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G. A. CROSBY ET AL

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STRAP FEEDING AND TENSIONING MECHANISM

Original Filed Nov. 13, 1956

2 Sheets-Sheet 1

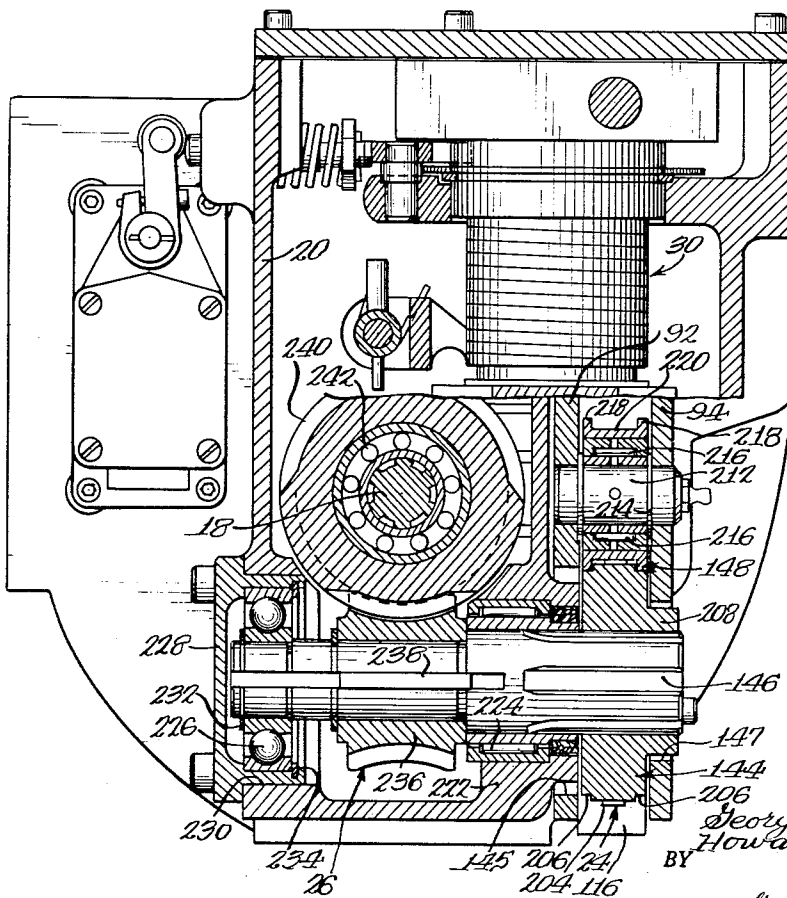
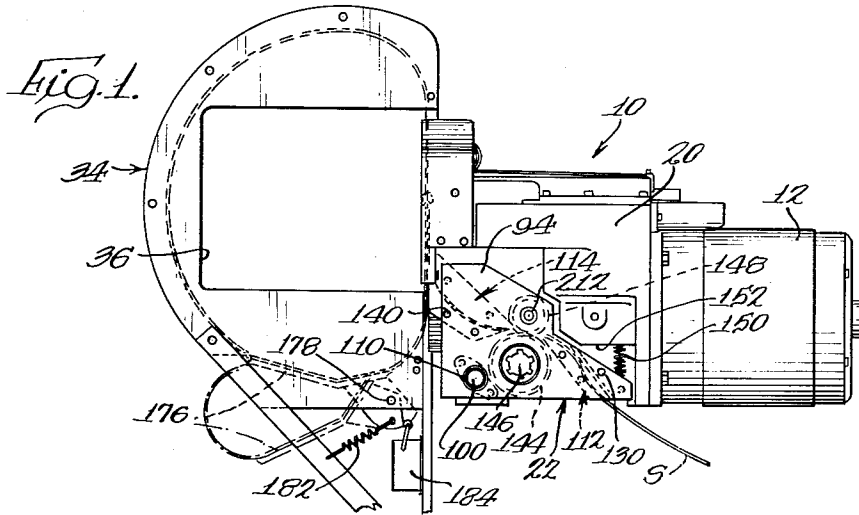


Fig. 3.

INVENTORS.

George A. Crosby
Howard H. Otto

BY

Whipple, Bradolph & Dove
Attys.

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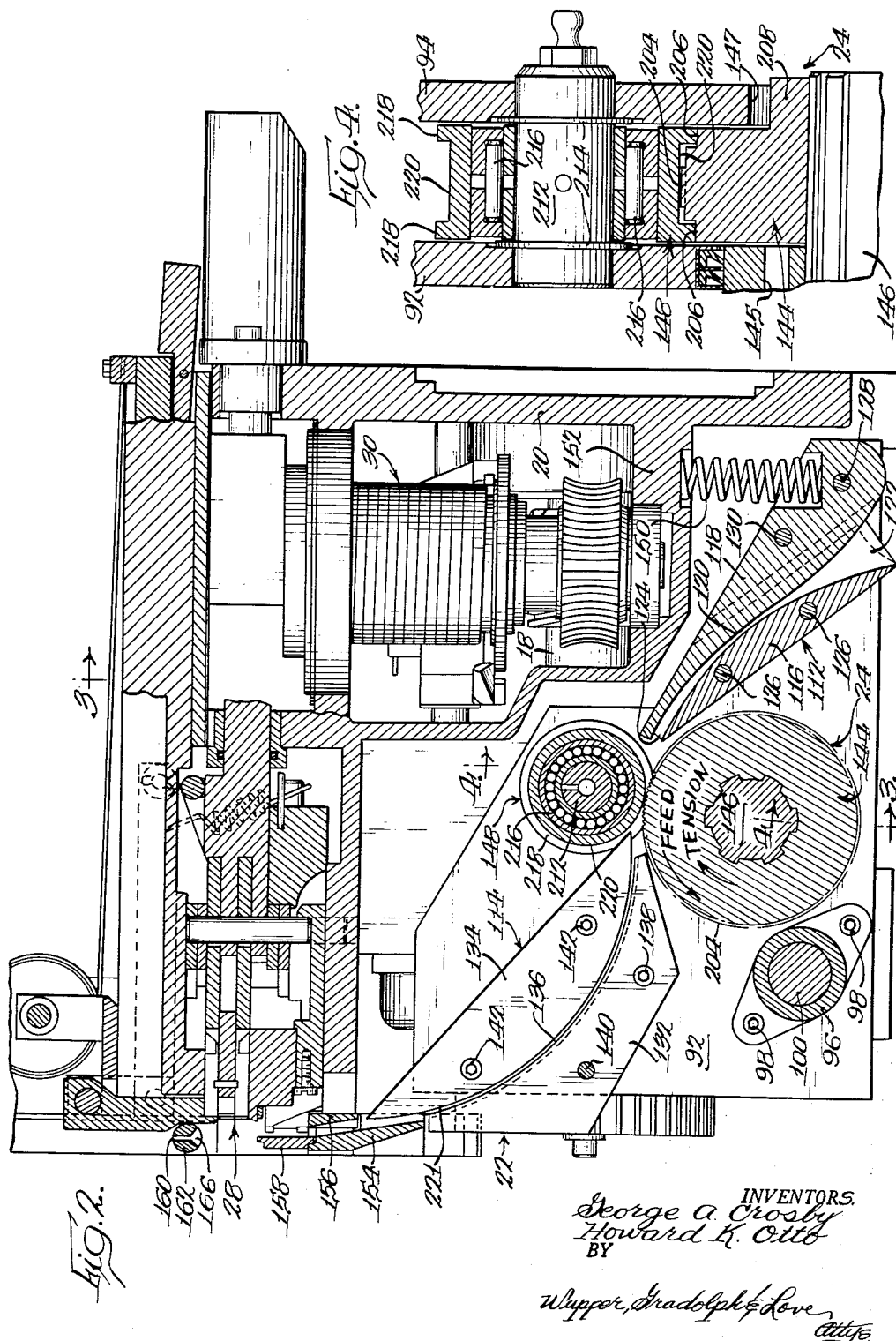
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STRAP FEEDING AND TENSIONING MECHANISM

George A. Crosby, Park Ridge, and Howard K. Otto, Berkeley, Ill., assignors to Signode Steel Strapping Company, Chicago, Ill., a corporation of Delaware
Original application Nov. 13, 1956, Ser. No. 621,724, now Patent No. 2,915,003, dated Dec. 1, 1959. Divided and this application Nov. 6, 1959, Ser. No. 851,428
8 Claims. (Cl. 100—32)

The present invention relates to a new and improved strap feeding and tensioning mechanism for power strapping machines, and in particular to a novel arrangement for increasing the gripping force on the strapping by the strap tensioning mechanism as the tension in the strapping increases during the tensioning operation. This application is a division of copending application Serial No. 621,724, filed November 13, 1956, entitled "Power Strapping Machine," and issued into Patent No. 2,915,003, dated December 1, 1959.

Power strapping machines of the type incorporating the present invention are capable of fully automatic or semi-automatic operation, and they are primarily used for binding bundles, boxes, packages, coils, and the like, with one or more bands of tensioned flat steel strapping, with the strapping ends overlapped and united in a tension resisting joint. The machine operates to pass the strapping about the bundle so that its free end is placed in overlapping position with the standing portion thereof which is connected to the source of strap supply or a coil of strapping. The strapping is shrunk closely about the bundle and a proper tension is applied thereto by the machine. When this tension reaches a satisfactory value, the overlapping portions of the strapping and an embracing seal blank are united into the tension resisting joint, and the strapping applied to the bundle is severed from the source of strap supply or the coil.

In the machine of the aforementioned application, the strapping is withdrawn from a coil and fed about the bundle by a combined feed and tensioning wheel which has associated with it a pressure roller to hold the strapping against the serrated or toothed periphery of the feed and tensioning wheel. Earlier machines using a feed and tensioning wheel for tensioning the strapping about the bundle were plagued with difficulties which limited the amount of tension that could be applied to the strapping to values below that desired, and far below the usable tensile strength of the strapping. In many of these machines the pressure roll was urged toward the feed and tensioning wheel by springs or by electromagnetic means. In some the pressure roll was manually held in pressing position. Such arrangements have readily reached limits on the amount of pressure which may be used in holding the strapping against the feed wheel. These limits might not seem to exist with respect to the use of extremely heavy springs acting on the pressure roll. However, the pressure roll must be readily moved away from the feed and tensioning wheel to load or "thread" the machine with strapping, and such heavy springs would prevent this. The tensioning wheels of the prior machines consequently did not apply sufficient tension to the strapping about the bundle because they were not capable of gripping the strapping with sufficient pressure for ultimate tensioning operations. This manifested itself by slipping of the tensioning wheel on the strapping, which resulted in excessive tensioning wheel wear and relatively short wheel life. Some machines incorporated secondary or supplemental strap tensioning mechanisms which imparted the final and high value tension to the strapping about the bundle. Such secondary or supplemental mechanisms added to the complexity and cost of the en-

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tire strapping machine and actually slowed the whole strap tensioning operation and lengthened the machine cycle, making it less efficient.

The strap feeding and tensioning mechanism of the present invention overcomes the above discussed disadvantages of the prior machines.

It is, therefore, a principal object of the present invention to provide a new and improved strap feeding and tensioning mechanism of the feed and tensioning wheel type which is capable of imparting the desired maximum tension to the strapping about the bundle or the like.

Another object is to provide a new and improved strap tensioning mechanism of the tensioning wheel type which is self-energizing in that its grip on the strapping being tensioned increased with increases in the tension of the strapping about the bundle.

Another object is to provide a new and improved strap tensioning mechanism of the tensioning wheel type wherein the force with which the strapping is gripped between the tensioning wheel and the pressure roll increases with the increase of tension in the strapping about the bundle.

Another object is to provide a new and improved strap tensioning mechanism of the tensioning wheel type wherein the tension in the strapping about the bundle is sensed and used to increase the pressure of the pressure roll against the strapping engaged by the tensioning wheel as the tension in the strapping about the bundle increases.

Another object is to provide a new and improved strap tensioning mechanism of the tensioning wheel type wherein increases in tension in the strapping about the bundle are sensed by a movable strap guiding means which increases the force with which the pressure roll holds the strapping against the surface of the tensioning wheel.

Another object is to provide a new and improved strap tensioning mechanism of the tensioning wheel type wherein wear on the tensioning wheel is reduced over that in prior machines, with a consequent extension of wheel life.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, wherein

FIG. 1 is a side elevational view on a small scale of a power strapping machine incorporating the strap feeding and strap tensioning mechanism of the present invention;

FIG. 2 is an enlarged longitudinal sectional view on an irregular plane showing principal features of the strap feeding and tensioning mechanism of this invention;

FIG. 3 is a transverse sectional view, taken generally along the line 3—3 of FIG. 2, looking in the direction of the arrows; and

FIG. 4 is an enlarged detail sectional view, taken along the line 4—4 of FIG. 2, looking in the direction of the arrows.

In the drawings, the strapping machine 10 is shown in its normal position wherein its strap guide or track is vertical and the opening for the package or bundle is oriented so that a bundle is placed therein in a horizontal direction. This disposition is purely arbitrary because it is possible to operate this machine and its new and improved strap feeding and tensioning in a variety of positions, and therefore the illustrated orientation is for the purpose of the description only.

The strapping machine 10 in which the feeding and tensioning mechanism of the present invention is incorporated is powered by a reversible electric motor 12 which has its motor shaft keyed or splined to a main drive shaft 18 of the machine. The drive shaft 18 is mounted in a housing 20 which also houses or supports a strap guiding structure 22, a novel, self-energizing strap feeding and tensioning mechanism 24, a drive 26 for the strap feeding and tensioning mechanism, a joint forming

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and strap cutting mechanism 28, a drive 30 for the joint forming and strap cutting mechanism, and a strap tension regulating mechanism (not shown) which is associated with the strap feeding and tensioning mechanism drive 26. Strapping S (FIG. 1) is drawn from a source of supply or dispenser (not shown) which may be of the type disclosed in Robert C. Luth Patent No. 2,844,334, dated July 22, 1958, and entitled "Strap Dispenser." The strap S is drawn from the dispenser or reel through the guide 22 by the strap feeding and tensioning mechanism 24 and is directed around a guide track or chute 34, which has a bundle receiving opening 36 therein, so that the leading end of the strap S overlaps a standing portion thereof in front of the joint forming mechanism 28.

During the strap feeding operation the motor 12 drives in a first direction, and when the strap feeding has been completed either through the closed chute 34 or about the bundle, a switch 184 in the electric control circuit is operated either to stop the machine, as at the end of a machine cycle, or to initiate subsequent machine operation. In either event the motor 12 is restarted in the opposite direction to operate the joint forming mechanism 28, first to clamp the free or leading end of the strap so as to anchor it against movement during strap tensioning, and secondly to fold the wings or flanges of a seal blank about the overlapping strapping portions to preform the seal blank for the final joining operation. This preforming of the blank is not sufficient, however, to prevent movement of the standing portion of the strapping during the strap loop shrinking and strap tensioning relative to the joint forming mechanism and the anchored end of the strapping.

At the same time, the feeding and tensioning mechanism 24 is operated in the tensioning direction, first to shrink the loop of strap S about the bundle, and then to apply a tension thereto. The tension regulating mechanism senses when the tension in the strap about the bundle reaches the desired or optimum value, and it operates to terminate the operation of the feeding and tensioning mechanism 24 and to release the joint forming mechanism 28 so that the latter may be further operated by its drive 30 to complete the joint in the overlapping strapping portions and seal blank, to sever the strap about the bundle from the standing portion thereof, and to withdraw the joint forming mechanism to its start or so called "zero" position, thereby readying the machine for a subsequent strap feeding operation. When the joint forming mechanism finishes its operation, the machine either is shut off or operates to feed strap S to fill the strap guide or chute 34.

The foregoing is a brief description of the general organization and operation of the power strapping machine 10 in which the novel strap feeding and tensioning mechanism 24 of this invention is incorporated, and is given so that a complete understanding of the nature of this invention may be had.

The strap guide 22 and the feeding and tensioning mechanism are enclosed between a pair of plates 92 and 94 which are spaced apart by guiding elements to be described hereinafter, and a bushing 96 which is secured to the plate 92 by bolts 98 and is rotatably mounted upon a pivot pin or shaft 100 which is nonrotatably secured in a boss at the lower front of the housing 20. The bushing 96 has an outer conical or tapered end which seats in a complementary tapered opening in the plate 94, and the latter is secured by a retaining ring 110 in a suitable groove in the outer end of the pivot pin 100. The guiding means 22 is thus mounted for limited pivotal movement on the pin 100 and on the machine frame or housing 20.

The guiding of the strapping between the plates 92 and 94 is accomplished by a lower guide assembly 112 and an upper guide assembly 114, which are mounted between the plates 92 and 94 and are secured thereto. The lower guide assembly 112 comprises a pair of interfitting

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guiding elements 116 and 118 which define therebetween a strap guiding slot or space 120 which has a flared lower or inlet end 122 and a slightly open upper end 124. The guide element 116 is secured to the plate 92 by a pair of bolts 126, and the guide element 118 is secured to the plate 92 by a bolt 128, and to both plates by a bolt 130 which passes through aligned apertures therein and also assists in holding the plate 94 to the plate 92.

The upper guide assembly 114 comprises a pair of interfitting guide elements 132 and 134 which define therebetween a guiding slot 136 which, it will be observed, is an arcuate slot extending upwardly toward the front of the machine to direct the strap past the front of the joint forming mechanism 28. The guide member 132 is secured to the plate 92 by a bolt 138, and to both plates by a bolt 140 which functions as does the bolt 130. The guide member 134 is secured to the plate 92 by a pair of bolts 142. Thus, the plates 92 and 94 enclose the guiding assemblies 112 and 114 and the bushing 96, and the whole assembly is arranged for limited pivotal movement about the pin 100.

The strapping is drawn from the dispenser or reel through the inlet 122, the slot 120, and between a feed wheel 144 which is fixed to the outer end of a shaft 146 for rotation about a fixed axis and a pressure or backup roll 148 which is journaled for rotation on and between the plates 92 and 94. The axis of rotation of the pressure roll is fixed relative to the plates 92 and 94, and it is urged toward the feed wheel 144 by a biasing spring 150 which acts between a wall 152 of the housing 20 and the guiding element 118, the ends of the spring 150 being held in keeper pockets in the wall 152 and element 118. The biasing spring insures that there will be no slippage of the strap on the feed wheel 144 during the feeding operation.

The strapping is fed by the wheel 144 through the slot 136, between a pair of stationary guiding members 154 and 156 and past the front of the joint forming mechanism 28 which may be of the type disclosed in George A. Crosby and Robert J. Frey Patent No. 2,801,558, dated August 6, 1957, and entitled "Joint Forming Mechanism." The strapping thereafter passes around the guide chute 34 until its leading end contacts the barrier 162 in the V-shaped notch 166 therein and against the standing portion of the strapping, it being understood that the leading portion is guided past the outer face of the stationary cutter block and anchoring member 158 by appropriate guides.

The guiding chute or track 34 includes a dropout section 176 which is pivoted at 178 to the chute structure, and a tension coil spring 182 normally holds the section 176 in strap guiding position. When the leading end of the strap contacts with the barrier 162 it stops, but the strap feed continues with the excess strap ballooning outwardly to depress the section 176 as shown in the dot-dash lines of FIG. 1. This movement of the section 176 operates a switch 184 in the motor circuit to terminate the strap feeding operation and shut off the motor 12 or to reverse its direction, depending upon the type of machine cycle being used.

When the strapping has completely traversed the chute or track 34 and the switch 184 has been actuated, the joint forming mechanism 28 is operated through a part of its cycle to anchor the leading bend of the strapping S against the stationary cutter block and anchoring member 158. The motor 12 is reversed and the machine 10 is operated to tension the strapping S about the bundle, to form the joint in the overlapping strapping portions, and to sever the bound bundle from the standing strapping portion.

As previously mentioned, the strap feeding and tensioning mechanism 24 includes the strap feed wheel 144 which is fixed to the outer end of the feed and tensioning shaft 146 and projects through oversize openings 145 and 147 in the plates 92 and 94, respectively, so that these

plates may rock on the pin 100 and relative to the feed wheel 144 thereby to accommodate the strap S between the wheel 144 and pressure roll 148. The feed wheel 144 has a peripheral surface 204 which is serrated or formed with a great multiplicity of tiny truncated pyramid shaped strap gripping elements which are relatively harder than the strap used in binding bundles. At either side of this toothed periphery 204 the feed wheel 144 is formed with annular shoulders 206 which are of smaller diameter than the diameter of the toothed periphery 204, and the feed wheel 144 is formed with a boss 208 which projects through the oversize opening 147 in the plate 94.

The pressure roll 148 is journaled on a shaft 212 which is carried in the plates 92 and 94 and is restrained against axial movement by a pair of retaining rings 214 (FIG. 7). The roller 148 is journaled on the shaft 212 by a needle or roller bearing 216. The pressure roll 148 has a pair of annular rims 218 which are adapted to ride upon the shoulders 206 of the feed wheel with the tread 220 between the rims forming the backup surface, and the rims 218 and shoulders 206 being so dimensioned that the hardened tread surface 220 does not contact the toothed periphery 204 of the feed wheel 144 when no strapping lies between the feed wheel 144 and the pressure roller 148 (FIG. 4). Thus, the hardened teeth are protected against accidental and inadvertent damage by careless adjustment of the machine or by failure to make certain that there is always strapping between the feed wheel and the backup roll when the feed wheel is being driven.

As seen in FIG. 4, where there is no strapping between the feed wheel 144 and the pressure roll 148, the two are almost in tangential contact. However, when strapping is fed into the machine through the guide slot 120 and between the feed wheel 144 and pressure roll 148, the latter moves upwardly (FIG. 2) and the pressure which it exerts on the strapping during the feeding operation is that which is supplied by the biasing spring 150; otherwise there would be insufficient pressure exerted by the pressure roller 148 to insure a proper feeding of the strap.

When the wheel 144 drives in the strap tensioning or clockwise direction (FIG. 2), the guiding means 22 is self energized to urge the pressure roll 148 tightly against the strap S which is between it and the feed wheel 144. After the strap has been shrunk closely about the bundle and the excess returned toward the supply source through the slot 120, the wheel 144 in cooperation with the pressure roll 148 imparts tension to the loop about the bundle, and during the tensioning operation considerable pressure should be used to hold the strap S in driving contact with the wheel periphery 204 to prevent slippage. As the slot guide 136 curves downwardly from its end 221 toward the nip between the wheel 144 and roll 148, an increase in strap tension causes the strap to resist its curved guide path in the slot 136 and its flat surface to push against the guiding element 134. This action of the strap tends to rock the guiding assembly 22 and the pressure roll 148 about the pivot 100 in the clockwise direction, thereby increasing the pressure of the roll 148 on the strap. Thus, as the strap tension and chance of strap slippage on the tensioning wheel 144 increases, the pressure exerted by the roll 148 on the strap increases to overcome the likelihood of slippage. It should be noted that the positions of the feed wheel 144 and pressure roll 148 with respect to the pivot 100 are such as to move the roll 148 toward the wheel 144 if the guide assembly 22 rotates in the clockwise direction.

The feed wheel shaft 146 is journaled in the wall 222 of the housing 20 on a roller bearing 224, and at its opposite end it is journaled by a ball bearing 226 in a cap 228 which closes an opening 230 in the housing. A retaining ring 232 holds the shaft 146 against axial movement relative to the bearing 226 which is also anchored by a retaining ring 234 in the cap or cover 228. Between the bearings 224 and 226 a worm gear 236 is mounted on the shaft 146 and secured thereto for rotation there-

with by keys 238. The worm gear 236 is in constant mesh with a worm 240 which has one end journaled on the main drive shaft 18 by a bearing 242. At its opposite end the worm 240 is journaled in an interior wall of the housing 20.

The worm 240 is not directly keyed to the shaft 18 but is operatively and selectively connected thereto by a cam clutch which does not form any part of this invention and is fully shown and described in the above mentioned application, Serial No. 621,724, of which this is a division. Such clutch is operated at appropriate times in the machine cycle to engage the worm 240 with the shaft 18 and then to disengage it from the shaft when the tension of the strapping about the bundle reaches a predetermined value as is sensed by a tension regulating mechanism (also not shown) which coacts with the clutch.

It is believed that the self-energizing feature of strap gripping by the feed and tensioning wheel 144 and pressure roll 148 is understood from the foregoing description, and that any further description of the operation of the machine is unnecessary. From the foregoing it is also appreciated that the objectives claimed for this invention are fully attained by the described structure.

While a preferred embodiment of this invention has been shown and described, it will be apparent that numerous modifications and variations thereof may be made without departing from the underlying principles of the invention. It is therefore desired, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of this invention may be obtained through the use of substantially the same or equivalent means.

What is claimed as new and desired to be secured by United States Letters Patent is:

1. A strap feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, comprising in combination a powered reversible feed wheel for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, a freely rotatable pressure roll, means mounting said pressure roll for movement toward and away from said feed wheel, means biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, and means responsive to the tension of the strap about the bundle and mechanically connected to said pressure roll for causing the latter to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

2. A strap feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, comprising in combination, a powered reversible feed wheel for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, a freely rotatable pressure roll, means mounting said pressure roll for movement toward and away from said feed wheel, means biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, and a strapping guide interposed between said feed wheel and the bundle and fixed to said pressure roll mounting means, and said guide guiding the strapping in a line so that the tension of the strapping causes the strapping to act on said guide so as to urge said pressure roll toward said feed wheel thereby to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

3. A strap feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, comprising in combination, a reversible feed wheel for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, reversible means connected to said feed wheel for rotating the latter in strapping feeding and withdrawing directions, a freely rotatable pressure

roll, means mounting said pressure roll for movement toward and away from said feed wheel, means biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, a strapping guide connected to said pressure roll mounting means and interposed in the strapping path between said feed wheel and the bundle, said strapping guide having a portion thereof fixed relative to said pressure roll, and said guide portion being curved and positioned relative to said pressure roll so as to urge the latter toward said feed wheel thereby to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

4. A strap feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, comprising in combination, a reversible feed wheel for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, reversible means connected to said feed wheel for rotating the latter in strapping feeding and withdrawing directions, a pair of guide plates between which said feed wheel is rotatable, a freely rotatable pressure roll mounted on and between said guide plates, means mounting said guide plates for rocking movement so as to move said pressure roll toward and away from said feed wheel, means acting on said guide plates biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, a strapping guide carried by said guide plates and interposed between the bundle and the nip between said feed wheel and said pressure roll, and said guide being curved and positioned relative to said pressure roll so as to cause the latter to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

5. A strapping feeding and tension mechanism for a machine for binding bundles and the like with a band of tensioned strapping, the machine having a powered reversible feed wheel rotatable about a fixed axis for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, the combination including, a freely rotatable pressure roll adapted to hold the strapping against the periphery of said feed wheel, means mounting said pressure roll for movement toward and away from said feed wheel, means connected to said pressure roll mounting means for biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feed of the strapping, and means connected to said pressure roll mounting means and contacted by the strapping between the bundle and said feed wheel so as to be sensitive to the tension of the strapping about the bundle for urging said pressure roll toward said feed wheel thereby to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

6. A strapping feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, the machine having a powered reversible feed wheel rotatable on a fixed axis for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, the combination including, a freely rotatable pressure roll adapted to hold the strapping against the periphery of said feed wheel, movable means mounting said pressure roll for movement toward and away from said feed wheel, means acting on said pressure roll mounting means for biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, and a strapping guide interposed between said feed wheel and the bundle and mounted on said pres-

sure roll mounting means, and said guide guiding the strapping in a nonlinear direction so that the tension of the strapping causes the strapping forcibly to bear against and move said guide and said mounting means so as to urge said pressure roll toward said feed wheel thereby to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

7. A strapping feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, said machine having a reversible feed wheel rotatable on a fixed axis for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, and reversible means connected to said feed wheel for rotating the latter in strapping feeding and withdrawing directions, the combination including, a freely rotatable pressure roll adapted to hold the strapping against the periphery of said feed wheel, means mounting said pressure roll on the machine for movement toward and away from said feed wheel, means acting on said mounting means for biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during feeding of the strapping, a strapping guide interposed between said feed wheel and the bundle, said strapping guide having a portion thereof carried by said mounting means and fixed relative to said pressure roll, and said guide portion being curved and so positioned relative to said pressure roll that when the strapping is tensioned and tends to straighten one face of it forcibly bears against said curved guide portion and urges said pressure roll toward said feed wheel thereby to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

8. A strapping feeding and tensioning mechanism for a machine for binding bundles and the like with a band of tensioned strapping, said machine having a reversible feed wheel rotatable on a fixed axis for feeding strapping and for withdrawing strapping to shrink it closely about the bundle and for applying a tension thereto, and reversible means connected to said feed wheel for rotating the latter in strapping feeding and withdrawing directions, the combination including, a pair of guide plates between which said feed wheel is rotatable, a freely rotatable pressure roll mounted on and between said guide plates and adapted to hold the strapping against the periphery of said feed wheel, means mounting said guide plates on the machine for rocking movement so as to move said pressure roll toward and away from said feed wheel, means acting on said guide plates biasing said pressure roll toward said feed wheel to hold the strapping thereagainst during the feeding of the strapping, a strapping guide carried by said guide plates and interposed between the bundle and the nip between said feed wheel and said pressure roll, and said guide being curved and so positioned relative to said pressure roll that when the strapping is tensioned and tends to straighten one face of it forcibly bears against said curved guide portion and causes said pressure roll to increase the pressure of the strapping on said feed wheel as the tension in the strapping is increased by said feed wheel.

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