Aug. 25, 1959 E. D. NYSTRAND 2,901,192

WEB WINDING MANDREL

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Fig. 1

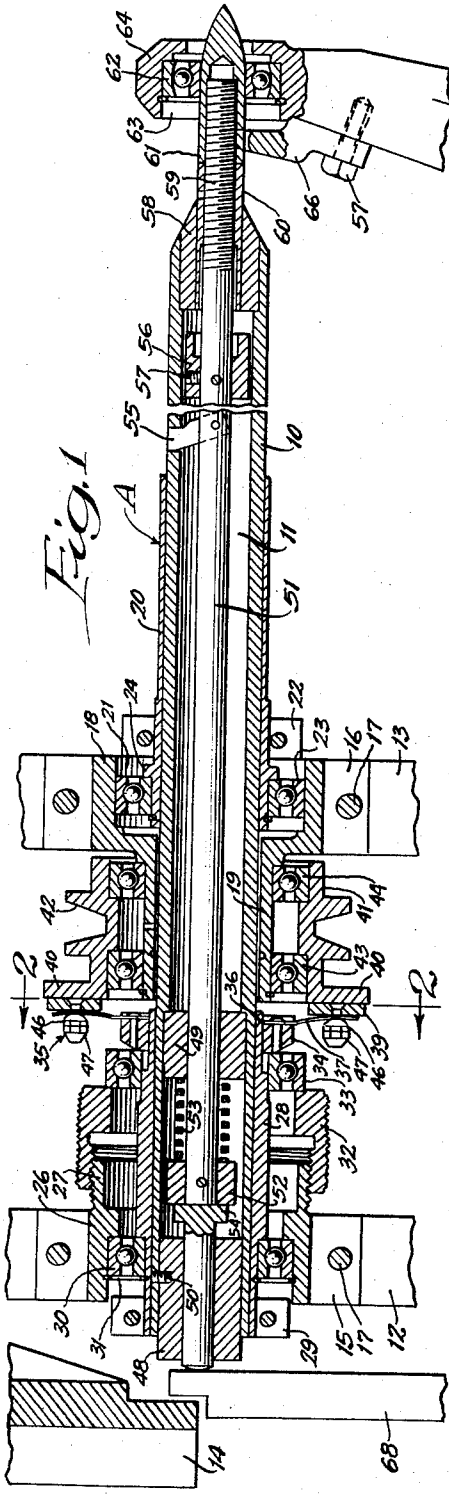


Fig. 3

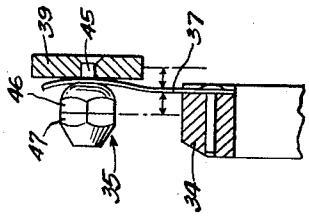
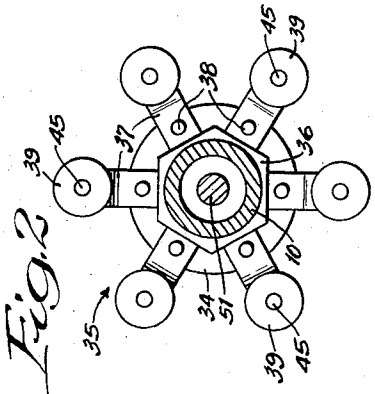


Fig. 2



INVENTOR:
Ernst Daniel Nystrand,
BY
Dawson, Tilton & Graham,
ATTORNEYS.

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WEB WINDING MANDREL

Ernst Daniel Nystrand, Green Bay, Wis., assignor to Paper Converting Machine Co., Inc., Green Bay, Wis., a corporation of Wisconsin

Application May 12, 1955, Serial No. 507,822

12 Claims. (Cl. 242—75.5)

This invention relates to a web winding mandrel and is particularly useful in the rewinding of thin paper webs from a parent roll. The web winding mandrel of this invention may be used, for example, in the automatic web rewinding machine disclosed in the copending application of Edwin M. Kwitek and Ernst D. Nystrand, Serial No. 299,108, filed July 16, 1952 now Patent No. 2,769,600 issued November 6, 1956.

While the web winding mandrel of this invention may be used in a variety of environmental conditions and with various web winding machines, it is desired in order to provide a setting for the invention to the end that the invention will be better understood, to describe briefly a web winding machine with which the invention may be used, and in such description reference will be made in particular to the web winding machine disclosed in the above-identified patent application.

The machine there disclosed comprises a turret that is adapted to be rotated intermittently to move a plurality of elongated mandrels extending laterally therefrom through a plurality of operating stations. At one station the mandrels, which are supported in a cantilever fashion, have an elongated paper core inserted thereover. The core equipped mandrel is then moved to a second station wherein the core is severed into a plurality of relatively short segments. At such time the core is locked on the mandrel. Thereafter the core equipped mandrel is moved through a glue station wherein an adhesive or glue is applied to the segmented core, and next the mandrel is moved toward a winding station wherein a thin paper web is secured to the glued core, and the mandrel rotated so as to wind the web upon the core. During the winding operation the web is slit longitudinally into a plurality of strips having substantially the same width as the core segments. Following the winding of a predetermined amount of web onto the segmented cores, the mandrel is again moved to a further station, and at this time the web is severed and thereafter the severed end of the web is secured to the web roll that has been wound on each of the segmented cores. In a subsequent stripping station the core is released from the mandrel and all of the segmented cores with their wound webs are stripped from the mandrel preferably by automatic machinery.

In the web rewinding stations the mandrels initially must be rotated at a relatively high rate of speed, and the speed of rotation must progressively decrease as the amount of web wound upon the core increases in thickness. The speed of the rotating mandrel, and particularly the decrease in the rotational speed thereof as the webbing wound thereon increases in thickness, is controlled by the tension applied against the mandrel by

the thin paper web. Thus, the webbing itself and the speed with which it is drawn from a parent roll determines the rotary speed of the mandrel and brings about a decrease in the speed thereof as progressive layers of webbing are wound upon the cores.

Several problems have been present in the prior art web rewinding machines, and one of these problems arises through the particular drive arrangement employed for rotating the mandrels during the web rewinding operation. Considerable web breakage has occurred during this operation because of the inability of the relatively thin paper webs to overcome the inertia of the rotating mandrels and reduce the rotational speed thereof as the web thickness increases on the cores. This problem will be better apppreciated if it is realized that the papers handled by the machinery often have relatively low tensile strength, as toilet tissue for example.

Another problem that has arisen is web breakage that is caused by vibration, and especially vibration of the mandrel. A large portion of the mandrel vibration has been caused by the stresses applied to the mandrel or parts thereof during the web winding operation. The vibration becomes particularly bad as the rotational speed of the mandrels approaches the critical speed; that is, the natural frequency of vibration of the mandrel, and stressing the mandrel at such time further aggravates the tendency toward vibration.

It is apparent that a need exists for a better mandrel structure, and it is accordingly an object of this invention to provide an improved mandrel structure that will overcome a number of the disadvantages present in prior art structures, and particularly those set forth above. Another object of the invention is to provide a web winding mandrel and drive means therefor that permits the relatively small tensions that can be applied by thin paper webs to overcome the inertia of the rotating mandrel structure to control and retard the rotational speed thereof. Still another object is in the provision of a clutch drive for rotating a mandrel in which friction pads engaging a drive wheel provide substantially the same frictional or driving engagement therewith irrespective of the rotational velocity of the mandrel.

A further object is in the provision of a clutch mounted concentrically upon a mandrel and having a plurality of spring biased friction pads engaging a drive wheel, the friction pads being counterbalanced so that the frictional engagement between the friction pad and drive wheel remain substantially constant, irrespective of the rotational velocity of the mandrel. Additional objects and advantages will appear as the specification proceeds.

An embodiment of the invention is illustrated in the accompanying drawing, in which—

Figure 1 is a longitudinal sectional view of a mandrel structure embodying the invention; Figure 2 is a transverse sectional view taken on the line 2—2 of Fig. 1; and Fig. 3 is a broken, enlarged longitudinal sectional view of a portion of the friction clutch.

The mandrel assembly is designated generally with the letter A. It includes an elongated mandrel **10** that is tubular and provides a chamber or bore **11** extending longitudinally therethrough. The mandrel **10** is a cantilever mandrel and is supported for rotational movement adjacent one end thereof, the other end normally extending freely outwardly from the rotational support means for the mandrel. However, in certain operative positions of the mandrel when it is incorporated in a web

rewinding machine, the free end thereof is adapted to be supported, and in Figure 1 such a support means is illustrated.

In Figure 1 the mandrel is shown supported in spaced apart spiders **12** and **13** that together comprise a turret adapted to be rotatably driven by an appropriate drive mechanism, such as a Geneva drive **14**. Since the turret, the spiders **12** and **13** thereof, and the Geneva drive **14** form no part of this invention per se, the entire mechanism is not shown in the drawing and will not be described in this specification. For details of a complete machine in which the mandrel structure A may be mounted, reference may be made to copending application Serial No. 299,108, identified hereinbefore.

The spiders **12** and **13** provide respectively bosses **15** and **16** that are contoured for receiving portions of the mandrel assembly therein, and which have threaded studs **17** extending outwardly therefrom that are adapted to project through caps (not shown) that will cooperate with the bosses for securely anchoring the mandrel assembly in position within the spiders **12** and **13**.

Rigidly clamped within the boss **16** is the enlarged end portion **18** of a sleeve **19** that is positioned coaxially about the mandrel **10**, but is spaced therefrom so that the mandrel may rotate freely relative to the sleeve. Slidably mounted upon the mandrel **10** is an elongated stop sleeve **20** having an end portion thereof received within the chamber **21** defined within the enlarged end portion of the sleeve **19**, and having also a portion that extends laterally outwardly therefrom along the circumferential surface of the mandrel. The stop sleeve **20** is snugly received about the mandrel **10**, and while being slidable with respect thereto, is slightly compressible so that the axial position of the stop sleeve upon the mandrel can be maintained by a clamp collar **22** that extends about the sleeve **20** and is effective to compress it tightly upon the mandrel. An antifriction bearing **23** is interposed between the enlarged end portion **18** of the sleeve **19** and the stop sleeve **20**. The axial position of the bearing **23** upon the stop sleeve **20** is determined by a laterally extending flange **24** with which the stop sleeve **20** is equipped, and that provides on one side an abutment for the bearing **23**. Adjacent the opposite side of the bearing the stop sleeve **20** is channeled for receiving a snap washer **25** that abuts the bearing **23**. The bearing **23** then provides one rotational support for the mandrel **10**.

Rigidly locked within the boss **15** of the spider **12** is an enlarged tubular screw **26** having a threaded end portion **27** that extends outwardly from the boss **15** and along the mandrel **10**. The screw member **26** is considerably larger than the mandrel **10**, and while being coaxially positioned thereabout, provides considerable clearance between the mandrel and internal surface of the screw. The mandrel **10** has coaxially positioned thereabout a drive sleeve **28** that is slidable longitudinally along the circumferential surface of the mandrel, but may be locked in position thereon by means of a clamp collar **29**. Interposed between the tubular screw **26** and the drive sleeve **28** is an antifriction bearing **30** that provides the rotational support for the mandrel within the spider **12**. The bearing **30** on one side thereof abuts an enlarged central portion of the sleeve **28**, and on the other side thereof abuts a snap ring **31**.

Threadedly received upon the end portion **27** of the screw **26** is an adjusting nut **32** that bears on one side thereof against the outer race of an antifriction bearing **33**. The inner race of the bearing **33** bears against the drive ring **34** of a friction clutch assembly designated generally with the numeral **35**. The drive ring **34** is splined or keyed about the drive sleeve **28**, as shown in Figure 1, so that the drive ring and drive sleeve cannot rotate relative to each other. The antifriction bearing **33** serves as a thrust bearing working between the mandrel **10** and the spider **12** through the intermediate parts described.

The clutch assembly, as is shown most clearly in Figure 2, comprises, in addition to the clutch ring **34**, a plurality of equally spaced-apart leaf springs or arms **37** that at their inner ends are received within appropriate slots provided in the ring **34** and are secured therein by means of the pins **38**. The outer end portions of the springs **37** are slightly arcuate and bear toward the right, as viewed in Figure 1, so as to urge the friction members or friction pads **39** into engagement with the face **40** of a drive wheel or pulley **41** having a circumferential V-shaped channel **42** extending thereabout adapted to receive a V-shaped drive belt therein. The pulley wheel **41** is mounted upon the sleeve **19** by means of spaced-apart antifriction bearings **43** and **44** that permit the drive pulley to rotate freely relative to the sleeve **19**.

The friction pads **39** may be formed of any suitable friction material and, for example, fiber or cork may be employed. The friction pads are secured to the leaf springs **37** by means of screws **45** that extend through the pads, through the leaf springs and threadedly receive thereon a pair of lock nuts **46** and **47** that serve as counterweights or balances for the friction pads and serve a function that will be described hereinafter. It is apparent from an inspection of Figure 1 that as the pulley wheel **41** is rotated, it frictionally engages the pads **39** and through the clutch ring **34** and drive sleeve **28** is effective to rotate the mandrel **10**.

Mounted within the hollow mandrel **10** in spaced-apart relation are a pair of bronze bearing members **48** and **49** that may be secured in axial positions within the mandrel by means of pins or set screws, such as the set screw **50**. Slidably mounted within the bearings **48** and **49** is a core locking rod **51** that is elongated and extends substantially the entire length of the mandrel **10**. Pinned to the rod **51** intermediate the bearings **48** and **49** is a stop **52** that serves as a seat for a coil spring **53** that at its opposite end seats upon the bearing **49**. Adjacent the stop or seat member **52** is an enlarged flange **54** that may be formed integrally with the rod **51** and that serves as a stop that abuts the inner side of the bearing **48** and limits axial movement of the rod toward the left, as viewed in Figure 1, under the biasing action of the coil spring **53**. Pivotally secured within appropriate slots provided in the rod **51** are a plurality of locking fingers or dogs **55** that extend into circumferential openings provided in the surface of the mandrel **10**. While in Figure 1 only one locking finger **55** is illustrated, it will be apparent that a plurality of locking fingers are required and the locking fingers will be arranged axially along the mandrel and rod **51** in spaced-apart relation, and at least one locking finger will be provided for every core segment carried by the mandrel **10**. Axial movement of the rod **51** is guided by a glide member or collar **56** that is locked on the rod **51** by means of a set screw **57**. The guide **56** is freely slidable longitudinally within the mandrel **10**.

A bearing **58** is positioned within the outer free end of the mandrel **10** and the threaded end portion **59** of the rod **51** extends therethrough and threadedly receives thereon an inner guide sleeve **60** and an outer locking guide sleeve **61**. The outer end of the guide sleeve **61** is tapered, as shown in Figure **1**, and is adapted to extend through a self-aligning antifriction bearing **62** provided within an opening **63** through the head **64** of a guide support arm **65**. A bifurcated guide **66** is secured to the arm **65** by a cap screw **67**, and the spaced legs thereof are positioned adjacent the opening **63** and serve to guide the sleeve **61** into the self-aligning bearing **62** of the arm head **64**. The support arm **65** is provided by a web rewinding machine, such as the one described briefly hereinbefore, and is movable between the position shown in Figure 1 wherein it is supporting the free end portion of the mandrel **10** and a retracted position wherein it is withdrawn from the

mandrel 10 and moved clear thereof. The support 65 functions to stabilize the mandrel 10 during rotational movement thereof in certain of the operating stations of a web rewinding machine.

It is clear from Figure 1 that the coil spring 53 tends to bias the rod 51 toward the left wherein the locking fingers 55 are extended outwardly through the surface of the mandrel 10 when a core is threaded onto the mandrel 10 and when the wound core or core segments are stripped therefrom the locking fingers must be retracted into the mandrel, as is shown in Figure 1, so as to afford free movement of the core upon the mandrel. The core is free of the mandrel only during the period when a core is inserted onto the mandrel and where the wound core is withdrawn therefrom. In order to move the rod 51 to the right and withdraw or retract the locking fingers 55 a stationary cam 68 may be provided by the web rewinding machine at the loading and feeding stations and as the turret or spiders 12 and 13 carry the mandrel 10 through various operating stations the cam 68 will be engaged by the laterally projecting end portion of the rod 51 and will function to move the rod inwardly to retract the locking fingers.

Operation

In operation of the apparatus the mandrel assembly A will first be located with the cam 68 engaging the rod 61 to retract the locking fingers 55. At the same time the support arm 65 will be withdrawn from the guide sleeve 61. The mandrel 10 will then be in condition to have an elongated continuous paper core inserted thereon. The core will be moved onto the mandrel until it abuts the stop sleeve 20. As has been brought out hereinbefore, the stop sleeve 20 is slidable upon the mandrel 10 when the clamp collar 22 is released so that the precise position of the stop sleeve may be adjusted for accurately positioning a core upon the mandrel. After a core has been threaded onto the mandrel, the mandrel assembly will be carried to subsequent operating stations in a web rewinding machine wherein the core will be cut into segments, glue applied thereto and finally the mandrel assembly will then be moved toward a web winding station.

In the movement of the mandrel assembly into the web winding station, the V-shaped channel 42 engages a moving V-shaped belt. The wheel 41 will then commence to rotate and through the face 40 thereof which bears against the friction pads 39, the leaf springs 37, the ring 34 and drive sleeve 28 to which it is secured, the mandrel 10 will be rotated. At such time the rod 51 will be free of the cam 68 so that the core or core segments will be locked against rotational movement relative to the mandrel 10 and the support arm 65 will be in the position shown in Figure 1.

After a web has been wound upon the core the mandrel assembly will be moved into a stripping station and at this time the cam 68 will move the rod 51 into the position shown in Figure 1, and the arm 65 will be retracted from the mandrel so that the wound core segments can be stripped therefrom.

The guide 66 on the arm 65 initially engages the pointed guide sleeve 61 as the arm moves into position to receive the guide sleeve therein. Since the bearing 62 is a self-aligning bearing the guide sleeve 61 and consequently the rod 51 and mandrel 10 are rotatably supported within the arm 65 with no stress or strain imparted to the mandrel assembly by the support. The mandrel assembly, in other words, is supported at its free end in the normal position. This feature is important in reducing vibration of the mandrel for it has been found that any stresses imparted to the mandrel, directly or indirectly, amplify any vibrational tendency of the mandrel.

Vibration is further minimized by placing the rod 51 under a slight tension when it is in its normal position with the locking fingers 55 projecting outwardly from the circumferential surface of the mandrel and lockingly engaging a core received upon the mandrel. The tension is caused by the coil spring 53 which biases the rod toward the left, as viewed in Figure 1, and the locking fingers 55 which are engaging a core and thereby tend to prevent or to limit the extent of movement of the arm 51 toward the left. Normal tension within the core locking rod 51 is contrasted with the usual compression of such a locking rod during the time the locking fingers are in extended position.

Through most of the operating stations in an automatic web rewinding machine the drive wheel 41 is out of engagement with the drive belt employed in the machine, and if the mandrel is to be rotated rotational movement is imparted thereto through some other arrangement. However, when the mandrel is moving into the web winding station, the V-shaped groove 42 propressively approaches and finally engages a complementary V-shaped drive belt and rotation of the mandrel commences. On the other hand, as the mandrel assembly is being moved out of a web-winding station, the drive wheel 41 progressively moves out of engagement with the drive pulley and rotation of the mandrel is shortly terminated. As has been brought out before, the velocity or rotational speed of the mandrel 10 must be progressively decreased as the extent or amount of webbing wound upon the cores increases. It is desired to effectuate an automatic decrease in the rotational velocity of the mandrel corresponding precisely to the amount of webbing wound about the mandrel at any time. This automatic regulation is provided by the tension exerted by the web which results in a resistance to free movement in the mandrel. The tension that can be exerted by thin paper, such as tissue paper, is very slight, but with the clutch arrangement described that tension, however slight, can be made to retard and progressively slow down the rotational velocity of the mandrel. There are several reasons for this.

In the first place a plurality of friction pads 39 are provided, and as a result, there is a limited frictional engagement with the face 40 of the drive wheel. Further, each friction pad is individually biased by a leaf spring into engagement with the face of the drive wheel and an equal distribution of the frictional engagement with the face 40 is provided thereabout.

Another reason is that the frictional engagement between the pads 39 and face 40 of the drive wheel can be accurately controlled and regulated. If it is desired to decrease the frictional engagement, the nut 32 is turned so as to advance it toward the spider 12, thereby decreasing the force imparted by the thrust bearing 33 against the clutch ring 34. Rotation of the nut 32 in the opposite direction will serve to increase the frictional engagement of the pads 39 with the face 40. The nut 32 is readily accessible and permits quick and easy regulation or adjustment of the driving friction between the pads 39 and drive wheel 41.

Another important reason is that the frictional engagement of the pads 39 with the face 40 is substantially independent of the rotational velocity of the mandrel 10. Thus, when the mandrel is rotating at a relatively high speed, the driving friction is substantially the same as when the mandrel is rotated at very slow speeds. The reason for this is that the lock nuts 46 and 47 are actually counterweights that balance the weight of the friction pads 39. By referring to Figure 3, which is an enlarged detail view of a single pad 39, counterweight assembly therefor and leaf spring 37 it will be seen that the friction pad 39 is spaced forwardly of the line wherein the leaf spring 37 is received within and supported by the ring 34. The distance between the center of the pad 39 and leaf

spring 37 is designated in Figure 3 with the letter Y. The nuts 46 and 47, which comprise the counterweight, are spaced rearwardly of the leaf spring 37 and the distance between the center of gravity of the counterweight and the leaf spring at its point of engagement with the ring 34 is designated with the letter X.

As the ring 34 rotates, the centrifugal force within the pad 39 will tend to rotate the spring 37 in a counterclockwise direction about its point of engagement with the ring 34. Since the centrifugal force increases with the velocity of rotation of the ring 34 (also the mandrel 10 to which it is secured), the pad 39 would tend to be withdrawn from the face 40 of the drive wheel 41 and the frictional engagement therewith would decrease. On the other hand, as the speed of the mandrel or ring 34 decreased, the pad 39 would tend to more firmly engage the face 40 of the drive wheel. There would then be a changing frictional drive force that would vary with the rotational velocity of the mandrel.

With the counterweight arrangement shown, however, the center of gravity of the counterweight or nuts 46 and 47 is spaced rearwardly by a distance X from the leaf spring 37 and the distance X is substantially equal to the distance Y. Thus, the centrifugal force of the counterweight assembly would tend to rotate the leaf spring 37 in a clockwise direction about the friction ring 34 and substantially cancels the centrifugal effects on the leaf spring 37 of the pad 39. Thus, irrespective of the rotational velocity of the mandrel 10, the frictional engagement of the pads 39 with the face 40 of the drive wheel is substantially constant, and since that force can be adjusted, as has been described, small tensions that can be exerted by thin paper webs are sufficient to control and automatically regulate the rotational velocity of the mandrel as required in accomodating the rotational velocity to the amount of webbing wound about the mandrel.

While the nuts 46 and 47 act as counter balance for friction pads 39, it may not be always desirable to effect a completely balanced condition. With arrangement shown, it is possible to have a very light but sufficient pressure between the friction pads and the mating surface when the mandrel is at its highest speed at the transfer point when the web starts winding on the core. As the roll builds up and the mandrel slows down it is also possible to have this pressure progressively increase so as to achieve constant tension, if desired. More often a curve between constant torque and constant tension will produce a better wound roll and by proper counter balancing of the friction pads this may be achieved.

While the specific embodiment of the invention illustrated in the drawing has been described in considerable detail for purposes of fully and completely disclosing the invention in a useful setting, it will be aparent that those skilled in the art may vary these details substantially without departing from the spirit and principles of the invention.

I claim:

1. In a mandrel structure adapted for use in the winding of a web thereon, an elongated mandrel adapted to receive a core thereon, means for supporting that mandrel for rotation, a drive wheel rotatably mounted coaxially with said mandrel and being adapted to be rotatably driven, and a friction clutch asembly coaxial with said mandrel and being locked against rotational movement with respect thereto, said clutch assembly having friction elements frictionally and adjustably engaging said drive wheel for drivingly coupling it to said mandrel.

2. In a mandrel structure having an elongated mandrel adapted to receive a core thereon for having a web wound thereabout, means for suporting said mandrel for rotational movement, a drive wheel coaxial with said mandrel and adapted to be rotatably driven, and a friction clutch assembly coaxial with said mandrel and being locked against rotational movement with respect thereto, said clutch assembly having a plurality of individual friction elements, and individual means for each of said friction elements resiliently urging the same into frictional engagement with said drive wheel.

3. The structure of claim 2 in which said individual means each comprise a leaf spring, each of said leaf springs extending radially outwardly from said mandrel and at its outer end carrying one of said friction elements.

4. The structure of claim 3 in which each of said leaf springs is curved forwardly and caries a friction element on the forward side thereof, and in which each of said leaf springs on the rear side thereof and adjacent the friction elements carries a counterweight for balancing the centrifugal effects on the leaf spring caused by said friction element carried thereby.

5. In a structure of the character described, an elongated mandrel supported for rotational movement about the longitudinal axis thereof, a drive wheel supported coaxially about said mandrel for free rotational movement with respect thereto and being adapted to be rotatably driven, a friction ring mounted upon said mandrel and being locked against rotational movement with respect thereto, a plurality of spaced-apart leaf springs rigidly secured to said ring at circumferentially spaced-apart points thereabout and extending radially outwardly therefrom, each of said leaf springs being equipped on the forward face thereof with a friction pad and being biased so as to urge the friction pad into frictional engagement with said drive wheel, and a counterweight carried by each leaf spring on the rear side thereof for substantially cancelling the effects upon the leaf spring of the friction pad carried thereby.

6. The structure of claim 5 in which each of said leaf springs is curved forwardly.

7. In a friction drive for an elongated mandrel adapted to receive a core thereon for having a web wound thereabout, a drive wheel coaxial with said mandrel and adapted to be rotatably driven, a friction clutch assembly coaxial with said mandrel and locked thereon against rotational movement with respect thereto, said clutch assembly having a plurality of individual friction elements spaced outwardly of a central clutch ring, and individual means for each of said frictional elements resiliently urging the same into frictional engagement with said drive wheel.

8. The structure of claim 7, in which said individual means each includes a member extending radially outward of said clutch ring and at its outer end carrying a friction element and a counterweight on opposite sides thereof.

9. The structure of claim 8, in which the friction elements are offset from the surface of said clutch ring adjacent said drive wheel, whereby the increased frictional engagement of said friction elements with said drive wheel at increasing speeds is opposed by the centrifugal force acting on said counterweights.

10. In a structure of the character described, an elongated shaft supported for rotational movement about the longitudinal axis thereof, a drive wheel supported coaxially about said shaft for free rotational movement with respect thereto and being adapted to be rotatably driven, a friction ring mounted upon said shaft and being locked against rotational movement with respect thereto, a plurality of spaced-apart arms rigidly secured to said ring at circumferentially spaced-apart points thereabout and extending radially outwardly therefrom, each of said arms being equipped on the forward face thereof with a friction pad, said pad being biased so as to be urged into frictional engagement with said drive wheel, and a counterweight carried by each arm on the rear side thereof.

11. The structure of claim 10, in which the centers of gravity of said pads and said counterweights are located at approximately equal distances from said arms.

12. In a mandrel structure, an elongated mandrel supported adjacent one end thereof for rotational movement, a friction clutch assembly equipped with a plu-

rality of spaced-apart arms carried by said mandrel, a drive wheel adapted to be driven and being in operative engagement with the arms of said clutch assembly for rotating said mandrel therethrough, a support arm having a head provided with an opening therethrough, a self-aligning bearing mounted within said opening, and a guide sleeve carried by said mandrel, said support arm being adapted to align with said drive sleeve for receiving the same within said self-aligning bearing.

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