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(54) **Yarn feeder with rotary drum for knitting processes with selection of the yarn**

(57) A housing (12) supports a yarn-winding drum (22) which is driven to rotate by a motor (18) controlled by an electronic circuit (C) as a function of signals from a sensor tension (40) integral with the housing (12). The tension sensor (40) comprises a flexible member (42) arranged to interfere with the yarn unwinding from the yarn-winding drum (22) and to bend to a variable extent depending on the yarn tension. The flexible member (42) incorporates circuit means (R) that generate a variable output depending on the bent configuration of the flexible member. The housing (12) has a first peripheral surface (12a) and an opposed, second peripheral surface (12b) which have mutually engageable profiles and are provided with respective male/female connectors (52, 54) for mechanical/electrical connection of a plurality of identical feeders in a stacked configuration (80). The electronic circuit (C) is programmed to enable the motor (18) to unwind yarn in response to a deformation of the flexible member (42) with respect to a resting configuration corresponding to a predetermined, minimum tension, on the basis of setup instruction transferred via the connectors (52, 54).

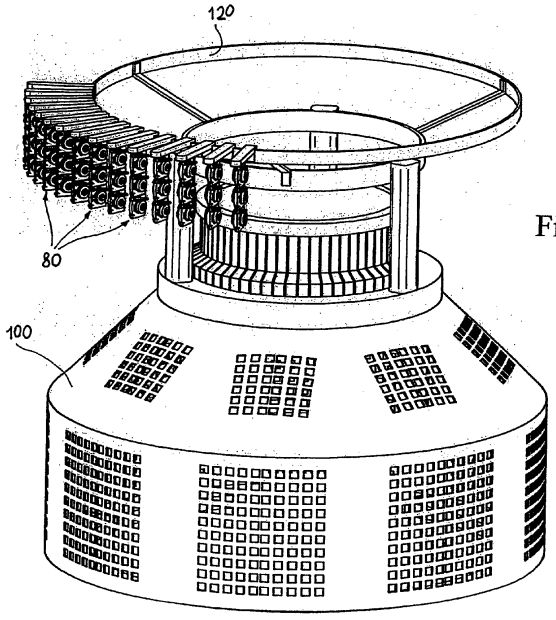

Fig. 4

EP 2 708 625 A1

Description

[0001] The present invention relates to a yarn feeder provided with a rotary drum for weaving processes with selection of the yarn, particularly for processes carried out by circular knitting machines of a "striper" type.

[0002] As known, a general "circular" knitting machine is designed to process a plurality of yarns unwinding in a substantially radial direction from a series of yarn feeders which are anchored to a horizontal annular frame supported coaxially above the machine.

[0003] In a relatively unexpensive type of feeder, the yarn is wound on a drum which is driven to rotate by the motor of the downstream machine via a belt drive, with a transmission ratio which is mechanically determined depending on the diameter of the pulleys forming the belt drive (so-called connection "in axis"). Due to this rigid, mechanical connection, with this system all the feeders are always active when the machine is running. Therefore, these feeders are only suitable for basic processes in which it is not required to select a yarn among a number of yarns.

[0004] In order to allow the above selection of yarns, e.g., for producing striped patterns by so-called "striper" circular knitting machines, a more sophisticated version of this type of feeder is known, e.g., from US 6,145,347, in which the feeder is provided with a number of drums, e.g., four drums, all of which are keyed to a single shaft which is driven to rotate via a belt drive likewise the previous case. Each drum has one of the yarns associated thereto, and also in this case the drums always rotate all together, along with the machine; however, when the feeder is at rest, the yarns are not entirely wound about the respective drums but they engage them only partially, so that there is no adhesion between the yarn and the drum. For the selection of a yarn, each drum has a lever associated thereto which can be operated to deviate the yarn in a direction such that it engages a larger portion of the respective drum and adheres to it, so that the yarn is delivered to the machine.

[0005] The above feeders driven by belt drives have the advantage that they are relatively unexpensive and, in the last-cited, more sophisticated version, they also provide for a selection of the yarn for use in combination with striper machines. However, adjusting the yarn-feeding speed and setting it as a function of the running speed of the machine is a very complex operation, which cannot be automated because it requires the intervention of an operator who must replace/adjust the components of the transmission (pulleys, belts, etc.).

[0006] Moreover, the feeders of the above type do not provide for any control of the tension of the delivered yarn, which circumstance limitates the quality of the weaving process considerably.

[0007] In order to overcome the above drawbacks, a plurality of computerized, motorized feeders (one per each yarn to be fed) could be used, such as the one described in EP 2 218 670A. With this type of feeder, the yarn is wound on a motorized drum whose speed is controlled by a circuit programmable via a control panel with display integrated into the feeder. The circuit receives a signal from a tension sensor and, via a feedback loop, modulates the speed of the drum accurately in such a way as to maintain the tension of the yarn (which depends on the difference between the yarn-feeding speed of the feeder and the yarn-drawing speed of the machine) substantially constant on a predetermined level.

[0008] However, the above solution is not cost effective, because the above-mentioned computerized feeders are very expensive and, therefore, their use is not justified in case of relatively basic processes such as those carried out by striper machines, mainly in consideration of the fact that a single machine is served by several tens of yarns, each of which is associated to a respective feeder.

[0009] In addition, this solution would be difficult to be put into practice, because the annular frames which are usually associated to circular knitting machines are not big enough to receive as many computerized feeders arranged side-by-side as they are required for such weaving processes.

[0010] Therefore, it is a main object of the present invention to provide a yarn feeder which, in combination with other identical feeders and in association with a circular knitting machines of the "striper" type, can be used to carry out processes with selection of the yarn in a more flexible and more accurate way with respect to conventional systems making use of multi-drum feeders driven by belt drives, thereby allowing the feeding speed, and consequently the tension, of each yarn to be adjusted regardless of the running speed of the downstream machine, but which is also considerably less expensive than a computerized, motorized feeder of the above-mentioned type, as well as suitably sized in relation to the capacity of conventional feeder-supporting frames associated to circular machines.

[0011] It is another object of the invention to provide a system which can be easily and flexibly modified depending on the requirements of a specific process, particularly in relation to the number of yarns which must be fed to the machine and to their feeding speeds.

[0012] The above objects and other advantages, which will better appear from the following description, are achieved by a yarn feeder having the features recited in claim 1, while the dependent claims state other advantageous, though secondary features of the invention.

[0013] The invention will be now described in more detail with reference to a few preferred, non-exclusive embodiments shown by way of non-limiting example in the attached drawings, wherein:

- Fig. 1 is a front view of a yarn feeder provided with a rotary drum according to the invention;
- Fig. 2 is a broken away, top view of the yarn feeder of Fig. 1;

- Fig. 3 is a perspective view showing an isolate component of the yarn feeder according to the invention;

- Fig. 4 is a perspective view showing a general circular knitting machine coupled to a plurality of yarn feeders according to the invention;

- Fig. 5 is a block diagram of a yarn-feeding apparatus provided with a plurality of yarn feeders according to the invention.

[0014] With reference to the above Figures, a yarn feeder 10 according to the invention comprises a hollow body or shell 12 molded in a synthetic material, which is comprised of a front panel 14 and a back cover 16.

[0015] Shell 12 houses a motor 18 (Fig. 2) provided with a driving shaft 20 which projects at right angles from front panel 14 of shell 12, and has a yarn-winding drum 22 keyed thereto.

[0016] An upper, peripheral surface 12a and an opposite, lower peripheral surface 12b of shell 12 are flat and lie on respective planes parallel to each other, as well as to the axis of the drum, so that they can respectively couple with the lower peripheral surface and the upper peripheral surface of two identical feeders, for connection of a plurality of feeders in a stacked configuration, as will be described in more detail below. The adjacent feeders in a stack are interconnected by screws (not shown) passing through holes such as 23 which are formed on respective anchor protrusions 24 projecting laterally from the four corners of shell 12.

[0017] Front panel 14 has an inlet yarn-guide eyelet 25 and an outlet yarn-guide eyelet 26 connected to it at respective opposite positions with respect to a centerline plane P which contains the axis of the drum and extends at right angles to the upper peripheral surface and the lower peripheral surface.

[0018] A loop-separing rod 38 projects from front panel 14, whose axis lies on centerline plane P and is slightly inclined towards the axis of the drum.

[0019] A tension sensor 40 of a type known per se, e.g., from EP 2067729, is arranged between loop-separing rod 38 and outlet yarn-guide eyelet 26. Tension sensor 40 is isolately shown in more detail in Fig. 3, and comprises a base 41 that supports a plate 42 having an anchor portion 42a attached to base 41 and an elongated, flexible portion 42b projecting from anchor portion 42a. A pad 43 attached to the free end of flexible portion 42b is adapted to be slidably engaged by the yarn unwinding from drum 22. Tension sensor 40 is arranged in such a way that pad 43 interferes with the path of the yarn running from drum 22 to outlet yarn-guide eyelet 26, so that flexible portion 42b bends in response to the variations of the yarn tension. Plate 42 has four resistors such as R (two on its upper face and two, not shown, on its lower face) embedded in the area which connects anchor portion 42a to flexible portion 42b, which resistors are interconnected to form a Wheatstone bridge which generates a variable output as a function of the bending of flexible portion 42b. The plate also incorporates another set of resistors, which is generally referred to as R', which are conventionally connected to set the Wheatstone bridge to zero and to compensate for the temperature of plate 42.

[0020] Yarn F, which is typically unwound from an upstream reel (not shown), passes through inlet yarn-guide eyelet 25, then is wound between drum 22 and yarn-separing pin 38 (which guides the yarn loops to shift towards the free end of drum 22 as they are wound in order to prevent overlapping of loops), slidably engages pad 43, passes through outlet yarn-guide eyelet 26, and finally is fed to the downstream machine. Shell 12 houses an electronic circuit C (only diagrammatically shown in Fig. 1) which is operatively connected to tension sensor 40, as well as to a USB male connector 52 projecting from upper peripheral surface 12a of shell 12, and to a corresponding USB female connector 54 opening to lower peripheral surface 12b. Circuit C is programmed to enable motor 18 to unwind yarn when tension sensor 40 detects that the tension of the yarn has increased because the downstream machine has started to draw yarn, and to stop the feed when the tension returns either to zero or to a predetermined, minimum value indicative of the fact that the downstream machine has ceased to draw yarn.

[0021] In particular, according to a first method of operation, motor 18 is driven to a constant speed set via USB, and continues to unwind yarn until tension sensor 40 returns to its resting position. Therefore, each sensor tension 40 essentially acts as a switch for the respective feeder.

[0022] According to a different method of operation; motor 18 is not simply enabled and driven to rotate at a constant speed, but it is driven by a conventional feedback loop embedded in electronic circuit C, which modulates its speed of rotation in such a way as to maintain the yarn tension substantially constant on a desired level set via USB, which tension, as mentioned above, depends on the difference between the yarn-drawing speed of the downstream machine and the yarn-feeding speed.

[0023] The feeder according to the invention is adapted to be connected in a stacked configuration to other identical feeders to form a stack 80 of three, four, or even more feeders. Fig. 4 shows a textile apparatus including a general circular knitting machine 100 provided with an annular feeder-supporting frame 120, to which a plurality of stacks 80 as above are anchored in place of belt-driven, multi-drum feeders of the type conventionally used until today. In Fig. 4, for better clarity of illustration, only a portion of annular frame 120 is occupied by stacks of feeders, but it should be understood that annular 120 is normally intended to be fully occupied by stacks of feeders.

[0024] The block diagram of Fig. 5 illustrates a yarn-feeding apparatus comprising a number m of stacks of feeders according to the invention, where each feeder is

identified by an address $A_{1,1}$, $A_{1,2}$, $A_{1,3}$, $A_{2,1}$, $A_{2,2}$, $A_{2,3}$, ..., $A_{m,1}$, $A_{m,2}$, $A_{m,3}$, with the first subscript indicating the stack to which the specific feeder belongs, and the second subscript indicating the position of the feeder in the respective stack. As a result, all the feeders can be set and programmed in a centralized way by a control unit CU which sends instructions to the various adresses, e.g., via a serial CAN-bus line L to which the first (or the last) feeder of the stack is connected.

[0025] Each stack 80 substatially has the same size of a conventional belt-driven, multi-drum yarn-feeder, but it has many advantages in terms of modularity (number of feeders in each stack) as well as flexibility, inadjusting the yarn-feeding speed of each single feeder. Moreover, the solution described herein is considerably less expensive, as well as smaller, compared with the solution employing multiple computerized feeders of the type described in the background part of the present description. In fact, the width of a stack of three, four, or even more feeders anchored to the annular frame is substantially the same as the width of a single computerized feeder of a conventional type.

[0026] A few preferred embodiments have been described herein, but of course many changes may be made by a person skilled in the art within the scope of the claims. For instance, the USB connectors can be replaced by other conventional types of connectors for transfer of data. Furthermore, using a serial CAN-bus for the transfer of data should only be regarded as a preferred, non-essential, solution. Of course, using yarn feeders according to the invention in association with circular knitting machines is particularly advantageous, but should only be intended as an example of application.

Claims

1. A yarn feeder (10) for textile machines, comprising a housing (12) supporting a yarn-winding drum (22) which is driven to rotate by a motor (18) controlled by an electronic circuit (C) as a function of signals from a sensor tension (40) integral to the housing (12), said tension sensor (40) comprising a flexible member (42) arranged to interfere with the yarn unwinding from said yarn-winding drum (22) and to bend to a variable extent depending on the yarn tension, said flexible member (42) incorporating circuit means (R) which generate a variable output depending on the bent configuration of the flexible member, **characterized in that** said housing (12) has a first peripheral surface (12a) and an opposed, second peripheral surface (12b) which have mutually engageable profiles and are provided with respective male/female connectors (52, 54) for mechanical/electrical connection of a plurality of identical feeders in a stacked configuration (80), said electronic circuit (C) being programmed to enable said motor (18) to unwind yarn in response to a deformation of said flexible member (42) with respect to a resting configuration corresponding to a predetermined, minimum tension, on the basis of setup instruction transferred via said connectors (52, 54).

2. The yarn feeder of claim 1, **characterized in that** said electronic circuit (C) is programmed to enable said motor (18) at a constant speed set via said male/female connectors (52, 54), and to stop it when said tension sensor (40) comes back to said resting configuration.

3. The yarn feeder of claim 1, **characterized in that** said electronic circuit (C) comprises a feedback loop which is programmed to modulate the speed of rotation of said motor (18) based on the signals from said tension sensor (40) in such a way as to maintain the yarn tension substantially constant on a desired value set via said male/female connectors (52, 54).

4. The yarn feeder of any of claims 1 to 3, **characterized in that** said male/female connectors (52, 54) are USB connectors.

5. The yarn feeder of any of claims 1 to 4, **characterized in that** said first peripheral surface (12a) and second peripheral surface (12b) are substantially flat and lie on respective planes parallel to each other and to the axis of the drum.

6. A textile apparatus, comprising a textile machine (100) which receives a plurality of yarns unwinding, in a substantially radial direction, from a series of yarn feeders anchored to a frame (120), **characterized in that** said series of yarn feeders comprises at least two yarn feeders (10) according to claim 1 which are connected to each other in a stacked configuration to form a stack (80), and **in that** it comprises a control unit (CU) which is connected to send instructions to an end feeder of said pile ($A_{1,1}$, $A_{2,1}$, $A_{3,1}$ ..., $A_{m,1}$) via a data transfer line (L).

7. The textile apparatus of claim 6, **characterized in that** said data transfer line is a rerial CAN-bus line (L).

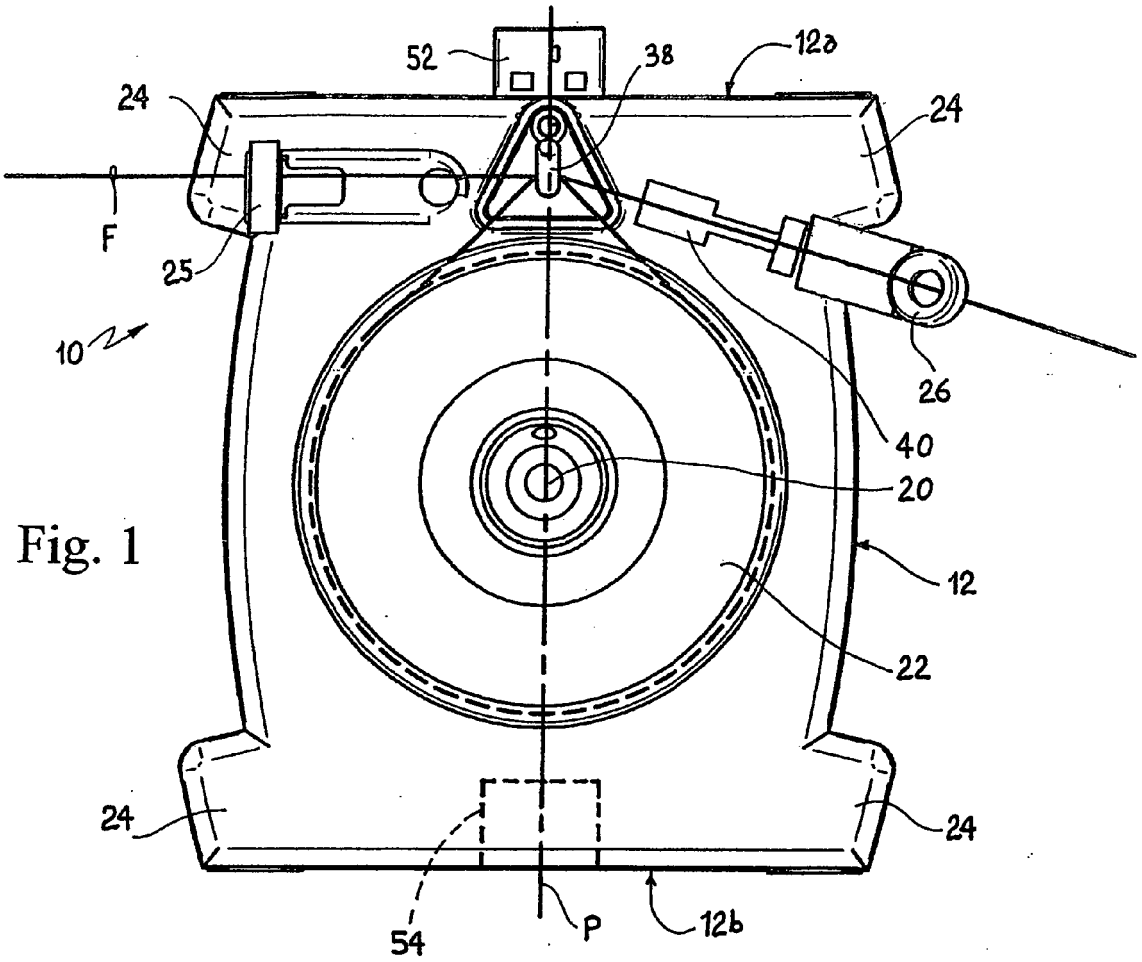
52
38
12a
24
24
F
25
10
26
40
20
12
22
24
24
54
P
12b

Fig. 1

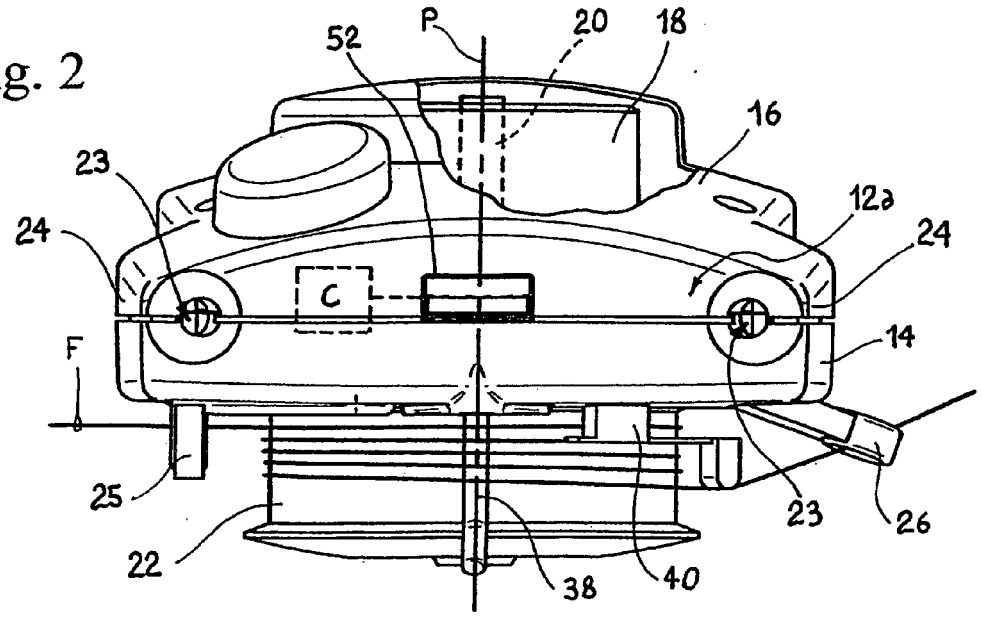
P
52
20
18
16
23
12a
24
24
C
F
14
25
23
26
22
38
40

Fig. 2

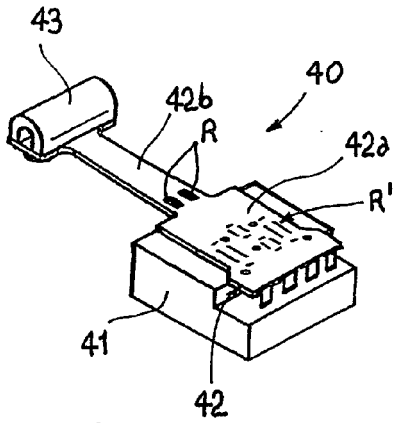

Fig. 3

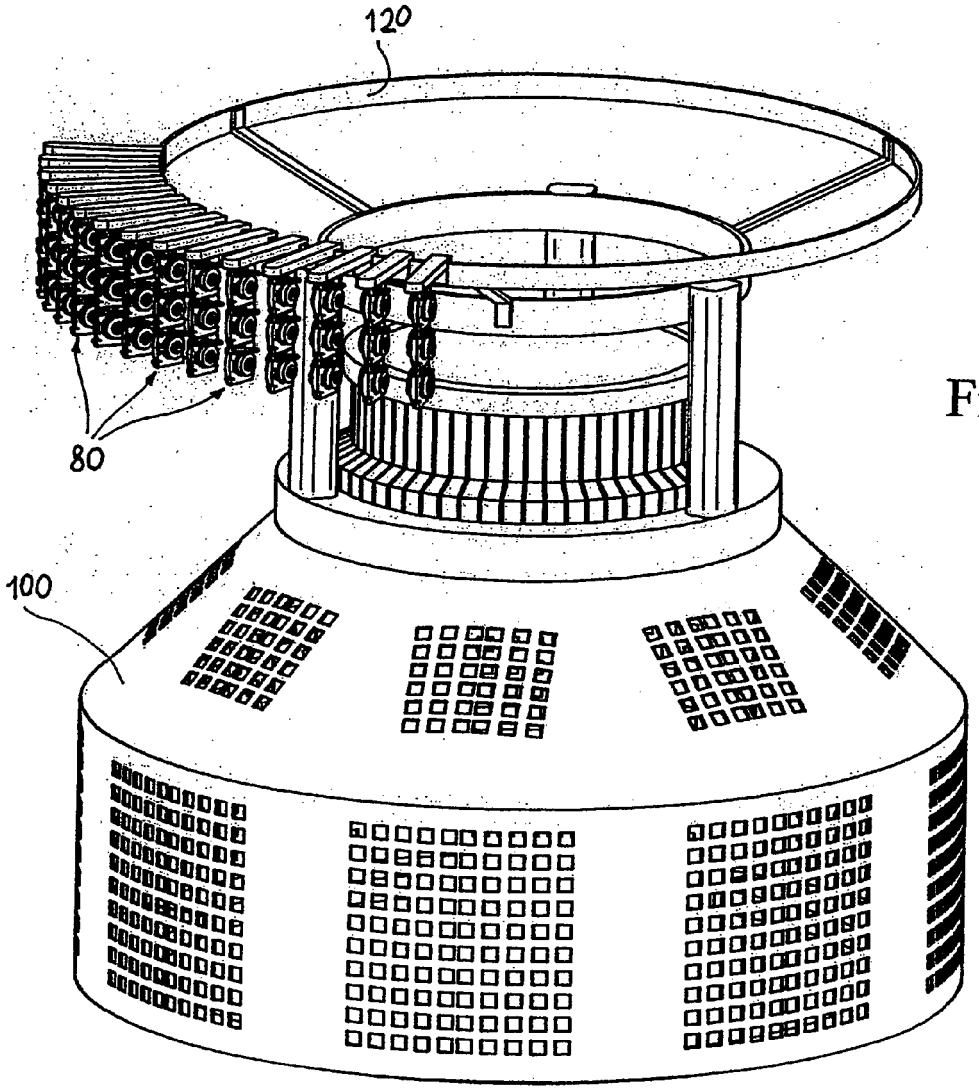

Fig. 4

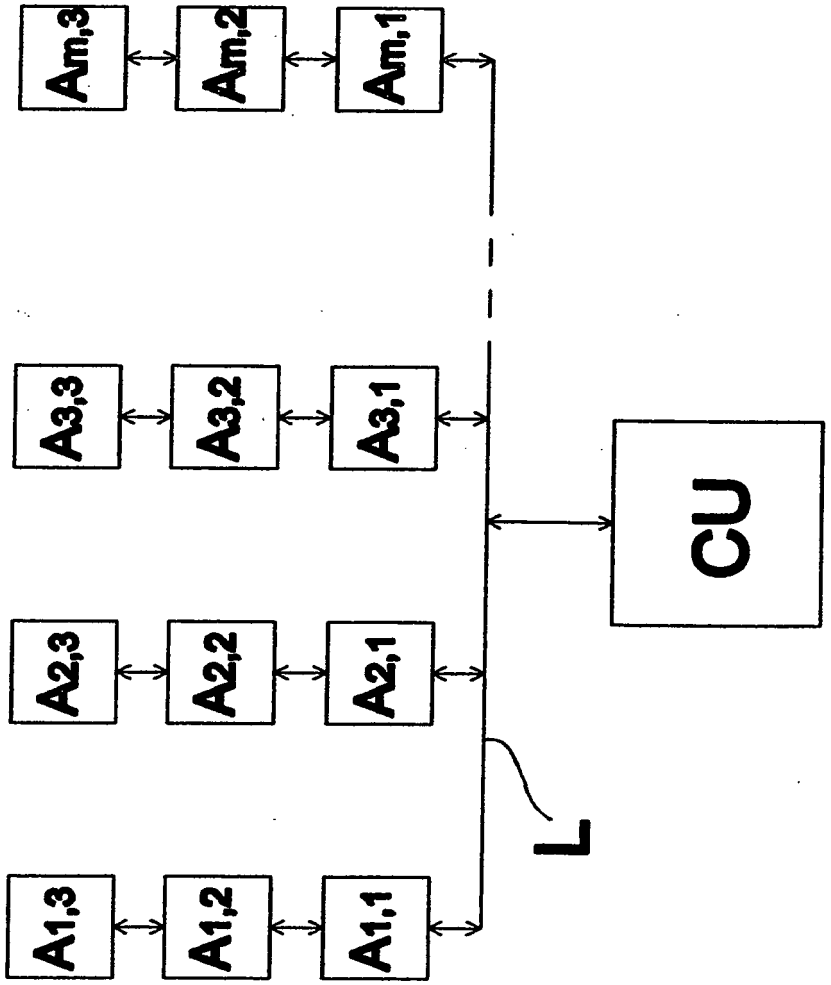

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 13 00 3738

DOCUMENTS CONSIDERED TO BE RELEVANT

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TECHNICAL FIELDS SEARCHED (IPC)

D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 December 2013	Sterle, Dieter

CATEGORY OF CITED DOCUMENTS

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