United States Patent [19]

Smolderen

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[54] **AUTOMATIC WINDING AND CUTTING APPARATUS FOR WEBS**

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[52] **U.S. Cl.**..... **242/56 A**

[51] **Int. Cl.**..... **B65b 19/20**

[58] **Field of Search**..... 242/56 A, 56 R, 67.1 R

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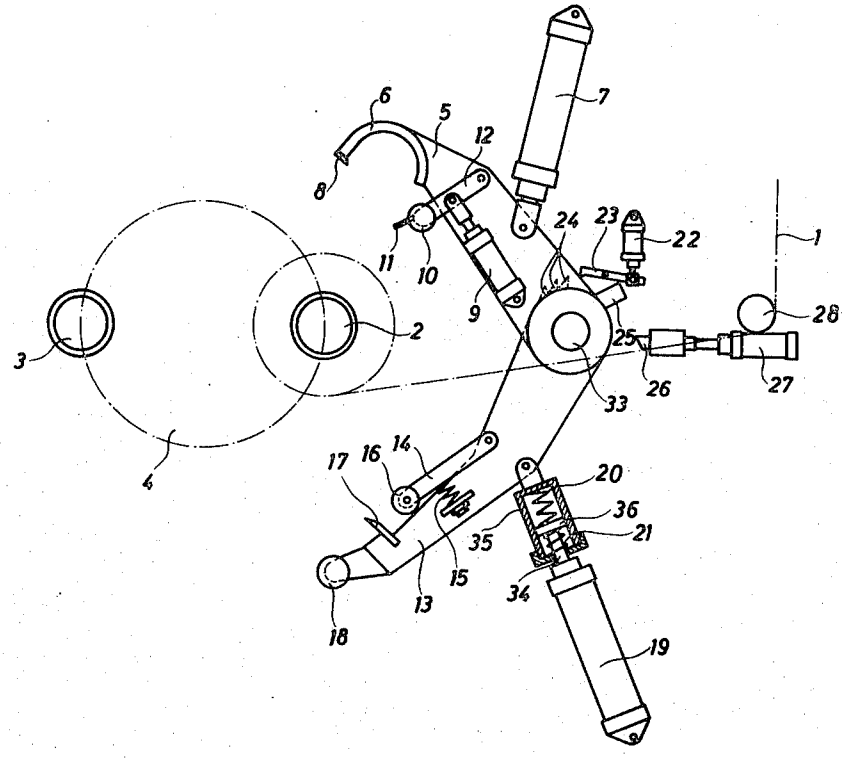
Attorney, Agent, or Firm—William J. Daniel

[57] **ABSTRACT**

A web winding and cutting apparatus capable of automatically cutting and coiling relatively short lengths of a material in web form onto a core. Excessive damage of the material at the leading edge of the freshly cut web is avoided because the cutting cycle is very short and because a mechanism provides for immediately tightening the web onto the core, so that slipping of the web cannot occur. Cutting is carried out by a mechanism through sudden release of stored energy and optimum tightening of the web onto the core is obtained by controlling the coefficients of friction between the web and the core at one side and between the web and a pressure roller at the other side.

12 Claims, 5 Drawing Figures



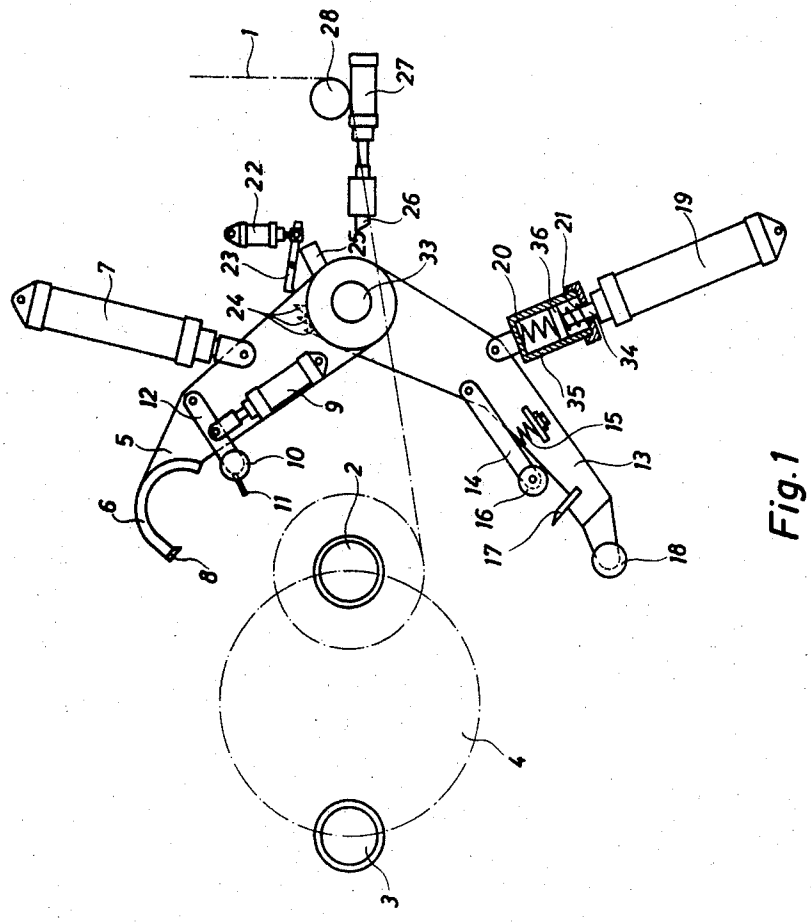

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Fig. 1

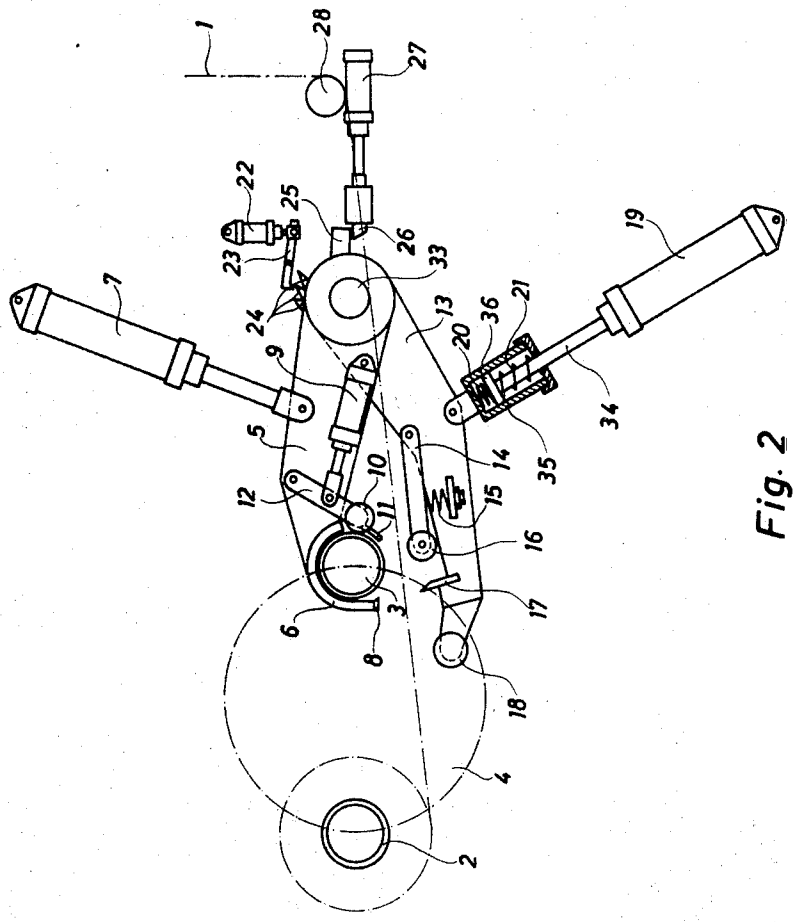
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Fig. 2

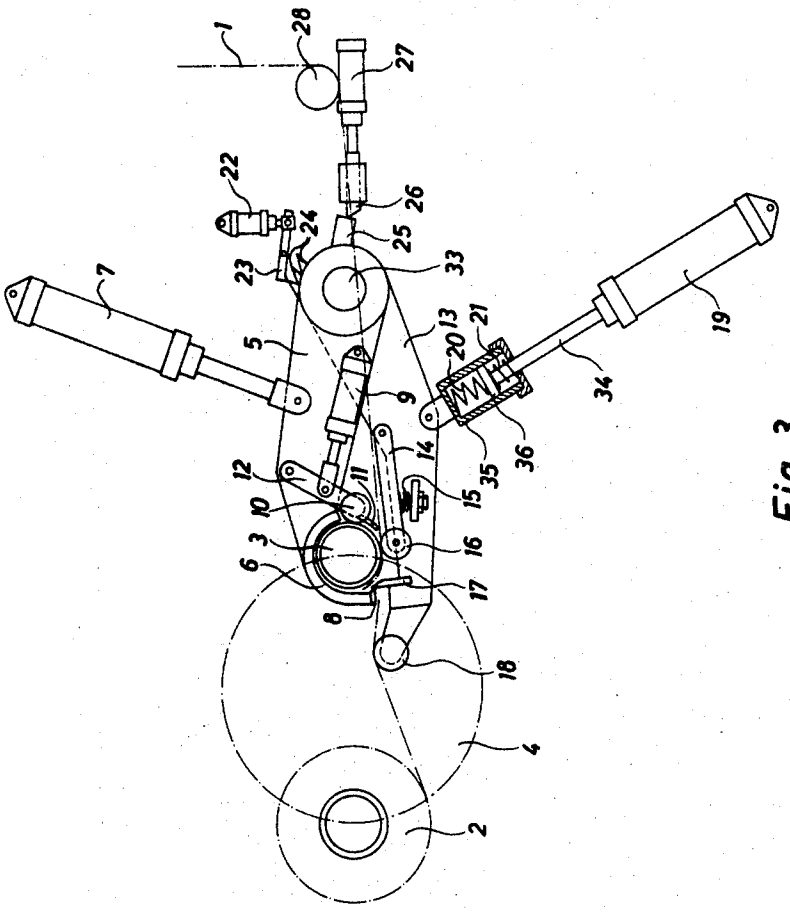
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Fig. 3

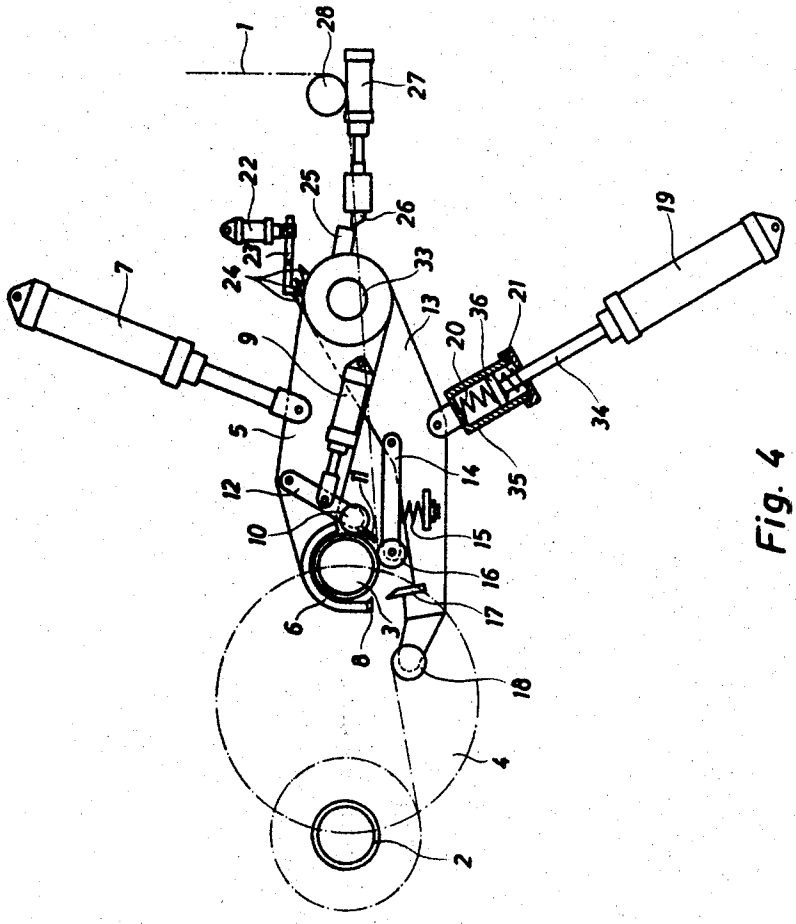
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Fig. 4

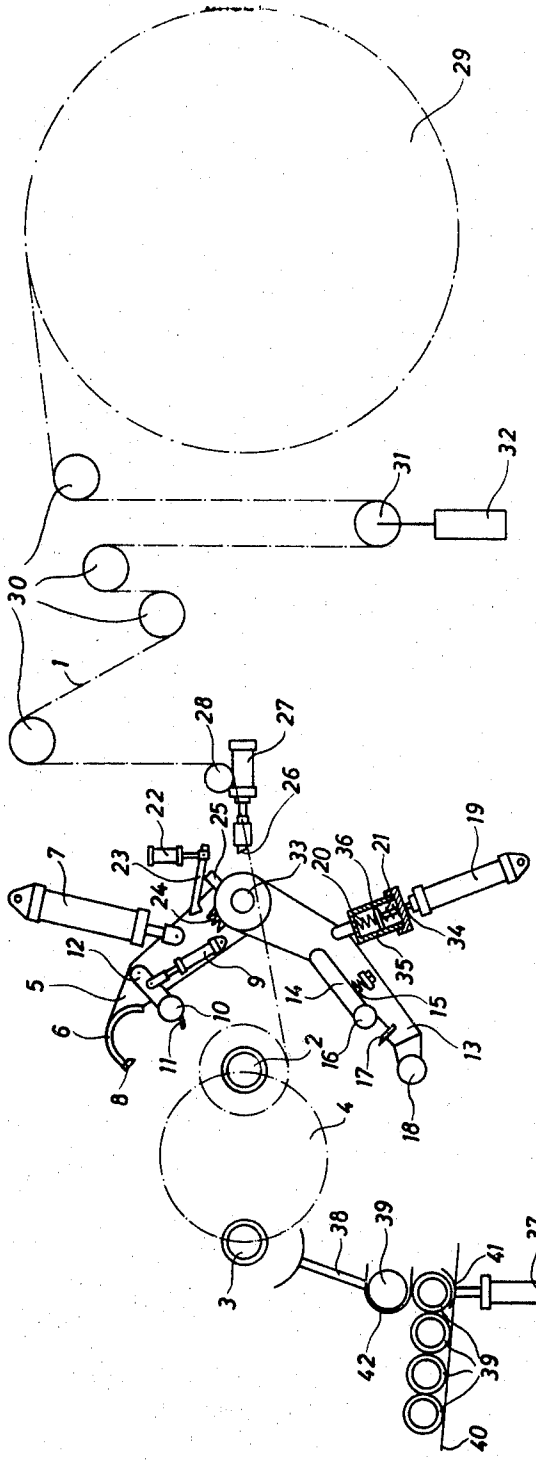
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Fig. 5

AUTOMATIC WINDING AND CUTTING APPARATUS FOR WEBS

The invention is related to a web winding and cutting apparatus and method and is particularly concerned with winders and cutters used for cutting a web into predetermined lengths and winding same subsequently onto a core in an automatic way.

The invention is particularly well-suited for cutting relatively short portions of a web of photographic material and winding them subsequently onto a core without excessive damage caused by grooves and scratches due to either mechanical friction between the web and the core or to fluttering of the web around the latter.

The term "web" denotes any coilable length of sheet material irrespective of its width or the material of which it is composed. Thus the invention can be used for winding and cutting webs of paper, fabric, high polymeric material or the like, in already coiled form or as a continuous web feeding from a web manufacturing plant.

During the manufacture of photographic materials, a web is moved through coating and drying stations in succession and wound upon a core in order to obtain a master-roll. The latter may either be spliced, as it is the case for motion picture films, or spliced and cut into formats, as is done for sheet films.

Some photographic material is marketed in rolled lengths of only a few meters. The material to be marketed, having already been cut to the final width is wound onto a core by winding apparatus provided with a cutting mechanism which cuts the material into the required predetermined lengths for the individual coils. This cutting step is carried out semi- or fully automatically and preferably at a relatively high speed.

Present day cutting and winding apparatus generally consist of a device that cuts a web transversally be means of a knife and/or a counter-knife and subsequently guides the freshly cut leading edge of the web towards a core which may either be provided with an adhesive substance or kept in a certain position promoting an easy "pick-up" of the leading edge. Other methods of winding consist in conferring to the core a rotational speed corresponding with the feeding speed of the web and subsequently guiding the leading edge of the web into a kind of shell which, in combination with an air stream urging the leading edge of the web towards the core, enables a first part of the web to be rapidly wound onto the core which is then transferred to a winding station for the winding on the remainder of the predetermined length of web. When that length has been wound onto the core, the cutting device cuts the web again and the cycle is repeated with a new core, the latter having been brought into stand-by position during the previous winding cycle.

Although the known apparatus is suitable for winding long lengths of web, and web which has a very high mechanical strength, the apparatus are not very suitable for winding short lengths of web, particularly webs or photographic material. A photographic emulsion layer, normally a dispersion of silver halide crystals in a gelatinous binder, is very vulnerable to damage by mechanical friction, and the method of engaging the leading edge of the web employed in modern winding machines may cause grooves and scratches, at least and especially at the beginning of a winding cycle since during the winding on of the first convolutions the material

tend to flutter on the core. Cutting and winding machines which use cores provided with adhesives show the inconvenience that most of the said adhesives are chemical incompatibile with the emulsion layer. Moreover, some adhesives, called "self-sticking," adhere only to surfaces which are covered with the same adhesive and require the machine to be stopped after cutting of the web in order to coat a leading edge of the web and press the coated edge onto the core. This supplementary step greatly reduces the operating speed of the machine. Moreover, a part of the web at the beginning of each winding cycle is spoiled and this is unacceptable when relatively short lengths of web are to be wound. In addition the known apparatus is complicated in design and operation.

It is an aim of the invention to provide a method and a machine in which the above mentioned drawbacks are obviated at least to a substantial extent. Another aim is to provide an automatic, high speed winding apparatus for winding short web portions without excessive loss of material.

The present invention provides a web winding and cutting apparatus comprising a holder which is adapted to be loaded with empty cores and is movable for bringing said cores successively to a web pick-up and winding station at which windingon of a least part of a predetermined length of web coming from a web supply station takes place. Prior to the completion of windingon of such predetermined length of web onto a core, the core holder is displaced to move that core to another position and to bring an empty core into position for receiving the new leading edge of the supplied web which will be formed when the web length presently being wound onto a core is severed from the following length of web. Web guiding means is provided which moves into operative position in relation to an empty core after its arrival at the winding station ready for guiding the new leading edge of the web around the empty core. In addition, a web severing mechanism is provided which severs the predetermined length of web from the following length of web at a position adjacent the pick-up and winding station and while the following part of the web is clamped against the empty core on which it is to be wound. The said severing mechanism is constructed so that the web severing movement takes place rapidly under energy stored in the said mechanism. For example, the mechanism may comprise a compression spring which bears against an arm carrying a web severing knife and which is placed in compression by another part of the mechanism prior to the moment at which the web is to be severed.

According to a preferred feature, the web guiding means comprises a shell which co-operates with an empty core to define a guide passage for the web, and a web-tightening roller which frictionally engages a web portion as it emerges from said guide passage and tightens the web portion around the core.

The web severing knife may be carried by a first arm and the shell and web-tightening roller may be carried by a second arm, the two arms being mounted for approach displacement towards an empty reel at the pick-up and winding station, from opposite sides thereof. The second arm may also carry a counter-knife so that the web is cut or sheared between the knife and counter-knife.

The invention includes web winding and cutting apparatus comprising:

a. a supply station from which the web to be cut is fed,

b. a turret for supporting at least two cores, the web being wound up onto one of these cores, while the remainder are empty and in stand-by position:

c. means to confer a predetermined rotational speed to the cores,

d. cutting means for cutting the web after a predetermined length of said web has been wound onto said core, said cutting means comprising a knife mounted on a first arm, which is driven by motor means with application of means for accumulating and for suddenly freeing stored energy, and a counter-knife mounted on a second arm,

e. guide means for guiding the leading edge of the web onto the empty core, the guide means comprising a guide shell for encircling the empty core, at least one idler roller capable of rotating against the web before, during and after cutting and at least one slippingly dirven roller for urging the web towards the core after cutting, the circumferential speed of the slippingly driven roller exceeding the circumferential speed of said empty core, wherein the coefficient of friction of the material, from which the slippingly driven roller is made relative to the web is greater than the coefficient of friction of said empty core relative to the web, and

f. means to support the guide means.

The scope of the invention will be exemplified with the help of a description of a preferred embodiment and with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic view of a cutting mechanism embodying the invention.

FIG. 2 presents the cutting mechanism of FIG. 1, prior to cutting.

FIG. 3 presents the cutting mechanism of FIG. 1, during the cutting cycle.

FIG. 4 presents the cutting mechanism of FIG. 1, immediately after the cutting cycle.

FIG. 5 is a diagrammatic view of a winding and cutting apparatus incorporating the invention.

In FIG. 1 there is shown a cutting mechanism during the winding up step of a web 1 onto a core 2. The core 2 is positioned on a turret 4, here represented by a circle, together with an empty core 3. The turret 4 may be driven stepwise after each winding cycle in order to bring a new core in winding position.

Around the core 2, being wound up, there is provided a cutting mechanism, mainly comprising two arms, 5 and 13, — both pivotally journalled on a shaft 33 — on which the cutting and guiding devices for the web are provided.

On arm 5, which is capable of performing pivotal movement around shaft 33 under the influence of air-motor 7, are provided a guide shell 6 carrying at its extremity a counterknife 8 and a second air-motor 9 which, when energized, extends so as to swing the free end of the arm 12, carrying a roller 10 and a guide member 11, towards the guide shell.

On the arm 13, which also pivots around shaft 33 under the action of air-motor 19, are provided the knife 17 and the rollers 16 and 18, roller 16 being separately mounted on the arm 14 and elastically supported by means of a spring 15. Between the air-motor 19 and the arm 13, there is provided a dash-pot 35 in which two springs, 20 and 21, are housed with their mutually adjacent ends bearing against the piston 36 at the end of the piston rod of air-motor 19. Arm 13 carries an extension crank 25 at its extremity which, upon rotation contacts a pawl 26, which is able to move longitudinally under action of air-motor 27. The arm 13 is also provided at its pivoted end with teeth 24, which after a certain pivotal motion of the arms 13 about shaft 33 engage with the toothed end of lever 23, which is pivotally connected to the arm of air-motor 22.

FIG. 2 presents the cutting mechanism in stand-by position, immediately before the cutting cycle. The core 2, having nearly attained its final diameter has moved over 180°, whereas the empty core 3 which is slippingly driven by a motor (not shown) is placed between the arms 5 and 13, by half a revolution of the turret 4 and starts rotating so that its circumferential speed is equal to the speed of the moving web. Arm 5 has already reached its position for cutting and the guide shell 6 lies in close proximity to the empty core 3. At the same time, air-motor 9 urges roller 10 against the empty core 3, so that the latter becomes surrrounded over about three quarters of its circumference. In contrast, arm 13 is temporarily maintained in "stand-by" position, due to the fact that upon its rotation about shaft 33, its movement is arrested at a given moment because the extension crank 25 is stopped by pawl 26. The arrestment of arm 13, while air-motor 19 remains energized, causes spring 20 to be compressed, whereas spring 21 is completely released.

In FIG. 3 is shown the cutting cycle, once a sufficient amount of web has been wound upon the core 2. At that moment the extension crank 25 is released by the pawl 26 due to retraction of the piston of air motor 27, and the energy, accumulated in the spring 20 is suddenly freed, so that arm 13 is rapidly swung further upwardly by the expansion of spring 20 (which has a greater compliance than that of spring 21) so that the knife 17 is driven through the web. At the same time the roller 16 resiliently presses the web 1 against the core 3 immediately behind the line of the cut.

The roller 18 provided at the end of arm 13 trailing cutoff end of the web as it travels towards the core 2, so avoiding an occasional fluttering of that end against machine parts. In the mean time, spring 21 has become compressed, whereas spring 20 is released. The whole cycle is carried out in a few hundredths of a second.

In FIG. 4 the situation immediately after the cutting stage is illustrated. At the moment air-motor 22 is energized and causes the toothed end of lever 23 to interlock with the teeth 24 on arm 13. In this way the arm 13 is maintained in a projected position, guaranteeing optimum contact between the web and the rollers while occasional vibrations of the arm are completely prevented. The knife 17 has already been withdrawn, but by the expansion of the spring 15 roller 16 remains in biased position against the core 3.

The leading edge of the web is guided in the space defined by the guide shell 6 and the core 3. By the fact that frictional contact occurs first between the web 1 and the roller 16 just prior to cutting and that at the instant of cutting, roller 16, web 1 and core 3 are firmly urged toward each other under influence of spring 15 which becomes compressed, the web 1 further advances in the space formed by the guide shell and the core. Because no difference in speed between the web 1 and the core 3 exists, the leading end of web 1 may

flutter during the period that it advances from the knife upto roller **10**, as no tightening action occurs.

Roller **10** is slippingly driven in such a way that — when not contacting core **3** — its circumferential speed is higher than that of the core **3**. Roller **10** consists of or is provided with a layer of a material which has a higher frictional coefficient with the web material than does the core **3**. Preferably the roller **10** is made of or coated with rubber. When the web reaches roller **10**, the portion of the web contacted by the roller acquires a speed equal to the circumferential speed of said roller **10**, so that the web **1** temporarily slides relative to the core **3** and the web becomes tightened. Then the leading edge is gripped between the following part of the web **1** and the core **3** and a new winding cycle can start.

Once a few windings are wound onto the core **3**, the airmotors **7** and **19** are de-energized and the arms **5** and **13** return to their inital position. The whole cycle is repeated when a predetermined amount of web is wound onto the core.

FIG. **5** gives a diagrammatic view of a complete winding apparatus embodying the invention. From a supply roller **29**, web **1** is fed to a core **2** by passing over guide rollers **30**, a tension regulating device, consisting of a weight **32** and a dancer-roller **31**, and the cutting device formed by the arms **5** and **13**. A number of empty cores **39**, lying on an inclined plane **40**, are prepared to be fed to a cradle **41**, mounted at the extremity of the arm of air-motor **37**. A turret **38**, provided at its extremity with a fork **42**, carries an empty roller to turret **4** when air-motor **37** becomes energized. The other extremity of turret **38** may be provided with a member suited to receive finished rollers, which may be forwarded to a packing station (not shown) for example.

The operation of the device is as follows (FIG. **5**). The web **1** is wound onto core **2** which is in operating position. Once a predetermined length of web is wound onto the core, which may easily be detected by means known in the art, the turret **4** starts revolving over a given angle — in this case 180° — in order to bring empty core **3** in operating position.

When the core **2** (now in the position at left of turret **4**) has almost fully wound up the amount of web which was preliminarily defined, the air motors **7** and **19** are energized and core **3**, being slippingly driven, starts rotating at a circumferential speed, equal to the linear speed of the web **1**.

The presence of the extension crank **25** urging against pawl **26** limits the movement of the arm **13**, attached to air motor **19**, but by the continuous energizing of the latter, spring **20**, enclosed in dash pot **35** becomes compressed, whereas spring **21**, also enclosed in dash pot **35** is stretched.

Arm **5**, carrying guide shell **6** at its free extremity which encircles the empty core **3**, carries also another air motor **9**, which by means of a lever **12** pivotally secured to arm **5**, urges roller **10** aganist core **3**. Roller **10** is slippingly driven and attains the same circumferential speed as that of core **3**. When, however, roller **10** is free turning and out of contact with core **3**, its circumferential speed exceeds that of core **3**.

The cutting cycle itself, is started when air motor **27** becomes energized and retracts pawl **26**, freeing extension crank **25**. This causes spring **20**, which has a greater compliance than spring **21**, to expand suddenly and to lift arm **13** somewhat further driving knife **17** through the web to be cut by a short, single stroke. In the means time, the free turning roller **16** urges resiliently against the core **3** by action of spring **15**. In this way, the web **1** is forced to enter into the shallow passage formed by the core **3** and the guide shell **6**, due to the fact that the knife **17** and the counterknife **8** prevent the leading edge of the web **1** form moving in the direction of core **2** by obstructing completely the path toward core **2**.

At the moment arm **13** has attained its maximum projected position, air motor **22** is energized causing the toothed end **23** at its associated lever to engage the teeth **24** latching thereby the arm **13** in that position and at the same time to preventing possible oscillation of the latter.

The web **1** continues to advance at its normal speed because it is pressed between roller **16** and core **3**, the latter being driven at the speed of the web. So, the leading edge is further advanced in the shallow passage formed by the guide shell **6** and the core **3**, until it reaches roller **10**. Then, the web movement is accelerated on account of the fact that this roller is of rotating at a higher circumferential speed of the web **1** and because the coefficient of friction between roller **10** and the web is greater than the coefficient of friction between core **3** and the web. Hence possible fluttering of the web around the core **3** is automatically neturalized and the web is tightened around the core. With the help of the supplementary guide member **11** the leading end of the web is directed between the web and the core, so that the step of winding the web on core **3** is started automatically.

After a few windings are round on core **3**, the air motor **22** is energized in such a way that its piston moves in an opposite direction, freeing the toothed end. The same cycle is performed with air motor **9**, causing roller **10** to come out of contact with the web. Then the main air motors **7** and **19** return arms **5** and **13** to their starting positions, so that core **3** is no longer surrounded by guide shell **6** and the rollers **10** and **16**. The partial rotation of arm **13** swings the extension crank **25** past the pawl **26**, the air motor **27** becomes then energized so that the latter pushes said pawl in forward direction.

The roll **2**, still being on the turret is removed theefrom by a kind of cradle mounted on one extremity of a turret **38** which forwards the roll to a receiving station (not shown). In the same time a fork **42** forces a core **39** into stand-by position with the help of a cradle **41** actuated by a vertically operating air motor **37**. The features explained in this paragraph however are not part of the invention.

From the foregoing it may be concluded that new automatic winding and cutting apparatus is provided which is suited for many purpose.

The utilization of the sudden freeing of accumulated energy combined with the use of mechanical parts of low weight enables a quick and clean cutting of the web. In a preferred embodiment, the time required to cut the web and winding one turn amounts only to about one-tenth of a second.

The apparatus may be completed with counting circuits, measuring and regulating devices and alarm circuits, without however departing from the scope and spirit of the invention. Also pneumatic deivces may be replaced by either their electrical or electromechanical equivalents. The appratus may operate individually or

as an end station of a production process and may be adapted for very small as for very big rollers as well.

Therefore, the foregoing apparatus is merely described as an example, and the scope and spirit of the invention shall be derived from the appended claims.

We claim:

1. A web winding and cutting apparatus for converting a continuously travelling web into rolls, said winding apparatus comprising:

a. a supply station from which the web to be cut is fed,

b. a turret for supporting at least two cores, said web being wound up onto one of these cores, with the remainder empty and in stand-by position,

c. means for rotatably driving the respective cores at a predetermined rotational speed,

d. cutting means for cutting said web after a predetermined length of said web has been wound onto said core, said cutting means comprising a knife mounted on a first arm, means for biasing said arm to cutting position, releasable detent means restraining the arm from moving to said cutting position and energy storage means between said biasing means and said arm to store the biasing force of said biasinng means until said detent means is released,

e. guide means for guiding the leading edge of said cut web onto said empty core, said guide means comprising a guide shell for encircling said empty core, at least one idler roller capable of rotating against the web adjacent said knife during cutting and at least one slippingly driven roller downstream of said guide shell for tightening the web against the core after cutting, said slippingly driven roller being driven at a circumferential speed exceeding the circumferintial speed of said empty core and having a coefficient of friction relative to the web greater than the coefficient of friction of said empty core relative to the web, and

f. means to support said guide means.

2. A web winding and cutting apparatus according to claim **1** in which said idler roller is mounted on said first arm, and said guide shell and said slippingly driven roller are mounted on a second arm arranged generally on the opposite side of said core from said first arm.

3. A web winding and cutting apparatus according to claim **1** in which said energy storage means comprise a pair of springs, one of which is compressed and the other released under action of said arm biasing means when the arm is restrained against movement.

4. A web winding and cutting apparatus, according to claim **3,** in which said first spring has a greater compliance than said second spring.

5. A web winding and cutting apparatus, according to claim **1,** in which said guide shell encircles the empty core over at least 180°.

6. A web winding and cutting apparatus, according to claim **1,** in which the surface material of the slippingly driven roller is rubber.

7. A web winding and cutting apparatus, according to claim **1** which is provided with stabilizing means in to keep the guide means in a stable position immediately after the cutting.

8. A web winding and cutting apparatus according to claim **1** in which said dentent means comprises an extension crank integral with said first arm, and a retractable latching pawl cooperating with said crank.

9. A web winding and cutting apparatus according to claim **8** including means for retracting and projecting said pawl.

10. A web winding and cutting apparatus according to claim **7** in which said stabilizing means consist of an array of ratchet teeth movable bodily with said guide means and a pawl interlocking with said array.

11. In a method of winding a continuously travelling web into rolls on cores by the steps of delivering the web to a first core in active winding position along a fixed path at a predetermined speed, positioning an empty core in stand-by position adjacent said web path upstream of said actively winding core while rotating the empty core at a speed substantially equal to the web speed, severing said web with a knife blade at a locus adjacent said second core and guiding the leading edge of the severed web onto said empty core to initiate winding thereon, the improvement of resiliently biasing said knife toward a position cutting said web while restraining said knife against movement to said cutting position until resilient energy is accummulated, and releasing said knife from restraint whereby said knife is impelled to cutting position by said accummulated resilient energy.

12. In a method of winding a continuously travelling web into rolls on cores by the steps of delivering the web to a first core in active winding position along a fixed path at a predetermined speed, positioning an empty core in stand-by position adjacent said web path upstream of said actively winding core while rotating the empty core at a speed substantially equal to the web speed, severing said web with a knife blade at a locus adjacent said second core and guiding the leading edge of the severed web through an arcuate passageway extending through an arc of at least 180° around said empty core, the improvement of adjacent the downstream end of said passageway frictionally engaging the leading web end to advance the same at a linear speed exceeding the linear speed of said core in order to tighten the web end around said empty core.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,871,595

DATED : March 18, 1975

INVENTOR(S) : Albert Emiel SMOLDEREN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 7, line 25, delete "biasinng" and insert --biasing--

line 35, delete "circumferintial" and insert --circumferential--

Column 8, line 7, delete "which is provided with" and insert --including-- and also in the same line delete "in"

Signed and sealed this 20th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks