May 14, 1968 E. F. MEIHOFER ET AL 3,383,062

METHOD AND APPARATUS FOR CONTINUOUSLY WINDING WEB MATERIAL WITH CONSTANT TENSION

Filed June 30, 1965 2 Sheets-Sheet 1

FIG-1

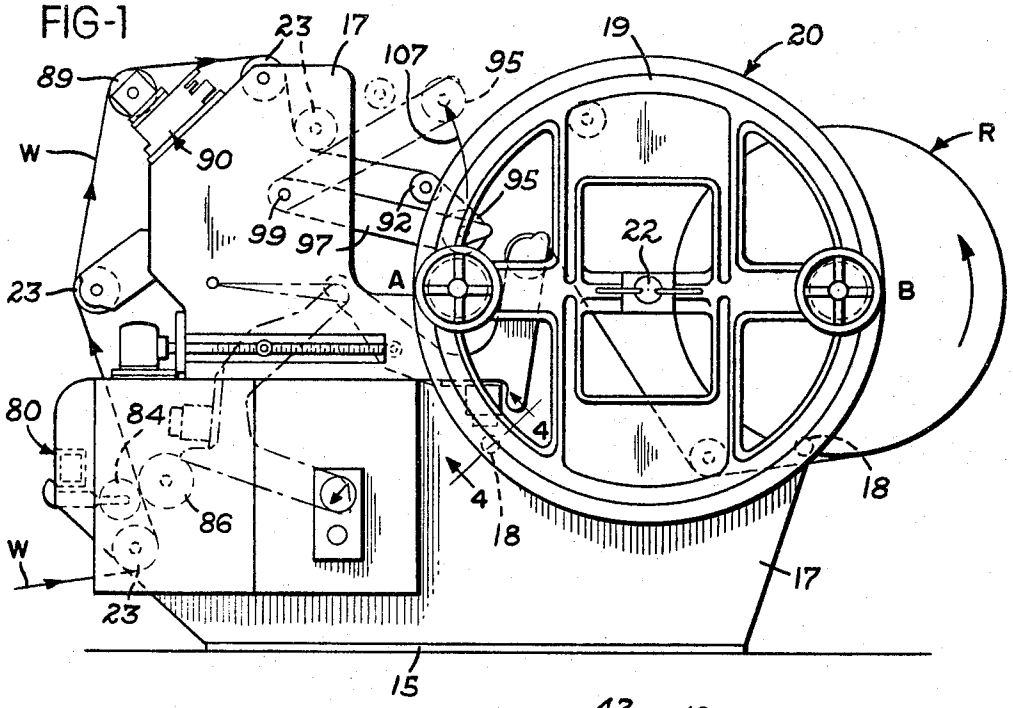
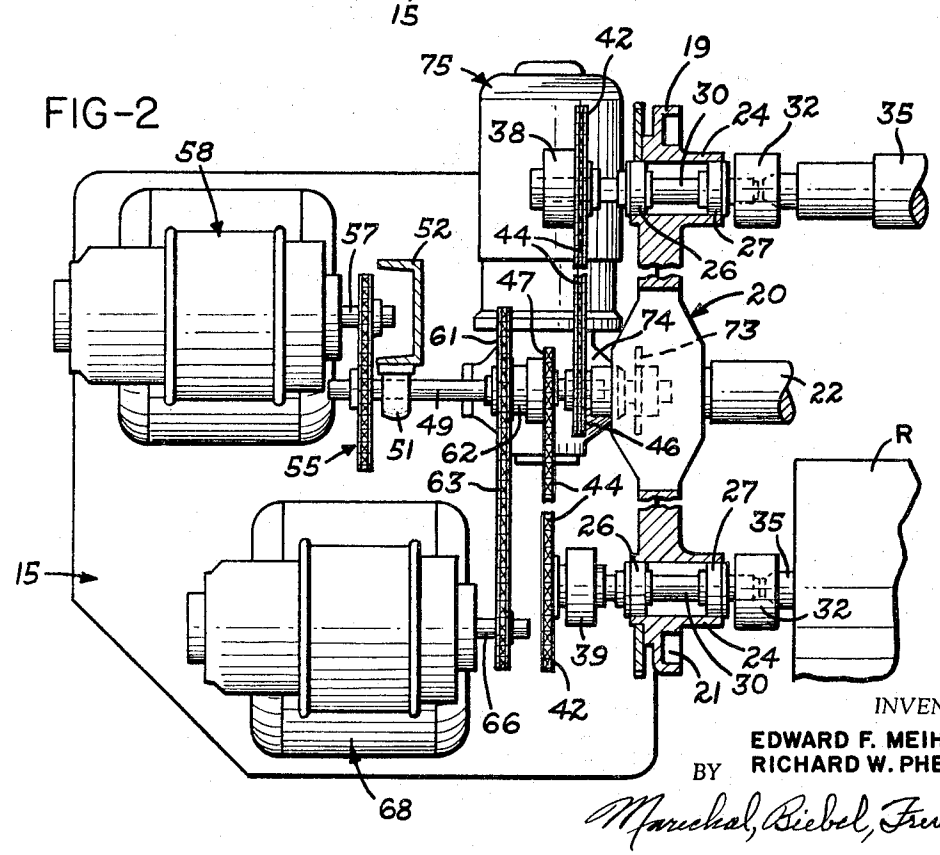


FIG-2



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FIG-3

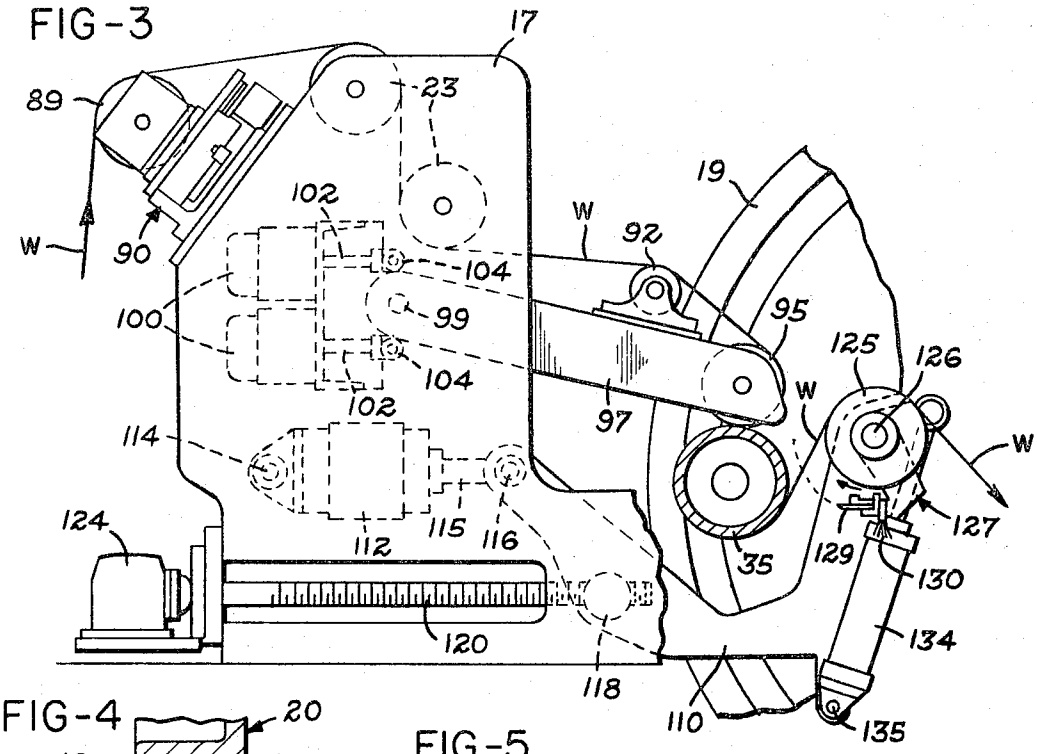


FIG-4

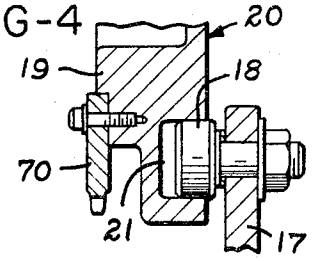


FIG-5

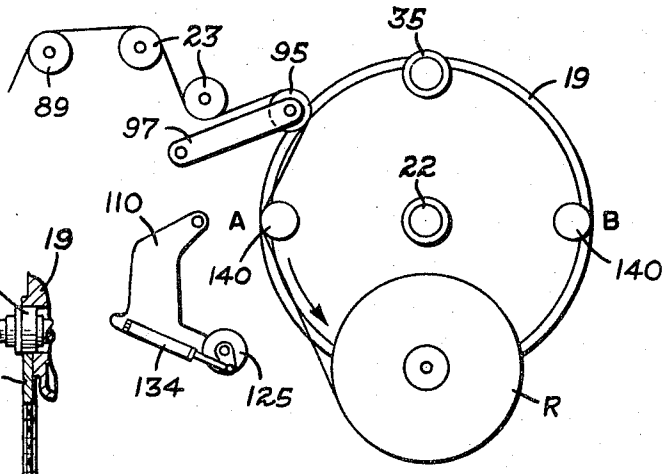
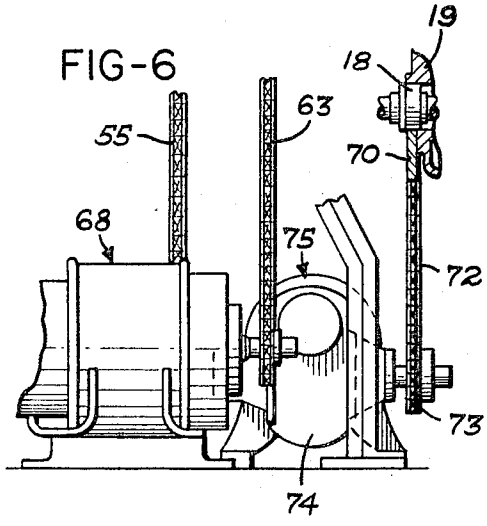


FIG-6



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METHOD AND APPARATUS FOR CONTINUOUSLY WINDING WEB MATERIAL WITH CONSTANT TENSION

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ABSTRACT OF THE DISCLOSURE

Apparatus and a method for transferring the unwinding of a web from a completed roll to an empty core on a reel supporting a plurality of cores. Each core is driven by a corresponding drive motor through an overrunning clutch to provide free running of each empty core without any drag from its corresponding drive motor after the peripheral speed of the core is brought up to slightly under the web speed, so that when such core is brought into engagement with the web during indexing of the reel, significant variations in the web tension are eliminated.

This invention relates to improvements in the continuous winding of web materials, and more particularly, to an improved method and apparatus for transferring, the continuous winding of a web from a completed roll to a new core so as to minimize variations in the tension within the web.

It has been found that with some web materials, as for example, a web of foam polystyrene film or light-grade paper, it is especially desirable to maintain substantially precise constant tension in the web as the continuous winding is transferred from a completed roll to a new core. Otherwise, if the tension is permitted to decrease slightly, the web becomes slack, and the severing of the web becomes ineffective or difficult. On the other hand, if the web tension increases it will result in stretching or possibily tearing of the web.

For this reason, it is common to provide a mechanism which continuously senses the tension within the web, as for example, a force transducer or a dancer roll. This mechanism, in turn, is connected to control the torque within the drive motor for the roll on which the web is winding. Thus if the mechanism senses slack in the web, it automatically compensates by increasing the motor torque, and vice versa, decreases the motor torque when the web tension increases.

It has been found, however, that during the transfer of the web, this sensing mechanism tends to produce false signals to the drive motor when the new core contacts the web, due to the appreciable differential in surface speeds between the core and the web resulting from the inaccuracies in the core speed-up device and/or variances in the diameters of different cores. Furthermore, when a core is being driven with a surface speed equal to the speed of the running web and the core is indexed into the moving web for envelopment and is advanced along the moving web into roll change position, the relative surface speed of the core to the running web, at time of indexing, is greater by an amount equal to the speed of the indexing. In addition, the core fixed speed-up devices produce a resistance to a free-running increase or decrease in the core speed when it comes in contact with the moving web.

Accordingly, the present invention is directed to an improved method and apparatus by which the winding of the continuously moving web can be transferred from the completed roll to the new core while substantially

eliminating variations in the web tension during the transfer and thus, eliminating false signals by the web tension sensing mechanism.

Thus it is a primary object of the present invention to provide an improved method for transferring the continuous winding of a web material from a completed or full roll to a fresh or new core while maintaining substantially constant tension in the web.

As another object, the present invention provides improved and novel apparatus for transferring the continuously winding web as described above wherein separate variable drive means are provided for both the completed roll and the new core and are adapted to be successively controlled by the web tension sensing mechanism so that the web tension remains substantially constant.

It is also an object of the invention to provide improved apparatus as outlined above wherein a reel is provided to carry a plurality of cores and each core is connected to its corresponding separate drive means through an overrunning clutch which enables the speed of each new core to be precisely matched with the speed of the web without being subjected to a drag or resistance from its speed-up drive means.

Still another object of the invention is to provide an improved method for transferring the continous winding of a web material, as outlined above, which is dependable and accurate in operation regardless of variances in the diameters of different cores or variances in speed inherent in its electric drive.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a somewhat schematic elevational view of apparatus according to the invention illustrating the general overall arrangement of the major components immediately before the severing and splicing operation;

FIG. 2 is a plan view, partly in section, of the plurality of drive units for each core and the reel as would be seen on the opposite end of the reel shown in FIG. 1;

FIG. 3 is an enlarged somewhat schematic elevational view of the mechanism for bringing the web into driving engagement with the new core and for severing the web while simultaneously starting winding on the new core;

FIG. 4 is a fragmentary section view of a support for the reel;

FIG. 5 is a schematic elevational view of the apparatus during rotation of the reel when a roll is nearing completion; and

FIG. 6 is a partial elevational view of the drive units shown in FIG. 2.

Referring to the drawings, which illustrate a preferred embodiment of the present invention, FIG. 1 shows a somewhat schematic general assembly of apparatus according to the invention including a base **15** and a pair of parallel spaced end stands **17** on which a pair of rollers **18** (FIG. 4) are mounted. The rollers **18** support the end spiders **19** of a reel **20** by engaging an annular channel **21** formed within the spiders **19** concentric with a center shaft **22**. The end stands also support a plurality of idler or guide rolls **23** about which the web W is directed. It is to be understood that the spacing between the side frames and the axial length of the reel **20** and rolls **23** can be of any particular dimension depending on the maximum width of the web W desired to be processed. Furthermore, is to be understood that the method and apparatus of the invention can be employed on any web material whenever it is desirable to transfer the continuous winding from a full roll to a new core with minimum variations in the web tension.

Diametrically spaced on each circular end spider 19 of the reel 20, as shown in FIG. 2, are a pair of hubs 24 which retain the bearings 26 and 27 for supporting the spindles 30. The inner end of each spindle 30 is provided with a coupling 32 which connects with one end of a core 35 shown partially in FIG. 2. The web W of material is wound on a core 35 until a full roll R is formed, as shown in FIG. 1, at which time the web is severed and the continuous winding is transferred to the new core 35. As mentioned above, the present invention relates to an improved method and apparatus which enable the continuous winding of the web W to be transferred from the roll R to the new core 35 while minimizing variations in the tension in the web W.

To accomplish this smooth transfer of the winding, each core is provided with a separate drive unit or system which enables separate and independent control over the torque applied to each core, and thus separate control over the speed of each core. Included as part of these drive systems are a pair of single direction overrunning clutches 38 and 39 which are mounted on the ends of the spindles 30. As shown in FIG. 2, a driven sprocket 42 is mounted on each of the overrunning clutches and is connected by an endless driving chain 44 to corresponding drive sprockets 46 and 47 which are rotatably mounted on a shaft 49 coaxial with the reel support shaft 22. As a result of the reverse mounting of the sprockets 42 on the overrunning clutches 38 and 39 (FIG. 2), it is necessary that clutch 38 be of right-hand rotation and that clutch 39 be of left-hand rotation in order to provide a similar drive direction to both of the spindles 30.

The sprocket 46 is rigidly connected to the drive shaft 49 which is rotatably supported at one end by the reel shaft 22 and near the opposite end by a bearing 51 mounted on a support member 52. The outer end of the drive shaft 49 is driven through a sprocket and chain drive 55 connected with the output shaft 57 of an electric motor 58. The sprocket 47 is rigidly connected to a sprocket 61 through a hub 62 rotatably mounted on the shaft 49. A chain and sprocket drive 63 connects the sprocket 61 with the output shaft 66 of another electrical motor 68. Through this separate drive system for each of the cores 35, it can be seen that the motors 58 and 68 can be mounted on the base member 15, and each core 35 can be driven independently at a predetermined constant speed regardless of the angular position of the reel 20.

For providing slow indexing and rotating of the reel 20, a large diameter sprocket 70 is mounted on one end spider 19 of the reel 20 and is driven by the chain drive 72 (FIG. 5) from a sprocket 73 (FIG. 2) mounted on the output shaft of a gear reduction unit 74 connected to the indexing motor 75.

As shown in FIG. 1, the apparatus of the invention may be coupled with a slitting mechanism 80 where the web W is directed around a guide roll 23 and between the slitting knives 84 and back-up rolls 86. This slitting operation is illustrated as a typical application for the apparatus according to the invention where the web W is first unwound, then slit into a series of webs of lesser width and then rewound as a new roll R all in a continuous operation. It is to be understood, however, that the apparatus and method are applicable whenever it is desirable to provide continuous winding of a web material whether employed at the end of a web forming machine or a rewind operation.

Following the slitting device, the web W is directed over an idler or guide roll 23 and then over the sensing roll 89 of a web tension sensing mechanism 90. Typically, the sensing mechanism 90 employs a transducer which senses the force applied by the web W to the roll 89 and varies an electrical current to the drive motor for the roll R according to the amount of force. The web W is then directed over the guide rolls 23 and 92 and over a pressure roll 95 carried by the ends of a pair of arms 97. As shown in FIG. 3, each arm 97 is pivotally mounted on a shaft 99 and is moved or operated by a pair of pneumatic pressure cylinders 100 including piston rods 102 having ends pivotally connected to brackets 104 extending outwardly from the arm 97. Thus it can be seen that by applying differential air pressure within the cylinders 100, the arms 97 will pivot vertically carrying the pressure roll 95 along the arcuate path 107 (FIG. 1).

A pair of lower support arms 110 (FIG. 3) are mounted on the end stands 17 for movement in a vertical plane. One end of each arm 110 is supported by a cushion pressure cylinder 112 which pivots about the pin 114 on one end and has a piston rod 115 pivotally connected to the arm 110 by the pin 116. At an intermediate point along the arm 110, a nut member 118 is rotatably mounted and is adapted to receive an elongated threaded jack screw 120 which extends horizontally from a power operated drive unit 124. Thus by rotating the jack screw 120, it can be seen that the support arms 110 can be pivoted about the pin 116 from a retracted position as shown by the dotted lines shown in FIG. 1 to the extended position shown by the full lines in FIGS. 1 and 3.

Rotatably carried between the ends of the arms 110 is a guide roll 125 which is supported on a shaft 126. Also rotatably mounted on the shaft 126 and supported by the ends of the arms 110 is a cut-off knife assembly 127 which includes a blade 129 and a wiping brush 130. The cut-off knife assembly is rotatably operated by the actuation of a pressure cylinder 134 pivotally mounted on the arm 110 by a pin 135 and having a piston rod 136 connected to the knife assembly 127 at a point eccentric of the shaft 126.

In operation, when a roll R is approaching the predetermined diameter of a completed or full roll and is being driven, for example, by the electric motor 68 controlled by the web tension sensing mechanism 90, it is moved from station A to station B by indexing the reel counterclockwise (FIG. 4) whereby the web is picked up by a guide roll 140 and a new core 35 is advanced to station A. Before the core 35 reaches station A, however, the peripheral surface speed of the core is brought up to slightly under the speed of the web by operation of the drive motor 58 and by observing a suitable speed indicating device such as a tachometer (not shown). Preferably, the peripheral speed of the core 35 is brought up to within 1% under the speed of the web W. While the core is running at this speed by its indepedent drive 58, it is brought into driving engagement with the web by slowly advancing the reel 20 until the core reaches station A.

The slight differential speed between the web W and the core causes an overrunning of the clutch 38 so that there is no drag or resistance caused by the running drive motor 58. It has been found that by bringing the speed of the core up to slightly under the web speed before driving engagement is made between the web W and the core 35, and by then bringing the core into contact at a slow rate, a precise speed match can be obtained between the core and the web without causing any significant disturbance in the web tension. In fact, the only slight disturbance to the web tension comes from the friction drive of the core by the web and the slight friction produced within the core support bearings.

The pressure roll 95 is then moved downwardly by actuation of the pressure cylinders 100 until an inrunning nip is formed between the exterior surface of the core 35 and pressure roll 95 with the web W spaced therebetween. After this nip is formed, the support arms 110 are moved upwardly so that the guide roll 125 wraps the web around the core 35 until it envelopes a major portion of the core 35. The path of the web W around the pressure roll 95, core 35 and guide roll 125 are then as shown in FIG. 3. At this point, the surfaces of the core 35 and the guide rolls 95 and 125 will all have the same speed as the web W.

The pneumatic cylinders 134 are then actuated, caus-

ing the knife assembly to rotate clockwise whereby the blade **129** serves the web W and the brush **130** directs and wipes the lead end of the web into the nip formed between the pressure roller **95** and the core **35**. The winding continues on the new core **35**, and simultaneously with the beginning of the winding, the torque control provided by the sensing mechanism **90** is transferred from the motor **68** to the motor **58**. This causes a slight speed-up on the motor **58** which occurs instantaneously, and the motor immediately picks up the slight differential speed within the overrunning clutch **38**. The pressure roll **95** is raised slowly upwardly and the guide roll **125** is lowered by their respective control systems as described above, and the web W continues to wind on the core **35** until it is approaching a full size at which time the process is repeated.

As can be seen from the drawings and the above description, the method and apparatus of the present invention have been found to provide several distinct advantages and features. In prior practice, there has been a problem of significantly affecting the web tension when the continuous winding is transferred from a full roll to a new core, as a result of inability to obtain closely matched speeds between the web and the core without complex and expensive controls. If this differential speed is substantial when the new core contacts the web, a substantial increase or decrease in tension is produced in the web, which in turn produces false sensing within the tension sensing mechanism.

With the present invention, on the other hand, by bringing the new core speed up to within 1% under the web speed by its separate drive system and then allowing the clutch to overrun by this slight amount, when the core is brought into driving engagement with the web, it has been found that slight variances in the web tension is insignificant. Furthermore, since there is very little speed change involved for the core drive motor after the tension is switched, the time for the control and drive motor to stabilize with the speed of the core is very short, such as a few milliseconds. Thus when the transfer of a continuous winding web is made on the apparatus and by the method of the present invention, there is no stretching or slack within the web during the transfer operation. This is especially desirable for a thin or light-grade web in which the tension during winding must be precisely controlled to avoid stretching, tearing, wrinkles or other irregularities in the material, in addition to providing a clean cut-off of the web.

While the method herein described, and the forms of apparatus for carrying this method into effect, constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and forms of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An improved method for transferring the continuous winding of a web from a completed roll to a new core both supported by a reel so as to minimize variations in the web tension, comprising the steps of driving the full roll with a first drive means adapted to provide a variable torque, controlling the torque by a web tension sensing mechanism, bringing up the peripheral speed of the new core to slightly under the speed of the web by a second drive means including an overrunning clutch, indexing the reel for enveloping a portion of the core in driven engagement with the web, effecting free rotation of the new core through slight overrunning of said clutch to obtain a precise speed match between the core and the web, forming a nip between a pressure roll and the new core at the inrunning end of the envelopment, severing the web and directing the leading edge of the web around the new core and into said nip to form a full envelopment, and immediately transferring the control of the sensing mechanism from the first drive means to the second drive means for eliminating the slight differential speed in the clutch so that the second drive means stabilizes substantially immediately with the speed of the core and continues the constant tension in the web.

2. An improved method for transferring the continuous winding of a web from a completed roll to a new core so as to minimize variations in the web tension, comprising the steps of driving the full roll with a first drive means including an electric motor adapted to provide a variable torque, controlling the torque by a web tension sensing mechanism adapted to control said motor, bringing up the peripheral speed of the new core to within substantially one percent under the speed of the web by a second drive means including an electric motor connected through an overrunning clutch and also adapted to provide a variable torque, interchanging the position of the new core and the completed roll by indexing the reel supporting the core and roll, directing a portion of the winding web to envelope a portion of the core in driven engagement with the web, effecting free rotation of the new core through slight overrunning of said clutch to obtain a precise speed match between the core and the web, forming a nip between a pressure roll and the new core at the inrunning end of the envelopment, severing the web and directing the leading edge of the web around the new core and into said nip to form a full envelopment, and substantially immediately transferring the control of the sensing mechanism from the first drive means to the second drive means for eliminating the slight differential speed in the clutch so that the second drive means stabilizes immediately with the speed of the core and continues the constant tension in the web.

3. An improved apparatus for transferring the continuous winding of a web from a completed roll to a new core so as to minimize variations in the web tension, comprising a rotatably mounted reel for supporting a plurality of cores, separate drive means for each of said cores adapted to provide each with a variable torque and speed, an overrunning clutch connecting each said core to all said drive means for said core and effective to provide free rotation of each said core without the resistance of corresponding said drive means, a web tension sensing mechanism adapted to control the torque of each said drive means when the web is winding on its corresponding core, means for operating said drive means for said new core to bring up its peripheral speed to slightly under the speed of the web, guide roll means for directing the web into driving engagement with a portion of the new core by enveloping a portion of said new core to provide a precise speed match between said core and the web resulting in a slight overrunning of the corresponding said clutch, pressure roll means for forming a nip with the core at the inrunning end of the envelopment, means to cut the web and direct the leading edge of the web to form a full envelopment of the new core, and means for operating said drive means for the new core by said sensing mechanism to pick up the slight differential overrunning speed of said clutch and to continue the constant tension in the web.

4. An improved apparatus for transferring the continuous winding of a web from a completed roll to a new core so as to minimize variations in the web tension, comprising a rotatably mounted reel for supporting a plurality of cores, power operated means for indexing said reel to position said cores at predetermined stations, a separate electrical drive motor for each of said cores and forming the sole drive for said core, a separate overrunning clutch connecting each of said drive motors with its corresponding said core and effective to provide free rotation in one direction of said core without the resistance of the corresponding said drive motor, a web tension sensing mechanism adapted to control the torque of each said motor when the web is winding on its corresponding core, means for operating said drive motor for said new core to bring up its peripheral speed to slightly under the speed

of the web, guide roll means for directing the web into driving engagement with a portion of the new core by enveloping a portion thereof to provide a precise speed match between said core and the web causing a slight overrunning of the corresponding said clutch to eliminate any resistance by its drive motor, means to cut the web and wipe the leading edge of the web to form a full envelopment of the new core, and means for operating said drive motor for said new core by said sensing mechanism to pick up the slight differential overrunning speed of said clutch and to continue the constant tension in the web.

5. An improved apparatus for transferring the continuous winding of a web from a completed roll to a new core so as to minimize variations in the web tension, comprising a rotatably mounted reel for supporting a plurality of cores, power operated means for indexing said reel to position said cores at predetermined stations, a separate electrical drive motor for each of said cores and forming the sole drive for said core, a separate overrunning clutch connecting each of said drive motors with its corresponding said core and effective to provide free rotation in one direction of said core without the resistance of the corresponding said drive motor, a web tension sensing mechanism adapted to control the torque of each of said motors when the web is winding on its corresponding core, means for operating said drive motor for said new core to bring up its peripheral speed to within one percent under the speed of the web, a pressure roll movably carried for forming a nip with the upper portion of the new core, a guide roll movably carried for directing the web into driving engagement with a portion of the new core by enveloping a portion thereof to provide a precise speed match between said core and the web causing a slight overrunning of the corresponding said clutch to eliminate any resistance by its drive motor, a cut-off knife assembly adapted to sever the web and wipe the leading edge of the web into said nip to form a full envelopment of the new core, and means for operating said drive motor for said new core by said sensing mechanism to pick up the slight differential overrunning speed of said clutch and to continue the constant tension in the web.

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