Oct. 23, 1962 E. J. VORRATH ET AL 3,059,386

STRAPPING MACHINE

Filed Dec. 2, 1959 6 Sheets-Sheet 1

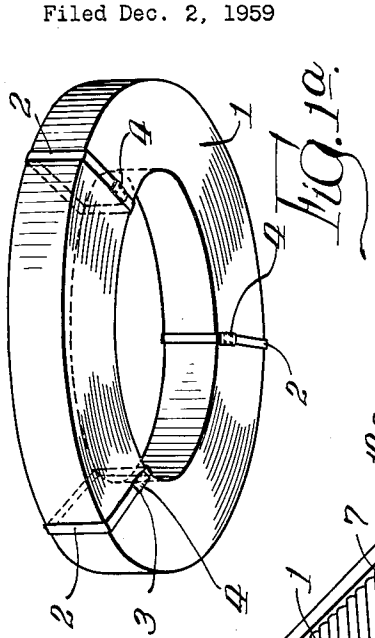


FIG. 1a.

FIG. 1.

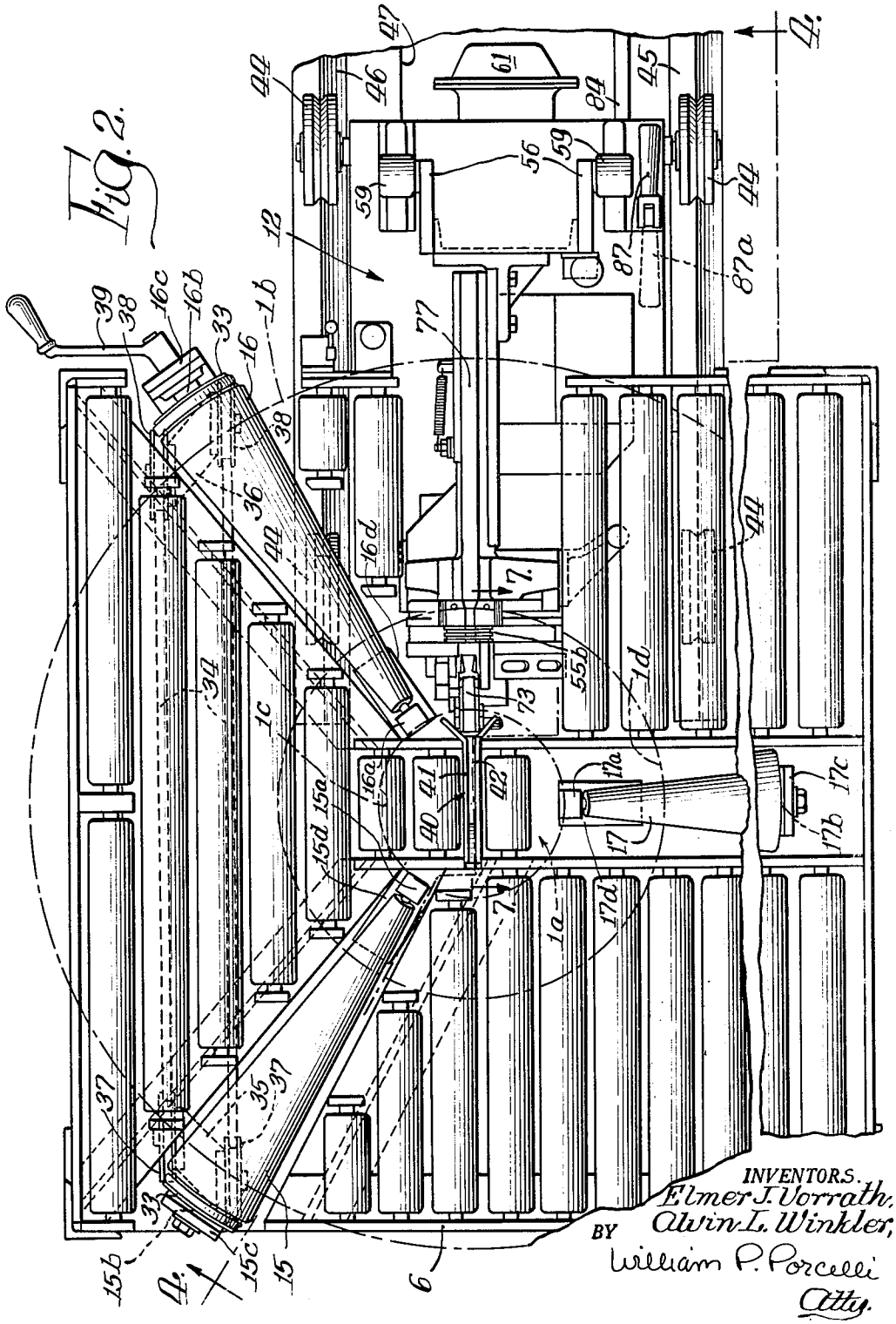
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FIG. 2.



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STRAPPING MACHINE

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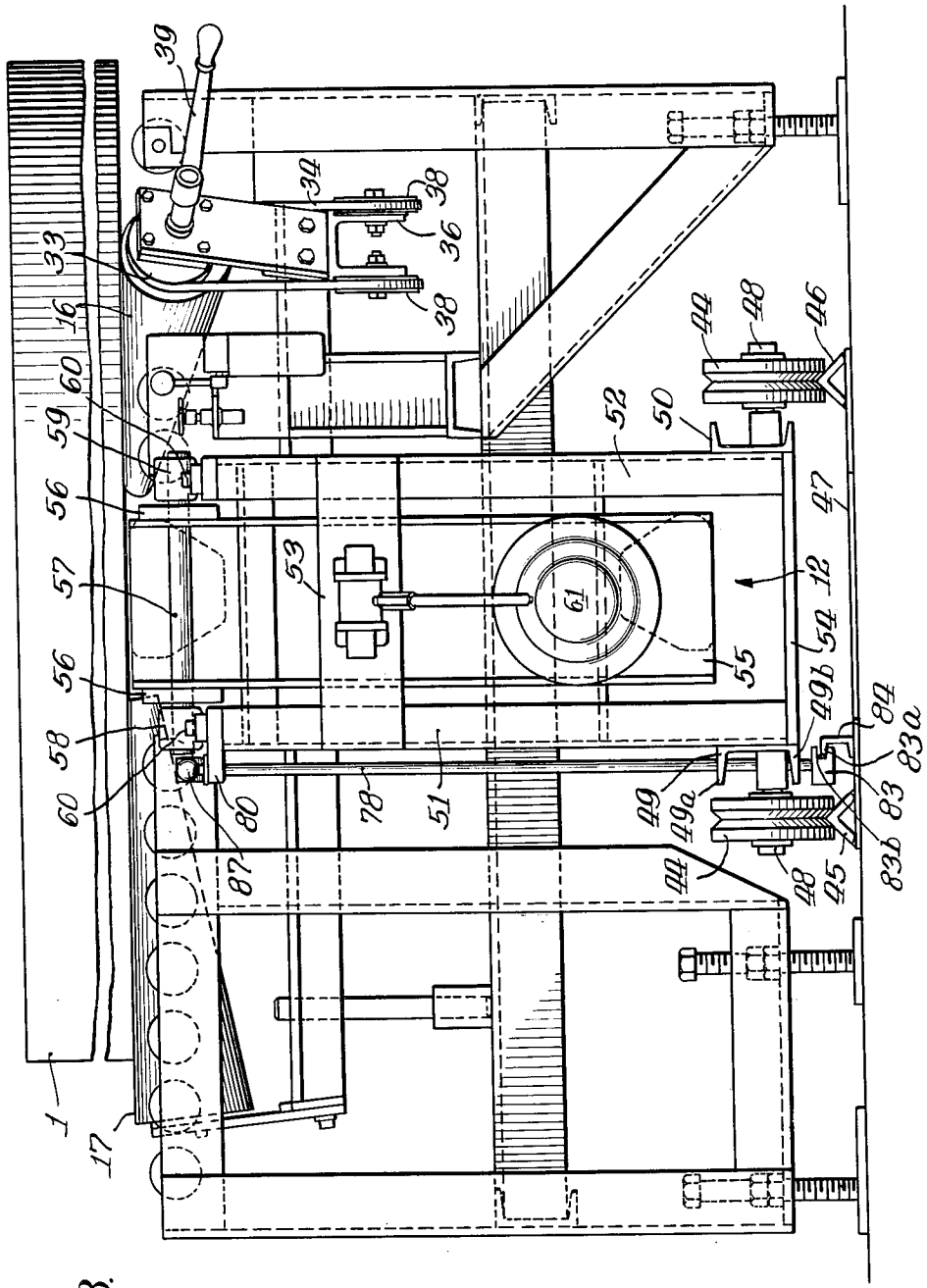


FIG. 3.

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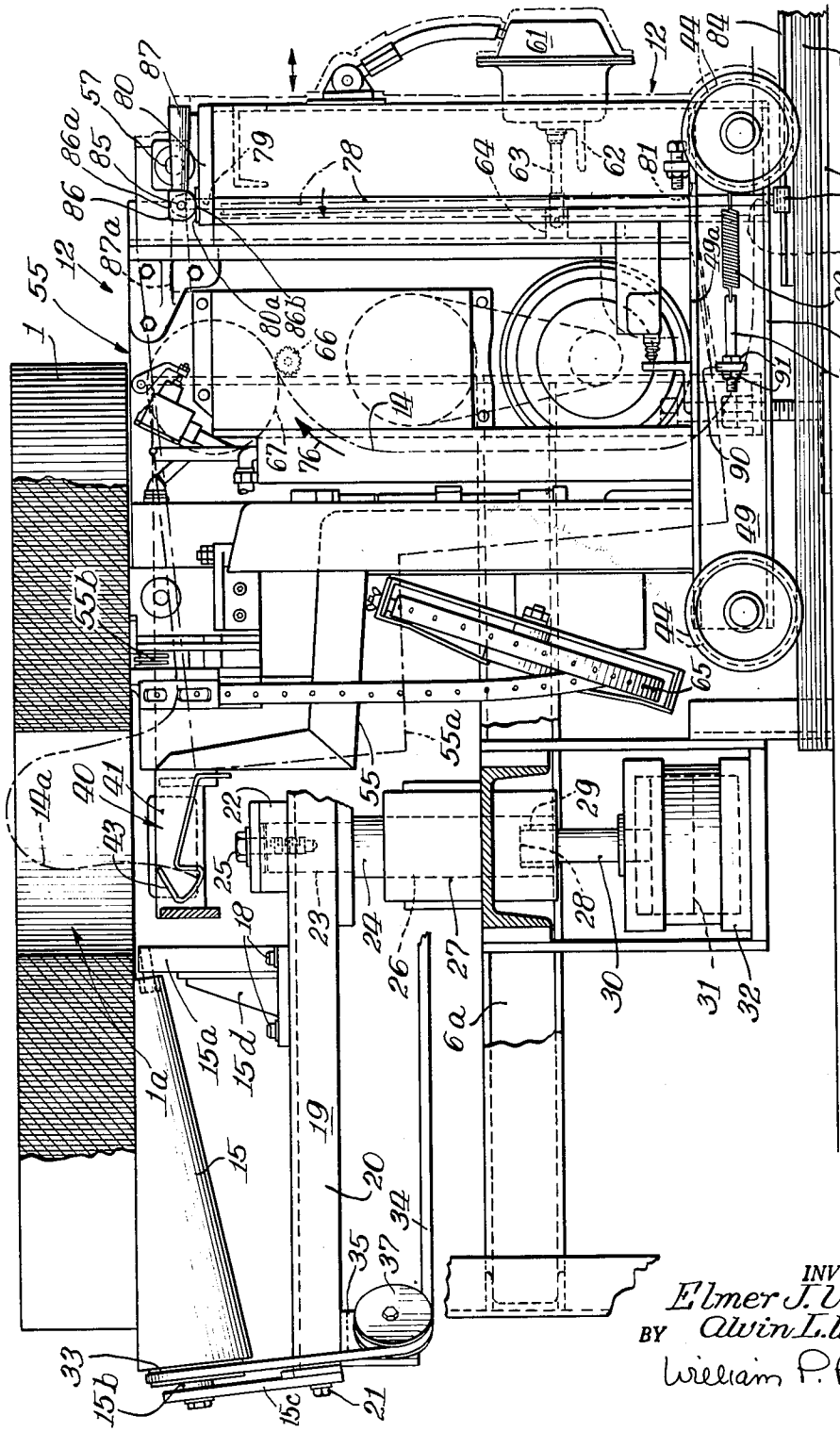


Fig. 4.

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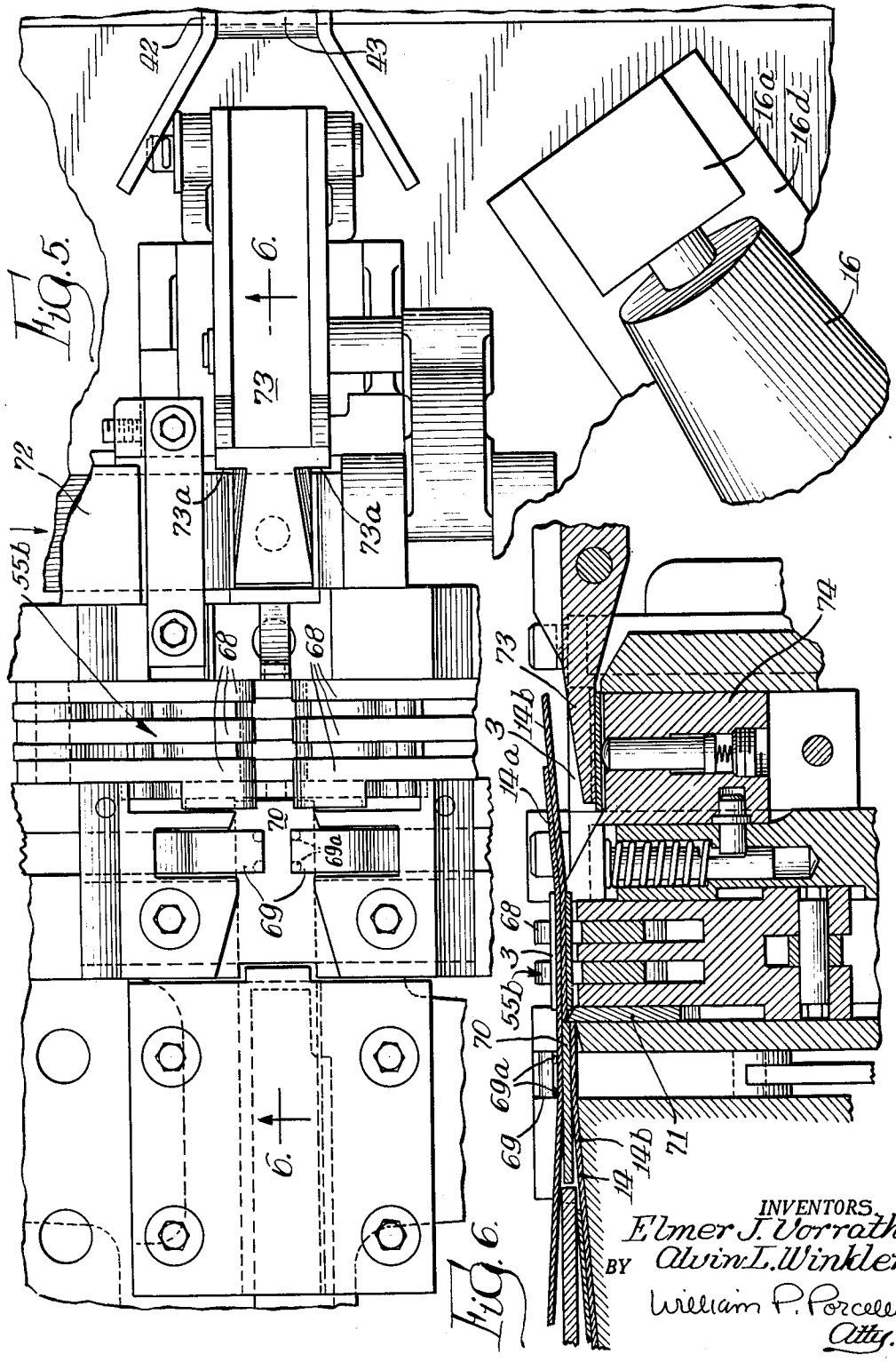


Fig. 5.

Fig. 6.

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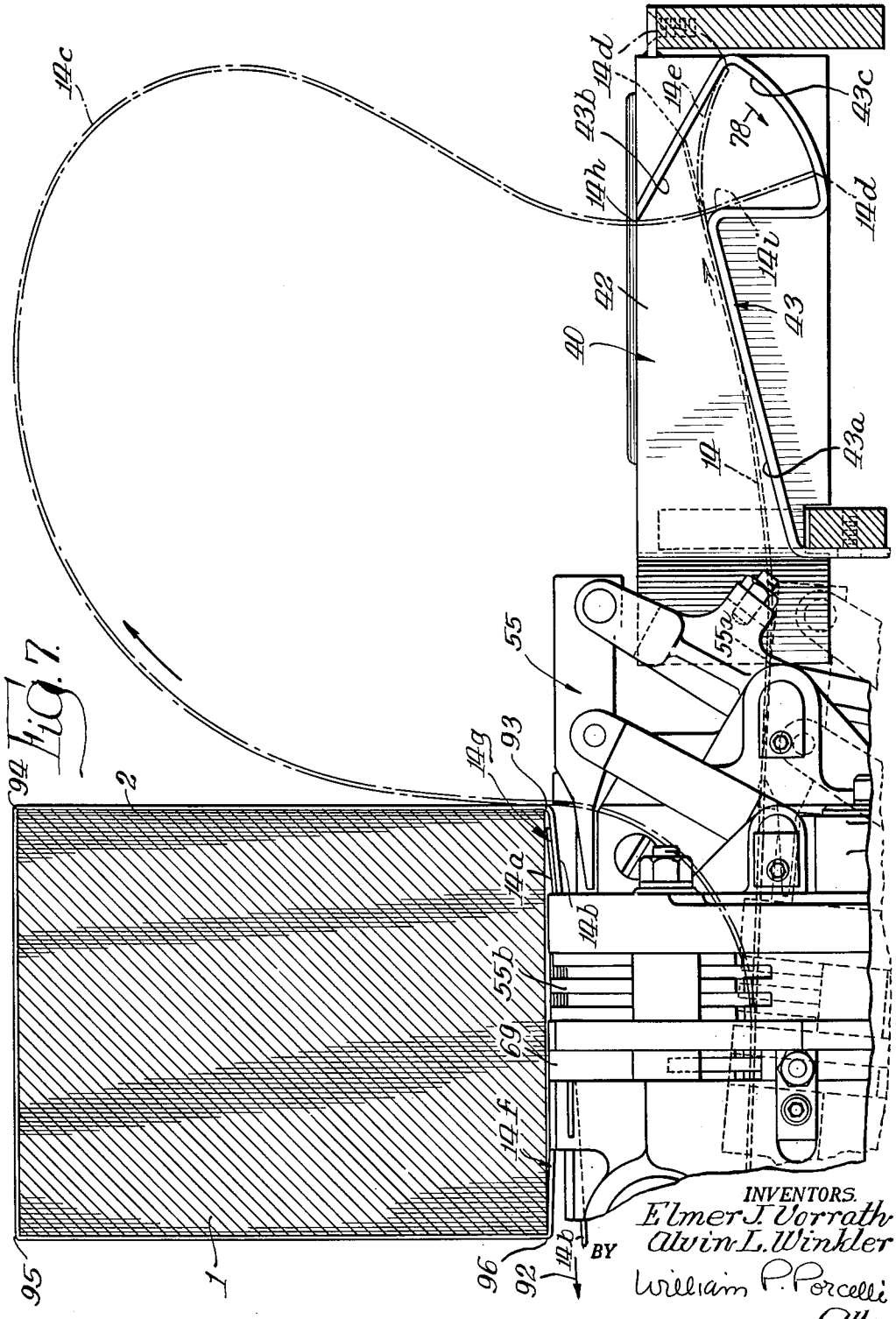


FIG. 7.

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United States Patent Office 3,059,386 Patented Oct. 23, 1962

3,059,386

STRAPPING MACHINE

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Filed Dec. 2, 1959, Ser. No. 856,853
25 Claims. (Cl. 53—13)

This invention relates to the art of strapping and particularly to the art of encircling a binding strap fed endwise into a loop about an object and thereafter securing the resultant overlapping strap ends of the loop into interlocking engagement with each other to thereby secure the strap loop as a binder on the object.

According to a common practice, in order to retain the convolutions of a tightly wound coil of metal strip such as metal binding strap, binding straps are secured as closed strap loops radially around the annular portions of the coil. In order to position the straps, a widely used method is to feed the strap endwise and manipulate the strap end into a loop about the annular portions of the coil. In doing this, auxiliary strap guide means can be used to facilitate the manipulation. Where the coils are delivered on a conveyor system the auxiliary strap guide means is usually limited to guiding the strap at a level below the delivery height of the coil because the guide cannot project above the level of the conveyor where it would interfere with movement of the coil. For this reason the guide usually does not help much toward directing the strap end to a position where it can be conveniently grasped by the worker and, so, it is ordinarily necessary for the worker to reach down into the center of the coil to grasp the strap end prior to encircling the strap on the coil, or else, if the guide directs the strap through the center of the coil, it ordinarily directs it away from and beyond the normal reach of the worker. In order to overcome this difficulty, it is the principal object of the invention to provide an improved guide means which assists the worker by causing the strap end, upon endwise feeding of the strap, to bulge upwardly through the central opening of the coil where a worker can conveniently grasp it. It is another object of the invention to provide such an improved guide means which causes the strap end to bulge upwardly through the central opening of the coil, which bulge can be regulated in size by mere regulation of the amount of strap feed, thus enabling the worker to grasp the strap at whatever level is convenient for him.

It is another object of the invention to provide a strap guide of the type mentioned which is aplicable for use on a strapping device wherein the strap feed is performed completely by hand or is readily adapted for use with means which automatically or semi-automatically feeds the strap and secures the overlapping ends of the strap loop together after the loop is encircled about the coil portions.

It is another object of the invention to provide an improvide strapping device having a strapping head for tensioning and joining together the ends of a strap loop encircled about an object which strapping head is mounted in such a way that it can be locked in position relative to its support but still be provided with a floating action which insures acquiring equalized tension of the strap loop on the coil during the strap tensioning period.

It is still another object of the invention to provide an improved strapping device embodying both the improved strap guide of this invention which is used for assisting in the formation of the strap loop around the coil portions and a strapping head of a type which is used to feed the strap, tension the strap, and secure the overlapping strap ends of a loop encircled about a coil portion, wherein the strapping head is movably mounted in such a way

that it can be locked in position relative to its support but still be provided with a floating action which insures acquiring equalized tension of the strap loops on the coil when the strapping head causes the strap to be tensioned.

It is another object of the invention to provide an improved method of making a binder strap available for conveniently encircling it around an object.

Another object is to provide an improved method of making a binder strap available for conveniently encircling it around an annular object.

Other objects and advantages of the invention should become apparent by referring to accompanying drawings in which

FIG. 1 shows a perspective view of the upper portions of a strapping apparatus embodying the invention and includes a showing of the relative position of a worker using the apparatus to strap coils of strip material;

FIG. 1*a* shows a perspective view of a coil of strip material after it has been strapped with the apparatus of FIG. 1;

FIG. 2 shows a top plan view of the strapping apparatus embodying the invention;

FIG. 3 shows an upper elevation of the apparatus of FIG. 2;

FIG. 4 shows a sectional view along the line 4—4 of FIG. 2;

FIG. 5 shows an enlarged view of a portion of the strapping head as viewed in the central region of FIG. 2;

FIG. 6 shows a sectional view of strapping head portions along the line 6—6 of FIG. 5, and

FIG. 7 shows a partial sectional view along the line 7—7 of FIG. 2 and particularly shows the relationship of the strapping head with the improved strap guide of this invention.

The apparatus of this invention is used to facilitate strapping of coils of strip material of the type shown in FIG. 1*a* where a coil 1, having been wound into an annular or ring shape, is provided by the apparatus with closed loops 2 of binder strap which are secured tightly in radial directions around annular portions of the coil in a radial direction. These loops 2 of strap are secured by joining together the two overlapping ends of the strap forming each loop by deforming the two overlapping strap ends and a tubular metal seal 3 encircling them to form a joint 4.

As shown in FIG. 1, a plurality of coils is supported on three conveyor units 5, 6 and 7. The conveyor unit 5 is any conventional roller type conveyor provided with free wheeling rollers 8 journaled to a supporting frame 9, the coils 1 being adapted to roll freely across the upper surfaces of the rollers 8, from a region where the coils are formed from continuous strip lengths. The conveyor unit 6 is actually part of the strapping apparatus embodying this invention and it has free wheeling rollers 10 of the same type as the rollers 8 of the unit 5 so that the coils 1 can be transported freely across their upper surfaces. After the coils 1 have been strapped they are passed beyond the rollers 10 to the conveyor unit 7 which is divided into two parts 7*a* and 7*b*, each being provided with free wheeling rollers 11*a* and 11*b*, respectively, on which the coils 1 can be easily transported.

Although the conveyor units 5 and 7 may be of any conventional type, the conveyor unit 6 is a necessary part of the apparatus associated with the strapping means of this invention. This unit 6 is associated with a strapping head 12 which is provided with means for feeding a length of strap endwise from a source of strap supply and is thereafter adapted to tension the strap by reverse endwise feeding of the strap after the strap is encircled in a loop about a coil portion, and then it secures together the overlapping strap ends of the loop encircling the coil portion and severs the supply of strap end from

the secured strap loop. One of the principal features of the invention is the apparatus providing for positioning the leading end of the strap where it is convenient for the operator to grasp it during the strapping operation. The manner of operation when strapping the coils 1 is for the operator to cause the strapping apparatus 12 to feed a length of strap endwise below the level of a coil 1 supported on the unit 6. The strap is fed as far as the region adjacent the central opening 1*a* of the coil 1. Ordinarily it is necessary for the operator or worker 13 to reach into the opening 1*a* and grasp the leading end 14*a* of the strap 14. He then manipulates the leading strap end 14*a* into a loop about an annular portion of the coil 1 in a direction radially of the coil and then inserts the leading strap end 14*a* beneath the coil in overlapping relationship with the supply strap end 14*b*. It is desirable to guide the leading strap end 14*a* up through the opening 1*a* of the coil 1 to a height above its upper level where it can more easily be grasped by the worker 13 but, when the ordinary guide is used which directs the strap through the center of the coil, it ordinarily is directed away and beyond the normal reach of the worker so that he must extend his reach to grasp the leading end 14*a*. Also, because the coils 1 must be freely passed over the rollers 10 of the conveyor unit 6, it is undesirable to have any guide projecting above the level of the rollers 10. Therefore, it is difficult to provide adequate guide means to accomplish the result without any upwardly projecting strap guide members. The manner of doing so is by providing a strap guide below the level of the rollers 10 which is provided with an abutment specially shaped to cause the leading strap end to be halted at its extreme end and thereupon caused to be bulged upwardly behind its extreme end into an upwardly extending bulge portion 14*c* or bubble of strap, as it is referred to, to a level where it can be conveniently grasped by the worker. The advantage of the bulge portion 14*c* is that there is no freely extending unsupported end extending randomly into the air which, due to its own springiness and flexibility, would tend to vibrate back and forth as it is fed to thereby make it more difficult for the operator to grasp. The bulge portion provides a length of strap formed into a loop whereby the leading end is held temporarily secured and the supply end is also restricted in movement with the result that the bulge portion 14*c* is relatively controlled in its movement and assumes a much more regulated path of movement than the situation where the free end of the strap is fed or discharged into the air in an unsupported manner. The effect of this is that the operator knows exactly where to reach for the bulge portion 14*c* of the strap and, consequently, is provided with greater facility for the strapping operation which is believed to make him more efficient by cutting down fatigue and thereby accelerating the strapping operation.

As particularly shown in FIGS. 1, 2, 3 and 4, the unit 6 consists of the rollers 10 which are of different lengths depending upon their location on the unit 6. In addition to the rollers 10, there are three tapered rollers 15, 16 and 17. These rollers are journaled at their near ends in vertically extending bearings 15*a*, 16*a* and 17*a*, respectively, and at their outer ends in bearings 15*b*, 16*b* and 17*b*, respectively, which are secured in substantially vertically extending plates 15*c*, 16*c* and 17*c*, respectively. The reason that the rollers 10 are of different lengths is to provide for the positioning of the tapered rollers 15, 16 and 17 in spaces between them (FIG. 2). The bearings 15*a*, 16*a* and 17*a* are secured to brackets 15*d*, 16*d* and 17*d* which are secured by means of screws 18 to a spider 19 having three radially extending arms 20, one for each of the tapered rollers 15, 16 and 17. Each of the brackets 15*c*, 16*c* and 17*c* are secured by means of screws 21 to the end of its respective arm 20 of the spider 19. The spider 19 is provided

at its central region with a hub 22 which fits over the upper end 23 of a shaft 24 and is held secured to this upper end 23 by means of a screw 25 passed through the outer end of the hub 22 and threadably engaging the shaft 24 in a longitudinally extending threaded hole. The shaft 24 passes through a circular hole 26 extending vertically through a sleeve 27 which is secured to an intermediate frame member 6*a* of the conveyor unit 6. The lower end of the shaft 24 is provided with an upwardly extending hole 28 which is provided with the upper end 29 of the piston rod 30. The fit between the upper end 29 of the piston rod is very loose so that space is provided between the outer wall of the piston rod and the inner wall of the hole 28. The lower end of the piston rod 30 is secured to a piston 31 contained in a cylinder 32. Upon proper introduction of fluid or air into the cylinder 32, the piston 31 is caused to move in such a way that the piston rod 30 is either extended or retracted. When the piston rod is extended, the spider 19 is elevated to cause the tapered rollers 15, 16 and 17 to likewise be elevated above the level of the top surfaces of the rollers 10. When this is done, a coil 1 resting on the rollers 10 above the positions of the tapered rollers 15, 16 and 17 is raised by these tapered rollers above the level of the rollers 10 so that the coil 1 rests only on the tapered rollers 15, 16 and 17. When the piston rod 30 is retracted, the tapered rollers 15, 16 and 17 are lowered below the level of the upper surfaces of the rollers 10 so that the coil 1 again rests upon the rollers 10 free and clear of the tapered rollers.

The outer ends of both of the rollers 15 and 16 are provided with integral flanged sheaves 33 which are encircled with portions of a continuous flexible belt 34. Secured to the under surfaces of the two arms 20 corresponding to the locations of the tapered rollers 15 and 16 are two depending inverted U-shaped brackets 35 and 36 which each rotatably support two additional sheaves 37 and 38. These sheaves are aligned parallel with each other and angularly with the sheaves 33 in a manner as particularly shown in FIG. 2 so that the continuous belt 34 passes below them and extends in straight paths between them. In this manner a continuous belt 34 passes up and over a first sheave 33, down around a sheave 38, over to and below a sheave 37, up and around the other sheave 33, down to the other sheave 37 and around beneath it, and finally in a straight path over to the first mentioned sheave 38 to complete the closed circuit path. The shaft of the tapered roller 16 extends outwardly beyond the sheave 33 attached to it and the shaft is provided with a hand crank 39 which may be used to rotate the tapered roller 16 on its axis. While so doing, the continuous belt 34 is also actuated as the corresponding sheave 33 is rotated with the tapered roller 16. Movement of the continuous belt 34 is transmitted to the other sheave 33 attached to the tapered roller 15 with the result that the roller 15 is similarly rotated when the roller 16 is. The purpose of rotation of these two rollers 15 and 16 is to cause the coil 1 positioned on the rollers to be rotated after a strap is secured to it so that a strap may be secured in a new location on the coil without relocating the strapping unit 12.

The conveyor unit 6, in addition to being provided with the rollers 10, 15, 16 and 17, and their related supporting structure, is also provided with a special strap end guide 40 at its central region approximately at the point of convergence of the three axes of the tapered rollers 15, 16 and 17. This is the region above which the central opening 1*a* of a coil 1 is automatically positioned for strapping purposes. The strap end guide 40 consists of two side plates 41 and 42 which are used to radially guide the leading strap end 14*a* when it is fed into the strap end guide. These side plates 41 and 42 are securely mounted in a permanent position to the frame of the conveyor unit 6. Between the two side plates 41 and 42

is secured to a strap end stop 43 which is a specially shaped flat strip for accomplishing one of the main objects of the invention. This strap end stop 43 is explained in more detail hereinafter.

The strapping apparatus 12 embodied as part of the invention is supported by four grooved wheels 44 which ride on two inverted V-shaped tracks 45 and 46 which rest on a plate 47 secured to the floor. These wheels 44 are journaled freely on shafts 48 which are secured to two parallel frame members 49 and 50 which have secured to them vertical frame members 51 and 52. These vertical frame members 51 and 52 are held parallel to each other by means of a transverse frame member 53 and also by a plate 54 also secured between the frame members 49 and 50. All of the frame members 49, 50, 51, 52, 53 and 54 provide an integral carriage for the support of a strapping head 55. The strapping head 55 is provided at its upper end with apertured ears 56 which are trunnioned through their apertures on a shaft 57. The shaft 57 has its two ends journaled in pillow blocks or bearings 58 and 59 mounted by means of screws 60 to the upper ends of the frame members 51 and 52. In this manner the strapping head 55 is pivotally mounted on the shaft 57 so that it can pivot between the position shown in bold outline at 57 and its position as shown in dotted lines 55*a* in FIG. 4. The means for causing the pivotal movement of the strapping head 55 is an air cylinder 61 secured on an L-shaped frame member 62 secured between the two vertical members 51 and 52. The cylinder 61 is provided with a piston rod 63 which is pivoted to a projection 64 at the rear end of the strapping head 55. When air or other fluid is properly admitted to the cylinder 61, the piston rod 63 is either caused to extend or retract. When it is extended, it causes the strapping head 55 to pivot in a clockwise direction as viewed in FIG. 4 and, when it is retracted, it causes the strapping head to be pivoted in the opposite direction. Clockwise pivoting of the strapping head 55 raises the joint forming mechanism 55*b* of the strapping head 55 to be elevated up to the region of a coil 1 resting on the tapered rollers 15, 16 and 17 where it can be used to secure the overlapping ends of a strap loop encircled on the coil 1. Pivotal movement of the strapping head 55 in a counter-clockwise direction causes the joint forming mechanism 55*b* to be lowered away from the coil region and aligns strap guide portions of the strapping head 55 in its proper strap feeding relationship with the strap end guide 40 in preparation for the beginning of a strapping cycle.

The strapping head 55 can be of many different forms and, in some cases, can be entirely eliminated, provided hand tools would be used for the formation of a strap joint. The advantage of using a strapping head 55 of the nature to be generally described is to accelerate the strapping cycle for increased speed and efficiency.

In addition to the joint forming mechanism 55*b*, the strapping head 55 may have a coil of strip 65 from which tubular metal seals can be formed in the head itself rather than providing preformed seals or clips as is sometimes ordinarily done. In addition, the strapping head 55 must be provided with some sort of strap feed mechanism which feeds the strap longitudinally in both a forward and reverse direction. Many forms of strap feed are possible and available. However, it is sufficient that the strap 14 be guided through the machine from a source of supply which may be in the form of a coil of strap material, in the ordinary situation, and have a toothed feed wheel 66 engaging the strap 14 against the periphery of an idler wheel 67. In this manner, rotation of the feed wheel 66 causes movement of the strap 14 around the idler wheel 67. In order to maintain the proper path of the strap through the strapping head, appropriate guide means can be used.

As an example of the type of strapping head 55 which may be used, FIGS. 5 and 6 show some of the details of such a unit. The joint forming mechanism 55*b* consists of a plurality of jaws 68 which can be appropriately actuated to deform a metal seal 3 encircled about two overlapping strap ends 14*a* and 14*b* to form a conventional interlocking type joint 4 as indicated generally in FIG. 1*a*. Before the joint is formed, the leading end 14*a* of the strap is gripped by means of two jaws 69 which press the strap end 14*a* against a plate 70 and grip it tightly by action of sharp projections 69*a* protruding from the tips of the jaws 69. After the joint is formed between the seal and the strap ends, a shear plate 71 is moved longitudinally to shear the supply of strap 14 from the strap loop 2 encircling the coil. The seal forming mechanism is generally indicated at 72 and consists of an anvil 73 over which a seal 3 can be formed into a U-shape as a U-shape plunger 74 is actuated against the anvil 73. After the seal 3 is formed, shoulders 73*a* on the anvil 73 are used to feed a seal 3 forward and in between the sealing jaws 68 in preparation for reception of the strap ends of a newly formed strap loop 2.

In general operation of the apparatus, the worker 13 stands in a position as shown in FIG. 1. In this situation, the coils 1 of strip are moved in the direction of the arrow 75 along the conveyor units 5, 6 and 7. An unstrapped coil 1 is moved manually from the conveyor unit 5 to strapping position centrally of the conveyor unit 6 to a position shown by dotted lines in FIG. 2 with the central opening 1*a* of the coil 1 positioned above the strap end guide 40. With the coil properly positioned, the strapping unit 12 is operated by power means within it to cause rotation of the feed wheel 66 in a clockwise direction as viewed in FIG. 4. This causes the strap 14 to be fed endwise in the direction of the arrow 76 (FIG. 4) and around the idler wheel 67, through the guide portion 77 (FIG. 2) of the strapping head 55, past the joint forming mechanism 55*b* and the anvil 73, and finally into the strap end guide 40 between its side plates 41 and 42. As particularly shown in FIG. 7, the strapping head 55 is lowered by pivotal movement on its shaft 57 to its lowermost position indicated by dotted lines 55*a* upon proper actuation of the air cylinder 61 so that its piston rod 63 is retracted. This position of the strapping head 55 aligns the strap guide means 77 so that the strap 14 fed longitudinally through it is directed at the proper level into the strap end guide 40 along an upwardly sloped surface 43*a* of the strap end stop 43. The extreme end 14*c* of the strap 14, in its longitudinal movement forward, strikes another downwardly sloped surface 43*b* of the strap end stop 43. The result of this is that the extreme end 14*d* is deflected in a path along the sloped surface 43*b* until it is arrested in its endwise movement by a downwardly sloped curved surface 43*c*. The downward deflection of the extreme end 14*d* creates an upward bow in the region 14*e* of the strap. As the strap 14 is continued to be fed forward, the action is such that the upward bow becomes larger in the form of a bulge portion 14*c* and extends into the opening 1*a* of the coil 1 and finally, if sufficient strap is fed, to a level well above the upper surface of the coil 1, as particularly shown in FIG. 1, where the operator can reach out to a position as indicated by dotted lines 13*a* to grasp the bulge portion 14*c* preparatory to forming the leading strap end 14*a* into a loop around a portion of the coil 1. As the upward bulge 14*c* develops, the strap engages the upper corner 14*f* of the guide and then pivots at this corner to cause the strap end 14*d* to slide around on the surface 43*c* in a reverse direction to the longitudinal travel of the strap 14 as indicated by the arrow 78. The location of the corner 14*f* is such that a locking action occurs on the strap end by its reaction between the corner 14*f* and the surface 14*g* of the guide so that the strap end is securely held in place.

After the operator or worker 13 grasps the bulge portion 14*c* of the leading strap end 14*a* he directs it in a looped path radially around an annular portion of the coil 1 in

a direction first toward him and then beneath the annular portion of the coil where a strap loop 2 is to be secured. This leading strap end is fed around far enough under the coil that it is delivered to the region of the strap gripping jaws 69. At that point, the strapping head 55 is caused to be actuated by power means which causes the gripping jaws 69 to grip the leading strap end 14*a* against the plate 70. It is also necessary that the leading strap end 14*a* be extended through a tubular seal 3 which, by proper operation of the strapping head, is already positioned within the joint forming mechanism 55*b*. Initially when the strap was fed forward, it too would have been fed through the tubular seal 3 so that the strap ends 14*a* and 14*b* assume positions indicated in FIG. 6. Next, further actuation of the strapping head causes retraction of the supply end 14*b* of the strap 14 to remove the slack from the strap loop 2 encircling the coil portion. When the slack has been removed, the joint forming mechanism 55*b* is actuated to produce an interlocking joint between the seal 3 and the overlapping strap ends 14*a* and 14*b* passing through it. Also, after the joint forming operation, the shear 71 is moved toward the plate 70 to shear off the supply end of strap from the strap loop 2 encircling the coil portion so that all parts are in positions as shown in FIG. 6.

At this time, the hand crank 39 is rotated to cause rotation of the tapered rollers 15 and 16 to orient the coil 1 to a new position relative to the strapping head 55 so that another strap loop 2 can be positioned at another portion of the coil. After the cycle is repeated again, the coil is again rotated and a third strap loop 2 is secured on the coil. Ordinarily three strap loops 2 seem to be sufficient, but more can be used if desired.

It should be made clear that it is not necessary to use a strapping mechanism as complicated as the strapping head 55 in order to obtain benefit from the use of the strap end guide 40. In fact, the strap end guide 40 can be made use of even when the strap 14 would be fed forward manually into it. The same effect would be achieved. The bulged portion 14*c* would occur and the operator would still have the advantage of being able to grasp the bulge portion 14*c* to increase his efficiency when strapping coils. In addition, the arrangement can be such that ordinary well known hand strapping tools could be used for tensioning the strap, for forming a strap joint and for severing the strap supply from the strap loop as it is secured on the coil. However, it is believed that there is greater speed when embodying the apparatus with an automatic or semi-automatic strapping head 55 as generally described. Of course, it is also possible to use many different type strapping heads and the details of the particular type strapping head shown herein does not constitute part of this invention per se.

When using a strapping head of the general type shown, it is desirable to relocate it when strapping different diameter coils so that the joint forming mechanism 55*b* of the strapping head is located in a proper position with respect to the coil so that a strap joint can be properly formed. Considering the size of the coil 1 shown in phantom lines in FIG. 2, it has an outer circumference 1*b* and an inner circumference 1*c* which defines the circular wall of the central opening 1*a*. It should be apparent that the joint forming mechanism 55*b* is positioned adequately to form a strap joint on the coil when the circumferences are as shown at 1*b* and 1*c*. However, if a coil having an inner circumference of 1*d* is to be strapped, the joint forming mechanism 55*b* is located below the central opening 1*a* of the coil and, so, it would be necessary to move the entire strapping head 55 radially outward of the coil so that the joint forming mechanism 55*b* is located in a region where a strap joint can be properly formed on the coil. This radial movement of the strapping head 55 is accomplished by transporting the entire strapping apparatus 12, including the strapping head 55 and its supporting frame, on the wheels 44 which are supported and guided by the two tracks 45 and 46.

When the strapping apparatus 12 is relocated to accommodate a particular size coil, a special locking device is actuated to maintain the strapping apparatus 12 in a relatively fixed position. The locking device consists of a rod 78 whose upper end passes through an aperture 79 in a horizontal flange 80 secured to the upper end of the vertical frame member 51. Slightly up from the lower end of the rod 78 it passes through a slotted hole 81 in the upper flange 49*a* of the horizontal frame member 49. The lower end of the rod 78 extends through another slotted hole 82 extending through the flange 49*b* of the horizontal frame member 49. The extreme lower end of the rod 78 is secured in a C-shaped locking shoe 83. This locking shoe 83 is provided with a groove 83*a* which has the upper flange of a channel member 84 passing through it. The channel member 84 is secured to the plate 47 which is ordinarily securely fastened to the floor where the entire apparatus is used. The extreme upper end of the rod 78 is pivotally connected on a pin 85 to a yoke-shaped cam 86. The yoke-shaped cam 86 has a flat surface 86*a* and an opposite bulged surface 86*b*. The bulged surface 86*b* projects further from the pin 85 than does the flat surface 86*a*. A handle 87 is secured to the cam 86 and the purpose of the handle 87 is to rotate the cam 86 between positions where the bulged portion 86*b* or the flat surface 86*a* of the cam is in contact with a flat pad 80*a* on the upper surface of the flange 80. The length of the rod 78 is proportioned with respect to the location of the locking shoe 83 and the groove 83*a* of the locking shoe is of sufficient width that when the lever 87 is rotated to a position at 87*a* the flat surface 86*a* of the cam 86 is resting against the pad 80*a*. This places the rod 78 in its lowermost position where the walls of the groove 83*a* are frictionally clear of the upper flange of the channel 84. When the arm 87 is moved to a position as shown in bold outline in FIG. 4, the bulged portion 86*b* of the cam 86 is in contact with the pad 80*a* and this raises the rod 78 to its highest position. When in this position, the lower inner surface of the groove 83*a* of the locking shoe 83 is in frictional contact up against the lower surface of the upper flange of the channel 84. With this arrangement, the supporting frame carried by the wheels 44 of the strapping apparatus 12 is substantially located in position with respect to the rails 45 and 46.

With this arrangement, the frame supported by the wheels 44 is free to move relative to the lower end of the rod 78 by the amount of the length of the two slotted holes 81 and 82. The hole 79 in the flange 80 is sufficiently large that movement of the frame allows the rod 78 to assume an angle to the vertical. For example, if the strapping apparatus 12 was moved to the left as viewed in FIG. 4, the rod 78 would form an angle to the left of the vertical. To facilitate this angular movement and still insure a good grip of the locking shoe on the lower inner surface of the channel or guide 84, it is desirable to longitudinally curve the contacting surface 83*b* of the shoe and provide the surface with sharpened protrusions. It should be observed that the rod 78 assumes the vertical position when its lower end portions are resting against the left ends of the slotted holes 81 and 82. Therefore, these ends of the slotted holes prevent the rod 78 from assuming an angle to the right of the vertical so that the frame cannot be rotated further to the right as viewed in FIG. 4 as long as the locking shoe 83 is frictionally engaged with the angle 84. A tension spring 88 is secured at one end around the rod 78 and at its other end to a shaft 89 which is held secured in an apertured ear 90 protruding from the frame member 49 by means of two threaded nuts 91. The purpose of the spring is to maintain the left ends of the slotted holes 81 and 82 against the rod 78 to establish the relatively fixed referenced position for the strapping mechanism 12. With what has been explained, it should be

apparent that the entire strapping apparatus can be moved to the left on its wheels 44 as the rod 78 tilts angularly to the left until the rod contacts the right end of either of the slotted holes 81 or 82. When this occurs, the spring 88 is stretched which urges the strapping apparatus back to a position where the rod 78 is again in contact with the left ends of the slotted holes 81 and 82.

The purpose of this limited movement of the strapping apparatus is to permit slight movement at the time when a strap loop 2 is being tensioned around a coil portion. By so doing, it has been found that the tension of the strap loop 2 is more or less equalized throughout its length around the coil portion so that loosening of the loop 2 does not occur to any substantial extent after the joint has been formed and the coil removed from strapping position. This loosening phenomenon is created by having uneven tension of the strap around the package. For example, in the ordinary situation, such as described for the apparatus disclosed herein, the leading end of the strap 14*a* is held securely by the gripping jaws 69 (FIG. 6). The enlarged strap loop as shown being held by the worker 13 in FIG. 1 is shrunk in size around a radial portion of the coil by reversing the feed direction of the strap which may be accomplished by reversing the feed wheel 66 (FIG. 4) to withdraw the strap. As shown in FIG. 7, where a strap loop 2 is encircled around an annular portion of the coil 1, ordinarily the tension on the strap loop 2 will vary around the coil portion depending upon the corner conditions. If a pull is exerted in the direction of the arrow 92 in the magnitude of 100 pounds, a certain portion of the tension will be lost as the strap is pulled around the corner 93. Another portion of the tension will be lost around the corner 94 and additional amounts are successively lost around the last two corners 95 and 96. The result is that the tension in the region 14*f* of the strap is considerably less than the 100 pounds tension exerted in the direction of the arrow 92 on the supply strap end 14*b*. Usually, part of the reason for this difference in tension is because the gripping jaws 69 or another type gripping device used for gripping the leading strap end 14*a* is stationary relative to the longitudinal path of the strap 14. It has been found that, by allowing a little longitudinal shift of the strapping head 55, in the manner described, the tension is equalized between the region 14*f* of the strap and the region 14*g* of the strap while the tensioning occurs. The result of this is that greater over-all tension is provided in the strap loop 2 for a given tension force in the direction of the arrow 92 with no subsequent loosening of the strap loop after the strapping head 55 is removed. To more clearly illustrate what happens, first assume that the gripping jaws 69 hold the strap end 14*a* fixed. Then, assume that 100 pounds of tension force is applied in the direction of the arrow 92. Next, assume that 20 pounds of tension is lost around each of the corners 93, 94, 95 and 96. With this condition, the tension in the strap between corners 93 and 94 would be 80 pounds, the tension between corners 94 and 95 would be 60 pounds, the tension between corners 95 and 96 would be 40 pounds and the tension between the corners 96 and the gripping jaws 69 would be 20 pounds. Then, upon release of the strapping head from the strap loop 2 after the shear plate 71 cuts through the supply end 14*b* of the strap, the 20 pound tension force in the region 14*f* would be overcome by the 100 pound tension force of region 14*g* with a resultant loosening of the strap loop 2. Now, assume that the strapping head 55 is allowed to move as it does in this invention, and the gripping jaws 69 grip the leading strap end 14*a*. In this situation, assuming again that 20 pounds of tension are lost around each corner, there would be 100 pounds of tension in the region 14*g*, 80 pounds of tension between the corners 93 and 94 and 60 pounds of tension between the regions 94 and 95. But, between the corners 95 and 96, instead of 40 pounds of tension, there would be 80 pounds of tension and, in the region 14*f*, instead of 20 pounds of tension there would be 100 pounds of tension. The final result of this is that, after the strap loop 2 is removed from the supply end of the strap 14, the tension established around the coil portion does not change since it is already equalized at 100 pounds in both of the regions 14*f* and 14*g*. Since no equalization occurs, there is no loosening of the strap 2 on the object.

This situation, where there is no loosening of the strap loop 2, is especially advantageous when strapping non-compressible objects such as rather solid, closely wound coils of metal strip, although not so significant when the object itself is compressible and is inherently resilient. In the case of non-compressible objects, the ability to provide a non-loosening loop 2 of strap may be the difference between success and failure when strapping such an object.

In summary, a coil is moved along the conveyor unit 5 to the conveyor 6 where it is positioned on the rollers 10 with the central opening 1*a* of the coil positioned above the strap end guide 40. At this time the air or fluid is admitted to the cylinder 32 to cause its piston rod 30 to elevate and raise the spider 19 and, consequently, raise the tapered rollers 15, 16 and 17 so that they elevate the coil 1 above the level of the rollers 10. This leaves the coil 1 supported by the tapered rollers. As previously mentioned, the locking shoe 83 can be adjusted along the channel 84 to substantially lock the strapping apparatus 12 in any particular position along the rails 45 and 46, depending upon what size coil is to be strapped. Then the worker 13 causes the strap 14 to be fed endwise in the direction of the arrow 76 (FIG. 4) until it emerges from the front end of the strapping head 55. At this time, the strapping head 55 is pivoted downwardly by action of the air cylinder 61 which causes its piston rod 63 to retract. With the strapping head 55 pivoted downwardly, the strap 14 fed endwise is guided into the strap end guide 40 so that the strap follows along the surface 43*a* of the member 43 of the guide (FIGS. 4 and 7). The strap continues forward until its extreme end 14*d* contacts surface 43*b* where it is deflected downwardly to create an upwardly bowed portion 14*e* immediately behind the extreme end 14*d*. This bowing creates the initial condition which starts an upward bulge of the strap. When the extreme end 14*d* rides completely down the surface 43*b* it contacts a stop surface 43*c* which arrests its endwise movement but allows the extreme end 14*d* to travel in a reverse direction down the sloped and curved surface 43*c* upon continued forward feeding of the strap 14 as the strap end pivots around the corner 14*f*. As this occurs, the upward bulging tendency initially started at 14*e* continues with the creation of an upwardly bulged portion 14*c*. The strap 14 is continued to be fed until the upwardly bulge portion 14*c* is elevated high enough for the worker 13 to be able to manually grasp it as indicated in dotted lines 13*a* in FIG. 1. When strapping annular objects it is desirable that this bulged portion 14*c* emerge through the central opening 1*a* of the coil 1. After the worker 13 grasps the bulged portion 14*c* he directs the extreme end 14*d* over and around the upper surface of the coil portion to be strapped and back beneath it so that the leading strap end 14*a* is above and in overlapping relationship with the supply strap end 14*b*. This leading strap end 14*a* must also pass through a tubular seal 3 which is pre-positioned in the joint forming mechanism 55*b* and through which the supply strap end 14*b* has already been passed during the strap feeding operation. This relationship of the strap ends and the strapping mechanism is shown in FIG. 6. After this, the gripping jaws 69 are caused to grip the strap end 14*a* against a plate 70 where it is held while the feed wheel 66 is reversed and the strap is caused to reverse in direction to remove the slack from the strap loop formed around the coil portion and, before or during the strap tensioning period, the piston rod 63 is extended by proper admission

of air or other fluid to the cylinder **61** to cause the strapping head **55** to pivot upwardly against the coil **1**. After all of the slack is removed, the strap loop **2** appears as shown in FIG. 7 in close contact with the coil **1**. Then, the joint forming mechanism **55***b* is actuated to provide the interlocking type joint **4** between the tubular metal seal **3** and the strap ends. After joint formation, the shear blade **71** is moved toward the plate **70** to shear off the strap loop **2** from the supply end of the strap **14**. After this occurs, the strapping head **55***b* is pivoted downwardly again by reason of retraction of the piston rod **63** of the cylinder **61**. Sometime during this retraction or afterward, a seal **3** freshly formed over the anvil **73** is fed by the anvil **73** into position in the joint forming mechanism **55***b* in preparation for a new strapping cycle. The coil **1** is then rotated to align another of its radial portions with the strapping head **55**. This is accomplished by turning the crank **39** to cause rotation of the tapered rollers **15** and **16**. Rotation is continued until proper alignment of the coil is achieved. After enough strap loops **2** are secured to the coil the piston rod **30** of the cylinder **32** is then caused to lower so that the spider **19** causes the tapered rollers **15**, **16** and **17** to again be lowered beneath the level of the rollers **10**. This releases the coil for free movement on the rollers **10** and, in this manner, the strapping coil **1** can be pushed on to the conveyor unit **7** for subsequent handling and shipping.

Although the invention has been emphasized with respect to the use of a strapping apparatus having separate feed means and joint forming means, the strap end guide can be used with great facility when the strap is fed to the strap end guide merely by hand. The action is identical when the extreme strap end **14***d* reacts with the surfaces **43***b* and **43***c* of the strap end guide so that a bulged portion **14***c* can be formed which is readily grasped by the worker. Also, the same principle can be used for strapping objects other than annular objects. It can be used for strapping elongated objects, such as perhaps pipes or tubes or other elongated pieces together. The elongated objects are pre-positioned in front of where the bulged portion would be formed. The bulge portion is then formed behind the objects and the worker **13** merely encircles the objects after the bulge portion is formed in the same manner as when strapping a portion of an annular object.

Although only a single embodiment of the invention has been shown and described, it should be understood that the invention can be modified in many different ways without departing from the true scope of the invention as defined by the appendant claims.

We claim:

1. In apparatus for securing a binder strap about portions of an annular object comprising, a frame for supporting the annular object, means for feeding a length of binder strap endwise below the annular object, a strap guide interposed in the path of travel of the binder strap being fed and located below the region of the central opening of the annular object supported by the frame, said strap guide having both a downwardly sloping portion against which the end of the strap contacts as it is fed forward and an abutment for arresting longitudinal movement of the end of the strap, the slope of said portion causing the strap end as the strap continues to be fed forward to be deflected downwardly into contact with said abutment to produce an upward bulge in the strap through the central opening of the annular object extending to a level where it can be conveniently manually grasped and encircled into a loop around a portion of the annular object.

2. In apparatus for securing a binder strap around an object comprising, a frame for supporting the object, means for feeding a length of binder strap endwise below the object, a strap guide interposed in the path of travel of the binder strap being fed and located below the region of the object supported by the frame, said strap guide having both a downwardly sloping portion against which the end of the strap contacts as it is fed forward and an abutment for arresting longitudinal movement of the end of the strap, the slope of said portion causing the strap end as the strap continues to be fed forward to be deflected downwardly into contact with said abutment to produce an upward bulge in the strap extending to a level where it can be conveniently manually grasped and encircled into a loop around the object.

3. In apparatus for securing a binder strap around an object comprising, a support for an object, a strap guide located adjacent to said support and aligned to receive the leading end of a length of strap fed endwise to it, said strap guide having means to deflect the strap end into a curved path to provide it with a bulge while the strap is fed endwise, said strap guide also having a stop means for arresting the forward movement of the strap end but not the strap proper to thereby increase the size of the bulge to make the bulge available for manual grasping so that the strap end can be manually encircled in a loop around the object on the support, and means adjacent to said guide for securing the loop onto the object.

4. The apparatus as defined by claim 1 characterized by, and means adjacent to said guide for securing the loop onto the object.

5. The apparatus as defined by claim 2 characterized by, and means adjacent to said guide for securing the loop onto the object.

6. The method of making a binder strap available for encircling it around an object comprising, feeding a binder strap endwise in a rectilinear path across at least a portion of the object, deflecting the strap end into a downwardly curved path to provide it with an upward bulge beyond said portion of the object, then arresting the endwise movement of the strap end while continuing the forward feeding movement of the strap proper to thereby increase the size of the upward bulge to one which can be manipulated around said portion of the object.

7. The method of making a binder strap available for encircling it around at least a portion of an object comprising, feeding a binder strap endwise across at least a portion of the object, deflecting the strap end into a curved path to provide it with a bulge beyond said portion of the object, then arresting the endwise movement of the strap end while continuing the endwise feeding movement of the strap to thereby increase the size of the bulge to one which can be manipulated around said portion of the object.

8. The method of making a binder strap available for encircling it around a radial portion of an annular object comprising, feeding a binder strap endwise below the annular object until the strap end passes beneath the central opening of the annular object, then arresting the endwise movement of the strap end while continuing the endwise feeding movement of the strap and thereby causing the strap end to bulge upward through the central opening where it can be conveniently manually grasped and encircled around the radial portion of the annular object.

9. The method of securing a binder strap around an annular object comprising, supporting the annular object with its axis extending approximately vertical, feeding a binder strap endwise beneath and radially of the annular object, deflecting the strap end into a downwardly curved path in a region below the central opening of the annular object to provide the strap with an upward bulge, then arresting the endwise movement of the strap end while continuing the endwise movement of the strap to thereby cause the bulge to enlarge upwardly to where it can be conveniently manually grasped, then manually grasping the bulge and encircling the strap end into a loop radially around a portion of the an-

nular object, and securing the loop onto the annular object.

10. Apparatus for securing a binder strap around an object comprising, a strapping station where an object to be strapped is positioned, a strapping head mounted on a carriage movable to any of a plurality of locations at said strapping station, bias means for biasing said carriage at one of said locations, and means allowing said bias means to be overcome by a force applied to said carriage and allow movement of said carriage relative to said one location in response to said force applied.

11. Apparatus as defined by claim 10 characterized by, stop means being provided between the bias means and the carriage for limiting the movement of the carriage relative to the bias means.

12. Apparatus for securing a binder strap around an object comprising, a strapping station where an object to be strapped is positioned, a carriage provided with wheels mounted on rails for movement to any of a plurality of locations at said strapping station, a strapping head mounted on and movable with said carriage, a locking shoe mounted on a rod pivotally supported by said carriage, said locking shoe being releasably engageable with a guide at any of said locations of said carriage, movement of the carriage along said rails causing said rod to pivot angularly with respect to the carriage when said locking shoe is engaged with said guide.

13. Apparatus as defined by claim 12 characterized by, and stop means being provided on the carriage which contacts said rod to limit its pivotal movement and thereby limit the movement of the carriage along said rails.

14. Apparatus for securing a binder strap around an object comprising, a strapping station where an object to be strapped is positioned, a carriage mounted for movement to any of a plurality of locations at said strapping station, a strapping head mounted on and movable with said carriage, a locking shoe movably mounted on said carriage and ordinarily held by resilient means against a first stop on said carriage and also releasably engageable with a fixed guide extending in the path of movement of said carriage, said carriage being freely movable when said locking shoe is disengaged from said fixed guide, but restrained from movement in one of said locations by the resilient force of said resilient means when said locking shoe is engaged with said fixed guide, the restraint from movement of the carriage being overcome upon the application of sufficient force against the carriage to thereby overcome the resilient force of said resilient means and cause movement of the carriage from said one location relative to the locking shoe.

15. Apparatus as defined by claim 14 characterized by, and a second stop on said carriage engageable by said locking shoe for limiting the movement of the carriage relative to the locking shoe.

16. Apparatus for securing a binder strap around an object comprising, a strapping station where an object to be strapped is positioned, a carriage mounted for movement to any of a plurality of locations at said strapping station, a strapping head mounted on said carriage and movable therewith, said strapping head having a gripper for gripping the leading end of a length of strap encircled into a loop about the object positioned at the strapping station with the leading end of the strap overlapping the supply end of the strap, said strapping head also having tension means for withdrawing the supply end of the length of strap relative to said leading end to tension the loop onto the object, a locking shoe movably mounted on said carriage and also releasably engageable with a fixed guide extending in the path of movement of said carriage, said carriage being freely movable when said locking shoe is disengaged from said fixed guide, but restrained from movement when in one of said locations by the resilient force of said resilient means when said locking shoe is engaged with said fixed guide, said tension means being capable of tensioning said loop sufficiently so that the tension force developed in said loop is sufficient to overcome said resilient force of said resilient means to thereby cause movement of the carriage from said one location relative to the shoe for the purpose of equalizing the tensions developed in the overlapping regions of the supply and leading ends of the loop.

17. The apparatus as defined in claim 16 characterized by, and stop means on said carriage for limiting the movement of said carriage relative to the locking shoe when the locking shoe is engaged with said fixed guide.

18. Apparatus for securing a binder strap around an object comprising, a strapping station where an object to be strapped is positioned, a strapping head mounted on a carriage movable to any of a plurality of locations at said strapping station, said strapping head having a gripper for gripping the leading end of a length of strap encircled into a loop about the object positioned at said strapping station with the leading and supply ends of the strap extending in overlapping relationship, said strapping head also having tension means for withdrawing the supply end of the length of strap relative to said leading end to tension the loop onto the object, bias means for biasing said carriage at one of said locations, said tension means being capable of tensioning said length of strap sufficiently to develop a tension force in the strap large enough to overcome said bias means to thereby cause movement of the carriage from said one location and equalize the tensions developed in the overlapping regions of the supply and leading ends of the strap.

19. The apparatus as defined in claim 18 characterized by, and stop means on said carriage for limiting movement of said carriage when the carriage is biased at said one location.

20. In apparatus for securing a binder strap around an object comprising, a frame for supporting an object, a strap guide located adjacent the region of the supported object and aligned to receive the leading end of a length of strap fed endwise to it, said strap guide having an abutment against which the strap end is first deflected and shaped into a bow and then arrested in its forward motion which causes said bow to increase in size as the feeding of the strap continues, said abutment having two regions of contact against which the strap end reacts as the bow is increased in size to thereby create a gripping action on the strap end which prevents displacement of the strap end from the region of said abutment.

21. The apparatus as defined by claim 2 characterized by, said strap guide also having two spaced apart regions of contact in the vicinity of said abutment against which the strap end reacts as said bulge is formed to thereby create a gripping action on the strap end which prevents displacement of the strap end from the region of said abutment.

22. In apparatus for securing a binder strap around an object comprising, a support, a strap guide located adjacent to said support, and aligned to receive the leading end of a length of strap fed endwise to it, said strap guide having means to deflect the strap end into a curved path to provide it with a bulge while the strap is fed endwise, said strap guide also having a stop means for arresting the forward movement of the strap end but not of the strap proper to thereby increase the size of the bulge, said strap guide also having two spaced apart regions of contact in the vicinity of the two mentioned means against which the strap end reacts as the bulge increases in size to thereby create a gripping action on the strap end which prevents displacement of the strap end from the region of said abutment.

23. In apparatus for securing a binder strap around an object comprising, a support for an object, a strap guide located adjacent to said support and aligned to receive the leading end of a length of strap fed endwise to it, said strap guide having deflection means to deflect the strap end into a curved path to provide it with a bulge while the strap is fed endwise, said strap guide also having a stop

means for arresting the forward movement of the strap end but not the strap proper to thereby increase the size of the bulge to make the bulge available for manual grasping so that the strap end can be manually encircled in a loop around the object on the support, said strap guide also having two spaced apart regions of contact in the vicinity of the deflection means and the stop means against which the strap end reacts as the bulge increases in size to thereby create a gripping action on the strap end which prevents displacement of the strap end from the region of said abutment.

24. The method of making a binder strap available for encircling it around an object comprising, feeding a binder strap endwise in a rectilinear path, deflecting the strap end into a downwardly curved path to provide an upward bulge in the strap immediately behind the strap end, arresting the endwise movement of the strap end while continuing the endwise feeding movement of the strap proper to thereby increase the upward bulge, then allowing the strap end to rotate in response to the forces resulting from the formation of the upward bulge and then restraining the rotational movement of the strap end to create a gripping pressure for gripping the strap end and preventing its further displacement.

25. In apparatus for securing a binder strap around an object comprising, a frame for supporting an object at a strapping station, a strap guide located adjacent the region of the supported object and aligned to receive the leading end of a length of strap fed endwise to it, said strap guide having an abutment against which the strap end is arrested in its forward motion, said guide being shaped to deflect the strap end and shape it into a bow which is caused to increase in size as the feeding of the strap continues, a strapping head mounted on a carriage movable to any of a plurality of locations at said strapping station to accommodate different positions and sizes of objects located at the strapping station, said strapping head having a strap end gripper for gripping the leading end of the strap and a strap feed means for feeding a length of strap endwise into said strap guide and for reverse feeding of said strap to tension it after it has been grasped when in the shape of said bow and encircled in a loop about an object with its leading end gripped by said gripper, bias means for biasing said carriage at one of said locations, and means allowing said bias means to be overcome by the force developed in the strap while it is tensioned to allow movement of said carriage relative to said one location in response to said force.

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