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(54) **CORE FOR AN ENDLESS WEB OF A
PLASTIC FILM**

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(76) Inventors: **Carlos Martinez**, Altendorf (CH); **Anh
Kiet Tran**, Jona (CH)

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(57) **ABSTRACT**

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A core which can be plugged onto a winding shaft for winding an endless, flexible material web to form a reel (**10, 60, 70**), wherein the core has means for adjusting the diameter of its surface to be wound between a rest state of reduced diameter and an expanded working state, and wherein the winding surface is of jointless configuration in the expanded state. A reel can therefore be stored until it is used up, and the core can then be pulled out of the reel and the reel can be surrendered, with the result that the circulation of sleeves is dispensed with.

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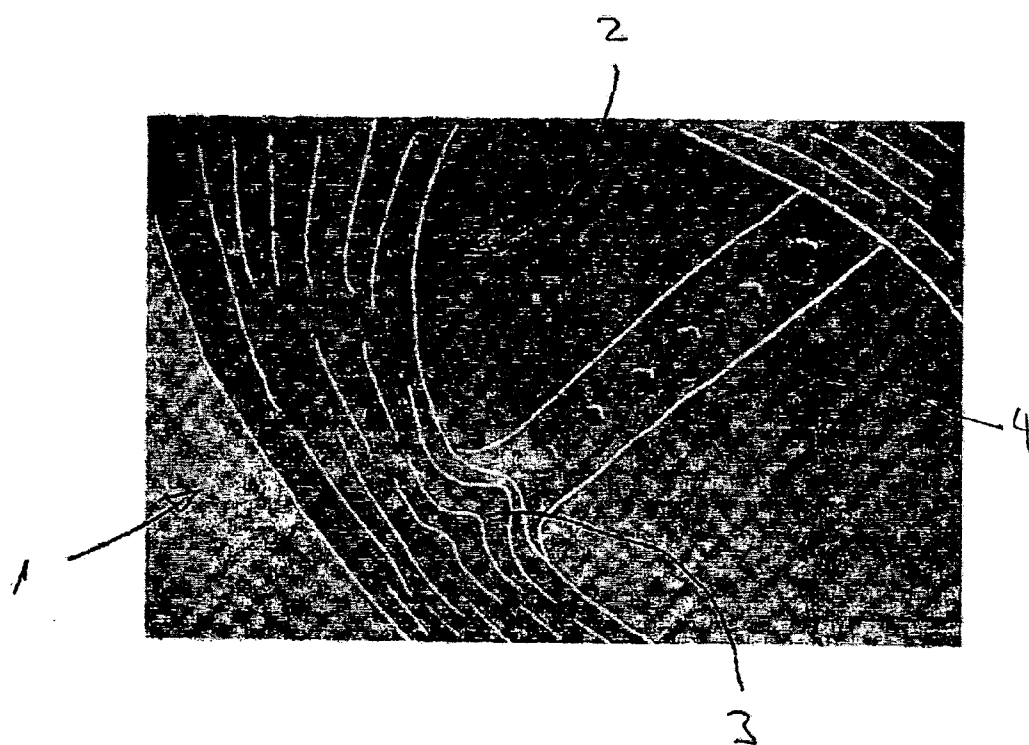
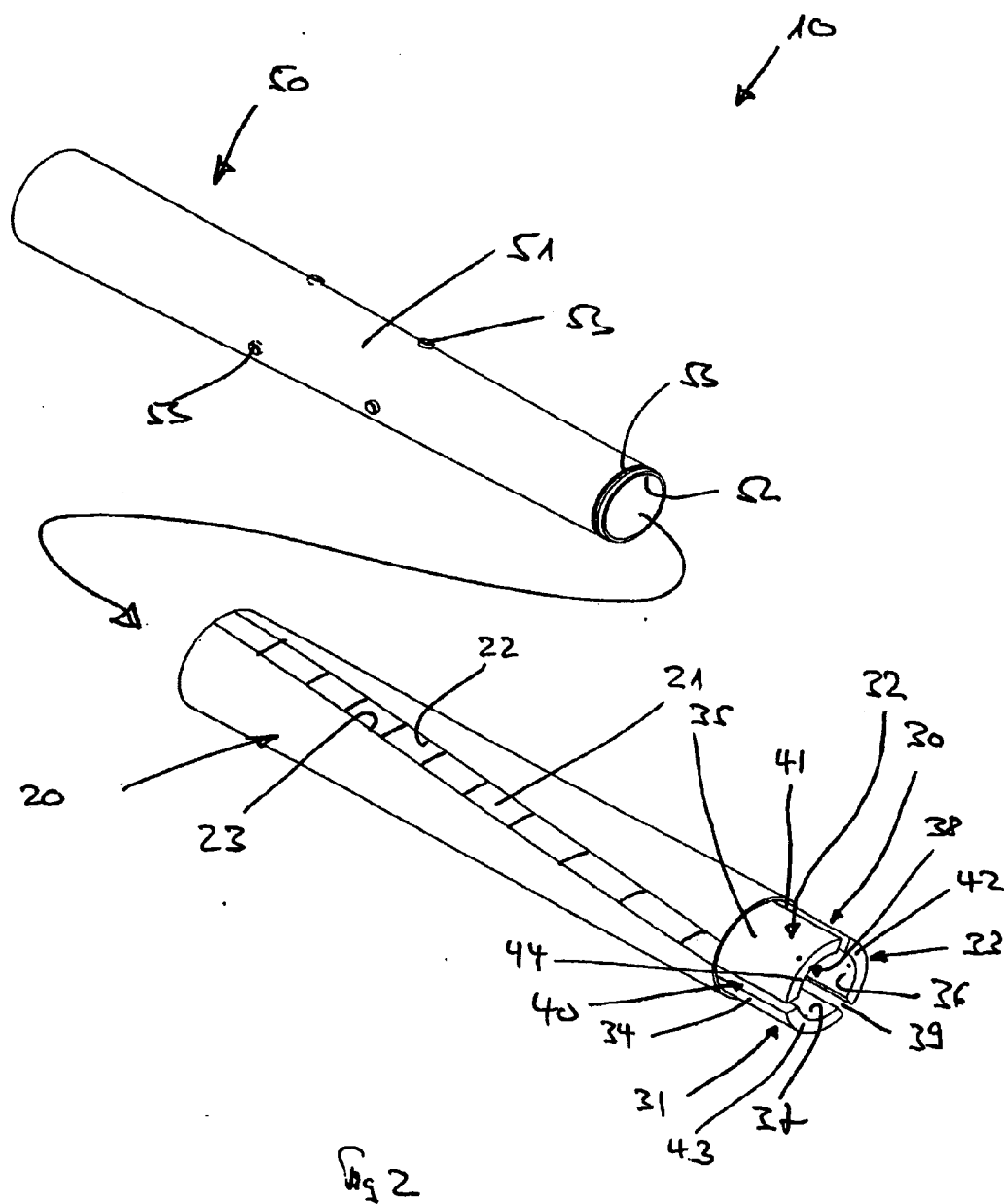


Fig 1



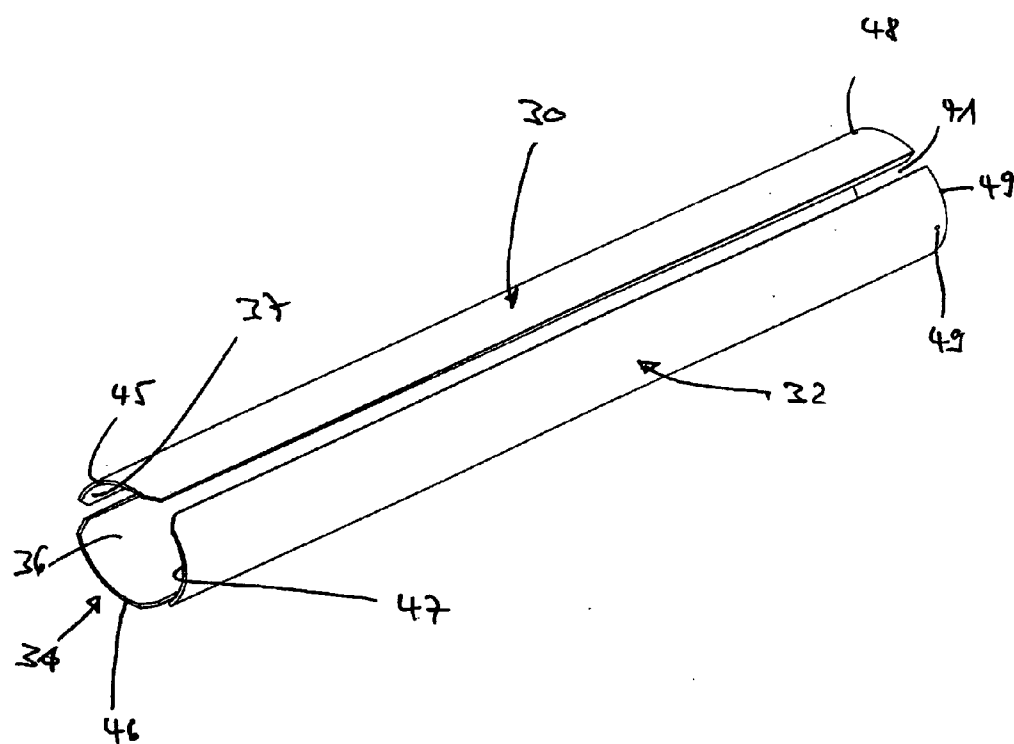
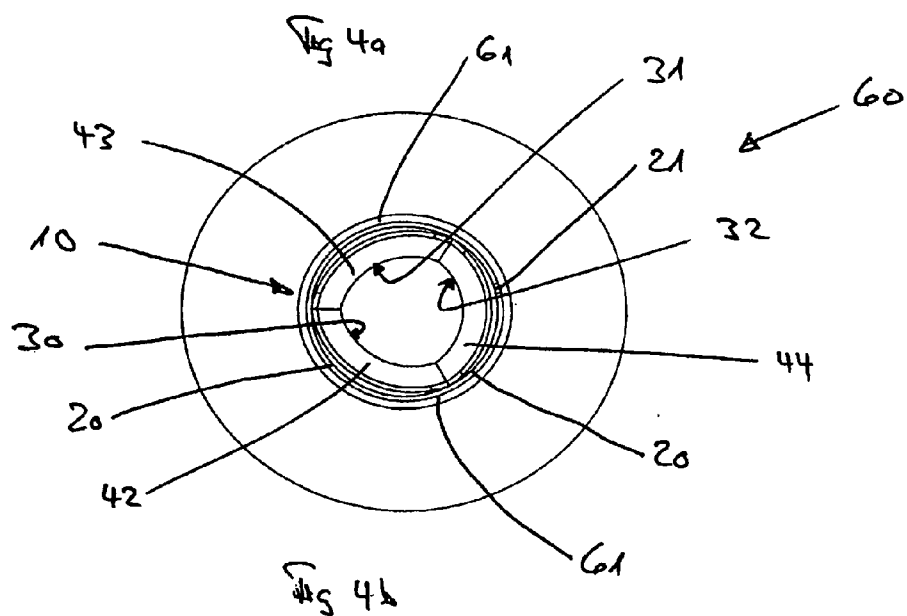
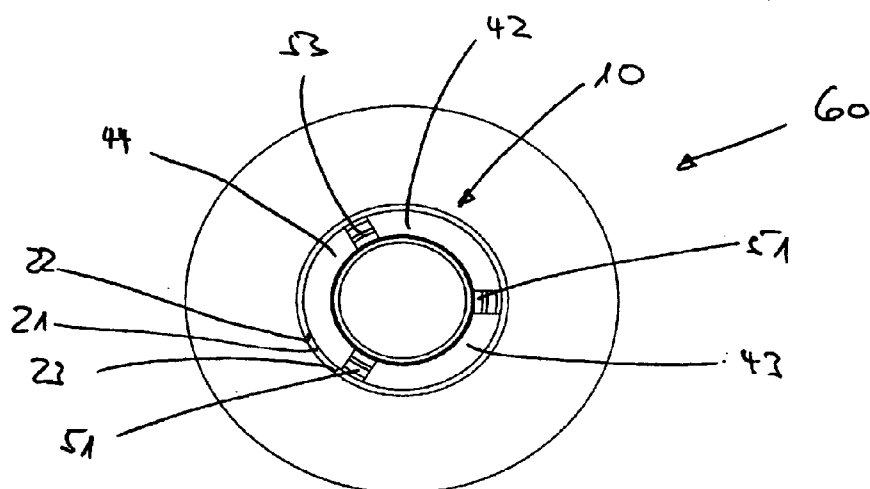
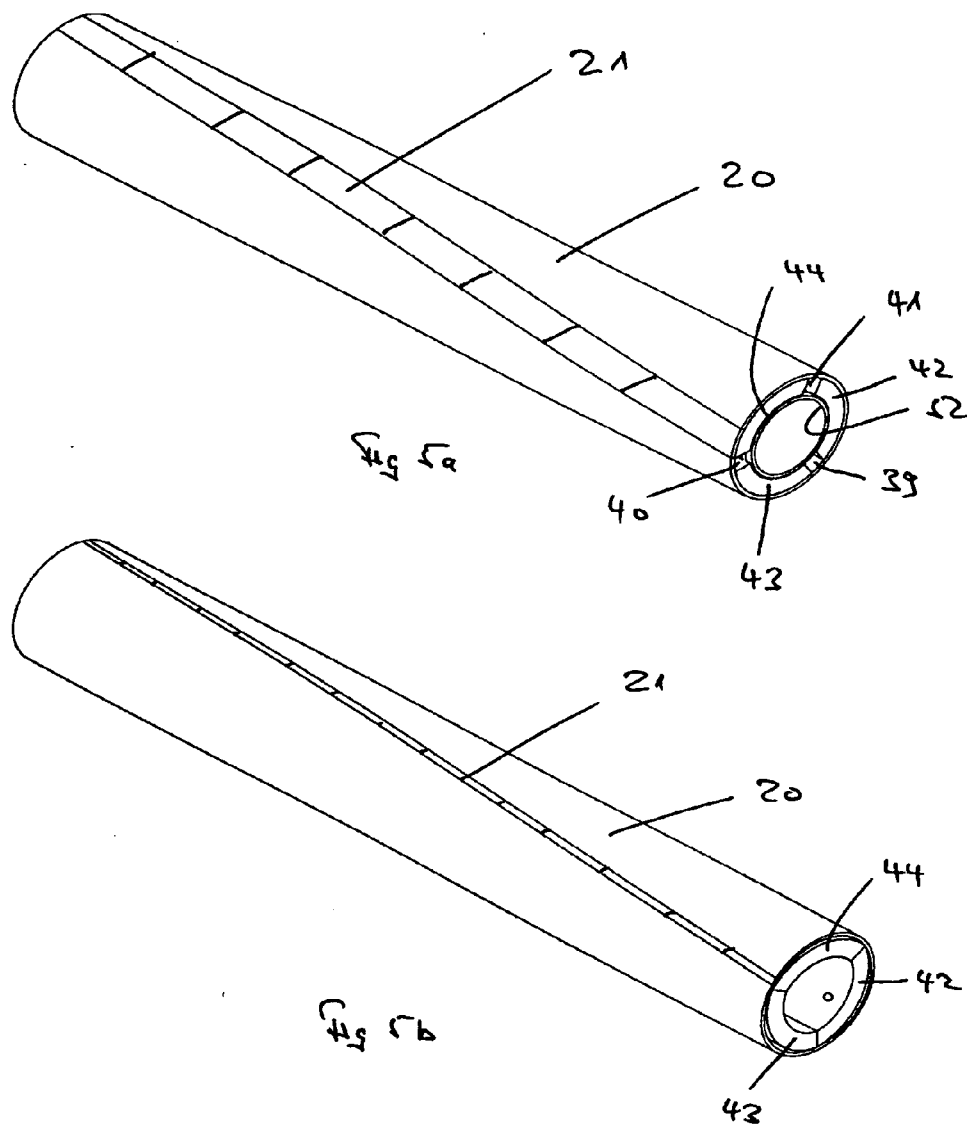
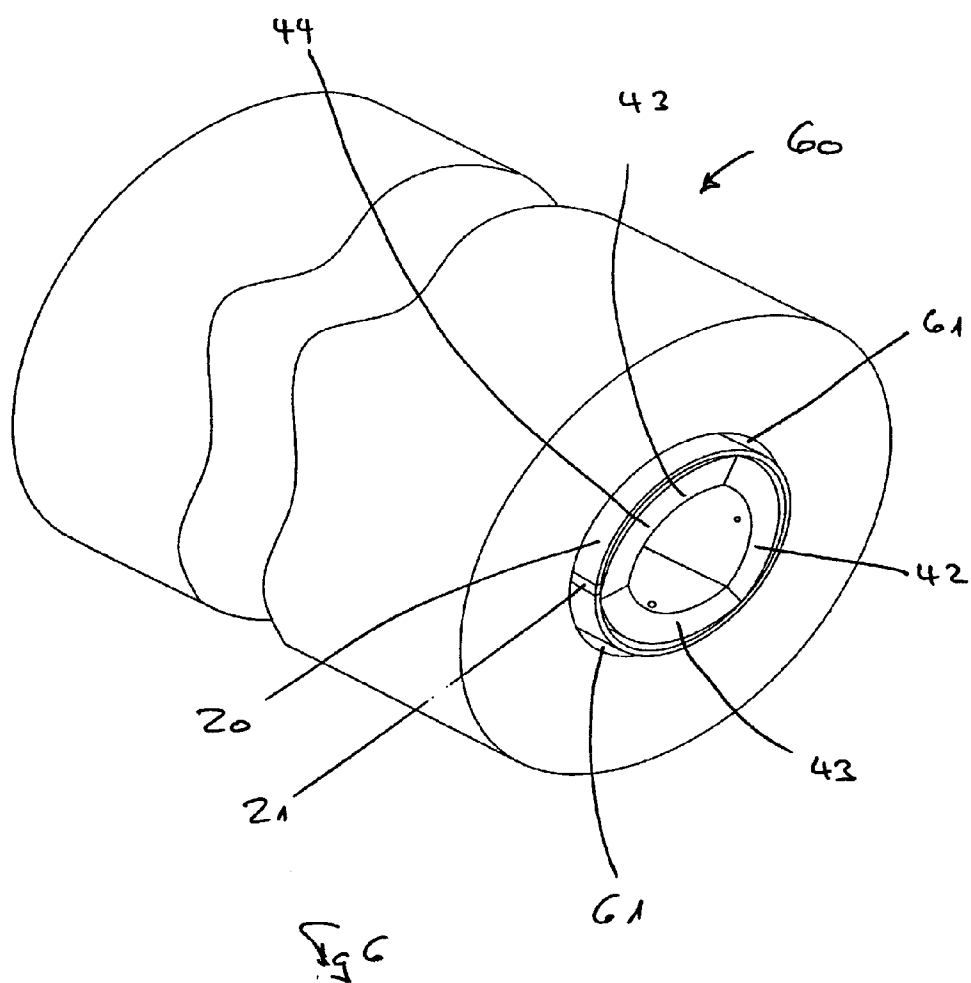
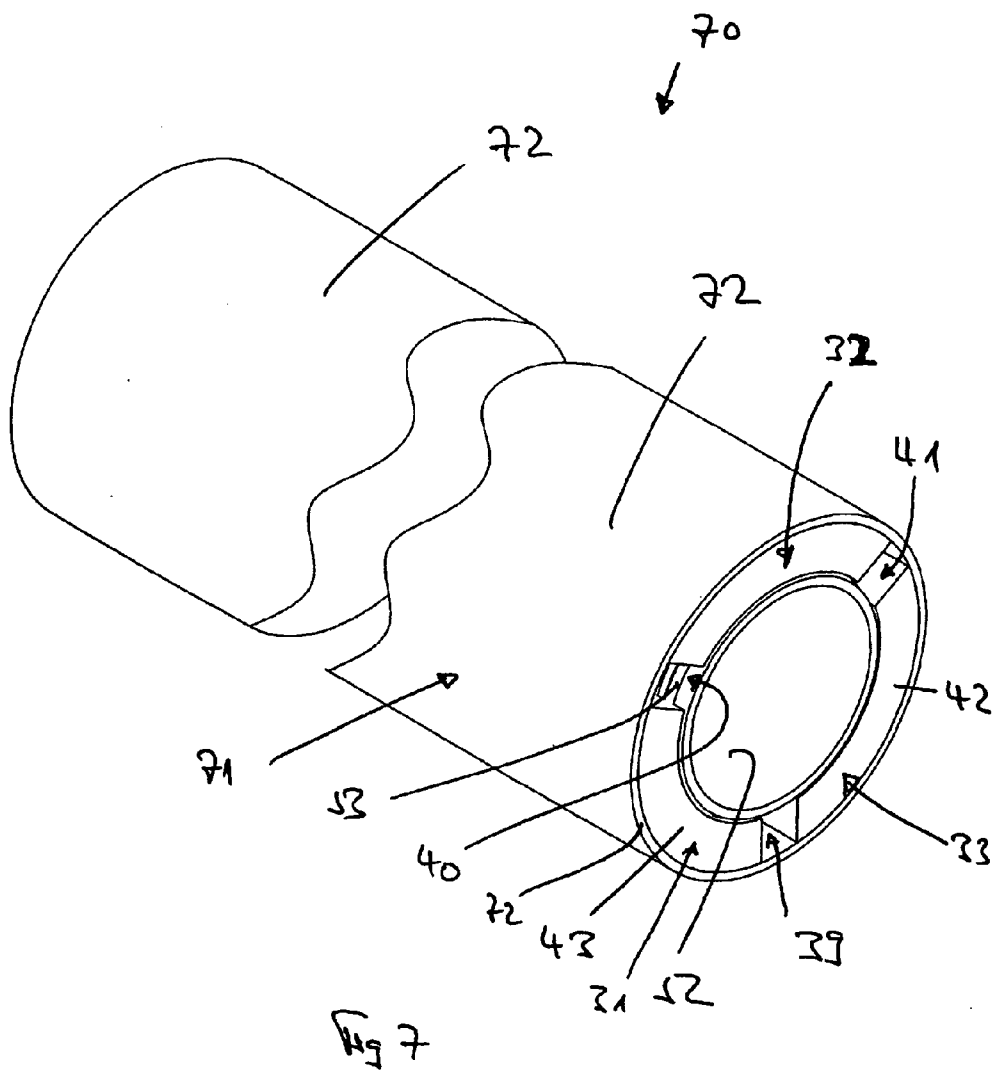


Fig 3









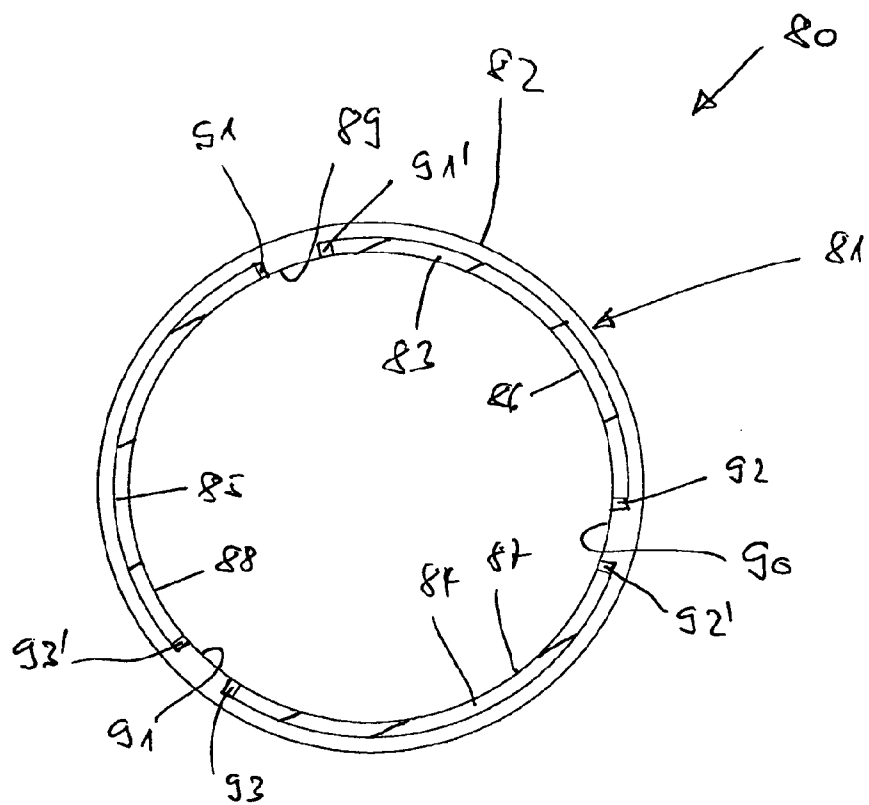


Fig. 8a

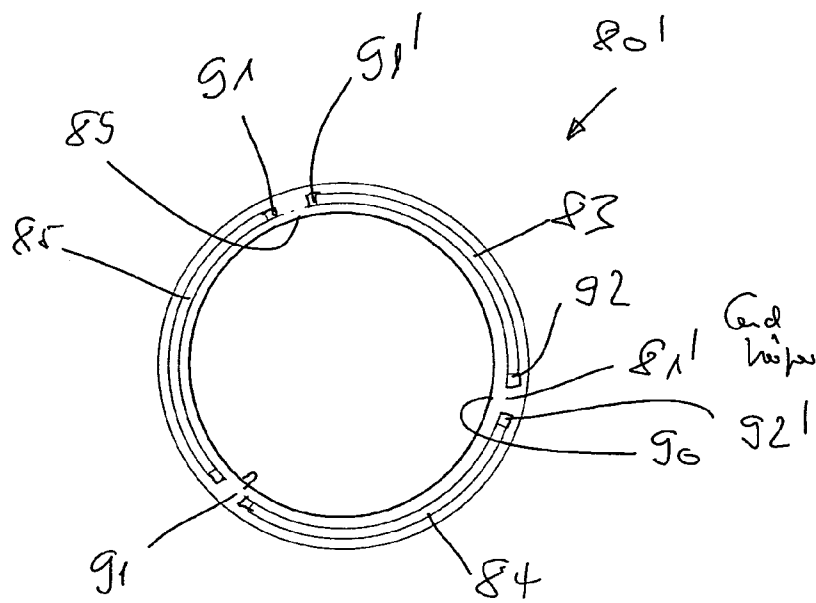
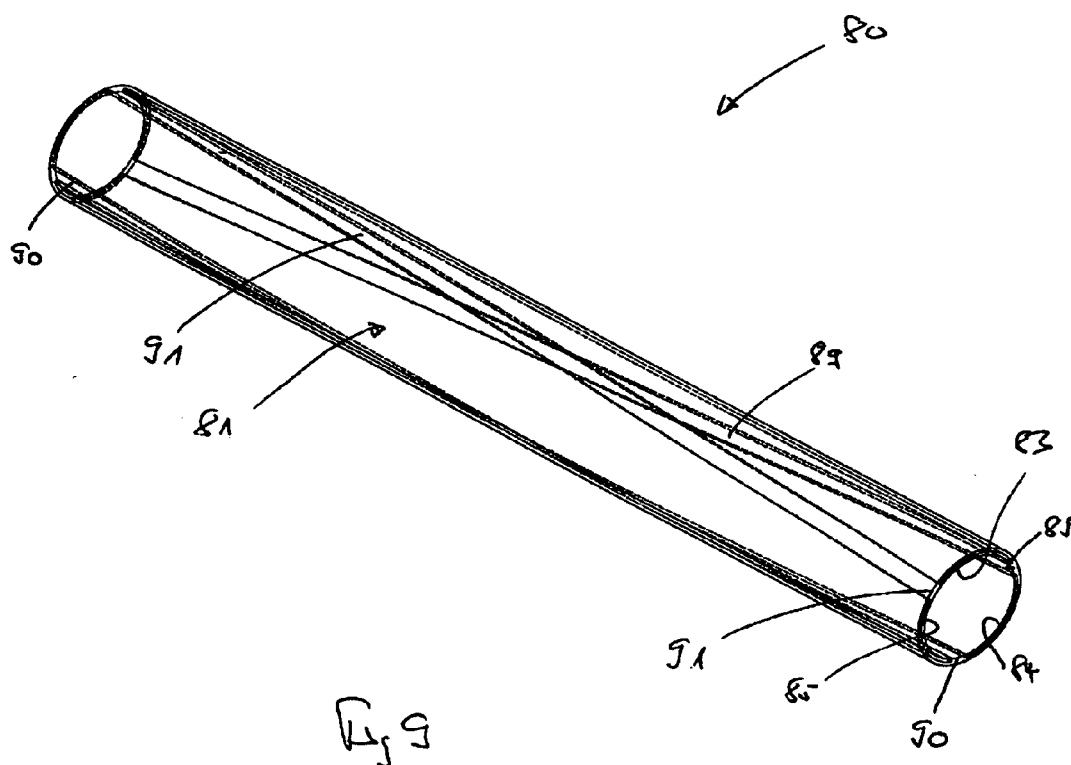


Fig 8b



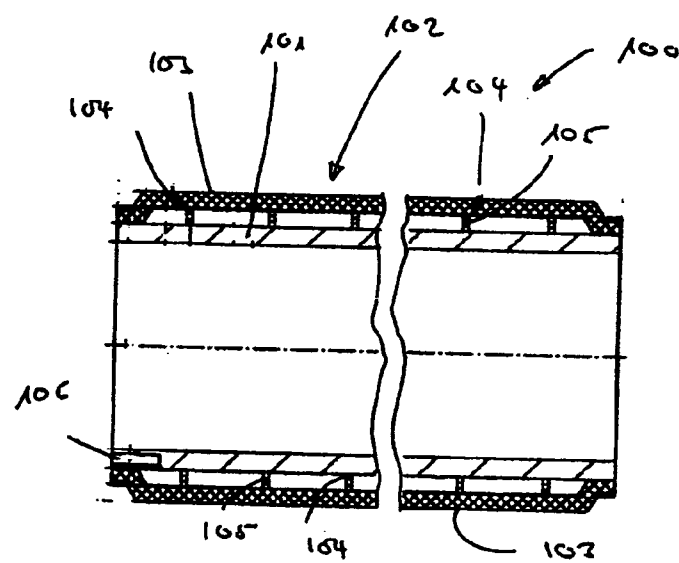


Fig 10

CORE FOR AN ENDLESS WEB OF A PLASTIC FILM

[0001] The present invention relates to a winding core according to the preamble of claim 1.

[0002] Such winding cores are used in winders which are known and described, for example, in EP 2 048 100. A usually freshly produced continuous plastic film is wound onto a winding core (a core plugged onto the winding shaft) to form a reel of predetermined size. The material web is then cut and the finished reel is preferably replaced in a flying manner by a new winding core, so that a new reel can be produced without delay and, as far as possible, without material loss.

[0003] Such plastic films are produced with an extraordinary diversity of compositions and accordingly with the most varied properties, which then also influence the winding behaviour and accordingly have to be taken into account during winding. The given production rate and the number of reels to be produced in a production run are also parameters which have to be taken into account for qualitatively satisfactory production with, at the same time, reasonable costs.

[0004] Typical processing rates range from 2 to 1000 m/min, whilst the finished reel bodies can have a diameter from 50 to 2000 mm and a width from 10 to 6000 mm. The thicknesses can range from a few μm up to the millimetre range. Mention may be made, by way of example, of films with a thickness from 4 μm to 25 μm , preferably 8 or 15 μm to 25 μm , which are wound at a rate of 100 m/min and with a width from approx. 300 mm to 770 mm onto a winding shaft with 4-up mode (i.e. four winding cores are plugged onto a winding shaft and four reels are thus wound beside one another in parallel).

[0005] The formulation of, in particular, plastic films of polyolefins (such as PE polyethylene or PP polypropylene) ranges from the mono-extruded film, comprising a single layer, up to co-extruded film with three, five or more plies, wherein adhesives of the most varied kind can for example be provided in the plies, so that the most varied multi-layer films arise.

[0006] Nowadays, some forty to fifty formulations are known in the area of silage and stretch films, which possess the various properties desired in each case for the application: in northern countries, for example, it is desirable in agriculture for the grass bales wrapped in foil, which can weigh up to 500 kg and are to remain in the field, also to retain their shape when covered in snow, which requires a film of high strength. In other countries, the film is supposed to be black. Alternatively, a film with a specific colour may also be preferred, e.g. green for optical reasons.

[0007] If a grass bale is being wrapped, the adhesive contained between the plastic plies of the films ensures that the individual windings adhere to one another around the grass bale, so that the winding reel possesses stability. Once the grass bale has been formed, a typical scratching noise arises during unwinding of the film, which is loud or quiet depending on the adhesive. Some farms require films that become detached quietly, which has a corresponding effect on the overall formulation of the film.

[0008] The same applies in the area of stretch films, for example, which are used for the packaging of goods stacked on pallets, as protective films (for example in electronics) or as food-wrapping films. The food-wrapping film used in the household thus adheres for example at the edge of the plate due to the adhesive excreted at the place where it is wrapped round the edge of the plate on account of the local pressure

thus produced. Here too, the formulations are as numerous as the possibilities of use of the films and are adapted to the given use.

[0009] Depending on the requirements, production varies between the production of only a few identical wrapped bales for special applications up to mass production of identical wrapped bales.

[0010] As a result of the different formulations, the films themselves have different properties, which in turn have to be taken into account during winding for fault-free film winding, which makes particular demands on the winder with regard to the parameters such as web tension, winding pressure, winding rate, film thickness, and elasticity of the film and adhesiveness of the film in the fresh reel etc.

[0011] The finish-wound film (the winder is usually located directly downstream of the extruder producing the film) is still living, since the various plastic plies are still settling down and the air enclosed between the plies or introduced substances, often the adhesives, are changing and also migrating through the layers. In other words, it is the case that the production process of the films is not yet completed after the winding.

[0012] The finished reels must therefore be stored in a controlled manner immediately following the winding, which often takes place at a temperature of 30 to 45° C. for up to four days. The internal changes in the film thereby taking place lead to a change in the reel itself: the reel changes chiefly in the reel hardness, which is accompanied by a considerable pressure in the interior of the reel. This pressure then continues to be maintained until the reel is unwound again for use of the film.

[0013] Once again, it is the case that the changes in the reel still living after the winding prove to be different (in severity), depending on the formulation and also depending on the winding parameters, until the reel has died, i.e. is subjected to no further changes and therefore is available ready for sale after the aforementioned storage and can be transported away.

[0014] After use of the films, the cores made of cardboard or, on account of the required stability (considerable internal pressure in the reel), usually of plastic accumulate. A plastic core costs on average 1-2 Euros (whereby costs would also be incurred in the case of recycling). The user of the film then incurs additional labour costs to collect, store and return the empty cores. This often leads to the empty cores being disposed of in some way or simply being burnt on site, so that the cost of the production of the cores is lost and, in the case of burning, the environment is polluted. Accordingly, attempts have been made to produce a core-less reel wherein the film has been wound onto a winding shaft with radially extended segments. After completion of the reel, the segments were retracted so that the living reel could be pulled off axially from the winding shaft and stored. During storage of the reel, its internal diameter then unavoidably caved in, probably due to the increasing internal pressure in the reel, in each case at the points which lay during winding over a gap between the extended segments of the winding shaft. These caved-in points represented in FIG. 1 are ruinous, since the disruption due to caving-in is propagated from the inner surface of the reel into its interior and disrupts the correct unwinding of the film. The film often tears at the site of the disruption during unwinding, so that a considerable part of the length of the film is lost for use. Were the torn-off end to be taken up again and further unwound, a new tear would soon be the consequence.

[0015] In the case of some less sensitive stretch films which do not contain adhesive, a stable reel can also be wound on a comparatively thin core, since the reel changes little until it dies. However, this requires winding under low tension and low compressive pressure, because otherwise the thin core could be squashed, whereby the core sticks fast here too on account of the winding in the stable reel and is then unable to be pulled off from the latter.

[0016] Such reels are then unavoidably very soft and have large air inclusions between the plies, which is undesirable: folds arise in the wound plies at the site of the air inclusions, so that the film loses transparency (the unwound film is insufficiently transparent at the site of the folds, so that the packaged material can no longer be seen or lettering to identify the material on the latter can no longer be read) and in addition its adhesion is destroyed, since differing pressure prevails in the reel at the site of the folds and the properties of the films have therefore changed locally.

[0017] In other words, it is the case that thinner and therefore cheaper cores, which also reduce the cost of transport, have to be bought at the price of impaired quality of the film.

[0018] Finally, it is conceivable to change the formulation of the film in such a way that the reel can be pulled off from the winding shaft without a core and then remain stable, i.e. does not cave in. According to present-day knowledge, however, it is the case that the film, on account of the changed formulation, then no longer meets market requirements, i.e. does not suffice in terms of quality.

[0019] Accordingly, the reels continue to be wound on cores and are brought to the consumer with these cores.

[0020] Accordingly, it is the problem of the present invention to enable the winding of flexible material webs of the aforementioned kind without the previously required circulation of cores.

[0021] This problem is solved by a winding core according to the characterising features of claim 1.

[0022] Due to the fact that the diameter of the winding shaft surface to be wound can be changed, it is possible to remove the reel with its winding core from the winding shaft and to store it with the winding core left unchanged in the reel, until the reel has died. The diameter of the winding core can then be reduced and the latter can be pulled out of the core, which on account of the internal pressure prevailing in the reel would not be possible without reducing the diameter of the winding core. Due to the fact that the surface of the winding core to be wound in the expanded operating state is constituted essentially gapless and is supported inwardly all round against the operating pressure in a dimensionally stable manner that is essentially uniform, the reel remains without disruption in its interior region during winding, so that it no longer caves in after storage when the core is removed, so that it can be transported to the consumer without a core and can be completely unwound in use without disruption.

[0023] The effect of this is that, in the production of films, i.e. during winding, only cores for the production quantity of four days are required, since the reels have died after four days and the winding cores according to the invention could be used on site for new reels. On the basis of a daily production of 1250 reels per production line (the average producer having around 8 production lines), 5000 withdrawable winding cores are then required compared, with the same production, to the otherwise approx. 450,000 conventional cores produced each year (at a cost of approx. 1 to 2 € for the

production of a core). With 8 production lines, the production, transport and disposal of over 3 million cores becomes unnecessary.

[0024] It should be added at this point that, depending on the formulation, the required storage time until the reel has died may also be only short (although with many formulations it amounts to several days). But the advantage described above also results even with a short storage time or even the shortest storage time. This is also the case when a reel is to be transported immediately, because in the case of a special formulation it does not involve uniform ambient conditions in the time interval following the winding: a conventional core cannot be withdrawn without disrupting the interior region of the reel, since the reel has an internal pressure merely on account of the winding tension or contact pressure of a contact-pressure roller during winding.

[0025] Preferred examples of embodiment of the winding core according to the invention are described in the dependent claims.

[0026] The invention will be explained in detail below with the aid of the figures. In the figures:

[0027] FIG. 1 shows a reel which has been wound according to the prior art and has a disruption in the interior region,

[0028] FIG. 2 shows a winding core according to the invention with a secondary core,

[0029] FIG. 3 shows a view of the segment shells of the winding core from FIG. 2 from the left-hand end,

[0030] FIG. 4a shows a view of a finished reel, wound onto the winding core from FIG. 2, viewed from the right-hand end, wherein the winding core is in the expanded operating state,

[0031] FIG. 4b shows a view of the finished reel from FIG. 4a, viewed from the left-hand end, wherein the winding core is in the diameter-reduced rest state,

[0032] FIG. 5a shows a view of the winding core from FIG. 2 in the expanded state,

[0033] FIG. 5b shows a view of the winding core from FIG. 2 in the diameter-reduced state,

[0034] FIG. 6 shows a view of a reel that has died, the winding core whereof can be pulled off, and

[0035] FIG. 7 shows a view of a further embodiment of the winding core according to the invention,

[0036] FIG. 8a shows a cross-section through an additional, preferred embodiment of the secondary core according to the invention,

[0037] FIG. 8b shows a cross-section through a further preferred embodiment of the secondary core according to the invention,

[0038] FIG. 9 shows a view of the secondary core from FIG. 8, and

[0039] FIG. 10 shows a view of yet another embodiment of the winding core according to the invention.

[0040] FIG. 1 shows a stored, i.e. dead reel 1 which has been wound onto a winding core according to the prior art. Such segment shafts are known to the person skilled in the art and they usually comprise three segments radially extendable from the winding shaft, which enlarge the diameter of the winding shaft during winding, so that after winding the diameter can be reduced again by retracting the segments and the reel can thus be pulled off from the winding shaft.

[0041] A reel produced in this way, after being pulled off from the winding shaft, already shows (depending on the formulation of the film) scarcely discernible or more marked pressure traces: adjacent segment edges stand out on the

innermost winding ply of the reel, but the curvature of internal region 2 of reel 1 is as a rule not disrupted.

[0042] After storage, the picture shown in the figure emerges: the reel has caved-in in its internal region 2 at the site of the previously only slight pressure traces. A corresponding disruption zone 3 extends, depending on the formulation, to a differing extent into reel 1 and subsequently prevents the proper unwinding of the wound-up material web or film. On account of the selected detail of the picture, the figure shows only one of the three disruption zones present in the case of three winding shaft segments. The wound film is indicated by the lines on the end face of reel 1, as also the caved-in windings in the interior of reel 1 at the site of disruption zone 3. A raised portion 4 can thus be seen in internal region 2, said raised portion having approximately a triangular cross-section.

[0043] FIG. 2 shows a winding core 10 according to the invention in an exploded representation. A secondary core 20 is shown, the length whereof corresponds at least to the windable surface of winding core 10, and onto which a film can be wound to form a reel. Secondary core 20 preferably comprises a hard surface and is made for example of a sheet metal, for example sheet steel. It can however also be made of a plastic such as for example CFRP. It comprises an insertion 21 running over its length, which is made of an elastic material, for example made of a rubber, which is vulcanised onto edges 22, 23 of secondary core 20. The person skilled in the art can easily produce the optimum connection between the rubber and edges 22, 23 in the specific case. As a result, secondary core 20 offers a gapless surface.

[0044] This arrangement makes it possible to expand secondary core 20, since the latter is elastically deformable: first it is itself elastically expandable, the elastic material of insertion 21 permits the increase in the length of the circumference required during the expansion. Secondary core 20 can thus assume a diameter-reduced rest state (see below in respect to FIG. 5 b) and the expanded operating state shown here and in FIG. 5 a, i.e. it can be adjusted between these two configurations.

[0045] Secondary core 20 is preferably constituted such that it assumes the rest position in a tension-free state, whilst in the expanded state insertion 21 then elastically stretched essentially assumes the thickness of secondary core 20. A uniformly round surface of secondary core 20 then results, which makes perfect winding possible even with the most sensitive films, without a disruption in the sense of disruption zone 3 of FIG. 1 arising after the withdrawal of winding core 10 from the dead reel. The material of insertion is particularly preferably volume-constant elastically, i.e. for the winding of sensitive formulations, so that, during the winding carried out under pressure, it offers a similarly firm support for the film to be wound, as is the case with secondary core 20 outside insertion 21.

[0046] It is also preferable for insertion 21 to run in the form of a helical line over the length of the secondary core, as is represented in the figure. This assists careful winding: the wound-up film enters along a lateral surface line onto the emerging reel and is pressed there against the reel by the winding tension and usually by a contact-pressure roller. The tendency towards the formation of a disruption zone with particularly sensitive formulations still exists (at least theoretically) on account of the different material (softer than sheet metal) in insertion 21, since the film there could still sink in somewhat into the reel on account of the winding

pressure or the pressure of the contact-pressure roller. This is not the case with an insertion running in the form of a helical line, since the contact-pressure roller runs beside the insertion on the hard material of secondary core 20, i.e. can no longer sink into the reel.

[0047] In a further embodiment not represented, it is possible to constitute the insertion as a flexible strip, preferably having the thickness of secondary core 20. The strip is then under tension in the expanded state and in the diameter-reduced state hangs loosely between edges 21, 23. In yet another example of embodiment, two (or more) insertions can be provided in the secondary core, with the result that the secondary core cannot then expand in the manner of a slit core, but rather its sections separated by the insertions can move radially away from one another (and towards one another).

[0048] By combining the preferred features described above, the person skilled in the art can produce a secondary core for the winding of all possible films, even the most demanding ones, or he can select a simpler secondary core, for example with a material in insertion 21 not of constant volume or a straight-running insertion 21, with which less demanding films can still be wound in a perfect manner, so that, in the dead reel, no disruption occurs in its internal region as before.

[0049] In other words, it is the case that secondary core 20 according to the invention represents a means of adjusting the surface to be wound of winding core 10 between a diameter-reduced rest state and an expanded operating state, wherein the reel surface in the expanded state is constituted gapless and is supported inwardly all round against the operating pressure in a dimensionally stable manner that is essentially uniform, as a result of which disruptions can no longer be formed.

[0050] FIG. 2 also shows three segment shells 30, 31, 32, which are surrounded by the secondary core 21 and project out of the latter on account of the exploded representation of the figure. Segment shells 30 to 32 in turn rest on a cone constituted as a conical mandrel 50, which can be introduced between segment shells 30 to 32 from the left-hand side according to the arrow drawn in the figure. Mandrel 50 has a concentrically axially running drill hole 52, which allows it to be plugged onto a winding shaft of a winder. Drill hole 52 forms the inner face of the winding core according to the invention, so that, as a result, the latter can adjust the diameter of its surface to be wound as described above between a diameter-reduced rest state and an expanded operating state, with the internal diameter remaining constant. Segment shells 30 to 32 themselves are constituted conical, i.e. increase in thickness over their length from the left-hand end to the right-hand end. Generally speaking, segment shells 30 to 32 are of smaller thickness at the end at which conical mandrel 50 is introduced. Outer faces 33 to 35 of segment shells 30 to 32 lie on a common cylindrical lateral surface, the gradient of inner faces 36 to 38 corresponding to the gradient of outer face 51 of mandrel 50, as a result of which segment shells 30 to 32 are constituted as a mirror image of mandrel 50.

[0051] Also represented are end faces 42 to 44 at the thicker end of segment shells 30 to 32, whilst end faces 45 to 47 can be seen at their thinner end in FIG. 3.

[0052] The length of segment shells 30 to 32 should correspond at least to the length of the windable surface of winding core 10, so that secondary core 20 is perfectly supported over this length. The length of mandrel 50 preferably also corre-

sponds (but not necessarily in view of the thickness of segment shells 30 to 32) to the length of the windable surface of winding core 10 in order to stabilise segment shells 30 to 32 perfectly during the operation.

[0053] In the exploded representation of FIG. 2, the position of segment shells 30 to 32 and therefore the position of secondary core 20 corresponds to the expanded operating state of winding core 20: the segment shells are separated from one another in each case by a gap 39 to 41, with the result that they can fall inwards when mandrel 40 is pulled out of winding core 10 to an extent such that gaps 39 to 41 close and segment shells 30 to 32 abut against one another. Secondary core 20 then also closes on account of its springy-elastic material, or also by the fact that elastic insertion 21 contracts, and enters with a reduced diameter into its rest state (as is represented in FIG. 5b). The person skilled in the art will constitute the gap with a predetermined width for the specific case, in such a way that the ratio of the gap width to the diameter reduction suffices in the optimum manner in relation to the overall thickness of the winding core or the use of a hose 71.

[0054] Mandrel 50 is provided with guide lugs 53 in the embodiment shown in the figure, said guide lugs running in gaps 39 to 41 when mandrel 50 is introduced into segment shells 30 to 32 and thus holding segment shells to 32 in the correct mutual position during the adjustment of the diameter of winding core 10.

[0055] A wedge arrangement thus results, comprising the cone and segment shells 30 to 32, in such a way that winding core 10 is brought into its expanded operating position via the interacting wedge surfaces as result of the complete introduction of mandrel 40 into its operating position, whilst the position of segment shells 30 to 32 and therefore also of secondary core 20 is adjusted as a result of the removal of mandrel 40, until winding core 10 enters into its diameter-reduced state.

[0056] It is represented in the figure that insertion 21 extending in the form of a helical line over the length of secondary core 20 lies fully on segment shell 32, with the advantage that it is supported by the latter over its whole length. Accordingly, the helical line extends less than a third of a full revolution, since the segment shell, in view of gaps 39 to 41, also occupies less than a third of the available circumference.

[0057] If only two segment shells are used, less than a half a revolution accordingly results for the helical line; in the case of more than three segment shells, for example four, less than a quarter of a revolution results, and so forth.

[0058] FIG. 3 shows segment shells 30 to 32 and a view looking onto end faces 45 to 47 of the thinner end, i.e. from the insertion side of mandrel 50. The position of segment shells 30 to 32 corresponds to that in FIG. 2. Represented in the shown embodiment are a further two of three locating cams for 48, 49 extending inwards and provided on each of segment shells 30 to 32, said locating cams being designed to engage into a locating groove 53 (FIG. 2) of mandrel 50, so that the operational end position of introduced mandrel 50 is defined. Not represented in the figure is the associated mandrel with its drill hole, which forms the internal diameter of the core.

[0059] FIG. 4a shows a completed, still living reel 60, such as it is stored until the changes still taking place in the reel have been completed to an extent such that winding core 10 can be removed from the reel without reel 60 then still form-

ing disruptions. A view of the right-hand side of winding core 10 according to FIGS. 2 and 3 is represented.

[0060] FIG. 4b shows reel 60, winding core 10 whereof has become smaller in diameter after removal of mandrel 60 (not represented to make the figure easier to read), so that the winding core can be withdrawn from winding 60.

[0061] The figure shows segment shells 30 to 22 and a view looking onto end faces 42 to 44 of the thicker end. Segment shells 30 to 32 have fallen inwards and rest against one another at their lateral edges. Accordingly, secondary core 20 has narrowed and insertion 21 has contracted. There is now a gap 61 between reel 60 and secondary core 20, which permits problem-free removal of winding core 10, which is then used for the next winding. Reel 60 can be stored without problem until it is transported away and can be unwound for use completely and without material loss.

[0062] FIGS. 5a and 5b show assembled winding core 10 in the expanded state and in the rest state, the reel having been omitted for the sake of clearer representation. FIG. 6 also shows a perspective view of reel 60 according to the representation in FIG. 4b.

[0063] FIG. 7 shows a further embodiment of a winding core 70 according to the present invention. Instead of a secondary core 20 (FIGS. 2 to 6), a stretchable-elastic hose 71 is provided, which lies on segments shell 30 to 32 and overlaps gaps 39 to 41 and which, with its outer side 72, forms the windable surface of winding shaft 70. Winding core 70 can thus be expanded from the diameter-reduced rest state to the expanded operating state. The windable surface of winding core 70 is gapless, but is not supported over gaps 39 to 41 and is held in shape only by the tension in stretched hose 71. The person skilled in the art would therefore wind only less sensitive formulations, although a large number thereof, with such a winding core 70, since the advantage according to the invention is also achieved with this embodiment in the case of the corresponding formulations. A 2 to 8 mm thick hose made of polyurethane is preferably used, so that a sufficiently stretchable surface results, but nonetheless a stiff hose 71 with an abrasion-resistant surface over the gap, polyurethane having the advantage that the hose surface closes and does not open in the event of any damage, this being desirable with regard to disruptions in reel 70.

[0064] Here, the person skilled in the art can also provide an additional core split over its length and disposed between hose 71 and segment shells 30 to 32, the length of said core corresponding at least to the windable surface, wherein the slit is preferably constituted in the form of a helical line and permits the change in the circumference of the secondary core between the rest state and the expanded operating state and wherein the hose then surrounds the core, is widened by the latter in the expanded operating state and lies on the latter. In view of the large number of formulations, a general rule cannot be given as to when a winding core 10 must be used with a secondary core 20, and when a winding core 70 just suffices with a rubber hose 71. This also applies to the thickness of rubber hose 71 required for a winding core 70 to avoid disruptions. Here, the person skilled in the art must rely on trials. On the one hand, he will recognise particularly sensitive formulations from his production know-how and, in the case of the latter, will preferably use a winding core 10 with secondary core 20. On the other hand, for less sensitive or new, still unknown formulations, he can ascertain with a few trial windings whether a winding core 70 is compatible or not with an elastic hose 71. If need be, the optimum thickness of

hose **71** can also be ascertained. Such trials are worthwhile in the case of large production quantities (since winding cores **70** that can then possibly be used with only one hose are cheaper), whereas in the case of small batches winding cores **10** can in any case be advantageously used with secondary cores **20**.

[0065] For the most sensitive formulations, it may be advantageous to provide a winding core **10** with secondary core **20** additionally with an elastic hose, wherein the hose then surrounds secondary core **20** and compensates for the finest areas of unevenness in the region of insertion **21**. In addition, the use of such a hose can make it possible to produce secondary core **20** cost-effectively, i.e. with a certain degree of unevenness in the region of the insertion. If need be, depending on the formulation and the associated tolerance of the winding in respect of a surface to be wound that is not completely uniform, the person skilled in the art can in turn determine the shape of the winding core according to the invention that is optimum for the specific application.

[0066] FIG. **8a** shows a cross-section through an additional, preferred embodiment of the winding core according to the invention, wherein secondary core **80** is modified compared to secondary core **20** described above by way of example with the aid of FIGS. **2**, **5a** and **5b**. This secondary core **80** can thus replace secondary core **20** shown in FIG. **2** and can be used for example together with the wedge arrangement shown there (comprising cone **50** and segment shells **30** to **32**).

[0067] Accordingly, FIG. **8a** shows only modified secondary core **80**, but not the associated wedge arrangement with cone **50** and segment shells **30** to **32**.

[0068] Secondary core **80** comprises a hose-shaped base body **81** made of an elastically stretchable material, preferably of a plastic such as polyurethane or rubber, wherein the person skilled in the art can himself easily determine the material to be used in the specific case. Outer surface **82** of base body **81** (which here is also the outer surface of secondary core **80** itself) forms the surface to be wound of the winding core, secondary core **80** being a component thereof.

[0069] Formed at the inner side of base body **81**, therefore at the inner side of secondary core **80**, are at least two, preferably three or even more supporting elements constituted here as shells **83** to **85**, which lie at a predetermined distance from one another in the expanded state shown in the figure, said distance being dimensioned by the person skilled in the art in such a way that the diameter of the secondary core is sufficiently small in the rest state for the core to be reliably pulled out of the reel. These supporting elements constituted as shells **83** to **85** extend according to the length of secondary core **80** over at least the length of the surface to be wound. Inner surfaces **86** to **88** of shells **83** to **85** thus form sections of the inner surface of secondary core **80**.

[0070] This configuration makes it possible to plug secondary core **80** onto retracted segment shells **30** to **32** of a wedge arrangement (see FIG. **2**), base body **81** and therefore secondary core **80** then being elastically expanded in circumference when mandrel **50** is introduced (FIG. **2**), so that their diameter is increased. The secondary core is plugged onto the wedge arrangement in such a way that supporting shells **83** to **85** lie over gaps **39** to **41** formed by segment shells **30** to **32** (FIG. **2**) and thus cover the latter. A gap **39** to **41** is thus associated with each of supporting shells **83** to **85**. Conversely, webs **89** to **91** of base body **81** then lie on segment shells **30** to **32**. It emerges that practically the whole outer

surface **82** of secondary core **80** is then reliably supported, first by hard supporting shells **83** to **85**, and then by webs **89** to **91**. Gaps **39** to **41** are thus reliably overlapped and a perfect reel can be produced. Small gaps **91**, **91'** to **93**, **93'**, which are formed during the expansion of elastic base body **81** with respect to supporting shells **83** to **85**, which do not or scarcely expand in the circumference, are negligible for the winding outcome.

[0071] In accordance with the intended use, supporting shells **83** to **85** comprise a material which is harder than that of expandable base body **81** (the expandability whereof permits the change in the circumferential length between the rest state and the operating state), so that they can perform their function as supporting plates lying over gaps **39** to **41** (FIG. **2**). Supporting shells **83** to **85** preferably comprises a sheet metal or a glass fibre-reinforced plastic. It should also be noted here that a simple rule for the hardness of supporting shells **83** to **85** cannot be given, since this depends on the formulation of the film to be wound: the more sensitive the formulation, the harder and more rigid the supporting shells must be.

[0072] FIG. **8b** shows an embodiment of a secondary core **80'**, wherein supporting shells **83** to **85** are completely admitted into expandable base body **81'** and are surrounded by the latter. In the expanded state of the winding shaft, however, supporting shells **83** to **85** still lie side by side at a distance from one another and are disposed with respect to the radially extendable segment shells in such a way that each intermediate space between the radially extendable segment shells is overlapped by an associated supporting shell **83** to **85**.

[0073] This arrangement offers the advantage that supporting shells **83** to **85** lying in the interior of the base body are firmly anchored in the latter and are therefore particularly well suited for a further preferred embodiment of a supporting shell:

[0074] If the supporting shells comprise a central region which lies between the longitudinal edges of the supporting shells and has the greatest thickness, whilst the supporting shells taper towards the longitudinal edges, this produces a particularly gentle and uniform transition between the zones without supporting shells of the base body and the zones in which supporting shells are present, with the result that the winding takes place particularly uniformly.

[0075] FIG. **9** shows a view of secondary core **80** from FIG. **8**. It is represented that the supporting shells run in the form of a helical line along the inner side of secondary core **80**. This helical line serves the same purpose as the helical line of insertion **21** of a secondary core **20**: a contact-pressure roller of a winder cannot then sink into the somewhat softer material at the site of webs **89** to **91**. Accordingly, the helical line, depending on the number of supporting shells used, has the same dimensions as are represented on the basis of insertion **21**.

[0076] FIG. **10** shows a cross-section through a further embodiment of a winding core **100** according to the invention, with a primary core **101** made for example of metal (or a plastic such as for example CFRP), which can be clamped on a winding shaft of a conventional winder in the usual way. Provided on the primary core is a pneumatic element **102** constituted as a hollow cylinder, said element extending along the windable surface of the winding core and preferably forming the windable surface with its outer face **103**. Ribs **104** associated with primary core **101** keep the outer face essentially cylindrical despite chambers **105** formed by ribs **104**.

Ribs **104** comprise openings **105**, through which a fluid introduced via a supply line **106** can flow into all chambers **108** with pressure compensation. The pneumatic element expands under the operating pressure and forms in a gapless expanded surface to be wound. If the pressure is released, surface **103** of pneumatic element **102** collapses, so that winding core **100** can be withdrawn from the dead reel.

[0077] The pneumatic element preferably comprises a hose made of polyurethane, which is vulcanised at the edge onto primary core **101** or is held fast by clamps. In this case, it may be advantageous to insert air-tight, possibly expandable, annular sacks into chambers **105**, so that the fastening of the hose at the edge has only to satisfy the mechanical requirements.

[0078] In a further embodiment, outer face **103** of pneumatic element **102** is surrounded by a hose made of a non-expandable fabric such as for example a polyester or glass-fibre fabric, which is stretched in the expanded state of winding shaft **100** and, on account of its shape, prevents the elastic material of the pneumatic element from arching on account of the internal pressure in the middle of winding core **100**. Such fabrics usually have an uneven surface on account of the strong fabric fibres. Accordingly, a thin rubber hose of PUR can then be pulled over the fabric hose, said rubber hose compensating for the areas of unevenness caused by the fibres and providing a perfectly smooth surface to be wound.

1. A winding core which can be plugged onto a winding shaft for the winding of a continuous, flexible plastic film to form a reel (**10**, **60**, **70**), characterised in that the winding core comprises means for adjusting the diameter of its surface to be wound on between a diameter-reduced rest state and an expanded operating state, with the internal diameter remaining constant, wherein the winding surface in the expanded state is constituted gapless and is supported inwardly all round against the operating pressure in a dimensionally stable manner that is essentially uniform.

2. The winding core according to claim 1, wherein the means comprises a secondary core (**80**) elastically expandable in the periphery, the outer surface (**81**) whereof forms the surface to be wound of the winding core, and wherein there are moulded-in at its inner side supporting elements running on it over at least the length of the surface to be wound and, in the expanded operating state, lying at a predetermined distance from one another.

3. The winding core according to claim 2, wherein the supporting elements are constituted as shells (**83** to **85**), the inner surfaces whereof form sections of the inner surface of the secondary core (**80**) and wherein the shells (**83** to **85**) preferably run in the form of a helical line along the inner side of the secondary core (**80**).

4. The winding core according to claim 2 or 3, wherein the secondary core (**80**) comprises an elastically expandable material, preferably a plastic such as polyurethane or rubber, the expandability whereof permits the change in the circumferential length between the rest state and the operating state.

5. The winding core according to claim 4, wherein the supporting elements (**83** to **85**) comprise a material which is harder than the expandable material of the secondary core (**80**), and are preferably made of sheet metal or glass fibre-reinforced plastic.

6. The winding core according to claim 1, wherein the means comprise a secondary core (**20**) elastically expandable in diameter, the length whereof corresponds at least to the windable surface, and which comprises over its length at least

one insertion (**21**) which permits the change in the length of the circumference of the secondary core (**20**) between the rest state and the operating state and, in the expanded state, essentially has the thickness of the secondary core (**20**).

7. The winding core according to claim 6, wherein the insertion (**21**) runs in the form of a helical line over the length of the secondary core (**20**) and the helical line in the region of the windable surface extends over less than a half, preferably less than a third, particularly preferably less than a quarter of a full revolution.

8. The winding core according to claim 6 or 7, wherein the material of the insertion is elastic and preferably elastically deformable with a constant volume.

9. The winding core according to any one of claims 6 to 8, wherein the secondary core (**20**) has a hard surface and is preferably made of sheet metal, particularly preferably of sheet steel.

10. The winding core according claim 1, wherein the means comprise a wedge arrangement with a cone (**50**) and at least two, preferably at least three segment shells (**30** to **32**) constituted as a mirror image of the cone (**50**), said segment shells being constituted such that the outer faces of the segment shells (**30** to **32**) lying operationally on the cone (**50**) lie on a common cylindrical lateral surface and enclosed between them in each case a gap (**39** to **41**) of predetermined width, wherein the length of the segment shells (**30** to **32**) and preferably that of the cone (**50**) corresponds at least to the length of the windable surface of the winding core and the cone (**50**) comprises a concentrically axially running drill hole (**52**) which permits it to be plugged onto a winding shaft.

11. The winding core according claims 2 and 10 or 6 and 10, wherein the secondary core (**20**) is positioned on the segment shells (**30** to **32**) in such a way that the supporting elements each overlap an associated gap (**39** to **41**) or the at least one insertion (**21**) rests completely on one of the segment shells (**30** to **32**).

12. The winding core according claim 1, wherein the means provides a pneumatic element constituted as a hollow cylinder and disposed concentrically with the longitudinal axis of the winding core (**100**), said pneumatic element extending along the windable surface of the winding core, preferably forming the windable surface with its outer face (**103**) and, under operating pressure, expanding the winding core into the expanded operating state, wherein the winding core assumes the diameter-reduced rest state in the pressure-relieved state of the pneumatic element.

13. The winding core according claim 12, wherein the pneumatic element comprises inner peripheral ribs (**104**), which limit its maximum external diameter in a predetermined manner, and wherein a hose made of flexible, non-expandable fabric is preferably provided on the outer side of the pneumatic element, said fabric surrounding the latter tightly and keeping it in a cylindrical shape in the expanded state of the pneumatic element.

14. The winding core according claim 1, wherein the means comprise a hose (**71**) made of an elastic material, preferably polyurethane, the outer surface (**72**) whereof forms the windable surface, wherein the elastic material can be stretched in such a way that the hose (**72**) can be expanded from the diameter-reduced rest state to the expanded operating state.

15. The winding core according claims **10** and **14**, wherein the hose (**71**) surrounds the segment shells (**30** to **32**) and, expanded by the latter in the expanded operating state, lies on the latter.

16. The winding core according claim **14**, wherein the means comprise a secondary core (**20**) expandable in diameter and slit over its length, the length whereof corresponds at least to the windable surface, wherein the slit is preferably constituted in the form of a helical line and permits the change in the circumference of the secondary core (**20**) between the rest state and the expanded operating state and wherein the hose surrounds the secondary core (**20**), is widened by the latter in the expanded operating state and lies on the latter.

17. The winding core according claims **2**, **6** and **10**, wherein the hose surrounds the secondary core (**20**), which in turn rests on the segment shells (**30** to **32**).

18. The winding core according claim **2**, wherein the supporting elements are constituted as supporting shells, which run in the interior of the winding shaft core on a common diameter between the surface to be wound and its inner surface and, in the expanded state of the winding shaft, lie side by side at a distance from one another, and wherein the supporting shells are disposed in respect of the radially expandable segments in such a way that each intermediate space between the radially expandable segments is overlapped by an associated supporting shell.

19. The winding shaft according claim **18**, wherein the supporting shells taper from a central region between the longitudinal edges towards the latter.

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