United States Patent

Plattner et al.

[15] **3,687,059**

[45] **Aug. 29, 1972**

[54] **STRAPPING MACHINE**

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[73] Assignee: **Interlake, Inc.,** Chicago, Ill.

[22] Filed: **Oct. 5, 1970**

[21] Appl. No.: **78,008**

[52] **U.S. Cl.** **100/4,** 100/26, 100/30

[51] **Int. Cl.** **B65b 13/34**

[58] **Field of Search**.....100/4, 26, 30, 32, 33

[56] **References Cited**

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[57] **ABSTRACT**

A machine for tensioning a strap around an object includes a pair of toothed gripping jaws movable by first drive means into and out of holding engagement with the strap in directions substantially normal thereto to prevent scoring thereof, the gripping jaws being pivotally movable to a releasing position for accommodating removal of the strap therefrom, sealing jaws and a seal feed member respectively movable by second and third drive means alternately into ea sealing region, the seal feed member in the sealing region positioning a seal therein and guiding the passage of the strap therethrough, the sealing jaws in the sealing region sequentially deforming the seal into partial sealing and full sealing engagement with the strap, straightening means movable by fourth drive means into and out of straightening engagement with the supply portion of the strap, and control circuitry for controlling the operation of the several drive means.

39 Claims, 19 Drawing Figures

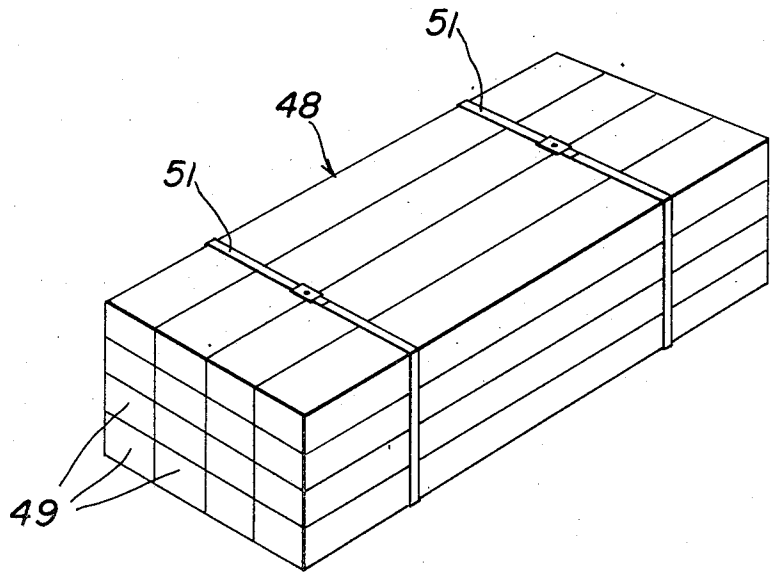


FIG. 2

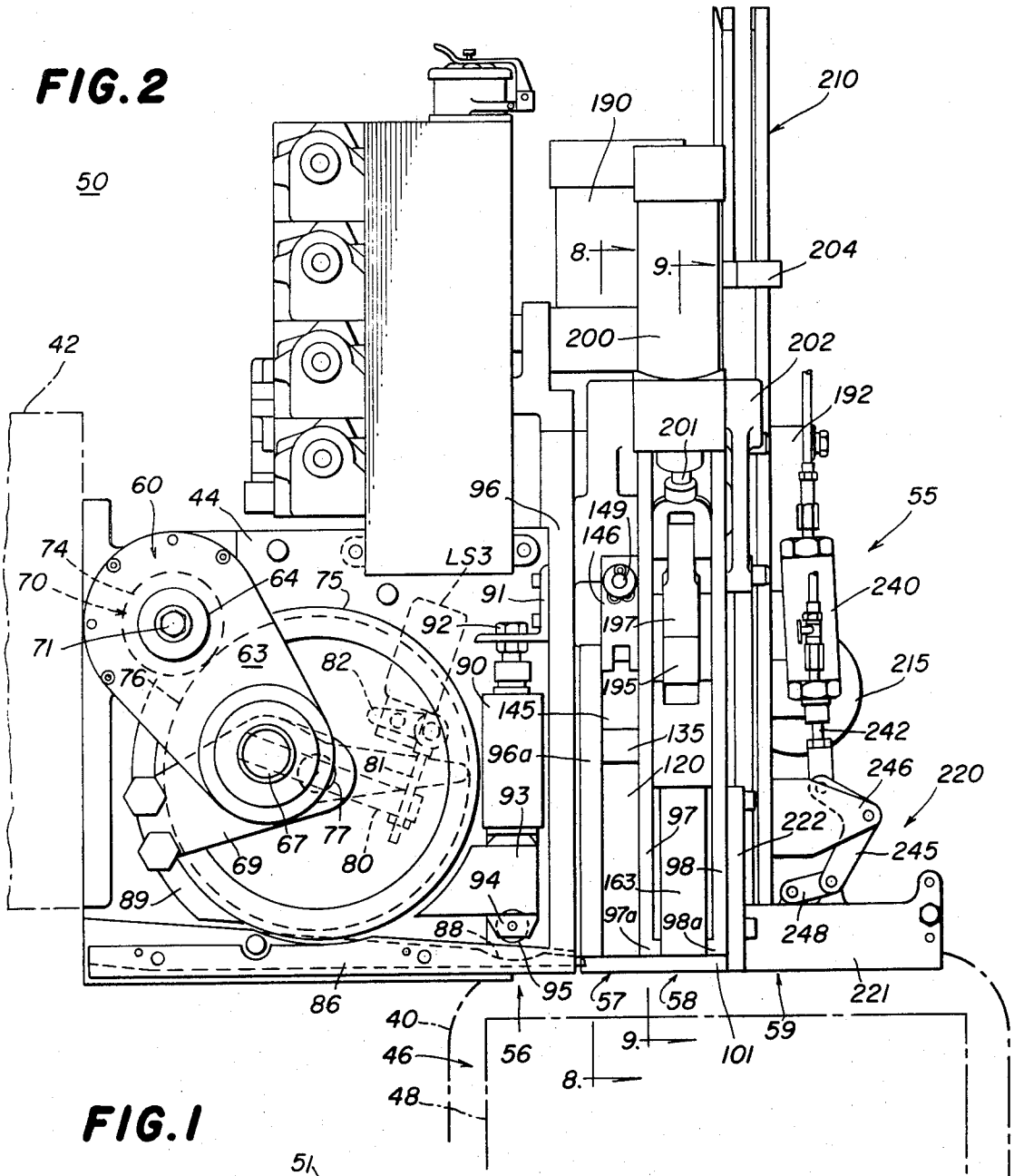
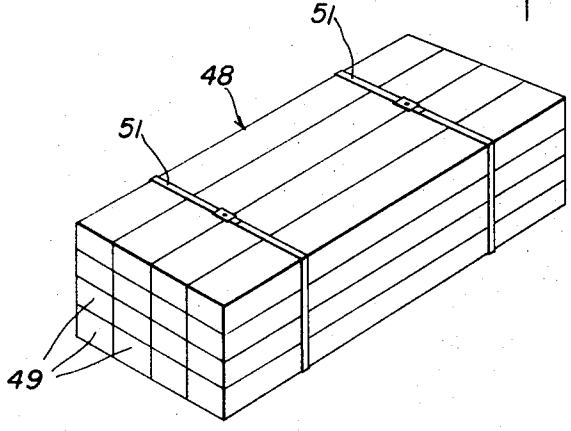


FIG. 1



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FIG. 8

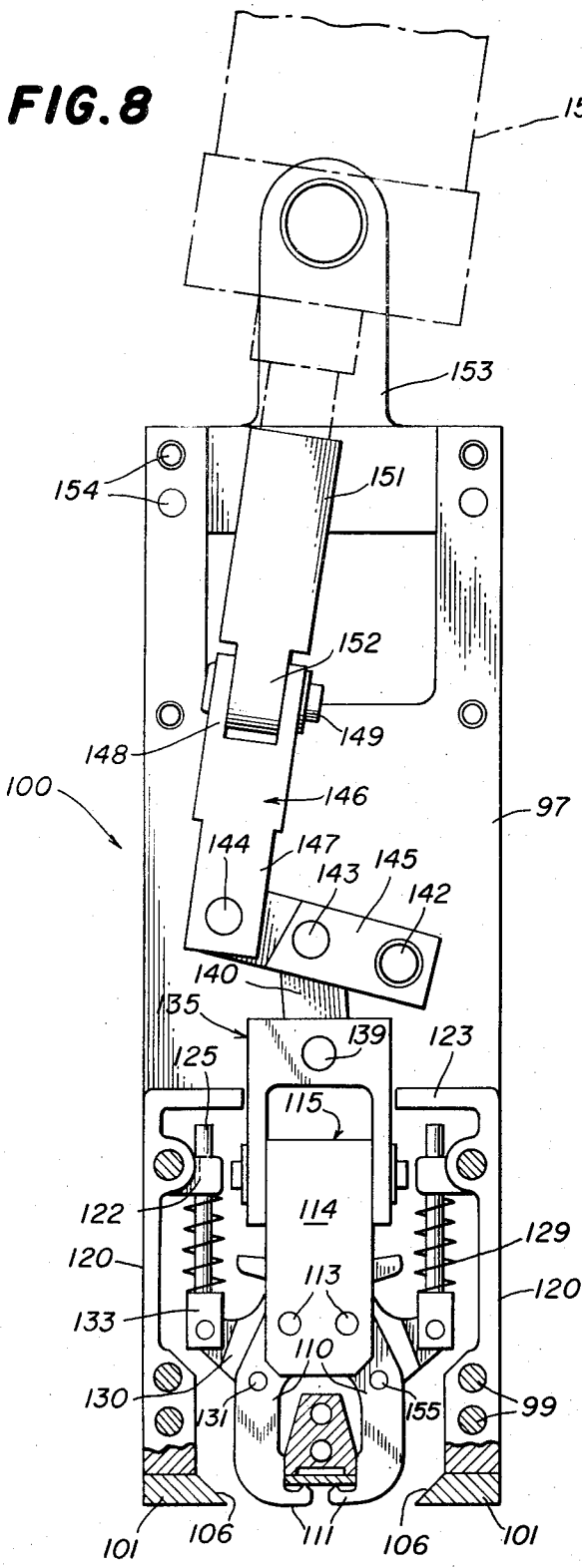

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FIG. 7

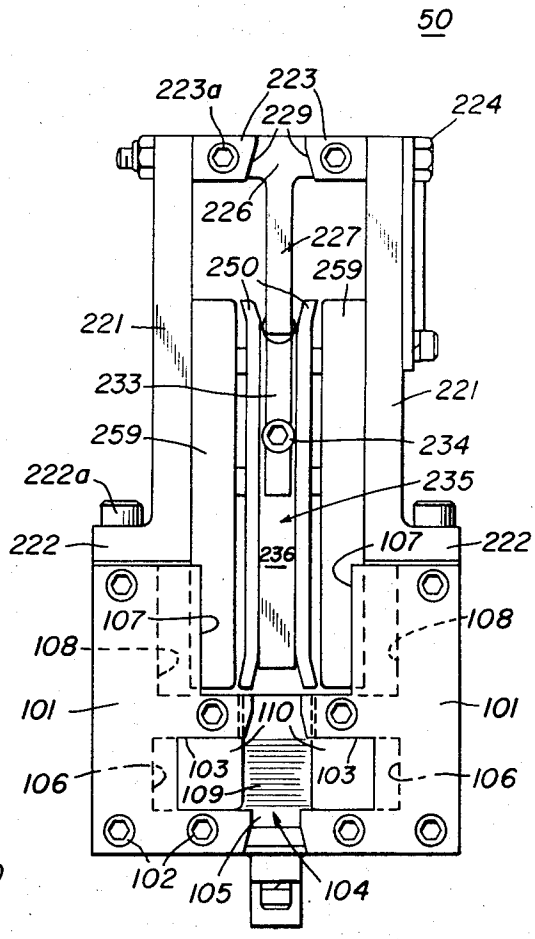

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FIG. 5

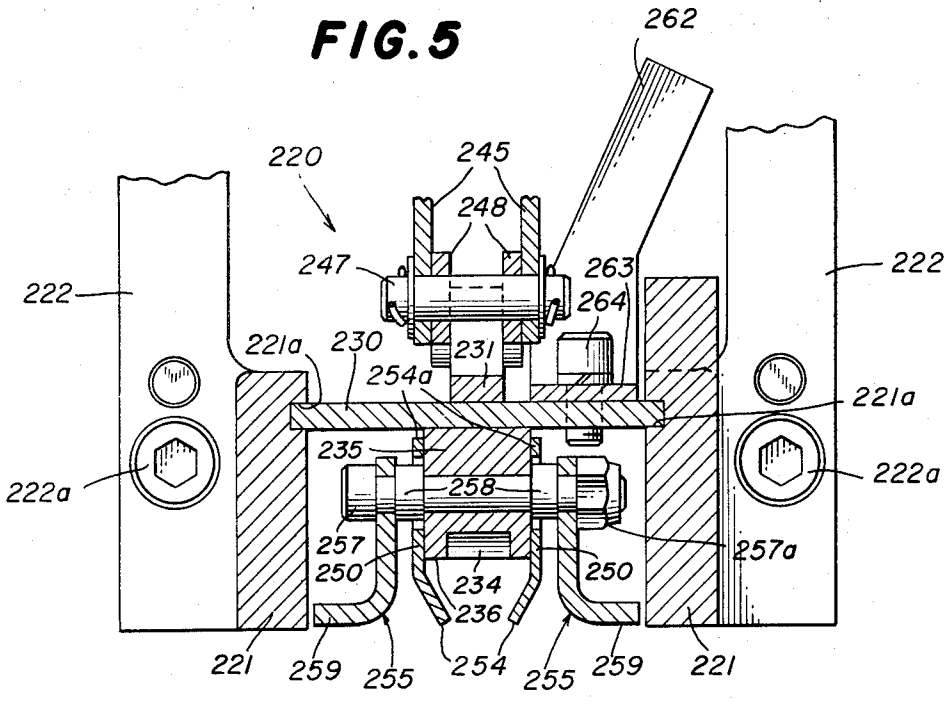

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FIG. 6

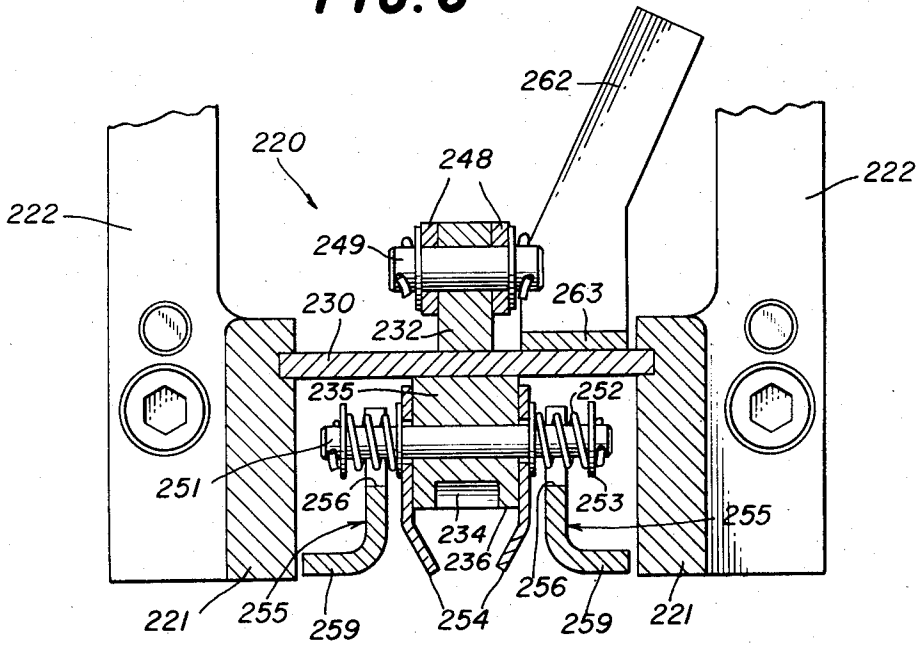

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FIG. 4

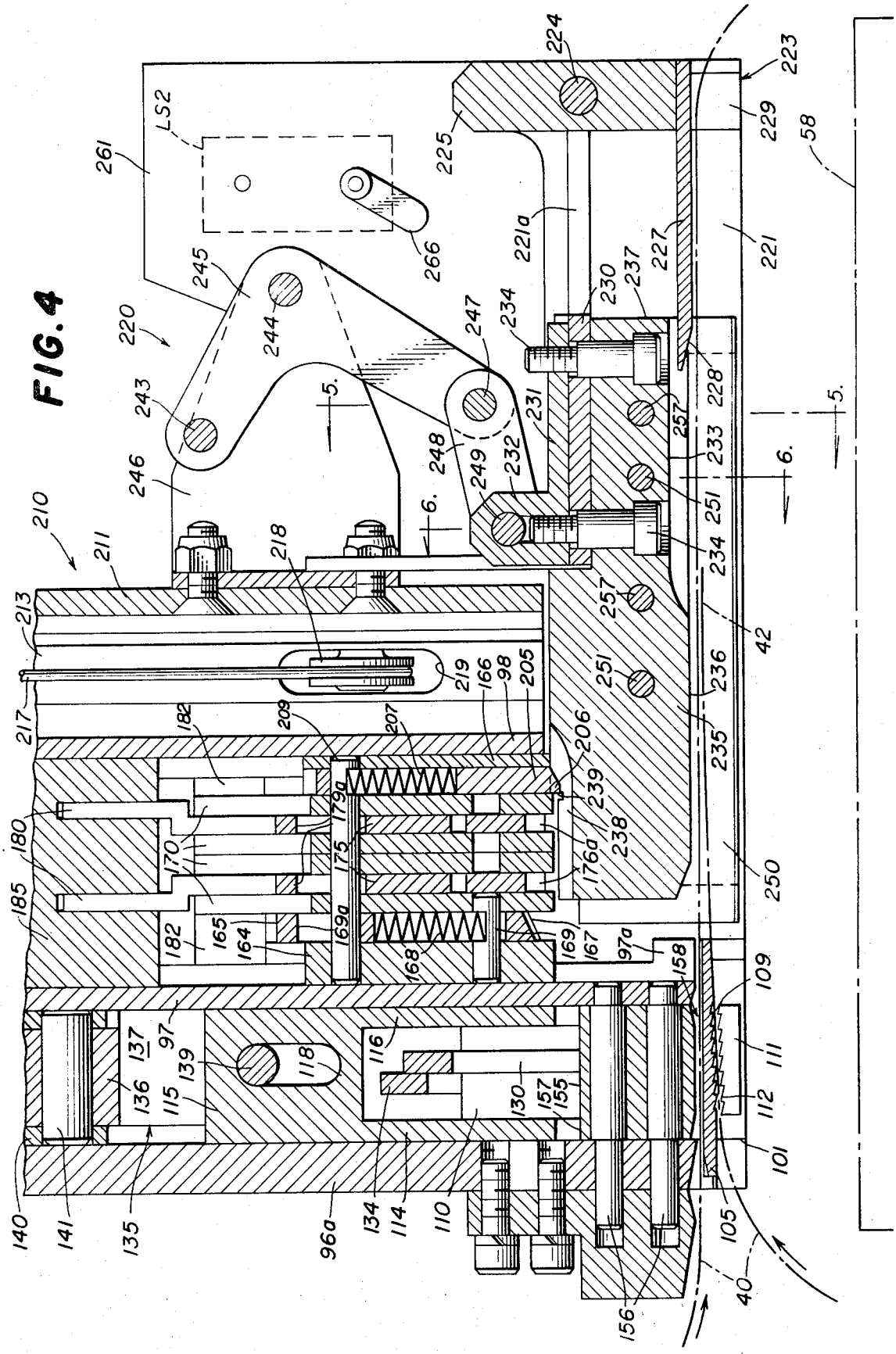
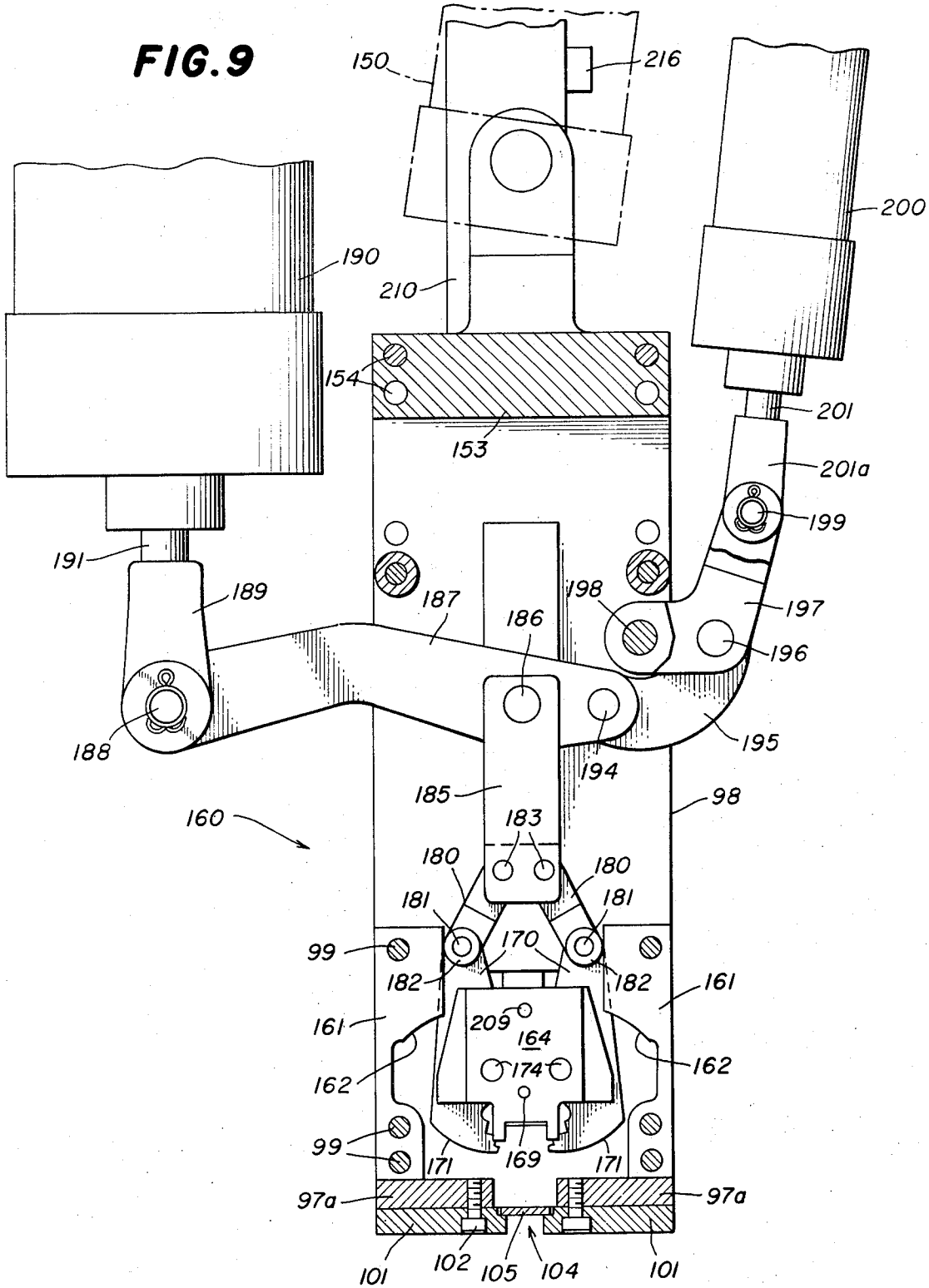

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FIG. 9


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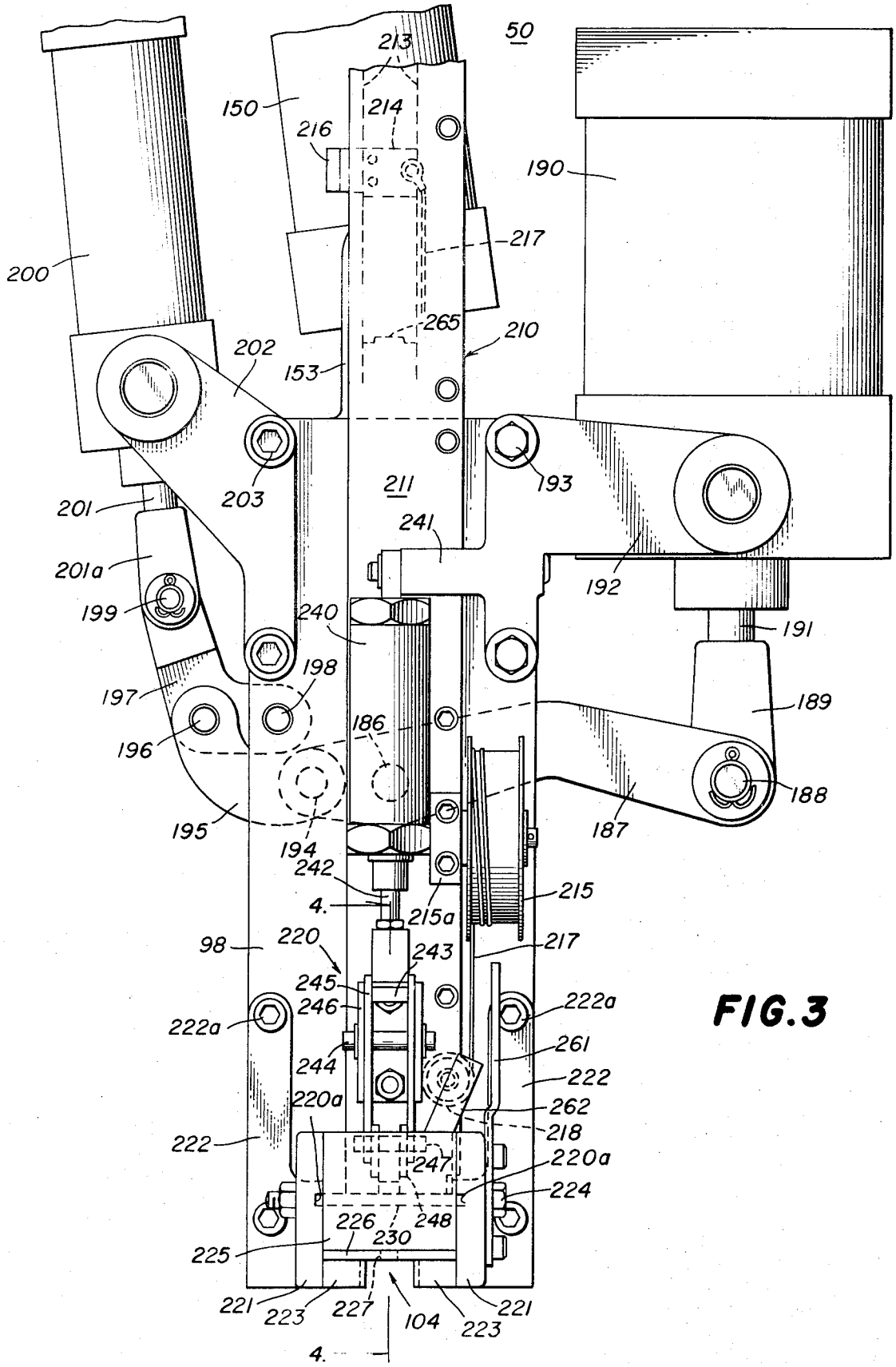
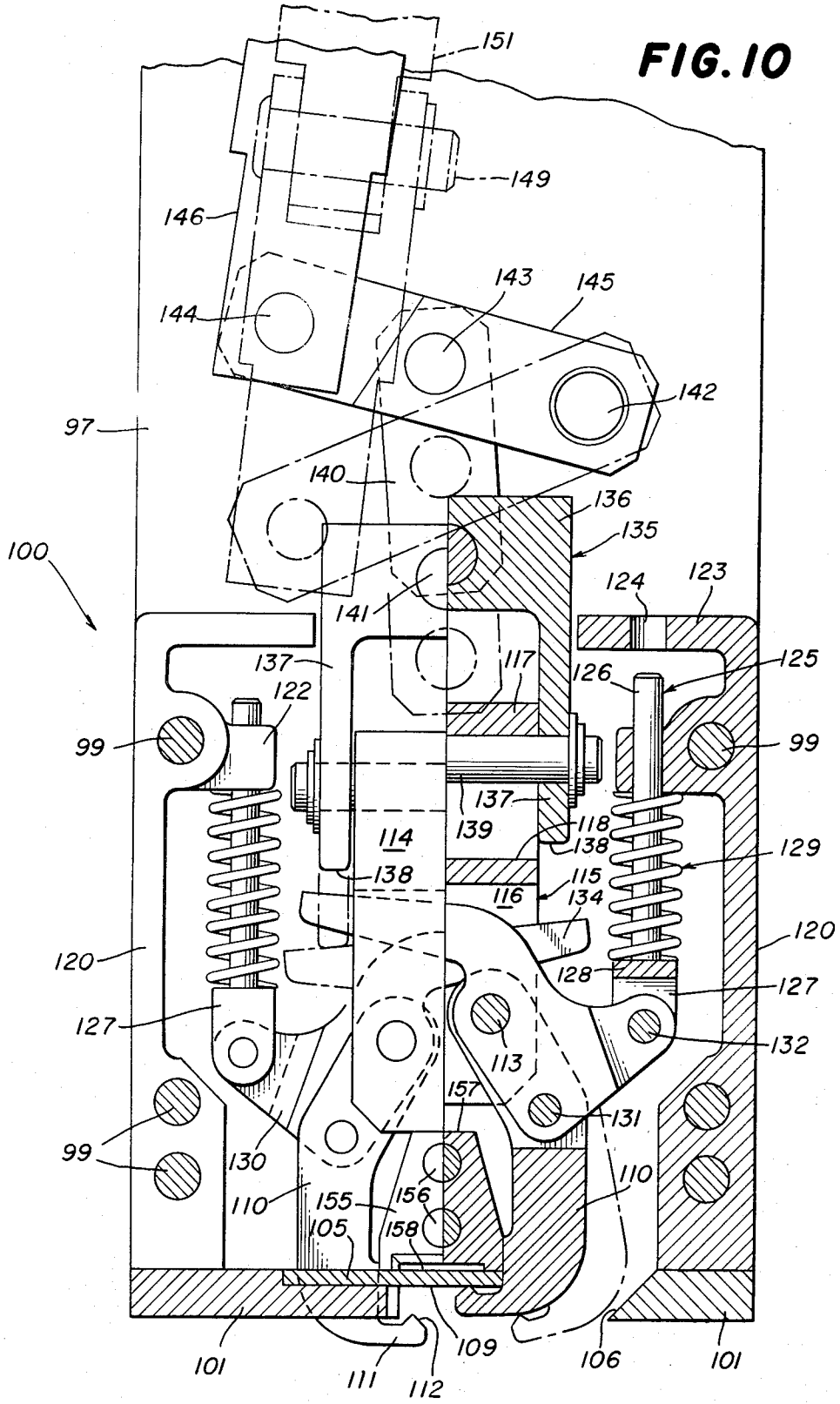

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FIG.3

FIG. 10


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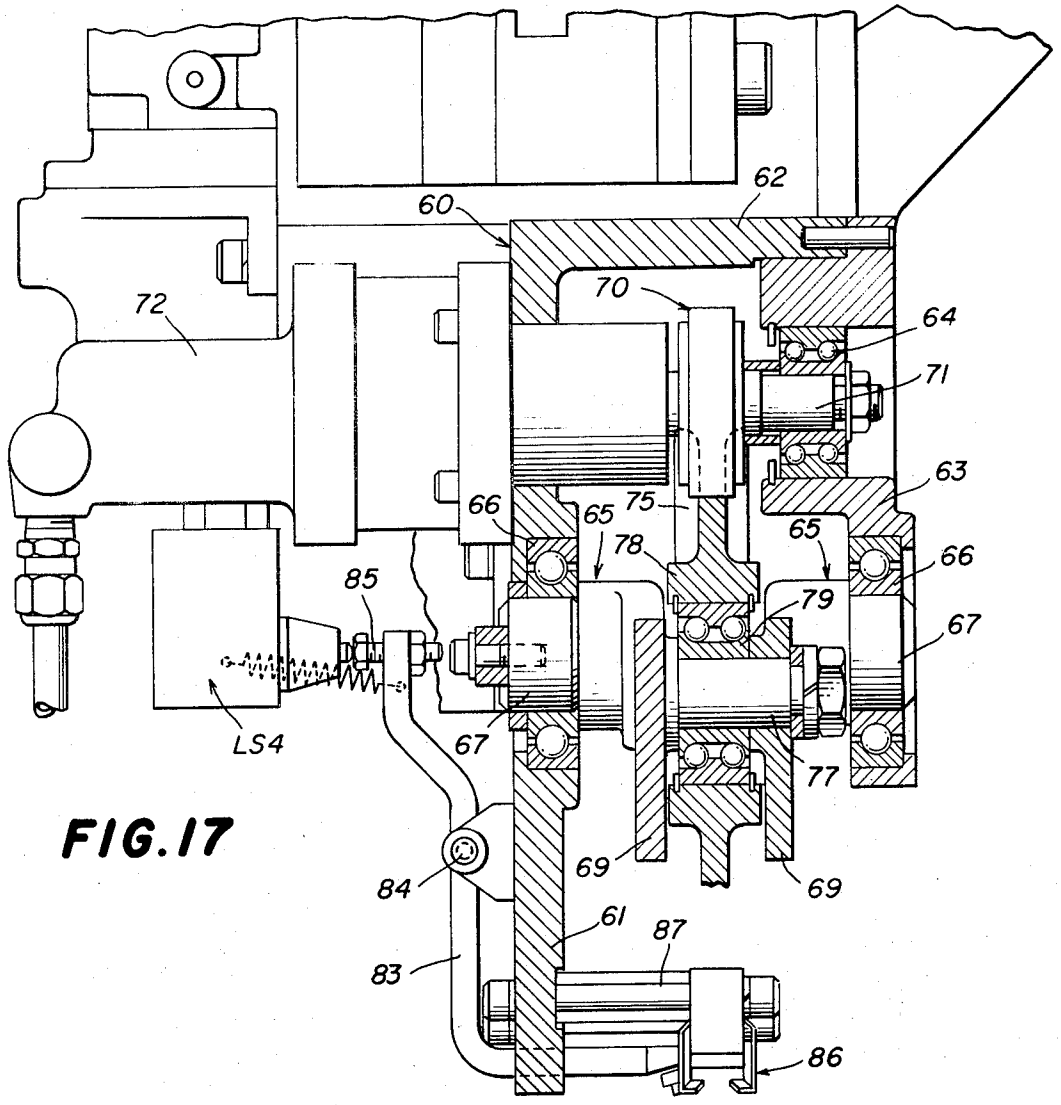

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FIG. 17

FIG. 18

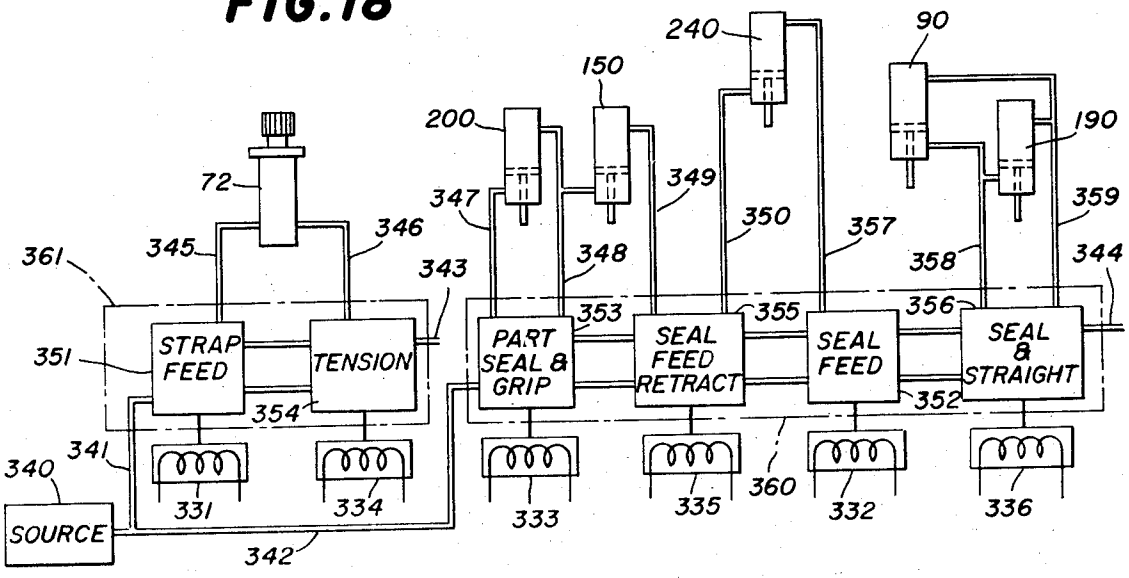

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STRAP FEED
TENSION
PART SEAL & GRIP
SEAL FEED RETRACT
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FIG. 12

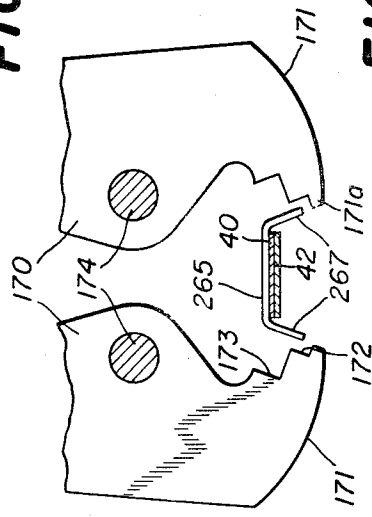


FIG. 13

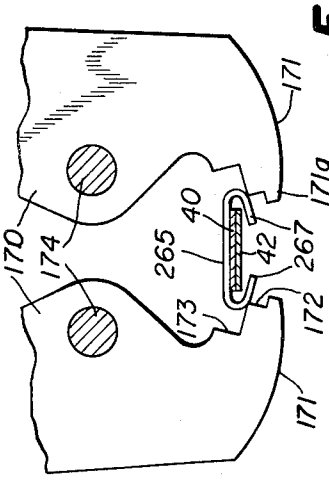


FIG. 14

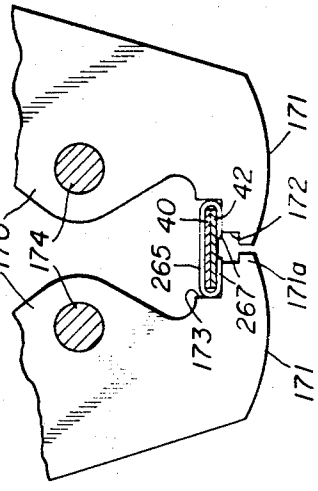


FIG. 11

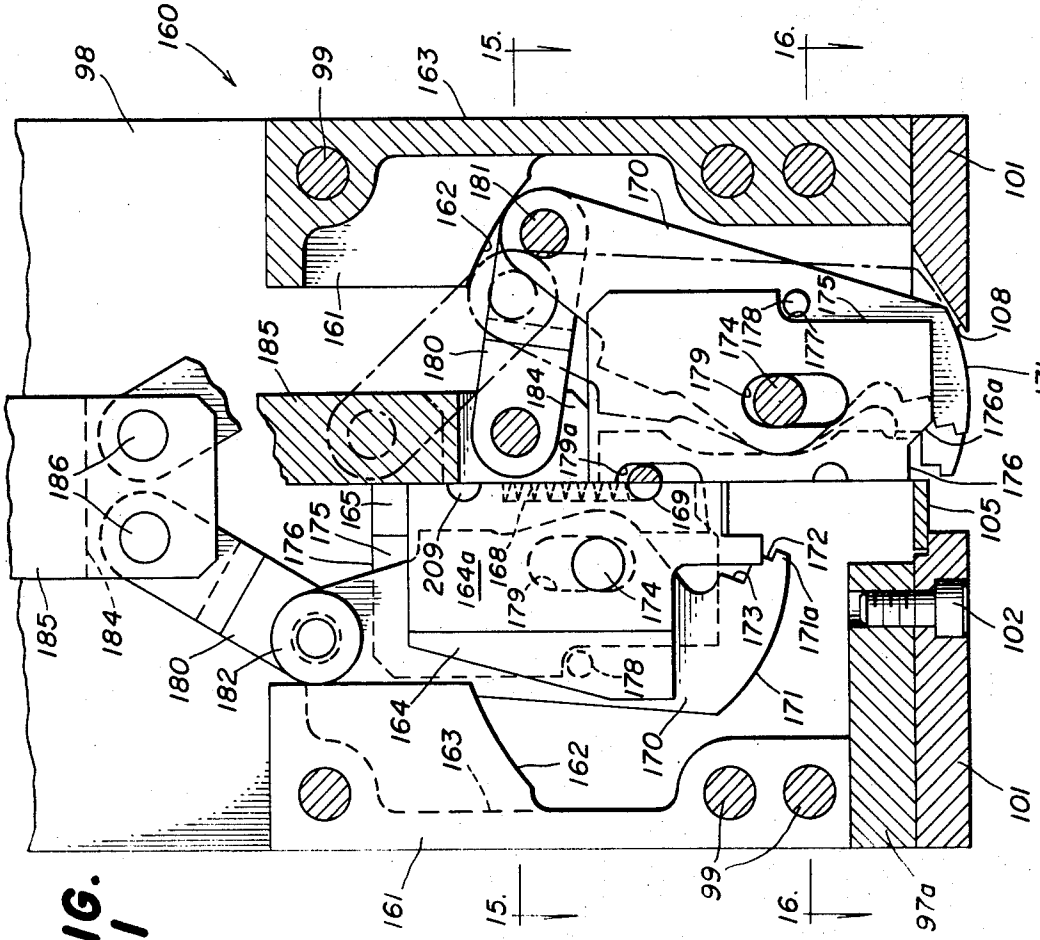


FIG. 15

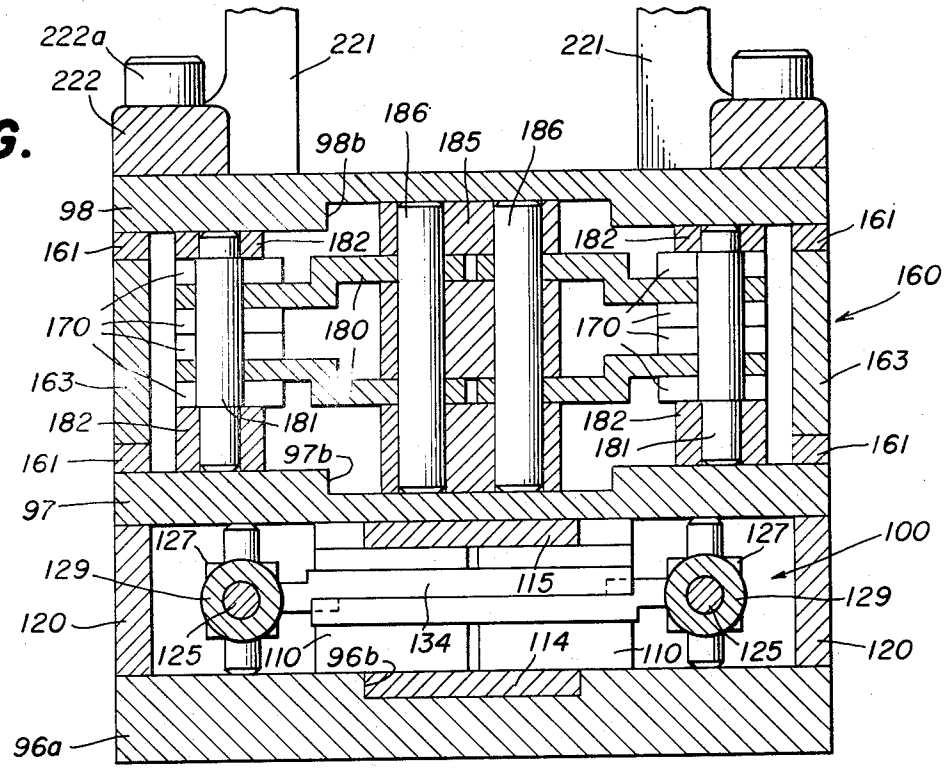

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FIG. 16

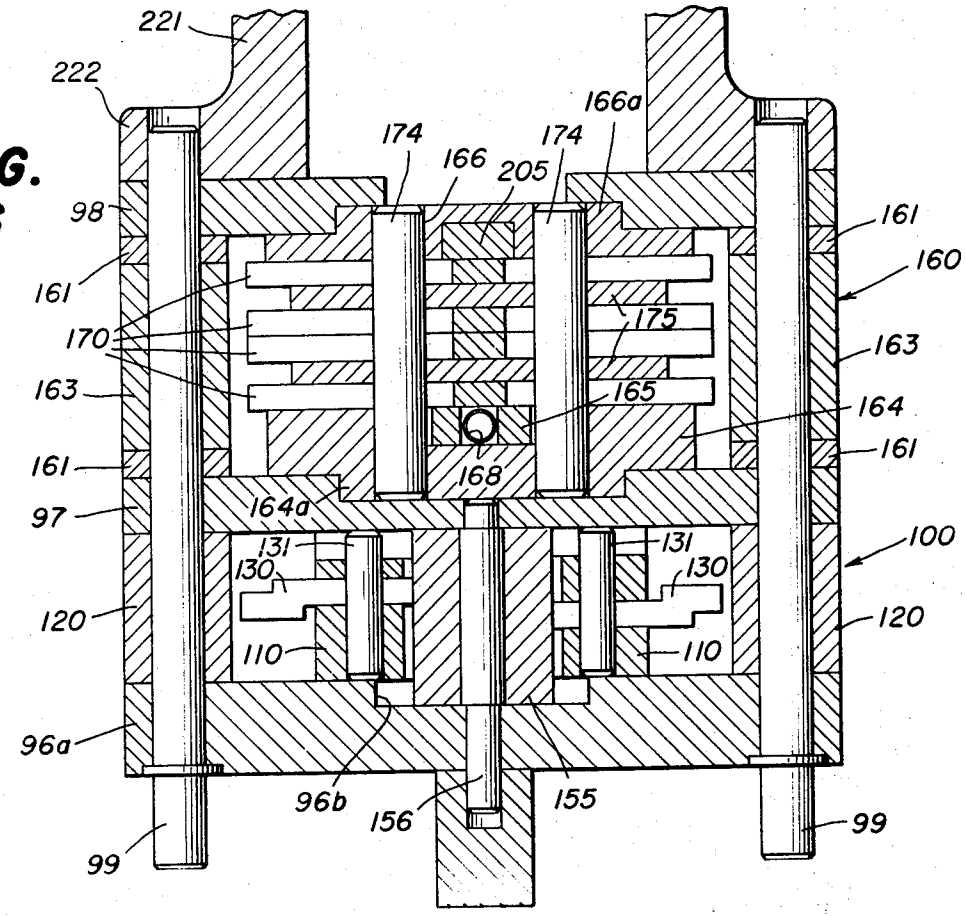
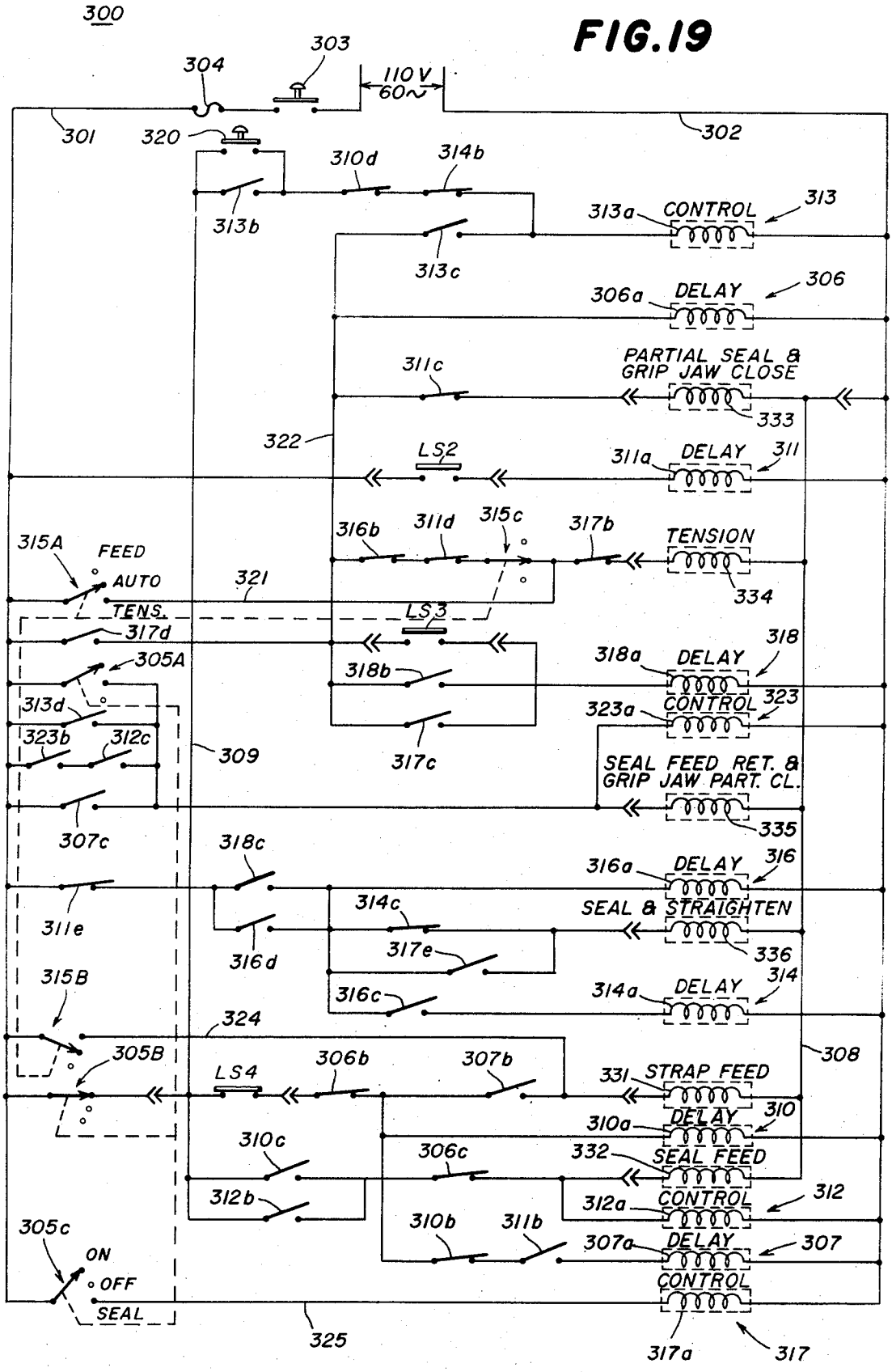

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FIG. 19


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PARTIAL SEAL &
GRIP JAW CLOSE
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DELAY
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316b
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315c
317b
TENSION
315A
FEED
AUTO
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334
TENS.
LS3
317d
318
305A
318a
DELAY
318b
313d
323a
CONTROL
323
323b
312c
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317c
SEAL FEED RET. &
GRIP JAW PART. CL.
335
307c
318c
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DELAY
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311e
314c
SEAL & STRAIGHTEN
316d
317e
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DELAY
314
324
308
305B
LS4
306b
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STRAP FEED
310a
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SEAL FEED
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CONTROL
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311b
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DELAY
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ON
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CONTROL
SEAL
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STRAPPING MACHINE

This invention relates to strapping machines for applying flexible straps about packages or other objects to be bound. More particularly, this invention relates to improvements in strapping machines of the general type disclosed in U. S. Pat. No. 3,139,813 issued July 7, 1964, to Marchand B. Hall et al., the disclosure of which patent is incorporated herein by reference.

It is an important object of this invention to provide a strapping machine for applying a length of strap around an object, the strapping machine comprising first and second gripping members having gripping surfaces thereon and being movable between a feeding condition and a gripping condition, the gripping members in the feeding condition thereof being spaced apart for accommodating the free passage of the leading end of the strap therebetween for forming a loop around the object with the leading end of the strap overlapping the supply portion thereof, the gripping members in the gripping condition thereof cooperating for securely clamping the leading end of the strap therebetween with the gripping surfaces respectively in engagement with the opposite sides of the leading end of the strap, drive mechanism coupled to the gripping members for effecting movement thereof between the feeding condition and the gripping condition thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, and joint forming means for forming a joint between the overlapped portions of the tensioned strap to secure the strap about the object, the drive mechanism effecting movement of the gripping members in a direction substantially normal to the plane of the adjacent portion of the strap just prior to contact therewith to prevent scoring thereof by the gripping surfaces, whereby the gripping members securely hold the leading end of the strap without scoring and resultant weakening thereof.

It is a further object of this invention to provide a strapping machine of a type set forth, wherein a first one of the gripping members is stationary and a second one of the gripping members is movable with respect to the first gripping member and is provided with gripping teeth thereon, the second gripping member being movable among the feeding condition and the gripping condition and a releasing condition disposed intermediate the feeding condition and the gripping condition, the drive mechanism effecting initial movement of the second gripping member away from the gripping condition thereof in a second direction opposite to the first direction.

It is another object of this invention to provide a strapping machine of the type set forth, wherein the second gripping member is movable to first and second releasing conditions, the second gripping member in the first releasing condition thereof being disposed intermediate the feeding condition and the gripping condition and abutting against the strapped object, the second gripping member in the second releasing condition thereof abutting the strapped object laterally of the strap and out of engagement therewith for accommodating release of the sealed strap from the gripping members, the drive mechanism effecting pivotal movement of the second gripping member from the first releasing condition to the second releasing condition thereof along the strapped object.

Another object of this invention is to provide a strapping machine of the type set forth, wherein the drive mechanism includes bias means urging the second gripping member toward the feeding condition thereof, and a drive assembly coupled to the second gripping member and operable to first and second actuated conditions and cooperating with the bias means for effecting movement of the second gripping member among the feeding and gripping and first and second releasing conditions thereof.

Yet another object of this invention is to provide a strapping machine for applying a length of strap around an object, the strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portions of the strap for holding a seal therein and a withdrawn position out of the sealing region, sealing jaws movable between a sealing position in the sealing region for deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of the sealing region, and drive mechanism coupled to the seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, the drive mechanism being coupled to the sealing jaws for effecting movement thereof between the sealing position and the retracted position thereof, the drive mechanism alternately placing the seal feed member and the sealing jaws in the sealing region without interference one with the other, whereby the seal feed member and the sealing jaws cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

In connection with the foregoing object, it is another object of this invention to provide a strapping machine of the type set forth wherein the sealing jaws have camming surfaces thereon and are spaced apart a distance greater than the width of the seal, and further including cam members respectively disposed for camming engagement with the camming surfaces of the sealing jaws and cooperating therewith and with the drive mechanism for effecting movement of the sealing jaws in a direction substantially normal to the plane of the adjacent portion of the strap during the first portion of the movement of the sealing jaws from the retracted position to the sealing position thereof and for effecting pivotal movement of the sealing jaws into engagement with the seal during the last portion of the movement of the sealing jaws from the retracted position to the sealing position thereof.

It is another object of this invention to provide a strapping machine of the type set forth, which includes first drive mechanism coupled to the seal feed member for effecting movement thereof, second drive mechanism coupled to the sealing jaws for effecting movement thereof, and control apparatus coupled to the first and second drive mechanisms for controlling the operation thereof.

It is another object of this invention to provide a strapping machine of this type set forth, wherein the

sealing jaws are movable in the sealing region between a partial sealing position and a full sealing position, the second drive mechanism effecting movement of the sealing jaws between the retracted position and the partial sealing position thereof, and further including a third drive mechanism coupled to the sealing jaws and to the control apparatus for effecting movement thereof between the partial sealing position and the full sealing position thereof, the control apparatus effecting movement of the sealing jaws into the partial sealing position thereof prior to operation of the tensioning means and effecting movement of the sealing jaws into the full sealing position thereof after operation of the tensioning means.

It is another object of this invention to provide a strapping machine of the type set forth, which further includes a die member movable between a sealing position in the sealing region for crimping the side edges of the seal and the strap for facilitating the formation of the seal joint therebetween and a retracted position out of the sealing region, the drive mechanism being coupled to the die member for effecting simultaneous movement of the sealing jaws and the die member.

It is still another object of this invention to provide a strapping machine for applying a length of strap around an object, the strapping machine comprising means for feeding the strap in a loop around the object with the leading end of the strap overlapping the supply portion thereof, gripping means for securely gripping the leading end of the strap, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, and joint forming means for forming a joint between the overlapped portions of the tensioned strap to secure the strap about the object, strap straightening means disposed adjacent to the feeding means and movable between a straightening configuration and a retracted configuration, the straightening means in the straightening configuration thereof engaging the supply portion of the strap for effecting the straightening thereof, the straightening means in the retracted configuration thereof being disposed out of engagement with the strap for accommodating free movement thereof, and drive means coupled to the straightening means for effecting movement thereof to the straightening configuration thereof during the operation of the feeding means and effecting movement thereof to the retracted configuration thereof during operation of the tensioning means, whereby the straightening means serves to straighten the strap without impeding the tensioning thereof.

Further features of the invention pertain to the particular arrangement of the parts of the strapping machine whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view on a reduced scale of a bundle of objects after having had straps applied thereto by the strapping machine according to the present invention;

FIG. 2 is a front elevational view of a strapping machine constructed in accordance with and embodying the features of the present invention, indicating the orientation of the strapping machine with respect to an object to be strapped;

FIG. 3 is an enlarged fragmentary side elevational view of the strapping machine illustrated in FIG. 2, as viewed from the right-hand side thereof;

FIG. 4 is a further enlarged view in vertical section taken along the line 4—4 in FIG. 3, and illustrating the seal feed bar in its feeding position;

FIG. 5 is a view in vertical section taken along line 5—5 in FIG. 4, and illustrating the strap guide assembly;

FIG. 6 is a view in vertical section taken along line 6—6 in FIG. 4, and illustrating further details of the strap guide assembly;

FIG. 7 is a reduced bottom plan view of the strapping machine illustrated in FIG. 2;

FIG. 8 is an enlarged view in vertical section taken along the line 8—8 in FIG. 2, and illustrating the holding jaw drive assembly of the present invention;

FIG. 9 is an enlarged view in vertical section taken along the line 9—9 in FIG. 2, and illustrating the sealing jaw drive assembly of the present invention;

FIG 10 is a further enlarged fragmentary view in partial section of the holding jaws and drive assembly therefor illustrated in FIG. 8, with portions of the holding jaw assembly broken away to illustrate the internal details thereof, and further illustrating the various positions of the holding jaw assembly;

FIG. 11 is a further enlarged fragmentary view of the sealing jaws and drive assembly therefor illustrated in FIG. 9, with portions of the sealing jaw assembly broken away to illustrate the internal details thereof, and further showing the various positions of the sealing jaw assembly;

FIG. 12 is a diagrammatic view of the sealing jaws in the retracted and open position thereof, illustrating their orientation with respect to the seal;

FIG. 13 is a diagrammatic view similar to FIG. 12, and illustrating the sealing jaws in the partial sealing position thereof;

FIG. 14 is a diagrammatic view similar to FIGS. 12 and 13, and illustrating the sealing jaws in the full-sealing position thereof;

FIG. 15 is a fragmentary view in horizontal section taken along the line 15—15 in FIG. 11, and illustrating the holding jaws and the sealing jaws in the fully closed positions thereof;

FIG. 16 is a fragmentary view in a horizontal section taken along the line 16—16 in FIG. 11, and illustrating the holding jaws and sealing jaws in the fully closed positions thereof;

FIG. 17 is a fragmentary side elevational view in partial section of the strapping machine of the present invention, as viewed from the left-hand side of FIG. 2;

FIG. 18 is a schematic circuit diagram of the pneumatic control circuit for the strapping machine of the present invention; and

FIG. 19 is a schematic circuit diagram of the electric control circuit for the strapping machine of the present invention.

Referring now to the drawings and, in particular, to FIGS. 1 to 3 thereof, there is illustrated a strapping

machine, generally designated by the numeral **50**, constructed in accordance with and embodying the features of the present invention. The strapping machine **50** includes a strapping head **55** to be utilized for tensioning and sealing a length of flexible strap **40** about an object **48**. The strapping machine **50** is useful for applying straps about any of numerous types of objects or groups of objects. FIG. **1** illustrates a package **48** of objects **49** which may typically be boards, bricks, etc. which have been securely strapped together by the strapping machine **50** of this invention. In use, the object **48** is placed into a strapping location **46** adjacent to the strapping head **55**, which strapping location will normally be surrounded by a strap guide track (not shown) for guiding the strap web **40** about the object **48**. Suitable conveyor apparatus may also by provided for delivering the object **48** to and from the strapping location **46**, all as is more fully disclosed in the aforementioned U. S. Pat. No. 3,139,813. While, in the preferred embodiment, the strapping head **55** has been shown overlying the strapping location **46**, it will be appreciated that other orientations of the strapping head **55** with respect to the strapping location **46** may be utilized.

The strapping machine **50** is suitably supported upon a support frame **42** and includes a main support plate **44** on which are mounted the strapping head **55** and a strap drive assembly housing **60**. The housing **60** includes an inner plate **61** having a part-cylindrical hood flange extending outwardly therefrom along the upper end thereof. Secured to the hood flange **62** and extending downwardly and rearwardly therefrom substantially parallel to the inner plate **61** is an oblong outer plate **63**. Mounted in horizontally aligned pairs of openings in the inner and outer plates **61** and **63** are a pair of upper ball bearings **64** and a pair of lower ball bearings **66**. Rotatably mounted in the lower ball bearings **66** are two stub shafts **67** of a pair of eccentric shaft support arms **65**, which are disposed substantially parallel to each other and spaced apart a predetermined distance.

A relatively small diameter rotary feed wheel **70** is mounted within the housing **60** for rotation about a shaft **71** journaled in the upper ball bearings **64**, the rotary feed wheel **70** being provided with a serrated or toothed annular outer surface **74** extending circumferentially therearound. The shaft **71** is rotatably driven by a reversible air motor **72** secured to the inner plate **61** of the housing **60** by suitable fastening means. A relatively large diameter idler wheel **75** is also disposed in the housing **60** and is provided with a hub **78** rotatably mounted by means of ball bearing **79** on a shaft **77** supported between the support arms **65** rearwardly of the stub shafts **67** and substantially parallel to the axis thereof. The idler wheel **75** is provided with a serrated or toothed annular outer surface **76** thereon disposed for tangential engagement with the serrated surface **74** on the feed wheel **70** for frictionally feeding the strap web **40** therebetween.

Coupled to the shaft **77** and extending radially downwardly and rearwardly therefrom is an actuator arm **80** carrying an actuator member **81** at the outer end thereof for engagement with the switch lever **82** of a limit switch LS3 mounted on the support plate **54**, the actuating member **81** serving to move the switch lever **82** between the open and closed switch positions thereof in response to rotational movement of the actuating arm **80** about the shaft **77**. Extending outwardly from the inner housing plate **61** adjacent to the lower end thereof is a spacer **87** supporting at the outer end thereof a pair of elongated spaced-apart strap guide members **86**, which terminate at a rearward end adjacent to the strapping head **55**, and which are preferably resiliently urged to the guiding configuration illustrated in FIG. **17**. Extending along the periphery of the idler wheel **75** from the feed wheel **70** to the guide members **86** is an arcuate strap guide **89** mounted on the main support plate **44** by suitable means. The arcuate guide member **89** cooperates with the serrated surface **76** of the idler wheel **75** and with the guide members **86** for guiding the leading end of the strap web **40** along a path from a supply thereof, between the guide members **86**, and to the strapping head **55**. More particularly, the strap web **40** is normally fed from a coil supply thereof with the leading end **42** of the strap web **40** being threaded between the serrated surfaces **74** and **76** of the feed wheel **70** and idler wheel **75**, respectively. The serrated surfaces **74** and **76** cooperate to frictionally grip the strap web **40** therebetween and feed the strap web **40** in a counterclockwise direction, as viewed in FIG. **2**, about the idler wheel **75** in response to a clockwise rotation of the drive wheel **70** by the air motor **72**, all in a well known manner. The leading end **42** of the strap web **40** is then guided along the guide members **89** and **86** to the strapping head **55**.

Pivotally mounted on a mounting bracket **84** secured to the inner housing plate **61**, is a generally L-shaped lever **83**, the lower end of the lever **83** extending into the strap path adjacent to the strapping head **55** for engagement by the leading end of the strap web **40** as it reenters the strapping head **55** after being looped around the object **48**. The other end of the lever **83** is coupled to the actuator arm **85** of a limit switch LS4 for movement of the switch LS4 between its open and closed conditions in response to movement of the lever **83** by the strap web **40**.

As is illustrated in FIG. **2**, the strapping head **55** comprises a straightening section **56**, a gripping and tensioning section **57**, a sealing and shearing section **58** and a seal feed section **59**, the strap web **40** being fed through each of these sections of the strapping head **55** by the feed wheel **70**, as described above. In the straightening section **56** the strap guide **86** is provided with an arcuate concave straightening surface **88**. Mounted on the mounting support plate **54** by suitable means and disposed substantially normal thereto is a side plate **96**, an air-actuated straightening piston **90** being mounted on the side plate **96** by means of an angular mounting bracket **91**. The piston **90** is provided with a piston rod carrying at the distal end thereof a clevis bracket **94** having a free-wheeling roll **95** rotatably mounted thereon. In use the circumferential surface of the roll **95** is disposed immediately opposite the straightening surface **88** on the guide member **86**, the piston rod being adapted for reciprocating movement between a retracted position, illustrated in FIG. **2**, wherein the roll **95** is spaced a predetermined distance upwardly from the straightening surface **88** out of engagement with the strap web **40**, and a straightening position wherein the roll **95** is disposed closely adjacent to the straightening surface **88** and cooperates

therewith to clamp the adjacent portion of the strap web 40 therebetween. The free-wheeling mounting of the roll 95 permits movement of the strap web 40 between the roll 95 and the straightening surface 88 when the roll 95 is in its straightening position and operates to effect a straightening of the strap web 40 after tensioning and sealing of the strap web 40 about the object 48, as will be described below.

Also carried by the main support plates 44 are a plurality of side plates 96*a*, 97 and 98, all disposed substantially parallel to the side plate 96 and cooperating therewith to support the various components of the strapping head 55 thereon. The side plates 97 and 98 are respectively provided with lips or projections 97*a* and 98*a* at the lower ends thereof extending toward each other, for purposes to be described in detail below. The side plates 96*a*, 97 and 98 are all interconnected by a pair of main connecting pins 99 extending through complementary openings therethrough and disposed substantially parallel to the main support plate 44.

Referring now also to FIGS. 4, 7, 8, 10, 15 and 16 of the drawings, there is provided a gripping jaw assembly, generally designated by the numeral 100, and disposed in the gripping and tensioning section 57 of the strapping head 55. Spanning the side plates 96*a*, 97 and 98 and secured thereto along the bottom edges thereof, by suitable fasteners 102 are a pair of base plates 101 which are constructed as mirror images of each other and are spaced apart laterally of the strapping head 55 to define a central passage 104 therebetween. Each of the base plates 101 is provided with a holding jaw slot 103 adjacent to the forward end thereof and a sealing jaw slot 107 at the rear end thereof, the outer side walls of the slots 103 and 107 being respectively beveled as at 106 and 108. Secured to the base plates 101 immediately thereabove and spanning the central passage 104 therebetween is a flat backing plate 105 having a toothed bottom gripping surface 109 disposed adjacent to the holding jaw slots 103. Mounted between the side plates 96*a* and 97 are a pair of gripping or holding jaws 110, respectively pivotally coupled adjacent to the upper ends thereof to a pair of pivot pins 113 extending between the side plates 96*a* and 97 and substantially normal thereto. The gripping jaws 110 are spaced apart laterally of the strapping head 55 by a predetermined distance and are each provided at the lower end thereof with an inwardly extending projection 111 having an upwardly extending set of teeth 112 thereon. In use, the gripping jaws 110 are respectively disposed on opposite sides of the backing plate 105 with the projections 111 extending therebeneath and inwardly toward each other so that the teeth 112 are disposed in generally facing relationship with the tooth gripping surface 109 on the backing plate 105, as is best illustrated in FIGS. 4, 8 and 10. Each of the pivot pins 113 is secured at the opposite ends thereof, respectively, to the front leg 114 and the rear leg 116 of a generally U-shaped drive member or crosshead 115, the legs 114 and 116 being interconnected at the upper ends thereof by a bight portion 117 having a vertically elongated slot 118 extending laterally therethrough. Thus, it will be seen, that vertical movement of the crosshead 115 will effect a corresponding vertical movement of the gripping jaws 110 as will be described in greater detail hereinafter.

Extending between the side plates 96*a* and 97 along the opposite side edges thereof, and cooperating therewith to substantially enclose the gripping and tensioning sections 57, are a pair of spacers 120, secured in position by the connecting pins 99 which extend through complementary openings therein. The lower end of each of the spacers 120 abuts against the upper surface of the associated base plate 101, each of the spacers 120 being provided at the upper end thereof with two laterally inwardly extending and vertically spaced-apart flanges 122 and 123. The flanges 122 and 123 are each provided with vertically aligned cylindrical openings 124 extending therethrough for accommodating an associated cylindrical connecting pin 125 therein. Each of the connecting pins 125 is provided at the lower end thereof with a clevis bracket 127 having downwardly extending legs and a substantially horizontal extending bight portion 128. Compression springs 129 are respectively disposed in surrounding relationship with the connecting pins 125, each of the springs 129 being retained between the adjacent flange 122 and the bight 128 of the adjacent clevis bracket 129 for resiliently urging the associated connecting pin 125 downwardly, as viewed in FIG. 10. Respectively secured to the gripping jaws 110 by means of the associated pivot pins 113 and by coupling pins 131 spaced from the pins 113 and disposed substantially parallel thereto, are two levers 130, which are in turn respectively connected by means of coupling pins 132 to the clevis brackets 127. Each lever 130 is further provided with a lever arm 134 disposed laterally between the front and rear legs 114 and 116 of the crosshead 115 and extending beyond the opposite side edge thereof.

Disposed immediately above the crosshead 115 is a clevis block 135 having a bight portion 136 at the upper end thereof interconnecting a pair of downwardly extending legs 137, respectively disposed adjacent to the opposite ends of the crosshead slot 118 and receiving the crosshead bight 117 therebetween. Each of the legs 137 has a bearing surface 138 at the lower end thereof, the legs 137 also being provided with laterally aligned openings therein for accommodating a drive pin 139 therethrough, the drive pin 139 extending through the slot 118 in the cross head 115. Coupled to the bight portion 136 of the clevis block 135 by means of a coupling pin 141 extending substantially horizontally from front to rear therethrough, is a drive link 140, and drive link 140 extending upwardly from the clevis block 135 and coupled adjacent to the upper end thereof by means of a coupling pin 143 to a lever arm 145, approximately midway between the ends thereof. The lever arm 145 is mounted adjacent to one end thereof for pivotal movement about a pivot pin 142 disposed substantially parallel to the coupling pins 141 and 143 and secured in place between the side plates 96*a* and 97. The lever arm 145 is coupled adjacent to the other end thereof by means of a coupling pin 144 to the lower clevis end 147 of a coupling member 146, the member 146 having an upper clevis end 148 coupled by means of a pin 149 to the lower end of a piston rod 151 of an air-actuated piston 150. The piston 150 is mounted on a mounting bracket 153 secured in place between the side plates 97 and 98 by means of suitable fasteners 154.

Disposed immediately above the backing plate **105** and between the gripping jaws **110** is a bridge member **155** secured in place between the side plates **96***a* and **97** by means of mounting pins **156**. The upper end of the bridge member **155** is provided with a flat bearing surface **157** for a purpose to be described below, and the lower end of the bridge member **155** is provided with a generally rectangular recess **158** having dimensions slightly greater than the cross-sectional dimensions of the strap web **40** and defining a slot between the bridge member **155** and the backing plate **105** to accommodate passage of the strap web **40** therethrough.

When the piston **150** is deactuated, the gripping jaw assembly **100** will assume a home or strap-feeding configuration illustrated in the left-hand side of FIG. **10**. In this feeding position, the gripping jaws **110** are pivoted toward each other with the projections **111** spaced apart a distance less than the width of the strap web **40**, and with the gripping teeth **112** spaced a predetermined distance below the gripping surface **109** of the backing plate **105** to accommodate ready passage of the leading end **42** of the strap web **40** along the gripping surface **109**. The gripping jaws **110** are held in this position by the action of the compression springs **129** bearing against the clevis brackets **127** and pivotally urging the levers **130** and the gripping jaws **110** downwardly and toward each other. The piston rod **151**, the coupler **147**, the lever arm **145** and the link **140** are all disposed downwardly in their lowermost positions, as indicated in broken lines in FIG. **10**, with the bottom end of the crosshead **115** abutting against the bearing surface **157** on the bridge member **155**. It will be noted that, in this position, the bearing surfaces **138** on the legs **137** of the clevis block **135** are disposed immediately above the lever arms **134**, but out of contact therewith.

In use, when air is introduced into the bottom end of the piston **150**, the piston rod **151** is moved upwardly, thereby moving the coupler **147**, the lever arm **145** and the link **140** to the positions illustrated in solid line in FIG. **10**. This upward movement of the drive linkage pulls the crosshead **135** upwardly so that the drive pin **139** engages the crosshead **115** along the upper edge of the slot **118**, thereby pulling the crosshead **115**, the levers **130** and the gripping jaws **110** vertically upwardly against the urging of the bias springs **129** to a gripping configuration illustrated in solid lines at the right-hand side of FIG. **10**. In this gripping configuration, the teeth **112** of the gripping jaws **110** are disposed in firm engagement with the gripping surface **109** on the backing wall **105**; or, if the leading end **42** of the strap web **40** is disposed along the gripping surface **109**, the teeth **112** will securely clamp and hold the leading end **42** of the strap **40** thereagainst. This movement of the gripping jaws **110** to the gripping configuration causes a corresponding upward movement of the connecting pins **125** which is accommodated by the openings **124** in the spacer flanges **123**. It will be noted that the movement of the gripping jaws **110** to this gripping configuration is such that the teeth **112** move into engagement with the adjacent portion of the strap web **40** in a direction substantially normal to the plane thereof, thereby avoiding any scraping of the teeth **112** laterally along the strap web **40** which could score and weaken the resulting strap loop.

When the air is removed from the lower end of the piston **150**, the entire gripping jaw assembly **100** will be urged vertically downwardly back toward the releasing or home position thereof by the compression springs **129**. It will be noted that this initial disengaging movement of the gripping jaws **110** away from the strap web **40** is in a direction substantially normal to the plane thereof, thereby to further minimize the possibility of scoring of the strap web **40**. However, as a result of the tensioning of the strap about the object **48**, the object **48** will be pulled up closely adjacent to or against the bottom surfaces of the gripping jaws **110**, thereby limiting downward movement thereof. Accordingly, the compression springs **129** will operate to relieve the gripping force of the teeth **112** on the adjacent portion of the strap **40**, but will be unable to move the gripping jaws **110** all the way back to their home position against the resistance of the object **48**. This is particularly true where the object **48** is a relatively inflexible material, such as bricks. When air is applied to the other end of the piston **150**, the piston rod **151** and the clevis block **135** are urged downwardly toward their home positions. However, before the drive pin **139** engages the crosshead **115** at the bottom of the slot **118**, the bearing surfaces **138** on the clevis block legs **137** will engage the lever arms **134**, thereby pivotally moving them about pivot pins **113**. This pivotal movement of the levers **130** will, through the coupling pins **131**, impart an outward pivotal movement to the gripping jaws **110**, for moving the gripping jaws **110** to an open releasing position illustrated in broken lines at the right-hand side of FIG. **10**, this spreading of the gripping jaws **110** being accommodated by the beveled surfaces **106** on the backing plates **101** and being limited by engagement of the drive pin **139** with the crosshead **115** at the bottom of the slot **118**. During this outward pivotal movement, the bottom edges of the gripping jaws **110** will slide along the adjacent surface of the package or object **48**. After the gripping jaws **110** have arrived in the open releasing position, the projections **111** thereof will be spaced apart a distance greater than the width of the strap web **40** to accommodate removal of the sealed strap loop **65** therefrom in a downward direction, as viewed in FIG. **10**. After removal of the strapped object **48**, the piston **150** will move the gripping jaws **110** downwardly until the crosshead **115** bottoms on the bearing surface **157** of the bridge member **155**, the piston **150** maintaining the gripping jaws **110** pivoted open against the urging of the springs **129**. After removal of the air from the upper end of the piston **150**, the gripping jaws **110** will immediately pivot back to their home or feeding configuration under the urging of the compression springs **129**.

Referring now also to FIGS. **6** and **11** to **14** of the drawings, there is disposed in the sealing and shearing section **58** of the strapping head **55** a sealing jaw assembly, generally designated by the numeral **160**. Disposed between the side plates **97** and **98** along the opposite side edges thereof are two identical pairs of cam plates **161**, including a pair of front cam plates abutting against the rear surface of the side plate **97** and a pair of rear cam plates abutting against the front surface of the side plate **98** (see FIGS. **15** and **16**). The cam plates **161** of each pair thereof are constructed as mirror images of each other, and are each provided with a curved camming surface **162** along the inner

edge thereof. The front ones of the cam plates **161** are respectively separated from the rear ones thereof by two spacers **160**, the spacers **160** and cam plates **161** all being held in place by the main connecting pins **99** which extend through complementary openings therein, the cam plates **161** and spacers **160** cooperating with the side plates **97** and **98** to substantially enclose the sealing and shearing section **58**. The side plate **97** is provided with a generally channel-shaped key slot **97***b* in the rear surface thereof for slidably receiving therein a key tab **164***a* of a front slide block **164**. Similarly, the side plate **98** is provided with a generally channel-shaped key slot **98***b* in the front surface thereof for slidably receiving therein a key tab **166***a* of a rear slide block **166**. Received in a recess in the rear surface of the front slide block **164** is a shear member **165** provided at the lower end thereof with a shear blade **167**. The shear member **165** has a slot centrally disposed therein extending from the front to the rear thereof for accommodating therein a coil spring **168**, the coil spring **168** engaging a substantially horizontally extending pin **169** at the lower end thereof (see FIGS. **4** and **11**), the front end of the pin **169** being received in a complementary opening in the front slide block **164**.

Four identical pairs of sealing jaws **170** are disposed in the area bounded by the spacers **160** and the slide blocks **164** and **166**. The middle two pairs of sealing jaws **170** are arranged back to back and are respectively separated from the front and rear pairs of sealing jaws **170** by two dies **175**. The sealing jaws **170** of each pair thereof are constructed as mirror images of each other, each sealing jaw **170** having an arcuate lower end **171** terminating in an inwardly directed projection **171a**, and being provided along the inner edge thereof with first and second recessed steps or shoulders **172** and **173** set back from the inner end of the projection **171***a*. Each of the dies **175** is generally rectangular in shape and is provided at the upper end thereof with a bearing surface **175***a* and is provided along the lower edge thereof with a crimping recess **176** having inclined side edges **176***a* for a purpose to be described more fully hereinafter. The opposite side edges of each of the dies **175** is provided with a recessed shoulder **177** for accommodating a return pin **178** extending from an adjacent one of the sealing jaws **170** substantially normal thereto. The sealing jaws **170** and the dies **175** are all secured together by means of a pair of pivot pins **174** extending through complementary openings therein substantially normal thereto, the opposite ends of each of the pivot pins **174** being respectively received in complementary openings in the slide blocks **164** and **166**. The two sealing jaws **170** of each pair thereof are respectively mounted for pivotal movement about the pivot pins **174**, while each of the dies **175** receives both of the pivot pins **174** through elongated openings **179** therein for accommodating vertical movement of the dies **175** with respect to the pivot pins **174**.

Each of the sealing jaws **170** is pivotally coupled by means of coupling pins **181** to a pair of links **180**, the front and rear ends of each of the coupling pins **181** extending a slight distance beyond the adjacent one of the sealing jaws **170** for rotatably mounting thereon four cam rollers **182**. Each of the cam rollers **182** is disposed with the circumferential surface thereof in rolling engagement with the camming surface **162** of the adjacent one of the cam plates **161** for guiding the movement of the sealing jaws **170** as will be described below. Each of the links **180** is connected at the other end thereof by means of coupling pins **186** to clevis slots **184** in the lower end of a crosshead **185**. The crosshead **185** is pivotally connected adjacent to the upper end thereof by means of a pivot pin **186** to a lever arm **187** adjacent to one end thereof. The other end of the lever arm **187** is pivotally coupled by means of a pin **188** to an extension member **189** carried by the piston rod **191** of an air-actuated sealing piston **190**. The sealing piston **190** is mounted on the main support plate **44** by means of a mounting bracket **192** secured to the main support plate **44** by fasteners **193**. The end of the lever arm **187** adjacent to the pivot pin **186** is coupled by means of a connecting pin **194** to one end of an arcuate toggle link **195**, the other end of the toggle link **195** being coupled by means of a pin **196** to a partial sealing lever **196**, intermediate the ends thereof. One end of the partial sealing lever **197** is mounted for pivotal movement about a pivot pin **198** extending substantially horizontally between the side plates **97** and **98**, the other end of the partial sealing lever **197** being coupled by means of a coupling pin **199** to an extension member **201***a* carried by the piston rod **102** of a partial sealing cylinder **200**. The partial sealing cylinder **200** is mounted on a mounting bracket **202** which is secured to the main support plate **44** by means of suitable fasteners **203**.

Disposed in a complementary slot in the front surface of the rear slide block **166** is a seal latch **205** provided with a beveled lip **206** at the lower end thereof for a purpose to be described below. The seal latch **205** has a centrally disposed recess formed therein for accommodating a latch spring **207**, the upper end of the latch spring **207** bearing against the rear end of a bridge pin **209** which extends substantially horizontally between the pairs of sealing jaws **170** and through complementary openings in the dies **175**, the front and rear ends of the bridge pin **209** being respectively received in complementary openings in the front and rear slide blocks **164** and **166**. It will be appreciated that by reason of the interconnection thereof by the pivot pins **174** and the bridge pin **209**, the slide blocks **164** and **166**, the dies **175**, the shear member **165** and the seal latch **205** will all move vertically in response to vertical movement of the sealing jaws **170** between the side plates **97** and **98**.

In use, the sealing jaw assembly **160** is initially disposed in a retracted configuration illustrated in FIGS. **4** and **9** and in the left-hand side of FIG. **11**. In this retracted configuration, air is being supplied to the bottom ends of the pistons **190** and **200**, holding the piston rods **191** and **201**, the levers **187** and **197** and the toggle link **195** in their uppermost positions illustrated in FIG. **9**. The lever arm **187**, through the crosshead **185** and the links **180** holds the sealing jaws **170** in the position illustrated in FIGS. **4** and **9**, with the cam rollers **182** engaging the upper vertical portions of the cam surfaces **162** for holding the lower ends of the sealing jaws **170** spaced apart a distance greater than the width of the strap web **40**. In this position, the lower ends of the sealing jaws **170** are spaced a predetermined distance vertically above the base plates **101** and cooperate therewith to define therebetween a sealing region adjacent to the overlapped portions of the strap

web 40. The dies 175 will be held out of the sealing region by means of the return pins 178 on the sealing jaws 170, while the slide blocks 164 and 166, and the seal latch 205 will be held out of the sealing region by means of the bridge pin 209, and the shear member 165 is held out of the sealing region by means of the pin 169 and compression spring 168.

When air is removed from the lower end of the piston 200 and added to the upper end thereof, the piston rod 201 will be moved downwardly, thereby pivoting the lever 197 in a counterclockwise direction about the pivot pin 198 as viewed in FIG. 9, which pivotal movement will in turn serve to move the toggle link 195 downwardly. The downward movement of the toggle link 195 will be transmitted through the pin 194 to the lever 187 and thence through the pin 186 to the crosshead 185 for effecting a downward movement thereof. It will be noted that the arrangement of the coupling pin 194 is such as to permit limited rotational movement of the toggle link 195 thereabout only in a counterclockwise direction from the uppermost position thereof illustrated in FIG. 9, whereby to transmit the initial downward movement of the toggle link 195 to the lever arm 187. The downward movement of the cross-head 195 will in turn be transmitted through the links 180 to the sealing jaws 170 to effect a vertical downward movement thereof, the direction of movement of the sealing jaws 170 being limited to a vertically downward direction by the engagement of the cam rollers 182 with the vertical upper portions of the camming surfaces 162. The downward movement of the sealing jaws 170 will continue until the cam rollers 182 engage the laterally extending portions of the camming surfaces 162, at which time the cam rollers 182 will roll laterally outwardly therealong to effect a pivotal movement of the sealing jaws 170 toward each other about the pivot pins 174, as indicated in FIG. 11. The downward movement of the piston rod 201 will continue until the sealing jaws 170 have been pivoted to a partial sealing position illustrated in solid lines in the right-hand half of FIG. 11 and in FIG. 13, this pivotal movement being accommodated by the beveled surfaces 108 on the backing plates 101. At this point, the pivotal movement of the lever 197 will have moved the toggle link 195 through a slight counterclockwise pivotal movement to a locking position locking the lever 197 against further pivotal movement with respect thereto and stalling the operation of the piston 200 to limit the movement of the sealing jaws 170.

When air is now removed from the rod end of the piston 190 and applied to the head end thereof, the piston rod 191 will be moved downwardly and will, through the coupler 189, exert a downward force on the adjacent end of the lever arm 187 for pivoting the lever arm 187 in a counterclockwise direction about the axis of the coupling pin 194. It will be noted that the locked configuration of the toggle link 195 will prevent upward movement of the coupling pin 194 and consequent driving of the piston rod 201 back up into the cylinder of the piston 200. Thus, the lever arm 187 must pivot about the pin 194 rather than about the pin 186, whereby all the movement of the lever arm 187 will be transmitted through the pin 186 to the crosshead 185. Accordingly, a further downward movement will be imparted to the crosshead 185 for continuing the downward movement of the sealing members to the full-sealing position thereof, illustrated in broken line in the right-hand side of FIG. 11 and in FIG. 14, in which position the bottom ends of the sealing jaws 170 are disposed closely adjacent to each other and are spaced apart a distance substantially less than the width of the strap web 40 for sealing engagement with an associated seal 265, as will be described more fully hereinafter. After removal of air from the upper ends of the pistons 190 and 200 and reapplication thereof to the lower ends of these pistons, the piston rods 191 and 201 will be returned to their uppermost positions illustrated in FIG. 9, thereby moving the sealing jaw assembly 160 back to its retracted configuration.

It will be observed that when the sealing jaws are initially moved from their retracted configuration to the partial-sealing configuration thereof, the slide blocks 164 and 166 will be moved downwardly with the sealing jaws 170 by means of the bridge pin 209, while the shear member 165 will be moved downwardly by the action of the pin 169. However, by reason of the elongated slots 179 and 179*a* therein, the dies 175 will not be moved by the bridge pin 209 and the pivot pins 174 until these pins have respectively reached the lower ends of the slots 179*a* and 179. This lost motion accomplishes a delayed movement of the dies 175 in response to the downward movement of the sealing jaws 170, to allow for movement of the sealing jaws 170 into their full-sealing position before the operation of the crimping dies 175. When the sealing jaws 170 have been pivoted to their fully closed or full sealing configuration, further pivotal movement thereof will be limited by the length of the links 180. However, when the sealing jaws 170 have reached this full-sealing configuration, the bottom end of the crosshead 185 will have bottomed against the bearing surface 176 on the die member 175 and against the upper end of the shear member 165. The components of the sealing body assembly 160 are so dimensioned and arranged that the last portion of the downward movement of the crosshead 185, after movement of the sealing jaws 170 to their full-sealing positions, will be imparted solely to the dies 175 and the shear member 165. Thus, immediately after the sealing jaws have been moved to their full-sealing configuration for forming the seal joint about the overlapped portions of the strap web 40, the crimping surfaces 176*a* of the dies 175 will be moved into engagement with the sealed joint for crimping the opposite side edges thereof and the shear plate 167 will be moved through the supply portion of the strap web 40 immediately in front of the sealed joint for severing the sealed strap loop 51 from the supply portion of the strap web 40. It will be noted that the shearing movement of the shear member 165 will be against the urging of the bias spring 168, whereby upon retraction of the crosshead 185, the shear member 165 will immediately spring back to its retracted position with respect to the slide block 164 of the adjacent sealing jaw 170 as illustrated in FIG. 4. Upon retraction of the sealing jaws 170, the return pins 178 thereon will engage the shoulders 177 of the dies 175 for pulling the dies 175 back to the retracted positions thereof.

Mounted immediately rearwardly of the side plate 98 is a seal magazine, generally designated by the numeral

210, which includes a back plate 211, a front plate 121 and a pair of opposed side plates 213, all cooperating to define a hollow tube having a substantially rectangular transverse cross section with an open upper loading end and an open lower discharge end. Disposed within the seal magazine 210 is a seal follower 214 provided with a generally L-shaped lift bracket 216 extending outwardly therefrom beyond one of the side plates 213 through an elongated slot therein running substantially the length thereof. Connected to the seal follower 214 is one end of a tension cable 217, the other end of the cable 217 extending downwardly along the seal magazine 210 and around a pulley 218 disposed at the rear end thereof in an opening 219 in one of the side plates 213, and thence upwardly to a reel 215 rotatably mounted on a mounting block 215*a* suitably secured to the main support plate 244. The cable reel 215 is suitably biased to maintain the cable 217 under tension to urge the seal follower 214 downwardly against the upper end of a stack of seals 265 stored in the seal magazine 210. The seals 265 are preferably of the type disclosed in the aforementioned U. S. Pat. No. 3,139,813, being generally channel-shaped with side flanges 267 extending downwardly and outwardly from the opposite side edges thereof, as viewed in FIGS. 12–14. The discharge end of the seal magazine 210 is spaced a predetermined distance above the backing plates 101 and is disposed substantially in horizontal alignment with the lower ends of the sealing jaws 170 in the retracted positions thereof.

Disposed at the rear end of the strapping head 55 is a seal feed assembly, generally designated by the numeral 220. The seal feed assembly 220 includes a pair of slide housings 221 extending rearwardly from the rear ends of the base plates 101, the inner surfaces of the slide housings 221 being disposed in substantially parallel vertical planes and spaced apart a predetermined distance in facing relationship with each other. The slide housings 220 are each provided with an upstanding attachment flange at the forward end thereof extending outwardly therefrom substantially normal thereto and being secured to the side plates 98 by suitable fasteners 222*a*. Disposed between the slide housings 221 at the rear ends thereof and secured thereto by means of a bolt 224, is an upstanding stop member 225, the bottom surface of the stop member 225 being disposed a predetermined distance above the bottom surfaces of the slide housings 221. Secured to the bottom surface of the stop member 225 is a generally T-shaped rear guide plate 226 provided with a forwardly extending tongue 227 intermediate the ends thereof, the tongue 227 terminating in a beveled distal end 228. Secured to the rear end of the guide plate 226 is a pair of guide blocks 223, suitable fasteners 223*a* securing together the guide blocks 223, the guide plate 226 and the stop member 225. The guide blocks 223 are spaced apart a predetermined distance slightly greater than the width of the strap web 40 and are each provided with an angled entry surface 229 for facilitating the passage of the strap web 40 therebetween.

Disposed between the slide housings 221 and slideably engaged in complementary grooves 221a in the inner surfaces thereof is a slide plate 230. Immediately overlying the slide plate 230 is a connector block 231 provided at the forward end thereof with an upwardly extending projection 232. Also disposed between the slide housings 221 is a seal feed bar 235 substantially rectangular in transverse cross section and having the rear end thereof immediately underlying the slide plate 230 and secured thereto and to the connector block 231 by means of bolts 234. The seal feed bar 235 has a flat, substantially horizontal strap guide surface 236 along the bottom thereof, the strap guide surface 236 having a recess 233 centrally disposed in the rear end thereof for accommodating the tongue 227 of the rear guide plate 226, the strap guide surface 236 being substantially coplanar with the bottom surface of the tongue 227. The seal feed bar 235 is provided at the upper front end thereof with a recess 238 for accommodating the lower end of the seal latch 205 in the retracted configuration thereof. Adjacent to the rear end of the recess 238 is a seal-engaging lip 239 for feeding the seals 265 from the magazine 210. It will be observed that the seal feed bar 235 is slidably movable forwardly and rearwardly between the slide housings 221 between a seal feeding position illustrated in FIG. 4, wherein the forward end of the seal feed bar 235 is disposed in the sealing region between the open and retracted sealing jaws 270 and a retracted position, wherein the seal feed bar 235 is disposed out of the sealing region, with the seal engaging lip 239 disposed rearwardly of the front surface of the back plate 211 of the seal magazine 210.

A seal feed piston 240 is provided for effecting movement of the seal feed bar 235 between the feeding and retracted positions thereof, the piston 240 being mounted on an arm 241 of the mounting bracket 192. The piston 240 is provided with a piston rod 242 connected at the lower end thereof by means of a connecting pin 243 to one end of a generally L-shaped lever 245. The lever 245 is pivotally mounted intermediate the ends thereof on a pivot pin 244 carried by a mounting bracket 246 secured to the back plate 211 of the seal magazine 210. The other end of the lever 245 is coupled by means of a connecting pin 247 to one end of the link 248, the other end of the link 248 being coupled by a connecting pin 249 to the projection 232 on the connector block 231. It will be appreciated that when the piston rod 242 is moved downwardly, the lever 245 will be pivoted in a counterclockwise direction, as viewed in FIG. 4, thereby pulling the seal feed bar 235 rearwardly to its retracted position, until the abutment surface 237 at the rear end of the seal feed bar 235 abuts against the stop member 225. Similarly, when the piston rod 242 is moved upwardly, the lever 245 will be pivoted in a clockwise direction, thereby pushing the seal feed bar 235 forwardly to its feeding position.

It will be noted that when the seal feed bar 235 is in its withdrawn position, the bottommost one of the seals 265 in the seal magazine 210 will be urged by the seal follower 214 downwardly against the upper surface of the seal feed bar 235 immediately in front of the seal engaging lip 239. Accordingly, when the seal feed bar 235 moves forwardly to its feeding position, the seal engaging lip 239 engages the adjacent seal 265 and carries it forwardly to a holding position between the open retracted sealing jaws 270. As the seal 265 moves forwardly, it engages the beveled lower edge 206 of the seal latch 205 and moves the seal latch 205 rearwardly

against the urging of the compression spring **207**. When the seal **265** has moved past the seal latch **205**, the latch **205** springs downwardly to its original position illustrated in FIG. **4**. When the seal feed bar **235** is moved back to its withdrawn position, the fed seal **265** remains in the holding position thereof and is prevented by the seal latch **205** from moving rearwardly. It will be noted that in the retracted positions thereof, the inner ends of the sealing jaw projections **171***a* are spaced apart a distance slightly less than the distance between the lower ends of the side flanges **267** of the seal **265** (see FIG. **12**). Thus, the seal **265** is prevented from falling from the holding position between the sealing jaws **170**, when the seal feed bar **235** is returned to its retracted position. The seal **265** is carried by the sealing jaw assembly **160** to a sealing position adjacent to the overlapped portions of the strap web **40** when the sealing jaws **170** move to the partial sealing configuration thereof, as described above.

When the seal feed bar **235** is disposed in its feeding position, the strap guide surface **236** thereon serves to guide the leading end of the strap web **40** from the gripping jaw section **57** through the sealing region and to the tongue **227** of the rear guide plate **226**, the strap web **40** then being guided along the tongue **227** and between the guide surfaces **229** of the guide blocks **223** and then from the strapping head **55**. When the seal feed bar **235** is moved to its withdrawn position, the tongue **227** is accommodated within the recess **233**. In order to facilitate the guiding of the strap web **40** along the guide surface **236**, a pair of strap guides **250** are respectively mounted on opposite sides of the seal feed bar **235** by means of mounting pins **251** extending therethrough. The opposite ends of each of the mounting pins **251** extend substantially beyond the outer surfaces of the adjacent strap guides **250** and are provided with compression springs disposed in surrounding relationship therewith between a pair of retaining washers **253** suitably held in place by means of cotter pins. Each of the strap guides **250** is provided with an inturned bottom lip **254** along the lower edge thereof, the bottom lips **254** being spaced apart a distance less than the width of the associated strap web **40** to prevent the strap web **40** from falling from between the strap guides **250**. However, after completion of the strapping operation, the compression springs **252** will accommodate a resilient lateral outward movement of the strap guides **250** for ready removal of the strap loop **55** therefrom.

Also mounted on the opposite sides of the seal feed bar **235** laterally outwardly of the strap guides **250** is a pair of generally L-shaped dust guards **255**, each of the dust guards **255** being mounted upon suitable mounting bolts **257** extending through the seal feed bar **235** and provided with nuts **255***a*. The dust guards **255** are each provided with an outturned lower flange **259**, the dust guards **255** being spaced from the adjacent side surfaces of the seal feed bar **235** by suitable spacers **258** accommodated in complementary openings **254***a* in the strap guides **250**, the spacers **258** holding the dust guards **255** in position so that the outer ends of the flanges **259** are disposed only a slight distance from the adjacent slide housing **221**. Each of the dust guards **255** is also provided with enlarged openings **256** therethrough for accommodating the compression springs **252** therein.

Secured to the strapping head **55** by means of a mounting plate **261** is a limit switch LS2. An upstanding actuator member **262** is provided with an attachment flange **263** secured by means of a bolt **264** to the slide plate **230** for movement therewith, the actuator member **262** being so positioned as to engage a switch lever **266** of the limit switch LS2 for operating the limit switch LS2 between the open and closed conditions thereof, when the seal feed bar **235** is moved between its feeding and withdrawn positions.

Referring now to FIG. **19** of the drawing, there is illustrated a schematic circuit diagram of the electrical control circuit **300** for controlling the operation of the strapping machine **50**. A pair of input lines **301** and **302** are connected to a suitable source of 110 volt, single phase, 60 Hz electrical power, a plurality of parallel branches being connected between the input lines **301** and **302**. The control circuit **300** may be manually switched among several different modes of operation by means of two selector switches **305** and **315**, each of the selector switches **305** and **315** comprising three banks of contacts respectively designated by the suffixes A, B, and C, as will be explained more fully below.

The input line **301** is connected through a manual main power switch **303** of the push-button variety and a suitable fuse **304** to the wiper of a bank of contacts **305B** of the selector switch **305**. The three contact banks of the selector switch **305** are ganged for simultaneous movement among three positions, respectively designated in FIG. **19** as ON (the top position), OFF (the middle position) and SEAL (the bottom position), the switch **305** normally being in the ON position illustrated in FIG. **19**. Thus, the contact bank **305B** is normally closed, the ON contact thereof being connected by a common conductor **309** to a plurality of parallel branch circuits. More particularly, the conductor **309** is connected to the series combination of the normally closed limit switch LS4, the normally closed contacts **306***b* of a time delay relay **306**, the normally open contacts **307***b* of a time delay relay **307** and a strap feed solenoid **331**, the strap feed solenoid **331** being in turn connected by a conductor **308** to the input line **302**. Connected in parallel with the series combination of the relay contacts **307***b* and the strap feed solenoid **331**, is the coil **310***a* of a time delay relay **310**. Connected in parallel with the relay coil **310***a* is a series combination of normally closed contacts **310***b* of the time delay relay **310**, normally open contacts **311***b* of a time delay relay **311** and the coil **307***a* of a time delay relay **307**.

The common conductor **309** is also connected to a series combination including normally open contacts **310***c* of the time delay relay **310**, normally closed contacts **306***c* of the time delay relay **306** and the seal feed solenoid **332**, which solenoid is in turn connected to the conductor **308**. In parallel with the relay contacts **310***c* are the normally open contacts **312***b* of a control relay **312**, which has a coil **312***a* connected in parallel with the seal feed solenoid **332**. The common conductor **309** is also connected to the input line **302** by a series combination including normally open contacts **313***b* of a control relay **313**, normally closed contacts **310***d* of the time delay relay **310**, normally closed contacts **314***b* of a time delay relay **314** and the coil **313***a* of the control relay **313**, a push button cycle switch **320** being connected in parallel with the relay contacts

313*b*. The junction between the relay contacts 314*b* and the relay coil 313*a* is connected by means of normally open contacts 313*c* of the control relay 313 to the coil 306*a* of the time delay relay 306, and to a common conductor 322, the coil 306*a* being in turn connected to the input line 302.

Connected to the conductor 322 in parallel with the relay coil 306*a* is the series combination of normally closed contacts 311*c* of the time delay relay 311 and a partial sealing and gripping jaw-closing solenoid 333, which is in turn connected to common conductor 308 and the input line 302. Also connected to the conductor 322 in parallel with the relay coil 306*a* is the series combination of normally closed contacts 316*b* of a time delay relay 316, normally closed contacts 311*b* of the time delay relay 311, the selector switch bank 315C in the AUTO position thereof, normally closed contacts 317*b* of a control relay 317 and a tensioning solenoid 334, which is in turn connected to the common conductor 308. The three contact banks of the selector switch 315 are ganged for simultaneous movement among three positions respectively designated in FIG. 19 as FEED (the top position), AUTO (the middle position) and TENSION (the bottom position), the switch 315 normally being in the AUTO position illustrated in FIG. 19. Also connected between the conductors 322 and 302, in parallel with the relay coil 306*a*, is the series combination of normally open contacts 318*b* and coil 318*a* of a time delay relay 318, which is in turn connected to input line 302, the relay contacts 318*b* being connected in parallel with a normally open limit switch LS3 and with normally open contacts 317*c* of the control relay 317. Also connected between the input lines 301 and 302 is the series combination of a normally open limit switch LS2 and coil 311*a* of a time delay relay 311.

The input line 301 is also connected to the wiper of contact bank 315A, the TENSION contact of the bank 315A being connected by a conductor 321 to the junction between the AUTO contact of the contact bank 315C and the relay contacts 317*b*. The input line 301 is also connected through normally open contacts 317D of the control relay 317 to the conductor 322. Connected in series between the input line 301 and the common conductor 308 are normally open contacts 307*c* of the time delay relay 307 and a seal feed-retracting and gripping jaw-partially-closing solenoid 335, the solenoid 335 being connected in parallel with a coil 323*a* of a control relay 323. The relay contacts 307*c* are connected in parallel with normally open contacts 313*d* of the control relay 313, and with the series combination of normally open contacts 323*b* of the control relay 323 and normally open contacts 312*c* of the control relay 312. Input line 301 is further connected to the wiper of selector switch contact bank 305A, the OFF contact of contact bank 305A being connected to the junction between the relay contacts 307C and the seal feed-retracting and holding jaw-partially-closing solenoid 335.

Also connected in series between the input lines 301 and 302 are normally closed contacts 311*e* of the time delay relay 311, normally open contacts 318*c* of the time delay relay 318 and coil 316*a* of the time delay relay 316. Connected in parallel with the relay contacts 318*c* are normally open contacts 316*d* of the time delay relay 316. The relay coil 316*a* is connected in parallel with the series combination of normally closed contacts 314*c* of the time delay relay 314 and a sealing and straightening solenoid 336, the relay contacts 314*c* being connected in parallel with normally open contacts 317*e* of the control relay 317. Also connected in parallel with the relay coil 316*a* is the series combination of normally open contact 316*c* of the time delay relay 316 and coil 314*a* of the time delay relay 314. The input line 301 is also connected to the wiper of the selector switch contact bank 315B, the FEED contact of the contact bank 315B being connected by means of a conductor 324 to the junction between the relay contacts 307*b* and the strap feed solenoid 331. The input line 301 is also connected to the wiper of the selector switch contact bank 305C, the SEAL contact of the contact bank 305C being connected by a conductor 325 to coil 317 *a* of the control relay 317, which is in turn connected to the input line 302.

It will be noted that each of the selector switches 305 and 315 includes at least three positions, in only one of which positions will the selector switch be closed. In normal operation, the selector switch 315 is set to its AUTO position. Thus, as is evident from FIG. 19, selector switch contact banks 305B and 315C are normally closed, while the other selector switch contact banks are normally open. It will also be noted that the solenoids 331, 332, 333, 334, 335 and 336 are all connected to the common conductor 308, whereby these solenoids will normally form a separate plug-in unit for plugging into the remainder of the control circuit 300, as indicated schematically in FIG. 19. Similarly, it will be noted that the limit switches LS2, LS3 and LS4 are also preferably of the plug-in variety for simple insertion in and removal from the circuit 300. It will, of course, be appreciated that, if it is not desired to utilize this plug-in arrangement, and or all of the solenoids 331–336 and the switches LS2–LS4 may be integrally connected in the circuit 300.

Referring now to FIG. 18 of the drawings, there is illustrated a schematic diagram of the pneumatic control circuit of the strapping machine 50. A suitable source 340 of pressurized air is connected by means of input conduits 341 and 342 to a plurality of solenoid-actuated control valves. More particularly, the input conduit 341 is connected to a strap feed valve 351 and to a strap tensioning valve 354, which valves are respectively actuated by solenoids 331 and 334 and may be connected to a common exhaust conduit 343. Similarly, the input conduit 342 is connected to each of a seal feed valve 352, a partial sealing and gripping jaw-closing valve 353, a seal feed-retracting and gripping jaw-partially-closing valve 355 and a sealing and straightening valve 356, which latter valves are respectively actuated by solenoids 332, 333, 335 and 336 and may be connected to a common exhaust conduit 344. The strap feed valve 351 is connected by means of a conduit 345 to one side of the air motor 72, while the strap tensioning valve 354 is connected to the other side of the air motor 72 by means of a conduit 346. The partial sealing and gripping jaw-closing valve 353 is connected by a conduit 347 to the bottom or rod end of the partial sealing piston 200, and is connected by a conduit 348 to both the upper or head end of the partial sealing piston 200 and to the rod end of the gripping jaw piston

150. The head end of the gripping jaw piston 150 is connected by a conduit 349 to the seal feed retracting and gripping jaw-partially-closing valve 355, which valve is also connected by a conduit 350 to the rod end of the seal feed piston 240. The head end of the seal feed piston 240 is connected by a conduit 357 to the seal feed valve 352. The sealing and straightening valve 350 is connected by a conduit 358 to the rod ends of both the straightening piston 90 and the sealing piston 190, the head ends of both of these pistons being connected to the sealing and straightening valve 356 by a conduit 359. It will be noted that, preferably, the valves 352, 353, 355 and 356 are all enclosed in a common manifold 360, while the valves 351 and 354 may also be housed in a common manifold 361.

The operation of the strapping machine 50 will now be described in detail. Initially, the leading end 42 of a strap web 40 will be fed from a suitable supply thereof and threaded between the feed wheel 70 and the idler wheel 75. The straightening roll 95 will be in its withdrawn position, the gripping jaws 110 will be held open in their releasing configuration, the sealing jaws 170 together with the dies 175 and the slide blocks 164 and 166 will all be in their retracted positions and the seal feed bar 235 will be in its retracted position. The main power switch 303 of the control circuit will be open and all of the switch and relay contacts will be in their normal positions illustrated in FIG. 19. The selector switch 305 will be in its ON position and the selector switch 315 will be in its AUTO position. It will be noted that, in this initial condition, all of the solenoids and relay coils will be de-energized.

Air is supplied from the source 340 through the input conduit 341 to each of the strap feed valve 351 and strap tension valve 354, while air is fed through the input conduit 342 to each of the valves 352, 353, 355 and 356. The strap feed valve 351 and the tension valve 354 and the seal feed valve 352 will be closed. Air will be supplied through the partial sealing and gripping valve 353 and the conduit 347 to the rod end of the partial sealing piston 200 for maintaining the piston rod 201 in its retracted position, while air will be supplied through the valve 355 and the conduit 349 to the head end of the gripping jaw piston 150 for maintaining the gripping jaws 110 in their open releasing configuration. Air will be supplied through the sealing and straightening valve 356 and the conduit 358 to the rod ends of each of the straightening piston 90 and sealing piston 190 for maintaining the straightening roll 95 in its withdrawn position and the sealing jaws 170 in their retracted positions.

When the main power switch 303 is closed, the time delay relay 310 is energized through a circuit including the input line 301, selector switch contact bank 305B, limit switch LS4, relay contacts 306*b*, relay coil 310*a* and input line 302. The energization of relay 310 instantaneously closes relay contacts 310*c* for thereby energizing the seal feed solenoid 332 and the control relay 312 through an obvious energizing circuit. The energization of the seal feed solenoid 332 opens the seal feed valve 352 to admit air to the head end of the seal feed piston 240 through the conduit 357 for moving the piston rod 241 downwardly and the seal feed bar 235 to its feeding position, thereby carrying a seal 265 to its holding position in the sealing region, as described above. Energization of the control relay 312 closes the contacts 312*b* for providing a holding circuit around the relay contacts 310*c*. The relay contacts 310*b* are timed to open approximately 6 seconds after the energization of the time delay relay 310, for a purpose to be described below.

The energization of the time delay relay 310 also causes an instantaneous opening of the relay contacts 310*d*, which has no immediate effect, because the cycle switch 320 and the relay contacts 313*b* are already open. The movement of the seal feed bar 235 to its feeding position causes a corresponding movement of the actuating arm 262 for closing the limit switch LS2 and thereby energizing the time delay relay 311 through an obvious circuit. Upon energization of the time delay relay 311, the contacts 311*b* thereof close instantaneously to thereby energize the time delay relay 307. After a short delay of approximately one-quarter of a second to insure that the seal 265 has been fed, the contacts 307*b* of the time delay relay 307 close to energize the strap feed solenoid 331. Energization of the strap feed solenoid 331 opens the strap feed valve 351 to admit air to one side of the air motor 72 through the conduit 345 for thereby causing the air motor 72 to rotate the feed wheel 70 in a strap feeding direction. Thus, the leading end 42 of the strap web 40 is fed around the idler wheel 75 and along the guide members 89 and 86 toward the strap head 55. It will be noted that since the straightening reel 95 is in its retracted position, it presents no impedance to the passage of the strap web 40 between the straightening reel 95 and the straightening surface 88 on the strap guide 86. It will be noted that the energization of the time delay relay 311 also instantaneously opens the contacts 311*c*, 311*d* and 311*e*, all without immediate effect, since these contacts are connected in already-open circuits.

The energization of the time delay relay 307 also closes the contacts 307*c* after a time delay of approximately one-quarter of a second, for energizing the control relay 323 and the seal feed retracting and gripping jaw-partially-closing solenoid 335. The energization of the solenoid 335 switches the valve 355 to remove air from the head end of the gripping jaw piston 150, thereby allowing the gripping jaws 110 to be closed to their feeding configuration by the springs 129. The switching of the valve 355 also admits air to the rod end of the seal feed piston 240 through the conduit 350, but this results in no mechanical movement of the seal feed assembly, since air is also being supplied to the head end of the piston 240 through the seal feed valve 352. The energization of the control relay 323 closes the relay contacts 323*b* for cooperating with the closed relay contacts 312*c* to provide a holding circuit around the relay contacts 307*c* for the solenoid 335 and the control relay 323. It will be noted that the open relay contacts 310*d* will prevent initiation of the tensioning portion of the strapping operation by accidental depression of the cycle switch 320 during the feeding of the strap web 40. Also, the timed contacts 310*b* will serve to stop the strap feed after six seconds by de-energizing the control relay 307 and thus the strap feed solenoid 331, in the event of a strap feed malfunction.

With the seal feed bar 335 in its feeding position, the leading end 42 of the strap web 40 will be fed past the straightening reel 95, through slot 158 between the

backing plate 105 and the bridge member 155, along the strap guide surface 236 on the seal feed bar 235, along the tongue 227 of the rear guide member 226 and, thence, from the strapping head 55 and around a suitable strap guide track (not shown) encircling the strapping location 46. The leading end of the strap web 40 will be fed along suitable guide means from the strap guide track through the central opening 104 in the base plates 101, and along the gripping surface 109 of the backing plate 105, and between the holding jaws 110 in their closed feeding configuration. As it reenters the strapping head 55, the leading end of the strap web 40 will engage the lever 83 thereby moving it pivotally about the pivot connection 84 for moving the actuator shaft 85 to open the limit switch LS4.

Opening of the limit switch LS4 de-energizes the strap feed solenoid 331, the time delay relay 310 and the time delay relay 307. The de-energization of the strap feed solenoid 331 recloses the strap feed valve 351 to shut off the supply of air to the air motor 72 and terminate rotation of the feed wheel 70. However, the inertia of the air motor 72, feed wheel 70 and the strap web 40 will serve to continue feeding the strap web 40 for the short time sufficient to move the leading end 42 of the strap web 40 upwardly into the seal feeding region, as indicated in FIG. 4. In this position, the leading end 42 of the strap web 40 will overlap the supply portion thereof along the entire longitudinal extent of the sealing jaw assembly 160. De-energization of the time delay relay 310 will instantaneously reclose the contacts 310*d* and will reopen the contacts 310*c*. However, the seal feed solenoid 332 will remain energized through the holding circuit provided by the relay contacts 312*b*. It will be noted that de-energization of the time delay relay 307 also serves to reopen the contacts 307*c*, but the seal feed-retracting and gripping jaw-partially-closing solenoid 335 is maintained energized through the closed relay contacts 323*b* and 312*c*, thus to insure later retraction of the seal feed bar 335.

When a package 48 has been located in the required strapping location 46, the cycle switch 320 will be closed momentarily, thereby energizing the control relay 313 through a circuit including the input line 301, the selector switch contact bank 305B, conductor 309, cycle switch 320, closed relay contacts 310*d* and 314*b*, relay coil 313*a* and input line 302. Energization of the control relay 313 closes the relay contacts 313*b* for providing a holding circuit around the cycle switch 320, and closes the contacts 313*d* for providing a holding circuit around the contacts 323*b* and 312*c*. Energization of the control relay 313 also closes the contacts 313*c* for energizing the time delay relay 306, thereby instantaneously opening the relay contacts 306*b* and 306*c*.

Opening of the contacts 306*b* insures that the strap feeding portions of the cycle cannot operate during the tensioning portion of the cycle. Opening of the relay contacts 306*c* de-energizes the control relay 312 for thereby instantaneously reopening the relay contacts 312*b* and 312*c*. However, the control relay 323 and the seal feed retracting and gripping jaws-partially-closing solenoid 335 remains energized through the holding circuit provided by the closed relay contacts 313*d*.

Opening of the contacts 306*c* also de-energizes the seal feed solenoid 332 for thereby reclosing the seal feed valve 352 and removing air from the head end of the seal feed piston 240. Thus, the air being supplied to the rod end of the piston 240 moves the piston rod 241 upwardly for retracting the seal feed bar 335 and reopening the limit switch LS2. Opening of the limit switch LS2 de-energizes the time delay relay 311 for thereby instantaneously reclosing the contacts 311*c* and reopening the contacts 311*b*. Closing the the contacts 311*c* energizes the partial sealing and holding jaw-closing solenoid 333, thereby switching the valve 353 to remove air from the rod end of the partial sealing piston 200 and apply air to the head end thereof and to the rod end of the gripping jaw piston 150 through the conduit 348. This causes the sealing jaws 170 to be moved downwardly to their partial sealing configuration, thereby partially closing the seal 265 about the overlapped portions of the strap web 40, and also results in movement of the gripping jaws 110 to their gripping configuration firmly gripping the leading end 42 of the strap web 40 against the gripping surface 109 of the backing plate 105.

After a delay of about one-half second to allow for completion of the partial sealing and gripping operations, the contacts 311*d* and 311*e* reclose, the closure of the contacts 311*d* energizing the tensioning solenoid 334. This opens the tension valve 354 to admit air through the conduit 346 to the other side of the air motor 72 for driving the feed wheel 70 in a strap tensioning direction for taking up the slack in the strap loop and applying tension thereto. It will be noted that after the slack has been removed from the strap loop, the resistance of the package 48 cooperates with the tensioning force applied by the feed wheel 70 to urge the idler wheel 75 upwardly in a counterclockwise direction, as viewed in FIG. 2, for more firmly urging the serrated surfaces 74 and 76 toward each other and more firmly gripping the supply portion of the strap web 40 therebetween. This affords the necessary frictional gripping force to be applied by the feed wheel 70 and idler 75 for tensioning the strap web 40 to a sufficiently high tension. When a predetermined tension has been reached, the above-described frictional gripping action will cause the idler wheel 75 to pivot sufficiently about the axis of the stub shafts 67 for actuating the switch lever 82 through the connecting arm 80 and an actuator arm 81 to close the limit switch LS3.

Closure of the limit switch LS3 energizes the time delay relay 318. After a time delay of about one second to allow for uniform tensioning and a build up of line pressure, the relay contacts 318*b* close for providing a holding circuit for the time delay relay 318 around limit switch LS3, and the contacts 318*c* close to energize the time delay relay 316 and the sealing and straightening solenoid 336. Energization of the time delay relay 316 instantaneously closes the contacts 316*d* for providing a holding circuit around the relay contacts 318*c*. Energization of the solenoid 336 switches the sealing and straightening valve 356 for removing air from the rod ends of the straightening piston 90 and sealing piston 190 and applying air to the head ends thereof through the conduit 359. Thus, the straightening roll 95 is moved into engagement with the supply portion of the strap web 40 for urging it into contact with the straightening surface 88, and the sealing jaws 170 are moved to their full sealing position for completing the

formation of the seal joint about the overlapped portions of the strap web 40.

As described above, immediately after movement of the sealing jaws 170 to their full-sealing positions, the continued downward movement of the crosshead 185 moves the dies 175 downwardly to crimp the side edges of the seal 265 to facilitate the sealing action thereof and moves the shear blade 167 through the supply portion of the strap web 40. The shear blade 167 cooperates with the upper edge of the backing plate 105 to act as a pair of shear blades for severing the completed strap loop 51 from the supply portion of the strap web 40 immediately ahead of the seal joint. When the strap web 40 is sheared, the tension therein is relieved and the air motor 72 again begins to rotate in the tensioning direction. After a delay of about one-quarter of a second to allow the sheared edge of the supply portion of the strap web 40 to be retracted between the straightening roll 95 and the straightening surface 88, the timed contacts 316*c* close to energize the time delay relay 314 and the timed contacts 316*b* open to de-energize the tensioning solenoid 334. De-energization of the tensioning solenoid 334 recloses the tensioning valve 354 to remove air from the air motor 72 and terminate movement of the strap web 40 in the tensioning direction. After a further time delay of about one-half second to allow for completion of the seal joint after shearing has occurred, the timed contacts 314*b* and 314*c* open.

The opening of the contacts 314*c* de-energize the sealing and straightening solenoid 336 for thereby switching the sealing and straightening valve 356 to remove air from the head ends of the pistons 90 and 190 and reapply air to the rod ends thereof through the conduit 358. This causes the straightening reel 95 to be returned to its retracted position and causes retraction of the sealing piston 191 to its retracted position. Opening of the contacts 314*b* de-energizes the control relay 313, the time delay relays 306 and 318, and the partial sealing and gripping jaw-closing solenoid 333. De-energization of the partial sealing and gripping jaw-closing solenoid 333 switches the valve 353 to remove air from the head end of the partial sealing piston 200 and from the rod end of the gripping piston 150 and to apply air to the rod end of the partial sealing piston 200 for returning sealing jaw assembly 160 to its retracted position. Removal of air from the rod end of gripping piston 150 permits a slight outward movement of the gripping jaws 110, in a direction substantially normal to the plane of the adjacent portion of the strap web 40, under the urging of the compression springs 129 to a position abutting against the strapped object 48 for releasing the gripping force of the teeth 112 on the strap web 40. De-energization of the control relay 313 causes reopening of the contacts 313*b*, 313*c* and 313*d*, opening of the contacts 313*d* de-energizing the control relay 323 and the seal feed-retracting and holding jaw-partially-closing solenoid 335. This switches the valve 355 to remove air from the rod end of the seal feed piston 240 through the conduit 350 and to apply air to the head end of the gripping piston 150 through the conduit 349. Thus, the gripping jaws 110 are pivotally moved to their open releasing configuration illustrated in broken lines in the right-hand side of FIG. 10, in the manner described above, for permitting removal of the strap loop 55 from the gripping jaws 110. De-energization of the time delay relay 318 instantaneously reopens the relay contacts 318*b* and 318*c* but the time delay relays 314 and 316 remain energized through the holding circuits provided by the closed relay contacts 316*c* and 316*d*.

Immediately upon de-energization of the relay 306, the contacts 306*c* reclose and, after a time delay of about one-quarter of a second to allow time for the sealing jaw 170 to be returned completely to their retracted position, the contacts 306*b* reclose to reset the seal feeding and strap feeding portions of the cycle, the limit switch LS4 reclosing upon removal of the completed strap loop from the machine 50. Thus, as described above, the time delay relay 310 will be reenergized, thereby energizing the seal feed solenoid 332 for moving the seal feed bar 235 to its feeding position. This recloses the limit switch LS2 to energize the time delay relay 311. Upon energization of the time delay relay 311, the contacts 311*e* open to de-energize the time delay relays 316 and 314, thereby instantaneously reclosing the relay contacts 314*b*, 314*c* and 314*d* and reopening the relay contacts 316*c* and 316*d*. Energization of the time delay relay 311 also closed the contacts 311*b* for energizing the time delay relay 307, thereby energizing the strap feed solenoid 331 to feed the strap web 40 around the track again. Energization of relay 307 also energizes the control relay 323 and the seal feed-retracting and gripping jaw-partially-closing solenoid 335 for moving the gripping jaws 110 to their feeding configuration, all as was explained above. When the strap has been fed completely around the track it again opens the limit switch LS4 for de-energizing the strap feed solenoid 331, the time delay relay 310 and the time delay relay 307. At this point, the strapping machine is in condition for the beginning of another tensioning and sealing cycle by closing of the cycle switch 320 when another package 48 has been moved into position in the strapping location 46. Thus, once the strapping machine 50 has been turned on, continued recycling thereof to strap numerous packages requires only the operation of the cycle switch 320 at the beginning of each tensioning and sealing cycle.

It will be noted that the manually operable selector switches 305 and 315 permit operation of the strapping machine 50 in modes other than the automatic one just described. Thus, if a seal 265 has been misfed or the leading end of the strap web 40 has been fed past the sealing region, the tensioning portion of the cycle may be bypassed and the seal or strap may be immediately cleared from the machine by manually operating the selector switch 305 to the SEAL position. In this position, the contact bank 305B will be opened to interrupt the strap feeding and seal feeding portions of the cycle, while the contact bank 305C will be closed to energize the control relay 317. Energization of the control relay 317 opens the contacts 317*b* to insure interruption of the tensioning operation if it is in process, and closes the contacts 317*c*, 317*d* and 317*e*. Closure of the contacts 317*c* and 317*d* energizes the time delay relay 318 and the partial sealing and gripping jaw-closing solenoid 333. This causes the sealing jaws 170 to carry the seal 265 to its sealing position adjacent to the overlapped portions of the strap web 40 and moves the gripping jaws 110 to their gripping configuration for

securely gripping the leading end of the strap web 40. After a time delay of about one second, to allow for completion of the operation of the gripping jaws and sealing jaws, the timed contacts 318c will close to energize the sealing and straightening solenoid 336. This results in completion of the sealed joint and shearing of the strap in the manner described above. The selector switch 305 may then be returned to its ON position to resume normal cycling of the strapping machine 50.

If it is desired to manually control the feeding of the strap web 40, the selector switch 315 can be moved to its FEED position, in which position the contact banks 315A and 315C will be opened to prevent operation of the tensioning portion of the cycle, and the contact bank 315B is closed for directly actuating the strap feed solenoid 331. In this manner, if it is desirable to alter the length of strap web being fed, the strap feeding operation may be taken over manually by operation of the selector switch 315.

Similarly, by operation of the selector switch 315 to its TENSION position, the contact banks 315B and 315C will be opened and contact bank 315A will be closed to provide direct energization of the tensioning solenoid 334. Thus, the tensioning operation is removed from the cycle control of of the cycle switch 320 and is placed directly under the manual control of the selector switch contact bank 315A.

Finally, by operation of the selector switch 305 to its OFF position, the contact banks 305B and 305C are opened and the contact bank 305A is closed. Thus, the seal feeding and strap feeding portions of the automatic cycle are interrupted and the seal feed retracting and holding jaw-partially-closing solenoid 335 is directly energized through the contact bank 305A.

It will be appreciated, of course, that while the selector switches 305 and 315 add a considerable amount of flexibility to the preferred embodiment of the invention, they are not necessary to the operation of the basic automatic cycle of the strapping machine 50. Accordingly, it will be apparent that the selector switches 305 and 315 and the control relays 317 may be removed from the circuit and be replaced with permanent connections corresponding to those existing when the selector switch 305 is in its ON position and the selector switch 315 is in its AUTO position for automatic operation of the strapping machine 50.

From the foregoing, it will be seen that there has been provided an improved strapping machine for applying a length of strapping material about an object. More particularly, there has been provided a gripping jaw assembly for movement into and out of engagement with the leading end of the strap web in directions substantially normal to the plane thereof to prevent scoring and resultant weakening thereof by the gripping jaw teeth.

In addition, there has been provided an improved seal feed assembly including a seal feed bar for feeding a seal into position for formation of the seal joint, the seal feed bar, in its feed position also serving as a strap guide for guiding the leading end of the strap web through the sealing region.

Also there has been provided an improved sealing jaw assembly movable into and out of the sealing region to accommodate operation of the seal feed bar. In particular, improved control apparatus has been provided for alternately placing the seal feed bar and the sealing jaws in the sealing region without interference one with the other.

In addition, an improved straightening assembly has been provided including a straightening roll movable into and out of straightening engagement with the strap web so as to avoid impeding the movement of the strap web when the straightening mechanism is not in use. Furthermore, improved electric and pneumatic control circuitry has been provided for controlling the operation of the strapping machine 50 so that a complete strapping cycle may be completed automatically.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A strapping machine for applying a length of strap around an object, said strapping machine comprising first and second gripping members having gripping surfaces thereon and being movable between a feeding condition and a gripping condition, said gripping members in the feeding condition thereof being spaced apart for accommodating the free passage of the leading end of the strap therebetween for forming a loop around the object with the leading end of the strap overlapping the supply portion thereof, said gripping members in the gripping condition thereof cooperating for securely clamping the leading end of the strap therebetween with said gripping surfaces respectively in engagement with the opposite sides of the leading end of the strap, drive mechanism coupled to said gripping members for effecting movement thereof between the feeding condition and the gripping condition thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, and joint forming means for forming a joint between the overlapped portions of the tensioned strap to secure the strap about the object, said drive mechanism effecting movement of said gripping members only in a direction substantially normal to the plane of the adjacent portion of the strap just prior to contact therewith to prevent scoring thereof by said gripping surfaces and to prevent relative movement between said gripping members and the strap in a direction longitudinally of the strap, whereby said gripping members securely hold the leading end of the strap without scoring and resultant weakening thereof.

2. The strapping machine set forth in claim 1, wherein each of said gripping surfaces is provided with a plurality of teeth thereon, the teeth on one of said gripping surfaces being shaped complementary to the teeth on the other of said gripping surfaces.

3. The strapping machine set forth in claim 1, wherein said drive mechanism effects movement of said gripping members from the feeding condition thereof to the gripping condition thereof in a direction substantially normal to the plane of the adjacent portion of the strap.

4. The strapping machine set forth in claim 1, wherein one of said gripping members is stationary, the other of said gripping members being movable with respect to said one gripping member between the feed-

ing condition and the gripping condition. 5. A strapping machine for applying a length of strap around an object, said strapping machine comprising a first gripping member having a gripping surface thereon, a second gripping member having teeth thereon and being movable among a strap feeding condition and a gripping condition and a releasing condition, said second gripping member in the feeding condition thereof being spaced from said gripping surface for accommodating free passage of the leading end of the strap therebetween to form a loop around the object with the leading end of the strap overlapping the supply portion thereof, said second gripping member in the gripping condition thereof cooperating with said first gripping member for securely clamping the leading end of the strap therebetween with said teeth and said gripping surface respectively firmly engaging the opposite sides of the leading end of the strap, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, and joint forming means for forming a joint between the overlapped portions of the tensioned strap to secure the strap about the object, said second gripping member in the releasing condition thereof being disposed out of engagement with the strap loop to accommodate release thereof from between said gripping members, and drive mechanism coupled to said second gripping member for effecting movement thereof among the feeding condition and the gripping condition and the releasing condition thereof, said drive mechanism effecting movement of said second gripping member only in a first direction substantially normal to the plane of the adjacent portion of the strap just prior to contact therewith to prevent scoring thereof by said teeth, said drive mechanism effecting initial movement of said second gripping member away from the gripping condition thereof only in a second direction opposite to said first direction to further prevent scoring of the strap by said teeth and to prevent relative movement between said gripping members and the strap in a direction longitudinally of the strap, whereby said gripping members alternately hold and release the leading end of the strap without scoring and resultant weakening thereof.

6. The strapping machine set forth in claim 5, and further including a pair of second gripping members each having teeth thereon and being movable among said strap feeding and gripping and releasing conditions.

7. The strapping machine set forth in claim 5, wherein said second gripping member in the releasing condition thereof abuts against the object, whereby the object limits the movement of said second gripping member in said second direction.

8. The strapping machine set forth in claim 5, wherein said first gripping member is provided with teeth thereon shaped complementary to the teeth on said second gripping member.

9. The strapping machine set forth in claim 5, and further including control apparatus coupled to said drive mechanism for controlling the operation thereof to move said second gripping member from the feeding condition thereof to the gripping condition thereof just prior to operation of said tensioning means and to said second gripping member from the gripping condition thereof to the releasing condition thereof after operation of said joint forming means.

10. A strapping machine for applying a length of strap around an object, said strapping machine comprising a first gripping member having a gripping surface thereon, a second gripping member having teeth thereon and being movable among a feeding condition and a gripping condition and first and second releasing conditions, said second gripping member in the feeding condition thereof being spaced from said gripping surface for accommodating free passage of the leading end of the strap therebetween to form a loop around the object with the leading end of the strap overlapping the supply portion thereof, said second gripping member in the gripping condition thereof cooperating with said first gripping member for securely clamping the leading end of the strap therebetween with said teeth and said gripping surface respectively firmly engaging the opposite sides of the leading end of the strap, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, joint forming means for forming a joint between the overlapped portions of the strap to secure the strap about the object, said second gripping member in the first releasing condition thereof being disposed intermediate the feeding condition and the gripping condition thereof and abutting against the strapped object, said second gripping member in the second releasing condition thereof abutting the strapped object laterally of the strap and out of engagement therewith for accommodating release of the sealed strap from said gripping members, and drive mechanism coupled to said second gripping member for effecting movement thereof among the feeding condition and the gripping condition and the first and second releasing conditions thereof, said drive mechanism effecting movement of said second gripping member in a predetermined direction substantially normal to the plane of the adjacent portion of the strap just prior to contact therewith to prevent scoring thereof by said teeth, said drive mechanism effecting initial movement of said second gripping member away from the gripping condition thereof in a direction opposite to said predetermined direction to further prevent scoring of the strap by said teeth, said drive mechanism effecting pivotal movement of said second gripping member from the first releasing condition to the second releasing condition thereof along the strapped object, whereby said gripping members alternately hold and release the leading end of the strap without scoring and resultant weakening thereof.

11. The strapping machine set forth in claim 10, and further including a pair of second gripping members each having teeth thereon and being movable among said strap feeding and gripping and releasing conditions.

12. The strapping machine set forth in claim 10, wherein said drive mechanism effects pivotal movement of said gripping member from the first releasing condition to the second releasing condition thereof about an axis disposed substantially parallel to the plane of the adjacent portion of the strap.

13. A strapping machine for applying a length of strap around an object, said strapping machine comprising a first gripping member having a gripping surface thereon, a second gripping member having teeth thereon and being movable among a feeding condition and a gripping condition and first and second releasing

conditions, said second gripping member in the feeding condition thereof being spaced from said gripping surface for accommodating free passage of the leading end of the strap therebetween to form a loop around the object with the leading end of the strap overlapping the supply portion thereof, said second gripping member in the gripping condition thereof cooperating with said first gripping member for securely clamping the leading end of the strap therebetween with said teeth and said gripping surface respectively firmly engaging the opposite sides of the leading end of the strap, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, joint forming means for forming a joint between the overlapped portions of the strap to secure the strap about the object, said second gripping member in the first releasing condition thereof being disposed intermediate the feeding condition and the gripping condition thereof and abutting against the strapped object, said second gripping member in the second releasing condition thereof abutting the strapped object laterally of the strap and out of engagement therewith for accommodating release of the sealed strap from said gripping members, bias means urging said second gripping member toward the feeding condition thereof, and a drive assembly coupled to said second gripping member and operable to first and second actuated conditions and cooperating with said bias means for effecting movement of said second gripping member among the feeding condition and the gripping condition and the first and second releasing conditions thereof, said drive assembly in the first actuated condition thereof effecting movement of said second gripping member in a predetermined direction substantially normal to the plane of the adjacent portion of the strap just prior to contact therewith to prevent scoring thereof by said teeth, said bias means and said drive assembly in the second actuated condition thereof effecting initial movement of said second gripping member away from the gripping condition thereof in a direction opposite to said predetermined direction to further prevent scoring of the strap by said teeth, said drive assembly in the second actuated condition thereof cooperating with said object for effecting pivotal movement of said second gripping member from the first releasing condition thereof to the second releasing condition thereof along the strapped object, said bias means effecting movement of said second gripping member back to the feeding condition thereof upon deactuation of said drive assembly after removal of the strapped object therefrom, whereby said gripping members alternately hold and release the leading end of the strap without scoring and resultant weakening thereof.

14. The strapping machine set forth in claim 13, wherein said drive assembly includes an air motor and a drive linkage coupling said air motor to said second gripping member.

15. The strapping machine set forth in claim 13, wherein said bias means comprises a spring.

16. The strapping machine set forth in claim 13, wherein said drive assembly includes an air motor operable to the first and second actuated conditions, drive linkage coupling said air motor to said second gripping member for effecting movement thereof, and a lever arm coupled to said second gripping member and movable therewith, said air motor in the first actuated condition thereof cooperating with said drive linkage for effecting movement of said second gripping member to the gripping condition thereof, said air motor in the second actuated condition thereof effecting movement of said drive linkage into engagement with said lever arm when said second gripping member is in the first releasing condition thereof for pivotally moving said second gripping member to the second releasing condition thereof.

17. The strapping machine set forth in claim 13, wherein said second gripping member is pivotally movable about an axis disposed substantially parallel to the plane of the adjacent portion of the strap.

18. The strapping machine set forth in claim 13, wherein said second gripping member is pivotally movable about an axis disposed substantially parallel to the plane of the adjacent portion of the strap, said axis passing through said second gripping member and being movable therewith.

19. A strapping machine for applying a length of strap around an object, said strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portions of the strap for holding a seal therein and a withdrawn position out of said sealing region, sealing jaws movable between a sealing position in said sealing region for deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of said sealing region, and drive mechanism coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, said drive mechanism being coupled to said sealing jaws for effecting movement thereof between the sealing position and the retracted position thereof, said drive mechanism alternately placing said seal feed member and said sealing jaws in the sealing region without interference one with the other, whereby said seal feed member and said sealing jaws cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

20. The strapping machine set forth in claim 19, wherein said seal feed member is provided with a guide surface thereon, said guide surface guiding the passage of the leading end of the strap through said sealing region when said seal feed member is in the feeding position thereof.

21. The strapping machine set forth in claim 19, wherein said drive mechanism includes a first air motor coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, a second air motor coupled to said sealing jaws for effecting movement thereof between the sealing position and the retracted position thereof, and control apparatus coupled to said first and second air motors for controlling the operation thereof to alternately place said seal feed member and said sealing jaws in the sealing region.

22. The strapping machine set forth in claim 19, wherein movement of said seal feed member from the withdrawn position thereof to the feeding position thereof effects movement of a seal from a supply thereof to a holding location in said sealing region adjacent to said sealing jaws in the retracted position thereof, movement of said sealing jaws from the retracted position thereof to the sealing position thereof effecting movement of the seal from said holding location into sealing engagement with the overlapped portions of the strap.

23. The strapping machine set forth in claim 19, wherein said sealing jaws include a plurality of pairs of jaws aligned longitudinally of the overlapped portions of the strap substantially parallel to one another and having a combined longitudinal extent substantially equal to the length of the associated seal.

24. The strapping machine set forth in claim 19, and further including a cutter coupled to said sealing jaws and movable therewith for severing the sealed strap loop from the supply portion of the strap immediately after formation of the seal joint.

25. A strapping machine for applying a length of strap around an object, said strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portion of the strap for holding a seal therein and a withdrawn position out of said sealing region, sealing jaws movable between a sealing position in said sealing region for deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of said sealing region, said sealing jaws having camming surfaces thereon and being spaced apart a distance greater than the width of the seal, cam members respectively disposed for camming engagement with the camming surfaces of said sealing jaws, and drive mechanism coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, said drive mechanism being coupled to said sealing jaws for effecting movement thereof between the sealing position and the retracted position thereof, said drive mechanism alternately placing said seal feed member and said sealing jaws in the sealing region without interference one with the other, said camming surfaces cooperating with said cam members and said drive means for effecting movement of said sealing jaws into said sealing region in a direction substantially normal to the plane of the adjacent portion of the strap during the first portion of the movement of said sealing jaws from the retracted position thereof to the sealing position thereof, said camming surfaces cooperating with said cam members and said drive means for effecting pivotal movement of said sealing jaws into engagement with the side edges of the seal for forming the seal joint during the last portion of the movement of said sealing jaws from the retracted position thereof to the sealing position thereof, whereby said seal feed member and said sealing jaws cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

26. The strapping machine set forth in claim 25, wherein said drive mechanism includes a first air motor coupled to said seal feed member for effecting movement thereof between the feeding and withdrawn positions thereof, a second air motor coupled to said sealing jaws for effecting movement thereof between the sealing and retracted positions thereof, and control apparatus coupled to said first and second air motors for controlling the operation thereof to alternately place said seal feed member and said sealing jaws in the sealing region.

27. The strapping machine set forth in claim 25, wherein said sealing jaws are respectively pivotally movable about axes disposed substantially parallel to the plane of the adjacent portion of the strap.

28. The strapping machine set forth in claim 25, wherein said sealing jaws are respectively pivotally movable about axes disposed substantially parallel to the plane of the adjacent portion of the strap, each of said axes passing through the associated sealing jaw and being movable therewith.

29. A strapping machine for applying a length of strap around an object, said strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portion of the strap for holding a seal therein and a withdrawn position out of said sealing region, sealing jaws movable between a sealing position in said sealing region for deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of said sealing region, said sealing jaws having camming surfaces thereon and being spaced apart a distance greater than the width of the seal, cam members respectively disposed for camming engagement with the camming surfaces of said sealing jaws, first drive mechanism coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, second drive mechanism coupled to said sealing jaws for effecting movement thereof between the sealing position and the retracted position thereof, said camming surfaces cooperating with said cam members and said drive means for effecting movement of said sealing jaws into said sealing region in a direction substantially normal to the plane of the adjacent portion of the strap during the first portion of the movement of said sealing jaws from the retracted position to the sealing position thereof, said camming surfaces cooperating with said cam members and said second drive means for effecting pivotal movement of said sealing jaws into engagement with the side edges of the seal for forming the seal joint during the last portion of the movement of said sealing jaws from the retracted position to the sealing position thereof, and control apparatus coupled to said first and second drive mechanisms for controlling the operation thereof to alternately place said seal feed member and said sealing jaws in the sealing region without interference one with

the other, whereby said seal feed member and said sealing jaws cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

30. The strapping machine set forth in claim 29, wherein each of said drive mechanisms comprises an air motor.

31. The strapping machine set forth in claim 29, wherein each of said drive mechanisms comprises an air motor, said control apparatus comprising an electric control circuit and a pneumatic control circuit coupling said electric control circuit to said air motors.

32. A strapping machine for applying a length of strap around an object, said strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portion of the strap for holding a seal therein and a withdrawn position out of said sealing region, sealing jaws movable among a partial sealing position and a full sealing position in said sealing region for sequentially deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of said sealing region, said sealing jaws having camming surfaces thereon and being spaced apart a distance greater than the width of the seal, cam members respectively disposed for camming engagement with the camming surfaces of said sealing jaws, and first drive mechanism coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, second drive mechanism coupled to said sealing jaws for effecting movement thereof between the retracted position and the partial sealing position thereof, third drive mechanism coupled to said sealing jaws for effecting movement thereof between the partial sealing position and the full sealing position thereof, said camming surfaces cooperating with said cam members and said second drive mechanism for effecting movement of said sealing jaws into said sealing region in a direction substantially normal to the plane of the adjacent portion of the strap during the first portion of the movement of said sealing jaws from the retracted position to the partial sealing position thereof, said camming surfaces cooperating with said cam members and said second drive mechanism for effecting pivotal movement of said sealing jaws into engagement with the side edges of the seal during the last portion of the movement of said sealing jaws from the retracted position to the sealing position thereof for deforming the seal into a configuration loosely enveloping the overlapped portions of the strap to accommodate tensioning thereof, said camming surfaces cooperating with said cam members and said third drive mechanism for effecting continued pivotal movement of said sealing jaws from the partial sealing position to the full sealing position thereof for forming the seal joint, and control apparatus coupled to said first and second and third drive mechanisms for controlling the operation thereof to alternately place said seal feed member and said sealing jaws in the sealing region without interference one with the other, said control apparatus controlling the operation of said second and third drive mechanisms for moving said sealing jaws into the partial sealing position thereof prior to operation of said tensioning means and for moving said sealing jaws from the partial sealing position to the full sealing position thereof after operation of said tensioning means, whereby said seal feed member and said sealing jaws cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

33. The strapping machine set forth in claim 32, wherein each of said drive mechanisms comprises an air motor.

34. The strapping machine set forth in claim 32, wherein movement of said seal feed member from the withdrawn position thereof to the feeding position thereof effects movement of a seal from a supply thereof to a holding location in said sealing region adjacent to said sealing jaws in the retracted position thereof, movement of said sealing jaws from the retracted position thereof to the sealing position thereof effecting movement of the seal from said holding location into sealing engagement with the overlapped portions of the strap.

35. The strapping machine set forth in claim 32, wherein said sealing jaws in the partial sealing position thereof cooperate to deform the associated seal into a configuration loosely enveloping the overlapping portions of the strap for preventing displacement thereof from the sealing region while accommodating tensioning of the strap.

36. A strapping machine for applying a length of strap around an object, said strapping machine comprising a strap gripper for holding the strap encircled in a loop about the object with the leading end of the strap overlapping the supply portion thereof, tensioning means for tensioning the loop of strap by withdrawing the supply portion thereof relative to the leading end thereof, a seal feed member movable between a feeding position in a sealing region adjacent to the overlapped portion of the strap for holding a seal therein and a withdrawn position out of said sealing region, sealing jaws movable between a sealing position in said sealing region for deforming the seal around the overlapped portions of the strap to form a seal joint therebetween and a retracted position out of said sealing region, a die member movable between a sealing position in said sealing region for crimping the side edges of the seal and the strap for facilitating the formation of the seal joint therebetween and a retracted position out of the sealing region, and drive mechanism coupled to said seal feed member for effecting movement thereof between the feeding position and the withdrawn position thereof, said drive mechanism being coupled to said sealing jaws and said die member for effecting movement thereof between the sealing positions and the retracted positions thereof, said drive mechanism simultaneously placing said sealing jaws and said die member in the sealing region for formation of the seal joint, said drive mechanism placing said seal feed member in the sealing region alternately with the simultaneous placement of the sealing jaws and die member therein without interference of the seal feed member with the sealing jaws and the die member, whereby said

seal feed member and said sealing jaws and said die member cooperate to place a seal in sealing engagement with the overlapped portions of the strap to form the seal joint therebetween.

37. The strapping machine set forth in claim 36, wherein said die member is coupled to said sealing jaws and is movable therewith into crimping engagement with the associated seal.

38. The strapping machine set forth in claim 36, wherein said sealing jaws include a plurality of pairs of sealing jaws, and further including a plurality of die members respectively disposed between adjacent pairs of said sealing jaws, and means coupling said die members to said sealing jaws for movement therewith.

39. The strapping machine set forth in claim 36, wherein said die member is coupled to said sealing jaws for movement therewith, and further including a cutter coupled to said sealing jaws and said die member for movement therewith to sever the seal strap loop from the supply portion of the strap immediately after formation of the seal joint.

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