **234** and **235**. A plate **236** is positioned on the bar **219** and is suitably apertured for receiving the clamp bolt **220**. A plurality of edge conditioning units commonly designated at **237** are mounted within the housing **230**, with each such unit mounting an edge conditioning roll as will be hereinafter described when particular reference is made to FIG. 7.

As can be seen in FIGS. 4 and 5, a similar housing **230** and enclosed group of edge conditioning units is mounted opposite to the one illustrated in FIG. 6 for contacting the opposite edge of the traveling strip for conditioning the same. The opposite assembly is constructed and mounted in the identical manner just described and no further description thereof is believed to be necessary.

Referring now to FIG. 7, each edge conditioning unit **237** comprises an elongated housing **240** which has mounted therein a sleeve **241**. The latter is formed with a square axial opening for receiving a square shaft **242**. The forward end of the shaft **242** extends outwardly of the housing **240** and is adapted to receive the bifurcated end of a yoke **243**. A pin **244** extends through aligned openings in the bifurcated ends and the shaft **242**, with the remote end being threaded for securing the yoke connection.

The yoke **243** is inwardly centrally recessed as indicated at **245** for receiving the edge conditioning roll **246**, with the latter being formed with an edge receiving groove **246*a*** having a radius equal to the desired radius of the strip edge. The conditioning roll is mounted on the outer race **247** of bearing **248**, with the inner race **249** thereof being press fit or otherwise secured to pin **250**. The inner bearing race **249** is supported by a bushing **251** disposed around the pin and extending through an opening **252** in the yoke, with the bushing being retained by washer **253** and lock nut **255**. The upper end of the pin **250** is externally threaded for engagement with a threaded opening **256** in the opposite leg of the yoke, with the upper pin end extending from the yoke and receiving a clamping nut **257**. The top of the pin is preferably slotted for vertical adjustment thereof, and thus the conditioning roll **246**, with the clamp nut **257** then serving to retain the roll in such vertically adjusted position.

The opposite end of the shaft **242** is adapted to be engaged by the piston rod **260** of an air cylinder generally indicated at **261**. The latter is provided with a reduced forward neck portion **262** which is externally threaded for receiving a nut **263** for clamping the cylinder to a retaining plate **264**. The latter extends laterally behind the several units **237** and is bolted to the several housings **240** by bolts **265**.

Each of the air cylinders **261** is provided with a suitable pressure regulating means (not shown) for varying the pressure of the piston rod **260** on the adjacent end of the shaft **242** and thus the pressure of the roll **246** on the adjacent edge of the strip. The roll pressure applied by the several aligned rolls on the strip edge can thus be simply and effectively regulated to provide optimum conditioning of the strip edge.

The strip while traveling through the edge conditioning unit is supported and vertically positioned and guided by upper and lower pads in generally the same manner as described above with reference to the pinch slitter unit. The pad mountings associated with the edge conditioning units vary, however, from the mountings previously described in that the pads here are not only mounted for vertical adjustment but are mounted for lateral floating while the strip is being edge conditioned. That is, the pads are capable of movement transverse to the direction of travel of the strip to accurately follow the strip edges. As well understood by those skilled in the art, in strip process lines of the type here concerned, there is a tendency of the strip edges to deviate somewhat from a perfectly true path. Since it is important that the strips at the very edges thereof be contacted by the bottom supporting and top pressure pads, means are provided in accordance with the present invention for permitting the pads to follow any deviation in path of the strip edges.

The lower support pads are commonly designated at **270** and are in the form shown three in number, with the outer pads preferably abutting the adjacent yokes for positioning the same as close as possible to the strip edge. The top pads **271** are disposed immediately above the lower pads **270**, with the outermost top pads similarly engaging the adjacent yokes **243** of the edge conditioning units.

The supporting pads **270** are carried by brackets **272** which are rigidly connected to rod **273**. The opposite ends of the latter extend through ball bushings **274**, with the extreme outer ends of the rod **273** being flanged as shown at **275** for limiting the axial movement of the rod in either direction. Thus, the rod **273** and pads **270** carried thereby can slide by virtue of their mounting in the ball bushing **274** in a direction normal to the direction of travel of the strip S.

The bushings **274** are carried by studs **276** which extend upwardly through openings provided therefor in housing extensions **277** mounted in any suitable manner on the edge conditioning units housing **230**. The upper end of the stud **276** is threaded for receiving nut **279** the adjustment of which can effectively vary the vertical position of the stud and thus the bushing **274** carried thereby. In this manner, the bottom supporting pads **270** can be vertically positioned as desired for proper support of the strip S as it travels through the unit.

The top pressure pads **271** are mounted in a generally similar manner. Brackets commonly designated at **282** mount the pads **271** and are in turn rigidly mounted on upper rods **283**. The opposite ends of each such rod extend through bushings **284** as previously described with the axial movement of each rod **283** being limited also as previously described. Each bushing **284** is supported by a stud **285** which is externally threaded for receiving an adjusting nut **286**, with the housing extension **277** being formed with an opening for loosely receiving the stud. It will thus be seen that by rotating the several adjusting nuts **286**, the bushing **284** can be vertically adjusted thereby adjusting the upper pressure pads **271** toward or away from the strip S.

To facilitate threading of the strip through the edge conditioning unit at the beginning of the operation, a quick release mechanism is provided which functions both to clamp the upper pad mounting assembly in its operative position in which the pad surfaces contact the strip, and to provide a biased release arrangement for vertically raising the pads following simple lever manipulation.

A bar **290** extends between and is mounted on the top of the longitudinally aligned bushings **284** at the strip inlet and outlet ends of the unit. Each bar **290** additionally mounts a cylindrical stud **292** the upper end of which is threaded for receiving a hold-down nut **293**. The lower end of the stud **292** extends downwardly into a cylindrical sleeve **294** which is rigidly attached to a plate **295** mounted in turn by bolts **296** to the housing **230**. A compression spring **297** continually biases the stud **292** and thus the bar **290** upwardly. A rod or lever **298** is operatively attached to the stud **292** and is adapted to travel in a generally L-shaped slot **299** formed in the wall of the sleeve **294**. It will thus be seen that when the lever **298** is rotated to a position vertically aligning the same with the vertical leg of the slot **299**, the spring **297** will force and thus the bar **290** upwardly, with the bar **290** in turn raising the bushings **284** and upper pressure pads **271** carried thereby. To move the upper pressure pad **271** to a clamped position engaging the top surface of the strip, the lever **298** is lowered to the bottom of the vertical portion of the slot **299** and moved laterally in the horizontal leg of the slot whereby the spring **297** is effectively neutralized and the bar **290** retained in its lowered, operative position.

It will thus be seen that each of the edge conditioning units **26** are constructed and arranged to provide optimum edge conditioning of the strip traveling therethrough. The conditioning rolls **246** are vertically adjustable to accurately receive the strip edge, and the pressure on each of the rolls is independently adjustable to vary the pressure applied to the strip edge. The lower support and upper pressure pads are mounted to accurately vertically guide and support the strip while traveling through the edge conditioning unit. Moreover, the lower supporting and upper pressure pads **270** and **271**, respectively, are mounted to permit floating thereof laterally so as to follow the strip edges at all times. This insures that the strip edges are vertically confined while being conditioned by the several edge conditioning rolls, an important consideration if optimum edge conditioning is to be realized and buckling of the strip edges avoided.

The operation of the slitting and edge conditioning units should be apparent from the above description. To briefly summarize, referring to the generally schematic FIGS. 8–11, the strip S passes under tension through the pinch slitter unit **18**, FIG. 8, and is vertically controlled and supported by the pads **120** and **121**. The upper and lower slitter blades **50** and **56** are vertically and laterally adjustable to partially penetrate the top and bottom of the strip and form generally V-shaped grooves therein, with each groove being preferably of a depth approximately one-third the total thickness of the strip. The blades **50** and **56** are beveled and the grooves formed in the strip approximate the desired radius of the finished, conditioned edges. It will be noted, referring to FIG. 8, that the peripheral edges of the slitter blades **50** and **56** are slightly rounded to effectively draw, rather than sharply cut, the strip during severing thereof. The metal is thereby drawn into the bottom of the groove and a reasonably true radius formed. The resulting metal flow not only produces the desired radius but forms edges which are essentially free of burrs. The groove configuration can be controlled by the bevel angle of the pinch slitter blades **65**. The pads **120** and **121** are vertically positioned so that the midpoint between the vertically aligned slitter blades **50** and **56** is coincidental with the central plane of the strip material. The bottom pads **120** support the strip S and the top pads **121** contact the same and serve to dampen out the vertical vibrations in the strip which inherently develop when the strip is tensioned.

The feed strip S with the grooves formed therein thereafter passes through the strip separator **19** whereat the strip is separated into a plurality of relatively narrow strips, with each of such strips at this process stage having relatively jagged edges *a* and *b*, FIG. 9. The strips S are thereafter passed through the edge conditioning units **26**, FIG. 10, with the edge conditioning rolls **246** engaging and smoothing the jagged edges *a* and *b* of the strip, and the strip being vertically supported and contained by the pads **270** and **271**. The radius of the concave grooves **246*a*** formed in the edge conditioning rolls is desirably the same as the final desired radius of the strip edge, with the roll thus complementing the reasonably true radii formed in the strip by the slitter blades **50** and **56**. The final product, illustrated in FIG. 1, is wound on recoilers for ultimate disposition.

It will be seen from the above that the described apparatus and method is distinctly advantageous when compared with present slitting equipment. A final strip product having the desired edge rounding is produced in essentially two process steps. The rounding is initiated at the slitting station and completed at the edge conditioning station following strip separation. The resulting strip product is of particular benefit in electrical applications as above noted.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We therefore particularly point out and distinctly claim as our invention:

1. A strip slitting and edge conditioning apparatus comprising a slitting station having a plurality of vertically aligned, transversely spaced pairs of pinch slitter blades positioned above and below such strip for forming in such strip as it passes through said slitting station vertically aligned grooves in the top and bottom of such strip, means operative to pull such strip under controlled tension through said slitting station, means for severing such strip at the occurrence of each vertically aligned pair of grooves to form at least one relatively narrower strip having relatively jagged edges, and edge conditioning means for edge conditioning the jagged edges of the thus formed narrower strip to form smooth, curved opposed edges, said slitting station further including support and pressure pad means mounted respectively below and above such strip for vertically supporting and guiding the same while passing through said slitting station.

2. The combination of claim **1** further including means for vertically adjusting each of said slitter blades and said support and pressure pad means for adjusting the same relative to said strip.

3. Apparatus for producing a plurality of strips from a relatively wide strip of thin metallic material, comprising a slitting station having a plurality of vertically aligned pairs of slitter blades extending transversely across the width of such strip above and below the same, with the adjacently disposed cutting edges of each pair of such blades being slightly vertically spaced and beveled thereby to form in such strip a plurality of partially severed yet connected sections, with the partially severed areas on both sides of such sections being generally V-shaped by virtue of the beveling of the cutting edges of said blades, means for vertically adjusting each of said blades to vary the depth of penetration of said blade in such strip, means for moving such strip under controlled tension through said slitting station, means for severing the thus formed sections thereby to provide a plurality of relatively narrow strips each of which has generally rounded opposed edges, and edge conditioning roll means for contacting the opposed edges of each of said strips for smoothing the same.

4. The combination of claim **3** further including pressure pad means mounted above and below such strip between said pairs of slitter blades for pressure engagement with such strip, and means for adjusting the position of said pressure pad means.

5. The combination of claim **3** further including pad means mounted above and below said strip and engaging the same adjacent said edge conditioning rolls, means mounting said pads for vertical adjustment and lateral floating movement whereby such strip is accurately vertically spaced and confined at the edges thereof for optimum conditioning by said rolls.

6. Strip slitting apparatus comprising a slitting station having a plurality of vertically aligned, transversely spaced pairs of pinch slitter blades positioned above and below such strip, the peripheries of each pair of said blades being slightly spaced for forming in such strip as it passes through said slitting station vertically aligned grooves in the top and bottom of such strip, means for moving such strip under controlled tension through said slitting station, pad means mounted at said slitting station engaging the top and bottom of such strip adjacent said blades, said pad means serving to support and accurately vertically position such strip as it passes through said station for accurate penetration of such strip by said blades, and means for severing such strip at the occurrence of each vertically aligned pair of grooves.

7. The combination of claim **6** further including means for vertically and laterally adjusting said blades to vary the spacing and penetration of the grooves formed in such strip by said blades, and means for vertically adjusting said pads.

8. Edge conditioning apparatus for conditioning the opposed edges of a strip of material traveling through said apparatus, comprising a plurality of edge conditioning rolls mounted adjacent such opposed edges, each of said rolls being formed with an edge-receiving groove the radius of which corresponds with the desired radius of such edge, means for resiliently biasing each of said rolls independently of the others into engagement with said adjacent strip edge, and pad means disposed above and below such strip in engagement therewith for vertically supporting and guiding said strip during edge conditioning thereof.

9. The combination of claim **8** including means mounting said pad for lateral floating movement in either direction transversely of the path of travel of such strip thereby to follow any lateral deviation in the path of the opposed edges thereof.

10. The method of separating a strip into a plurality of relatively narrow strips and subsequently rounding the opposed edges of each of the thus formed strips, comprising the steps of drawing such strip under controlled tension through a station having a pluraliy of slitter blades disposed above and below such strip, each vertically aligned pair of slitter blades partially severing the strip at a spacing along the width thereof generally corresponding to the desired width of each relatively narrow strip, the adjacently disposed peripheries of such slitter blades being slightly spaced to leave an unsevered section at the occurrence of each such slitter blade along the width of such strip, separating such strip at each unsevered section thereof to provide a plurality of strips of relatively narrow width, with each opposed edge of each of such thus formed strips as a result of such tearing action having an edge which is relatively jagged, and thereafter smoothing the opposed jagged edges of each of such strips thereby to provide a strip having a relatively smooth and substantially true radius.

11. The method of slitting and edge conditioning a relatively wide strip of metallic material, comprising the steps of passing said relatively wide strip through a series of transversely spaced, vertically aligned pairs of slitting blades, with the adjacently disposed edges of each pair of said blades being inclined relative to the plane of the blade and slightly spaced from each other thereby to partially sever said strip at the occurrence of such blades, with the inclined cutting edges of each of said blades rounding the strip in the thus partially severed areas, tearing the strip along each unsevered area thereby to provide a plurality of relatively narrow strips, and smoothing the torn edge of each of the thus produced strips thereby to provide a strip having smooth, rounded edges.

12. The method of claim **11** wherein the inclined cutting edge of each of said slitting blades extends into said strip material approximately one-third the thickness thereof thereby to leave an unsevered portion having a thickness of approximately one-third the thickness of said material.

13. The combination of claim **8** including a pneumatic cylinder for each of said rolls operative to bias said rolls into engagement with the edge of such strip.

14. The method of forming electrical strip and the like comprising the steps of pinch slitting a strip of greater width by passing the latter under controlled tension through vertically aligned cutters which place a pair of grooves on opposite sides of such strip without penetrating such strip, and then fracturing such strip along such grooves to provide narrower strip having partially rounded but nonetheless partially jagged edges, and then edge conditioning such narrower strip by passing the latter under controlled tension through an edge conditioning unit to form smooth curved opposite edges thereon.

15. The method of claim **14** including the steps of confining such strip over a substantial area between the edges thereof during such grooving and edge conditioning to dampen vibrations therein.

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