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(54) Filament packaging.

(57) A length of filament (5), such as wire or optical fibre, is loosely coiled in substantially circular turns on a flat carrier (1), the turns of the coil being laid eccentrically with precession of the crossover points of successive turns. The coil is formed by feeding the filament (5) downwards through guide means (3,4) on to a horizontally disposed rotating carrier (1), the path of travel of the filament being caused to rotate in the direction (C) opposite to that (B) of the carrier, the guide means (3,4) being arranged to cause deposition of the coil turns eccentrically with respect to the carrier surface (1), and the rate of rotation of the carrier and rate of feed of the filament being so adjusted relative to one another that precession of the coil turns around the coil-receiving area of the carrier is effected. A specific method and apparatus for depositing an optical fibre coil are described.

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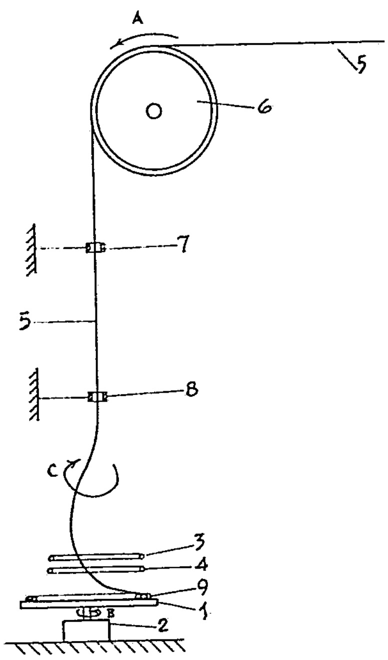

FIG.1.

This invention relates to the packaging of lengths of filamentary material, such as wire or optical fibre, an object of the invention being the provision of a form of package, for one or more filament lengths, which is less bulky than the conventional type of package in which the filament is wound on a reel or drum, is compact and convenient for transportation and storage, and provides protection for the filament against exposure and damage. The invention also relates to a method of, and apparatus for, carrying out the packaging.

According to the invention, a filament package consists of one or more lengths of filament lying loosely coiled in substantially circular turns on a plane surface of a flat carrier and covered with a layer of padding material, the carrier being integral with or inserted into a shallow container in which the assembly of carrier, filament coil and padding is enclosed, wherein each turn of the coil after the first turn is laid eccentrically with respect to the immediately preceding turn so as to cross over said preceding turn at at least one point, and the crossover points of successive turns are displaced in a constant direction, so that the complete coil is in the form of an annulus of substantially uniform width.

Preferably the coil carrier is provided with a surface layer of padding material on which the coil is laid. This padding, and that covering the coil, may consist of any soft, resilient material, such as felt, foam rubber, or plastics foam. The packing of the coil between padding layers prevents movement of the turns of the coil during transit, and protects the filament from damage. The carrier may be constituted by the bottom of a suitable container, such as a shallow carton provided with a lid or flaps which, when closed, lies or lie on the padding covering the coil. Alternatively the carrier may be a flat board or shallow tray which, after the filament coil has been laid thereon and covered with padding, is inserted into a closely fitting carton or metal container.

The filament package of the invention, in addition to being in a lightweight, compact form which facilitates stacking for convenience of storage and transportation, is advantageous in that a coil laid in the form described above is stable and, since each turn of the coil overlies and crosses over the preceding turn, the turns remain in the correct sequence and thus cannot become interlinked and tangled during subsequent unwinding of the coil. This form of package is particularly advantageous for the transportation and storage of optical fibres, since the coil can be laid in such a manner that the fibre is substantially free from tension, so that optical losses in the fibre, when it is subsequently employed for the transmission of telecommunication signals, are minimised; furthermore, the absence of tension enables any desired tests or measurements to be carried out on the fibre while it is retained in the coiled condition on the carrier. In addition, this form of package, in which the fibre is freely coiled, is not subject to the problems of differential thermal expansion which can arise when a length of optical fibre is wound on a drum.

Before being packaged, glass optical fibres are covered with a protective coating and/or jacket of synthetic resin, which is usually applied during the manufacture of the fibre.

When a relatively stiff filament, such as wire or optical fibre, is fed vertically on to a horizontal surface without being subjected to external disturbances, it travels naturally along a circular spiral downward path describing a conical surface of revolution, so as to fall into a substantially circular coil. The turns of a coil formed in this way are substantially concentric, and the narrow stack so formed becomes unstable and topples, which may cause the turns to become interlinked, resulting in tangling on unwinding of the coil. In addition, each turn of the coil acquires 100% twist, that is to say has one full axial twist induced in it, which may contribute to subsequent tangling. One object of the present invention is the provision of a method of forming a filament coil, whereby these difficulties can be overcome.

In a method in accordance with the invention, for forming a filament coil in the production of a filament package of the form described above, the carrier for receiving the filament is disposed horizontally and is rotated about a vertical axis, and a length of filament is continuously fed downwards through guide means and on to the upper plane surface of the rotating carrier, so that the filament is laid on said surface in a substantially circular annular coil, the natural circular downward path of travel of the filament being caused to rotate in the direction opposite to the direction of rotation of the carrier, the guide means being so arranged that the circle described by each turn of the coil as it is deposited on the carrier is eccentric with respect to the area of the carrier surface on which the coil is laid, and the rate of rotation of the carrier and rate of feed of the filament being so adjusted in relation to one another that consecutive turns of the coil precess around the said area.

When the filament coil is formed by this method, the eccentricity of the filament deposition with respect to the coil-receiving area of the carrier surface, and the precession of the turns of the coil, result in the second and each subsequent turn crossing over the immediately preceding turn, and in regular displacement of the crossover points in a constant direction, the turns being deposited in a repeating pattern, so that the coil so produced is stable, of substantially uniform annular width, and free from interlinking of the turns.

Furthermore, the contra-rotation of the coil carrier and the filament travel path causes the degree of twist imparted to the turns of the coil to be less than 100%, and the coiled filament is substantially free from tension.

The amount of twist in the coil turns is determined by the relationship between the linear speed of the coil, produced by the rotation of the carrier, and the linear speed of the filament input during its downward travel to the guide means. For example, if the carrier is rotated at a rate to give a linear speed of the mean coil circumference equal to half the filament input downward speed, the resultant twist in the coil turns will be 50%, and the rates of rotation of the carrier and of the circular downward path of the filament will be equal. In practise, in order that the desired precession of the coil turns is achieved, the rate of rotation of the carrier is adjusted to be slightly different from that of the filament path, such that the linear speed of travel of the point at which the filament meets the carrier, which corresponds to the linear speed of the mean coil circumference, is slightly more or less than half the filament input downward speed.

Preferably the degree of eccentricity of the deposited turns of the coil with respect to the coil-receiving area of the carrier surface, and the ratio between the rate of rotation of the carrier and that of the circular downward path of the filament, are so adjusted that the crossovers between consecutive turns of the coil occur at a wide angle, considerably in excess of 90°.

A preferred form of apparatus for forming a filament package in accordance with the invention, by the method described above, includes a horizontal support for a flat filament-receiving carrier, which support is rotatable about a central vertical axis, one or more guide rings disposed horizontally above said support so as to be located eccentrically with respect to the coil-receiving area of the carrier on said support, and means for feeding a length of filament continuously downwards towards the carrier and for bringing the filament into contact with the interior surface or surfaces of said ring or rings so that the downwardly travelling filament is caused to follow a circular path around said ring surface or surfaces, in the direction opposite to the direction of rotation of the carrier support.

It is preferable to employ at least two guide rings, placed one above the other, the lowermost ring having the largest internal diameter and each successive higher ring having a smaller internal diameter than the ring immediately below it; the height of the lowermost ring above the filament-receiving surface of the carrier, the distance or distances apart of adjacent rings, and the relative internal diameters thereof, are so arranged that the internal surfaces of the ring assembly lie on the conical surface which is naturally swept by the filament during its downward travel, as explained above.

The filament may be delivered to the coil carrier from any convenient source, for example from a drum or reel, or directly from a filament-manufacturing line, by being passed around a capstan by means of which the linear speed of downward travel of the filament to the guide rings is controlled. The filament is usually passed from the capstan to the guide rings through additional guide means by means of which the filament is directed on to the interior surface of the uppermost guide ring at an appropriate angle for ensuring that the filament path subsequently follows the interior surfaces of the rings.

The filament guiding system should be so arranged that the travel of the filament is not appreciably impeded by friction. In addition, where the filament is an optical fibre with a protective coating, the latter is preferably formed of a hard resin, such as polyurethane, which will give minimal friction with the guide rings, or with any other guide means which may be employed. If the fibre has a softer coating, such as a silicone resin, the coiling speed is adjusted to accommodate the effect of the increased friction.

If it is required to incorporate a plurality of lengths of filament in a single package, these are usually laid on the carrier consecutively, and are preferably spaced apart by a layer of suitable padding material.

An additional advantage of the filament package of the invention is that it provides for easy withdrawal of the filament from the package by a simple unwinding procedure, which can be carried out by reversing the process described above for depositing the coil on the carrier. Thus the carrier and coil are rotated about a vertical axis, while the filament is drawn upwards through one or more guide rings, which may be placed either eccentrically or concentrically with respect to the coil. It is desirable initially to place over the free end of the filament a small collar of low friction material, suitably polytetrafluoroethylene, which will slide down the filament and lie adjacent to the coil: this assists in ensuring smooth unwinding, the filament running through the collar as it rises from the coil.

A specific method of forming a filament coil, for a package in accordance with the invention, will now be described by way of example, with reference to the accompanying diagrammatic drawings, in which

Figure 1 shows the coil-forming apparatus in elevation, and

Figure 2 shows the pattern formed by two consecutive turns of the coil formed.

Referring to Figure 1 of the drawings, a square tray or board 1, suitably of wood with a covering of antistatic foam on its upper surface, which is to constitute the coil carrier, is mounted horizontally on a rotatable vertical shaft 2. Two concentric guide rings 3, 4, which may be of wire or may be formed by cutting circular apertures in metal, suitably aluminium, plates, and which have smooth, polished internal surfaces, are mounted eccentrically above the tray 1: the upper ring 3 has a smaller internal diameter than the lower ring 4. An optical fibre 5 is pulled from a source (not shown) by a motor driven capstan 6 which is rotated about a horizontal shaft in the direction indicated by the arrow A. After passing around the capstan, the fibre is guided downwards through two eyes 7, 8, and inside the rings 3, 4, the eyes being so positioned in relation to the rings that the fibre contacts the internal surface of the upper ring 3 at an angle of approximately 45°. The eyes may consist of short lengths of tubing of low friction material, suitably polytetrafluoroethylene, or of short wire coils; alternatively the upper eye may be replaced by an inclined strip of polytetrafluoroethylene over which the fibre passes.

In operation of the apparatus described above with reference to Figure 1, the capstan is rotated at a speed to give a suitable linear rate of downward travel of the fibre, and the speed of rotation of the tray is appropriately adjusted, in relation to the fibre speed, to effect deposition of the fibre in a coil 9 of the desired form. To initiate the coiling process, the free end of the fibre is passed through the eyes and is allowed to fall on to the central region of the tray 1, then the portion of the fibre in contact with the upper ring 7 is pushed to cause the fibre to continue travelling around the inner surfaces of the rings in the direction opposite to the direction of rotation of the tray; the directions of rotation of the tray and the fibre path are shown by the arrows B and C respectively.

The speed ratio between the capstan and the tray which is required to produce precession of the coil pattern around the receiving surface of the tray, together with an acceptable degree of twist in the coil turns, is determined by the ratio between the circumference of the capstan surface around which the fibre passes and the mean circumference of the coil formed, the latter being controlled by the inner diameters of the rings 3 and 4: conveniently the capstan circumference and the mean coil circumference are substantially equal. Preferably the said speed ratio is so adjusted that the linear speed of the mean coil circumference is slightly less than half the downward linear feed speed of the fibre: under these conditions, the coil is deposited in a repeating pattern of the form shown in Figure 2.

In Figure 2, points 10 and 11 respectively represent the centres of the coil-receiving tray and of the pair of guide rings 3, 4, the distance $\underline{e}$ thus being the eccentricity between the tray and the rings. Two consecutive turns of the coil cross over at the point 12, the maximum separation between the turns being equal to $2\underline{e}$. Preceding and subsequent turns of the coil are deposited in the same pattern, and crossover points 12 precess around the coil in the direction indicated by the arrow D, when the tray is rotated in a clockwise direction and the fibre path anticlockwise, as viewed from above, the rate of rotation of the fibre path being slightly greater than that of the coil.

The relative rates of rotation of the capstan and the coil-receiving tray are suitably controlled by means of a synchro-transmitter carried by the capstan shaft, co-operating with a synchro-receiver which drives the tray through a gearbox. This arrangement may be of well known form, and is not shown in the drawings.

In a specific example of the method described above with reference to the drawings, the coil-receiving tray 1 is 400 mm square, and the guide rings 3 and 4 are respectively 310 mm and 325 mm in internal diameter. The rings are so located that the eccentricity between them and the tray is 20 mm, the lower ring 4 being disposed 100 mm above the tray, and the distance between the two rings being 25 mm. The circumference of the surface of the capstan 6 over which the fibre passes is one metre. The internal diameter of both the guide eyes 7 and 8 is suitably 5 mm, but may be less provided that there is adequate clearance for the fibre passing through them. The lower eye 8 is located 750 mm above the tray, and the position of the upper eye 7 is such that the fibre is travelling substantially vertically when it reaches the lower eye. The coil 9 formed by this arrangement has an internal diameter of 280 mm and an external diameter of 360 mm, each turn of the coil being approximately one metre in length, that is to say substantially equal to the capstan circumference.

The capstan 6 is arranged to drive a synchro-transmitter through gearing giving an increased speed ratio of 4 : 1, and this co-operates with a synchro-receiver which drives the tray 1 through gearing giving a reduced speed ratio of 1 : 8.33. Thus in the time required for one metre length of fibre to be fed from the capstan, the tray is rotated through 0.48 revolution, and the point at which the fibre meets the tray travels 0.52 metre relative to a stationary reference frame, this being slightly more than half the length of fibre fed in: this arrangement results in the production of a precessing coil pattern of the form shown in Figure 2.

For coiling a polyurethane-coated silica optical fibre, the capstan is rotated at a rate of 50 rpm, hence the fibre input downward speed is 50 metres per minute; the tray is rotated at a rate of 24 rpm, and the rate of rotation of the fibre path relative to the guide rings is 26 rpm. The degree of twist induced in the fibre coiled in this manner is slightly greater than 50%. If the fibre has a softer coating, such as silicone resin, it will be necessary to reduce the coiling speed, the downward fibre feed speed suitably being 20 metres per minute, and the speed of rotation of the tray being adjusted accordingly.

After the whole of the required length of optical fibre has been coiled on the tray, the packaging of the fibre is completed by covering the coil with a layer of suitable padding material, and inserting the assembly of tray, coil and padding into a closely fitting carton.

If desired, the square coil-receiving tray referred to in the above example may be replaced by a circular tray or board of 400 mm diameter.

CLAIMS

1. A filament package consisting of one or more lengths of filament lying loosely coiled in substantially circular turns on a plane surface of a flat carrier and covered with a layer of padding material, the carrier being integral with or inserted into a shallow container in which the assembly of carrier, filament coil and padding is enclosed, characterised in that each turn of the coil after the first turn is laid eccentrically with respect to the immediately preceding turn so as to cross over the said preceding turn at at least one point, and the cross-over points of successive turns are displaced in a constant direction, so that the complete coil is in the form of an annulus of substantially uniform width.

2. A method of forming a filament coil, for producing a filament package according to Claim 1, characterised in that the carrier for receiving the filament is disposed horizontally and is rotated about a vertical axis, and a length of filament is continuously fed downwards through guide means and on to the upper plane surface of the rotating carrier, so that the filament is laid on said surface in a substantially circular annular coil, the natural circular downward path of travel of the filament being caused to rotate in the direction opposite to the direction of rotation of the carrier, the guide means being so arranged that the circle described by each turn of the coil as it is deposited on the carrier is eccentric with respect to the area of the carrier surface on which the coil is laid, and the rate of rotation of the carrier and rate of feed of the filament being so adjusted in relation to one another that consecutive turns of the coil precess around the said area.

3. A method according to Claim 2, characterised in that the rate of rotation of the filament-receiving carrier, and the linear speed of downward travel of the filament to

said guide means, are adjusted so that the linear speed of the mean coil circumference, produced by the rotation of the carrier, is slightly more or less than half the linear downward speed of the filament, the rate of rotation of the carrier being slightly different from the rate of rotation of the circular downward path of the filament.

4. A method according to Claim 2 or 3 characterised in that the degree of eccentricity of the deposited turns of the coil with respect to the coil-receiving area of the carrier surface, and the ratio between the rate of rotation of the carrier and that of the circular downward path of the filament, are so adjusted that the crossovers between consecutive turns of the coil occur at an angle in excess of 90°.

5. Apparatus for carrying out the method according to Claim 2, 3 or 4, which includes a horizontal support for a flat filament-receiving carrier (1), which support is rotatable about a central vertical axis (2), one or more guide rings (3,4) disposed horizontally above said support so as to be located eccentrically with respect to the coil-receiving area of the carrier on said support, and means for feeding a length of filament (5) continuously downwards towards the carrier and for bringing the filament into contact with the interior surface or surfaces of said ring or rings so that the downwardly travelling filament is caused to follow a circular path around said ring surface or surfaces, in the direction (C) opposite to the direction (B) of rotation of the carrier support.

6. Apparatus according to Claim 5, which includes at least two said guide rings (3,4), placed one above the other, the lowermost ring having the largest internal diameter and each successive higher ring having a smaller internal diameter than the ring immediately below it, and the height of the lowermost ring above the filament-receiving surface of the carrier (1), the distance or

distances apart of adjacent rings, and the relative internal diameters thereof, being so arranged that the internal surfaces of the ring assembly lie on the conical surface which is naturally swept by the filament during its downward travel.

7. Apparatus according to Claim 5 or 6, which includes a capstan (6) around which the filament is passed and by means of which the linear speed of downward travel of the filament (5) to the guide rings (3,4) is controlled.

8. Apparatus according to Claim 7, which includes additional guide means (7,8), located between the capstan and the guide rings, through which the filament is passed and by means of which the filament is directed on to the interior surface of the uppermost ring (3) at an appropriate angle for ensuring that the filament path subsequently follows the interior surfaces of the rings.

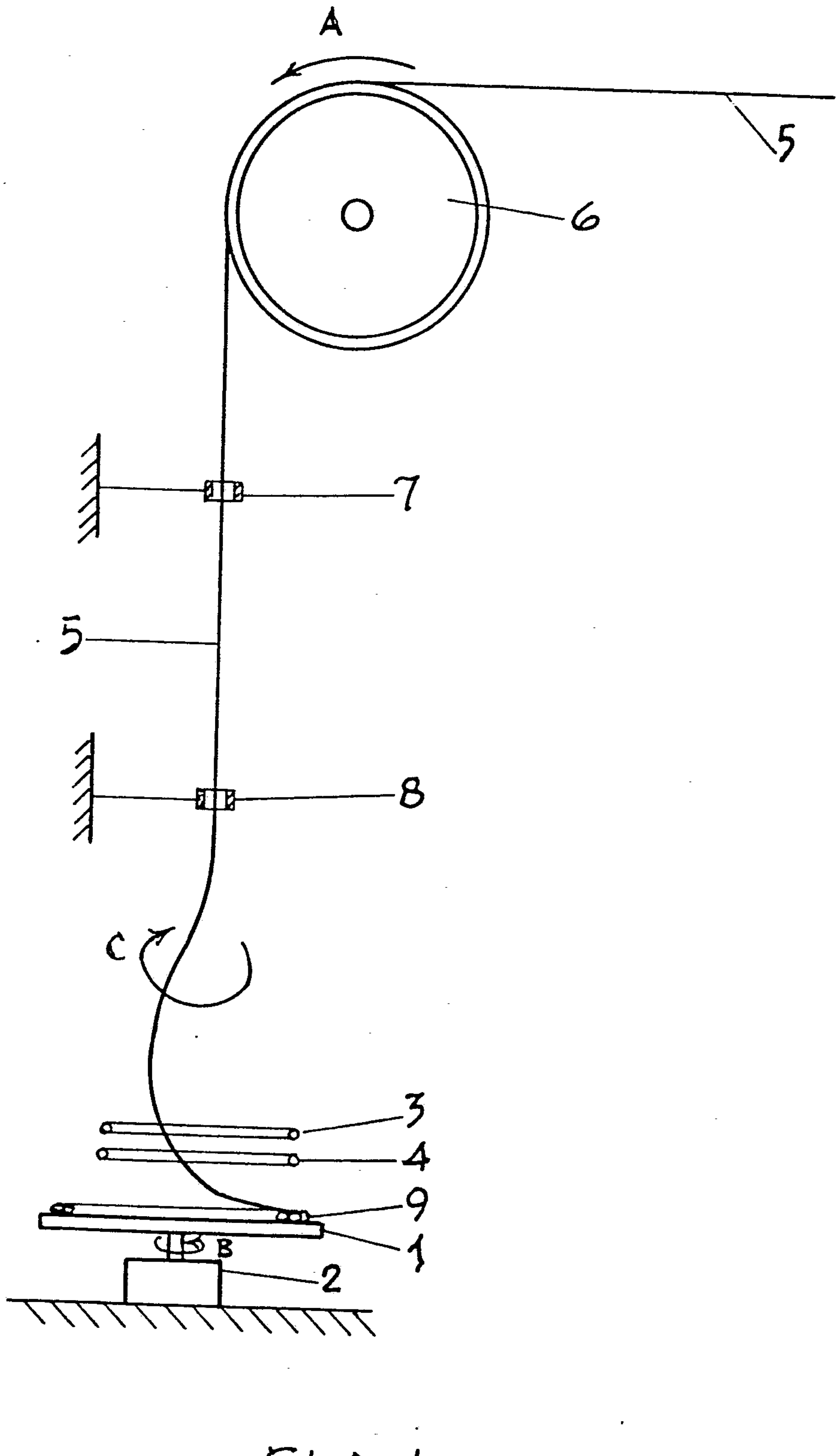

FIG.1.

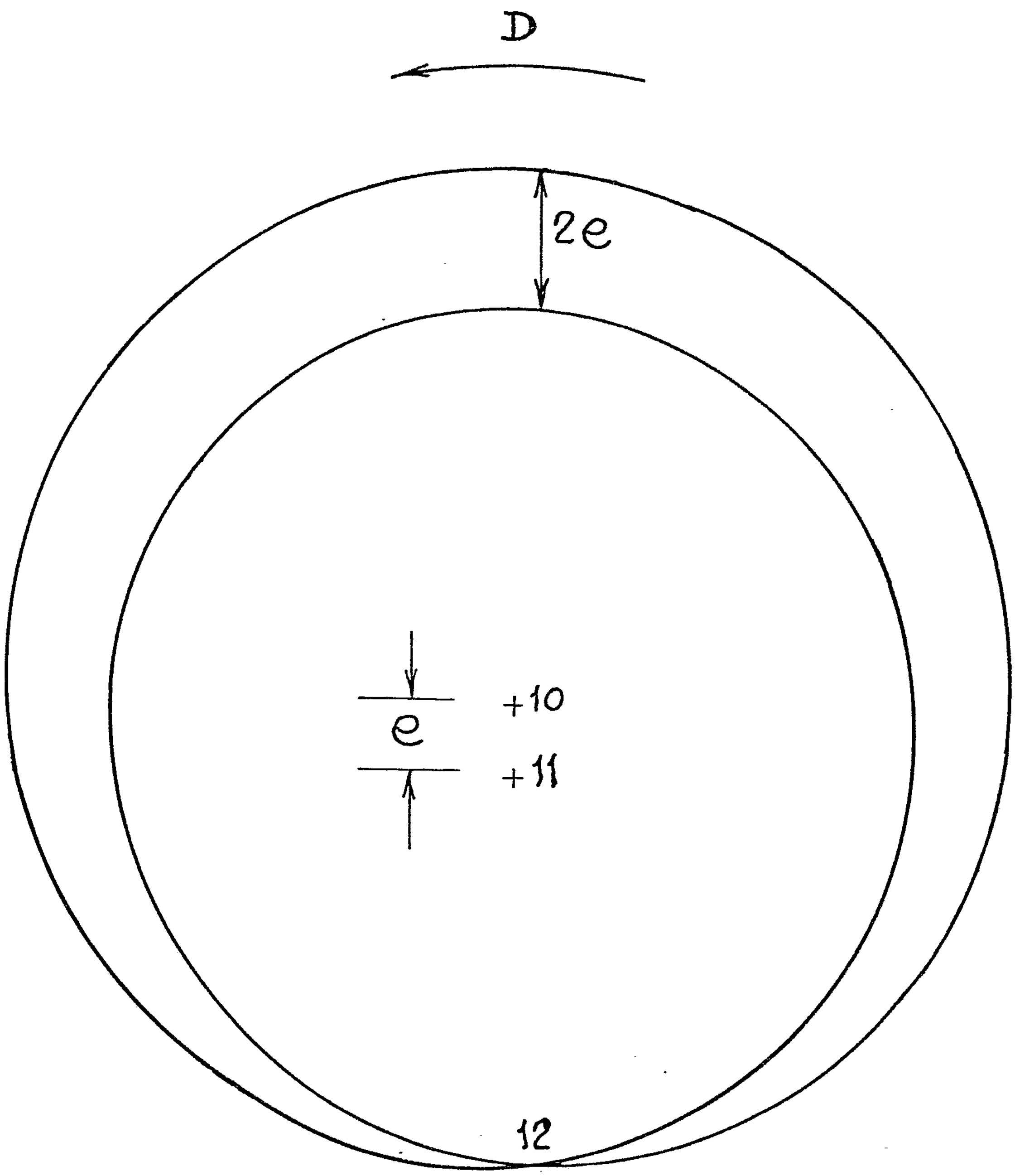

FIG.2.

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Application number

EP 81 30 1329

European Patent Office

EUROPEAN SEARCH REPORT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
	L'INDUSTRIE TEXTILE, January 1967, no. 953, Paris, US A. VALOTA "La fonction du pot en filature", pages 13-16 * Page 14, right-hand column, figure 4 * --	1,2	B 65 H 54/80
	US - A - 2 936 509 (S.M. MARTIN) * Entirely * --	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.³)
	US - A - 3 253 800 (D.P. WHITACRE) * Entirely * --	1,2,5	B 65 H B 21 C
	DE - B - 1 019 222 (F. VON SCHMOLLER) * Entirely * --	1	
A	EP - A - 0 026 019 (N.V. PHILIPS) * Entirely * ----	1	

CATEGORY OF CITED DOCUMENTS

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T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24-07-1981	DEPRUN

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