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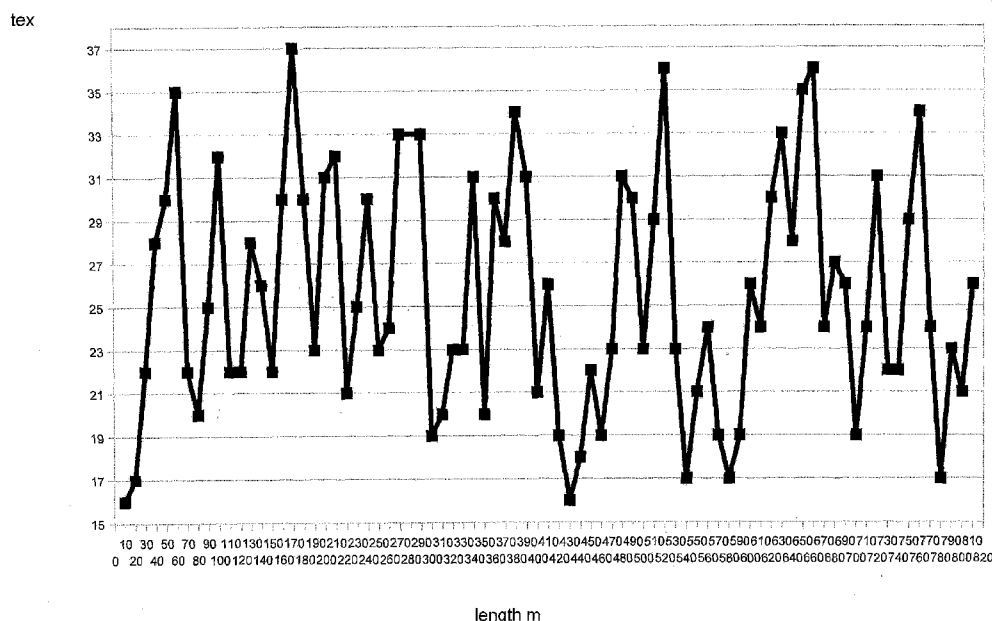
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length m

FIG.6

(57) Abstract: Innovation suggests methods and installations for productions of viscose filament rayon with cyclically varying linear density. According to the method of the invention, constantly synchronized viscose solution supplying and spinning devices actuation is interrupted, as first (27) and second (28) spinning devices and arranging freshly spun yarn in centrifuge system 39-5 are actuated by the use of existing power feeding installation (40-4), motors 40-1 and 40-2 and reduction gear groups 39-1 and 39-2 named as the first power feeding and actuating installation. According to the method of the invention new power feeding 40-7 and actuating 40-3 installation is added to the same spinning machine named second power feeding and actuating installation which work runs under unit 42 control. According to the invention power shaft 21 actuation do not depends on other spinning devices actuation anymore and

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quantity of viscose dozed to the spinning could be changed independently of other devices work. When to the spinning machine one or two individual installations for dyeing are joined suggested method allows production of dyed in one or two colours filament rayon with cyclically varying linear density.

METHOD FOR OBTAINING VISCOSE FILAMENT RAYON WITH CYCLICALLY VARYING LINEAR DENSITY CALLED "FLAME" RAYON, AN INSTALLATION FOR THE REALIZATION OF THIS METHOD, AND A PRODUCT, OBTAINED USING THIS METHOD AND THIS INSTALLATION

SCOPE OF APPLICATION

The present invention concerns a method for obtaining viscose rayon with cyclically varying linear density called "flame" rayon yarn, an installation for the realization of this method, and a product, obtained using this method and this installation.

PREVIOUS STATE OF THE TECHNOLOGY

The production of viscose rayon dates back as the beginning of the previous century. Viscose filament rayon is a part of various types of white or dyed fibers and yarns, as well as other fancy yarns widely used in the industry.

There is a method described in patent US 5,890,355. According to this method of and apparatus for production a thin/thick effect yarn provides a thin/thick effect by segmentwise stretching of a filamentary precursor yarn, which is combined with a fully-stretched filamentary precursor yarn so that the latter supports the former. The combination can be effected by twisting, nub entanglement or winding of one yarn around the other.

There is also a method for obtaining fancy yarns as described in the US 4,258,542 based on bundle of fibrous elements. Disclosed is a bundle of fibrous elements, at least some of which are uneven in the thickness in the axial direction thereof namely some of which include thick portions having a larger sectional area and thin portion having a smaller sectional area. In these fibrous elements constituting the fibrous bundle, the thick portions have, in general, a higher dyeability than the thin portions, and in a fibrous bundle, these higher dyeability portions are formed substantially randomly at a distribution ratio of at least 300 portions per 10 cm of the length of the fibrous bundle. This fibrous bundle is characterized in that it apparently resembles a fibrous bundle composed of fibrous elements uniform in th thickness and dyeability. Also a process and apparatus for manufacturing such fibrous bundles are disclosed.

Document EP 0848094 describes a fancy yarn, based on a process where a filament yarn which is not fully drawn in sections and with thick/thin zones is brought together with an effect filament over its whole length. The filament yarn is fully drawn into an affect yarn. Also claimed is an apparatus with at least one eddy jet or at least one winding spindle with a supply bobbin for effect filament where the filament are brought together, and a following drawing field for the combined yarn.

The combination of the two fibres is achieved through air blowing and pressing one of the fibres over the other or by joint rewinding of both fibres in one bobbin.

The main characteristic of the above-described known methods for obtaining of fancy yarn is that they are performed during textile processing of already spun fibres after their combination by means of various methods in order to result in a new combined yarn, generally defined as some kind of a fancy yarn, i.e. using two fibres to obtain a yarn different by type from the source fibres after the application of one or a couple of additional textile operations, using specially constructed technical means.

There is no known method for obtaining viscose filament rayon with irregular thickness where the cyclically deviated linear density is formed directly as early as the stage of spinning.

There is a technology for the production of viscose rayon which includes the following stages: mercerization, being processing of the initial pulp (cellulose) with a concentrated solution of sodium hydroxide (NaOH), resulting in alkali cellulose, which afterwards is subjected to destruction, i.e. aging, where the degree of polymerization is decreased. This is followed by temperature reduction and dosing of the alkali cellulose amount for the production of one batch of viscose. The next stage is carbon-disulphide treatment, which causes the alkali cellulose to transform into cellulose xanthate, whose most important property is that it is soluble in diluted solutions of sodium hydroxide. The cellulose solution of one batch is then mixed and homogenized with the one from the previous and the following batch, deaerated, and filtered to remove the impurities. Then the viscose solution is fed under pressure for spinning to the spinning machines.

The stage of **spinning** is performed as the viscose solution from a main pipeline under pressure is passed for spinning in a viscose pipe collector to each spinning machine, where **by means of synchronously actuated dosing pumps** equal quantities of the viscose solution from this viscose pipe collector are supplied to the spinnerets at each working position. The viscose solution then passes under pressure into a spin bath where as a result of the chemical reactions in course transforms into freshly-spun cellulose filament rayon fibers with a specified /linear density/thickness depending on the quantity of dozed viscose solution .

Leaving the spin bath the freshly-spun cellulose passes consecutively to the first and then the second spinning devices, and then it is arranged in the centrifuge. Further, the process is interrupted as when the centrifuge is filled up to a specific volume, the fiber between the first and the second spinning devices is cut off and wound only on the first one. Meanwhile the centrifuge is stopped, the formed in it rayon cake is taken out, and it is again put into operation.

The fiber from the first spinning device is again transferred to the second one, and then passed into the centrifuge to obtain the next rayon cake.

In the production of dyed in mass **viscose filament rayon**, to the ready for spinning viscose solution is added a preliminarily prepared pigment suspension consisting of one or a couple of pigments. The required quantity of the suspension is dosed and mixed with the viscose into homogenizer, thus causing the pigment particles to distribute uniformly throughout the entire volume of this solution. The dyed and homogenized viscose solution after ward is subjected to the above-described spinning operations.

This is followed by washing procedures where the freshly-spun viscose filament rayon rayon is treated with various solutions to clear the residues of the spin bath, the sodium sulfate and sulfur resulted from the chemical reactions during spinning. The obtained semi-finished product is then dried, conditioned, rewound, prepared for quality control inspection and packaging as a finished product finally.

Using this technology can be obtained white or dyed in mass viscose filament rayon, uniform in thickness notwithstanding the length of the fiber. This to some extent is regarded as a disadvantage because only a limited range of products is obtained, which could not live up to the demands of the textile industry for visually fancier yarns.

There is an installation which puts into practice the above-described method of production of viscose filament rayon obtaining a product with uniform thickness/linear density/ (*Chart 3*). The installation includes the range of technological operations and following units connected serially : mercerization unit, aging unit, unit for temperature reduction, a dosing unit for the amount of the alkali cellulose needed for the production of one batch of rayon; carbon-disulphide treatment unit – treatment of the alkali cellulose with carbon-disulphide to obtain cellulose xanthate, units for mixing and homogenization of the cellulose solution from one batch to the one from the previous and the following batch , deaeration unit and filtering units for removal of the impurities.

In order to obtain dyed in mass viscose filament rayon in a connected to the spinning machine individual dyeing installation, a pigment suspension is preliminarily prepared, which for the planned production cycle is stored in a special tank, it is dosed by means of a pump into the viscose and the mixture enters a homogenizer, thus the pigment or pigment particles are distributed uniformly throughout the entire volume of the viscose solution. The coloured after the homogenization cellulose solution is fed under pressure to a viscose pipe collector for

spinning in the spinning machine to which dosing gear pumps 22 are joined, actuated by one and the same power shaft 21 (*fig. 3*).

The **classically equipped spinning machine** actuating is arranged by the use of two electric motors. First motor 40-1, powered by feeding unit 40-4, which through the first reduction gear 39-1 and the gear transmission system 39-3 is mechanically connected to the first spinning devices 27-1, second spinning devices 28-1 and power shaft 21 to which viscose solution dosing pumps 22 are joined.

The second electric motor 40-2, powered by the same feeding unit 40-4, through the second reduction gear 39-4 has a mechanical connection and transmits motion to the arranging device 39-5, which transfers already spun filament rayon to the centrifuge 29-1 of the spinning machine 10.

In this classically designed and well known **installation**, the spinning stage is carried out as the cellulose solution from a main pipeline under pressure is fed into a viscose pipe collector to each spinning machine. This pipeline being permanently filled up with viscose solution under pressure for the prevention of gas phase occurrence. All viscose solution dosing gear pumps of a spinning machine have a common actuation by one and the same power shaft. The revolutions of this shaft defines the viscose solution quantity transferred by each dosing pump from the viscose pipe collector to the spinnerets at each working position. This uniformity of dosing of the viscose solution is a result of the specified and continuously controlled number of revolutions of power shaft to which viscose dosing pumps are joined.

Further, the viscose solution coming out from the spinnerets enters a spin bath where, as a result of the chemical reactions in course, transforms into rayon filament fibers. Leaving the spin bath, the freshly-spun cellulose as filament rayon fiber passes consecutively to the first and then the second spinning devices after which it is arranged in the centrifuge. When the centrifuge is filled up to a definite volume, the fiber between the first and the second spinning device is interrupted and wound only on the first one. Meanwhile the centrifuge is stopped, the formed in it rayon cake is taken out, and the centrifuge is put into operation again. When the same is in operating mode the rayon filament fiber from the first spinning device is again transferred to the second spinning device and passed to the centrifuge, thus starting the production of the next rayon cake.

An important especiality of **classically equipped spinning machine** is that its power feeding and the motors and the reduction gears actuation is constantly balanced during the time of the spinning process realization, i.e. the revolutions of the power shaft actuating the viscose

dozing pumps and those of the spinning devices (27-1 and 28-2) are mutually connected and in constant synchronization for the time of the whole spinning cycle.

Thus in all working positions of one **classically equipped** spinning machine depending on the chosen adjustment viscose filament rayon with one and the same thickness /linear density/ will be produced..

The textile industry needs new types of fibers and yarns, which in contrast to the existing ones would make the articles visually fancier.

The purpose of the present invention is to suggest a method for obtaining of viscose filament rayon with cyclically varying thickness/linear density/ and a product manufactured using this method, as well as an installation for the realization of the invented method, where fancy viscose filament rayon is obtained directly as early as the stage of the spinning of the rayon filament fiber without using additional stages or specially designed machines.

NATURE OF THE INVENTION

According to the invention, a method for obtaining of viscose rayon filament yarn with cyclically varying thickness/linear density is suggested, including the following stages: the initial cellulose undergoes mercerization, being processing with a concentrated solution of sodium hydroxide (NaOH), resulting in alkali cellulose, which afterwards is subjected to destruction, i.e. aging, to decrease the degree of polymerization. This is followed by temperature reduction and dosing of the alkali cellulose amount for the production of one batch of viscose. The next stage is carbon-disulphide treatment during which the alkali cellulose transforms into cellulose xanthate, whose most important property is that it is soluble in diluted solutions of sodium hydroxide. The cellulose solution of one batch is mixed and homogenized with the one from the previous and the following batch, deaerated, and filtered several times to remove the impurities. Then the viscose solution, with is passed through a viscose pipe collector under pressure to the spinnerets of the spinning machine for spinning .

According to the method of the invention, constantly synchronized viscose solution supplying/feeding/ and spinning devices actuation is **interrupted** ,as first and second spinning devices and arranging freshly spun yarn in centrifuge system are actuated by the use of existing power feeding installation ,motors and reduction gear groups named as **the first power feeding and actuating installation**. **According to the method of the invention** new power feeding and actuating installation is added to the same spinning machine named **second power feeding and actuating installation** which work runs by a control unit (inverter) and by the use of which

power shaft and joined to it viscose solution dosing pumps can be actuated independently of first and second spinning devices actuation. **According to the invention** power shaft actuation do not depends on spinning and arranging freshly-spun filament rayon devices actuation anymore and quantity of viscose solution dozed to the spinnerets for spinning could be changed independently of spinning and arranging devices work.

The viscose solution coming out from the spinnerets enters a spin bath, where as a result of the chemical reactions in course transforms into rayon filament fibers.

Leaving the spin bath the freshly-spun cellulose filament fibers are passed to the located at each working position first and then second spinning devices, and then transported and arranged in the centrifuge at the same working position. When the centrifuge is filled up to a specific volume, the filament fiber between the first and the second spinning devices is cut off and wound only on the first one. Meanwhile the centrifuge is stopped, the formed in it rayon cake is taken out, and the centrifuge is again put into operation. When the same is in operating mode, the fiber from the first spinning device is again transferred to the second one, and then passed into the centrifuge to obtain the next rayon cake.

This is followed by washing procedures where the freshly-spun viscose rayon is treated with various solutions to clear the residues of the spin bath, the sodium sulfate and sulfur resulted from the chemical reactions during spinning. The obtained semi-finished product is then dried, conditioned, rewound, prepared for quality control inspection and packaging as a finished product.

The method of production of dyed in mass viscose filament rayon with cyclically varying thickness/linear density involves mixing of the viscose solution with a preliminarily prepared pigment suspension, consisting of one or a couple of pigments, homogenization of the mixture where the pigment particles are uniformly distributed throughout the entire volume of this solution, which afterwards is fed for **spinning and the stages as above described process according to the invention**, followed by the next already known operations.

Thus after the interruption of the classical actuation of the power shaft and its transformation to actuation with an additionally mounted motor with loaded into new control unit program, in all working positions **simultaneously and synchronously** viscose filament rayon is being spun with cyclically varying thickness/linear density.

The installation for the production of filament yarn with cyclically varying thickness/linear density - named flame viscose filament rayon according to the invention includes the following stages and units consecutively connected as: mercerization unit, aging

unit, unit for temperature reduction, a dosing unit for the amount of the alkali cellulose needed for the production of one batch of rayon; carbon-disulphide treatment unit, units for mixing of the cellulose solution from one batch to the one from the previous and the following batch to homogenization and for deaeration, filtering unit for removal of the impurities, a pipe collector to the spinning machine to which a range of working positions are added, each of them equipped with a first and a second spinning devices and a centrifuge where to obtain a rayon cake. In this arrangement, the first electric motor, through the first reduction gear and gear transmission system, is connected for actuation of the first and the second spinning devices, and the second electric motor powers the arranging device to the first centrifuge. The first and the second electric motors are powered by the **first power feeding unit**.

According to the invention a **second power feeding installation** is added includes a new third electric motor powered by the new second power feeding unit, connected to an inverter control system, which through an additional reduction gear group is connected to the power shaft and actuating the viscose solution dosing pumps only.

In the control unit a preliminary invented operation program is set, which defines the frequency and range of change of the revolutions of the power shaft actuating the viscose dosing pumps independently from the operation of the other spinning devices. The dosing pumps revolution deviations change the cellulose solution quantity supplied for spinning and, as a result of this, also the thickness/linear density of the spun rayon filament fiber. With the invented program and added new elements of the machine can be achieved cyclically repeating sections of the filament rayon with varying thickness and different length of the same, obtaining various effects in the freshly spun viscose filament rayon directly during the spinning process which are stable in finished filament rayon itself and articles by its use done.

Further, freshly spun filament yarn with cyclically varying linear density is passing through already described following units: washing operations unit where the freshly-spun viscose rayon is treated with different solutions for removal of the impurities resulting from the spin bath and the chemical reactions during spinning, unit for centrifugation of the semi-finished product, drying unit, conditioning unit, rewinding unit, quality control unit (18) and storage unit (19).

The installation for the production of dyed in mass filament yarn with cyclically varying thickness/linear density (flame viscose rayon), includes an added to the described up construction of the spinning machine an individual or group dyeing installation. It includes a storage tank for a preliminarily prepared pigment suspension, added pigment suspension dosing

pump and a homogenizer connected to the existing viscose pipe collector from which through the dosing pumps the dyed in mass viscose solution is fed for spinning to the spinnerets of the spinning machine, to which are connected the above-described, according to the invention, first power feeding installation with its pertaining devices, and invented new second power feeding installation with its pertaining devices.

The only particularity in this installation is that the viscose solution from the main pipeline, before being passed to the viscose pipe collector, is fed to the homogenizer. Again in the homogenizer, the pigment suspension is introduced from the tank dosed by means of a pigment suspension dosing pump. The viscose solution and the suspension are mixed and homogenized, and then passed to the viscose pipe collector part of spinning machine. From there the already dyed solution by the use of viscose dosing pumps is fed for spinning to the spinnerets. The dyed in mass viscose solution coming out from the spinnerets enters a spin bath, where as a result the chemical reactions in course is transformed in fibers. Considering that the revolutions of the power shaft are not constant but are under changes depending on the program set in the control unit, the final result of this spinning according to the invention is dyed in mass viscose filament yarn with cyclically varying linear density/thickness – so called (flame) dyed in mass filament rayon.

Leaving the spin bath, the freshly-spun cellulose as filament fibers passes consecutively to the first and the second spinning device, and then arranged in the centrifuge. When the centrifuge is filled up to a specific volume, the fiber between the first and the second spinning devices for each working position is interrupted and wound only on the first spinning device. Meanwhile the centrifuge is stopped, the formed in it rayon cake is taken out, and the centrifuge is again put into operation. When the same enters in operating mode, the fiber from the first spinning device is again transferred to the second one and then passed into the centrifuge to start the production of the next rayon cake.

This is followed by washing procedures where the freshly-spun viscose filament rayon with cyclically varying thickness is treated with various solutions to clear the residues of the spin bath, the sodium sulfate and sulfur resulted from the chemical reactions during spinning. The obtained semi-finished product is then dried, conditioned, rewound, quality control and packaging as a finished product.

The same installation and method are applicable in the production of bicolour filament rayon with **cyclically varying thickness/linear density** - (flame) viscose rayon. This installation, according to the invention, includes an added to the first a second pipe collector for

viscose, powered by the same motor actuating the first and operating synchronously with it. The second viscose pipe collector is connected to a second individually operating dyeing installation, as the dosing pumps supplying viscose for spinning to the spinnerets, for each pair of working positions are fed with viscose for spinning from the separate viscose pipe collectors in the following way: a dosing pump at the first working position is supplied with viscose from the first pipe collector, and the neighbouring one, i.e. second working position dosing pump, is fed with viscose by the second pipe collector. The same is then repeated for each successive pair of working positions. Thus, on the half of the neighbouring working positions a viscose solution in one colour is spun, and on the rest – a viscose solution in a different colour, thus obtaining differently dyed viscose filament fiber. Due to the program set in the control unit, apart from being coloured differently, the filament fibers will also be with cyclically varying thickness/linear density.

In addition, according to the invention, the spun on the neighbouring working positions differently dyed in mass rayon filament fibers instead of being separately taken by the first and second spinning devices are joined together only to the first spinning device of first working positions. After that, the two differently dyed and already combined fibers are transferred together to the second spinning device at the first working position and then to the centrifuge at the same first working position. The result of this innovative way of spinning is that the bicolor and (flame) filament yarn is obtained directly as early as the stage of the first spinning device and later viscose filament rayon with **cyclically varying thickness/linear density and** dyed in two colours as cake is taken out from centrifuge.

The application of this innovative scheme of power shaft actuating enables a scheduled change in the quantity of the supplied for spinning cellulose solution independently from the operation of the other spinning devices, and respectively a cyclically changes of the linear density /thickness/ of the viscose rayon filament fiber.

An advantage of the method and installation suggested is the direct production of raw white bright or dyed in mass viscose filament rayon with cyclical variation of its linear density/thickness, i.e. flame viscose filament rayon.

SHORT DESCRIPTION OF THE FIGURES ENCLOSED

Figure 1 illustrates the sequence of the processes in the classical production of raw white bright or dyed in mass viscose filament rayon.

Figure 2 presents the classical unit structure of installation 10-1, i.e. the installation performing the dyeing in mass of the viscose filament rayon.

Figure 3 illustrates a design of the classical actuation of the spinning machine for the production of raw white bright or dyed in mass viscose rayon filament rayon with uniform thickness/linear density.

Figure 4 presents the actuation of the spinning machine according to the invention.

Figure 5 illustrates the variation of the linear density /thickness/ of the viscose filament rayon from one cake, whose spinning is performed following the classical spinning procedure, i.e. of the actuation of the spinning machine's units. On the abscissa is marked the rayon fiber length of investigated rayon cake, and the ordinate (Y-axis) shows the variation of the fiber linear density / thickness presented in tex. This figure gives a clear concept of the way the rayon fibre thickness changes from start to the end of a centrifugal filament rayon cake using the classical spinning procedure.

Figure 6 illustrates the variation of the linear density/ thickness of a viscose filament rayon filament from cake whose spinning follows the innovative method and actuation procedure of the spinning machine's units according to the invention.

Figure 7 illustrates the installation, which added to Figure 4, enables the production of bicolour rayon with **cyclically varying thickness** (flame one) simultaneously.

MODEL PERFORMANCE OF THE INVENTION

The installation for the production of raw white bright or dyed in mass viscose filament rayon presented on Figure 1 includes the following units, consecutively connected following the technological operations as: unit 1 for mercerization - treatment of the initial pulp (cellulose) with a concentrated solution of sodium hydroxide, unit 2 – for aging, where as a result of the process of destruction alkali cellulose is obtained, i.e. the degree of polymerization is decreased, unit 3 – temperature reduction, unit 4 – dosing of the alkali cellulose amount for the production of one batch of viscose, unit 5 – for carbon-disulphide treatment of the alkali cellulose to obtain cellulose xanthate, units 6 and 7 for mixing and homogenization of the cellulose solution of one batch to the one from the previous and the following batch and deaeration, unit 8 – filtering to remove the impurities.

Unit 9, for the preparation of a dyeing suspension and unit 10-1 for viscose solution dyeing could be connected to spinning machine 10 if dyed in mass rayon filament rayon have to be produced. After the spinning, the freshly-spun viscose rayon is treated in unit 12 with various

solutions, prepared in unit 13 to remove the residues from the spin bath and chemical reactions after the spinning.

Further, following the technology serially connected are units 14, 15, 16, 17 and 18 for centrifugation, drying, conditioning, rewinding, quality control inspection and packing as finished production to be stored in unit 19.

In order to obtain dyed in mass filament rayon, to the spinning machine 10 an individual dyeing installation 10-1 is connected. As shown in Figure 2, it includes a pigment suspension storage tank 30, pigment suspension dosing pump 31, a control unit 34 for the dosing pump 31 control, a homogenizer 32, where the pigment or pigments particles have to be mixed with viscose solution and distributed uniformly throughout the entire volume of it; reduction geared electromotors 35 which guarantee the components mixing inside of homogenizer 32 and suspension circulation in suspension storage tank. From the main pipe collector 36 the cellulose solution passes into the homogenizer 32 through the local viscose pipeline 37. The already dyed after the homogenization solution fills up under pressure the viscose pipe collector 38, which supplies dyed in mass viscose to all the working positions of the spinning machine 10.

According to **Figure 4** for the actuation of the spinning machine are used two independent from each other power feeding units as follows: feeding unit 40-4 powers the first and the second electric motors 40-1 and 40-2, as motor 40-1 through reduction gear 39-1 and the gear transmission system 39-3 continues actuating the first 27-1 and second 28-1 spinning devices, and the motor 40-2 through reduction gear 39-4 keeps actuating the fiber arranging in the centrifuge 29-1 device 39-5 of the spinning machine 10. According to the invention is added a third electric motor 40-3, powered by a second feeding unit 40-7, as the electric motor 40-3 through reduction gear 39-2 actuates the power shaft 21 and the viscose solution dosing pump 22 joined to it. According to the invention, the third electric motor operation is controlled by the control unit 42.

Thus, the actuation of the power shaft 21 is performed independently from the powering of the spinning devices. In accordance with the program set in the control unit 42, a change of the revolutions of the power shaft takes place – when the number of revolutions is higher, a greater amount of viscose is being dosed, so the fiber spun will be thicker. Oppositely when the number of power shaft revolutions is lower, a smaller amount of the solution to be spun will result in a thinner fiber. The result from the alternation – higher/lower solution fed for spinning, according to the invented method and program set in control unit 42, is the production of

viscose filament rayon with a **cyclically varying thickness** / linear density/ without the number of filaments changes.

Example: If the classical scheme of spinning devices including power shaft actuating is under use the spinning will run with constant quantity of viscose solution dozed from dozing pumps and transferred from local pipe collector to the spinnerets for spinning. This quantity supplied for spinning will be around 22 grams per minute and is a constant for the whole production cycle of 33,0 tex for example. The result of this classical production behaviour, where power shaft and other spinning devices actuation is strongly connected is production of 33,0 tex with actual count between 33,4 till 35,3 because of centrifugal way of spinning presented on Fig.5 .

If actuating scheme is under use and actuating of power shaft is independent from other spinning devices according innovation and program in control unit 42 set power shaft revolutions could be cyclically changed from 8 to 24 turns and respectively the quantity of viscose solution fed for spinning will cyclically range between 7 and 30 grams per minute. The result of this innovative way of viscose solution dozing for spinning is production of 33, 0 tex filament rayon with cyclically **varying thickness between** 18,0 till 35,0 tex presented on Fig. 6.

In the production of dyed in mass **viscose filament rayon with cyclically varying thickness**, the prepared viscose solution from pipeline 37 before being fed under pressure in the pipe collector 38 of the spinning machine is supplied to the homogenizer 32 of the installation for the production of dyed in mass viscose filament rayon. The preliminarily prepared pigment suspension, which for the time of the production cycle is stored in tank 30 (Fig.2) is dosed by pump 31 to the viscose solution before the same is passed to the homogenizer 32 (Fig.2). In the homogenizer 32 the viscose solution is mixed with the dosed by pump 31 suspension thus causing the pigment particles to distribute uniformly throughout its entire volume. The already dyed after homogenization viscose solution is again fed under pressure to the local viscose pipe collector 38 of the spinning machine /Fig.2/, to which the solution dosing pumps have been added. The quantity of the already dyed in mass viscose supplied to the spinnerets for spinning is controlled by the program set in the control unit 42. Based on this program, the inverter operate the motor 40-3, which through reduction gear 39-2 and the connection 41-2 actuates the power shaft 21 and respectively the viscose dosing pumps 22. When the number of revs of the power shaft is higher, a greater amount of viscose is dosed and the fiber spun is thicker, and when the number of power shaft revs is lower the spun fiber is thinner. Thus, dyed in mass

viscose filament rayon with cyclical change of the linear density /thickness/ is obtained, where linear density cyclically deviation depends on the type of program set in the control unit 42.

Further, the installation operates in the already known way: in unit 12 the freshly-spun viscose filament rayon is treated with various solutions prepared in unit 13 for removal of the residues of the spin bath, the sodium sulfate and sulfur resulted from the chemical reactions during spinning.

The obtained semi-finished product is centrifuged, conditioned, rewound and prepared for quality control inspection and packaging as finished production – units 14, 15, 16, 17, 18 and after quality inspection – stored in unit 19.

In control unit 42 can be installed various programs for the operation control of the third electric motor 40-3, which practically enhances the possibilities for production of different types of viscose filament rayon with cyclically variation of thickness, i.e. differently (flamed).

With the new product, a wide range of items is created of a new fancy article preparing – viscose filament rayon yarn with cyclically variation of the linear density /thickness/ along the fiber length with unique effects.

PATENT CLAIMS

1. **A method for obtaining viscose filament rayon with ciclically varying thickness**, including the following stages: mercerization of initial pulp , i.e. processing with a concentrated solution of sodium hydroxide, resulting in alkali cellulose, which afterwards undergoes the process of destruction to decrease the cellulose degree of polymerization, followed by temperature reduction and dosing of the alkali cellulose amount for the production of one batch of viscose; carbon-disulphide treatment which causes the alkali cellulose to transform into cellulose xanthate; the cellulose solution of one batch is then mixed and homogenized with the one from the previous and the following batch and deaerated, filtered to remove the impurities; then the viscose solution is fed for spinning to the spinning machine, as the viscose solution coming out from the spinnerets enters the spin bath where as a result of the chemical reactions in course transforms into filament fibres which are passed through spinning devices to a centrifuge at each working position in order a rayon cake to be formed;

With the main characteristic that the spinning is performed by **interrupting** the synchronization of the viscose solution supply to the spinnerets of spinning machine and the takeover of the freshly-spun in the spin bath filament rayon **by separately actuating of** the first and the second spinning devices and the rayon arranging in centrifuge device using the existing **first power feeding installation**, and **separately actuation** and control of the power shaft and viscose dosing pump joined to it by using new **second power feeding installation**, run by a control unit (inverter) thus carrying out a programmed change of the quantity of the supplied for spinning viscose **independently** from the operation of the first and second spinning and ect. devices of the spinning machine .

2. **A method for obtaining dyed in mass viscose filament rayon with ciclically varying thickness/linear density according to Claim 1, with the main characteristic that viscose solution before spinning is mixed** with preliminarily prepared pigment suspension from one or a couple of dispersed in water organic pigments prepared as pastes; homogenization of the mixture, which is passed for the same way of **spinning as claim 1** and all other stages of the above-described processes.

3. **A method for obtaining bicolour dyed in mass viscose filament rayon with ciclically varying thickness/linear density according to Claims 1 and 2, with the main characteristic that** to the spinning machine are added two independently operating installations for dying in mass by the use of which viscose solution before spinning could be coloured by two

preliminary prepared different in colour pigment suspensions. By the use of two homogenizers and two local viscose pipe collectors to the neighbour working positions of spinning machine at the same time could be supplied differently coloured viscose solutions for spinning. After spinning differently coloured freshly spun filament fibers from these two working positions are transferred to the first working position centrifuge only by the use of first and second spinning devices of the same first working position. After spinning as **claim1** freshly spun bicolour filament rayon with cyclically varying thickness is passing through all other stages of the above described processes.

4. An installation for the production of viscose filament rayon with cyclically varying thickness, added to the existing spinning machine part of which are local viscose pipe collector (38) to which a range of working positions are joined each one supplied with viscose solution dosing pumps, power shaft actuating viscose dosing pumps, first and second spinning devices (27,28), an arranging system (39 - 5) by which freshly spun filament rayon is transferred from second spinning device (28) to the centrifuge (29) where freshly spun cake is obtained, two electric motors 40-1 and 40-2 powered by electricity from **first feeding unit 40 - 4** and actuating as follows: first electric motor 40-1 through the first reduction gear 39-1 and a gear transmission system 39-3 is connected for actuation of first 27-1 and the second 28-1 spinning devices as the second electric motor (40 - 2) is actuating the arranging device 39-5 **with the main characteristic that a second power feeding installation is added** consisting of a third electric motor (40-3), powered by electricity from the second feeding unit (40-7) and connected to it a new control unit (42 -controlling inverter system), as the third electric motor through an additional reduction gear group (39-2) is actuating the power shaft (21) only and the viscose solution dosing pumps (22) both work of which is controlled by unit (42) according to the preliminarily set into this unit program operating range of changes of the power shaft (21) and viscose dosing pumps/22/ revolutions, **independently** from the operation of the all other devices. The spinning on the spinning machine (10) is followed by all other stages of the above-described processes from washing unit (12), till a storage unit (19).

5. An installation for the production of dyed in mass viscose filament rayon with cyclically varying thickness according to Claim 2, **with the main characteristic that** to the spinning machine (10) an individual installation for dying in mass (10-1) is joined, including a storage tank for a preliminarily prepared pigment suspension (30), a suspension dosing pump (31), a homogenizer (32) connected to the local viscose pipe collector of the spinning machine,

to which are joined a range of working positions. Power shaft and all other spinning devices actuating is arranged in accordance with scheme described in **Claim 4**.

6. An installation for the production of bicolour viscose filament rayon with cyclically varying thickness according to Claim 3, **with the main characteristic that** to the spinning machine (10) are joined two individual installations for dying in mass (10-1), with two storage tanks for preliminarily prepared pigment suspensions (30), including two suspension dosing pumps 31 and two homogenizers 32 connected through two local viscose pipe collectors to one spinning machine with joined to them a range of working positions. The actuation of viscose dosing pumps independently to which viscose pipe collectors are joined is arranged by one and the same power shaft (21)(which operation follows the scheme described in **Claim 4**.

7. Viscose filament rayon with cyclically varying thickness/ linear density obtained following the method and installation as described in **Claims 1 and Claim 4**.

8. Viscose filament rayon dyed in mass with cyclically varying thickness/linear density obtained following the method and installation as described in **Claim 2 and Claim 5**.

9. Bicolour viscose filament rayon with cyclically varying thickness/ linear density obtained following the method and installation as described in **Claim 3 and Claim 6**.

AMENDED CLAIMS

received by the International Bureau on 22 November 2018 (22.11.2018)

1. **Method for obtaining viscose filament rayon with cyclically varying thickness**, inclusive of the following stages: mercerization of the initial pulp /cellulose, i.e. treatment with a concentrated solution of sodium hydroxide (NaOH), resulting in alkali cellulose, followed by (oxidizing) destruction (aging) to decrease the degree of polymerization, temperature reduction and dosing of the alkali cellulose amount for the production of one batch of viscose, carbon-disulphide treatment which causes the alkali cellulose to transform into cellulose xanthate, dissolution of the cellulose xanthate, after which the cellulose of one batch is mixed and homogenized with the one from the previous and the following batches, then deaerated, and filtered in a couple of stages to remove the impurities, and successive spinning of the viscose solution **in the spinning machine**, as the viscose solution streams flowing out of the spinnerets of the spinning machine are passed through a spin bath, where as a result of the chemical reactions in course are transformed into fibres, which by means of receiving mechanisms are then transported to a centrifuge to each working position to form a rayon cake;

With the main characteristic that the spinning is performed as the **synchronization of dosing of the viscose solution for spinning**, i.e. the revolutions of the pump shaft of the spinning machine and the passage of the freshly-spun fibre in the spin bath by the **receiving mechanisms**, actuated by one and the same motor, **is interrupted as** the power supply and control of the motors, driving the receiving mechanisms, leading the freshly-spun continuous fibre out of the spin bath to the arranging device of the spinning machine, continues to be preformed by the existing **first actuating unit**, and the power-supply, actuation and running of the pump shaft and the pumps dosing the viscose solution is performed **only by** the additionally constructed and added to the spinning machine **second actuation unit** with programmable control, where in the conditions of this independence of actuation is possible to change in a programmed mode the quantity of the supplied for spinning cellulose solution, notwithstanding the parameters of operation of the receiving mechanisms and centrifuges of the spinning machine i.e. a method for spinning of smooth fancy raw white bright ,dyed in one colour or in two colours simultaneously with cyclically varying thickness is created by which implementation the point of action in case of fancy rayon production **is not** in the distance of spinning solution movement between dosing pump to the spinneret, **with not** creating of second spinning solution flow for pulsating adding of additional quantities from the same solution to the existing main flow, **without** fancy effects along the whole length as irregularly

formed loops, knopsq slubs, or spirals spaced at random intervals along the fiber length and **not** due to the difference in shrinkage of the fiber sections.

2. Installation for the production of viscose filament rayon with cyclically varying thickness, including the following units, connected serially to perform the technological operations: unit 1 for mercerization, unit 2 – for aging, unit 3 – for temperature reduction, unit 4 - for dosing of the alkali cellulose quantity for the production of one batch of viscose, unit 5 – for carbon-disulphide treatment, units 6 and 7 – for mixing and homogenization of the cellulose solution of one batch with the one from the previous and following batches and deaeration, unit 8 – for removal of the impurities, a spinning machine 10, mechanically connected to a local collection pipeline 38 to which is added a specific number of working positions, each of them provided with the receiving mechanisms 27 and 28 and a centrifuge 29 for the obtaining of a rayon cake, as the first electromotor 40-1 through the reduction gear 39-1 and a system of geared transmission 39-3 directly actuates the first receiving mechanism 27-1, which takes the freshly-spun fibre immediately after the same leaves the spin bath, and the second receiving mechanism 28-1, which takes the same fibre from the first receiving mechanism 27-1 and passes it to the arranging device 39-5, actuated by means of the reduction gear 39-4 of the second electromotor 40-2, to the first centrifuge 29-1, as the first electromotor 40-1 and the second electromotor 40-2 are powered with voltage by the first power-supply unit 40-4;

With the main characteristic that a second actuation unit is introduced, including a third electromotor 40-3, powered with voltage by a second power-supply unit 40-7, and connected to a control unit 42 consisting of a controller and a frequency inverter, which third electromotor by means of the additional reduction gear 39-2 sets into operation only the pump shaft 21 and through it only the dosing pumps 22 of the solution for spinning, as in the control unit 42 there is a preset programme which determines the frequency and range of change of the revolutions of the shaft 21, and respectively the quantity of the dosed viscose solution to be spun, independently from the operation of the other mechanisms 27, 28 and 39-5 of the spinning machine 10. As after the spinning with the spin bath 11 there follow a filtering unit 12, accompanied by the unit 13 for preparation of the filtering solutions for treatment of the freshly-spun viscose rayon with various solutions for removal of the residues from the spin bath and the chemical reactions during spinning, unit for centrifugation of the obtained semi-finished product 14, a drying unit 15, conditioning unit 16, rewinding unit 17, units for quality control and packaging - 18 and 19, and a storage unit 20.

3. When to the installation according to claim 2 is joined also the installation for dyeing in mass – unit 10-1, fig.2 and the operation is synchronized with the spinning machine 10, on the added installation unit according to claim 2 can be produced coloured viscose filament rayon with cyclically varying thickness dyed in mass.

4. When to the installation according to claim 2 are joined two independently operating installations for dyeing in mass – unit 10-1, fig. 2, and their operation is synchronized with the spinning machine 10, on the supplemented with these two units installation, according to claim 2, can be produced bi-colour viscose filament rayon with cyclically varying thickness, dyed in mass.

5. Smooth viscose filament rayon with cyclically varying thickness, obtained using the method from claim 1 and the installation from claim 2 in which thin sections really are thinner and thick section really thicker in comparison with the average nominal linear density of continual rayon fiber and are uniformly distributed in the whole fiber length.

6. Smooth coloured viscose filament rayon with cyclically varying thickness, obtained using to the method from claim 1 and the installation from claim 3 in which thin sections really are thinner and thick section really thicker in comparison with the average nominal linear density of continual rayon fiber and are uniformly distributed in the whole fiber length.

7. Smooth bi-colour viscose filament rayon with cyclically varying thickness, obtained according to the method in claim 1 and the installation from claim 4 in which thin sections really are thinner and thick section really thicker in comparison with the average nominal linear density of continual rayon fiber and are uniformly distributed in the whole fiber length.

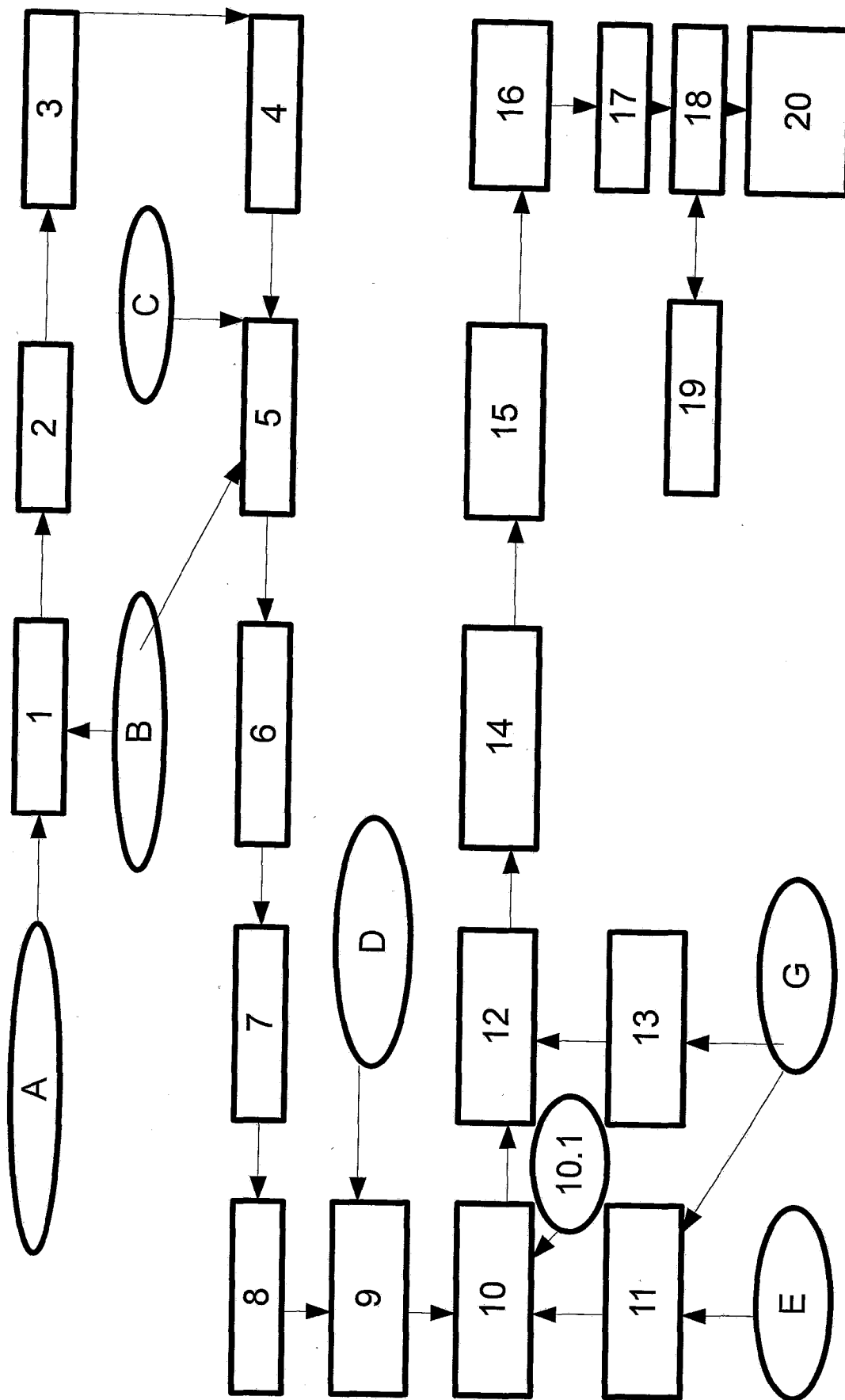


FIG.1

SCHEME 10 - 1

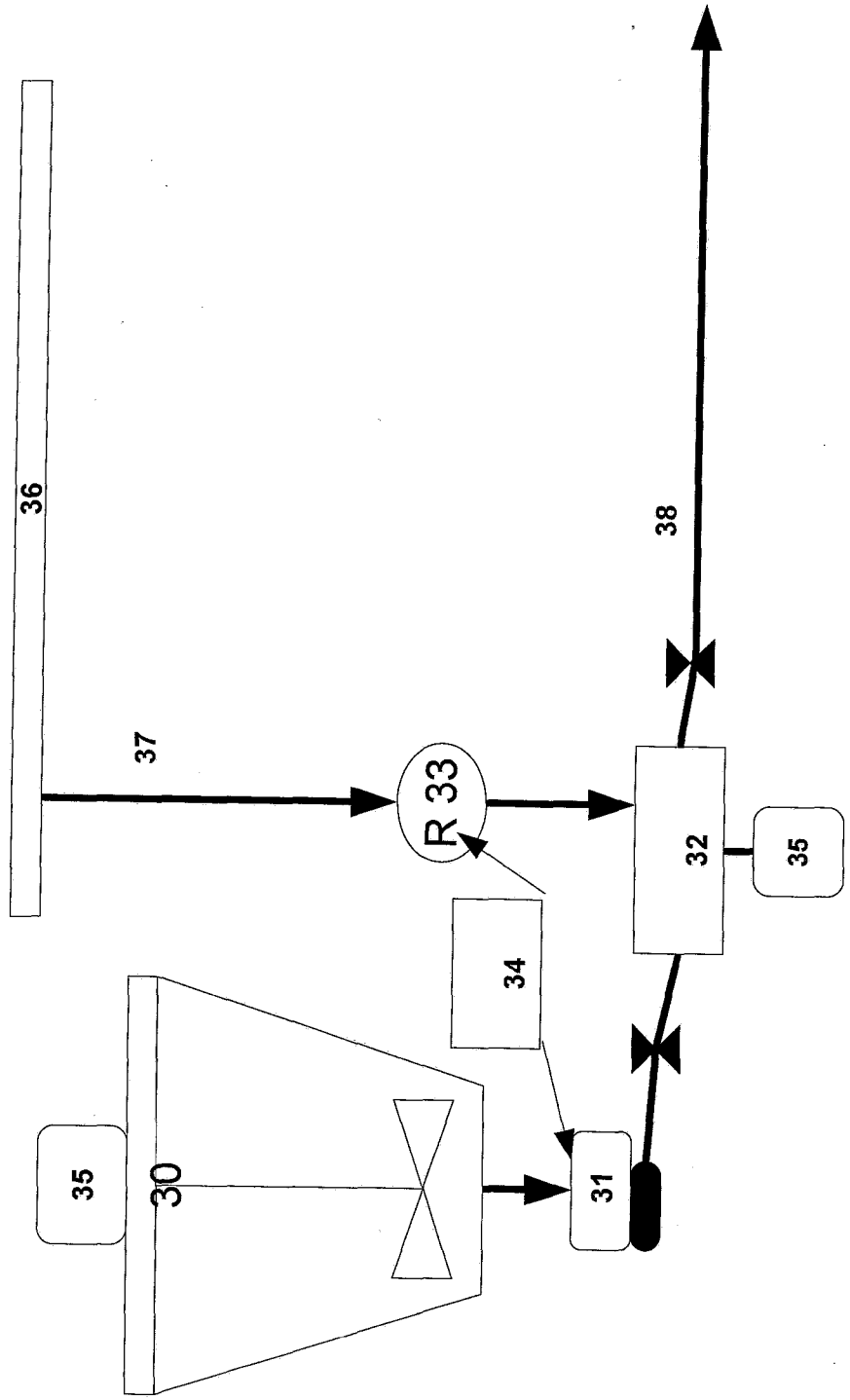


FIG. 2

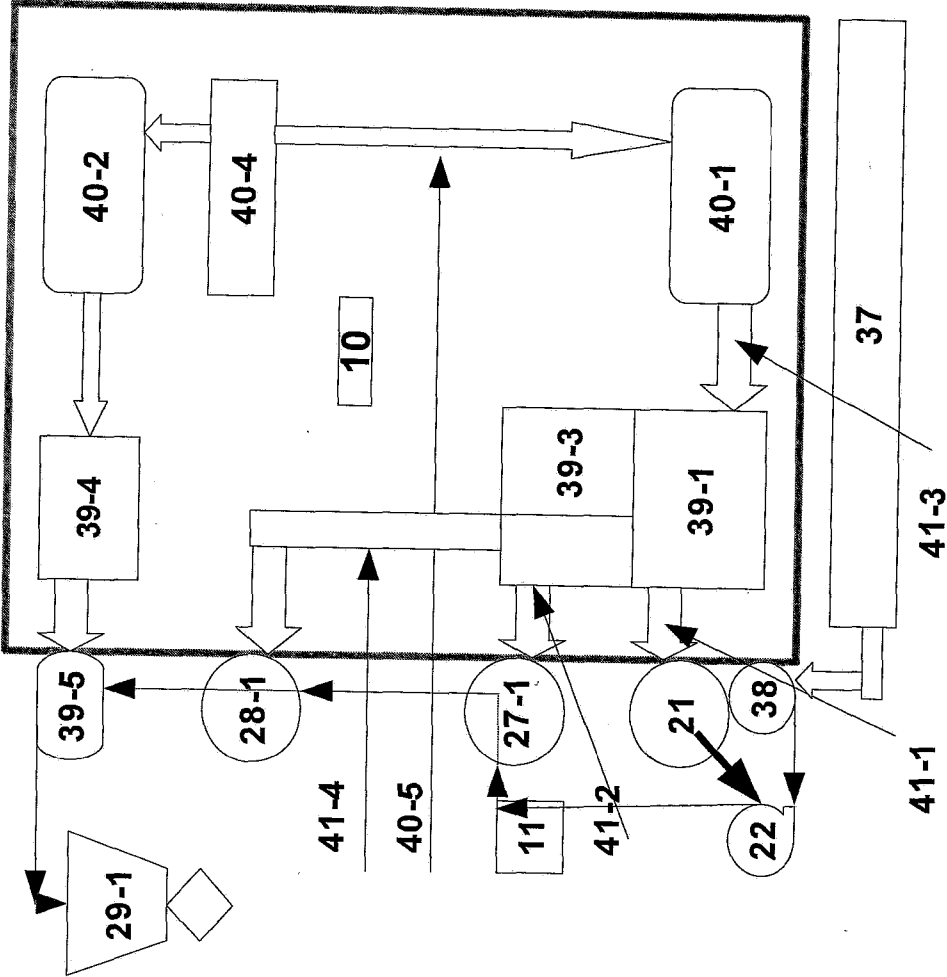


FIG 3

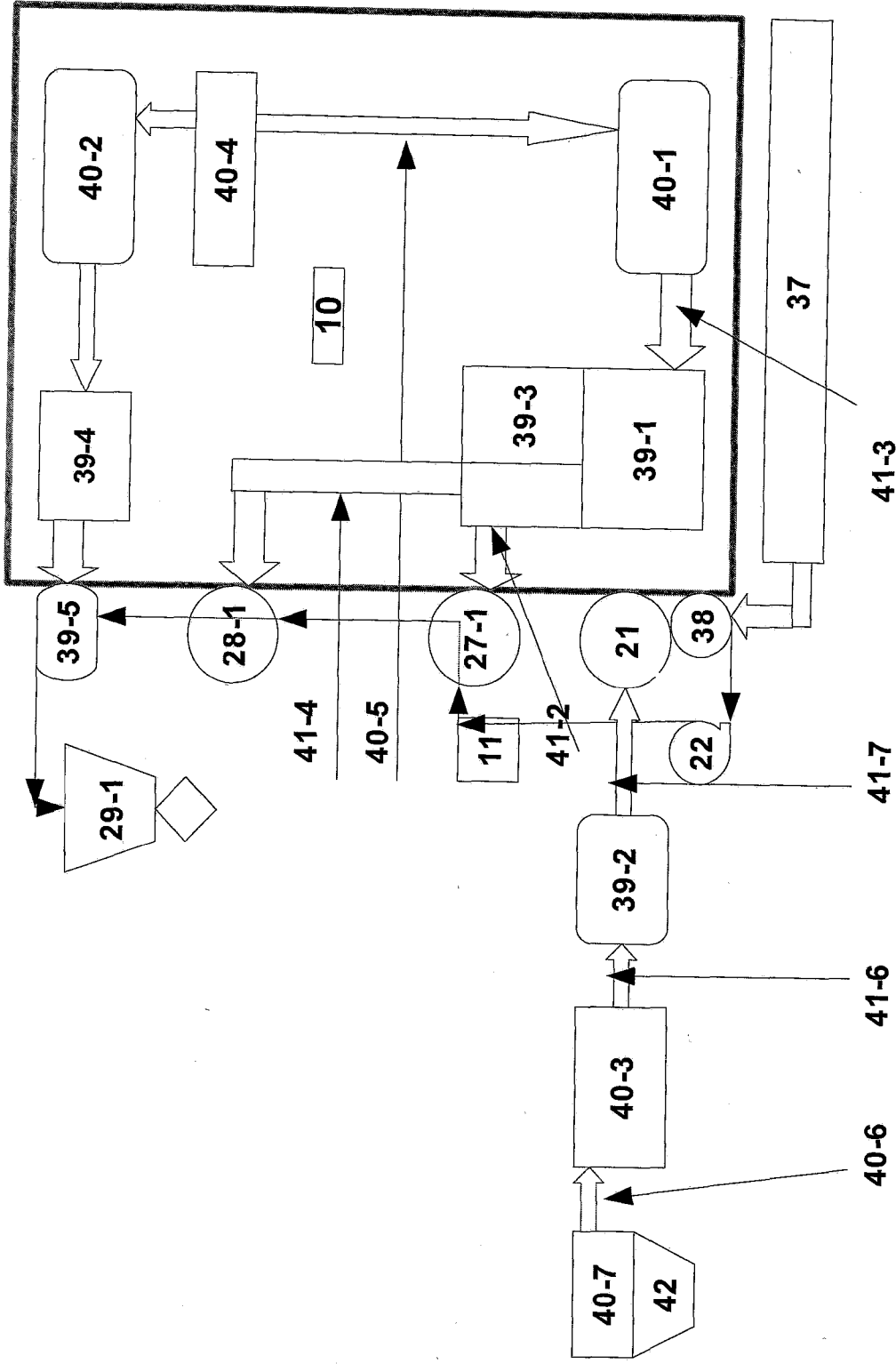


FIG. 4

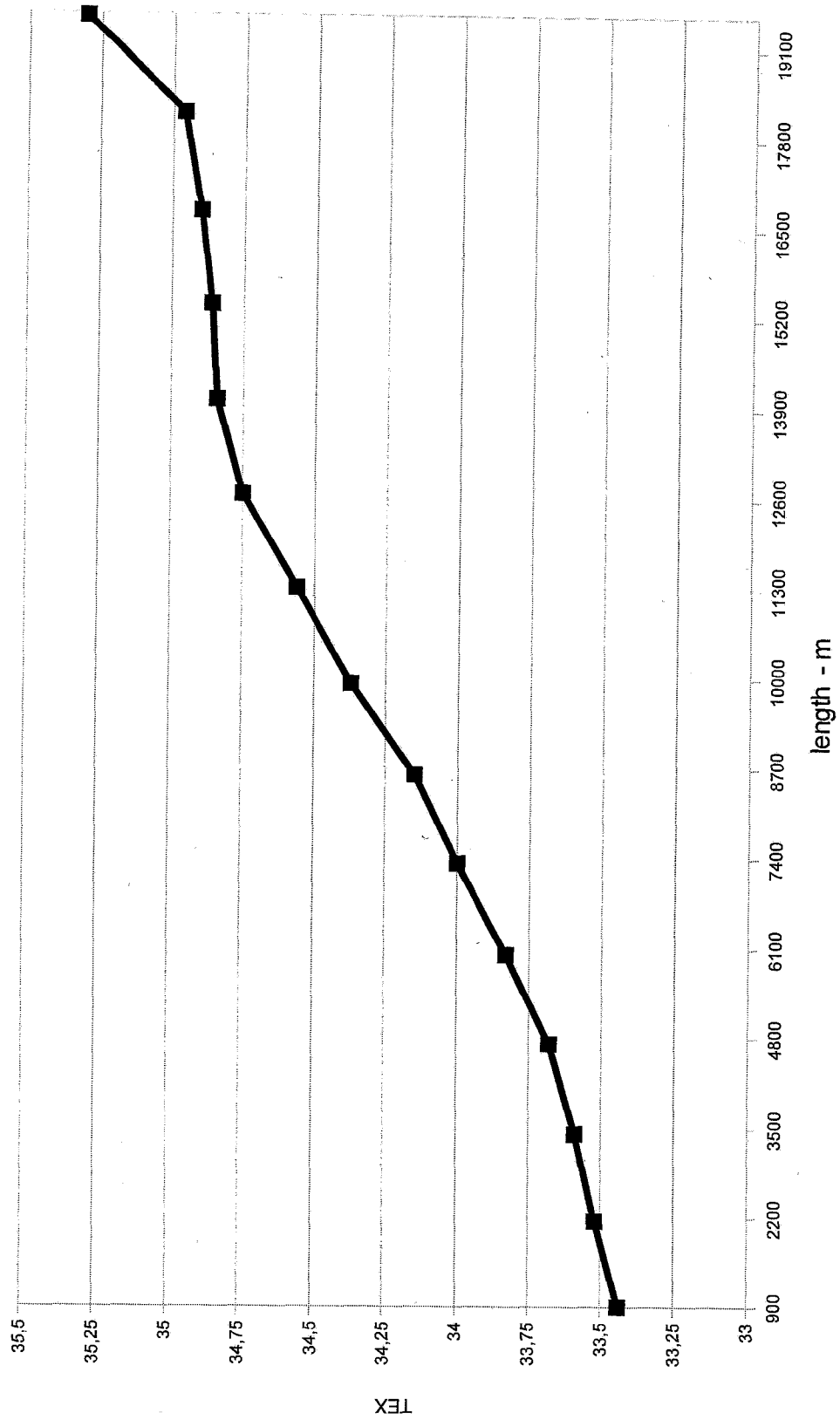
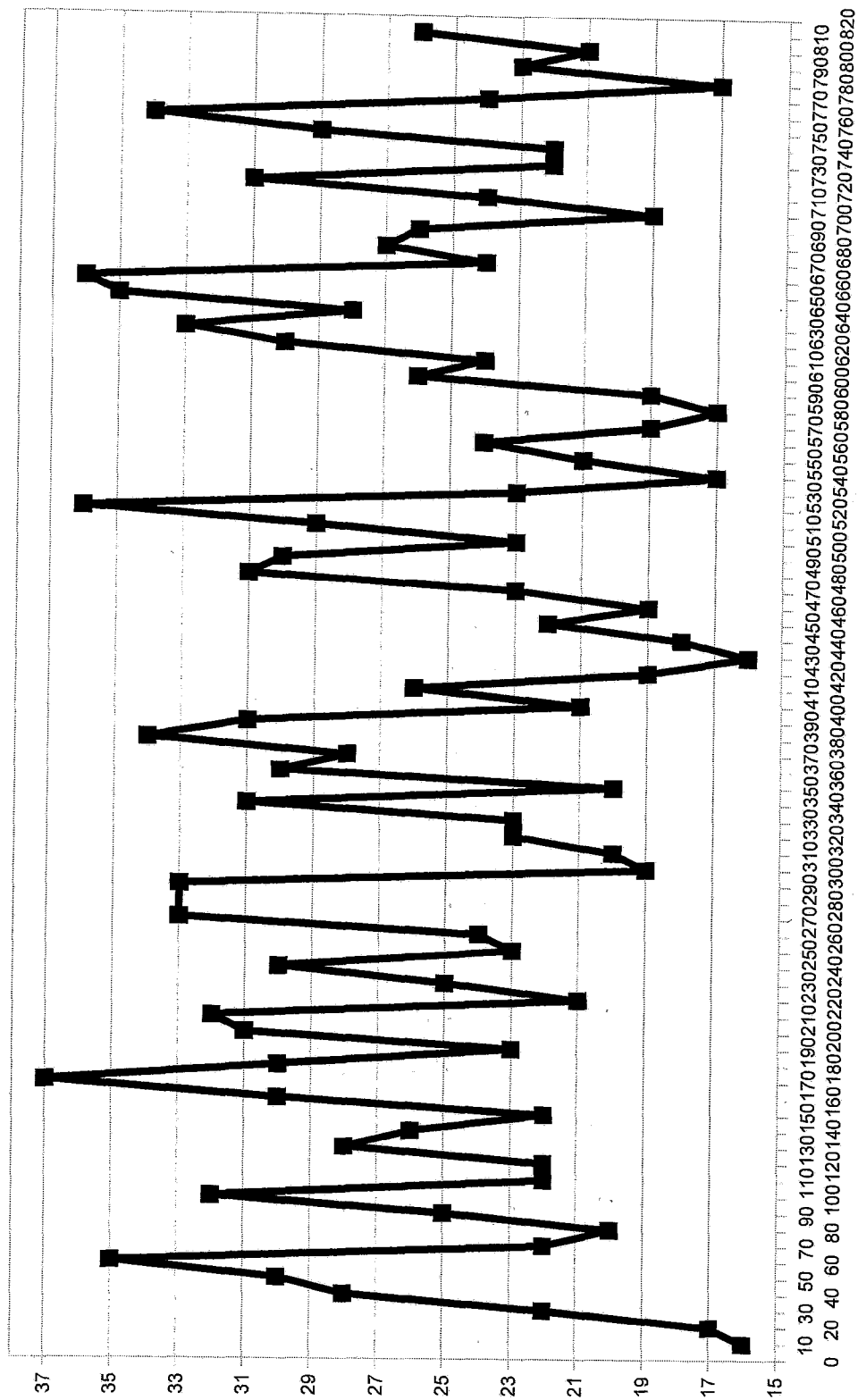


FIG.5

tex



length m

FIG.6

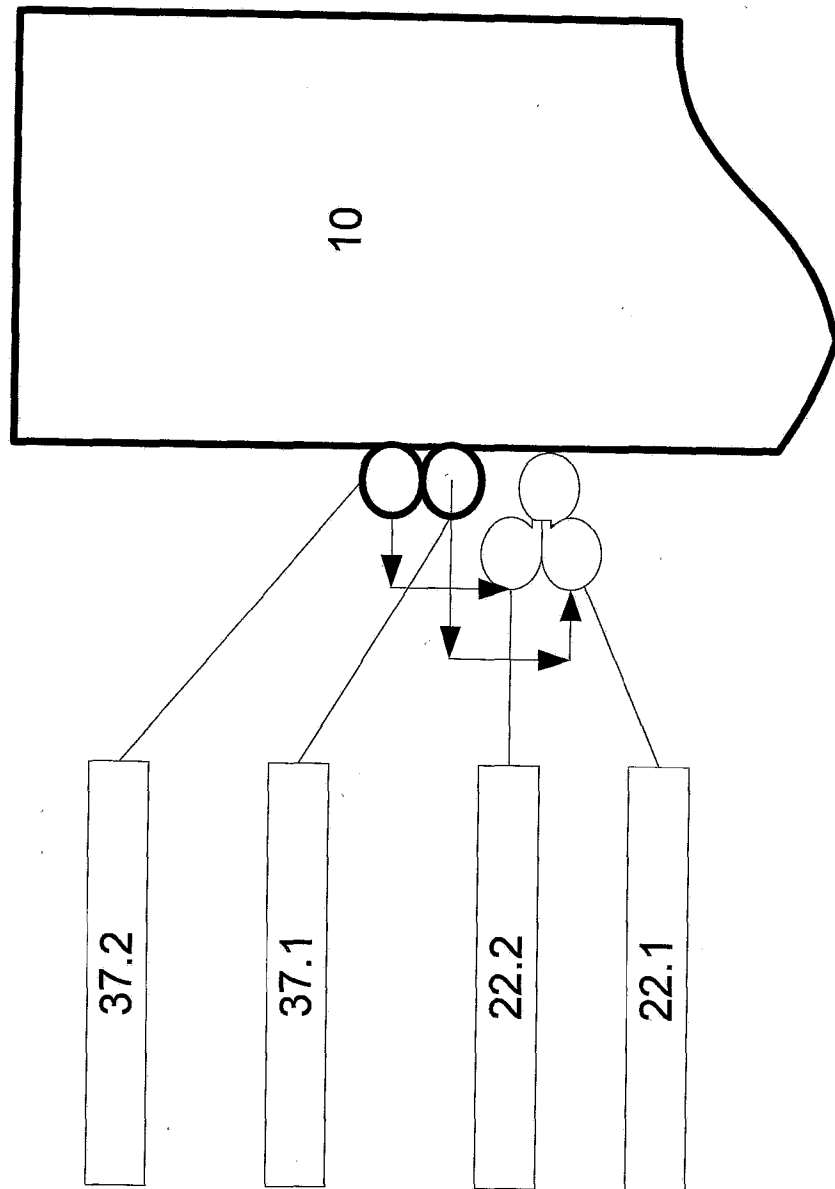


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/BG2018/000029

A. CLASSIFICATION OF SUBJECT MATTER

INV. D01D1/09 D01D5/20 D01F2/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D01D D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2 949047 B2 (KURARAY CO) 13 September 1999 (1999-09-13) figures 1, 3-12 example 1 paragraphs [0029] - [0030] -----	1-9
X	US 3 042 482 A (RUDLOPH WOODCELL) 3 July 1962 (1962-07-03) figures 2-4 examples IV-VI -----	7-9
A		1-6
X	US 2 878 548 A (MEEKS LOHR WILMER ET AL) 24 March 1959 (1959-03-24) figure 6 column 2, line 40 - column 3, line 40 -----	7-9
A		1-6
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

13 September 2018

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No

PCT/BG2018/000029

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International application No

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			US	2984889 A		23-05-1961
