

June 3, 1969

E. C. RUTTY

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STRAPPING MECHANISM

Filed Feb. 21, 1967

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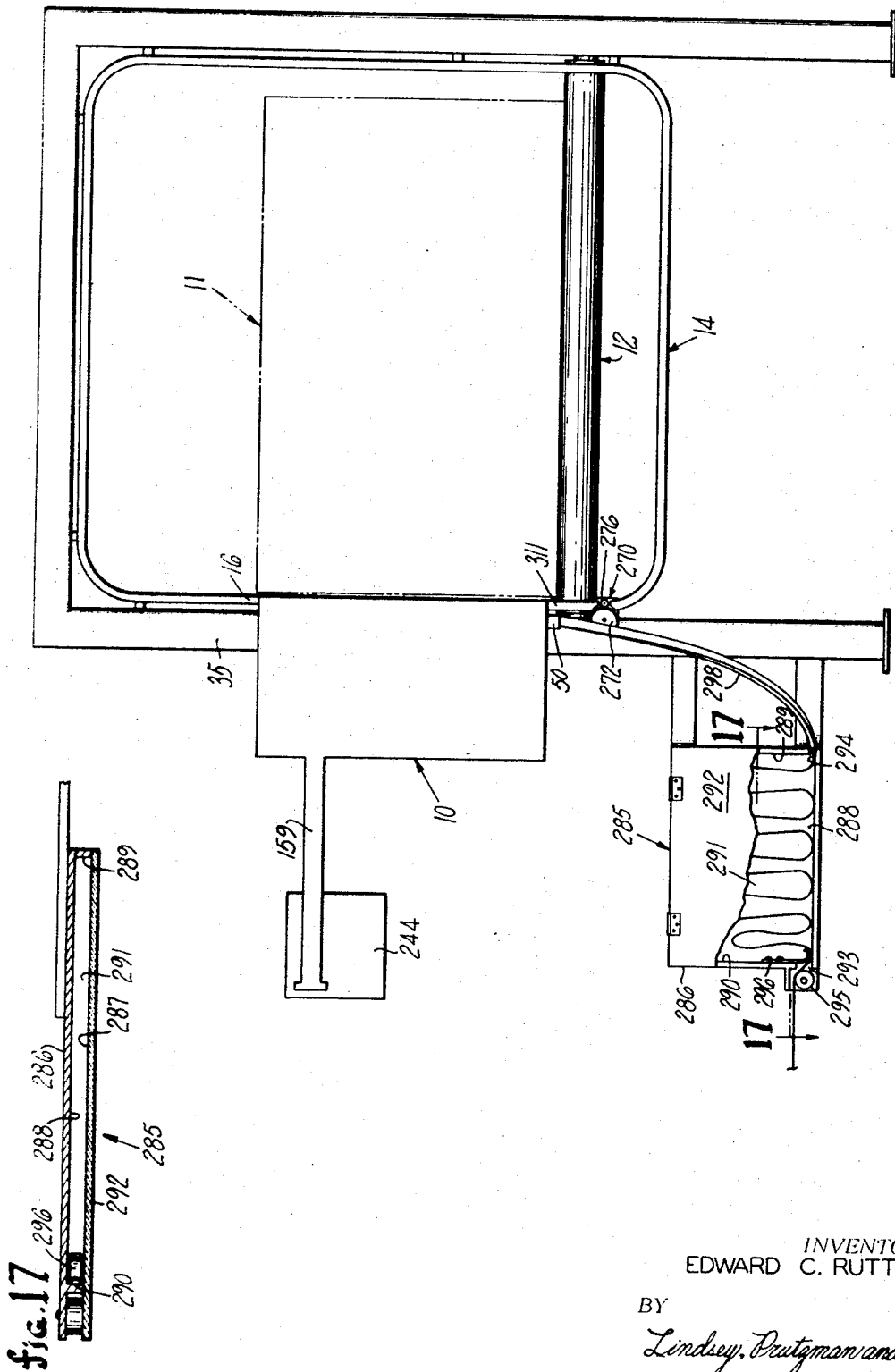


fig. 1

fig. 17

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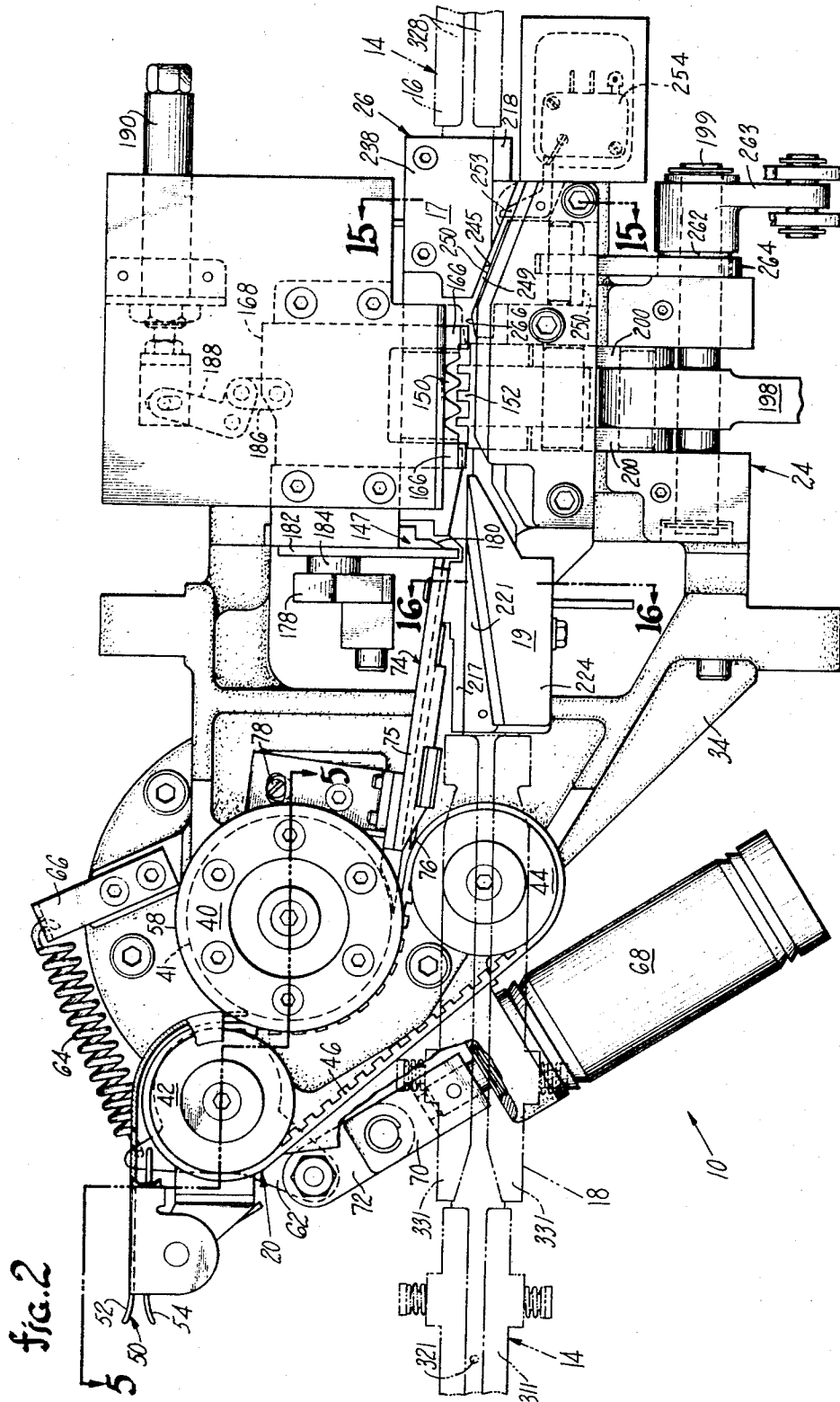
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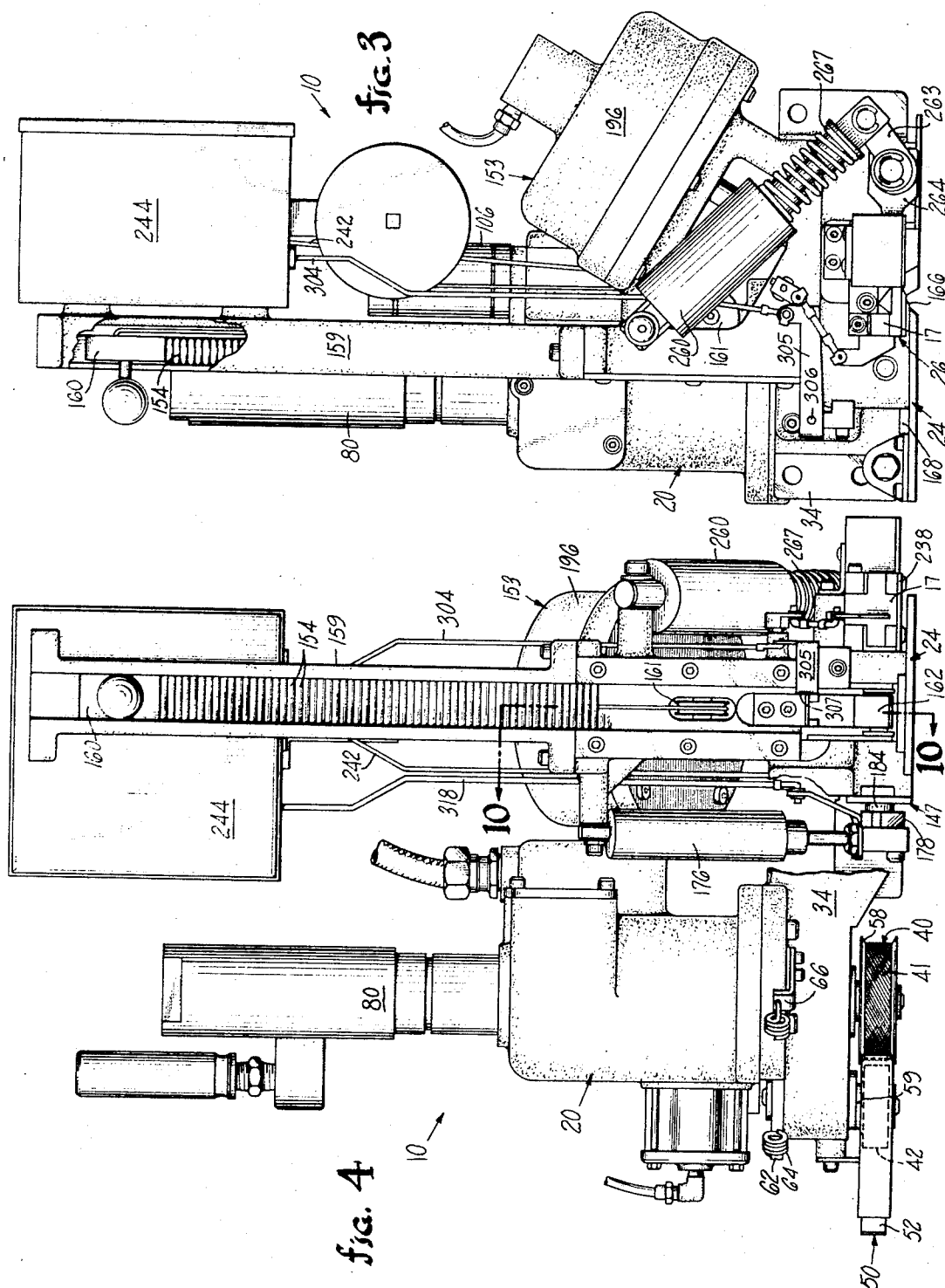
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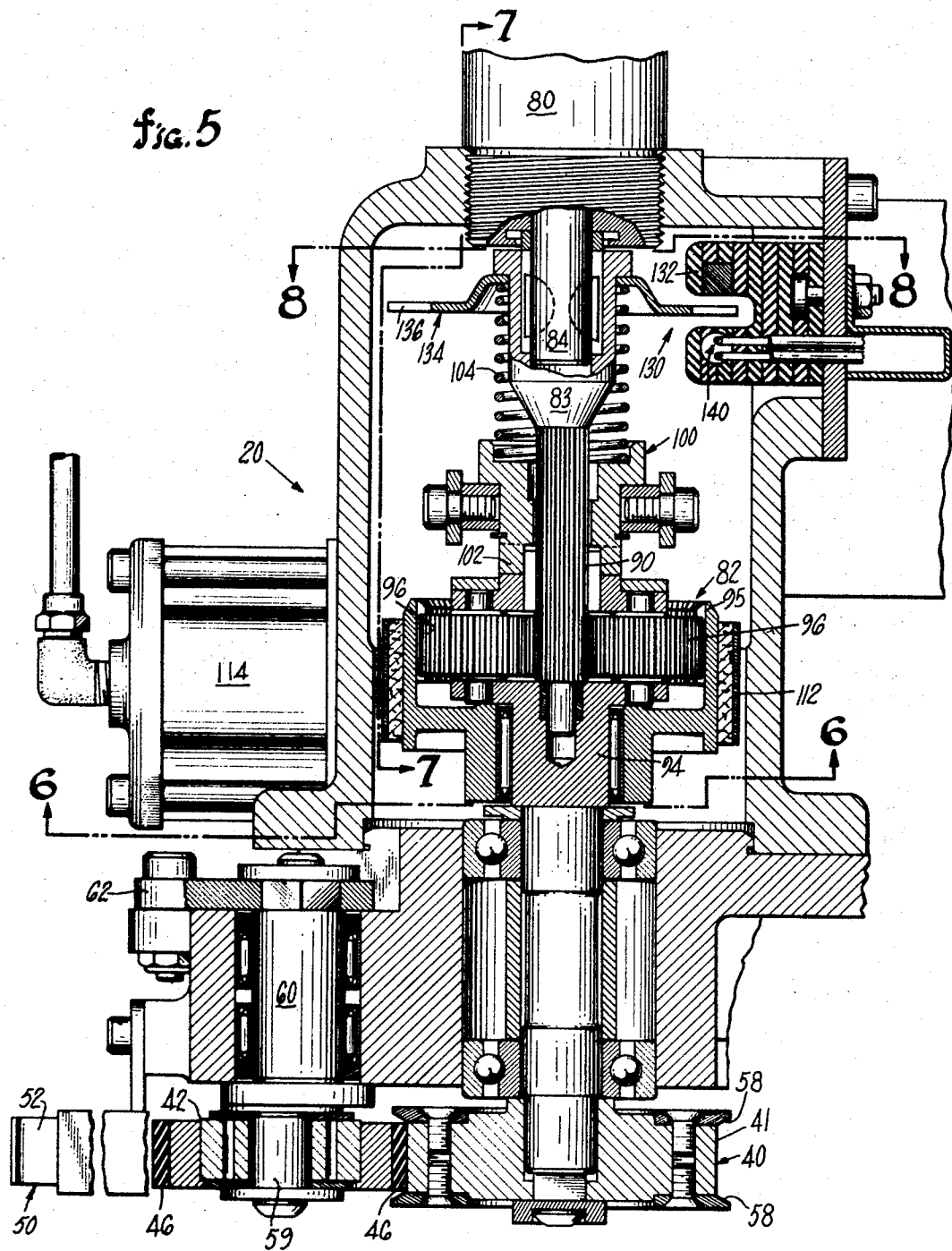
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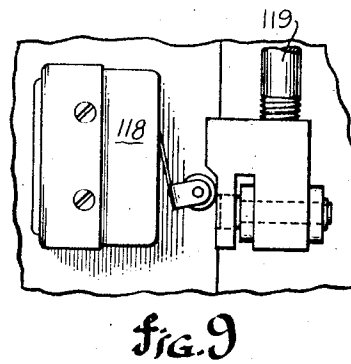
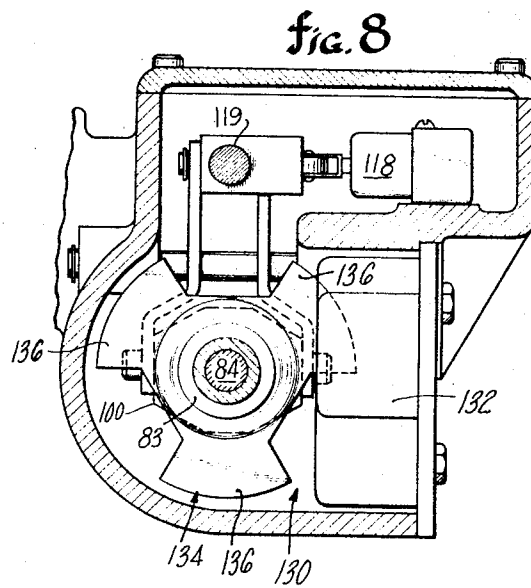
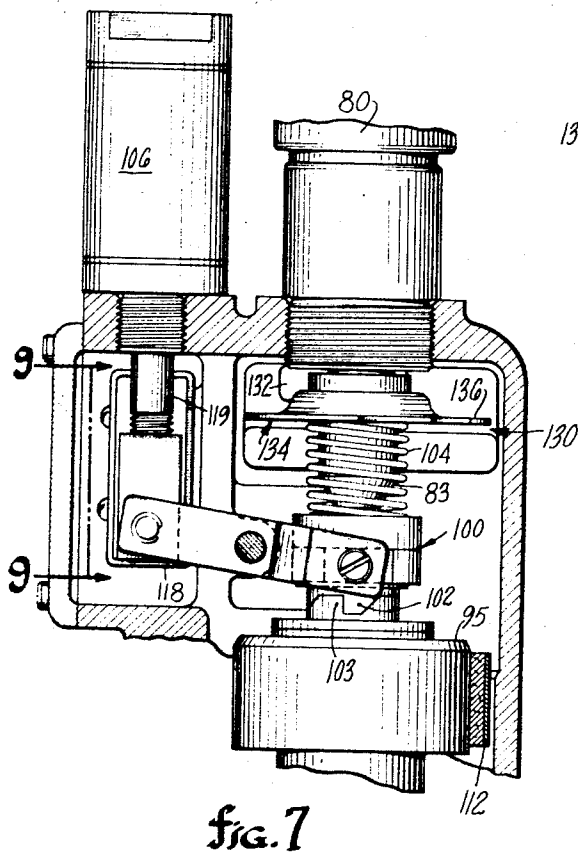
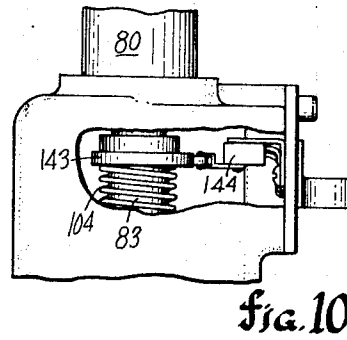
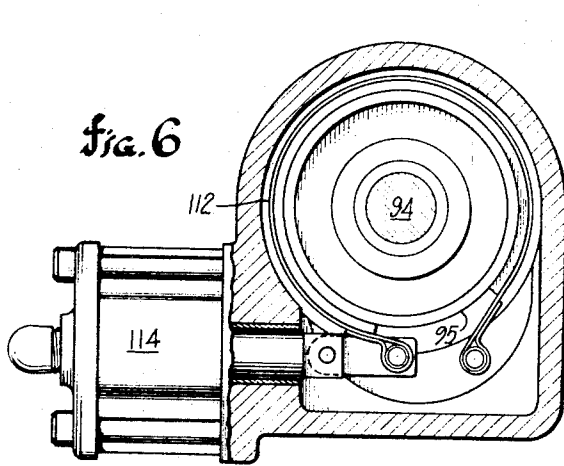
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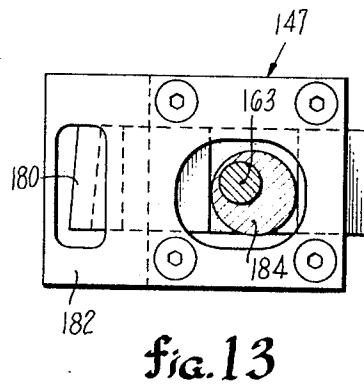
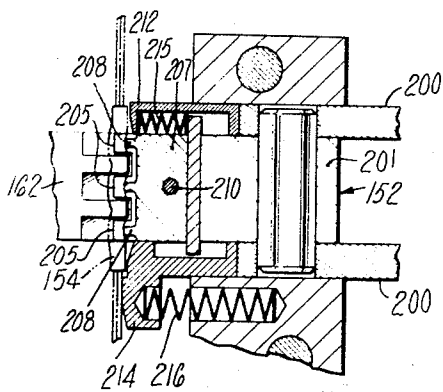
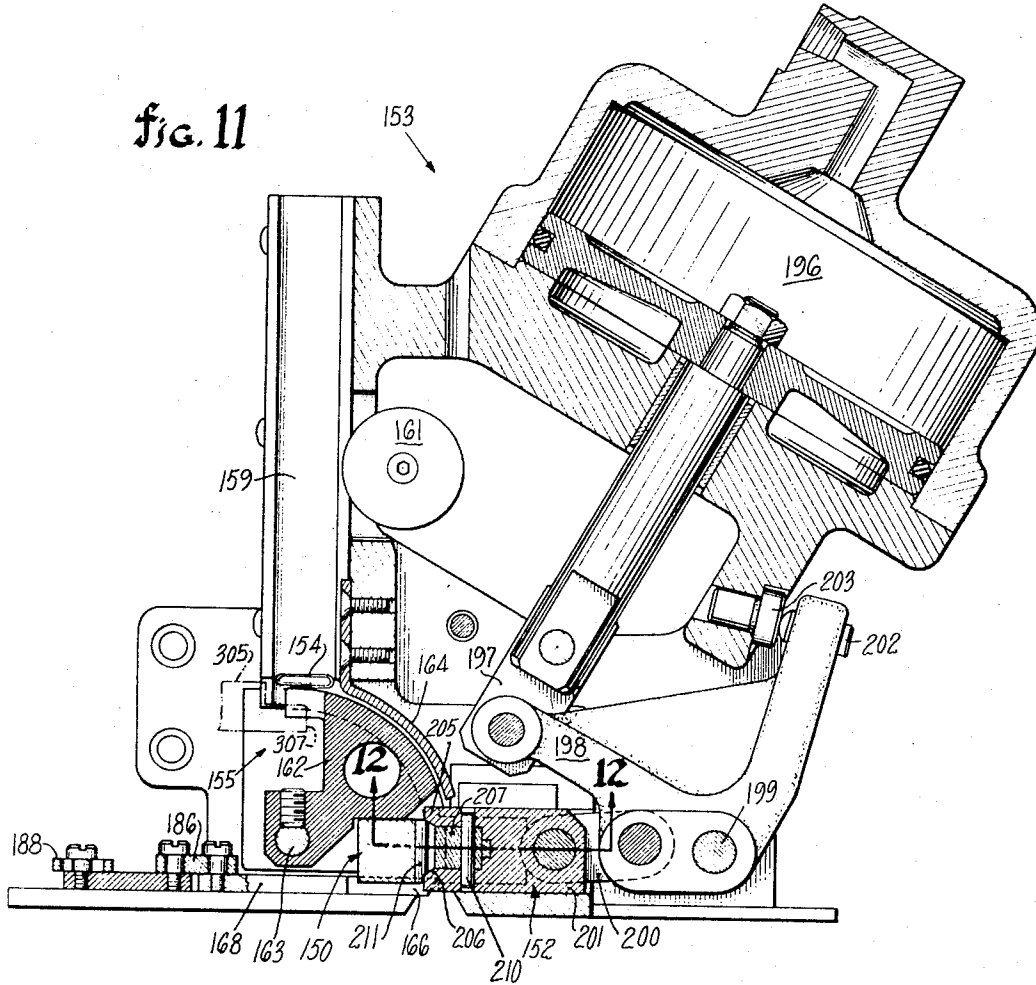
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fig. 15

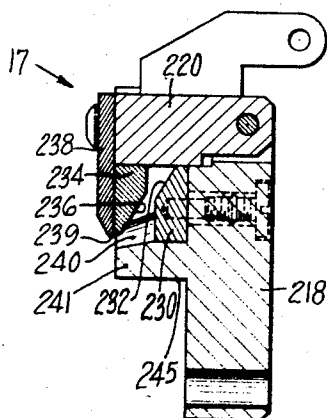
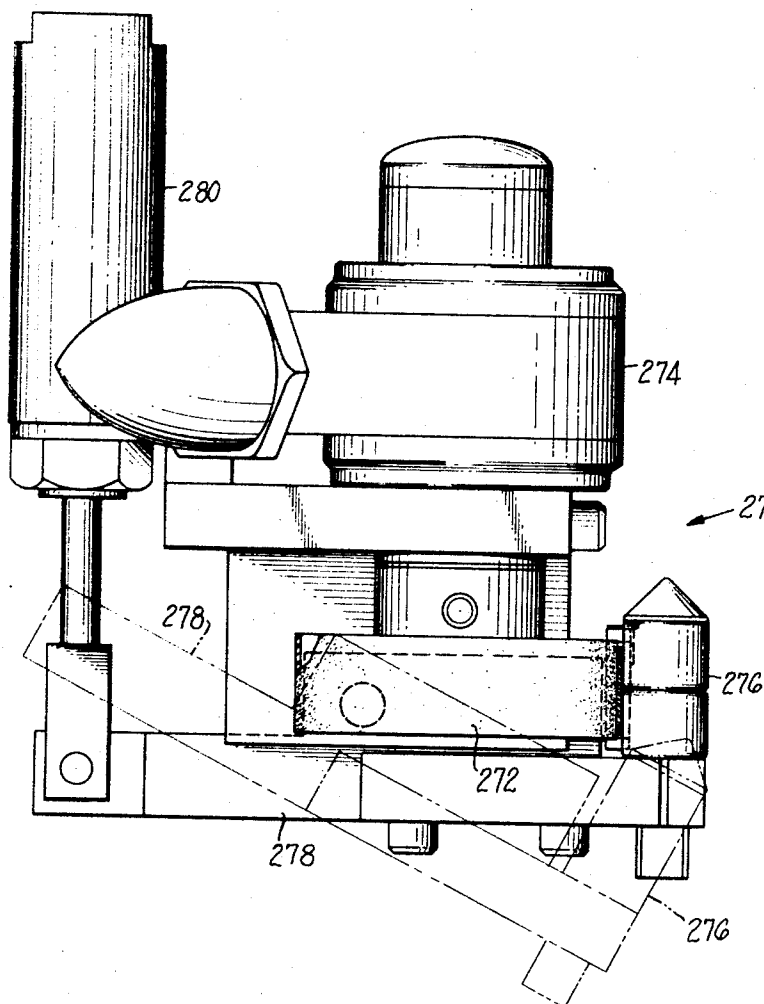
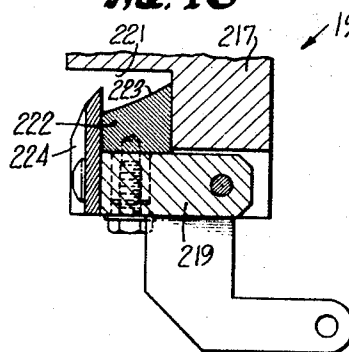


fig. 16



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fig. 18

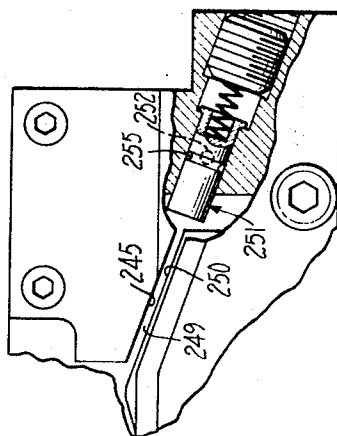
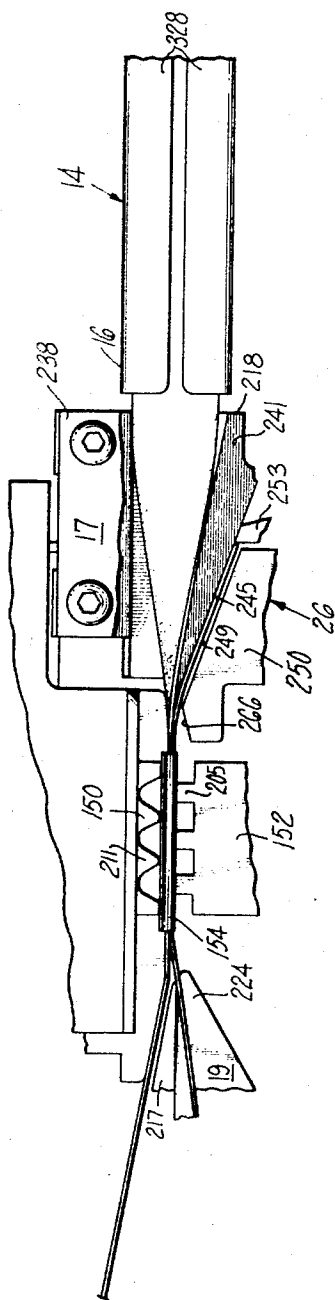


fig. 21

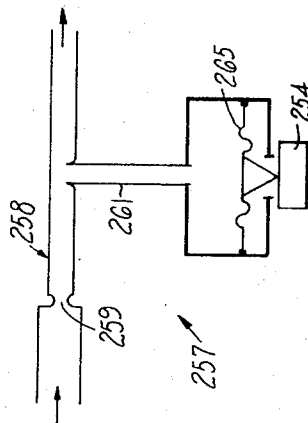


fig. 22

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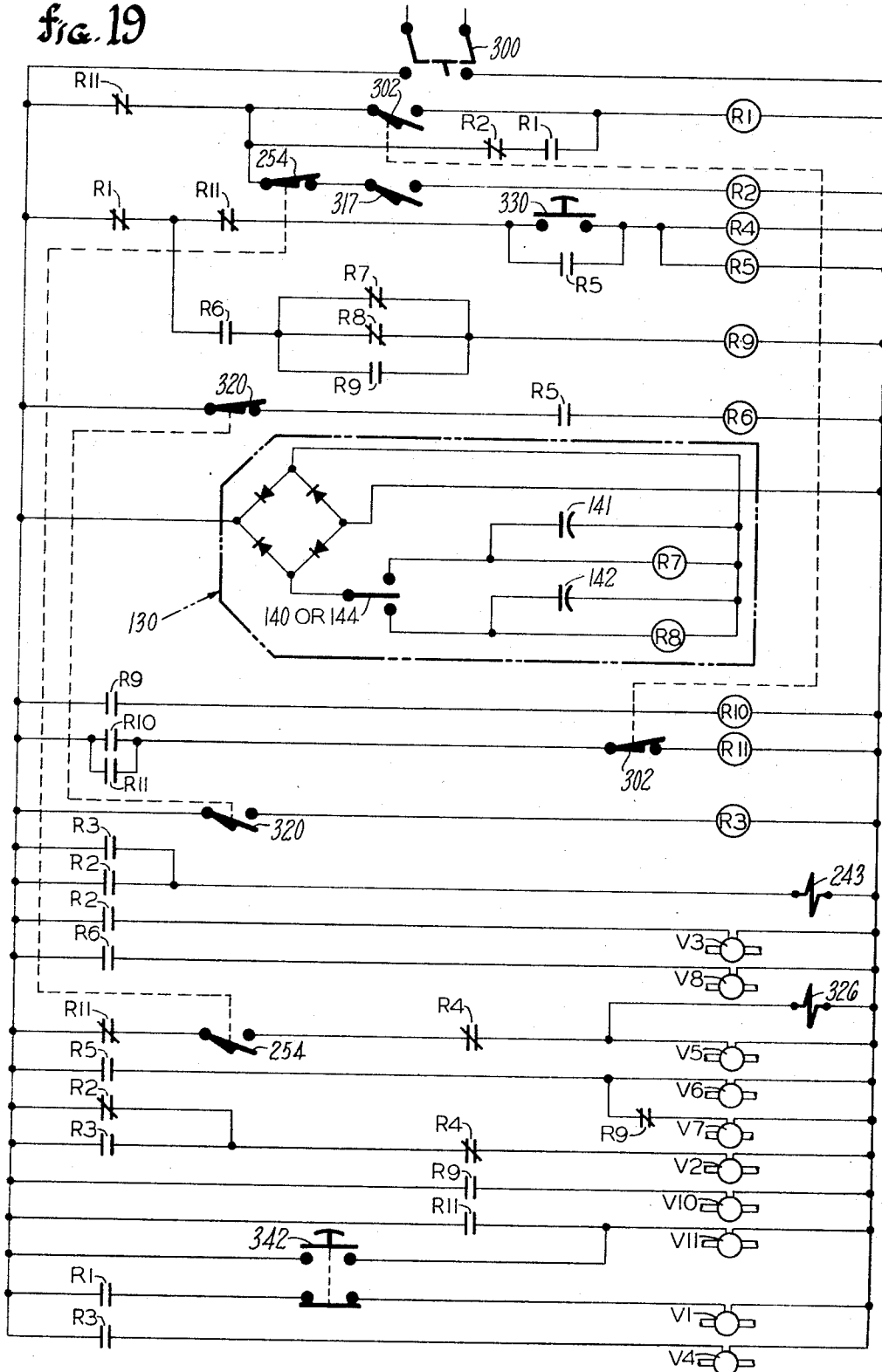
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FIG. 19



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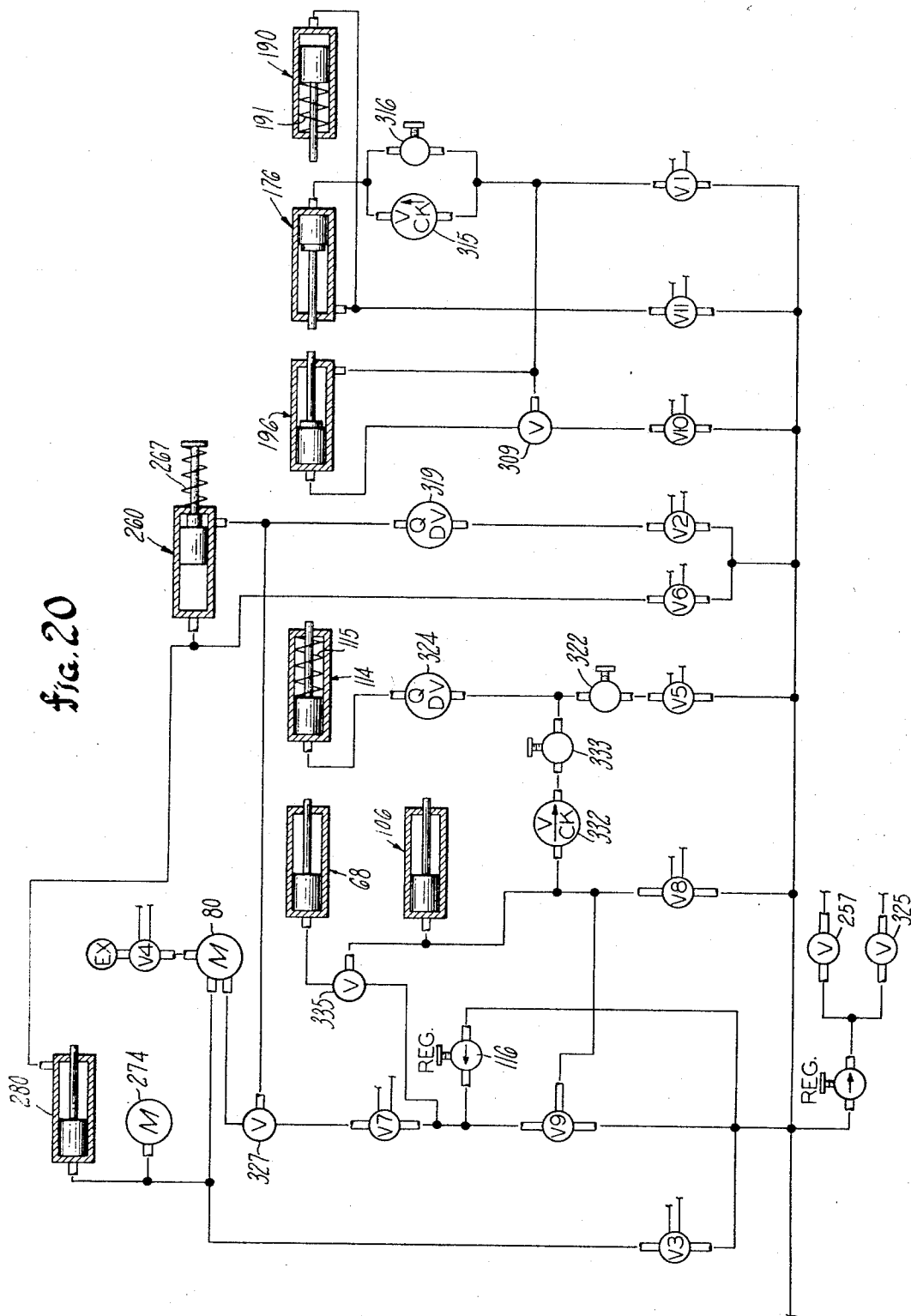
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STRAPPING MECHANISM

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U.S. Cl. 100—4

31 Claims

ABSTRACT OF THE DISCLOSURE

The technical disclosure of the present application is directed to a strapping mechanism installation for applying a tensioned loop of strapping to a package or other article supported on a roller conveyor and includes drawings and descriptions of the operation and construction of the mechanical parts of the mechanism and the circuitry and operation of the pneumatic and electrical systems of the mechanism.

The present invention relates to strapping mechanisms which are conventionally employed for binding with a length of strapping material formed into a loop and having its end sealed together to secure the loop.

It is a principal aim of the present invention to provide a new and improved strapping mechanism having notable utility in binding with nonmetallic strapping, for example, nonmetallic strapping constructed of solid or cord plastic material.

It is another aim of the present invention to provide a new and improved strapping mechanism for sealing the ends of the length of strapping at a sealing station which provides for presenting both sides of the ends of the length of strapping at the sealing station in a novel and useful manner giving greater flexibility in the design of the strapping mechanism and improved and more reliable sealing.

It is another aim of the present invention to provide a strapping mechanism with a strap sealer of simple and economical design.

It is a further aim of the present invention to provide a new and improved strapping machine which is substantially fully automatic and which may be installed for feeding strapping into a chute for forming a loop about an enclosed article, for taking-up the excess strapping while holding the free end thereof to withdraw the loop into contact with the article and to tension the loop about the article, for sealing the tensioned loop of strapping, and for shearing the sealed tensioned loop of strapping from the remaining strapping.

It is a still further aim of the present invention to provide a new and improved feed and take-up mechanism for a strapping machine which is useful with nonmetallic strapping and which is capable of feeding and taking-up the strapping at high rates of speed and of tensioning the strapping with the desired tension, all reliably and without harmfully marring the strapping material.

It is another aim of the present invention to provide a new and improved strap feeding mechanism which is useful with a relatively large chute, as for packaging large articles, and which is capable of feeding strapping material around the chute without buckling the strapping material.

It is a further aim of the present invention to provide a new and improved accumulating device for a strapping machine for accumulating the strapping which is withdrawn during the take-up phase of the machine cycle and which is subsequently adapted to permit rapid removal of the strapping therefrom during the following strap feeding phase of the machine cycle.

It is another aim of the present invention to provide a new and improved accumulating device for a strapping machine having notable utility with nonmetallic strapping material for accumulating the strapping material in a compact manner without overstressing or entangling the material.

It is a further aim of the present invention to provide a new and improved accumulating device for nonmetallic strapping which is of economical and durable construction.

It is another aim of the present invention to provide a new and improved control system for a strapping machine which gives reliable machine operation and which is adapted for applying a tensioned loop of strapping in a minimum period of time.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a side elevation view, partly broken away, of an exemplary strapping machine installation diagrammatically showing an embodiment of a strapping machine of the present invention installed for applying a tensioned loop of strapping about a package, shown in broken lines, supported on a roller conveyor of the installation;

FIG. 2 shows an enlarged front elevation view, partly broken away and partly in section, of the strapping machine of FIG. 1 with a first embodiment of a strap end sensing device, and additionally shows in broken lines portions of the strap guideway of the machine installation;

FIG. 3 is an enlarged top plan view, partly broken away and partly in section, of the strapping machine of FIG. 1;

FIG. 4 is an enlarged side elevation view, partly broken away, of the strapping machine of FIG. 1;

FIG. 5 is an enlarged section view, partly broken away and partly in section, taken substantially along line 5—5 of FIG. 2;

FIG. 6 is a reduced section view, partly broken away and partly in section, taken substantially along line 6—6 of FIG. 5;

FIG. 7 is a reduced section view, partly broken away and partly in section, taken substantially along line 7—7 of FIG. 5;

FIG. 8 is a reduced section view, partly broken away and partly in section, taken substantially along line 8—8 of FIG. 5, showing an embodiment of a stall-sensing device employed in the strapping machine;

FIG. 9 is a section view, partly broken away and partly in section, taken substantially along line 9—9 of FIG. 7;

FIG. 10 is a reduced fragmentary view showing another embodiment of a stall-sensing device;

FIG. 11 is an enlarged section view, partly broken away and partly in section, taken substantially along line 10—10 of FIG. 4, and showing in broken lines a portion of a seal sensing device of the strapping machine;

FIG. 12 is an enlarged section view partly broken away and partly in section taken substantially along line 12—12 of FIG. 11;

FIG. 13 is an enlarged section view partly broken away and partly in section showing a strap shearing device of the strapping machine;

FIG. 14 is an enlarged plan view of an auxiliary drive assembly of the strapping machine showing a pivotally mounted back-up roller thereof in its operative position in

full lines and in its fully withdrawn position in broken lines;

FIG. 15 is an enlarged section view, partly in section, taken substantially along line 15—15 of FIG. 2;

FIG. 16 is an enlarged section view, partly broken away and partly in section, taken substantially along line 16—16 of FIG. 2;

FIG. 17 is an enlarged section view, partly broken away and partly in section, taken substantially along line 17—17 of FIG. 1;

FIG. 18 is an enlarged fragmentary view partly broken away, showing the operative relationship of a pair of sealing jaws, a clamping jaw, an exit guide, and a re-entry guide of the strapping machine;

FIG. 19 is a schematic representation of the electrical system of the strapping machine;

FIG. 20 is a schematic representation of the pneumatic system of the strapping machine;

FIG. 21 is a fragmentary view, partly broken away and partly in section showing another embodiment of a strap end sensing device; and

FIG. 22 is an enlarged generally schematic view showing a pneumatically operated switching device employed with the strap end sensing device of FIG. 21.

Referring now to the drawings in detail, an embodiment of the strapping machine of the present invention, generally denoted by the numeral 10, is shown in a strapping machine installation in FIG. 1, for applying a strapping as for example a nonmetallic strapping of solid plastic or plastic cord material, about an article or package 11, shown in broken lines in FIG. 1, supported on a roller conveyor 12. The installation includes a generally rectangular strapping chute or guideway 14 for encircling the package with a loop of strapping and having an entrance end 16 for receiving a free end of strapping from an exit guide 17 of the machine 10 and a re-entry end 18 for feeding the free end of strapping into a re-entry guide 19 of the machine.

Referring now specifically to FIGS. 2-4, the strapping machine 10 is shown comprising in operative alignment a strap feed and take-up mechanism 20, the reentry strap guide 19, a combined strap sealer and shearing device 24, and a combined strap guide and clamping mechanism 26 which includes the exit guide 17. Also, as shown, the strapping machine includes a multipart frame 34 for mounting the various parts of the strapping machine in proper operative association and for installing the machine on an appropriate supporting frame 35 (FIG. 1).

Referring now specifically to FIGS. 2 and 5, the feed and take-up mechanism 20 comprises a drive or feed wheel 40 having a generally cylindrical knurled strap driving surface 41 which preferably has a relatively large number of fine teeth to provide for firmly engaging the strapping material. A pair of idler pulleys 42, 44 and a pressure distributing or feed belt 46 mounted on the idler pulleys 42, 44 are provided for maintaining the strapping material in operative engagement with a relatively large portion of the driving surface 41 of the drive wheel, in the shown embodiment in engagement with approximately one-fourth of the driving surface of the drive wheel, to provide for feeding and withdrawing the strapping at a fairly high rate of speed and for reliably tensioning the strapping material about the package without harmfully marring the strapping material.

An inlet strapping guide or chute 50 having a pair of guide members 52, 54 is mounted on the frame 34 for guiding the strapping to between the belt 46 and the knurled surface 41 of the feed wheel 40, for which purpose the outer guide member 52 is curved about the idler roll 42 in spaced parallel relationship with the belt 46. Also, the drive wheel 40 is shown provided with flanges 58 and the outer guide member 52 is designed to extend between these flanges to effectively guide the strapping during the feeding and take-up phases of the machine cycle.

The idler pulley 42 is rotatably mounted on an eccentric stub shaft or crank 59 of a shaft 60 so that the axis of the idler pulley 42 can be laterally displaced to control the tension on the belt 46 (and thus the radial force maintaining the strapping in engagement with the drive wheel 40) by angular adjustment of the shaft 60. For this purpose, a lever 62 is fixed on the inner end of the shaft 60, and a tension spring 64 is connected between the lever 62 and an arm 66 fixed to the frame 34 for maintaining a relatively constant radial force on the strapping material. Also, an air cylinder 68 which is connected to the lever 62 by a yoke 70 and a link 72 is provided for increasing the torsional bias on the lever 62 and thus to increase the belt force on the strapping material during the latter stages of the take-up phase when the tension on the strapping is the greatest.

An outlet strapping guide or chute 74 is provided for guiding the strapping from the drive wheel 40 to the combined strap sealer and shearing device 24 and includes a pair of opposed spaced guide members 75, 76 which are mounted for adjustment by an eccentric adjusting screw 78 for cooperative association with the knurled surface 41 of the drive wheel and with the belt 46 respectively.

The drive wheel 40 is driven by a reversible rotary air motor 80 which is mounted on the frame 34 coaxially with the drive wheel 40 and connected to the drive wheel through an epicyclic or planetary gear train 82 and a drive shaft 83 keyed to the motor shaft 84 and having a splined end 90 forming the sun gear of the planetary gear train. The planetary gear train further comprises a planetary carrier 94, a ring gear 95, and a pair of planetary pinions 96 which are in engagement with the sun and ring gears and rotatably mounted on the planetary carrier 94.

Referring to FIGS. 5 and 7, the planetary gear train 82 is adapted to be locked to provide a direct drive to the drive wheel 40 by a clutch 100 which is reciprocally mounted on the splined end 90 of the drive shaft 83 and which is provided with suitable teeth 102 for engaging complementary teeth 103 on the planetary carrier 94. The clutch 100 is normally held in engagement with the carrier 94 by a compression coil spring 104, and an air cylinder 106 is suitably connected for disengagement of the clutch 100.

Referring to FIGS. 5 and 6, a brake mechanism comprising a brake band 112 and an air cylinder 114 connected for operating the brake band is employed for braking the ring gear 95. The air cylinder 114 is provided with a return spring 115 (FIG. 19) for disengaging the brake and is pneumatically operated to apply the brake. The brake cylinder 114 is pneumatically actuated with the clutch cylinder 106 so as to provide for substantially simultaneous operation of the clutch and brake and smooth and rapid changeover from the relatively high speed low torque direct drive to the relatively low speed high torque drive provided by the planetary gear train 82. Also, the brake cylinder 114 may if desired be independently pneumatically operated to brake the forward rotation of the drive wheel 40 to provide for rapid termination of the strap feeding phase of the machine.

In operation the reversible air motor 80 is driven in one direction to feed the strapping outwardly into a loop about the enclosed package, during which phase the wheel 40 is directly driven by the air motor 80 to provide a relatively high speed feed, for example at a rate of seven feet per second. For withdrawing the strapping the drive wheel 40 is driven in the opposite angular direction, initially at this relatively high speed, and approximately as but just before the strapping is tensioned about the article, the clutch and brake cylinders 106 and 114 are pneumatically actuated to provide for sufficiently and accurately tensioning the strapping. Also, a suitable adjustable air pressure regulator 116 (FIG. 20) is employed during this latter low speed high torque tensioning phase to provide for accurate control of the resulting strap tension. For this purpose a microswitch 118 (FIG. 9) which is positioned to be actuated by the piston rod 119

of the clutch motor 106 when the air motor is pneumatically extended to disengage the clutch, may be employed for connecting the regulator 116 to the air motor 80. Alternatively, as shown in the schematic of FIG. 20 the adjustable pressure regulator 116 may be connected for automatically supplying regulated air to the air motor 80 when the clutch and brake cylinders 106, 114 are pneumatically actuated. Also, at the same time the clutch and brake cylinders 106, 114 are pneumatically actuated, the belt tensioning cylinder 68 is pneumatically actuated with the regulated air provided by the regulator 116 to provide for ensuring sufficient gripping force for tensioning the strapping without marring the strapping material.

Referring to FIGS. 5, 7, 8 and 19 a stall-sensor 130 is employed for initiating the operation of the strap sealer when the desired strap tension is obtained. The stall-sensor shown in FIGS. 5, 7 and 8 employs a fixed permanent magnet 132 and a rotating disc 134 mounted on the drive shaft 83. The disc 134 is provided with three flat blades 136 which, as the shaft 83 rotates, pass between the poles of the permanent magnet 132 and thereby vary the reluctance between the poles to operate a magnetic switch 140 and, as a result, to periodically energize relays R7, R8 and capacitors 141, 142 (FIG. 19) of the stall-sensor 130. Alternatively, as shown in FIG. 10 a cam 143 having three lobes for example could be mounted on the drive shaft 83 to operate a switch 144 which is connected in the sensor circuit to energize the relays R7, R8 and the capacitors 141, 142, in the manner of the switch 140. The stall-sensor 130 is thereby adapted to provide a signal, as a result of the deenergization of one of the relays R7 or R8, for operating the strap sealer when the shaft 83 is rotating below a predetermined speed, at approximately a complete stall if desired.

Referring to FIGS. 2, 3, 4, and 13 the combined strap sealer and shearing device 24 is mounted in alignment with the strap feed and take-up mechanism 20 so that the strap fed therefrom will pass through a shearing device 147 to between the stationary and reciprocable sealing jaws 150, 152, respectively of the strap sealer 153. In the shown embodiment the sealer 153 is designed for use with sleeve type seals 154 and accordingly employs a seal feeding mechanism 155 which is adapted for prepositioning a seal between the jaws of the sealer.

The seal feeding mechanism 155 comprises a magazine 159 which extends horizontally in the shown installation and which includes a conventional seal follower 160 (FIGS. 3 and 4) and a follower reel 161 (FIG. 11) for urging the seals to the forward end of the magazine. The seals are individually stripped from the forward end of the magazine by a pivotal seal stripping finger 162 mounted on a control shaft 163 and adapted to positively convey the seal from the magazine via an arcuate chute 164 into engagement with a pair of spaced fingers 166 (FIGS. 2 and 11) of a seal locating and retaining plate 168 and as a result into appropriate position between the sealer jaws 150, 152.

The stripping finger 162 is operated by an air cylinder 176 which is connected to the control shaft 163 through an intermediate lever 178 (FIG. 4). The air cylinder 176 is adapted to be pneumatically extended to strip a seal from the magazine and convey the seal to the jaws and to be pneumatically withdrawn after the sealing phase is completed. The air cylinder 176 is also employed for operating the strap shearing device 147 (FIG. 13) for shearing the sealed loop of tensioned strapping from the remaining strapping in the machine. For this purpose a reciprocable shear blade 180 of the shearing device 147 which cooperates with a stationary shear blade 182 thereof through which the strapping passes, is mounted for operation by an eccentric 184 fixed onto the shaft 163 to shear the strapping as the stripping finger 162 is withdrawn. Thus the air cylinder 176 is adapted to be pneumatically withdrawn after the sealing phase of the machine (and also preferably after the air motor 80 has been deactivated to ensure that the ten-

sion in the strapping is relieved before shearing) to withdraw the stripping finger 162 and to shear the strapping.

Referring to FIGS. 2 and 11 the reciprocable seal retaining plate 168 is shown connected by a link 186 and a bellcrank 188 for operation by an air cylinder 190. The air cylinder 190 is adapted to be withdrawn by a spring 191 (FIG. 20) to extend the seal retaining plate 168 to its forward or operating position and to be pneumatically extended, preferably when the shear and seal feed cylinder 176 is pneumatically withdrawn to retract the seal retaining plate 168 before the loop of strapping is severed from the remaining strap in the machine. Alternatively the seal retaining plate 168 may be suitably connected for actuation by the air cylinder 176 for withdrawing the plate 168 as the stripping finger 162 is withdrawn.

Referring to FIGS. 11 and 12 the reciprocable sealing jaw 152 is connected for operation by an air cylinder 196 through a link 197, a lever 198 pivotally mounted on the frame 34 by a shaft 199, and a pair of links 200 pivotally connected to the lever 198 and to the body 201 of the jaw 152. The sealer operating cylinder 196 is pneumatically operated to actuate the reciprocable jaw to its forward or extended position made adjustable by a set screw 202 mounted on the lever 198 and engageable with a hardened fixed insert 203. Accordingly the amount of deformation of the seal can be effectively controlled by adjustment of the set screw 202 to provide optimum sealing results.

The body 201 of the sealer jaw 152 has a bifurcated inner end forming laterally spaced opposed projections 205 with opposed tapered edges 206 for crimping the lateral edges of the sleeve seal. A replaceable crimping jaw element 207 (FIG. 12), shown having three laterally extending projections 208, is fixed intermediate the opposed projections 205 with a pin 210 and is adapted to cooperate with four laterally extending projections 211 of the stationary jaw 150 to deform or crimp the central portion of the seal. A pair of longitudinally spaced slides 212, 214 are reciprocally mounted at the ends of the jaw body 201 for actuation by the links 200 for crimping the longitudinal ends of the seal. Also the slides 212, 214 are urged outwardly by the springs 215, 216 to provide a light frictional retention of the seal in appropriate position between the jaws 150, 152 when the reciprocable jaw 152 is in its fully retracted position.

Upon reference to FIGS. 2 and 11 it can be seen that the plane of the seal between the jaws 150, 152 is angularly offset substantially 90° from, or at right angles to, the front face of the machine or the adjacent face of the package to be strapped. The use of this angular offset arrangement at the sealing station has the advantage of providing greater sealing reliability and of permitting greater flexibility in the design, operation, etc., of the strap sealer. Exemplary of this design flexibility is the economical and reliable strap sealer design shown and described. Of course, other suitable strap sealer designs could be usefully employed with this type of angular offset sealing arrangement. For example, a suitable welding head which may be used with or without seals may be conveniently employed.

In order to provide for angularly offsetting the strapping at the sealing station, the exit and re-entry guides 17, 19 are contoured for twisting the strapping 90° in one direction as it is fed from the sealer to the guideway 14—to the right in the shown embodiment—and for twisting the strapping 90° in the opposite direction as it is fed from the guideway 14 back to the sealer—to the left in the shown embodiment. Referring to FIGS. 2-4, 15 and 16, the guides comprise inner fixed guide portions 217, 218, respectively, and outer pivotal guide portions or gates 219, 220, respectively, which are pivotal between their operating or closed positions shown in FIGS. 15 and 16 in which they cooperate with the fixed guide portions to form appropriate guideways or channels for

twisting the strapping, and withdrawn or open positions for releasing the strapping.

More particularly, the fixed guide portion 217 of the re-entry guide 19 forms an outwardly opening rectangular channel 221 and the pivotal guide portion or gate 219 thereof includes a guide insert 222 with a twist surface 223 for twisting the strapping and an outer cover plate 224 for retaining the strapping within the re-entry guide when the pivotal guide portion 219 is in its closed position. The pivotal guide portion 219 is adapted to be pivoted outwardly and to the right as seen in FIG. 2 for releasing the strapping.

The fixed guide portion 218 of the exit guide 17 includes a replaceable insert 230 with a twist surface 232, and the pivotal guide portion or gate 220 of the exit guide includes a replaceable insert 234 with a twist surface 236 which, with the gate 220 in its closed position, cooperates with the twist surface 232 to twist the strapping 90° to the right. The pivotal guide portion 220 also includes a cover plate 238 having a lower edge 239 which cooperates with an inner tapered surface 240 of an upstanding flange 241 of the fixed guide portion to retain the strapping within the guide.

The gate portion 220 of the exit guide 17 is adapted to be pivoted outwardly and to the left as seen in FIG. 2, and is suitably connected with the gate 219 of the re-entry guide 19 (FIGS. 3 and 4) for simultaneously closing the gates 219, 220 with a link 242 (FIG. 3) operated by a suitable solenoid 243 (FIG. 19) mounted in the control box 244 (FIG. 3) of the strapping machine. Also a suitable spring (not shown) may be employed for opening the gates 219, 220 when the solenoid 243 is de-energized.

Referring to FIGS. 2 and 18 the upstanding flange 241 of the exit guide 17 has a lower surface 245 with a leading edge generally in line with but slightly offset from the centerline of the seal within the sealer jaws so that after the free end of strapping has passed through the seal held between the jaws and the exit guide 17, around the guideway 14, through the re-entry guide 19 and back through the seal, it is adapted to engage the lower inclined surface 245 of the upstanding flange 241 to divert the free end of strapping laterally into the inclined bypass channel 249 formed between the flange 241 and a clamping jaw 250.

A suitable strap sensing device is employed for sensing the receipt of the strapping within the bypass channel 249 and to terminate the strap feeding phase of the machine. In FIGS. 2 and 18 this sensing device is shown employing a lever 253 for operating a switch 254 when the lever is engaged by the free end of strapping passing into the bypass channel, and which also functions as a stop for preventing excessive overfeed of the free end of strapping through the seal. Alternatively as seen in FIG. 21 the strap sensing device may employ a suitable spring biased piston or bleed valve 251 which is actuated by the free end of strapping to close off an air bleed passage 252 normally in communication with an external annulus 255 on the valve 251 for exhausting air out a suitable exhaust passage (not shown). Referring to FIG. 22 the bleed passage 252 also normally in communication with the annulus 255 is connected to a pneumatic control system 257 having an elongated plenum 258 with an inlet orifice 259 connected to a suitable air pressure source. A tube 261 forming a venturi or restriction in the plenum 258 provides for pneumatically connecting the plenum 258 with a diaphragm 265 for actuating the switch 254. Accordingly when the free end of strapping actuates the bleed passage valve 251 the pressure in the plenum 258 will increase to actuate the switch 254.

Referring to FIGS. 2, 3, 18 and 20 the clamping jaw 250 is operated by an air cylinder 260 through an eccentric 262 mounted on the shaft 199, an eccentric operating lever 263 and a link 264 connected to the eccentric 262 and to the clamping jaw 250. The clamping jaw 250 is provided with a protrusion or deflector 266 which

provides for deflecting or diverting the strapping into the exit guide 17 when the jaw is closed and thereby ensure that the strapping is properly fed through the exit guide 17 and around the guideway 14 during the initial portion of the strap feeding phase, and for this reason the clamping jaw 250 is normally held closed by a compression spring 267 (FIG. 3) encircling the piston rod of air cylinder 260. Subsequently the clamping jaw 250 is pneumatically retracted with the air cylinder 260 to provide for subsequently receiving the strapping in the inclined bypass channel 249. The clamping jaw 250 is then pneumatically extended to clamp the free end of strapping against the flange 241.

Referring to FIGS. 1 and 14 and auxiliary drive mechanism 270 is employed for ensuring that the strapping is properly fed around the guideway 14 and returned to the strapping machine. As seen in FIG. 1 this auxiliary drive mechanism 270 is mounted below the strapping machine adjacent the re-entry end 18 of the guideway 14. If desired the auxiliary drive mechanism 270 could be positioned elsewhere and/or additional auxiliary drive mechanisms could be provided along the guideway. The auxiliary drive mechanism 270 comprises an auxiliary feed or drive wheel 272 connected to be driven by an air motor 274 and having a resilient urethane coating for frictionally engaging the surface of the strapping. The drive wheel 272 is mounted adjacent to but outwardly of the guideway and with its surface substantially in line with the channel or chute formed by the guideway. A rotatable back-up roll 276 is mounted on a lever 278 pivotally controlled by an air cylinder 280, and the air cylinder is adapted to be pneumatically extended to position the back-up roll 276 in its operating position inwardly of and adjacent to the auxiliary drive wheel for cooperating therewith to feed the strapping along the guideway.

The auxiliary drive motor 274 is preferably operated in conjunction with the primary drive motor 80 during the strap feeding phase, and in the present embodiment is preferably operated to feed the strapping slightly faster, for example 10% faster, than it is fed by the feed and take-up mechanism 20 so as to provide an assist which will pull the strapping around the guideway and thereby prevent inadvertent strap buckling in the guideway. The auxiliary drive mechanism is preferably employed during the strap feeding phase only and the back-up roll cylinder 280 is pneumatically operated to withdraw the back-up roll 276 to its retracted position shown in broken lines in FIG. 14 when the strap feeding phase is terminated.

Referring to FIGS. 1 and 17 a strapping accumulator 285 is provided between the inlet chute 50 and a suitable strap dispensing mechanism (not shown) for storing the strapping material which is withdrawn by the feed and take-up mechanism 20 during the taking up and tensioning phases of the machine cycle. The accumulator 285 comprises a generally box-like enclosure 286 having a pair of substantially parallel internal sidewalls 287, 288, substantially parallel internal end walls 289, 290, and substantially parallel internal bottom and top walls. The sidewalls 287, 288 have a lateral spacing substantially equal to but slightly greater than the width of the strapping material. The enclosure is shown constructed with a cover panel 292 which is hinged at its top edge to provide for access to the internal chamber 291 and which may be provided with a suitable closure fastener if desired and be made of a suitable transparent material, for example glass or plastic to enable the machine operator to view the operation of the accumulator.

The accumulator has an inlet opening 293 at the bottom of the end wall 290 and an outlet opening 294 in alignment therewith at the bottom of the end wall 289. A guide roller 295 is mounted adjacent the inlet opening 293 for guiding the strapping into the accumulator chamber 291, and a leaf spring 296 having a lower inwardly

curved end is provided for restraining the strapping against withdrawal from the chamber through the inlet opening. The leaf spring also forms with the bottom wall a thin inlet guide opening for guiding the strapping into the chamber substantially perpendicular to the sidewalls 287, 288. The outlet opening 294 is also dimensioned to provide a thin outlet guide opening which is substantially parallel to the inlet guide opening and which during the taking up and tensioning phase of the machine cycle provides for freely guiding the strapping into the chamber without restraint and substantially perpendicular to the sidewalls 287, 288. An accumulator exit chute 298 is also provided between the outlet guide opening and the inlet guide 50 to provide for guiding the strapping to and from the accumulator 285.

The accumulator, it has been found, provides for accumulating a large amount of strapping material compactly and at as fast a rate as the strapping material can be withdrawn by the machine. Also it has been found that the accumulator is capable of storing and subsequently feeding nonmetallic strapping without twisting or otherwise entangling the strapping material.

Referring specifically to the schematics of the electrical and pneumatic systems of the strapping machine shown in FIGS. 19 and 20 respectively, an "ON"-"OFF" switch 300 provides for energizing the electrical circuit of the machine, and, with the seal magazine loaded, a seal supply switch 302 is closed to energize a relay R1. Referring to FIGS. 3, 4 and 11 the seal supply switch 302 is mounted in the control box 244 and is operated by a linkage which includes a switch operating rod 304 and a seal sensing arm 305 pivotally mounted on a pin 306 adjacent the forward end of the seal magazine 159. The seal sensing arm 305 has an intumed inner end 307 (FIG. 11) which extends to within the magazine 159 adjacent the stripping finger 162, and when the stripping finger is fully withdrawn the forwardmost seal 154 in the magazine is adapted to move forwardly under the bias of the seal follower 160 into engagement with the intumed inner end 307 of the sensing arm to actuate the seal supply switch 302. Also, when the stripping finger 162 is operated to convey a seal to between the sealer jaws 150, 152 the seals in the magazine are supported by the stripping finger 162 and the sensing arm 305 is thereby released to reopen the seal supply switch 302.

When energized the relay R1 energizes a solenoid operated valve V1 which is connected (1) to the sealer cylinder 196 and to a pneumatically operated exhaust valve 309 for withdrawing the sealing jaws 152 and (2), via a one-way check valve 315 and an orifice 316 to the seal feed cylinder 176 for transferring a seal from the seal magazine to between the sealing jaws 150, 152 and into engagement with the fingers 166 of the seal retaining plate 168. As a result a seal position switch 317 mounted in the control box 244 and actuated by a link 318 (FIG. 4) connected to the piston rod of the cylinder 176 is closed to energize a relay R2 when the seal is positioned between the jaws of the sealer. The relay R2 (1) energizes the solenoid 243 to close the exit and re-entry guides 17, 19; (2) de-energizes a normally energized unclamping solenoid valve V2 to permit the compression spring 267 of the air cylinder 260 to close the clamping jaw 250 and thereby assure that the strap is diverted through the exit guide 17, for which purpose a quick dump valve 319 is employed in the air line between the valve V2 and the air cylinder 260; and (3) energizes a solenoid operated valve V3 for (a) operating the air drive motor 80 in the forward direction, (b) operating the auxiliary drive motor 274, and (c) for actuating the air cylinder 280 to pivot the back-up roll 276 into operative position with the auxiliary drive wheel 272.

The strapping is accordingly fed forwardly through the seal positioned between the sealer jaws through the exit guide 17 and around the guideway 14. As the strap is fed through an end portion 311 of the guideway 14, it is

sensed by an air bleed pneumatic control system 325 (FIG. 20) like the control system 257 and having an air bleed opening 321 (FIG. 2) in the re-entry portion 311 of the guideway 14 which is adapted to be closed off by the free end of the strapping for operating a suitable strap detector switch 320. The strap detector switch 320 energizes a relay R3 (1) to complete a holding circuit for the solenoid 243 for maintaining the exit and re-entry guides 17, 19 closed during the initial stage of the subsequent take-up of strapping; (2) to energize the unclamping solenoid valve V2 to withdraw the clamping jaw 250 for subsequent receipt of the strapping in the bypass channel 249; and (3) to energize a solenoid operated shut-off valve V4 connected to the motor casing or secondary exhaust line of the drive motor 80 to decelerate the strap feed. In addition or alternatively to the shut-off valve V4, a pneumatically actuated shut-off valve 327 in the motor supply line connected in the forward feed exhaust line of the drive motor 80 may be operated with the valve V2 as shown in FIG. 20 to decelerate the strap feed.

The strap then passes through the re-entry guide 19 and the seal located between the crimping jaws and into the bypass channel 249, whereupon it actuates the switch 254 (1) to de-energize the relay R2 and thus de-energize the relay R1 and to thereby de-energize the seal feed solenoid valve V1 and the forward strap feed solenoid valve V3, (2) to energize a brake solenoid valve V5 which is connected via an orifice 322 and a quick dump valve 324 to the brake cylinder 114 to provide for rapidly terminating the strap feed, and (3) to energize a track opening solenoid 326 which may be provided for opening the usual spring returned retractable retainers 328, for example in the entrance portion 16 of the guideway 14, to provide for strap overfeed if it occurs.

The system is now in a "ready condition" for applying a strap to a package placed in position. The system may provide for automatic application of the strap to the package as soon as it is in appropriate position on the roller conveyor, or semi-automatic operation may be accomplished with a manual push button 330, which when pressed, energized relays R4 and R5 (1) to de-energize the unclamping solenoid valve V2, (2) to energize the clamping solenoid valve V6 for clamping the free end of strapping and to withdraw the auxiliary drive back-up roll 276 with the air cylinder 280, (3) to energize the reverse feed valve V7 to operate the primary drive motor 80 in the reverse direction to withdraw the strapping; and (4) to break the circuit to the brake solenoid valve V5 and the track opening solenoid 326.

The strap is accordingly withdrawn from the guideways 14 by the air motor 80. The strapping is however withdrawn out of the end portion 311 of the guideway 14 approximately as but just before the loop of strapping has begun to be tensioned about the enclosed package, such being due in part to the greater spring force employed with the retractable retainers 331 (FIG. 2) of this section of the guideway. Accordingly, the strap sensing switch 320 is actuated—as a result of the removal of strap from the end portion 311 of the guideway 14 at the latter part of the strap withdrawal phase and just prior to the strap tensioning portion of the withdrawal phase. The switch 320 provides (1) for energizing relay R6 for energizing a tension solenoid valve V8 which is connected (a) via a one-way check valve 332 and an orifice 333 to operate the brake cylinder 114, (b) to operate a pneumatically operated shut-off valve V9 for controlling the air pressure to the drive motor 80 and the belt tension cylinder 68 with the pressure regulator 116, (c) to operate the clutch cylinder 106 to disengage the clutch 100 and (d) to operate a pneumatically operated control valve 335 for the belt tension cylinder 68 for increasing the grip on the strapping material; (2) for energizing the stall sensor 130; and (3) for de-energizing the holding circuit for the solenoid 243 for opening the exit and re-entry guides 17, 19.

In this configuration the machine tensions the strap until the motor stalls at which point the stall switch 140 or 144 provides for de-energizing one of the relays R7 or R8 and thereby energize the relay R9.

Relay R9 (1) energizes a sealing solenoid valve V10 to seal the tensioned loop of strap, (2) de-energizes the reverse feed valve V7 to deactivate the drive motor 80 and (3) energizes a time delay relay R10 which provides a delay of approximately 2 seconds to assure complete and thorough sealing before it energizes a relay R11. Relay R11 (1) de-energizes the relays R4 and R5 for de-energizing the clamping valve V6 and for de-energizing the relay R6 to de-energize the tension valve V8 for releasing the strap tension, and (2) energizes the solenoid valve V11 to withdraw the seal stripping finger 162 and to thereby shear the sealed loop of strap from the remaining strap and to withdraw the seal retaining plate 168.

As soon as the stripping finger 162 is fully withdrawn, the seal supply switch 302 is actuated to deenergize the relay R11 and to energize the relay R1 for withdrawing the sealer jaw 152 and for initiating the following machine cycle. The tensioned loop of strapping is then free to snap out of the strapping machine into engagement with the package to complete the strapping cycle.

To prevent inadvertent untimely feeding of strap or seals, several interlocks are provided. A normally closed contact of relay R11 is provided in the seal feeding and the strapping take-up circuits to be sure that the reciprocable shear blade 180 is withdrawn and the seal is in position between the sealer jaws before the strap is fed forwardly from the strap feed and take-up mechanism 20. There are also normally closed contacts of relays R11 and R4 in the ring gear brake circuit to prevent the brake from being applied while strap is being fed out or taken up at the normal rate of 7 ft. per second. The strapping machine is also known including a push button 342 (FIG. 19) for cycling the seal feed cylinder 176 and thereby provide for selectively stripping a seal from the magazine 159 as for example when the seal stripping device miscues.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a strapping device for binding an article with a length of generally flat strapping material having its ends joined together at a sealing station to form a loop of strapping, the improvement wherein the strapping device comprises means for twisting the ends of the length of strapping material for presenting both sides of the loop of flat strapping material at the sealing station in an angularly offset plane.

2. In the strapping device of claim 1 wherein the strapping device includes an elongated strap guideway for guiding strapping into an enlarged loop, strap feeding and tensioning means for feeding a free end of strapping through the guideway and for thereby forming the strapping into an enlarged loop and for subsequently withdrawing the strapping for tensioning the loop about an article encircled thereby, and a strap sealer for sealing the ends of the loop of strapping at the sealing station, and wherein the twisting means comprises an exit twist guide between the strap sealer and one end of the guideway for twisting the strapping in one angular direction from said angularly offset plane and a re-entry twist guide between the other end of the guideway and the strap sealer for twisting the strapping in the opposite angular direction into said angularly offset plane.

3. In the strapping device of claim 2 wherein the strapping device includes a strap accumulator for accumulating the strapping withdrawn by the strap feeding and tensioning means comprising an enclosure with a pair of laterally substantially parallel internal sidewalls having a lateral spacing substantially equal to but greater

than the lateral width of the strapping material and forming an accumulating chamber for accumulating the strapping therebetween, an inlet guide for guiding the strapping into the accumulating chamber, and an outlet guide for guiding the strapping from the accumulating chamber.

4. In the strapping device of claim 2 wherein the strap feeding and tensioning means comprises, a feed wheel, a pair of belt wheels and a feed belt thereon co-operating with the feed wheel for gripping the strapping therebetween.

5. In the strapping device of claim 2 wherein the strap feeding and tensioning means comprises a chute for guiding the strapping along a first path to the sealing station, wherein the re-entry twist guide is adjacent to and laterally offset from said chute, and wherein the re-entry twist guide provides for feeding the strapping to the sealing station along a second path adjacent to and inclined toward said first path.

6. The improvement of claim 1 wherein the twisting means includes a twist guide on each side of the sealing station which is adapted to twist the strapping material substantially 90° into the plane of the loop of strapping.

7. The improvement of claim 6 wherein the strapping device includes a strap tensioning device for tensioning the loop of strapping having a feed wheel engageable with the strapping for the tensioning thereof which is rotatable about an axis substantially parallel to said angularly offset plane and substantially perpendicular to the plane of the loop of strapping.

8. In the strapping device of claim 6 wherein the twist guides comprise fixed guide portions and reciprocable gate portions having closed positions adapted to cooperate with the fixed guide portions for twisting the strapping and open positions permitting the strapping to be withdrawn from the twist guides, and wherein the strapping device includes means for opening and closing the reciprocable gate portions.

9. The improvement of claim 6 wherein the loop of strapping is formed with the ends of the length of strapping material overlapping at the sealing station and wherein the strapping device comprises clamping means adapted to provide a diversion channel adjacent to the sealing station and laterally offset from one of the twist guides for receiving an end of the length of strapping material and for clamping the end of strapping material therein.

10. The improvement of claim 9 wherein the clamping means comprises a reciprocable clamping jaw having a withdrawn position and an extended channel for clamping the strapping in the diversion channel and operative without the strapping in the diversion channel for diverting the strapping into said one twist guide.

11. In the strapping device of claim 1 wherein the strapping device has a front face which is adapted to face the article to be bound with the loop of strapping material and wherein said angularly offset plane is substantially perpendicular to said front face of the strapping device.

12. The improvement of claim 6 wherein the strapping device includes a strap sealer for sealing the ends of the loop of strapping material at the sealing station which comprises a first jaw on one side of said angularly offset plane and a second jaw on the opposite side of said angularly offset plane mounted for rectilinear reciprocable movement generally perpendicular to said angularly offset plane between a withdrawn outer position and an extended inward sealing position.

13. The improvement of claim 12 wherein the strap sealer is adapted for sealing the ends of the loop of strapping with seals and wherein the strap sealer further comprises a seal magazine for storing seals and a pivotal seal stripping finger operable from a withdrawn pivotal position to an extended pivotal position for individually stripping the seals from the magazine and for feeding them to the sealing station between the first and second jaws.

14. The improvement of claim 13 wherein the strapping device comprises a strap shearing mechanism connected for operation with the pivotal seal stripping finger for shearing the strapping material as the pivotal seal stripping finger is pivoted from its extended to its withdrawn pivotal positions.

15. The improvement of claim 13 wherein the second jaw comprises seal retaining means for retaining a seal at the sealing station between the jaws of the sealer when said second jaw is in its withdrawn position.

16. The improvement of claim 15 wherein the seal retaining means comprises a pair of spaced slides mounted for rectilinear reciprocable movement and spring means biasing the slides inwardly into engagement with a seal positioned between the jaws.

17. The improvement of claim 12 wherein the strap sealer comprises an actuating cylinder for actuating said second jaw to its sealing position and means for adjustably limiting the stroke of the actuating cylinder for adjusting the sealing position of the second jaw.

18. In a strapping device for binding with a loop of strapping material having strap feeding means for feeding the strapping material, the improvement wherein the strap feeding means comprises a feed wheel, a pair of belt wheels and a feed belt thereon cooperating with the feed wheel to provide for gripping the strapping material therebetween, drive means for rotating the feed belt and feed wheel for feeding the strapping material, and belt tensioning means operable for increasing the belt tension and for concomitantly increasing the gripping force on the strapping material provided by the feed wheel and feed belt, comprising eccentric mounting means for eccentrically mounting at least one of the wheels, and means for adjusting the eccentric mounting means.

19. In the strapping device of claim 18 wherein the adjusting means comprises a lever fixed to the mounting means and spring means connected to the lever and urging the mounting means in a belt tensioning direction.

20. In a strapping device for binding with a loop of strapping material having strap feeding means for feeding the strapping material, the improvement wherein the strap feeding means comprises a feed wheel, a pair of belt wheels and a feed belt thereon cooperating with the feed wheel to provide for gripping the strapping material therebetween, drive means for rotating the feed belt and feed wheel for feeding the strapping material, belt tensioning means operable for increasing the belt tension and for concomitantly increasing the gripping force on the strapping material provided by the feed wheel and feed belt, the strap feeding means being adapted for feeding the strapping in one direction for forming a loop thereof and for feeding the strapping in the opposite direction for tensioning the loop about an article encircled thereby, and means for automatically operating the tensioning means for increasing the gripping force on the strapping material while the strapping is being tensioned about the article.

21. In a strapping device for binding with a loop of strapping material comprising a sealing station for sealing the ends of the loop of strapping, a strap guideway for guiding the strapping material into an enlarged loop having an exit end on one side of the sealing station and a re-entry end on the opposite side of the sealing station, and strap feed and tensioning means selectively operable for feeding the strapping in one direction into the exit end of the strap guideway for forming the enlarged loop and for feeding the strapping in the opposite direction for taking-up the slack in the loop and for thereby withdrawing the strapping from the guideway and for tensioning the loop about an article encircled thereby, the improvement wherein the strap feed and tensioning means is adapted to feed the strapping at relatively high and relatively low rates of feed, and wherein the strapping device comprises first control means responsive to the withdrawal of the strapping from the guideway for operat-

ing the strap feed and tensioning means at said relatively low rate of feed.

22. In the strapping device of claim 21 wherein the feed and tensioning means comprises motor means and wherein the strapping device comprises second control means for automatically decreasing the speed of the motor means just prior to the formation of the enlarged loop of strapping.

23. In the strapping device of claim 22 wherein the second control means is responsive to the presence of the strapping in the re-entry end of the guideway to decrease the speed of the motor means.

24. In the strapping device of claim 22 wherein the motor means comprises a fluid motor and wherein the second control means provides for decreasing the speed of the fluid motor by decreasing the fluid flow therethrough.

25. The improvement of claim 21 wherein the first control means comprises an air bleed control system having a jet bleed opening adapted to be covered by the strapping as it is fed in said one direction to form the enlarged loop, an air plenum connected to said bleed opening having a restricted inlet adapted to be connected to an air supply, and a pneumatic operator connected to the plenum for operating the strap feed and tensioning means at said relatively low rate of feed when the bleed jet opening is uncovered by the strapping as it is withdrawn by the feed and tensioning means.

26. In combination with a strapping machine adapted for binding with a loop of strapping and having a strap guideway with a loop portion for guiding the strapping into an enlarged loop and strap feeding means for feeding the strapping forwardly along the guideway to form the loop, an auxiliary strap feed mechanism mounted in cooperative relationship with said loop portion comprising an auxiliary feed wheel mounted for frictional engagement with the strapping in said loop portion for feeding the strapping forwardly therealong.

27. The combination of claim 26 wherein the auxiliary strap feed mechanism comprises a back-up wheel mounted for movement between an extended operating position in which it cooperates with the auxiliary feed wheel to feed the strapping forwardly along said loop portion and a retracted position permitting the strapping to be withdrawn from said loop portion.

28. In combination with a strapping machine adapted for binding with a loop of strapping and having a strap guideway for guiding the strapping into an enlarged loop and strap feeding means for feeding the strapping forwardly along the guideway to form the loop, an auxiliary strap feed mechanism mounted in cooperative relationship with the guideway comprising an auxiliary feed wheel mounted for frictional engagement with the strapping in the guideway for feeding the strapping forwardly therealong, and means providing for rotating the auxiliary feed wheel for forwardly feeding the strapping along the guideway at a rate slightly greater than the rate the strapping is fed by said strap feeding means.

29. In a strapping device for binding an article with a loop of strapping comprising strap feeding and tensioning means for feeding the strapping forwardly in one direction to form a loop thereof and for feeding the strapping in the opposite direction for tensioning the loop about an article encircled thereby, the improvement wherein the feeding and tensioning means comprises, strap feed means, drive motor means, planetary gear means interconnecting the drive motor means with said strap feed means and operable for selectively providing relatively high and relatively low drive ratios for feeding the strapping at relatively high and low speeds respectively, the planetary gear means comprising an input gear driven by the drive motor means, a control gear, and planetary gearing in engagement with the input gear and the control gear connected for driving said strap feed means; clutch means engageable for locking said planetary gear means for

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providing the relatively high drive ratio, and brake means operable for braking the control gear for providing the relatively low drive ratio when the clutch means is disengaged and for braking said strap feed means when the clutch means is engaged.

30. In the strapping device of claim 29 wherein the motor means is a fluid motor and wherein the strapping device comprises fluid pressure regulator means for regulating the fluid pressure to the motor when the planetary gear means is operated to provide said relatively low drive ratio.

31. In the strapping device of claim 30 wherein the fluid motor is reversible for feeding the strapping in said forward and opposite directions and wherein the strapping device comprises control means for automatically disengaging the clutch means and for operating the brake means to provide said relatively low drive ratio while the loop of strapping is being tensioned by the strap feeding and tensioning means.

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