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(54) Multi-position front clutch having a blocking device of the movable element in a control drive of a loom

(57) Multi-position front clutch for the drive unit of a weaving loom, consisting of a pair of coaxial gearwheels (3, 2) which may be meshed together, one (3) of which being fixed and the other (2) axially movable. The axially fixed gearwheel (3) of the clutch is connected to a motor (20) for actuating the loom, while the axially movable gearwheel (2) is connected to the weaving devices (27) of the loom. The axially movable gearwheel (2) also comprises a second set of teeth, opposite to that which forms the clutch (28), apt to engage with a toothed support (1) integral with the loom when the clutch is in the disengaged position and vice versa. The use of a locking brake (35) for the weaving devices (27) is thus eliminated.

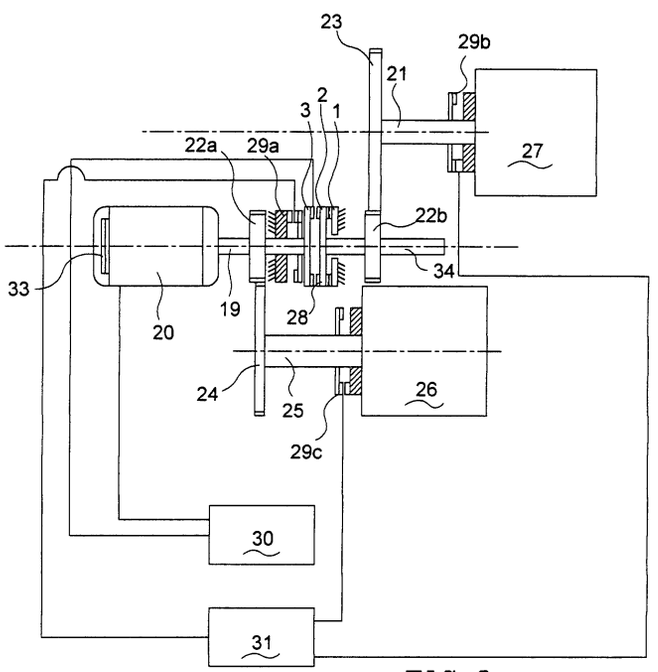

FIG.2

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Description

[0001] The present invention relates to a novel multi-position front clutch having a locking device of the movable element, which can be used in a drive unit of a weaving loom.

[0002] It is known how in weaving looms the main shaft of the loom, in addition to driving the main weaving devices of the loom (grippers and sley with associated reed), also drives the weave machine, which operates in conjunction with the loom and which controls and drives the heald frames for the formation of the fabric. It is also known how, in the event of stoppage of the loom due to any type of malfunction (breakage of a warp yarn, faulty insertion of a weft, broken wefts and the like), it is required to move separately and at low speed the main weaving devices and the weave machine; in fact, whereas the former must be simply brought into their rest position, with the weave machine it may be necessary to perform one or more backward strokes of the loom, in order to bring the loom itself into the position where the defect occurred and thus be able to repair it and then drive the loom in the desired starting position, in synchronism with the position of the weaving devices.

[0003] Conventionally these low-speed operations - i. e. the so-called "slow running" condition of the loom - used to be performed by means of an auxiliary motor which can be engaged, as required, with the drive transmission from the main motor to the weave machine, after said main motor was obviously disengaged from said transmission.

[0004] More recently, the same Applicant has introduced a new type of drive unit, described in the unpublished Italian patent application MI00A-001157, wherein only one driving motor, without the conventional brake/clutch unit, is used. The electrical power supply of this driving motor is controlled so as to be able to provide all the movement and braking conditions of the loom, which in conventional systems are obtained by means of the co-operation between a main motor, an auxiliary motor, a brake/clutch unit and two separate front clutches for alternate connection to said motors.

[0005] The improved front clutch according to the present invention, although it may also be used in more conventional drive units, is particularly advantageous when applied to a drive unit according to the abovementioned Italian patent application MI00A-001157. The description which follows will therefore be provided with reference to such a drive unit and the entire contents of the aforementioned patent application are understood as being incorporated herein by reference.

[0006] Fig. 1 schematically shows a preferred embodiment of the abovementioned drive unit, in which the improved front clutch according to the present invention is incorporated; for the sake of greater clarity, the same reference numbers for the individual parts of the device, already used in the description of the aforementioned prior patent, have been retained. The drive unit illustrated in fig. 1 therefore comprises a single motor 20, on the output shaft 19 of which a first pinion 22a is keyed; a second pinion 22b is also keyed onto an intermediate shaft 34, coaxial and aligned with the shaft 19. The shaft 34 is connected to the shaft 19, so as to be driven therefrom, by means of an electromechanical front clutch 28, which is preferably of the multi-position type and remotely operated by a drive unit 30 which is in turn controlled by a control unit 31.

[0007] When the shaft 34 is rotating, its movement is transferred, by means of the pinion 22b and a gearwheel 23 meshing with it, to the main shaft 21 of the loom with which the gearwheel 23 is coaxially keyed. The main shaft 21 moves solely the weaving devices of the loom, schematically indicated by the block 27, namely the sley with associated reed and, in the case of a gripper-type looms, the mechanisms to control the grippers in addition to any auxiliary weaving devices, for example for the selvedge formation.

[0008] The pinion 22a, on the other hand, is meshed with a gearwheel 24, said gearwheel 24 being keyed coaxially with a driven shaft 25 of the loom. The driven shaft 25 is in turn connected to a weave machine schematically indicated by the block 26 and to any other accessory devices thereof.

[0009] Owing to this arrangement, the driven shaft 25 and therefore the weave machine 26, are always connected to the movement of the motor 20, while the main shaft 21 and therefore the weaving devices 27, may be separated therefrom, as required, by disengagement of the clutch 28.

[0010] During normal operating conditions, the front clutch 28 is in the engaged position and the motor 20 drives both the weaving devices 27 and the weave machine 26 at the desired speed, and therefore also optionally in the slow running condition, by means of suitable adjustment of its speed value to the constant desired speed. By reversing the torque direction, on the other hand, it is possible to obtain a braking effect with the required gradual action and rapidity.

[0011] When the motor 20 is stopped, the front clutch 28 may be disengaged and therefore, upon starting the motor again, it is possible to obtain the desired forward and backward operating movements of the weave machine alone, in order to carry out the search of the shed in which a faulty weft has been inserted and must be replaced.

[0012] The angular position of rotation of the shafts 19 and 21 are respectively and instantaneously controlled by means of position sensors 29a and 29b, for example of the encoder type, which send corresponding signals to the control unit 31; in this way it is possible to perform the connection between the shaft 19 of the motor 20 and the main shaft 21 in angular positions which may be varied as required, according to a program which is controlled by the control unit 31 depending on the weaving conditions. A third sensor 29c, finally, is provided in the vicinity of the weave machine 26, for reading

the instantaneous angular position of the driven shaft 25. With this arrangement it is therefore possible to obtain a programmed and non-manual phase timing, if necessary also during the course of weaving, between the weaving devices 27 of the loom and the weaving machine 26 which performs the opening and closing movements of the shed. In a preferred manner, as mentioned, the electromechanical front clutch 28 allows a plurality of coupling positions separated by a constant angular pitch; said pitch therefore determines the minimum phase shifting level between the driven shaft 25 and the main shaft 21.

[0013] Finally, the above described drive unit also comprises a locking brake 35 which is apt to act upon the main shaft 21 or the shaft 34 and which is activated during the shed searching and weft repairing operations, in order to counteract the residual potential energy of the weaving devices 27; this, in fact, could produce undesirable displacements of said weaving devices with respect to the predefined position upon disengagement of the front clutch 28.

[0014] The presence of the locking brake 35, in addition to increasing the cost and overall dimensions, also has intrinsic operating drawbacks. Since this brake is in fact connected only operationally, by means of the control unit 31 and drive unit 30, to the front clutch 28, it is still possible that, in the event of incorrect or delayed operation of the latter, the brake 35 may be respectively released in advance or actuated with a delay with respect to the engagement/disengagement time of the front clutch 28, therefore momentarily leaving the main shaft 21 of the loom and therefore the weaving devices 27 free to move due to the potential energy accumulated therein.

[0015] It would therefore be desirable to provide a new type of locking brake, the operation of which be intrinsically associated with that of the front clutch 28 so as to avoid any possible drawbacks of the type indicated above.

[0016] The object of the present invention is therefore that of providing a multi-position clutch of the type indicated above for use in the drive unit of a weaving loom and a braking device associated therewith and apt to steadily keep the main shaft of the loom, or in any case the intermediate shaft connected to the front clutch 28, in the exact position in which disengagement from the front clutch 28 is occurred.

[0017] This object is achieved, according to the present invention, by means of a multi-position front clutch in a drive unit of a weaving loom of the type consisting of a pair of coaxial gearwheels which may be meshed together, one of said gearwheels, which is axially fixed, being connected to a motor for actuating the loom, the other one of said gearwheels, which is axially movable so as to cause engagement or disengagement of the clutch, being connected to the weaving devices of the loom, characterized in that said axially movable gearwheel comprises a second set of teeth, opposite to a first set of teeth which forms the front clutch, apt to engage with a toothed support integral with the loom when the front clutch is in the disengaged position and vice versa.

[0018] Further characteristic features and advantages of the present invention will nevertheless emerge more clearly from the following description of a preferred embodiment thereof, in which:

Fig. 1 is a schematic view illustrating a drive unit according to a preferred known art;

Fig. 2 is a view of the drive unit according to fig. 1 in which the front clutch according to the present invention is incorporated;

Fig. 3 is a view which illustrates, schematically and on a larger scale, the front clutch of the present invention during five different operating steps, from the coupling position of the movable element to the disengaged and locked position thereof; and

Fig. 4 is a front view - similar to that of fig. 3 - which shows five different operating steps of the front clutch according to the present invention, from the disengaged and locked position of the movable element to the coupling position thereof.

[0019] Fig. 2 schematically shows a drive unit of the known type which is illustrated in fig. 1, wherein the front clutch 28 - which, as described above, connects the shaft 19 of the motor 20 to the main shaft 21 of the loom by means of the intermediate shaft 34 - is provided, according to the present invention, with a device for locking the movable element.

[0020] This locking device consists of a gearwheel 1 integral with the loom and arranged in the immediate vicinity of the movable element 2 of the clutch 28 and coaxial therewith. The gearwheel 1, with respect to which the shaft 34 is idle, can be meshed with the movable element 2 by means of a matching set of teeth formed on the latter and owing to the fact that its axial distance from the movable element 2 is such as to produce complete meshing with the movable element 2, during the normal movement of the latter away from the axially fixed gearwheel 3 of the clutch 28, as described in greater detail below with reference to Figs. 3 and 4.

[0021] The front clutch 28 is formed in a manner known per se by an axially fixed gearwheel 3, which is integral and corotating with the shaft 19 of the motor 20, and by a movable gearwheel, or movable element 2, which is integral with the intermediate shaft 34 and axially movable between a position engaged with the gearwheel 3 and a position disengaged from said gearwheel. In a preferred embodiment, the front clutch 28 consists of a pair of matching sets of teeth formed on the gearwheels 2 and 3 and each composed of 24 conical axial teeth; the minimum phase-shifting pitch value of the clutch 28 is therefore 15°.

[0022] The movable element 2 is also provided, on the side facing the fixed gearwheel 1, with a second set of

teeth which also have the same pitch of 15°, suitable for engagement with a corresponding set of teeth of the fixed gearwheel 1 in order to form the locking device according to the present invention. Said locking device is preferably formed by sets of teeth comprising straight teeth, in order to ensure a stable grip of the locking device, and said sets of teeth are characterized by a small mutual tangential play in order to facilitate the engagement/disengagement operations thereof. Sets of teeth comprising conical teeth, however, may also be used.

[0023] The electromagnetic driving means of the movable element 2, with a spring for return into the coupling position of the clutch 28, normally allow a working stroke of said element of about 1.8 - 2.5 mm and preferably 1.8 - 2.0 mm. In the front clutch having a locking device of the movable element according to the present invention, the axial meshing distance between the conical teeth of the clutch 28 takes about 1.4 - 1.5 mm of this stroke, while the remaining part of the stroke, equal to about 0.4 - 1.0 mm, preferably 0.4 - 0.5 mm, forms the axial play between the movable element 2 and the fixed gearwheel 1 when the clutch 28 is in the coupling position, or between the gearwheel 3 and the movable element 2, when the clutch is in the disengaged position and the movable element 2 has engaged with the fixed gearwheel 1, being locked in the desired position.

[0024] According to the fundamental concept of the present invention, in fact, owing to the same movement with which the movable element 2 and therefore the weaving devices 27 of the loom are disengaged from the shaft 19 of the motor 20, the simultaneous locking of the movable element 2 with the fixed gearwheel 1, i. e. the perfect and steady mechanical locking of the weaving devices 27 in the exact position in which it was located when disengaged from the driving motor, is achieved. In fact, the axial play of the bilateral clutch is, according to the present invention, less than the axial meshing distance of its teeth (preferably, but not necessarily the same both on the motor side and on the locking device side). Due to this, the angular position of the movable element 2 is transferred from the gearwheel 3 to the gearwheel 1 (and vice versa) without there ever being a moment during which this gearwheel is free and can therefore change its angular position in response to the residual potential forces present in the weaving devices.

[0025] As seen above, the clutch 28 may be engaged both after a certain exact number of cycles of the weave machine and in positions mutually phase-shifted by a constant pitch of 15°. This phase-shifting is reduced, on the main shaft of the loom 21 by the same reduction ratio existing between the gearwheels 22b and 23, such that the minimum phase-shifting pitch on the loom has a value normally in the range between about 4° and 5°, for reduction ratios between the fast shaft (drive shaft 10) and main shaft (shaft 21) of between 3 and 4.

[0026] Figs. 3 and 4 show in detail, respectively, the various steps of gradual disengagement and gradual engagement of the front clutch 28, which will be briefly described below.

[0027] Fig. 3A shows the normal operating condition of the loom, where the clutch 28 is in the coupling position, i.e. the movable element 2 is kept in position meshed with the gearwheel 3 by spring means (not shown) provided for this purpose in the clutch itself. The motor 20 drives both the weaving devices 27 and the weave machine 26, which are therefore connected to each other.

[0028] Fig. 3B shows the first step of disengagement of the clutch 28 where the movable element 2, as a result of the action of the electromagnetic means (not shown) provided in the clutch is moved away from the gearwheel 3, against the action of the abovementioned spring means. This operation may be performed only with the loom at stop and in predetermined angular positions of the main shaft of the loom 21 in which the various components of the weaving devices are in a position such as to allow the free movement of the weave machine and the components operated by the same, so as to be able to carry out searching and replacement of the faulty wefts or adjustment of the phase timing of the weaving devices with respect to the weave machine. When the loom has therefore been stopped in one of these positions, which can be detected by means of the position sensor 29b, the movable element 2 is displaced. In most cases, in view of the probable situation of non-matching with the fixed gearwheel 1, after a first stroke of 0.4 - 0.1 mm corresponding to the play previously existing with respect to said gearwheel, the movable element 2 comes into abutment, with its axial straight toothing, against the similar set of teeth provided on the fixed gearwheel 1, in a so-called "tooth-to-tooth" position.

[0029] During the next step (fig. 3C), the motor 20 is operated at a very slow speed until the gearwheel 3 comes into lateral engagement with the movable element 2, driving the latter rotationally, still in the "tooth-to-tooth" position with respect to the fixed gearwheel 1, until, at the most after 15° of rotation, the toothing of the movable element 2 matches with that of the fixed gearwheel 1 (fig. 3D), so that the force developed by the electromagnetic means for thrusting the movable element 2 is able to complete the engagement of said element with the fixed gearwheel 1.

[0030] Obviously, during the whole of this displacement and engagement step of the movable element 2 with the fixed gearwheel 1, the motor 20 is actuated with a controlled torque, namely with just that which is sufficient to overcome the rubbing friction, any effect of magnetic attraction occurring, due to the presence of magnetic fluxes, in particular in the "tooth-to-tooth" position between the element 2 and the gearwheel 1, and the potential energy of the weave machine. If, despite the application of this limited torque, the desired position of complete engagement is not reached (which position may be easily detected, for example, by the fact that the

movement of the weave machine is freed, as a result of disengagement of the gearwheel 3 from the movable element 2), the movement of the motor 20 is reversed (fig. 3E) in order to free the toothings and achieve the complete mutual engagement thereof. Proximity sensors may be provided on the movable element 2 in order to detect this complete engagement and enable the successive operations of the weave machine and weft repair.

[0031] Once the weft repair or loom phase timing operations have been completed, the operations described above are performed in reverse, in order to bring the clutch 28 back into the coupling position and therefore the loom into its normal operation position.

[0032] The condition of the clutch 28 at the end of said operations was therefore that shown lastly in fig. 3E and, for the sake of convenience, reproduced in fig. 4A, where the electromagnetic means of the clutch are excited and keep locked the movable element 2, and the whole weaving devices 27, together with the same meshing by against the fixed disk 1. In this case also, before being able to start the step of engagement of the clutch 28, it is necessary for the weave machine 26, always connected with the shaft 19 of the motor 20, to be brought into a predetermined enabled position, namely a position which has the desired phase-shifting angle with respect to the locked position in which the weaving devices were stopped at the moment of release of the clutch 28.

[0033] As soon as the weave machine has reached this predefined position, in a manner which can be easily controlled by means of the position sensors 29c, the electromagnetic means of the clutch 28 are de-energised such that the spring means provided in said clutch recall the movable element 2 towards the gearwheel 3. Generally this action does not result in immediate meshing of the gearwheels 2 and 3, but, in a similar manner to that seen above, the situation illustrated in fig. 4B occurs, where said two gearwheels come into "tooth-to-tooth" contact.

[0034] The motor 20 is then operated at a slow speed and with a limited maximum torque - so as to overcome the rubbing friction between the teeth of the gearwheels 2 and 3, any effect of magnetic attraction characteristic of the "tooth-to-tooth" position and the potential energy of the weave machine - until initial meshing of the two sets of conical teeth is achieved (fig. 4C), with an angular movement of the gearwheel 3 which in this case, in view precisely of the conicity of the teeth, is always less than the pitch of 15°.

[0035] If this engagement does not occur in a complete manner (fig. 4D), as may be easily detected by the fact that there is no movement of the weaving devices or the weave machine (which are now mutually locked together again), it is sufficient to reverse the direction of rotation of the gearwheel 3 (fig. 4E) in order to free the movable element 2 from the fixed gearwheel 1 and obtain the complete meshing of the gearwheels 2 and 3 and therefore the proper engagement of the clutch 28. In this case also, the completely engaged position may be detected by means of suitable sensors or other methods for detecting the axial position of the movable element 2, which enable operation of the loom to be resumed only when this position does exactly correspond to a predefined position.

[0036] From the above description it should be clear how the clutch having a locking device of the movable element according to the invention has simply and effectively solved the problem of obtaining the immediate, safe and stable locking of the weaving devices, during the operations for searching and repairing a faulty weft or during an operation for adjustment of the phase timing between said weaving devices and the weave machine. The locking device described here, in fact, although controlled by electronic systems, has an operating mode which is purely mechanical and it is therefore impossible for uncontrolled and undesirable phase shifting of the weaving devices to occur in the event of malfunctioning of said electronic systems. As has been seen, in fact, there is no position where the movable element 2, and therefore the weaving devices connected to the same, is free to rotate with respect to the gearwheel 3 without being already locked by the fixed gearwheel 1.

[0037] The clutch having a locking device of the movable element according to the present invention is therefore apt to entirely eliminate the locking brake previously incorporated necessarily on the main shaft of the loom, carrying out the functions thereof with an improved performance and considerable reduction in overall dimensions, costs and checking operations, and thus fully achieving the object according to the invention.

[0038] The clutch having a locking device of the movable element according to the present invention has been described with reference to a particular preferred embodiment, but it is obvious that various mechanical embodiments thereof may be possible, without thereby departing from the scope of protection of the invention defined by the accompanying claims.

[0039] In particular, the shape and number of the teeth of the gearwheels 1, 2 and 3 may be varied, without problems, depending on particular design requirements and/or clutch loads. It is also not necessary for the teeth forming the two sets of co-operating toothings of the movable element 2 and the fixed gearwheel 1 to be equal in number; for example, in the gearwheel 1 a single tooth, or a pair of teeth facing each other at 180° could be envisaged, while the teeth on the gearwheel 2 could consist of a smaller number, so as to be present in adjacent pairs only at the possible positions of the weaving devices where it is possible to start the weft searching, thus resulting in a reduction in weight and lower cost of these components, without the functional nature of the system being modified in any way.

Claims

1. Multi-position front clutch in a drive unit of a weaving loom of the type consisting of a pair of coaxial gearwheels (2, 3) which may be meshed together, one (3) of said gearwheels, which is axially fixed, being connected to a motor (20) for actuating the loom, the other one (2) of said gearwheels, which is axially movable so as to cause engagement or disengagement of the front clutch, being connected to the weaving devices (27) of the loom, **characterized in that** said axially movable gearwheel (2) comprises a second set of teeth, opposite to a first set of teeth which forms the front clutch, apt to engage with a toothed support (1) integral with the loom when the front clutch is in the disengaged position and vice versa.

2. Front clutch according to Claim 1, wherein the play existing between said axially movable gearwheel (2) and said toothed support (1) integral with the loom or said axially fixed gearwheel (3), respectively in the engaged and disengaged positions of said front clutch, is less than the axial meshing distance of said sets of teeth.

3. Front clutch according to Claim 2, wherein said play lies in the range of 0.4 mm to 1.0 mm, preferably 0.4 to 0.5 mm, said meshing distance lies in the range of 1.4 mm to 1.5 mm and the working stroke of said axially movable gearwheel (2) lies in the range of 1.8 to 2.5 mm, preferably 1.8 to 2.0 mm.

4. Front clutch according to any one of Claims 1 to 3, wherein said first and second sets of teeth of the axially movable gearwheel (2) are both sets of teeth comprising conical teeth.

5. Front clutch according to any one of Claims 1 to 3, wherein said second set of teeth of the axially movable gearwheel (2) is a set of teeth comprising straight teeth.

6. Front clutch according to any one of the preceding claims, wherein said second set of teeth of the axially movable gearwheel (2) has a pitch which is the same as that of said first set of teeth.

7. Front clutch according to any one of the preceding claims, wherein said first and second sets of teeth have a pitch of 15°.

8. Front clutch according to any one of the preceding claims, wherein sensor means for detecting the axial position of said axially movable gearwheel (2) are further provided.

9. Front clutch according to any one of the preceding claims, wherein said toothed support (1) integral with the loom is in the form of a gearwheel coaxial with said axially movable gearwheel (2).

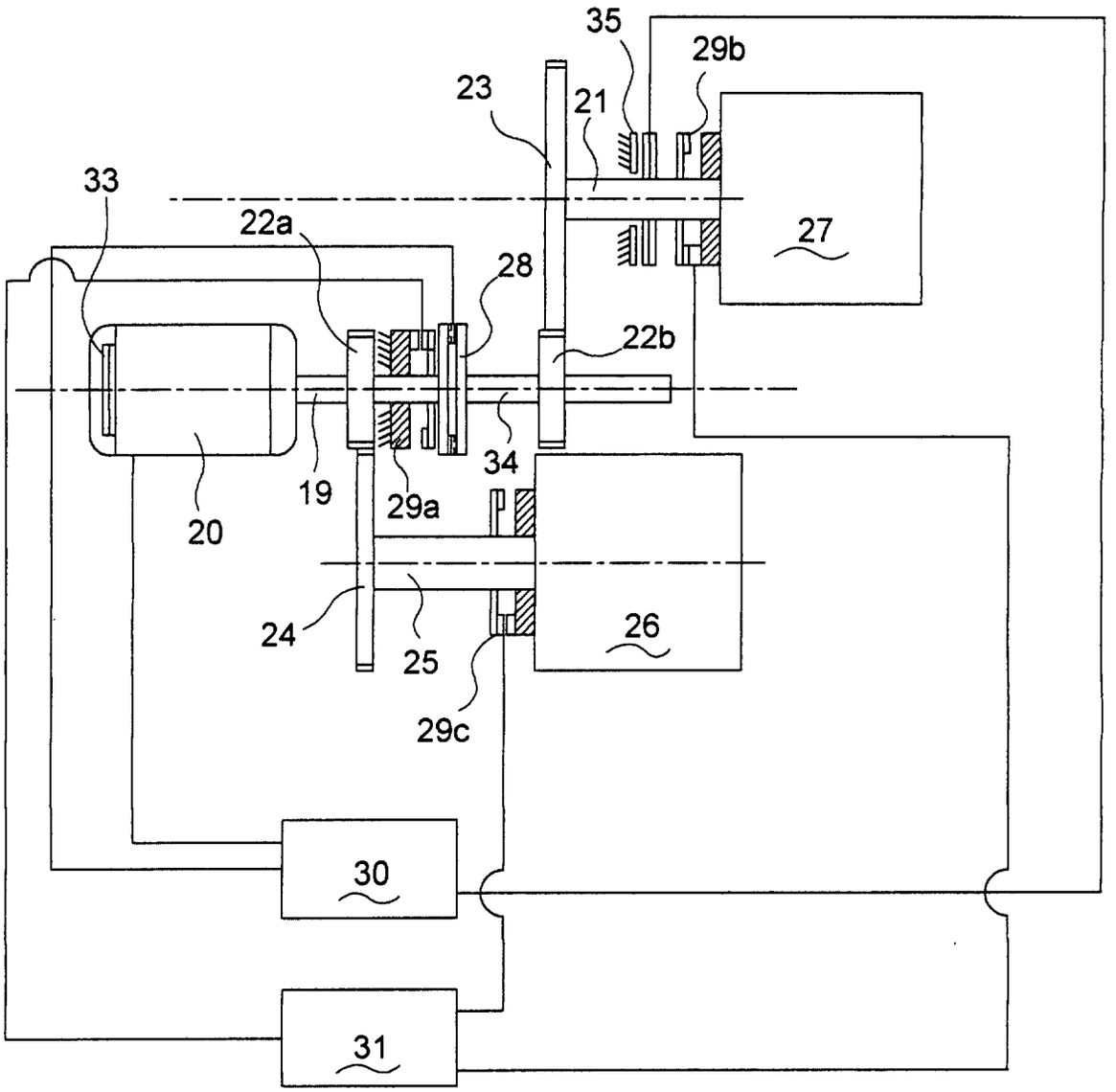

FIG.1

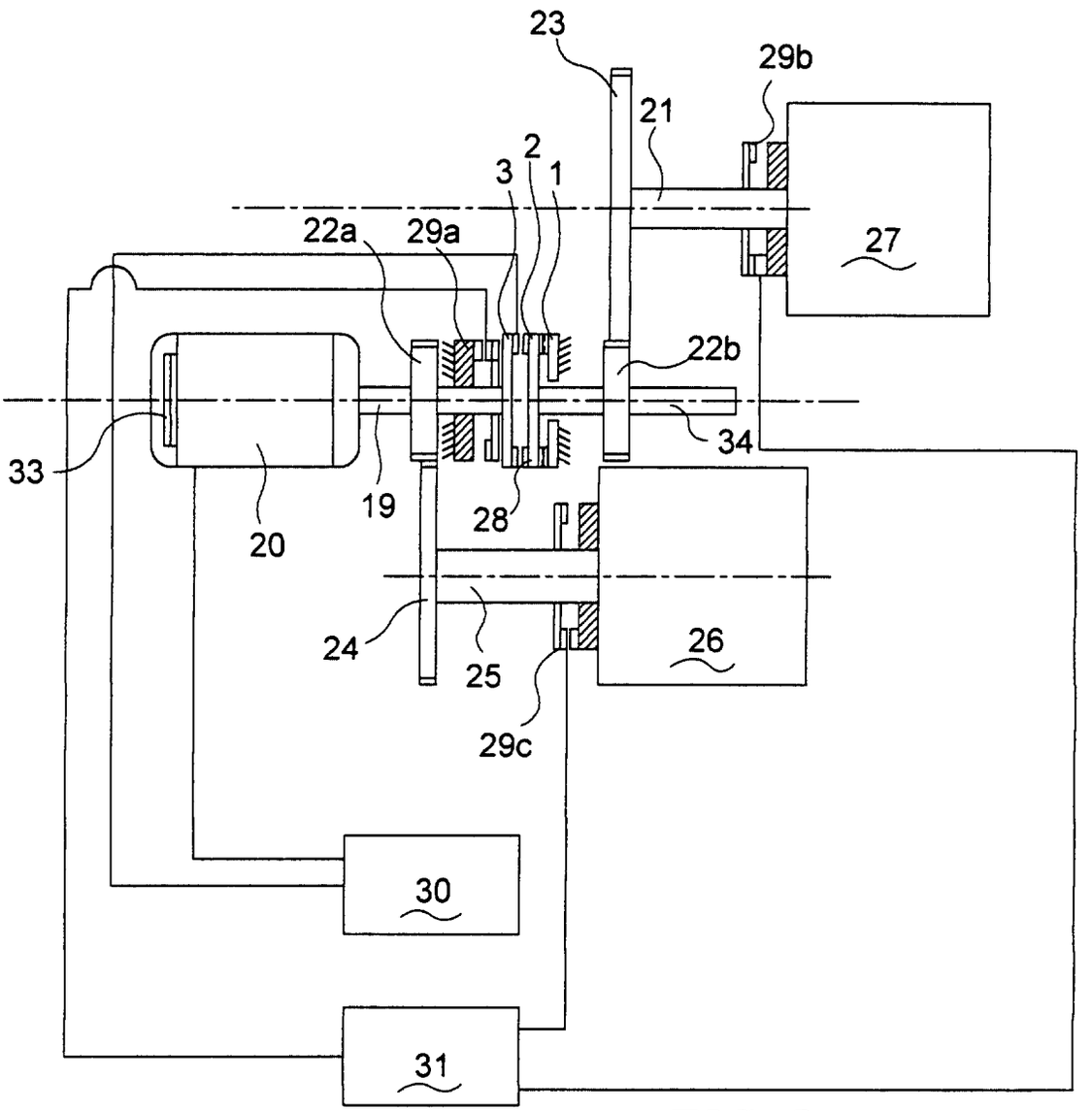

FIG.2

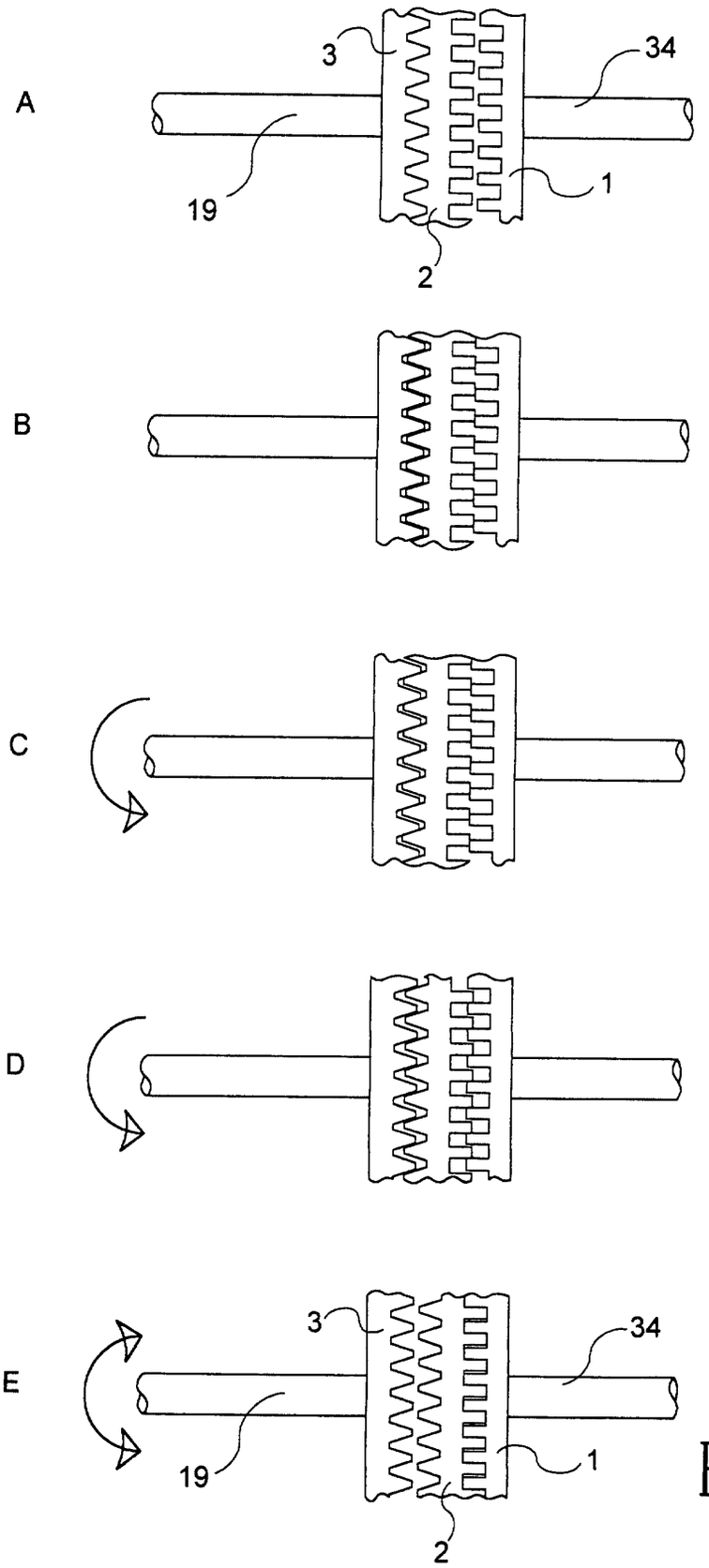

FIG.3

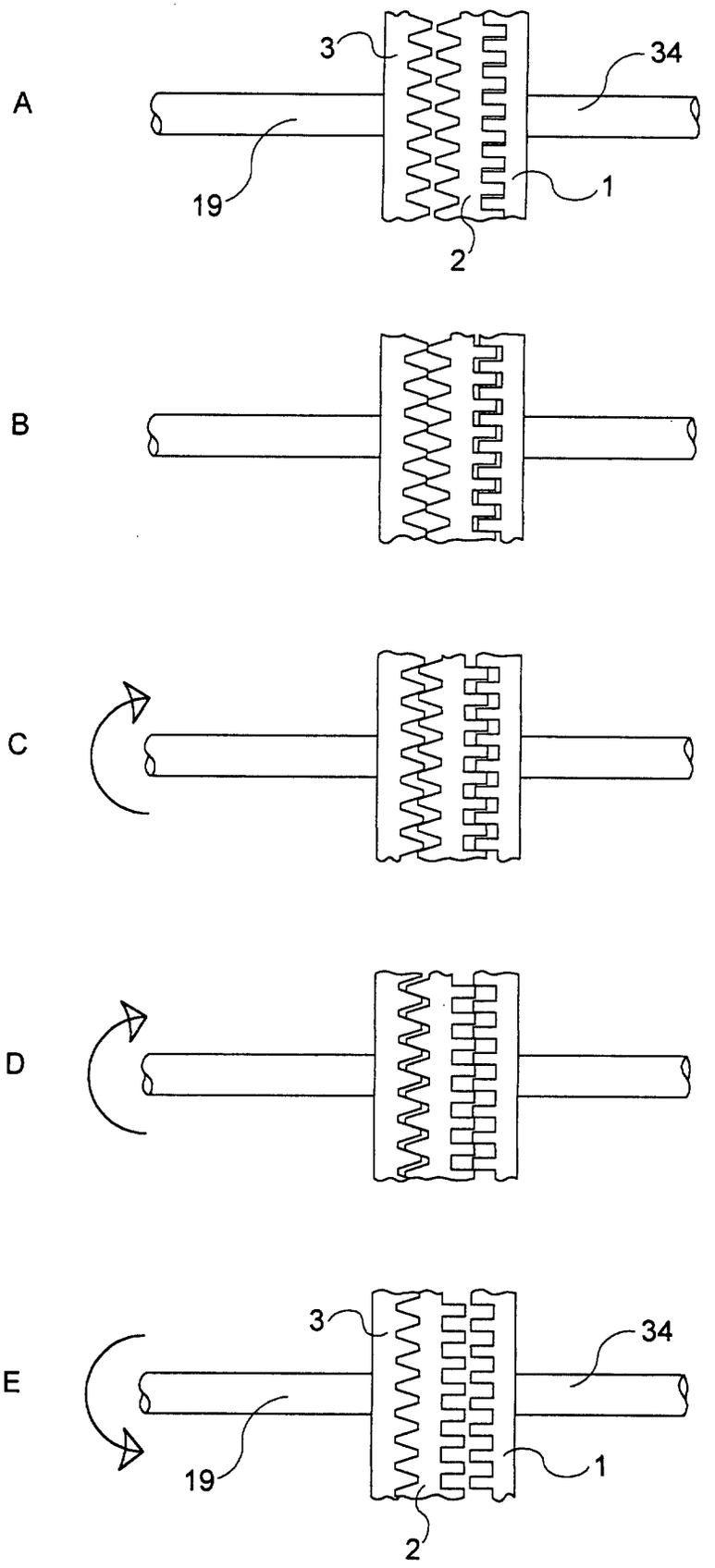

FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 01 83 0224

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)
D03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 October 2001	Rebiere, J-L

CATEGORY OF CITED DOCUMENTS

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