

[54] **APPARATUS FOR SETTING UP A RAPIDLY MOVING WEB FOR REMOVAL OF A SIDE PORTION THEREFROM**

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[58] Field of Search.....83/302, 321, 353, 357, 406, 83/554, 555, 408

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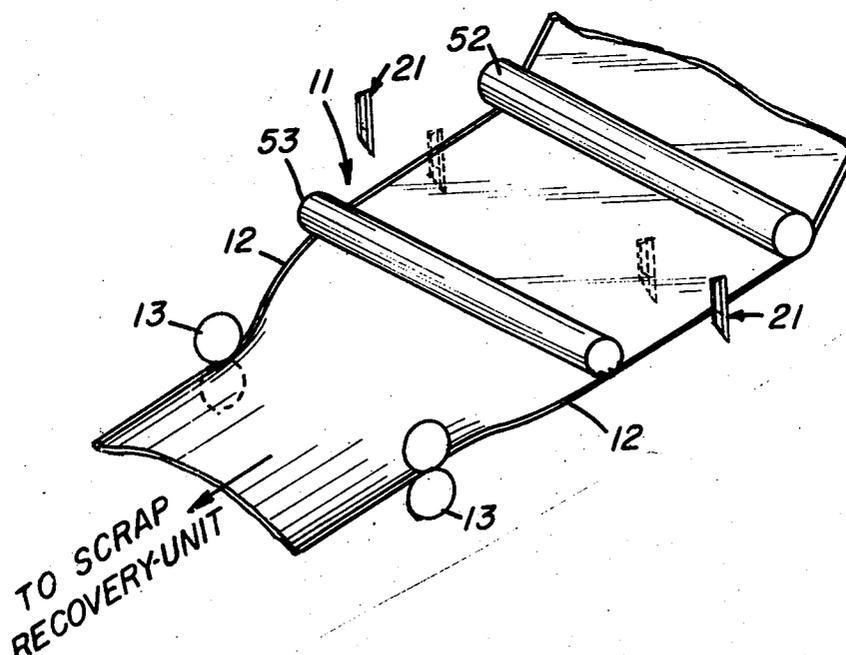
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[57] **ABSTRACT**

In an apparatus for removing the side portions from a rapidly moving web such as by threading the web through a pair of rotary slitting knives that have their cutting edges spaced apart a distance corresponding to the width of the desired web, there is provided a pair of piercing knives located upstream of the slitting knives for setting-up the rapidly moving web for initial entry into the slitting knives. The piercing-knives are supported on vertically reciprocable piston rods for plunging the piercing knives into the rapidly moving web at points inward of where the web is to be slit and on horizontally reciprocable piston rods for advancing the piercing knives outwardly through the side edges of the web to form transverse cuts therein. The piercing knives are pivotably mounted so that they may rotate during their outward movement to enable their cutting edges to be utilized in cutting through the side edges.

11 Claims, 7 Drawing Figures



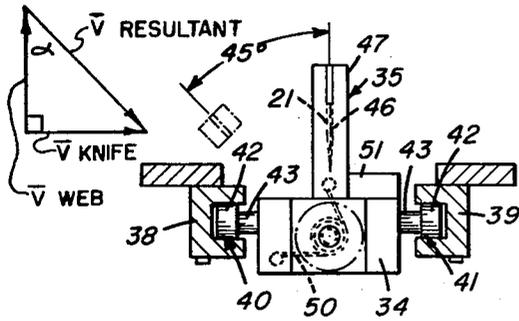


FIG. 6

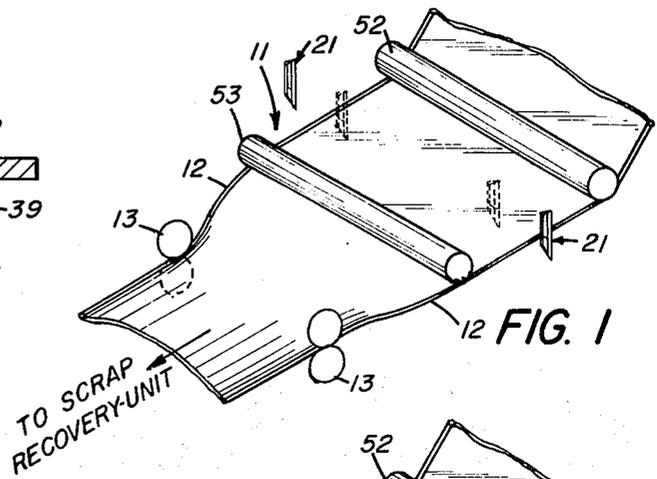


FIG. 1

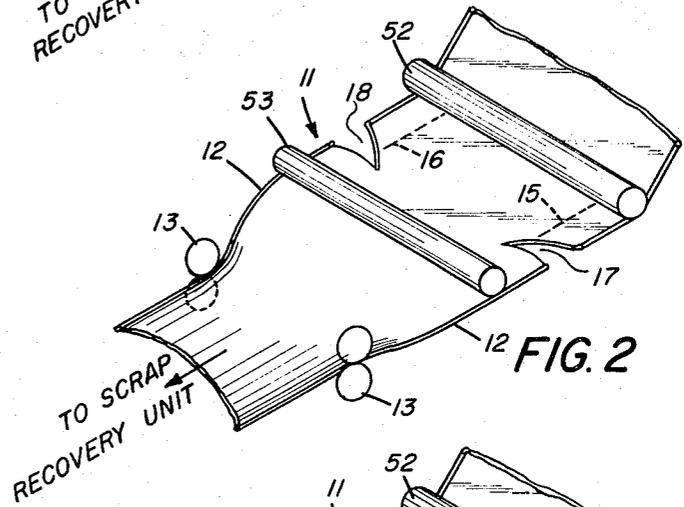


FIG. 2

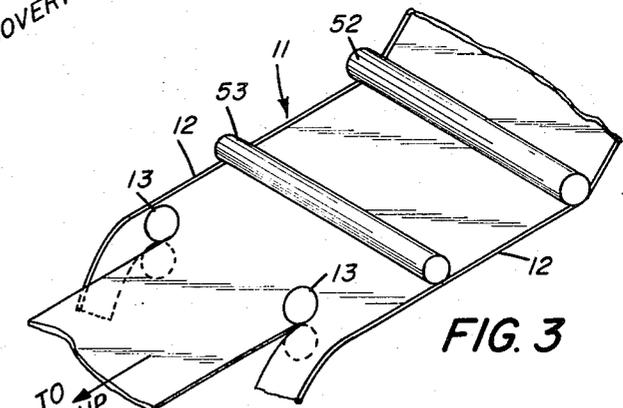


FIG. 3

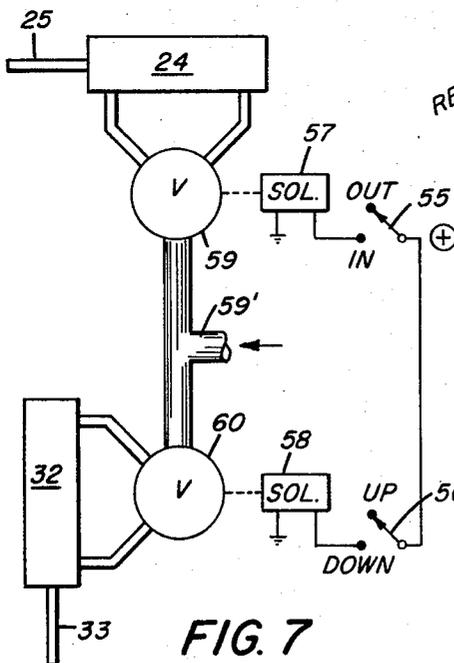


FIG. 7

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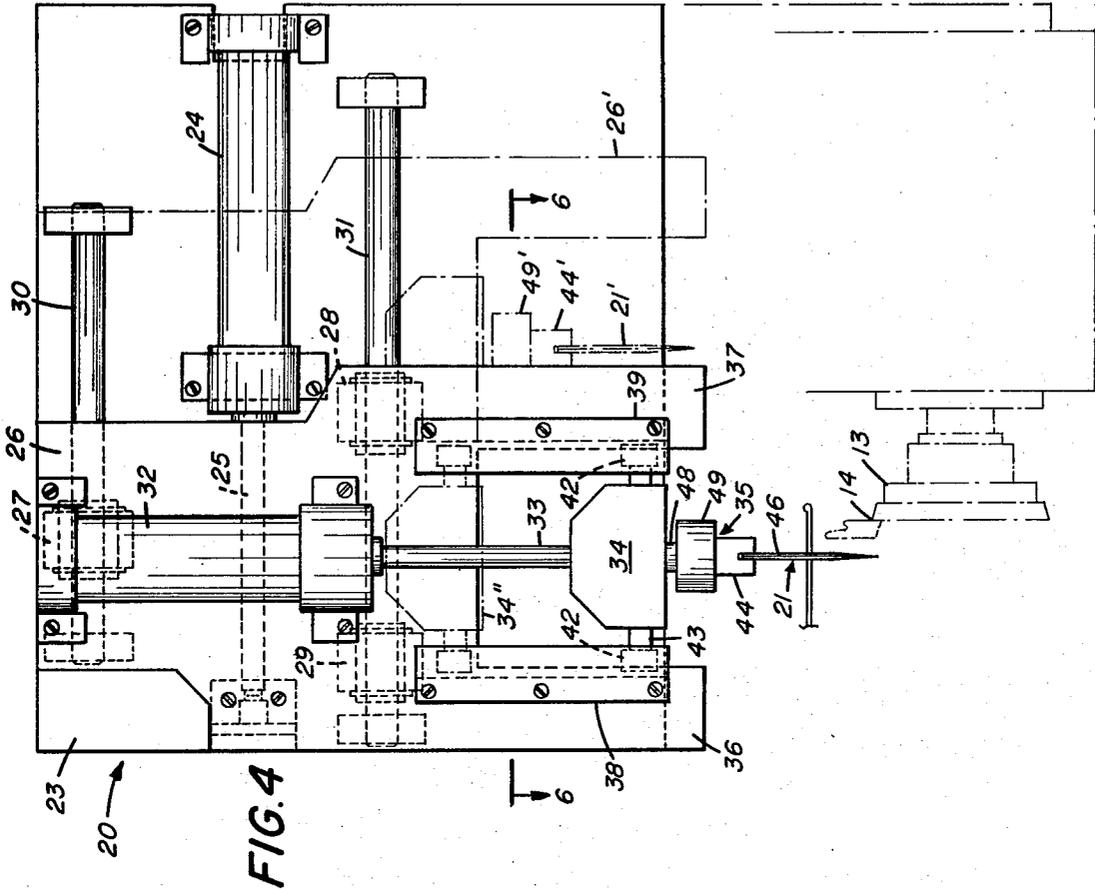


FIG. 4

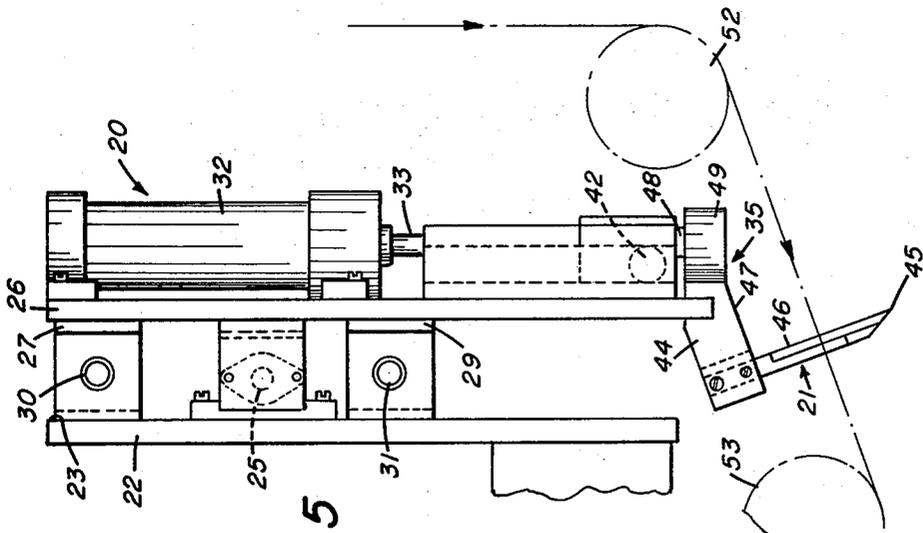


FIG. 5

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APPARATUS FOR SETTING UP A RAPIDLY MOVING WEB FOR REMOVAL OF A SIDE PORTION THEREFROM

BACKGROUND OF THE INVENTION

This invention relates to apparatus for manufacturing webs. More particularly, this invention relates to the manufacture of webs wherein there is a need to remove the side portion of the web before winding the webs into rolls.

In the manufacture of polyethylene terephthalate webs or films, for example, particularly for use as photographic film base, the plastic film is produced in a continuous operation in which it is first cast on a casting wheel and then advanced to stretching stations which stretch the film to the desired thickness. Generally, the stretching stations are comprised of a drafting station which stretches the rapidly moving film in the longitudinal direction and a tentering station which stretches the film in the transverse direction. To facilitate gripping of the side edges of the film for the tentering operation, it has been proposed to cast the film with a beaded side edge to allow positive gripping by the tenter's clips. After the web has been stretched, the beaded side edge is removed by slitting the web to the particular width that is desired. To do this, the web is threaded into rotary slitter knives which have their cutting edges spaced the desired web width. While this apparatus works quite satisfactorily, there is a problem of threading the web into the rotary slitters.

The problem arises during the start-up period in the production of a new web. During this start-up period many feet of defective material are produced before satisfactory material is formed. Since the defective material must be disposed of before the satisfactory material can be threaded into the slitter knives it has been proposed to advance the defective material between the slitter knives and then divert it to a scrap recovery unit. It should be appreciated that the web is not introduced into the slitter knives, nor is it cut by the slitter knives at this time, but is merely advancing between the knives before being diverted to the scrap recovery unit. In order for a full width web to pass between the slitter knives, which are spaced apart a distance less than the full width of the advancing web, the web is required to distort and assume a bowed configuration. When satisfactory material is being formed the web must be introduced into the slitters to be cut to the desired width. However, the problem is that the bowed web will not thread into the slitter knives. In an attempt to overcome this problem, a procedure has been utilized to set up the web for the rotary slitters. In this procedure, two operators, one on each side of the web are each required to use a knife and manually make a transverse cut through the side edges of the web so that the web lies flat for entry into the rotary slitters. While this procedure may be acceptable at relatively low web speeds, it is disadvantageous when attempted at the high web speeds that manufacturers are capable of achieving today. One important disadvantage of having operators do this manually is that a high web speeds this becomes a hazardous operation and involves a serious risk of injury to the operators. A further important disadvantage is that the web may not be readily accessible to the operators to manually perform this operation. In view of the above, it is apparent that a need has

developed for a workable alternative which overcomes the disadvantages stated above and which is capable of being utilized with the existing machinery so as to minimize changeover costs. In considering appropriate alternatives to manual cutting one must be cognizant of the difficult conditions under which such alternative is to operate. One condition as stated above is that the web is advancing at a very high speed and when interfered with there is the likelihood that it may pile-up possibly requiring the operator to close down the machine to remove the piled-up section. IN addition, a web of polyethylene terephthalate is quite tough and a problem arises in cutting this material without binding of the cutter in the web. It will be appreciated that development of an apparatus that overcomes the disadvantages of the presently known procedures represents a significant advance in the art. Therefore, it is an object of the present invention to provide a safe, reliable and relatively inexpensive apparatus for setting up a rapidly moving web for initial threading into a slitter knife.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided in an apparatus for removing a side portion from a web, the apparatus including web slitting means for slitting the web inward of a side edge thereof, the improvement which comprises web cutting means positioned upstream of the web slitting means, for forming in the advancing web, prior to the threading of the web into the slitting means, a transverse cut extending from a point inward of where the slit is to be made outward through the side edge of the web so as to cause the web to lie generally flat for threading into the slitting means.

There is further provided an apparatus for forming a cut in an article, the apparatus including a knife, means for relatively moving the knife laterally through the article, and means for pivotably mounting the knife in such manner that it is permitted to rotate through interaction with the article which it is cutting so that the cutting edge rotates at least partially toward the direction of advancement of the knife through the article.

The invention and its objects and advantages will be more fully understood from the following description when it is read with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1-3 are similar diagrammatic perspective views representing in sequence a series of steps performed on a moving web during the manufacture thereof in accordance with the teachings of this disclosure.

FIG. 4 is a front elevational view of one embodiment of an apparatus incorporating the teachings of the invention and showing in phantom various positions which the structure of the apparatus may assume.

FIG. 5 is a side elevational view of the embodiment shown in FIG. 4.

FIG. 6 is a cross-sectional view taken on the line 6-6 of FIG. 4 and including a vector diagram illustrating the relationship of the movement of the knife to that of the web.

FIG. 7 is a diagram of the controls for the embodiment shown in FIGS. 4-6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to FIGS. 1-2 there is shown a web 11 including a pair of beaded side edges 12, the web being defective at this time and therefore advanced in the longitudinal direction toward a scrap recovery unit. Before being diverted to the scrap recovery unit the web is successively passed under guide rollers 52, 53 and between a pair of rotary slitter knives 13 having their cutting edges spaced apart a distance corresponding to that of the desired web to be produced; the desired web width being indicated in FIG. 2 by the distance between the dotted lines 15, 16. Since web 11 is wider than the distance between the slitter knives 13, the web distorts so that it may pass between the knives. As satisfactory material begins to be produced, the web 11 is required to lie flat for entry into the slitter knives 13 for removal of the side portions and the beaded side edges 12. To set up the web for entry into the slitter knives 13 the apparatus forming one embodiment of the invention includes web piercing knives 21 located adjacent each of the sides of the web for forming transverse cuts 17, 18 through the side portions of the web. The lateral movement of piercing knives 21 across the web being indicated in FIG. 1 with the inward extreme position of the knives shown in phantom.

As shown in FIG. 3 after the transverse cuts 17, 18 have been formed in the web, the web continuously threads into the slitter knives and the operator has, previous to this time, performed a splicing step that causes the web to be wound onto a wind-up roll.

The preferred embodiment of the apparatus for forming the transverse cuts in the web 11 is illustrated in FIGS. 4-7. While the description is specific to the forming of the transverse cut, 17, at but one side of the web by one cutting apparatus, 20, it will be appreciated that a similar apparatus involving a similar operation is located in a corresponding position on the opposite side of the web to form transverse cut, 18.

Cutting apparatus 20 is located upstream of slitters 13 and includes a knife 21 mounted for horizontal and vertical movement so that the knife may be horizontally moved above the web to a position inward of where the slit is to be made, vertically plunged into the web, moved horizontally outward through the side edge of the web to form the transverse cut 17 and thereafter moved vertically upward to its starting position. To produce this motion the apparatus includes horizontally and vertically mounted air cylinders for propelling the knife in the manner indicated above. The air cylinders are particularly suited for use in this apparatus since they are capable of imparting high speed to the knife so that the tendency of the knife to bind in the web is reduced. Another advantage of the air cylinders is that they are capable of reaching high speeds almost instantaneously and are also amenable to push button control by an operator.

To support the air cylinders for the desired movement there is provided a stationary vertical first plate 22 with its front face 23 generally disposed in the upstream direction. Suitable means within the skill of the art may be used to secure plate 22 to a rigid column so that the plate is rigid and immovable. To face 23 there is rigidly secured a double-acting horizontally directed air cylinder 24, the piston rod 25 of cylinder 24 being free to reciprocate horizontally with respect to plate

22. Coupled to piston rod 25 is a horizontally moveable second plate 26. Plate 26 is disposed upstream of and parallel to stationary plate 22 and is further supported for movement in the horizontal direction by being rigidly connected to mounting blocks 27, 28 and 29 which are slidably moveable along guide rods that are connected to plate 22. Block 27 has a horizontally extending bore through which there is placed a horizontal guide rod 30 that is rigidly mounted to stationary plate 22 above air cylinder 24. Blocks 28 and 29 are horizontally spaced and each have a similar bore extending through them. A guide rod 31 rigidly mounted to stationary plate 22 below air cylinder 24 passes through the bores formed in blocks 28 and 29. The mounting blocks 27, 28, 29 include a suitable conventional bushing to reduce friction between the blocks and the guide rods enabling the guide blocks to be rapidly accelerated along the rods.

With regard to the horizontally moveable plate 26 there is rigidly secured to it a double-acting vertically directed air cylinder 32 with its piston rod 33 being vertically reciprocable with respect to the plate 26. Rigidly secured to the end of piston rod 33 is a knife assembly mounting block 34 which supports the knife assembly 35. To permit vertical movement of the knife assembly 35 with respect to the moveable plate 26, there is formed in plate 26 a rectangular cutout so as to produce a pair of legs 36, 37 between which the assembly 35 may be raised and lowered. To give more positive guiding to the assembly there is connected to the plate 26 along the legs 36, 37 vertical channel-like guide ways 38, 39 respectively. Ways 38, 39 have positioned therewithin slides 40, 41, respectively, which are rigidly attached to the mounting block 34. Slides 40, 41 each may be formed from a roller bearing assembly 42 which is fitted to ride in the ways and a mounting shaft 43 for connection to the mounting block 34.

Rigidly secured to the lower end of the mounting block 34 is the knife assembly 35 which comprises a knife 21 and a pivotable knife support 44 that is joined to the knife. Knife 21 includes a needle like pointed tip 45 which is used to initially pierce the web 11 and double raked cutting edge 46 for forming the transverse cut 17. Knife support 44 includes a knife holder portion 47 that includes a slot into which the knife may be placed, the slot being arranged so that the knife's cutting edge 46 will be held perpendicular to the web during the cutting operation. In addition, the knife holder 47 holds the knife in such manner that during the initial plunging movement of the knife into the web the knife's cutting edge 46 is supported so as to face in the upstream direction. In order to utilize the cutting edge for forming the transverse cut 17 and for reducing the risk of the knife binding in the web, the knife support 44 is pivotably mounted to a stud 48 depending from the mounting block 34. The particular pivotable mounting means may be comprised of ball bearings wherein the inner race is defined by the stud 48 and the outer race defined by a generally annular member 49 forming a part of the knife support 44. A torsion spring 50 connected between the mounting block 34 and the knife holder 47 may be used to bias the knife's cutting edge 46 to face in the upstream direction but allows the knife support 44 and knife edge 46 to pivot up to 45 degrees so that the knife edge may face at least partially

toward the web's beaded side edge 12 during the forming of the transverse cut 17. In place of or in addition to the torsion spring 50 the knife support 44 may be weighted or positioned such that gravity biases the knife to face in the upstream direction. A stop block 51 is mounted to the knife assembly mounting block 34 to cooperate with the spring biased knife support 44 to align the knife in the upstream direction.

With regard to FIG. 7, the controls for the apparatus 20 include a toggle switch 55 having "Out" and "In" terminals, the "Out" designation being used to define the lateral extreme position of the knife when it is outward of the web and the "In" designation being used to define the lateral extreme position of the knife when it is over the web and inward of the beaded side edge thereof. The "In" terminal is electrically coupled to a solenoid 57 which is in turn mechanically coupled to a valve 59. Valve 59 is connected to a main air supply 59' and is adapted to distribute air from this supply to either of two chambers in double-acting horizontal cylinder 24 while venting the other chamber, the particular chamber being fed at any one time being dependent upon the position of switch 55.

A similar system is employed to actuate double-acting vertical air cylinder 32. This latter system includes a toggle switch 56 that has terminals designated "Up" and "Down" to represent the vertical extreme limits of the knife. A solenoid 58 is electrically coupled to the "Down" terminal and a valve 60 in turn mechanically coupled to the solenoid. The valve 60 is connected to the main air supply and is adapted to supply air to either of two chambers in cylinder 32.

In the operation of the preferred embodiment the web 11 is rapidly advanced around guide rollers 52, 53 and between rotary slitters 13 to a scrap recovery unit, located downstream thereof. As defective material is being led to the scrap recovery unit the toggle switches 55, 56 are in the "Out-Up" position causing the piercing knife 21 to be located outside of and vertically above the web as indicated in phantom lines in FIG. 4 at 21'. When it is desired to thread the web between the slitter knives 13 the operator flips switch 55 to the "In" position. This action allows current to energize solenoid 57 which in turn causes valve 59 to direct compressed air into the chamber of air cylinder 24 that forces piston rod 25 to be rapidly moved to its extended position. As piston rod 25 moves to the left (as shown in FIG. 4) it carries with it moveable plate 26 and its associated members. The horizontal movement of moveable plate 26 and its associated members is indicated in FIG. 4 by showing the initial position in phantom with the corresponding structure being designated by the placement of a prime (') after its respective assigned number. As plate 26 is moved to the left the knife assembly mounting block 34 is in its "Up" position so that the knife 21 is above the web as it is moved horizontally across the web. The plate 26 is moved until the piston rod 25 reaches the end of its stroke and in this position the knife will be located above the web at a point inward of where the web is to be slit by the rotary slitters. This position is indicated in FIG. 4 with the mounting block 34 shown in phantom in its raised position, a double prime (") being used to identify corresponding structures in the "In-Up" position.

After the moveable plate 26 reaches its leftward extreme position the operator closes switch 56 to the "Down" position thereby energizing solenoid 58 which actuates valve 60 into diverting compressed air into the chamber of air cylinder 32 that forces the piston rod 33 to be moved to its extended position. As the piston rod 33 is rapidly moved downward it plunges knife 21 into the web at a point inward of where the slit is to be made. After knife 21 reaches its lowermost extreme position, the operator flips switch 55 to the "Out" position and thereby deenergizes solenoid 57 which causes the valve 59 to divert compressed air into the other chamber of cylinder 24 to retract piston rod 25. Thus, moveable plate 26 will now be rapidly moved horizontally back towards the right (as shown in FIG. 4). As plate 26 is moved to the right, knife 21 is being rapidly moved transversely through the web. The interaction between knife 21 and web 11 tends to force knife support 44 to pivot about stud 48 causing knife edge 46 to rotate up to 45° towards beaded side edge 12. This enables knife edge 46 to do the transverse cutting and reduces the risk of the knife binding in the web.

With reference to FIG. 6 it can be appreciated that because the web is rapidly advancing in the longitudinal direction at a velocity \bar{V}_{web} while the knife is rapidly advancing across the web in a direction perpendicular to the direction of advancement of the web at a velocity \bar{V}_{knife} the transverse cut 17 will generally be in the direction of the resultant vector $\bar{V}_{resultant} = \bar{V}_{knife} - \bar{V}_{web}$. By allowing the knife 21 to rotate through interaction with the web, the knife may be allowed to adjust itself so that its cutting edge faces in the direction $\bar{V}_{resultant}$ during its outward movement through the web. This, it will be appreciated, permits for a more efficient cutting operation.

In practice, since the preferred embodiment limits rotation of the blade to an angle α of up to 45° it will be necessary for best operation to have the speed of the knife be equal to or less than the speed of the web. Should the knife be moved at a speed, faster than the web the knife will not rotate more than 45° and will not face in the direction of $\bar{V}_{resultant}$ and is likely to be pulled sideways through the web which could produce tearing of the product or breakage of the knife. While rotation of less than 45° has been found to give satisfactory results there might be instances where it is desired to have the knife speed be greater than that of the web. In such cases the torsion spring of the preferred embodiment may be replaced by one that will permit the particular rotation that is desired. In addition, any obstructing structures should be eliminated to permit the desired rotation.

When the rightward extreme position is reached, the knife has cut through the side edge and formed the transverse cut 17 and the operator now opens switch 56 to the "Up" position to deenergize solenoid 58 so that compressed air is diverted by valve 60 into the other chamber of vertical air cylinder 32 so that the knife is forced to rise to its initial position. Assuming that a similar operation has taken place at the other side of the web, it can be appreciated that the web is now set up for introduction into rotary slitters 13.

While the invention has been described in detail with particular reference to preferred embodiments thereof, it will be understood that variations and modifications

can be effected within the spirit and scope of the invention.

I claim:

1. In an apparatus for removing a side portion from a web, said apparatus including driving means for advancing said web in the longitudinal direction thereof and slitting means for slitting said advancing web inward of a side edge thereof in a direction parallel to said longitudinal direction, the improvement which comprises: web cutting means positioned upstream of said slitting means for forming in said advancing web, prior to the threading of said web into said slitting means, a transverse cut extending from a point inward of where said slit is to be made outward through said side edge of said web so as to cause said web to lie generally flat for threading into said slitting means, said web cutting means including a cutting member and means connected to said cutting member for plunging said cutting member into said web at said point inward of where said slit is to be made and means for advancing said cutting member outwardly through said side edge to form said transverse cut.

2. The invention according to claim 1 further including means for connecting said cutting member to said plunging means and for holding said cutting member in such manner that a cutting edge thereof faces in the upstream direction during plunging movement into said web.

3. The invention according to claim 1, said cutting member including a cutting edge, and the invention further including means for pivotably connecting said cutting member to said plunging means and for holding said cutting member in such manner that during plunging movement of said cutting member into said web said cutting edge faces in the upstream direction and during advancing movement of said cutting member outward through said side edge of said web said cutting member rotates by interaction with said web so that said cutting edge faces at least partially toward said side edge to allow said cutting edge to cut through said web in the forming of said transverse cut.

4. The invention according to claim 3 wherein said web driving means advances said web at a velocity \bar{V}_{web} and said cutting member advancing means advances said cutting member at a velocity \bar{V}_{member} and the direction to which said cutting edge is adapted to rotate is in the direction of $\bar{V}_{resultant}$, wherein $\bar{V}_{resultant} = \bar{V}_{member} - \bar{V}_{web}$.

5. In an apparatus for removing a side portion from a web, said apparatus including driving means for advancing said web in the longitudinal direction thereof and slitting means for slitting said advancing web inward of a side edge thereof in a direction parallel to said longitudinal direction, the improvement which comprises: web cutting means positioned upstream of said slitting means for forming in said advancing web, prior to the threading of said web into said slitting means, a transverse cut extending from a point inward of where said slit is to be made outward through said side edge of said web so as to cause said web to lie generally flat for threading into said slitting means, said web cutting means including a knife, means connected to said knife for plunging said knife into said web at said point inward of where said slit is to be made and means connected to said knife for advancing said knife

outwardly through said side edge to form said transverse cut.

6. The invention according to claim 5, said plunging means including an air cylinder having a generally vertically reciprocable piston rod connected to said knife for plunging said knife into said web.

7. The invention according to claim 6, said means for advancing said knife outwardly through said side edge including a generally horizontally reciprocable piston rod mounted upon a stationary support and connected to said vertically reciprocable piston rod for moving said vertically reciprocable piston rod in the horizontal direction.

8. The invention according to claim 6, further including means for pivotably connecting said knife to said plunging means and for holding said knife in such manner that during plunging movement of said knife into said web a cutting edge thereof faces in the upstream direction and during advancing movement of said knife outward through said side edge of said web said knife rotates by interaction with said web so that said cutting edge faces at least partially toward said side edge to allow said cutting edge to cut through said web in the forming of said transverse cut.

9. The invention according to claim 8 wherein said web driving means advances said web at a velocity \bar{V}_{web} and said knife advancing means advances said knife at a velocity \bar{V}_{knife} and the direction to which said cutting edge is adapted to rotate is in the direction of $\bar{V}_{resultant}$, wherein $\bar{V}_{resultant} = \bar{V}_{knife} - \bar{V}_{web}$.

10. In an apparatus for removing the side portions from a web, said apparatus including driving means for continuously advancing said web in the longitudinal direction thereof and slitting means for slitting said advancing web inward of the side edges thereof in a direction parallel to said longitudinal direction, said slitting means including first and second web slitting members spaced from each other a distance less than the width of said advancing web to be slit and said slitting members having their cutting edges in position for removing respective opposite side portions of said web, the improvement which comprises:

web cutting means positioned upstream of said slitting means for forming in said advancing web, prior to the threading of said web into said slitting means, transverse cuts extending from points inward of where said slits are to be made outward through said side edges of said web so as to cause said web to lie generally flat for threading into said slitting means, each of said web cutting means including a knife, means connected to said knife for plunging said knife into said web at each of said points inward of where said slit is to be made and means for advancing said knife outwardly through each of said side edges to form each of said transverse cuts.

11. An apparatus for forming a cut in a web like article, said apparatus comprising:
a knife having a pointed tip and a cutting edge;
means for advancing said article in a first direction at a velocity $\bar{V}_{article}$,
means connected to said knife for relatively plunging said knife into said article and for relatively advancing said knife laterally through said article in a second direction at a velocity \bar{V}_{knife} , and;

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knife holder means for pivotably connecting said knife to said plunging means and for holding said knife in such manner that during plunging movement of said knife into said article said cutting edge faces in said first direction and during advancing movement of said knife laterally through

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said article said cutting edge is free to rotate, through interaction with said article so that the cutting edge faces in the direction \bar{V} resultant, wherein \bar{V} resultant = \bar{V} knife - \bar{V} article.

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