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(54) **Improved arrangement of a back rest for a weaving loom**

(57) The invention relates to an improved arrangement of a back rest, and to the corresponding loom, of the type comprising a back rest (C) - which carries the warp yarns (T) coming from a warp beam - mounted os-

cillating on a suspension mechanism and further provided with a sensor detecting the average tension of the warp yarns carried thereon, wherein said sensor is a torsional load cell located between said back rest (C) and the suspension mechanism.

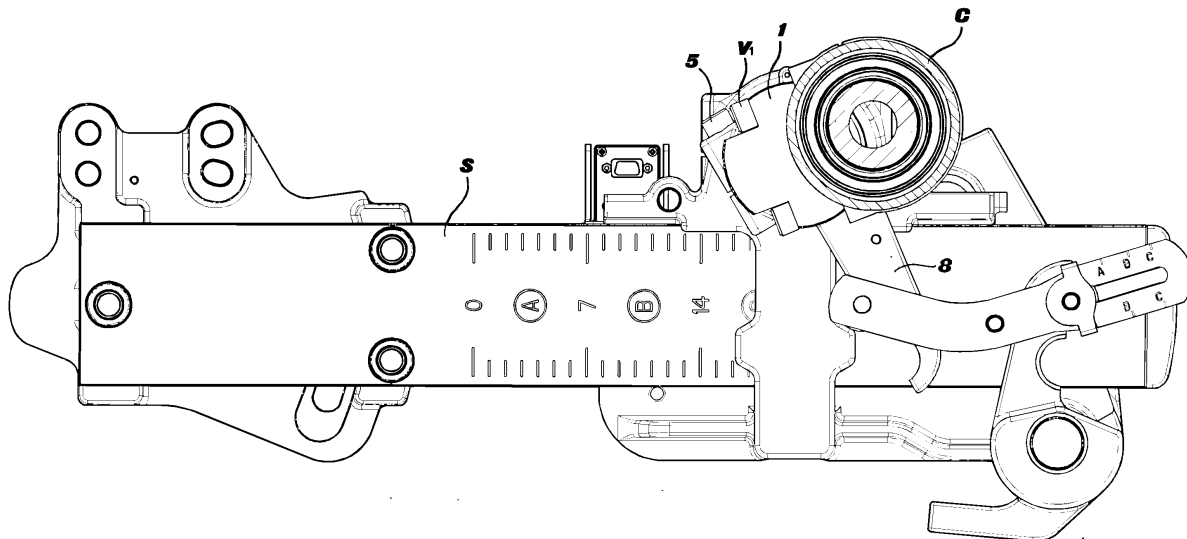


Fig.10

Description

[0001] The present invention relates to a back rest for a weaving loom, specifically to an improved back rest arrangement comprising a load cell for reading the average tension of the warp yarns.

[0002] As known, in a weaving loom the warp yarns must be guided between the warp beam and the weaving plane. This is normally accomplished through a back rest, which extends along the whole width of the loom, by means of which the warp yarns are deviated from a substantially vertical plane - defined by the array of warp yarns coming from the warp beam located in the lower part of the loom - to a substantially horizontal plane - which corresponds to the weaving plane comfortably accessible by the operator and along which the warp stop motion device (fig. 1) is located.

[0003] Given that, during the cyclic operation of the loom, the healds force the warp yarns to perform a reciprocating movement opening and closing the shed to allow the weft yarn to be inserted, a corresponding tensioning and loosening action is performed on the warp yarns themselves. It must be possible to simultaneously release or draw again these yarns to prevent them from being overtensed or from remaining excessively loose, respectively, which would affect the quality of the operated fabric as well as the reliability of the loom due to the possible breaking of the yarns.

[0004] To that purpose, the back rest is capable of performing an oscillating movement to follow the movement of the warp yarns and is indeed also called "warp thread tensioning device". Typically, the back rest is displaced from its balance position by the tension applied thereto by the warp yarns, against the force of a series of pre-loaded springs acting through suitable leverages. An example of a support assembly of a back rest is shown in figg. 4A and 4B, which are partial perspective views of the left end (as seen from the loom operator) of a prior art back rest seen from inside and outside the loom, respectively.

[0005] Since the oscillation of the back rest also introduces dynamics issues of no easy solution, ingenious articulation and suspension systems have been developed to achieve optimal guide in a number of circumstances. One such back rest is for instance the one described in EP-A2-1.031.652 in the name of the same Applicant, which is here incorporated by reference.

[0006] However, it must be noted that the stresses produced by the healds are not unique, since the yarns are stressed at each interaction with the mechanical members also, if only due to the presence of friction. This variation of tension is not only time-dependent, but is a function of the position, too: an idea of the complexity of such tensions can be derived from the diagrams of fig. 2 and fig. 3, which represent the tension over time, in different loom areas, and the average tension in a transversal direction to the loom along its width, respectively.

[0007] Thus, it can be understood how difficult it is to predict the theoretic tensions and to determine a unique adjustment aiming at achieving the desired results in terms of stress optimisation.

[0008] Therefore, the support frame of the back rest is typically further equipped with a displacement transducer, by means of which it is possible to detect the displacement of the back rest and thus to have a signal substantially proportional to the average tension existing in the warp yarns.

[0009] A design according to the prior art (figg. 4A and 4B) provides to mount a back rest C onto a main bracket B1 of an articulated linkage B1-B2-B3 working against a coil spring A; furthermore, a proximity sensor S is adjacent to the end of the shock absorber A, which is engaged on a butterfly-shaped elastic element F.

[0010] The signal obtained from the proximity sensor - which is an index of the displacement of the end of the shock absorber A, and hence of the tension applied by the warp yarns to the back rest C - is then feedback-inserted into an adjustment loop which suitably intervenes on the rotation speeds of the let-off motion cylinder and of the fabric-tensioning roller to achieve the desired tension. As a matter of fact, referring to fig. 1, as a first approximation the following can be inferred:

$$T_{warp}(T) = \frac{Ks_{yarn} \cdot n^{\circ}_{yarns}}{L_{warp}} \cdot \int_0^T (w_1(t) \cdot r_1 - w_2(t) \cdot r_2(t)) \cdot dt$$

where T_{warp} is the warp tension (N), W_1 is the angular velocity of the fabric-tensioning roller (rad/s), W_2 is the angular velocity of the let-off motion cylinder (rad/s), r_1 is the radius of the fabric-tensioning roller (mm), r_2 is the radius of the let-off motion cylinder (time-dependent, since the yarn is unwinding, mm), Ks_{yarn} is the rigidity per length unit of the individual warp yarn (N), and L_{warp} is the total geometric length of the chain (mm). Due to the extremely high inertia of the warp beam, the intervention times of the let-off motion cylinder are such that a significant intervention within the individual loom cycle is prevented: this means that it is not so important to detect and act on the instant value of the tension, but rather on the average thereof.

[0011] Despite these adjustment opportunities, the prior art system suffers from some serious drawbacks. First of all, the butterfly spring F, specifically employed to obtain the proximity reading, is prone to fatigue failure and reproducibility of its rigidity (elastic modulus) can only rarely be obtained within production batches.

[0012] Besides, reading of the sensor is performed downstream of the kinematic chain of the various rods B1, B2 and B3, which introduces disturbances in terms of friction and therefore in terms of the undesired delays and changes in the reading of the tension value.

[0013] Besides, it has been noticed that the butterfly spring/sensor assembly causes problems of poor measurement reproducibility, making it rather difficult to find a constant ratio between an adjustment parameter to be set on the loom and the desired result.

[0014] Thus, it is an object of the present invention to provide such an arrangement of the back rest that a reading of the average tension of the warp yarns can be acquired, which is not affected by the presence of a kinematic chain of the support system, and which is sufficiently reproducible over time and between one device and the other.

[0015] Such object is achieved by means of a device as described in its essential features in the accompanying main claim.

[0016] Other inventive aspects of the arrangement are described in the dependent claims.

[0017] Further features and advantages of the device according to the invention will become apparent from the following detailed description of a preferred embodiment of the same given by way of example and taken in conjunction with the accompanying drawings, wherein:

[0018] fig. 1, as already mentioned, is a diagrammatic elevation side view of a configuration typical of a weaving loom;

[0019] fig. 2, as already mentioned, is a diagram showing the time-dependent warp tension in different weaving areas;

[0020] fig. 3, as already mentioned, is a diagram showing the average tension in the warp yarns versus the transversal position along the loom width;

[0021] figg. 4A and 4B, as already mentioned, are partial perspective views, from the inside and the outside, respectively, of the left end of an arrangement of the back rest according to the prior art;

[0022] fig. 5 is an exemplary functional diagram of a feedback loop including the device of the invention;

[0023] figg. 6A, 6B and 6C are a top plan view, an elevation side view, and an elevation front view, respectively, of a load cell device according to the invention;

[0024] fig. 7 is a top plan view of an end of the arrangement according to the invention;

[0025] fig. 8 is an elevation side view of the end of fig. 7;

[0026] fig. 9 is a cross-section view according to the line IX-IX in fig. 8;

[0027] fig. 10 is an elevation side view from inside the loom, of the left suspension system onto which the arrangement of the invention is mounted; and

[0028] fig. 11 is an elevation side view of a left shoulder of the loom onto which the arrangement of the invention is mounted.

[0029] A back rest C is mounted at each end thereof, in a manner known per se, onto supporting hub devices C₁.

[0030] According to the invention, each hub device C₁ has a fastening flange C₂ by means of which it is fixed, through fastening screws V₁ and V₂, to the force-applying foot 1 of a torsional load cell.

[0031] The design of the torsional load cell is clearly shown in figg. 6A-6C.

[0032] The force-applying foot 1 of the cell is substantially T-shaped: on the two arms 1a and 1b are obtained holes 1a' and 1b' in which screws V₁ and V₂ shall engage to fix the fastening flange C₂. From the force-applying foot 1 a cylindrical body 2 projects perpendicularly, for example having a diameter of 45 mm. Between this one and the force-applying foot 1 a relief groove 3 is provided, into which measuring strain-gauges are mounted.

[0033] The groove 3 has the advantage of representing a "protected" physical area into which the strain-gauges can be placed and, above all, of allowing to best exploit the deformability range of the strain-gauges themselves (the load conditions being equal, a stronger signal is obtained), however without compromising fatigue resistance of the same and of the load cell material.

[0034] Preferably, such groove has a reduced diameter, for example 30 mm.

[0035] For an optimal reading of the torsional moment, the strain-gauges have a full bridge connection to each other, which in addition to the higher signal/strain ratio, allows to compensate the undesired effects due to bending, traction and compression.

[0036] By way of example, the load cell according to the invention has been implemented through strain-gauges MM of the type J2A-06S11K350 (specific for transducers, and inexpensive) glued with cyanoacrylate adhesives, and balanced within a range of $\pm 40 \mu V$ and powered by a 10-Volt supply.

[0037] On the cylindrical body 2 a tightening sleeve 4 is fixed, consisting of an annular tightening portion 4a - providing two jaws, mutually interlocking by means of a screw element 5 - and a thinner enveloping portion 4b, which preferably extends at least along the whole length of the cylindrical body 2.

[0038] In the upper part of the tightening portion 4a is further provided a flap or flange 6 from which an abutting pin projects perpendicularly, which is useful during the assembling step.

[0039] Finally, from the annular tightening portion 4a projects downwards a supporting bracket 8, capable of connecting the whole arrangement of the back rest to a suitable supporting kinetic mechanism of the loom (fig. 10).

[0040] As can be easily understood, thanks to the arrangement according to the invention, the tension of the warp

yarns T (fig. 11) is applied onto the back rest C, then reaches the supporting structure of the weaving loom through the load cell, which is capable of reading the value thereof and of translating it into an electric signal. Advantageously, in order to establish the application of a torsional moment sufficient for the readability of the torsional load cell signal, the axis of the back rest C is offset in respect of the central axis of the cylindrical body 2 of the load cell, respectively marked by projections O and O' in fig. 8.

[0041] The electric signal coming from the torsional load cell is then fed and processed within a feedback loop capable of intervening correctly on the chain controls, in particular on the motors of the let-off motion cylinder and of the fabric-tensioning roller.

[0042] An exemplary circuit of this type is shown in fig. 5. The signal coming from the load cell is fed into an amplifier (A) having the function of translating the signal into a range of values expected by a voltage-to-frequency converter. It should be appreciated that the amplifier, due to the inevitable presence of a resistor-capacitor-type circuit, has an own time constant, which therefore already causes a first damping of the input signal. The signal is then processed by a voltage-to-frequency converter (V/F) which translates the analogical tension signal, coming from the amplifier, into a frequency modulated signal: the output in Hertz is proportional to the input in Volts. The frequency signal is then translated into a digital piece of information within a suitable microprocessor (MP): over a certain time interval the periods of the signal coming from the V/F converter are counted. The sampling of the signal is not continuous, but repeated at constant time intervals. Since it is not dependent on the cycle period of the machine, it is called asynchronous: for example, it occurs every 10 ms, which is a sufficiently short period to prevent the signal from being misinterpreted. In an RTC (Real Time Controller), an "offset" (for example the tare of the back rest) can be applied to the signal coming from the MP, and the sign can be inverted, if necessary. Inside a P.I.D. (Proportional, Integral, Derivative) control unit, the signal t coming from the RTC is compared against a preset reference voltage: the error obtained is examined both in its proportional part - used for major changes (for example at the starting of the loom) - and in its integral part - used to compensate the oscillations about the preset reference value; each of these two parts has an own associated coefficient of intervention: clearly, the value assigned to these parameters is important for the correct operation of the system. The output signal of the P.I.D. control unit is used to adjust warp beam drive and thus the tension of the warp yarns on the back rest, which provides a certain reaction in the load cell, which in turn produces a rectifying signal to be feedback-fed into the loop and so on, until convergence towards an optimal value is reached.

[0043] The error value coming from the P.I.D. control unit is preferably corrected by varying a single parameter, which is the so-called fictitious warp-beam-releasing radius (also called transmission ratio, i.e. the ratio of loom cycles to warp beam revolutions): if the tension is lower than the preset value, the fictitious warp beam radius is increased ($\Rightarrow$ the warp beam slows down), if the tension is higher, the radius is reduced ($\Rightarrow$ the warp beam accelerates). In this way both the correction of the actual variation of the warp beam radius, and that of the variation of the tension are conveyed into the same parameter. Should the loom start with a wrong warp beam radius value, the system would in any case be capable of operating correctly, rectifying the value of the fictitious radius until it is near the actual value.

[0044] Thanks to the arrangement according to the invention, which ensures good proportionality and excellent reproducibility, it is possible to obtain a certain proportionality between the "number" set by the operator and the actual warp tension, in particular proportional to the average tension expressed in cN.

[0045] This system, as a matter of fact, is not affected by the friction introduced by leverages or by the supporting kinetic mechanism, as opposed to the prior art, since reading occurs between the back rest and the bracket 8 at the oscillation fulcrum. Besides, the butterfly spring and the corresponding sensor, which used to be a source of considerable errors in prior art devices, can be removed.

[0046] The Applicant was able to practically obtain an arrangement according to the invention which, by means of a single cell, made it possible to cover the whole range of possible tensions, from the lowest ones to the highest ones, estimated to be - in terms of the torsional moment on the cell - $20 \div 770$ Nm plus the torsional moment due to the mass of the back rest which, depending on the length of the back rest, is $24 \div 116$ Nm. With these specifications, the load cell always used and transferred a signal of a few mVolts correctly, which was subsequently suitably conditioned and amplified in the circuit described above. Also, detection reproducibility was excellent, with maximum deviation in the region of 1%.

[0047] It is understood that the invention is not limited to the specific embodiment illustrated above, which represents only a non-limiting example of the scope of the invention, but that a number of changes may be made, all within the reach of a skilled person in the field, without departing from the scope of the invention.

Claims

1. Back rest arrangement for weaving looms, of the type comprising a back rest (C) - which carries warp yarns (T) coming from a warp beam - mounted oscillating on a suspension mechanism and further provided with a sensor detecting the average tension of the warp yarns carried thereon, **characterised in that** said sensor is a torsional

load cell located between said back rest (C) and the suspension mechanism.

2. Arrangement as claimed in claim 1), wherein the longitudinal axis (O) of said back rest is parallel to but offset in respect of the detection axis (O') of said torsional load cell.

3. Arrangement as claimed in claim 1) or 2), wherein said back rest (C) is mounted rotating at its ends onto supporting hub devices (C₁) fastened onto respective force-applying feet (1) of said load cell, which cell is in turn tightened in a mounting sleeve (4) to a bracket (8) of the suspension mechanism.

4. Arrangement as claimed in any one of the preceding claims, wherein a signal output from the load cell is fed into a feedback control loop of the warp yarn tension.

5. Arrangement as claimed in claim 4), wherein said control loop acts on the controls of one or both of a warp beam motor and a motor of the fabric-tensioning roller of the loom.

6. Arrangement as claimed in claim 5), wherein said control loop acts exclusively onto the fictitious warp-beam-releasing radius.

7. Weaving loom of the type comprising at least one back rest between a warp beam and the weaving area, **characterised in that** it further comprises an arrangement as claimed in any one of the preceding claims.

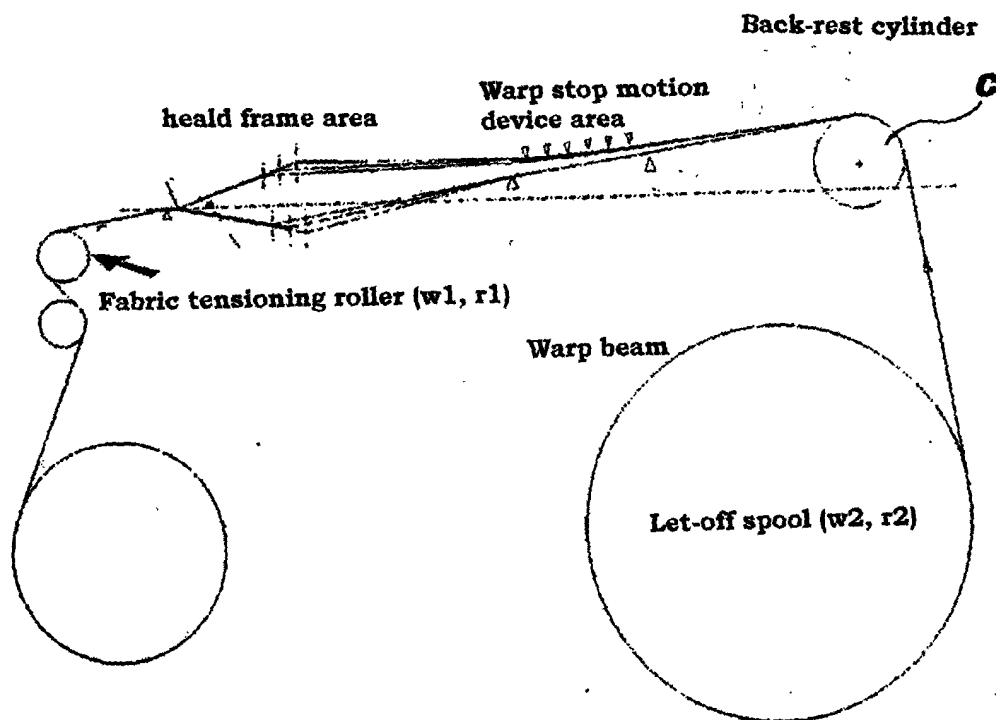


Fig. 1

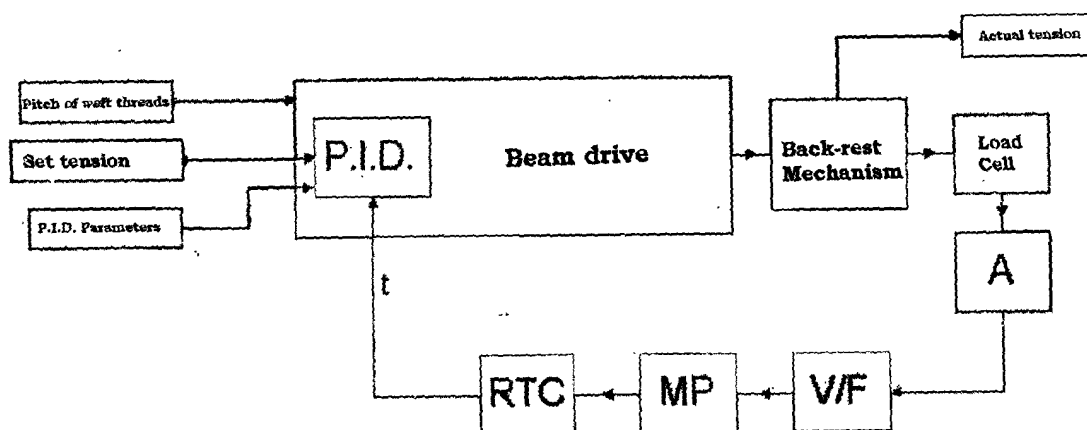
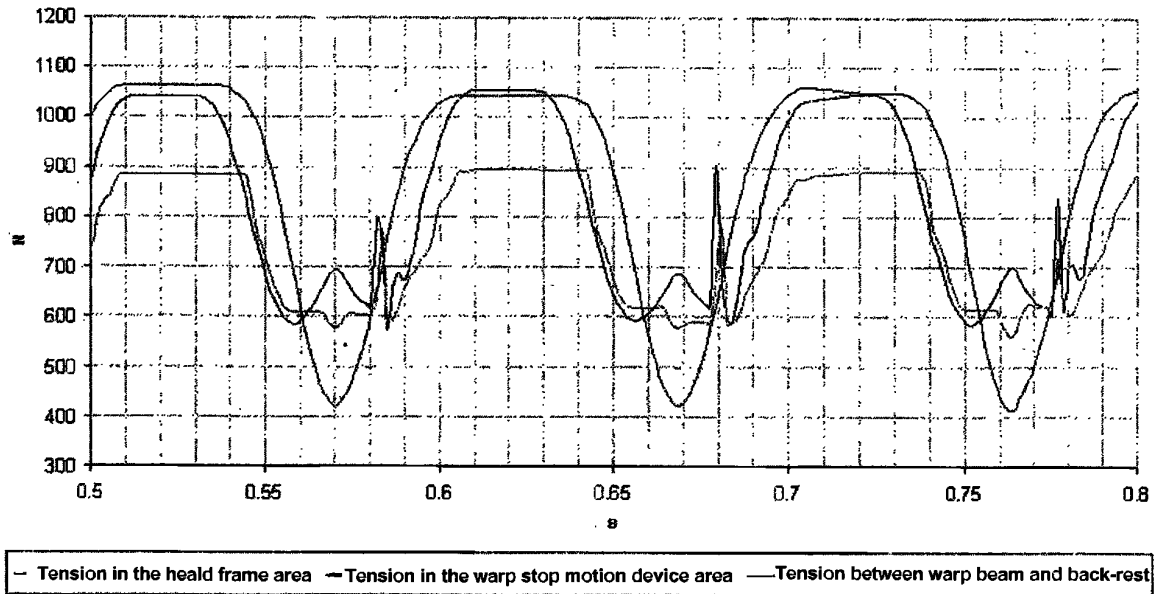
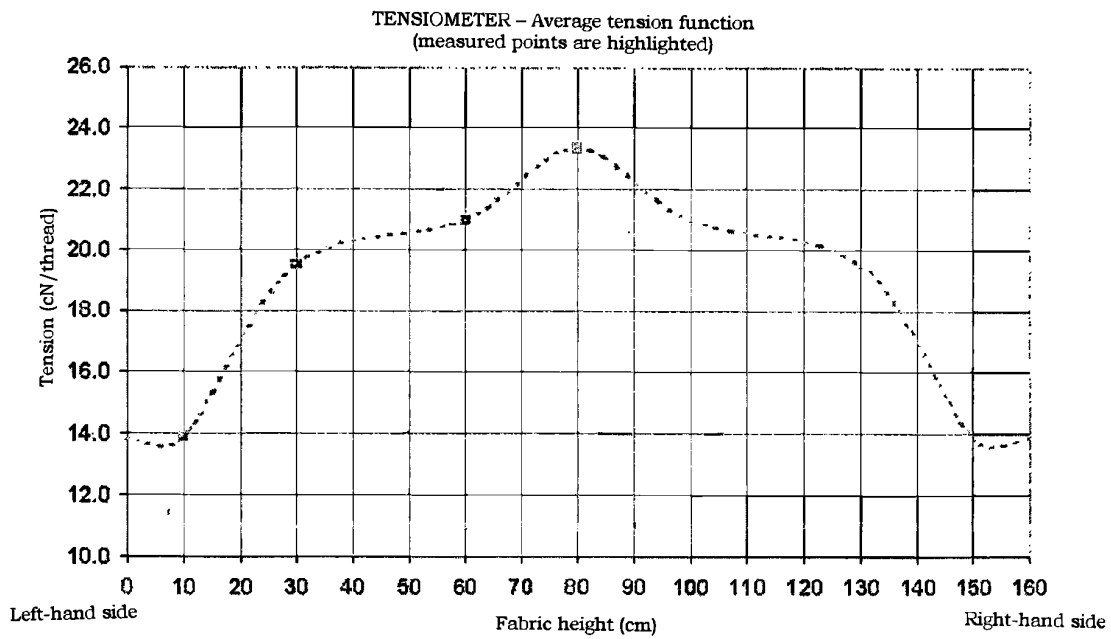
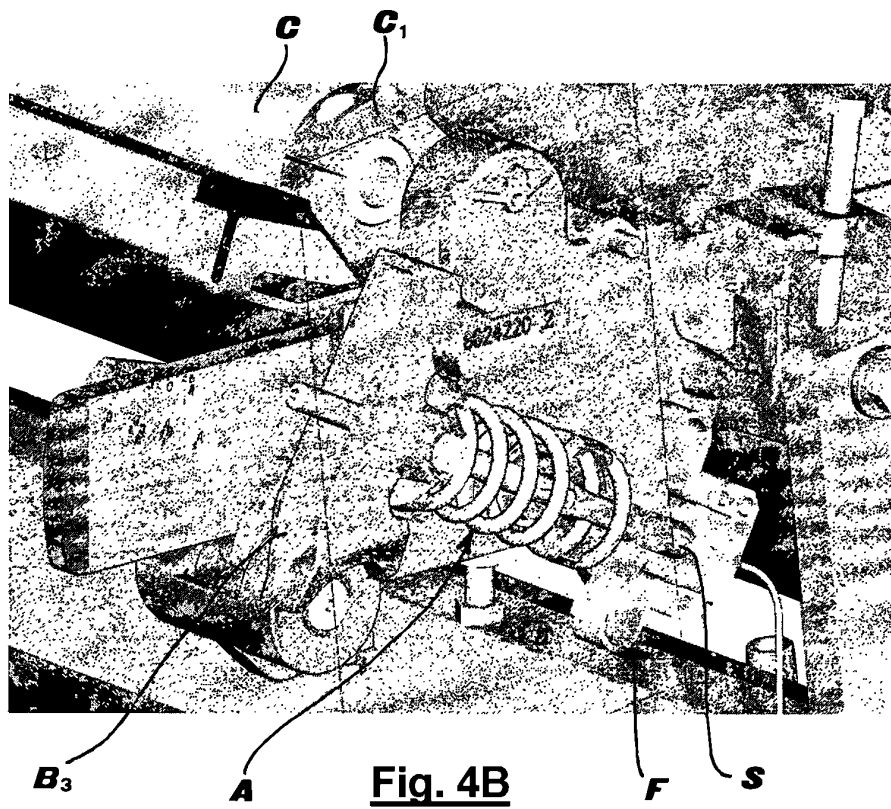
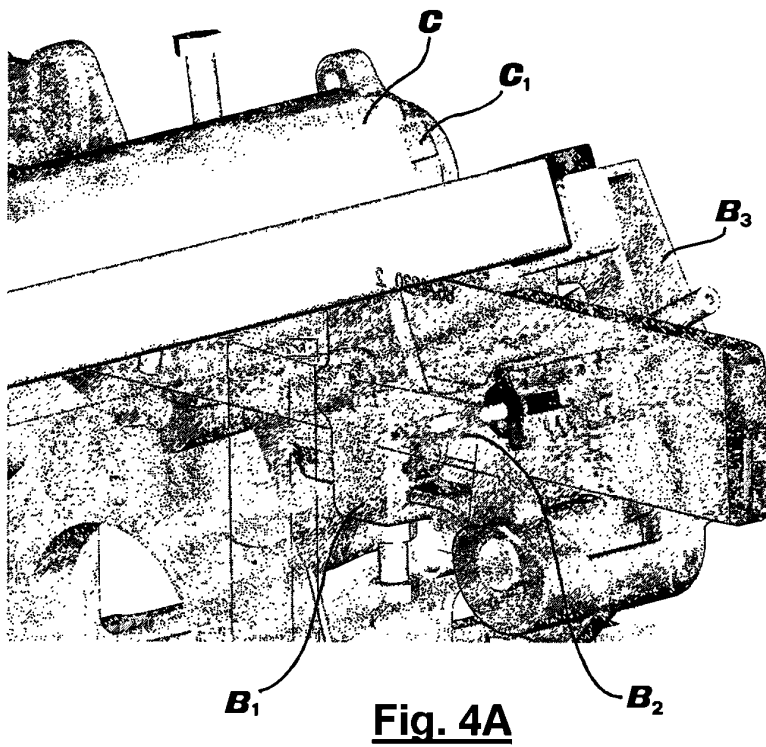


Fig. 5

Warp tension in different chain areas**Fig. 2****Fig. 3**



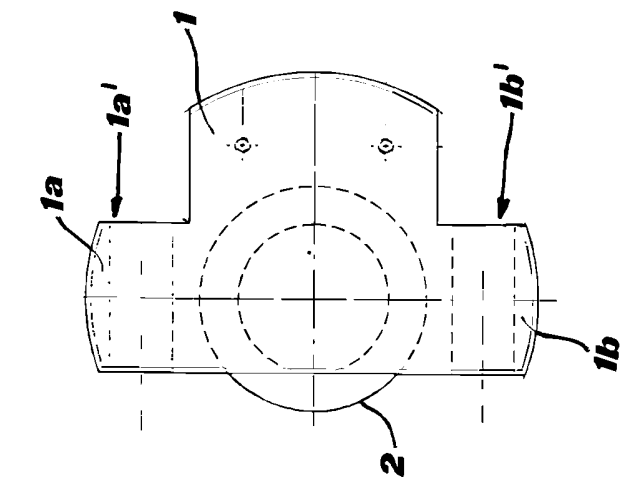


Fig. 6C

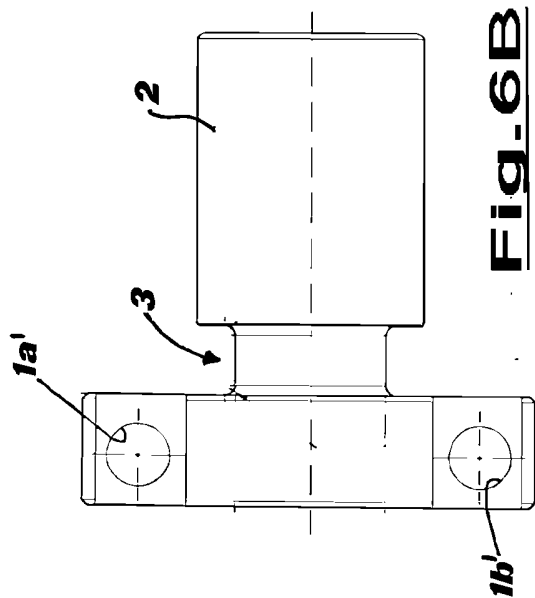


Fig. 6B

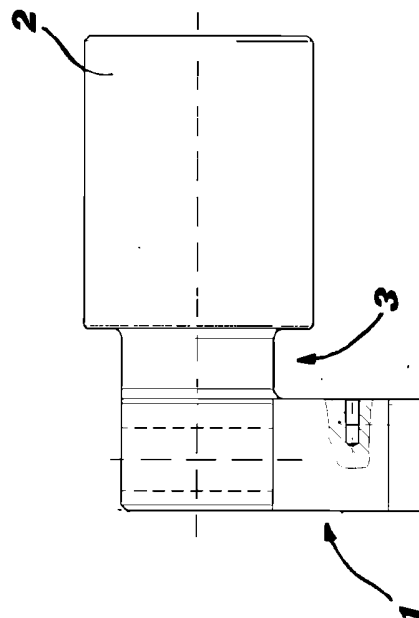


Fig. 6A

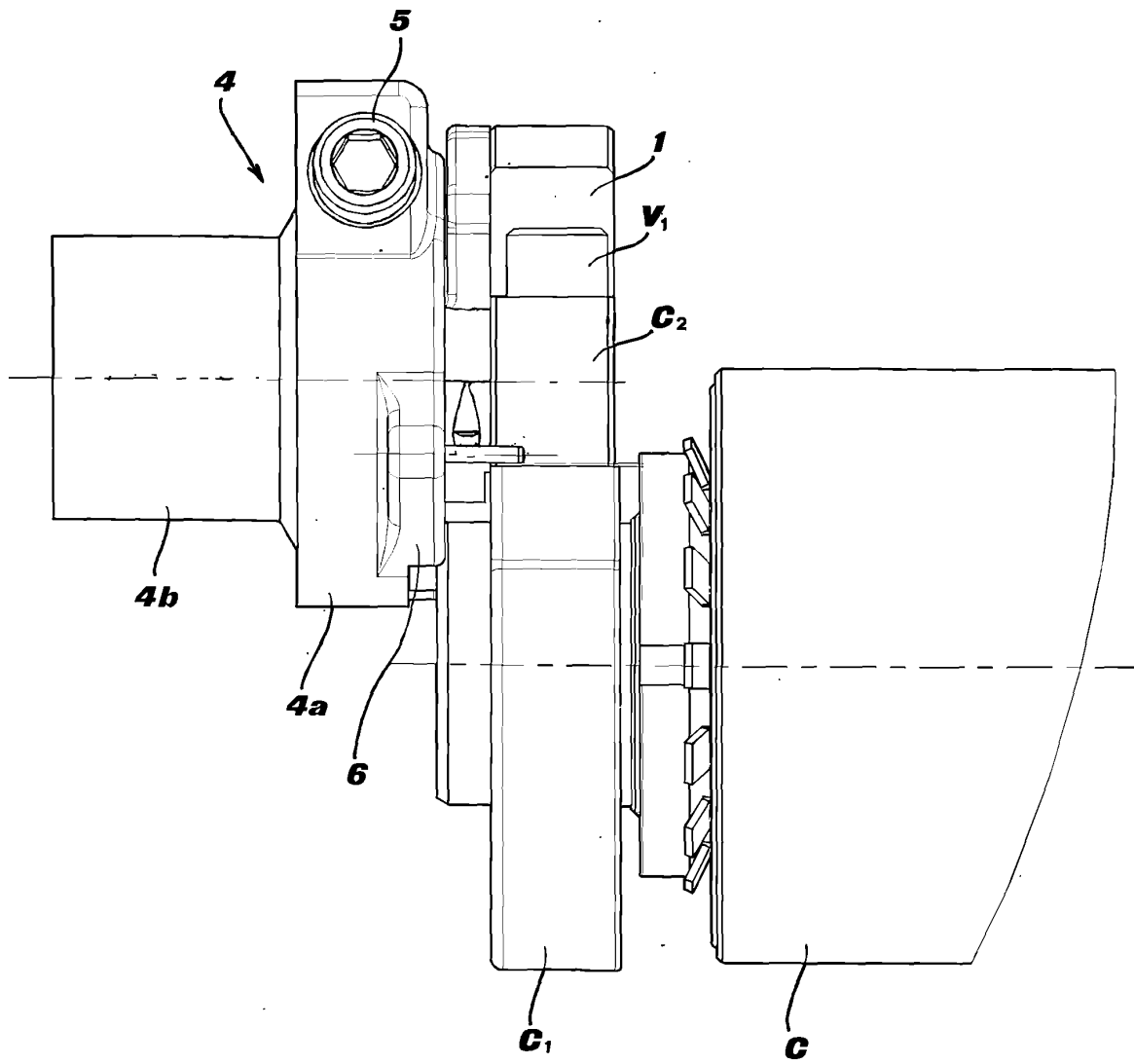
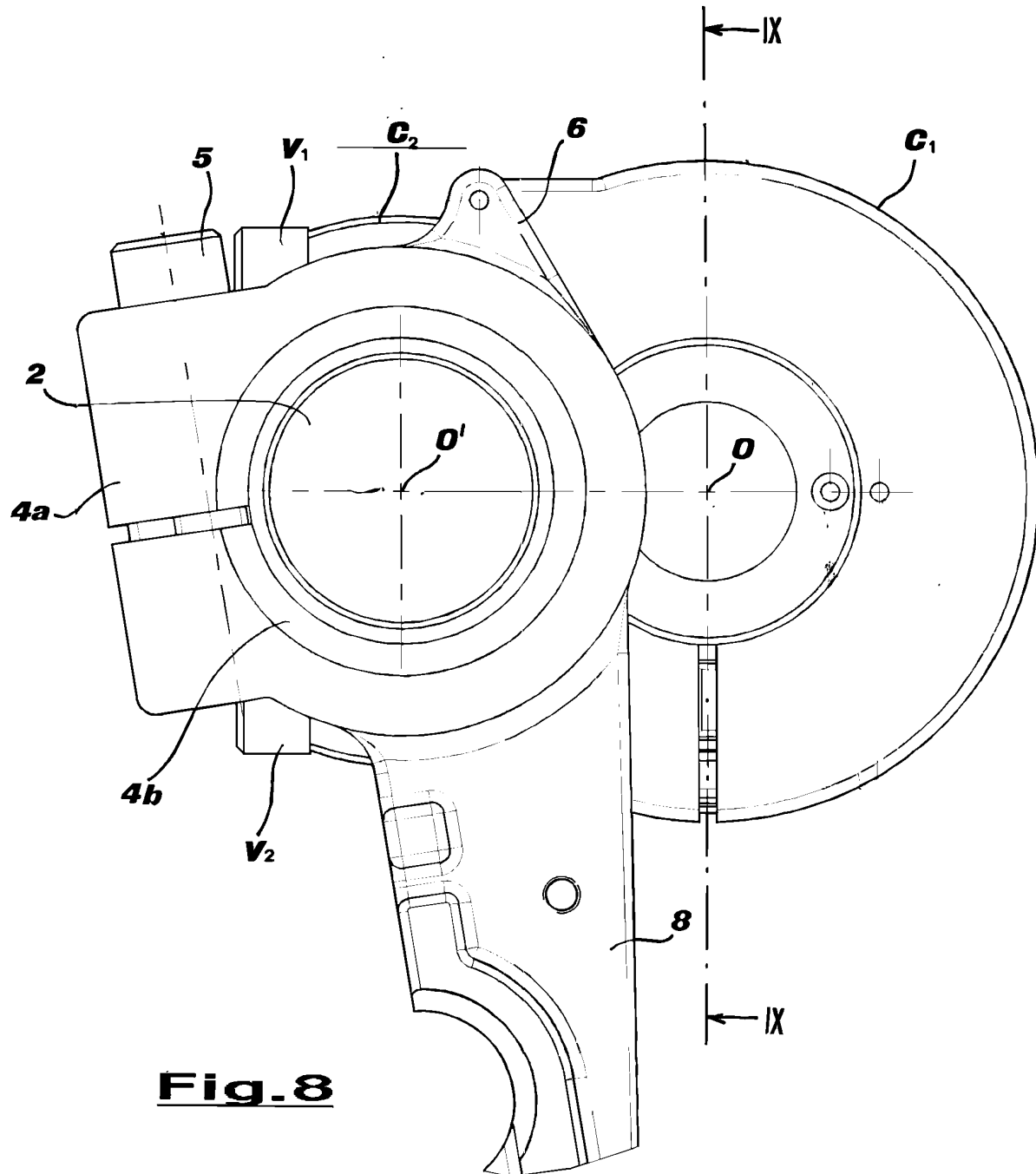


Fig. 7



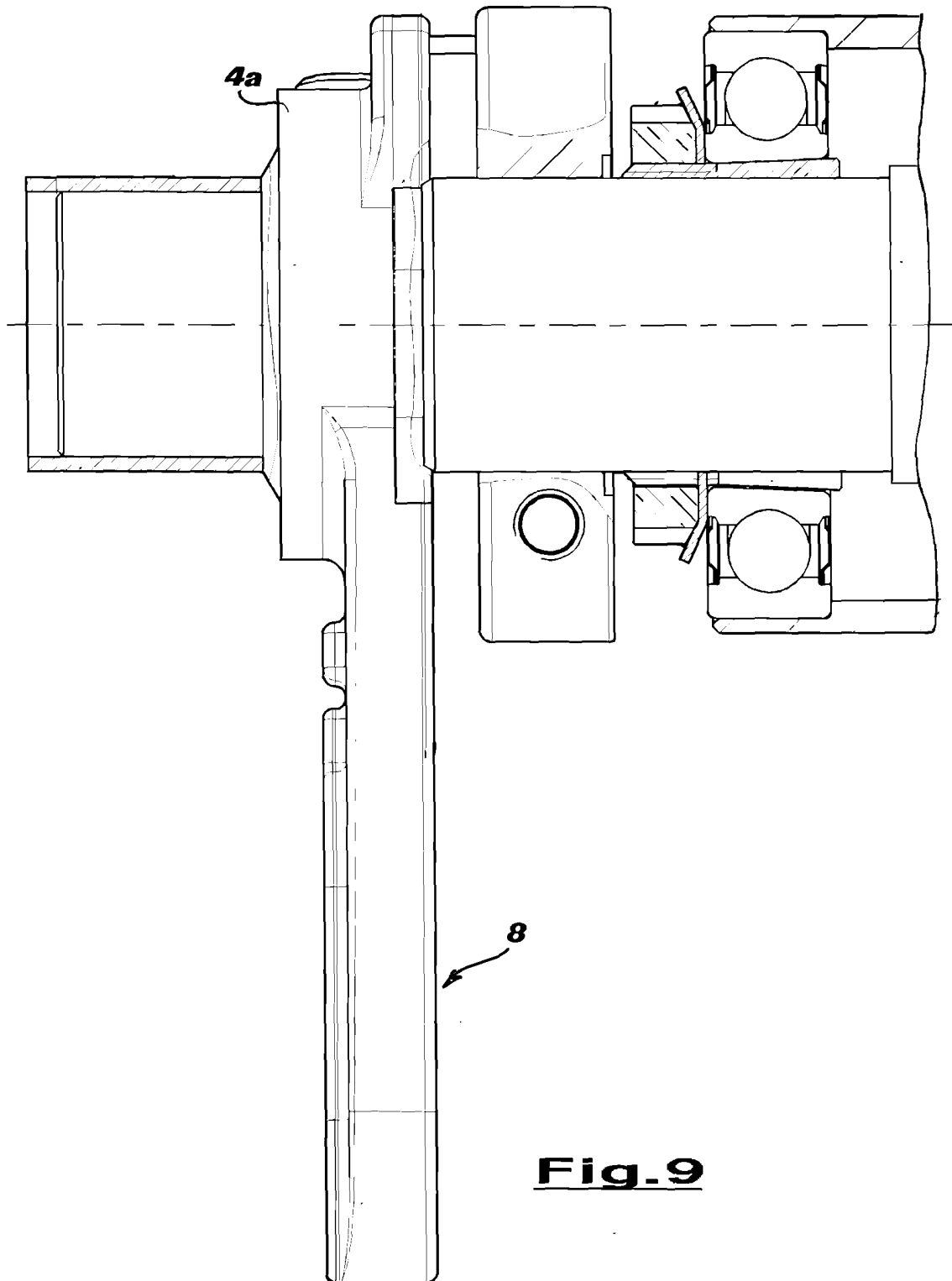


Fig. 9

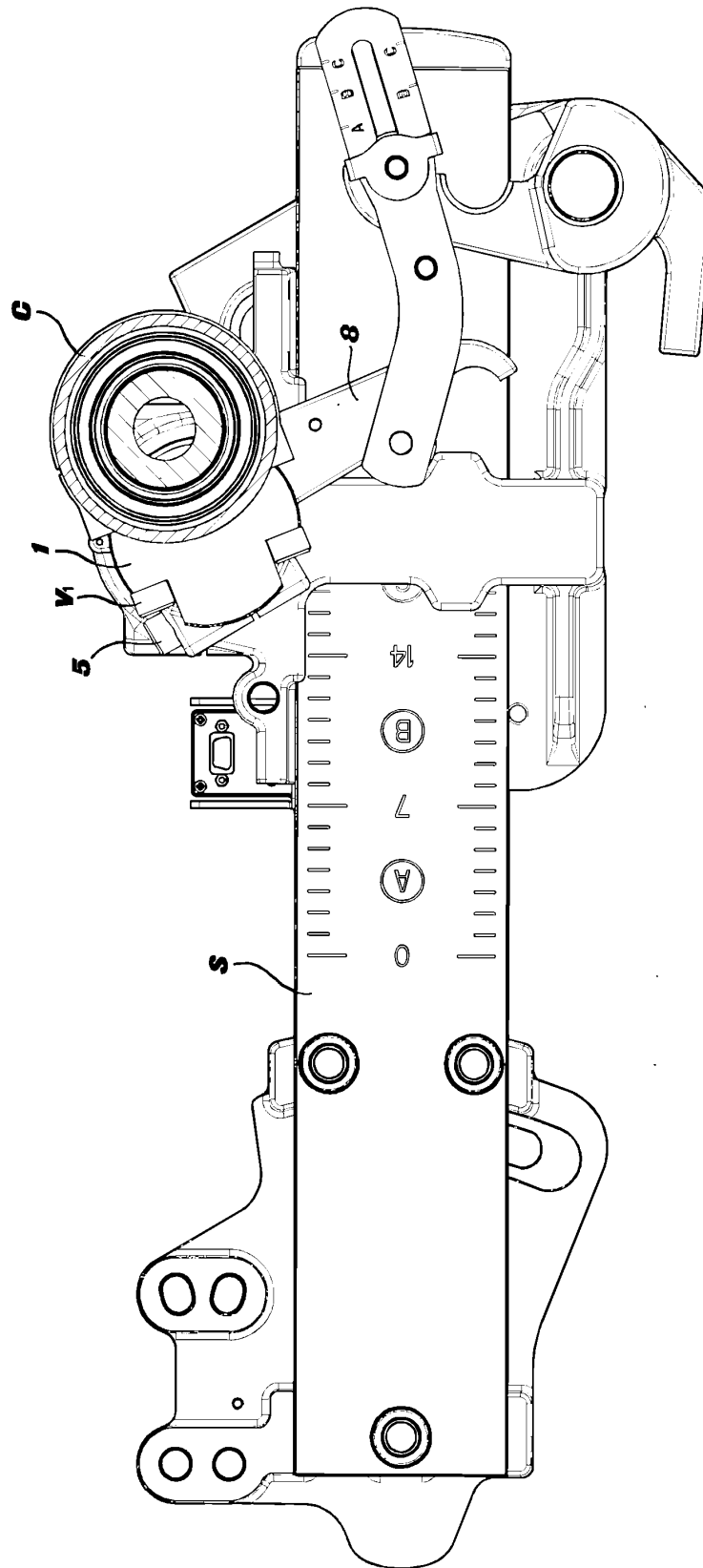


Fig.10

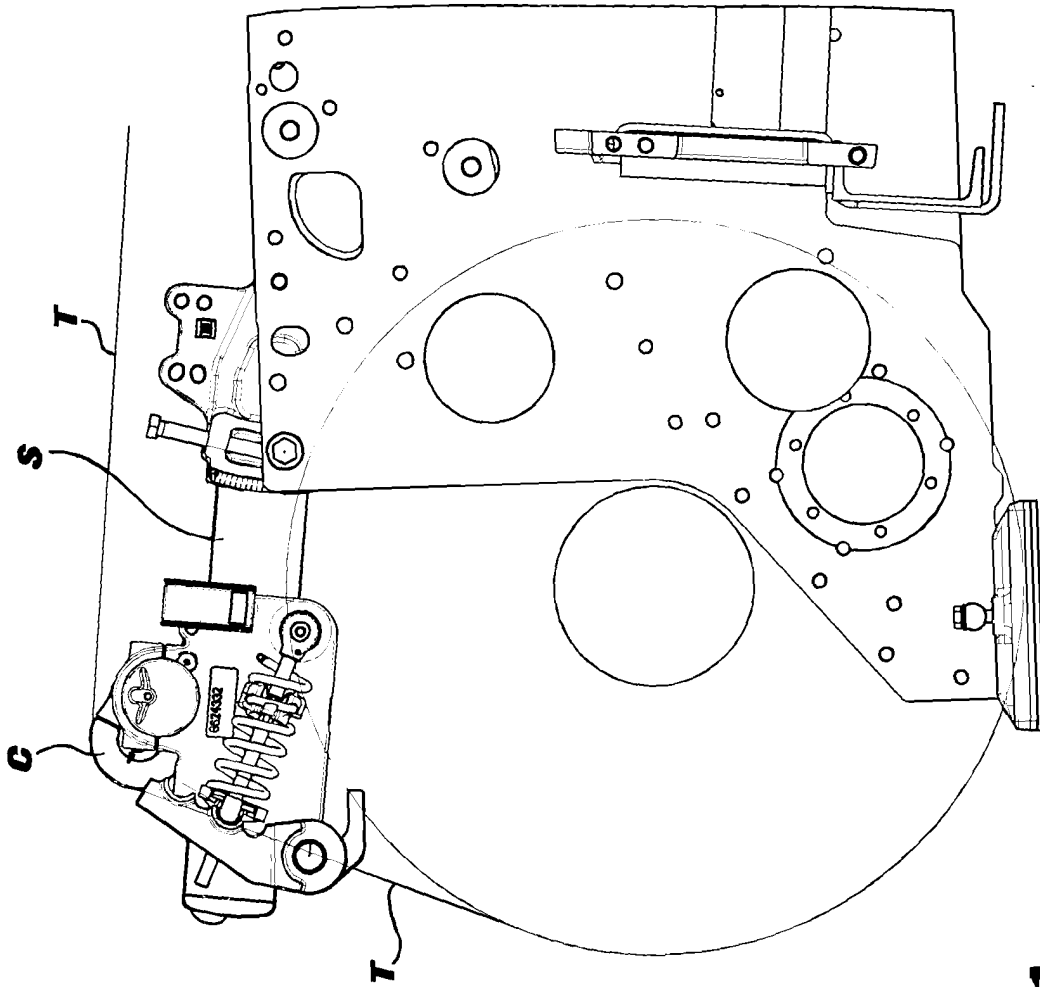


Fig. 11