United States Patent

Brauweiler et al.

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[45] **Sept. 26, 1972**

[54] **APPARATUS FOR WINDING STRANDS OF THERMOPLASTIC MATERIAL, PARTICULARLY OF GLASS FILAMENTS IN THE COURSE OF THEIR PRODUCTION**

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Aug. 22, 1969 France.....6928825

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[51] **Int. Cl.** **B65h 54/02**

[58] **Field of Search**.....242/18 A, 18 G, 18 EW, 18 PW; 65/11

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[57] **ABSTRACT**

A winding apparatus for newly formed strands of thermoplastic material, constituted by filaments issuing from a plurality of spinning nozzles of a spinneret containing said material in liquid form, such as molten glass, disposed below the latter. Two winding drums on fixed axes extend in parallel to each other in a plane inclined to the horizontal, onto which are adapted to be mounted empty spools, and with which cooperate strand traverse mechanisms which serve to lay up the strands on the spools in crossing relation while the rotary movement of the latter effects a drawing-out of the filaments. The specific disposition of the winding drums permits a convenient transfer of the strands issuing from the spinneret, from the filled bobbins on one drum to the empty bobbins on the other drum without interrupting the drawing-out of the filaments. This transfer may be executed in a non-automatic, semi-automatic, or fully automatic manner. In the last-mentioned case, the completion of a predetermined number of revolutions of the active winding drum, automatically positions an auxiliary rotary winding cage onto the end of the last-mentioned drum by means of a pivotal movement followed by an axial movement of the cage. A deflecting bar shifts the strands from the bobbins being wound on the winding drum onto the winding cage whereat the drawing out of the filaments continues. The rotary cage is then moved axially from the end of the active winding drum, rotated into coaxial position with the heretofore idle winding drum and axially shifted onto the end thereof, without any interruption of the drawing out of the filaments. When the last-mentioned drum reaches its proper rotary speed, the strands are moved back from the winding cage to their winding positions governed by the strand traverse device associated with the last-mentioned drum, for filling up the spools which had been mounted on the last-mentioned drum. The first drum is braked, unloaded and charged with empty spools in readiness for the next transfer of the strands thereto, during the winding operation on the second drum.

6 Claims, 10 Drawing Figures

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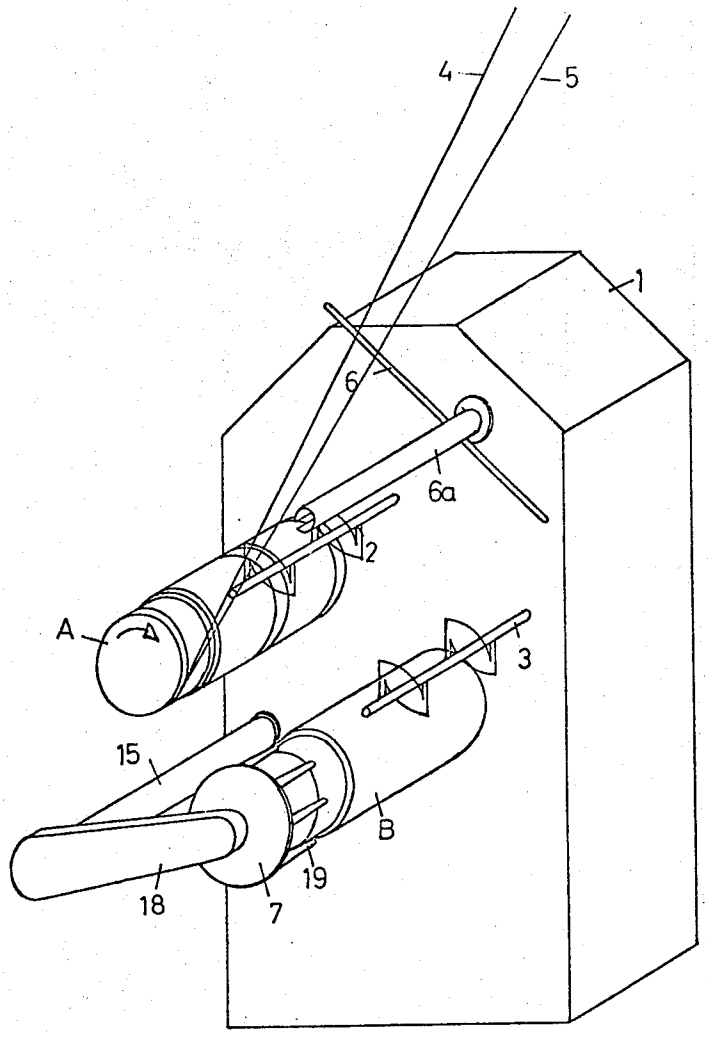


Fig.1

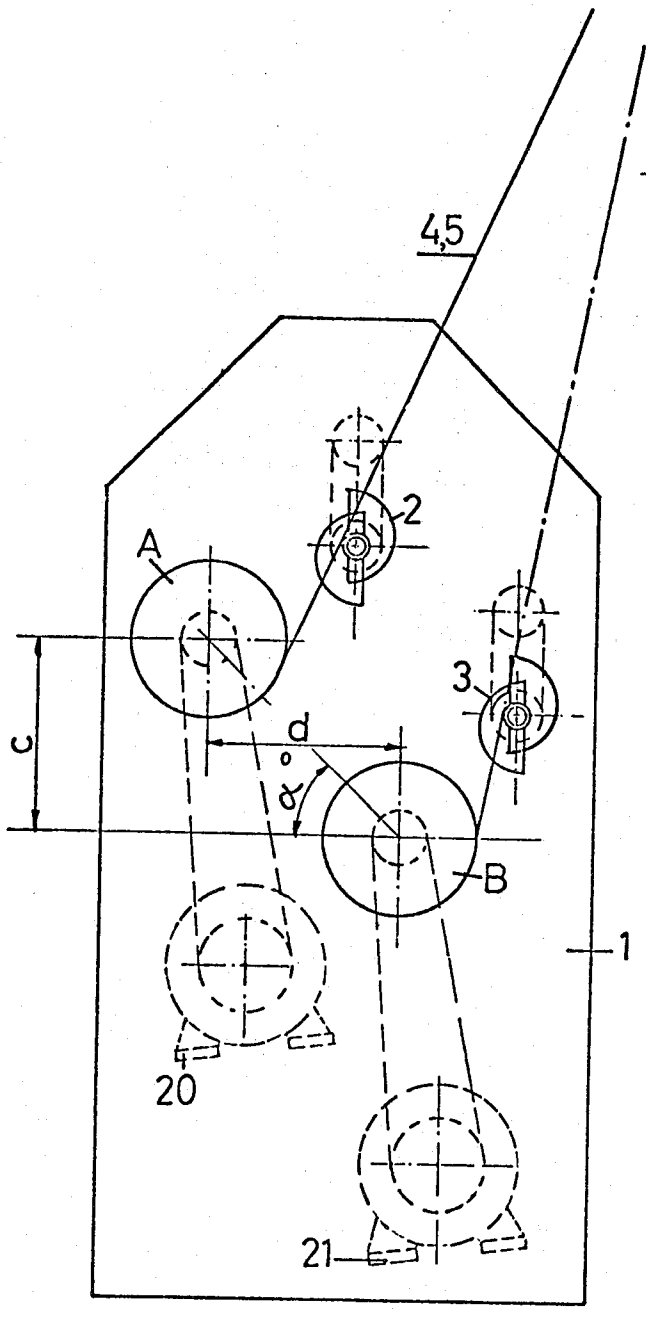
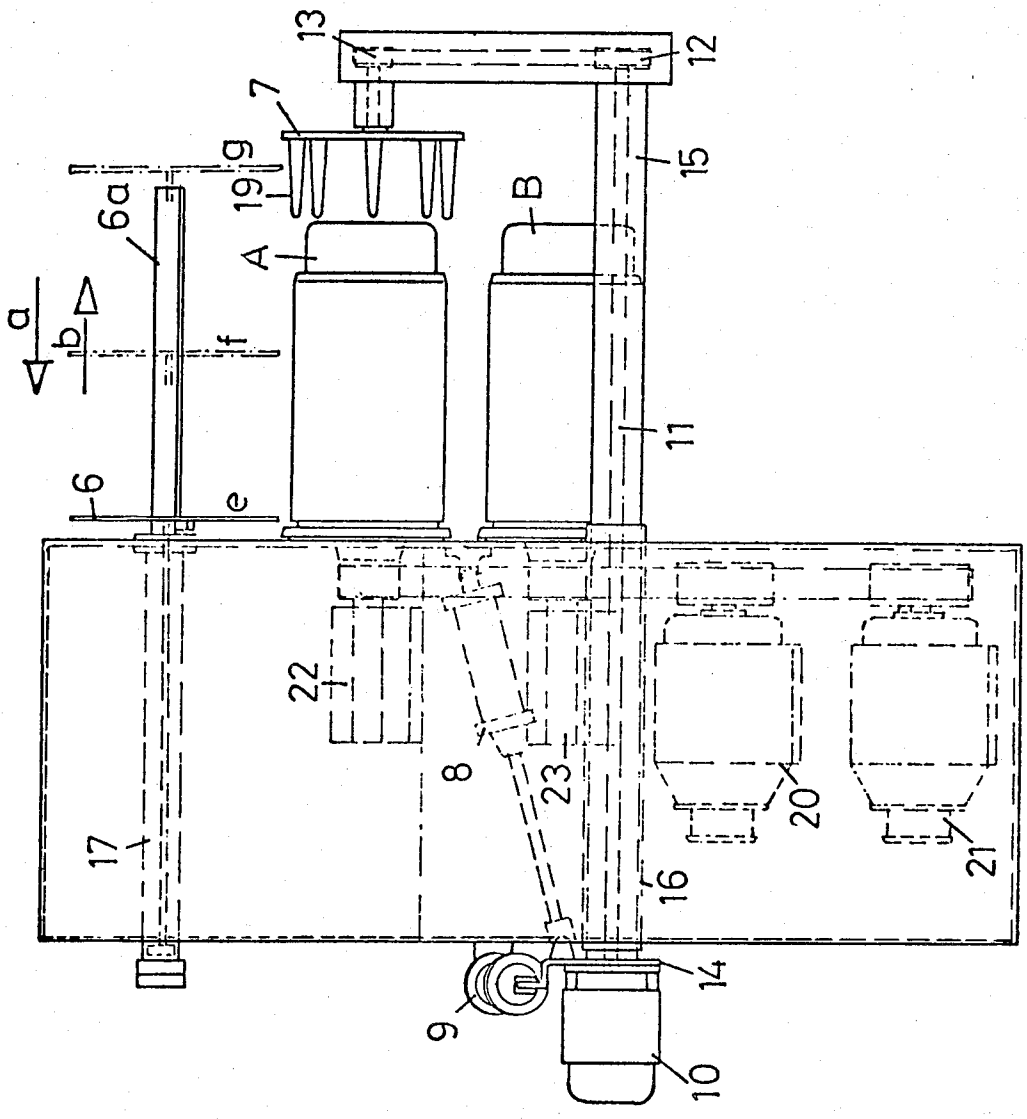


Fig. 2



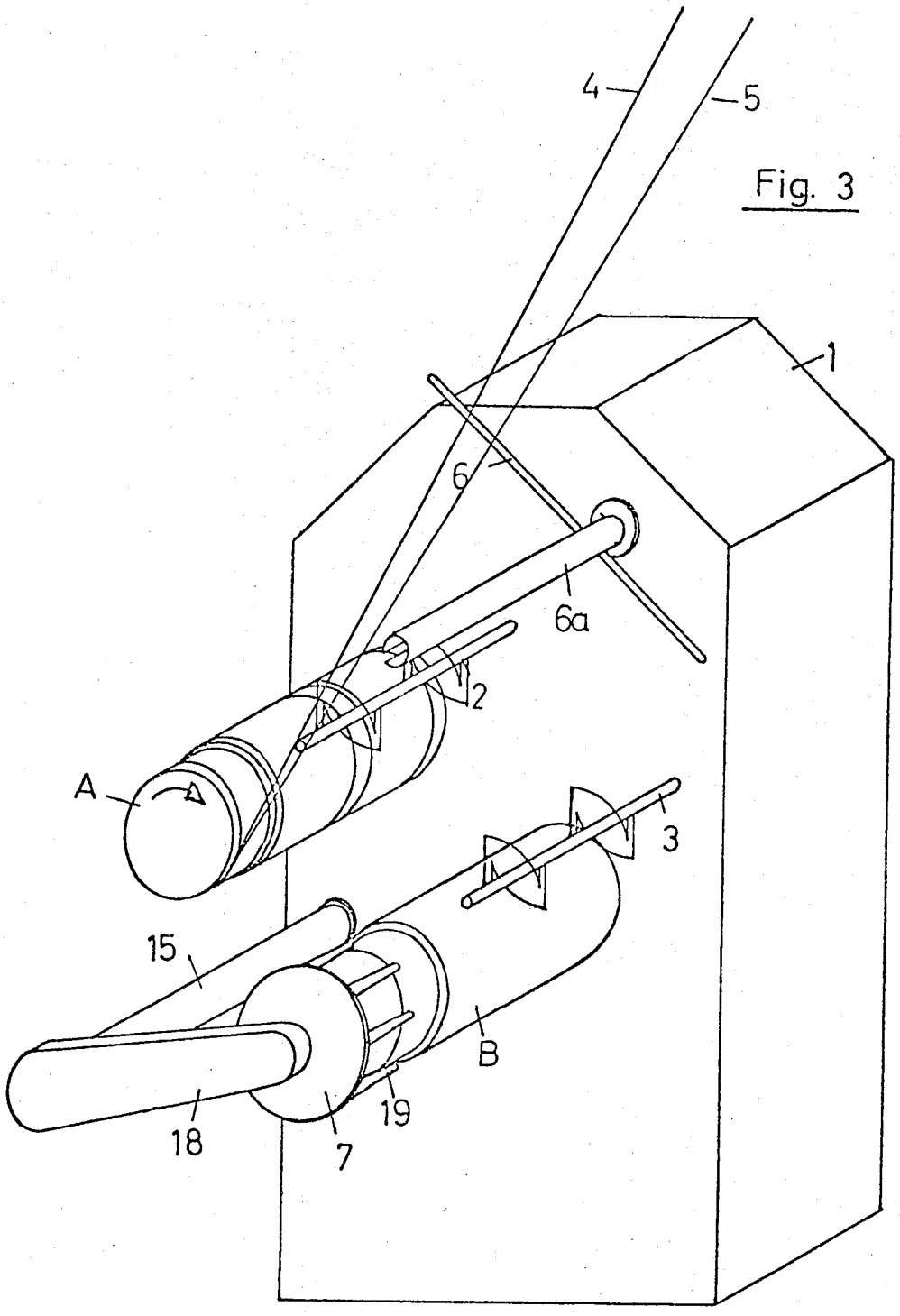


Fig. 3

Fig. 4

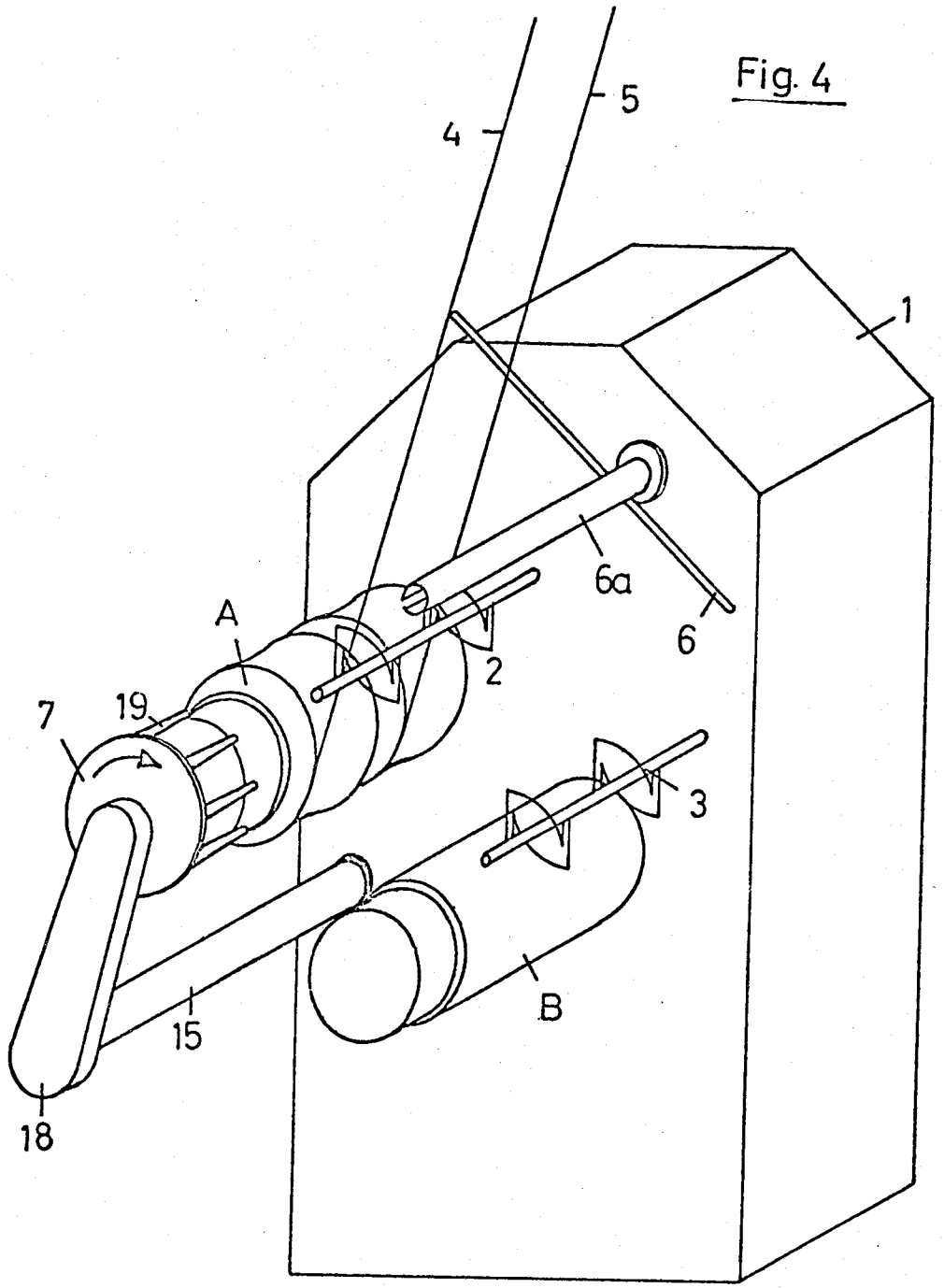


Fig. 5

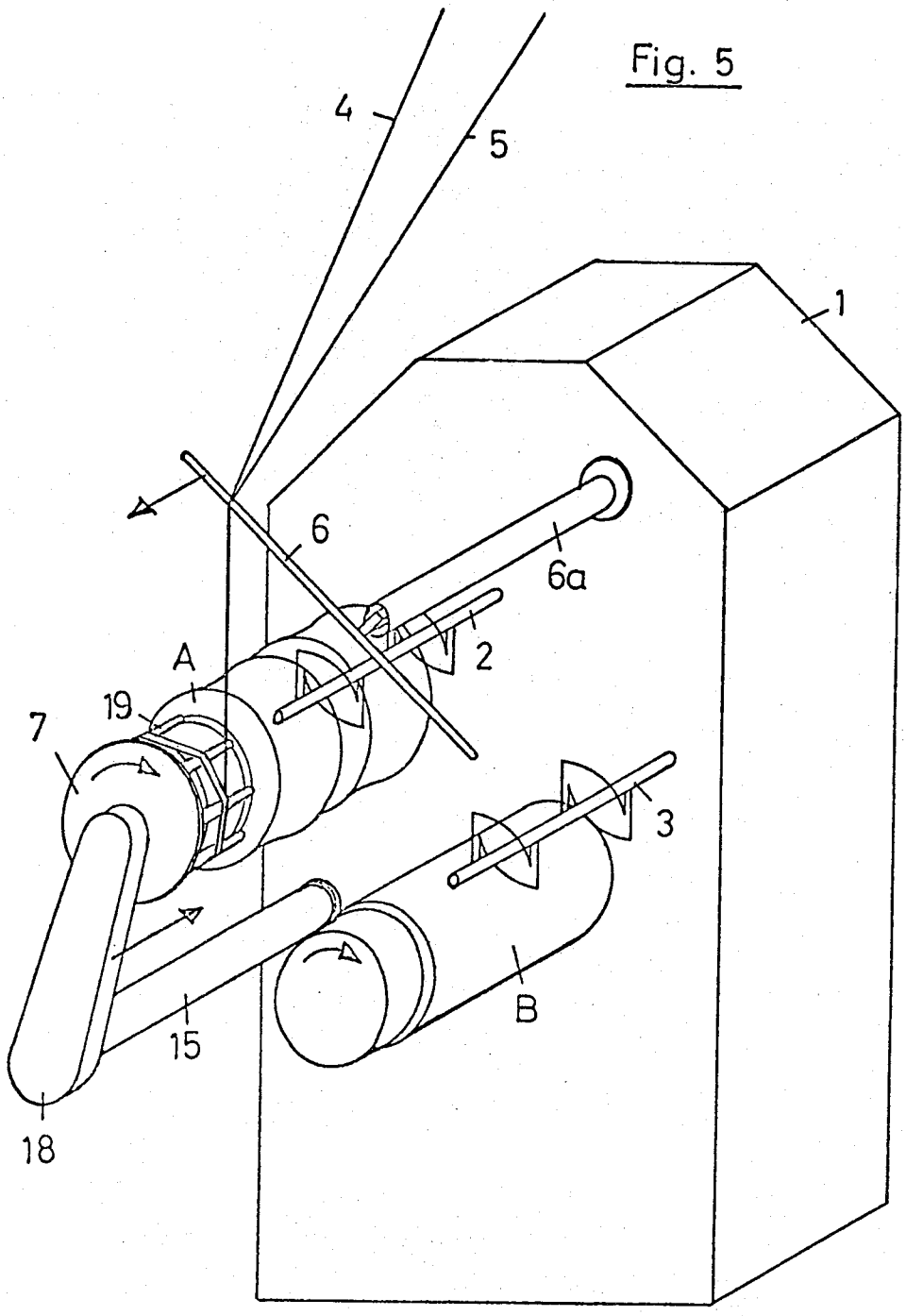


Fig. 6

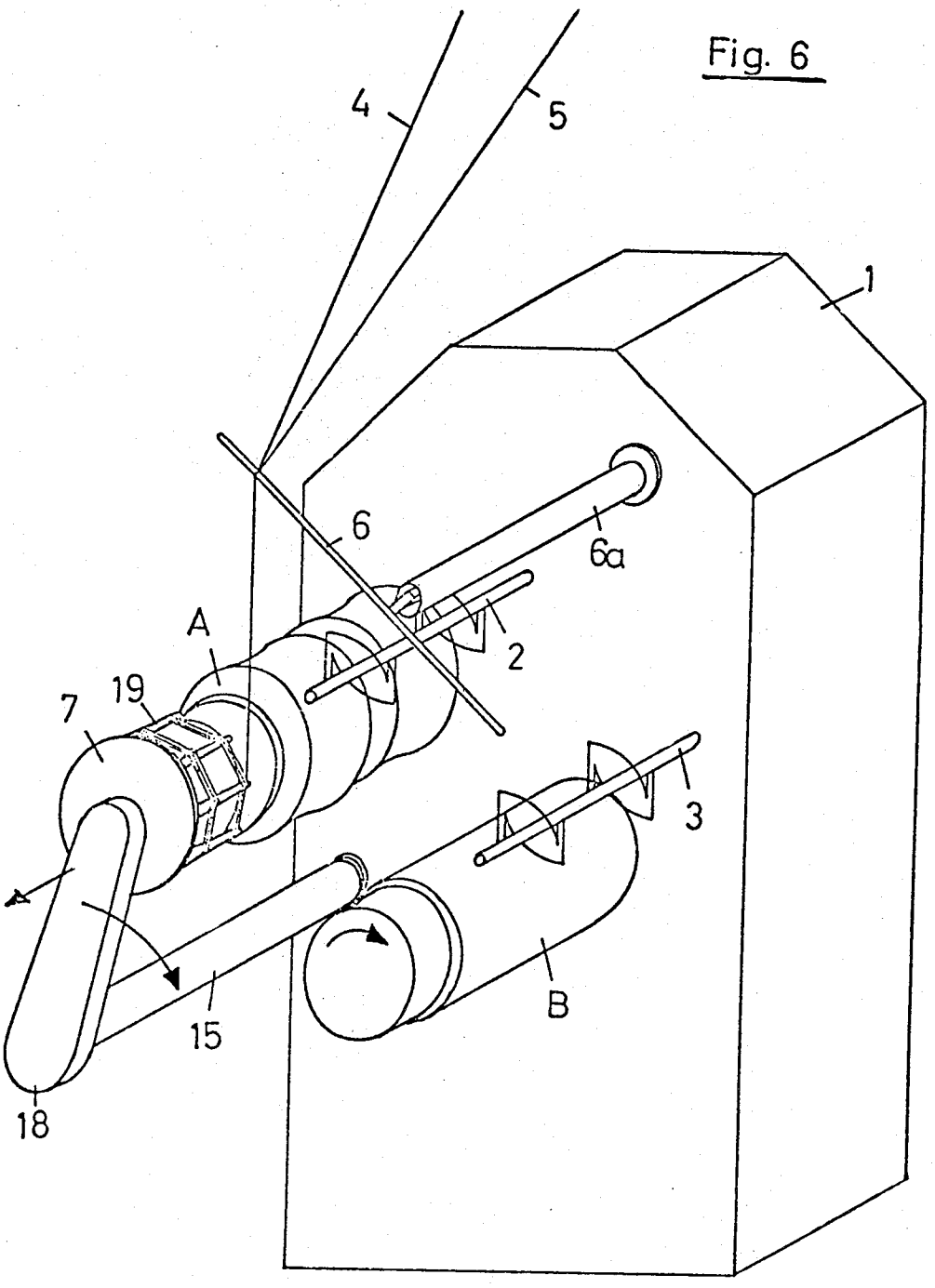


Fig. 7

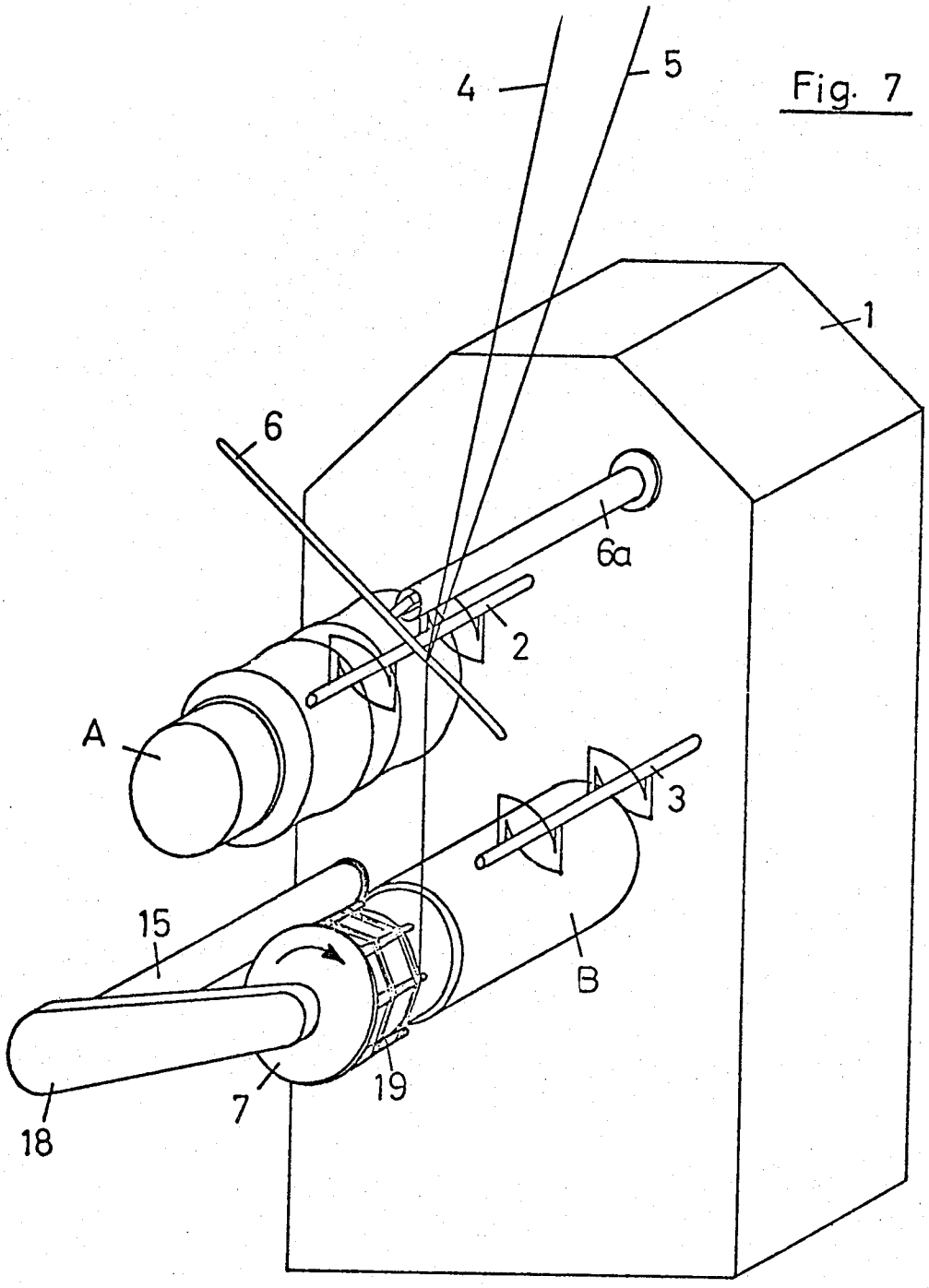
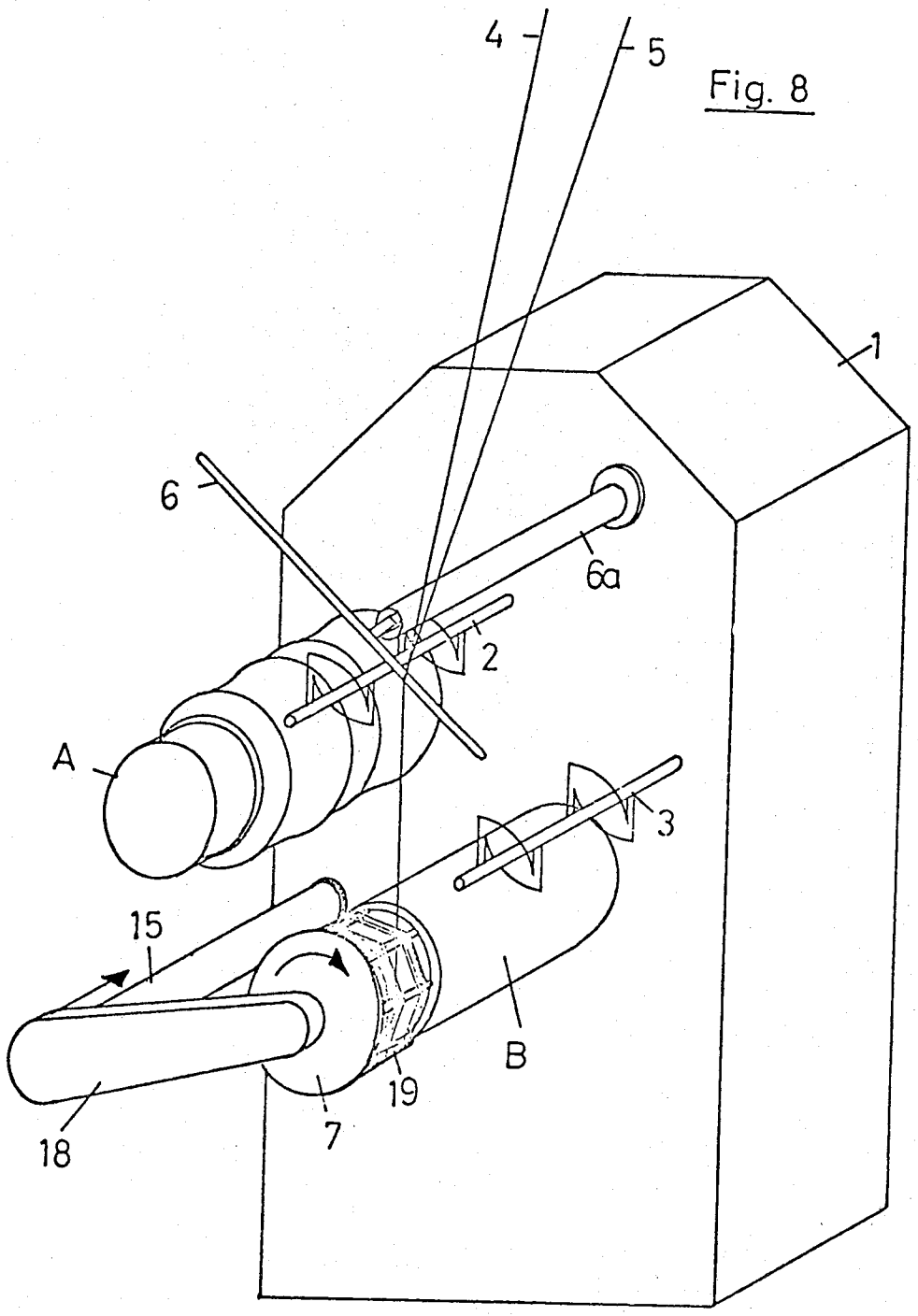


Fig. 8



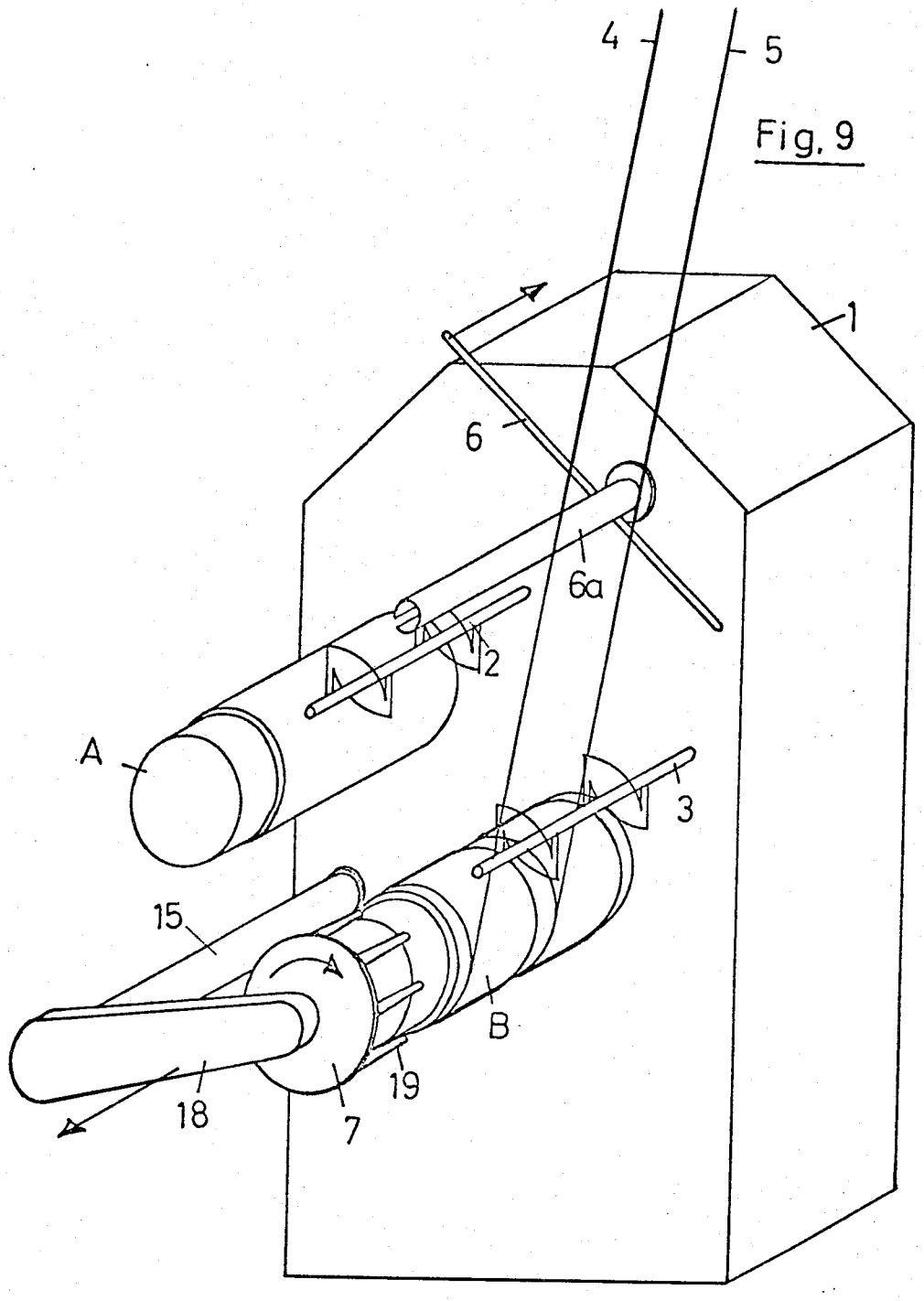
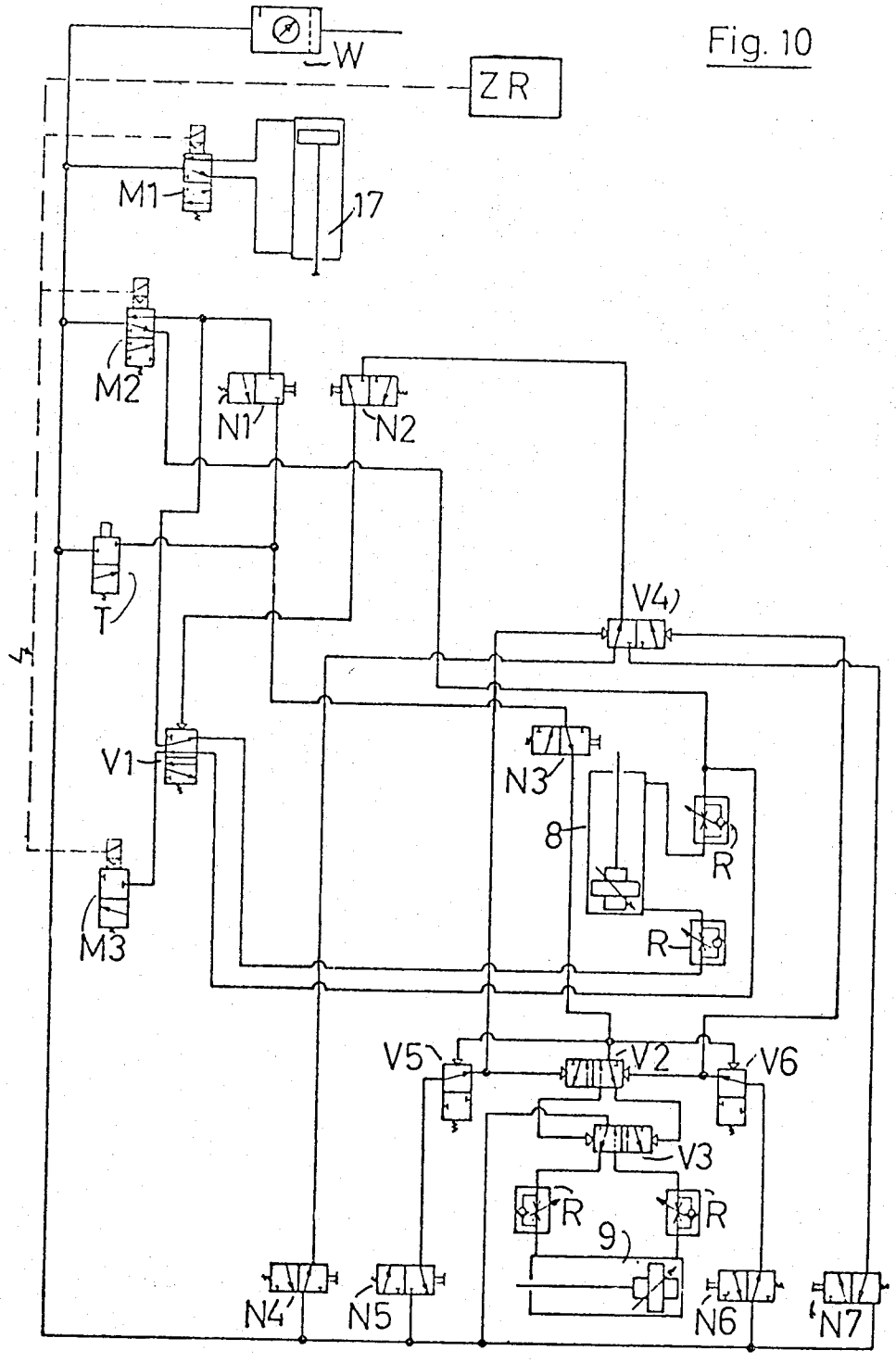


Fig. 9

Fig. 10



APPARATUS FOR WINDING STRANDS OF THERMOPLASTIC MATERIAL, PARTICULARLY OF GLASS FILAMENTS IN THE COURSE OF THEIR PRODUCTION

The invention relates to the production of threads or strands of thermoplastic material, particularly glass threads formed by groups of filaments issuing from the orifices of a spinneret which are drawn-out by winding on rotary bobbins. The elementary or primary newly formed filaments are gathered in a unitary strand are are wound on the bobbin which effects their attenuation or drawing-out.

When the quantity of thread wound on the bobbin has reached the desired value, the operator cuts the thread and replaces the full sleeve or bobbin with an empty sleeve, after having stopped the winding drum or cylinder. In order to effect a new winding, it is necessary to gather the primary or elementary filaments by hand at the outlet of the spinneret or spinning nozzles in order to form the thread. At the start of the new winding, several turns are formed by hand on the edge of the winding drum at the time the winding cylinder is put in motion, and it is only when the winding cylinder has attained the necessary speed, and when the thread-guide has been set in motion, that the thread is passed into the thread-guide and wound on the sleeve.

This usual method of operation up to the present time has considerable drawbacks. In particular, it requires the stopping of the drawing-out at the time of changing sleeves, which gives rise to substantial lengths of threads of different fineness, which must be discarded. This method of operation also requires qualified personnel and a relatively long period of time.

This drawback led to the use of winding machines having a winding drum which permits the placement of two sleeves on the latter, with the thread being wound successively thereon, by the provisions of devices which transfer the threads automatically from the finished sleeve to an empty one. The winding is continued on the latter sleeve without any interruption in the drawing-out procedure. It is only when the two sleeves are filled that it is necessary to stop the winding cylinder and replace the full sleeves by empty ones. Such an arrangement is disclosed in U.S. Pat. No. 3,334,980, Aug. 8, 1967. The result is a saving of time and less waste.

When it was desired to operate with spinnerets having a large number of orifices, i.e., 400 or more orifices, or when it was desired to obtain fine strands of light weight, the primary filaments were divided into two groups and each group was gathered into one strand which was wound on a separate sleeve, with the two sleeves mounted on the winding cylinder being wound at the same time. Such an arrangement is shown in U.S. Pat. No. 3,254,850, June 7, 1966. This mode of operation is characterized by the same drawbacks as winding on a single bobbin at a single winding point.

On the other hand, a device is known for the continuous successive winding of a strand or bundle of fibers, in particular of thermoplastic material, on two or more rotating bobbins arranged on a turntable, with the full bobbin being displaced from the winding position and the empty spool being placed in the path of the strand or bundle of fibers. Such an arrangement is disclosed in German Pat. No. 546,162. This known device presents

very complex inconveniences, because the winding cylinders are mounted on a turntable and are arranged for rotary movement, which gives rise to several problems. Besides, it is very difficult to make the rotating turntable water-tight and dust-proof with respect to the framework of the machine, the soiling thus produced inside the framework causing other difficulties. This apparatus also requires a great deal of space, in particular when it is necessary to work with winding drums 250 mm. in diameter. This space is not always available in a direct fusion installation, if it is not intended to increase the separation of the spinning nozzles, which would lead to operational difficulties of the front crucibles containing the spinnerets, which in turn would lead to difficulties in regard to the production of the strands.

It is the object of the invention to provide a strand-winding apparatus, in particular for glass strands formed of newly formed filaments or fibers produced from molten glass, which avoids the disadvantages of known devices, in particular the disadvantages described above, or at least to reduce them to a minimum. Also, it is the object of the invention to provide specific arrangements which make possible the attainment of special advantages.

In order to attain these objectives, the apparatus according to the invention comprises two winding drums or cylinders, the axes of which are horizontal and parallel to each other and disposed in a common plane at an inclination to the horizontal. It is thus possible, when the sleeves mounted on one of the winding drums becomes full, to pass the thread immediately by hand onto the empty sleeves on the other winding drum. The removal of the full bobbins from the first winding drum and the charging of the latter with empty sleeves is accomplished during the winding of the sleeves on the second winding drum. In this way about 50 percent of the time for changing is saved, (formerly 47 seconds, presently 17 seconds); and the amount of waste is reduced to a minimum.

In order to avoid the aforementioned disadvantages, it should have been possible in principle, to arrange the two winding drums side by side or one above the other. Nevertheless, such arrangements give rise to other disadvantages which render such a winding operation unprofitable and thus inadequate. In this case it would be necessary to arrange the winding drums sufficiently far away from one another so that the operator would not impede the winding operation on the active winding drum while replacing the full bobbins with empty sleeves on the idle winding drum. Besides, it is necessary that the path of the thread be completely free. Such an arrangement would then give rise to great congestion, since the required space is generally not available, and it would be necessary to provide points of return for the filaments. In addition, the results would be sources of disturbance through supplementary friction and other factors.

According to one advantageous characteristic of the invention, the axes of the parallel winding drums are disposed in a plane having an inclination of angle α with respect to the horizontal. This inclination may vary from 30° to 60°, and preferably is 45°. If the angle of inclination α is too small or too large, it is necessary to select a wide separation between the two winding

drums so that the replacement of the full spools by the empty ones can take place without difficulty and without disturbing the travel of the strand during the winding of the sleeves on the other winding drum. Such an arrangement therefore requires a lot of space and cannot be adopted in the case of a direct fusion installation. If the angle of inclination is too large, one of the winding cylinders is at a height which makes difficult the replacement of a full spool by an empty one. The adoption of a 45° angle of inclination permits the arrangement of the two winding cylinders as close together as possible along a horizontal projection, while reducing to a minimum the required space, which is of particular importance in the production of glass filaments in a direct fusion installation.

Another advantageous characteristic of the apparatus in accordance with the invention results from a horizontal and vertical separation between the winding drums or cylinders of preferably about 318 mm. By virtue of such an arrangement of the winding cylinders, the winder can still be placed in the direct fusion installation, even if the diameter of the winding drums is 300 mm. Such a separation or spacing also permits the operator to replace the full spools with empty ones without difficulty, and without disturbing the winding operation.

A special feature of the invention concerns an apparatus which makes possible the transfer of the winding operation from one winding cylinder onto the other entirely automatically.

Devices already have been proposed which tend to automatically effect the passage of the thread from the full to an empty spool, an operation which formerly was performed by hand.

An apparatus as disclosed in U.S. Pat. No. 3,231,207, Jan. 25, 1966, contemplates winding a strand or bundle of primary fine filaments derived from a stream feeder of heat-softened material, such as molten glass. In this apparatus, an empty bobbin is set in rotation after being put in place, and the winding of the strand of filaments is primed near the marginal zone of the empty bobbin, the strand being then wound over the winding zone of the bobbin. A guide rod is positioned parallel to the axis of the bobbin and is axially movable to automatically push off the strand in the axial direction of the bobbin at the end of the winding by separating it from the full bobbin and beyond the strand traverse guide. The strand is maintained in separated position from the winding zone during the changing of bobbins and is brought back to the winding zone of the empty bobbin as soon as the latter has been put in place and has reached its normal rotary speed. Thus, it is assured that each bobbin contains substantially the same quantity of filament bundles or strands. This device make possible a reduction of personnel. However, this device does not eliminate lengths of the strands of different fineness, since the arrangement requires an interruption of the drawing-out action during changing of spools. Also, this apparatus does not reduce substantially the time necessary to change the spools.

According to an arrangement which has been made the subject of the German Pat. application No. P 19 01 124.6, the disadvantages of the operations which have been executed by hand can be avoided by automation of a new winding operation which avoids the interruption of the drawing-out action of the strand. This method consists in maintaining the drawing-out action, as soon as one spool is filled, by winding the strand on an auxiliary member capable of transfer onto an empty sleeve located on another spool, and passing the strand from said auxiliary member onto the new sleeve to effect a new winding. A proposed device for executing this mode of operation comprises an auxiliary member in the shape of a crown which has fingers, which is set in a rotary motion, and which is mounted on an arm capable of pivotal movement. The device is also equipped with forks which serve to guide the strand and which are controlled by two pushers or strikers. The device thus proposed is complicated and has the disadvantage that changing the bobbin is possible only when using a single winding cylinder.

In accordance with the invention, the existing disadvantages, especially those noted above, are avoided. An apparatus according to the invention consists in arranging the above device, having an auxiliary member constituted by a winding crown or cage, fitted with fingers and capable of being set in rotation, upon which the strand is deflected as soon as the spool is full, and which is wound until it is transferred to a new empty sleeve or spool, and a deflecting device for the strand, making it pass from the full spool onto the auxiliary member and from the auxiliary member to the empty sleeve, in such a way that the work can be assured with a winding apparatus having two rotary winding cylinders with fixed axes disposed in an inclined plane. Thereby the above-mentioned disadvantages are avoided.

The desired objectives of the invention are attained by providing the winding cage with a pivoting arm as well as with means to displace the winding cage in the axial direction of the winding cylinders, and also with means to make the winding cage pivot from the axis of one of the winding cylinders into the axis of the other winding cylinder. Thus, when the winding operation is under way, the automatic transfer from a winding cylinder having full spools onto a winding cylinder furnished with empty spools is effected in a simple and economical manner, without the disadvantages attendant the working with winding cylinders which are not disposed on fixed axes.

The simplification arising from the invention may be attributed in part to the mobile arrangement of the winding crown or cage, so that its fingers may move along the axis of the winding cylinders and also surround their extremities. The passage of the strand from the full sleeve onto the fingers of the winding cage, as well as the passage of the strand from the fingers onto the new empty sleeve is effected by means of a deflecting member.

In accordance with the invention, an advantageous arrangement of the deflecting device comprises a deflecting bar adapted to deflect the strands beyond the winding zone on one winding drum following the completion of the winding of the spools on the latter, and to guide the strands onto the fingers of the coiling cage, which is followed by the conveyance of the strands from the fingers onto the empty spools of the winding drum; a guide cylinder adapted to guide the deflection bar; and a double acting pneumatic jack

adapted to displace the deflecting bar from the starting position to the operating position and return. As tests have demonstrated, this simple arrangement of the deflecting device makes possible a weak deflection of the two strands simultaneously and the transfer of these strands onto the fingers of the rolling crown or cage, as well as the presentation of the strands from the fingers of the rolling crown onto the empty sleeves of the other winding drum. However, in the case where the strands could not be guided together, because they could not be maintained under the same tension together, the guiding may be executed by means of a deflecting bar shaped as a fork.

Other objects and advantages of the invention will appear from the following description of a preferred and illustrative embodiment of the invention, wherein two strands are delivered simultaneously from a unitary spinneret or fiberizing apparatus for effecting two separate winding operations. The description of the preferred embodiment makes reference to the attached drawings wherein:

FIG. 1 is a front view of the winding apparatus with two rotary winding drums or cylinders having fixed axes disposed in an inclined plane;

FIG. 2 is a plan view of the winding arrangement shown in FIG. 1, including a coiling crown or cage and a strand-deflecting device, with their control mechanisms;

FIG. 3 is a perspective view of the winding apparatus shown in FIG. 2, at the beginning of the winding operation on the upper winding cylinder;

FIG. 4 is a perspective view of the winding apparatus shown in FIG. 3 shortly before the end of winding on the spools or sleeves of the upper winding cylinder, with the coiling cage already having been pivoted in position in front of the upper winding cylinder;

FIG. 5 is a perspective view of the winding apparatus shown in FIG. 4 at a later stage of the winding operation following the completion of the winding on the spools, and after the strands have been deflected to the winding cage;

FIG. 6 is a perspective view of the apparatus at the moment of pivoting of the coiling cage from the first winding cylinder to the second winding cylinder;

FIG. 7 is a perspective view of the apparatus at the moment when the coiling cage has been pivoted into position adjacent to the second winding cylinder;

FIG. 8 is a perspective view of the apparatus at the moment when the fingers of the coiling cage are shifted onto the end of the second winding cylinder;

FIG. 9 is a perspective view of the apparatus at the time of starting the winding on the second winding cylinder, following the shifting of the strands wound on the coiling cage onto the empty spools on the latter, with the coiling cage and the deflecting device in starting position; and

FIG. 10 is a schematic diagram of the control system for controlling the pivoting and translating movements of the coiling cage and of the translating movements of the deflecting device for the strands of filaments.

In the drawings is shown a winding machine 1 equipped with two winding drums or cylinders A and B having fixed horizontal axes parallel to each other which are disposed in an inclined plane. Two motors 20 and 21 rotate the winding cylinders A and B along the axes 22 and 23, respectively. Rotatable and reciprocable traverse guides 2,3 for the strands of filaments 4 and 5 are associated with the winding cylinders A and B, respectively. Such are well known in the art and are shown in the above-mentioned United States patents as well as in U.S. Pat. No. 2,391,870. The winder 1 is also equipped with a coiling crown or cage 7 having fingers 19 which should not have sharp edges and which are located along a circle which does not vary substantially from the diameter of the sleeves which are fitted on the winding drums. The coiling cage is movably mounted for rotation on an arm 18. A rotary movement is imparted to the coiling cage 7 by a motor 10, which is preferably a three-phase alternating current motor, through the intermediary of a drive acting on a transmission belt and pulley system 12, 13. A double-acting jack 8, controlling the horizontal movements of the coiling cage in either direction *a* and *b* (FIG. 2), acts on loop 14 attached to a hollow shaft 15 mounted in a body 16. The control motor 10 is integral with one of the extremities of the hollow shaft 15 and the coiling cage 7 is fixed to the other extremity by means of an arm 18. Another double-acting pneumatic jack 9, also acting on the loop 14, controls the pivoting movements of arm 18 and thus of coiling cage 7. The winding machine is also equipped with a thread deflecting device having a thread deflecting bar 6 guided within a guide cylinder 6a and capable of being displaced by a double-acting jack 17 extending in parallel to the axes of the winding cylinders A and B. The thread deflecting bar 6 is fastened to the extremity of the piston shaft of jack 17.

The winding apparatus, without automatic transfer of the strand from one winding cylinder to the other operates in the following manner: At the start of the operation, the winding is primed manually, for example on the winding cylinder A. The operator winds several turns around the extremity of the winding cylinder, starts up the winding cylinder A and puts bundles of threads 4,5, composited from filaments issuing from the nozzles of a superposed glass melting furnace in contact with the sets of cam members on the strand traverse device 2 as soon as the winding cylinder A has reached its proper speed and the strand traversing device 2 begins operating. At the end of the period of the winding cycle of the bobbins, the operator withdraws the strands from winding drum A and places them on winding drum B. The latter is started up and the operator places the strands in contact with strand traverse device 3 for to-and-fro movement of the strands as soon as the winding cylinder B attains its required speed. Removal of the full bobbins from the winding drum A and the furnishing of the latter with empty spools is accomplished after braking the winding cylinder A, during the winding operation on winding cylinder B.

The winding apparatus, with automatic transfer of the strand from one winding cylinder or drum to the other, according to FIGS. 2 to 10, operates as follows:

At the start of the operation the winding is primed manually, for example on the winding cylinder A. The operator winds several turns around the extremity of the winding cylinder, starts up the winding cylinder A and puts the bundles of threads 4 and 5 into contact with the strand traverse device 2 when the winding

cylinder A has reached operating speed and the cam members on the strand traverse device start. During this time, the coiling cage 7 is in front of winding cylinder B and the strand shifting device 6 is in starting position (FIG. 3). At the end of the starting operation, the operator actuates a manual pneumatic valve, which causes the coiling cage to pivot and assume its position in front of the winding cylinder A (FIG. 4).

The coiling sequence of the work is effected automatically by means of a delay relay ZR designed for this purpose. The starting operation can also be initiated with winding cylinder B. In this case the coiling cage 7 is at rest in front of winding cylinder A during this operation.

The schematic diagram of the system shown in FIG. 10 portrays the position of the jacks and valves during the winding operation on cylinder A before changing the winding operation from cylinder A to winding cylinder B. Jack 17 is held in position of rest by means of a magnetic valve M1 and jack 8 is held in rest position by means of a magnetic valve M2 and a regulating valve R. The coiling cage 7 is maintained in front of the rotary winding cylinder A by means of jack 9 through the intermediary of pneumatically actuated auxiliary valve V3 and the regulating valve R.

A little before the end of the preselected time cycle of operation of the winding drum A, winding cylinder B starts so that it reaches its predetermined operating speed at the end of the operating cycle of winding cylinder A. The control motor 10 of coiling cage 7 starts, attains its predetermined speed, and imparts a rotary movement to the coiling cage 7. At the end of the operating cycle of winding cylinder A, the time-delay relay ZR actuates magnetic valves M1, M2 and M3 for initiating the automatic transfer of strands 4, 5 onto winding drum B. Jack 8 is controlled by magnetic valve M2 through the intermediary of pneumatically actuated auxiliary valve V1 and regulating valve R and is decompressed by cam or tappet valve N1 and magnetic valve M3. The coiling cage 7 is displaced in the *a* direction (FIG. 2), and is positioned with its fingers 19 over the end of winding cylinder A. Magnetic valve M1 simultaneously actuates jack 17 and pushes the deflecting bar 6 in the direction *b* (FIG. 2), to its extreme position (FIG. 5). Thread deflecting bar 6 seizes strands 4,5 and directs them from winding cylinder A, at the zones of operation of strand traverse device 2, onto fingers 19 of coiling cage 7, to start the auxiliary drawing-out operation. In the forward position of jack 17, that is, when strands 4,5 are being wound on coiling cage 7, the shaft of the piston of jack 17 engages tappet valves N1 and N2. Valve N2 actuates pneumatically controlled auxiliary valve V1 to move the pivoted coiling cage 7 beyond the zone of winding cylinder A (FIG. 6). The tappet or cam valve N1 serves as an interlock and assures that the pivoting movement may be disengaged only by the tappet valve N3, that is, when the coiling cage is disposed in front of winding cylinder A. The pneumatically controlled auxiliary valve V3 is switched by means of tappet valves N1, N3, and by pneumatically controlled auxiliary valve V2 to actuate jack 9 which serves to pivot coiling cage 7 in front of the empty winding cylinder B (FIG. 7). Winding cylinder A, as well as strand traverse device 2, are disengaged and braked. Auxiliary valves V5 and V6 are closed simultaneously with pneumatically controlled auxiliary valve V3, which cuts off the control air of auxiliary valve V2. Valve V2, as well as valve V3 cannot be switched anew. Thereby a constant pendular movement of coiling cage 7 is avoided. At its new end position, jack 9 actuates tappet valves N4 and N5. Tappet valve N5 preselects the switching of auxiliary valve V2. The disengagement is prevented by pneumatically controlled auxiliary valve V5 which is then closed. Tappet valve N4 cuts in the control pressure of pneumatically controlled auxiliary valve V1, through the intermediary of pneumatically controlled auxiliary valve V4 and tappet valve N2 which is opened by deflector bar 6. The pneumatically controlled auxiliary valve V1 switches, and jack 8 pushes the coiling cage 7 onto the end of the empty winding cylinder B (FIG. 8). Auxiliary valves V5 and V6 are then exhausted by means of tappet valve N3, and auxiliary valve V2 is switched by means of tappet valve N5 and pneumatically controlled auxiliary valve V5. Thus, the pivoting movement for the following changing operation is set. In addition, the valve V4 is switched by means of tappet valve N5 and auxiliary valve V5. Thereby it is assured that an axial displacement can take place only in the extreme positions of the pivoting movement, that is, when the coiling cage 7 is in the extreme radial position in front of the associated winding drum. Also, assurance is had that a pivoting movement can only take place if the coiling cage 7 is placed in front of the winding cylinder and is spaced from the end of it, when its fingers 19 are not in engagement with the extremity of the winding cylinder.

The exchange is accomplished. Time-delay relay ZR disengages. Magnetic valves M1, M2, and M3 are no longer supplied with current and switch off. Jack 17, energized by magnetic valve M1 pushes back deflecting bar 6 to its rest position and strands 4,5 are transferred from coiling cage 7 onto winding cylinder B and into the zone of the cam members of strand traverse device 3. Jack 8 is actuated by means of magnetic valve M2 and regulating valve R and it pushes coiling cage 7 in the direction *b*, axially in front of winding cylinder B (FIG. 9). Jack 9 holds the winding cage 7 in front of winding cylinder B by virtue of the switched off auxiliary valve V3. Motor 10 of the coiling cage is then braked. The automatic transfer of threads 4,5 from winding cylinder A onto winding cylinder B has been effected and the full bobbins can be removed from the former and new spools can be placed thereon. In addition, the bundles of filaments which had been wound during the auxiliary drawing out on fingers 19, are cut and removed from the fingers.

A new exchange takes place in similar fashion after the lapse of the preselected period of winding, valves V2, V3 being switched and valves N4 and N5 being actuated, while valves N6 and N7 are not actuated.

Thus, it appears from the description above, that the translating and pivoting operations in accordance with the invention, take place in strictly pneumatic fashion, following their electrical preselection. Tappet valves and control valves necessary for this purpose are regulated in order, and in chronological order, so that the operations of the winding machine develop entirely automatically.

Although, in the illustrative embodiment described above, the winding operation is started manually, it can

also be done semi-automatically, as is described in the yet unpublished German patent application mentioned above. For this purpose, the strand pulling device which is placed near the spinneret, permits the strands to fall between the fingers of the coiling cage 7, and imparts a rotary movement to the cage 7 by actuating an interrupter, and the other operations are executed automatically as described above.

It should be understood that the invention is not limited to the specific embodiments which are illustrated and described, but that many variations thereof may be made.

We claim:

1. An apparatus for winding strands of thermoplastic material composed of a plurality of newly-formed primary filaments of said material comprising

a. a supporting frame,

b. a pair of rotary winding cylinders mounted on said frame for alternately collecting the strands of thermoplastic material issuing from a filament forming apparatus thereabove and simultaneously drawing out the primary filaments following their formation, said rotary winding cylinders being disposed along fixed horizontal axes parallel to each other and in a plane inclined to the horizontal,

c. a tubular spool adapted to be detachably mounted on each cylinder,

d. traverse guide means cooperating with each cylinder for depositing the strands fed thereto in crossing relation along the length of the spool mounted thereon,

e. independent driving means for each winding cylinder for permitting the transfer of the winding strands onto an empty tubular spool on the previously idle winding cylinder while the fully wound spool is removed from the previously rotating cylinder following the braking thereof preparatory to the charging of said last-mentioned cylinder with an empty spool, comprising means for continuing the winding and drawing out of the filaments following the completion of the fully wound spool on the first cylinder while the strands are shifted into position for winding on the empty spool on the second cylinder,

f. said last-mentioned means comprising

g. a rotary coiling cage of cylindrical outline of a diameter conforming substantially to that of said winding cylinders,

h. pivoted mounting means for said coiling cage to alternately shift the longitudinal axis thereof into alignment with the longitudinal axis of said winding cylinders,

i. translating means for alternately shifting said coiling cage onto the end of one of said winding cylinders and removing it therefrom, and

j. means for deflecting the strands longitudinally of the axis of the winding cylinder from the fields of operation thereon to the field of operation of said winding cage disposed on the end of said last-mentioned cylinder.

2. An apparatus as set forth in claim 1, wherein said coiling cage comprises a plurality of longitudinal fingers constituting its lateral wall which are adapted to slide onto the end of each of said winding cylinders.

3. An apparatus as set forth in claim 1, including electrical and pneumatic means for automatically and cyclically rotating and shifting said coiling cage and shifting said strand deflecting means to effect the rapid transfer of the winding strands from the fully wound spool on one cylinder to the empty tubular spool on the other cylinder.

4. An apparatus for winding strands of thermoplastic material composed of a plurality of newly-formed primary filaments of said material comprising

a. a supporting frame,

b. a pair of rotary winding cylinders mounted on said frame for alternately collecting the strands of thermoplastic material issuing from a filament-forming apparatus thereabove and simultaneously drawing out the primary filaments following their formation, said rotary winding cylinders being disposed along fixed horizontal axes parallel to each other and in a plane inclined to the horizontal,

c. a tubular spool adapted to be detachably mounted on each cylinder,

d. traverse guide means cooperating with each cylinder for depositing the strands fed thereto in crossing relation along the length of the spool mounted thereon,

e. independent driving means for each winding cylinder for permitting the transfer of the winding strands onto an empty tubular spool on the previously idle winding cylinder while the fully wound spool is removed from the previously rotating cylinder following the braking thereof preparatory to the charging of said last-mentioned cylinder with an empty spool, comprising means for continuing the winding and drawing out of the filaments following the completion of the fully wound spool on the first cylinder while the strands are shifted into position for winding on the empty spool on the second cylinder,

f. said last-mentioned means comprising

g. a rotary coiling cage of cylindrical outline of a diameter conforming substantially to that of said winding cylinders,

h. an electric motor and transmission means extending therefrom to said coiling cage,

i. a cylindrical housing surrounding part of said transmission means,

j. means for pivoting said coiling cage to alternately shift the longitudinal axis thereof into alignment with the longitudinal axes of said winding cylinders, comprising an annular member fastened to said housing at the end thereof remote from said cage and a fluid actuator connected thereto for rocking said housing,

k. means for shifting alternately said coiling cage onto the end of one of said winding cylinders and removing it therefrom, comprising a second fluid actuator connected to said annular member for reciprocating said housing along an axis parallel to those of said winding cylinders, and

l. means for deflecting the strands longitudinally of the axis of the winding cylinder from the fields of operation thereon to the field of operation of said winding cage disposed on the end of said last-mentioned cylinder.

5. An apparatus as set forth in claim 4, wherein said last-mentioned means comprises a third fluid actuator having a piston movable along an axis parallel to those of said winding cylinders, and a transverse rod extending radially from said piston for intersecting the path of the strands from the filament-forming apparatus to the winding cylinders in the course of the outward movement of said piston.

6. An apparatus for winding strands of thermoplastic material composed of a plurality of newly formed primary filaments of said material comprising,

a. a fixed supporting frame,

b. a pair of rotary winding cylinders mounted on said frame for alternately collecting the strands of thermoplastic material issuing from a filament forming apparatus thereabove and simultaneously drawing out the primary filaments following their formation, said rotary winding cylinders being disposed along fixed horizontal axes parallel to each other and in a plane inclined to the horizontal, the disposition of said plane from the horizontal ranging from approximately 30° to 60°,

c. a tubular spool adapted to be detachably mounted on each cylinder,

d. traverse guide means cooperating with each cylinder for depositing the strands fed thereto in crossing relation along the length of the spool mounted thereon,

e. independent driving means for each winding cylinder for permitting the transfer of the winding strands onto an empty tubular spool on the previously idle winding cylinder while the fully wound spool is removed from the previously rotating cylinder following the braking thereof preparatory to the charging of said last-mentioned cylinder with an empty spool, and

f. means for transferring the winding strands from one winding cylinder to the other, comprising rotating means for continuing the winding and drawing out of the filaments following the completion of the fully wound spool on the first cylinder while the strands are shifted into position for winding on the empty spool on the second cylinder.

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