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METHOD AND APPARATUS FOR WINDING

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FIG. 1

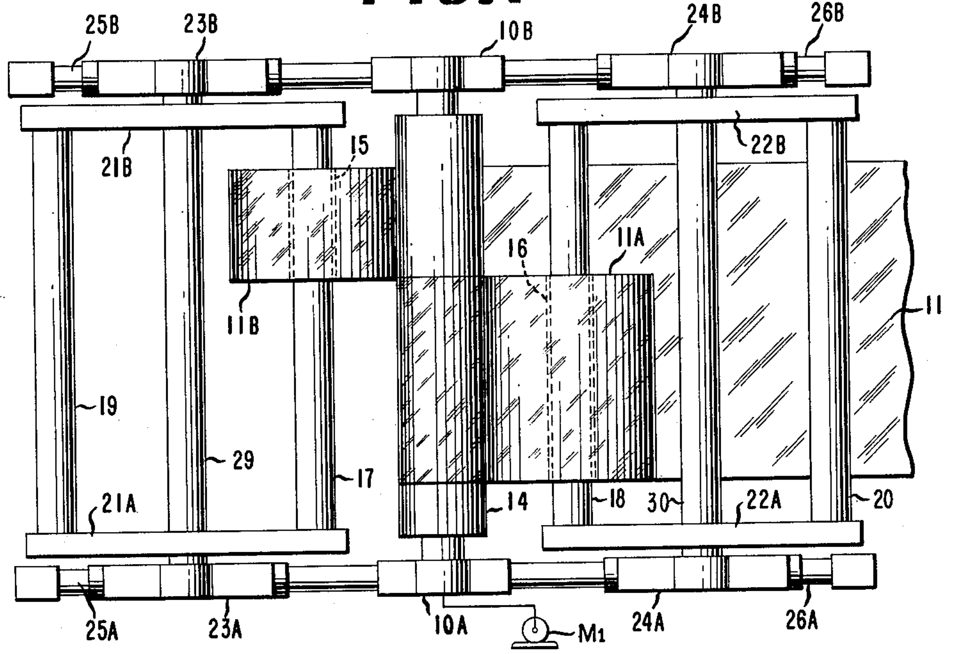
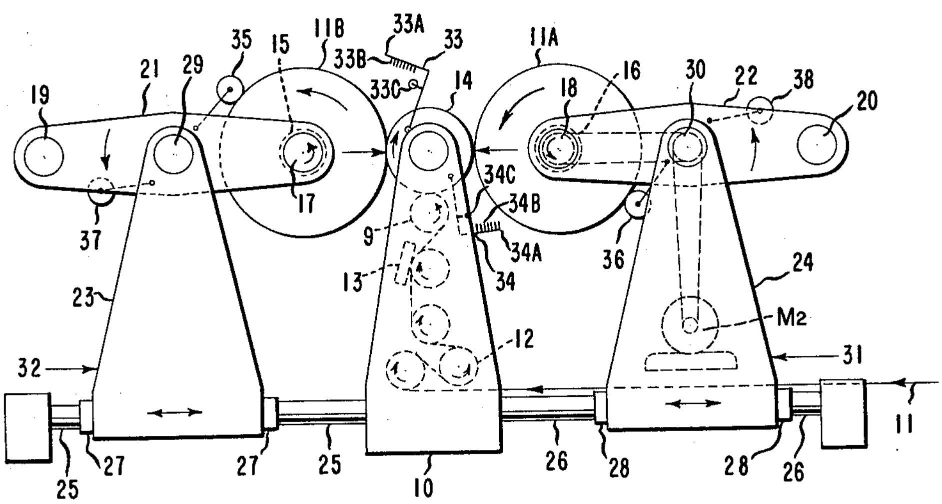


FIG. 2



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METHOD AND APPARATUS FOR WINDING

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This invention relates to a method and apparatus for winding webs of flexible material and, more particularly, to a method and apparatus for slitting flexible material and winding the slit material on rolls.

One of the important problems posed in winding any material onto a core is to obtain a tightly wound material that displays substantially uniform density throughout the roll. One approach to obtaining a tightly wound roll has been to employ "surface winding." This mode of winding involves the use of a surface-pressure driving roll against the surface of the web on a winding roll, the winding roll resting on the driving roll. This type of winding assures that the rates of winding and feeding are identical, the rotation of the driving roll determining both rates. Surface winding also involves the pressure of the web winding on the core against the driving roll serving to squeeze air out from the wound roll. If the material being wound is of uniform gauge, the result is a tight, high density roll. However, since the tightness, and hence the density, will depend on the weight of the winding roll, this will be difficult to control since the weight of the winding roll changes as the web builds up on the roll.

Furthermore, in the nature of things and particularly with plastic materials there is a tendency for gauge variations to exist across the width of the material. The surface winding technique, particularly where a plurality of cores are being wound simultaneously, is very sensitive to gauge variations. Winding on a single core tends to produce a crooked roll. Where several rolls are being wound simultaneously, gauge variations can raise havoc with uniformity from roll to roll.

A technique that is not substantially sensitive to gauge variations is the "center differential winding" technique. In this technique, the core is mounted on a driven mandrel in slippable relation with the mandrel. The mandrel is driven at a slightly higher speed than the speed at which the material is fed to the core. The amount of slippage of the core on the mandrel will vary with gauge variations. However, each roll will be substantially uniform in density. Since there is no pressure of the feeding drum on the web being wound, a "soft" roll, i.e. a roll of low density, is produced.

In an effort to obviate the above shortcomings, a third technique combines the previously mentioned two techniques in a "center-surface differential winding" technique. According to this method, the mill web after being slit passes around a constant speed surface-pressure driving roll known as the surface winding drum or platen drum. The smaller widths, i.e. the slit web widths, then pass to the rewind cores which contact the surface winding drum. The cores are mounted on one or more independently driven mandrels which are adapted to provide a linear speed that is slightly greater, about 10% greater, than that provided by the surface winding drum. In this way, the sensitivity to gauge variation is reduced while producing a substantially tight roll. However, this technique is still sensitive to gauge variation and is further complicated by the changing weights of the winding rolls as material is wound on the rolls. Since the weight of each roll is constantly changing, it becomes necessary to add or subtract from the surface contact pressure continuously during build up of the wound rolls. To overcome this with existing machinery requires a complicated counterbalancing system.

An object of the present invention is to provide a method and an apparatus for winding flexible material wherein the surface winding pressure is substantially independent of the changing weight of the roll or any component of this weight as the roll builds up during winding. A further object is to provide a relatively simplified control system for applying the surface winding pressure, a system that can be easily and accurately set, adjusted and controlled in accordance with the requirements for the particular type and width of the film being wound. Another object is to provide a method and apparatus to improve the efficiency of slitting and winding by permitting slitting and winding to be conducted in a continuous manner. Other objects will appear hereinafter.

The invention involves a web winding apparatus which comprises, in combination, a positively driven surface winding drum, a core-supporting, positively-driven mandrel spaced from, in the same horizontal plane with the axis of, and parallel to the axis of the surface winding drum; a core upon which the web is wound mounted on the core-supporting mandrel, the surface winding drum being in peripheral rotating contact with the web being wound on the core; a support assembly supporting the core-supporting mandrel and adapted to move substantially frictionlessly in a horizontal plane away from said surface winding drum as the web is wound on the core to form a roll on the core; and means for applying a predetermined pressure on the support assembly whereby a substantially uniform density throughout the thickness of the roll on the core is provided.

The principle of the invention is particularly applicable to a web slitting machine. In a web slitting machine composed of a web supply from which a continuous web is fed; means for slitting the web into a plurality of continuous strips; a positively driven surface winding drum over which the strips pass; at least one positively driven core-supporting mandrel spaced from, in the same horizontal plane with the axis of, and parallel to the axis of the surface winding drum; and cores disposed on the core-supporting mandrel in peripheral rotating contact with the strips being wound on the cores to form rolls, the invention involves the improvement wherein the core-supporting mandrel or mandrels are themselves supported on a support assembly or assemblies, the support assemblies adapted for substantially frictionless horizontal movement; and means for applying a predetermined pressure on the support assemblies to provide a substantially uniform density throughout the thickness of the rolls wound on the cores.

In the process for slitting and winding wherein a web of flexible material is slit into a plurality of strips and each strip is wound on a separate core by leading the strips over a driven drum to their respective core, the core mounted in slipping contact on a driven mandrel, in peripheral contact with the driven drum, and in the same horizontal plane as the axis of the driven drum, the process improvement of the present invention arises from the substantially frictionless movement in a horizontal direction of the core (along the same horizontal center line as the driven drum) from the driven drum as the strip builds up on the core.

The invention will be more clearly understood by referring to the following description read in conjunction with the drawings, in which the same reference numbers indicate the same parts in the various views.

FIGURE 1 is a plan view of a preferred embodiment of the apparatus of the invention; and

FIGURE 2 is a side elevation of the preferred embodiment.

Referring to the figures, a plastic film or similar flexible web of material 11 is unwound from a supply roll, not shown, and passed through a nest of isolation rolls

12. These rolls serve to isolate the tension on the web between the isolation rolls and the surface winding drum or platen roll 14. From the isolation rolls, the web is next passed through the slitting section 13 where it is slit into narrower widths or strips. The strips are then led concurrently around idler roll 9 to the surface winding drum 14. The drum 14 is supported in bearings, not shown, at each end by supports 10A and 10B and is rotated by motor means, schematically indicated in FIGURE 1 of the drawing as M_1.

From the drum 14, one of the strips 11B of the web is led to core 15 and the other strip 11A is led to core 16. It should be understood that although only two widths are shown, one being wound on core 15 and the other being wound on core 16, several cores could be mounted on each of the mandrels or rewind shafts 17 and 18. In this way a plurality of strips greater than two could be provided by the slitter and wound on the plurality of cores. Similarly, only a single strip can be wound on either mandrel, as in a trimming operation. It should also be understood that instead of a slitting section 13, slitting may be done at other locations.

The mandrels or rotatable rewind shafts 17 and 18 which support the cores 15 and 16, respectively, are rotated by motor means, schematically indicated in FIGURE 2 of the drawing as M_2 by way of illustration with respect to rewind shaft 18, preferably at a rate greater than the linear rate provided by the drum 14. The rate of rotation of mandrels 17 and 18 is gradually reduced during the build-up of slit material on cores 15 and 16 to provide a substantially constant linear rate that is about 10% greater than the linear rate provided by drum 14 throughout build-up. The resulting slippage of cores 15 and 16 on mandrels 17 and 18 will compensate for any gauge variations in the material being wound.

Mandrel 17 is fitted into side members 21A and 21B and mandrel 18 is fitted into side members 22A and 22B. The side members are mounted pivotably on shafts 29 and 30 which in turn, are fitted within bearings, not shown, and within openings in support stands 23 and 24. The support stands have cylindrical longitudinal openings in their bases which permit them to be mounted on low friction bed ways. The bed ways are each composed of shafts 25 (25A and 25B) and 26 (26A and 26B) operating within linear ball bearings 27 and 28.

Illustrated schematically by the arrows at 31 and 32 are hydraulic or pneumatic pressure systems. These systems provide a force which is transmitted to the surface winding drum 14, the force serving substantially as the surface rewind pressure. As the slit web builds up on each of the cores 15, 16 or the like, the substantially frictionless bed way permits the core and its complete supporting means to move away from the surface winding drum in compensation for the increase in the amount of rewound material 11A or 11B on the cores. However, the increased weight of the rewind roll will make substantially no contribution to the effective force at the interface of the roll and the surface winding drum. This important fact; namely, that the increased weight of the rewound roll has little if any effect on the force at the interface of the roll being wound and the surface winding drum is illustrated as follows:

The total force at the interface is made up of two components, F_1, the surface winding pressure imposed by the controllable pressure systems 31 and 32 and, F_2, the frictional force which is dependent upon the total weight of the support assemblies (the core, the rewind shaft, the support stand and the changing weight of the rewind roll as material builds upon the core) multiplied by the coefficient of friction, which coefficient may vary from 0.002 to 0.004, preferably no greater than about 0.01. The weight of an 18-inch diameter cellophane roll is 12.4 lbs./inch of width.

It is generally desired to keep the total surface pressure of the material on the rewind roll on the surface winding drum constant throughout build-up of the roll at 2–3.5 lbs./inch of width. Under the conditions of greatest possible error; namely, 2 lbs./inch of width pressure and the maximum coefficient of friction 0.004, the system of the present invention will be in error by 2.5%, i.e.

$$\frac{(.004)(12.4)}{2.0}\times 100$$

in providing the desired total surface pressure of 2 lbs./inch of width when the roll is fully wound. This maximum error will be reduced to 0.7% for a winding pressure of 3.5 lbs./inch of width surface. Furthermore, each of these percentages will be cut in half, to 1.25% and 0.35% respectively, if the coefficient of friction is reduced to 0.002. Higher coefficients of friction than 0.004 are acceptable if one is willing to accept the greater errors that would be inherent.

After the desired amount of slit material has been wound on cores 15 and 16, an electrical mechanism is actuated which starts the rotation, by motor means not shown, of shafts 29 and 30. This serves to rotate arms 21A, 21B, 22A and 22B, and to pivot the mandrels 17 and 19 at one end and 18 and 20 at the other end about the shafts 29 and 30. As the rolls 11A and 11B pivot, the cut-off knives, rolls and brushes shown at 33 and 34, actuated by a pneumatic or hydraulic cylinder when the web of material is in position, are rotated toward the web. The knives 33A and 34A cut the web; the brushes 33B and 34B wipe the leading edges of the remaining webs of material onto new cores on mandrels 19 and 20, each core containing adhesive on its outer surface; and rolls 33C and 34C hold the webs on the new cores as the mandrels 19 and 20 rotate to wind the web thereon. Lay-on rolls 35, 36, 37 and 38 contact the surface of the wound rolls 11A and 11B during transfer to prevent telescoping of the outer layers of the web.

After transfer is completed, the new roll is permitted to build up to the desired diameter using the previously-described technique. In the meantime, the wound rolls are removed from the inactive mandrels 17 and 18 and new cores are mounted thereon in preparation for the next transfer. The operation described permits continuous slitting and winding of a web of material while providing substantially constant contact pressure on the surface of the rolls being wound throughout the winding operation. It should be understood that the turrets, which are each composed of a support stand 23, two shaft supports 21A and 21B, and two mandrels 17 and 19 can be operated together, as shown in the previous description, or independently. If operated independently, the operator can control the final diameter of each wound roll separately.

The apparatus is not limited to the winding of cellophane, polyethylene terephthalate film, polyethylene film or similar plastic films. It may be used for winding any material into a wound roll having a controlled, preferably substantially uniform, density throughout the thickness of the roll.

Having fully described the invention, what is claimed is:

1. In a web winding apparatus which comprises, in combination, a positively-driven surface winding drum and means for driving said surface winding drum; a core-supporting, positively-driven mandrel spaced from, in the same horizontal plane with the axis of, and parallel to the axis of said surface winding drum; means for driving said core-supporting, positively-driven mandrel; a core, upon which the web is wound, mounted on said core-supporting mandrel, said surface winding drum being in peripheral rotating contact with the web being wound on said core; the improvement wherein a support assembly is provided to support said core-supporting mandrel, said support assembly having bearing elements on which said core-supporting mandrel is rotatably supported, said support assembly also having base portions and low friction

bed ways, said base portions mounted on said low friction bed ways and said support assembly adapted to move on said low friction bed ways positioned in a horizontal plane different from the first-mentioned plane and movable in a direction to and fro with respect to said surface-winding drum such that said core-supporting mandrel moves correspondingly to and away from said surface-winding drum with the axes of said drum and said mandrel always parallel and in the same horizontal plane, as said web is wound on the core to form a roll on said core under the influence of a coefficient of friction of 0.002–0.01; and means are provided for applying a predetermined pressure on said support assembly whereby a controlled density throughout the thickness of the roll on the core is obtained.

2. In a web winding apparatus which comprises, in combination, a positively-driven surface winding drum and means for driving said surface winding drum; two core-supporting, positively-driven mandrels spaced from, in the same horizontal plane with the axis of, parallel to the axis of, and on either side of said surface winding drum; means for driving said core-supporting, positively-driven mandrel; at least one core upon which web is wound mounted on each mandrel, said surface winding drum being in peripheral rotating contact with the web being wound on each core; the improvement wherein support assemblies are provided to support said core-supporting mandrels, said support assemblies each having bearing elements on which said core-supporting mandrels are rotatably supported, said support assemblies also having base portions and low friction bed ways, said base portions mounted on said low friction bed ways and said support assemblies adapted to move on said low friction bed ways positioned in a horizontal plane different from the first-mentioned plane and movable in a direction to and fro with respect to said surface winding drum such that said core-supporting mandrels move correspondingly to and away from said surface winding drum with the axes of said drum and said mandrels always parallel and in the same horizontal plane, as said web is wound on the core to form a roll on said core under the influence of a coefficient of friction of 0.002–0.01; and means are provided for applying a predetermined pressure on said support assemblies whereby a controlled density throughout the thickness of the roll on each core is obtained.

3. In a web slitting machine comprising a web supply from which a continuous web is fed; means for slitting said web into a plurality of continuous strips; a positively-driven surface winding drum over which said strips pass; means for driving said surface winding drum; core-supporting mandrels spaced from, in the same horizontal plane with the axis of, parallel to the axis of, and on

either side of said surface winding drum; means for driving said core-supporting mandrels; at least one core disposed on each of said core-supporting mandrels, said surface winding drum being in peripheral rotating contact with the strips being wound on said cores to form rolls on said cores; the improvement wherein support assemblies are provided to support said core-supporting mandrels, said support assemblies each having bearing elements on which said core-supporting mandrels are rotatably supported, said support assemblies also having base portions and low friction bed ways, said base portions mounted on said low friction bed ways and said support assemblies adapted to move on said low friction bed ways positioned in a horizontal plane different from the first-mentioned plane and movable in a direction to and fro with respect to said surface winding drum such that said core-supporting mandrels move correspondingly to and away from said surface winding drum with the axes of said drum and said mandrels always parallel and in the same horizontal plane, as said web is wound on the core to form a roll on said core under the influence of a coefficient of friction of 0.002–0.01; and means are provided for applying a predetermined pressure on each support assembly whereby a controlled density throughout the thickness of the roll on each core is obtained.

4. Apparatus as in claim 2 wherein each core-supporting mandrel is mounted on a support member, said support member also adapted to support an unused mandrel parallel to said core-supporting shaft and wherein each support member is pivotably disposed and adapted to rotate so that the unused mandrel can be transferred into the original position of the core-supporting mandrel.

5. A machine as in claim 3 wherein each of said core-supporting mandrels is mounted on a support member, said support member also adapted to support an unused mandrel parallel to said core-supporting mandrel, each support member is pivotably disposed and adapted to rotate so that the unused mandrel can be transferred into the original position of the core-supporting mandrel.

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