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(54) METHOD OF APPLYING HYDROPHILIC COATINGS

VERFAHREN ZUM AUFBRINGEN VON HYDROPHILEN BESCHICHTUNGEN

PROCÉDÉ D'APPLICATION DE REVÊTEMENTS HYDROPHILES

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Description

Background and Summary

BACKGROUND OF THE INVENTION

A. Field of the Invention

[0001] The present invention relates generally to a system that applies hydrophilic coatings on wires in a quasi-continuous process. This allowing high-throughput manufacturing of respective devices. More specifically the invention concerns a system that applies hydrophilic coatings on sensing wires. Such a system is able to apply the specific coating in a continuous process or quasi-continuous process allowing high-throughput manufacturing of respective devices. This system is used to manufacture sensing wires that are applied for monitoring of potentially defect structures suffering from e.g. adverse moisture ingress.

B. Description of the Related Art

[0002] Nowadays, the application of coatings for different kind of wires is usually performed by pressure extrusion performed at high temperature whereby thermoplastic coatings are applied on the respective wire-materials. There are however only a few industrial processes known where a high-throughput application of hydrophilic coatings is possible. US2211584A discloses a conductive wire, coated with an inner insulation layer and outer conductive layer. Both layers are coated onto the wire through a coating vessel, drying the coating, passing the coating through another coating vessel with a different coating solution and optionally repeating the process several times.

SUMMARY OF THE INVENTION

[0003] The present invention solves the problems of the related art by using a system whereby the wire is drawn through a vessel filled with the raw, aqueous coating material and which is dried afterwards by a hot air-stream that is conducted by a dedicated pipe.

[0004] The present invention provides a method of coating a wire with an outer insulation coating and an inner conductive coating between said wire and outer insulation coating, characterised in that the to be coated wire comprises an outer material made of hydrophilic textile and further characterized in that this wire is passed through a first coating vessel comprising an aqueous medium comprising a water-solution of a conductive coating material, followed by a respective drying unit, thereafter through a second coating vessel comprising an solution of a non-conductive polymer coating material and finally again through a drying unit.

[0005] In another embodiment of the invention a method of coating a wire is provided the method comprising

an outer material made of hydrophilic textile, characterised in that 1) the to be coated wire is released over a bobbin into a first vessel comprising an aqueous medium comprising a water-solution of a conductive polymer coating material and further comprising a non-conductive material, 2) through an aperture at the bottom of said vessel, said outlet aperture having a diameter size value that is the value of the thickness of the wire and the thickness new coating, through 3) a first wire guide drying channel into 4) a second vessel comprising an aqueous medium comprising a water-soluble non-conductive material, 5) through an aperture at the bottom of said vessel, said outlet aperture having a diameter size value that is the value of the thickness of the wire and the thickness new second coating and 6) through a second wire guide drying channel onto a receiving bobbin. This techniques described above may be embodied as the receiving bobbin having a motorized computer steered function.

[0006] Some of the techniques described above may be embodied as a method whereby the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and further comprising a titanium carbon nitride (TiCN) or titanium aluminium nitride (TiAlN or AlTiN), thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit or some of the techniques described above may be embodied as a method, whereby the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and further comprising graphite, for instance graphite particles, thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit.

[0007] In particular embodiment of the invention, the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and a titanium carbon nitride, thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit.

[0008] In yet another particular embodiment of the invention, the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and further comprising titanium carbon nitride (TiCN) or titanium aluminium nitride (TiAlN or AlTiN) or graphite or a combination thereof, thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit.

[0009] In another aspect, the method of present invention provides that the wire leaves the vessel at a lower outlet having a diameter which is only a few larger than

the diameter of the wire, a layer being 1 to 5 mm.

[0010] In yet another aspect, the method of present invention provides that the vessel is filled with an aqueous coating material.

[0011] In yet another aspect, the method of present invention provides that the vessel is filled with an aqueous medium comprising a water-soluble synthetic polymer coating material.

[0012] In yet another aspect, the method of present invention provides that the wire after the coating vessel passes through a drying unit. Hereby the coating vessel the wire can pass through a drying unit which comprises a wire guidance channel or a drying pipe. Hereby the wire after leaving the vessel can be transported through a pipe where a hot airstream for instance through an air drier.

[0013] In yet another aspect, the method of present invention provides that the velocity of the wire transport is computer-steered and wire passes a wire guidance channel or a drying pipe with a length that is adapted so that the coating can sufficiently dry on its way through the pipe or guidance.

[0014] In yet another aspect, the method of present invention provides that the wire is passed through a first coating vessel leaving the first vessel through its outlet aperture, thereafter through a drying unit, thereafter through a second coating vessel leaving the second vessel through its outlet aperture and finally through a drying unit.

[0015] In yet another aspect, the method of present invention provides that the wire already covered with the dried functional coating is again transported through a second vessel with another aqueous coating material wire leaves the new vessel again at a lower outlet of the second vessel.

[0016] In yet another aspect, the method of present invention provides that the water-soluble synthetic polymer coating material is the water-soluble synthetic polymer polyvinylalcohol (also known as PVOH, PVA, or PVAL).

[0017] In yet another aspect, the method of present invention provides that the polyvinylalcohol is crosslinked for enhancing water-resistance of the coating material.

[0018] By using the inventive method it is possible to produce textile wire that is at its elongate surface completely surrounded by the coating material.

[0019] By using the inventive method it is possible to produce textile wire that is at its elongate surface completely surrounded by the coating material in a continuous process and to have the textile comprising a conductive layer coat surrendered by a non-conductive outer or surface coat. Moreover by using the inventive method it is possible to produce coated textile wires with hydrophilic coatings in a high-throughput manufacturing process.

[0020] In yet another aspect, the method of present invention provides that no pressure extrusion is used and the application is at room temperature.

[0021] In an advantageous embodiment, the method according to the present invention further comprises that the coated wire is winded-up at another for instance on a motorized bobbin.

Detailed Description

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0022] Present invention involves a method for applying hydrophilic coatings comprising a bobbin which continuously releases the raw wire that is via a computer-steered motor transported through a vessel containing the raw, aqueous coating material. In this way, the wire is completely surrounded by the coating material. The wire leaves the vessel at a lower outlet having a diameter which is only a few larger than the diameter of the wire. This can furthermore comprise that the wire after leaving the vessel is freely transported through a pipe where a hot airstream is present created by a dedicated air drier. The velocity of the computer-steered wire transport and the length of the drying pipe is optimised that the coating can sufficiently dry on its way through the pipe.

[0023] In a particular embodiment the wire already covered with the dried functional coating is again transported through a second vessel with another aqueous coating material, e.g. a new, protective coating. Also here, the wire is completely surrounded by the new coating material. The wire leaves the new vessel again at a lower outlet having a diameter which is only a few larger than the diameter of the coated wire.

[0024] Another particular aspect of the invention is that the wire after leaving the vessel is freely transported through a pipe where a hot airstream is present created by a dedicated air drier.

[0025] The velocity of the computer-steered wire transport and the length of the drying pipe is optimised that the coating can sufficiently dry on its way through the pipe.

[0026] Particular suitable for the system of coating is a to use raw wire comprises an outer material made of hydrophilic textile enabling appropriate coating of the wire regarding its wetting properties and a homogenous distribution of the coating around on the wire surface.

[0027] Finally another aspect of the invention can be that the coated wire is winded-up at another, e.g. motorized bobbin.

Drawing Description

[0028] FIG. 1 is a graphic that shows the set-up of the mechanism where the coating with a sensitive material, such as Titanium Carbon Nitride (TiCN) and a water-soluble synthetic polymer such as Poly(vinyl alcohol) (PVOH, PVA, or PVAI). The graphic displays a deflection sheave 1, the first vessel 2 for coating material, the first pipe or channel with drying facility 3, the second vessel

for coating material 4, the second pipe or channel with drying facility 5, the computer steered motorized bobbin for receiving the double coated wire 6 and the bobbin for receiving the raw or the to be coated wire 7. The values 400, 15, 100 and 40 are optional distances in cm.

Claims

1. A method of coating a wire with an outer insulation coating and an inner conductive coating between said wire and outer insulation coating, **characterized in that** the to be coated wire comprises an outer material made of hydrophilic textile and further **characterized in that** this wire is passed through a first coating vessel comprising an aqueous medium comprising a water-solution of a conductive coating material, followed by a respective drying unit, thereafter through a second coating vessel comprising an solution of a non-conductive polymer coating material and finally again through a drying unit.
2. A method of coating a wire comprising an outer material made of hydrophilic textile, **characterised in that** 1) the to be coated wire is released over a bobbin into a first vessel comprising an aqueous medium comprising a water-solution of a conductive polymer coating material and further comprising a non-conductive material, 2) through an aperture at the bottom of said vessel, said outlet aperture having a diameter size value that is the value of the thickness of the wire and the thickness new coating, through 3) a first wire guide drying channel into 4) a second vessel comprising a comprising an aqueous medium comprising a water-soluble non-conductive material, 5) through an aperture at the bottom of said vessel, said outlet aperture having a diameter size value that is the value of the thickness of the wire and the thickness new second coating and 6) through a second wire guide drying channel onto a receiving bobbin.
3. The method according to any one of the previous claims 1 to 2, whereby the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and further comprising titanium carbon nitride (TiCN) or titanium aluminium nitride (TiAlN or AlTiN) or further comprising graphite, thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit.
4. The method according to any one of the previous claims 1 to 3, whereby the wire is passed through a first coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and a titanium carbon nitride, thereafter through a drying unit, thereafter through a second coating vessel comprising an aqueous medium comprising a water-soluble synthetic polymer coating material and finally through a drying unit.
5. The method according to any one of the claims 1 to 4, whereby the velocity of the wire transport is computer-steered and wire passes a wire guidance channel or a drying pipe with a length that is adapted so that the coating can sufficiently dry on its way through the pipe or guidance.
6. The method according to any one of the previous claims 1 to 5, whereby the wire is passed through a first coating vessel leaving the first vessel through its outlet aperture, thereafter through a drying unit, thereafter through a second coating vessel leaving the second vessel through its outlet aperture and finally through a drying unit.
7. The method according to any one of the previous claims 1 to 6, wherein the wire already covered with the dried functional coating is again transported through a second vessel with another aqueous coating material wire leaves the new vessel again at a lower outlet of the second vessel.
8. The method according to any one of the previous claims 1 to 7, whereby the water-soluble synthetic polymer coating material is the water-soluble synthetic polymer polyvinylalcohol (also known as PVOH, PVA, or PVAL).
9. The method according to claim 8, whereby the polyvinylalcohol is crosslinked for enhancing water-resistance of the coating material.
10. The method according any one of the previous claims to produce textile wire that is at its elongate surface completely surrounded by the coating material.
11. The method according to any one of the previous claims 1 to 10, whereby no pressure extrusion is used and the application is at room temperature.
12. The method according to any one of the previous claims 1 to 11, to produce coated wires in a high-throughput manufacturing process.
13. The method according to any one of the previous claims 1 to 11 to produce coated wires with hydrophilic coatings in a high-throughput manufacturing process.
14. The use of method according to any one of the previous claims, to manufacture a wire shaped sensor.

Patentansprüche

1. Verfahren zum Beschichten eines Drahtes mit einer äußeren Isolierungsbeschichtung und einer inneren leitfähigen Beschichtung zwischen dem Draht und der äußeren Isolierungsbeschichtung, **dadurch gekennzeichnet, dass** der zu beschichtende Draht ein Außenmaterial aus hydrophilem Textil umfasst und ferner **dadurch gekennzeichnet, dass** dieser Draht durch einen ersten Beschichtungsbehälter, der ein wässriges Medium umfasst, das eine wässrige Lösung eines leitfähigen Beschichtungsmaterials umfasst, gefolgt von einer entsprechenden Trocknungseinheit, danach durch einen zweiten Beschichtungsbehälter, der eine Lösung eines nichtleitenden polymeren Beschichtungsmaterials umfasst, und schließlich wieder durch eine Trocknungseinheit geführt wird.

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2. Verfahren zum Beschichten eines Drahts, der ein Außenmaterial aus hydrophilem Textil umfasst, **dadurch gekennzeichnet**, 1) dass der zu beschichtende Draht über eine Spule in ein erstes Gefäß freigegeben wird, das ein wässriges Medium umfasst, das eine Wasserlösung eines leitfähigen Polymerbeschichtungsmaterials umfasst und ferner ein nichtleitendes Material umfasst, 2) durch eine Öffnung auf der Unterseite des Gefäßes, wobei die Auslassöffnung einen Wert für die Größe des Durchmessers aufweist, welcher der Wert der Dicke des Drahts und der Dicke der neuen Beschichtung ist, durch 3) einen ersten Drahtführungstrocknungskanal in 4) ein zweites Gefäß, das ein wasserlösliches, nichtleitendes Material umfassendes wässriges Medium aufweist, 5) durch eine Öffnung an der Unterseite des Gefäßes, wobei die Auslassöffnung einen Wert für die Größe des Durchmessers aufweist, der dem Wert der Dicke des Drahtes und der Dicke der neuen zweiten Beschichtung entspricht, und 6) durch einen zweiten Drahtführungstrocknungskanal auf eine empfangende Spule.

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3. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 2, wobei der Draht durch einen ersten Beschichtungsbehälter, der ein wässriges Medium umfasst, das ein wasserlösliches synthetisches Polymerbeschichtungsmaterial umfasst und ferner Titankohlenstoffnitrid (TiCN) oder Titanaluminiumnitrid (TiAlN oder AlTiN) oder ferner Graphit umfasst, danach durch eine Trocknungseinheit, danach durch einen zweiten Beschichtungsbehälter, der ein wässriges Medium umfasst, das ein wasserlösliches synthetisches Polymerbeschichtungsmaterial umfasst, und schließlich durch eine Trocknungseinheit geführt wird.

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4. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 3, wobei der Draht durch einen ersten Beschichtungsbehälter, der ein wässriges Medium umfasst, das ein wasserlösliches synthetisches Polymerbeschichtungsmaterial und einem Titankohlenstoffnitrid umfasst, danach durch eine Trocknungseinheit, danach durch einen zweiten Beschichtungsbehälter, der ein wässriges Medium umfasst, das ein wasserlösliches synthetisches Polymerbeschichtungsmaterial umfasst, und schließlich durch eine Trocknungseinheit geführt wird.

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5. Verfahren nach einem der Patentansprüche 1 bis 4, wobei die Geschwindigkeit des Drahttransports rechnergesteuert ist und der Draht einen Drahtführungs Kanal oder ein Trocknungsrohr mit einer Länge passiert, die so angepasst ist, dass die Beschichtung auf ihrem Weg durch das Rohr oder die Führung ausreichend trocknen kann.

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6. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 5, wobei der Draht durch einen ersten Beschichtungsbehälter, der den ersten Behälter durch seine Auslassöffnung verlässt, danach durch eine Trocknungseinheit, danach durch einen zweiten Beschichtungsbehälter, der den zweiten Behälter durch seine Auslassöffnung verlässt, und schließlich durch eine Trocknungseinheit geführt wird.

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7. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 6, wobei der bereits mit der getrockneten Funktionsschicht überzogene Draht erneut durch ein zweites Gefäß mit einem anderen wässrigen Beschichtungsmaterial transportiert wird, wobei der Draht das neue Gefäß an einem unteren Auslass des zweiten Gefäßes wieder verlässt.

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8. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 7, wobei das wasserlösliche synthetische Polymer-Beschichtungsmaterial der wasserlösliche synthetische Polymer Polyvinylalkohol (auch bekannt als PVOH, PVA oder PVAL) ist.

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9. Verfahren nach Patentanspruch 8, wobei der Polyvinylalkohol zur Verbesserung der Wasserbeständigkeit des Beschichtungsmaterials vernetzt wird.

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10. Verfahren nach einem der vorhergehenden Patentansprüche zur Herstellung von Textildraht, der an seiner länglichen Oberfläche vollständig von dem Beschichtungsmaterial umgeben ist.

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11. Verfahren nach einem vorhergehenden Patentanspruch 1 bis 10, wobei keine Druckextrusion verwendet wird und die Anwendung bei Raumtemperatur erfolgt.

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12. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 11, um beschichtete Drähte in ei-

nem Hochdurchsatz-Herstellungsverfahren herzustellen.

13. Verfahren nach einem der vorhergehenden Patentansprüche 1 bis 11, um beschichtete Drähte mit einer hydrophilen Beschichtung in einem Hochdurchsatz-Herstellungsverfahren herzustellen.
14. Verwendung des Verfahrens nach einem der vorhergehenden Patentansprüche, um einen drahtförmigen Sensor herzustellen.

Revendications

1. Procédé de revêtement d'un fil avec un revêtement d'isolation extérieure et un revêtement conducteur intérieur entre ledit fil et le revêtement d'isolation extérieure, **caractérisé en ce que** le fil à revêtir comprend un matériau extérieur en textile hydrophile et **caractérisé en outre en ce que** ce fil passe par un premier récipient de revêtement comprenant un milieu aqueux comprenant une solution aqueuse d'un matériau de revêtement conducteur, suivi par une unité de séchage respective, puis par un second récipient de revêtement comprenant une solution d'un matériau de revêtement polymère non conducteur et enfin à nouveau par une unité de séchage.
2. Procédé de revêtement d'un fil comprenant un matériau extérieur en textile hydrophile, **caractérisé en ce que** 1) le fil à revêtir est libéré sur une bobine dans un premier récipient comprenant un milieu aqueux comportant une solution aqueuse d'un matériau de revêtement polymère conducteur et comprenant en outre un matériau non conducteur, 2) par une ouverture au fond dudit récipient, ladite ouverture de sortie ayant une valeur de taille de diamètre qui est la valeur de l'épaisseur du fil et du nouveau revêtement, par 3) un premier canal de séchage de guide-fil dans 4) un second récipient comprenant un milieu aqueux comportant un matériau non conducteur soluble dans l'eau, 5) par une ouverture au fond dudit récipient, ladite ouverture de sortie ayant une valeur de taille de diamètre qui est la valeur de l'épaisseur du fil et du nouveau second revêtement et 6) par un second canal de séchage de guide-fil sur une bobine réceptrice.
3. Procédé selon l'une quelconque des revendications précédentes 1 à 2, dans lequel le fil passe par un premier récipient de revêtement comprenant un milieu aqueux comprenant un matériau de revêtement polymère synthétique hydrosoluble et comprenant en outre du nitrure de carbone de titane (TiCN) ou de nitrure d'aluminium de titane (TiAlN ou AlTiN) ou comprenant en outre du graphite, puis par un second récipient de revêtement comprenant un milieu

aqueux comprenant un matériau de revêtement polymère synthétique hydrosoluble et enfin par une unité de séchage.

4. Procédé selon l'une des revendications précédentes 1 à 3, par laquelle le fil passe par un premier récipient de revêtement comprenant un milieu aqueux comprenant un matériau de revêtement polymère synthétique hydrosoluble et un nitrure de carbone de titane, ensuite par une unité de séchage, puis par un second récipient de revêtement comprenant un milieu aqueux comprenant un matériau de revêtement polymère synthétique hydrosoluble et enfin par une unité de séchage.
5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel la vitesse du transport de fil est pilotée par ordinateur et le fil passe dans un canal de guidage de fil ou un tuyau de séchage avec une longueur qui est adaptée de sorte que le revêtement peut suffisamment sécher sur son chemin à travers le tuyau ou le guidage.
6. Procédé selon l'une quelconque des revendications précédentes 1 à 5, dans lequel le fil passe par un premier récipient de revêtement quittant le premier récipient par son ouverture de sortie, ensuite par une unité de séchage, puis par un second récipient de revêtement quittant le second récipient par son ouverture de sortie et enfin par une unité de séchage.
7. Procédé selon l'une quelconque des revendications précédentes 1 à 6, dans lequel le fil déjà recouvert du revêtement fonctionnel séché est à nouveau transporté par un second récipient avec un autre matériau de revêtement aqueux ; le fil quitte à nouveau le nouveau récipient à une sortie inférieure du second récipient.
8. Procédé selon l'une quelconque des revendications précédentes 1 à 7, dans lequel le matériau de revêtement polymère synthétique hydrosoluble est le polymère synthétique hydrosoluble l'alcool polyvinylique (également connu sous le nom de PVOH, PVA ou PVAL).
9. Procédé selon la revendication 8, dans lequel l'alcool polyvinylique est réticulé pour améliorer la résistance à l'eau du matériau de revêtement.
10. Procédé selon l'une quelconque des revendications précédentes pour produire un fil textile qui est à sa surface allongée complètement entouré par le matériau de revêtement.
11. Procédé selon l'une quelconque des revendications précédentes 1 à 10, dans lequel aucune extrusion sous pression n'est utilisée et l'application se fait à

température ambiante.

12. Procédé selon l'une quelconque des revendications précédentes 1 à 11, pour produire des fils revêtus dans un processus de fabrication à haut débit. 5
13. Procédé selon l'une quelconque des revendications précédentes 1 à 11, pour produire des fils revêtus d'un revêtement hydrophile dans un processus de fabrication à haut débit. 10
14. Utilisation du procédé selon l'une quelconque des revendications précédentes, pour fabriquer un capteur en forme de fil. 15

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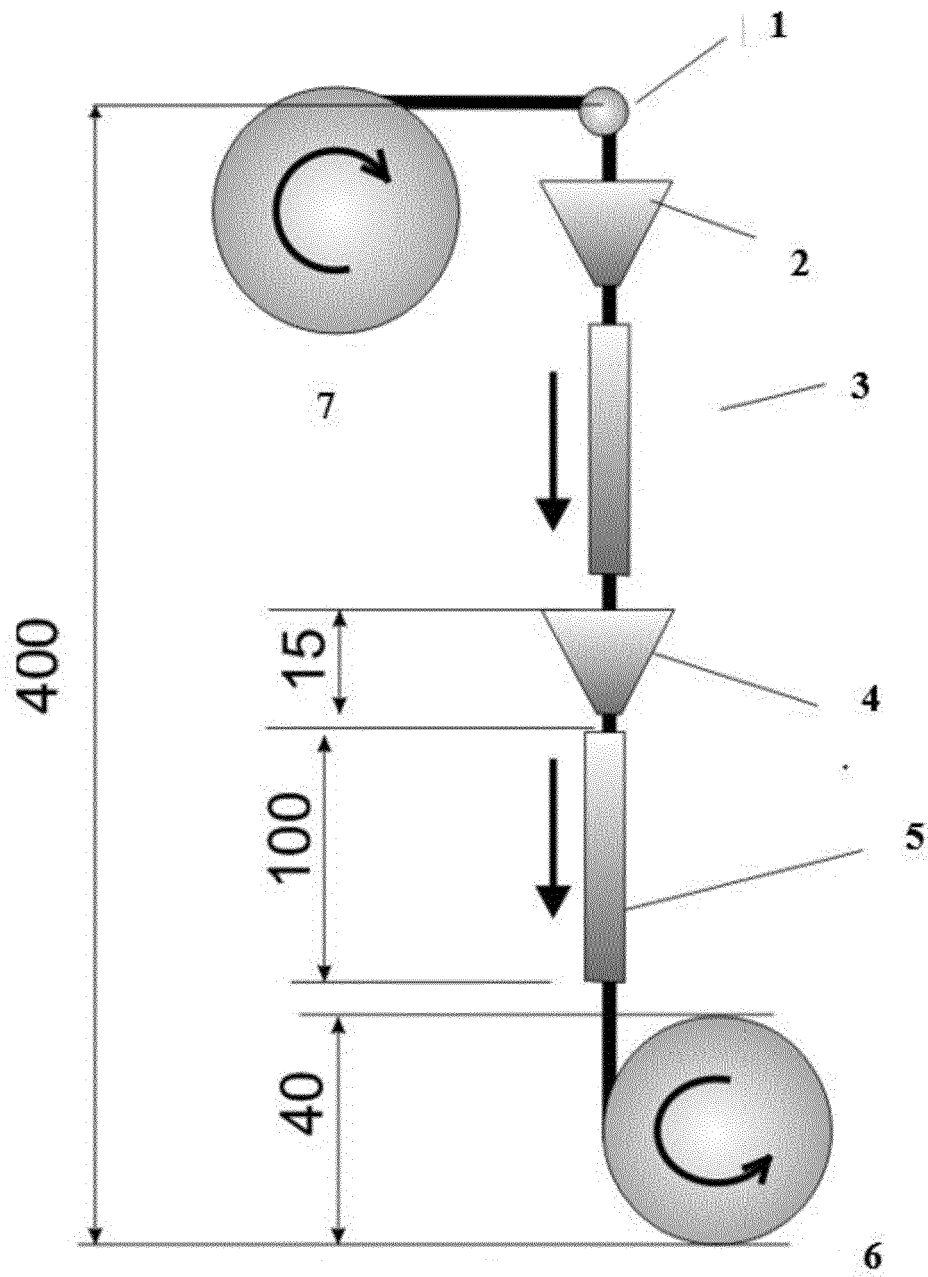
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Fig 1.



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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