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(54) **SHRINK WRAP MACHINE WITH FILM CUTTING MECHANISM, FILM CUTTING ASSEMBLY, AND RELATED METHODS**

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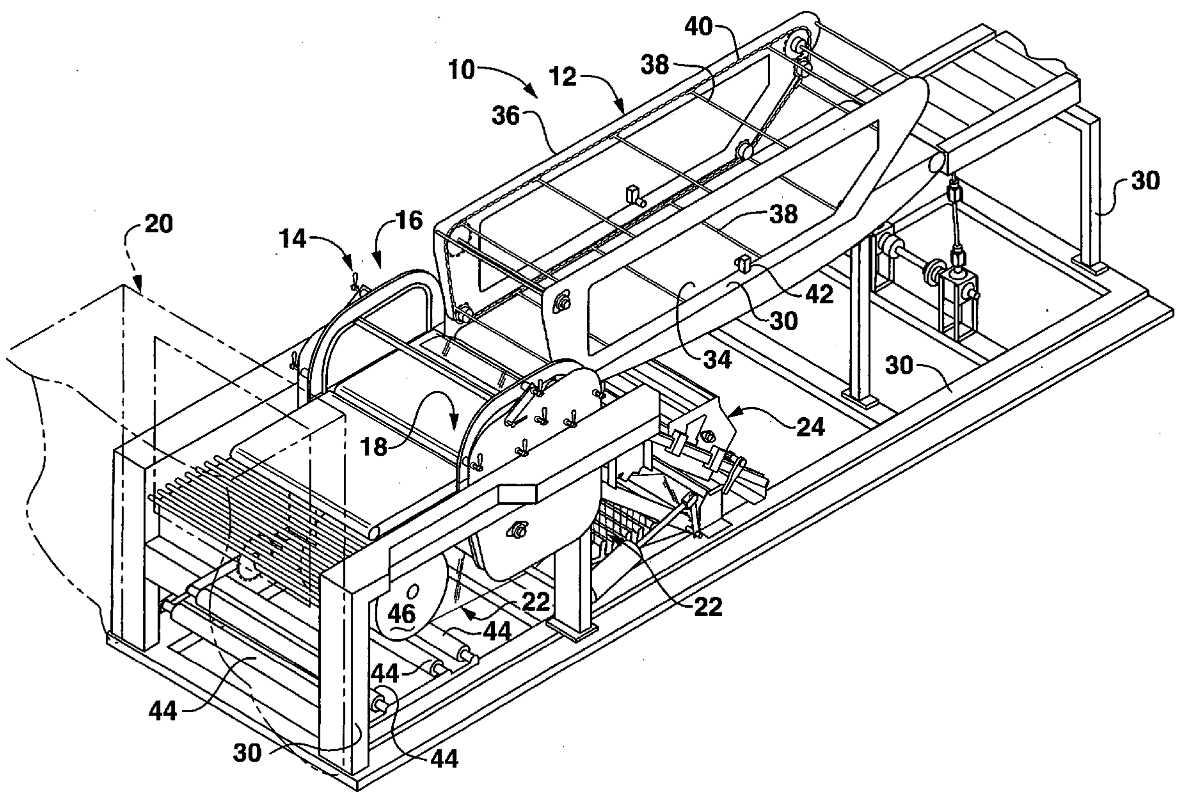
(57) **ABSTRACT**

A machine is disclosed for shrink wrapping a load of a given size, the machine including a supply conveyor for supplying the load to a wrapping zone, and a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor. A film supply supplies a film to the wrapping zone. The film supply includes a cutting mechanism having a position selectively fixed within a cutting zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load. The wrap guide includes a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed. The cutting mechanism cuts the film when the film speed is below the maximum speed. A heat supply shrinks the film so as to shrink wrap the load. Related machines, cutting assemblies, and methods are disclosed.



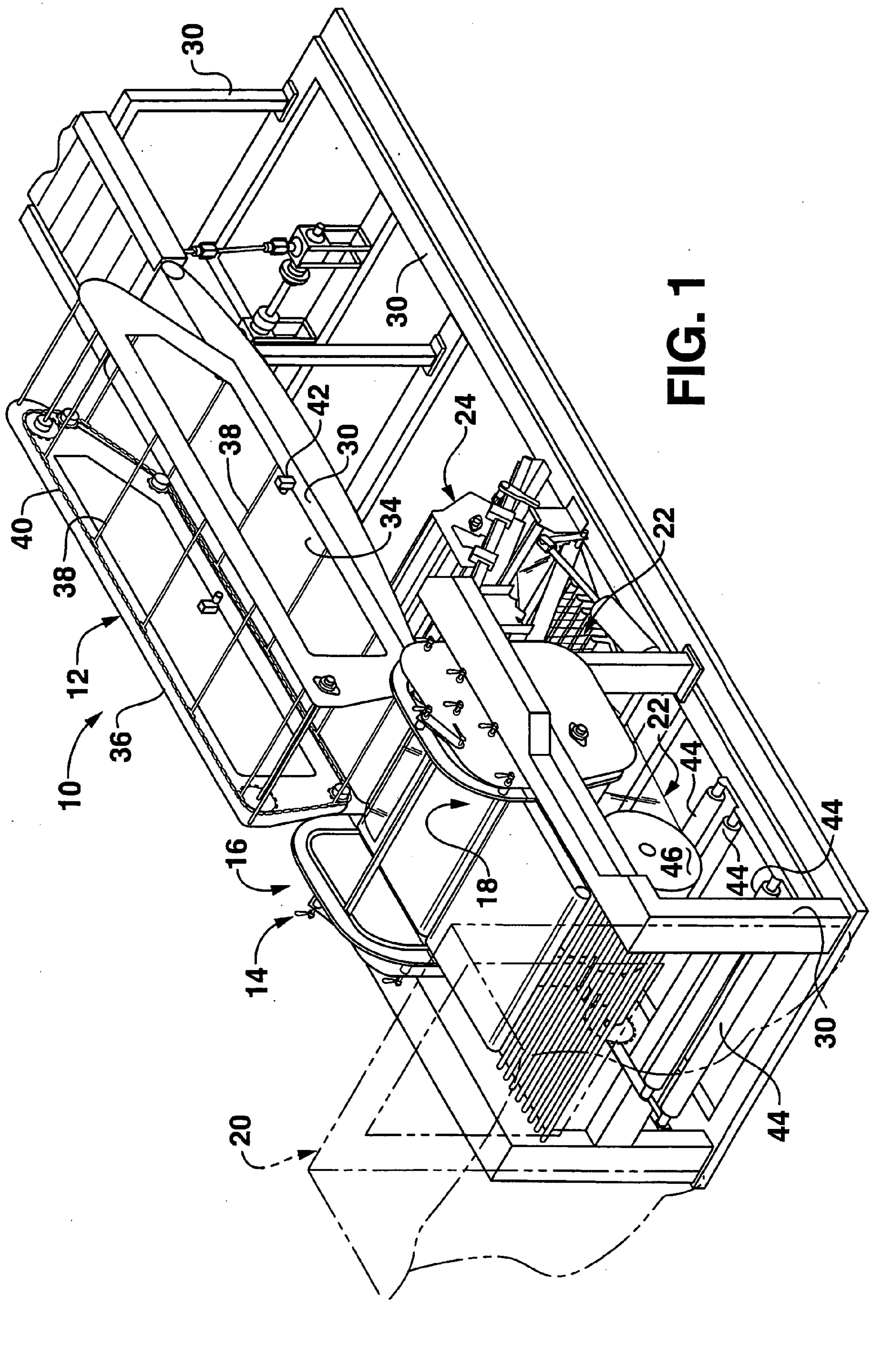


FIG. 1

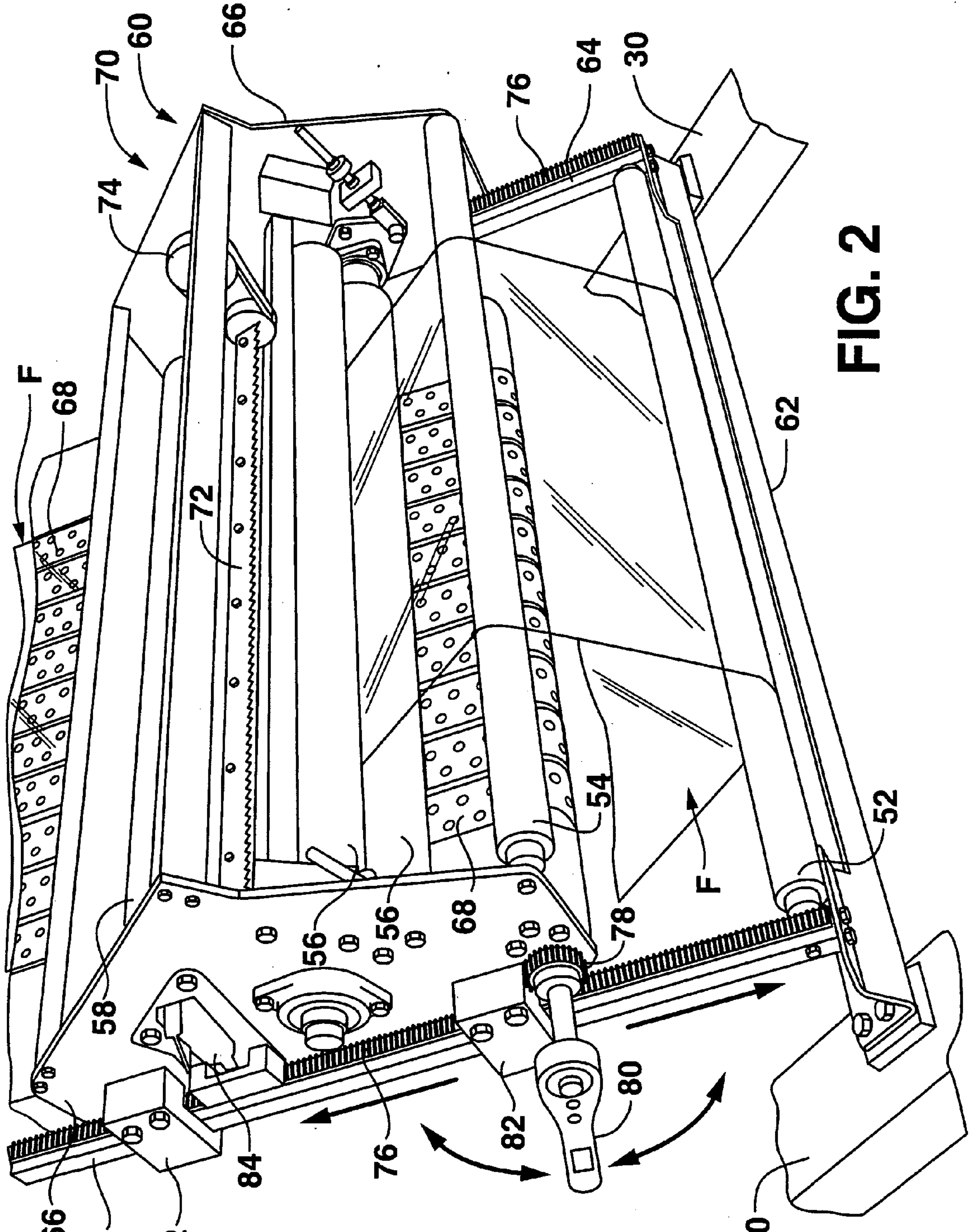
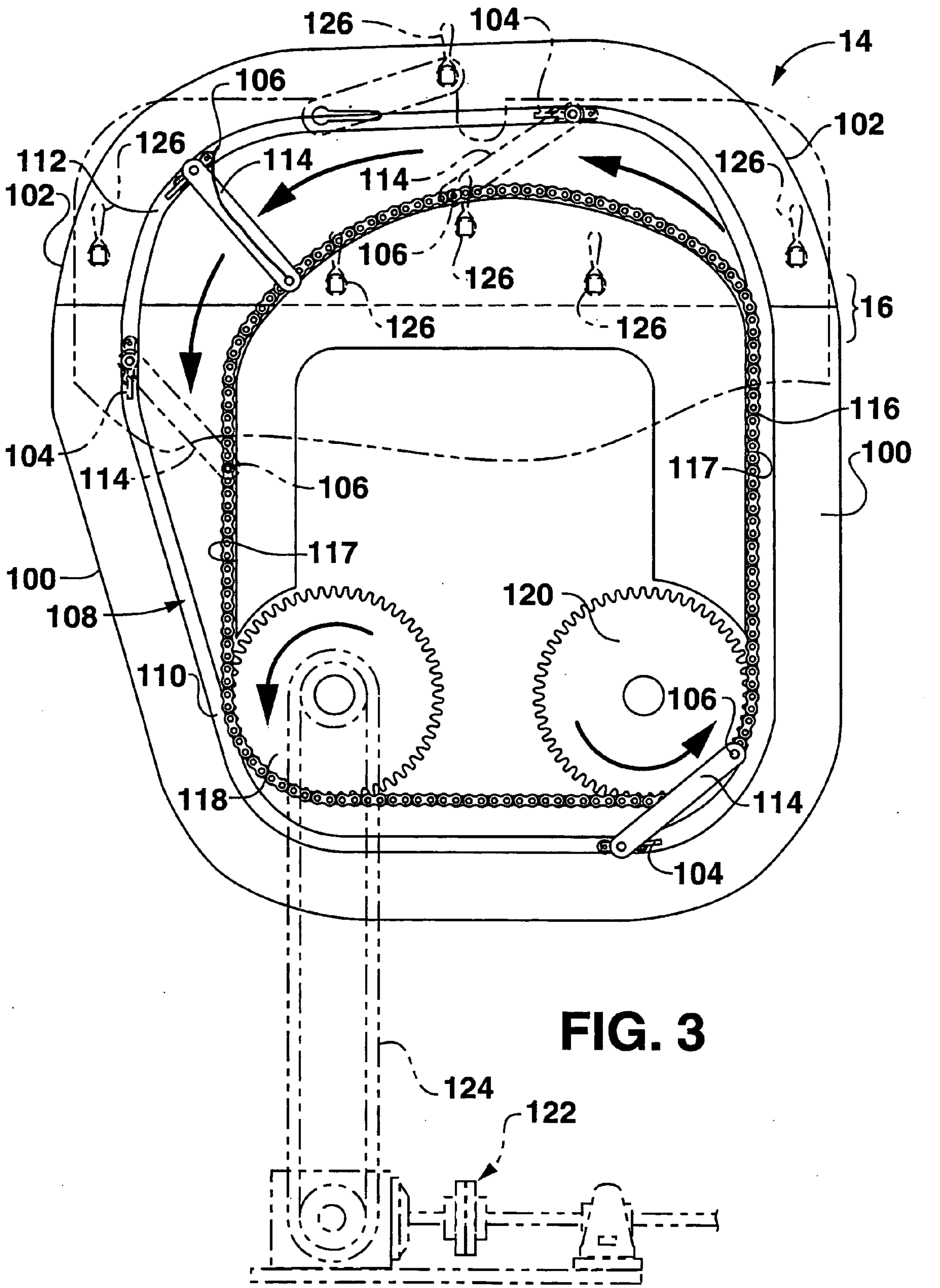


FIG. 2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122

FIG. 3

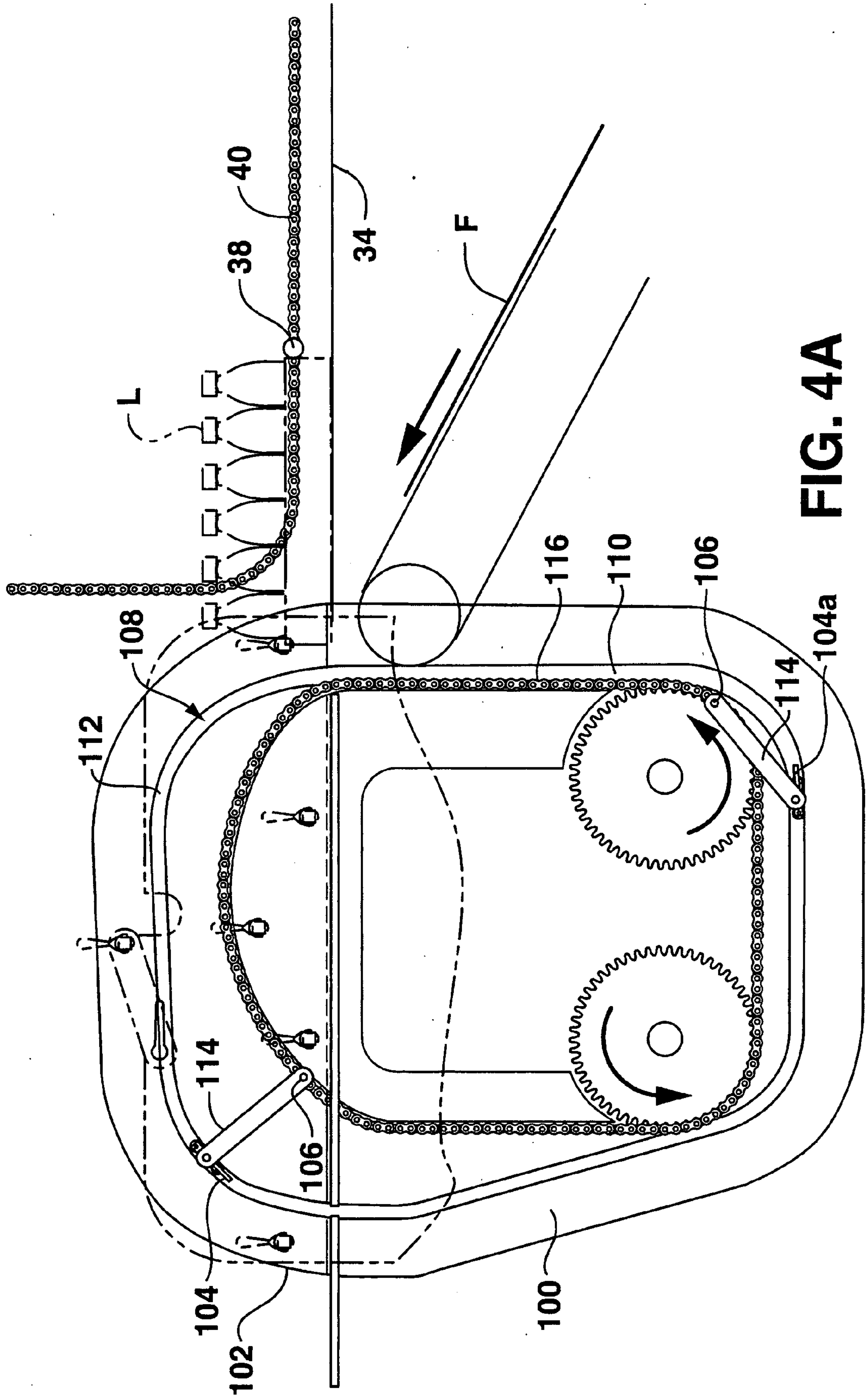

FIG. 4A

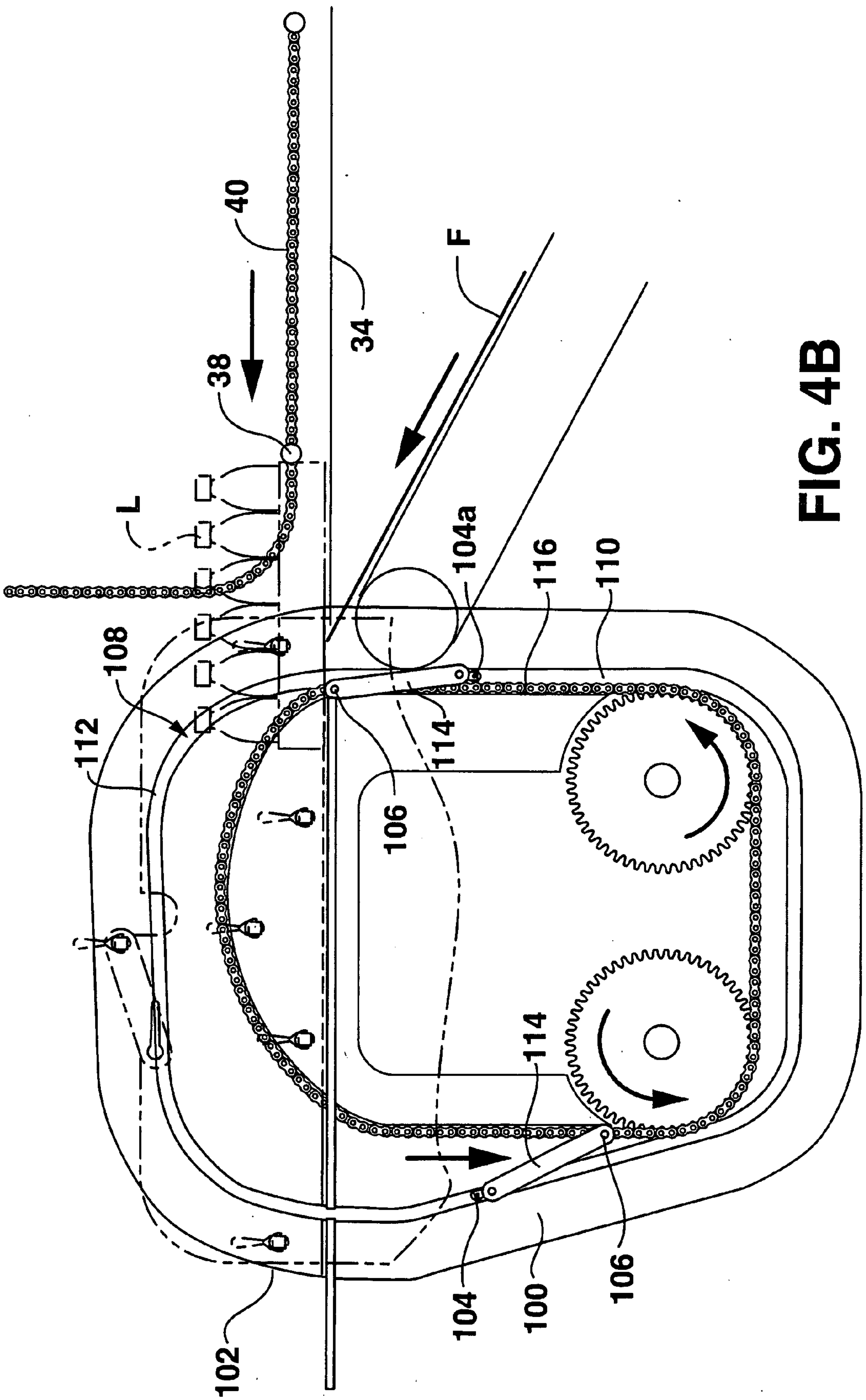

FIG. 4B

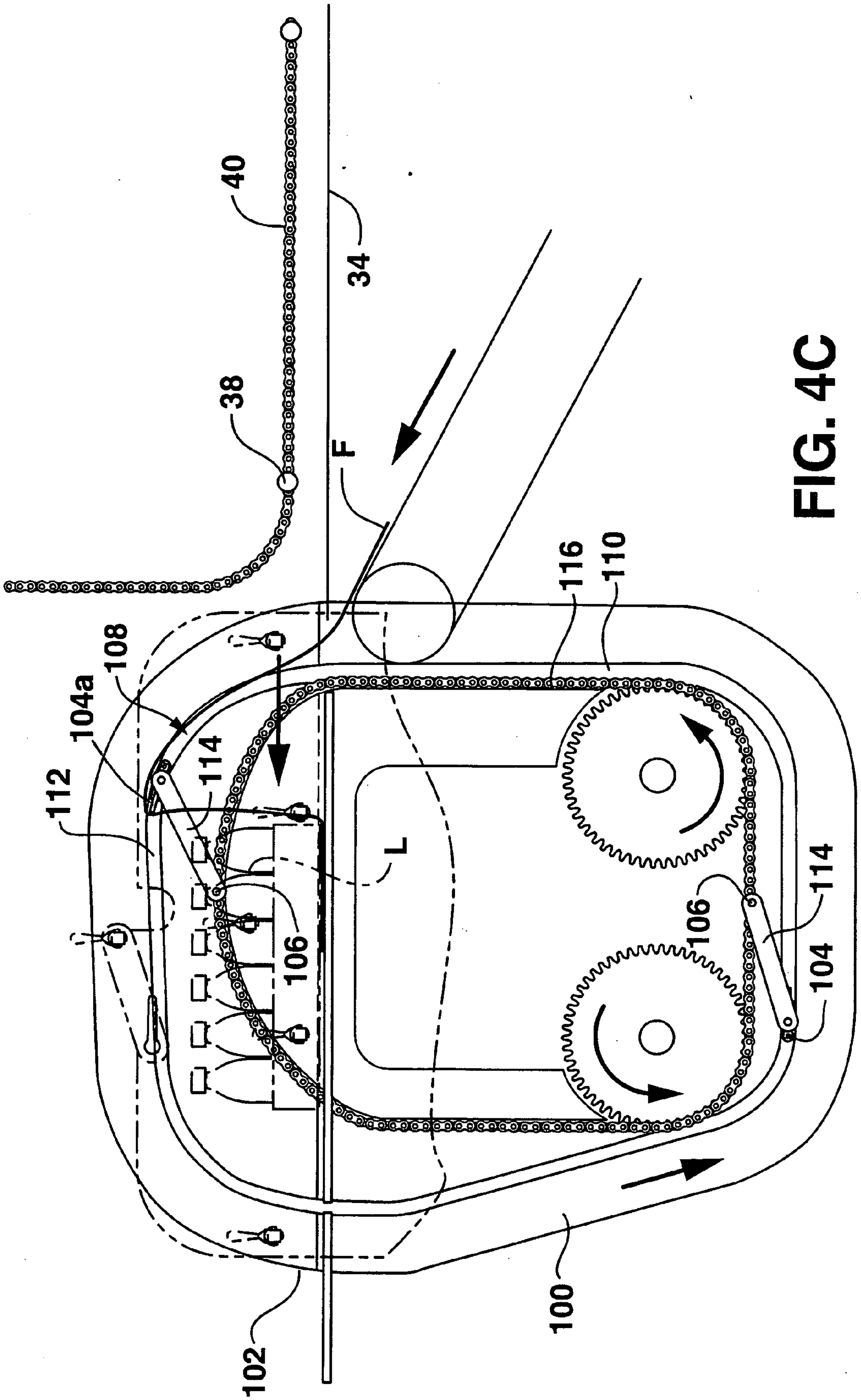

FIG. 4C

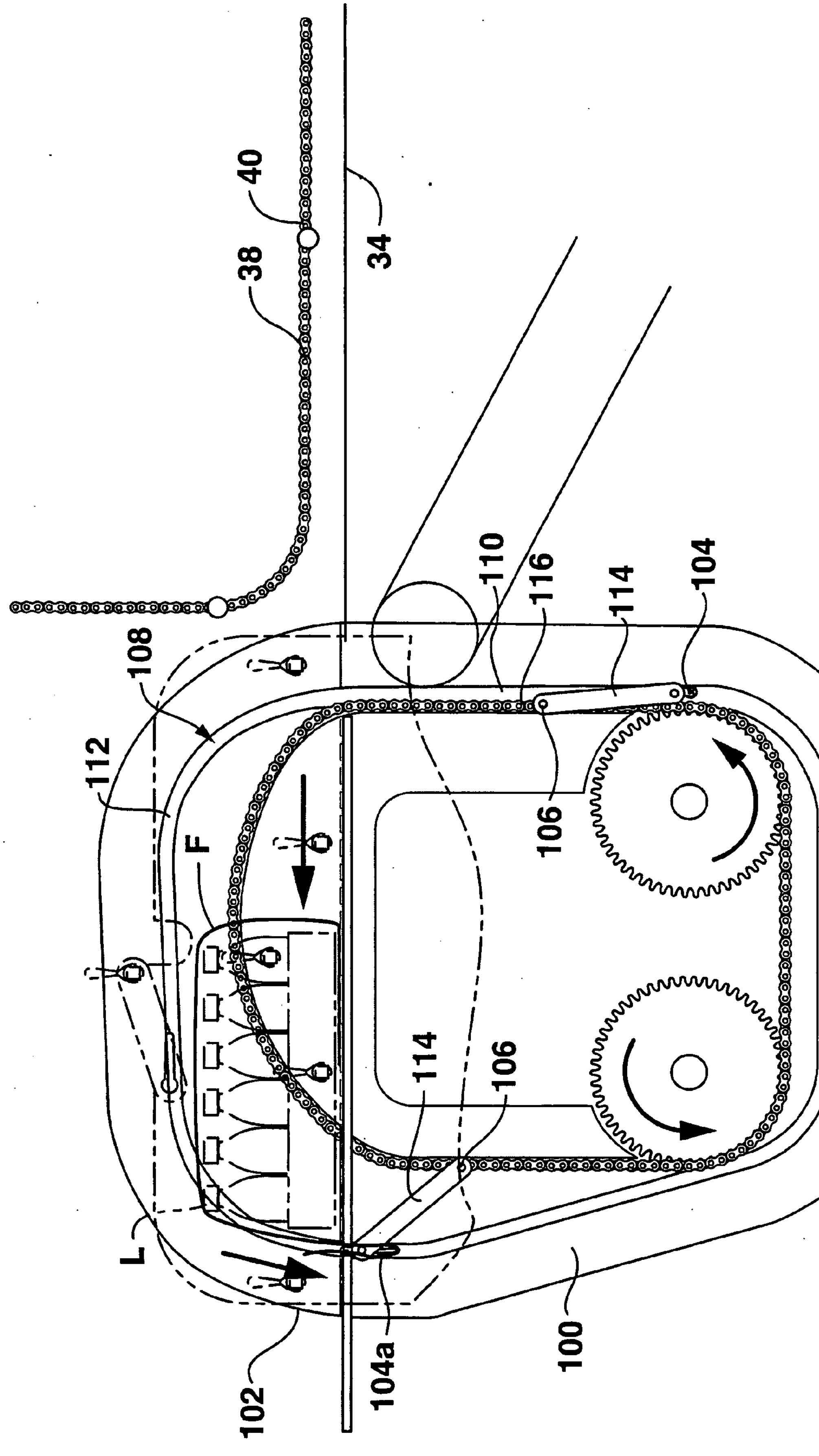

FIG. 4D

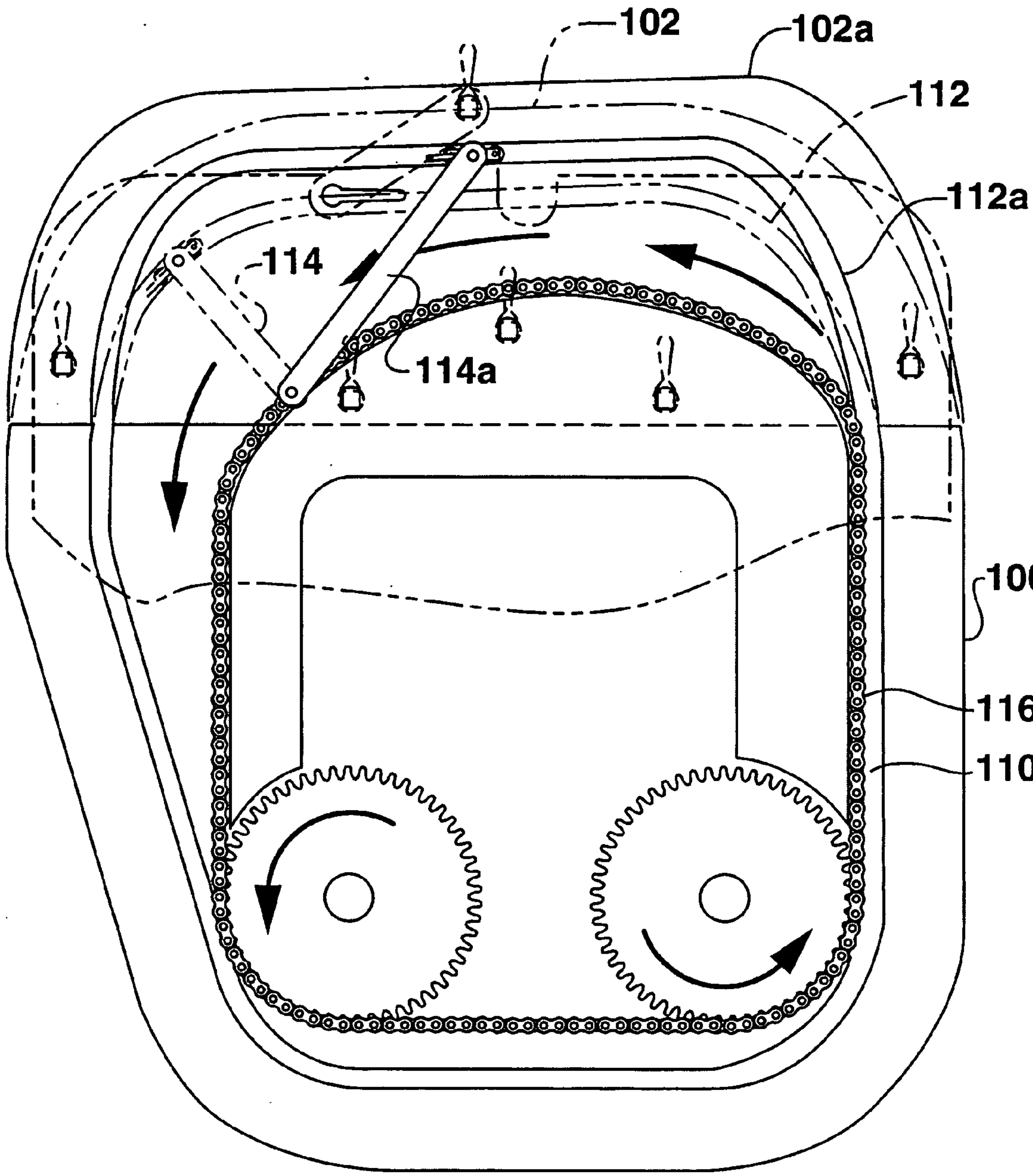

FIG. 5A

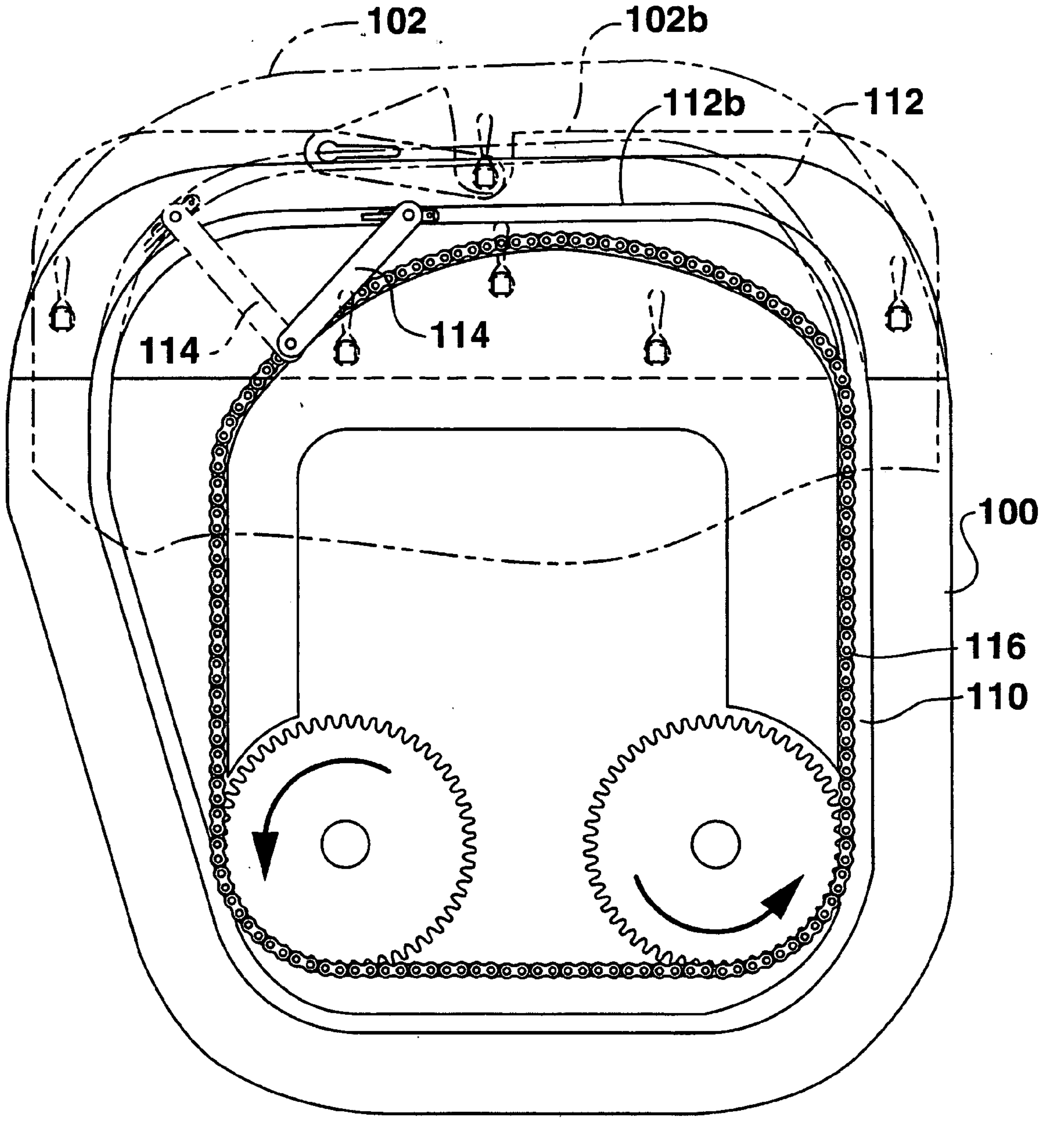

FIG. 5B

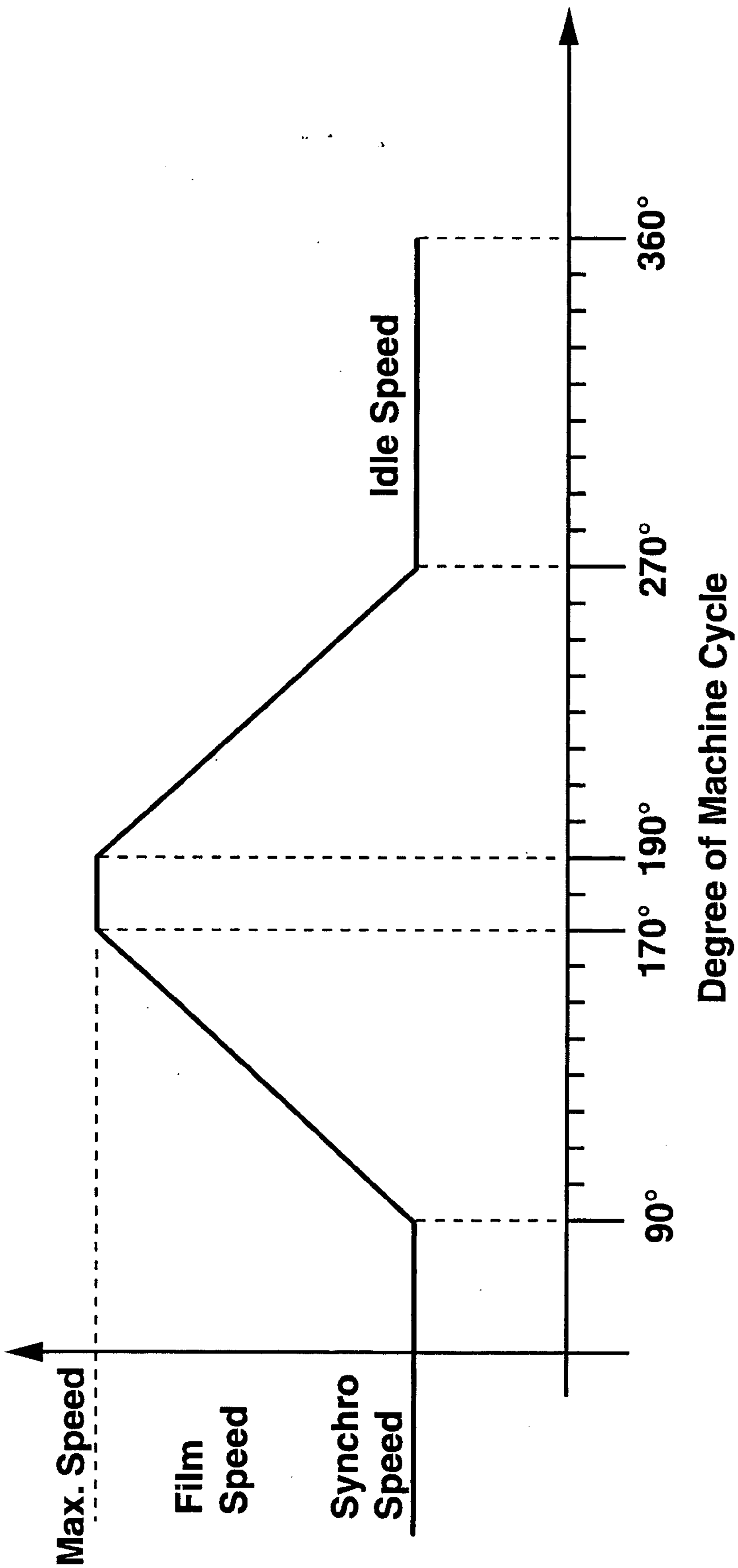
Max. Speed
Film Speed
Synchro Speed
Idle Speed
90°
170°
190°
270°
360°
Degree of Machine Cycle

FIG. 6

SHRINK WRAP MACHINE WITH FILM CUTTING MECHANISM, FILM CUTTING ASSEMBLY, AND RELATED METHODS

FIELD OF THE INVENTION

[0001] The present invention relates generally to machines, assemblies, and related methods for shrink wrap packaging loads. Particularly, the present invention relates to machines, assemblies, and related methods, where cutting of film is performed in a particular way.

BACKGROUND OF THE INVENTION

[0002] In conventional shrink wrapping, a load is fed to a wrapping zone in which a shrink wrap film is placed on the load. The film is cut into pieces or sheets before or during the placement on the load. The load and film are then passed into a heating tunnel causing the film to shrink and compress against the load. Typically, the film is cut into sheets large enough to allow for some overlap between edges when placed on the load. During the heating process, the edges may therefore be sealed together forming a unitary package.

[0003] Some users of shrink wrapping machines use the machines to shrink wrap loads having different sizes, such as groups of small or large bottles, or small or large groupings of bottles. In such situations, various machine parameters have to be altered when the load size is changed. For example, the length of the sheet of film may have to be enlarged to accommodate a larger load. Also, the path of the portion of the machine that places the film on the load and/or the speed of wrapping along the path may have to be changed if the load is of a different size.

[0004] Conventional shrink wrap machines have attempted to address issues raised by shrink wrapping differently sized loads using a number of approaches. While these approaches may work in certain situations, they have been expensive in terms of complication of parts and assembly of the parts, the cost of more highly skilled laborers needed to operate the machinery, and in terms of repair and replacement of expensive worn parts. For example, conventional shrink wrapping machines have utilized adjustable wrap guides that alter the wrap path followed for wrapping a load. These guides have been complex to properly adjust and calibrate, and may require removal and replacement of a driven wrap chain. Such chain replacement can be complex and time consuming. Also, conventional shrink wrap machines have utilized complex servomotor and/or clutch arrangements to drive wrap guides at the varying speeds used during a wrap cycle. These parts are expensive to procure, maintain, and replace. Thus, it would be desirable to achieve simpler solutions than have been currently proposed for machines capable of shrink wrapping loads of different sizes.

[0005] Conventional shrink wrapping machines have also utilized servomotors and/or clutches to drive a cutting knife to cut the film to size for shrink wrapping. The placement of the cutting knife within the machine is fixed. Therefore, since the film speed during a wrap varies, often dictated by the size of the load, the film speed may or may not be at a desirable speed at the time that cutting is necessary for proper film sheet sizing. For example, the film may have to be cut at an undesirably high speed for certain load sizes. Cutting at a high speed can produce inaccurate cuts. Alternatively, complex drive systems have been used to slow down or stop the film for cutting when the proper cut location reaches the fixed knife (see, for example, U.S. Pat. No. 6,128,888). Such systems are also unnecessarily complex and such artificial manipulation of film speed for cutting causes an uneven flow and induces wear on machine parts.

SUMMARY OF THE INVENTION

[0006] According to certain aspects of the invention, a machine is disclosed for shrink wrapping a load of a given size, the machine including a supply conveyor for supplying the load to a wrapping zone, and a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor. A film supply supplies a film to the wrapping zone. The film supply includes a cutting mechanism having a position selectively fixed within a cutting zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load. The wrap guide includes a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed. The cutting mechanism cuts the film when the film speed is below the maximum speed. A heat supply shrinks the film so as to shrink wrap the load. Various options and modifications are possible.

[0007] For example, the film supply may include a track extending along the cutting zone, and the cutting mechanism may be positionable along the track. The film supply may include a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar. A servomotor may drive the vacuum belt at a varying speed corresponding to the speed of the wrapping bar, and the cutting mechanism may be driven by the servomotor. The cutting mechanism may be triggered by an electronic clutch, and may rotate substantially synchronized with the film speed. The cutting mechanism may include a cutter triggered when the film is substantially at or proximate the minimum speed. The film supply may include a film supply roll and a plurality of dance bars. The position of the cutting mechanism may be dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

[0008] According to certain other aspects of the invention, a cut film supplying assembly is disclosed for a machine for shrink wrapping a load of a given size, the assembly including a wrap conveyor disposed in a wrapping zone, and a film supply for supplying a film to the wrapping zone. The film supply includes a cutting mechanism having a position selectively fixed within a cutting zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load. The wrap guide includes a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed. The cutting mechanism cuts the film when the film speed is below the maximum speed. As above, various options and modifications are possible.

[0009] According to other aspects of the invention, a machine is disclosed for shrink wrapping a load of a given size, the machine including a supply conveyor for supplying the load to a wrapping zone, and a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor. A film supply supplies a film to the wrapping zone, and a wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load. The wrap guide moves the film along the wrap path at a speed varying between a maximum speed and a minimum speed. A selectively fixable cutting means cuts the film when the film speed is below the maximum speed. A heat supply shrinks the film so as to shrink wrap the load. Again, various options and modifications are possible.

[0010] According to other aspects of the invention, a cut film supplying assembly is disclosed for a machine for shrink wrapping a load of a given size, the assembly including a wrap conveyor disposed in a wrapping zone, the wrap conveyor receiving the load from the supply conveyor, and a film supply for supplying a film to the wrapping zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load. The wrap guide moves the film along the wrap path at a speed varying between a maximum speed and a minimum speed. A selectively fixable cutting means cuts the film when the film speed is below the maximum speed. As above, various options and modifications are possible.

[0011] According to other aspects of the invention, a machine is disclosed for shrink wrapping a load of a given size, the machine including a supply conveyor for supplying the load to a wrapping zone, and a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor. A film supply supplies a film to the wrapping zone, the film supply including a cutting mechanism having a position selectively fixed within a cutting zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load. The wrap guide includes at least one wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed. The cutting mechanism cuts the film when the film speed is substantially at or proximate the minimum speed. A heat supply shrinks the film so as to shrink wrap the load. Again, various options and modifications are possible.

[0012] According to other aspects of the invention, a cut film supplying assembly is disclosed for a machine for shrink wrapping a load of a given size, the assembly including a wrap conveyor disposed in a wrapping zone, and a film supply for supplying a film to the wrapping zone. The film supply includes a cutting mechanism having a position selectively fixed within a cutting zone. A wrap guide is disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load. The wrap guide includes at least one wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed. The cutting mechanism cuts the film when the film speed is substantially at or proximate the minimum speed. Again, various options and modifications are possible.

[0013] According to other aspects of the invention, a method is disclosed for selectively shrink wrapping a first load of a first size and a second load of a second size, the method including the steps of: (a) fixing a cutting mechanism in a first position in a cutting zone, the first position dependent upon the size of the first load; (b) supplying the first load of the first size to a wrapping conveyor; (c) supplying a film for wrapping the first load; (d) driving a wrap guide in a wrap path proximate the wrap conveyor so as to place the film on the first load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed; (e) cutting the film with the cutting mechanism when the film speed is below the maximum speed; (f) heating the film so as to shrink wrap the first load; (g) fixing the cutting mechanism in a second position within the cutting zone, the second position dependent upon the size of the second load; and (h) repeating steps (b) to (f) with the second load. Various options and modifications are possible.

[0014] For example, step (e) may include cutting the film when it is substantially at or proximate the minimum speed. Also, steps (a) and (g) may include moving the cutting mechanism along a track and fixing the cutting mechanism at the respective first or second position along the track. The first and second positions may be determined based on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

[0015] According to other aspects of the invention, a method is disclosed for shrink wrapping a load having a size, the method including the steps of: (a) selecting a cutting position from a range of cutting positions within a cutting zone dependent on the size of the load; (b) fixing a cutting mechanism in the cutting position; (c) supplying the load to a wrapping conveyor; (d) supplying a film for wrapping the load; (e) driving a wrap guide in a wrap path proximate the wrap conveyor so as to place the film on the load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed; (f) cutting the film with the cutting mechanism when the film speed is below the maximum speed; and (g) heating the film so as to shrink wrap the first load. Again, various options and modifications are possible.

[0016] For example, step (f) may include cutting the film when it is substantially at or proximate the minimum speed. Also, step (a) may include moving the cutting mechanism along a track and fixing the cutting mechanism at the selected cutting position along the track. Further, the selected cutting position may be determined based on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1** is a perspective view of a shrink wrapping machine according to certain aspects of the invention.

[0018] **FIG. 2** is a perspective view of a cutting assembly suitable for use in the device of **FIG. 1**.

[0019] **FIG. 3** is a side diagrammatical view of a wrapping assembly suitable for use in the device of **FIG. 1**.

[0020] **FIG. 4A** is a side diagrammatical view of the wrapping assembly of **FIG. 3** showing a first wrapping stage.

[0021] **FIG. 4B** is a side diagrammatical view of the wrapping assembly of **FIG. 3** showing a second wrapping stage.

[0022] **FIG. 4C** is a side diagrammatical view of the wrapping assembly of **FIG. 3** showing a third wrapping stage.

[0023] **FIG. 4D** is a side diagrammatical view of the wrapping assembly of **FIG. 3** showing a fourth wrapping stage.

[0024] **FIG. 5A** is a side diagrammatical view of the wrapping assembly as in **FIG. 3**, showing one example of a removable portion of a wrap guide of the wrapping assembly as in **FIG. 3**.

[0025] **FIG. 5B** is a side diagrammatical view of the wrapping assembly as in **FIG. 3**, showing another example of a removable portion of a wrap guide of the wrapping assembly as in **FIG. 3**.

[0026] **FIG. 6** is a diagram showing an example of possible film speed during the wrapping cycle and potential film cutting points.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Reference will now be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, and not meant as a limitation of the invention. For example, features illustrated or described as part of one embodiment can be used with another embodiment to yield still a third embodiment. It is intended that the present invention include these and other modifications and variations. In discussing various embodiments, like or similar reference numerals are used below with like or similar parts of various embodiments.

[0028] **FIG. 1** generally shows a shrink wrapping machine **10** useful for shrink wrapping loads using conventional shrink wrapping films. Machine **10** generally includes a supply conveyor **12**, a wrap zone **14**, in which is disposed a wrap conveyor **16** and a wrap guide **18**, and a heat supply **20**. A film supply **22** supplies film to a cutting assembly **24**, which supplies cut film to the wrapping zone **14**. As will become apparent from the following, various aspects, combinations, and sub-combinations of features of the above elements are within the scope of the present invention. Also, it is possible to bring into practice the inventions disclosed below in numerous ways and with numerous modifications. Therefore, the specifics shown in **FIG. 1** and the following figures should not be considered limiting of the invention, but only as one example of how to carry out the various inventive concepts.

[0029] **FIG. 1** further shows that machine **10** is supported by a frame **30** including a number of upright and horizontal members. The various parts of machine **10** may be attached to frame **30** in conventional ways. For example, an infeed conveyor **32** may be provided to supply loads to be wrapped to machine **10**. Infeed conveyor **32** may be an integral part of machine **10**, or may be considered part of a separate device or conveyor, depending upon the application. Infeed conveyor **32** may supply grouped, stacked, or boxed loads, or any load to be wrapped, as desired.

[0030] Supply conveyor **12** includes a supply belt **34** and a flight bar assembly **36** for driving loads received from the infeed conveyor **32** to wrapping zone **14**. Supply belt **34** may be driven or undriven, or may be replaced by rollers. Flight bar assembly **36** may include a plurality of flight bars **38** driven on chains **40** by a conventional motor drive with servo-clutches. Flight bars **38**, supply belt **34** and infeed conveyor **32** may all be driven at synchronous speeds as controlled by a programmable logic controller, as desired. Sensors **42** may be provided within supply conveyor **12** to detect presence of loads being pushed by flight bars **38** for feedback loop control of various aspects of machine **10**.

[0031] Film supply **22** may include rollers **44** for supporting one or more film rolls **46** for supplying film to machine **10**. Rollers **44** may be driven or undriven. The film F is paid out from film roll **46** through a series of rollers **48**. If desired, rollers **48** may comprise a portion of a conventional dance bar assembly used to provide more steady rotation of roll **46** while the downstream speed of film F varies due to wrapping cycle film speed changes, as is known.

[0032] **FIG. 2** shows a perspective view of cutting assembly **24** according to certain aspects of the present invention. As shown, film F enters a lower portion of cutting assembly **24** threading around a first roller **52**, a second roller **54**, between pinch rollers **56** and past exit roller **58**.

[0033] Cutting assembly **24** includes a frame **60** including a base **62** and side pieces **64**. Mounting plates **66** are attached to side pieces **64**. Roller **52** is an idler roller mounted between side pieces **64**. Rollers **54** and **58** are idler rollers mounted between mounting plates **66**. At least one of pinch rollers **56** mounted between mounting plates **66** is driven. It should be understood that various different arrangements of rollers or other structures for passing film F from film supply **22** to and through cutting assembly **24** could be utilized, if desired.

[0034] A vacuum belt **68** is mounted between side pieces **64**. Vacuum belt **68** may be a conventional vacuum belt used for transmitting film in a desired direction, as is known. Vacuum belt **68** may be driven with a variable speed so as to move cut film at a desired wrapping speed. Thus, vacuum belt **68** may be driven via a variable speed servomotor, a controlled by a conventional programmable logic device. Film speeds during different portions of a wrapping cycle will be discussed in further detail below.

[0035] Cutting assembly **24** further includes a cutting mechanism **70** mounted within frame **60**. As shown, cutting mechanism **70** may include a cutting blade **72** rotationally mounted within mounting plates **66**. Cutting mechanism **70** may be driven by the same servomotor used to drive vacuum belt **68**, and is triggered by an electronic clutch **74**. It can be desirable to cause cutting blades **72** to be rotated by the servomotor and electronic clutch **74** so as to be substantially synchronized in tangential speed with the speed of film F. It is believed that such synchronization of the cutting mechanism and the film speeds creates a more accurate cut.

[0036] In some aspects of the present invention, it is desirable to selectively fix the position of the cutting mechanism within a cutting zone within cutting assembly **24**. As shown in **FIG. 2**, rack gears **76** may be provided along side pieces **64** to mesh with pinion gears **78** attached to mounting plates **66**. The rotation of handle **80** causes pinion gears **78** to rotate relative to rack gears **76**, thereby positioning cutting mechanism **70** at a predetermined location along the cutting zone within cutting assembly **24**. Guides **82** assist in maintaining alignment along rack gear **76**. Thus, rack gears **76** may be said to comprise a track along a cutting zone, with cutting mechanism **70** being positionable along the track. If desired, a sensor **84** may be utilized to determine position along the track, such as by using an optical sensor to count teeth of rack gears **76**, etc., or some equivalent.

[0037] As will be discussed in further detail below, use of handle **80** to position cutting mechanism **70** within the cutting zone between rack gears **76** can provide certain benefits in certain applications. For example, cutting mechanism **70** may be placed in a position so as to achieve a certain length of cut film, or so as to cut the film at a certain point in the wrap cycle, or at a certain film speed, or within a range of film speeds. However, it should be understood that the movable cutting mechanism **70** is not required for all aspects of the invention.

[0038] It should also be understood that other cutting mechanism location adjustment designs could be substituted for the rack and pinion arrangement shown in **FIG. 2**. Thus, a hydraulic, pneumatic, or electric adjustment assembly could be used. Also, other continuously or selectively (stepwise) adjustable mechanisms could be utilized, if desired. Although the cutting mechanism **70** of **FIG. 2** as shown is configured to be positioned while machine **10** is not running (i.e. is only to be positioned while the machine is stopped), it would also be possible to configure cutting assembly **24** so that the location of cutting mechanism **70** would be repositionable during use of machine **10**, if desired. Thus, various options and modifications are possible for the elements of cutting assembly **24** shown in **FIG. 2**.

[0039] **FIG. 3** shows a diagram of one example of equipment useful in a wrap zone **14** according to certain aspects of the invention. More specifically, **FIG. 3** shows a side view of one side of wrap guide **16** that would be disposed adjacent wrap conveyor **18** (see **FIG. 1**). Wrap guide **16** is disposed in wrapping zone **14** for guiding film received from film supply **22** via cutting assembly **24** in a wrap path. Wrap guide **16** includes a fixed portion **100** and a removable portion **102**. Fixed portion **100** is fixed to frame **30**, and removable portion **102** is fixed to frame **30** and the fixed portion. Together, the fixed and removable portions **100** and **102** define a wrap path **108** for film being wrapped around a given load.

[0040] Wrap guide **16** further includes at least one wrapping bar **104** driven along the wrap path. Wrapping bar **104** is mounted to a follower **106** that follows a chain **116** along a track **117**. Fixed portion **110** of wrap path **108** is disposed within fixed portion **100** of wrap guide **16**. Removable portion **112** of wrap path **108** is disposed within removable portion **102** of wrap guide **16**. Linkages **114** are connected to followers **106**, and are in turn driven by chain **116**. Driven gear **118** drives chain **116**, and gear **120** is an idler gear. Machine main drive assembly **122** is schematically shown as connected to driven gear **118** by belt **124**.

[0041] If desired, main drive assembly **122** may be utilized to drive chain **116** at a substantially constant speed. The track **117** followed by chain **116** is fixed. However, wrap path **108** may have differing shapes, depending upon the size of the load, the length of the linkages **114**, etc. Thus, by designing track portion **112** accordingly, different sized loads may be wrapped without modifying main drive assembly **122** or chain **116** or its path. The profile along portion **112** of track **108** defines the path that wrap bars **104** take along the wrap path when wrapping a load with film. Quick-connect assembly devices such as clamps **126** may be utilized to readily attach and detach removable portion **102** so as to change the track portion **112** if desired. Thus, if different sized loads are to be wrapped using machine **10**, a simple change out of portions **102** on either side of wrap guide **116** can accommodate the different sized loads by providing a different wrap path. By designing track portion **112** and linkage length **114** accordingly, varying wrap paths can be achieved. In such situation, chain **116** may continue to be driven at a substantially constant speed using main drive **122**. Further, the orientation and/or location of chain **116** within machine **10** need not be changed, or the actual chain itself need not be changed out for different loads. Thus, it is a relatively simple matter to change the size and/or shape of load being wrapped by machine **10** by simply changing out the removable portions **102** of a first predetermined size for a second alternate removable portions of another predetermined size to provide alternate wrap paths of different configurations. However, the track **117** followed by chain **116** does not change when removable portions **102** are changed.

[0042] **FIGS. 4A-4D** show a portion of a wrap cycle in which cut film F is transferred from vacuum belt **68** to load L for wrapping the load. As shown therein, film F is fed so as to provide a leading edge that is captured beneath load L (between **FIGS. 4B and 4C**). As load L moves further to the left between **FIGS. 4B and 4C** the wrap bar **104** attached to linkage **114***a* is driven into contact with the cut film and is pulled over and around load L as it moves through wrap zone **14** along wrap conveyor **18**. As shown in **FIG. 4D**, cut film F has been looped over top of load L. As load L moves further to the left from the position shown in **4**D, the trailing edge of cut film will overlap with the leading edge beneath load L. At that point, the load will be ready for passing into a heat supply, such as a tunnel or oven **20**, as shown in **FIG. 1**. Chain **116** may be driven at a substantially constant speed during this wrap cycle.

[0043] The wrap path **108** generated by fixed and removable portions **100** and **102**, in combination with linkage **114** causes the cut film to accelerate substantially between the positions of **FIGS. 4C and 4D** so that the cut film will essentially pass over and in front of the load. Film speeds will be discussed below in connection with **FIG. 6**.

[0044] **FIGS. 5A and 5B** show two alternate constructions whereby different sized wrap paths are created by providing different sized removable portions **102**. In **FIG. 5A**, linkage **114** is replaced by linkage **114***a* as well as replacing removable portion **102** with removable portion **102***a*. Wrap path portion **112***a* in removable portion **102***a* is defined accordingly. In **FIG. 5B**, linkage **114** is not replaced when removable portion **102** is replaced by removable portion **102***b*. Accordingly a different alternate wrap path portion **112***b* is created. **FIGS. 5A and 5B** illustrate that, through a relatively simple change out of removable portions **102**, with an optional change out of linkages **114**, alternate wrap paths may be readily achieved, thereby allowing differently sized loads to be wrapped using the same equipment with minimal changes. Such change out can be done readily during operation requiring less down time and less technically skilled labor personnel to achieve such change out, than if the drive chain had to be changed out or its path modified.

[**0045**] Also, driving a wrap assembly by driving wrap bars through such a linkage attached to a substantially constant speed loop, such as chain **116**, allows for a relatively simple mechanism for providing a wrap path having a wrap bar that moves at a substantially varying speed. Therefore, instead of complex servomotors and controls, a simpler and less expensive drive may be used along with a linkage and wrap path spaced from a chain track, to achieve a desired changing film speed during load wrapping.

[**0046**] One example of such a film speed distribution is shown in **FIG. 6**. More particularly, **FIG. 6** shows one wrap cycle divided into 360 degrees according to the position of a wrap bar **104** on chain **116**. In **FIG. 6**, the 0 degrees position is with the wrap bar **104** at a "3 o'clock" position around track **117**, as shown in **FIG. 3**. As shown in **FIG. 6**, the speed of wrap bar **114** increases from 90 to 170 degrees. Such point corresponds to position shown, for example, in **FIG. 4C** where wrap bar is advancing film F from behind and over the load to be wrapped. Essentially, the wrap bar must speed up to a speed faster than the synchro speed of the load and past the load so that the leading and trailing edges may overlap. At 190 to 270 degrees the speed of wrap bar **104** slows down as the wrap bar returns for another cycle.

[**0047**] It should be understood that the speed profile as shown in **FIG. 6** can vary a great deal according to the present invention. For example, the speed increases and decreases need not be linear, the speeds need not reach constant levels, etc. The speeds are essentially a function of the size of the guide path and the length of the linkages, as well as the speed of the load through the wrap zone. In any event, the wrap bar **104** will typically have to accelerate as it picks up a piece of cut film from behind the load, passes over top of the load, and then passes down in front of the load so as to allow for overlapping of the cut film. Thus, there is a base speed and an acceleration portion found in the curve. Again, it should be kept in mind that multiple wrap bars may be used, so the curve could show a similar speed profile in 0 to 180 degrees, 0 to 120 degrees, 0 to 90 degrees of chain rotation, depending on the number of wrap bars attached to the chain.

[**0048**] If desired, it can be useful in certain applications to selectively cut the film at particular points along the speed curve. For example, it may be desired to cut the film when it is moving at a speed less than the maximum speed. It may also be useful to cut the film at a minimum speed, or somewhat proximate the minimum speed. In such case a less expensive low speed clutch may be used and synchronizing blade speed and film speed is less complicated. Thus, if desired, the position of cutting mechanism **70** within the cutting zone may be altered by using the rack and pinion gears **76** and **78** so as to locate the cutting mechanism so as to achieve cutting at a desired film speed for the desired application. Accordingly, one may therefore choose a position of cutting mechanism **70** depending upon one or more of a size of the load, a length of the film after cutting (so as to wrap the film about the load), a point in the wrap cycle in which the cutting mechanism is to cut the film, an amount of leading edge of the film to be placed beneath the load during the wrap cycle, etc. Therefore, having a cutting mechanism with an adjustable positioning device can provide certain benefits.

[**0049**] It is believed that programming can be created to assist in setting the optimal position of the cutting mechanism within the cutting zone based on various system parameters, such as load size, wrap path dimensions, machine speed, etc. Such optimum position could also be determined empirically through testing and experience. In any event, the optimal placement may be provided to a machine user for manual manipulation or may be automatically achieved by a drive mechanism, for example through the use of programmable logic servomotors, position sensors, etc. If desired, such positioning could be automatically achieved during operation as well based on various sensor input.

[**0050**] According to certain other aspects of the invention, methods of using the above shrink wrap machine components are also contemplated within the scope of the invention. For example, it is within the scope of the invention to wrap a load of a certain size using a first removable portion of a wrap guide, switching out that removable portion for an alternate removable portion of a different size defining a different wrap path, and then wrapping a load of a different size. Similarly, one may fix the cutting mechanism at a certain position, run the machine to wrap a load of a given size, and then move cutting mechanism to a different position so as to cut film so as to wrap loads of a different size. The methods may be complementary or may be employed separately, if desired. Thus, the machine and methods described above provide a flexible wrapping machine that can be utilized for different loads and for different applications, where change out and down time, if loads of different sizes are to be wrapped, is reduced.

[**0051**] It should be understood that various other modifications and combinations of the above embodiments are contemplated and are also within the scope of the present invention. Thus, the present invention contemplates that any and all such subject matter is included within the scope of the present invention.

What is claimed is:

1. A machine for shrink wrapping a load of a given size, the machine comprising:

a supply conveyor for supplying the load to a wrapping zone;

a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor;

a film supply for supplying a film to the wrapping zone, the film supply including a cutting mechanism having a position selectively fixed within a cutting zone;

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed, the cutting mechanism cutting the film when the film speed is below the maximum speed; and

a heat supply for shrinking the film so as to shrink wrap the load.

2. The machine of claim 1, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

3. The machine of claim 1, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

4. The machine of claim 3, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

5. The machine of claim 4, wherein the cutting mechanism is driven by the servomotor.

6. The machine of claim 5, wherein the cutting mechanism is triggered by an electronic clutch.

7. The machine of claim 6, wherein the cutting mechanism rotates substantially synchronized with the film speed.

8. The machine of claim 1, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

9. The machine of claim 1, wherein the film supply includes a film supply roll and a plurality of dance bars.

10. The machine of claim 1, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

11. A cut film supplying assembly for a machine for shrink wrapping a load of a given size, the assembly comprising:

a wrap conveyor disposed in a wrapping zone;

a film supply for supplying a film to the wrapping zone, the film supply including a cutting mechanism having a position selectively fixed within a cutting zone; and

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed, the cutting mechanism cutting the film when the film speed is below the maximum speed.

12. The assembly of claim 11, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

13. The assembly of claim 11, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

14. The assembly of claim 13, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

15. The assembly of claim 14, wherein the cutting mechanism is driven by the servomotor.

16. The assembly of claim 15, wherein the cutting mechanism is triggered by an electronic clutch.

17. The assembly of claim 16, wherein the cutting mechanism rotates substantially synchronized with the film speed.

18. The assembly of claim 11, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

19. The assembly of claim 11, wherein the film supply includes a film supply roll and a plurality of dance bars.

20. The assembly of claim 11, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

21. A machine for shrink wrapping a load of a given size, the machine comprising:

a supply conveyor for supplying the load to a wrapping zone;

a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor;

a film supply for supplying a film to the wrapping zone;

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load, the wrap guide moving the film along the wrap path at a speed varying between a maximum speed and a minimum speed;

selectively fixable cutting means for cutting the film when the film speed is below the maximum speed; and

a heat supply for shrinking the film so as to shrink wrap the load.

22. The machine of claim 21, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

23. The machine of claim 21, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

24. The machine of claim 23, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

25. The machine of claim 24, wherein the cutting mechanism is driven by the servomotor.

26. The machine of claim 25, wherein the cutting mechanism is triggered by an electronic clutch.

27. The machine of claim 26, wherein the cutting mechanism rotates substantially synchronized with the film speed.

28. The machine of claim 21, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

29. The machine of claim 21, wherein the film supply includes a film supply roll and a plurality of dance bars.

30. The machine of claim 21, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

31. A cut film supplying assembly for a machine for shrink wrapping a load of a given size, the assembly comprising:

a wrap conveyor disposed in a wrapping zone, the wrap conveyor receiving the load from the supply conveyor;

a film supply for supplying a film to the wrapping zone; and

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load, the wrap guide moving the film along the wrap path at a speed varying between a maximum speed and a minimum speed; and

selectively fixable cutting means for cutting the film when the film speed is below the maximum speed.

32. The assembly of claim 31, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

33. The assembly of claim 31, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

34. The assembly of claim 33, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

35. The assembly of claim 34, wherein the cutting mechanism is driven by the servomotor.

36. The assembly of claim 35, wherein the cutting mechanism is triggered by an electronic clutch.

37. The assembly of claim 36, wherein the cutting mechanism rotates substantially synchronized with the film speed.

38. The assembly of claim 31, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

39. The assembly of claim 31, wherein the film supply includes a film supply roll and a plurality of dance bars.

40. The assembly of claim 31, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

41. A machine for shrink wrapping a load of a given size, the machine comprising:

a supply conveyor for supplying the load to a wrapping zone;

a wrap conveyor disposed in the wrapping zone, the wrap conveyor receiving the load from the supply conveyor;

a film supply for supplying a film to the wrapping zone, the film supply including a cutting mechanism having a position selectively fixed within a cutting zone;

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the wrap conveyor so as to place the film on the load, the wrap guide including at least one wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed, the cutting mechanism cutting the film when the film speed is substantially at or proximate the minimum speed; and

a heat supply for shrinking the film so as to shrink wrap the load.

42. The machine of claim 41, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

43. The machine of claim 41, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

44. The machine of claim 43, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

45. The machine of claim 44, wherein the cutting mechanism is driven by the servomotor.

46. The machine of claim 45, wherein the cutting mechanism is triggered by an electronic clutch.

47. The machine of claim 46, wherein the cutting mechanism rotates substantially synchronized with the film speed.

48. The machine of claim 41, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

49. The machine of claim 41, wherein the film supply includes a film supply roll and a plurality of dance bars.

50. The machine of claim 41, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

51. A cut film supplying assembly for a machine for shrink wrapping a load of a given size, the assembly comprising:

a wrap conveyor disposed in a wrapping zone;

a film supply for supplying a film to the wrapping zone, the film supply including a cutting mechanism having a position selectively fixed within a cutting zone; and

a wrap guide disposed in the wrapping zone for guiding film received from the film supply in a wrap path proximate the load on the wrap conveyor so as to place the film on the load, the wrap guide including at least one wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed, the cutting mechanism cutting the film when the film speed is substantially at or proximate the minimum speed.

52. The assembly of claim 51, wherein the film supply includes a track extending along the cutting zone, and the cutting mechanism is positionable along the track.

53. The assembly of claim 51, wherein the film supply includes a variable speed vacuum belt operative downstream of the cutting mechanism for moving the film to the wrapping bar.

54. The assembly of claim 53, further including a servomotor for driving the vacuum belt at a varying speed corresponding to the speed of the wrapping bar.

55. The assembly of claim 54, wherein the cutting mechanism is driven by the servomotor.

56. The assembly of claim 55, wherein the cutting mechanism is triggered by an electronic clutch.

57. The assembly of claim 56, wherein the cutting mechanism rotates substantially synchronized with the film speed.

58. The assembly of claim 51, wherein the cutting mechanism includes a cutter triggered when the film is substantially at or proximate the minimum speed.

59. The assembly of claim 51, wherein the film supply includes a film supply roll and a plurality of dance bars.

60. The assembly of claim 51, wherein the position of the cutting mechanism is dependent on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

61. A method for selectively shrink wrapping a first load of a first size and a second load of a second size, the method comprising the steps of:

(a) fixing a cutting mechanism in a first position in a cutting zone, the first position dependent upon the size of the first load;

(b) supplying the first load of the first size to a wrapping conveyor;

(c) supplying a film for wrapping the first load;

(d) driving a wrap guide in a wrap path proximate the wrap conveyor so as to place the film on the first load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed;

(e) cutting the film with the cutting mechanism when the film speed is below the maximum speed;

(f) heating the film so as to shrink wrap the first load;

(g) fixing the cutting mechanism in a second position within the cutting zone, the second position dependent upon the size of the second load; and

(h) repeating steps (b) to (f) with the second load.

62. The method of claim 61, wherein step (e) includes cutting the film when it is substantially at or proximate the minimum speed.

63. The method of claim 61, wherein steps (a) and (g) include moving the cutting mechanism along a track and fixing the cutting mechanism at the respective first or second position along the track.

64. The method of claim 63, wherein the first and second positions are determined based on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

65. A method for shrink wrapping a load having a size, the method comprising the steps of:

(a) selecting a cutting position from a range of cutting positions within a cutting zone dependent on the size of the load;

(b) fixing a cutting mechanism in the cutting position;

(c) supplying the load to a wrapping conveyor;

(d) supplying a film for wrapping the load;

(e) driving a wrap guide in a wrap path proximate the wrap conveyor so as to place the film on the load, the wrap guide including a wrapping bar that moves along the wrap path so as to move the film at a speed varying between a maximum speed and a minimum speed;

(f) cutting the film with the cutting mechanism when the film speed is below the maximum speed; and

(g) heating the film so as to shrink wrap the first load.

66. The method of claim 65, wherein step (f) includes cutting the film when it is substantially at or proximate the minimum speed.

67. The method of claim 65, wherein step (a) includes moving the cutting mechanism along a track and fixing the cutting mechanism at the selected cutting position along the track.

68. The method of claim 67, wherein the selected cutting position is determined based on one or more of: the size of the load, a length of the film after cutting, a point in a wrap cycle in which the cutting mechanism cuts the film, and an amount of leading edge of film placed beneath the load during the wrap cycle.

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