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(71) Applicant: **SAVIO S.p.A.**
Via Udine 105
I-33170 Pordenone(IT)

(72) Inventor: **Montali, Sergio**
Via Garibaldi 106
I-33080 Roveredo in Piano, Pordenone(IT)

Inventor: **Ferro, Francesco**
Via Grado 5
I-33170 Pordenone(IT)

Inventor: **Colli, Luigi**
Via Azzano X, 30
I-33170 Pordenone(IT)

(74) Representative: **De Carli, Erberto et al**
ING. BARZANO' & ZANARDO MILANO S.p.A.
Via Borgonuovo, 10
I-20121 Milano(IT)

(54) Improved open-end spinning machine.

(57) An open-end spinning machine consisting of a plurality of rotor spinning stations to which feed sliver is fed by a rotary roller driven by a stepping motor which converts the electrical signals supplied to it into rotations which are controlled in terms of direction, speed and position.

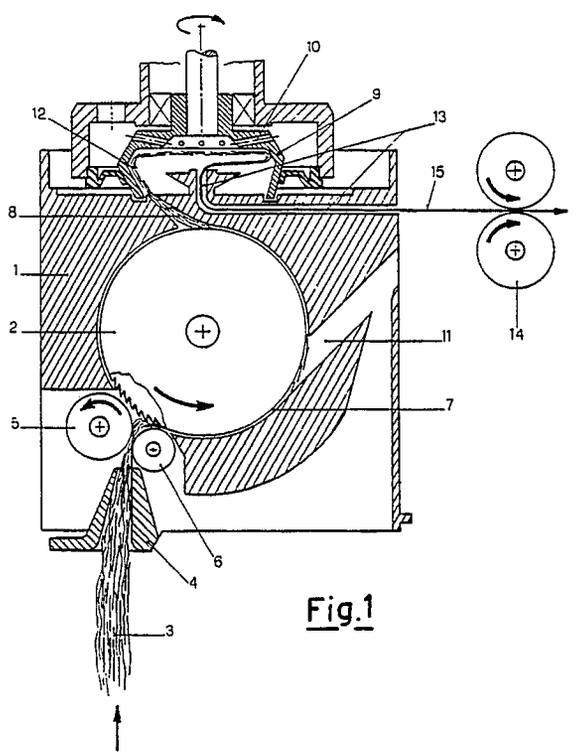

Fig.1

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IMPROVED OPEN-END SPINNING MACHINE

This invention relates to an improvement in open-end spinning machines and more particularly to an improvement in the feed device for the fibre sliver from which the yarn is produced. The open-end spinning process consists essentially of the following stages:

- feeding the fibre sliver to the spinning station by a feed roller;
- unravelling the sliver by a toothed-profile carder which rotates at high speed and separates the sliver into individual fibres;
- pneumatically feeding the individual fibres to the hollow spinning rotor which is provided with an inner groove within which the fibres are deposited in layers by the effect of the centrifugal force generated by the rotor rotating at a very high speed of up to 100,000 r.p.m.;
- initially inserting an already formed yarn through a channel located substantially on the axis of rotation of the motor, centrifugal force propelling its free end to the periphery, ie into the groove where it encounters the fibre layer; on drawing out the yarn the fibres become joined to the yarn, acquiring twist in the section between the groove and the exit channel to produce new yarn.
- collecting the thus produced new yarn by winding it on bobbins driven by a drive roller. The yarn production process and the characteristics of the produced yarn are essentially governed by the speed of rotation of the following members:
- feed roller
- spinning rotor
- collection bobbin

which must rotate at speeds which are in proper and constant mutual ratio, to obtain a constant product having the desired characteristics.

An open-end spinning machine generally consists of a plurality of spinning units aligned along the machine face. The essential components of a spinning unit will now be described with reference to a typical embodiment shown schematically by way of non-limiting example in Figure 1.

The spinning unit consists of a fixed support 1 in which the rotary carder 2 is positioned, provided along its outer cylindrical surface with saw-toothing to separate the fibres of the feed sliver.

The fibre sliver 3, originating from an underlying chamber not shown on the figure, is fed via a fixed guide 4 by the feed roller 5 which rotates in an anticlockwise direction in order to feed the sliver towards the carder 2.

The feed roller 5 is preferably provided with knurling on its cylindrical surface to increase the dragging effect on the sliver, contact between the sliver 3 and roller 5 being ensured by a counter-roller 6 the surface of which is kept in proximity to, but not in contact with, the cylindrical surface of the roller 5 by a suitable pneumatic or elastic device not shown on the figure, so that the sliver 3 is guided into engagement with the cylindrical surface of the roller 5.

During normal spinning, the feed roller 5 is driven by a shaft transmission or equivalent device, whereas the roller 6 can either be driven to rotate coherently with the roller 5 or be kept idle so that it is rotated by the actual sliver 3 fed to the carder 2 by the roller 5.

Figure 1 shows an embodiment comprising only one counter-roller 6, but two or more counter-rollers 6 can be incorporated to guide the sliver 3 into adherence with the cylindrical surface of the feed roller 5 along a more or less extended sector.

In this manner the sliver 3 is fed to the carder 2, which separates it into individual fibres.

The individual fibres travel through the interspace 7 surrounding the carder 2 and are conveyed pneumatically through the channel 8 to the cavity of the rotor 9, which rotates at very high speed. A vacuum is generated within the cavity of the rotor 9 by the effect of its speed and the perforations 10, or by the action of a separate suction source, and sucks the fibres separated by the carder 2, withdrawing air both from the interspace 7 and through the aperture 11.

Inside the rotor 9 the fibres are subjected to high centrifugal force and are urged towards the periphery where they collect in the annular groove 12 to form a layer of suitable size. An already formed yarn is then inserted through the channel 13 at the commencement of spinning. Its free end is urged by centrifugal force to the periphery of the rotor where it encounters the fibre layer, the yarn then being withdrawn for example by a pair of rollers 14.

The fibres join to the inserted yarn and acquire twist along the path between the annular groove and the axis of the rotor 9, where the exit channel 13 is located.

The produced yarn 15 is extracted and collected in packages or bobbins downstream of the rollers 14, not shown on the figure. In some arrangements the counter-roller 6 can be replaced by a shoe urged elastically into the proximity of 5, to keep the sliver 3 always adhering to the feed roller 5. Such an arrangement is shown in Figure 2.

The open-end spinning machine consists of a plurality of spinning units and a control bock which contains the drive motors for the spinning unit members (feed, spinning rotor, yarn collection), to which the drive is distributed by long longitudinally-

extending shafts, a control computer, the centralized services (such as tube loading and bobbin doffing devices), the controls and the alarms. In the automatic versions the spinning machine is also provided with a service carriage which patrols along the machine face to automatically effect the service cycles which have to be carried out at the various spinning units, such as yarn rejoining, doffing of finished bobbins and their replacement with new tubes, cleaning of spinning rotors etc.

As a consequence of the general architecture of the machine as heretofore described, the operational characteristics of the spinning machine are affected by a certain rigidity deriving from the fact that in all the constituent spinning units of the spinning machine there is only one working speed for each of the various members, which are therefore in a relationship of constant speed ratios.

This inflexibility means for example that if it is required to change the working speed of the spinning machine in order to produce a yarn of different characteristics, the transmission ratios in the end of the machine have to be changed, with the result that all the spinning units along the machine face must simultaneously produce the same yarn.

The biggest drawback deriving from the operational inflexibility of the spinning machine is encountered in the aforesaid service cycles.

During the service cycles it would be convenient to be able to vary both the value and the sign of the speed ratios between the various members of the spinning unit and to operate them at variable speed, vary their acceleration and deceleration and rotate them in the opposite direction.

Instead, the spinning machine architecture enables these members only to be engaged with or disengaged from their normal drive in accordance with an on-off logic by the use of clutches.

The aforesaid variations can be obtained only at the cost of considerable complication, by disengaging the members from their normal drive and driving them by motors or auxiliary drives provided in each spinning unit or on the service carriage. Such systems as these, which provide alternative drives for the spinning unit members to provide differentiation between normal production working, service cycle motion requirements and the various transient states between the service cycles and the cessation and restarting of normal production, are a source of considerable imprecision, both in synchronization and in the positions of the various members.

Of the various members of the spinning units, that which requires most variability of movement together with considerable precision in terms of speed, synchronization and position, is the roller which feeds the sliver to the separating carder.

In this respect, during normal production a constant yarn count is dependent on a constant sliver feed rate.

During yarn rejoining and restarting, the feed roller can be required to perform various functions.

One of these functions is that of prefeed, the purpose of which is to eliminate the damaged end of the sliver, which remains at rest and exposed to the action of the separating carder while waiting for the yarn rejoining operation and the restart of the spinning unit. This practice is described by Rohlena in the book Open-End Spinning of 1974.

Another function of the feed roller is to retract the sliver by counter-rotating the roller to withdraw it from the action of the carder both while waiting for and during the rejoining cycle, the subject of copending patent applications by the present applicant. A further function of the feed roller is to progressively refeed the sliver during the starting of the spinning unit. For normal open-end spinning machines with only on-off drive of the feed roller, Italian patent No. 1,045,600 in the name of Stahlecker describes a pulsed operation which approximates to progressive refeeding by means of a stepped variation.

All the described drive operations, and in particular those during starting and during the rejoining cycle, must be effected with considerable precision in terms of synchronization, duration, angular position and speed.

In devices of the known art, this precision suffers considerably by depending on mechanical and electromechanical devices such as electromagnetic clutches, which are subject to hysteresis and slippage, taking account of the fact that the fine adjustments made to the service cycles are of the order of a hundredth of a second with regard to time and a few degrees with regard to the angular positions of the various rotary members.

The device according to the present invention consists essentially of an automatic open-end spinning machine in which the sliver feed roller is driven by a stepping motor in each spinning station, with centralized control by an electronic control system forming part of the computer provided with the spinning machine. The control exercised by the computer consists of feeding the various stepping motors in each spinning unit with electrical digital signals, these being converted by the stepping motor into rotations which are controlled in terms of direction, speed and position.

All the aforesaid functions which can be required of the feed roller, ie:

- rotation at constant speed,
- prefeed, ie rotational advancement through a determined angle,
- retraction, ie counter-rotation through a determined angle,
- progressive refeeding, ie restart of the roller in

accordance with a determined speed/time relationship, are implemented by the electronic control system, which generates the necessary electrical digital signals.

In addition to the great advantages of control precision of the feed roller in terms of both its speed and position, and of counter-rotation without the need for mechanical motion reversal devices, the present invention provides other considerable advantages.

One of these is that the spinning machine is no longer obliged to produce the same type of product on all the spinning units aligned along the spinning machine face, because the feed roller of each spinning unit can be operated independently.

A further advantage is that when it is required to vary the feed roller speed in the spinning machine, it is no longer necessary to adjust the mechanical transmission by changing gears and/or pulleys, it being sufficient for the stepping motor electronic control system to be provided with programs for varying the sequence of the digital electrical signals, to enable the feed rollers of the various spinning units to be moved as required.

There is the further advantage that as the stepping motor interacts with the electronic control system, the machine computer can know moment by moment how the motion and/or the position of the feed roller has responded to the commands fed by the electronic control system, and can provide any correcting instructions.

The present invention can comprise different locations for the stepping motor electronic control system in the case of automatic open-end spinning machines provided with service carriages which patrol the spinning stations arranged along the machine faces. The service carriages are designed for a number of automatic service cycles, such as doffing the bobbins of produced yarn and replacing them with empty tubes on which a new bobbin will be formed, rejoining the yarn following breakage, programmed cleaning of the rotors etc. Control of the feed roller 5 is generally required during the course of these service cycles.

The electronic control system for the stepping motors which drive the feed rollers can for example be entirely concentrated within the computer located in the end of the open-end spinning machine, and which interacts with the automatic systems of the service carriage. In such a case, during the service cycles undertaken by the service carriage in a determined spinning station, the feed roller 5 of this latter is made to rotate by the electronic control system in the end of the spinning machine in accordance with the speeds, directions of rotation and times required by the operations performed by the carriage automatic systems within a given service cycle.

Alternatively, the electronic control system for the stepping motors can for example be split, with the electronic system for controlling the feed roller stepping motors during normal spinning being located in the end computer, and the electronic system for controlling the feed roller stepping motor during the service cycles being located on the service carriage.

In such a case, when the service carriage reaches a spinning station in which a given service is required, the carriage becomes connected to the control line for the stepping motor of the feed roller 5 of the spinning station in question, to undertake the control of this roller instead of the computer, to which it returns control at the end of the cycle. In this manner, complete coordination of the service cycle is retained on the service carriage.

Finally, a further possible solution is to provide each open-end spinning station with a controlling microprocessor for the spinning station, which also contains an electrical control generator able to supply the electrical signals for operating the stepping motor both for normal operation and for the service cycles.

During these cycles the microprocessor interreacts with the electronic control system of the service carriage which controls the automatic systems on board. This interreaction is preferably via the central control unit located in the end of the open-end spinning machine.

The microprocessor located in each spinning station receives the set of working parameters from the end computer, controls the operation of the spinning unit in accordance with said parameters and feeds the central unit with the information required for data acquisition, the monitoring of the work carried out and the monitoring of the overall machine operation.

A typical embodiment of the device according to the invention is described hereinafter by way of example and is illustrated schematically in Figure 3.

The spinning stations, shown schematically in the figure, are provided with feed rollers 5 for the sliver 3, driven by stepping motors 16. Said motors are controlled by the electrical generators 17 which under the control of the microprocessor MP generate wave forms corresponding to the motion required of the roller 5. All the microprocessors MP are connected to the central control unit UC by the two-wire bidirectional serial line 18. This line allows communication in both directions.

The service carriage control unit UG is also provided with a serial line 19 for connection to UC.

The central unit UC performs essentially the functions of setting the working parameters in the spinning stations and service carriage, acquiring processing and operating data and monitoring their

response.

The control unit UC controls among other things the alarms and the starting and stopping of the spinning machine, and can put out of service those spinning stations which do not meet working standards in terms of yield and quality.

Among other things, the spinning machine according to the invention allows yarn rejoining cycles to be implemented by a method which represents an improvement to the known art, resulting in joints which are more uniform and reliable and a higher yarn quality, by varying the feed of the feed sliver in accordance with determined speed/time relationships. To better illustrate the advantages of the present invention from this aspect, a description is given by way of example of a yarn rejoining cycle implemented by the device according to the invention, the essential stages of the joining cycle being shown diagrammatically in Figure 4.

In diagram I the horizontal axis represents time t, which is common to all the illustrated stages, and the vertical axis represents the rotational speed of the feed roller 5, this being positive when advancing and negative when retracting.

Zero time corresponds to the occurrence of yarn breakage, with the yarn feed and winding halted, and thus the commencement of the rejoining cycle.

In diagram II the vertical axis represents the rotational speed of the rotor, which when under full working conditions can reach 100,000 r.p.m.

Diagram III represents the opening of the spinning unit.

Diagram IV represents the rotor cleaning stage.

In diagram V the vertical axis represents the speed of extraction of the produced yarn, which when under full working conditions is of the order of 150 metres per minute.

Prefeed is commenced at time t_1 to equalize the sliver 3, the end of which has remained exposed to deterioration by the carder 2, and is stopped at time t_2. The quantity of sliver consumed is proportional to the area A. It is preferably at least equal to the length of the damaged end, but no particular exact requirement is imposed because even if a slightly greater length is consumed there would be no prejudicial effect. By time t_2 the sliver has become whole.

At time t_3, which is very close to t_2, the roller 5 is rotated in the reverse direction and withdraws the sliver end from the action of the carder 2, so that said end remains whole.

As a possible modification to the procedure as described up to this point, these first two stages of the rejoining cycle, ie the prefeed and subsequent retraction of the sliver, can be replaced by prior retraction of the sliver end as soon as yarn breakage occurs, this forming the subject of a copending patent application by the present applicants.

At time t_4 the counter-rotation of the roller 5 is halted. The area B corresponds to the length of sliver retracted.

At time t_4 the spinning unit is opened, with simultaneous operation of the brake for the spinning rotor, which by time t_5 is at rest.

The rotor cleaning cycle is conducted with the rotor at rest and begins at time t_5, to terminate at time t_6.

Cleaning can also be effected with the rotor slowly rotating. When cleaning is complete, the spinning unit is reclosed at time t_7 and the rotor can be restarted, to reach its working speed at time t_8. At time t_9, by which the rotor is definitely up to speed, the operation of the roller 5 can be started, to refeed yarn.

By time t_{10} there have been deposited in the rotor the fibres required to form a new fibre layer in the rotor groove suitable for rejoining purposes, and corresponding substantially to the area C which represents the sliver fed since time t_9.

The fibre quantity deposited in the rotor can be adjusted either by adjusting the time gap t_{10}-t_9 or by adjusting the speed of the roller 5, an extremely precise time control not being critical as in the case of the prior art.

To effect rejoining, the yarn end is inserted into the rotor to fish out the new fibre layer at time t_{10}, at which rejoining occurs, and yarn extraction is resumed at working speed.

According to a preferred embodiment of the rejoining procedure, with the device of the present invention the rejoining at time t_{10} is immediately followed, until time t_{11}, by an increase in the feed speed of the roller 5 to give the rotor an excess feed of fibres and prevent the phenomenon of thinning of the produced yarn immediately downstream of the joint, as happens in the case of yarn produced by the known art when rejoining is carried out with the rotor at working speed.

The fact that the sliver feed can be adjusted with time in accordance with the present invention obviates the aforesaid phenomenon. It also allows the produced yarn, or portions of it, to be of variable predetermined dimensions.

Claims

1. An open-end spinning machine consisting of a plurality of spinning stations in which the fibre sliver is fed to the separating carder in each station by a rotary feed roller, characterised in that said rotary roller is driven by an electric stepping motor supplied with electrical signals, these being converted by the motor into rotations which are controlled in terms of direction, speed and position.

2. An open-end spinning machine as claimed in claim 1, characterised in that the electronic control system for the stepping motors is located in the computer forming the central control unit positioned in the end of the spinning machine.

3. An open-end spinning machine as claimed in claim 1, characterised in that the electronic system which controls the feed roller stepping drive motor during the service cycles of the service carriage in automatic spinning machines is located on the carriage.

4. An open-end spinning machine as claimed in claim 1, characterised in that the spinning stations are provided with controlling microprocessors which comprise an electrical generator for controlling the stepping motor both during normal operation and during the service cycles.

5. An open-end spinning machine as claimed in one or more of the preceding claims, characterised in that the controlling microprocessors located in the spinning stations are connected to the central control unit by serial lines.

6. An open-end spinning machine as claimed in one or more of the preceding claims, characterised in that the service carriage control unit is connected to the central control unit by a serial line, the interreaction between the controlling microprocessors located in the spinning stations and the service carriage control unit being via the central control unit.

7. A method for rejoining yarn in an automatic spinning machine claimed in one or more of the preceding claims, characterised in that the rejoining cycle comprises as its initial stages the prefeed and retraction of the sliver, by rotating the feed roller in opposite directions.

8. A method for rejoining yarn in an automatic spinning machine claimed in one or more of claims 1 to 6, characterised in that the yarn rejoining cycle comprises, conjointly with the insertion of the yarn end into the spinning rotor for reconnection to the new fibre layer and its extraction therefrom, a period in which the sliver is fed at a speed higher than the normal working speed.

9. A method for rejoining yarn in an automatic spinning machine as claimed in one or more of claims 7 and 8, characterised in that the stages of the rejoining cycle are carried out in accordance with the time sequence of Figure 4.

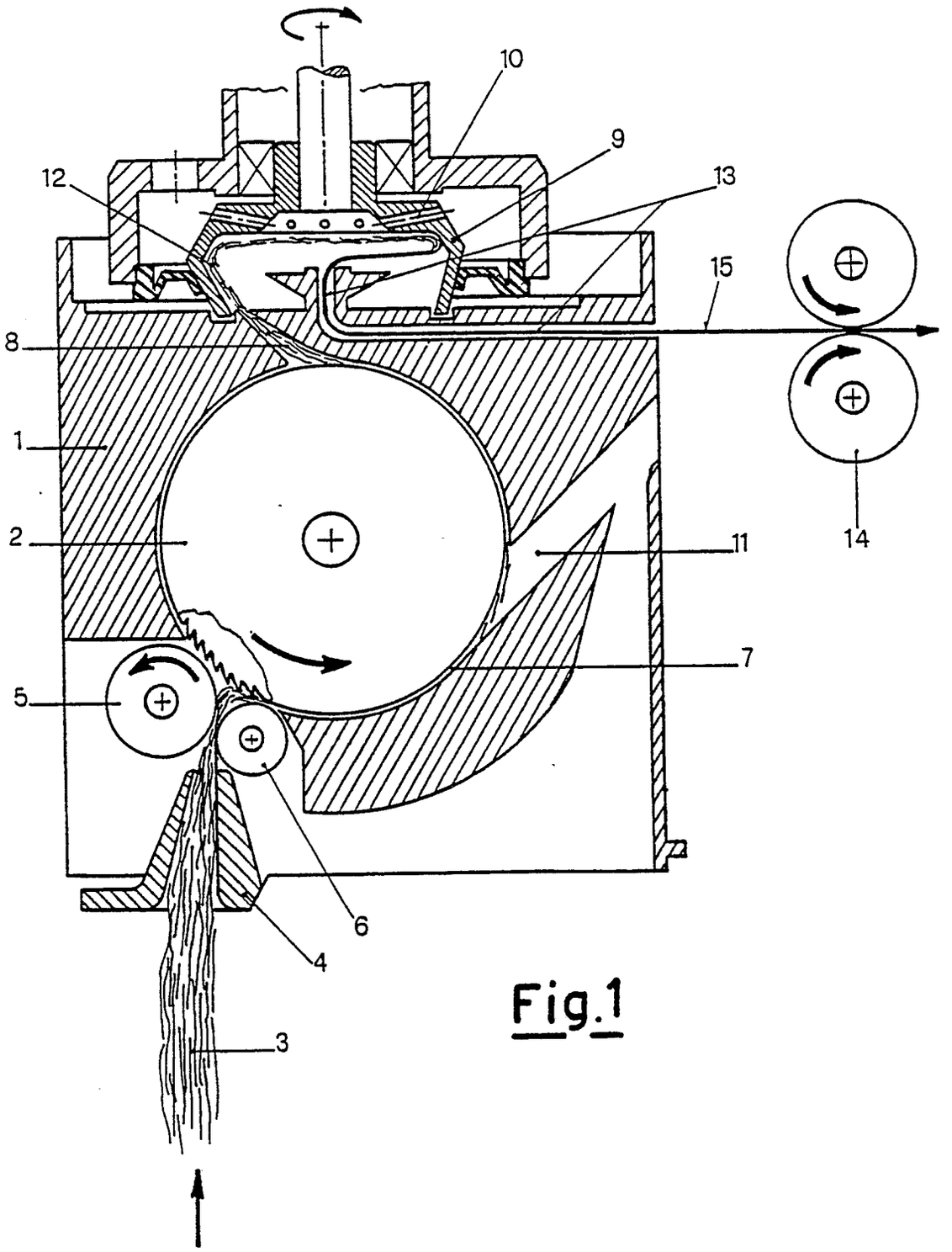

Fig.1

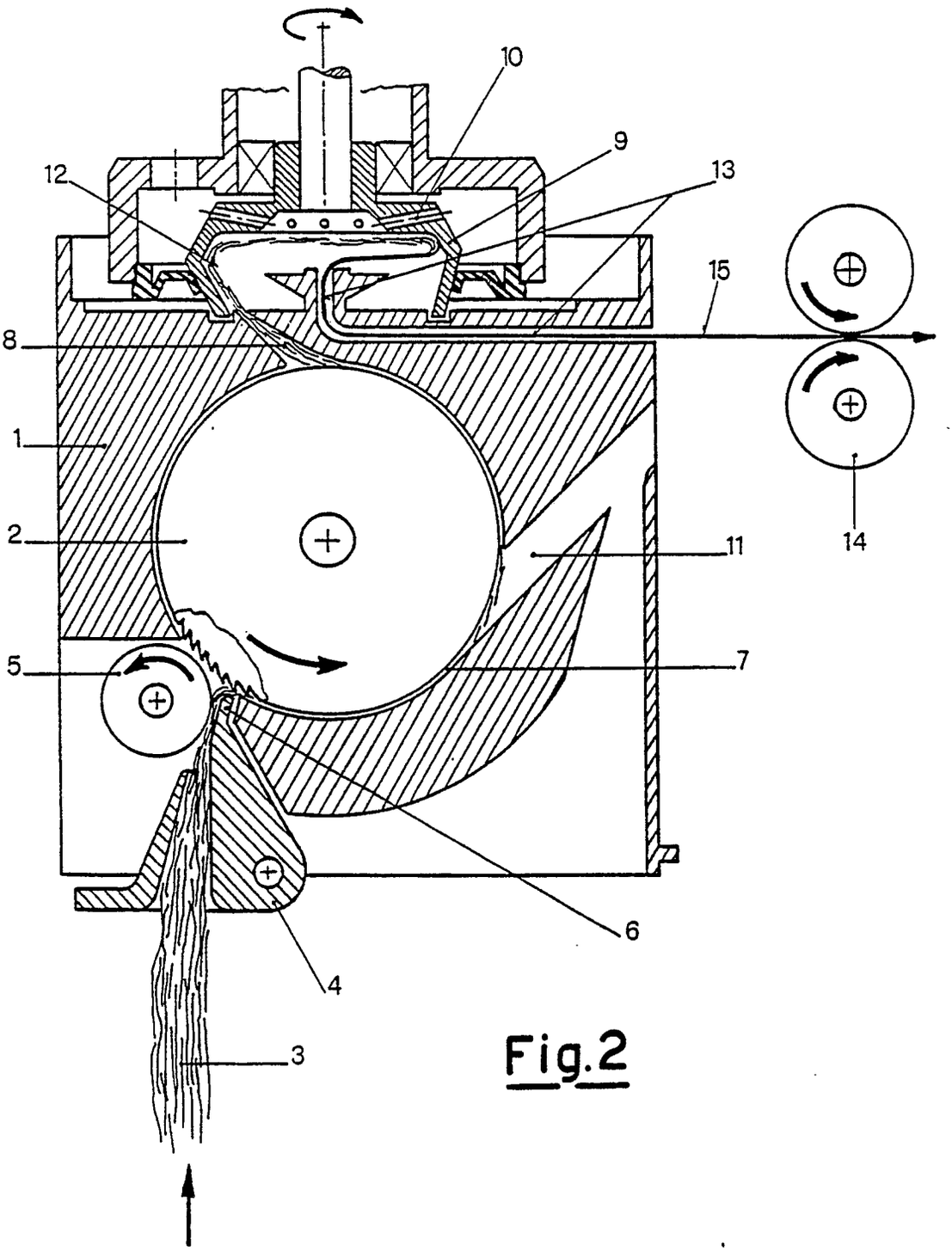

Fig.2

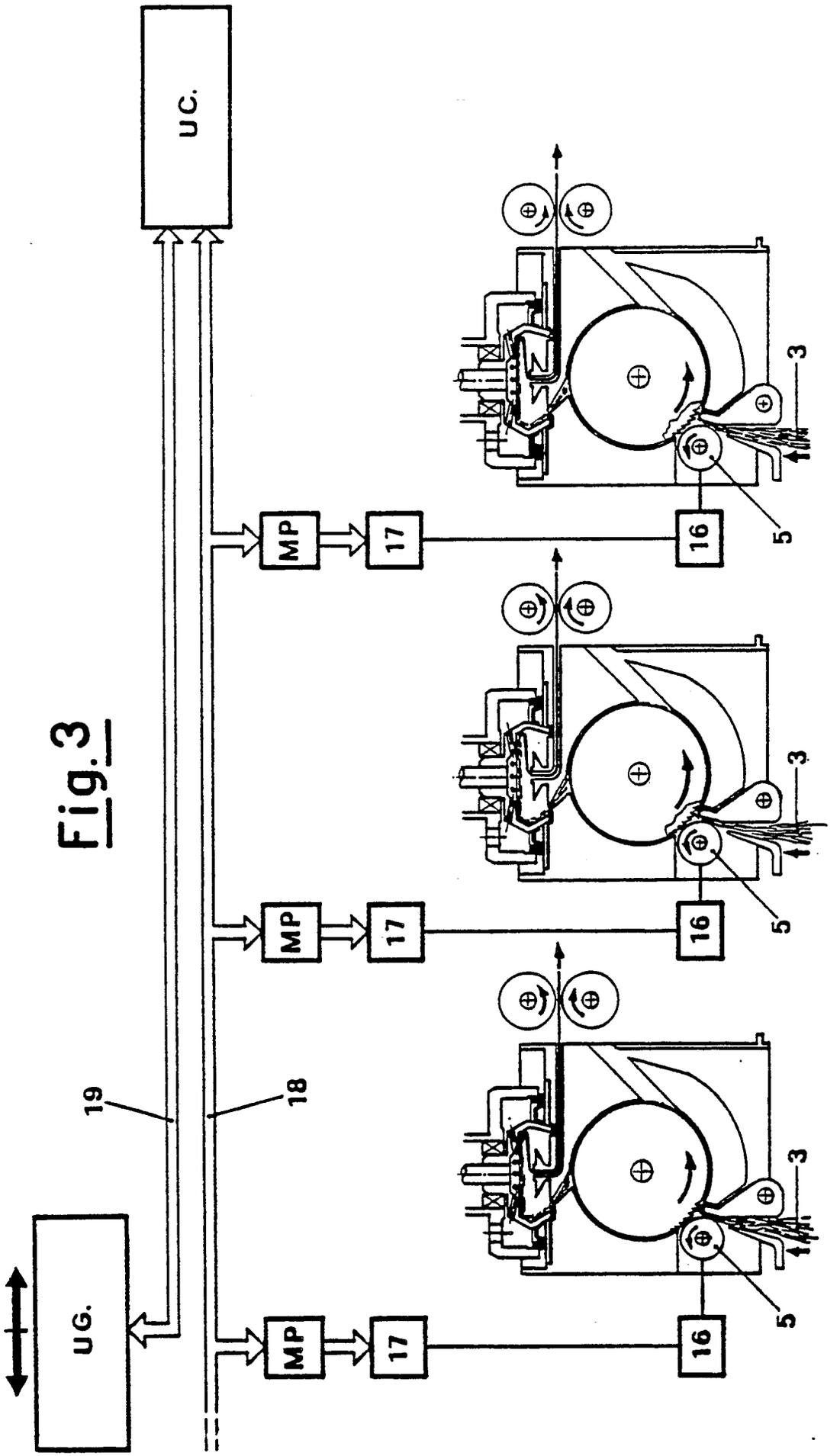

Fig.3

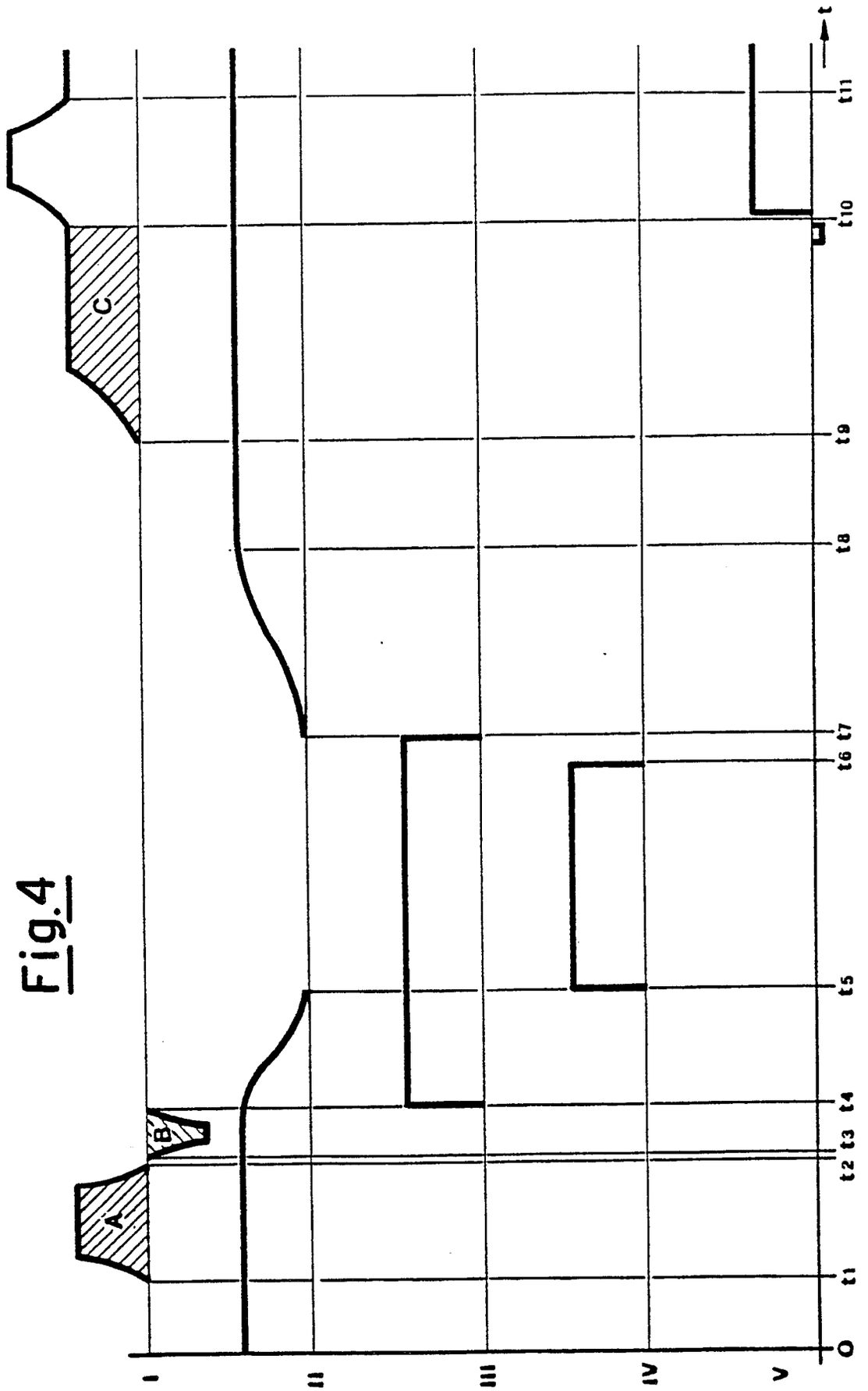

Fig.4

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EUROPEAN SEARCH REPORT

Application Number

EP 90 20 0389

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	FR-A-2301613 (W. SCHLAFHORST & CO) * claims 7, 8, 12, 15 * ---	1	D01H4/48 D01H13/18
Y	FR-A-2099555 (MASCHINENFABRIK RIETER A.G.) * page 4, lines 9 - 34; figures 5, 6 * ---	1	
A	GB-A-2109422 (W. REINERS VERWALTUNGS GMBH) * page 1, lines 44 - 108 * * page 2, line 4 - page 3, line 45 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 JUNE 1990	HOEFER W.D.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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