April 16, 1963 G. E. WIMMER 3,085,501

SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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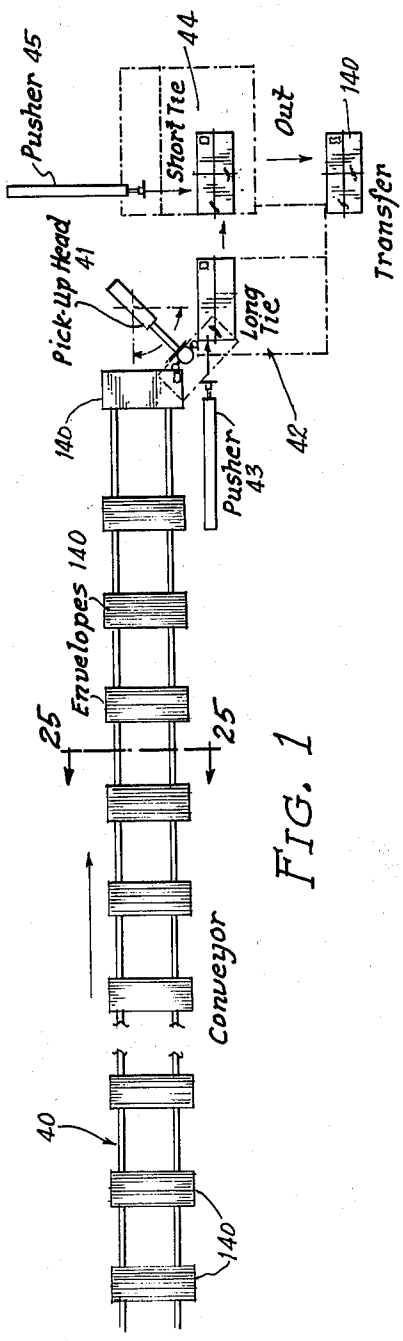

FIG. 1

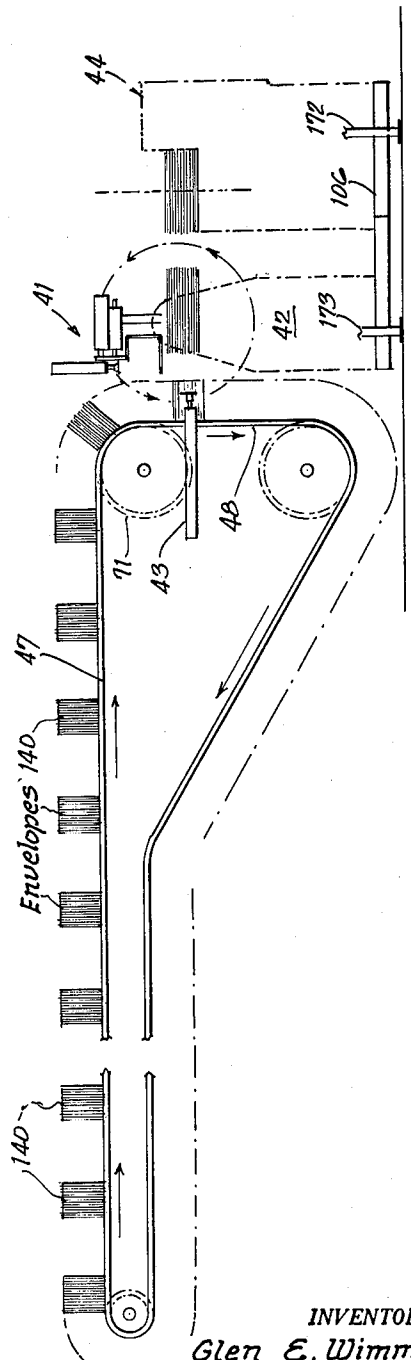

FIG. 2

INVENTOR.
Glen E. Wimmer
BY Norton, Davis, Brewer & Brugman
Attys

April 16, 1963 G. E. WIMMER 3,085,501

SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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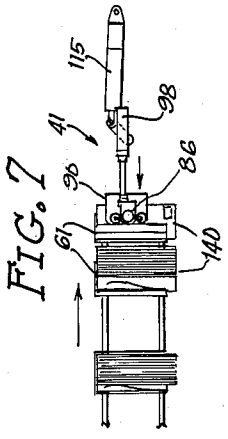

FIG. 7

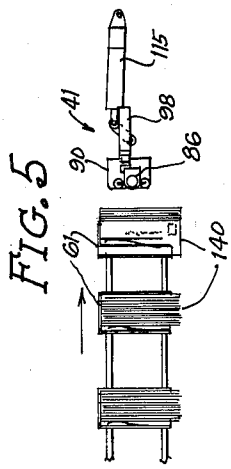

FIG. 5

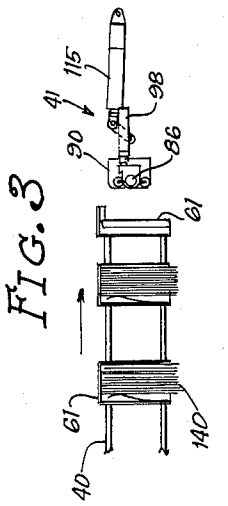

FIG. 3

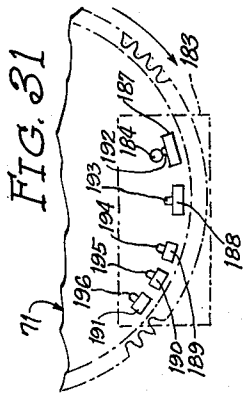

FIG. 31

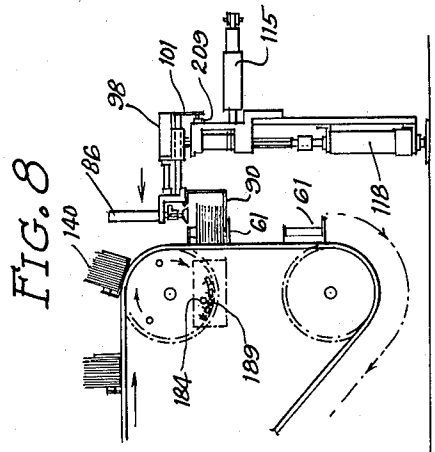

FIG. 8

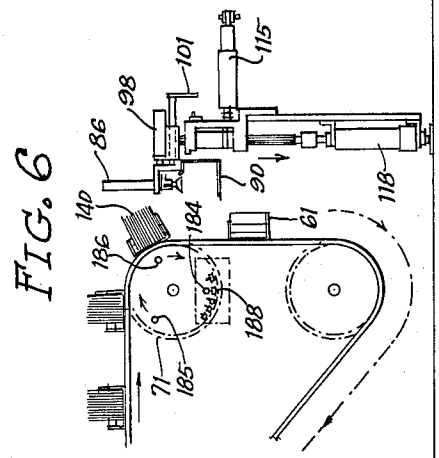

FIG. 6

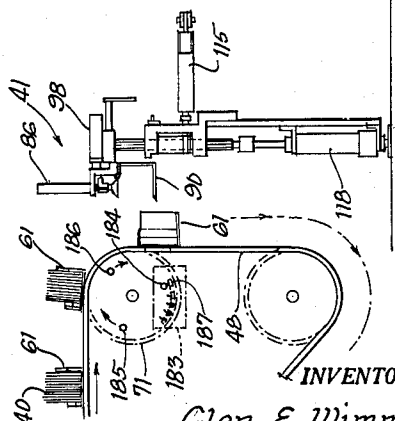

FIG. 4

INVENTOR.

Glen E. Wimmer

BY Horton, Davis, Brewer & Brugman Attys

April 16, 1963 G. E. WIMMER 3,085,501

SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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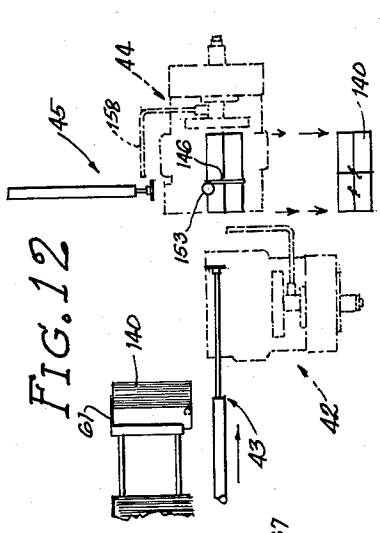

FIG. 12

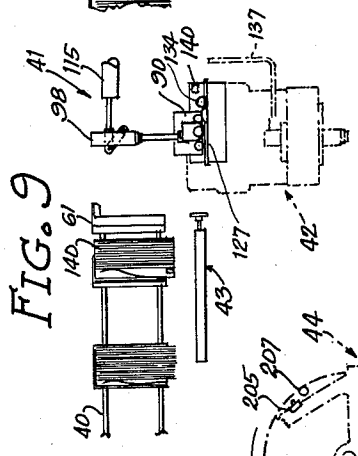

FIG. 9

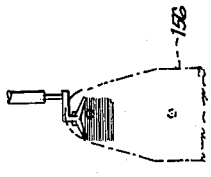

FIG. 14

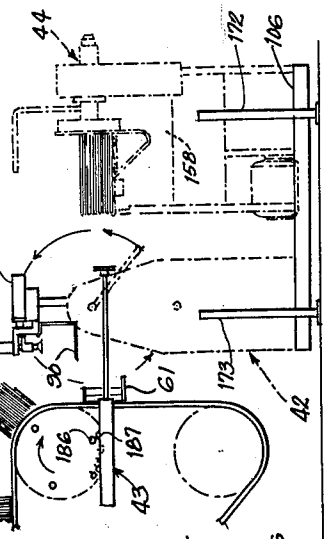

FIG. 13

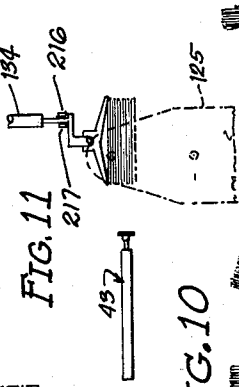

FIG. 11

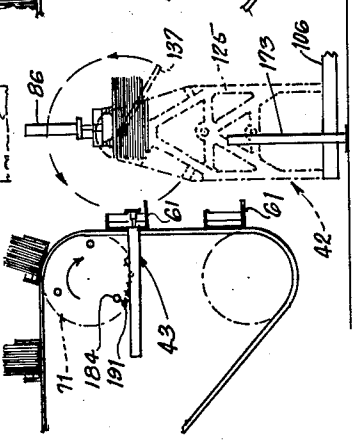

FIG. 10

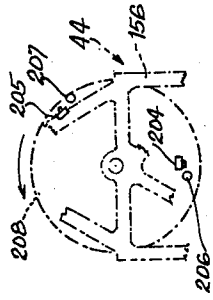

FIG. 14a

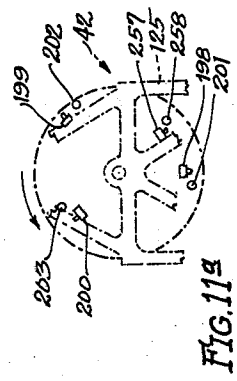

FIG. 11a

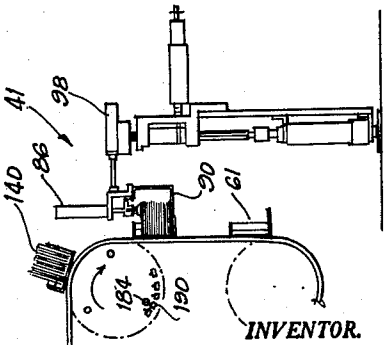

FIG. 8a

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Atty's

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FIG. 15

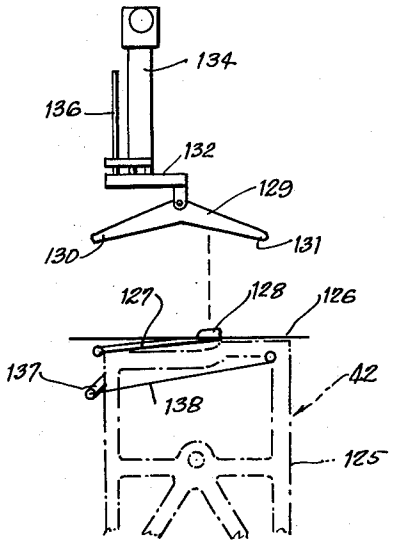


FIG. 16

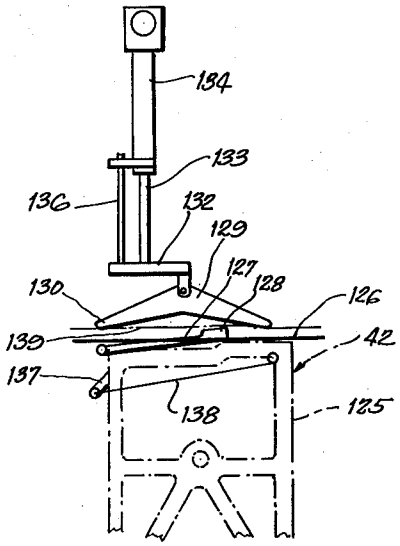


FIG. 17

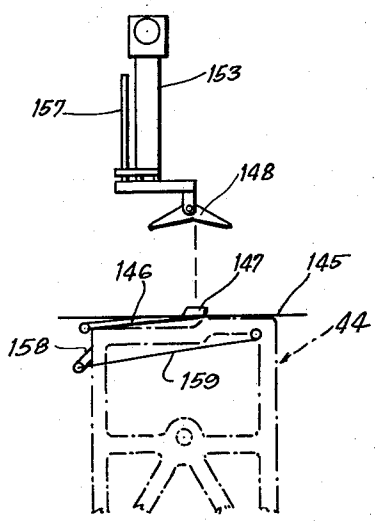
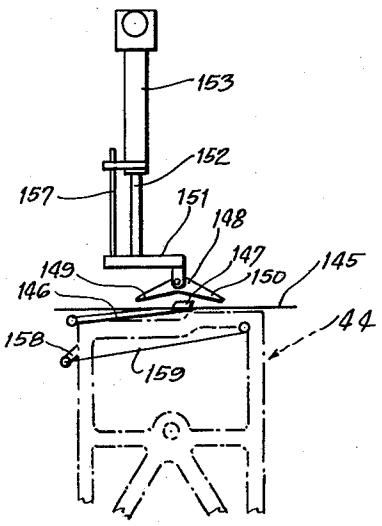


FIG. 18



INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Att'ys

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FIG. 19

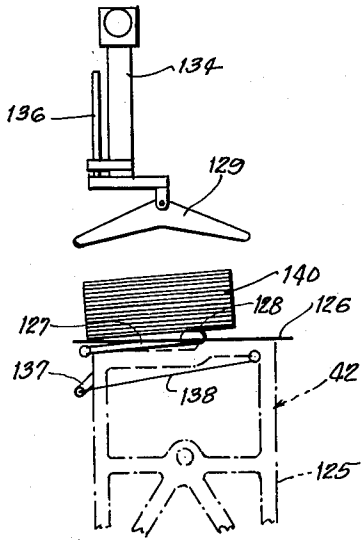


FIG. 20

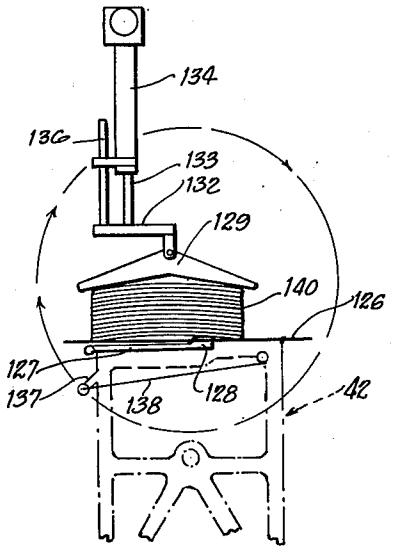


FIG. 21

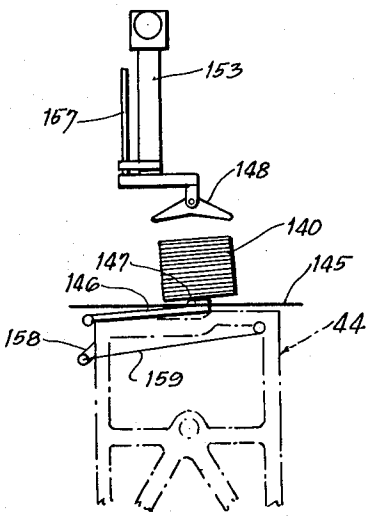
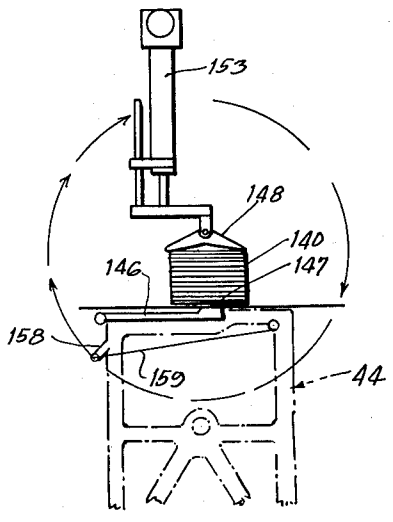


FIG. 22



INVENTOR.
Glen E. Wimmer

BY Horton, Davis, Brewer & Brugman Att'ys

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SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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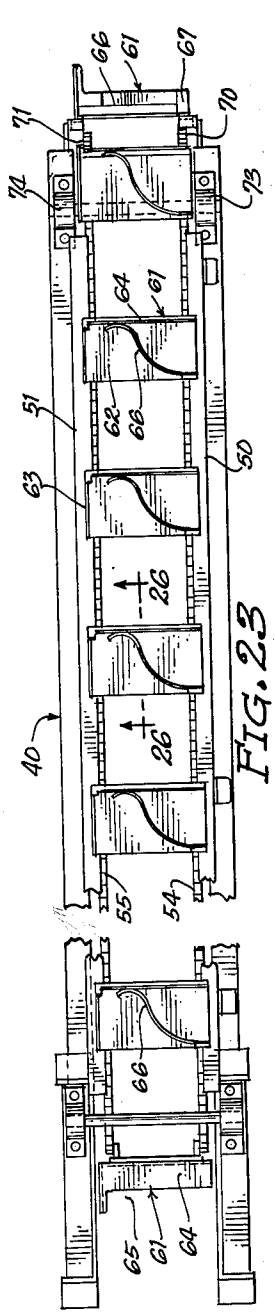

FIG. 23

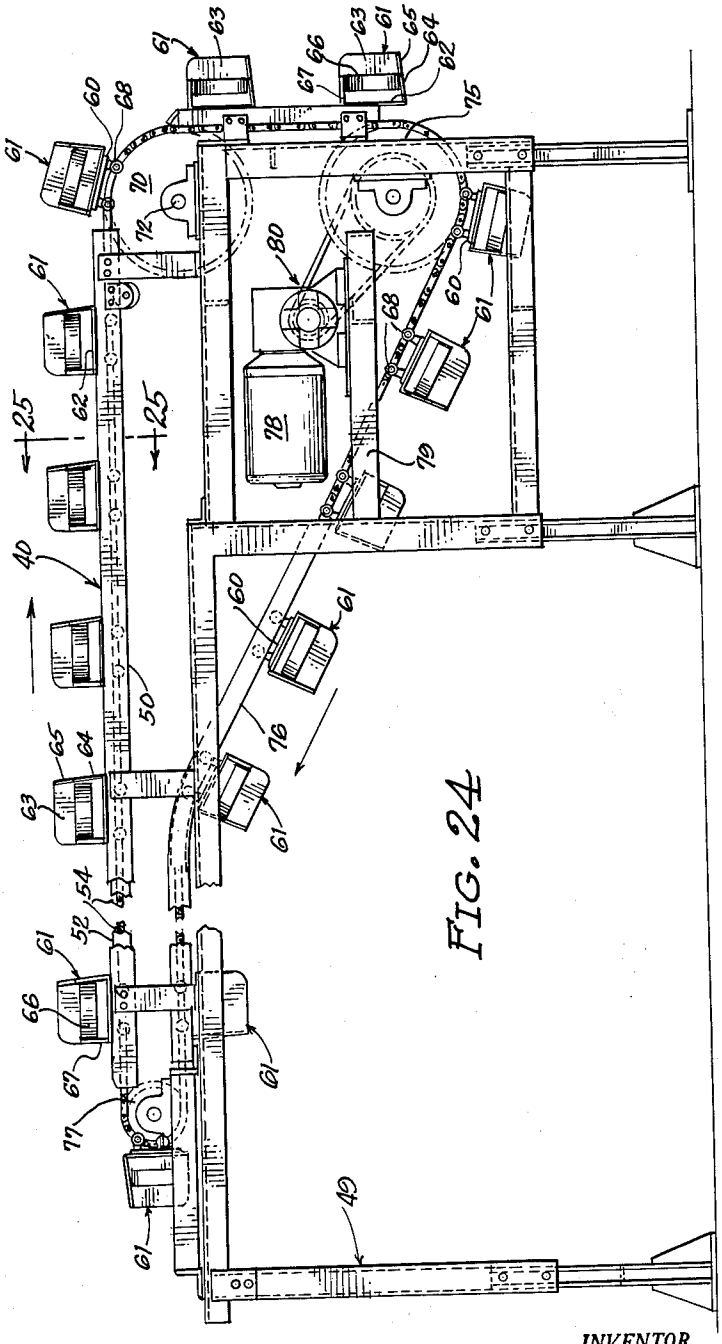

FIG. 24

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Attys

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FIG. 25

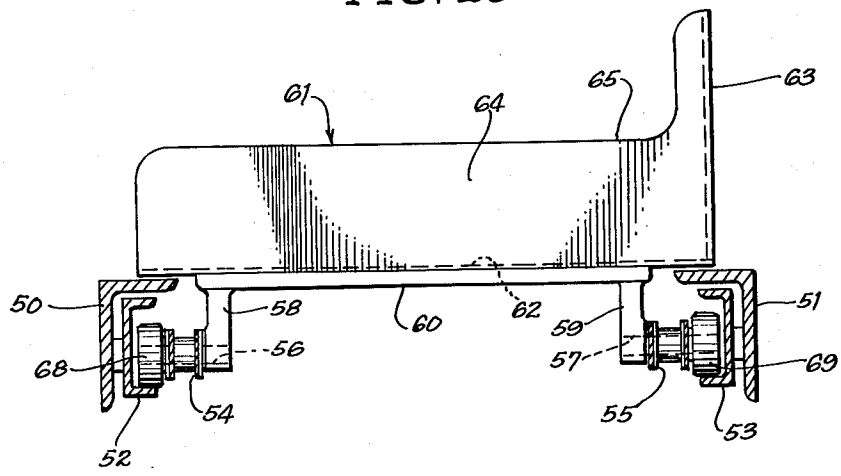
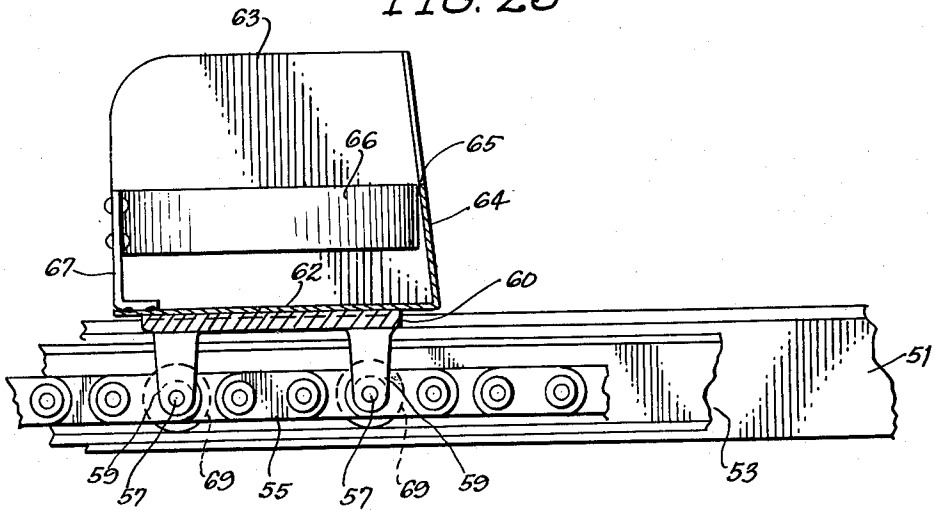


FIG. 26



INVENTOR.
Glen E. Wimmer

BY Horton, Davis, Brewer & Brugman Att'ys

April 16, 1963 G. E. WIMMER 3,085,501

SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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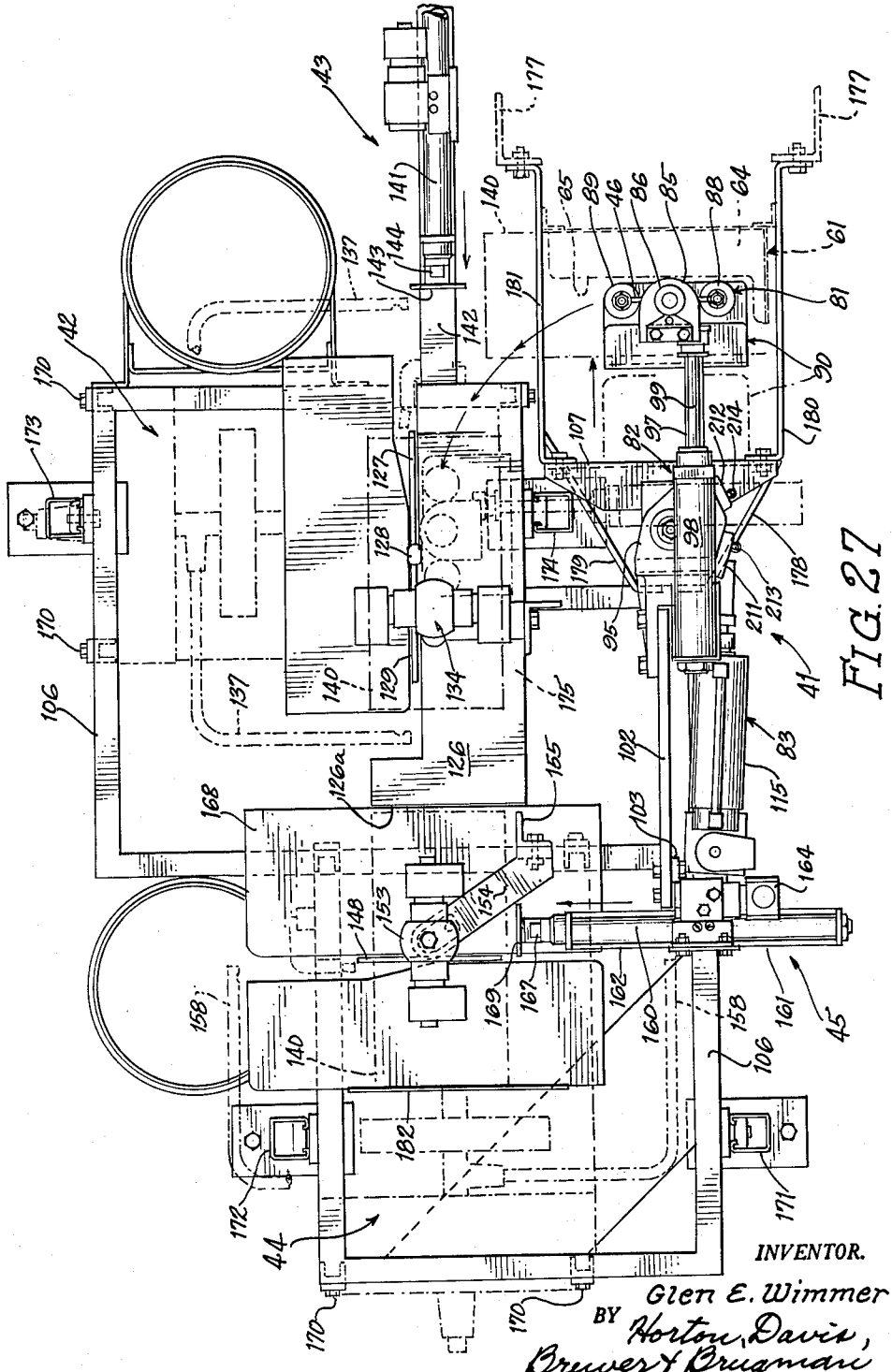

FIG. 27

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Att'ys

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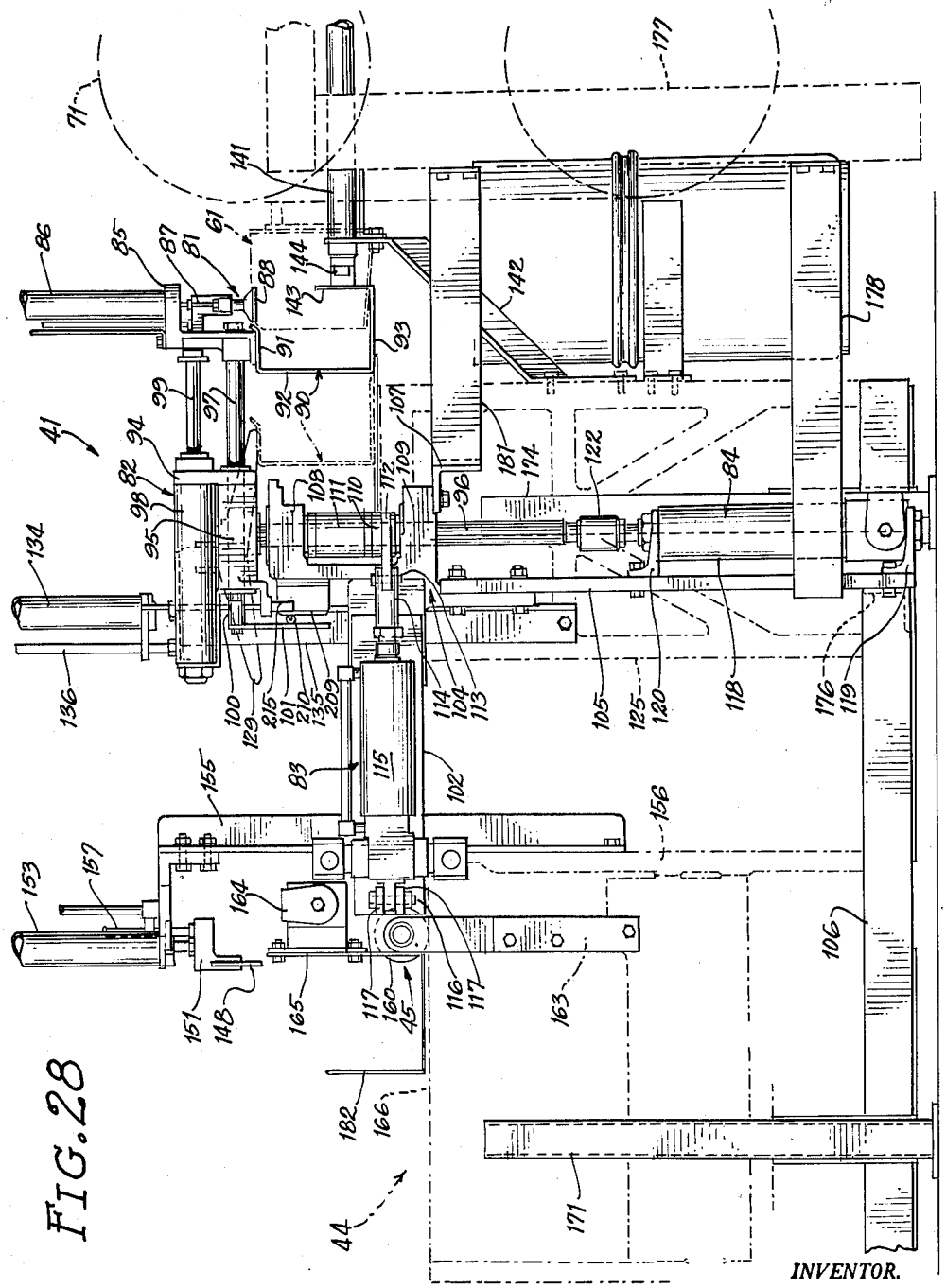

FIG. 28

INVENTOR.
Glen E. Wimmer
BY Norton, Davis, Brewer & Brugman
Att'ys

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SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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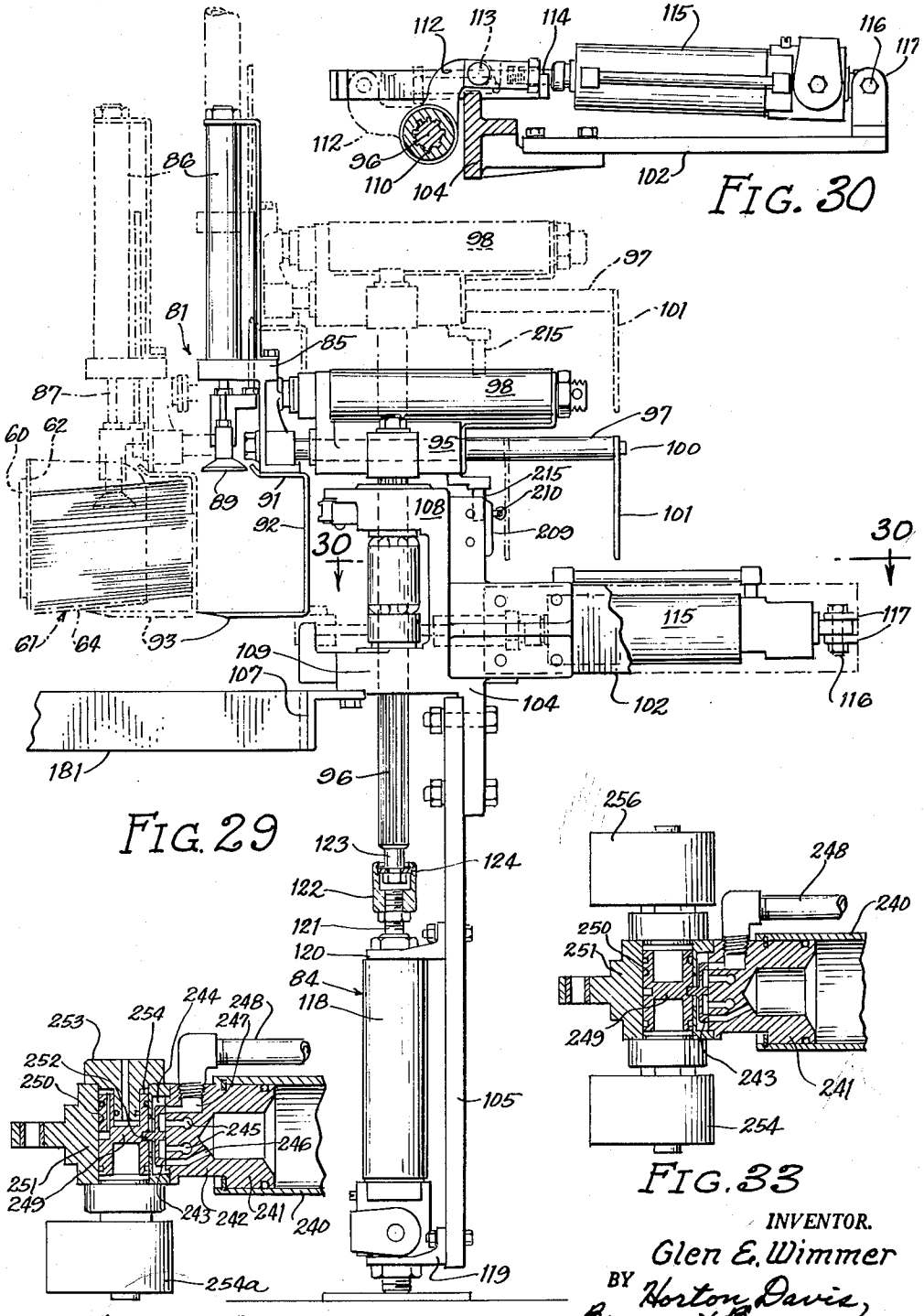

FIG. 30

FIG. 29

FIG. 32

FIG. 33

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Attys

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SYSTEM FOR AUTOMATICALLY TYING BUNDLES

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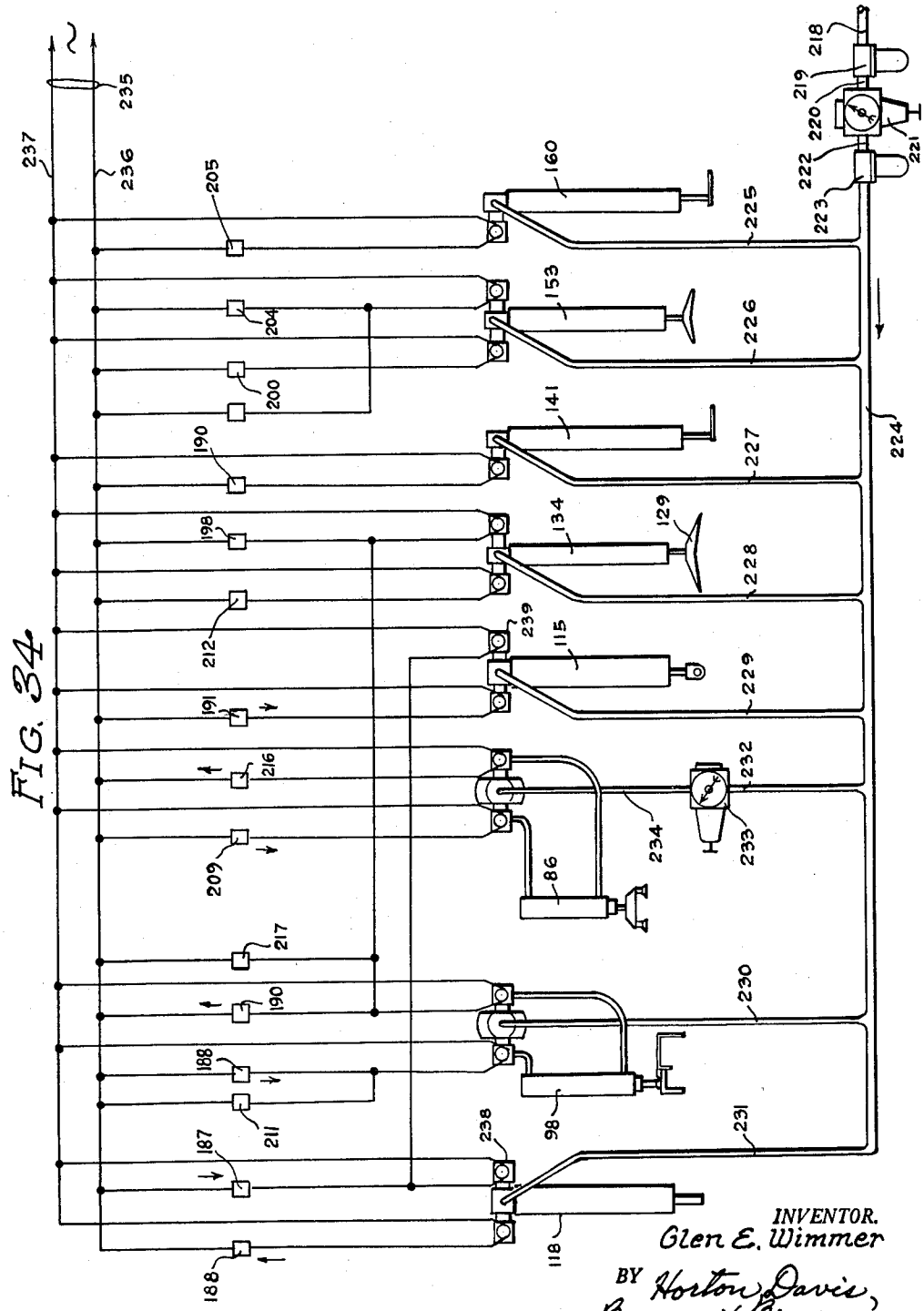

FIG. 34

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Att'ys

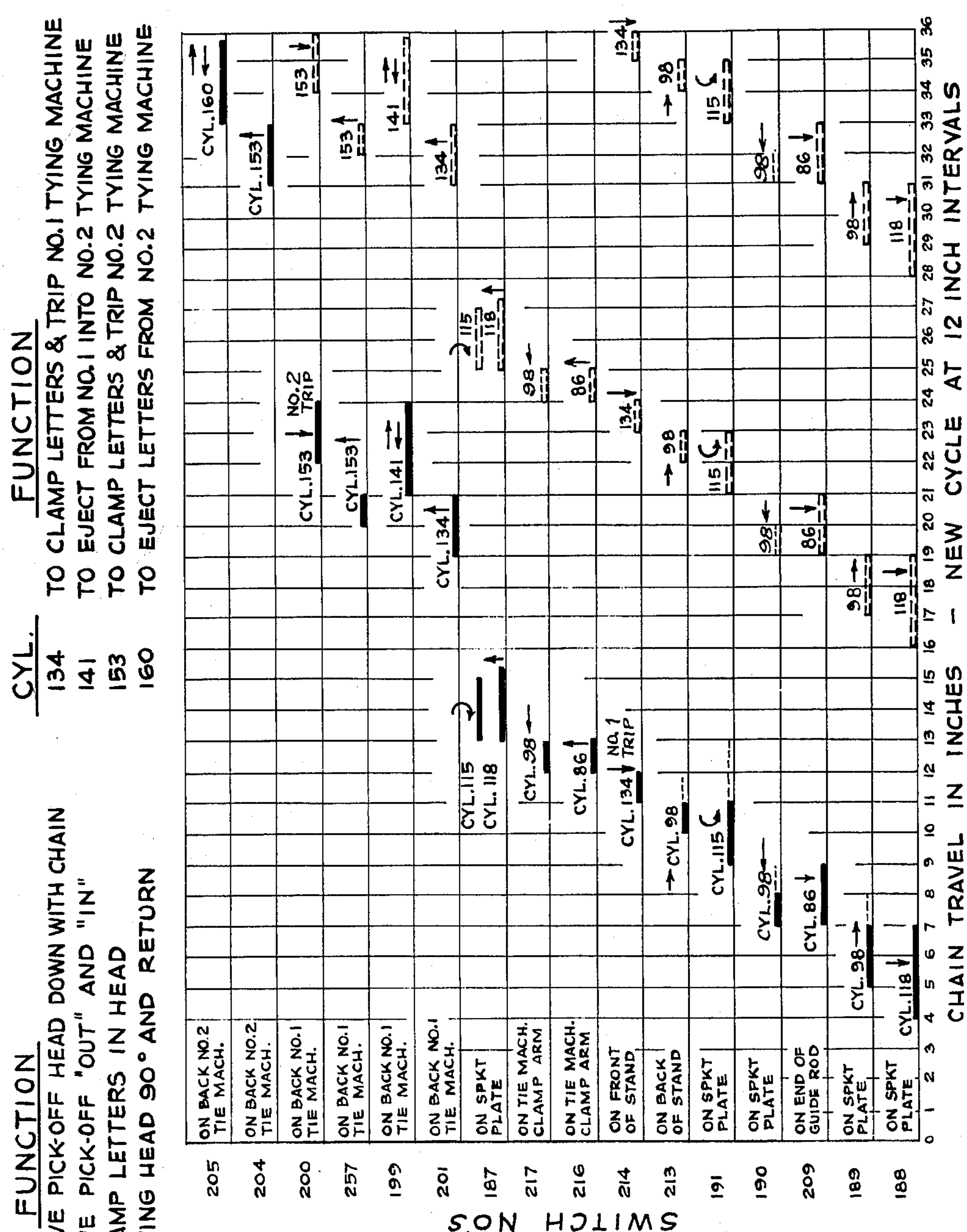

FIG. 35

INVENTOR.
Glen E. Wimmer
BY Horton, Davis, Brewer & Brugman
Att'ys

United States Patent Office 3,085,501 Patented Apr. 16, 1963

3,085,501

SYSTEM FOR AUTOMATICALLY TYING BUNDLES

Glen E. Wimmer, Evanston, Ill., assignor to B. H. Bunn Company, Chicago, Ill., a corporation of Illinois

Filed Oct. 6, 1960, Ser. No. 60,945
14 Claims. (Cl. 100—4)

This invention relates to a conveyorized system for tying bundles of letters or the like. For purposes of illustration it will be described with reference to its application to handling mail in a post office.

Incoming mail in a post office is generally sorted as to destination, and all letters having the same destination are assembled into a bundle which is then tied with a string to facilitate subsequent handling thereof. A bundle of mail may be approximately 5½ inches wide, 11½ inches long and 4½ inches thick, these dimensions being the maximum dimensions for the width and length of the envelopes handled and for the thickness of the bundle into which the envelopes are assembled. Each such bundle is tied in a tying machine which may be of the type described in B. H. Bunn Patent No. 2,898,847 dated August 11, 1959. Such machines are adapted to tie a bundle in one direction with a double wrap, the operator then turning the bundle through 90° to effect a tying of the bundle in a transverse direction. Such machines may also be equipped with a trip mechanism which initiates the operation of the tying mechanism when a bundle of mail is placed over the trip mechanism and depressed to operate the trip mechanism.

The machines as heretofore constructed required that an operator be assigned to each machine, each such operator bringing a bundle of mail to be tied to the machine and holding it on the machine while the bundle was tied in one direction. He was then required to turn the tied bundle through 90°, hold the turned bundle on the machine to effect a cross tie thereof, and then remove the cross tied bundle from the machine.

An object of this invention is the provision of a conveyorized system for delivering sorted mail in bundles to a bundle-tying station where the bundle is automatically transferred from the conveyor to a tying machine, with means for automatically ejecting a tied bundle from the machine.

Another object of this invention is the provision of a transfer mechanism for transferring a bundle of loose, untied mail from a conveyor to a tying machine without interrupting the continuous operation of the conveyor.

Yet another object of this invention is the provision of a pair of tying machines each adapted to tie a bundle of loose mail in a direction transverse to the other, with means for automatically transferring the bundle from one machine to the other, thereby effecting an assembly line operation of the tying machines.

As a more specific object, this invention has within its purview the provision of a control mechanism for initiating the operation of a pair of bundle-tying machines, said control mechanism automatically rendering a machine inoperative unless a bundle to be tied is placed thereon.

As a further specific object, this invention provides a control mechanism for operating transfer mechanisms and bundle-tying machines in proper sequence to effect a tie in two directions on said bundle, with means for automatically cutting out certain of the operations when no bundle is to be tied.

Yet another specific object of this invention is the provision of a conveyorized system of tying bundles of mail, said system incorporating a conveyor unit for bringing mail sorted at one or more locations to a common point, picking off the sorted bundle from the moving conveyor and transferring these one at a time to a first tying machine for tying the bundles in one direction, transferring the bundles to a second tying machine for tying them in a direction transverse to the first tie, and finally ejecting the tied bundle from the second machine.

These and other objects of this invention will become apparent from the following detailed description of a preferred embodiment thereof when taken together with the accompanying drawings in which—

FIGURE 1 is a schematic plan view of the principal components of this invention;

FIG. 2 is a schematic elevational view of the units of FIGURE 1;

FIGS. 3, 5, 7 and 9, and FIGS. 4, 6, 8, 8*a* and 10 are, respectively, plan and elevational views of a first transfer mechanism forming part of this invention in the first stages of operation;

FIG. 11 is a fragmentary end elevational view of a first tying machine forming part of this invention showing a bundle hold-down mechanism thereof in operative condition;

FIG. 11*a* is an enlarged view of an element of the first tying machine showing the placement of certain controls for the components of this invention;

FIGS. 12 and 13 are, respectively, simplified plan and elevational views of a second transfer mechanism forming part of this invention, showing the movement of a tied bundle from one tying machine to an adjacent tying machine;

FIG. 14 is a fragmentary end elevational view of the second tying machine with the bundle hold-down mechanism thereof in operative condition;

FIG. 14*a* is an enlarged view of an element of the second tying machine, showing the placement of certain other controls for the components of said second tying machine;

FIGS. 15 and 16 are schematic front elevational views of the first tying machine showing the failure of the trip mechanism thereof to operate in the absence of a bundle thereon;

FIGS. 17 and 18 are end elevational views of the second tying machine (looking from the left of FIG. 1) showing the failure of the trip mechanism thereof to operate in the absence of a bundle placed thereon;

FIGS. 19 and 20 are front elevational views of the first tying machine showing the operation thereof when a bundle is placed thereon;

FIGS. 21 and 22 are end elevational views of the second tying machine (looking from the left of FIG. 1) showing the operation thereof when a bundle is placed thereon;

FIGS. 23 and 24 are, respectively, plan and front elevational views of the conveyor mechanism which carries bundles of mail to the vicinity of the tying machines;

FIG. 25 is an enlarged end elevational view of the conveyor mechanism (looking from the right of FIG. 1) taken in section along line **25—25** of FIG. 1 and showing one of the mail bundle-supporting buckets and the roller-supporting mechanism therefor;

FIG. 26 is a front elevational view in section, also on an enlarged scale, of one of the mail bundle-supporting buckets, the view being taken along line **26—26** of FIG. 23;

FIG. 27 is an enlarged plan view of the transfer mechanisms and the two tying machines with the observer standing to the rear thereof and looking toward the front as viewed in FIG. 1;

FIG. 28 is a rear elevational view of the transfer mechanisms and tying machines of FIG. 27 on substantially the same scale as FIG. 27;

FIG. 29 is a front elevational view of the transfer

mechanism for transferring a bundle of mail from the conveyor to the first tying machine said view being on a still larger scale than FIGS. 27 and 28;

FIG. 30 is a plan view in section of a portion of the transfer mechanism of FIG. 29;

FIG. 31 is an enlarged fragmentary rear elevational view of a sprocket of the conveyor, showing the relative placement for still other controls for certain elements of this invention;

FIGS. 32 and 33 are sections through typical valves for controlling the air cylinders used in the apparatus;

FIG. 34 is a schematic wiring diagram for the electrical components of the invention; and

FIG. 35 is a cycling diagram for the components of this invention.

Referring now to FIGS. 1 and 2 for a general description of the invention, the system is comprised of a conveyor unit 40, the function of which is to bring sorted bundles of mail from the sorting stations in a post office to the tying machines, a first transfer mechanism 41 which takes the bundles from the conveyor 40, a first tying machine 42 to which the bundles are transferred from conveyor 40 and on which the said bundles are tied in one direction, a second transfer mechanism 43 which removes a tied bundle from the first tying machine 42, a second tying machine 44 to which the bundles are transferred from first tying machine 42 and which ties said bundle in another direction, and a third transfer mechanism 45 which removes a tied bundle from the second tying machine 44 and ejects it into a hopper or the like.

It is contemplated that the conveyor 40 will be of such length and so disposed as to run past a number of sorting stations in a post office. The sorters will manually place each sorted bundle on conveyor 40, which is equipped with spaced buckets 61, hereinafter to be described in detail, and in which each bundle is placed by the sorters with the envelopes standing on edge and held by a suitable spring clamp. The conveyor moves continuously toward the first transfer mechanism 41.

The tying machines are designed to wrap a length of twine around a plurality of envelopes while the envelopes are stacked upon one another with their general planes in a horizontal position. The conveyor 40 therefore is arranged to have, first, a horizontal section 47 on which the envelopes are disposed upon their edges, and a vertical section 48 which turns the envelopes through 90° to cause them to lie substantially parallel with the horizontal position in which they are to be tied.

It may be observed that when the bundle of envelopes is placed in a bucket with the edges of the envelopes down, the envelopes will tend to align themselves against the bottom of the bucket and thereby avoid a loose and misaligned tie.

The transfer mechanism 41 is required to pick off a bundle from the vertical section 48 of the conveyor while the bundle is moving downwardly, and transfer such bundle to the first tying machine 42. Means hereinafter to be described are therefore provided for imparting a vertical movement to the first transfer mechanism 41 in synchronism with the vertical movement of the bundle to be removed from the conveyor while the removal thereof takes place, a horizontal movement into the bucket to grasp the bundle of envelopes carried therein, a reverse movement in a horizontal direction to withdraw the bundle from the bucket, a swinging movement in a horizontal plane to bring the bundle to a desired location on the first tying machine, and a final withdrawing movement and swinging movement to bring the transfer mechanism into position for grasping a second bundle. To effect a simplification of the controls for the system, the first transfer mechanism is designed to run continuously with the conveyor 40 and to go through its cycle of movements whether or not there is a bundle of mail in each bucket. It is not desirable, however, to have the first tying machine 42 running continuously and hence means are provided, hereinafter to be described in detail, for preventing operation of the first tying machine when no bundle is placed thereon.

It is likewise undesirable for the second transfer mechanism 43 to run through its motions and for the second tying machine 44 and the third transfer mechanism 45 likewise to run through their motions unless a bundle is placed thereon. The second transfer mechanism 43 therefore is triggered to operate from the operation of first tying machine 42 so that if the first tying mechanism or machine does not operate, the second transferring mechanism likewise will not operate.

Assuming, however, that a bundle of mail has been placed upon the first tying machine 42 by transfer mechanism 41 and has been tied thereby in one direction, the operation of the first tying machine will cause an operation of the transfer mechanism 43, which then pushes the tied bundle to the table of the second tying machine 44. There a mechanism will sense the presence of a bundle and will cause the bundle to be tied in a direction crosswise of the first tie. The sensing mechanism for the second tying machine will be triggered by the operation of the first tying machine so that if there is no bundle in the first tying machine, the sensing mechanism will not operate and the second machine, as well as the third transfer mechanism, will be inoperative. In the event that the first machine operates, but for some reason there is a malfunctioning of the transfer mechanism 43, the sensing mechanism for the second tying machine 44 will operate but will sense the absence of a bundle and hence will prevent the automatic operation of the second tying machine.

Assuming that the second tying machine has performed its tying operation, a control for the third transfer mechanism will be set in operation and will cause the third transfer mechanism to remove the tied bundle from the second tying machine and into a hopper or possibly to another conveyor (not shown).

The transfer mechanisms and certain bundle hold-down mechanisms associated with the two tying machines, in the form chosen to illustrate this invention, are powered by known readily available air cylinders controlled by electromagnetically operated valves which in turn are energized by micro-switches disposed in the path of movement of a member performing an antecedent function. Thus, a first group of micro-switches controls certain movements of the first transfer mechanism and is operated by an element or elements movable with the conveyor. A second group of microswitches, operated by the movement of elements of the first transfer mechanism, controls other movements of the first transfer mechanism and initiates the movement of the hold-down mechanism of the first tying machine. A third group of switches, operated by elements of the hold-down mechanism for the first tying machine, controls the remaining movements of the first transfer machine to complete the cycle thereof. A fourth group of switches is operated by elements of the first tying machine and releases the hold-down mechanism of the first tying machine, operates the second transfer mechanism and engages the hold down mechanism of the second tying machine. A fifth group of switches is operated by elements of the second tying machine and releases the hold-down mechanism thereof and operates the third transfer mechanism.

The Conveyor Unit

The details of construction of the conveyor unit 40 are shown in FIGS. 23 to 26 inclusive, to which reference is now made.

Conveyor unit 40 may comprise a frame 49 having parallel horizontally disposed frame members 50 and 51 to which are fastened oppositely disposed channel-shaped tracks 52 and 53. Spaced endless chains 54 and 55 are supported on horizontal pins 56 and 57 extending outwardly from the downwardly depending legs 58 and 59 of a base plate 60 which may be a casting. Said plate 60

extends slightly above frame members 50 and 51 and supports a bucket 61 which may be made of sheet metal and may have a bottom 62, a side wall 63 and a front wall 64. Bucket 61 is intended to receive and carry a bundle of envelopes which is placed therein by the mail sorter. Said front wall 64 is relieved or notched at its upper end as at 65 to expose the upper ends of the envelopes in the bucket to the pick-up elements of the first transfer mechanism 41.

It may be noted that the front wall 64 slopes backwardly from the perpendicular to the bottom 62 as viewed in FIG. 26. The purpose of this slope is to make certain that as the buckets move down the vertical section of the conveyor, the envelopes will tend to slide toward the bottom 62 rather than in the opposite direction and fall out of the bucket. It is contemplated that as a bundle of envelopes is placed into a bucket, the operator will push the bundle against side wall 63 to level the bundle somewhat at that end and that he will allow the individual envelopes in the bundle to fall against the bottom 62 of the bucket and thus level off the edges of the envelopes adjacent thereto.

Inasmuch as the rearwardly sloping wall 64 would tend to make the envelopes fall over in that direction (i.e., to the left as viewed in FIG. 26), support for the envelopes is afforded by a finger spring 66 riveted at one end to an L-shaped stamping 67 spot-welded to bucket bottom 62 at the corner of said bottom farthest removed from side wall 63 and front wall 64. Said finger spring 66, as viewed in FIG. 23, is S-shaped in section to provide a rounded surface at the free end thereof to bear against the bundle of envelopes and thereby to avoid cutting or tearing of the envelopes.

Each of the pins 54, 55 has mounted thereon an anti-friction roller 68, 69, which rides on the inside of the side flanges of the channel-shaped tracks 52, 53. At the forward end of tracks 52, 53 are sprockets 70 and 71 which may be mounted on a common shaft 72 supported in spaced bearings 73 and 74 secured to frame 49. Said sprockets 70, 71 turn the conveyor chains downwardly over the vertical section 48 of the conveyor. A pair of drive sprockets 75 below sprockets 70 and 71 serves to turn the conveyor chains backwardly away from the said vertical section 48 and upwardly through guides 76 which then turn the chains in a horizontal direction to rear sprockets 77 where the direction of the chain is reversed for the horizontal section 47. Drive sprockets 75 are driven from a motor 78 mounted on a platform 79 on frame 49 and connected to drive sprockets 75 through suitable reduction gearing and sprocket and chain mechanism shown schematically at 80.

The First Transfer Unit

The details of the first transfer mechanism are shown in FIGS. 27 28, 29 and 30, and will now be described.

Referring first to FIG. 28, the first transfer mechanism 41 includes a clamping device 81 which seizes a bundle of mail from one of the buckets 61 on the conveyor, a horizontally reciprocating mechanism 82 for withdrawing a bundle from a conveyor bucket, a rotating mechanism 83 which swings mechanisms 81 and 82 about a vertical axs to deposit a bundle on the first tying machine 42 and a raising and lowering mechanism 84 which moves the mechanisms 81 and 82 vertically to follow a moving bucket 61.

Clamping mechanism 81 is comprised of an L-shaped casting 85 on which is disposed a pneumatic cylinder 86 of known construction with its axis in a vertical plane, the piston rod 87 of which is connected to a cross member 46 on the ends of which are secured disk-shaped pads 88 and 89 which contact the upper surface of the bundle to be seized. To the under side of casting 85 is secured a U-shaped stamping 90 having a short horizontal side 91 by which said stamping is secured to said casting 85, a vertically disposed back 92 and a horizontally disposed side 93 which is longer than side 91 and extends generally under pads 88 and 89. The horizontal length of stamping 90 is less than the horizontal length of a bucket 61 on vertical section 48, and the stamping is so placed with reference to the transfer mechanism that in the position in which it picks off a bundle of mail, side 93 will be well within the notch 65 in the bucket wall 64. Side 93, therefore, does not contact wall 64 of the bucket at any time.

The stamping 90 and the clamping mechanism 81 are sometimes hereinafter referred to as the "pick-off head."

Horizontally reciprocating mechanism 82 is comprised of a frame member 94, also L-shaped, and having a base 95 secured to a splined shaft 96. Said frame member 94 supports a horizontal guide rod 97 which is secured at its right hand end (FIG. 28) to L-shaped frame casting 85. Immediately above guide rod 97 is mounted a pneumatic cylinder 98 of known construction, the piston rod 99 of which is also connected to L-shaped frame member 85. Guide rod 97 extends through base 95, and its left hand end 100 (FIG. 28) has a depending finger 101 secured thereto, the function of which is to operate a micro-switch in a manner hereinafter to be described.

Rotating mechanism 83 is supported by various elements of the machine frame. The first such element is a plate 102 which is secured at one end to a vertically disposed angle iron or the like 103 (FIG. 27), and at its other end to a casting 104 which in turn is secured to a vertically disposed plate 105 appropriately secured to an angle iron 106 forming a part of the lower portion of the machine frame. Said casting 104 is also secured to another angle iron 107 forming an upper part of the machine frame. Thus, casting 104 is rigidly supported from, and forms a part of, the machine frame.

Casting 104 extends upwardly under base 95 of the horizontally reciprocating mechanism 82 to provide a support for a first bearing 108 for shaft 96, a second bearing 109 for said shaft 96 being formed in casting 104 below and separated from bearing 108. Suitable anti-friction supports (not shown) are provided in the supports for the shaft 96 to permit said shaft to rotate freely therein. Between bearings 108 and 109 is disposed a hub member 110 which, as shown in FIGS. 28 and 30, is splined to shaft 96 so that said shaft may move vertically with respect to said hub, but is constrained to rotate with said hub. Suitable spacers and thrust washers 111 are interposed between hub 110 and upper bearing 108 to prevent vertical movement of the hub with respect to casting 104. An arm 112 extends radially outwardly from hub 110 and is pivoted at 113 to a piston rod 114 extending outwardly from a pneumatic cylinder 115 of known construction pivoted in turn at 116 to spaced ears 117 secured to plate 102.

It may be apparent from the description thus far given of the rotating mechanism 83 that when cylinder 115 is activated to reciprocate its piston rod 114, arm 112 will be oscillated about the axis of shaft 96, and, through its splined connection therewith, will likewise oscillate said shaft. This, in turn, will impart the rotating movement to the base 95 of frame member 94 which effects a swinging movement in a horizontal plane of the bundle carried by pick-off head 90.

The vertically movable mechanism 84 is comprised of a pneumatic cylinder 118 of known construction disposed with its axis in a vertical position and secured at its lower end to a bracket 119 mounted on plate 105, and at its upper end, to a bracket 120 likewise secured to plate 105. The piston rod 121 is secured through a connection 122 to the lower end 123 of splined shaft 96. Said connection 122 includes an anti-friction bearing 124 which allows free rotation of shaft 96 relative to connection 122 about the axis of cylinder 118, but which prevents relative axial movement between shaft 96 and connection 122. Thus cylinder 118 may be activated and

in operation to raise and lower shaft 96 at the same time that cylinder 115 is activated to rotate said shaft.

The First Tying Machine

The first tying machine 42, as stated previously, may be of the type disclosed in the aforementioned B. H. Bunn Patent No. 2,898,847 for Tying Machine granted August 11, 1959, modified slightly to adapt it to use with the transfer mechanism 41. Thus, in the machine disclosed in the aforesaid Bunn patent, a bundle-locating mechanism, such as an upstanding post on the table of the machine normally used in said prior machine, may be dispensed with since the transfer mechanism will always locate a bundle of mail precisely in the same place on the table of the first tying machine 42. The trip mechanism disclosed in the aforesaid patent may be modified in form, but not in function, as will hereinafter appear, to enable an automatic sensing mechanism to sense the absence of a bundle on the machine and thereby to halt all subsequent operations of the tying machines and associated mechanisms.

Referring now to FIGS. 15, 16, 19 and 20, the modifications of, and additions to, the tying machine of the Bunn patent will now be described. Said machine includes a frame 125, shown in dotted outline, on which is supported a bundle-receiving table top 126. In accordance with the teachings in the aforesaid Bunn patent, operation of the machine is initiated by a lever 127 which has a portion 128 extending above the surface of table top 126. Said lever portion 128 is in the form of a knob so that the length of the lever protruding above table top 126 is considerably reduced over that of the corresponding lever in the aforesaid patent.

Above lever 128 is a hold-down mechanism comprising a wide angle yoke 129 having diverging arms 130 and 131. Yoke 129 is supported from a bar 132 which, in turn, is secured to the lower end of the piston rod 133 of a pneumatic cylinder 134 of known construction, said cylinder, in turn, being rigidly secured to an angle iron 135 (FIG. 28) secured to frame 125. A guide rod 136 prevents bar 132 from turning about the axis of piston rod 133 and hence maintains yoke 129 in a predetermined aligned position over lever 127.

The twine arm 137 of the tying machine is substantially identical to the corresponding twine arm of the tying machine of the aforesaid Bunn patent and is adapted to swing in a circle shown in dotted line in FIG. 20 to tie a reach of twine 138 around a bundle of letters in one direction. As arranged in the present apparatus, the first tying machine 42 will wrap a reach of twine around the long dimension of the bundle of envelopes.

FIGS. 15 and 16 show the raised and lowered positions, respectively, of the hold-down mechanism when there is no bundle on the table top 126. It may be observed from FIG. 16 that in the lowermost position of the yoke 129, knob 128 of lever 127, though extending to a line 139 connecting the lowermost points of the diverging arms 130 and 131, is nevertheless not contacted by the yoke and hence is not depressed to initiate the operation of the tying machine. By making the subsequent operations of the apparatus dependent upon the functioning of tying machine 42, the failure of the machine to operate under the conditions disclosed in FIG. 16 provides the control necessary to effect the aforesaid desired result.

Referring now to FIGS. 19 and 20, the uppermost and lowermost positions of yoke 129 when a bundle of mail has been placed upon table top 126 over lever 127 are depicted. It may be observed from FIG. 19 that the mere weight of the bundle 140 is not sufficient to cause the lever 127 to be depressed to operative position. Upon the actuation of cylinder 134 to push piston rod 133, bar 132 and yoke 129 downward against bundle 140, however, the increased pressure provided by the cylinder will cause lever 127 to be depressed, and the machine will then be set into operation to cause twine arm 137 to wrap the twine 138 around bundle 140 in the manner described in the aforesaid Bunn patent.

The Second Transfer Mechanism

The second transfer mechanism 43 (FIGURE 1) is shown in FIGS. 27 and 28. It is comprised of a pneumatic cylinder 141 of known construction mounted on a bracket 142 secured to machine frame 125. The operative end of said cylinder 141 is comprised of a plate 143 secured to the piston rod 144 of the cylinder so as to be movable therewith. Inasmuch as the sole function of the transfer mechanism 43 is to push bundle 140 from the first tying machine to the second tying machine, plate 143 may be circular in shape, and hence it is unnecessary that it be guided to prevent it from turning.

The location of the second transfer mechanism 43 with respect to the table top 126 is dictated by the clearance required between said transfer mechanism and a bundle of letters as it is being swung in an arc from a conveyor bucket 61 to the table top 126 of the first tying machine. The axis of the cylinder 141 is disposed to direct a tied bundle of mail from the first tying machine to the proper location on the second tying machine for effecting a cross tie of the bundle at the desired location thereon.

The Second Tying Machine

The second tying machine 44 may be substantially identical with the first tying machine 42. It is disposed at right angles to the first tying machine, and with its table top no higher than, and immediately adjacent to, the table top 126 of the first tying machine. As shown in FIGS. 17, 18, 21 and 22, the second tying machine 44 is provided with a table top 145 similar to table top 126 of the first tying machine 42 through which extends a trip lever 146, the free end of which is formed as a knob 147, which is to be contacted by a bundle of mail. Immediately over knob 147 is disposed a yoke 148 having diverging arms 149 and 150 defining between them a notch into which knob 147 may extend without contacting the yoke. Since the second tying machine is designed to tie the bundle of mail across the short dimension thereof, the length of the yoke arms 149 and 150 is considerably less than that of yoke 129 of the first tying machine.

Yoke 148 is mounted on the end of a bar 151 which, in turn, is secured to the lower end, as viewed in FIG. 18, for example, of the piston rod 152 of a vertically disposed pneumatic cylinder 153. Said cylinder 153, as shown more clearly in FIG. 28, is rigidly secured to a bracket 154 which, in turn, is bolted, or otherwise secured, to an upstanding angle iron 155 bolted to frame 156 of the second tying machine 44. A guide rod 157 (FIG. 18) serves to prevent bar 151 from rotating about the axis of piston rod 152 and hence maintains yoke 148 in proper position crosswise of a bundle to be tied.

FIG. 17 shows the second tying machine with the yoke 148 elevated to receive thereunder a bundle of mail to be tied. FIG. 18 shows the second tying machine with the yoke 148 in its lowermost position without a bundle having been inserted thereunder. Under these conditions yoke 148 does not contact knob 147 and hence the trip mechanism is not depressed to initiate the operation of the machine. In FIG. 21, bundle 140 has been pushed upon the table top 145 and upon knob 147 and under yoke 148. As in the first tying machine, the weight of the bundle is not sufficient to depress lever 146 and hence cross-tying machine 44 will not be set in operation by the mere presence of a bundle on lever 146. FIG. 22 shows the yoke 148 lowered upon bundle 140 and pressed thereagainst by cylinder 153, the pressure of the cylinder being sufficient to depress trip lever 146, through contact between knob 147 and bundle 140, to initiate the operation of the machine. As shown by the dotted arrows in FIG.

22, the end of the twine arm 158 of the machine will describe a circle around bundle 140, thereby tying a reach of twine 159 therearound.

The Third Transfer Mechanism

After the second tying machine 44 has completed its operation, it is necessary to remove the tied bundle from its table top to make room for the next bundle. The removal of the tied bundle is effected by transfer mechanism 45 which is shown to best advantage in FIGS. 27 and 28. Said transfer mechanism may be substantially identical to second transfer mechanism 43 and is comprised of a pneumatic cylinder 160 supported at its end regions from brackets 161 and 162 similar in construction to bracket 142 associated with cylinder 141 and converging downwardly against a frame member 163 of the second tying machine 44 to which they are bolted. The control mechanism 164 for cylinder 160 is mounted above said cylinder on a vertically disposed bracket 165 secured to a special frame member 166 the function of which is to secure the two tying machines and the first transfer mechanism together to form a unit. Said cylinder 160 has a piston rod 167 which is reciprocable across the table top 168 of the second tying machine 44 and has secured to the end thereof a plate 169 disposed transversely of the axis of the piston rod and of substantially the same configuration as plate 143 of cylinder 141 for the purpose of contacting a tied bundle and pushing said bundle off table top 168.

The Frame

The conveyor 40, first transfer mechanism 41 and the tying machines 42 and 44 are united into a single structure by a frame which includes at the lower portion thereof the horizontally disposed angle iron 106 previously referred to and which, as seen in FIGS. 27 and 28, extends around the lower portion of both tying machines and is secured to said tying machines by suitable bolt fasteners 170. Said angle iron may be bent in the form of connected rectangles which are supported from the floor through channel posts 171, 172, 173 and 174. Said posts are made vertically adjustable by known means with respect to angle iron 106 to allow for varying the height of the conveyor from the floor and to take care of irregularities in the level of the floor on which the machine is mounted. Angle iron 106 extends from plate 105, to which it is secured, across to the portion 175 (FIG. 27) of the frame at the lower regions of the first tying machine through a section 176 (FIG. 28), thereby giving horizontal support to the lower region of said plate 105. The angle iron frame is secured to frame 177 of the conveyor through a pair of lower brackets 178, 179 (FIGS. 27 and 28) which extend around, and are secured to, plate 105 at the lower regions thereof, and by a pair of upper straps 180, 181 secured to conveyor frame 177 at one end, and at their other ends to angle iron 107 which is bolted to the second bearing 109.

It may be noted that the bundle to be tied, 140, is shown in dot-dash outline in FIG. 27 in the positions it occupies in each of the tying machines 42 and 44. It may be noted further that it is important that said bundle 140 assume a predetermined position on the second tying machine 44 so that the twine will be tied around said bundle at a predetermined location on the bundle. Inasmuch as the transfer mechanism 43 imparts considerable momentum to the bundle as it moves said bundle from the first tying machine 42 to the second tying machine 44, the latter is provided with a backstop 182 which is a standard construction for such tying machines as will be apparent by reference to the machine shown in the aforesaid Bunn patent. Said backstop limits movement of the bundle to the left as viewed in FIGS. 27 and 28. If sufficient momentum is given the bundle, the latter may tend to spring back away from backstop 182, and hence it may be desirable to lower the table top 168 for the second tying machine 44 with respect to the table top 126 for the first tying machine 42 rather than have the two table tops at the same level. In this manner the bundle, in rebounding from the backstop 182, will be stopped by edge 126*a* of the table top 126 and hence will be prevented from assuming an undesirable position on the table top 168 of the second tying machine. Alternatively, it may be desirable to tilt the second tying machine 44 with respect to the first tying machine 42 in such manner that table top 168 slopes downward toward backstop 182, and hence any bundle resting on table top 168 will normally slide toward, and come to rest at, backstop 182.

The Controls

The controls for the pneumatic cylinders, as stated previously, are solenoid-operated valves of a known construction which valves in turn are rendered operative by fifteen switches of the micro-switch type, closed by the movement of various elements of the machine as will hereinafter be described. In addition to the solenoid-operated valves are the two mechanical trip devices, each associated with one of the tying machines, said trip devices functioning to set into operation a clutch of the tying machine which drives the tying arm and knotter of the tying machine. It is contemplated that the motor of each tying machine will be operated continuously from a manually operated master switch, but that the operation of the individual tying arms and knotters will be intermittent and controlled solely by their associated trip mechanisms.

The solenoid-operated valves used herein are of a type which is readily available commercially. Two forms are shown for illustrative purposes in FIGS. 32 and 33, respectively, the FIG. 32 form being used where the piston rod is to be extended as long as current is applied to its control solenoid and then automatically retracted, and the FIG. 33 form being used where an instantaneous pulse of current is applied to one of two control solenoids to operate and hold the piston rod in one or the other of its extreme positions. The valves and valve bodies for both forms may be identical and will be given the same reference characters herein.

Referring to FIG. 32, the typical cylinder wall is shown at 240 and the cylinder is closed at one end by a machined head 241 which extends outwardly of the cylinder to form a portion of a valve body 242. A slide valve 243 is reciprocable in a valve chamber 244 which is continuously exposed to air under pressure and through which said air under pressure is conducted to one side or the other of the cylinder. A pair of exhaust ports 245 is formed in valve body portion 242 and communicates with valve chamber 244. A port 246 connects valve chamber 244 with one end of cylinder 240 and a port 247 connects valve chamber 244 with the other end of cylinder 240 (not shown) through a pipe 248. Valve 243 is shown in a "neutral" position which, however, it never occupies when the cylinder is in operation; it is always either in its lowermost position as viewed in FIG. 32 in which it connects port 246 to vent port 245, or in its uppermost position as viewed in FIG. 32 in which it connects port 247 to vent port 245. In the former position, air under pressure is admitted around the exterior of valve 243 to port 247 and in the latter position, air under pressure is admitted to port 246.

The position of valve 243 is controlled by a plunger 249 slidable in a bore 250 in the outer portion 251 of the valve block and connected to valve 243 by a tongue-and-groove connection 252. Said bore is closed at one end by a plug 253. Plunger 249 is exposed on one side 253 to air under pressure from chamber 244 through suitable passages (not shown) so that the plunger is continuously biased to its lowermost position (FIG. 32) in which air under pressure is admitted to pipe 248 to hold the piston rod in its retracted position. A solenoid 254 is mounted on outer valve body portion 251 and its armature 255 is press fitted into an appropriate opening in plunger 249 to compel said plunger to move with its armature. Energization of solenoid 254 causes armature

255 to move downwardly in bore 250 as viewed in FIG. 32 against the air pressure exerted in the opposite direction against end 254. Armature 255 remains in its lower position only as long as solenoid 254 is energized.

In FIG. 33 the head 241, valve 243, plunger 249 and solenoid 254 are the same as in FIG. 32, but a second solenoid 256 has been substituted for the plug 253, and plunger 249 is balanced as to air pressure so that its position in bore 250 is determined solely by the energization of solenoids 254 and 256. When either solenoid 254 or 256 is energized, plunger 249 will move away from the energized solenoid and will stay there. Thus, solenoids 254 and 256 need be energized only long enough to move their respective armatures to the limit of the movement permitted plunger 249, regardless of the instantaneous position of the piston and piston rod in the associated cylinder, and since valve 243 remains in one or the other of its extreme positions, a complete operation of the cylinder, i.e., of the piston and piston rod is assured.

A first group of five switches is shown in FIG. 31 and is mounted on a plate 183 shown in dotted outlines in FIG. 31 and fixed to the frame 49 of the conveyor unit 40. Said plate 183 is preferably mounted in proximity to the upper sprocket 71 of the conveyor (FIG. 28) and in proximity to the path of movement of three pins 184, 185 and 186 mounted on the face of sprocket 71 and extending laterally therefrom. In the form chosen to illustrate this invention, the linear distance between adjacent buckets 61 on conveyor chains 54 and 55 (FIG. 5) is exactly one-third the circumference of sprocket 71, and hence, the cycle of picking off a bundle of mail from conveyor 40 occurs three times during a single rotation of sprocket 71. It is for this reason that three pins are used, said pins, accordingly, angularly spaced 120° apart.

The five switches in the first group are shown (FIG. 31) arranged in an arc of a circle at 187, 188, 189, 190 and 191, the switch-operating portions of which are shown at 192, 193, 194, 195 and 196. Said operating portions may comprise the usual rollers (not shown) which are contacted by said pins 184, 185 and 186 as they are rotated past the switches.

The second group of switches (FIG. 11*a*) comprises three mounted on frame 125 of the first tying machine 42 in proximity to the mutilated gear 197 of said tying machine 42. The details of construction of said mutilated gear are shown in detail in the aforesaid Bunn patent and will not be given here. Said second group is shown at 198, 199 and 200, each being located at a different radial distance from one another so that each will be activated but once during the rotation of the mutilated gear. As is more fully described in the aforesaid Bunn patent, mutilated gear 197 rotates only after the trip mechanism associated with tying machine 42 has been activated and its associated clutch has been operated. The angular spacing between the switches 198, 199 and 200 is dictated more by convenience of location on the frame 125 than by any timing requirements inasmuch as each switch is operated by its own pin 201, cam 202 and pin 203 mounted at different radial distances on mutilated gear 197, and hence the location of the pins and cam may be selected, one with reference to the other, to give the desired sequence of operation.

The third group of switches (FIG. 14*a*) comprises two in number which are mounted on the frame 156 of the second tying machine 44. These switches are shown at 204 and 205 disposed at different radial distances from one another and adapted to be contacted by their respective pin 206 and cam 207 mounted on the corresponding mutilated gear 208 of the tying machine 44. Here again the location of the switches 204 and 205 is dictated more by convenience of attachment to a frame member than by cyclic timing inasmuch as the latter may be regulated by appropriate location of the individual pin 206 and cam 207.

A fourth group of switches has already been referred to and is associated with the first transfer mechanism 41. The first of these is switch 209 shown in FIG. 29 mounted on casting 108 and having an operative element 210 adapted to be contacted by finger 101 mounted on the end 100 of guide rod 97. The second and third switches are shown in FIG. 27 at 211 and 212 having, respectively, operative elements 213 and 214 adapted to be contacted by a pin 215 shown in FIGS. 28 and 29 as depending from the base 95.

A fifth and last group of switches is shown schematically in FIG. 11 at 216 and 217, these switches and their operative members being mounted on the frame member 135 (FIG. 28) and contacted by a portion of the hold-down mechanism 129 which is reciprocated by cylinder 134. Preferably the said switches are mounted adjacent the guide rod for the hold-down mechanism and operated by an extension thereon.

The several cylinders 118, 98, 86, 115, 134, 141, 153 and 160 and their control switches are shown schematically in FIG. 34. In that figure there is shown a pipe 218 which conducts air from a suitable source of air under pressure (not shown) to the usual trap 219 and through a short pipe 220 to a pressure regulator 221. Said pressure regulator is connected through a short pipe 222 to an oiler 223 which in turn is connected to a header 224. Said header is connected through branch lines numbered 225 to 231, inclusive, to cylinders 160, 153, 141, 134, 115, 98 and 118, respectively. Cylinder 86 provides the pressure for contacting a bundle of mail and hence, to avoid exerting destructive pressure upon the mail, is designed to operate at a lesser pressure than the remaining cylinders. Accordingly, a branch line 232 is connected to a pressure reducer and regulator 233, from which the air passes through a pipe 234 to cylinder 86.

It is understood that interposed between each header and its cylinder is a solenoid-operated valve of the type shown in FIGS. 32 or 33 which controls the actual flow of the air under pressure to and from each cylinder. Cylinders 118, 98, 86, 115, 134 and 153 are of the type shown in FIG. 33 and have a separate solenoid for controlling movement of the associated piston in each direction; that is, one solenoid controls movement of the piston rod associated with the enclosed piston out of the cylinder, and the other solenoid controls the return movement of the piston rod into the cylinder. Cylinders 141 and 160 utilize a solenoid of the type shown in FIG. 32 which automatically reverses the air connections upon release of the energizing coil switch so that the piston rod retracts into the cylinder soon after it reaches its outermost excursion out of the cylinder. It may be recalled that cylinders 141 and 160 are associated with the second and third transfer mechanisms which serve merely to push a bundle of mail from one tying machine to the other, or to eject a tied bundle from the second tying machine, and hence there is no requirement that the extended rod remain in such position for any length of time.

Energy for the solenoids is derived from a common line 235 which may be the usual 110 volts, 60 cycle line. One side 236 is connected to each of the switches, and the other side of the line 237 is connected directly to the solenoid controlled by each of the switches. The switches thus are in series with their solenoids.

It may be observed that the solenoids 238 and 239, controlling the return of the pistons and their associated connecting rods of cylinders 118 and 115, are controlled by the same switch 187. It may be noted further that movement of the piston rod for cylinder 98 out of said cylinder is controlled by two separate switches 188 and 211 and that the return of the piston rod to said cylinder 98 is controlled by three switches, 190, 217 and 198, the said three switches also controlling the withdrawal or raising of the hold-down mechanism 129 associated with the first tying machine. The reasons for these interconnected switches will be made apparent hereinafter.

Operation

The operation of the machine will now be described with reference to the schematic drawings shown in FIG. 3 to 14*a* inclusive to which reference is now made. For ease of description, the U-shaped stamping **90** shown in FIG. 8 will be called hereinafter a "pick-off head."

It is understood that the conveyor **40**, after having been previously set into operation by its drive motor **78** and then subsequently stopped, may come to rest with its sprocket **71** in any one of an infinite number of angular positions with reference to the frame of the conveyor. For purposes of illustration, however, it will be assumed that initially the pick-off head is at its highest point with reference to the machine frame and has been moved back away from the vertical section **48** of the conveyor. This position is shown in FIGS. 3 and 4. Assuming now that the conveyor motor **78** is energized and the conveyor is set in motion with the chains and buckets thereof moving toward the vertical section **48**, a pin **184** on the sprocket wheel **71** will contact the switch operator of micro-switch **187**, causing the vertically disposed cylinder **118** to retract its piston rod and thereby lower the pick-off head **90**. The lowered position of the head is shown in FIG. 6. While the head was being lowered, the conveyor continued to move and sprocket **71** brought pin **184** into contact with the operative portion **193** of micro-switch **188**. This caused the piston rod for cylinder **98** to be extended to bring the head **90** to a bundle of mail. In reality, due to the proximity of the switches **187** and **188**, the movement of the head toward the bundle overlaps the last portion of the downward movement of the head so that the head moves toward in synchronism with the movement of the bundle along the vertical portion of the conveyor while at the same time moving in toward a bundle. The position of the head around the portion of the bundle protruding out of a conveyor bucket is shown in FIG. 8, the corresponding plan view being shown in FIG. 7. The head is now ready to clamp a bundle and this operation takes place next, due to the movement of finger **101** against the operative portion **210** of micro-switch **209**. The operation of the clamping cylinder **86** is shown in FIG. 8*a*.

After the bundle is firmly clamped by the cylinder **86**, pin **184** will have contacted the operative end **195** of micro-switch **190**, thereby energizing the solenoid for cylinder **98**. This retracts the piston thereof into said cylinder, thereby pulling the clamped bundle away from the conveyor and out of the bucket in which it was retained. Continued rotation of the sprocket wheel **71** brings the pin **184** into contact with the operative end **196** of micro-switch **191** which energizes the control valve solenoid of cylinder **115** of the first transfer mechanism. This cylinder rotates the pick-off head with the clamped bundle in it through 90° to the first tying machine **42**. This is shown in FIGS. 9 and 10. As the cylinder **115** is rotating the pick-off head to the first tying machine, the operative ends **213** and **214** of switches **211** and **212** are contacted by pin **215** mounted on base **95**. Switch **211** being in parallel with switch **188**, performs the identical function as switch **188** and causes the cylinder **98** to extend its rod and the associated head toward the tying machine while the cylinder **115** is swinging the pick-off head toward the tying machine as stated above.

Switch **212** controls the hold-down mechanism operated by cylinder **134**. It is desirable, of course, that the bundle be properly located on the tying machine before it is clamped by the hold-down mechanism **129**, and hence switch **211** is operated in advance of switch **212**. It is also essential that the bundle be in place before the tying operation commences. Since the pressure of the hold-down cylinder **134** is relied upon to operate the trip lever **127**, this provides additional reason for causing switch **211** to be operated before switch **212**.

As the cylinder **134** is operated to lower the hold-down mechanism upon the transferred bundle, it actuates

switches **216** and **217**. Switch **216** controls the raising of the clamping cylinder **86** from the bundle and switch **217** duplicates the function of switch **190** and therefore serves to withdraw the head linearly from the bundle. By this time, the next pin **186** on sprocket **71** has contacted the operative end **192** of switch **187** which causes the piston rod and cylinder **118** to be extended to raise the head at the same time that the cylinder **115** is rotating the head back to a position confronting the vertical section **48** of the conveyor. This brings the pick-off head back to its starting position.

Although the pick-off head has described a complete cycle of operation, the bundle is only in its first tying position on the first tying machine. It may be recalled that when the cylinder **134** was operated to lower the hold-down mechanism **129** upon the bundle, and the bundle thereupon operated the trip mechanism for the machine, the tying operation for the machine was commenced which involved the rotation of the mutilated gear **197** of the first tying machine to cause the sequential operation of the switches to be contacted by the pin **201**, cam **202** and pin **203** on said mutilated gear. The rotation of the mutilated gear brings the pin **201** into contact with the operative portion of switch **198** which causes cylinder **134** to raise the hold-down **129** from the bundle and release the bundle for its transfer to the next tying machine, and at the same time, as shown in FIG. 34, causes cylinder **98** to be operated to withdraw the head from the tying machine.

Continued rotation of the mutilated gear next brings cam **202** into contact with the operative portion of switch **199** which causes the solenoid-operated valve for cylinder **141** to operate to admit air under pressure to that cylinder in the manner hereinabove described to cause an extension and retraction of its piston and associated rod, whereby to transfer the tied bundle from the first tying machine **42** to the second tying machine **44**. Cam **202** will hold switch **199** operative until the bundle has been completely ejected. Still further rotation of the mutilated gear causes pin **203** to contact the operative portion of switch **200** to result in the operation of cylinder **153** associated with the second tying machine **44** and thereby to bring the hold-down mechanism of that cylinder against the transferred bundle on the second tying machine **44**.

FIGS. 12 and 13 show the bundle in place on the second tying machine, and FIG. 14 shows the hold-down mechanism **148** for the second tying machine operated which, as previously described, exerts pressure upon the bundle to depress the trip lever **146** of the second tying machine and thus initiates the operation of the said second tying machine. During the operation of said second tying machine, mutilated gear **208** thereof will be rotated and will cause contact to be established between the pin **206** carried by said gear and the operative portion of switch **204** to close said switch. This energizes the solenoid valve for cylinder **153** and results in an operation of the cylinder to retract hold-down mechanism **148** to free the tied bundle. Further rotation of mutilated gear **208** causes cam **207** movable therewith to contact the operative portion of switch **205** which, as seen in FIG. 34, controls the solenoid for cylinder **160**, the function of the latter being to eject the tied bundle from the second tying machine. The said cylinder will be operated to cause an extension of its rod and a retraction thereof in the manner described with reference to cylinder **141** and thus to complete the cycle as to the tied bundle. Cam **207** will hold switch **205** in operative condition long enough to insure a complete ejection of the tied bundle from the machine.

During the operation of the second tying machine, the conveyor **40**, of course, has been continuously and steadily moving toward the transfer mechanism, and with the movement of the conveyor, there has been a continuous and steady rotation of the sprocket **71**, with pin **186** passing sequentially from one to another of the operative por-

tions 193, 194, 195 and 196 of the switches 188, 189, 190 and 191 to perform the transferring cycle by which a bundle is picked off the conveyor and placed upon the first tying machine 42. Thus, as soon as a bundle has been tied by the first tying machine 42 and ejected therefrom, a second bundle is transferred from the conveyor to said first tying machine so that the first and second tying machines are operating substantially simultaneously. The interval between tying operations for the machines is thus controlled by the speed with which a bundle may be transferred from the conveyor to the first tying machine.

As a safety measure, it is desirable to make certain that the hold-down mechanism 148 of the second tying machine 44 is in its raised position while a bundle is being transferred from the first tying machine 42 to the second machine 44. An additional switch 257 is mounted on the frame of the first tying machine 42 (FIG. 11*a*) to be contacted by a pin 258 on mutilated gear 197 thereof and timed to raise the hold-down mechanism 148 just before mechanism 43 begins to operate.

Referring now to FIG. 35, there is shown a sequence and timing diagram for all of the operations performed by the tying machines and transfer mechanisms. The diagram is in the form of a chart, the horizontal scale referring to equal increments of movement of the conveyor (each increment representing one inch of movement in the form chosen to illustrate this invention) and the numbers arranged vertically corresponding to the switches which are to be operated. The heavy lines show the operations of the cylinders, the time when they are operated, and the duration of each operation. The arrows at the ends of the cylinder designations indicate the direction in which the piston rods thereof are moved.

It may be noted from the dotted representation of the repeating cycles that there is an overlap between the operation of the first tying machine and the second tying machine in the manner hereinabove described whereby said machines are made to operate at substantially their maximum capacity. This makes for a most efficient operation of the machines.

I claim:

1. In combination, a frame, conveyor means on said frame for moving bundles of mail from one or more assembly stations to a pick-off station, means on the frame for tying a bundle of mail together, means on the frame at the pick-off station for seizing a moving bundle, means for transferring a seized bundle from the conveyor means to a pre-determined location on the tying means, control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means, said conveyor means having a horizontal section and a vertical section, said vertical section being disposed at the pick-off station, and said transfer means including a bundle pick-off head, means for lowering the pick-off head in timed relation to the movement of the conveyor means over said pick-off station, and means for moving the pick-off head toward and away from a bundle on said conveyor means.

2. In combination, a frame, conveyor means on said frame for moving bundles of mail from one or more assembly stations to a pick-off station, means on the frame for tying a bundle of mail together, means on the frame at the pick-off station for seizing a moving bundle, means for transferring a seized bundle from the conveyor means to a pre-determined location on the tying means, control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means, said conveyor means having a horizontal section and a vertical section, said vertical section being disposed at the pick-off station, said transfer means including a bundle pick-off head, means for moving the pick-off head in timed relation to the movement of the conveyor means over said pick-off section, means for moving the pick-off head toward and away from a bundle on the conveyor means, clamping means on said pick-off head for seizing a bundle of mail on said conveyor means, and means operated by the means for moving the pick-off head toward and away from a bundle for initiating the operation of said clamping means.

3. In combination, a frame, conveyor means on said frame for moving bundles of mail from one or more assembly stations to a pick-off station, means on the frame for tying a bundle of mail together, means on the frame at the pick-off station for seizing a moving bundle, means for transferring a seized bundle from the conveyor means to a pre-determined location on the tying means, control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means, said tying means being disposed to one side of said conveyor means, said conveyor means having a horizontal section and a vertical section wherein the conveyor means moves downwardly, said vertical section including the pick-off station being adjacent the tying means, and said transfer means including a bundle pick-off head, means for lowering the pick-off head in timed relation to the movement of the conveyor means over said pick-off station, means on the pick-off head for seizing a bundle of mail on the conveyor means while said pick-off head is moving in timed relation thereto, and means for simultaneously withdrawing a seized bundle from said conveyor means, rotating said bundle through 90° toward the tying means and lowering said bundle upon said tying means.

4. The combination described in claim 3 characterized by means operable upon movement of the transferring means to a predetermined position over the tying means for arresting the turning movement of said pick-off head and for withdrawing said pick-off head from said tying means.

5. In combination, a frame, conveyor means on said frame for moving bundles of mail from one or more assembly stations to a pick-off station, means on the frame for tying a bundle of mail together, means on the frame at the pick-off station for seizing a moving bundle, means for transferring a seized bundle from the conveyor means to a pre-determined location on the tying means, control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means, said conveyor means for moving bundles of mail comprising a chain conveyor having a plurality of equally spaced mail receiving buckets thereon, each said bucket including a bottom wall, an upstanding end wall and a side wall contacting the end and bottom walls, said side wall being inclined with respect to the bottom wall, and resilient means for holding a bundle of mail against said side wall.

6. In combination, a frame, conveyor means on said frame for moving bundles of mail from one or more assembly stations to a pick-off station, means on the frame for tying a bundle of mail together, means on the frame at the pick-off station for seizing a moving bundle, means for transferring a seized bundle from the conveyor means to a pre-determined location on the tying means, control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means, said conveyor means for moving bundles of mail comprising a chain conveyor having a horizontal section and a vertical section, a plurality of equally spaced buckets mounted on and movable with said chain conveyor, each said bucket comprising a wall disposed substantially in the plane of the chain conveyor, an end wall disposed substantially at right angles with the first mentioned wall and a side wall connected to the first and second mentioned walls and inclined with respect to the first mentioned wall such that as said bucket traverses the vertical section of the conveyor means, mail disposed in said bucket will tend to slide toward said first-mentioned wall to be retained thereby.

7. The combination described in claim 6, the inclined

wall of the bucket having a notch formed therein and the means for transferring the bundle from the chain conveyor to the tying means comprising a pick-off head, bundle clamping means on the pick-off head and means for moving said clamping means into the notch for seizing a bundle of mail while said mail is supported in said bucket.

8. In combination, a tying machine having a table top for the reception of a bundle of mail or the like to be tied, a trip lever extending above the surface of said table top at the region thereof adapted to receive a bundle to be tied, means for placing a bundle of mail over said trip lever, and means for compressing said bundle against said trip lever and for depressing said trip lever to initiate the operation of said tying machine, said last mentioned means including a bundle-contacting member having a notch on the under side thereof, facing said bundle, said notch being adapted to receive said trip lever with said bundle-contacting member free of contact with the trip lever when the bundle-contacting member is moved to the limit of its movement toward said lever, whereby to prevent the operation of the tying machine when no bundle is placed over the trip lever.

9. A tying machine as described in claim 8, said bundle-contacting member comprising a yoke having spaced arms defining therebetween a notch, means for moving the yoke member toward the table top, said notch being disposed over the trip lever, and said means for moving the bundle-contacting member toward the bundle comprising a pneumatic cylinder having a piston rod movable thereby, and guide means for preventing rotation of the bundle-contacting member about the axis of said piston rod.

10. In combination, a frame, conveyor means on said frame for conveying bundles of mail from one or more assembly stations to a pick-off station, a first tying means mounted on the frame for tying a bundle of mail together in one direction, a second tying means mounted on the frame for tying said bundle together in a direction transverse to that of the first tying machine, means on the frame at the pick-off station for seizing a moving bundle means for transferring a seized bundle of mail from the conveyor means to a pre-determined location on the first tying means, means on the frame for transferring a tied bundle from the first tying means to the second tying means, and means on the frame for ejecting a tied bundle from the second tying means, means on the conveyor means for initiating the operation of the first transferring means, means on the first tying means for initiating the operation of the second transferring means, and means on the second tying machine for initiating the operation of the ejecting means.

11. In combination a frame, an endless belt conveyor means for bundles of mail or the like mounted on said frame and having an upper horizontally movable section and a downwardly movable section at one end of the horizontally movable section, a bundle tying machine mounted on said frame adjacent the downwardly movable section and out of the path of movement of the horizontally movable section, a pick-off mechanism disposed into the path of movement of the horizontal section and adjacent the tying machine, said pick-off mechanism comprising a horizontally disposed support, a horizontally reciprocable head mounted on said support, a vertically disposed shaft secured to said support, bearing means on the frame for said shaft and supporting said shaft for oscillating movement about the axis of said shaft and for reciprocating movement in the direction of the longitudinal axis of said shaft, means for imparting reciprocating movement to the shaft, means for imparting oscillatory movement to said shaft, clamping means on said horizontally reciprocable head for seizing a bundle of mail from the downwardly movable section, and means operated by movement of the conveyor means and said support for energizing the axial and oscillatory movement imparting means and the clamping means whereby to cause said head to move horizontally toward the downwardly movable conveyor section, seize a bundle on said conveyor, move said bundle horizontally off said conveyor section, turn the bundle toward said bundle tying machine and release the said bundle on said tying machine.

12. The combination described in claim 11, said tying machine including a table on which said bundle is released by the pick-off mechanism, said combination including further a hold-down mechanism for holding a bundle against said table while said bundle is being tied, said hold-down mechanism comprising a clamping head mounted on said tying machine over said table, pressure differential fluid-operated means mounted on the tying machine for reciprocating said head toward and away from said table to hold a bundle thereagainst while said bundle is tied by said machine, and means operated by movement of the pressure differential fluid-operated means for controlling the operation of the means for imparting reciprocating and oscillatory movement to said shaft, whereby to initiate the return movement of said pick-off mechanism to its said position in the path of movement of the horizontal conveyor section.

13. In combination, a frame, conveyor means on said frame for moving untied bundles of letters from one or more assembly stations to a pick-off station, means for moving said conveyor means at a substantially constant rate, means on the frame for tying a bundle of letters together, means on the frame at the pick-off station and intermittently movable with the conveyor means for seizing a bundle of letters from the moving conveyor, means for transferring a seized bundle from the conveyor means to a predetermined location on the tying means, said transferring means including a bundle pick-off head, means for intermittently moving said head with the conveyor means, and means operable while said head is moving with said conveyor means to seize a bundle from said conveyor means; control means movable in timed relation with the conveyor means, and means operated by said control means for initiating operation of the transfer means.

14. In combination, a frame, conveyor means on said frame for conveying bundles of mail from one or more assembly stations to a pick-off station, means for moving said conveyor at a substantially constant rate, a first tying means mounted on the frame for tying a bundle of mail together in one direction, a second tying means mounted on the frame for tying a bundle together in a direction transverse to that of the first tying machine, means on the frame at the pick-off station for seizing a bundle of mail from the moving conveyor, means for transferring a seized bundle from the conveyor to a predetermined location on the first tying means, means on the frame for transferring a tied bundle from the first tying means to the second tying means, and means on the frame for ejecting a tied bundle from the second tying means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,071,333	Pease	Aug. 26, 1913
1,760,030	Algar	May 27, 1930
1,935,739	Freese	Nov. 21, 1933
2,630,750	Eberle	Mar. 10, 1953
2,662,468	Shenigo	Dec. 15, 1953
2,678,151	Geisler	May 11, 1954
2,850,963	Grebe et al.	Sept. 9, 1958
2,867,166	Saxton et al.	Jan. 6, 1959
2,895,587	Willsey	July 21, 1959
2,898,847	Bunn	Aug. 11, 1959
2,963,141	Pellow et al.	Dec. 6, 1960

FOREIGN PATENTS

786,474	Great Britain	Nov. 20, 1957