Jan. 14, 1969 J. A. SCROGGIE ET AL 3,421,712

STATIONARY SWIFT

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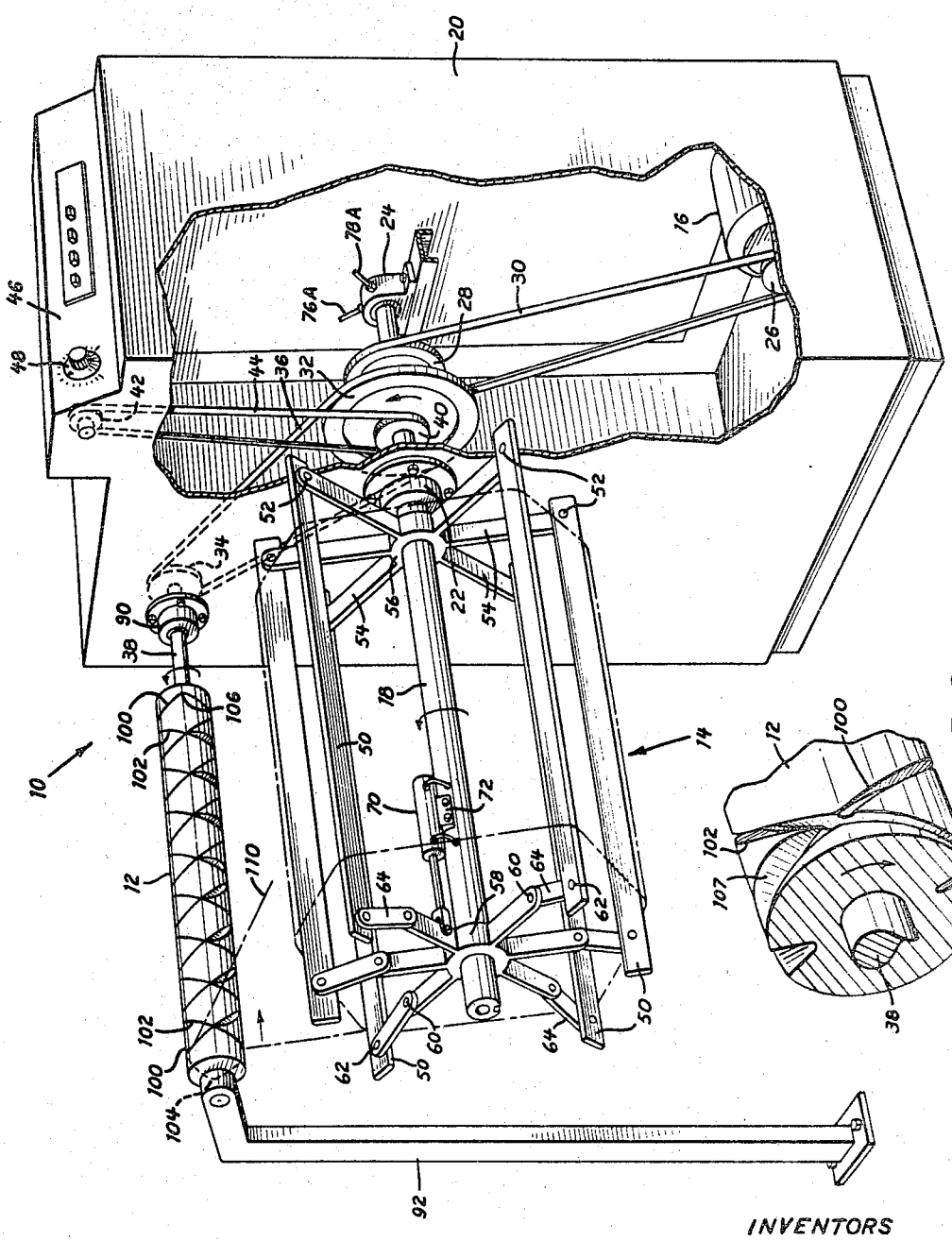

FIG. 1

FIG. 7

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FIG. 2

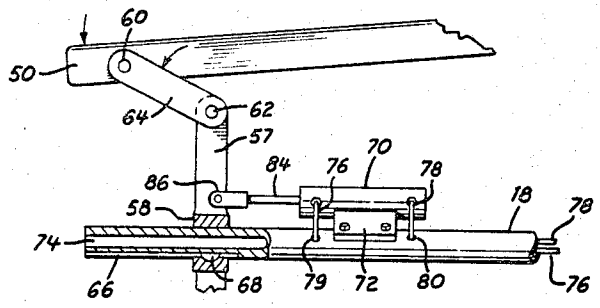


FIG. 3

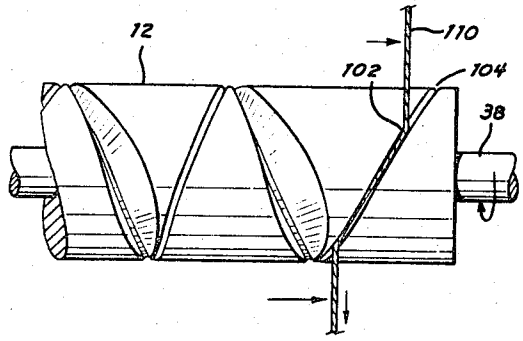


FIG. 4

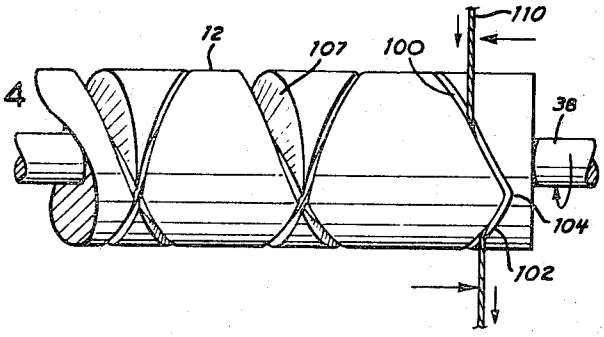
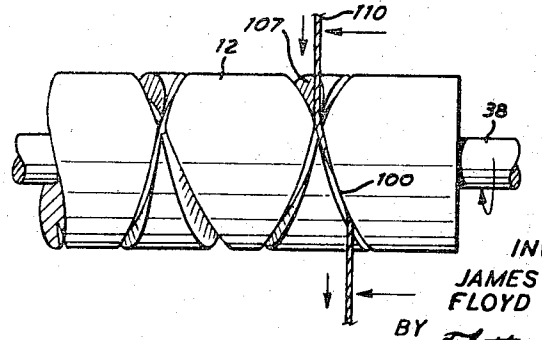


FIG. 5



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STATIONARY SWIFT

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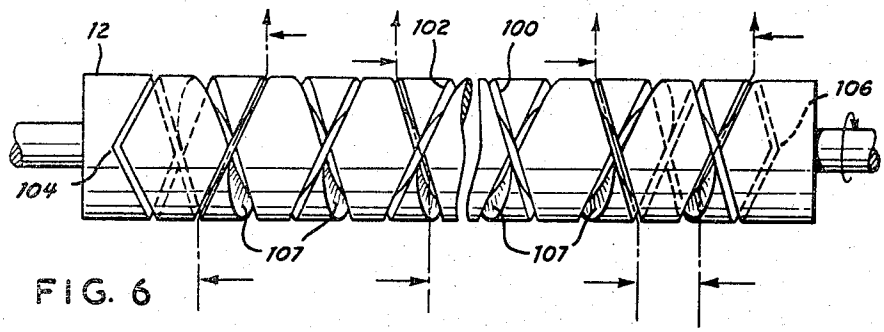

FIG. 6

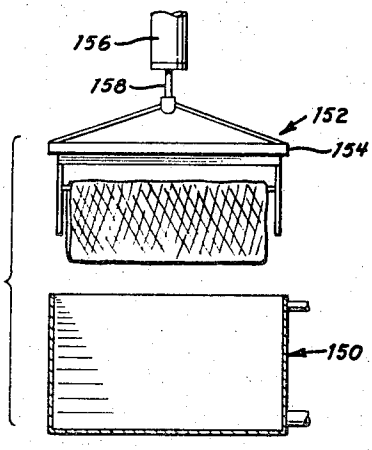

FIG. 8

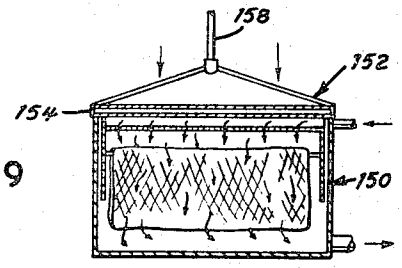

FIG. 9

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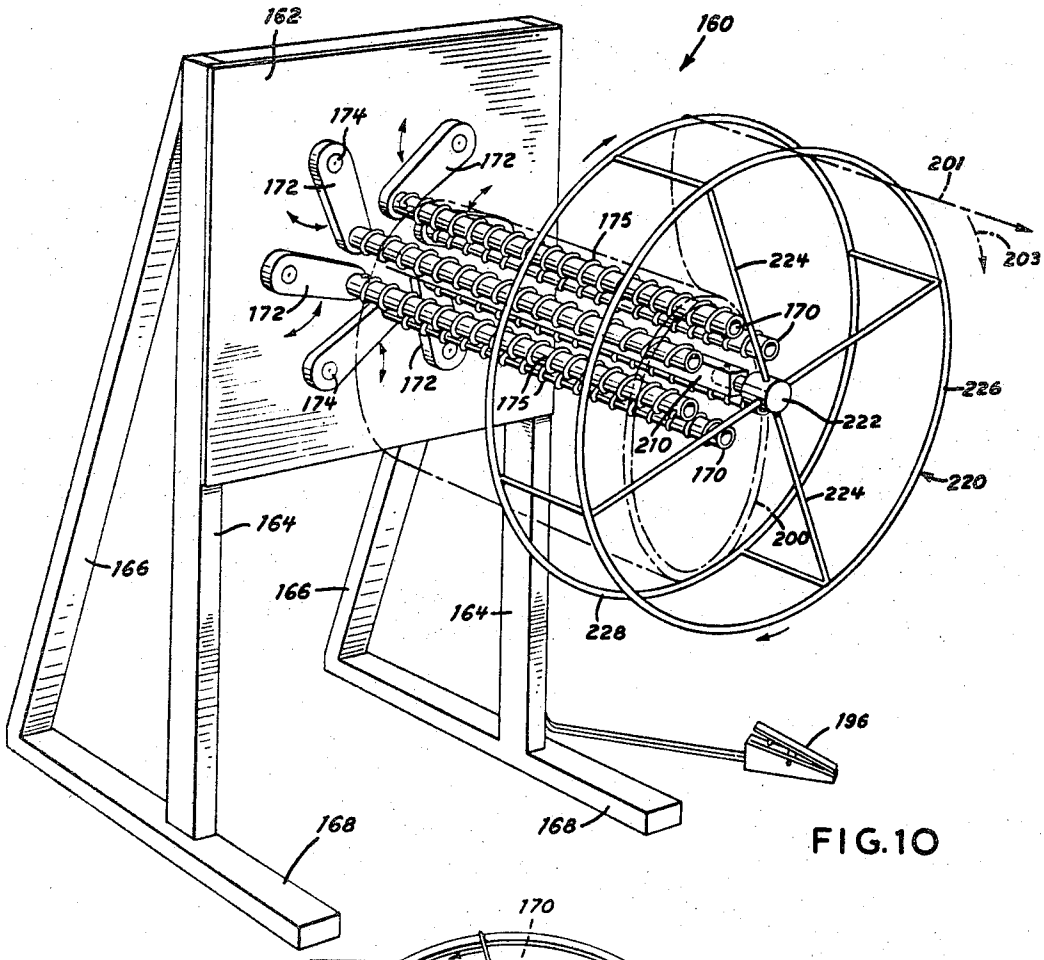

FIG. 10

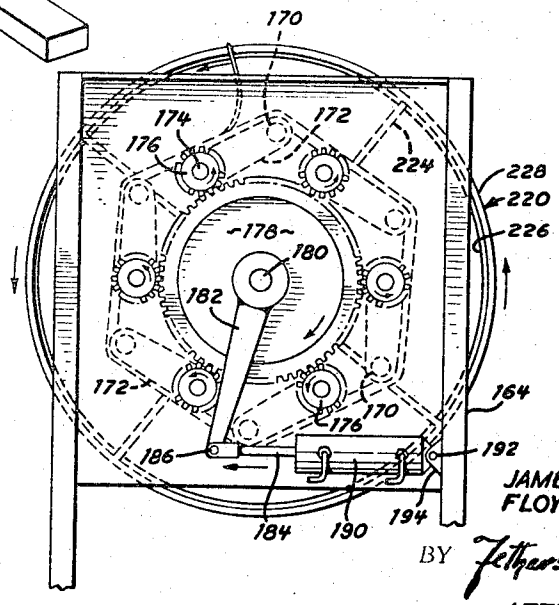

FIG. 11

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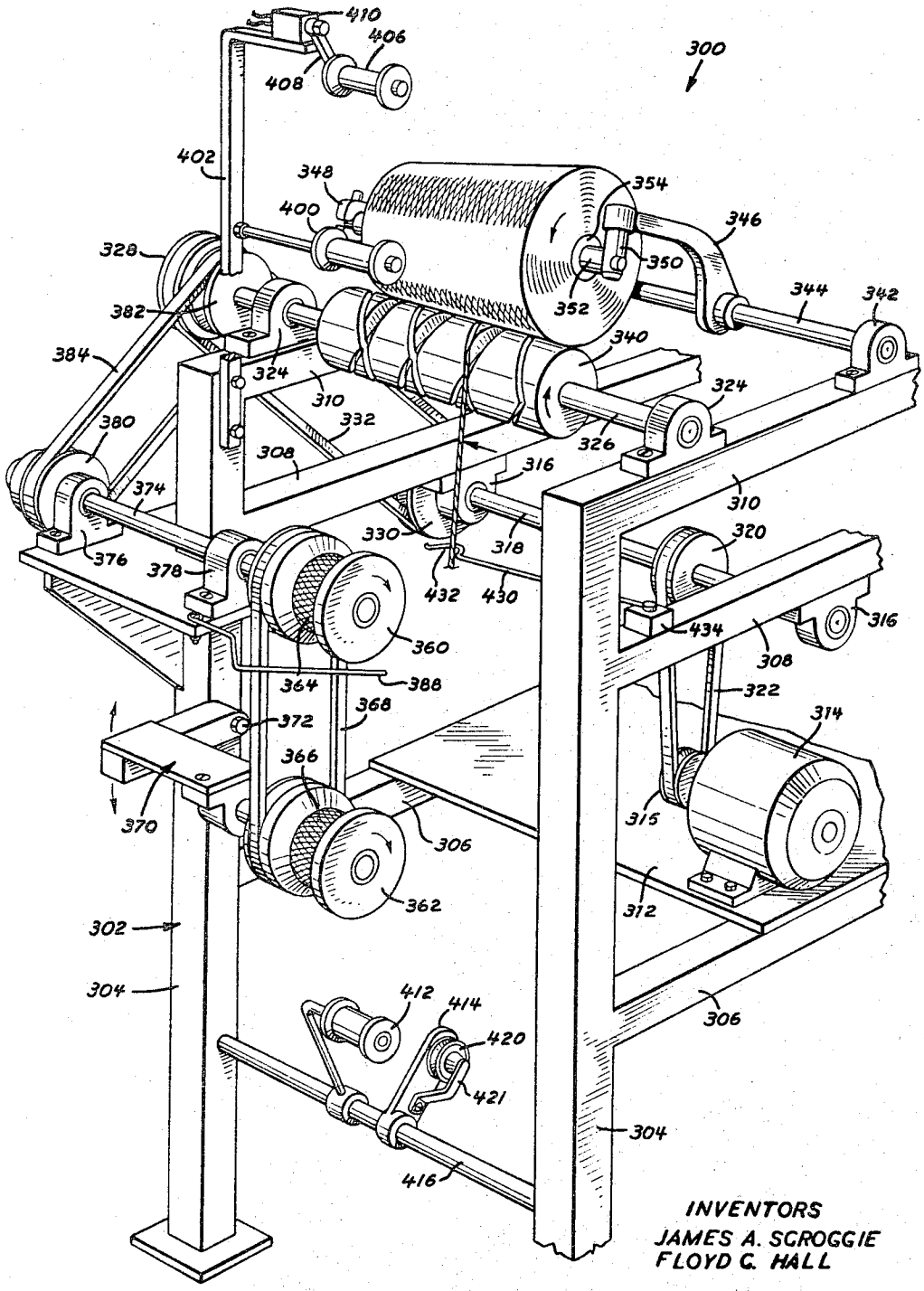

FIG. 12

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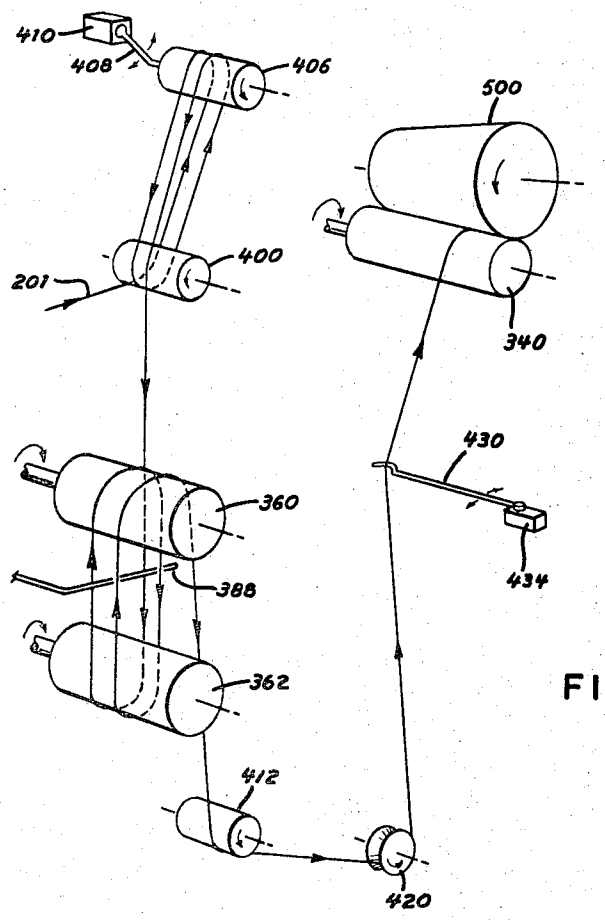

FIG. 13

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3,421,712

STATIONARY SWIFT

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Filed Apr. 25, 1966, Ser. No. 545,147
Claims priority, application Canada, May 18, 1965, 930,932; Jan. 6, 1966, 949,260
U.S. Cl. 242—110.1 6 Claims
Int. Cl. B65h 75/24

ABSTRACT OF THE DISCLOSURE

A stationary swift comprising a plurality of circumferentially spaced support arms forming a radially expandable mandrel adapted to support a wound skein for unwinding, a wire coil extending spirally around each of the support arms to prevent lateral movement of the skein on the arms, a rotatable guide ring mounted coaxially with respect to the mandrel and located substantially centrally of the length of the mandrel, and means to adjust the size of the circumferential spacing of the support arms to vary the size of the mandrel.

This invention relates to a stationary swift for use in the handling of yarn.

It is well known to employ a rotary swift in the process involved in the transposition of yarn from a skein to a bobbin. The known rotary swift is generally in the form of a wire frame which is adapted to support a skein in an extended position. The swift is mounted for free rotation upon a shaft and the skein is unwound from the swift by applying a pulling force to the end, thereby causing the swift to rotate as the yarn is unwound from the swift. Customarily skeins are in the neighborhood of 6 ounces of weight and consequently it does not require any great pulling force to rotate a loaded wire frame type swift. The quality and uniformity of the yarn can be readily affected by the amount of tension to which it is subjected during the various processes to which it is subjected. Consequently if the weight of the skein was greatly increased, then the pulling force required to cause rotation of the rotary swift would have to be increased and this would have a detrimental effect upon the quality of the yarn and may in fact cause the yarn to break.

It is an object of the present invention to provide an apparatus which is adapted to permit yarn to be unwound from a skein without the application of a pulling force sufficiently great to cause any significant deterioration in the quality of the yarn.

It is a further object of this invention to provide an apparatus which is adapted to permit yarn to be unwound from a skein without rotating the skein.

It is a still further object of this invention to provide an apparatus which is adapted to permit yarn to be unwound from a skein of considerably greater weight than the conventional skeins heretofore known.

The present invention relates to an apparatus which is conveniently referred to herein as a stationary swift. The stationary swift comprises a frame which supports an expandable skein support means which comprises a plurality of horizontally extending arms which form an elongated mandrel. A skein is supported by the mandrel in an unwinding position when the arms are in their expanded position. Guide means in the form of a wire guide ring, which is preferably free to rotate, is also provided to guide the yarn as it is unwound from the skein. The guide means is located substantially equidistant between the ends of the mandrel and is spaced radially outwardly from the expanded skein such that the yarn

passes over the guide means as it is unwound from the skein.

The invention will be more clearly understood after reference to the following detailed specification read in conjunction with the drawings.

In the drawings:

FIGURE 1 is a pictorial partially sectioned view of the skein reel;

FIGURE 2 is a partial view of the collapsible reel of FIGURE 1;

FIGURE 3 is a partial view of a guide roll and the end being guided;

FIGURE 4 is a view similar to FIGURE 3 showing the change-over in traverse direction of the guided end;

FIGURE 5 is a view similar to FIGURE 3 showing the end traversing in the opposite direction to that shown in FIGURE 3;

FIGURE 6 is a detialed view of the guide roll of FIGURE 1 showing the form of the grooves;

FIGURE 7 (see sheet containing FIGURE 1) is a partial sectional view of the guide roll of FIGURE 1;

FIGURE 8 is an end view of a conventional skein dyeing vat;

FIGURE 9 is a sectional side view of a dye vat showing the circulation of the dye;

FIGURE 10 is a pictorial front view of a stationary swift;

FIGURE 11 is an end view of the stationary swift of FIGURE 10;

FIGURE 12 is a pictorial view of the skein winder; and

FIGURE 13 is a diagrammatic representation of the path followed by the end in the bobbin winder of FIGURE 11.

With reference to the drawings, the end is wound into a skein on the skein reel which is generally indicated by the reference numeral **10** in FIGURE 1. The skein reel **10** includes a driven guide roll **12** and a driven collapsible reel **14** onto which the yarn is wound to form a skein. In the preferred embodiment the skein reel **10** is used to wind a single skein and in this respect the present invention differs from the conventional skein reel which winds a plurality of ends onto a large collapsible reel to form a plurality of independent skeins.

A housing **20** is adapted to enclose a variable speed electric motor **16** and to support a rotatable shaft **18** of a collapsible reel. The shaft **18** is adapted to rotate within bearings **22** and **24** and extends hoirzontally outwardly from the housing **20**. The electric motor **16** drives the shaft **18** by means of pulleys **26** and **28** and drive belt **30**. The pulley **28** is keyed to the shaft **18**. A second pulley **32** of greaer diameter than the pulley **28** is also keyed to the shaft **18** and rotates with the shaft **18** to drive the pulley **34** by means of the drive belt **36**. The pulley **34** is rigidly keyed to the guide roll shaft **38** which is in turn keyed to the guide roll **12**. From the aforegoing it will be apparent that electric motor **16** drives the collapsible reel **14** and the guide roll **12**, and the required relative speed of the guide roll **12** and the collapsible reel **14** can be achieved by the selection of appropriate pulleys.

A third pulley **40** is rigidly secured to and rotates with the shaft **18**. The pulley **40** drives a revolution counter pulley **42** by means of the drive belt **44**. The pulley **42** drives a revolution counter which indicates the number of revolutions of the collapsible reel on the control panel **46** by means of an indicator **48**.

With reference to FIGURES 1 and 2, the collapsible reel **14** comprises a plurality of blades **50** which are pivotably connected by means of pivot pins **52** to the radially extending arms **54** of a spider wheel **56**. The

spider wheel **56** is rigidly keyed to the rotatable shaft **18** and rotates with the shaft **18** to drive the blades **50**. The blades **50** are pivotably connected at their other end to a second spider wheel **58** by means of pivot pins **60**, **62** and spacer link **64**. The spider wheel **58** is substantially the same as the spider wheel **56** but has shorter radially extending arms.

With particular reference to FIGURE 2 it can be seen that the rotatable shaft **18** is formed with a longitudinally extending key way **66** which is adapted to receive a key **68** carried by the spider wheel **58** such that the spider wheel **58** will rotate with the shaft **18** and may be moved longitudinally with respect to the shaft **18**. With reference to FIGURES 1 and 2 it will be apparent that as the spider wheel **58** moves inwardly from the position shown in FIGURE 1 to the position shown in FIGURE 2, the ends of the blades **50**, connected to the spider wheel **58** by means of the links **64**, will be collapsed inwardly toward the shaft **18** and the other end of the blade will will pivot at pivot pins **52** such that the reel **14** will be tapered toward the free end thereof to facilitate the removal of a skein.

Collapsing and expanding of the reel is achieved by means of a double acting pneumatic unit **70** which is rigidly secured to the shaft **18** by means of a clamping bracket **72**. As shown in FIGURE 2, the shaft **18** is formed with a bore **74** and the air lines **76** and **78** connecting to the pneumatic unit **70** pass into the bore **74** by way of openings **79** and **80**. The air lines **76** and **78** pass through the bore **80** to the bearing **24** wherein they communicate with stationary air lines **76A** and **78A** respectively. The air lines **76** and **78** rotate with the shaft **18** and communicate in a well known manner with the stationary air lines **76** and **78A** respectively by means of passageways (not shown) formed in the bearing housing **24**. The double acting pneumatic unit **70** is connected to a radially extending arm **57** of the spider wheel **58** by means of a direting rod **84** and a securement **86**. From the aforegoing it will be apparent that when air is applied to the double acting pneumatic unit **70** by way of the air line **76**, the spider wheel **58** will be drawn inwardly toward the pneumatic unit **70** and when air is supplied to the pneumatic unit by way of air lines **78**, the spider wheel **58** will be pushed outwardly away from the pneumatic unit **70**. The collapse and expansion of the collapsible reel **14** is achieved by means of the actuation of the double acting pneumatic unit **70**.

Referring once more to FIGURE 1, it can be seen that the guide roll **12** is carried by the guide roll shaft **38** which as previously described is driven by means of the pulley **34**. The guide roll shaft **38** is supported by a bearing **90** towards its inner end, the bearing **90** being rigidly supported by the housing **20**. The outer end of the guide roll shaft **38** is supported by and rotates relative to an upstanding support prop **92**. The upstanding prop **92** is preferably grouted in position to support the guide roll shaft such that the axis of rotation with the guide roll shaft **38** is substantially parallel to the axis of rotation of the rotatable shaft **18** of the reel **40**.

An important feature of the present invention is the use of a continuously rotating guide roll in combination with a collapsible reel. The rotatable guide roll replaces the conventional reciprocating guide means and overcomes the problem of the build-up of the end toward the edges of the skein normally associated with skein winding. In the dyeing process it is extremely important that the skein is of uniform thickness to ensure uniform colouring of the yarn.

In the known skein winders the traverse speed of the yarn as it is guided relative to the rotating skein, to wind a skein, is not constant. Generally the traverse speed of the yarn is greatest at the centre of the skein and decreases toward the edge of the skein. As the rotational speed of the collapsible reel is constant it follows that the amount of yarn wound onto the skein at any one point

is dependent upon the traverse speed of the end across the reel. Consequently in the known devices a greater amount of yarn is deposited toward the edges of the skein due to the reduced traverse speed of the end, and this build-up tends to cause uneven colouring of the yarn in the dyeing process.

The problem of providing an evenly wound skein has been overcome in the present invention by employing a guide roll of the type hereinafter described in detail which causes the end to traverse the width of the skein at a substantially uniform speed.

With reference to the drawings, it can be seen that the guide roll **12** is provided with spiral grooves **100** and **102** which extend over substantially the full width of the guide roll and which coincide with one another at cross-over points **104** and **106**. The groove **100** is adapted to cause the end **110** to traverse the guide roll in a direction from the cross-over point **104** to the cross-over point **106** and the groove **102** is adapted to cause the end **110** to traverse the guide roll from the cross-over point **106** to the cross-over point **104**.

With particular reference to FIGURES 3, 4 and 5, it can be seen that the reversal of the direction of traverse of the end is achieved by the rotation of the guide roll. In FIGURE 3 the end **110** is travelling in the groove **102** toward the cross-over point **104**. As the guide roll rotates to the position shown in FIGURE 4 the end follows the groove **102** to the cross-over **104** and then the direction of traverse of the end is reversed and the end follows the groove **100**. In the position shown in FIGURE 4 the portion of the end leading to the guide roll lies in the groove **100** and is traversing to the left while the portion of the end leading from the guide roll lies in the groove **102** and is traversing to the right. In the position shown in FIGURE 5 the end is in the groove **100** and is traversing to the left. At the cross-over points **104** and **106** the depth of both grooves decreases to facilitate the change-over from one groove to the other. It will be apparent that the traverse feed of the end is directly related to the pitch of the grooves. A principal object of the present invention is to provide skeins of even depth and it has been found that the best results can be achieved by increasing the pitch of the grooves over the last turn. This practice overcomes the increase in depth of the skein which arises from the folding over of the end required to achieve the reversal of direction of traverse.

In guiding the end across the width of the guide roll the end tends to reverse its direction of travel at each intersection. This problem has been overcome by making one groove deeper than the other at the intersections. When the end is travelling in a deep groove there is no danger of the end engaging the shallow groove and reversing its direction of traverse. As it has been found that there is greater difficulty encountered in moving the yarn outwardly from the centre portion of the guide roll to the cross-over points, the portion of each groove which carries the yarn away from the centre portion of the guide roll toward both ends of the roll have been cut deep and the portion of the grooves which move the yarn inwardly towards the centre portion of the guide roll have been cut shallow at the intersection points. A bail **107** is formed as shown in FIGURE 5 to guide the arm into the groove **100** which is moving the yarn towards the centre portion of the guide roll.

FIGURE 6 clearly shows the arrangement of the bails **107** and their relationship to the traversing direction of the end. Groove **100** is adapted to guide the end from left to right as seen in FIGURE 6 and the first portion of the groove which guides the yarn towards the centre portion of the roll is formed with bails **107** whereas the remaining portion of the groove which carries the yarn toward the edge of the guide roll is cut deep and does not have bails. The groove **102** is similarly provided with bails **107** over the portion which guides the end inwardly towards the centre portion of the guide roll.

When in use the guide roll is spaced from the unwinding package a minimum distance of 3 ft. and the deep grooves are preferably cut to a depth of 1¼" and the grooves are ⅜" deep at the crossing.

Due to the fact that the skein reel hereinbefore described forms a skein which does not have the edge build up which produces uneven colouring in the dyeing process, it is possible to increase the weight of the yarn wound into a single skein. Heretofore considerable difficulty has been experienced in obtaining the required uniformity of colouring when working with skeins weighing in excess of 6 ounces. The apparatus of the present invention has proved that skeins weighing from 5 to 6 pounds can easily be processed in the existing dye vats and the limiting factor is only the ability of existing equipment to handle the skeins of greater weight than have previously been employed. It is known that skeins weighing up to 12 pounds can be evenly wound upon the apparatus of the present invention and these can be dyed successfully with minor modifications to the existing dye vats.

The depth of the skein wound by the reel of the present invention will be substantially the same as the depth of the normal skein produced by the apparatus now in use. The normal depth of a skein is in the region of 2" on the reel. This is a factor which has been determined by the dyeing operation and any improvement in the dyeing operation could result in an increase in the skein depth.

The width of the skein wound by the apparatus of the present invention is preferably 10" to 28" and may go to 80". In the prior art skeins are normally wound in widths from 4" to 7".

Numerous advantages are derived from the fact that larger skeins can be wound on the skein winder of the present invention and a principal advantage lies in the fact that productivity can be increased by 4.5 or 5 to 1 with the corresponding reduction in processing costs.

The fact that the skeins are wound in larger packages means that there are fewer stoppages in the winding and unwinding process with a resultant increase in throughput and a reduction of waste due to the number of knots. The use of larger skeins also reduces the storage problems associated with work in progress and simplifies the programming of the work. Furthermore the skein reel apparatus hereinbefore described and the package winding apparatus described hereinafter are simpler to operate than the apparatus at present in use with the result that there is less skill required in their operation and this considerably reduces the operator training period and eliminates the stoppages which result from the failure of the operator to coordinate the various manipulations required in the operation of existing apparatus.

Passing now to the dyeing operation it is to be noted that the larger skeins provided by the skein winder of the present invention can readily be processed in the known dye vats and the design of the dye vats forms no part of the present invention. With reference to FIGURES 7 and 8 the dye vat is generally indicated by the reference numeral **150** and the skein carrier rack is generally indicated by the reference numeral **152**. The dye vat **150** is a substantially rectangular open chamber which is adapted to receive the carrier **152** such that the top cover **154** of the carrier **152** closed the open end of the dye vat when the carrier is operably located within the dye vat. The carrier **152** is carried by a hydraulic cylinder **156** by means of a connecting rod **158** and the carrier **152** is lowered into and raised out of the dye vat by the action of the hydraulic cylinder. When the carrier **152** is loaded with skeins it is loaded into the vat **150** and the dye is circulated through the vat first in one direction and then in the opposite direction in a well known manner.

After the dyeing process, the yarn is dried and then rewound into packages as is the practice in the conventional dyeing process.

FIGURES 10 and 11 illustrate the apparatus employed in the present invention which replaces the rotating swift of the conventional apparatus. For the purpose of this description, this apparatus is hereinafter referred to as a stationary swift and is generally indicated by the reference numeral **160** in FIGURE 10. The stationary swift **160** comprises a back plate **162** which is rigidly supported by upright support pillars **164**, struts **166** and base support members **168**. Six skein support arms **170** extend horizontally outwardly from the back plate **162** and are rigidly carried at their inner ends by link arms **172**. The support arms form an elongated mandrel adapted to support a skein in an unwinding position. The link arms **172** are rigidly connected to one end of rotatable shafts **174** which extend through the back plate **162** and are rotatable with respect to the back plate **162**. The other ends of the shafts **174** are adapted to rigidly carry planetary gears **176** which in turn engage the large sun gear **178** (see FIGURE 9). The planetary gears **176** are arranged at equally spaced apart points around the sun gear **178**. The sun gear **178** is rotatably mounted on a centrally located shaft **180** which is rigidly supported by the back plate **162**. A lever arm **182** is rigidly secured to the sun gear **178** and is adapted to rotate with the sun gear **178** about the shaft **180**. The free end of the lever arm **182** is pivotably connected to the free end of a piston rod **184** by means of a pivot pin **186**. The connecting rod **184** extends outwardly from a double acting pneumatic unit **190** which is pivotably connected at its other end to the support frame **164** by means of a pivot pin **192** and a bracket **194**. The double acting pneumatic unit **190** is adapted to provide a reciprocating motion of the connecting rod **184** which in turn transmits a rotational motion to the sun gear **178** by means of the connecting rod **182**. The rotational motion of the sun gear **178** causes the planetary gears **176** to rotate and this rotation is transmitted to the link arms **172**. In FIGURE 10 the skein support arms **170** are located in the collapsed position such that they are closely grouped to receive a skein as illustrated by the broken lines **200**. By activating the pneumatic cylinder **190** the planetary wheels are rotated as previously described to cause the link arms **172** to pivot and thereby move the skein support arms **170** outwardly to contact the skein in the manner shown in broken lines on FIGURE 11. A foot pedal **196** is conveniently located to activate the pneumatic cylinder to expand or collapse the skein support arms as required. The ability of the skein support arms to collapse inwardly considerably simplifies the handling of the skein and the provision of a pneumatic unit which applies the expansive force to the expanded skein ensure that the skein is subjected to a substantially constant expansive tension.

Each of the skein support arms **170** is provided with a spirally extending coil **175** which is rigidly connected to the support arms **170** adjacent each end thereof and prevents lateral movement of the skein during the unwinding process described hereinafter.

A central support shaft **210** is rigidly secured to the back plate **162** at its inner end and is centrally located with respect to the longitudinal axes of the skein support arms **170**. The support shaft **210** is adapted to rotatably carry a free floating guide wheel **220** at its outer end. The free floating wheel **220** comprises a central boss **222** which is adapted to rotate within an opening formed in the free end of the support shaft **210** and radially extending wire frame arms **224**. The frame arms **224** extend radially outwardly from the boss **222** and support an outer guide ring **226** and then the arms are bent over to extend horizontally toward the back support plate **162** to support a continuous inner guide ring **228** at their inner free ends; the diameter of the outer guide ring **226** being somewhat smaller than the diameter of the inner guide ring **228**; the diameter of both outer ring **226** and the inner ring **228** being greater than the external diameter of an expanded skein mounted on the support arms **170** (see FIGURE 11). An important feature of the stationary swift lies in the fact that the inner ring **228** is

located substantially equidistant between the inner and outer ends of the support arms **170** thereby ensuring the maximum inclination of the end relative to the skein as it is being unwound from the skein.

In use the free floating guide wheel **220** is removed from the end of the shaft **210** and the support arms **170** are collapsed to the position shown in FIGURE 10. A skein, shown by the broken lines **200**, is loosely placed over the support arms **170**. The free floating wheel **220** is then mounted on the shaft **210** as previously described and the end **201** shown in broken lines is fed over the inner ring **228** and the outer ring **226** as shown in FIGURE 10. The support arms **170** are then expanded to the position shown in FIGURE 11 by operating the foot pedal **196**. The end **201** is fed to a bobbin winder, described hereinafter, which pulls the end **201** in a direction substantially parallel to the horizontal axis of the skein, and causes it to unwind from the stationary skein. As the skein is stationary the unwinding is achieved by the pull applied to the end by the skein winder and this causes the end to rotate around the free floating wheel **220** in the direction of the arrow **203** (see FIGURE 10). It will be apparent that the direction of unwinding is determined by the way in which the skein is located on the swift. As the wheel **220** is free floating, the friction of the end passing over the inner and outer rings **228** and **226** causes the wheel to rotate freely and this action assists the lifting of the unwinding end from the stationary skein. The fact that the inner ring **228** is located equidistant between the outer and inner edges of the skein **200** causes the minimum unwinding angle of the end relative to the stationary skein to be greater than would be the case if only the outer ring **226** were employed, and this increases the tendency of the end to lift away from the skein rather than causing the end to move laterally across the skein during the unwinding process. It will be apparent that if the free floating wheel **220** were removed then the end could be removed from the expanded skein by applying a pulling force in a direction substantially parallel to the axis of the skein but this would cause the end, when unwinding from the inner edge of the skein adjacent the back plate **162**, to extend over and contact the surface of a large part of the skein and this would greatly increase the tension required to unwind the end and increase the likelihood of tangling during the unwinding process. It will also be apparent that the process could be carried out with the wheel **220** rigidly located relative to the centre shaft **210** such that it did not rotate, but it has been found that the best results are achieved by permitting the wheel to rotate freely. In a further modification of the guide means a single rotatable arm could be employed, the arm having an eyelet at the free end to receive the yarn and being rotatably mounted for rotation of the eyelet about the skein.

The end is rewound onto a package by means of the skein winder generally indicated by the reference numeral **300** in FIGURE 12. The skein winder **300** comprises a frame **302** which includes upright supports **304** and horizontal supports **306**, **308** and **310**. Only two upright supports **304** are shown in FIGURE 12 but it will be understood that the frame is symmetrical and includes four upright support posts. The horizontal supports **306** support a base plate **312** which extends therebetween and upon which is mounted an electric motor **314**. Bearings **316** are supported by the horizontal supports **308** and are adapted to rotatably locate a drive shaft **318**. The drive shaft **318** is driven by the electric motor **314** by means of pulleys **315** and **320** and drive belt **322**. The upper horizontal supports **310** carry bearings **324** which are adapted to rotatably locate drive shaft **326**. Drive shaft **326** is driven by means of pulleys **328**, **330** and drive belt **332**. The drive shaft **326** rigidly supports and drives a guide roll **340** which is substantially the same as the guide roll **12** previously described in detail with the exception that it is of less width. The horizontal supports **310** also carry bearings **342**, only one of which is shown in FIGURE 12. The bearings **342** support a rotatable shaft **344** substantially parallel to the shaft **326** of the guide roll. The shaft **344** carries bobbin support arms **346** and **348** which are rigidly secured to the shaft **344**. The support arm **346** is pivotally connected at its other end to a secondary support arm **350** which has an axis of rotation at right angles to the axis of rotation of the shaft **344**. The bobbin spindle **352** extends between the secondary shaft **350** and the support arm **348** and is adapted to support a free running bobbin spool **354**. The bobbin spindle **352** is detachably located with respect to the support arm **348** such that it can swing about the axis of rotation of the shaft **350** to permit the spool **354** to be mounted on or removed from the spindle **352**.

As previously stated the skein winder **300** is adapted to operate in conjunction with the stationary swift **160** and the winder provides the pulling tension on the end which causes unwinding of the end from the stationary swift. This pull is applied by means of driven pulleys **360** and **362** which are provided with knurled grooves **364** and **366** which provide a gripping surface capable of applying a pulling force to the end. The pulley **360** and **362** are interconnected by means of a drive belt **368** such that they rotate in the same direction at the same speed. The pulley **362** is rotatably mounted on a bracket generally indicated by the numeral **370** which is pivotably connected to the upright support **304** by means of a pivot pin **372** such that the pulley **362** is free to swing upwardly toward the pulley **360**.

The pulley **360** is keyed to a drive shaft **374** which is rotatably carried by bearings **376** and **378**. The drive shaft **374** is driven by means of pulleys **380** and **382** and drive belt **384**. The pulley **382** is rigidly mounted on the drive shaft **326** which as previously described is driven by the electric motor **314**.

An end separating wire **388** is rigidly secured to the frame and is bent to separate adjacent coils of the ends which extend around the pulleys **360** and **362** as will be described later.

The incoming end to the skein winder is fed over a pulley **400** which is rigidly carried by an upstanding support pillar **402** which is in turn rigidly secured to the frame. The pulley **400** is adapted to rotate freely upon the horizontally extending arm **404** which is rigidly secured to the upstanding member **402**. The end passes from the pulley **400** upwardly to a pulley **406** which is carried by a pivoting arm **408**. The arm **408** pivots relative to a control switch **410** which is carried by the upper end of the upstanding support **402**. The switch **410** is adapted to be operated by the movement of the pulley **406** in response to tension in the end which is wound about the pulleys **400** and **406** as will be described later. The switch **410** is operable to stop the electric motor **314** and bring the complete bobbin winder to a halt.

The end passes to the guide roll **340** by way of a guide pulley **412** and a slack take-up device **414** both of which are mounted on a cross bar **416** which extends between uprights **304**. The guide roll **412** and the device **414** are rigidly mounted with respect to the cross bar **416**. The slack take-up device **414** is provided with an expandable pulley **420** which has a spring **421** tending to increase the effective diameter of the pulley. A tension sensing arm **430** is formed with a semi-circular loop at its free end **432** and is pivotably connected to a cut-out switch **434** which is carried by the transverse support **308**. The arm **430** senses the tension in the end leading to the guide roll **340** and if the tension is relaxed then the arm pivots to interrupt the switch **434** which stops the electric motor **314** and thereby brings the bobbin winder unit to a halt.

In FIGURE 13, the path of the end through the various pulleys and tension sensing devices is clearly shown in schematic form. The reference numerals applied in FIGURE 13 correspond to those applied in FIGURE 12.

The end **201** comes from the stationary swift as previously described and leads to the guide roll **400**. The end is looped over the roll **406** and the roll **400**. The end **201** leads from the roll **400** to the drive pulleys **360** and **362** and is looped over these pulleys to provide two complete loops which are separated by the separating wire **388**. The end **201** then passes to the guide pulley **412** and then to the slack take-up pulley **420**. From the pulley **420** the end passes by way of the tension sensing arm **430** to the guide roll **340**. The end is then wound into the package **500** which is driven by contact with the guide roll **340**.

In operation the guide roll **340** and the pulleys **360** and **362** are driven and all other relating members are free running members. The pulling force for pulling the end from the skein is provided by the knurled pulleys **360** and **362**. The tension in the end leading to the driven rolls is sensed by the rolls **400** and **406** and if the tension exceeds a predetermined amount then the roll **406** is pulled toward the roll **400** and this actuates the switch **410** which de-energizes the electric motor **314** and applies a backing force to the driven members.

The tension sensing arm **430** is adapted to sense the tension in the end extending between the tensioning roll **420** and the guide roll **340**. In the event that there is not sufficient tension in the end to permit even winding of the bobbin, then the tension sensing arm will move forward and actuate the switch **434** which in turn deactivates the electric motor **314** and applies a breaking force to the complete unit.

From the foregoing it will be apparent that the tensioning means are operable to stop the bobbin winder **300** when the tension in the end increases to a point where the end would break and also when the tension decreases to a point where uneven winding of the bobbin would occur or when the end breaks.

Turning now to the consideration of the process as a whole, it will be apparent that this process provides an efficient method of skein dyeing yarn which comprises the steps of: winding the yarn from a bobbin onto a collapsible wheel, guiding the yarn transversely of the reel as it is wound onto the reel to wind it in layers of equal depth that extend fully across the reel, stopping the winding operation when a predetermined amount of yarn is wound onto the reel, collapsing the reel and removing the yarn as a skein, dyeing the skein, mounting the skein on a stationary swift and winding the yarn from the stationary swift onto a bobbin.

Referring once more to FIGURE 1, it can be seen that the end **110** is wound onto the expanded collapsible reel **14** to form a skein. The end is guided transversely of the reel as it is wound onto the reel by the guide roll **12** and the grooves formed in the guide roll are arranged as previously described to deposit a layer of even thickness across the width of the reel. When the required quantity of yarn is wound onto the reel the skein winder is stopped and the end is broken. The reel **14** is then collapsed by activating the pneumatic cylinder **70** and the skein is removed from the reel.

The skein then passes to the dyeing operation wherein a plurality of skeins are immersed in a dye vat and the dyeing fluid circulates the vat.

After the skein has been allowed to dry, it then passes to the stationary swift and is placed over the collapsed support arms **170**. The flyer ring **220** is then mounted on the shaft **210** and the end is lagged over the ring **228**. The collapsible arms **170** are then expanded to engage the skein **200** by actuating the foot pedal **196**. The end is fed to the skein winder **300** and the pull exerted by the bobbin winder causes the end to unwind from the stationary swift. The unwinding of the end from the stationary swift causes rotation of the flyer ring **220** and the rotation of the flyer ring assists the lifting of the end from the skein. The fact that the inner ring **228** is located centrally with respect to the expanded skein prevents the unwinding end from dragging across the skein and thereby avoids the danger of tangling.

In the final operation the end is rewound by the skein winder **300**. In the skein winder the end is at first led over a tension sensing device which is sensitive to excessive tension which could cause the end to break. This tension sensing device is arranged to stop the skein winder before a tension capable of breaking the yarn is produced, and further, the device provides a slack which prevents the end from breaking due to the delay in time between the excessive tension being sensed and the time when the drive means is finally halted. It is to be noted that this sensing device is placed between the stationary swift and the drive pulleys carried by the skein winder which unwind the end from the stationary swift.

The end passes from the tension sensing device to the drive pulleys **360** and **362** which unwind the end from the skein and feed the end to the guide roll **340**. The end is wound onto a package spool **354** by the friction created between the bobbin spool and the guide roll **340** and the tension in the end leading to the bobbin is sensed by the tension sensing device **340** as previosuly described.

An important feature of the present invention is the fact that the apparatus is capable of speeds considerably greater than those previously known.

The speed of winding from the package to the reel is limited by the strength of the yarn and it has been found that most common yarns can be processed at speeds from 600 to 1500 yards per minute. This compares favourably with the speeds commonly used in the prior art which are generally in the region of 200 to 600 yards per minute with a possible maximum speed of 1200 yards per minute.

When winding from the skein to the package, the apparatus of the present invention is capable of operating at speeds from 600 to 1500 yards per minute, again the upper limit being determined by the strength of the yarn. In the prior art the conventional working speeds are in the region of 120 to 450 yards per minute.

It will be apparent from the foregoing speed comparisons that a considerable increase in speed can be achieved and when this fact is considered together with the fact that greater lengths of yarn are being processed, it will be apparent that the efficiency of the overall process is greatly increased.

The quality and uniformity of the yarn can be greatly affected by the amount of tension to which it is subjected and the uniformity of the tension. In the normal process the yarn is subjected to considerable tension when it is unwinding from the rotating swift as it is the tension in the yarn which causes the swift to rotate. In the apparatus of the present invention there is very little tension in the end as it is unwinding from the stationary swift and feeding to the package and consequently there is little or no stretching of the yarn.

The depth of the yarn on the reel must be such that it can be properly dyed in the vat as a skein. According to present practice the depth of the skein is about two inches and is adapted to fit the pole distances in the skein kettle. The width of the skein is preferably about 22". This represents a substantial increase in the width over normal practice which is between 4 and 7". Certainly to achieve advantages from the present invention a width greater than 10" is necessary having regard to the standard depth of two inches. The upper limit of the width of the skein is dictated by practical considerations, 40" however is contemplated and even larger if dyeing equipment can be designed. The essence of the invention is the provision of means whereby the overall weight of the skein can be increased and this is done by arranging the layers so that they are of equal depth and extend fully across the skein as distinct from having the skein of a greater depth at the edge portions.

What we claim is:

1. A stationary swift adapted to support yarn which has been wound into a skein, said swift comprising: a

frame, a plurality of skein support arms arranged to extend parallel to one another at substantially equally spaced circumferential intervals, said arms having surfaces adapted to support a skein in a tubular form for unwinding, ridge means formed on said surfaces of said support arms and extending substantially transversely of the longitudinal extent of said arms to prevent lateral movement of an unwinding skein relative to said support arms, a plurality of link arms, an end of each link arm being connected to one end of a support arm, the other end of each link arm being pivotably connected to said frame at substantially equally spaced circumferential intervals, a planetary gear wheel rigidly secured to each of said link arms, a sun gear wheel rotatably carried by said frame and arranged to mesh with said planetary gear wheels, actuating means adapted to rotate said sun gear wheel which in turn rotates said planetary gear wheels which in turn causes said link arms to pivot relative to said frame to uniformly vary the size of the circumferential intervals between said support arms as required in use.

2. A stationary swift adapted to support yarn which has been wound into a skein, said swift comprising; a frame, a plurality of skein support arms arranged to extend parallel to one another at substantially equally spaced circumferential intervals, said arms having surfaces adapted to support a skein in a tubular form for unwinding, a wire coil extending spirally around each of said support arms to prevent lateral movement of an unwinding skein relative to said support arms, a plurality of link arms, an end of each link arm being connected to one end of a support arm, the other end of each link arm being pivotably connected to said frame at substantially equally spaced circumferential intervals, a planetary gear wheel rigidly secured to each of said link arms, a sun gear wheel rotatably carried by said frame and arranged to mesh with said planetary gear wheels, expansion means adapted to rotate said sun gear wheel which in turn rotates said planetary gear wheels which in turn causes said link arms to pivot relative to said frame to uniformly vary the size of the circumferential intervals between said support arms and apply a substantially constant expansive tension to a skein mounted on said mandrel, freely rotatable continuous guide ring means spaced radially outwardly from and substantially centrally of said support arms to guide an unwinding end of a skein circumferentially about an unwinding skein and to maintain it at an angle to the tubular form of the outer surface of the unwinding skein.

3. A stationary swift adapted to support yarn which has been wound into a skein, said swift comprising, a frame, skein support means carried by said frame forming a radially expandable elongated mandrel adapted to support a skein between the ends of the mandrel in tubular form, ridge means formed on the surface of said mandrel and extending substantially transversely of said mandrel to prevent lateral movement of an unwinding skein relative to said mandrel, rotatable guide ring means spaced radially outwardly from said mandrel to guide an unwinding end of a skein circumferentially about an unwinding skein and maintain it at an angle to the tubular form of the outer surface of the mandrel.

4. A stationary swift as claimed in claim **3** wherein said guide ring is co-axially mounted with respect to the axis of said mandrel and radially outwardly substantially centrally of the length of said mandrel.

5. A stationary swift as claimed in claim **3** wherein said skein support means comprises a plurality of horizontally extending support arms arranged to extend parallel to one another at substantially equally spaced circumferential intervals, a plurality of link arms, an end of each link arm being rigidly connected to one end of a support arm, the other end of each link arm being pivotably connected to said frame, adjusting means adapted to cause said link arms to pivot relative to said frame to uniformly vary the size of the circumferential intervals between said support arms, a horizontally extending support shaft extending coincidently with the axis of said mandrel, the inner end of said shaft being rigidly connected to said frame, the outer end of said shaft rotatably supporting said guide ring.

6. A stationary swift adapted to support yarn which has been wound into a skein, said swift comprising a frame, stationary skein support means carried by said frame and forming an elongated mandrel adapted to support a skein between the ends of the mandrel in tubular form for unwinding, rotationally mounted guide ring means spaced radially outwardly of the said support means to guide an unwinding end of a skein circumferentially about an unwinding skein and maintain it at an angle to the tubular form of the outer surface of the unwinding skein, said guide ring being co-axially mounted with respect to said mandrel and located substantially centrally of the length of the mandrel.

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