Jan. 19, 1971 A. A. ENNEPER ET AL 3,557,156

SECTIONAL DRIVE APPARATUS FOR CONTINUOUSLY FEEDING AN ELASTIC MATERIAL

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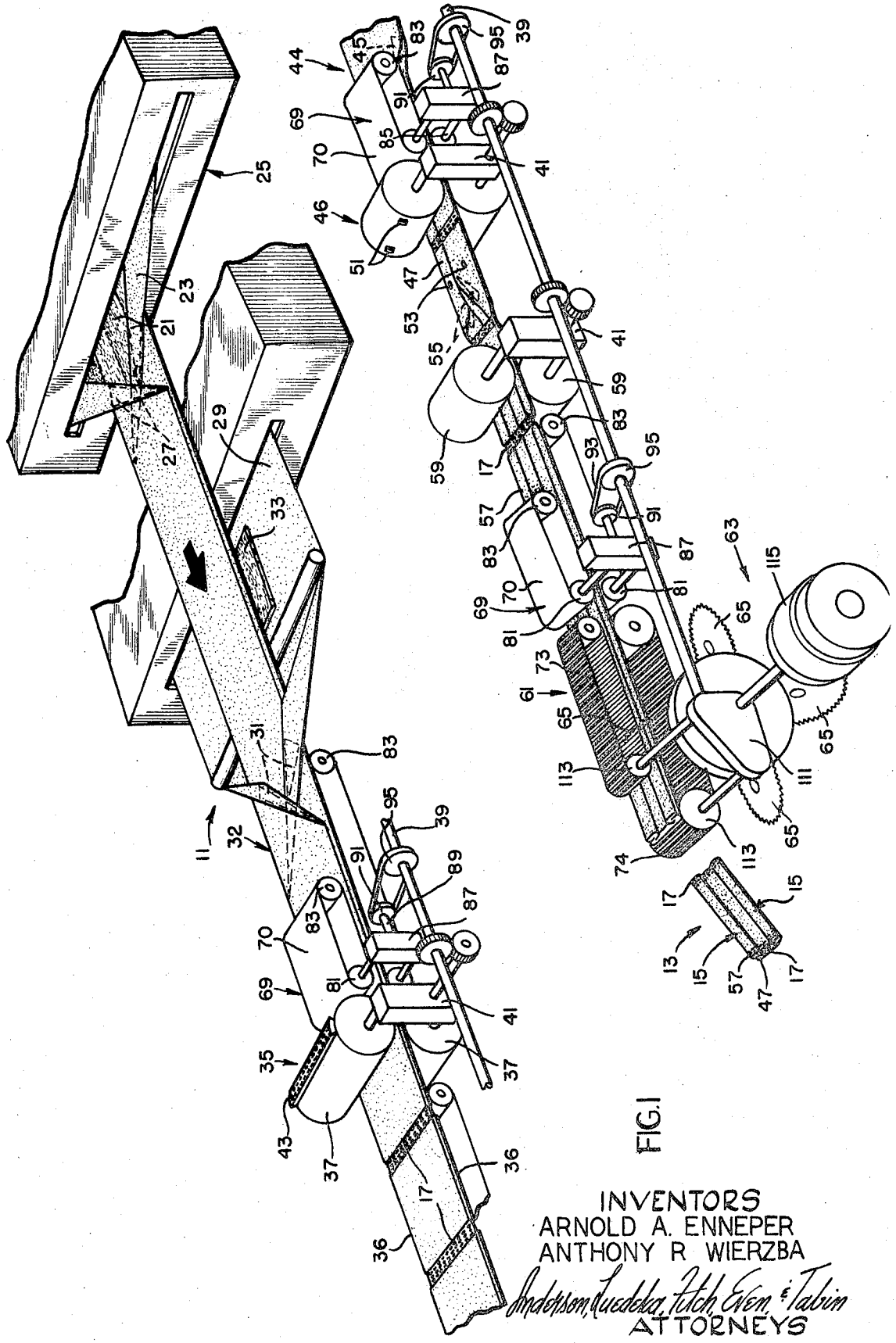


FIG. 1

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FIG. 2

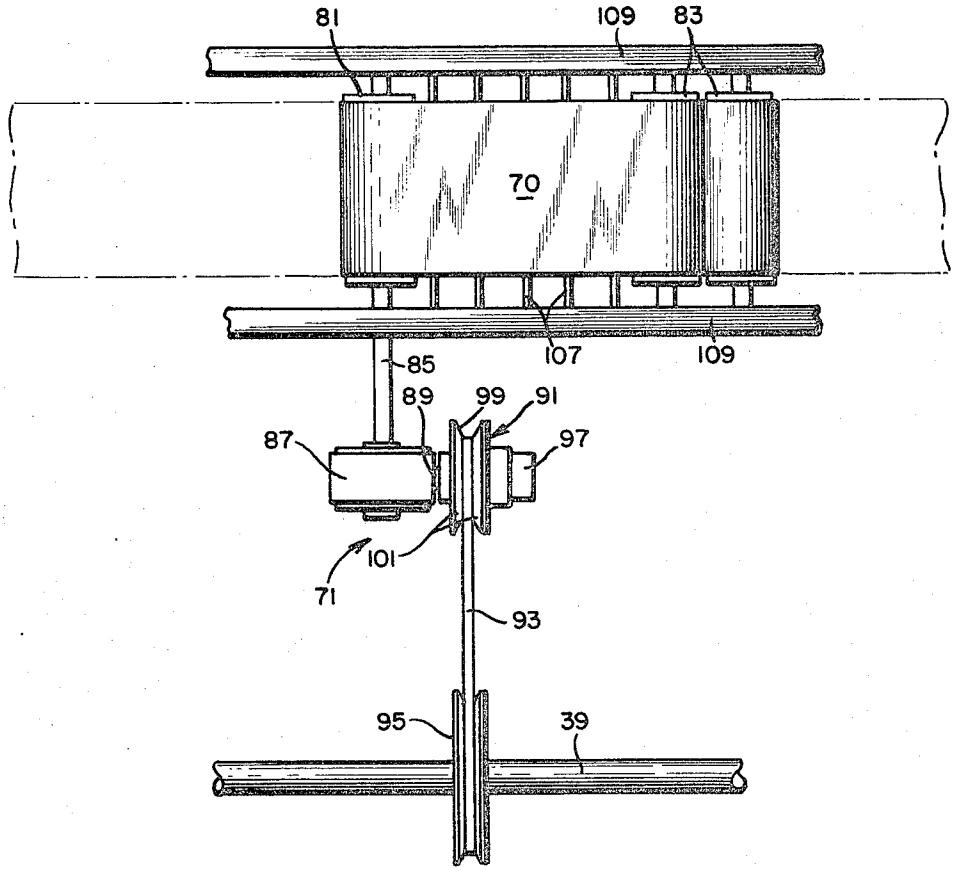
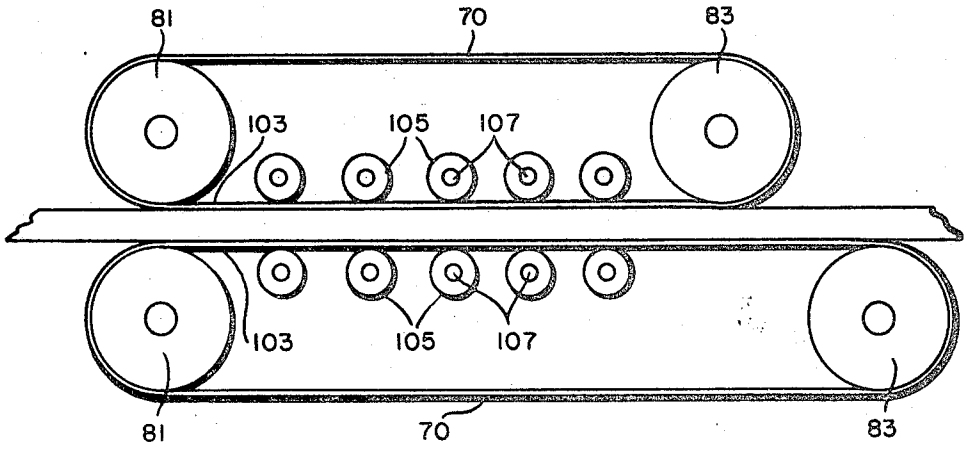


FIG. 3



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SECTIONAL DRIVE APPARATUS FOR CONTINUOUSLY FEEDING AN ELASTIC MATERIAL

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ABSTRACT OF THE DISCLOSURE

A plurality of sectional drives feed a web of elastic material along a predetermined path of travel during which successive operations are performed upon the web. The sectional drives operate to move the web through the various operating stations at respective linear speeds, the respective speeds being adjustable relative to one another, thereby controlling the tension in the web at various stations so that a given length of web has a predetermined mass at various stations to provide an accurate registration of various operations on the web.

This invention relates to an apparatus for feeding a web of stretchable material and performing successive operations thereupon.

The present invention is described in connection with an elongated, continuously traveling web of creped tissue on which is carried an absorbent pad of fibrous material. The pad and web are formed into a pleated disposable diaper by a number of operations performed in registry. During formation of the diaper, the pad and web stretch to various degrees and, unless this stretch is compensated for, the various operations performed on the pad will be out of registry. In the illustrated form of diaper, which is substantially similar to the diaper shown in the copending application of James A. Murphy, S.N. 494,573, filed Oct. 11, 1965, and entitled, "Disposable Diaper," now U.S. Pat. 3,430,629, the creped tissue web is folded about the pad by folding shoes, and then the covered pad is pulled through additional shoes which fold and pleat the pad. Pulling the pad through folding shoes generates considerable friction and resistance to movement and results in stretching of the web and pad at each of the shoes. Stretching is less severe at other stations, for instance, at embossing stations where embossing rolls have a rolling contact with the pad and have a tangential speed which is approximately the same as the pad travel speed. Thus, the pad may stretch or contract during its different portions of its travel, making registry of operations difficult.

For example, the last operation performed is that of severing the pad into individual diapers, and this cut must be accurately located with an end seal for the diaper lest a diaper have only a small width of seal or no seal at all. Moreover, due to changes in raw materials, ambient conditions or the like, it has been observed that the amount of pad stretching or tension in the pad changes from time to time, and a fine compensation is needed to compensate for these changes in order that the desired degree of accuracy be assured.

Accordingly, a general object of the invention is a synchronized drive for feeding and operating on an elastic material.

A more specific object of the invention is a synchronized drive for feeding, folding, embossing and severing a pad of elastic material to form disposable diapers.

Other objects and advantages of the invention will become apparent from the detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic view of an apparatus for making a disposable diaper and for carrying out the present invention;

FIG. 2 is a plan view of a speed control device and a sectional drive used in the apparatus of FIG. 1; and

FIG. 3 is an enlarged longitudinal view of a sectional drive shown in FIG. 2.

As shown in the drawings for purposes of illustration, the invention is embodied very generally in an apparatus **11** for producing individual diapers **13** (FIG. 1) which have longitudinally extending pleats **15** disposed along the longitudinal side edges of the diaper and extending between the ends of the diaper at which are formed transversely extending end seals **17**. As will be explained, the preferred diaper has an outer envelope formed of several plies of creped tissue wrapped about an internal absorbent pad **21** of absorbent wood pulp, the latter serving to absorb the fluids discharged by the diaper wearer.

To facilitate understanding, a general description of the method of forming the diaper **13** will now be described. Intially, a first or carrier web **23** of creped tissue travels through a station **25** (FIG. 1) at which wood pulp is deposited by an air laying apparatus to form the longitudinally extending absorbent pad **21** in the center of the web **23**. The wood pulp pad is approximately ⅓ the width of the carrier web **23**, and as this web leaves the air laying station **25**, a pair of conventional forming shoes **27** fold one side of the web **23** inwardly to form a flap over the pad and then fold the other side of the web to overlie the first flap. The shoes thus fold the web **23** to enclose the pad in an envelope of creped tissue. The enclosed pad moves forwardly to receive another envelope as a second web **29** of creped tissue is folded about the pad by shoes **31** at a web folding station **32**.

In the illustrated embodiment of the invention, a reinforcing strip **33** formed of several plies of creped tissue is placed on the web **29** prior to its being folded about the pad. The reinforcing strip is disposed at the location of the subsequently formed end seals **17** for the diaper so that it may encircle the wearer's waist and receive fasteners such as safety pins.

The diaper pad continues to move forwardly, that is, to the left as viewed in FIG. 1, to a station **35** at which the transverse end seals **17** are formed at longitudinally spaced distances, e.g., every 16½ inches. In this instance, the end seals **17** are in the form of embosses which extend transversely across the diaper pad between its longitudinally extending edges **36**. To form the end seals, a pair of embossing rolls **37** are rotated in timed sequence by a line shaft **39** through a gear box **41** to bring an embossing bar **43** into position to emboss the pad generally centrally of each reinforcing strip **33**. The embossing bars **43** exert sufficient pressure to glassine the web and pad fibers together.

From the embossing rolls, the covered pad moves forwardly to a first fold station **44** at which a set of shoes **45** make first pleat folds **47** by folding the longitudinally extending edges **36** in the diaper pad inwardly and one over the other. At the next operating station, namely, a tacking station **46**, these first pleat folds **47** are tacked at small spots to the underlying pad at locations generally midway between the end seals **17**. Thus. the folds **47** at the center of the diaper are held in the folded condition when the ends of the folds open as the diaper is spread laterally to encircle the wearer's waist. To tack the lower pleat folds **47** to the unfolded portion of the pad therebeneath, it is preferred to employ embossing rolls **49** which carry peg embossing bars **51** to form spot or peg embosses **53** at which the fibers in the pleats are glassined to the fibers in the underlying pad. The peg embossing rolls **49** are also driven from the line shaft **39**

through a right angle gear box **41** to rotate in timed relationship to the end emboss rolls **37**.

After the pleat folds **47** are tacked, the diaper pad moves downstream to another set of shoes **55** which fold the pad edges **36** outwardly over the inner fold **47** and thereby provide a second or upper fold **57** along each side edge of the diaper pad. The pleated pad then passes through a set of calendering rolls **59** which flatten the pleats to retain their shape. From the calendering rolls, the now pleated pad travels forwardly to a severing station **61** which, in this instance, includes an orbital saw device **63** which has saw blades **65** for severing the pad through the center of each end seal **17** to form the individual diapers. Since the reinforcing strips **33** are generally centered on the end seals, they are severed in half and provide reinforcement at both diaper ends.

Apparatus for making a disposable diaper in a process becomes quite long, e.g., 50 ft., and travel speeds are quite fast, for example, 300 f.p.m. During travel at these speeds, the spacing between end seals **17** may vary due to pad elongation or contraction, but the severing cut should be accurately located within about ¼ inch distance of the center of each end seal. However, unless some control is provided, the position of the center of the end seal may shift much more than that in the longitudinal direction due to changes in amount of tension in the diaper. It will be appreciated that there is considerable friction generated at each of the shoes **27**, **31**, **45** and **55** and that this friction causes the pad to stretch and elongate during each of the folding processes. After stretching at a folding station, the pad may contract to recovery slightly prior to the next operation, depending upon how the pad is transported. This localized stretching and/or contracting changes the pad length for a given mass unit, i.e., the number of grams of material per diaper, and interferes with a number of dimensional relationships desired to be maintained, for example, centering of the embossed end seal **17** on the reinforcing strip **33**, making the tacking embosses **53** midway between the end seals, and severing the diaper through the center of the end seals **17**.

In accordance with the present invention, the pad of elastic material is fed by sectional drives which not only move the pad through the respective sections of the machine at a predetermined linear speed but also control the tension in the pad in the respective sections. Thus, the pad is tensioned to provide a given length for a predetermined number of grams of pad at those stations at which operations must be accurately located relative to a previous or subsequent operation.

To achieve this controlled tension and length per mass unit, individual sectional drives **69** are associated with various operating stations to grip the diaper pad and to tension it while conveying it forwardly through the apparatus. The tension in the pad is changed by adjusting the speed of one sectional drive relative to an adjacent sectional drive. Herein, the drives **69** are in the form of opposed feed belts **70** (FIGS. 2 and 3) driven through variable speed devices **71** from the line shaft **39**. These variable speed devices permit the speed of one sectional drive to be adjusted relative to adjacent upstream or downstream sectional drive. For example, tension can be increased and the pad stretched between two drives by increasing the speed of a downstream sectional drive relative to speed of an adjacent upstream sectional drive. On the other hand, the pad tension and length can be reduced by adjusting a downstream sectional drive to run slightly slower.

Referring now to a detailed description of the illustrated apparatus, each of the sectional drives **69** operates in timed relationship to operation of the saws **65** at the severing station **61**. At the severing station, the pad is gripped in the nip of a pair of upper and lower slatted feed belts **73** and **74** which are driven at a constant predetermined linear velocity, e.g., 300 f.p.m., which is, in

this instance, the nominal speed for the pad travel. Each of the saw blades **65** is driven through an orbital path and becomes effective along a portion of this path to move into a space between belt slats to engage and to sever the pad as the blade travels forwardly with the pad. That is, each blade **65** progressively moves across the pad to sever it while also traveling forwardly. A detailed description of the preferred orbital saw mechanism is in copending application of Arnold A. Enneper, Harvey J. Spencer and Anthony R. Weirzba, Ser. No. 648,007, entitled, "Cutting Apparatus," filed June 22, 1967.

The pad held in the nip of the slatted feed belts **73** and **74** at the severing station **61** extends rearwardly and into the nip of feed belts **70** of a first one of the sectional drives **69**. With the pad gripped in the nips of these sets of feed belts, the linear speed of the feed belts **70** is adjusted slightly from the nominal linear speed for the pad at the slatted belts and thereby exerts either a slight retarding or additional propelling force on the pad relative to the propelling force of the slatted belts.

The illustrated feed belts **70** are trained about and driven by drive rolls **81** at their forward ends and are trained about suitable idler rolls **83** at their rearward ends. Driving shafts **85** for the driving rolls **81** extend to a common gear box **87** which is driven by an input shaft **89** from a variable pitch sheave **91** which is driven by a V-section belt **93** trained about a driving sheave **95** fixed to the line shaft **39**. By turning a control nut **97** (FIG. 2) on a supporting shaft for the variable pitch sheave, at least one of its separable flanges **99** is moved axially of the shaft to cause its tapered belt engaging walls **101** to shift the belt radially and thereby change the diameter of its pitch circle, all in a conventional manner. In this manner, the speed of the driving shaft **85** and drive rolls **81** are varied which, in turn, varies the linear speed of the belts **70** engaging the pad. The pad is gripped in the nip of the belts with sufficient pressure to prevent relative sliding between the pad and belt. Therefore, the portions of the pad within the nip of the belts travel at the linear speed of the belts.

For the purpose of providing a low pressure nip and easy entry for the diaper pad between the pull belts **70**, it is preferred that the facing runs **103** of the belts (FIG. 3) be spaced apart by a distance greater than the pad thickness at the upstream mouth for the belts and then converge slightly in the downstream direction to grip the pad. To provide a low pressure grip, these runs are backed by a series of rollers **105** rotatably mounted on shafts **107** journaled in longitudinally extending side frames **109** (shown in FIG. 2, but omitted from FIG. 1). The pressure rollers are disposed opposite one another whereas the driving rolls **81** for the belts are sligthly offset from each other at the discharge end of each sectional drive. Preferably, the lower belt of each sectional drive extends upstream as far as possible so that the pad is supported substantially throughout its length of travel. To this end, each of the lower pull belts **70** extends to and runs beneath the forming shoes at a preceeding one of the folding stations to assist in overcoming the frictional drag resulting from a folding operation.

The slatted belts **73** and **74** also constitute a sectional drive, the speed of which is controlled by a common gear drive **111** (FIG. 1) connected between its driving rolls **113** and the line shaft **39**. A suitable source of driving power, such as a motor **115**, supplies sufficient torque to drive the saw and the line shaft **39** in concert. The drive shaft **39** and the geared connections between the drive shaft and the respective rotating embossing rolls at the various stations result in high speed, finely timed operations, which if the pad were substantially rigid, would maintain the desired registry between various operations on the pad.

It will be appreciated that the change of the tension at one station results in a changing in tension of those

stations immediately upstream of it. More specifically, the changing of the belt speed for one sectionalized drive **69**, such as that at the severing station **61**, also effects the tension of the portion of the pad immediately upstream of it since its speed is now changed relative to the upstream feeding speed. For example, an increase in pad tension caused by slowing down the linear speed of the belts **70** at the severeing station **61** will cause a slight pad accumulation at the entrance to its nip due to the pad issuing at a rate from the adjacent upstream sectional drive that is greater than the rate it is being accepted. If this results in loss of registry, the operator will also make a similar suitable adjustment for the speed of the belts **70** at the first folding station **44** by adjusting the variable sheave **91** at the station **44** while observing the position of the peg embosses **53** until they are again substantially intermediate the end seals **17**. Since the pad is now traveling from the sectional drive at the end embossing station **35** at a speed faster than it is being accepted by the sectional drive at the first fold station **44**, the speed of the sectional drive at the cross embossing station **35** is reduced accordingly by adjusting the pitch diameter of its sheave **91**.

As an aid to understanding the invention, a brief description of the operation of the apparatus will be made. The pad is gripped and pulled through the various operating stations by a series of spaced sectional drives **69**, each having a nip at which the pad is gripped and pulled forwardly. Each of the sectional drives operates from and at a nominal speed as determined by the common drive shaft **39** for the operating mechanisms, such as the end and tack embossing rolls and the orbital saw mechanism. Because the pad is long and formed of an elastic material, the pad will elongate during the folding operations, which exert considerable frictional drag at localized areas along the length of the pad. The amount of elongation varies from time to time with changes in ambient conditions and with changes of the material forming the diaper. When such changes occur, the final cut and the various embosses which are being performed at relatively high speeds may get out of registry.

To bring such operations back into alignment and particularly to make sure that the severing cut by the saw blades **65** is centered in the embossed end seal **17**, the speed of the sectional drive **69** immediately prior to the severing station is adjusted to increase or decrease the amount of tension in the pad by changing its feeding speed relative to the feeding speed of the slatted belts **73** and **74**. As the pad is gripped in the nips of these respective drives, the pad between the drives receives either an increase in tension or a decrease in tension. A change in tension also causes a change in length of a pad for a given mass as it moves through the severing station for the given operating speed, which is nominally 300 f.p.m.

As a consequence of the changing of the feeding speed for these sectional drives at the severing station, there is also a change in tension between them and the upstream sectional drive or drives. Thus, it is usual practice to adjust the speed of the other upstream sectional drives to maintain the relationships between the drives.

From the foregoing, it will be seen that the present invention is particularly useful for feeding elongated webs of elastic material and provides a manner in which the tension can be controlled so that a given length for a mass unit may be maintained in each operating station having to perform an operation which must register with a previous or subsequent operation on the elastic material. The apparatus is relatively simple and easy to control and, once it is adjusted, operates successfully for a considerable period of time. The speed control devices permit operation while the machine is in operation at high speeds and allow the operator to exert a very fine adjustment of the web tension.

While a preferred embodiment has been shown and described, it will be understood that there is no intent to limit the invention by such disclosure but, rather, it is intended to cover all modifications and alternate constructions falling with the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In an apparatus for making disposable diapers by performing a series of operations in registry on an elongated continuously moving pad of stretchable material, the combination comprising means at a first station to form end seals at predetermined longitudinally spaced intervals along said pad and extending traversely thereacross, means at a subsequent station to sever said elongated pad while the latter is continuously moving to form individual diapers, means to drive said end seal forming means and said severing means in timed relationship to each other, and a separate feed means for continuously moving and feeding said pad through each of said end seal forming means and said severing means and for separately controlling the tension in said pad at at least one of said end seal forming means and said severing means so that substantially the same length for a unit mass of said pad travels through the end seal forming means and said severing means during each operation thereof, whereby said severing is performed in registry with said end seals and substantially centrally thereof.

2. An apparatus in accordance with claim **1** in which said feed means includes a first pair of opposed moving surfaces defining a first nip for gripping said pad at said subsequent station and for pulling said pad forwardly and further includes a second pair of opposed moving surfaces defining a second nip for gripping said pad at a location upstream of said first nip, and in which said feed means includes an adjustable speed control means for at least one of said pair of moving surfaces to vary their linear speed relative to the linear speed of the other pair whereby a speed differential between said nips changes the tension in said pad and causes an adjustment in the location of the severing cut.

3. The apparatus of claim **2** in which endless feed belts are disposed above and below the pad and have the opposing surfaces for driving said pad and tensioning the pad.

4. The apparatus of claim **2** in which said feed means includes a line shaft extending between said end seal forming means and said severing means for operating them in concert, and in which said speed control means is disposed between said line shaft and one of said pairs of moving surfaces to permit adjustment of its linear speed.

5. An apparatus in accordance with claim **4** in which said speed control means is in the form of a variable pitch sheave, the pitch of which can be adjusted while the apparatus is running to vary the speed of one driving nip relative to the speed of the other driving nip.

6. In an apparatus for making a disposable diaper by continuously feeding a web of creped tissue along a predetermined path through a series of operating stations, said apparatus comprising apparatus at an air laying station for depositing a layer of fibrous material in the form of an absorbent pad on said web, means for folding the longitudinal side edges of said web at a web folding station to overlie said pad and thereby provide an envelope therefor, a first sectional drive for pulling said web and said pad continuously through said web folding station, means at an embossing station for embossing transversely extending end seals at longitudinally spaced intervals on said enveloped pad, means at an inner fold station to fold the side edges of the pad inwardly toward one another, a second sectional drive for exerting a pulling force on said folded pad to feed the same forwardly in a continuous manner, means at a tacking station for tacking said inner fold to said underlying portion of said pad substantially midway between the respective end seals, means at an outer fold station for folding said longitudinal edges back on themselves to form an outer fold for said diaper, a third sectional drive for pulling the now pleated pad forwardly to feed the same in a continuous manner, means

at a severing station for severing the pleated pad into individual diapers, and a fourth sectional drive at said severing station for feeding said pad forwardly in a continuous manner, driving means operating said embossing, tacking and severing means in concert, and adjustable speed control devices for respective ones of said sectional drives whereby their speed may be adjusted relative to the speed of adjacent sectional drives so that the tension in the pad can be adjusted between drives to maintain a predetermined length of pad per mass unit through the respective operating stations at which operations are preformed in registry upon said continuously moving pad.

7. The apparatus of claim 6 in which the sectional drives are each in the form of a pair of endless belts disposed on opposite sides of said diaper pad with the diaper pad being gripped by a nip between the belts.

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