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Wolfelsperger et al.

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[54] **FOLDING APPARATUS**

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[52] **U.S. Cl.** **270/67**, 270/81

[51] **Int. Cl.** **B65h 45/18**

[58] **Field of Search** 270/65, 67, 76, 80–82, 270/58, 83–85

[56] **References Cited**

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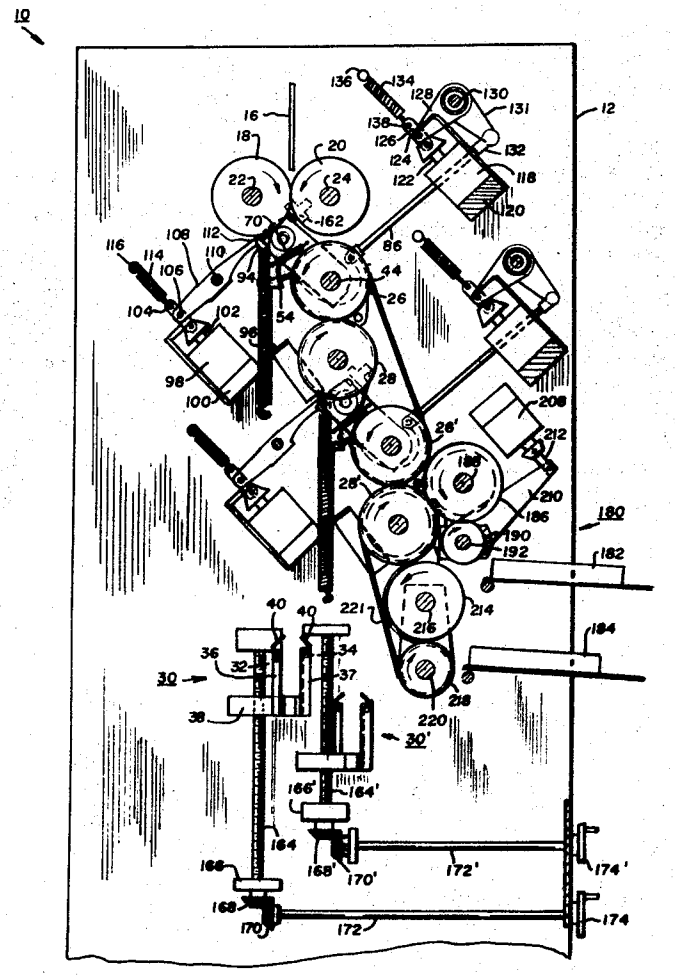
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[57] **ABSTRACT**

Apparatus for placing one or more folds in a web of material of discrete length wherein the web of material, which may be a longitudinally folded and flattened bag of polyethylene or the like, is fed through a pair of oppositely rotating draw rolls. After a predetermined segment of the web has been drawn into the apparatus by the draw rolls, a detecting means in the apparatus detects the presence of the web and actuates a first folding mechanism rotatably mounted about a first nip roll vertically displaced from the draw rolls. The folding mechanism contacts the moving web along an intermediate portion thereof and moves it toward the nip roll where the web is tucked between the first nip roll and a second vertically displaced and oppositely rotating nip roll to be drawn therebetween to place a transverse fold therein. Additional folder mechanisms on additional nip rolls may be provided as the web moves through the apparatus in order to place two or more folds in the web. Collection means may be provided to collect the folded webs for packaging.

12 Claims, 6 Drawing Figures



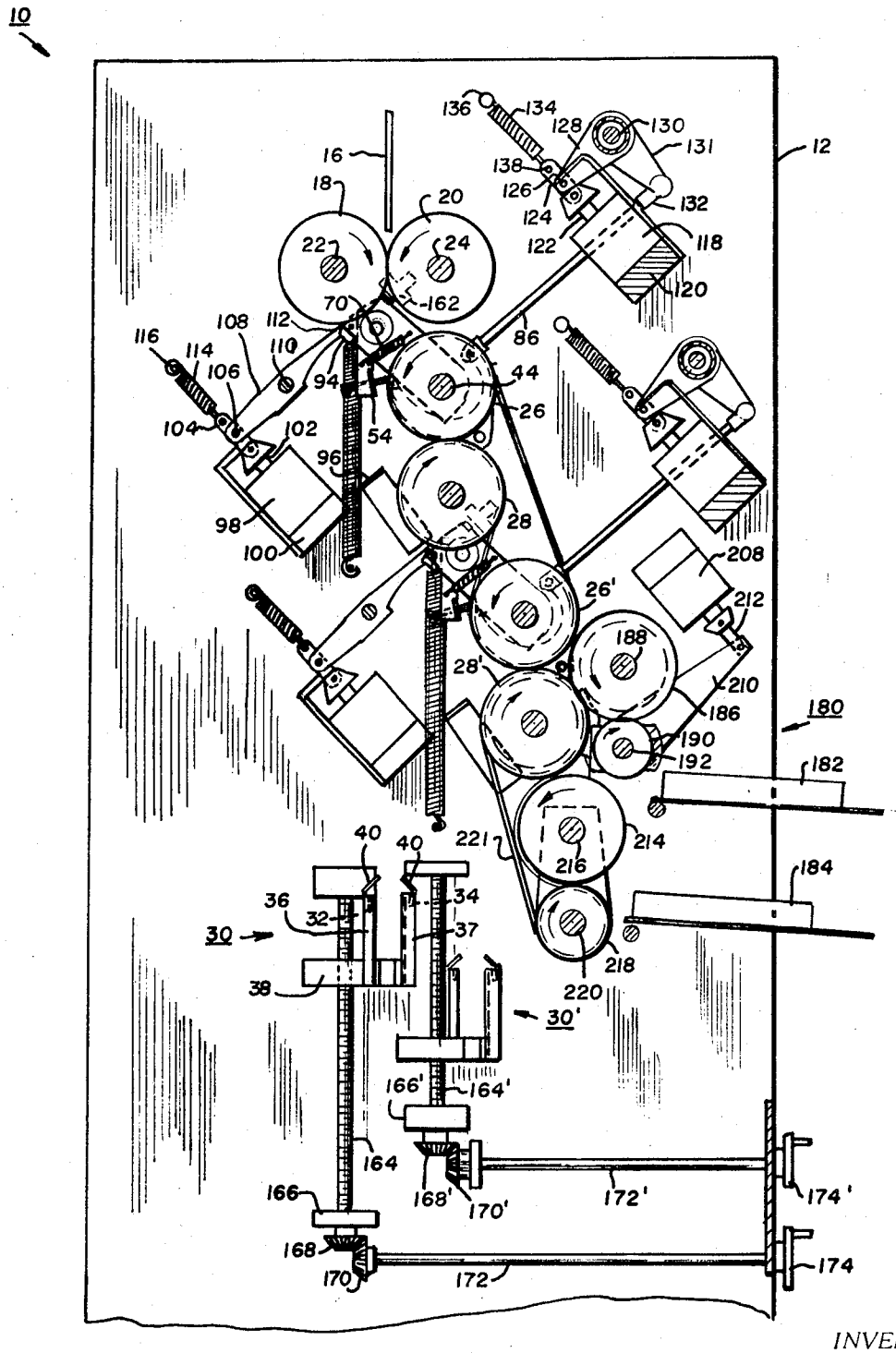


Fig. 1

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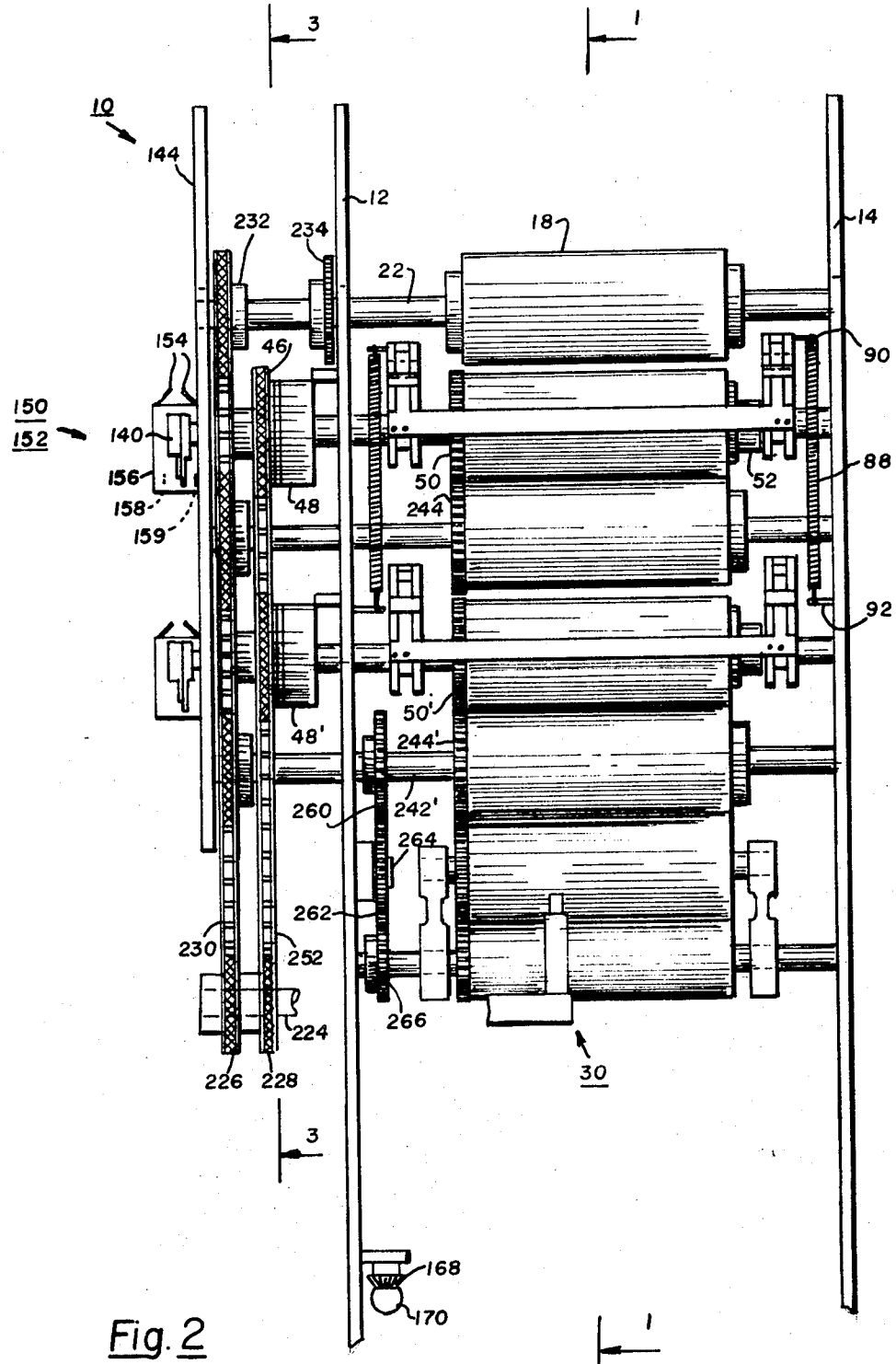


Fig. 2

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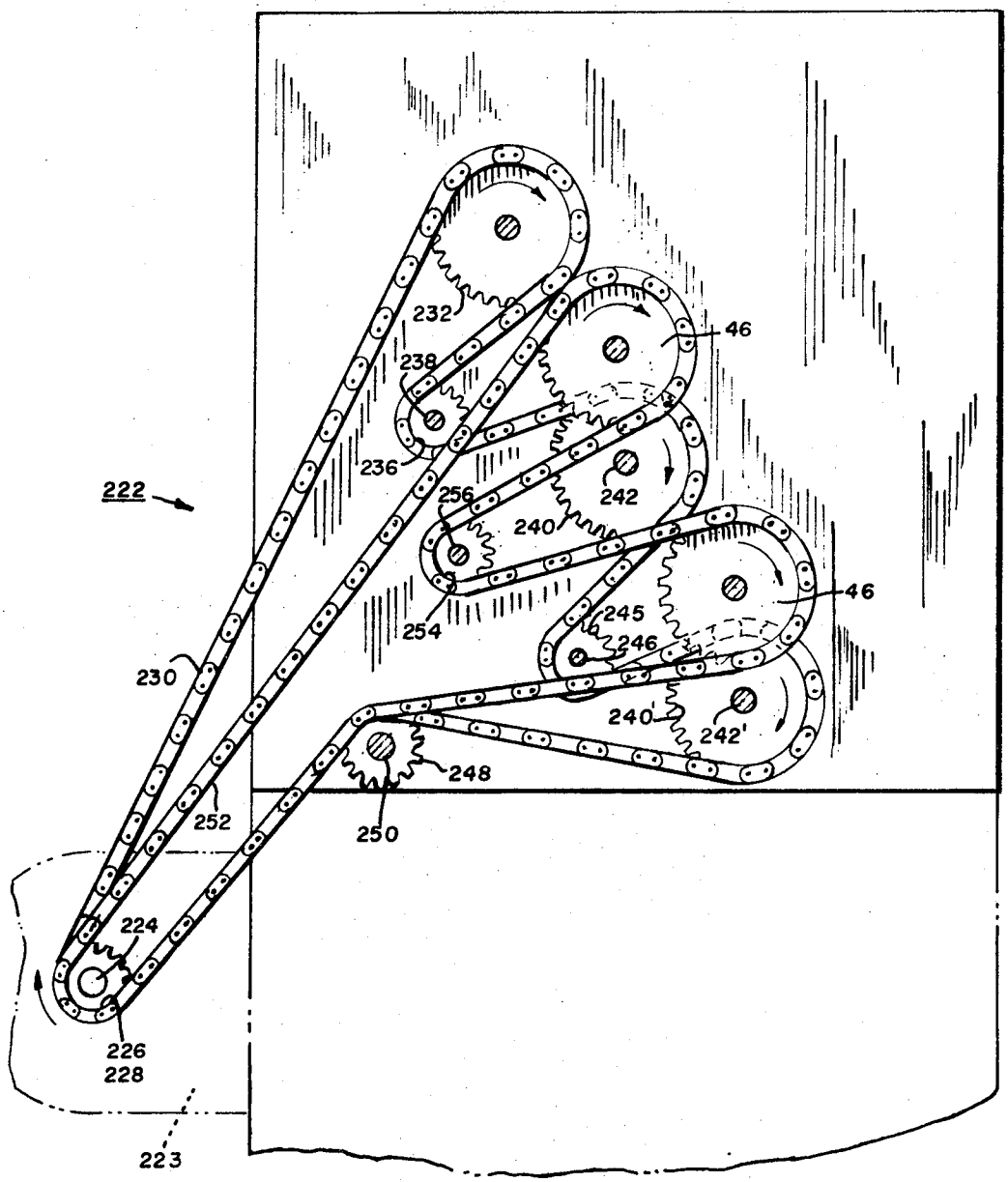


Fig. 3

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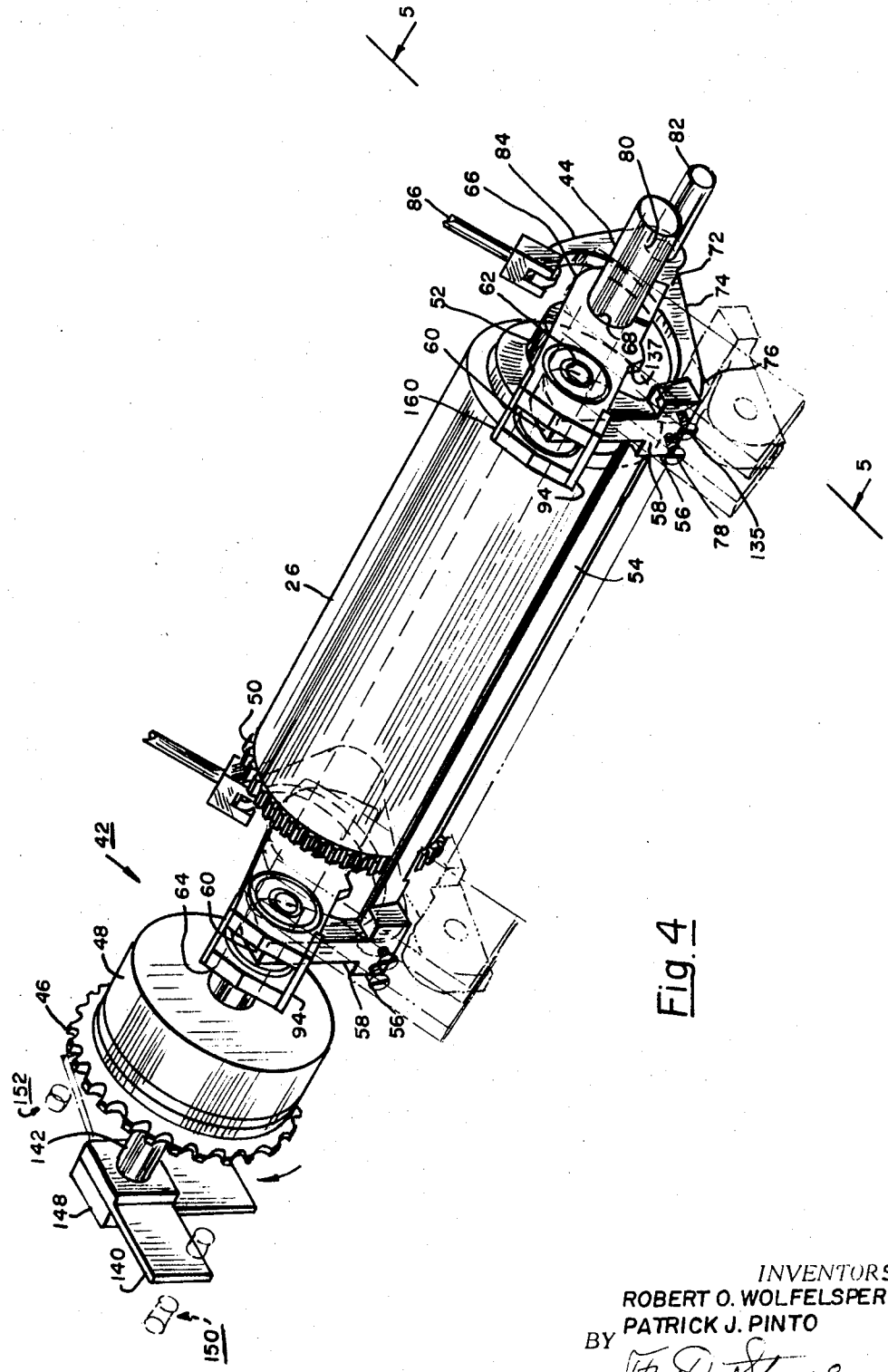


Fig. 4

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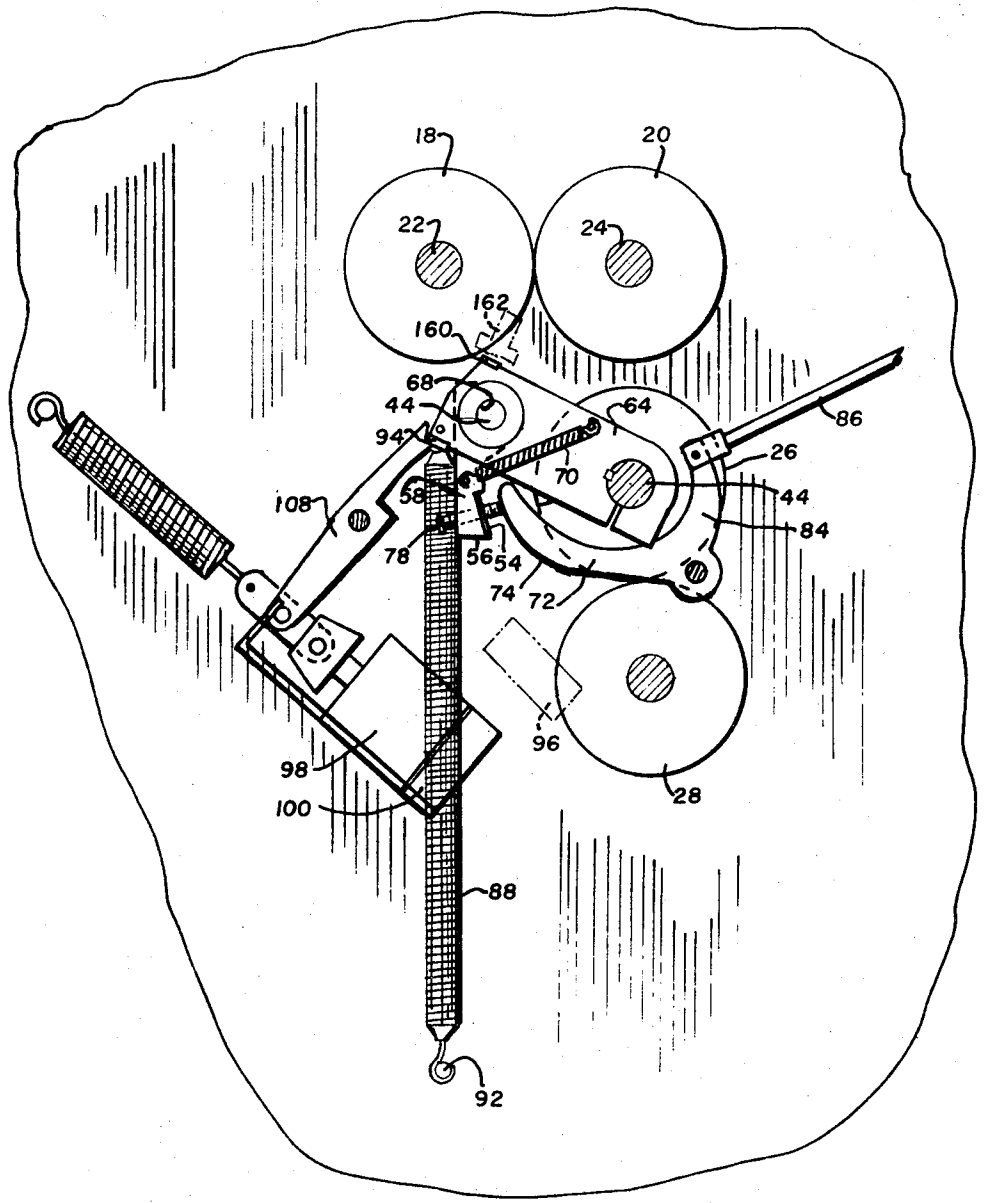


Fig. 5

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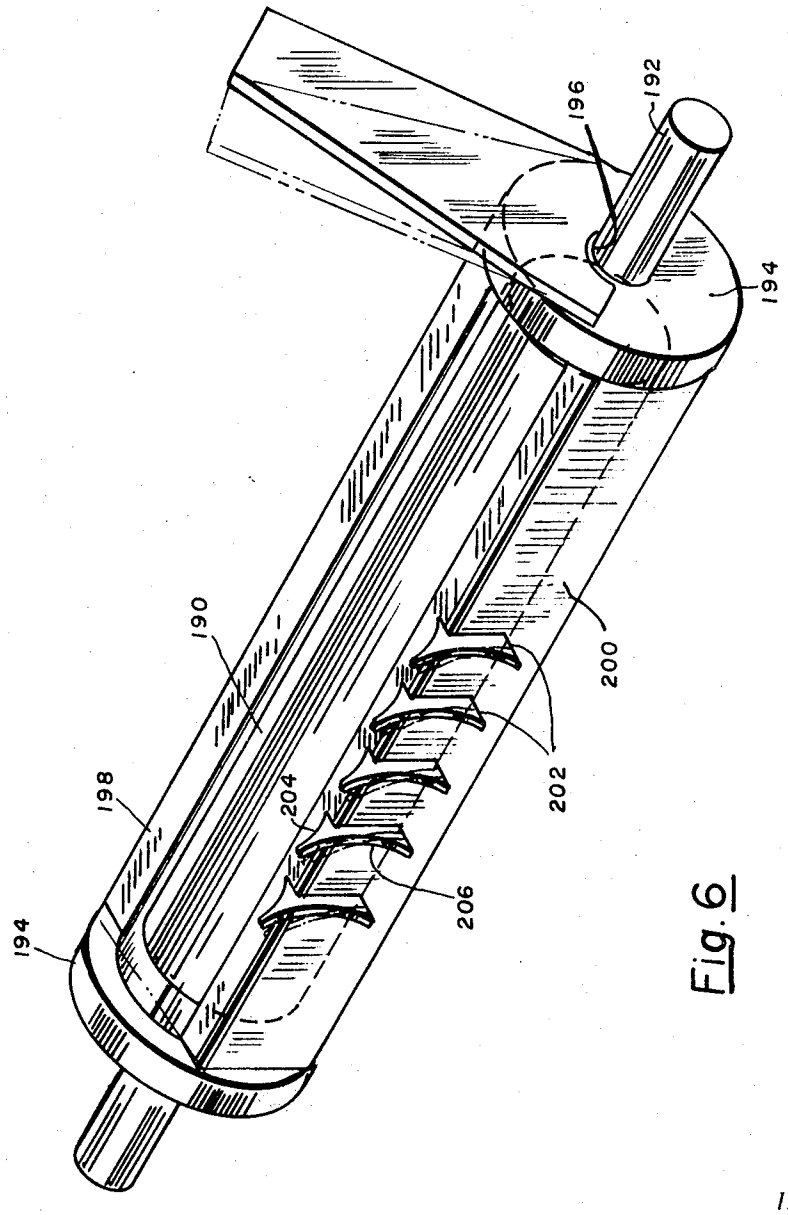


Fig. 6

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FOLDING APPARATUS

This invention relates to a folding apparatus and more particularly to folding apparatus to place one or more transverse folds in a web of material of discrete length such as a bag of plastic material, for example polyethylene or the like.

Disposable bags of a plastic material, such as polyethylene and the like, are used for a wide variety of trash disposal applications and are most commonly sold in a boxed container where a number of bags are individually folded to relatively small sizes so as to be readily stored in the container and easily removable. In the manufacture of such polyethylene bags, the bags are generally manufactued on a production line with the ultimate manufacturing step being that of the bags coming from the bag forming operation in a generally longitudinally folded and flattened condition. Prior to the plastic bags being packaged, for example 10 to 12 to a carton, the longitudinally folded flat bags must be transversely folded either once or twice, depending on the length of the bag in order to have the bag folded to a size to fit in a boxed container of relatively small size. Heretofore, such additional transverse folds in the polyethylene bags have been done manually with the manually folded bags being counted and packed in their folded condition in a suitable container.

Accordingly, it is an object of the present invention to provide a bag folding apparatus which can rapidly and efficiently place one or more transverse folds in discrete lengths of a moving web of material such as a plastic bag of polyethylene or the like to fold the bag into a predetermined transverse fold pattern.

It is another object of the present invention to provide a folding apparatus to place one or more transverse folds in a plastic bag and to dispense the transversely folded bag so that it may be packaged into a suitable container.

It is a further object of the present invention to provide a plastic bag folding apparatus which is adapted to place a transverse fold in a longitudinally folded and flattened plastic bag including means in the apparatus to vary the placement of the transverse folds in the plastic bags according to predetermined requirements so that bags of varying lengths may be folded or the placement of the fold in the bags may be varied to obtain varying fold patterns.

A still further object of the present invention is to provide an apparatus to place transverse folds in a flattened plastic material which is moving through the apparatus by actuating a folding mechanism which is pivoted into contact with the moving plastic material at substantially the same speed as the plastic material is moving to divert the plastic material transversely between two oppositely rotating nip rolls thereby to place a transverse fold in the flattened plastic material.

These and other objects of the present invention will be more fully understood after a consideration of the following specification taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an elevational view of the folding apparatus of the present invention taken on line 1—1 of FIG. 2;

FIG. 2 is a front elevational view of the apparatus of the present invention;

FIG. 3 is an elevational view taken on line 3—3 of FIG. 2 showing a detail of the drive system for the rolls of the bag folding apparatus of the present invention;

FIG. 4 is a perspective view, on an enlarged scale showing the nip roll and folder bar mechanism;

FIG. 5 is an elevational view taken on line 5—5 of FIG. 4; and

FIG. 6 is a perspective view, on an enlarged scale, showing the diverting assembly for the transversely folded bags.

With reference now to the drawings and particularly FIGS. 1 and 2, the bag folding apparatus 10 includes a pair of spaced side support plates 12 and 14 which serve as frame members to which the various drive rolls and nip rolls used to transport a web of material of discrete length, such as a plastic bag of polyethylene or the like, through the apparatus are supported. A web of material of discrete length, which preferably is a longitudinally folded and flattened bag 16 of polyethylene or the like, is fed between a pair of draw rolls 18 and 20 fixed to shafts 22 and 24, respectively, which shafts are rotatably mounted at opposite ends in side frames 12 and 14. The drive system for draw rolls 18 and 20 and the remaining rolls of the apparatus of the present invention will be described in greater detail hereinafter.

Draw rolls 18 and 20 rotate in opposite directions, as indicated by the arrows in FIG. 1 and are spaced from each other a sufficient distance so that the peripheral surface of each roll contacts a bag 16 and draws the bag 16 vertically downwardly between rolls 18 and 20 past a pair of laterally displaced nip rolls 26 and 28 until the presence of the bag 16 in the apparatus is detected by a detector assembly 30 which signals the presence of a bag in the apparatus to initiate the first bag folding step. Detector assembly 30 may be any suitable detecting means but preferably is a photoelectric sensing means including a light source 32 and a photoelectric cell 34 mounted respectively in upstanding support columns 36 and 37 which are in turn secured to a support block 38. Mounted at the top of each column 36 and 37 are a pair of mirrors 40 disposed at 45° angle to the horizontal so that light is reflected up from light source 32 to be incident on one of the mirrors 40 and is reflected to the other mirror 40 and back to the photoelectric cell 34. Thus, when the bottom edge of a bag 16 passes between mirrors 40, the light signal is interrupted and the interruption of the light incident on photoelectric cell 34 provides a suitable signal to actuate the folding mechanism.

The folding mechanism 42 (see FIGS. 4 and 5 as well) is operatively associated with nip roll 26 and is adapted to engage an intermediate portion of the bag 16 and move the engaged portion transversely to its initial vertical path of travel to fold the bag over on itself and push the bag between the oppositely rotating nip rolls 26 and 28. Rolls 26 and 28 are spaced from each other so that when the folded bag 16 moves between the rolls, the peripheral surface of the rotating rolls contacts the bag and moves it between the rolls.

Nip roll 26 is rotatably mounted on shaft 44 which is in turn rotatably mounted between side plates 12 and 14. Shaft 44 is driven through the drive system, which will be explained more fully hereinafter, through a drive sprocket 46 fixed near one end of the shaft to an electromechanical clutch 48 so that shaft 44 rotates only when clutch 48 is engaged. Nip roll 26 is independently rotated through a gear 50 fixed to one end of the roll. A sprag-type overrunning clutch 52 is mounted to the other end of nip roll 26 and locks the nip roll 26 to the shaft 44 when shaft 44 attempts to rotate faster

than nip roll 26. Thus, shaft 44 is precluded from rotating faster than the speed of rotation of nip roll 26. Substantially lateral movement of the engaged portion of the bag 16 toward nip rolls 26 and 28 is accomplished by a folder bar 54 within folding mechanism 42 which is adapted to pivot from a first elevated position, shown in FIG. 1, wherein the vertically descending bag passes between the folder bar 54 and nip roll 26 and a second lower position wherein the folder bar, after contacting the engaged portion of the bag, has pushed the bag 16 toward nip rolls 26 and 28 so that the folded over bag is engaged therebetween and passed by the rotation of nip rolls 26 and 28 to a subsequent folding operation, if so desired, or ejected from the apparatus to a further processing step.

Folder bar 54 is rigidly secured at each end to one end 56 of folder bar support arms 58. The other end 60 of each folder bar support arm 58 is rotatably mounted, as at 62, between a pair of mounting arms 64. The other end 66 of each mounting arm 64 has a shaft receiving bore 68 therein to receive shaft 44 therethrough and ends 66 of mounting arms 64 are rigidly secured to the shaft 44 so that the arms 64 and, hence, the folder mechanism 42, including the folder bar 54, will rotate when clutch 48 is engaged to cause shaft 44 to rotate.

Springs 70, mounted at one end of each folder bar support arm 58 and at the other end to mounting arm 64, cause the folder bar support arms 58 to pivot on their pivotal mountings 62 to urge the folder bar 54 inwardly toward the mounting arms 64 and nip roll 26. The folder bar 54 is held away from contacting nip roll 26 by a pair of wish-bone cams 72 mounted between each pair of mounting arms to allow passage of the bag 16 to be folded between the folder bar 54 and nip roll 26. Wish-bone cams 72 are generally U-shaped with one leg portion 74 being normally aligned between mounting arms 64 so that an exterior cam surface 76 provides an abutment surface to contact a stop screw 78 in folder bar support arm 58. Stop screw 78 can be adjusted to position the degree of separation between folder bar 54 and the periphery of nip roll 26 in an initial start position.

The central portion of each wish-bone cam 72 includes a bore 80 therethrough to pivotally receive a cam support shaft 82 and each shaft 82 is rigidly fixed to side frame members 12 and 14, respectively. The other leg 84 of each wish-bone cam 72 has attached thereto an actuating shaft 86 which, when reciprocated along its axial extent, causes the wish-bond cam 72 to pivot about shaft 82. Pivoting of the wish-bone cams 72 about the support shaft 82 causes the cam surface 76 of each cam to move away from the stop screws 78 thereby allowing folder bar 54 under the urgings of spring 70 to pivot about pivotal mounting 62 and move toward nip roll 26. Pivoting of the wish-bone cams in the other direction moves cam surface 76 against stop screws 78 to force the folder bar 54 to move away from nip roll 26. Actuation of the wish-bone cam 72 will be discussed in greater detail hereinafter.

The folding mechanism 42, including the folder bar 54, folder bar support arms 58 and mounting arms 64 are urged to rotate about the axis of shaft 44 by tension springs 88 which have one end secured to a spring post 90 on each of the outermost mounting arms 64 and the other end secured to a spring post 92 fixed to side plate 12 or 14. Stop plates 94 are provided on the upper end of mounting arms 64 to engage stop blocks 96 fixed to side plates 12 and 14 to limit the pivoting movement of the folding mechanism 42 under the urging of the springs.

Rotation of the folding mechanism 42 is initiated in response to a signal received from the detector assembly 30 which indicates when a bag 16 is in position to be folded. The signal from detector assembly 30 actuates a solenoid 98 which is secured by a bracket 100 to side plate 12.

Fixed to the reciprocating plunger 102 of solenoid 98 is a link 104 and secured at a mid-portion of link 104 by a pivotal connection 106 is one end of a latch arm 108. Latch arm 108 is rigidly connected at its mid-portion to a shaft 110 which is pivotally mounted between side plates 12 and 14. The other arm of latch arm 108 includes a notched nose portion 112 which engages the stop plate 94 on one pair of mounting arms 64 in the folding mechanism 42 when the folding mechanism is in an elevated position. A second latch arm 108 (not shown) identical to the first latch arm is also rigidly connected to shaft 110 and positioned to interpose the stop plate 94 on the other pair of mounting arms 64 and both latch arms pivot about the axis of shaft 110 when solenoid 98 is actuated. A tension spring 114 has one end secured to a spring post 116 extending from side plate 12 and its other end secured to link 104 to urge both latch arms 108 to pivot into, and remain in, engagement with stop plates 94.

When the solenoid 98 is actuated, plunger 102 is retracted and the latch arm 108 pivots against the tension of spring 114 thereby pivoting nose portion 112 out of engagement with stop plate 94. Once the latch arms 108 are moved out of engagement with the respective stop plates 94, the folding mechanism 42 will pivot about the axis of shaft 44 under the tension of spring members 88.

At the same time as the signal is sent to solenoid 98, a signal is sent to a solenoid 118 mounted by a bracket support 120 between side plates 12 and 14, respectively, to actuate shafts 86 which operate the wish-bone cams 72. The solenoid 118 includes a plunger arm 122 which is secured a link 124 which has one end of a crank arm 128 rigidly secured along a mid-portion thereof, as at 126. The other end of crank arm 128 is rigidly secured to a shaft 130 which is rotatably mounted between side plates 12 and 14. A pair of crank arms 131 have one end rigidly secured to shaft 130 and their other ends pivotally connected, as at 132, to respective shafts 86. A tension spring 134 secured at one end to a spring post 136 mounted between side plates 12 and 14 has its other end secured to an end 138 of link 124. Spring 134 thus urges crank arm 128 to pivot shaft 130 about its longitudinal axis thereby pivoting the pair of crank arms 131 to urge both shafts 86 toward the folding mechanism 42.

Movement of shafts 86 in this direction moves the cam surfaces 76 on wish-bone cams 72 toward stop screws 78 to maintain the folder bar 54 spaced away from the peripheral surface of nip roll 26. When solenoid 118 is actuated, plunger arm 122 is retracted causing crank arm 128 to pivot in the opposite direction against the tension of spring 134. This moves shafts 86 in the opposite direction thereby pivoting wish-bone cams 72 so that folder bar 54, under urging of springs 70, moves inwardly toward the surface or nip roll 26. Pivoting movement of folder bar 54 is accomplished as

the folding mechanism 42 pivots about the axis of shaft 44 under the action of springs 88 and the stop screws do not contact the wish-bone cams 72 until the end of the pivoting movement of folder bar 54. When the folder bar is pivotally returned to its initial position, as will be explained more fully hereinbelow, the stop screws 78 move in sliding contact along the cam surface 76 of wish-bone cams 72.

A second set of stop screws 135 are positioned in each folder bar support arm 58 outwardly of stop screws 78. Stop screws 135 are positioned outside of wish-bone cams 72 and are adapted to engage an abutment surface 137 on one of the mounting arms 64 after wish-bone cams 72 have been fully withdrawn. Stop screws 135, thus afford a final adjustment for the position of folder bar 54 with respect to nip rolls 26 and 28. Preferably, stop screws 135 are adjusted to maintain folder bar 54 slightly spaced from nip rolls 26 and 28 during and at the conclusion of the folding stroke.

In operation, when the apparatus 10 is operable to receive a bag 16 to be folded, the draw rolls 18 and 20 and nip rolls 26 and 28 are rotated through the drive system but shaft 44 is not rotated. When bag 16 passes between draw rolls 18 and 20 and is sensed by bag sensing mechanism 30, solenoids 98 and 118 are activated and, as described hereinabove, the folding mechanism 42 pivots about the axis of shaft 44 and the folder bar 54 pivots inwardly to engage and tuck an intermediate portion of the bag 16 between rotating nip rolls 26 and 28 to place a transverse fold therein. The oppositely rotating nip rolls 26 and 28 draw the now folded bag between the nip rolls. Because the folding mechanism 42 is coupled to shaft 44 and because shaft 44, through overrunning clutch 52, is coupled to nip roll 26, the folding mechanism 42, and particularly the folder bar 54, cannot pivot about the axis of shaft 44 faster than the speed of rotation of nip roll 26.

This feature is particulaly important where a fold is being placed in a bag 16 of polyethylene or some other similar plastic material. The bag to be folded is continuously moving through the apparatus 10 at a uniform rate of speed governed by the speed of rotation of draw rolls 18 and 20 and nip rolls 26 and 28, which rolls are rotating at the same uniform rate. Since the folder bar 54 comes into contact with an intermediate portion of the bag 16 and since the plastic material, due to friction characteristics, would tend to adhere to the folder bar, it is important that the folder bar be moving at substantially the same relative speed as the bag in order to preclude the bag from adhering to the surface of the folder bar. Hence, since the folder bar is coupled to the drive system through clutch 52, it is rotating at the same speed as the bag is moving. Consequently, the bag's movement is not retarded in any way because of its contact with folder bar 54 and is smoothly passed between nip rolls 26 and 28. The speed of movement of the bag 16 through the apparatus 10 is governed by the surface speed of rotation of the draw and nip rolls and when the intermediate portion of the bag is engaged by the folder bar 54, the folder bar is pivoting at a velocity which closely approximates the speed of rotation of the rolls.

After an initial fold has been placed in a bag, the bag may be passed through a second or even a third set of folding rolls or, if only one fold is desired, the now folded bag may be passed out of the apparatus to a suitable collecting trough or packing operation.

The rotation of the folding mechanism 42 is arrested when stop plates 94 contact stop blocks 96 and, at this point, it is necessary to recycle the folder mechanism to place it in readiness for a subsequent folding operation on another bag. Accordingly, suitable sensing mechanisms must be provided to sense when the folding operation is completed in order to pivot the folding mechanism 42 back to its initial position. Limit switches may be employed but, preferably, a photoelectric system is used. Accordingly, an extending tab or flag 140 is provided on an extension 142 of shaft 44 with the shaft extension 142 extending beyond an auxiliary side plate member 144 which is spaced from side plate 12. Hence, the flag 140 fixed to the shaft extension 142, for example by a hub support 148, is on the exterior face of auxiliary side frame member 144. Suitable photoelectric detecting units 150 and 152 are appropriately located so that as the flag 140 moves with the rotation of shaft 44 the flag will interrupt the light beam in photodetection unit 150 in one position and the light beam in photodetection unit 152 in the second position. As with the photodetection unit 30, a pair of mirrors 154 mounted on a housing 156 on side frame 144 and disposed at 45° angle to the horizontal are used so that light from a light source 158 is reflected by the mirrors 154 back to photoelectric cell 159 and the mirrors 154 are positioned to permit movement of the flag 140 therebetween.

Thus, in operation, when the folding mechanism 42 moves from its elevated position to the lower folding position and stop plates 94 are resting on stop blocks 96, the flag 140 will interrupt the light beam from photodetection unit 152 to initiate a signal which activates the electromagnetic clutch 48 and deactivates the solenoids 98 and 118. Deactivating the solenoid 98 resets the latch arms 108 so that the notched nose portions 112 are in position to latch mounting arms 64 through stop plates 94. Deactivating the solenoid 118 moves the wish-bone cams outward so that the folder bar 54 is moved away from the nip roll 26 as the mounting arms 64 are returned to their starting or latched position by the rotation of shaft 44 through drive sprocket 46 and electromagnetic clutch 48. With activation of electromagnetic clutch 48, the drive system, which will be described in greater detail hereinbelow, and which is operatively engaged with sprocket 46, is activated to rotate shaft 44 in the opposite direction to retract the folding mechanism 42 against the tension of springs 88 through overrunning clutch 52 until stop plates 160 on the rear of mounting arms 64 opposite stop plates 94 engage stop blocks 162 fixed to respective side plate members 12 and 14.

When the folding mechanism 42 has been retracted to this position, which is a fully retracted position above the latched, at rest position shown in FIG. 1, the flag 140 interrupts the second photodetection unit 150 to initiate a signal which disengages electromagnetic clutch 48. With the deactivation of the electromagnetic clutch 48, the spring tension of springs 88 initiates rotation of the folding mechanism 42 but, since solenoid 98 has been deactivated, latch arms 108 now pivot downwardly due to the tension of spring 114 so that nose 112 of each latch arm is in the path of rotation of the folding mechanism 42. Thus, stop plates 94 are now engaged in nose 112 of each latch arm 108. In this manner, the partial rotation of folding mechanism 42 is arrested and the mechanism is now recycled and ready to

be activated again once the presence of another bag **16** is indicated. When solenoid **118** is deactivated, the tension of spring **134** causes plunger element **122** to move out from solenoid **118** thereby pivoting crank arm **131** about its pivotal axis **130** to move shaft **86.** This pivots the wish-bone cams **72** so that cam surface **76** moves outwardly and stop screws **78** slide up the cam surface retracting the folder bar **54** as it rotates about the axis of shaft **44** to space folder bar **54** away from the periphery of nip roll **26.**

In a preferred embodiment of the present invention, the apparatus is adapted to place two folds in a bag and accordingly, after the first fold has been made in the bag, the bag is passed by nip roll **28** to an additional folding operation which is identical with the folding mechanism described above. A suitable detecting unit **30'** is provided which is identical to detecting unit **30** and senses the presence of the lower portion of the bag **16** to initiate actuation of folding mechanism **42'** to tuck the bag **16** between nip rolls **26'** and **28'.** Since this folding mechanism **42'** is identical to the folding mechanism **42,** like parts are designated with like primed numbers on FIG. **1** and it is understood that the operation is the same as described above.

When a bag of a different length is run through the apparatus, or when the placement of the folds is desired to be changed, an adjustment can be made to the position of the detecting units **30** and **30'** so that the folding mechanisms **42** and **42'** can be actuated according to the length of the bag being folded or the desired placement of the folds. Hence, the support blocks **38** and **38'** upon which the detecting units are mounted include a threaded bore (not shown) therethrough to accommodate threaded jack shafts **164** and **164',** respectively. The lower end of each jack shaft is journaled within mounting blocks **166** and **166'** fixed to a support surface and are in turn secured to beveled gears **168** and **168',** respectively. Beveled gears **170** and **170'** engage the gears **168** and **168',** respectively, and are secured to support shafts **172** and **172',** respectively. Crank handles **174** and **174',** respectively, are operative to rotate shafts **172** and **172'** to rotate the bevel gears and elevate or lower the respective detecting units to vary the point at which the presence of a bag is detected so that the folding mechanisms are actuated at the proper time to place the folds in the bag when desired.

After the desired number of folds in a bag **16** is made, the folded bag may be passed out of apparatus **10** to be packaged. In a preferred embodiment of the present invention, a counter (not shown) is utilized to count the number of bags that have been folded so that the number of bags which will be packaged in one container can be ascertained. These bags are dispensed from the apparatus where they can be collected or automatically placed in the container. Once this desired number of bags has been counted by the counter, the counter activates a signal to cause a diverter within apparatus **10** to divert the flow of folded bags to another collection station. This alternate dispensing of bags from the machine in a sequence allows for the ready collection and/or packing of the folded bags.

Accordingly, a diverter assembly **180** is provided to alternately divert the folded bags from a first collection station **182** to a second collection station **184** and back to the first collection station after the preset number of bags has been dispensed.

With reference to FIGS. **1** and **6,** after the folded bags have passed between nip rolls **26'** and **28',** the bags remain in contact with the surface of lower nip roll **28'** and pass between nip roll **28'** and an oppositely rotating nip roll **186.** Nip roll **186** is mounted on a shaft **188** which is rotatably journaled within side plates **12** and **14** and is driven through the drive system, as will be explained more fully hereinafter, at the same circumferential speed of rotation as nip roll **28'.**

The bags pass through nip rolls **28'** and **186** and then pass between nip roll **186** and a smaller diameter nip roll **190** fixed to a shaft **192** journaled within side plates **12** and **14.** Nip roll **190** is geared to nip roll **186** and, thus, rotates in an opposite direction at the same speed.

When the preset numbers of bags have been deposited at collection station **182,** as determined by the counter, the diverter mechanism **180** is activated to divert the flow of bags to collection station **184.** The diverter mechanism includes circular end frame members **194** having a bore **196** therein through which shaft **192** is rotatably disposed. Lateral support arms **198** and **200** interconnect the end frame members **194** and the support arms are dimensioned so that nip roll **190** is exposed therebetween so as to contact a bag when bags are being dispensed to collection station **182.**

A plurality of diverting fingers **202** are spaced along support arm **200** and each finger **202** includes an upper curved surface **204** which, when the fingers are in the position shown in full line in FIG. **6,** guide the bags over the rotating nip roll **190.** Additionally, each finger **202** includes a lateral curved surface **206** which, when the fingers are pivoted clockwise as seen in FIG. **1,** will divert the bags away from nip roll **190.**

To pivot the fingers, a solenoid **208** suitably mounted on a side plate is provided with a link arm **210** connected to the plunger arm **212** of solenoid **208.** Link arm **210** is fixed to one of the end frame members **194** and actuation of the solenoid pivots the end frame members, and hence, lateral support arm **200** and the fingers **202,** between the full line position and the brake line position shown in FIG. **6.** The solenoid is actuated in response to a signal received from the counter after the preset number of bags has been diverted to either of the collection stations.

When the diverter fingers **202** are pivoted to the solid line position shown in FIG. **6,** the bags are diverted by the lateral curved surface **206** which is now in the path of bags passing between nip rolls **28'** and **186** and the curved surface **206** diverts the moving bags so that the bags are diposited on a rotating nip roll **214** fixed to a shaft **216** suitably journaled within the apparatus **10.** The bags then pass between nip rolls **28'** and **214** and are drawn by the rotating nip roll **214** downwardly until the bags pass between nip roll **214** and a smaller diameter rotating nip roll **218** fixed to a shaft **220** which is also journaled within side plates **12** and **14.** A series of spaced endless belts **221** wrapped around and driven by rolls **28', 214** and **218** maintains the bags in contact with nip roll **214** and prevents them from falling away from the roll. The smaller diameter nip roll **218** draws the bags out from between the rolls and deposits them at collection station **184.** After the preset number of bags have been deposited at collection station **184,** solenoid **208** is actuated and the diverter pivoted to divert the next series of bags to collection station **182.**

With reference now to FIGS. **2** and **3,** the drive system **222** for the apparatus **10** includes a motor **223** hav-

ing an output shaft 224 upon which is secured spaced drive sprockets 226 and 228. A first endless drive chain 230 is engaged about drive sprocket 226 and extends about a sprocket 232 fixed to shaft 22 of draw roll 18. Shaft 22 extends between side plate 12 and auxiliary plate 144 and is rotatably mounted in each as well as being rotatably mounted in side plate 14. Thus, as viewed in FIG. 3, rotation of sprocket 232, as indicated by the arrow, is clockwise. A gear 234 is secured to shaft 22 adjacent the exterior face of side plate 12 and is adapted to mesh with and engage an identical gear (not shown) fixed to shaft 24 of draw roll 20. Thus, draw rolls 18 and 20 are geared together and rotate in opposite directions at the same speed.

After passing over sprocket 232, drive chain 230 is passed over an idler sprocket 236 fixed to a shaft 238 rotatably journaled between side plate 12 and auxiliary plate 144 and then passes over a sprocket 240 fixed to the shaft 242 of nip roll 28 to drive nip roll 28 in the direction indicated by the arrow in FIG. 3.

A gear 244 is fixed to one end of nip roll 28 (see FIG. 2) and is adapted to mesh with and engage the gear 50 fixed to nip roll 26. Thus, nip rolls 26 and 28 are interconnected and rotate in opposite directions and at the same speed.

After passing over sprocket 240, drive chain 230 is passed over an idler sprocket 245 fixed to a shaft 246 which is journaled within side plate 12 and auxiliary plate 144. The drive chain then passes over a sprocket 240' fixed to shaft 242' of nip roll 28' to drive nip roll 28' and then returns over idler sprocket 248 fixed to shaft 250 to drive sprocket 226. Nip roll 26' is geared to nip roll 28' in the same manner as the nip rolls 26 and 28.

The second endless drive chain 252 is engaged with drive sprocket 228 and is passed about sprocket 46 fixed to clutch 48 on shaft 44 and is only engaged to rotate shaft 44 when clutch 48 is activated to retract the folding mechanism 42. Normally, drive chain 252 rotates sprocket 46 which idles about shaft 44.

Drive chain 252 then passes over idler sprocket 254 fixed to shaft 256 and then over sprocket 46' on shaft 44' and then over an idler sprocket to return to drive sprocket 228. Sprocket 46' on shaft 44' functions in the same manner as sprocket 46 and only operates to rotate shaft 44' when clutch 48' is engaged.

The drive for nip rolls 186, 190, 214 and 218 is accomplished by transferring rotative motion to these rolls through a gearing network fixed to each roll. The gear 244' on nip roll 28' engages a similar gear fixed to nip roll 186 and nip roll 214; while a gear 260 secured to shaft 242' drives an idler gear 262 fixed to a shaft 264 extending from side plate 12 to drive a gear 266 fixed to shaft 220 of nip roll 218 to drive this nip roll.

While a particular chain drive and gear system has been disclosed it is evident that any suitable drive system may be employed to obtain the same relative rotations of the various shafts and rolls.

It is thus seen that a bag folding apparatus is disclosed which is adapted to fold bags of polyethylene and the like which are continuously moving through the apparatus at a high rate of speed. The folding is accomplished by a folder bar adapted to contact the moving bag and move it transverse to its initial path of movement to be folded over on itself by passing the bag between two oppositely rotating and closely spaced rolls. The folder bar shown and described is not necessarily the only shape which will operate satisfactorily, for example, the folder bar may be a wire or it may be a series of fingers whose tips define a plane which tucks the bag into a nip. The folder bar is geared to move at the same rate of speed as the moving bag when it contacts the bag so as to effect a smooth transition as the bag is diverted between the two rolls which fold it. Also provided is a diverting assembly to divert a preset series of bags to alternate collecting stations to facilitate further handling and packaging of the folded bags.

Although the present disclosure has referred to the folding of bags which may lay flat, be gusseted, or prefolded in the longitudinal direction, it is expressly understood that the apparatus of the present invention is not limited to the folding of bags of plastic or other material. The folder apparatus of this invention is capable of folding any web of material, for example fabric, paper, plastic films, flexible laminates and the like. Also, the apparatus is capable of folding multiple layers or webs if desired.

What is claimed is:

1. An apparatus for folding a web of material of discrete length comprising:

means within said apparatus for transporting said web along an initial straight line path, folding means disposed adjacent said initial path adapted to contact a portion of said moving web intermediate its ends and move said contacted portion of said web transversely of said initial path whereby said web is folded over on itself with said contacted portion of said web becoming the leading edge of the folded web as it continues to move through said apparatus, means to move said folded web along a second path transverse to said initial path after said web has been folded, said folding means including a folder bar movable from a first position spaced from one side of said initial path thereby to contact and move said contacted portion of said web transverse to said initial path to said means to move said web along a second path and wherein said folder bar includes means operatively associated therewith to insure that the speed with which said folder bar pivots from said first position to a second position is substantially the same speed as the rate of speed said web is moving through said apparatus, said means for transporting said web along a second path comprises a pair of oppositely rotating rolls spaced from each other such that the peripheral surface of each roll contacts an opposite side of said web thereby to draw said web therebetween and said folding means is operatively associated with one of said rolls in the pair of rolls to move said web along said second path, said folding means is pivotally mounted to pivot about the axis of said one of said rolls whereby said folder bar when it pivots from said first position to said second position moves said contacted portion of said web between said one of said rolls and its oppositely rotating associated roll whereby said web is transported along said second path.

2. Apparatus as defined in claim 1 wherein said web of material comprises a longitudinally folded and flattened bag of plastic material and said apparatus is adapted to place a transverse fold therein.

3. Apparatus as defined in claim 1 wherein said apparatus includes a plurality of folding means and each said plurality of folding means is operatively associated

with a pair of oppositely rotating rolls to place a plurality of transverse folds in said web of material.

4. An apparatus for placing a transverse fold in a web of material comprising:

spaced upstanding side frame members,

means to move said web along a first substantially vertical path of movement,

a pair of nip rolls rotatably mounted between said side frame members and having their axes of rotation within a substantially vertically disposed common plane laterally offset to one side of said first vertical path of movement,

said nip rolls being adapted to rotate in opposite directions and spaced from each other so that the peripheral surface of each said nip roll is adapted to contact one side of said web to draw said web between said nip rolls,

drive means within said apparatus to rotate said nip rolls so that each nip roll rotates in opposite directions,

folding means pivotally mounted between said side frame members including a folder bar adapted to pivot from a first position on the other side of said first vertical path of movement to a second position on said one side of said first vertical path of movement wherein said folder bar is intermediate said nip rolls thereby to contact a portion of said web intermediate its ends as said web is moving along said vertical path of movement and move said contacted portion of said web between said rotating nip rolls to be drawn therebetween and folded over on itself to place a transverse fold therein,

said folded web being drawn by said nip rolls along a second path of movement substantially transverse to said first vertical path of movement,

said folding means being pivoted about an axis which is coextensive with the axis of rotation of one of said nip rolls and including means to couple said folding means to said drive means to limit the speed of movement of said folder bar when it pivots from said first position to said second position so as not to exceed the speed of said web through said apparatus whereby said folder bar and said web are moving at substantially the same relative speed to effectuate a smooth transition when said web is diverted from said first path of movement to said second path of movement.

5. Apparatus as defined in claim 4, wherein said one of said nip rolls is independently rotatably mounted on a support shaft and said support shaft is rotatably mounted between said side frame members, said folding means being fixed to said support shaft so that said folding means pivots about the axis of said support shaft when said shaft is rotated and stop means fixed to said side frame members to limit pivoting movement of said folding means and rotation of said support shaft.

6. Apparatus as defined in claim 5 including spring means mounted between said folding means and said side frame members to urge said folding means to pivot about its pivotal axis against one of said stop means thereby to pivot said folder bar from said first position to said second position and wherein said means to couple said folding means to said drive means comprises clutch means operatively linking said support shaft to said one of said nip rolls so that the rotational speed of said support shaft is not greater than said one of said nip rolls.

7. Apparatus as defined in claim 4 including a first and a second receiving station to receive folded webs after said webs have been folded between said nip rolls, and diverter means mounted in said apparatus to sequentially divert folded webs between said first and second receiving stations, said diverter means comprising a driven roller fixed to a shaft rotatably mounted between said side frame members, support frame members at each end of said roller rotatably mounted about said roller shaft, a lateral frame member interconnecting said support frame members, a plurality of projecting diverting fingers mounted on said lateral frame member, each said finger including a first and second convexly curved surface, said end support frame members being rotatable between a first position wherein said first curved surface on said diverting fingers is in the path of movement of said folded webs as the webs move along said second path of movement to divert said webs over said roller to said first receiving station and a second position wherein said second curved surface on said diverting fingers is in the path of movement of said folded webs as the webs move along said second path of movement to divert said webs away from said roller to means to transport said webs to said second receiving station, and means to rotate said diverter between said first and second positions responsive to a predetermined sequential pattern.

8. A folding mechanism to place a transverse fold in a web of material which is moving along a linear path comprising:

spaced upstanding support members,

a pair of nip rolls rotatably mounted between said support members and having their axes of rotation within a common plane which is laterally offset and substantially parallel to said linear path of movement of said web,

drive means to drive said nip rolls to rotate in opposite directions,

said nip rolls being spaced from each other so that the peripheral surface of each said nip roll is adapted to contact opposite sides of said web to draw said web between said rolls,

folding means pivotally mounted between said support members including a folder bar, said folder bar being disposed parallel to a flat side of said web as it moves along said linear path and movable from a first position on one side of said linear path to a second position on the other side of said linear path intermediate said nip rolls thereby to contact a portion of said web as said web is moving along said linear path and move said contacted portion laterally between said nip rolls to be drawn therebetween and folded over on itself to place a transverse fold therein, said folding means comprising at least two spaced support arms, each said support arm having one end rigidly secured to a shaft member, said shaft member being rotatably mounted between said support members, each said support arm having a folder bar support member rotatably secured to its other end, each said folder bar support member being rigidly fixed at its other end to a respective end of said folder bar, one of said nip rolls being independently rotatably mounted about said shaft member so that the axis of rotation of said one of said nip rolls is coextensive with the longitudinal axis of said shaft member, means to pivot said folding means about the axes of said shaft

member thereby rotating said shaft member therewith and clutch means coupling said shaft member to said one of said nip rolls to limit the speed of pivoting of said folding means so as not to exceed the speed of rotation of said one of said nip rolls.

9. A folding mechanism as defined in claim **8** wherein said folding means includes selectively retractable cam means interposed between said folder bar and said shaft member, said cam means being retractable from a first position wherein said cam means is in contact with said folder bar support arm to a second position wherein said folder bar support arm pivots about its pivotal mounting toward said support shaft whereby said folder bar moves from a position removed from contact with said one of said nip rolls to a position intermediate said pair of nip rolls thereby to direct said contacted portion of said web to a position where said web may be engaged by said nip rolls and drawn therebetween.

10. A folding mechanism as defined in claim **9** wherein said cam means is retracted while said folder bar pivots from said first position to said second position.

11. A folding mechanism as defined in claim **9** including stop means to limit pivoting movement of said folding means between said first and second positions.

12. A folding mechanism as defined in claim **9** including means to retract said folding means from said second position and pivot said folding means back to said first position, including means coupling said shaft member to said drive means to rotate said shaft member so that said folding means pivots from said second position to said first position.

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