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(54) Device for continuously winding a continuous elongate element.

(57) A device for continuously winding a continuous elongate element, especially a strand (6) formed by gathering together a large number of glass filaments drawn from a bushing, provided with two or more main winding spools (8a, 8b) which are adapted to be brought to a predetermined winding position one by one and an auxiliary winding spool (13) which is normally held in an inoperative position spaced apart from the winding position by such a distance as not to interfere with the operation of the main winding spool in the winding position and, whenever the main spool in the winding position becomes full, is brought into engagement with this main spool in coaxial relationship (Fig. 6) and rotates at the same speed as the winding speed of the main spool. The strand is transferred from the full main spool to the auxiliary spool connected to the former and after an empty main spool is brought to be engagement with the auxiliary spool in place of the full main spool, the strand is transferred from the auxiliary spool to the empty main spool. In this manner, even when the full main spool is replaced with the empty main spool, the winding of the strand is continued at a substantially constant speed. The auxiliary winding spool (13) further may have a built-in strand cutter (118) which acts to cut off the strand bridging between the main spool and the auxiliary spool in a moment when the both spools are disconnected from one another.

FIG. 1

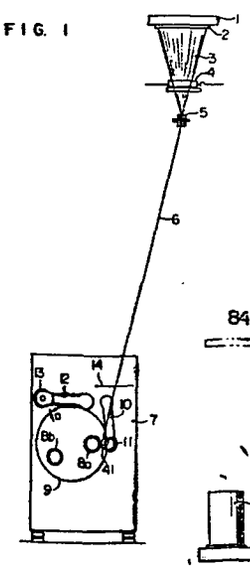
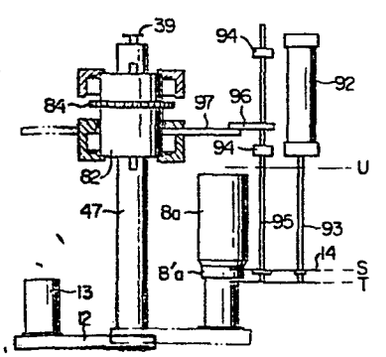


FIG. 6



EP 0 025 340 A1

DEVICE FOR CONTINUOUSLY WINDING A CONTINUOUS ELONGATE ELEMENT

BACKGROUND OF THE INVENTION

The present invention relates to a device for continuously winding a continuous elongate element and especially a glass fiber strand.

In general, conventional bushings for producing glass fibers have been provided with orifices from 400 to 800 in number and drawn therethrough glass filaments from 10 to 13 microns in diameter. In order to form a package of roving having a desired diameter from glass filaments drawn from such bushing there has been required such a troublesome process that glass filaments from 400 to 800 in number drawn from the single bushing are gathered into a strand and wound around a spool to form a cake of strand and thereafter strands are unwound from 15 to 30 cakes and gathered into a roving and wound around another spool to form a package.

Recently there has been provided various multiple-nozzle spinning techniques of the type in which glass filaments from 2000 to 4000 in number and from 15 to more than 20 microns in diameter can be simultaneously spun from a single bushing so that a desired package can be formed directly by merely gathering filaments drawn from the bushing into a strand and winding the strand around a spool. In

the case of forming the package directly from glass filaments drawn from the multiple-nozzle bushing, it is very important to maintain the tension imparted to the glass filaments always uniform so that the stable spinning feasible and all the glass filaments have a uniform cross sectional area. Upon the replacement of a full winding spool with an empty winding spool, if the spinning of glass filaments is interrupted, these filaments immediately coalesce together into a monolith and accordingly much labor and a long time are needed before the stable spinning can be re-started. In addition the interruption of spinning of glass filaments tends to adversely affect the operation of the glass melting furnace due to occurence of thermal hysteresis so that stable spinning cannot be continued. It is therefore obviously preferable to continue the spinning while imparting a uniform tension to the glass filaments even when a full winding spool is replaced with an empty one. To this end, there have been devised and demonstrated various types of winding devices as disclosed in Japanese Patent Publication Nos. 36-18369, 43-8996, 47-9862 and 48-32626.

Japanese Patent Publication No. 36-18369 discloses a method for continuously winding strands by a plurality of winding spools mounted equiangularly on a turntable which is supported by a horizontal shaft and rotated in one direction. Whenever the spool in the winding position becomes full, the turntable

is rotated through a predetermined angle so that an empty spool is brought to the winding position and the strand is wound around it. More specifically, when the strand has been transferred onto the empty spool which is rotated at the same speed as the full spool, the latter is decreased in speed so that the strand between the full and empty spools is slacked and caused to adhere to the empty spool so as to be wound around it. According to this method, it is possible to continuously wind strands consisting of a smaller number of filaments and having a smaller diameter which have a low degree of rigidity and a low drawing tension, but there is not provided a means for positively holding the strand on the empty spool and as a result, with the strands consisting of a larger number of filaments and having a larger diameter which have a relatively higher degree of rigidity and a high drawing tension the failures of transfer of the strand from the full spool to the empty spool frequently result so that the spinning must be interrupted. Thus this continuous winding method is inefficient and unsatisfactory in practice.

Japanese Patent Publication No. 43-8996 discloses a winding device in which a plurality of spools are mounted on a turntable and a supporting plate is disposed in front of the free end of each spool so that when the strand is transferred from a full spool to an empty spool, it is clamped between the plate and

the free end of the empty spool. To this end, mechanical clamping means driven with a magnet, spring or the like are needed in order to clamp the strand so that the winding spools become very complex in construction and are not adapted to spin at high speeds. Furthermore, with strands consisting of a larger number of filaments and having a larger diameter which have a relatively higher degree of rigidity and are relatively fragile, breakages frequently occur when clamped.

Japanese Patent Publication Nos. 47-9862 and 48-32626 disclose winding devices of the type using an auxiliary winding spool in order to ensure the smooth and positive transfer of the strand from a full spool to an empty spool. When one spool becomes full, the auxiliary winding spool is brought to the position in line with the full spool and the strand is transferred from the full spool to the empty spool. Thereafter the full spool is retracted from the winding position while an empty spool is brought to the winding position and subsequently the strand is transferred from the auxiliary winding spool onto the empty spool.

The winding device disclosed in Japanese Patent Publication No. 47-9862 is such that the auxiliary winding spool is held stationary while two main winding spools are alternately brought to the winding position in opposed coaxial relationship with the stationary spool.

The winding device disclosed in Japanese

Patent Publication No. 48-32626 is such that the auxiliary winding spool is so designed and constructed as to be alternately brought into alignment with one of two main winding spools which are held stationary.

Both the winding devices have a common defect that when the strand is transferred between the main and auxiliary winding spools, variations in winding tension result so that these devices are unsatisfactory in practice in providing strand packages of uniform configurations and qualities. In addition, when breakages of strands occur or solidification of lubricants occur during the winding operations, remedies or counter-measures cannot be carried out smoothly because of the presence of the auxiliary winding spool.

SUMMARY OF THE INVENTION

The present invention was made to overcome the above and other problems encountered in the prior art continuous winding devices.

One of the objects of the present invention is therefore to provide a continuous winding device capable of continuous and stable winding especially of glass-fiber strands consisting of a larger number of filaments and having a larger diameter, whereby packages of high qualities can be provided.

Briefly stated, to the above and other ends, the present invention provides a device for continuously winding a continuous elongate element having a main

winding spool supporting means which carries a plurality of main winding spools and is so movable as to bring said main winding spools sequentially to a winding position one by one, an auxiliary winding spool whose free end is adapted to engage with the free end of the main winding spool in said winding position, a traversing means movable between a first position adjacent to the main winding spool in said winding position at which said traversing means imparts the traversing movement to the element being wound around said main winding spool in said winding position and a second position spaced apart from said main winding spool in said winding position by a predetermined distance at which said traversing means is disengaged from the element being wound, and a guide rod movable in the direction in parallel with the axis of said main winding spool in said winding position between a first position above said auxiliary winding spool engaged with said main winding spool in said winding position and a second position beyond the end of said main winding spool in said winding position remote from said free end thereof, in which said auxiliary winding spool is movable to an inoperative position spaced apart from the axis of said main winding spool in said winding position by a considerable distance.

The above and other objects, features and effects of the present invention will become more apparent from the following description of one preferred

embodiment thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing that glass filaments drawn from a bushing are directly formed into a package by a continuous winding device in accordance with the present invention;

Fig. 2 is a rear view of a main body of the continuous winding device shown in Fig. 1 with the rear wall removed so as to show the interior;

Fig. 3 is a side view thereof showing the arrangement of driving systems;

Fig. 4 is a top view of a mechanism for controlling not only the retracting movement of a traverse motion in response to the increase in diameter of a strand package being wound but also the winding speed;

Fig. 5 is a block diagram used for the explanation of the mode of operation of the mechanism shown in Fig, 4;

Fig. 6 is a view used for the explanation of a mechanism for driving a strand guide rod for transferring the strand between a main winding spool and an auxiliary winding spool when the main winding spool with a full package is retracted from the winding position while an empty main winding spool is brought to the winding position;

Fig. 7 is a longitudinal sectional view, on enlarged scale, of the auxiliary winding spool showing a strand cutting means incorporated therein;

Fig. 8a is a sectional view taken along the line VIII-VIII of Fig. 7 showing the strand cutting means in its inoperative position; and

Fig. 8b is a view similar to Fig. 8a, but shows the strand cutting means in the operative position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 shows that a large number of glass filaments are gathered into a strand which in turn is directly wound into a package by a winding machine in accordance with the present invention. Molten glass is drawn through from 2000 to 4000 nozzles 2 at the bottom of a bushing 1 into glass filaments 3. After having been applied with a lubricant by a roll sizer 4, they are gathered by a gathering roller 5 into a strand 6 which in turn is wound by the winding device.

The winding device has a main body 7 in which are mounted drive motors, hydraulic cylinders, transmission gears, control devices and so on as will be described in detail below. Mounted on the front panel of the main body are a turret 9 which carries two horizontal winding spools 8a and 8b, a traverse motion 11 mounted on a swinging arm 10, an auxiliary winding spool 13 mounted rotatably on a swinging arm 12 and a strand guide rod 14 which is extended at right angles

to the axes of the main and auxiliary winding spools 8a, 8b and 13 and the traverse motion 11 and is movable in the same direction as these axes. The strand 6 is shown as being wound around the main winding spool 8a while being traversed by the traverse motion 11.

As will be described in detail hereinafter, when the strand 6 is fully wound around the main winding spool 8a, the arm 12 is swung in the direction indicated by the arrow a so that the auxiliary winding spool 13 is made into abutment with the free end of the main winding spool 8a. Thereafter, the strand guide rod 14 transfers the strand 6 to the auxiliary winding spool 13 so that the latter starts winding the strand 6. Next the turret 9 is rotated through a predetermined angle to bring the second main winding spool 8b, which is empty, to the winding position while the first main winding spool 8a is retracted therefrom. The strand guide rod 14 is retracted so that the strand is transferred to the second main winding spool 8b so as to be wound therearound. The auxiliary winding spool 13 is returned to the initial position shown and is ready for the next operation. Thus even when the main winding spools 8a and 8b are being exchanged for one another, the stand 6 can be continuously wound because of the provision of the auxiliary winding spool 13 which operates in the manner just described above.

Next referring to Figs. 2 and 3, the mechanisms

incorporated in the main body 7 will be described in detail. Fig. 2 is a rear view while Fig. 3 is a view mainly used for the explanation of the arrangements and modes of operation of driving mechanisms. The rotations of the two main winding spools 8a and 8b, the auxiliary winding spool 13 and the traverse motion 11 are all provided by a variable speed motor 15 mounted on the bottom of the main body 7. Thus relatively much space is left in the main body 7 so that maintenance and inspection may be facilitated. The motor 15 carries two timing pulleys 16 and 17 on its shaft and the timing pulley 16 is drivingly coupled to a timing pulley 19 mounted on the input shaft of an electromagnetic clutch 18 through a timing belt 20. The electromagnetic clutch 18 is of the double-clutch type having two output shafts carrying timing pulleys 21 and 22, respectively. When one clutch is energized, one corresponding output shaft is connected to the input shaft; when both the clutches are energized, both the output shafts are connected to the input shaft; and when the two clutches are de-energized, both the output shafts are disconnected from the input shaft.

The main winding spools 8a and 8b are mounted on spindles 25 and 26, respectively, which in turn are rotatably supported by bearings in housings 23 and 24 mounted on the rear surface of the turret 9. Timing pulleys 27 and 28 which are mounted at the rear

ends of the spindles 25 and 26, respectively, are drivingly coupled through timing belts 29 and 30, respectively, to the timing pulleys 21 and 22 on the output shafts of the electromagnetic clutch 18. The spindles 25 and 26 are angularly spaced apart from each other for example by 140°.

The timing pulley 17 on the motor 15 is drivingly coupled through a timing belt 33 to a timing pulley 32 on the input shaft of an electromagnetic clutch 31. The electromagnetic clutch 31 is also of the double-clutch type having two output shafts carrying timing pulleys 34 and 35, respectively. These timing pulleys 34 and 35 are drivingly coupled through timing belts 36 and 37, respectively, to a timing pulley 38 on the traverse motion 11 and a timing pulley 39 for driving the auxiliary winding spool 13.

The traverse motion 11 is most preferably of the type having a strand guide 40 which makes reciprocating movements in response to the rotation of a scroll cam. In addition, in order not only to smooth the surfaces of the strand packages wound on the winding spools but also to maintain uniform pressure distributions within the strand packages, thereby ensuring uniform qualities of the strand packages, it is preferable to provide a pressure roller 41 which is disposed in parallel with the scroll cam and rolls in contact with the surface of the strand package under a suitable pressure while the strand is being

wound (See Fig. 1).

The swingable arm 10 which supports the traverse motion 11 is hollow and has its one end securely joined to one end of a hollow shaft 42 so that as the latter is rotated, the former is swung. A rotating shaft 43 is extended through the hollow shaft 42 and the timing pulley 38 is attached to the rear end of the rotating shaft 43. A timing pulley 44 which is mounted at the front end of the rotating shaft 43 is drivingly coupled through a timing belt 45 to a timing pulley 46 mounted on a scroll cam shaft, the belt 45 being extended through the arm 10.

The swingable arm 12 which supports the auxiliary winding spool 13 is hollow and has its upper end securely joined to the front end of a hollow shaft 47 so that as the latter is rotated, the former is caused to swing. A rotating shaft 48 is extended through the hollow shaft 47 and the timing pulley 39 is attached to the rear end of the shaft 48. A timing pulley 49 is attached to the front end of the shaft 48 and is drivingly coupled through a timing belt 50 to a timing pulley 51 carried by a spindle of the auxiliary winding spool 13, the timing belt 50 being extended through the arm 12.

As best shown in Fig. 2, the turrer 9 is imparted with reciprocating rotations by a hydraulic cylinder 53 which in turn is mounted on the bottom of the main body 7 with a bracket 52. A piston rod 54

of the hydraulic cylinder 53 is connected to the lower end of a rack 55 which is mounted for vertical movement and is in mesh with a pinion 56. An intermediate gear 57 is carried by the shaft of the pinion 56 for rotation in unison therewith and is in mesh with a gear 58 securely fixed to the turret 9. Therefore as the cylinder 53 extends or retracts its piston rod 54, the rack 55 is caused to move upward or downward so that the turret 9 is caused to reciprocably rotate through the pinion 56, intermediate gear 57 and gear 58. At the top of the stroke of the piston rod 54, the first main winding spool 8a is brought to the winding position shown in Fig. 1 while at the bottom of the stroke the second main winding spool 8b is brought to the winding position.

Next referring to Fig. 4, the mechanism will be described which causes the traverse motion 11 to retract as the diameter of the strand package being formed around the main winding spool 8 increases. A variable motor 59 is drivingly coupled to a reduction gear 62 through meshing gears 60 and 61. The reduction gear 62 is directly coupled to an electromagnetic clutch 64 with an output shaft 65 supported by a bearing 63 and carrying two plate cams 66 and 67. The plate cam 66 engages with a cam follower or cylindrical roller 70 rotatably mounted at the upper end of a rack 69 which is vertically slidably supported by brackets 68 (See Fig. 2). The rack 69 is in mesh with a sector gear 71 carried by the hollow shaft 42

of the traverse motion so that as the rack 69 is caused to move up and down, the hollow shaft 42 and hence the swinging arm 10 (See Fig. 1) are caused to swing. More specifically, during energization of the clutch 64 the rotation of the motor 59 is reduced by the reduction gear 62 at a predetermined ratio and transmitted to the plate cam 66. As the plate cam 66 is rotated, the rack 69 is caused to move upward so that the sector gear 71 is caused to rotate in the clockwise direction in Fig. 2 and subsequently the traverse motion 11 is gradually moved away from the main winding spool 8. The plate cam 66 is designed to have such a cam profile that the traverse motion 11 is moved away in proportion to the quadratic increase in diameter of the strand package being formed around the main winding spool 8.

Referring to Fig. 2, a hydraulic cylinder 73 is pivoted to a bracket 72 and the piston rod of this cylinder 73 is pivoted with a pin 74 to the sector gear 71. When the strand is being wound, the piston rod is forced to be retracted so that the sector gear 71 is imparted with a torque in the counterclockwise direction. This torque, which is weaker than the torque imparted in the clockwise direction to the sector gear 71 from the rack 69, has double functions of causing the pressure roller 41 to maintain the contact with the surface of the package under a predetermined pressure when moving away therefrom in unison with

the traverse motion 11 and preventing the vibrations of both the traverse motion 11 and the pressure roller 41. In addition, when, upon complete or full winding of the strand package on the main winding spool 8, the electromagnetic clutch 64 is disengaged so that the upward movement of the rack 69 is stopped, the hydraulic cylinder 73 is actuated to extend its piston rod so that the sector gear 71 is further rotated in the clockwise direction and consequently the traverse motion 11 and the pressure roller 41 are moved away from the surface of the strand package, whereby the change in position between the main winding spool 8a and 8b is permitted.

Referring back to Fig. 4, the other plate cam 67 controls the speed of the variable motor 15 which drives the main winding spool 8, the scroll cam of the traverse motion 11 and the auxiliary winding spool 13. In order that the glass filaments drawn from the bushing 1 (See Fig. 1) may have a uniform diameter and that the strand packages of uniform qualities may be obtained, the strand winding speed; that is, the peripheral velocity of the package on the main winding spool must be maintained constant. As a result, the rotational speed of the main winding spool must be decreased in inverse proportion to the increase in diameter of the strand package.

The plate cam 67 is made into engagement with a cylindrical roller or cam follower 174 mounted at

the left end of a rack 173 which in turn is horizontally slidably supported by brackets 172 and is in mesh with a pinion 76 supported by a bracket 75. A gear 77 (See also Fig. 2), which is carried by the shaft of the pinion 76 for rotation in unison therewith, is in mesh with a gear 80 carried by a shaft 79 of a potentiometer or a displacement sensor 78 (See Fig. 5). The gear 80 is loaded with a bias spring (not shown) so as to be normally biased in the counterclockwise direction so that the rack 173 is normally imparted with the force acting in the left direction in Fig. 4 and consequently the cylindrical roller 174 is pressed against the periphery of the cam plate 67.

Referring also to Fig. 5, the rotation of the shaft 79 of the potentiometer 78 is converted into a voltage signal and transmitted to a winding speed control panel 81, whereby the speed of the motor 15 for winding the strand is controlled. The plate cam 67 is mounted on the output shaft 65 coaxially with the plate cam 66 in such a way that the starting points of their cam profiles coincide with each other. The cam profile of the plate cam 67 is so determined that the voltage signal from the potentiometer 78 changes its magnitude in response to the increase in diameter of the strand package being wound and subsequently the rotational speed of the motor 15 is gradually decreased so as to maintain the peripheral velocity of the strand package being wound constant.

Next referring back to Figs. 2 and 3, an auxiliary winding spool transfer device will be described. The hollow shaft 47 is extended through a rotatable cylindrical housing 82 and keyed with a key 83 to the housing 82 in such a way that the shaft 47 can slide in the axial direction but is not permitted to rotate. A gear 84 is formed integral with and coaxially of the cylindrical housing 82 and is made into engagement with an intermediate gear 88 which in turn is in mesh with a rack 87 which is vertically slidable by a hydraulic cylinder 86 mounted with a bracket 85.

A rack 89 is formed at the rear end portion of the hollow shaft 47 and is in mesh with a pinion 90 which is mounted on the shaft of a motor (not shown). Therefore as the motor is driven, the hollow shaft 47 is caused to slide in the axial direction relative to the cylindrical housing 82. Obviously, the direction of the axial movement of the hollow shaft 47 is depending upon the direction of the rotation of the motor.

As shown in Fig. 1, when the main winding spool 8a is winding the strand therearound, the auxiliary winding spool 13 is placed in an inoperative position remote from the main spool 8a. When the main winding spool 8a becomes full and then is retracted from the winding position to the inoperative position while the second main winding spool 8b is brought to the winding position, the cylinder 86 is actuated to cause the rack 87 to move upward so as to cause the housing 82

to rotate in the clockwise direction in Fig. 2 through the intermediate gear 88 and the gear 84. As a result, the arm 12 supporting the auxiliary winding spool 13 is caused to swing in the direction a in Fig. 1 until the auxiliary winding spool 13 becomes in line with the first main winding spool 8a. In this position, further rotation of the housing 82 is prevented by the engagement of its extension with a stopper 91 as best shown in Fig. 2. Thereafter the pinion 90 is rotated in such a direction that the hollow shaft 47 is caused to move to the right in Fig. 3 and consequently the free end of the auxiliary winding spool 13 is made into engagement with the mating free end of the main winding spool 8a. Under these conditions, as will be described in more detail, the strand guide rod 14 is actuated so that the strand 6 is transferred from the main winding spool 8a to the auxiliary winding spool 13. Thereafter the rotation of the pinion 90 is reversed so that the hollow shaft 47 is caused to move to the left in Fig. 3 toward the initial position. Next the turret 9 is rotated so that the second empty main winding spool 8b is brought to the winding position. The pinion 90 is rotated again so that the hollow cylinder 47 is advanced and subsequently the free end of the auxiliary winding spool 13 is made into engagement with that of the second main winding spool 8b which is now in the winding position. Next the strand guide rod 14 is retracted so that the strand 6 is transferred from

the auxiliary winding spool 13 to the empty main winding spool 8b. Thereafter the rotation of the pinion 90 is reversed again so that the hollow shaft 47 is retracted and consequently the auxiliary winding spool 13 is disconnected from the main winding spool 8b. The piston rod of the hydraulic cylinder 86 is actuated such that the rack 87 is caused to move downward and thus the housing 82 is caused to rotate in the counter-clockwise direction, whereby the auxiliary winding spool 13 is returned to the initial inoperative position shown in Fig. 1. When the auxiliary winding sleeve 13 is disconnected from the main winding spools 8a and 8b, a strand cutter is actuated as will be described in detail later.

Next referring to Fig. 6, the construction and mode of operation of a strand guide rod actuating mechanism which coacts with the auxiliary winding spool transfer mechanism will be described. The strand guide rod 14 is attached to the free end of the piston rod 93 of a hydraulic cylinder 92 and arranged such that the strand guide rod 14 is in the position indicated by the straight line T when the piston rod 93 is fully extended but in the position indicated by the straight line U when the piston rod 93 is fully retracted. In the position T, the strand guide rod 14 is above the auxiliary winding spool 13 in engagement with the main winding spool 8. One end of an auxiliary rod 95 which is supported by brackets 94 for slidable movement in

parallel with the piston rod 93 is attached to the strand guide rod 14 and a stopper 96 is attached to the auxiliary rod 95 intermediate at its ends. An arm 97 (See also Fig. 2), which is extended radially outwardly from the housing 82, is adapted to engage with the stopper 96 so that a further advancement of the strand guide rod 14 beyond the line S toward the line T is prevented when the auxiliary winding spool 13 is in the initial inoperative position shown in Fig. 1.

Next referring to Fig. 7, the construction and mode of operation of the strand cutter which is disposed within the auxiliary winding spool 13 will be described. A supporting ring 101 is securely joined to the hollow supporting arm 12 adjacent to its lower end and a rotary barrel 104 is rotatably supported by bearings 102 and 103 which are mounted in the supporting ring 101. The auxiliary winding spool 13 is fitted over flanges 105 and 106 of the rotary barrel 104, the flange 105 being formed at the front end (the right end in Fig. 7) while the flange 106 intermediate between the ends of the rotary barrel 104. A radially inwardly extended flange 107 of the auxiliary winding spool 13 at the front end thereof is abutted against the front flange 105 of the rotary barrel 104 and is securely joined thereto with bolts 108. The timing pulley 51, which is mounted at the rear end (the left end in Fig. 7) of the rotary barrel 104 is drivingly coupled through

the timing belt 50 to the timing pulley 49 carried by the rotating shaft 48 (See also Fig. 3). One end (rear end) of a hollow shaft 109 which is extended through the center bore of the rotary barrel 104 is securely fixed to the lower end of the supporting arm 12 and a circular retaining member 111 is fitted over the other end of the hollow shaft 109 and securely keyed thereto with a key 110. A disk 112 is mounted on the retaining member 111. The timing pulley 51 and the rotary barrel 104 are supported by bearings 113 and 114 mounted on the hollow shaft 109 so as to be rotatable relative to the hollow shaft 109.

A hydraulic motor 115 of the oscillating type is mounted on the supporting arm 12 adjacent to its lower end and the output shaft of the motor 115 is connected to an oscillating shaft 116 extended through the hollow shaft 109 coaxially thereof. A cutting blade 118 is pivoted with pin 117 to the disk 112 and an oscillating arm 119 is carried by the shaft 116 at its front end (See also Figs. 8a and 8b).

As shown in Figs. 8a and 8b, one end of a connecting rod 121 is pivoted with a pivot pin 120 to the free end of the oscillating arm 119 while the other end is pivoted with a pin 122 to the rear end of the cutting blade 118.

Fig. 8a shows the cutting blade 118 in its in inoperative position. When the auxiliary winding spool 13 is caused to move to the left in Fig. 7 in

the manner described previously so that the free end of the auxiliary spool 13 is disconnected from that of the main spool 8, the motor 115 is energized so as to cause the oscillating arm 119 to rotate in the counter-clockwise direction in Fig. 8a. As a result, the cutting blade 118 is caused to rotate in the counter-clockwise direction about the pivot pin 117 and projected radially outwardly through the space between the free ends of the main and auxiliary winding spools 8 and 13 as shown in Fig. 8b so that the strand 6 bridging between the main and auxiliary winding spools 8 and 13 is cut off. The disk 112 is formed with a partially circular protective flange 123 which extends axially forwardly (to the right in Fig. 7) from the periphery of the disk 112. The protective flange 123 is not completely circular because it must be provided a passage for the cutting blade 118. The counterclockwise rotation of the cutting blade 118 is stopped when it engages with the upper end of the protective flange 123 as shown in Fig. 8b.

After the strand 6 is cut off, the motor 115 is reversed in rotation so that the oscillating arm 119 is swung in the clockwise direction so that the cutting blade 118 is returned from the position shown in Fig. 8a to the inoperative initial position shown in Fig. 8a.

Referring back to Fig. 7, the end face of the main winding spool 8 which is in opposed relationship with the end face of the auxiliary winding spool 13

is formed with a cylindrical recess 124 which is slightly greater in diameter than the free end of the auxiliary winding spool 13 so that when the auxiliary winding spool 13 is connected to the main winding spool 8, the free end of the spool 13 is projected into the recess 124 and is surrounded by the peripheral wall 8' thereof. This arrangement is very effective for smoothly transferring the strand between the main and auxiliary winding spools 8 and 13 as will be described in detail later.

Next the mode of operation of the continuous strand winding device with the above-described construction will be described in more detail below. Prior to the strand winding, the piston rod 54 of the hydraulic cylinder 53 is fully extended as shown in Fig. 2 and consequently the first main winding spool 8a on the turret 9 is in the winding position shown in Fig. 1. The piston rod of the cylinder 73 is also fully extended so that the traverse motion 11 is moved away from the main winding spool 8a. The auxiliary winding spool 13 is in the inoperative position shown in Fig. 1. Under these conditions, first the hydraulic cylinder 92 is actuated to advance the strand guide rod 14 (See Fig. 6). Because the auxiliary winding spool 13 is in the inoperative position, the stopper 96 carried by the auxiliary rod 95 engages with the arm 97 (See also Fig. 2) of the housing 82 so that the strand guide 14 is stopped at the line S.

The glass filaments from 2000 to 4000 in number drawn from the bushing 1 are applied with lubricant by the roller sizer 4 and gathered by the gathering roller 5 into a strand 6. An operator brings the strand 6 past the front side of the strand guide rod 14 toward the main winding spool 8a and winds it around the front end portion 8a' thereof. Thereafter the motor 15 is energized and the double-action electromagnetic clutch 18 is so actuated that the timing pulley 21 is rotated and the main winding spool 8a is spinned (See Fig. 3). The axial position of the main winding spool 8a is so determined that the strand 6 leaving from the gathering roller 8 is naturally forced to move toward the center of the main winding spool 8a by the tension of the strand 6, but at the start the path of the strand 6 is so restrained by the strand guide rod 14 at the position S that the strand 6 is wound around the front end portion 8a' only until the strand 6 having a predetermined diameter is obtained the rotational speed of the motor 15 reaches a predetermined speed. When the motor 15 is energized, the motor 59 for displacing the traverse motion 11 (See 4) is also energized, but the electromagnetic clutch 64 is kept disconnected so that the plate cams 66 and 67 are stationary.

After the condition under which the strand 6 is wound in the predetermined diameter has been obtained, the piston rod 93 of the hydraulic cylinder 92 is retracted so that the strand guide rod 14 is

retracted to the position U. Then, under its own tension the strand 6 moves toward the center of the main winding spool 8a. Immediately before the strand guide rod 14 is retracted, the double-action electromagnetic clutch 31 is so actuated that the timing pulley 34 is rotated and consequently the scroll cam of the traverse motion 11 is rotated, whereby the strand guide 40 starts its straight reciprocating movements.

Next the piston rod of the hydraulic cylinder 73 is retracted so that the sector gear 71 is caused to rotate in the counterclockwise direction in Fig. 2, whereby the traverse motion 11 is caused to move toward the main winding spool 8a and the pressure roller 41 on the traverse motion 11 is made into contact with the surface of the main winding spool 8a. Immediately before the pressure roller 41 is made into contact with the main winding spool 8a, the strand guide 40 catches the strand 6 which is being wound around the center portion of the main winding spool 8a, whereby the strand 6 is traversed.

At the instant when the pressure roller 41 is brought into contact with the main winding spool 8a, the electromagnetic clutch 64 is energized so that the plate cams 66 and 67 are rotated. Upon rotation of the plate cam 66, the rack 69 is caused to move upward so that the sector gear 71, which is in mesh with the rack 69, is caused to rotate in the clockwise direction

against the force which is imparted from the hydraulic cylinder 73 and tends to rotate the sector gear 71 in the counterclockwise direction. As a result, the traverse motion 11 is caused to move away from the main winding spool 8a. As already described, the plate cam 66 has such a cam profile that the retracting speed of the traverse motion 11 corresponds to the rate at which the strand package is increased in diameter. As a result, the traverse motion 11 is always maintained in predetermined spaced apart relationship with the surface of the strand package during the winding. In addition, because of the torque provided by the hydraulic cylinder 73, the traverse motion 11 is urged toward the main winding spool 8a so that the pressure roller 41 is pressed against the surface of the strand package under a predetermined pressure while the pressure roller 41 being retracted as the diameter of the strand package is increased.

As described, the plate cam 67, which rotates in unison with the cam 66, controls the motor 15 so as to gradually decrease the rotational speed of the main winding spool 8a in inverse proportion to the increase in diameter of the strand package being wound so that the winding speed or the surface velocity of the strand package can be maintained always constant. Thus the strand is wound under a constant tension regardless of the increase in diameter of the strand package. In addition, the pressure roller is always

pressed against the surface of the strand package being wound under a predetermined pressure so that the strand packages with uniform qualities can be obtained.

When the diameter of the strand package on the main winding spool 8a reaches a predetermined value, the electromagnetic clutches 18 and 31 are so energized that the timing pulleys 22 and 35 are rotated so as to rotate the empty main winding spool 8b and the auxiliary winding spool 13. Simultaneously, the hydraulic cylinder 86 is so actuated as to raise the rack 87 so that the auxiliary winding spool-housing 82 is caused to rotate in the clockwise direction in Fig. 2 through the gears 88 and 84. As a result, the auxiliary winding spool 13 is caused to swing to the operative position at which the spool 13 is in line with the main winding sleeve 8a and is axially spaced apart therefrom by a predetermined short distance. Thereafter the pinion 90 (See Fig. 3) is caused to rotate in the clockwise direction so that the hollow shaft 47 is caused to move to the right and the free end of the auxiliary winding spool 13 is fitted into the recess 124 at the free end 8a' of the main winding spool 8a as shown in Fig. 7. When the auxiliary winding spool 13 is coupled to the main winding spool 8a with a fully wound strand package, the electromagnetic clutch 64 is de-energized so that the rotations of the plate cams 66 and 67 are stopped and subsequently the

hydraulic cylinder 73 (See Fig. 2) is so actuated as to extend its piston rod so that the hollow shaft 42 is caused to rotate in the clockwise direction through the sector gear 71 and as a result the traverse motion 11 and the pressure roller 41 are caused to move away from the fully wound strand package, thereby releasing the strand 6 from the strand guide 40. The rotation in the clockwise direction of the sector gear 71 causes the rack 69 to rise so that the cylindrical roller 70 is moved away from the cam plate 66. As a result, the cam plate 66 is returned to its initial position under the force of a bias spring (not shown).

Next the hydraulic cylinder 92 (See Fig. 6) is actuated to advance the strand guide rod 14. At this time, since the auxiliary winding spool 13 is in line with the main winding spool 8a, the arm 97 of the housing 82 is retracted away from the path of the stopper 96 carried by the auxiliary rod 95 which is advanced in unison with the strand guide rod 14 so that the strand guide rod 14 is advanced to the position T. Accordingly, the strand 6 which is being wound around the center portion of the main winding spool 8a is transferred over the front portion 8a' thereof to the auxiliary winding spool 13 which is rotating at the same speed as the main winding spool 8a. In this case, the closer toward the auxiliary winding spool 13 the strand guide rod 14 pushes the strand 6, the higher the tension of the strand becomes so that it may have

a tendency of being more easily cut off. But the very smooth transfer of the strand 6 from the main winding spool 8a to the auxiliary winding spool 13 is ensured because the free end of the latter is fitted into the free end portion 8a' of the main winding spool 8a so that the breakage of the strand 6 during the transfer can be avoided. If the auxiliary winding spool 13 were greater in diameter than the main winding spool 8a, the strand 6 would have to pass past a step between them so that an excessive tension would be induced in the strand 6 with the resultant breakage.

After the strand 6 has been transferred onto the auxiliary winding spool 13, the pinion 90 (See Fig. 3) is caused to rotate in the counterclockwise direction so that the auxiliary winding spool 13 is disconnected from the main winding spool 8a. Concurrently, the motor 115 (See Fig. 7) is energized so that the cutting blade 118 is swung radially outwardly through the space between the auxiliary and main winding spools 13 and 8a, thereby cutting off the strand 6 bridging between them. Thereafter the motor 115 is reversed in rotation so that the cutting blade is returned to its initial position shown in Fig. 8a. This strand cutting operation is almost instantly accomplished.

Almost concurrently with the strand cutting operation, the electromagnetic clutch 18 is so actuated as to disconnect the timing pulley 21. Simultaneously, a brake pad 98a (See Fig. 2) is pressed against a brake

disk 99a (See also Fig. 2) mounted on the spindle 25 of the main winding spool 8a, whereby the latter is stopped.

Next the hydraulic cylinder 53 (See Figs. 2 and 3) is retracted so that the rack 53 is lowered and the turret 9 is caused to rotate in the clockwise direction in Fig. 2 so that the empty main winding spool 8b is brought to the winding position and aligned with the auxiliary winding spool 13 which is now winding the strand 6. Thereafter the auxiliary winding sleeve 13 is moved toward and engaged with the empty main winding spool 8b in a manner similar to that of the engagement between the main winding spool 8a and the auxiliary winding spool 13 as described. The strand guide rod 14 is then retracted from the position T to the position U (See Fig. 6) so that the strand 6 which has been being wound around the auxiliary winding spool 13 is now automatically transferred toward the center of the main auxiliary winding spool 8b under the tension of the strand itself. The transfer of the strand 6 from the auxiliary winding spool 13 to the empty main winding spool 8b is smoothly carried out because the uphill step from the spool 13 to the spool 8b is almost eliminated by the increase in apparent diameter of the auxiliary winding spool 13 by winding of the strand 6 during exchanging in position between the main winding spools 8a and 8b and because even when there remains some uphill step, the transfer of

the strand from the spool 13 to the spool 8b is in the direction in which the tension of the strand 6 is decreased instead of being increased.

After the strand 6 has been transferred from the auxiliary winding spool 13 to the main winding spool 8b, the traverse motion 11 is advanced again from its retracted position toward the main winding spool 8b and in the course of this advancement the strand guide 40, which is making the rectilinear reciprocating movements, catches the strand 6 again, whereby the strand 6 is traversed while being wound around the main winding spool 8b. The pressure roller 41 is pressed against the surface of the package being formed on the main winding spool 8b. The clutch 64 (See Fig. 4) is energized again so that the retracting movements of the traverse motion 11 and the pressure roller 41 are controlled by the plate cam 66 while the winding speed of the strand 6; that is, the peripheral speed of the package on the main winding spool 8b is controlled by the plate cam 67 in the manner described.

After the winding of the strand 6 around the main winding spool 8b has been started in the manner described above, the auxiliary winding spool 13 is axially moved away from the spool 8b and almost concurrently the cutting blade 118 is actuated again, thereby cutting off the strand 6 bridging between the spool 13 and the spool 8b.

Next the hydraulic cylinder 86 (See Fig. 2)

is actuated so as to lower the rack 87, thereby causing the housing 82 to rotate in the counterclockwise direction. As a result, the auxiliary winding spool 13 is swung back to its initial position shown in Fig. 1. Next the electromagnetic clutch 31 is so actuated as to disconnect the timing pulley 35, thereby stopping the spinning of the auxiliary winding spool 13. The operator takes off the strand package from the main winding spool 8a and removes the waste strand wound around the auxiliary winding spool 13 so as to be ready for the next exchanging operation of main winding spools.

In summary, according to the present invention, even during the operation for exchanging the position between the main winding spools 8a and 8b, the strand 6 can be wound around the auxiliary winding spool 13 without any interruption. In addition, the strand winding is carried out at the same position. As a result, during the winding of the strand 6 around the main or auxiliary winding spool 8 or 13, the path of travel of the strand 6 as well as the winding tension can be maintained substantially constant. It follows therefore that the most desirable advantages and effects can be obtained when the present invention is applied to the continuous winding of strands consisting of a larger number of glass filaments and having a larger diameter, which is sensitive to variations in strand winding conditions thereby to easily cause the breakages

of glass filaments and degradation in quality of strand packages.

The auxiliary winding spool 13 is held in the inoperative position remote from the winding position during the time when the strand is being wound to be formed into a package around the main winding spool 8a or 8b, so that an operator can be easy of access to the main winding spool 8a or 8b in the winding position when the strand 6 is broken or when the lubricant is solidified on the strand.

In addition, whenever the auxiliary winding spool 13 is disconnected from the main winding spool 8a or 8b, the strand 6 is cut off by the cutting blade 118 so that the formation of fuzz at the cut ends can be avoided and consequently the degradation in quality due to the presence of fuzz can be prevented.

It is to be understood that the present invention is not limited to the preferred embodiment described above and that various modifications can be effected without departing from the true spirit of the present invention. For instance, instead of two main winding spools, more than three spools can be mounted on the turret 9 which in turn, instead of being reciprocated, is rotated in one direction so that the winding spools can be sequentially brought to the winding position. Alternatively, two winding spools can be mounted on a stand which makes rectilinear reciprocating movements.

WHAT IS CLAIMED IS:

1. A device for continuously winding a continuous elongate element having:

a main winding spool supporting means which carries a plurality of main winding spools and is so movable as to bring said main winding spools sequentially to a winding position one by one;

an auxiliary winding spool whose free end is adapted to engage with the free end of the main winding spool in said winding position;

a traversing means movable between a first position adjacent to the main winding spool in said winding position at which said traversing means imparts the traversing movement to the element being wound around said main winding spool in said winding position and a second position spaced apart from said main winding spool in said winding position by a predetermined distance at which said traversing means is disengaged from the element being wound, and a guide rod movable in the direction in parallel with the axis of said main winding spool in said winding position between a first position above said auxiliary winding spool engaged with said main winding spool in said winding position and a second position beyond the end of said main winding spool in said winding position remote from said free end thereof;

in which said auxiliary winding spool is movable to an inoperative position spaced apart from the axis

of said main winding spool in said winding position by a considerable distance.

2. A device as set forth in Claim 1, in which:

said main winding spool supporting means comprises a turret which carries two main winding spools angularly spaced apart by a predetermined angle and has an axis of rotation in parallel with the axes of said two main winding spools mounted thereon, whereby as said turret is caused to make reciprocating rotations, said two main winding spools are alternately brought to said winding position.

3. A device as set forth in Claim 2, in which:

a double-action electromagnetic clutch with one input shaft and two output shafts is disposed in coaxial relationship with said turret; and

said input shaft is drivingly coupled to the output shaft of a variable-speed motor while said two output shafts are drivingly connected to the spindles of said two main winding spools, respectively.

4. A device as set forth in Claim 2, in which:

said auxiliary winding spool is mounted at one end of a supporting arm whose the other end is securely joined to one end of a rotating shaft extended in parallel with the axis of rotation of said turret and adapted to be displaced axially.

5. A device as set forth in Claim 4, in which:

a stopper which is reciprocated in unison with said guide rod and an arm which is rotatable in

unison with said rotating shaft of said supporting arm are provided;

said arm is so positioned that when said auxiliary winding spool is retracted to said inoperative position, said arm is brought into the path of travel of said stopper so that when said guide rod is advanced, said arm is made into engagement with said stopper, whereby the advancement of said guide rod is limited to a position adjacent to said free end of said main winding spool in said winding position.

6. A device as set forth in Claim 1, in which:

the free end of said auxiliary winding spool is smaller in diameter than the free end of each main winding spool; and

each main winding spool has a recess which is formed in said free end thereof for receiving said free end of said auxiliary winding spool.

7. A device as set forth in Claim 1, in which; said auxiliary winding spool is adapted to move axially toward or away from said main winding spool in said winding position and incorporates a cutting means having a cutting blade which is radially outwardly swung when said auxiliary winding spool is moved away from said main winding spool in said winding position, thereby cutting off the element bridging between them.

8. A device as set forth in Claim 7, in which:

said cutting means has

a stationary retaining member which is disposed adjacent to said free end of said auxiliary winding spool and upon which is mounted said cutting blade in such a way that said cutting blade can swing about an axis in parallel with the axis of rotation of said auxiliary winding spool;

an arm swingable about said axis of rotation of said auxiliary winding spool relative to said retaining member; and

a connecting lever interconnecting between the rear end of said cutting blade remote from its cutting edge and the free end of said arm.

9. A device as set forth in Claim 8, in which:

said retaining member is securely joined to one end of a hollow stationary shaft extended through said auxiliary winding spool coaxially thereof;

said swinging arm is securely joined to one end of an oscillating shaft extended through said hollow stationary shaft coaxially thereof; and

the other end of said oscillating shaft is connected to the output shaft of a motor mounted adjacent to the other end of said hollow stationary shaft for causing the oscillating motions of said arm.

FIG. 1

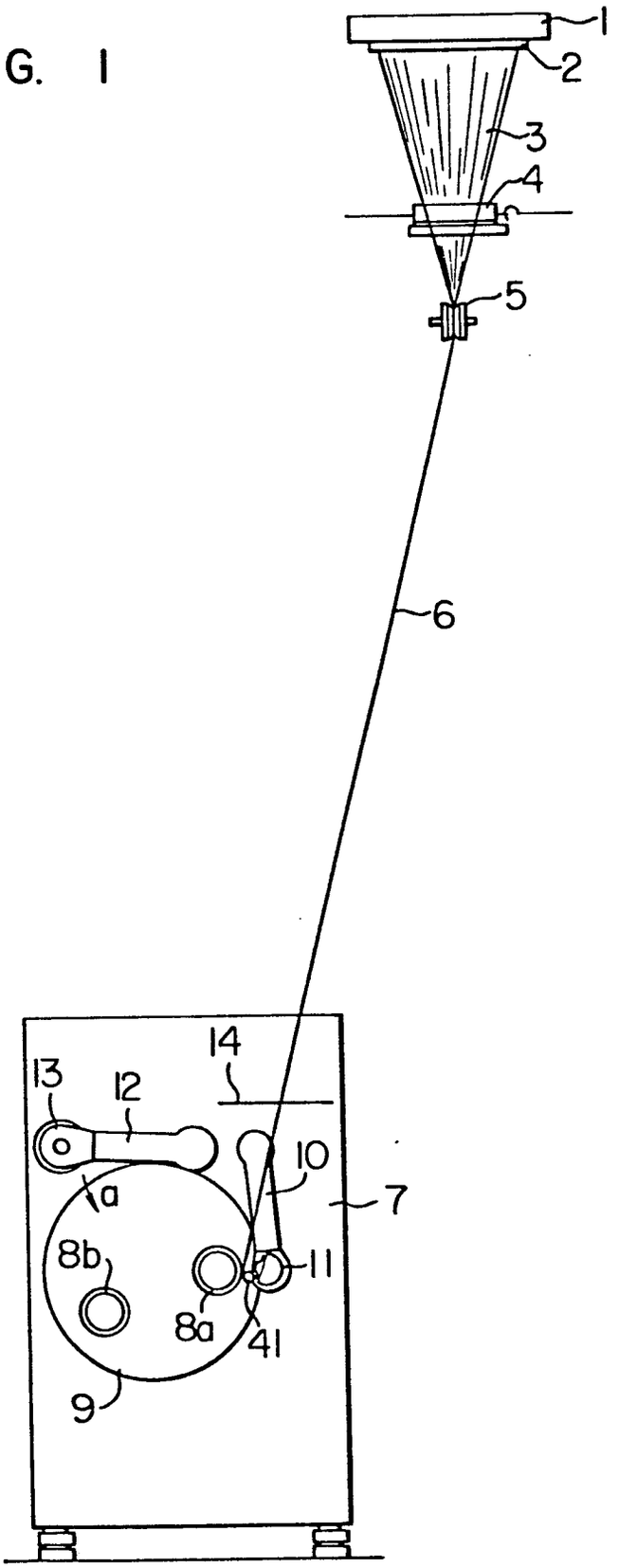


FIG. 2

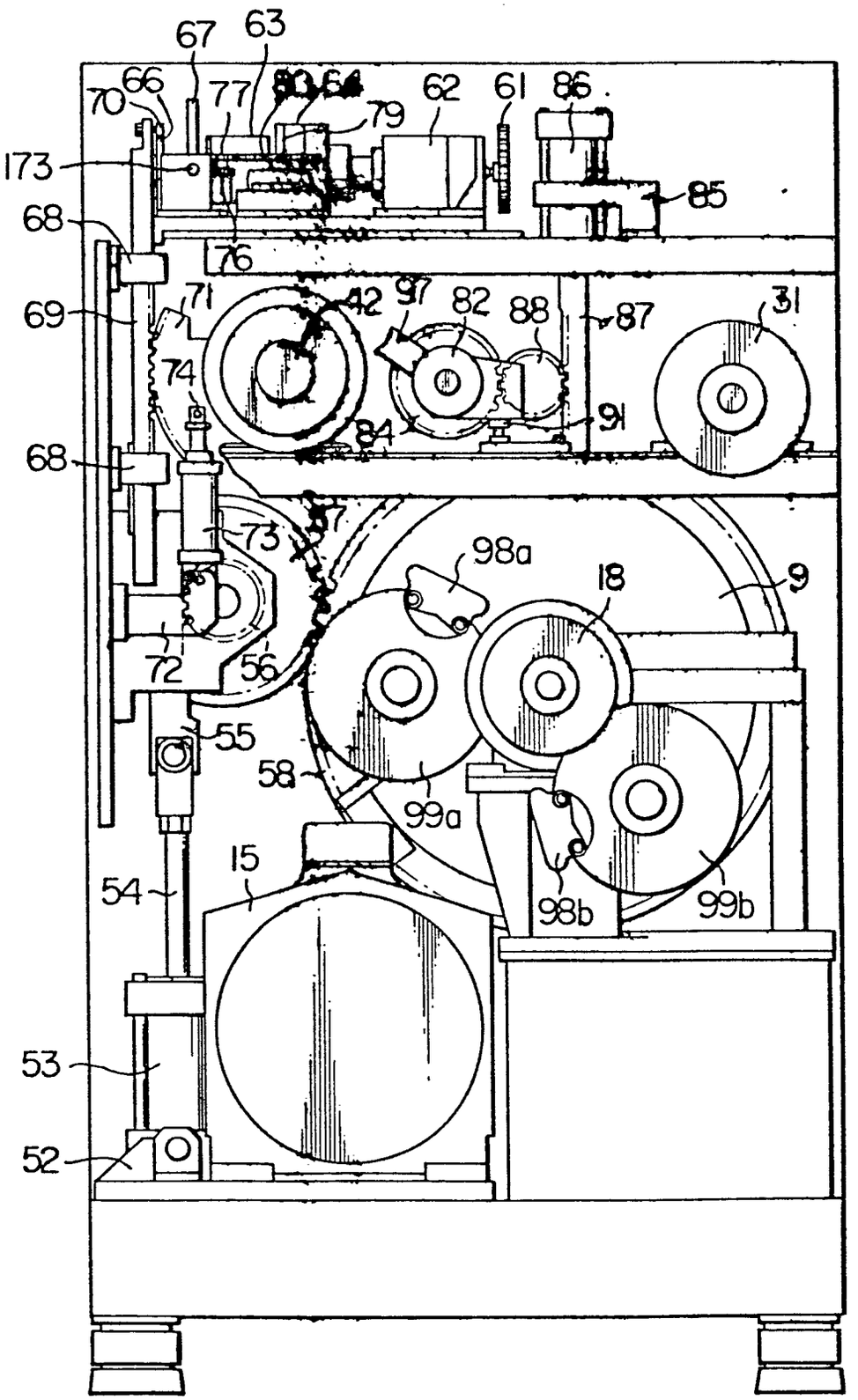

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FIG. 3

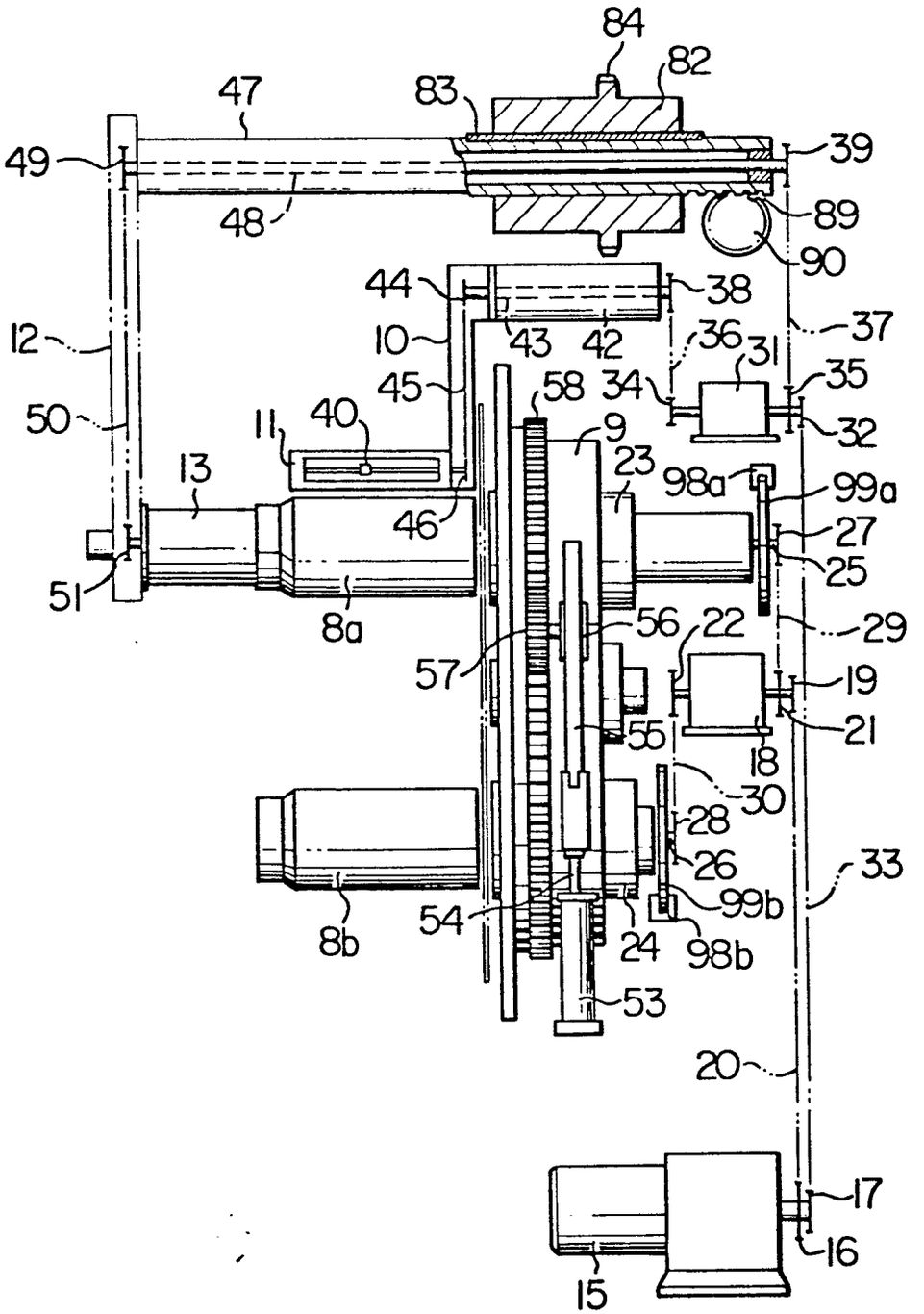
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FIG. 4

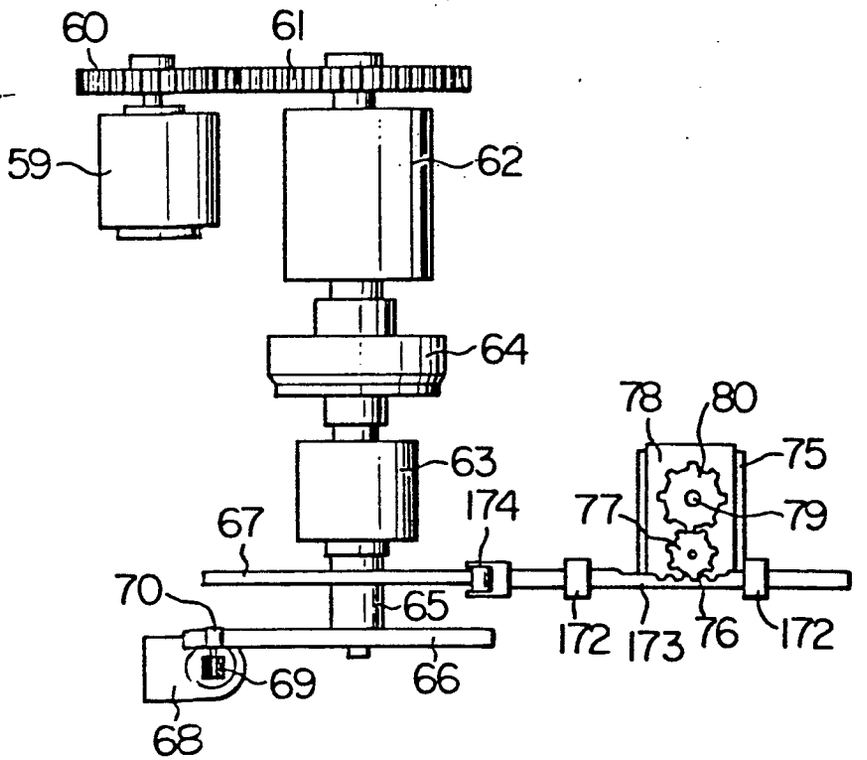
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FIG. 6

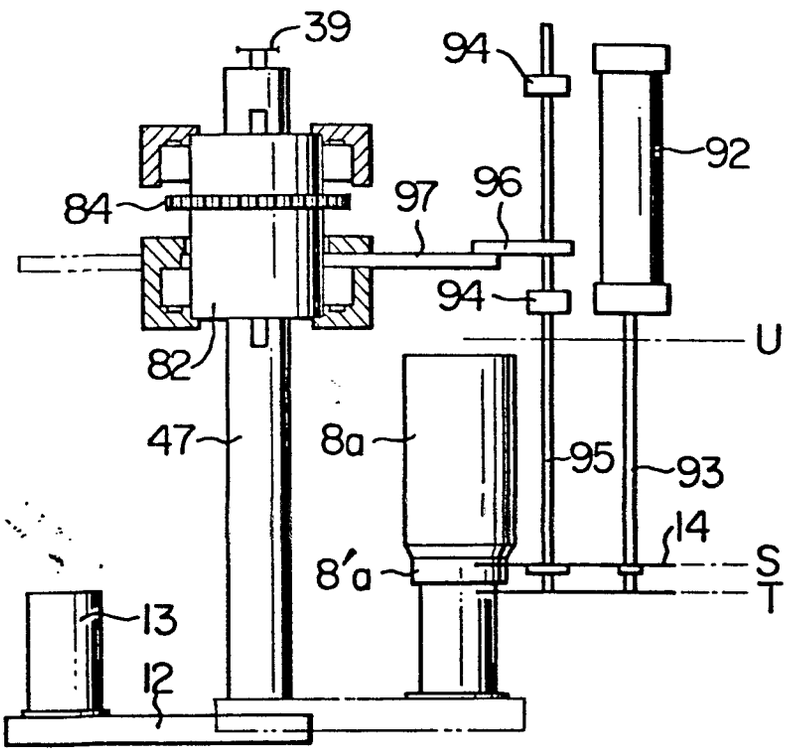
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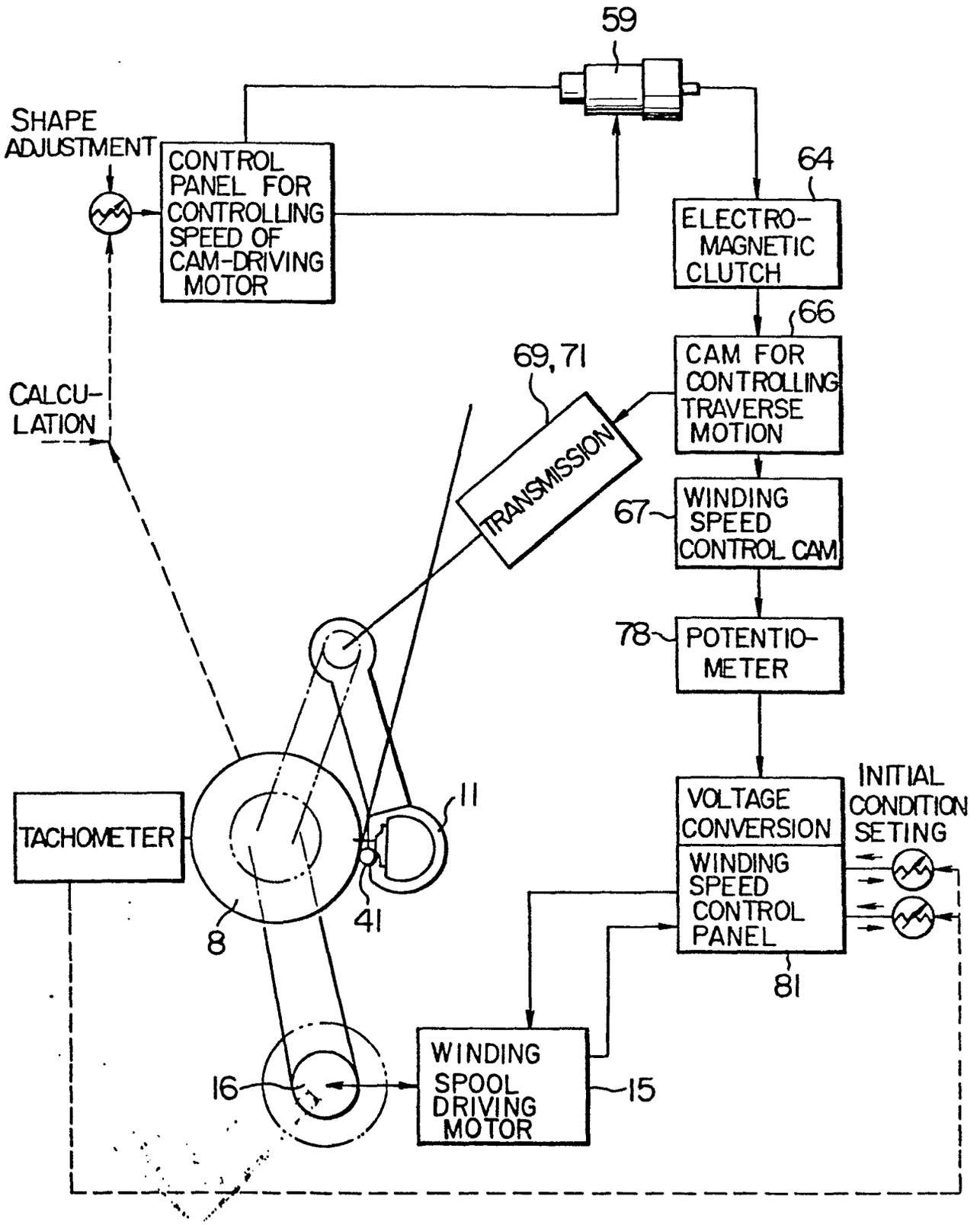
FIG. 5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SHAPE ADJUSTMENT
CONTROL PANEL FOR CONTROLLING SPEED OF CAM-DRIVING MOTOR
64
ELECTRO-MAGNETIC CLUTCH
66
CAM FOR CONTROLLING TRAVERSE MOTION
69, 71
TRANSMISSION
CALCU-LATION
67
WINDING SPEED CONTROL CAM
78
POTENTIO-METER
INITIAL CONDITION SETING
VOLTAGE CONVERSION
WINDING SPEED CONTROL PANEL
81
TACHOMETER
11
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WINDING SPOOL DRIVING MOTOR
15

FIG. 7

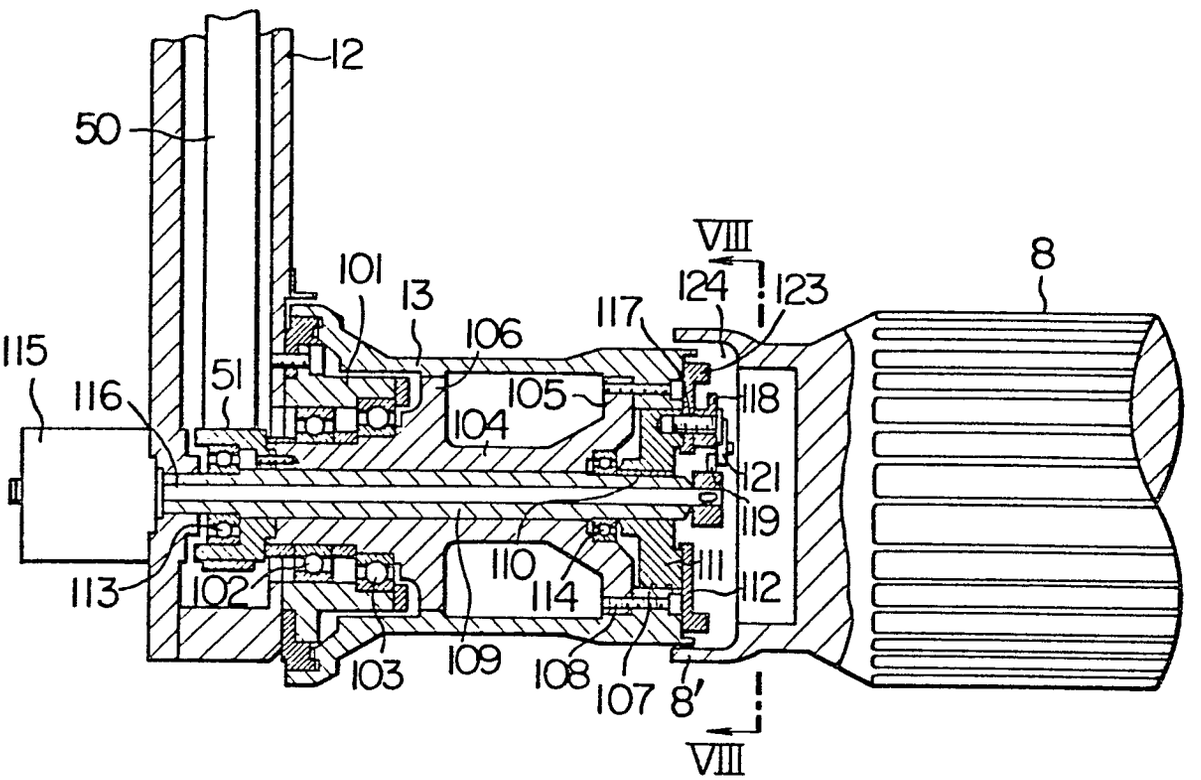


FIG. 8a

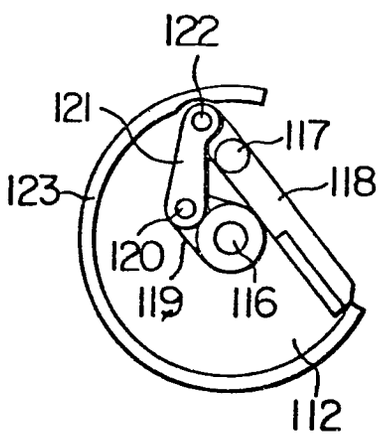
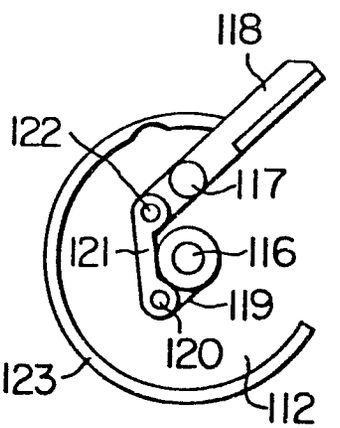


FIG. 8b



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European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80303078.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	DE - A - 2 032 225 (KLÖCKNER-WERKE) + Claims 1,4,5,6; fig. 1-5; pages 4-7 + --	1,4
	GB - A - 1 318 253 (SAINT-GOBAIN) + Claims 1,5,6; fig. 3-9; page 3, lines 27-117; page 4, lines 116-119 + --	1,4
	AT - B - 302 786 (M.A.G. MASCHINEN UND APPARATEBAU) + Gesamt + --	1,3,6
	DE - A1 - 2 627 947 (OWENS-CORNING) + Claims 1,3,4; fig. 1-8 + --	1,2
	US - A - 3 523 650 (KLINK) + Claims 1,2; fig. 1,2; column 5, lines 43-57 + --	1
	DE - B - 1 255 852 (AACHEN-GERRES-HEIMER) + Claim 1; fig. 1 + --	1
	DE - A - 2 359 394 (WINGET LTD.) + Claim 1; fig. 2,3,4; pages 6,7 + ----	1,7

CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)

B 65 H 54/02
B 65 H 67/04
C 03 B 37/10

TECHNICAL FIELDS SEARCHED (Int Cl. ³)

B 65 H 54/00
B 65 H 67/00
C 03 B
D 01 D
B 21 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
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

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	13-11-1980	HAUSWIRTH