United States Patent

[11] 3,548,740

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[21] Appl. No. **748,698**
[22] Filed **July 30, 1968**
[45] Patented **Dec. 22, 1970**
[73] Assignee **Signode Corporation**
a corporation of Delaware

[54] **STRAPPING APPARATUS**
29 Claims, 18 Drawing Figs.

[52] **U.S. Cl.** **100/28,** 100/33; 156/73
[51] **Int. Cl.** **B65b 13/10**
[50] **Field of Search** 100/2.8, 27, 28, 29, 30, 31, 32, 33

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Primary Examiner—Billy J. Wilhite
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ABSTRACT: An apparatus for providing a tensioned loop of strap about an object wherein a carrier in slip feed engagement with a length of strap moves the strap in a closed path around the object to form a closed tensioned loop having overlapping portions that are sealed to one another. The carrier is movable in opposite directions along the closed path for forming successive loops, and a single supply provides strap for the carrier in both directions of its movement. A strap storage means is associated with the carrier for accumulating strap during certain portions of the carrier movement, and for paying out strap during other portions of the carrier movement. The strap sealing means includes an anvil that is movable between a first position in the strap path during the wrapping and sealing operation and a second position displaced from the strap path allowing the strap to move into engagement with the strapped object. The sealing means further includes a hammer that is supported on a carriage which is movable to a position wherein spring means cause the hammer to compress the overlapped strap portions against the anvil for a subsequent friction fusing operation.

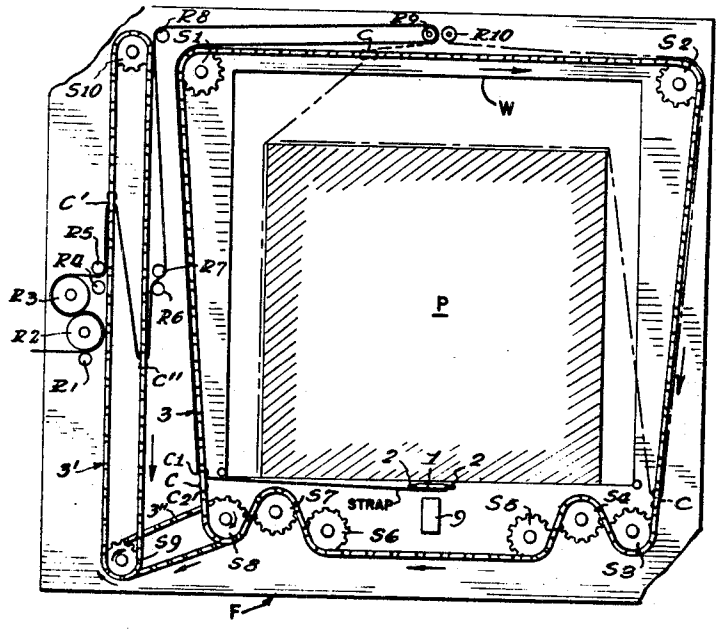

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Fig. 1

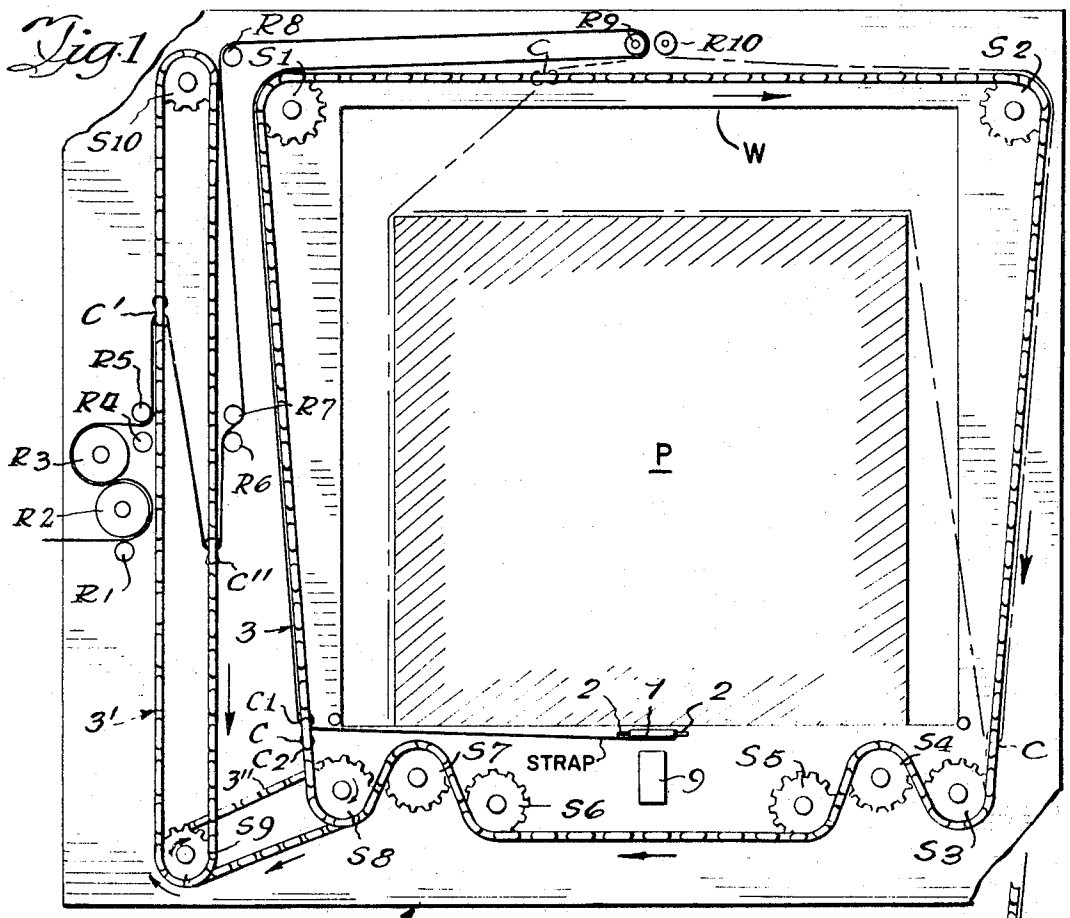

Fig. 2

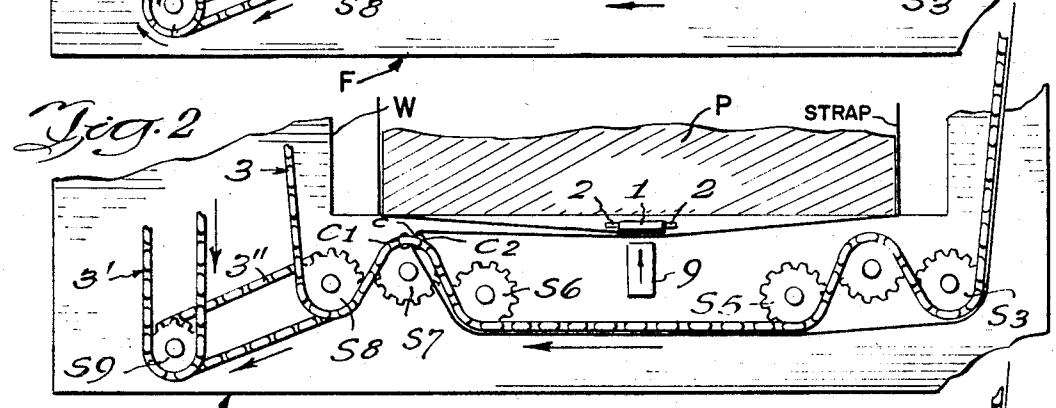

Fig. 3

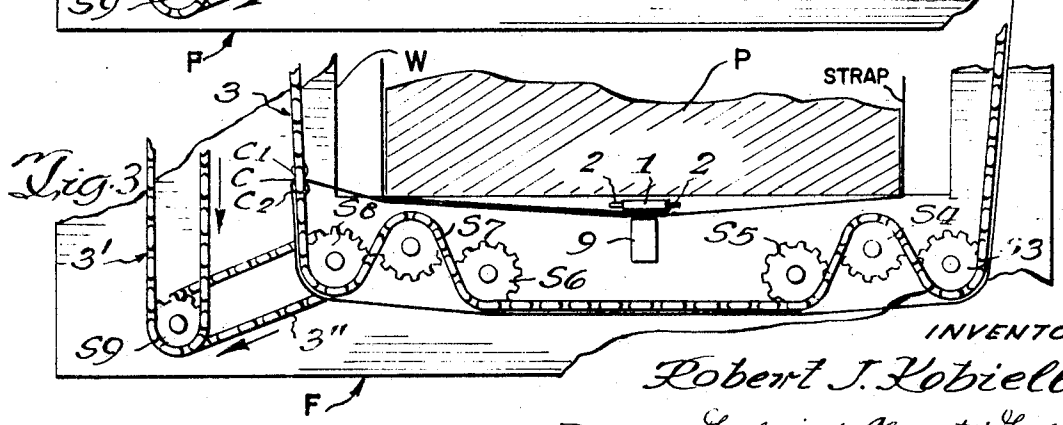

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Fig. 4

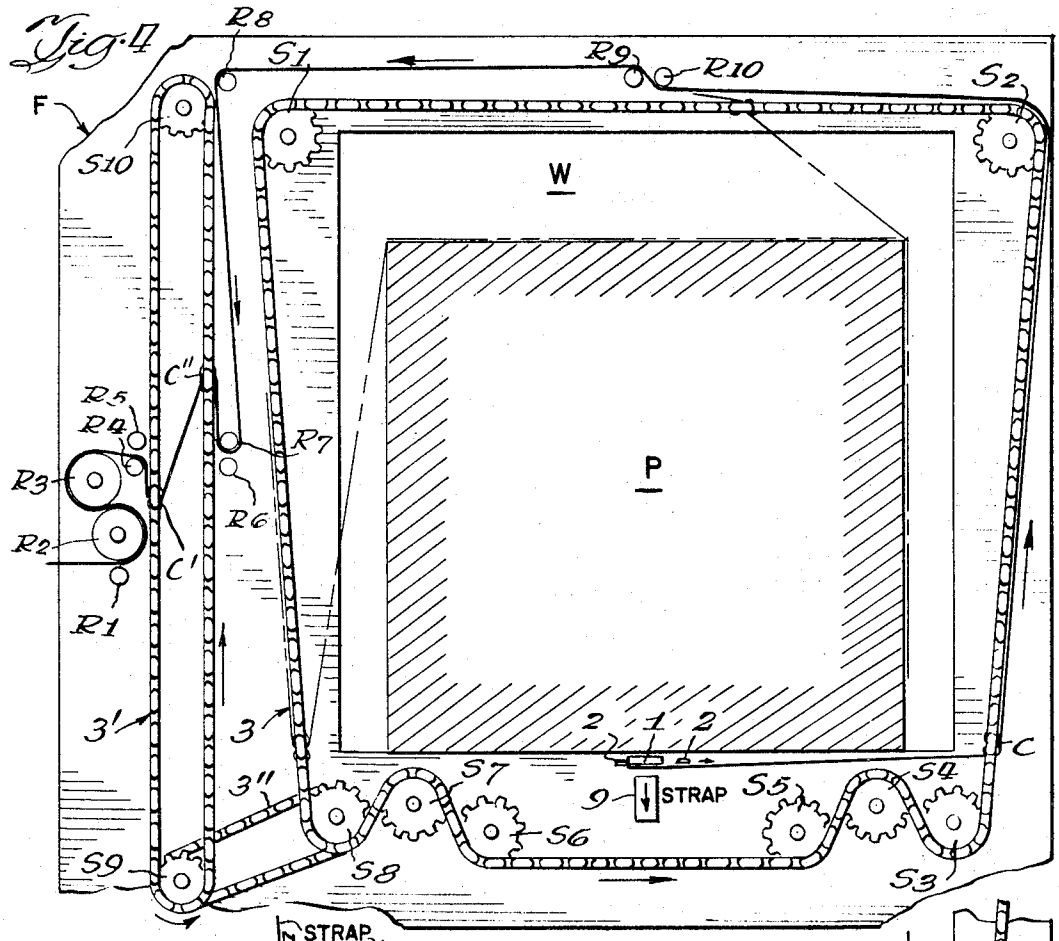

Fig. 5

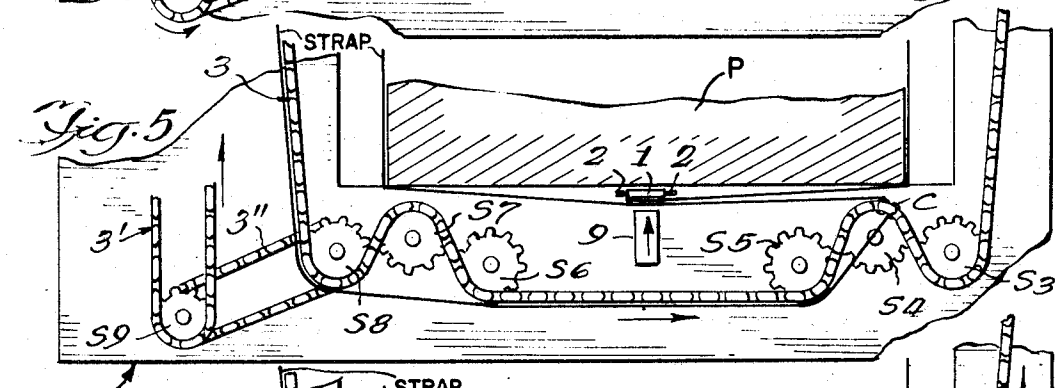

Fig. 6

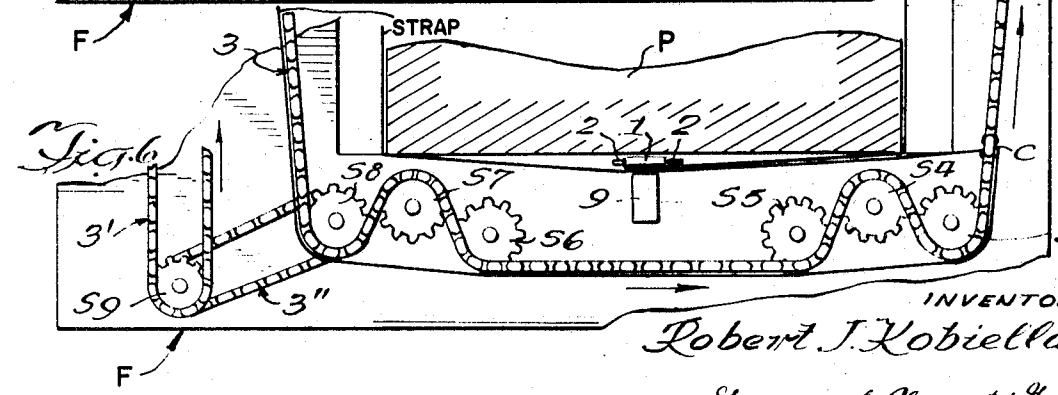

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Fig. 7

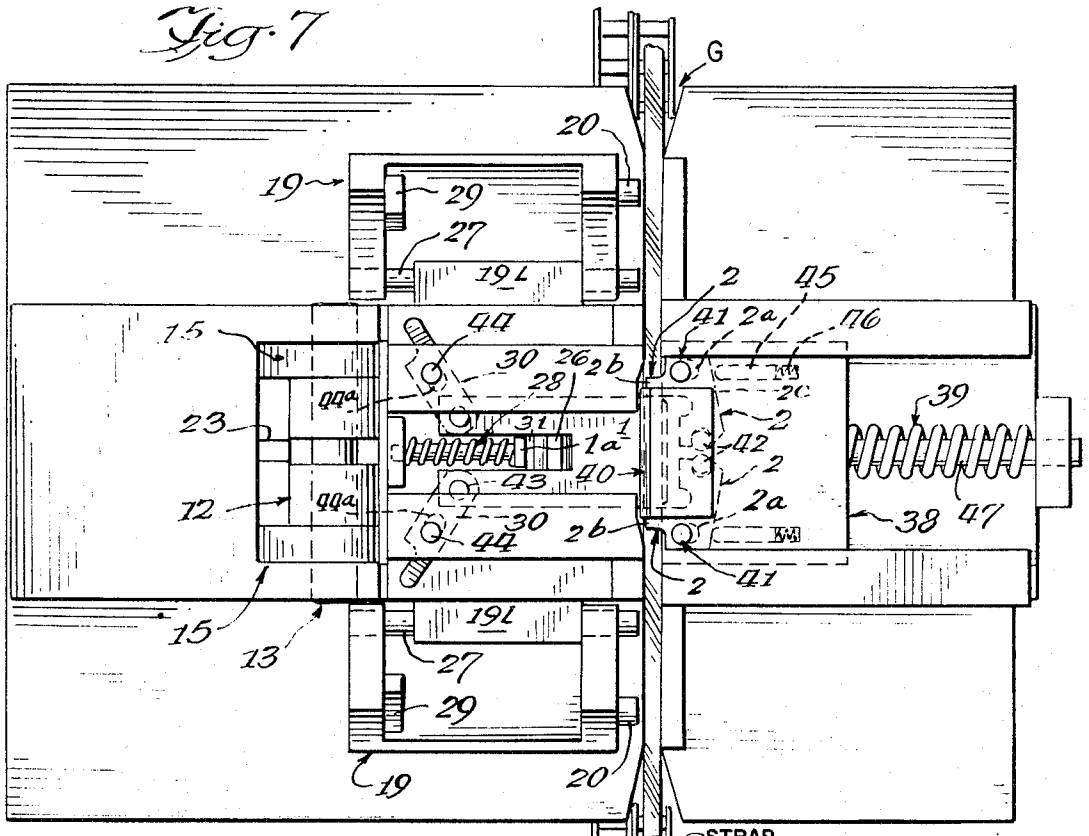

Fig. 8

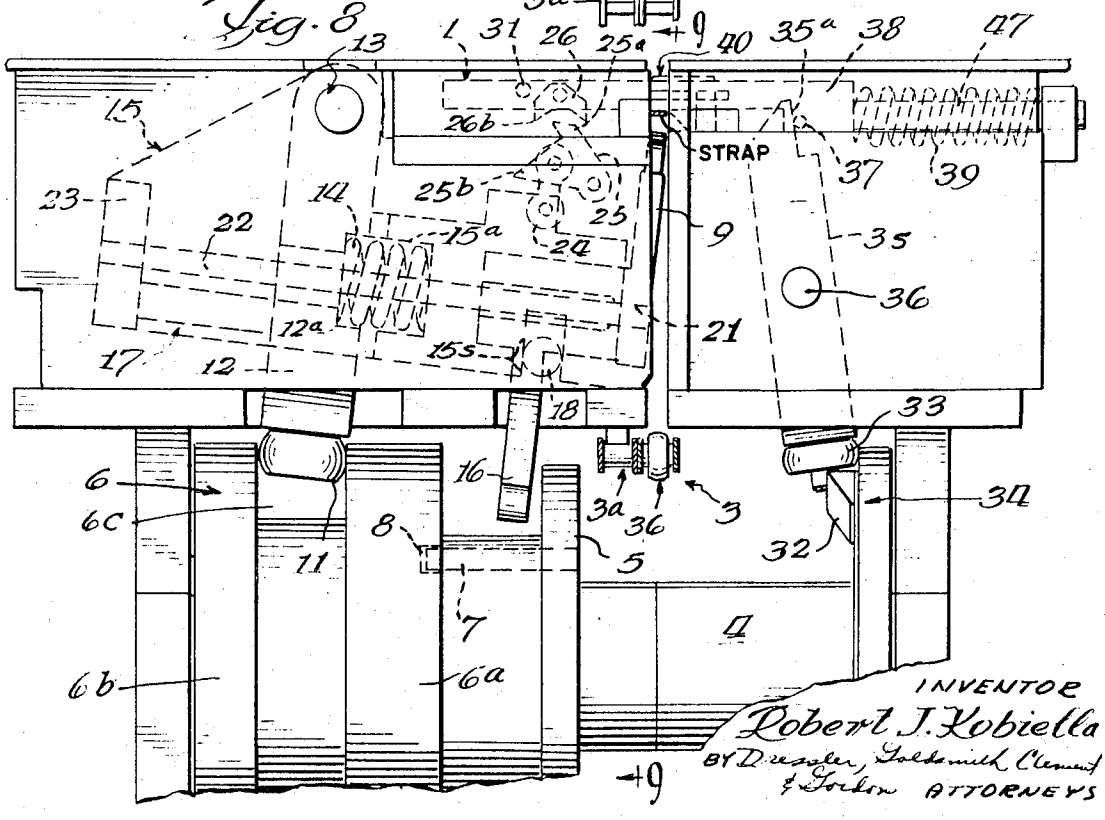

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Fig. 7b

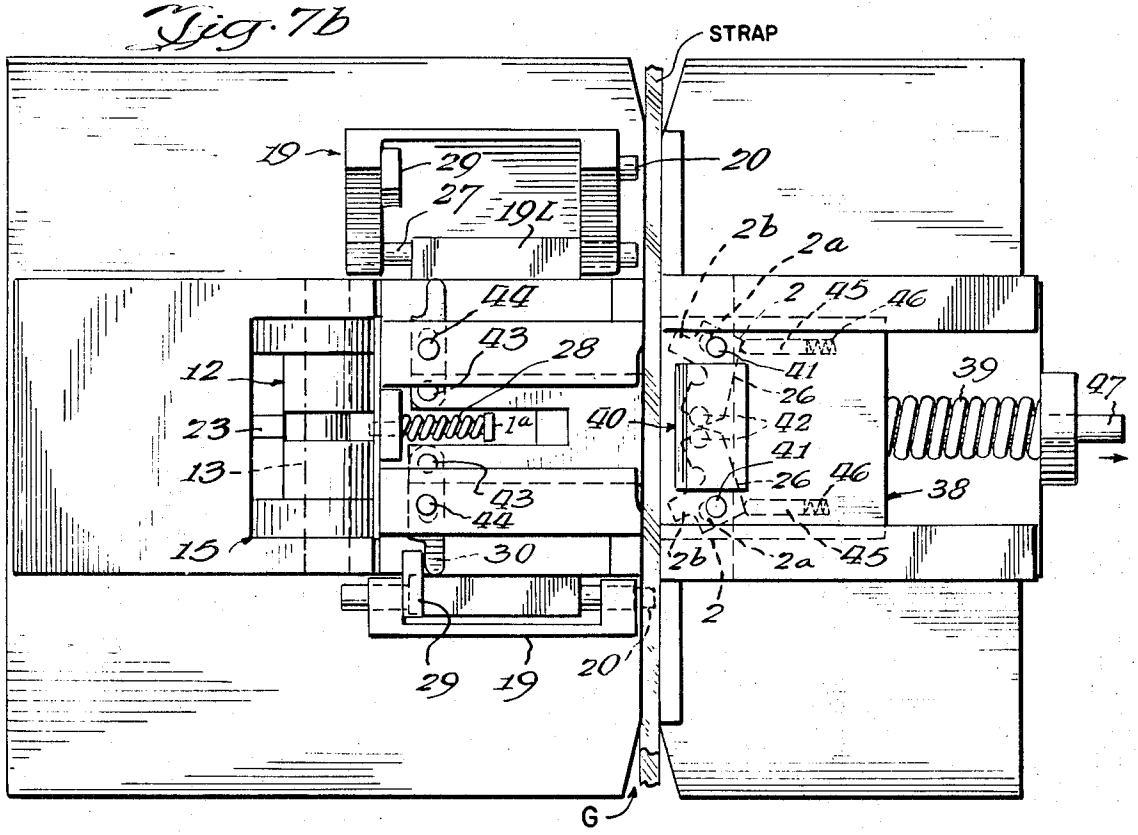

Fig. 7a

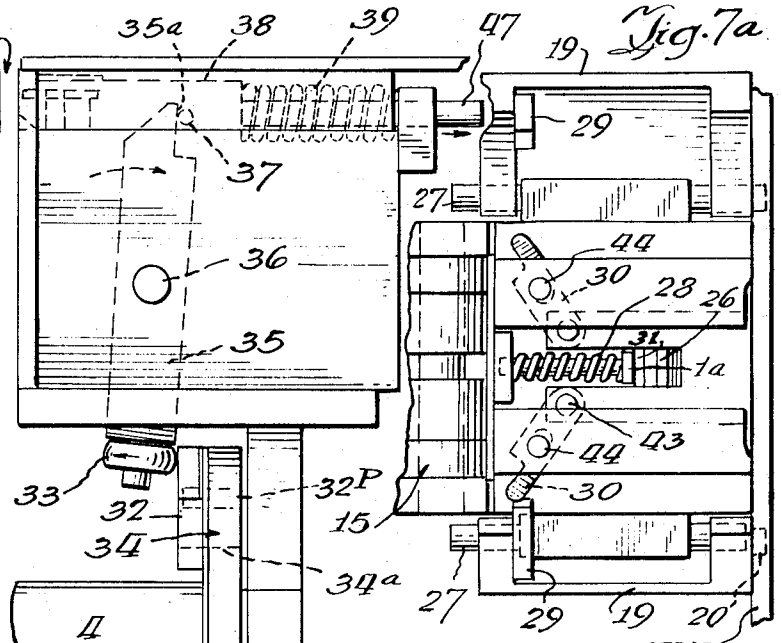

Fig. 1a

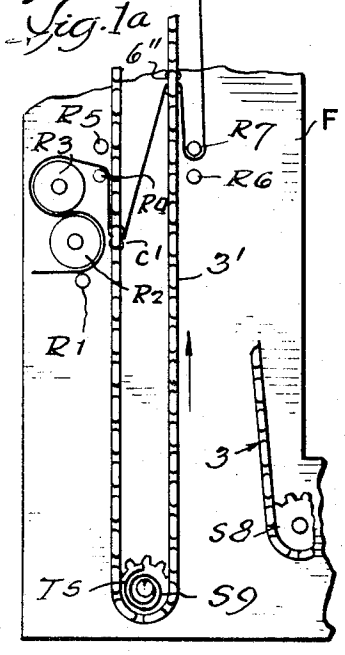

Fig. 8a

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Fig. 9

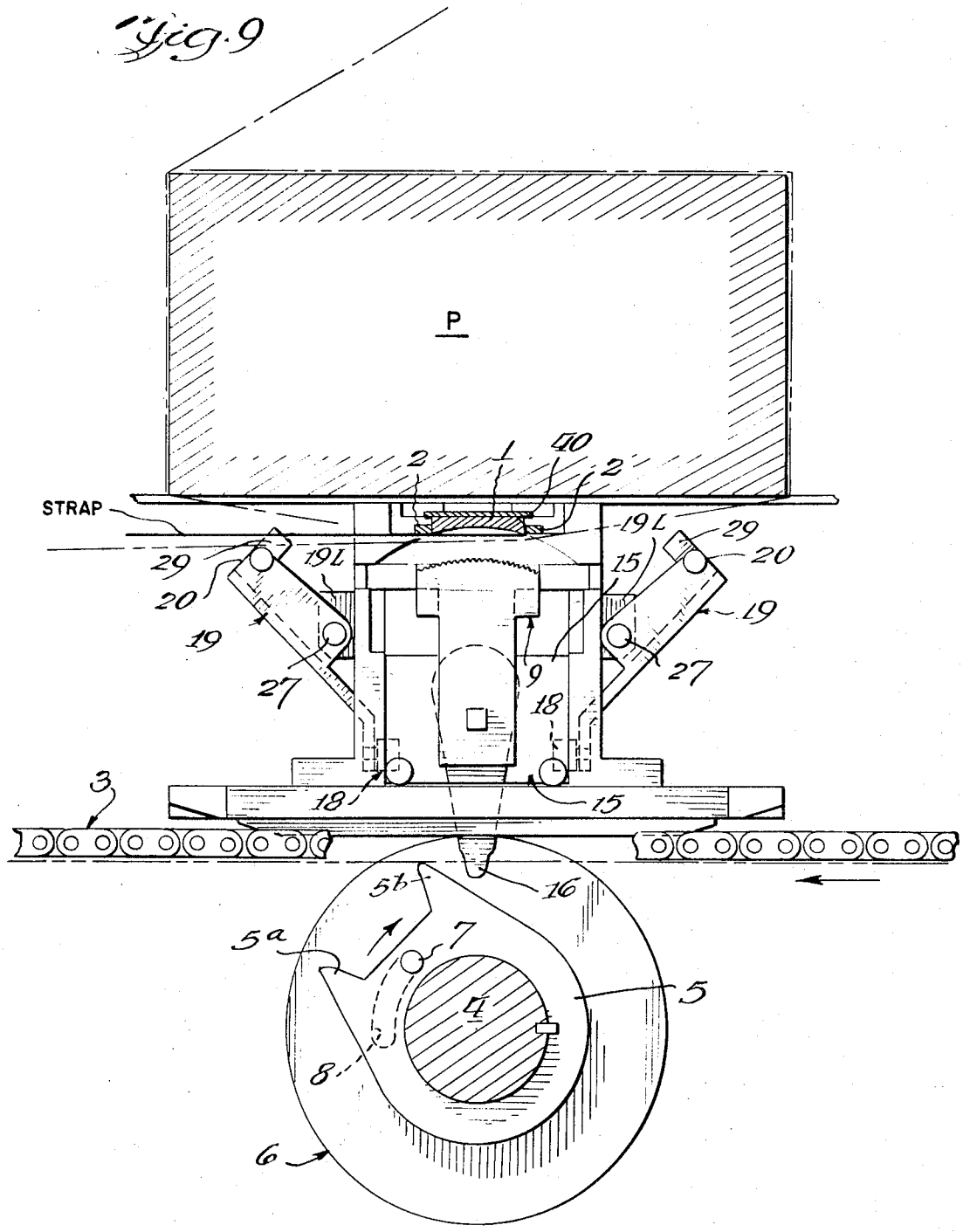

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Fig. 10

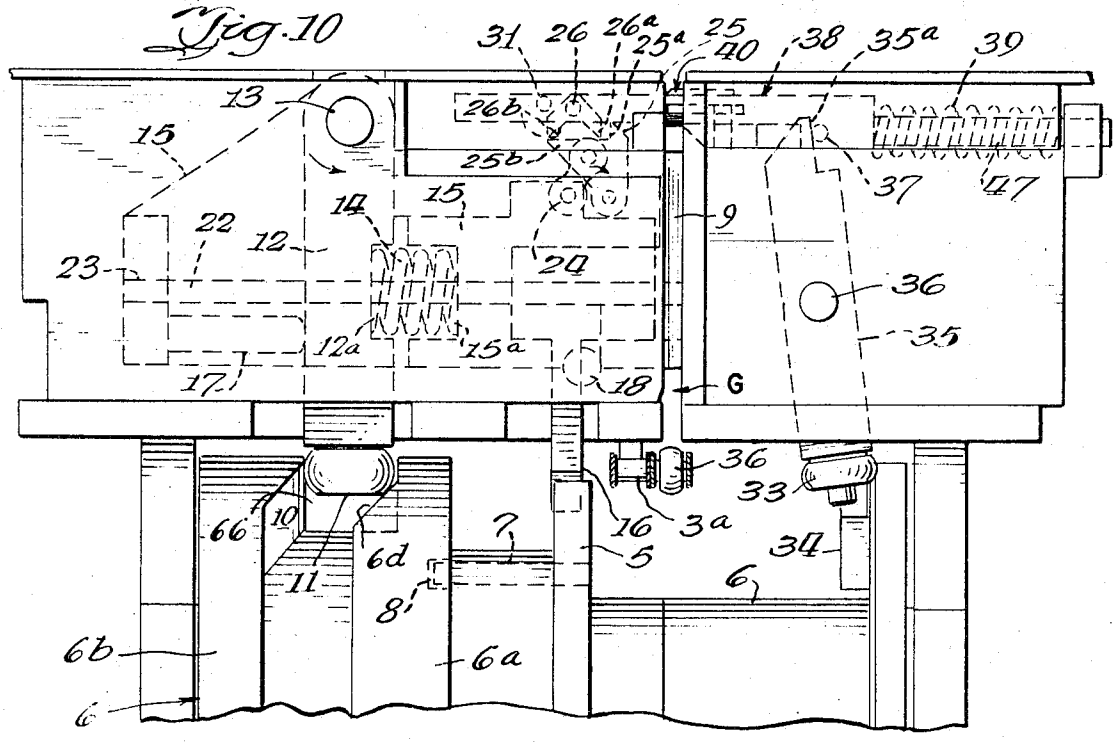

Fig. 11

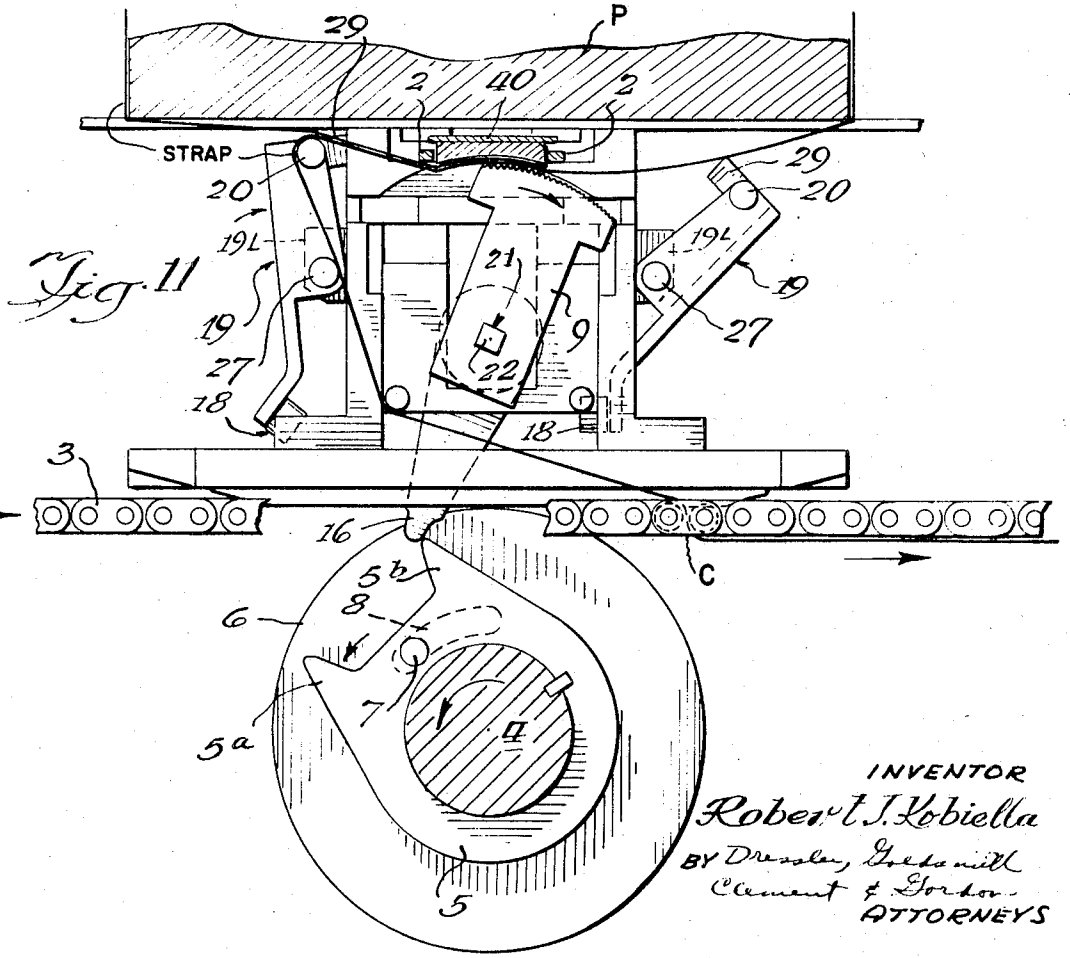

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Fig. 11a

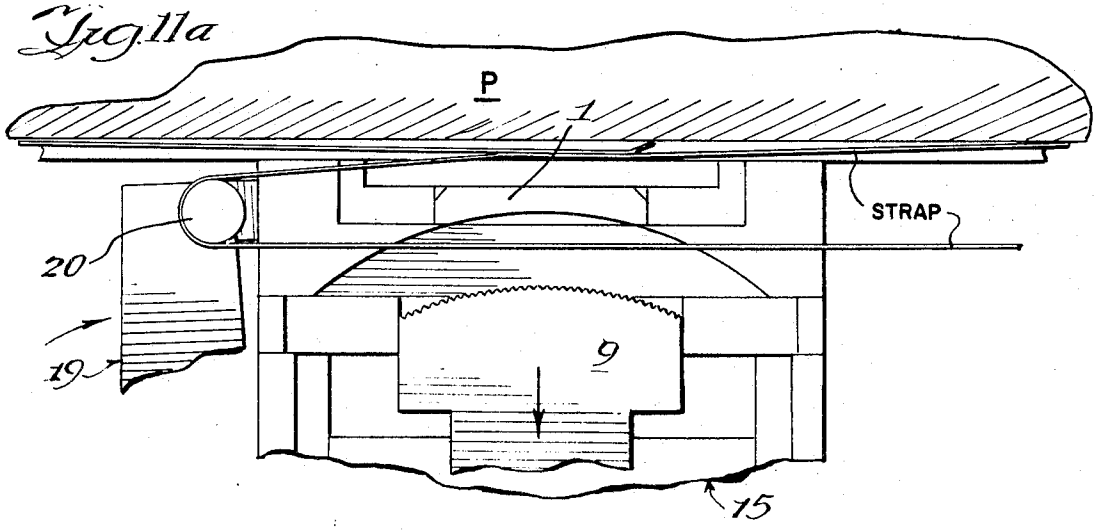


Fig. 11b

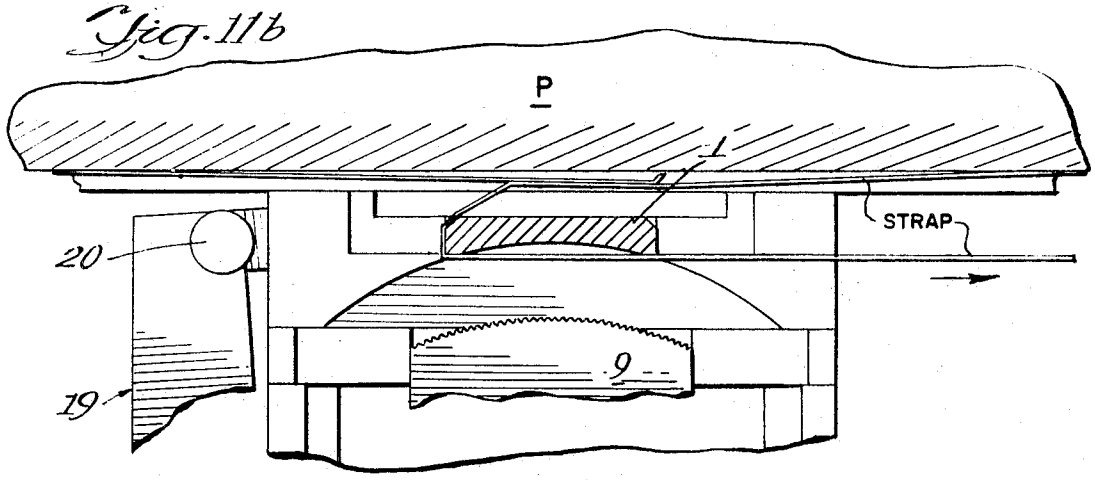
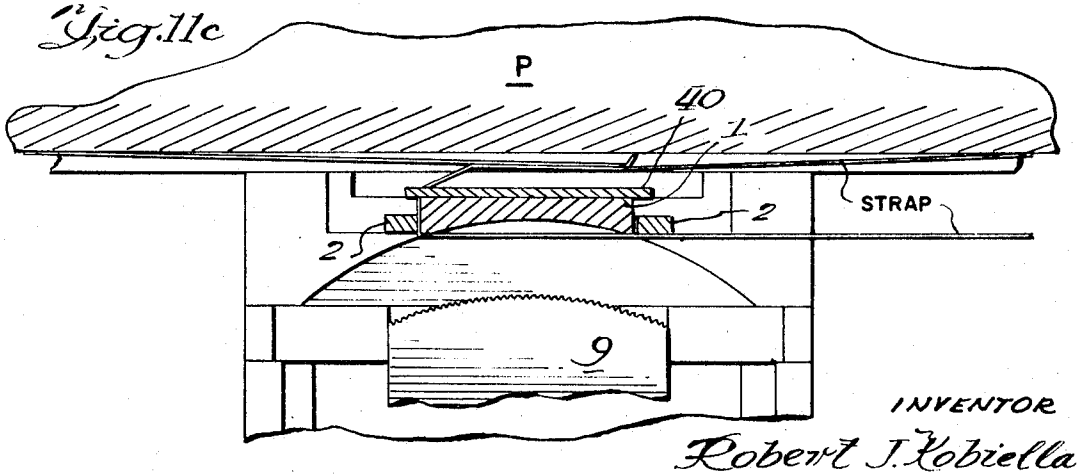


Fig. 11c



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STRAPPING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to systems for draping and tying a loop of strap about a package or other object to be tied and, more particularly, the invention is concerned with a method and an apparatus for effecting draping of a loop of strap completely about an object without need for a conventional strap chute or strap feeding equipment.

It is frequently quite difficult to handle small lightweight steel or plastic straps in a conventional strap chute such as is normally employed for guiding such straps around bundles and packages. This difficulty increases with the length of the chute.

In conventional strap feeding through a strap chute, it has proven extremely difficult to control accurately the amount of strap feed around a chute so as to avoid both overfeeding and underfeeding. Frequently, delicate controls have been required to measure the amount of strap being fed through a conventional chute.

These problems encountered in the present day conventional equipment are greatly aggravated by camber, curl and twist effects which are usually present in lightweight metal and nonmetallic strapping.

SUMMARY OF THE INVENTION

The present invention provides a system for overcoming these problems and for eliminating the conventional strap chute. For this purpose, a chain powered slip feed arrangement is provided and includes a reversible movable carrier that follows a generally rectangular chain loop that encircles a package tying position.

The chain driven draping arrangement is mechanically simple, making it particularly useful for power strapping applications in plants where only a minimum of maintenance is available. Additionally, the slip feed arrangement eliminates the necessity of positively securing the binding to the carrier member. Also, the reversible draping arrangement lends itself to automatic cycling while utilizing only a single supply of binding material.

The anvil structure of the present invention has novel strap gripping means including a pair of gripping fingers, one of which is operative during carrier movement in one direction to hold the leading end of the strap against the anvil, and the other of which is active during movement of the carrier in an opposite direction to hold the strap against the anvil. The anvil structure is normally disposed in the strap path during strap feeding and sealing operations, and the anvil is retractable to a position beyond the strap path after sealing is effected, so that the sealed loop can snap into engagement with the strapped object. A novel finger structure is associated with the anvil, so that the strap will be positively held in a clearance position allowing the anvil to freely move into and out of the strap path.

The hammer structure of the present invention, which cooperates with the anvil to effect a friction-fusing operation of overlapping strap portions, is mounted on a movable carriage assembly, and a cam control structure shifts the carriage to move the hammer into a position wherein spring means urge the hammer toward the anvil with a predetermined force to compress the overlapped strap portions therebetween. The hammer is oscillated by a torsion bar sealing mechanism disclosed and claimed in the commonly assigned application Ser. No. 735,842 filed June 10, 1968, which issued as Pat. No. 3,494,280 on Feb. 10, 1970.

Other features and advantages of the invention will be apparent from the following description and claims, and are illustrated in the accompanying drawings which show structure embodying features of the present invention, and the principles thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic front view of a strapping apparatus utilizing a chain-driven carrier for draping a loop of strap about a package, and showing the carrier at a start position along the chain path in full lines and at various other positions therealong in broken lines;

FIG. **1***a* is a fragmentary diagrammatic view illustrating a modification of the strap carrier tensioning and slack controlling structure;

FIG. **2** is a related fragmentary view showing the carrier pulling final tension after a complete loop has been drawn about the package;

FIG. **3** is a related fragmentary view showing the carrier at the end of its clockwise cycle and prepared for reverse travel;

FIG. **4** is a diagrammatic front view of the apparatus in the rest position immediately following sealing of the loop, and also showing the carrier at various positions of its counterclockwise draping travel path in broken lines;

FIG. **5** is a related fragmentary front elevational view showing the carrier pulling final tension for the counterclockwise draping movement;

FIG. **6** is a related fragmentary view showing the carrier at a reverse point immediately prior to sealing of the second loop;

FIG. **7** is an enlarged fragmentary top plan view showing the arrangement of parts at the sealing station for the carrier positions of FIGS. **1** and **2**;

FIG. **8** is a front elevational view of the structure illustrated in FIG. **7**;

FIG. **9** is a transverse sectional view through the carrier station taken in the plane of the strap loop as indicated by the line **9–9** on FIG. **8**;

FIG. **10** is a front view similar to FIG. **8** and showing the sealer in its working position which corresponds to the sequence view of FIG. **3**;

FIG. **11** is a fragmentary sectional view similar to FIG. **9** but showing the parts in a position at a time immediately prior to the position shown in FIG. **4**, this position being the presealing cocked hammer position;

FIG. **7***a* is a fragmentary top plan view similar to FIG. **7**, and showing the parts in the position assumed at a time between the positions shown in FIGS. **3** and **4**;

FIG. **7***b* is a top plan view, similar to FIGS. **7** and **7***a*, and illustrating the parts in the position assumed at full anvil retraction, after the position of FIG. **7***a*;

FIG. **8***a* is a fragmentary front view similar to FIG. **8**, and showing the parts in a position at a time that corresponds to a position just prior to FIG. **4**; and

FIGS. **11***a*, *b* and *c* are fragmentary sectional sequence view showing, respectively, the release of the completed loop from the anvil, the snubbing of the strap about the anvil, and the cutting of the formed loop from the remainder of the strap.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

General Operation

While the invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail a preferred embodiment of the invention and modifications thereof, with the understanding that the present disclosure is to be considered as an exemplification of the principals of the invention and is not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

Referring now to the drawings, the general arrangement and sequence of operation of the chain driven draping arrangement can best be traced with reference to FIG. **1** to **6**. The apparatus includes main framing designated generally at F which provides a generally rectangularly shaped window W for receiving the package P which is to be strapped. A support structure underlies the bottom of the window, and as is illustrated hereinafter, the support structure provides a guideway G which receives the opposite ends of the strap loop that is being formed about the package. The main framing F mounts a set of sprocketlike rollers S1—S8 which have a chain **3** trained thereabout, as illustrated in FIG. **1**, the chain being a

multiple strand type (FIG. 7) so that one strand 3*a* engages the sprocket teeth and the other strand 3*b* rides free adjacent to the sprockets. There are upper corner sprocket rollers S1 and S2 about and outboard each side of the window W and there are two sets of three vertically staggered sprocket rollers S3, S4, S5 and S6, S7, S8 adjacent and beneath each of the lower corners of the window. The roller strand 3*b* includes a strap carrier C as an intermediate segment thereof and the carrier includes spaced rollers C1 and C2 defining a pass region for the strap. The support structure includes an anvil 1 arranged to receive the free end of the strap in underlying relation and a sealer 9 is shown positioned beneath the anvil 1 for movement in working position after an overlapping strap layer is formed beneath the free end upon completion of the strap draping and tensioning movement of the carrier. Grippers 2 are shown flanking the anvil 1 to engage the free end of the strap for holding strap tension.

The strap supply arrangement illustrated herein includes an infeed roller R1 and a pair of intermediate rollers R2 and R3 which are operable to set and control the back tension acting upon the strap. The supply arrangement includes a section capable of conveniently storing slack in preparation for draping about the package, for paying out the slack from storage to permit the back rollers R2 and R3 to set the tension and for taking up slack which accumulates during the tension drawing operation of the main chain 3. The storage section includes a slack takeup roller chain 3' trained about sprocket rollers S9 and S10 which are spaced apart vertically a distance sufficient to provide the required storage capacity. The line of strap leading from the back tension rollers R2 and R3 extends between a pair of infeed guide rollers R4 and R5 bordering the left hand side of the takeup chain 3', through a carrier C' which operates exclusively along the left hand run of the takeup chain 3', through a carrier C'' which operates exclusively along the right hand vertical run of the takeup chain 3', through a pair of outfeed rollers R6 and R7 bordering the right hand side of the takeup chain 3', around an upper corner roller R8 and through a pair of centering rollers R9 and R10 midway across the top of the window which allow for feed of the strap in either wrapping direction about the package.

FIGS. 1, 2 and 3 are sequence views illustrating the operation of the chain during a clockwise draping movement. At the beginning of the cycle, as shown in FIG. 1, the free end of the strap is fixedly held against the right side of the anvil 1 by the right-hand gripper 2, and a layer of the strap underlies the anvil in contacting relation and leads through the carrier C and around the upper left hand sprocket S1 to the entry rollers R9 and R10 that overhand the center of the window. A common drive motor (not shown) directly powers the lower left hand sprocket S8 for advancing the carrier chain in a clockwise travel direction to move the carrier successively from the full line position to the successive phantom line position illustrated at the top and then at the lower right-hand side of the chain travel path in FIG. 1, it being understood that the other sprockets are idlers which guide the chain.

An intermediate chain 3'' is connected to drive a slip clutch associated with the lower sprocket S9 of the slack takeup mechanism to move the slack takeup chain 3' in a clockwise direction and accumulate strap from the main loop during the first half of the travel of the carrier, that is, when carrier C moves up to the region of the centering rollers R9 and R10. In the modification of FIG. 1*a*, the intermediate chain 3'' and slip clutch associated with pulley S9 is eliminated, and instead, the hub of sprocket S9 is rotatable against the bias of a torsion spring TS, which controls movement of the takeup chain 3' in a manner similar to the previously mentioned intermediate chain 3'' and slip clutch.

During the next portion of the carrier travel, i.e. as the carrier C moves to the broken line position of FIG. 1 at the lower right-hand side of the package, strap is paid out from storage so that the storage carriers C' and C'' return approximately to the position illustrated in FIG. 1, it being understood that the slip clutch associated with sprocket S9 allows the direction of travel of chain 3' to reverse. During further travel of the carrier C through the path to the position illustrated in FIG. 2, the slack carriers C' and C'' come into registry with the infeed rollers R4 and R5 and outfeed rollers R6 and R7, so that all of the accumulated slack has been paid out and any continued travel of the carrier requires direct pay out of the strap from the supply reel (not shown). Therefore, during the phase of the travel when the loop is being completed and the second overlapping strap layer is being formed beneath the anvil 1 and tension is drawn on the loop, the back tension rollers R2 and R3 are operative to determine the value of the tension.

It may be noted that as the carrier 3 moves over the undulation in the carrier path created by sprocket S7 (FIG. 2), the line of strap being wrapped across the bottom of the package P is shifted up the sealer 9 to a location next to the gripped strap end. After the strap is above the sealer 9, the sealer is shifted from the position of FIG. 2 toward the working position of FIG. 3, and when the sealer reaches the working position, it holds the strap against the back tension while the carrier C continues to its reversal point shown in FIG. 3.

When the reversal position of FIG. 3 is reached, suitable switch means (not shown) is actuated to reverse the drive motor and rotate sprocket S8 and chain 3 in a counterclockwise direction. Chain 3'' and sprocket S9 are also rotated in a counterclockwise direction to rotate chain 3' in a counterclockwise direction and take up the slack induced by the reverse movement of carrier 3. Sealing occurs between the reversal point shown in FIG. 3 and the position shown in FIG. 4, and it should be noted that in FIG. 4, the anvil 1 has shifted backwardly, or into the paper as viewed therein, so that the completed joint snaps up against the underside of the package, after which the anvil returns to its projected position wherein it intercepts the plane of the strap loop but is located now beneath the completed joint. As the carrier C moves toward the FIG. 4 position, the strap is being snubbed about the left hand side of the anvil 1 and the left hand gripper 2 comes into play to the strap portion adjacent the sealed joint against the side of the anvil 1. At this time, a cutter, as is described later, severs the completed strap loop from the newly gripped strap and the device is now ready to drape a loop of strap in an opposite direction about the package.

During further travel of the carrier C in the counterclockwise draping direction from the position of FIG. 4, slack is being accumulated in the storage section up to the time that the main carrier reaches the centering rollers r9 and R10, and upon further travel, slack is payed out from the storage section so that by the time the carrier C has completed the formation of the loop and reaches the position shown in FIG. 5, the slack carriers C' and C'' are aligned with the infeed rollers R4 and R5 and outfeed rollers R6 and R7, so that the strap is being fed directly from the supply to the back tension R2 and R3 rollers and up through the centering rollers R9 and R10. The tension of the strap loop is thus determined by the back tension of rollers R2 and R3. Once again, the section of strap being wrapped beneath the bottom of the package rises above the sealer 9 to move into overlapping relation between the sealer 9 and anvil 1, and as the carrier C continues its travel to the FIG. 6 position, the sealer 9 moves up to working position. FIG. 6 is the reversal position and during subsequent movement of the carrier C in a clockwise direction, the sealing of the joint is completed and the anvil 1 retracts to permit the joint to snap up against the package P and allow the succeeding portion of strap to snub about the anvil 1 for the beginning of a further clockwise draping movement.

From the foregoing, it will be apparent that with the free end of the strap clamped by right hand gripper 2, as is shown in FIG. 1, a generally open strap loop is formed between the right hand gripper 2 and the carrier member C''with the right portion of the open loop being disposed adjacent roller R9. As the carrier C moves from the full line position of FIG. 1 to the first broken line position, carrier C essentially travels along one reach of the aforedescribed open loop, causing the reach to conform to the configuration of the package P as the carrier

C moves between sprocket S1 and rollers R9 and R10. As the carrier C passes rollers R9 and R10, and completes its travel around the package P, the bight portion of the aforedescribed open loop is pulled around the package, with the inner reach of the open loop conforming to the package and the outer reach of the open loop traveling with the chain 3. By pulling the bight portion of the open loop around the package P, an inner reach is provided for sealing to the gripped end of the strap, and an outer reach is provided for subsequently wrapping around a further package, when the direction of carrier movement is reversed. The sets of clustered rollers S3, S4, S5 and S6, S7, S8 function to enlarge the bight portion of the open loop, so that the inner reach can pass closely adjacent to the anvil 1, while the outer reach remains in a clearance position. The sprocket S7 functions to position the inner reach closely adjacent to the anvil 1, as is evident from FIG. 2 during clockwise movement, while sprocket S4 functions to position the inner reach closely adjacent to anvil 1 during a counterclockwise movement, as is event from FIG. 5.

Detailed Description of Operation

The operation station is centered along the lower reach of the main carrier chain 3 and includes a sealer section and a gripper and cutter section spaced on opposite sides of the plane of the strap loop to define guideway gap G for reception of the strap.

A common drive (FIG. 8 and 9) for timing the operation of the moving parts in these sections is located therebeneath and is synchronized with the movement of the carrier chain 3 as is described in detail herein. The drive includes a main cam shaft 4 that is supported in suitable bearings (not shown) on the main frame, and shaft 4 is reversibly operable by the same motor which moves the carrier chain 3. A bifurcated cocking cam 5 and a barrel cam 6 are coaxially arranged on the cam shaft 4, and cam 5 has a rearwardly extending drive pin 7 operating in lost-motion relation in a drive slot 8 in the front face of barrel cam 6.

The cam shaft 4 controls the actuating and timing of a number of related mechanisms. For example, a cam arm 34 FIGS. 8, 8*a* and 10) is pivoted at 34*a* to ride with a flange portion of the cam shaft 4 to swing past a position for operating a gripper and cutter actuation arm 35 that is swingable about a pivot 36 in the support housing of the gripper and cutter section. The cocking cam 5 has spaced tips 5*a* and 5*b* (one for each strap draping direction) that rotate to crank and then release a trigger arm 16 for operating the sealer. The barrel cam 6 has a cam slot 6*c* between flanges 6*a* and 6*b* that receives a cam follower 11 carried by a pressure arm 12 that regulates the positioning of a sealer carriage 15.

The pressure arm 12 and sealer carriage 15 are swingable about a common axis defined by a shaft 13 which is supported in the housing structure. A preload stop screw 17 FIGS. 8 and 10) is threaded through the rear of the sealer carriage 15 for engagement with the pressure arm 12 to set its bias relation with respect to a pressure spring 14 that reacts between the pressure arm 12 and sealer carriage 15. In this respect it will be noted from FIGS. 8 and 10 that the rearward end of spring 14 is confined within a forwardly facing socket 12*a* in the front face of pressure arm 12, while the forward end of spring 14 is confined within a rearwardly facing socket 15*a* in carrier 15. The rear of the sealer carriage 15 provides a rigid socket mount 23 that anchors one end of a torsion bar 22 which extends full length through the carriage 15 to receive a hammer 9 in keyed relation on its free forward end. The trigger arm 16 is journaled in the carriage 15 and supports the torsion bar 22 in drivingly keyed relation along an intermediate position.

Thus the sealer carriage 15, pressure arm 12, torsion bar 22, trigger 16 and hammer 9 are swingable as a unit about the axis of the shaft 13 between the rest position shown in FIGS. 8 and 9 and the sealing position shown in FIGS. 10 and 11. This movement is controlled by the pressure arm 12 which is positioned in accordance with the rotary position of the barrel cam 6, with the working pressure of the hammer 9 that holds the overlapping strap ends against the anvil 1 being determined by the spring 14.

The anvil 1 is normally biased to a position projecting through the plane of the strap loop by means of a spring 28 (FIGS. 7 and 7*b*) reacting between the sealer section framing and an anvil abutment 1*a*, but return movement of the sealer carriage 15, that is, from FIG. 10 to FIG. 8 retracts the anvil, as will be hereinafter explained, to allow the sealed strap joint to move about the anvil 1 and against the package, thereby freeing the finished loop from the strapping machine.

As shown in FIGS. 1, 2, 3 and 9, the free strap end is pinched between the upright right hand side of anvil 1 and the right hand gripper 2, with the strap passing under the anvil 1 to the left to lead in a clockwise direction around the package P. The strap passes through the chainlike carrier C and through the remainder of guide and snubber rollers R1—R10 as shown in FIG. 1.

During the clockwise strap wrapping cycle, the motor drives the carrier C and cam shaft 4 in a clockwise direction, as viewed in FIGS. 1 and 9. The cam shaft 4 drives the cocking cam 5 which drives the barrel cam 6 through the engagement of pin 7 with the end of the lost-motion slot 8. The carrier C pulls the strap around the package as shown by the broken line sequence positions in FIG. 1.

When the strap has passed completely around the package, as shown in FIG. 2, and has slid up along the hammer 9, it is located in proper sealing position, due to the undulation in the carrier path defined by sprocket S7. As cam shaft 4 and cam 5 continue to rotate in a clockwise direction, the barrel cam 6 reaches a position which causes a ramp portion 10 (FIG. 10) on flange 6*b* to contact the cam follower 11 at the lower end of pressure arm 12. Further motion of the carrier C and cam shaft 4 in the clockwise direction (ultimately ending in position shown in FIG. 3) causes the cam follower 11 to rotate the pressure arm 12 counterclockwise about axis 13 to apply pressure to spring 14. The spring 14 rotates the sealer carriage 15, to which is mounted the swing hammer 9 and the trigger 16, counterclockwise.

Near full travel of the cam follower 11 brings the swing hammer 9 into contact with the two layers of strap squeezing them against the anvil 1. As the cam follower 11 reaches its full travel, the pressure on the straps between the hammer and anvil will exceed the rate of the pressure spring 14 causing the sealer carriage 15 to stop rotating and further compress the spring, thereby effecting a controlled pressure at the strap's interface. This allows the pressure arm 12 to advance slightly pulling away from the stop screw 17. The screw 17 reduces unnecessary pressure spring preload travel. When the cam follower 11 is at its full travel, the machine is at its reversal point, and a limit switch (not shown) is actuated by the cam shaft 4 which causes the motor to immediately reverse.

At reversal, the cocking cam 5 has been rotated to assume a vertically centered symmetrical position beneath the trigger 16. As the sealer carriage 15 swings up into working position, it carries trigger 16 along with it, and the trigger swings up in between the cocking cam teeth 5*a* and 5*b*, being synchronized by proper spacing of the teeth to prevent interference. As the drive chain C reverses, the strap tends to go slack but the tension pulled on the strap convolution surrounding package P is retained by the interface pressure applied against anvil 1 by hammer 9. The motor reversal also reverses cam shaft 4, causing it to rotate counterclockwise.

During counterclockwise rotation of shaft 4, the pin 7 attached to the cocking cam 5 initially rides free in the slot 8 of the barrel cam 6 allowing the barrel cam to remain stationary while the cocking cam rotates relative to it. As the cocking cam 5 rotates, its trailing tooth 5*b* contacts the trigger 16 pivoting it in a clockwise direction about the axis of torsion bar 22 to the position at FIG. 11. The trigger, through a positive drive socket 21, twists the torsion bar 22, which has its rear end securely fastened in the rear socket 23 to prevent rotation of the rear end. The trigger 16 also drives the swing

hammer 9 to the position shown in FIG. 11, and the swing hammer 9 slides the outside or lower strap layer over the inside or upper strap layer due to teeth on its contact surface. The strap moves in a direction to slacken the tension on the package.

The cocking cam tooth 5*b* continues rotating the trigger 16 until ultimately it releases the trigger. At this instant, the torsion bar 22 has stored the necessary energy (500—750 inch-pounds of torque for a one-fourth inch strap) to make a joint by the bodily sliding friction-fusion technique such as is described in Stensaker et al. application Ser. No. 479,446, filed Aug. 13, 1965 now U.S. Pat. No. 3,442,732 which issued May 6, 1969. The releasing of the trigger 16 by the cocking cam tooth 5*b* allows the torsion bar 22 to return to a relaxed state being impeded only by the frictional force at the strap's interface and whatever small resistance the remaining strap tension and mounting bearings offer. The torsion bar 22 has more energy stored than the resistances offer, therefore, it oscillates very rapidly as a pendulum for a few cycles until substantially all the stored energy has been transferred to heat energy. The heat is mainly concentrated at the strap's interface regions, which melts the plastic material the strap is made of.

After the straps' surfaces are molten, the pressure applied by the hammer 9 is retained long enough to solidify the plastic material thereby effecting a securely fused joint. As the joint is fusing, pin 7 in the cocking cam 5 moves into engagement with the end of the slot 8 in the barrel cam 6 to rotate the barrel cam in a counterclockwise direction and move its cam surfaces to allow the cam follower 11 to start back to its initial position.

The pressure spring 14 swings the pressure arm 12 back until it contacts the stop screw 17. Further travel is imparted to the arm by a return ramp 6*d* (FIG. 10) of the barrel cam flange 6*a*. The pressure arm 12 acts against stop screw 17 to swing the sealer carriage 15 clockwise about shaft 13, and the sealer carriage pulls the swing hammer 9 down away from the straps.

Generally D-shaped finger carriages 19 (FIG. 7) are mounted along opposite sides of the sealer section to rotate about pivot pins 27 carried in fixed outboard lug portions 19L. When the finger carriages are in their rest position as shown in FIG. 9, rollers 18 on the depending lower ends of the finger carriages are nested within downwardly opening slots 15S (FIG. 8) of the sealer carriage 15 so that upward swinging movement of the carriage towards working position cams the rollers 18 to shift the finger carriages forwardly or to the right as viewed in FIG. 7, to a position where the finger portions 20 project into the plane of the strap path for interference with the strap as shown at the left in FIG. 11.

When the strap is raised to the level shown in FIGS. 2, 3 and 9, finger abutment 20 is spaced rearwardly of the strap path, so that the strap is free to move to the rest position elevation above the finger portion 20. The abutment 20 on the left hand finger 19 thereafter shifts forwardly during upward swinging movement of the carriage 15 to a position below the strap. Now with the carrier chain moving counterclockwise, it pulls the supply strap back down to wrap around left hand finger abutment 20 as shown in FIG. 11. Tension reactions of the strap cause the left hand finger 20 to pivot the left hand finger carriage 19 clockwise about axis 27. The left hand finger carriage thereby brings its left hand shipper finger 29 into contact with a left hand return finger 30 (FIG. 7*a*.

As the sealer carriage 15 is fully raised into sealing position, that is from FIG. 8 to FIG. 10, a link 24, which has one end connected to the upper forward portion of carrier 15, is pushed up. The other end of link 24 is connected to a pivotally mounted release pawl 25, and upward movement of link 24 rotates release pawl 25 in a clockwise direction. A release catch 26 is pivotally mounted above and to one side of pawl 25, and a tang 25*a* on pawl 25 rotates release catch 26 counterclockwise until the tang 25*a* moves past a catch tang 26*a* on release catch 26. A foot 25*b* on pawl 25 kicks another tang 26*b* on catch 26 to return the catch to its initial position. The sealer carriage 15 during return movement clockwise, that is, from FIG. 10 to FIG. 8, pulls the link 24 down to rotate release pawl 25 counterclockwise. Release pawl tang 25*a* contacts the release catch tang 26*a* to rotate release catch 26 clockwise, but the release catch 26 contacts a stop pin 31 in anvil 1 which stops rotation of the release catch. The locked release catch 26 is then forced back carrying the anvil 1 and compressing the return spring 28. When the pawl 25 has rotated nearly its full travel, tang 25*a* moves out of engagement with catch tang 26*a* to release catch 26, and the return spring 28 forces the anvil 1 back to its strap engaging position.

The rotation of the cam shaft 4, simultaneously with causing return of the sealer carriage 15, brings cam surface 32 on arm 34 into contact with cam follower 33 to swing arm 35 from the FIG. 8 to the FIG. 8*a* position. A cam art stop pin 32P (FIG. 8*a*) is arranged so that the cam arm 34 is free to pivot in one direction only about an axis 34A so as to bypass the cam follower 33 when the cam shaft 4 was rotating clockwise, as viewed in FIG. 9. The cam follower 33 causes gripper and cutter actuation arm 35 to rotate clockwise about pivot shaft 36, and an abutment 35*a* at the upper end of arm 35 contacts a pin 37 to drive a gripper and cutter carriage 38 to the right against spring 39. A guide rod 47 is fixed to carriage 38 and extends through spring 39 and through a suitable opening in the support frame.

Pins 41 extend upwardly from gripper and cutter carriage 38 through elongated slots 2*a* in grippers 2, and as arm 35 moves carriage 38 to the right from the position of FIG. 7 toward the position of FIG. 7*b*, carriage 38 moves pins 41 back until the pins contact the end of the gripper slots 2*a*. Pins 42 are fixed relative to the machine frame, and the inner ends of grippers 2 are pivotally mounted on pins 42, so that further motion of carriage 38 to the right causes the grippers 2 to rotate about pins 42, pulling the gripping arms 2*b* out of the strap path, as shown in FIG. 7*b*, with the right hand gripper 2 thereby releasing the strap. A cutter blade 40 is attached to the carriage 38 and is also pulled back out of the strap path as the carriage is retracted by actuation arm 35. The action of retracting the grippers 2 is timed to occur prior to the full retraction of the anvil 1.

When the anvil 1 is near its full retraction, the fused straps are released to freely snap out from under the anvil. At this time, fingers 20 remain in the strap path and the strap from the supply reel is still wrapped around the left hand finger 20 in a fashion to spread the straps to straddle the anvil path, as shown in FIG. 11*a*. This insures that the anvil will return between the fused straps and the supply strap as it moves forwardly. As the anvil 1 is retracting, it moves upright pins 43 at the rearward end of the anvil to cause left hand return finger 30 to swing about a fixed pin 44, it being understood that slots 44*a* in fingers 30 allow the fingers to move longitudinally relative to the anvil. At a stroke just short of full anvil retraction, the end of the left hand return finger 30 has moved from the position of FIG. 7*a* to the position of FIG. 7*b* out of contact with left hand finger carriage shipper finger 29. This allows the back tension of the supply strap, which is wrapped around left hand finger 20, to pivot the left hand finger carriage 19 inwardly to its full travel. This moves the left hand shipper finger 29 rearwardly to the left hand return finger 30, as is illustrated in FIG. 7*b*.

When the anvil 1 is released and returned to strap engaging position (FIG. 11*b*) it pulls pins 43 with itself to rotate the return fingers 30 back to their initial position, but since the left hand shipper finger 29 now lies in the path of the left hand return finger, the left hand return finger contacts the left hand shipper finger 29 pushing it to the left from the position shown in FIG. 7*b*. The left hand shipper finger 29 moves the left hand finger carriage 19 and the left hand finger 20 back out of the strap path releasing the supply strap, as is shown in FIG. 11*b*. The left hand finger carriage 19 is now free to rotate back to its initial position, as shown in FIG. 7. The back tension of the supply strap takes up the slack caused by the retraction of the

left hand finger 20, and the supply strap now pulls up to wrap around the extended anvil, as shown in FIG. 11*b*. Shortly after the supply strap is snubbed around the anvil, as shown in FIG. 11*c*, the cam arm 34 rotates out from under cam follower 33 to allow the gripper and cutter carriage 38 to be pushed back to its initial position FIGS. 7 and 8) by spring 39.

When the carriage 38 was pulled back initially (FIG. 7*b*) and pins 41 contacted the end of the gripper slots 2*a*, ramps 2*c* on grippers 2 move into contact with gripper advance plungers 45 in carriage 38 to force the plungers 45 back compressing springs 46. Now when the carriage 38 is returning and pins 41 tend to travel to the other end of the gripper slots 2*a*, the springs 46 force plungers 45 to follow the ramps 2*c*, thus keeping the same end of the gripper slots 2*a* in contact with the pins 41. This, in turn, allows the grippers 2 and their arms 2*b* to be in an advanced position relative to pivot pins 42. The cutter 40, being attached to the carriage 38, is also moved toward its initial position and contacts the edge of the supply strap which is now snubbed around the anvil 1, as shown in FIG. 11*c*. The spring 39 exerts the force required to cut the strap at a plane just above the top of the anvil.

As the cutter blade 40 is being driven through the supply strap, the advanced position of the left hand gripper 2 causes its arm 2*b* to contact the portion of the supply strap just below the top of the anvil 1. This occurs before the blade 40 has completely severed the supply strap. The left hand gripper 2 stops rotation and the pin 41 leaves the back of the slot 2*a*. This allows the spring 46 to impart its force through the plunger 45 against the ramp 2*c* to supply a small pinching force by the left hand gripper arm 2*b* on the supply strap against the anvil 1. At this time, the back tension on the supply strap is light. The carriage 38 continues its advancement causing the cutter 40 to completely sever the strap. When the carriage 38 nearly completes its travel, the pins 41 contact the other end of the gripper slots 2*a*. The spring 39 then imparts its force through the pins 41 to cause the left hand gripper 2 to apply a large pinching force against the strap. This force is sufficient to hold the strap when high tensions are pulled during the wrap cycle. A switch is tripped by the mechanism to stop the motor.

The machine is now ready for another cycle but in the opposite, i.e., counterclockwise, wrap direction. It may now be noted that the right hand finger carriage 19 was returned to its initial position when the sealer carriage 15 returned to its initial or rest position since there was no strap to rotate its roller 18 out of engagement with the sealer carriage slot 15S.

It will be readily observed from the foregoing detailed description of the invention and in the illustrated embodiments thereof that numerous variations and modifications may be effected without departing from the true spirit and scope of the novel concepts and principles of this invention.

I claim:

1. Apparatus operative upon a length of flexible binding having a free end and a supply end for forming a loop of binding material about an object comprising:

carrier means in skip feeding engagement with a portion of said binding between said free end and said supply end;

means for engaging and holding the free end of said binding;

interengaging chain and sprocket means for moving said carrier means along a closed path around said object to transport said binding around said object and form a loop having overlapping regions;

further chain and sprocket means for taking up slack in said binding during a portion of the movement of said carrier means and for paying out slack during a further portion of the movement of said carrier means;

means for sealing said overlapping regions to one another;

and means for severing said loop from said supply end.

2. Apparatus as set forth in claim 1 wherein said carrier means is defined by at least one pair of spaced rollers associated with said chain means, said binding being freely interleaved between said spaced rollers.

3. Apparatus for compressing and sealing overlapping strap portions comprising:

an anvil having a strap engaging surface;

carrier means including an actuator;

a hammer mounted on said carrier means and having a strap engaging surface;

means for oscillating said hammer relative to said carrier means including an actuator at a fixed location; and

means mounting said carrier means for movement between a first position wherein said hammer is spaced from said anvil and said carrier member actuator is spaced from the actuator at said fixed location, and a second position wherein said hammer surface is positioned in juxtaposed relationship with respect to said anvil surface to compress said overlapping strap portions against one another with a predetermined amount of force and to locate said carrier member actuator in operative association with the actuator at said fixed location.

4. Apparatus for compressing and sealing overlapping strap portions comprising:

an anvil having a strap engaging surface;

carrier means including an actuator;

a hammer mounted on said carrier means and having a strap engaging surface;

means for oscillating said hammer relative to said carrier means including an actuator at a fixed location and a torsion bar having one end fixed to said carrier means and the other end connected to said hammer, said carrier member actuator being a trigger fixed to said torsion bar and having an abutment thereon, and said other actuator being a cocking cam having at least one abutment thereon engageable with said trigger abutment to stress said torsion bar; and

means mounting said carrier means for movement between a first position wherein said hammer is spaced from said anvil, and a second position wherein said hammer surface is positioned in juxtaposed relationship with respect to said anvil surface to compress said overlapping strap portions against one another with a predetermined amount of force and to locate said carrier member actuator in operative association with the actuator at said fixed location.

5. Apparatus as set forth in claim 4 wherein said cocking cam has a pair of spaced abutments engageable with said trigger abutment for stressing said torsion bar upon movement of said cam in either of two opposite directions.

6. Apparatus as set forth in claim 5 wherein said cam is mounted for rotation with a cam shaft, with the rotation of said cam shaft being synchronized with the carrier member movement so that said trigger abutment is positioned between said cam abutments when said hammer is in said second position.

7. Strap gripping apparatus comprising:

an anvil;

a carrier mounted for movement between a first position adjacent said anvil and a second position removed therefrom;

means biasing said carrier toward said first position;

a gripping finger mounted for pivotal movement relative to said anvil between an active strap gripping position and an inactive strap releasing position

means on said carrier for moving said gripping finger from active to inactive position upon movement of said carrier from said first to said second position, and for moving said gripping finger from inactive to active position upon movement of said carrier from second to first position;

and means for moving said carrier against said biasing means from said first to said second position.

8. Apparatus as set forth in claim 7 wherein said gripping finger includes a slot, and wherein said carrier member means includes an abutment received in said slot for effecting controlled movement of said gripping finger between said active and inactive positions.

9. Apparatus as set forth in claim 8 wherein said slot has a dimension larger than said abutment whereby a lost motion connection is provided between said gripping finger and said

carrier, and wherein said carrier includes means for retaining said abutment at one end of said slot during movement of said finger from inactive to active position so that said gripping finger will reach active position before said biasing means returns said carrier to said first position.

10. Apparatus as set forth in claim 9 wherein said last mentioned retaining means includes a plunger movable relative to said carriage, and spring means biasing said plunger into engagement with said gripping finger.

11. Apparatus as set forth in claim 10 wherein identical gripping finger structures are provided at opposite sides of said anvil for use in apparatus for forming successive strap loops by feeding strap in opposite direction.

12. For use in apparatus for draping a strap loop about an object and for sealing overlapped end portions of the strap at a sealing station, an anvil structure comprising:

an anvil mounted for movement between a first position at said sealing station and a second position removed therefrom;

means urging said anvil into said first position during strap draping and sealing operations;

carrier means;

a hammer on said carrier means and movable toward said anvil when said anvil is in said first position for compressing overlapped strap portions therebetween; and

means for moving said anvil to said second position when a sealing operation is completed, said anvil moving means being conditioned for actuation by movement of said hammer toward said anvil.

13. The invention set forth in claim 12 wherein said anvil structure further includes a first gripping means for retaining a strap end against said anvil during a first strap draping and sealing operation; a second gripping means for retaining a further strap end against said anvil during a second strap draping and sealing operation; and common means for moving said first and second gripping means between a gripping position and a release position.

14. The invention set forth in claim 12 in which said hammer is movable away from said anvil to a rest position when a sealing operation is complete and wherein the means for moving the anvil to second position includes an abutment on said anvil and a cooperating abutment on said carrier means engaging said anvil abutment upon movement of said hammer toward said rest position.

15. The invention set forth in claim 14 wherein said carrier abutment moves out of engagement with said anvil abutment before said hammer reaches the rest position, whereby said urging means moves said anvil to first position.

16. The invention set forth in claim 15 in which said carrier abutment is a catch pivotally mounted on said carrier means and having an abutment surface engaging said anvil abutment, and wherein a release pawl is pivotally mounted on said carrier means for moving past said catch during movement of said hammer toward said anvil to condition said catch for moving said anvil to said second position as said hammer moves toward said rest position.

17. Apparatus for gripping and retaining strap portions in overlapping relationship comprising:

an anvil having a strap engaging surface;

a hammer having a strap engaging surface; and

means for moving said hammer relative to said anvil to compress overlapping strap portions between said strap engaging surfaces including, carrier means having said hammer thereon, means mounting said carrier means for movement between a first position wherein said hammer is spaced from said anvil and a second position wherein said hammer surface is positioned in juxtaposed relationship with respect to said anvil surface, regulating means mounted for movement relative to said carrier means, and means biasing said carrier means outwardly of said regulating means for urging said hammer surface toward said anvil surface to compress said overlapping strap portions against one another with a predetermined amount of force.

18. Apparatus as set forth in claim 17 wherein said mounting means includes a shaft pivotally supporting said carrier means.

19. Apparatus as set forth in claim 18 wherein said regulating means includes a pressure arm pivotally mounted on said shaft, said biasing means being defined by a spring acting between said pressure arm and said carrier means.

20. Apparatus as set forth in claim 19 wherein said pressure arm includes a cam follower thereon, and wherein said hammer moving means includes cam means engageable with said cam follower.

21. Apparatus as set forth in claim 20 including means for adjusting the position of the pressure arm relative to the carrier.

22. Apparatus as set forth in claim 21 wherein said cam is shaped to move said pressure arm away from said adjusting means in the second position of said hammer, whereby said pressure arm compresses said spring to thereby compress said overlapped strap portions with said predetermined force.

23. Apparatus for compressing and sealing overlapping strap portions in a strap path comprising:

first and second members for compressing overlapping strap portions therebetween, said first member being an anvil having a strap engaging surface and said second member being a hammer having a strap engaging surface;

means for effecting relative movement between said first and second members between a spaced position and a strap compressing position, said relative movement effecting means including movable carrier structure supporting said hammer for bringing said hammer surface into juxtaposition with said anvil surface to compress the overlapping strap portions therebetween;

strap holding means; and

means responsive to said relative movement for moving said strap holding means between an inactive position spaced from said strap path and an active position in the plane of said strap path for holding a further portion of the strap adjacent said overlapped portions, said means for moving said strap holding means including cooperating abutments on said carrier structure and said strap holding means.

24. Apparatus as set forth in claim 23 wherein said holding means is defined by an arm having an intermediate portion mounted for pivotal movement, with one of said abutments being provided at one end of said arm and with a strap holding finger being provided at an opposite end of said arm, said finger being adapted to pivot said arm when said further portion of strap is wrapped therearound.

25. Apparatus as set forth in claim 24 wherein a pair of identical arms are provided at opposite sides of said anvil for performing strap holding functions during successive strapping cycles.

26. Apparatus as set forth in claim 25 including means mounting said anvil for movement out of said strap path after a sealing operation is completed, said holding means further including means responsive to movement of said anvil out of said strap path for moving the abutment on said pivoted arm out of said strap path.

27. Apparatus as set forth in claim 26 wherein said holding means includes a stop that is positioned by pivotal movement of said arm, and wherein said anvil includes a shifting link engageable with said stop for effecting return movement of said holding means.

28. Apparatus as set forth in claim 27 wherein said link has an abutment at one end engageable with the holding means stop, the opposite end of said link being pivotally connected to said anvil and an intermediate portion of said link being connected to said anvil by a lost motion guide means.

29. Apparatus as set forth in claim 25 in which said fingers are alternately operative during successive strapping cycles, the nonoperating finger being moved between said active and inactive positions by said cooperating abutments, and wherein means is provided on said anvil for moving the operating finger from active to inactive position upon movement of said anvil out of said strap path.