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(54) Modulated thread braking device for weft feeders.

(57) The device comprises a braking body which has a continuous circular extension, typically a truncated-cone body (12), which is supported by elastic means (13) frontally and coaxially to the drum (T) of the feeder (10) and is actuated by said means (13) into elastic contact engagement with its larger cross-section against said drum along a tangency circumference (C1) of the drum which is slightly smaller than the maximum one. The thread (F) runs between said drum (T) and said braking body (12) along an inclined path which extends between the tangency circumference (C1) of the braking body with respect to the drum and the smaller cross-section of the braking body. The braking body (12) has a cylindrical portion (120) which is rigidly coupled thereto at its smaller cross-section, extends into the annular gap of the skirt (18) of a permanent magnet (19) and is provided with a coil (20) which is supplied with an energization current (I) which is modulated in accordance with the variations in the mechanical tension of the thread ; means (21-23 and 26-28) being provided for detecting the mechanical tension of the thread and for converting said mechanical tension into a corresponding electrical signal (t) used to modulate said energization current.

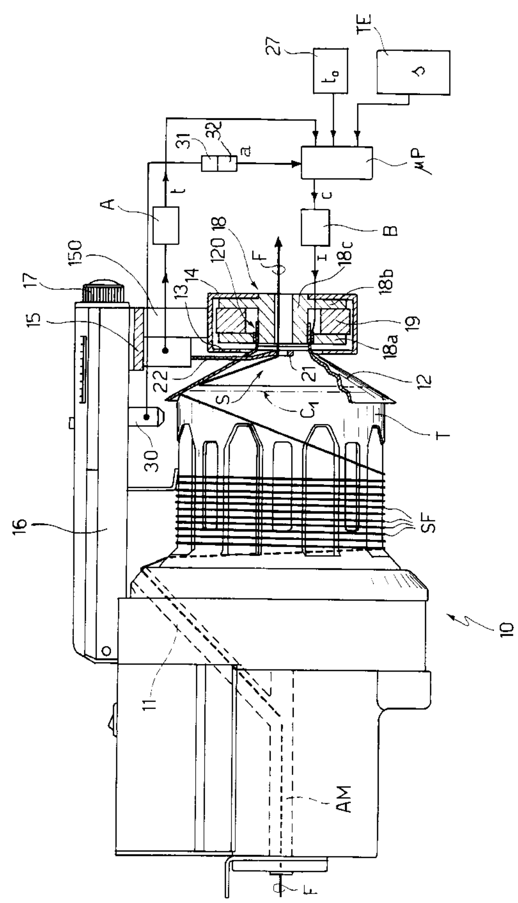

FIG. 1

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The present invention relates to a modulated thread braking device in weft feeders for shuttle-less looms and in particular for gripper, bullet and pneumatic looms.

As is known, weft feeders are devices which comprise a fixed drum on which a rotating arm winds a plurality of turns of thread which constitute a loom feed reserve. At each beat, the loom removes a certain number of threads from said reserve, and the thread which unwinds from the drum of the feeder is subjected to braking means which allow to control its mechanical tension.

Two kinds of braking means have substantially been used so far, and both are mechanical: brush brakes and metallic-lamina brakes. Brush brakes, of the first type, are constituted by a ring of bristles, typically made of synthetic fibers, arranged inside a ring which surrounds the feeder drum. The bristles are in contact with the drum, and by means of their elastic action they brake the thread which unwinds from said drum. Lamina brakes, of the second type, are constituted by a ring of individual elastically yielding metallic laminae or fingers which are arranged in a row along the generatrices of a rotational solid, such as a conoid or a paraboloid, and also elastically engage the surface of the drum.

Both of these known kinds of brake, in addition to specific problems such as rapid wear and the possibility of being easily clogged by lint and the like, have the severe problem in that the braking action applied to the thread depends on the advancement speed of said thread and increases in an approximately linear manner as said speed increases. This phenomenon, which is well-known to the expert in the field, is due to the fact that in known braking systems of the specified type the coefficient of friction between the braking means and the thread varies correspondingly to the changes in the speed imparted to said thread by the loom. Typically, in modern gripper (or bullet) looms the speed of the grippers (or other means) for weft insertion varies in an approximately sinusoidal manner with two half-periods per beat cycle. Consequently, the thread advancement speed passes from a nil value, which corresponds to the exchange of the weft among the grippers or to the release of weft, to a maximum value during the traction of said weft.

For a correct weaving process, the thread must be subjected to adequate mechanical tension during the entire beat cycle. In particular, the thread must be subjected to adequate tension -- hereinafter termed static tension -- even when its speed becomes zero, for example during the exchange of the thread among the clamps, or when the weft is released at the sides of the portion of fabric.

The static tension of the thread is set by means of adjustment elements which act on the braking means; said elements vary the contact pressure between the braking means and the thread which runs in contact with the drum of the feeder. Said tension cannot drop below a given value in order to avoid the presence of slack wefts on the sides of the portion of fabric being formed. Said static tension, which is normally set to the minimum value compatible with these requirements, reaches -- as the thread advancement speed increases -- values which are percentually much higher, and with modern looms it is easy to reach 700% increases in static tension. It is easily understood that this causes easy and frequent breakages of the thread during the weaving process.

In order to obviate this severe problem, it has already been proposed to positively modulate the braking action by means of an additional braking element which is subjected to an electromagnetic actuator supplied with a current which varies according to a rule which is analogous to the rule of variation of the thread advancement speed.

Said known braking element is generally used in combination with a brush braking means and is constituted by a movable annular disk which is arranged coaxially to the drum of the feeder and in front of it in the thread exit direction. The outer diameter of the disk is much smaller than the diameter of the drum of the feeder, for example 60-70% smaller, and the thread is pressed with a variable elastic force between said annular disk and a corresponding protruding central part of the drum . The movable disk is subjected to the elastic load of a spring and is rigidly coupled to the movable element of an electromagnet which is supplied with a current which varies proportionally to the speed of the loom. By virtue of this electromagnet, the elastic load of the spring which acts on the disk is modulated proportionally to the speed of the loom.

However, this known construction has not yielded satisfactory results. In fact, if said known braking element is used in combination with a brush braking means (or the like), the modulation of the braking action which it applies to the thread is affected decisively by said braking means and it is practically impossible to make the thread maintain a sufficiently constant tension -- for example not higher than 20-50% of the static tension -- as the speed of the loom changes.

On the other hand, if said braking element is used on its own, due to the small diameter of its movable disk the thread is not controlled during the motion for unwinding from the drum. This produces, as observed experimentally, the forming of an unwanted "balloon" and of consequent possible tangles of said thread in the section upstream of the braking element. Furthermore, the small diameter of the disk causes it to have a correspondingly reduced elasticity and this on one hand prevents the easy passage of any knots in the thread and on the other hand makes it more difficult to adjust the static tension on said thread.

The aim of the present invention is essentially to eliminate these severe problems and, within the scope of this general aim, an important object of said invention is to provide a device for positively modulated braking which can control the unwinding of the thread from the drum of the feeder and can vary the braking action applied to the thread proportionally with respect to the mechanical tension which acts on said thread in order to keep said tension substantially constant, for example within variation limits not higher than 20-50% of the static tension.

Another important object of the present invention is to provide a device which is constructively very simple and can respond, in terms of adaptation of the braking action applied to the thread, even to instantaneous changes in the mechanical tension of said thread. This high sensitivity of the device in practice allows the passage of any knots present on the thread, without producing such stresses as to cause its breakage.

This aim, these important objects and others which will become apparent from the following detailed description are obtained, according to the present invention, by virtue of the fact that a positive modulated braking device is provided which comprises a braking body which has a continuous circular extension, typically a truncated-cone body, is supported by elastic means frontally and coaxially with respect to the drum of the feeder and is actuated by said means into elastic contact engagement with its larger cross-section against said drum along a circumference of the drum which is slightly smaller than the maximum one, in that the thread runs between said drum and said braking body along an inclined path which extends between the tangency circumference of the braking body with respect to the drum and the smaller cross-section of the braking body and in that the braking body has, at its smaller cross-section, a cylindrical portion which is rigidly coupled thereto, extends into the annular gap of the skirt of a permanent magnet and is provided with a coil which is supplied with an energization current which is modulated in accordance with the variations in the mechanical tension of the thread; means being provided for directly or indirectly detecting the mechanical tension of the thread and for converting the variations of said mechanical tension into a corresponding electrical signal used to modulate said energization current.

Further objects, characteristics and advantages of the present invention will become apparent from the following detailed description and with reference to the accompanying drawings, given by way of non-limitative example, wherein:

figure 1 is a lateral elevation view of a weft feeder with the modulated braking device according to the present invention; the device is shown in axial longitudinal cross-section;

figure 1a is an enlarged-scale view of a detail of figure 1;

figure 1b is an enlarged-scale plan view of a means for elastically supporting the braking body according to a constructive variation;

figure 2 is a sectional view of a detail of figure 1, illustrating an embodiment of the means for directly detecting the mechanical tension of the thread;

figure 3 is an electrical diagram which illustrates the circuital connection of the detection means of figure 2;

figure 4 is a partial view, similar to figure 2, of a variation of the invention;

figure 4a is an enlarged-scale view of a detail of figure 4.

Figure 1 shows a weft feeder 10 with a fixed drum T on which a hollow rotating arm 11 winds a plurality of turns of thread SF which constitute a weft reserve. The rotating arm 11 is rigidly coupled to an equally hollow drive shaft AM of the feeder 10, and the thread F which arrives from the spool of thread, which is not illustrated, runs in the cavity of said shaft and of said arm.

Upon each beat, the loom TE removes from the reserve SF a certain number of turns and the thread which unwinds from the drum T of the feeder is subjected to a braking means which allows to control its mechanical tension. The braking means is constituted by a braking body 12 which has a continuous circular extension and is typically a truncated-cone body. The generatrices of the braking body 12 are preferably straight, but this is non-limitative and it is equally possible to use bodies such as 12 with curved generatrices, for example parabolic ones. An elastic means is provided in order to support the truncated-cone braking body 12 frontally and coaxially to the drum T, with its larger cross-section directed toward said drum. The elastic means furthermore actuates the braking body 12 into elastic contact engagement with the drum along a circumference C1 thereof, termed tangency circumference, which is slightly smaller than the maximum circumference of said drum.

The elastic means is constituted by a lamina 13 which is centrally perforated and is made of metal or synthetic material or cardboard impregnated with synthetic resin. The lamina 13 surrounds the body 12 with the edge of its central hole, for example at the smaller cross-section of said body, and has a surface which is elastically deformable along a direction which is parallel to the axis of the drum T.

In the embodiment of figures 1 and 1a, the axial elasticity of the laminae 13 is obtained by means of concentric undulations 130 formed on the surface of said laminae.

In the variation of figure 1b, the lamina 13 is provided with a lobed outer contour 131 and with a double series of punched openings 132-133 which surround the central hole 134 which is meant to surround the truncated-cone body 12. Each one of the openings 132-133 extends through an arc of approximately 120° and delimits corresponding series of radial spokes 135-136. The arrangement is advantageous, since it provides the lamina 13 with high elasticity in an axial direction and at the same time with adequate rigidity in a radial direction.

The lamina 13, regardless of its execution, is accommodated in a cup-shaped support 14 to which it is rigidly coupled along its entire outer contour in the case of the lamina of figure 1a and at points of said contour in the case of the lamina of figure 1b; said points are delimited by holes P1-P2-P3 through which corresponding retention means pass. The support 14 is rigidly coupled, by means of a rigid arm 150, to a slider 15 which can slide on a guide 16 which is arranged parallel to the drum T. A known traction device, for example of the screw-and-nut type, provided with an actuation knob 17, allows to move the slider 15 along the guide 16 and consequently to move the support 14 in order to vary the elastic force with which the body 12 presses on the drum T. This allows to adjust the static tension applied to the thread F.

The braking body 12 is made of a high-strength synthetic material, for example a fabric or laminate of carbon fibers impregnated with polymeric resin, and has a cylindrical portion 120 at its smaller cross-section. Said cylindrical portion 120 extends into the annular gap of a skirt 18 of magnetic material which surrounds an annular permanent magnet 19. The skirt 18, which is contained in the cup-shaped support 14, is formed by two disks 18a-18b and by a perforated hub which delimits said annular gap together with the disk 18a; the thread F which exits from the device 10 passes through the hole in the hub.

A winding 20 is arranged on the extension 120 and is supplied with an energization current I which is modulated and can vary in accordance with the variations in the mechanical tension of the thread detected by a tension sensor S which probes said thread. The current I interacts with the magnetic field produced by the magnet 19 and generates a magnetomotive force which acts in order to vary, in a correspondingly modulated manner, the contact pressure of the truncated-cone body 12 on the drum T.

In figure 1, the sensor for the mechanical tension of the thread is constituted by a thread guiding eyelet 21 which is arranged adjacent to the smaller cross-section of the truncated-cone body 12.

The thread F extends from the tangency circumference C1 of the drum T to the eyelet 21 and forms, with respect to the axis of the drum T, an angle which is greater than the taper of the truncated-cone braking body 12; therefore the truncated-cone braking body 12 engages the thread only at said tangency circumference.

The eyelet 21 is supported at the free end of an elastic arm 22, and figure 2 shows that the other end of the arm 22 is rigidly coupled, by means of an L-shaped wing 220, to the rigid arm 150. Parallel to the arm 22, the wing 220 has a free arm portion 221. Four strain gauges, designated by the reference numerals 23 to 26, are arranged on the arm 22 and on the arm portion 221 and are located in pairs on both faces of said arm and of said arm portion. The four strain gauges 23 to 26 are connected with a bridge-like arrangement P, as shown in the detail view of figure 3, and the diagonal of the bridge P is connected to the inputs of a differential amplifier A which provides in output a signal "t" which is proportional to the mechanical tension of the thread. The described arrangement for the four strain gauges 23 to 26 eliminates any noise signals due to the vibrations of the feeder 10, and the signal "t" correctly depends only on the mechanical tension of the thread.

As clearly shown in figure 1, the signal t present at the output of the amplifier A is sent to a microprocessor µP. The microprocessor also receives a signal "to", for example set by means of a keyboard 27, which represents the maximum tension which the thread can reach during the beat of the loom, and a synchronization signal "s" provided by the loom TE. A control signal "c" is output by the microprocessor µP and drives an amplifier B which provides in output the energization current I, modulated proportionally to the variation in the mechanical tension of the thread with respect to said maximum tension "to", which supplies the winding 20. The microprocessor µP is programmed to provide a signal to the amplifier B such that the corresponding energization current I allows to keep the signal "t" within values equal to 20-50% of the preset signal "to".

In the variation of figure 4, wherein similar or corresponding parts are designated by the same reference numeral, the means for sensing the mechanical tension of the thread is constituted by a probe 28 with rollers which is located externally to the feeder 10 and is not rigidly coupled thereto. The probe 28 can be of the known type with three rollers, wherein the central roller is supported by an elastic arm (not illustrated) with which at least one strain gauge is associated, said strain gauge being capable of providing a tension signal "t" which is proportional to the stress which the thread discharges onto said central roller. In this case, the truncated-cone braking body 12 has a greater taper than the angle which the thread forms with respect to the axis of the drum T and constitutes, with its smaller cross-section, a thread guide for the thread F arranged upstream of the hole of the hub of the skirt 18.

For this purpose, the smaller cross-section of the truncated-cone braking body 12 is surrounded by a protruding ring 210 which extends slightly inside the truncated-cone braking body 12. Consequently, the thread is in contact with the body 12 only at the points of the tangency circumference C1 and at the points of the ring 210. In this manner the thread, which rotates clockwise with respect to the truncated-cone braking body 12, is not subjected to unwanted torsions and provides a self-cleaning action as regards lint and other deposits which tend to accumulate on the truncated-cone body.

As in the case of figure 1, according to the variated embodiment of figure 4, too, the cylindrical portion 120 which extends in the annular gap of the skirt 18 and is provided with the winding 20 is associated with the smaller cross-section of the truncated-cone braking body 12. The energization current I is fed to the winding 20 by the amplifier B under the control of the microprocessor μP, and said microprocessor receives the signal "t" which corresponds to the mechanical tension of the thread from the probe 28 with the interposition of the amplifier A.

With the construction according to the invention it is also possible, by means of a dedicated signal produced by the microprocessor μP, to block the sliding of the thread after the unwinding of a preset and possibly non-integer number of turns. This possibility makes the device according to the invention particularly suitable to feed pneumatic looms. As is known in the feeding of these looms, the feeder 10 also acts as device for pre-measuring the length L of the weft inserted at each loom beat; since:

$$L = \pi Dn + K\pi D$$

where D is the diameter of the drum T, n is the integer number of turns and K is a number comprised between 0 (zero) and 1 (one) which represents the generic fraction of a turn.

In figure 1, this function is performed by an optical sensor 30 which detects the turns which unwind from the drum T. The sensor 30 is associated with a counter 31 whose output is connected to a timer 32 which is in turn connected to the microprocessor μP. The counter 31, after the unwinding of a preset integer number of turns of thread, activates the timer 32 which, after a time which corresponds to the unwinding of the possible fraction of a turn K, issues a stop signal "a". In the presence of said stop signal, the microprocessor μP, by means of the amplifier B, energizes the coil 20 with a stop current which pushes the truncated-cone body 12 against the drum T with a force which is sufficient to prevent the further advancement of the thread F.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Modulated thread braking device in weft feeders (10) which comprise a fixed drum (T) on which a reserve of thread is accumulated in the form of turns of thread (SF), characterized in that it comprises a braking body which has a continuous circular extension, typically a truncated-cone body (12), which is supported by elastic means (13) frontally and coaxially to the drum (T) of the feeder (10) and is actuated by said means (13) into elastic contact engagement with its larger cross-section against said drum along a tangency circumference (C1) of the drum which is slightly smaller than the maximum one, in that the thread (F) runs between said drum (T) and said braking body (12) along an inclined path which extends between the tangency circumference (C1) of the braking body with respect to the drum and the smaller cross-section of the braking body, and in that the braking body (12) has a cylindrical portion (120) which is rigidly coupled thereto at its smaller cross-section, extends into the annular gap of the skirt (18) of a permanent magnet (19) and is provided with a coil (20) which is supplied with an energization current (I) which is modulated in accordance with the variations in the mechanical tension of the thread; means (21-23 and 26-28) being provided for detecting the mechanical tension of the thread and for converting said mechanical tension into a corresponding electrical signal (t) used to modulate said energization current.

2. Device according to claim 1, characterized in that the truncated-cone braking body (12) is supported by a lamina (13) which is centrally perforated and surrounds, with its central hole, the truncated-cone braking body; said lamina being elastically deformable along an axial direction which is parallel to the axis of the drum (T) of the feeder (10).

3. Device according to claims 1 and 2, characterized in that the axial elasticity of the lamina (13) which supports the truncated-cone braking body (12) is obtained by providing a series of concentric undulations (130) on the body of said lamina.

4. Device according to claims 1 and 2, characterized in that the axial elasticity of the lamina (13) which supports the truncated-cone braking body is obtained by providing, on the body of the lamina, two series of punched openings (132-133) which surround the central hole of the lamina and in that each one of said openings extends through an arc of approximately 120°, delimiting corresponding series of radial spokes (134-135).

5. Device according to claims 1, 2, 3 or 4, characterized in that the lamina (13) is rigidly coupled, at least at discrete points of its external contour, to a cup-like support (14) which is rigidly coupled to a slider (15) which can slide on a guide (16) which is parallel to the drum (T) of the feeder (10) and in that the slider is controlled by a movement mechanism with a knob (17) which allows to vary the static tension which the braking body (12) exerts on the thread (F).

6. Device according to claims 1 to 5, characterized in that the cylindrical portion (120) of the truncated-cone braking body (12) extends into the annular gap of a skirt (18) made of magnetic material which surrounds an annular permanent magnet (19), and in that the skirt (18) is contained in, and rigidly coupled to, the cup-like support (14) and is formed by two disks and by a perforated hub through which the thread which leaves the feeder (10) passes.

7. Device according to claim 1, characterized in that the means for detecting the mechanical tension of the thread and for converting it into a useful signal comprise a thread guiding eyelet (21) which is arranged adjacent to the smaller cross-section of the truncated-cone braking body (12) and is supported at the free end of an elastic arm (22) whose other end, formed like an L-shaped wing (220), is rigidly coupled to the rigid adjustable support (150) of the truncated-cone braking body (12), in that said L-shaped wing (220) has a free arm portion (221) arranged parallel to the arm (22) of the eyelet and in that four strain gauges (23 to 26) are arranged on said arm (22) and on said arm portion (221) and are located in pairs on both faces of said arm and arm portion, said strain gauges being suitable to provide an electric signal which is correctly dependent solely on the mechanical tension of the thread.

8. Device according to claim 7, characterized in that said four strain gauges (23 to 26) are mutually connected according to a bridge-like circuital arrangement (P) and in that the output diagonal of the bridge is connected to the inputs of a differential amplifier (A) which provides in output the signal (t) which is proportional to the mechanical tension of the thread.

9. Device according to claim 1, characterized in that the means for detecting the mechanical tension of the thread and for converting it into a useful signal are arranged externally to the feeder (10) and are constituted by a probe (28) with movable rollers of the piezoelectric type which is suitable to provide an electric signal which is proportional to the relative displacement of the rollers.

10. Device according to claims 1, 7 and 8, characterized in that the truncated-cone braking body (12) has a smaller taper than the inclined path of the thread comprised between said tangency circumference (C1) and the thread guiding eyelet (21) which constitutes the means for detecting the mechanical tension of the thread, so that contact between the thread and the braking body occurs only at the points of said tangency circumference (C1).

11. Device according to claims 1 and 9, characterized in that the truncated-cone braking body (12) has a greater taper than the inclined path comprised between said tangency circumference (C1) and the thread output hole which is coaxial to the annular gap of the skirt (18) of the permanent magnet, so that the thread is in contact with the braking body at the points of said tangency circumference and at the smaller cross-section of the braking body; said smaller cross-section being surrounded by a protruding ring which extends slightly toward the inside of the truncated-cone braking body.

12. Device according to claim 1 and any one of claims 2 to 11, characterized in that the modulated current (I) for energizing the coil (20) of the truncated-cone body (12) is supplied by an amplifier (B) which is driven by the output signal produced by a microprocessor (μP) which receives in input the signal (t) which is proportional to the instantaneous value of the mechanical tension on the thread, a preset comparison signal (to) and a further synchronization signal which arrives from the loom, and in that the microprocessor is programmed in order to drive the amplifier (B) so that the braking action of the braking body (12) produced by the energization current (I) allows to keep the signal (t) within values equal to 20-50% of the preset signal (to).

13. Device according to claims 1 and 12, characterized in that the microprocessor (μP) furthermore receives a stop signal (a) issued by a counter-timer unit (31-32) which detects the turns and the portion of turn which unwind from the drum (T) of the feeder (10) and is programmed to energize, in the presence of said stop signal and by means of the interposed amplifier (B), the coil (20) of the truncated-cone braking body (12) with a corresponding stop current which pushes said truncated-cone braking body (12) against the drum (T) with a force sufficient to prevent the advancement of the thread (F).

FIG. 1

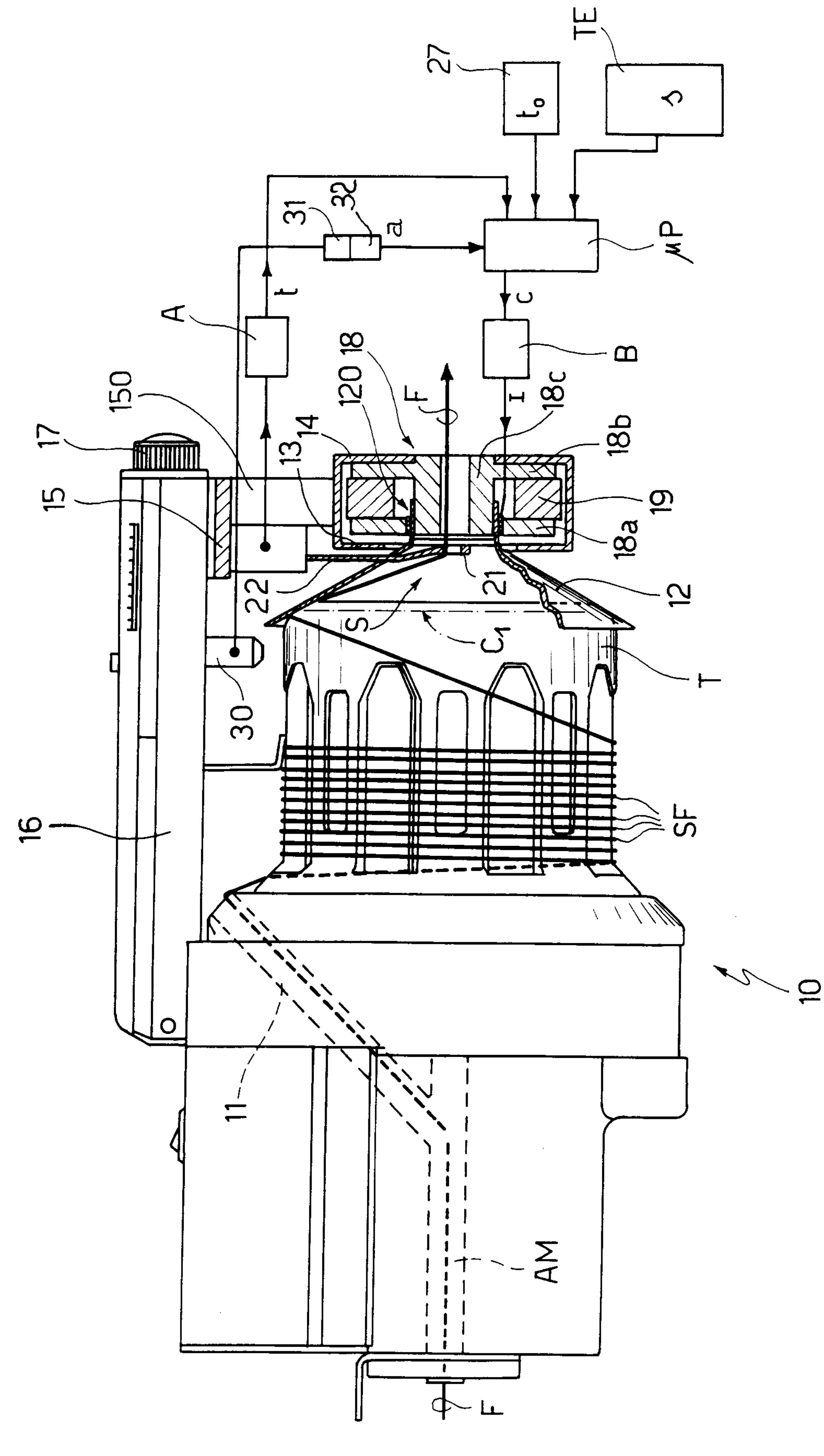
27
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FIG. 1a

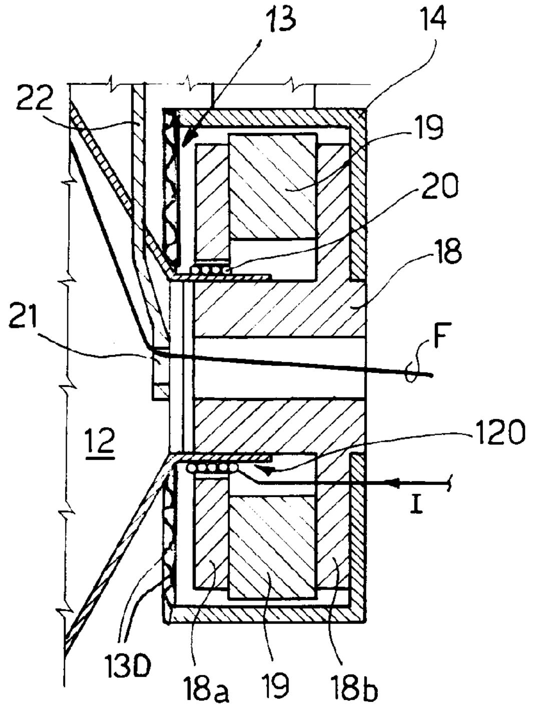


FIG. 1b

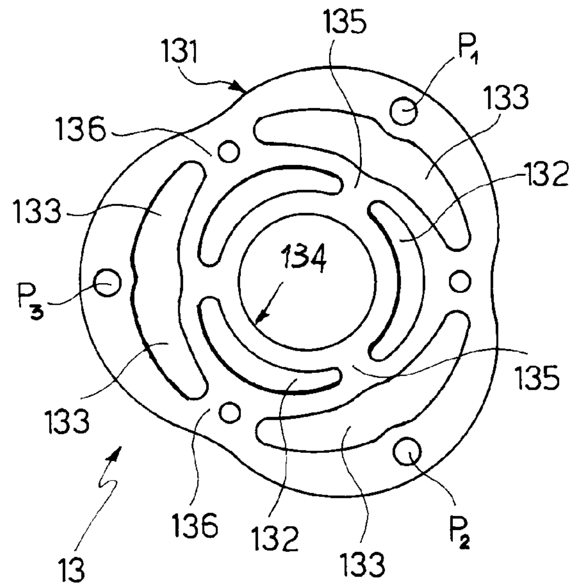


FIG. 2

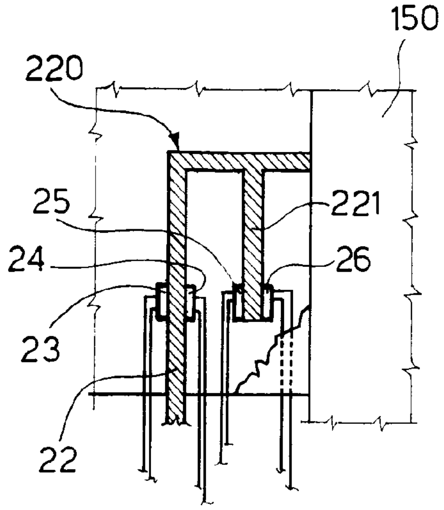


FIG. 4a

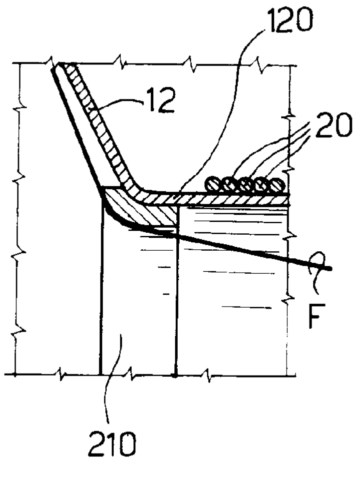


FIG. 3

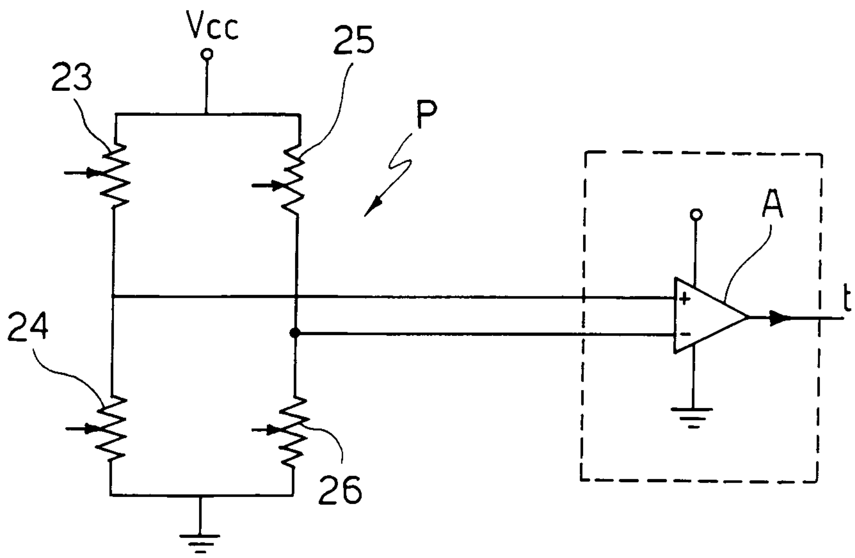
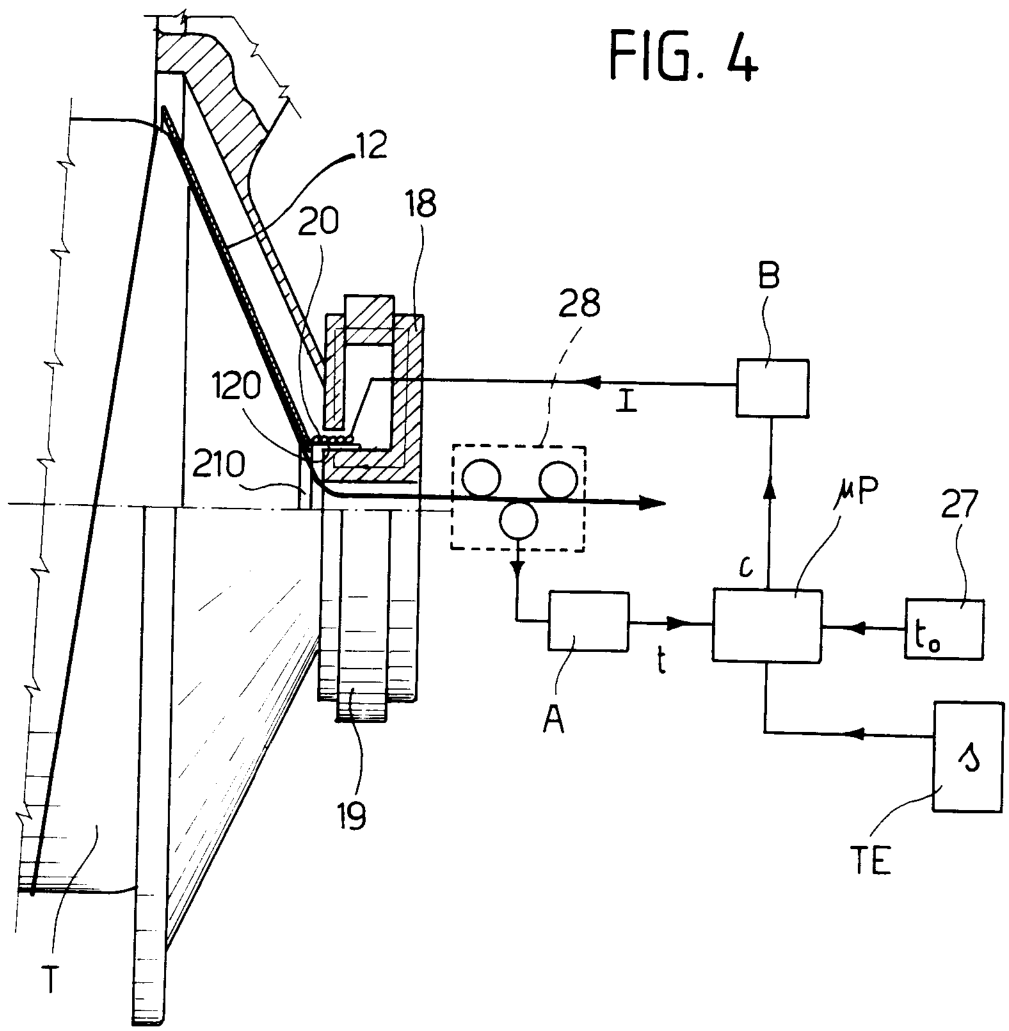


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number

EP 92 83 0487

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	WO-A-9 114 032 (JACOBSSON) * page 32, line 7 - page 33, line 31; figures 4,5 * ---	1-13	D03D1/00 D03D47/34
A	EP-A-0 246 182 (GEBRÜDER SULZER A,G.) * page 5, line 22 - page 7, line 15; figures 2,3 * ---	1-13	
A	WO-A-9 105 728 (IRO ÄB) * claim 22; figures 1-12 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			D03D B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 JANUARY 1993	HENNINGSEN O.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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