US 20110017861A1

(19) **United States**

(12) **Patent Application Publication**

Nakanishi et al.

(10) **Pub. No.: US 2011/0017861 A1**

(43) **Pub. Date: Jan. 27, 2011**

(54) **CORE ASSEMBLY FOR WINDING SHEET AND WINDING METHOD**

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(21) Appl. No.: **12/840,721**

(22) Filed: **Jul. 21, 2010**

(30) **Foreign Application Priority Data**

Jul. 23, 2009 (JP) 2009-171997

Publication Classification

(51) **Int. Cl.**

B65H 75/24	(2006.01)
B65H 75/10	(2006.01)
B65H 19/30	(2006.01)
B65H 19/22	(2006.01)

(52) **U.S. Cl.** **242/533**; 242/575; 242/575.3

(57) **ABSTRACT**

A core assembly for a continuous sheet includes a core of a cylindrical form. A side channel is formed in the core to extend fully in an axial direction thereof. A shaft hub is disposed through the core movably in the axial direction. A changing unit or adjuster displaces the core in response to moving of the shaft hub between first and second positions, and enlarges an outer diameter of the core when the shaft hub is in the second position than when the shaft hub is in the first position. Preferably, the changing unit includes a cam roller, disposed on the shaft hub, for projecting in a radial direction. A cam ramp surface is formed with an inner surface of the core, has a height increasing toward the second position, is pressed by the cam roller.

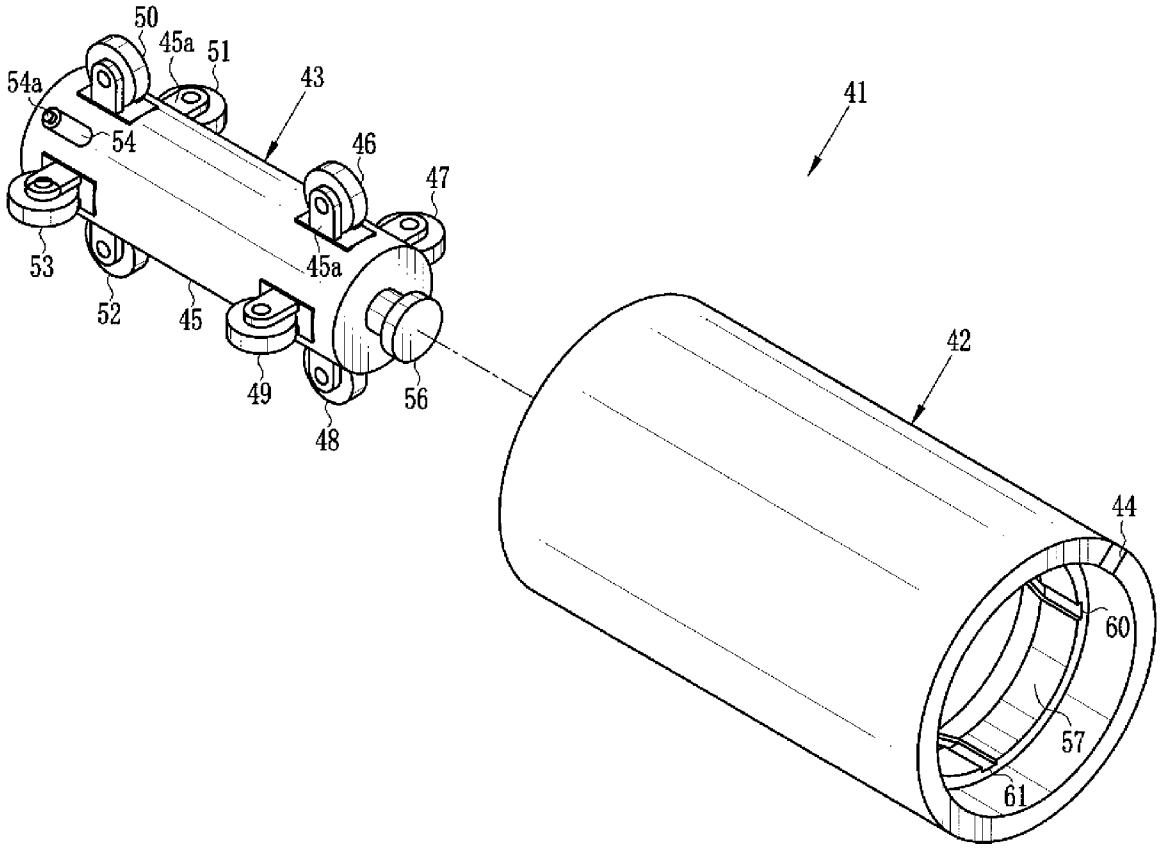
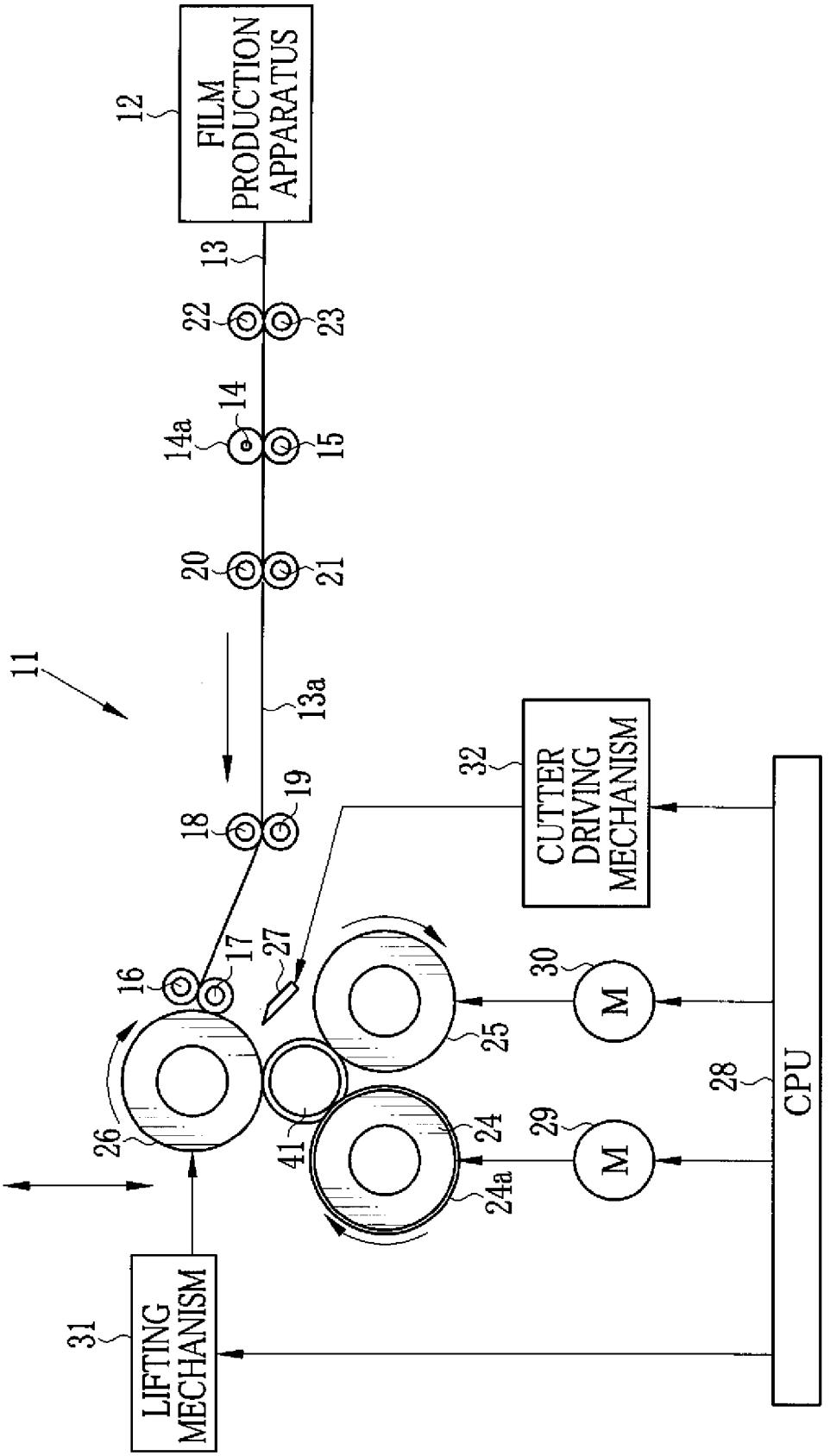


FIG. 1


FILM PRODUCTION APPARATUS
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CUTTER DRIVING MECHANISM
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CPU
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LIFTING MECHANISM

FIG. 2

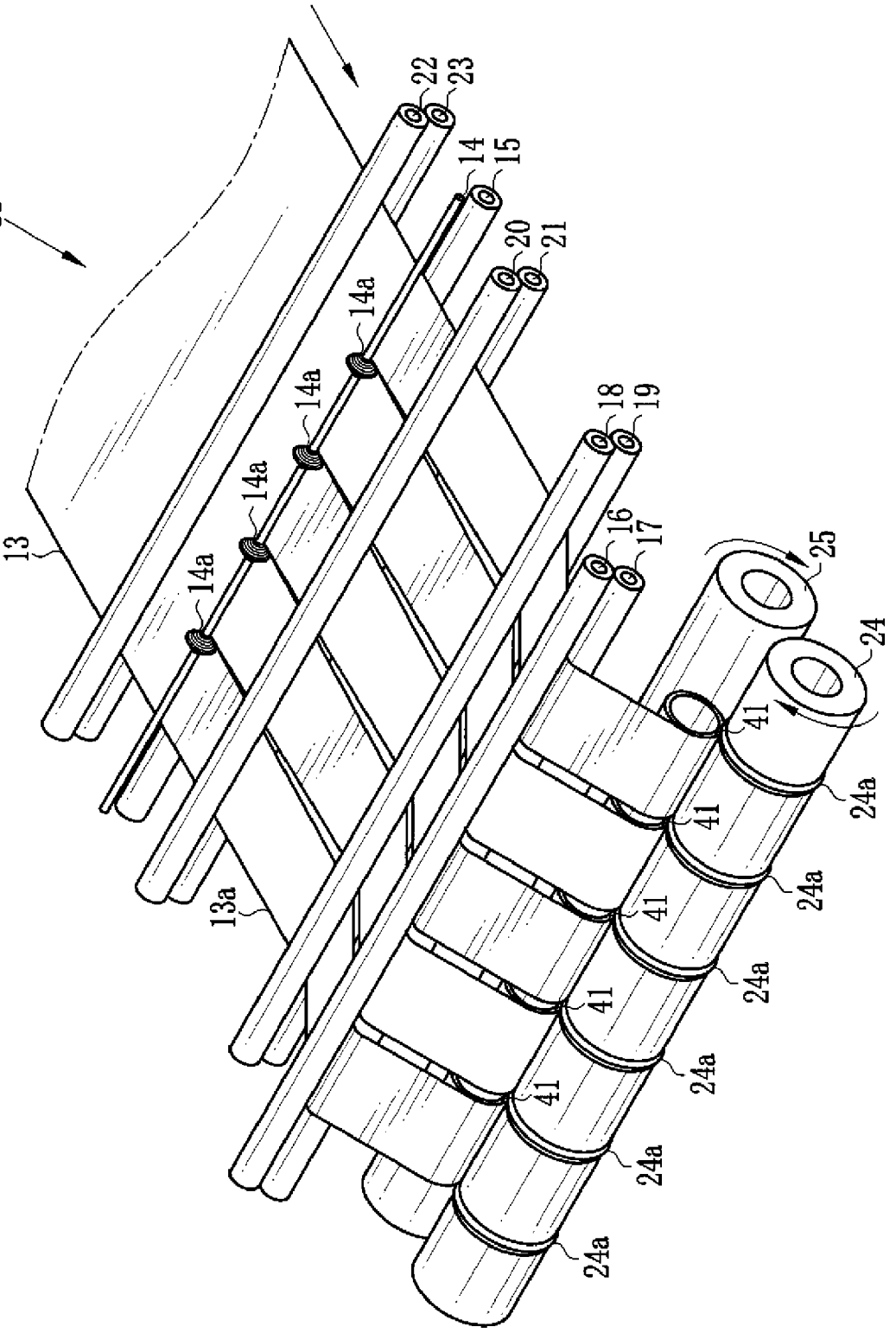


FIG. 3

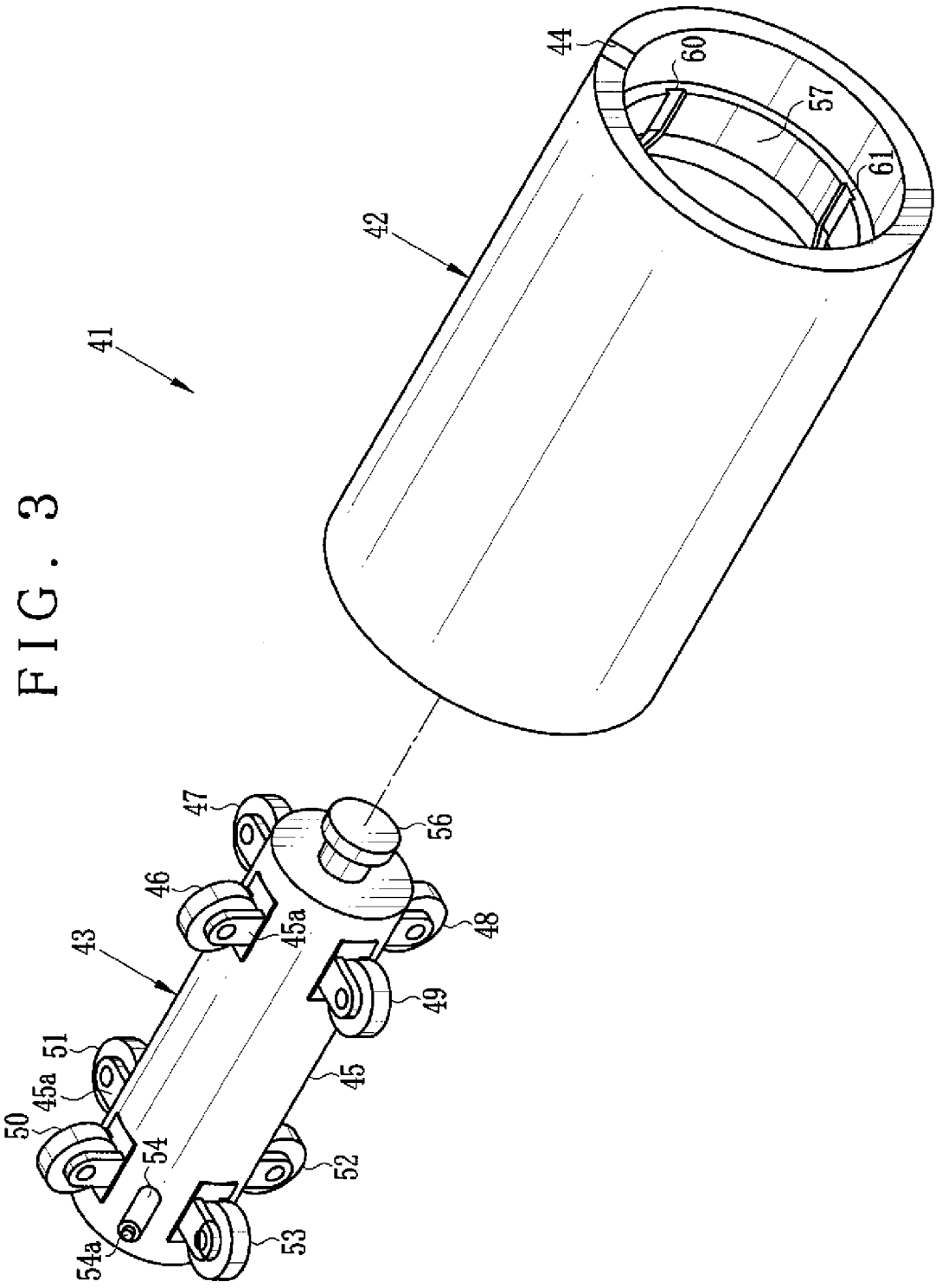


FIG. 4A

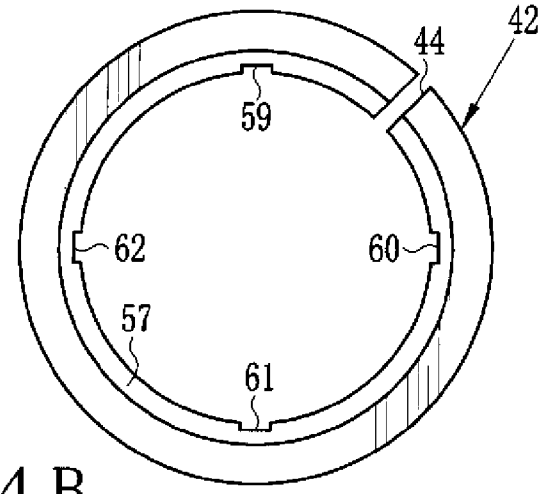


FIG. 4B

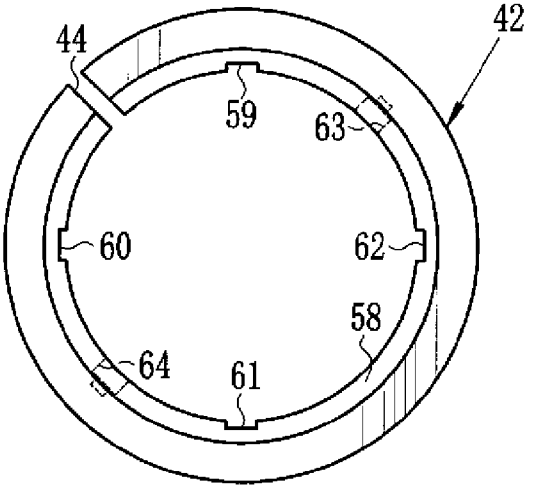
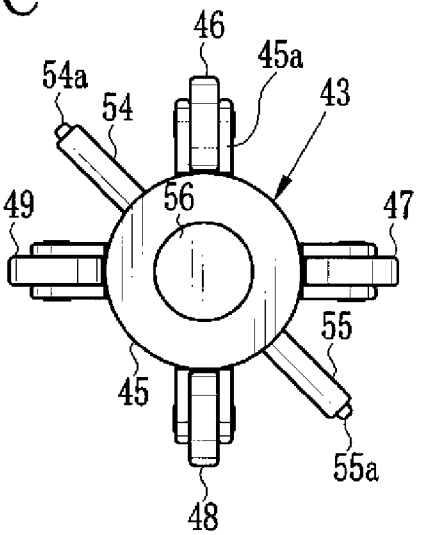


FIG. 4C



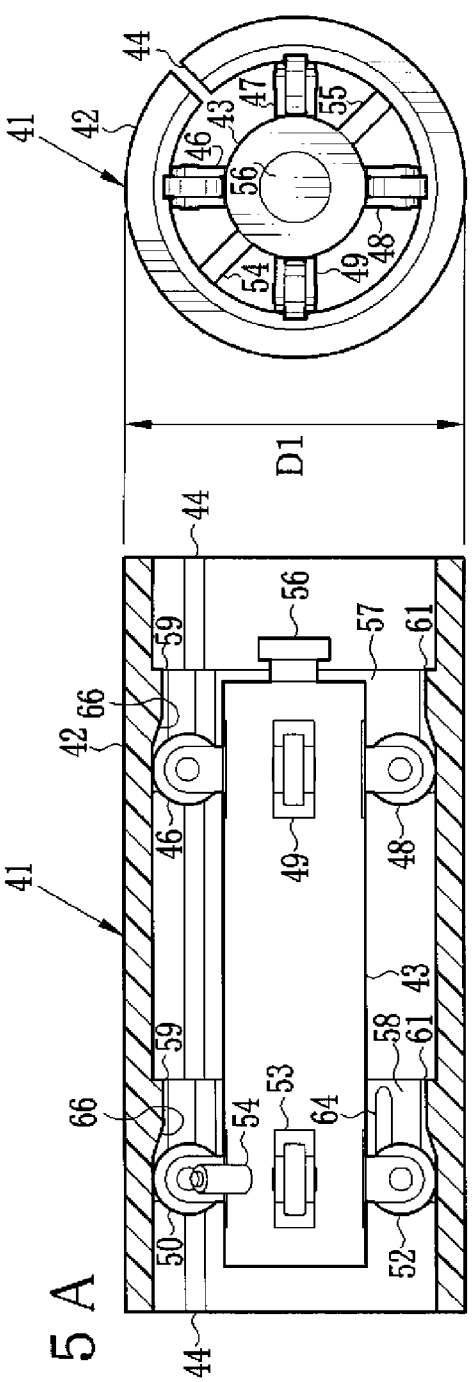

41
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FIG. 5A

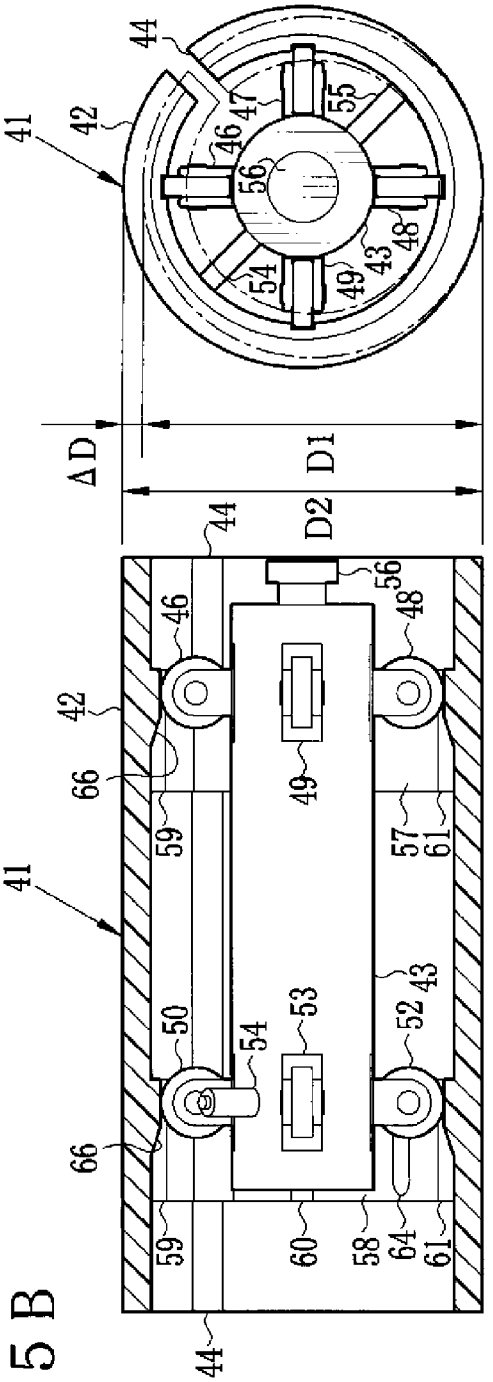
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FIG. 5B

FIG. 6B

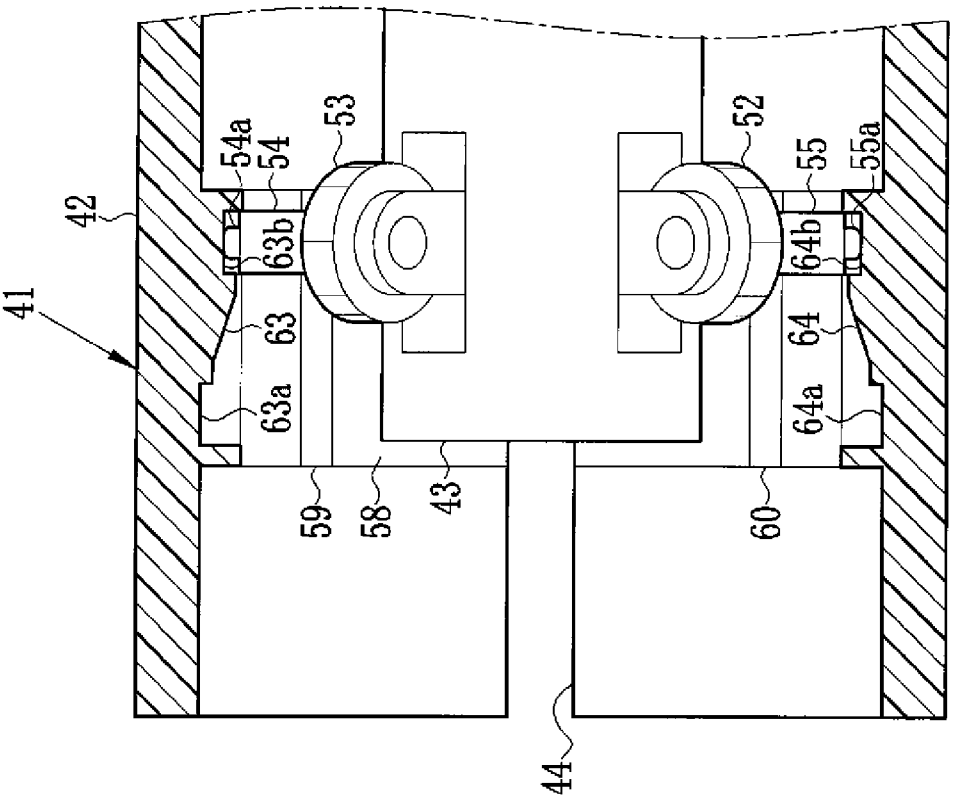
41
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FIG. 6A

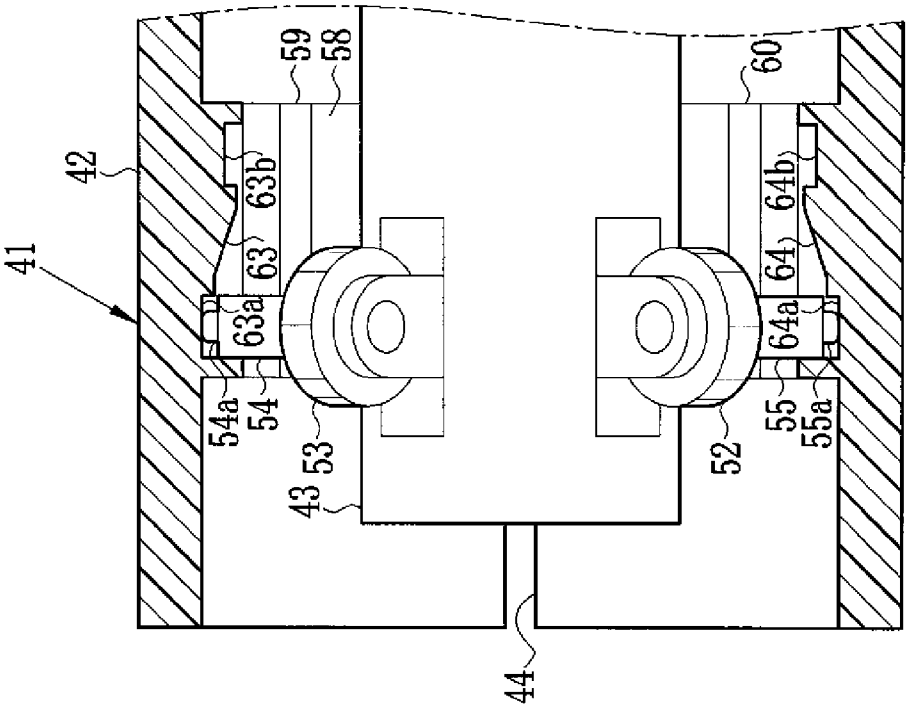
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FIG. 7A

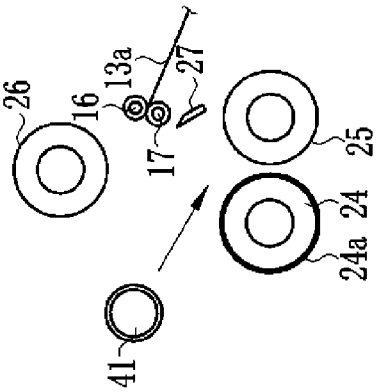


FIG. 7B

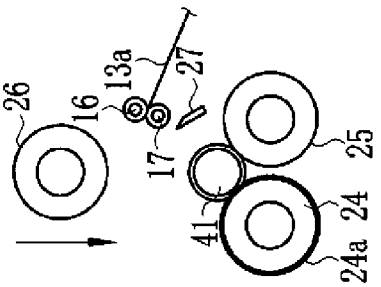


FIG. 7C

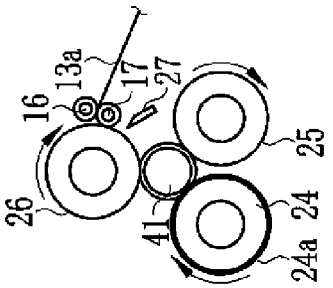


FIG. 7D

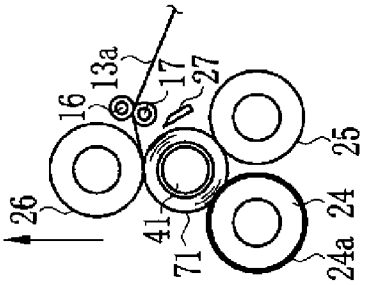


FIG. 7E

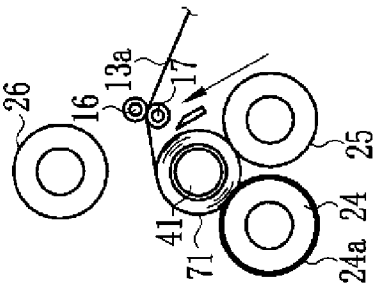


FIG. 7F

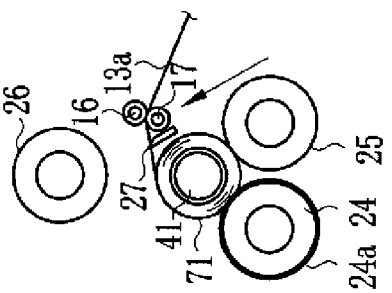


FIG. 7G

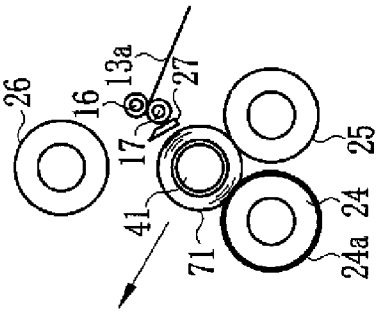


FIG. 7H

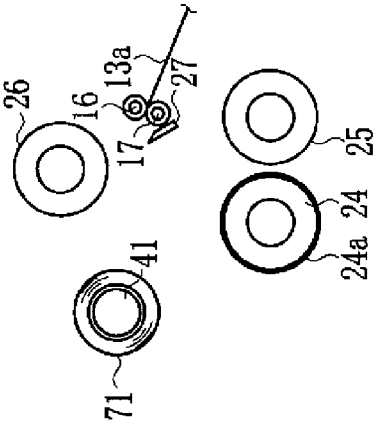


FIG. 8A

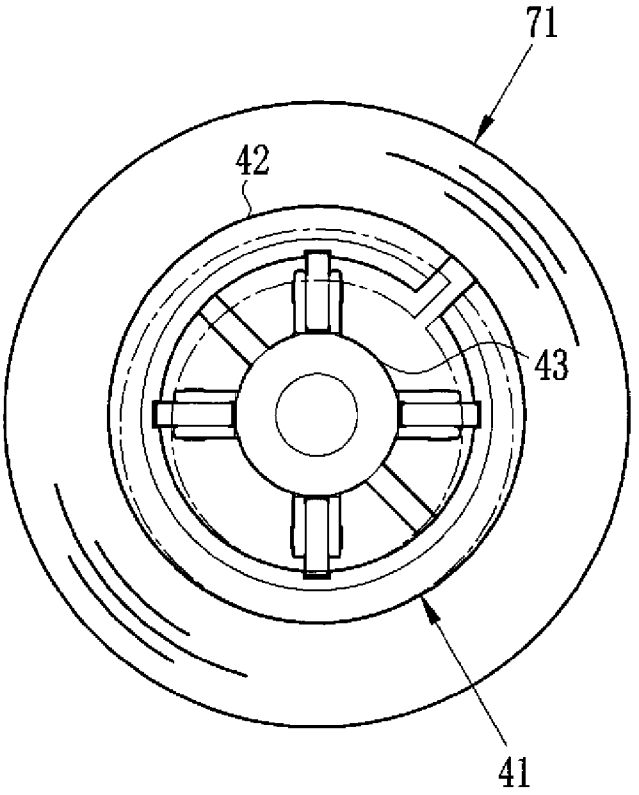
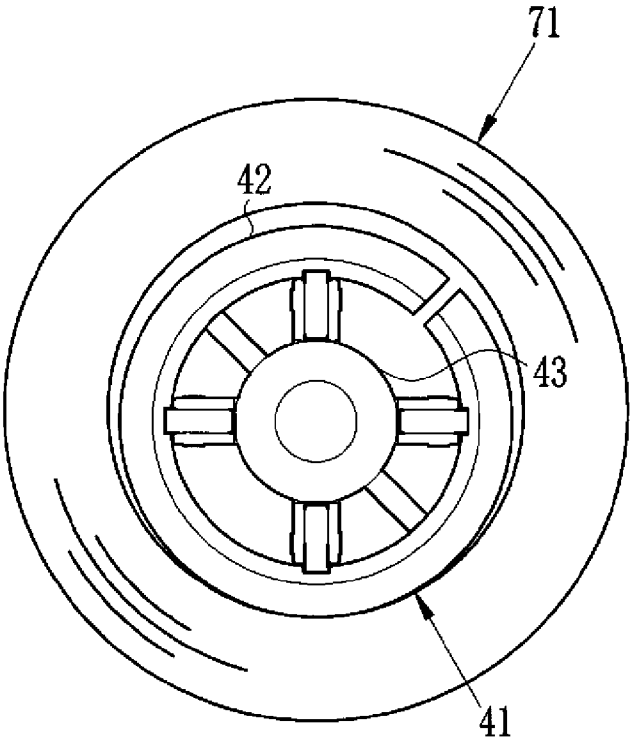


FIG. 8B



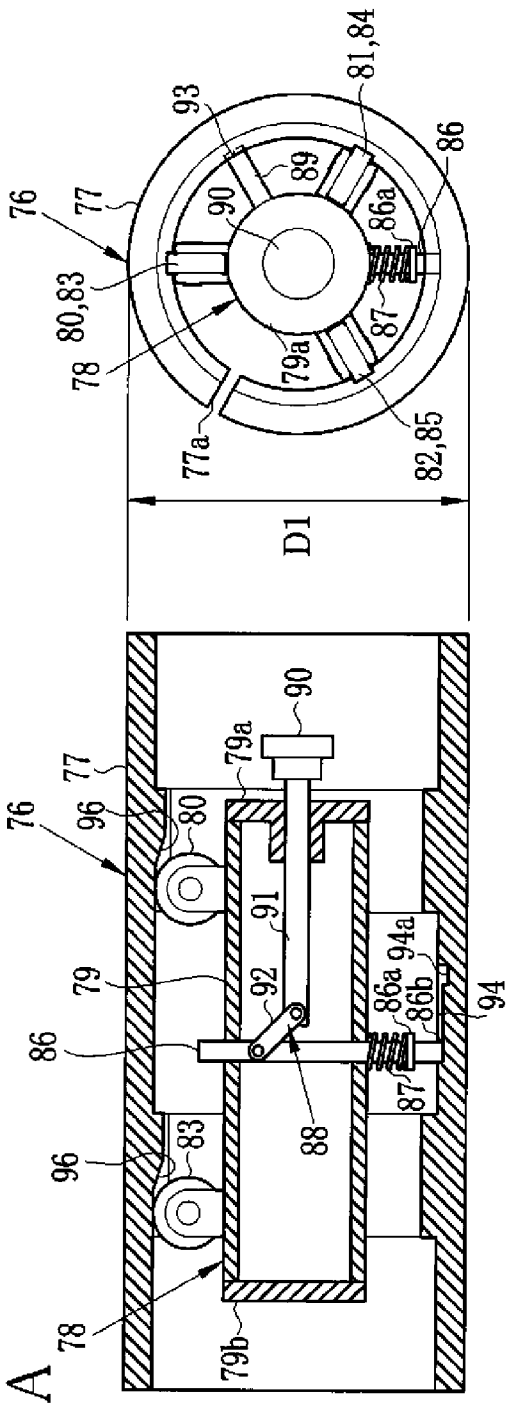

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FIG. 9A

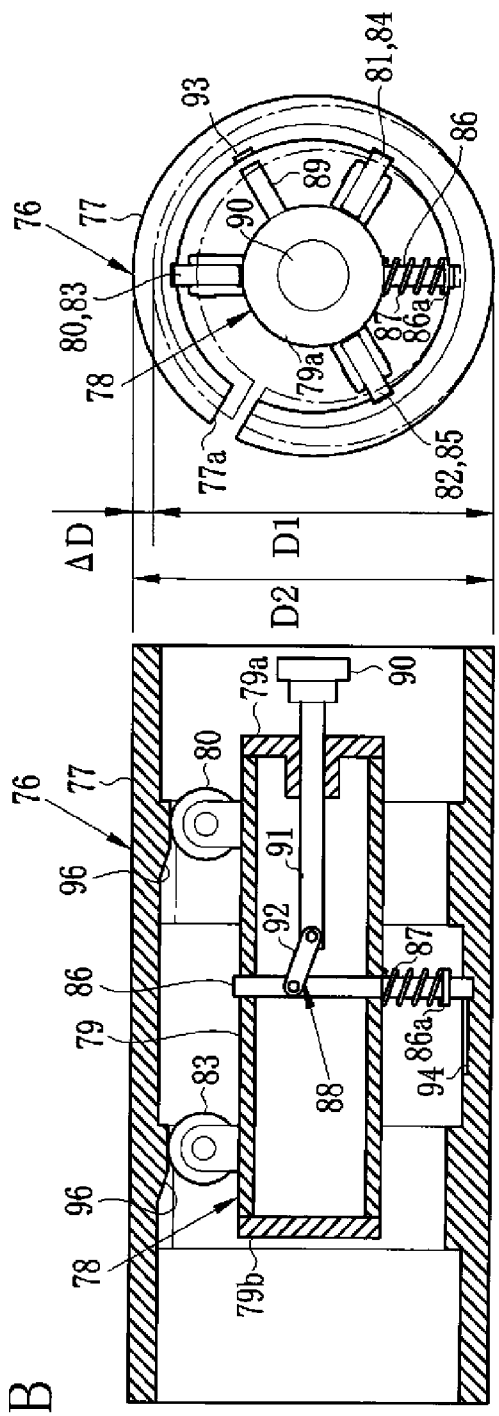
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FIG. 9B

CORE ASSEMBLY FOR WINDING SHEET AND WINDING METHOD

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a core assembly for winding a sheet and a winding method. More particularly, the present invention relates to a core assembly for winding a sheet to form a sheet roll without an internal support core in an efficient manner, and a winding method.

[0003] 2. Description Related to the Prior Art

[0004] A continuous sheet or continuous film is a material of plastic film, paper or the like and is manufactured continuously. A sheet roll or film roll of the continuous sheet is provided in a form wound about an internal support core. As the sheet roll is shipped commercially in a form wound about the internal support core, the internal support core will be a waste produced to discard after use of the sheet roll.

[0005] Various methods of producing the sheet roll without the internal support core has been suggested. JP-A 6-127758 discloses the use of a core assembly or spool assembly in which air is blown or discharged to enlarge or reduce an outer diameter of the core assembly. Also, JP-A 2004-231399 discloses the core assembly in which a side channel is formed in the full length of its sleeve form. A first edge portion of the side channel is directed to lie under its second edge portion to reduce the outer diameter of the core assembly. In any of those methods, the continuous sheet is wound on the core assembly before reducing the outer diameter of the core assembly. The core assembly is removed from the sheet roll after the reduction of the outer diameter.

[0006] However, the method of JP-A 6-127758 has a problem in that a specific pump is required for blow and discharge of air, and will raise the structural cost. Furthermore, adjustment of the outer diameter of the core assembly is difficult because of easy compression of air. Differences between products as specificity will be considerably large in an inner diameter of the sheet roll determined by the outer diameter of the core assembly.

[0007] In JP-A 2004-231399, the outer diameter of the core assembly is not fixed. There is a drawback of failure in keeping high precision of an inner diameter of the sheet roll due to a change in the outer diameter of the core assembly in the course of winding the continuous sheet. This problem is typically serious in a surface winding method in which torque is applied to a peripheral surface of the core assembly for rotating the same.

SUMMARY OF THE INVENTION

[0008] In view of the foregoing problems, an object of the present invention is to provide a core assembly for winding a sheet to form a sheet roll without an internal support core in an efficient manner, and a winding method.

[0009] In order to achieve the above and other objects and advantages of this invention, a core assembly for winding a continuous sheet to form a sheet roll includes a core of a sleeve shape for winding the sheet thereabout. A side channel is formed in the core fully in an axial direction, for enabling an outer diameter of the core to change. A changing unit is disposed through the core movably in the axial direction, shifted to a first position before forming the sheet roll, and shifted to a second position before removing the core from the sheet roll, for pressing an inner surface of the core radially to enlarge the outer diameter when in the first position, and for releasing the inner surface from pressure to reduce the outer diameter when in the second position.

[0010] The changing unit includes plural cam rollers rotatable in contact with the inner surface. Furthermore, plural cam ramp surfaces are formed with the inner surface, pressed by the cam rollers in association therewith when the changing unit is in the first position.

[0011] The changing unit includes a shaft hub. Plural roller holders are arranged on the shaft hub, secured to first and second axial positions thereon, for projecting radially in each of the first and second axial positions, and for supporting the cam rollers rotatably at holder ends thereof.

[0012] Furthermore, plural receiving grooves are formed in the inner surface to extend in the axial direction, for receiving and guiding respectively the cam rollers.

[0013] Furthermore, the adjuster includes a cam projection for projecting from the shaft hub in a radial direction. A cam ramp surface is formed with an inner surface of the core, has a height increasing toward the second position, is pressed by the cam projection when the shaft hub moves toward the second position.

[0014] The cam projection includes a cam roller, caused by the cam ramp surface to rotate, for pressing the cam ramp surface while the shaft hub moves between the first and second positions.

[0015] The cam projection is constituted by plural cam projections of at least first and second groups, the second group is offset from the first group in the axial direction, and each of the first and second groups includes a predetermined number of cam projections arranged radially about an axis of the shaft hub.

[0016] Furthermore, a regulating device positions the shaft hub in the second position in the axial direction, to maintain a large diameter for the outer diameter.

[0017] The regulating device further positions the shaft hub in the first position in the axial direction, to maintain a small diameter for the outer diameter.

[0018] The regulating device includes a retaining hole formed in the inner surface of the core. A pin portion is formed to project from the shaft hub, for engagement with the retaining hole.

[0019] Furthermore, a regulating groove is formed in the inner surface of the core, for receiving and regulating the pin portion in the axial direction. The retaining hole is positioned at each of two ends of the regulating groove with respect to the axial direction, has a greater depth than the regulating groove, for retaining the pin portion.

[0020] The pin portion is constituted by a ball plunger.

[0021] Furthermore, a moving device is disposed on the shaft hub, for moving the pin portion in the radial direction between a retained position of entry in the retaining hole and a released position of release from the retaining hole.

[0022] The shaft hub includes an end opening formed in an end disposed close to the second position. A pull rod is secured through the end opening, and slidable in a push direction defined toward the first position and a pull direction defined toward the second position. The moving device is secured between the pull rod and the pin portion, moves the pin portion from the released position to the retained position when the pull rod is moved in the pull direction, and moves the pin portion from the retained position to the released position when the pull rod is moved in the push direction.

[0023] The moving device includes a link arm, having a first end secured to the pull rod in a rotatable manner, and a second end secured to the pin portion in a rotatable manner. A bias portion biases the pin portion toward the retained position.

[0024] Also, a winding method of winding a continuous sheet about a core assembly is provided. The core assembly includes a core of a sleeve shape, a side channel formed in the core fully in an axial direction, and a changing unit disposed through the core movably in the axial direction. In the winding method, the changing unit is shifted to a first position by moving through the core, for the changing unit in the first position to press an inner surface of the core radially to enlarge an outer diameter thereof. The core assembly is rotated to wind the sheet thereabout. After winding the sheet, the changing unit is shifted to a second position to release the inner surface from pressure to reduce the outer diameter. The core assembly is removed from a sheet roll of the sheet.

[0025] In one preferred embodiment, a method of forming a sheet roll includes a step of winding a continuous sheet about a core assembly, wherein the core assembly includes a core of a cylindrical form, a side channel formed in the core to extend fully in an axial direction thereof, an shaft hub disposed through the core movably in the axial direction, and an adjuster for displacing the core in response to moving of the shaft hub between first and second positions, and for enlarging an outer diameter of the core when the shaft hub is in the second position than when the shaft hub is in the first position. In the winding step, a large diameter is maintained for the outer diameter of the core assembly. The outer diameter is reduced after winding of the continuous sheet about the core assembly. The core assembly is removed from the continuous sheet being wound.

[0026] Accordingly, the core assembly can be used for forming a sheet roll without an internal support core in an efficient manner, because the outer diameter of the core can be adjusted stepwise for sheet winding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The above objects and advantages of the present invention will become more apparent from the following detailed description when read in connection with the accompanying drawings, in which:

[0028] FIG. **1** is a side elevation illustrating a film winding system;

[0029] FIG. **2** is a perspective view illustrating the film winding system;

[0030] FIG. **3** is an exploded perspective view illustrating a core assembly;

[0031] FIG. **4**A is a front elevation illustrating a core;

[0032] FIG. **4**B is a rear elevation illustrating the core;

[0033] FIG. **4**C is a front elevation illustrating a changing unit;

[0034] FIG. **5**A is an explanatory view illustrating the core assembly;

[0035] FIG. **5**B is an explanatory view illustrating the same FIG. **5**A but after enlarging the outer diameter;

[0036] FIG. **6**A is an explanatory view in a section illustrating positioning of the changing unit relative to the core;

[0037] FIG. **6**B is an explanatory view in a section illustrating the same as FIG. **6**A but in a state of enlarging the outer diameter;

[0038] FIG. **7**A-**7**H are explanatory views illustrating various steps in a sequence of winding a continuous sheet;

[0039] FIG. **8**A is a front elevation illustrating a sheet roll wound about the core assembly;

[0040] FIG. **8**B is a front elevation illustrating the same as FIG. **8**A but after reducing the outer diameter;

[0041] FIG. **9**A is an explanatory view illustrating another preferred core assembly;

[0042] FIG. **9**B is an explanatory view illustrating the same as FIG. **9**A but after enlarging the outer diameter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S) OF THE PRESENT INVENTION

[0043] In FIGS. **1** and **2**, a film winding system **11** or a film winding line is connected with a film production apparatus **12**. Film web **13** is produced by the film production apparatus **12** continuously. A plurality of continuous sheets **13***a* or continuous film of a strip shape are formed by slitting the film web **13**. In the film winding system **11**, a core assembly **41** or spool assembly or a winder winds the continuous sheet **13***a* to obtain a sheet roll **71** or film roll. See FIG. **8**.

[0044] The film winding system **11** includes a slitting roller **14**, a blade receiving roller **15**, guide rollers **16**, **17**, **18**, **19**, **20**, **21**, **22** and **23**, surface rollers **24** and **25**, a rider roller **26**, a cutter **27**, a CPU **28**, motors **29** and **30**, a lifting mechanism **31** and a cutter driving mechanism **32**. In FIG. **2**, elements are clarified in a simplified manner, so the rider roller **26**, the cutter **27**, the CPU **28**, the motors **29** and **30**, the lifting mechanism **31** and the cutter driving mechanism **32** are not illustrated.

[0045] A plurality of blades **14***a* are included in the slitting roller **14**, and arranged at a regular interval. Each of the blades **14***a* has a shape of two frustums of a cone which are combined together by positioning their large circular surfaces on one another. The film web **13** moves on a path defined between the slitting roller **14** and the blade receiving roller **15** as pairs of upper and lower sides. An annular groove (not shown) is formed in the blade receiving roller **15** for partial entry of the blades **14***a* of the slitting roller **14**. The blades **14***a* of the slitting roller **14** slit the film web **13** by shearing in passage between the slitting roller **14** and the blade receiving roller **15**, to form a plurality of continuous sheets **13***a* (five in the drawing).

[0046] The guide rollers **16**-**23** squeeze the film web **13** or the continuous sheet **13***a* as plural pairs of rollers. A peripheral surface of the rider roller **26** contacts a peripheral surface of the guide roller **17**. The guide roller **17** is rotated by rotation of the rider roller **26**, to guide the continuous sheet **13***a* to the rider roller **26**.

[0047] The surface rollers **24** and **25** are arranged in parallel with one another with an interval. A plurality of the core assemblies **41** are disposed near to the surface rollers **24** and **25** for winding respectively the continuous sheet **13***a*. Annular guide ridges **24***a* are disposed on the peripheral surface of the surface roller **24** at a regular interval. The plural core assemblies **41** near to the surface rollers **24** and **25** are kept at a regular interval. The surface rollers **24** and **25** rotate by themselves to rotate the core assemblies **41**. A rotational direction of the surface roller **25** is equal to that of the surface roller **24**. Their forward rotational direction is clockwise in the drawing. Their backward rotational direction is counterclockwise.

[0048] The rider roller **26** is disposed higher than the surface rollers **24** and **25**, and movable up and down in parallel with those. The rider roller **26**, when shifted down, contacts a

peripheral surface of the core assembly **41**, to keep the core assembly **41** positioned in cooperation with the surface rollers **24** and **25**. The rider roller **26** is rotated by rotation of the core assembly **41**.

[0049] The rider roller **26** moved down contacts the guide roller **17**, and guides the continuous sheet **13***a* from the guide roller **17** toward the core assembly **41**. The rider roller **26** winds the continuous sheet **13***a* about the core assembly **41** in cooperation with the surface rollers **24** and **25**, and forms the sheet roll **71** of FIG. **8**. The rider roller **26** moves up in contact with an outer surface of the sheet roll **71** in response to the increase in the diameter of the sheet roll **71**. Note that a surface winding method as a term used herein means a method in which the core assembly **41** is rotated by force applied to its peripheral surface to wind the continuous sheet **13***a*.

[0050] The cutter **27** is disposed upstream from the core assembly **41** placed on the peripheral surface of the surface rollers **24** and **25**. The cutter **27** cuts the continuous sheet **13***a* to separate the sheet roll **71** about from an unwound portion of the continuous sheet **13***a*. See FIG. **8**.

[0051] The CPU **28** controls the entirety of the film winding system **11** for actuation of the motors **29** and **30**, the lifting mechanism **31** and the cutter driving mechanism **32**. The motors **29** and **30** rotate respectively the surface rollers **24** and **25**. The lifting mechanism **31** moves the rider roller **26** up and down. The cutter driving mechanism **32** drives the cutter **27**.

[0052] In FIGS. **3**, **4**A, **4**B and **4**C, the core assembly **41** includes a core **42** or outer sleeve and a changing unit **43** or inner shaft unit. An example of material from which the core **42** is formed is synthetic resin. The changing unit **43** of metal is disposed inside the core **42**.

[0053] There is a side channel **44** or slit formed in the core **42** to extend in its longitudinal direction. The core **42**, when pressed with internal pressure, expands with a larger outer diameter. The core **42**, when application of the internal pressure is discontinued, comes to have an original diameter by its recovery force.

[0054] The changing unit **43** includes a shaft hub **45**, cam rollers **46**, **47**, **48**, **49**, **50**, **51**, **52** and **53**, ball plungers **54** and **55** as a regulating device, and a grip projection **56**.

[0055] The shaft hub **45** is cylindrical. The cam rollers **46-49** and **50-53** are secured by roller holders **45***a* to the peripheral surface of the shaft hub **45** and arranged at points of four even intervals at two ends with respect to its axial direction. The cam rollers **46-53** rotate and move on the inner surface of the core **42** in the axial direction.

[0056] The ball plungers **54** and **55** as retaining portions or pin portions are included in one pair, and protrude between the cam rollers **50** and **53** and between the cam rollers **51** and **52** near to one end of the shaft hub **45** as viewed in the axial direction. Balls **54***a* and **55***a* are rotatably disposed at ends of pin portions of the ball plungers **54** and **55**. A compression coil spring (not shown) is contained in the inside of the respective pin portions and biases each of the balls **54***a* and **55***a* in a direction for protrusion. The balls **54***a* and **55***a*, when depressed, move to the inside of the pin portions against the bias of the coil spring, and when released from the depression, move back to the initial positions with the bias of the compression coil spring.

[0057] The grip projection **56** is disposed on one end surface of the shaft hub **45** to protrude in the axial direction. The grip projection **56** is manually pushed or pulled to move the changing unit **43** inside the core **42** axially.

[0058] Thick wall portions **57** and **58** of an annular shape are formed inside the core **42** and near to sleeve ends in the axial direction. Receiving grooves **59**, **60**, **61** and **62** are formed in the thick wall portions **57** and **58** in an equidistant manner in the peripheral direction. The receiving grooves **59-62** extend in the axial direction of the core **42** to define paths of the cam rollers **46-49** and **50-53**.

[0059] Each of the receiving grooves **59-62** includes a large diameter portion (root), a small diameter portion (top) and a cam ramp surface **66**. The large diameter portion has a small height, and a relatively large inner diameter of the core **42**. The small diameter portion has a large height, and a relatively small inner diameter of the core **42**. The cam ramp surface **66** extends between the large and small diameter portions. The cam rollers **46-53** are entered in the receiving grooves **59-62** rotatably and movably.

[0060] There are regulating grooves **63** and **64** with a click as regulating device. A movable range of the cam rollers **46-53** is limited by the ball plungers **54** and **55** and the regulating grooves **63** and **64**. The cam rollers **46-53** rotate and move in the receiving grooves **59-62** between one end position where retaining holes **63***a* and **64***a* with a click are engaged with the balls **54***a* and **55***a* (See FIG. **6**A) and another end position where retaining holes **63***b* and **64***b* with a click are engaged with the balls **54***a* and **55***a* (See FIG. **6**B).

[0061] The regulating grooves **63** and **64** are formed in the thick wall portion **58** with inclinations, and disposed between the receiving grooves **59** and **62** and between the receiving grooves **60** and **61**. The regulating grooves **63** and **64** extend in the axial direction of the core **42**, and are paths of the balls **54***a* and **55***a* of the ball plungers **54** and **55**. The retaining holes **63***a* and **63***b* are formed at ends of the regulating groove **63** of FIGS. **6**A and **6**B. The retaining holes **64***a* and **64***b* are formed at ends of the regulating groove **64**.

[0062] In FIG. **5**A, the cam rollers **46-53** are set on the large diameter portion of the receiving grooves **59-62**, namely first position. An outer diameter of the core **42** is D**1**. When the cam rollers **46-53** are rotated and moved up in contact with the cam ramp surface **66** and enter the area of the small diameter portion, namely second position, then the small diameter portion is pressed by the cam rollers **46-53** as illustrated in FIG. **5**B. The outer diameter of the core **42** becomes as large as D**2** which is equal to D**1**+ΔD. When the cam rollers **46-53** are moved back and rotated in contact with the cam ramp surface **66** and shifted down to the large diameter portion, then the cam rollers **46-53** discontinue application of pressure as illustrated in FIG. **5**A. The outer diameter of the core **42** is reduced to D**1**.

[0063] When the cam rollers **46-53** are positioned at the large diameter portion of the receiving grooves **59-62** in FIG. **5**A, the balls **54***a* and **55***a* of the ball plungers **54** and **55** are entered in the retaining holes **63***a* and **64***a* of the regulating grooves **63** and **64**. See FIG. **6**A. This keeps the changing unit **43** positioned with the core **42**. An outer diameter of the core **42** is kept at D**1**. See FIG. **5**A.

[0064] When the cam rollers **46-53** are rotated and moved up to enter the area of the small diameter portion, the balls **54***a* and **55***a* of the ball plungers **54** and **55** are pressed by edges of the retaining holes **63***a* and **64***a* and set inside the ball plungers **54** and **55**. The balls **54***a* and **55***a* pressed to the inside of the ball plungers **54** and **55** continue being pressed by the regulating grooves **63** and **64**. The ball plungers **54** and **55** move forwards in the regulating grooves **63** and **64** while the balls **54***a* and **55***a* are kept depressed.

[0065] When the cam rollers **46-53** enter the area of the small diameter portion of the receiving grooves **59-62** in FIG. **5**B, the balls **54***a* and **55***a* are released from pressure of the regulating grooves **63** and **64**. In FIG. **6**B, the balls **54***a* and **55***a* are entered in the retaining holes **63***b* and **64***b* of the regulating grooves **63** and **64**. This determines the position of the changing unit **43** relative to the core **42**, of which the outer diameter is kept at D**2**. See FIG. **5**B.

[0066] When the cam rollers **46-53** are rotated and moved back toward the large diameter portion, the balls **54***a* and **55***a* of the ball plungers **54** and **55** are pressed by edges of the retaining holes **63***b* and **64***b* and depressed to the inside of the ball plungers **54** and **55**. The balls **54***a* and **55***a* continue being pressed by the edge of the regulating grooves **63** and **64**. The ball plungers **54** and **55** move forwards in the regulating grooves **63** and **64** while the balls **54***a* and **55***a* are depressed.

[0067] When the cam rollers **46-53** return to the large diameter portion of the receiving grooves **59-62** in FIG. **5**A, the balls **54***a* and **55***a* are released from pressure of the regulating grooves **63** and **64**. In FIG. **6**A, the balls **54***a* and **55***a* are entered in the retaining holes **63***a* and **64***a* of the regulating grooves **63** and **64**.

[0068] Thus, the ball plungers **54** and **55** and the regulating grooves **63** and **64** position the changing unit **43** so as to set the outer diameter of the core **42** equal to the predetermined size D**2**, and also position the changing unit **43** so as to set the outer diameter equal to the predetermined size D**1** which is D**2**−ΔD smaller than D**2**, by way of a regulating device. Also, the retaining holes **63***a* and **64***a* are formed with the regulating grooves **63** and **64**. The ball plungers **54** and **55** have the balls **54***a* and **55***a* for retention in the retaining holes **63***a* and **64***a* by way of retaining portions or pin portions.

[0069] A process of winding the continuous sheet **13***a* in the film winding system **11** is described now by referring to FIGS. **7**A-**7**H. At first, a plurality of the core assemblies **41** are expanded with an enlarged outer diameter D**2**, and are manually aligned and placed on the peripheral surface of the surface rollers **24** and **25**. See FIG. **7**A.

[0070] The lifting mechanism **31** moves down the rider roller **26** as illustrated in FIG. **7**B. Then the peripheral surface of the rider roller **26** contacts that of the core assembly **41**, which is squeezed between the rider roller **26** and the surface rollers **24** and **25**.

[0071] In FIG. **7**C, the motors **29** and **30** cause the surface rollers **24** and **25** to rotate in a forward direction. The core assembly **41**, the rider roller **26** and the guide roller **17** are rotated by rotation of the surface rollers **24** and **25**. The guide roller **17** rotates to guide the continuous sheet **13***a* to the rider roller **26**. Thus, the continuous sheet **13***a* from the guide roller **17** is directed to the core assembly **41**. As the core assembly **41** rotates, the continuous sheet **13***a* guided from the rider roller **26** is wound to form the sheet roll **71**. The motors **29** and **30** stop rotation of the surface rollers **24** and **25** upon forming of the sheet roll **71**.

[0072] In FIG. **7**D, the lifting mechanism **31** moves up the rider roller **26**. In FIG. **7**E, the cutter driving mechanism **32** drives the cutter **27**. In FIG. **7**F, the cutter **27** cuts the continuous sheet **13***a*, and separates the sheet roll **71** about the core assembly **41** from the continuous sheet **13***a* before being wound about the core assembly **41**.

[0073] The sheet roll **71** separated from an unwound portion of the continuous sheet **13***a* upstream from the core assembly **41** is manually removed from the surface rollers **24** and **25**. See FIGS. **7**G and **7**H.

[0074] A sequence of removing the core assembly **41** from the sheet roll **71** is described now by referring to FIGS. **8**A and **8**B. An inner diameter of the sheet roll **71** about the core assembly **41** in the film winding system **11** is initially equal to the outer diameter of the core assembly **41**. See FIG. **8**A.

[0075] When the grip projection **56** is pressed in, the cam rollers **46-53** of FIG. **5**B at the small diameter portion of the receiving grooves **59-62** move and rotate in contact with the cam ramp surface **66** to come to the large diameter portion of FIG. **5**A. An outer diameter of the core assembly **41** decreases from D**2** to D**1** which is equal to D**2**−ΔD.

[0076] The outer diameter of the core assembly **41** becomes smaller than an inner diameter of the sheet roll **71** to dechuck the sheet roll **71**. See FIG. **8**B. Finally, the core assembly **41** is manually removed from the sheet roll **71**.

[0077] The outer diameter of the core assembly **41** is reduced after its expansion for winding the continuous sheet **13***a*. The sheet roll **71** is dechucked and removed from the core assembly **41** with the reduced diameter, and can be produced without an internal support core. As the core assembly **41** is expanded with inner pressure of the changing unit **43** or inner shaft unit within the core **42** or outer sleeve, the sheet roll **71** can be produced with high precision in its inner diameter owing to a small change in the outer diameter of the core assembly **41** to wind the continuous sheet **13***a*.

[0078] Another preferred film winding system is described now. A core assembly **76** or spool assembly as a winder of FIGS. **9**A and **9**B is installed in place of the core assembly **41** of the above embodiment. Elements similar to those of the above embodiments are designated with identical reference numerals.

[0079] The core assembly **76** includes a core **77** and a changing unit **78**. A side channel **77***a* or slit extends in the core **77** in its longitudinal direction. The changing unit **78** includes a shaft hub **79**, cam rollers **80**, **81**, **82**, **83**, **84** and **85**, a regulating rod **86**, a compression coil spring **87**, a moving device **88**, a guide projection **89** or anti roll bar, and a grip projection **90**.

[0080] The shaft hub **79** has a rod shape with shaft ends **79***a* and **79***b*. The cam rollers **80-82** and **83-85** are secured to the peripheral surface of the shaft hub **79** and positioned at points with a pitch of one third of a rotation at the shaft ends **79***a* and **79***b* of the shaft hub **79**.

[0081] The regulating rod **86** is inserted through the changing unit **78** in a radial direction, and is slidable back and forth. A stopper **86***a* is formed with the regulating rod **86**, and positioned near to its one end outside the changing unit **78**, for retention of a spring end of the compression coil spring **87**. The compression coil spring **87** is disposed about the regulating rod **86**, and between the stopper **86***a* and an outer surface of the shaft hub **79**. The regulating rod **86** is biased by the compression coil spring **87** in a direction to shift the stopper **86***a* away from the shaft hub **79**, namely downwards in the drawing. A pin portion **86***b* of the regulating rod **86** is pressed against the inner surface of the core **77**, to compress the compression coil spring **87**.

[0082] The moving device **88** includes a pull rod **91** and a link arm **92**. The pull rod **91** extends through the shaft end **79***a* of the shaft hub **79**. The grip projection **90** is secured to a front end of the pull rod **91** protruding through the shaft end **79***a*. The pull rod **91** is slidable in the axial direction of the shaft hub **79**, and is connected with the regulating rod **86** by the link arm **92**. When the pull rod **91** moves in a direction of entry of the grip projection **90**, namely to the left in the drawing, the

link arm **92** moves the regulating rod **86** in a direction of compressing the compression coil spring **87**, namely to the upper side in the drawing.

[0083] The guide projection **89** protrudes from an outer surface of the shaft hub **79**. A guide groove **93** or keyway is formed in the inner surface of the core **77** to extend in the axial direction. An end of the guide projection **89** is inserted in the guide groove **93** and is movable along the same. The insertion of the end of the guide projection **89** in the guide groove **93** prevents the changing unit **78** from rotating inside the core **77**.

[0084] A receiving groove **94** is formed in an inner surface of the core **77** and extends in the axial direction as a path of moving the pin portion **86***b* of the regulating rod **86**. A retaining hole **94***a* is formed in one end of the receiving groove **94**, namely at the right end in the drawing, for engagement of the pin portion **86***b* of the regulating rod **86**.

[0085] A movable range of the cam rollers **80-85** is limited by the guide projection **89**, the guide groove **93**, the regulating rod **86** and the receiving groove **94**. The cam rollers **80-85** are caused to move and rotate in receiving grooves between a first position (See FIG. **9**A) at a large diameter portion and a second position (See FIG. **9**B) at a small diameter portion.

[0086] When the cam rollers **80-85** enter the area of the small diameter portion of a cam ramp surface **96** of the receiving groove (See FIG. **9**B), the pin portion **86***b* of the regulating rod **86** becomes received in the retaining hole **94***a* of the receiving groove **94**. In short, the pin portion **86***b* of the regulating rod **86** moves from a released position away from the retaining hole **94***a* to a retained position of receiving in the receiving groove **94**. The changing unit **78** is positioned exactly relative to the core **77** by receiving the pin portion **86***b* of the regulating rod **86** in the retaining hole **94***a*. In FIG. **9**B, the outer diameter of the core **77** is kept at D**2**.

[0087] When the grip projection **90** is depressed from a state of keeping the core **77** with the outer diameter of D**2** of FIG. **9**B, the moving device **88** operates to move the pin portion **86***b* of the regulating rod **86** from the retained position to the released position against the bias of the compression coil spring **87**. The cam rollers **80-85** become rotatable and movable by shift of the pin portion **86***b* of the regulating rod **86** in the released position.

[0088] Thus, the retaining hole **94***a* and the pin portion **86***b* of the regulating rod **86** are combined by way of a regulating device for positioning the changing unit **78** to expand the core **77** with the outer diameter D**2**.

[0089] In operation of removal of the core assembly **76** from a film roll, an operator manually depresses the grip projection **90** to enable the cam rollers **80-85** to rotate and move. Those move from the small diameter portion and pass the cam ramp surface **96** to the large diameter portion, from the state of FIG. **9**B to the state of FIG. **9**A. The core assembly **76** can be pulled away manually, as its outer diameter decreases from D**2** to D**1**.

[0090] In the above embodiment, the material to be wound is the continuous film. However, winding on the core assembly may be used for winding paper or other material of a continuous sheet form or film form.

[0091] Although the winding method is the surface winding method in the above embodiments, a winding method of the invention can be any one of known methods. For example, it is possible to hold a core assembly between two plates at ends of the core, and to cause the plates to rotate together with the core assembly in contact with the core. Furthermore, it is possible in another winding method to chuck ends of the core in contact with their inner surface by use of a chuck device, and to rotate the chuck device together with the core assembly in the chucked state.

[0092] Also, the tasks performed manually in the above embodiment can be performed automatically by industrial robots or the like, including setting of the core assembly in the film winding system, removal of the sheet roll, depression of the grip projection, and removal of the core assembly from the sheet roll.

[0093] In the above embodiments, the changing unit is supported at three or four points by use of three of cam rollers arranged equidistantly. However, the number of points at which the changing unit is supported may be two or five or more, for the purpose of keeping a circular form of the profile of the core in a predetermined limit. It is possible in the core to form receiving grooves of a number equal to the number of the points of support.

[0094] In the above embodiments, the core has one side channel. However, the core may have other forms in which the outer diameter is enlarged by inner pressure and becomes reduced again upon discontinuation of the inner pressure. For example, the number of the side channels may be two or more in the core. To this end, the core is constituted by plural plate-shaped parts. A structure for connecting the parts may be added. Also, a structure for biasing one of the parts to decrease the outer diameter may be added.

[0095] Note that the continuous sheet can have suitable rigidity in view of forming a sheet roll without an internal support core. If the rigidity of the continuous sheet is relatively higher than a reference rigidity, the shape of a cavity created after removal of the core assembly will be maintained without collapsing. If the rigidity of the continuous sheet is lower than the reference rigidity, a cavity created after removal of the core assembly will have a reduced shape because of weakness of the innermost turns of the sheet roll.

[0096] The changing unit of the above embodiment includes cam rollers for engagement with the cam ramp surface. However, other cam elements may be used in combination with the cam ramp surface, including cam roller balls, cam projections with a lubricant layer, which satisfy suitable conditions of low friction, high resistance to polish, and property for transmitting force to the cam ramp surface.

[0097] Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A core assembly for winding a continuous sheet to form a sheet roll, comprising:

a core of a sleeve shape for winding said sheet thereabout;

a side channel, formed in said core fully in an axial direction, for enabling an outer diameter of said core to change;

a changing unit, disposed through said core movably in said axial direction, shifted to a first position before forming said sheet roll, and shifted to a second position before removing said core from said sheet roll, for pressing an inner surface of said core radially to enlarge said outer diameter when in said first position, and for releasing said inner surface from pressure to reduce said outer diameter when in said second position.

2. A core assembly as defined in claim 1, wherein said changing unit includes plural cam rollers rotatable in contact with said inner surface;

further comprising plural cam ramp surfaces, formed with said inner surface, pressed by said cam rollers in association therewith when said changing unit is in said first position.

3. A core assembly as defined in claim 2, wherein said changing unit includes:

a shaft hub; and

plural roller holders, arranged on said shaft hub, secured to first and second axial positions thereon, for projecting radially in each of said first and second axial positions, and for supporting said cam rollers rotatably at holder ends thereof.

4. A core assembly as defined in claim 3, further comprising plural receiving grooves, formed in said inner surface to extend in said axial direction, for receiving and guiding respectively said cam rollers.

5. A core assembly as defined in claim 3, further comprising a regulating device for retaining said changing unit in said first position.

6. A core assembly as defined in claim 5, wherein said regulating device further retains said changing unit in said second position.

7. A core assembly as defined in claim 6, wherein said regulating device includes:

a first retaining hole formed in said inner surface;

a retaining portion, secured to said changing unit, for entry in said first retaining hole to retain said changing unit in said first position.

8. A core assembly as defined in claim 7, wherein said regulating device further includes a second retaining hole, formed in said inner surface, for positioning said changing unit in said second position upon entry of said retaining portion.

9. A core assembly as defined in claim 7, further comprising a regulating groove, formed in said inner surface, for receiving said retaining portion, said first retaining hole being formed with said regulating groove.

10. A core assembly as defined in claim 9, wherein said retaining portion is constituted by a ball plunger for retention in a releasable manner.

11. A core assembly as defined in claim 9, further comprising a moving device for moving said retaining portion between a retained position of entry in said first retaining hole and a released position of release from said first retaining hole.

12. A core assembly as defined in claim 11, wherein said retaining portion includes a regulating rod biased toward said retained position;

said moving device includes:

a projection, disposed at an end of said shaft hub, pulled for moving said changing unit from said second position to said first position, and pushed for moving said changing unit from said first position to said second position; and

a rod, disposed through said shaft hub in a slidable manner, having one end provided with said projection, for moving said regulating rod toward said released position when said projection is pushed.

13. A core assembly as defined in claim 12, wherein said moving mechanism further includes a link arm for connecting said rod and said regulating rod.

14. A winding method of winding a continuous sheet about a core assembly including a core of a sleeve shape, a side channel formed in said core fully in an axial direction, and a changing unit disposed through said core movably in said axial direction, said winding method comprising steps of:

shifting said changing unit to a first position by moving through said core, for said changing unit in said first position to press an inner surface of said core radially to enlarge an outer diameter thereof;

rotating said core assembly to wind said sheet thereabout;

after winding said sheet, shifting said changing unit to a second position to release said inner surface from pressure to reduce said outer diameter;

removing said core assembly from a sheet roll of said sheet.

15. A winding method as defined in claim 14, wherein said core assembly is supported by a pair of surface rollers disposed in parallel with one another, and is rotated by rotation of said surface rollers in a common direction.

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