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(71) Applicant: **Shima Seiki Mfg., Ltd.**
Wakayama-shi, Wakayama 641-0003 (JP)

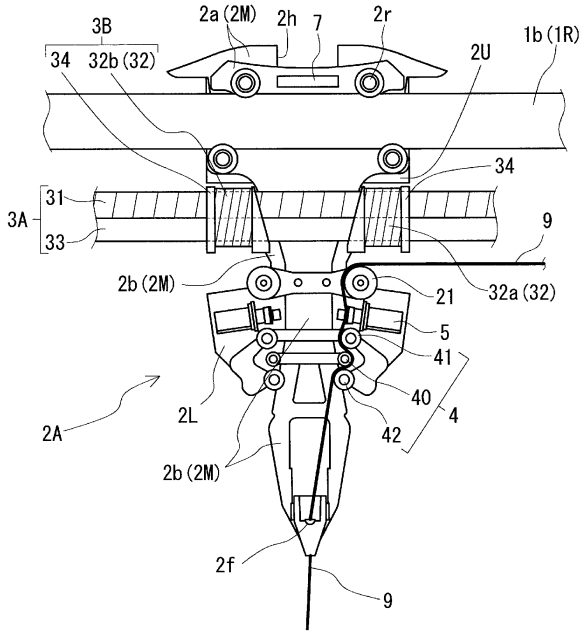
(72) Inventors:
- **FUJIMOTO, Hiromi**
  Wakayama 641-0003 (JP)
- **SHIMOYAMA, Yasuo**
  Wakayama 641-0003 (JP)

(74) Representative: **Emde, Eric**
Wagner & Geyer Partnerschaft mbB
Patent- und Rechtsanwälte
Gewürzmühlstrasse 5
80538 München (DE)

(54) FLAT KNITTING MACHINE

(57) A flat knitting machine that contactlessly supplies electrical power to moving bodies of the flat knitting machine is provided. The flat knitting machine includes needle beds in which multiple knitting needles are arranged side-by-side, and moving bodies 2 that are involved in the knitting of a knitted fabric by traveling along a rail 1R. This flat knitting machine includes: a primary coil 31 that is connected to a power supply of the flat knitting machine and has an axis that is held parallel with the axis of the rail 1R; a tubular member 34 that is provided on each of the moving bodies 2, the primary coil 31 passing through the tubular member 34; a secondary coil 32 that is wound around the tubular member 34 and receives electrical power from the primary coil 31 through electromagnetic induction; a control circuit 20 that is provided on each of the movingbodies 2 and is connected to the secondary coil 32; and at least one electrical device 6 that is provided on each of the moving bodies 2 and operates under control of the control circuit 20.

Fig. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a flat knitting machine.

BACKGROUND ART

[0002] A flat knitting machine includes a needle bed in which multiple knitting needles are arranged side-by-side, and is provided with multiple moving bodies that are involved in the knitting of a knitted fabric, and these moving bodies are attached to a rail and travel along the rail. One example of such moving bodies is yarn feeders (hereinafter, sometimes called "YF") that feed yarn to the knitting needles in the needle bed.

[0003] Patent Document 1 discloses a configuration in which a YF is driven by a linear motor, or a drive motor or the like is attached to a YF, such that the YF is self-propelled. The drive motor provided for the YF and the control apparatus for control thereof are supplied with electrical power through contact power supply via a contact strip that is provided on the rail.

[0004] Patent Document 2 discloses a moving body (reference sign 300 in Patent Document 2) that travels on a rail to which the YF is attached, and that moves the YF by insertion of a changeover pin into the YF. In Patent Document 2, the insertion and removal of the changeover pin is performed using electrical power that is supplied to the moving body through contact between a conductive sheet provided on the rail and a carbon brush provided on the moving body.

PRIOR ART DOCUMENT

PATENT DOCUMENTS

[0005]

Patent Document 1: German Patent Application Publication No. 4308251
Patent Document 2: Chinese Patent Application Publication No. 101139777

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] In the configurations of both of these background art documents, power is supplied to the moving body through contact power supply. However, in a knitting environment in which oil and dust fly around, there is a possibility that the supply of power will be hindered if oil or dust becomes affixed to a contact location. Also, in configurations in which power is supplied through contact, there is also a possibility that power supply will be hindered if a contact location becomes worn down.

[0007] The present invention was achieved in light of the foregoing circumstances, and an object thereof is to provide a flat knitting machine in which power is supplied contactlessly to a moving body that is provided in the flat knitting machine.

MEANS FOR SOLVING THE PROBLEMS

[0008] A flat knitting machine of the present invention is a flat knitting machine provided with a needle bed in which a plurality of knitting needles are arranged side-by-side, and a moving body that is involved in knitting of a knitted fabric by traveling along a rail, the flat knitting machine including:

a primary coil that is connected to a power supply of the flat knitting machine and has an axis that is held parallel with an axis of the rail;
a tubular member that is provided on the moving body, the primary coil passing through the tubular member;
a secondary coil that is wound around the tubular member and receives electrical power from the primary coil through electromagnetic induction;
a control circuit that is provided on the moving body and is connected to the secondary coil; and
at least one electrical device that is provided on the moving body and operates under control of the control circuit.

[0009] In an aspect of the flat knitting machine of the present invention, the moving body is a yarn feeder that feeds knitting yarn to the knitting needles.

[0010] In an aspect of the flat knitting machine of the present invention, the primary coil is arranged in a free space below the rail.

[0011] In an aspect of the flat knitting machine of the present invention, the flat knitting machine further includes a brace means for bracing the primary coil such that the axis of the primary coil is parallel with the rail.

[0012] In an aspect of the present invention including the brace means, the flat knitting machine further includes a holding member that is continuous and elongated, holds the primary coil, and is coupled to an immovable member of the flat knitting machine,
wherein the primary coil is braced by the holding member.

[0013] In an aspect of the flat knitting machine of the present invention including the brace means, the primary coil is braced by two end portions of the primary coil being mechanically coupled to an immovable member of the flat knitting machine in a state where pulling tension is applied to the primary coil.

[0014] In an aspect of the flat knitting machine of the present invention, the flat knitting machine further includes a movable support mechanism that supports the tubular member in a way capable of being displaced relative to the moving body in at least a vertical direction.

[0015] In an aspect of the flat knitting machine of the

present invention, the secondary coil is formed by serially connecting a plurality of divided coils that are separated from each other in an extending direction of the primary coil.

[0016] In an aspect of the flat knitting machine of the present invention, the moving body is a yarn feeder that feeds knitting yarn to the knitting needles, and
the electrical device is a tension sensor that measures tension of the knitting yarn.

[0017] In an aspect of the flat knitting machine of the present invention, a plurality of the moving bodies are arranged on the rail,
the electrical device is an optical wireless transceiver, and
optical wireless communication from one end side of the rail to another end side is relayed through the moving bodies.

EFFECTS OF THE INVENTION

[0018] According to the flat knitting machine of the present invention, electrical power can be contactlessly supplied to the moving body that is provided in the flat knitting machine, thus making it possible to eliminate the problem of a contact failure that can occur in contact power supply. Also, the primary coil passes through the tubular member that holds the secondary coil, thus making it possible to achieve a compact form for the contactless power supply mechanism that is configured by the primary coil and the secondary coil.

[0019] The YF is located in the vicinity of the knitting location, and therefore if electrical power can be supplied to the YF, it is possible to obtain various types of information related to the knitting state. For example, as will be described later, it is possible to provide the YF with a tension sensor and obtain information regarding the tension of knitting yarn, and provide the YF with a position sensor and obtain information regarding the precise position of the YF. It is possible to provide the YF with multiple electrical devices, obtain various types of information from the electrical devices, and execute various operations.

[0020] The primary coil is provided in free space below the rail, thus eliminating the need to make a design change to a mechanism other than the moving body to which the configuration of the present invention is applied. For example, there is no need to increase the size of various constituent elements of the flat knitting machine, such as increasing the gap between adjacent rails, and a compact contactless power supply mechanism can be realized.

[0021] Curving of the axis of the primary coil is suppressed by the brace means that corrects bending and warping of the primary coil, thus allowing smooth movement of the tubular member that is arranged on the primary coil. As will be described later, examples of the brace means include a means using some sort of brace member, and a means not using a brace member.

[0022] If a holding member is used as the brace member, it is possible to suppress curving of the axis of the primary coil caused by bending or warping of the primary coil.

[0023] The brace means is configured such that the primary coil is mechanically coupled to the immovable member of the flat knitting machine in a state where pulling tension is applied to the primary coil, thus suppressing curving of the axis of the primary coil, and making it possible to omit a member for bracing the primary coil.

[0024] The tubular member is supported on the moving body by the movable support mechanism, thus allowing the tubular member that holds the secondary coil to smoothly move along the primary coil even if the central portion of the primary coil in the axial direction thereof bends.

[0025] The secondary coil is divided into multiple divided coils, thus making it possible to shorten the axial length of the tubular members that hold the divided coils, and this allows the tubular members to easily move in accordance with bending of the primary coil. Also, the divided coils are each short, and the degree of freedom in the arrangement of the secondary coil is therefore high. For this reason, the secondary coil can be arranged at a position that does not interfere with members located in the vicinity of the traveling route of the moving body.

[0026] Providing the YF with the tension sensor makes it possible to measure the tension of the knitting yarn at a position near the knitting location, thus making it possible to swiftly perform processing in accordance with the measurement result. For example, knitting can be stabilized by adjusting the tension of the knitting yarn with a tension adjusting apparatus that is provided on the YF or on the yarn feeding route outside the YF, and adjusting the knitting yarn feeding amount.

[0027] Providing the optical wireless transceiver in the moving body makes it possible for information to be exchanged between the moving body and a computer of the flat knitting machine. If the moving body is a YF, such information is information related to the position of the YF, for example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a schematic front view of a flat knitting machine according to an embodiment.

FIG. 2 is a schematic diagram of a yarn feeder viewed from one side of a rail.

FIG. 3 is a schematic diagram of the yarn feeder viewed from the side opposite to that in FIG. 2.

FIG. 4 is a schematic perspective view of a contactless power supply mechanism that includes a primary coil and a secondary coil.

FIG. 5 is a schematic configuration diagram of optical wireless communication relayed through yarn feeders.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

[0029] A flat knitting machine 1 according to an embodiment of the present invention will be described below with reference to FIGS. 1 to 5.

[0030] As shown in FIG. 1, the flat knitting machine 1 includes a pair of needle beds 1B that are arranged facing each other in the depth direction with respect to the paper plane, and yarn feeders (hereinafter, called "YF") 2A to 2D that feed knitting yarn 9 to a needle bed gap formed between the two needle beds 1B. Multiple knitting needles are aligned in each of the needle beds 1B, and these knitting needles are driven by a cam system (not shown) provided in a carriage 1C that moves back and forth over the needle beds 1B. Also, the YFs 2A to 2D travel along a rail 1R. The rail 1R spans between a pair of frames 1FR and 1FL, which are immovable members that are provided upright on respective end sides of the flat knitting machine 1 and are integrated with the flat knitting machine 1. Multiple rails 1R are provided parallel with each other in the depth direction with respect to the paper plane, and the rails 1R each extend parallel with the needle beds 1B at positions above the needle beds 1B. Hereinafter, when giving descriptions that are common to all of the YFs 2A to 2D, the term "YFs 2" will be used instead of distinguishing between the YFs 2A to 2D.

[0031] In this embodiment, multiple YFs 2 are attached to each of the rails 1R. The YFs 2A and 2B are attached to the surface of the rail 1R that is on the front side with respect to the paper plane, and the YFs 2C and 2D are attached to the surface of the rail 1R that is on the back side with respect to the paper plane. These YFs 2 travel along the rail 1R by being selected and moved by a selector 1S that hangs over the rail 1R. The YFs 2 are selected by engagement with a retractable changeover pin that is provided in the selector 1S. The selector 1S is coupled to the carriage 1C, and moves integrally with the carriage 1C. When the selector 1S selects and moves the YFs 2 to be used in knitting, knitting is performed using the knitting yarn 9 that is supplied from the YFs 2. Note that the configuration for moving the YFs 2 is not limited to the configuration in this embodiment, and can be a configuration in which the YFs 2 are self-propelled. The operations of the carriage 1C and the selector 1S are controlled by a computer 10 that is provided in the flat knitting machine 1.

[0032] The YFs 2 are each supplied with knitting yarn 9 from a knitting yarn supply source (not shown) such as a cone that is arranged above the flat knitting machine 1 for example, and the knitting yarn 9 is fed via a tension equipment 90 and a side tension system (not shown) provided on one side of the flat knitting machine 1. In other words, the YFs 2 in this embodiment are configured to receive a supply of the knitting yarn 9 from its lateral side. In contrast to this example, a configuration is possible in which the YFs 2 receive a supply of the knitting yarn 9 from above.

[0033] In the flat knitting machine 1 of this embodiment, the YFs 2 are each provided with a control circuit and at least one electrical device that operates under control of the control circuit, and a contactless power supply mechanism 3 is provided in order to supply electrical power to these control circuits and electrical devices. First, the overall configuration of the YF 2A of this embodiment will be briefly described with reference to FIGS. 2 and 3, and then the contactless power supply mechanism 3 will be described. Lastly, the control circuit and electrical devices that operate using electrical power from the contactless power supply mechanism 3 will be mentioned.

Yarn feeder

[0034] FIG. 2 is a diagram showing the YF 2A attached to the rail 1R, as viewed from the front side with respect to the paper plane in FIG. 1, and FIG. 3 is a diagram showing the YF 2A as viewed from the back side with respect to the paper plane in FIG. 1. FIGS. 2 and 3 show only one ridge 1b that is provided on a side surface of the rail 1R, and the YF 2A slides along this ridge 1b. For the sake of convenience, the side shown in FIG. 2 will be called the front side of the YF 2A, and the side shown in FIG. 3 will be called the back side of the YF 2A. The YF 2A of this embodiment shown in FIGS. 2 and 3 includes a main body portion 2M, a lower mounting portion 2L, an upper mounting portion 2U, and a connecting portion 2J. Of course, the configuration of the YF 2A shown in FIGS. 2 and 3 is merely one example, and there is no limitation to this configuration. Note that the knitting yarn 9 is emphasized in FIGS. 2 and 3 in order to aid understanding of the path of the knitting yarn 9.

[0035] The main body portion 2M is an elongated member that extends downward from the rail 1R, and includes traveling rollers 2r that sandwich the ridge 1b of the rail 1R from above and below. More specifically, the main body portion 2M is divided into a carrier portion 2a on which the traveling rollers 2r are provided, and a suspended portion 2b that extends so as to hang downward from the carrier portion 2a. In order to ensure strength, the main body portion 2M is preferably made of a metal. A pin groove 2h for receiving the changeover pin of the selector 1S shown in FIG. 1 is provided in the upper edge of the carrier portion 2a. Also, a yarn feeding opening 2f for guiding the knitting yarn 9 to the needle bed gap is provided at the lower end of the suspended portion 2b, and a roller-shaped introduction guide 21 for guiding the knitting yarn 9 toward the yarn feeding opening 2f is provided somewhat upward of the intermediate portion. The introduction guide 21 of this embodiment is configured by a roller that has a rotation shaft that extends in the thickness direction of the main body portion 2M. The introduction guide 21 is provided on a small piece that extends in the extending direction of the rail 1R and is fixed to the suspended portion 2b, and more specifically in a portion of the small piece that projects out from the sus-

pended portion 2b. Note that the introduction guide 21 is not limited to being a roller, and may be a tubular member through which the knitting yarn 9 can pass, for example.

[0036] The lower mounting portion 2L is attached at a position that is below the introduction guide 21. Although the lower mounting portion 2L appears to be a plate-shaped member in the drawings, it is actually constituted by combining a plate piece and a framework member or the like. This lower mounting portion 2L is for the mounting of electrical devices such as a tension sensor 4 and a tension adjusting apparatus 5 that are shown in FIG. 3, and is made of an insulating material. A portion of the lower mounting portion 2L projects laterally from the main body portion 2M in a front view of the YF 2A from a direction orthogonal to the extending direction of the rail 1R, and the tension sensor 4 and the tension adjusting apparatus 5 are provided on the back side (side shown in FIG. 3) of this projecting portion.

[0037] The upper mounting portion 2U is a plate-shaped member that is provided on the front side (side shown in FIG. 2) of the carrier portion 2a. The upper mounting portion 2U is for the mounting of a later-described control circuit 20 and the like, and is made of an insulating material. The front side of the carrier portion 2a may be formed with a box-like shape, and the upper mounting portion 2U may be stored inside the carrier portion 2a. In this case, if the carrier portion 2a is provided with a lid, it is possible to protect the control circuit 20 from dust and oil.

[0038] As shown in FIG. 4, the connecting portion 2J is configured by three longitudinal pieces j1, j2, and j3, two lateral pieces j4 and j5 that connect the upper ends and lower ends of the longitudinal pieces j1 to j3, and two arm portions 24a that extend diagonally downward. The connecting portion 2J is a member for attaching a second assembly 3B of the later-described contactless power supply mechanism 3 to the YF 2A, and is coupled to the upper mounting portion 2U in this embodiment.

Contactless power supply mechanism

[0039] The contactless power supply mechanism 3 will be described with reference to FIGS. 2 and 3, as well as FIG. 4, which is an enlarged view of a portion of the YF 2A that is in the vicinity of the contactless power supply mechanism 3.

[0040] As shown in FIG. 4, the contactless power supply mechanism 3 includes a primary coil 31 that is connected to a power supply of the flat knitting machine 1, and a secondary coil 32 that is provided on the YF 2A side. If the primary coil 31 and the secondary coil 32 are maintained in a contactless state, when alternating current is supplied to the primary coil 31, current flows to the secondary coil 32 through electromagnetic induction. In this embodiment, the secondary coil 32 is formed by two divided coils 32a and 32b that are serially connected, and the two end portions of the secondary coil 32 are electrically connected to the later-described control circuit 20. In other words, the secondary coil 32 functions as a power supply portion that supplies the control circuit 20 with electrical power obtained from the primary coil 31 through electromagnetic induction.

[0041] The primary coil 31 has an axis that is parallel with the shaft of the rail 1R, and has a length corresponding to the moving range of the YF 2A. In this embodiment, the primary coil 31 has a length equivalent to that of the rail 1R. As shown in FIG. 4, a core 31c constituted by a magnetic member made of ferrite or the like is arranged inside the primary coil 31 of this embodiment. The primary coil 31 is held from below by a gutter-shaped holding member (brace member) 33, and is braced so as to be parallel with the rail 1R. The holding member 33 of this embodiment is a continuous elongated member that is coupled to the frames 1FL and 1FR of the flat knitting machine 1, and the cross-section orthogonal to the axial direction of the holding member 33 is shaped as a "C" that has sharp corners and is open upward. A first assembly 3A, in which the primary coil 31 is arranged and held, is formed such that a portion of the primary coil 31 passes through the opening of the holding member 33 and is fitted inside the holding member 33. The holding member 33 may be formed with a size that enables the primary coil 31 to be entirely fitted therein. There are no limitations on the holding member 33 as long as it has a shape capable of supporting the primary coil 31 from below.

[0042] The secondary coil 32 is wound around a tubular member 34. The primary coil 31 and the holding member 33 are inserted into the tubular member 34, and therefore the tubular member 34 with the secondary coil 32 wound thereon can move along the axial direction of the primary coil 31. The primary coil 31 and the secondary coil 32 are maintained in a contactless state by the tubular member 34, and therefore if alternating current is supplied to the primary coil 31, inductive current flows to the secondary coil 32 though electromagnetic induction. The interior shape of the tubular member 34 preferably conforms to the outer shape of the first assembly 3A.

[0043] Here, the rails 1R of the flat knitting machine 1 are arranged side-by-side in the front-rear direction of the flat knitting machine 1, and therefore it is difficult to arrange the primary coil 31 between the rails 1R. Also, in the flat knitting machine 1 of this embodiment, the selector 1S travels above the rails 1R, and therefore the selector 1S needs to be moved upward from its original position in order to arrange the primary coil 31 above the rails 1R, thus leading to an increase in the size of the flat knitting machine 1. Additionally, in the case where the primary coil 31 is arranged above the rails 1R, the secondary coil 32 provided for the YF 2A also needs to be provided above the YF 2A, thus leading to an increase in the size of the YF 2A. To address this, in the configuration of this embodiment, the first assembly 3A is provided using the free space below the rail 1R, thus eliminating the need to make a design change to configurations other than the YF 2A, and the contactless power

supply mechanism 3 can be constructed with a compact form. Note that in the case where the YF 2A is self-propelled, the selector 1S is not necessary, and the primary coil 31 can be arranged above the rail 1R.

[0044] The secondary coil 32 of this embodiment is formed by serially connecting the divided coils 32a and 32b that are separated from each other in the extending direction of the primary coil 31. The divided coils 32a and 32b are respectively wrapped around two tubular members 34 that are independent of each other . The second assembly 3B constituted by the divided coil 32a and one tubular member 34, and the other second assembly 3B constituted by the divided coil 32b and the other tubular member 34 are respectively arranged on the left and right sides of the YF 2A in a front view of the YF 2A from a direction orthogonal to the extending direction of the rail 1R. According to this configuration, it is possible to shorten the axial length of the tubular members 34 that hold the divided coils 32a and 32b. As a result, the tubular members 34 (second assemblies 3B) are likely to move in accordance with bending and warping of the primary coil 31 (first assembly 3A), and the tubular members 34 can move smoothly. Also, if the second assemblies 3B are arranged at positions on the left and right of the YF 2A in a front view, it is possible to prevent the case where the second assemblies 3B interfere with other members in the vicinity of the traveling route of the YF 2A. Note that although the two divided coils 32a and 32b are provided in this embodiment, three or more may be provided. In this case as well, the second assemblies 3B are arranged at positions that do not interfere with other members in the vicinity of the traveling route of the YF 2A.

[0045] The second assemblies 3B are each attached to the connecting portion 2J of the YF 2A via a movable support mechanism 24 (see FIG. 4 in particular). The configuration of the movable support mechanism 24 is not limited, as long as it can support the tubular member 34 in a way capable of being displaced relative to the YF 2A in at least the vertical direction. The movable support mechanism 24 of this embodiment includes an arm portion 24a that extends from the connecting portion 2J, and a housing 24h that is coupled to the second assembly 3B and houses the leading end of the arm portion 24a. A support shaft 24b extends from the upper inner peripheral surface of the housing 24h and is loosely fitted into a through-hole at the leading end of the arm portion 24a, and an elastic body 24s such as a compression spring is arranged on the circumferential surface of the support shaft 24b. According to this configuration, the second assembly 3B, which is integrated with the housing 24h that is energized by the elastic body 24s, can be displaced in the vertical direction along the support shaft 24b. Also, in this embodiment, the leading end of the support shaft 24b is loosely fitted into the through-hole of the arm portion 24a, and therefore the housing 24h can be displaced about the leading end in a predetermined solid angular range. For this reason, in this embodiment, the second assembly 3B can be displaced relative to the YF 2A in a direction other than the vertical direction as well.

[0046] The movable support mechanism 24 is not limited to the configuration shown in FIG. 4. For example, the movable support mechanism 24 can have a configuration in which the connecting portion 2J and the second assembly 3B are simply coupled by an elastic body such as a compression spring.

Electrical device and control circuit

[0047] The control circuit 20 is provided on the front side of the upper mounting portion 2U, and operates using electrical power from the secondary coil 32. The control circuit 20 includes a control portion that controls electrical apparatuses that are mounted to the YF 2A. The electrical devices that are mounted to the YF 2A of this embodiment are the tension sensor 4 the tension adjusting apparatus 5, an optical wireless transceiver 6, and a position measuring apparatus 7. Examples of control portions for these electrical devices include a tension control portion that controls the tension adjusting apparatus 5 based on information from the tension sensor 4, and a communication control portion for the optical wireless transceiver 6 that transmits measurement information from the position measuring apparatus 7 and the like. These control portions provided on the YF 2A are controlled in coordination with each other by an overall control portion provided in the computer 10 of the flat knitting machine 1.

[0048] The tension sensor 4 acquires a physical amount that is correlated with the tension of the knitting yarn 9, and outputs the physical amount to the control circuit 20 as an electrical signal. There are no particular limitations on the acquired physical amount, as long as it changes in correlation with change in the tension of the knitting yarn 9. The tension sensor 4 of this embodiment comes into contact with the knitting yarn 9 and acquires a physical amount that corresponds to stress applied by the knitting yarn 9. More specifically, the tension sensor 4 of this embodiment is constituted by guide rollers 41 and 42 that are provided on the lower mounting portion 2L of the YF 2A, and a guide shaft portion 40 that is attached in a cantilevered manner at a position between the guide rollers 41 and 42. The tension of the knitting yarn 9 spanning between the guide rollers 41 and 42 is measured by the guide shaft portion 40. The guide shaft portion 40 is constituted so as to be capable of being displaced in the left-right direction with respect to the paper plane, and acquires, as the physical amount, a strain amount that corresponds to the amount of displacement. The higher the amount of tension in the knitting yarn 9 acting on the guide shaft portion 40 is, the larger the displacement amount of the guide shaft portion 40 is, and the higher the detected strain amount also is. The lower the amount of tension in the knitting yarn 9 acting on the guide shaft portion 40 is, the smaller the displacement amount of the guide shaft portion 40 is, and the smaller

the detected strain amount also is. Providing the YF 2A with the tension sensor 4 makes it possible for slack and tension of the knitting yarn 9 to be obtained more swiftly than in conventional technology.

[0049] The physical amount acquired by the tension sensor 4 is input to the control circuit 20 as an electrical signal. The tension control portion of the control circuit 20 obtains the tension of the knitting yarn 9 by referencing a look up table that indicates a correlation relationship between physical amounts and tensions of the knitting yarn 9. The control circuit 20 compares the obtained tension of the knitting yarn 9 with a predetermined set tension, and controls the tension adjusting apparatus 5 such that the tension of the knitting yarn 9 approaches the set tension.

[0050] As shown in FIG. 3, the tension adjusting apparatus 5 adjusts the tension of the knitting yarn 9 by acting on a portion of the knitting yarn 9 that spans between the introduction guide 21 and the tension sensor 4. The tension adjusting apparatus 5 is conventionally provided at a position of the side tension system of the flat knitting machine 1 in FIG. 1, but if the tension adjusting apparatus 5 adjusts the knitting yarn 9 at a position closer to the needle bed gap as in this embodiment, the tension of the knitting yarn 9 can be adjusted more swiftly, which is preferable.

[0051] The tension adjusting apparatus 5 of this embodiment adjusts the tension of the knitting yarn 9 by sandwiching the knitting yarn 9 between an immovable fixed piece that is fixed to the lower mounting portion 2L and a movable piece that moves linearly in a direction of movement toward and away from the fixed piece . The movable piece can be configured to be operated by a solenoid or the like, and the force by which the knitting yarn 9 is sandwiched by the fixed piece and the movable piece can be changed by changing the amount of electrical power supplied to the solenoid. The stronger the force sandwiching the knitting yarn 9 is, the more difficult it is for the knitting yarn 9 to move, and the higher the tension of the knitting yarn 9 becomes on the downstream side of the tension adjusting apparatus 5. Conversely, the weaker the force sandwiching the knitting yarn 9 is, the easier it is for the knitting yarn 9 to move, and the lower the tension of the knitting yarn 9 becomes on the downstream side of the tension adjusting apparatus 5.

[0052] The optical wireless transceiver 6 includes an optical wireless YF side receiver 6r and YF side transmitter 6t, and a communication control portion that controls these receivers. The optical wireless communication method of this embodiment employs infrared light, but may employ visible light. The members 6r and 6t of this embodiment are implemented in the control circuit 20, and an IC chip of the control circuit 20 is employed as the communication control portion. In the flat knitting machine 1 of this embodiment, this optical wireless transceiver 6 is used for the exchange of information between the computer 10 and the YF 2A of the flat knitting machine 1. One example of an optical wireless system for exchanging this information will be described below with reference to FIG. 5.

[0053] In the example shown in FIG. 5, the two YFs 2A and 2B attached to one rail 1R. The optical wireless system of this embodiment includes a main body side transmitter 1t and a main body side receiver 1r that are connected to the computer 10 of the flat knitting machine 1, and the optical wireless transceivers 6 that are provided on the YFs 2A and 2B. The main body side transmitter 1t is an apparatus that transmits knitting-related information from the computer 10 to the YFs 2A and 2B using optical wireless communication method, and is arranged on one end side of a rail 1R (e.g., the frame 1FL in FIG. 1). The light projection axis of the main body side transmitter 1t is directly faced to the YF side receiver 6r of the YF 2A that is located closer to the main body side transmitter 1t. Also, the main body side receiver 1r is an apparatus that receives information transmitted by the YF 2B using optical wireless communication method, and is arranged on the other end side of the rail 1R (e.g., the frame 1FR in FIG. 1). The light reception axis of the main body side receiver 1r is directly faced to the YF side transmitter 6t of the YF 2B that is closer to the main body side receiver 1r. Also, the light axis of the YF side transmitter 6t of the YF 2A is directly faced to the YF side receiver 6r of the YF 2B.

[0054] According to the optical wireless system having the above-described configuration, optical wireless communication from the main body side transmitter 1t to the main body side receiver 1r is relayed through the YFs 2A and 2B as shown by the outlined arrows. Information including individual instructions for the YFs 2A and 2Bs is transmitted from the main body side transmitter 1t. This information is first received by the control circuit 20 of the YF 2A, which extracts the instruction that is for itself, and then shifts to the execution of that instruction. The control circuit 20 of the YF 2A then adds information acquired by itself (e.g., information regarding the tension of the knitting yarn, and position information) to the information received from the main body side transmitter 1t, and transmits the resulting information to the subsequent YF 2B. Similarly to the YF 2A, the YF 2B also extracts the instruction that is for itself, executes the extracted instruction, and then transmits information (including information acquired by the YF 2B) to the main body side receiver 1r. The information acquired by the YFs 2A and 2B is fed back to the computer 10 and used for optimization of knitting conditions for example. The above-described usage of information and transmission procedure are the same even when there are three or more YFs.

[0055] The position measuring apparatus 7 shown in FIG. 3 measures the position of the YF 2A on the rail 1R. Examples of the position measuring apparatus 7 include an optical device that optically reads a scale provided on the rail 1R, and a Hall element that detects a linear scale provided along the rail 1R. The position of the YF 2A is transmitted to the computer 10 of the flat knitting machine 1 via the optical wireless transceivers 6 (FIGS. 2 and 5) .

The computer 10 realizes optimal movement of the YF 2A based on the position information from the YF 2A. For example, if the YF 2A is provided with a brake mechanism, the stopping position of the YF 2A can be highly accurately controlled based on the position information. Also, the position information from the YF 2A can be used to perform control for operating some sort of electrical device when the YF 2A reaches a predetermined position.

[0056] Other examples of electrical devices mounted to the YF 2A include a camera and a drive mechanism for causing the YF 2A to travel autonomously. Besides the YF 2A, a presser apparatus or the like is arranged in the vicinity of the needle bed gap, thus making it difficult to check details in the vicinity of the needle bed gap, but if a camera is mounted to the YF 2A, it is possible to easily check the details in the vicinity of the needle bed gap. Also, if the YF 2A is provided with a drive mechanism for autonomous travel, the selector 1S shown in FIG. 1 can be omitted.

Variations

[0057] In the first embodiment, the primary coil 31 is held by the holding member 33, thus fixing the primary coil 31 to the flat knitting machine 1. In contrast, it is possible to use a brace member other than the holding member 33, such as the case of bracing the core 31c shown in FIG. 4 in a tube so as to extend in a straight manner, and brace the primary coil 31 from the inward side by this tube. Alternatively, a configuration is possible in which pulling tension is applied to the primary coil 31, and the two end portions of the primary coil 31 are mechanically coupled to the frames 1FL and 1FR of the flat knitting machine 1. According to this configuration, the brace member can be omitted. In this case, the diameter of the wire that constitutes the primary coil 31 is increased to a certain extent (e.g., 1 mm or higher), so as to hold the shape of the primary coil 31. Of course, the primary coil 31 may be mechanically coupled to the flat knitting machine 1 without using the holding member 33 or pulling tension being applied to the primary coil 31.

[0058] Although the example of applying the contactless power supply mechanism 3 to the YF 2A is described in the first embodiment, the contactless power supply mechanism 3 can also be applied to moving bodies other than the YF 2A. For example, the contactless power supply mechanism 3 can be applied to a gripper that grips the knitting yarn 9 at a position between the knitting needles of the needle bed 1B and the YF 2A, and a knitting yarn cutting apparatus that cuts the knitting yarn 9 at a position between the gripper and the knitting needles.

Claims

1. A flat knitting machine (1) provided with a needle bed (1B) in which a plurality of knitting needles are arranged side-by-side, and a moving body (2A-2D) that is involved in knitting of a knitted fabric by traveling along a rail (1R), the flat knitting machine (1) **characterized by**:

a primary coil (31) that is connected to a power supply of the flat knitting machine (1) and has an axis that is held parallel with an axis of the rail (1R);
a tubular member (34) that is provided on the moving body (2A-2D), the primary coil (31) passing through the tubular member (34);
a secondary coil (32) that is wound around the tubular member (34) and receives electrical power from the primary coil (31) through electromagnetic induction;
a control circuit (20) that is provided on the moving body (2A-2D) and is connected to the secondary coil (32); and
at least one electrical device (4, 5, 6, 7) that is provided on the moving body (2A-2D) and operates under control of the control circuit (20).

2. The flat knitting machine (1) according to claim 1, wherein the moving body (2A-2D) is a yarn feeder (2A-2D) that feeds knitting yarn (9) to the knitting needles.

3. The flat knitting machine (1) according to claim 1 or 2, wherein the primary coil (31) is arranged in a free space below the rail (1R).

4. The flat knitting machine (1) according to any one of claims 1 to 3,
further comprising a brace means for bracing the primary coil (31) such that the axis of the primary coil (31) is parallel with the rail (1R).

5. The flat knitting machine (1) according to claim 4,
further comprising a holding member (33) that is continuous and elongated, holds the primary coil (31), and is coupled to an immovable member of the flat knitting machine (1),
wherein the primary coil (31) is braced by the holding member (33).

6. The flat knitting machine (1) according to claim 4, wherein the primary coil (31) is braced by two end portions of the primary coil (31) being mechanically coupled to an immovable member of the flat knitting machine (1) in a state where pulling tension is applied to the primary coil (31).

7. The flat knitting machine (1) according to any one of claims 1 to 6,
further comprising a movable support mechanism (24) that supports the tubular member (34) in a way capable of being displaced relative to the moving

body (2A-2D) in at least a vertical direction.

8. The flat knitting machine (1) according to any one of claims 1 to 7,
wherein the secondary coil (32) is formed by serially connecting a plurality of divided coils (32a, 32b) that are separated from each other in an extending direction of the primary coil (31).

9. The flat knitting machine (1) according to any one of claims 1 to 8,
wherein the moving body (2A-2D) is a yarn feeder (2A-2D) that feeds knitting yarn (9) to the knitting needles, and
the electrical device (4) is a tension sensor (4) that measures tension of the knitting yarn (9).

10. The flat knitting machine (1) according to any one of claims 1 to 9,
wherein a plurality of the moving bodies (2A-2D) are arranged on the rail (1R),
the electrical device (6) is an optical wireless transceiver (6), and
optical wireless communication from one end side of the rail (1R) to another end side is relayed through the moving bodies (2A-2D).

Fig. 1

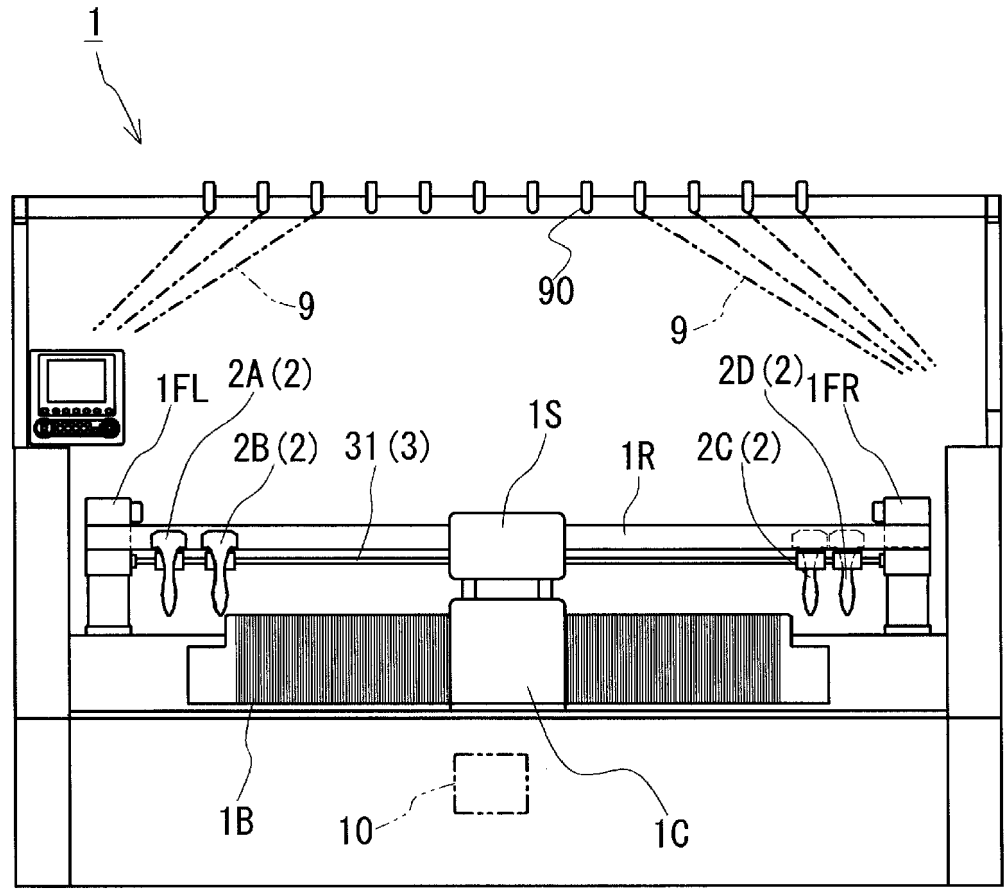
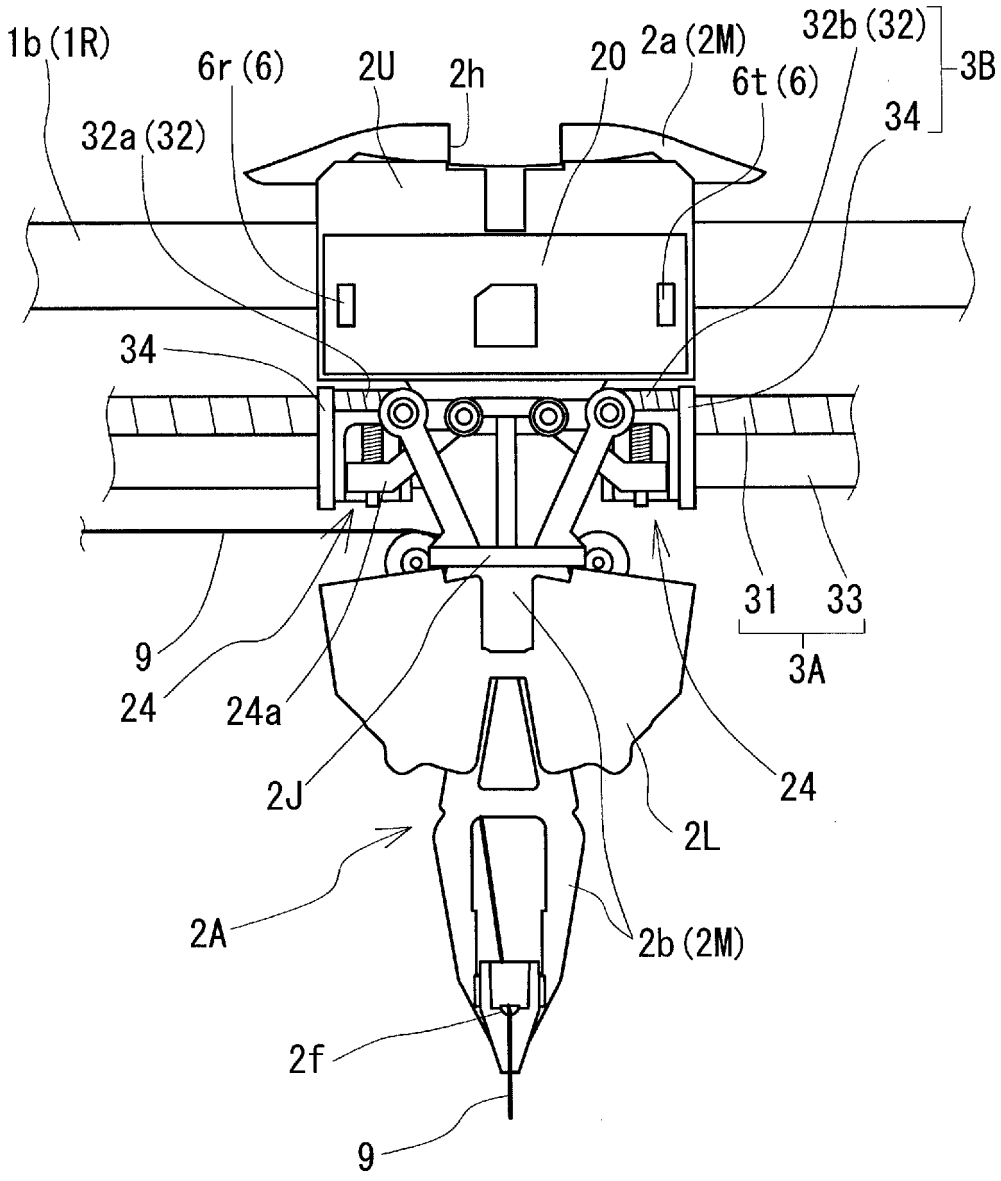


Fig. 2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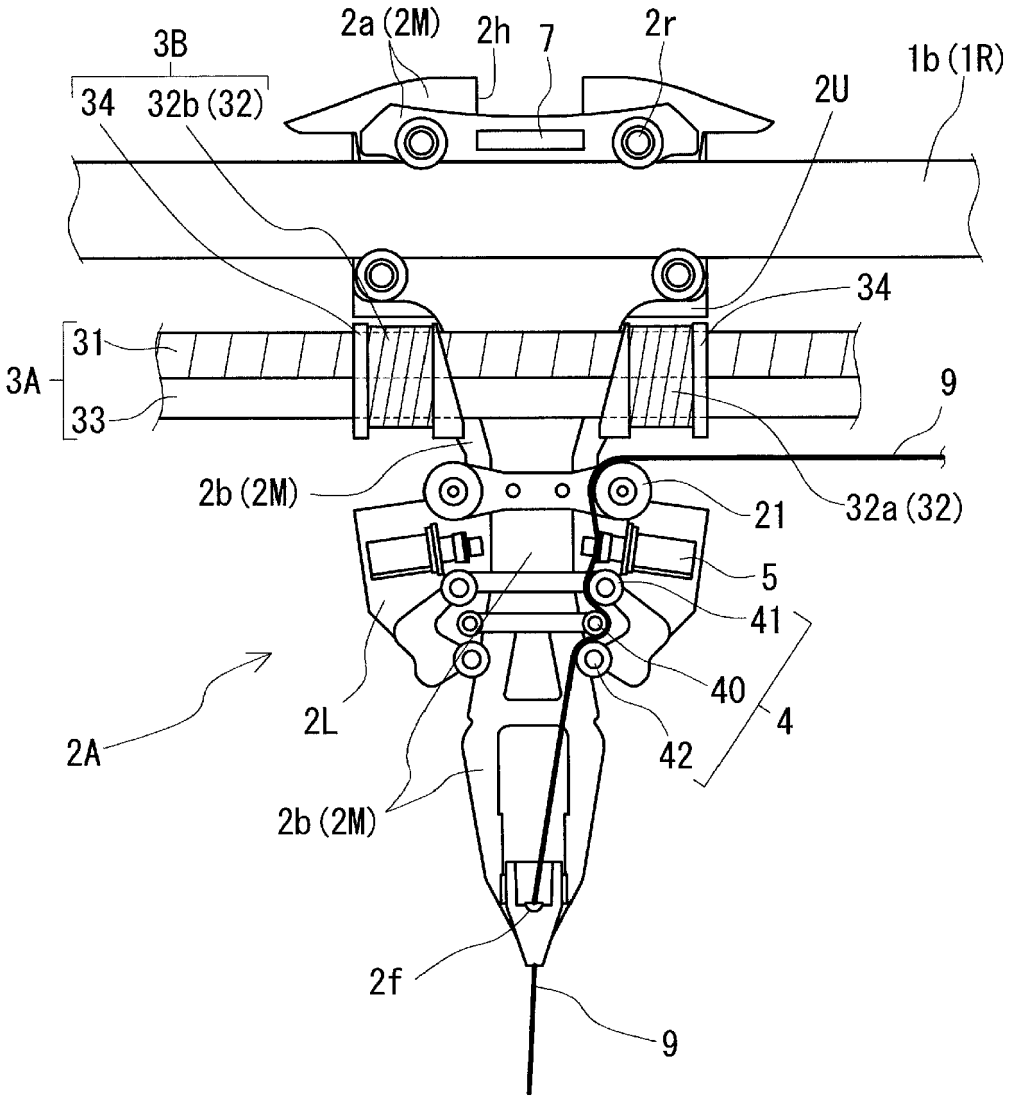
6r (6)
2U
2h
20
2a (2M)
6t (6)
32b (32)
3B
34
32a (32)
34
9
24
24a
2J
31
33
3A
24
2L
2A
2b (2M)
2f
9

Fig. 3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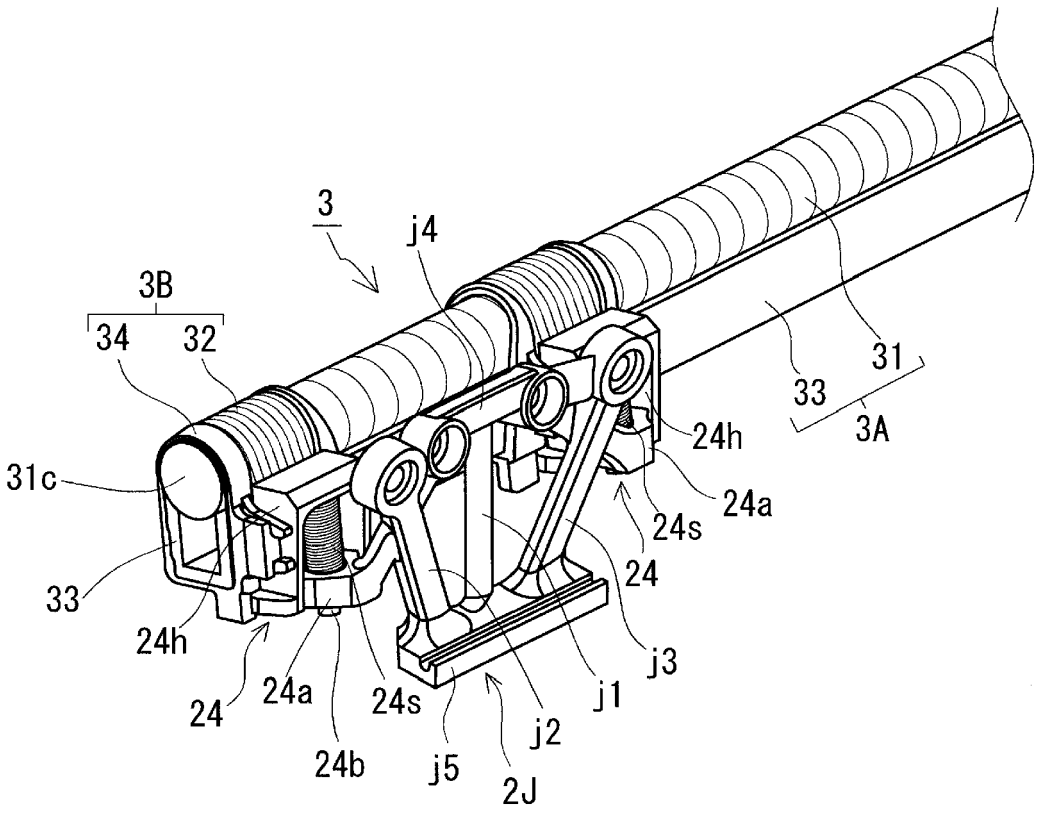
2a (2M)
2h
7
2r
1b (1R)
2U
34
3A
31
33
9
2b (2M)
21
32a (32)
5
41
40
4
42
2A
2L
2b (2M)
2f
9

Fig. 4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3A
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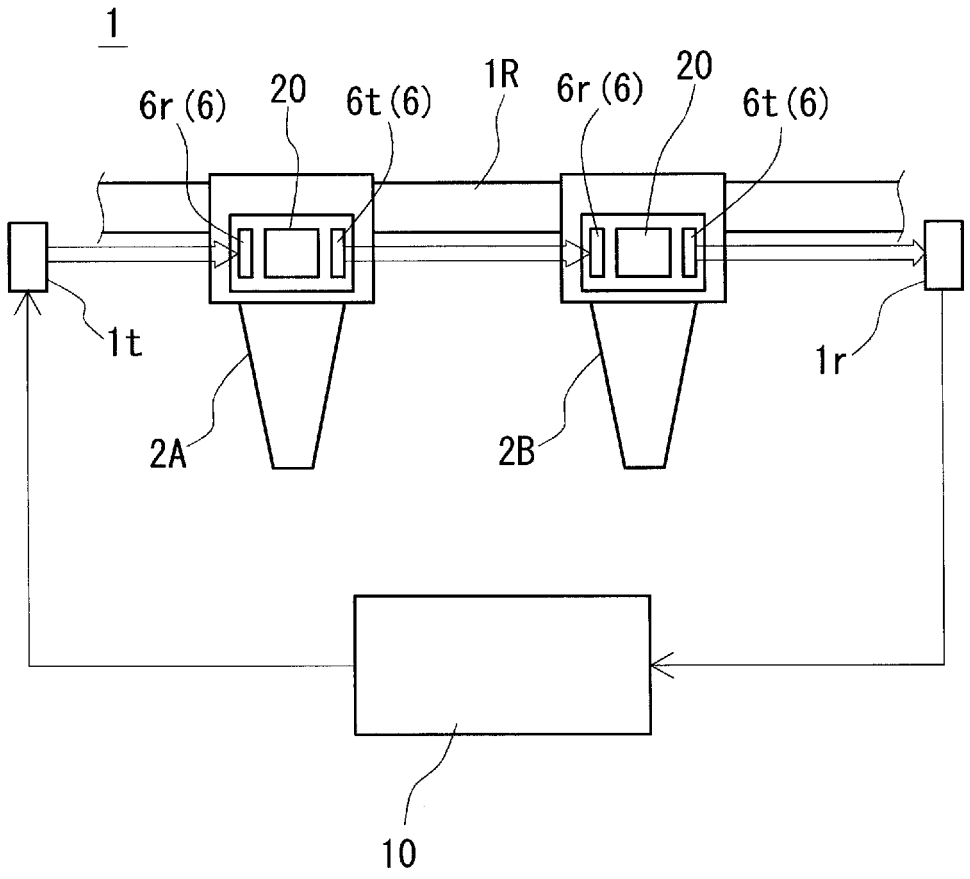
j3
j1
j2
24b
j5
2J

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 6014

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A,D	DE 43 08 251 A1 (SCHIEBER UNIVERSAL MASCHF [DE]) 4 November 1993 (1993-11-04) * column 1, line 28 - column 2, line 4; figure 1 * * column 2, line 55 - column 3, line 29 * * column 5, lines 7-60 *	1-10	INV. D04B15/94 D04B15/00 D04B15/48 D04B15/44 D04B15/56
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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	23 May 2019	Wendl, Helen

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23-05-2019

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