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(54) **CORELESS WINDING APPARATUS**

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(57) **ABSTRACT**

Disclosed is an apparatus for forming coreless paper rolls. The invention is an inflatable mandrel that can take on an increased diameter while a paper web is being wound around its outer surface. The mandrel can then be deflated to decrease the diameter sufficiently to allow for the removal of the paper roll.

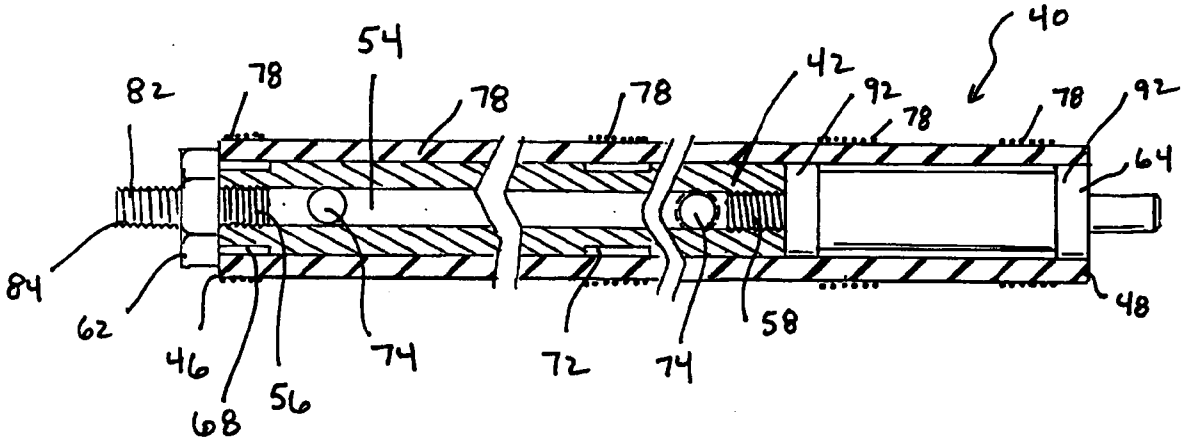
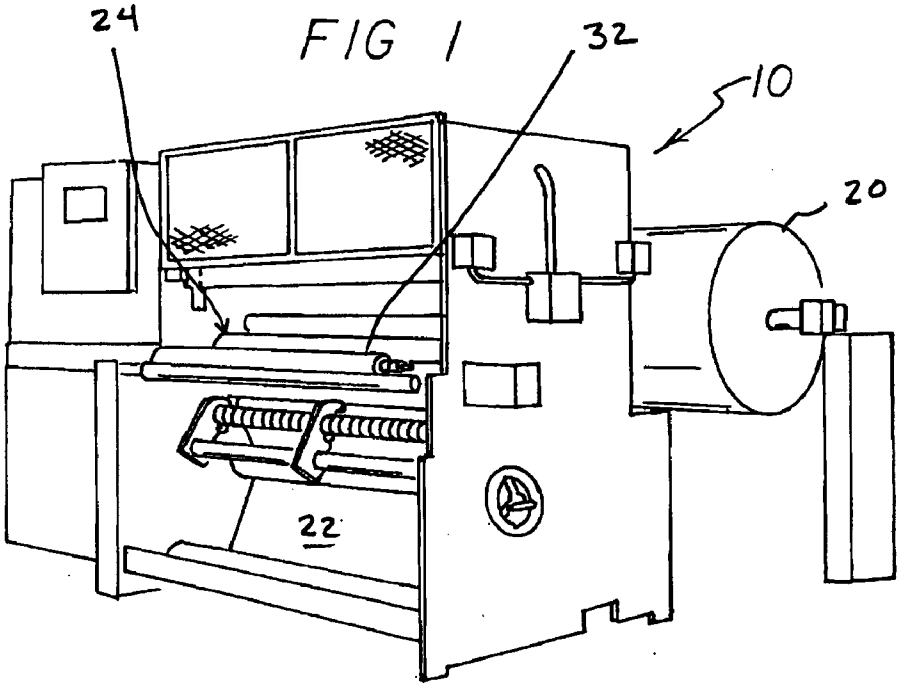


FIG 1



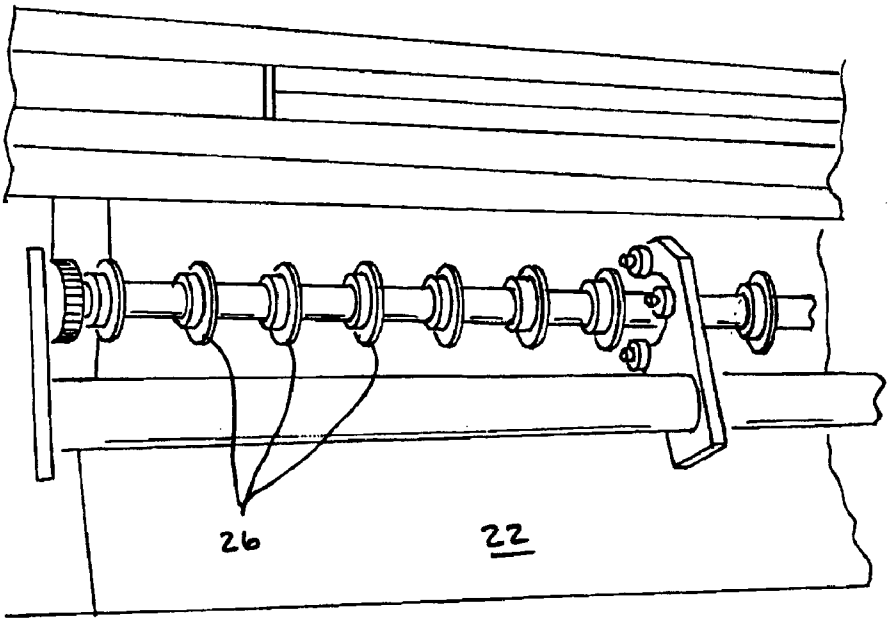
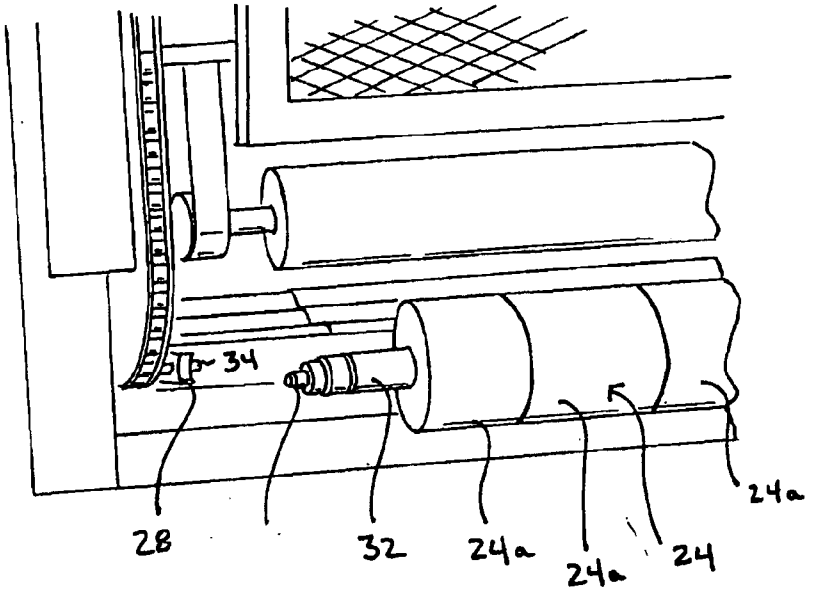


FIG 2

FIG 3



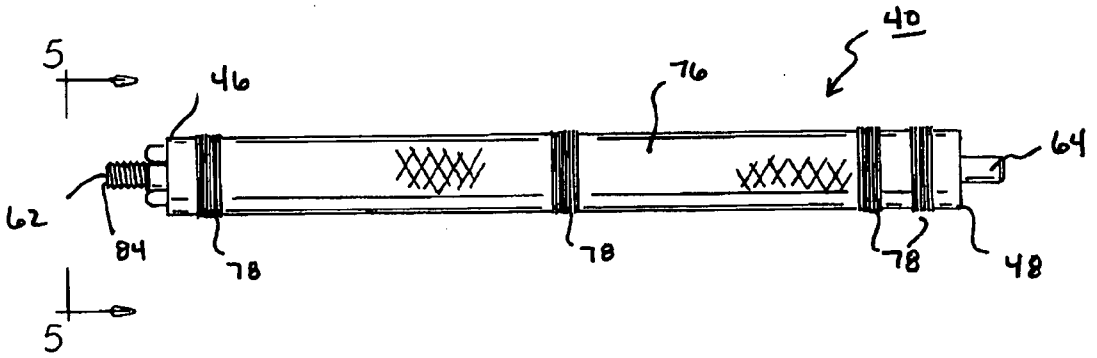
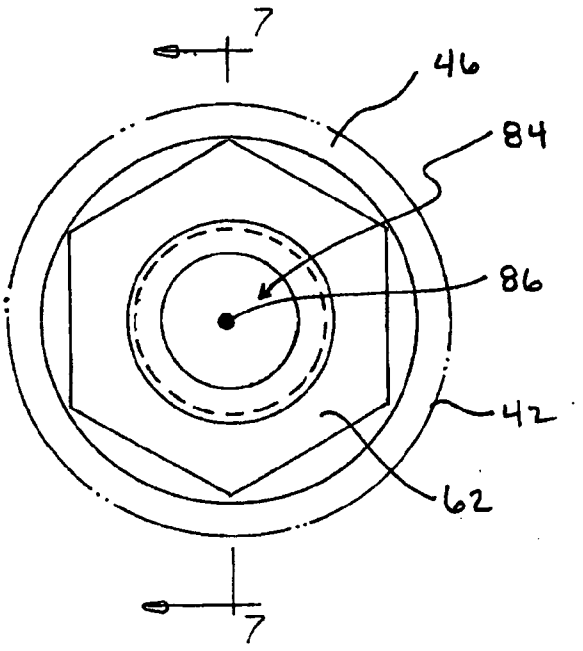


FIG 4

FIG 5



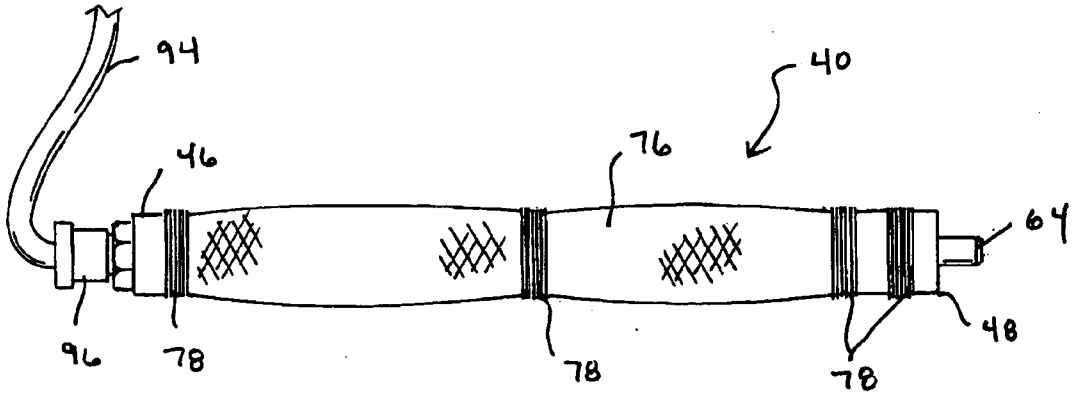
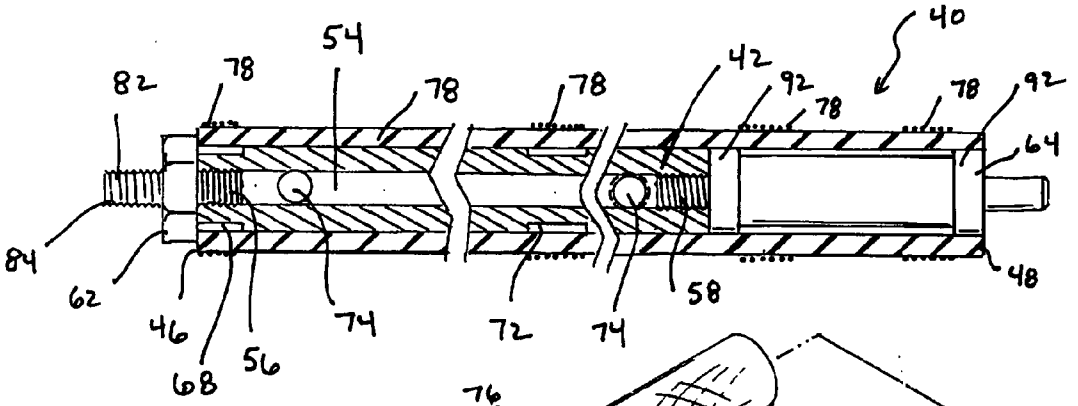


FIG 6

FIG 7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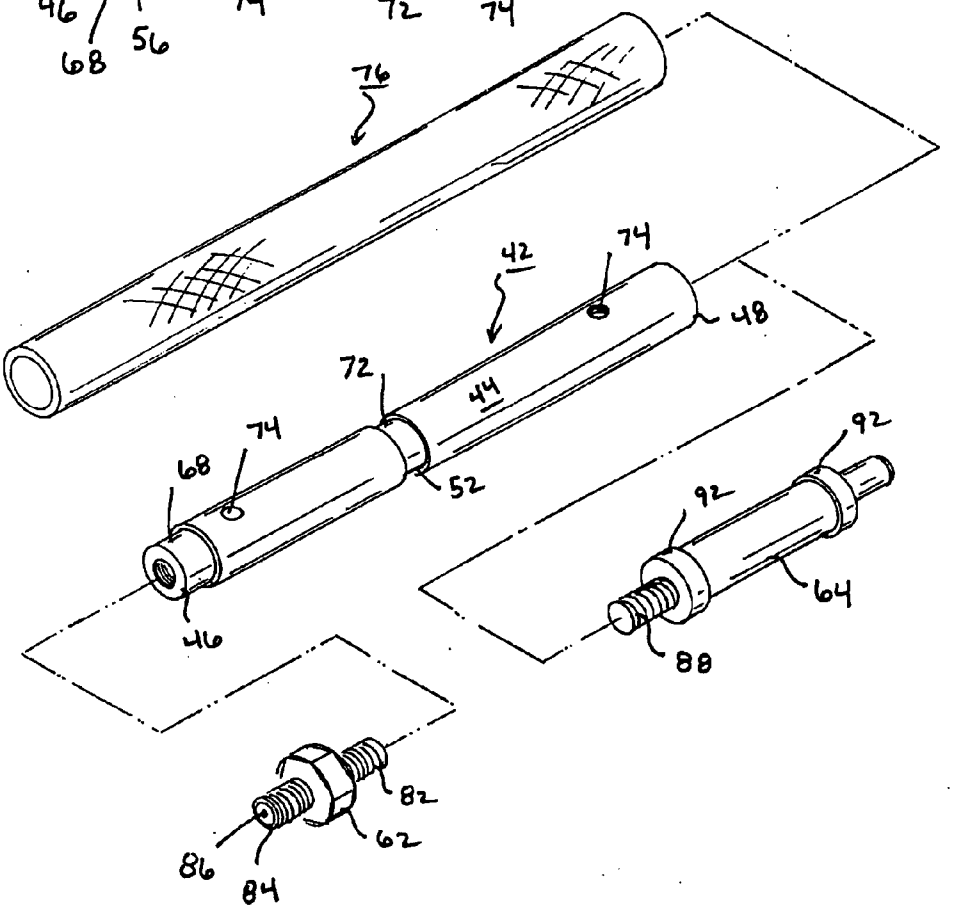
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FIG 8

CORELESS WINDING APPARATUS

RELATED APPLICATION DATA

[0001] This application is a continuation-in-part of co-pending application Ser. No. 60/737,814 filed on Nov. 17, 2005 and entitled Coreless Mandrel Operation, the contents of this application are fully incorporated herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to a coreless winding apparatus. More specifically, the present invention relates to a rewinding apparatus that employs an expansible mandrel whereby coreless rolls of paper can be created.

[0004] 2. Description of the Background Art

[0005] Devices for use in constructing coreless rolls are known in the art. For instance, U.S. Pat. No. 4,695,005 to Gietman discloses a winder for making coreless rolls of pliable sheet material, such as plastic, cloth, or paper. The paper is initially rolled about a pair of rods and after a sufficient amount of material has been wound, the rods are collapsed towards one another. Thereafter, an air cylinder is activated to cause a push off plate to force the roll off the rods. The result is a coreless roll of material.

[0006] Similarly, U.S. Pat. No. 5,497,959 to Johnson discloses a coreless winding method. The leading edge of a sheet of paper, such as the type used for bathroom or kitchen toweling, is secured to a mandrel by way of suction delivered axially through the mandrel. Once a sufficient amount of material has been wound upon the mandrel, the resulting log is stripped from the mandrel.

[0007] U.S. Pat. No. 5,453,070 to Moody discloses a system for manufacturing a coreless roll of a paper product. A roll is initially formed upon a mandrel, after which a portion of the roll is pushed onto a support shaft by way of a pusher device. With a portion of the roll on the shaft, a saw blade is used to cut the roll to a desired width and form a roll segment. The individual roll segments are then removed from the shaft by a pusher element.

[0008] Finally, U.S. Pat. No. 1,977,668 to Dallas discloses a winding machine including a rotatable arbor. The cross section of the arbor can be expanded or reduced by way of a series of slides to assist in ejecting a wound roll. With the cross section of the arbor in its reduced configuration, an ejector collar is used to push the roll from the arbor.

[0009] Although each of the above referenced inventions achieves its individual objective, they all suffer from a common drawback. Namely, all of the referenced inventions require complex and especially designed machinery to create coreless rolls. The present invention overcomes this deficiency by allowing coreless rolls to be formed on existing rewinding machines without the need to purchase costly and complicated equipment.

SUMMARY OF THE INVENTION

[0010] It is therefore an objective of this invention to facilitate the manufacture of coreless paper rolls.

[0011] It is another objective of this invention to provide an expansible mandrel that can be used to construct coreless rolls.

[0012] It is also an objective of this invention to enable existing rewinders to construct coreless receipt rolls.

[0013] These and other objectives are achieved by a mandrel that includes an elongated rigid shaft with an outer cylindrical surfaces, first and second ends and an intermediate extent. The shaft includes a hollow interior, first and second threaded extents, and recesses formed within the outer cylindrical surface. First and second air ports are formed through the outer cylindrical surface of the shaft proximate the two threaded ends. The mandrel further includes a length of flexible tubing that is equal in length to the shaft. The tubing is fitted over top of the cylindrical surface of the rigid shaft. Lengths of thread are wound around the flexible tubing over the recesses to thereby create a seal between the tubing and shaft. A threaded end cap is secured within the first threaded extent of the rigid shaft. The cap includes an integral air valve for selectively delivering pressurized air into the hollow interior of the shaft. A threaded plug with a peripheral seal is threadably secured within the second threaded extent of the rigid shaft such that the peripheral seal forms a fluid tight barrier within the second end of the rigid shaft. A source of compressed air is supplied and is adapted to be delivered into the hollow interior of the rigid shaft via the air valve and through the air ports. The delivery of the compressed air causes annular spaces to be created between the recesses of the shaft and between the shaft and the tubing. The creation of the annular spaces, in turn, causes an increase in the outer diameter of the mandrel. The air valve functions to retain the compressed air within the mandrel during winding operations and further allows an operator to release the compressed air once winding operations are complete.

[0014] The foregoing has outlined rather broadly the more pertinent and important features of the present invention in order that the detailed description of the invention that follows may be better understood so that the present contribution to the art can be more fully appreciated. Additional features of the invention will be described hereinafter which form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and the specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings in which:

[0016] FIG. **1** is a prospective view of the rewinder used in conjunction with the present invention.

[0017] FIG. **2** is a detailed view of the slitters that are used on the rewinder of the present invention.

[0018] FIG. **3** is a detailed view of a mandrel that is used in supporting a paper roll.

[0019] FIG. **4** is a detailed view of the expansible mandrel of the present invention.

[0020] FIG. **5** is an end view of the mandrel of the present invention taken along line **5-5** of FIG. **4**.

[0021] FIG. **6** is a detailed view of an inflated mandrel of the present invention.

[0022] FIG. **7** is a sectional view of the mandrel taken along line **7-7** of FIG. **5**.

[0023] FIG. **8** is an exploded view of the mandrel of the present invention.

[0024] Similar reference characters refer to similar parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0025] The present invention relates to an apparatus for forming coreless paper rolls. The invention is a mandrel construction that can be inflated with air to take on an increased diameter while a paper web is being wound around its outer surface. The mandrel can then be deflated to decrease the diameter sufficiently to allow for the removal of the paper roll. The result is a paper roll that does not need to be supported with a disposable core. The mandrel can be used on existing rewinders, such as the type described below.

Rewinder Apparatus

[0026] FIG. **1** illustrates a rewinder **10** that can be used in conjunction with the mandrel of the present invention. More specifically, the depicted rewinder is a surface winder sold by Dusenbery Worldwide. As is known in the art, such rewinders include a supply roll **20** from which a web of material **22** is unwound. Thereafter, web **22** is delivered over a number of transport rollers and a series of slitters **26** (note FIG. **2**). Slitters **26** are spaced to cut web **22** into a number of smaller webs whereby rolls of a desired width can be constructed. After being cut, web **22** is rewound into a take-up roll **24**.

[0027] FIG. **2** illustrates slitters **26** disposed at the lower portion of rewinder **10**. The rewinder depicted has its slitters configured to form register receipt rolls. Rewinder **10** also includes a carousel **28** (note FIG. **3**) that can accommodate a series of mandrels **32**, each of which can accommodate a take up roll **24**. The carousel **28** allows one mandrel to be unloaded while another mandrel supports as a take-up roll **24**. Mandrels are secured upon the carousel **28** via opposing mandrel guides **34**.

[0028] FIG. **3** is a detailed view illustrating one of the mandrels **32** after a suitable length of paper web **22** has been wound upon it. The mandrel **32** has just been released from carousel **28** and the individual rolls **24***a* are ready to be removed. In the present invention, the cross section of mandrel **32** is reduced after being removed from carousel **28** such that the rolls can be easily removed. The exact operation of expansible mandrel **32** is described in greater detail hereinafter.

[0029] In conventional mandrels, web **22** is wound about both a mandrel and a series of cores (not illustrated) that are positioned on the mandrel. After winding is complete, the conventional mandrel is removed from carousel **28** and the mandrel is removed from the interior of the cores. The result is a series of individual rolls each supported by a disposable core.

Inflatable Mandrel

[0030] The present invention relates to a mandrel construction **40** that can be used with existing rewinders, such as the rewinder depicted in FIG. **1**. Mandrel **40** of the present invention is specifically constructed to allow rolls of paper, such as register receipt rolls **24***a*, to be formed without the need for plastic or fiber cores. This is achieved by providing inflatable mandrel **40**, whereby the outside diameter of the mandrel can be increased via a working fluid during winding operations. Thereafter, once the desired amount of material **22** has been wound upon the mandrel, it can be deflated, thereby decreasing the outside diameter and allowing enough clearance to cleanly remove rolls **24***a* from mandrel **40** without disturbing the inside of the wound rolls.

[0031] FIG. **4** is an illustration of mandrel **40** in its uninflated and unexpanded state, and FIG. **6** is a view of mandrel **40** in its inflated and expanded state. FIGS. **7** and **8** are cross-sectional and exploded views, respectively, of mandrel **40** and its associated components. These figures show the elongated rigid shaft **42** that forms the primary component of mandrel **40**. Rigid shaft **42**, which is preferably constructed from a hardened steel, is defined by an outer generally cylindrical surface **44**, first and second ends (**46** and **48**, respectively), and an intermediate extent **52**. The exact length of shaft **42** will depend upon the specific type of product being wound. Nonetheless, in the case of register receipt rolls, the preferred length is 53.5" or greater. This length allows a number of standard register receipt rolls **24***a* to be made upon a single mandrel **40**. It is within the scope of the present invention to use shorter or longer shafts. For example, many winding operations call for the use of 2" shafts. The mandrel of the present invention can be used in winding a variety of materials, such as plastic, foil and foil laminates.

[0032] As noted in FIG. **7**, shaft **42** has a hollow interior **54** that can be sealed at both ends. In the preferred embodiment, first and second threaded extents (**56** and **58**, respectively) are sealed by an end cap **62** and end plug **64**, respectively. In the depicted embodiment, first threaded extent **56** is located at the first end **46** of shaft **42**, while the second threaded extent **58** is recessed inwardly of second end **48** of shaft **42**. This recessed area **66** between the threaded end **58** and the end of the shaft **48** allows for the insertion of end plug **64**. Nonetheless, it is within the scope of the present invention to employ a mandrel **40** without this recess; namely, to provide the second threaded extent **58** at the second end **48** of shaft **42**.

[0033] With continuing reference to FIGS. **7** and **8**, shaft **42** also includes circular recesses formed around outer surface **44** of shaft **42**. In the preferred embodiment, first and second recesses (**68** and **72**, respectively) are located at the first end **46** and at the midpoint **52** of shaft **42**. The exact function of these recesses is described more fully hereinafter. The shaft further includes air ports **74** formed through the outer wall. In the depicted embodiment; two air ports **74** are included proximate the threaded extents **56** and **58** of shaft **42**. Air ports **74** permit compressed air to escape from hollow interior **54** of shaft **42** and, thereby, inflate mandrel **40**.

[0034] The expandability of mandrel **40** is created by fitting a length of flexible tubing **76** over top of rigid shaft **42**. The preferred tubing **76** is formed from polyvinylchlo-

ride (PVC). This PVC tubing can optionally be reinforced with fibers. A nylon braded PVC tubing can also be employed. Nonetheless, it has been discovered that a clear unreinforced PVC tubing is most beneficial in promoting a uniform expansion of mandrel **40**. The use of other flexible plastic tubings is also within the scope of the present invention. Flexible tubing **76** preferably has a length that corresponds to the length of rigid shaft **42**. A snug fit between tubing **76** and shaft **42** is necessary to ensure that the outside diameter of mandrel **40** is as concentric as possible in both the inflated and deflated state.

[**0035**] Thus, in one exemplary embodiment, the inside diameter of tubing **76** is approximately 0.5" while the outside diameter of shaft **42** is approximately 0.545". It has been found that this 0.045" clearance creates a sufficiently snug fit to yield a uniform outer diameter in the inflated and deflated states. Yet, such a small clearance makes it difficult to fit tubing **76** over shaft **42**. In order to overcome this, air under pressure is delivered to the interior of shaft **42** while tubing **76** is being fitted. Tubing **76** is first manually fitted over shaft **42** a sufficient distance to cover one of the two air ports **74**. Thereafter, compressed air is delivered to the interior **54** of shaft **42** and out through the air ports **74**. This serves to create an air cushion between shaft **42** and tubing **76** which, in turn, permits tubing **76** to be slid over the remaining length of shaft **42**.

[**0036**] After tubing **76** is fitted over shaft **42**, it is then sealed to shaft **42** via wound thread **78** and adhesives. In the preferred embodiment, a cloth type thread **78**, such as sewing thread, is employed for this purpose. Thread **78** is wound around both tubing **76** and shaft **42** at locations corresponding to the two circular recesses (**68** and **72**) within shaft **42** to promote bonding between shaft **42** and tubing **76**. Prior to the thread being wound, these areas are first covered with a layer of epoxy. Additional bonding is obtained by coating the thread in an adhesive, such as superglue, before winding it about the tubing. After these adhesives are applied, thread **78** is then wound around tubing **76** and shaft **42** over top of recesses **68** and **72**. This winding is done under tension. It has been found that winding the thread 30 times over each recess is sufficient. The adhesives allow thread **78** to be secured to the outer surface of tubing **76** and ensures an airtight seal is formed between tubing **76** and shaft **42**. Tension is applied during the winding step because it is critical that no other part of mandrel **40** is larger than the outside diameter of tube **76** in its uninflated state. By winding thread **78** over recesses **68** and **72** of shaft **42** under tension, thread **78** slightly compress tubing **76** so as not to create enlarged portions that would otherwise hinder removal of wound rolls **24***a* after deflation. Winding thread **78** over the first recess **68** adjacent the first end **46** of shaft **42** creates an airtight seal that prevents the air from escaping from the end of mandrel **40** after inflation. The thread **78** secured over the centrally located recess **72** performs a slightly different function. Namely, this thread **78**, which is applied in the same way as the thread **78** over the first recess **68**, ensures that there is no unwanted warping or curvature of tubing **76** over the length of mandrel **40**.

[**0037**] In order to keep the mandrel inflated end caps are threadably received into the ends of the mandrel. With reference now to FIG. **8**, the first threaded end cap **56** is depicted. This end cap **56** includes male threads **82** that permit cap **56** to be releasably secured into the first female threaded extent **56** of rigid shaft **42**. This engagement forms a pneumatic seal between the hollow interior **54** and the outside of shaft **42**. End cap **62** further includes an integral air valve **84**, which can be similar to the air valve found in a bicycle tire. Air valve **84** is axially aligned with end cap **62** and allows air to be selectively delivered under pressure to hollow interior **54** of shaft **42**. More specifically, air valve **84** includes a valve stem **86** that is spring loaded, whereby air is admitted to the interior **54** of shaft **42** only when the external pressure is greater than the internal pressure. Valve **84** also permits air to be released from the interior **54** of shaft **42** by manually depressing valve stem **86**. Although end cap **62** is described and depicted with a threaded interconnection, those skilled in the art will appreciate that other types of interconnections, such as a friction fit or interlocking tabs, will suffice. It is also within the scope of the present invention to provide end cap **62** that is integral with, yet smaller than, shaft **42**.

[**0038**] FIG. **8** also discloses the threaded end plug **64** which is threadably secured within the opposite end **48** of shaft **42**. Again, plug **64** includes a male threaded extent **88** that mates with the female threaded extent **58** of shaft **42** to form a pneumatic seal. As with end cap **62**, other types of interconnections are within the scope of the present invention. Threaded plug **64** also includes one or more peripheral seals **92** that form an air barrier adjacent the recessed end **66** of shaft **42**. The space between seals **92** and the body of plug **64** creates an additional recess that permits an additional amount of thread **78** to be wound about the surface of tubing **76** in a manner described in detail hereinabove. This additional thread forms a barrier to prevent air from escaping from the second end **48** of mandrel **40**. As noted above, the recess created by plug **64** ensures that no enlarged areas interfere with the removal of wound rolls **24***a*.

[**0039**] Once both the threaded plug **64** and end cap **62** are secure, and the mandrel **40** is otherwise assembled, air can be delivered under pressure to the interior **54** of shaft **42** by way of a supply of compressed air. In this regard, a length of tubing **94** is provided adjacent the winding apparatus, with one end of the tubing connected to the source of compressed air and the other end **96** adapted for selectively engaging air valve **84**. Once compressed air is delivered through the air valve **84** to the interior **54** of the shaft **42**, it then travels out through the two air ports **74** and inflates mandrel **40**. More specifically, the compressed air fills annular areas bounded by the circular recesses (**68** and **72**), the outer surface of shaft **42** and the inner surface of tubing **76**. In the preferred embodiment, air is delivered at 125 psi to achieve a desired degree of inflation.

[**0040**] In one particular embodiment, air delivered at 125 psi was sufficient to increase the outer diameter of the mandrel from 0.8" to 0.84." These, however, are only representative dimensions. Nonetheless, for the purpose of forming register receipt rolls, mandrels with an expanded outside diameter of approximately 0.875" are preferred. Nonetheless, mandrels with a significantly reduced outside diameter can also be made in accordance with the present invention. Additionally, although the preferred embodiment has been described with air as the working fluid, the present invention can also be used with hydraulic oil as the working fluid. In this embodiment, care should be taken to use tubing that is impermeable to oil.

[0041] The present disclosure includes that contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention.

[0042] Now that the invention has been described,

What is claimed is:

1. A mandrel for use within a winding apparatus having opposing mandrel guides, the mandrel permitting the production of coreless rolls and comprising:

an elongated rigid shaft having a length of 53.5" or greater, an outer cylindrical surface, first and second ends and an intermediate extent therebetween, the shaft including a hollow interior with first and second threaded extents, recesses formed within the outer cylindrical surface, first and second air ports formed through the outer cylindrical surface proximate the first and second threaded extents;

a length of flexible tubing formed from polyvinylchloride, the tubing having a length that is equal to the length of the rigid shaft, the tubing fitted over top of the outer cylindrical surface of the rigid shaft, lengths of thread wound around the flexible tubing over the recesses to thereby form a seal between the flexible tubing and the rigid shaft;

a threaded end cap threadably secured within the first threaded extent of the rigid shaft, the threaded end cap including an integral air valve for selectively delivering pressurized air into the hollow interior of the rigid shaft;

a threaded plug with a peripheral seal threadably secured within the second threaded extent of the rigid shaft such that the peripheral seal forms a fluid tight barrier within the second end of the rigid shaft;

a source of compressed air for delivery to the hollow interior of the rigid shaft via the air valve, and through the air ports, the delivery of compressed air causing annual spaces to be created between the recesses of the shaft and between the shaft and the tubing, the creation of the annular spaces in turn causing an increase in the outer diameter of the mandrel, the air valve functioning to retain the compressed air within the mandrel while the mandrel is mounted to the mandrel guides of the winding apparatus, the air valve further functioning to allow an operator to selectively release the compressed air from the mandrel after the mandrel is removed from the mandrel guides at the conclusion of winding operations.

2. An expansible mandrel comprising:

a shaft with first and second ends and a hollow interior and at least one air port formed along its length;

a length of tubing secured over the shaft, the tubing being sealed to the first and second ends of the shaft;

an air valve coupled to one end of the shaft;

a source of compressed air for selective delivery into the hollow interior of the shaft and through the air port, whereby the tubing is inflated and the diameter of the mandrel is increased.

3. The mandrel as described in claim 2 wherein the air valve is incorporated into an end cap that is threadably secured within an end of the shaft.

4. The mandrel as described in claim 2 wherein the tubing is sealed to the shaft via wound thread and adhesive.

5. The mandrel as described in claim 2 wherein the length of the mandrel is greater than 53.5".

6. The mandrel is described in claim 2 wherein the outer diameter of the mandrel in its expanded state is less than 0.875".

7. The mandrel as described in claim 2 wherein the tubing is a flexible polyvinylchloride tubing.

8. A method of making coreless rolls, the method employing a mandrel adapted to be removably secured between the opposing mandrel guides of a winding apparatus, the mandrel having an inner rigid shaft with an air valve and an air port and having an outer flexible tubing that is secured over top of the shaft, the method comprising the following steps:

supplying air under pressure into the shaft via the air valve, the pressurized air being expelled from the shaft via the air port and causing the outer flexible tubing to expand to an increased diameter, whereby the mandrel is in an inflated state;

removing the supply of air under pressure, whereby the air valve is closed and the mandrel is maintained in an inflated state;

securing the mandrel in the inflated state between the opposing mandrel guides of the winding apparatus;

winding a sheet of material over the mandrel while it is in the inflated state;

removing the mandrel from the opposing mandrel guides after a sufficient amount of material has been wound upon the mandrel;

manually engaging the air valve to permit pressurized air to escape from the mandrel, whereby the flexible tubing contracts and the mandrel takes on a deflated state;

sliding the wound material off of the mandrel while the mandrel is in the deflated state.

9. The method as described in claim 8 wherein a number of separate register receipt rolls are formed upon the mandrel.

10. The method as described in claim 8 wherein the user employs a tool to manually engage the air valve.

* * * * *