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(54) THREAD PACKAGE BUILDING

AUFBAU EINES FADENWICKELS

PRODUCTION DE PAQUETS DE FIL

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Description

[0001] This invention relates to the building of thread packages for textile yarns and other threads.

[0002] Textile threads are wound on to packages following their production or after some processing step, or are rewound from another package to build a package with better take-off characteristics for use e.g. in a knitting machine or to produce special packages e.g. for dyeing. There are numerous types of package winding procedure or "build" producing packages suited to particular types of thread or for particular purposes.

[0003] There are two basic approaches, namely cross-winding, in which the package is rotated and the thread is fed from the side and distributed axially along the package by a traverse arrangement which may comprise a reciprocating thread guide or a helically grooved roll, the thread being reciprocated by contact with the sides of the groove, and overend winding as by a ring-and-traveller arrangement or a flyer.

[0004] The present invention is concerned particularly, but not necessarily exclusively, with cross winding techniques which themselves fall into a number of different kinds of which the most important are random and precision winding. In random winding the package is rotated by frictional contact with a drive roller acting directly on the surface of the package, which therefore has the same surface speed as the driver roller, usually constant, and hence a declining rotational speed as the package increases in diameter. In precision winding, the rotational speed of the package is constant since it is its support not its surface that is driven. Hence the angular wrap of the thread around the package is not affected by the diameter of the package, but the helix angle of the thread on the package surface decreases as the package grows.

[0005] One of the problems of random as opposed to precision winding is that in ramdom winding, as the package grows, at certain diameters, unless steps are taken to avoid it, successive turns of thread (or every other or every third or fourth turn of thread) lie one on top of the other giving rise to obvious patterning or ribbons of threads which tend to distort the package shape and characteristics, particularly unwinding characteristics. To counteract this tendency, pattern breaker arrangements are incorporated into random winding mechanisms which usually take the form of a mechanical arrangement superimposing a more or less complicated perturbation on the normal motion of the traversing guide. These arrangements are more or less successful in counteracting patterning - the requirements become more demanding as the size of packages that can be wound is required to increase on economic grounds-but bring their own problems in regard to varying package density and imperfectly formed package edges.

[0006] A recent development, the Schweiter DIGICONE (RTM) uses a precision winding technique coupled with a microprocessor controlled arrangement that alters the winding ratio (number of revolutions of the package for each traversing cycle) progressively in small steps throughout the build to mimic the characteristics of the random wind. Because the winding ratio can be precisely related to the winding speed at each step, patterning can be avoided altogether.

[0007] The DIGICONE (RTM) thus produces yet a different type of build from previously conventional types and is claimed to produce substantially better packages with better unwinding characteristics; it can moreover be programmed to build different package shapes.

[0008] However, the DIGICONE (RTM) in addressing only one problem, namely that of patterning, by combining the techniques of random and precision winding, fails to deal with other problems which affect the way in which thread unwinds from a package or is stored on the pack-age - different tensions at different places along the yarn can result in strains which manifest themselves as faults in fabric woven or knitted from the package.

[0009] The present invention facilitates new approaches to thread winding which produce improved packages of the conventional or even of the DIGICONE (RTM) types.

[0010] Conventional winding methods, including the DIGICONE (RTM), involve only static control within each traversing stroke; even where a pattern breaker mechanism is used or even considering the DIGICONE (RTM) arrangement, the traverse stroke is always effected in a predetermined way, usually comprising a brief acceleration followed by a constant speed section followed by a brief deceleration to zero speed: The present invention, on the other hand, comprises dynamic control in a number of ways as illustrated below.

[0011] The invention comprises a method according to claim 1.

[0012] The thread may be traversed relatively to the package by a thread reciprocating guide driven by an electronically controlled actuator. At this point it would be noted that usually the rotating package will remain in one place and the thread will move, because in this way a much faster traverse rate is possible because of the low inertia of the thread and any moving thread guide as compared to the package; aside from this there is no reason why the package should not move axially, whether the thread guide also moves or not

[0013] Said actuator may comprise a linear actuator, which may reciprocate a thread guide, or a rotary actuator. A rotary actuator may be used to produce a linear reciprocation, as of a thread guide, through a rotary to linear convertor, or it may be used to drive a grooved roll thread distibutor in rotation, or to drive the package or to impose a perturbation on the rotation of such a distributor or the package. The actuator may in any event comprise a servo actuator.

[0014] In a method according to the invention, package rotation may be predetermined while traverse rate

15 controlled, or traverse rate may be predetermined while package rotation is controlled - or both traverse rate and package rotation may be controlled.

[0015] However, the invention, in another aspect, comprises a method for building thread on a rotating package by traversing the point of application of the thread axially relatively to the package, comprising dynamically controlling the thread tension within each traverse stroke. This can be in addition to or alternative to the dynamic control of package rotation and/or traverse rate.

[0016] Package rotation and thread traversing may be effected by independent drive means, or by a single drive means acting through a transmission arrangement which can controllingly vary the relationship between the package rotation and the traversing rate.

[0017] The invention also comprises apparatus according to claim 10.

[0018] Said control means may comprise variable sensing means sensing a variable affecting the said relationship and adjusting means adjusting the said relationship so as to counteract any deviation of said variable from a predetermined value - which might be a constant value or a value which is itself dependent upon another variable such for example as the progress of the build. Said control means may comprise digital information processing means.

[0019] Said control means may comprise an electrically controlled actuator, which may be a linear or a rotary actuator and which may be of a type (which includes stepper motors and linear stepper actuators) in which a given input signal is reflected in a predetermined response regardless (at least in the circumstances) of operational loadings to which the actuator is subjected, or may be a servo actuator in which an error signal in a feedback loop adjusts the actuator's response to counteract operational loadings to which the actuator is subjected. The error signal may be derived from measurement of a variable of the system as a whole or of the actuator per se such as may be derived from measurement of the operating power supplied to the actuator.

[0020] Embodiments of apparatus and methods for building thread on a rotating package according to the invention will now be described with reference to the accompanying drawings, in which :-

Figure 1 is a diagrammatic illustration of one embodiment of apparatus;

Figure 2 is a graphical representation of traverse rate in one method of operating the apparatus of Figure 1;

Figure 3 is a graphical representation of traverse rate in another method of operating the apparatus of Figure 1;

Figure 4 is a diagrammatic illustration of another embodiment of apparatus; and

Figure 5 is a diagrammatic illustration of another embodiment of apparatus.

[0021] Figures 1, 4 and 5 illustrate apparatus for building thread 11 on a package 12 comprising a rotary package support 13 and a thread traversing arrangement 14.

[0022] In Figure 1 the support 13 comprises a spindle which is driven directly by a motor 15. The thread traversing arrangement 14 comprises a thread distributing finger 16 on a rod 17 which is connected directly to a linear actuator 18 which reciprocates the rod 17 in response to signals from a control arrangement 19.

[0023] Figure 4 illustrates apparatus in which the rotary package support 43 comprises a cradle 43a holding a free-running spool 43b on which the package 12 is built resting on a driving roll 43c which is on a shaft 43d rotated by a motor 45.

[0024] The thread traversing arrangement 14 comprises a thread distributing finger 16 which is reciporocated on a track 47 by a rotary actuator 48 which has an arm 48a engaging the finger 16 which executes an angular oscillation in response to signals from a control arrangement 49.

[0025] Figure 5 illustrates apparatus in which the thread 11 tension is dynamically controlled within each traverse stroke by a tension regulator 51 comprising a thread deflecting arrangement of two fixed (51a) and one movable (51b) guides, the movable guide being moved by a linear actuator 52 in response to signals from a controller 59. The package 12 is supported and driven in rotation as described with reference to Figure 4.

[0026] The drawings specifically illustrate the winding of parallel-sided packages 12 but of course cones can be wound on conical spools whether by the "precision" technique illustrated in Figure 1 or by the "random" technique illustrated in Figures 4 and 5.

[0027] The controller 19 of Figure 1 comprises a digital microprocessor which controls the output of driving signals, which may be in the form of pulses or a d.c. potential to the linear actuator 18 according to the type of linear actuator used. The controller 19 may also control the output of driving signals to the package-rotating motor 15, or this may be rotated at constant speed by connection to an independent energising source speed information being input to the controller 19 e.g. as a signal representative of the frequency of the energising current or from a shaft encoder (not shown).

[0028] The controller 19 can be programmed to control dynamically the reciprocation of the thread guide 16 within each traverse stroke. Figure 2 illustrates one possibility for such control; in the Figure, three graphs of traverse rate against thread guide displacement at three different package diameters are shown. In a manner akin to the DIGICONE (RTM) mentioned above, the traverse speed increases with increasing package diameter so that the winding ratio (the number of package revolutions for each cycle of the traverse guide, i.e. for each two traverse strokes) decreases as the build progresses.

[0029] It is recognized as a distinct advantage of all winding operations if any marked non-linearity of traverse rate can be avoided, in particular at the ends of each stroke where the traverse guide reverses direction. Because of the inertia of the traversing arrangement, instantaneous reversal is impossible, and so it has to be accepted that there will be some non-linearity which results in a build-up in package diameter (because of the slower traverse rate at the end regions, more thread is wound there than in the intervening, linear portion) at the ends of the package, unless other measures are taken. One such measure is a periodic small shifting left and right of the entire traverse stroke, to spread out the excess yarn over more extended end regions. This, alas, has the effect of reducing the package density at the ends, producing relatively soft "edges" which can lead to unwinding problems.

[0030] As shown in Figure 2, however, using the present invention, whilst the problem with the reversal time cannot altogether be eliminated, nevertheless it can be alleviated to some extent, particularly in the early part of the build by taking advantage of the ability to control the traverse rate dynamically within the traverse stroke. By arranging that the traverse guide decelerates to rest and then accelerates from rest at the fastest possible rate regardless of the mean rate of traverse (which depends on the package diameter in the method particularly described) at least in the early part of the build the portions of the traverse stroke spent accelerating and decelerating are less than in the later part of the build, when the mean traverse rate increases. Thus there is the possibility of programming the arrangement to build packages with relatively firm edges at least during the early part of the build, which will provide a better basis for the outer layers.

[0031] By contrast, conventional helical roll and cam drive traversing arrangements cannot alter the ratio of time spent at reversals to total stroke time; maximum possible acceleration and decelaration is attainable only at the fastest traverse speed, i.e. at the maximum package diameter.

[0032] Figure 1 also illustrates a tension sensor 21 sensing tension in the thread 11. It is apparent that as the traverse guide 16 reciprocates the thread the length of thread from the guide 16 back to the guide eye 22 which is the last encountered thread restraint before the wind-up arrangement, will vary according to the position of the traverse guide in the stroke, being longer when the guide 16 is at the ends of the stroke than in the middle. This will result in a tension difference in the yarn as between these positions which may affect the way the thread is wound on to the package and which may cause the package to be wound more softly in the middle than at the ends.

[0033] By dynamic control of the traverse rate as illustrated in Figure 3 where instead of the traverse rate being constant it increases slightly in the middle of the stroke, this tendency may be counteracted. This may be done in a number of ways.

[0034] One way is by a feedback arrangement acting on the linear actuator 18 to vary the traverse rate so as to maintain the tension sensed by sensor 21 substantially constant. Another is for the controller 19 to alter the traverse rate in programmed fashion.

[0035] Another way is for the controller to speed up the motor 15 (which can also comprise an electrically controlled rotary actuator for this purpose) to absorb the extra yarn fed per unit time in the middle of the stroke, possible at the same time increasing the traverse rate to keep the winding angle sensibly constant throughout the traverse.

[0036] In the apparatus illustrated in Figure 4, the control arrangement 49 comprises a computer 49a controlled electronic gear box 49b controlling the rate of operation of the rotary actuator 38 in dependence on the rate of operation of the drive motor 35 and various other variables such as package diameter (sensed by a pivoting finger 61) and thread tension sensed by sensor 21 as in Figure 1.

[0037] Figure 5 illustrates a more or less conventional package random winding arrangement in which the only controlled variable is thread tension which is controlled in accordance with the instantaneous position of the thread guide 56 sensed by a position transducer 57, which supplies a position signal to the controller 59 that is programmed with a tension regime for the traverse strokes and which controls the linear actuator 52 which, in this instance, will be of a type from which an indication can be obtained of the tension in the thread that it is in fact tensioning - this may be done by analysing the energizing current in some types. Of course a separate tension sensing device may be used in a feedback loop.

[0038] It will be appreciated from the above that in accordance with the invention a wide range of possibilities exists for both apparatus for winding packages of different types and the methods which can be practised using the apparatus for producing particular effects and improvements in thread packages.

[0039] The involvement of digital information processing means in the apparatus can be used advantageously in connection with other aspects of the winding operation, for example in the control of doffing equipment and in thread failure or fault sensing, as well as in performance monitoring and recording.

[0040] In a further variant, a rotary actuator can be used as a drive motor for a feed package in the same way and with the same kinds and aims of control as in regard to the take-up package, and such may be used as the sole actuator or in combination with a linear traverse actuator or a rotary take-up package driving actuator.

Claims

1. A method for building thread (11) on a rotating package (12) by traversing the point of application of the thread axially relatively to the package, **characterised by** controlling package build with control means (19) by controlling the relationship between package rotation and traversing rate in accordance with the instantaneous position of said point of application by a feedback arrangement controlling package rotation and traverse rate, wherein the control means comprises an electronically controlled servo actuator (18, 48) in which an error signal in a feedback loop adjusts the actuator's response to counteract operational loadings to which the actuator is subjected.

2. A method according to claim 1, in which the said relationship is also controlled by a function of the progress of the build.

3. A method according to claim 1 or claim 2, in which the thread (11) is traversed relatively to the package (12) by a thread reciprocating guide (16) driven by the electronically controlled servo actuator (18,48).

4. A method according to claim 3, in which said actuator comprises a linear actuator (18).

5. A method according to claim 3, in which said actuator comprises a rotary actuator (48).

6. A method according to claim 5, in which said rotary actuator (48) produced a linear reciprocation through a rotary to linear converter (48a).

7. A method according to any one of claims 1 to 6, in which the said relationship is controlled in accordance with thread tension.

8. A method according to any one of claims 1 to 7, in which the package rotation and the thread traversing are effected by independent drive means (18,48,45).

9. A method according to any one of claims 1 to 7, in which the package rotation and the thread traversing are effected by a single drive means (45) acting through a transmission arrangement (49b) which can controllingly vary the relationship between the package rotation and the traversing rate.

10. Apparatus for building thread (11) on a package (12) comprising a rotary package support (13) and a thread traversing arrangement (14) which traverses the point of application of the thread (11) axially relatively to the package (12) **characterised by** control means (19) controlling package build by controlling the relationship between package rotation and traversing rate in accordance with the instantaneous position of said point of application by a feedback arrangement controlling package rotation and traverse rate, wherein the control means comprises an electronically controlled servo actuator (18, 48) in which an error signal in a feedback loop adjusts the actuator's response to counteract operational loadings to which the actuator is subjected.

11. Apparatus according to claim 10, said control means (19) comprising digital information processing means.

12. Apparatus according to claim 10 or claim 11 in which said actuator is a linear actuator (18).

13. Apparatus according to claim 10 or claim 11, in which said actuator is a rotary actuator (48).

14. Apparatus according to claim 10, in which the error signal is derived from measurement of the operating power supplied to the actuator (18,48).

Patentansprüche

1. Verfahren zum Aufbauen eines Fadens (11) auf einer rotierenden Wicklung (12) durch axiales Verschieben des Punktes des Anlegens des Fadens relativ zur Wicklung, **gekennzeichnet durch** Steuern des Aufbaus der Wicklung **durch** Steuermittel (19) **durch** Steuern der Beziehung zwischen der Drehung der Wicklung und der Geschwindigkeit der Verschiebung in Übereinstimmung mit der augenblicklichen Stellung des Anlegepunkts **durch** eine die Drehung der Wicklung und die Geschwindigkeit der Verschiebung steuernde Rückführungsanordnung, worin die Steuermittel ein elektronisch gesteuertes Servo-Betätigungsglied (18, 48) aufweisen, in welchem ein Fehlersignal in einer Rückführungsschleife die Antwort des Betätigungsglieds einstellt, um Betriebsbelastungen entgegenzuwirken, denen das Betätigungsglied unterworfen ist.

2. Verfahren nach Anspruch 1, bei dem die Beziehung auch durch eine Funktion des Fortschreitens des Aufbaus gesteuert wird.

3. Verfahren nach Anspruch 1 oder Anspruch 2, bei dem der Faden (11) relativ zur Wicklung (12) verschoben wird durch eine hin- und hergehende Fadenführung (16), die durch das elektronisch gesteuerte Servo-Betätigungsglied (18, 48) angetrieben wird.

4. Verfahren nach Anspruch 3, bei dem das Betätigungsglied ein lineares Betätigungsglied (18) aufweist.

5. Verfahren nach Anspruch 3, bei dem das Betätigungsglied ein Dreh-Betätigungsglied (48) aufweist.

6. Verfahren nach Anspruch 5, bei dem das Dreh-Betätigungsglied (48) eine lineare Hin- und Herbewegung durch einen Dreh/Linear-Wandler (48a) erzeugt.

7. Verfahren nach einem der Ansprüche 1-6, bei dem die Beziehung in Übereinstimmung mit der Fadenspannung gesteuert wird.

8. Verfahren nach einem der Ansprüche 1-7, bei dem die Drehung der Wicklung und die Verschiebung des Fadens durch unabhängige Antriebsmittel (18, 48, 45) bewirkt werden.

9. Verfahren nach einem der Ansprüche 1-7, bei dem die Drehung der Wicklung und die Verschiebung des Fadens durch ein einziges Antriebsmittel (45) bewirkt werden, welches über eine Übertragungsanordnung (49b) wirkt, die steuernd die Beziehung zwischen der Drehung der Wicklung und der Geschwindigkeit der Verschiebung verändern kann.

10. Vorrichtung zum Aufbauen eines Fadens (11) auf einer Wicklung (12) mit einem drehbaren Wicklungsträger (13) und einer Fadenverschiebungsanordnung (14), welche den Punkt des Anlegens des Fadens (11) relativ zu der Wicklung (12) axial verschiebt, **gekennzeichnet durch** Steuermittel (19), die den Aufbau der Wicklung steuern **durch** Steuern der Beziehung zwischen der Drehung der Wicklung und der Geschwindigkeit der Verschiebung in Übereinstimmung mit der augenblicklichen Lage des Anlegepunktes **durch** eine die Drehung der Wicklung und die Geschwindigkeit der Verschiebung steuernde Rückführungsanordnung, worin die Steuermittel ein elektronisch gesteuertes Servo-Betätigungsglied (18, 48) aufweisen, in welchem ein Fehlersignal in einer Rückführungsschleife die Antwort des Betätigungsglieds einstellt, um Betriebsbelastungen entgegenzuwirken, denen das Betätigungsglied unterworfen ist.

11. Vorrichtung nach Anspruch 10, bei der die Steuermittel (19) digitale Informationsverarbeitungsmittel aufweisen.

12. Vorrichtung nach Anspruch 10 oder Anspruch 11, bei der das Betätigungsglied ein lineares Betätigungsglied (18) ist.

13. Vorrichtung nach Anspruch 10 oder Anspruch 11, bei der das Betätigungsglied ein Dreh-Betätigungsglied (48) ist.

14. Vorrichtung nach Anspruch 11, bei der das Fehlersignal von der Messung der zu dem Betätigungsglied (18, 48) gelieferten Betriebsleistung abgeleitet ist.

Revendications

1. Procédé pour enrouler un fil (11) sur un paquet tournant (12) en faisant traverser le point d'application du fil axialement par rapport au paquet, **caractérisé en ce que** l'on commande la croissance du paquet à l'aide de moyens de commande (19) en commandant la relation entre la rotation du paquet et la vitesse de traversée en accord avec la position instantanée dudit point d'application par un agencement à rétraoaction qui commande la rotation du paquet et la vitesse de traversée, dans lequel les moyens de commande comprennent un servo-actionneur à commande électronique (18, 48) dans lequel un signal d'erreur dans une boucle de rétroaction ajuste la réponse de l'actionneur pour contrecarrer les charges fonctionnelles auxquelles l'actionneur est soumis.

2. Procédé selon la revendication 1, dans lequel ladite relation est aussi commandée par une fonction de la progression de la croissance.

3. Procédé selon l'une ou l'autre des revendications 1 et 2, dans lequel le fil (11) est traversé par rapport au paquet (12) par un guide-fil en va-et-vient (16) entraîné par le servo-actionneur à commande électronique (18, 48).

4. Procédé selon la revendication 3, dans lequel ledit actionneur comprend un actionneur linéaire (18).

5. Procédé selon la revendication 3, dans lequel ledit actionneur comprend un actionneur rotatif (48).

6. Procédé selon la revendication 5, dans lequel ledit actionneur rotatif (48) produit un va-et-vient linéaire par l'intermédiaire d'un convertisseur rotatif/linéaire (48a).

7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel ladite relation est commandée en accord avec la tension du fil.

8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel la rotation du paquet et la traversée du fil sont effectuées par des moyens d'entraînement indépendants (18, 48, 45).

9. Procédé selon l'une quelconque des revendications

1 à 7, dans lequel la rotation du paquet et la traversée du fil sont effectuées par des moyens d'entraînement uniques (45) qui agissent via un agencement de transmission (49b) qui peut faire varier de façon commandée la relation entre la rotation du paquet et la vitesse de traversée.

10. Appareil pour enrouler un fil (11) sur un paquet (12) comprenant un support de paquet rotatif (13) et un agencement de traversée de fil (14) qui fait traverser le point d'application du fil (11) axialement par rapport au paquet (12), **caractérisé par** des moyens de commande (19) qui commandent la croissance du paquet en commandant la relation entre la rotation du paquet et la vitesse de traversée en accord avec la position instantanée dudit point d'application par un agencement à rétroaction qui commande la rotation du paquet et la vitesse de traversée, dans lequel les moyens de commande comprennent un servo-actionneur à commande électronique (18, 48) dans lequel un signal d'erreur dans une boucle de rétroaction ajuste la réponse de l'actionneur pour contrecarrer les charges fonctionnelles auxquelles l'actionneur est soumis.

11. Appareil selon la revendication 10, lesdits moyens de commande (19) comprenant des moyens de traitement d'information numériques.

12. Appareil selon l'une ou l'autre des revendications 10 et 11, dans lequel ledit actionneur est un actionneur linéaire (18).

13. Appareil selon l'une ou l'autre des revendications 10 et 11, dans lequel ledit actionneur est un actionneur rotatif (48).

14. Appareil selon la revendication 10, dans lequel le signal d'erreur est dérivé de la mesure de la puissance de fonctionnement fournie à l'actionneur (18, 48).

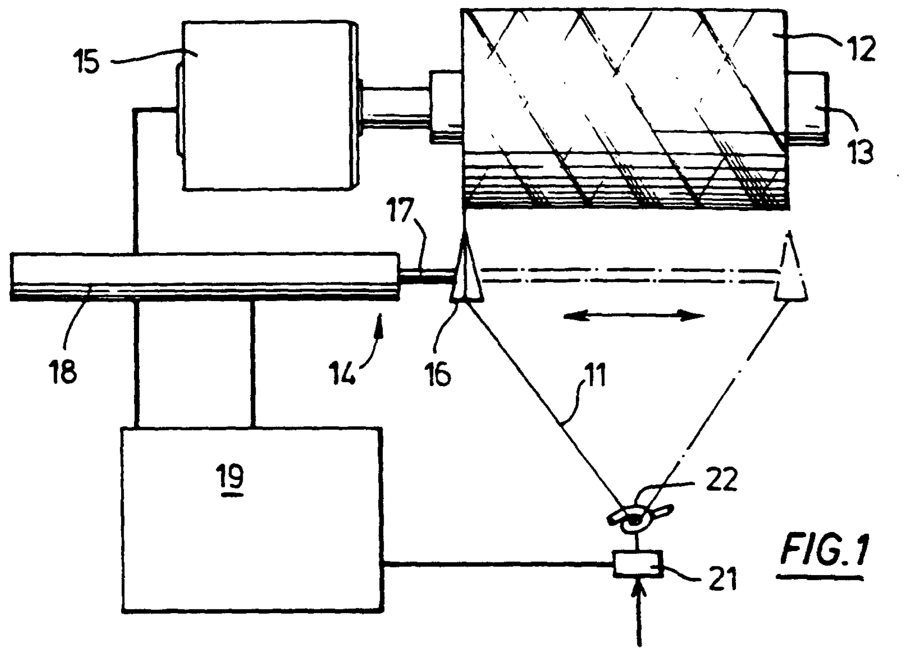
15
12
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FIG.1

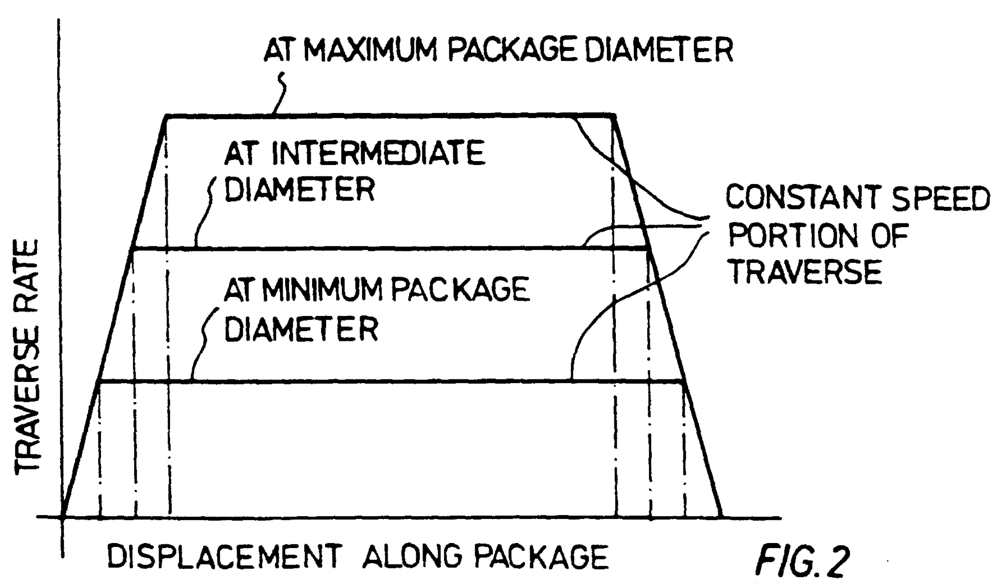
AT MAXIMUM PACKAGE DIAMETER
AT INTERMEDIATE DIAMETER
AT MINIMUM PACKAGE DIAMETER
CONSTANT SPEED PORTION OF TRAVERSE
TRAVERSE RATE
DISPLACEMENT ALONG PACKAGE

FIG.2

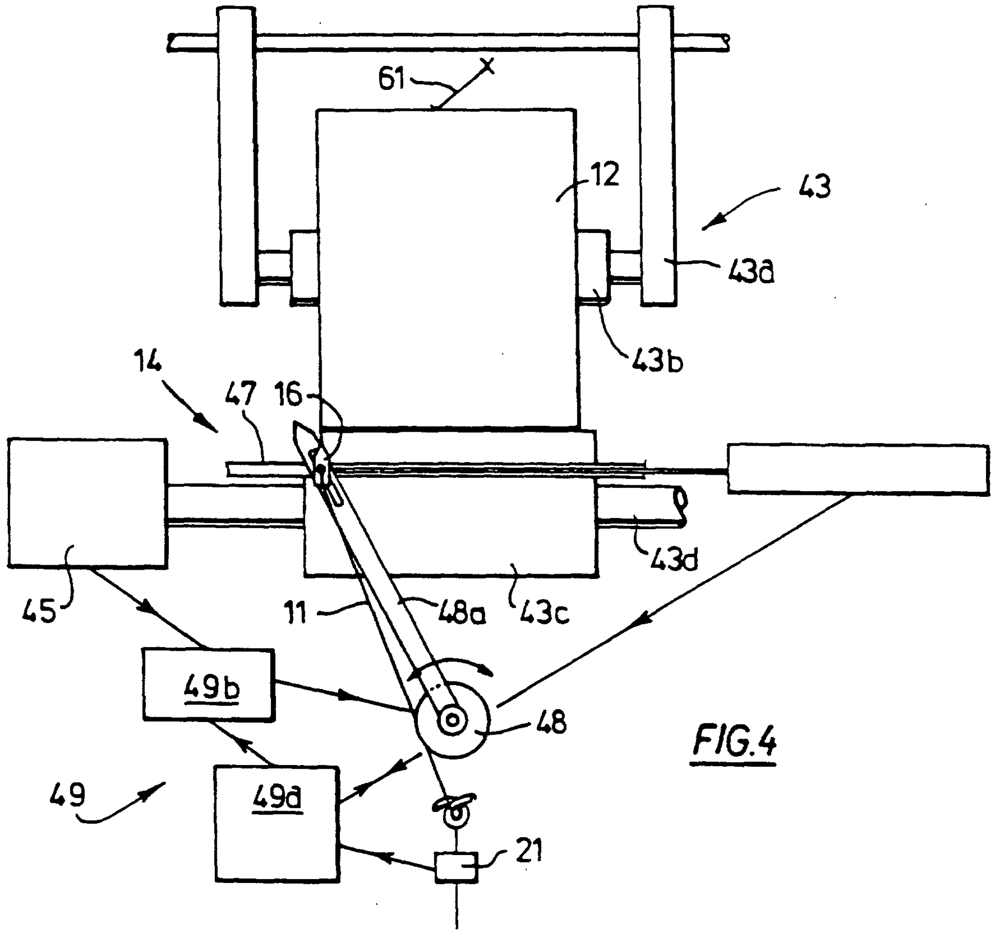

FIG.4

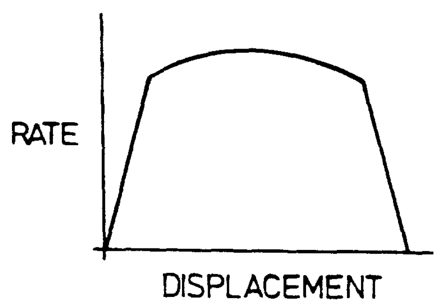

FIG.3

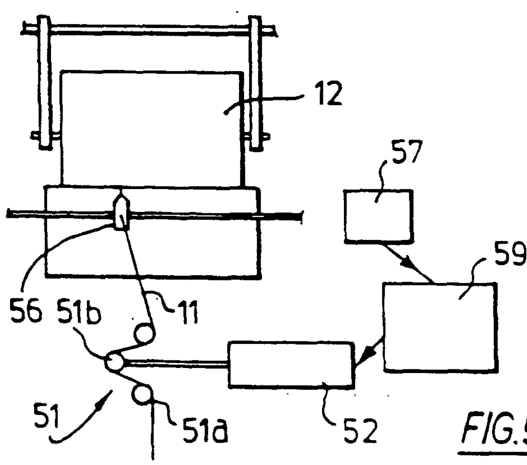

FIG.5