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(54) **Warp tension device with a gradual-action suspension for weaving looms**

(57) A warp tension device is disclosed, of the type comprising a compensating cylinder (1) supported on at least two stations arranged along the width of the loom and on at least two support elements (2,3) for each station, movable by the action of a force expressed by the tension of the warp yarns passing over it and an opposing action of a resilient element (7), wherein the dis-

placements of the two support elements (2,3) of each station are in a respective relationship established by a predefined kinematic mechanism, said resilient element (7) reacting to the displacement of at least one of said support elements (2,3).

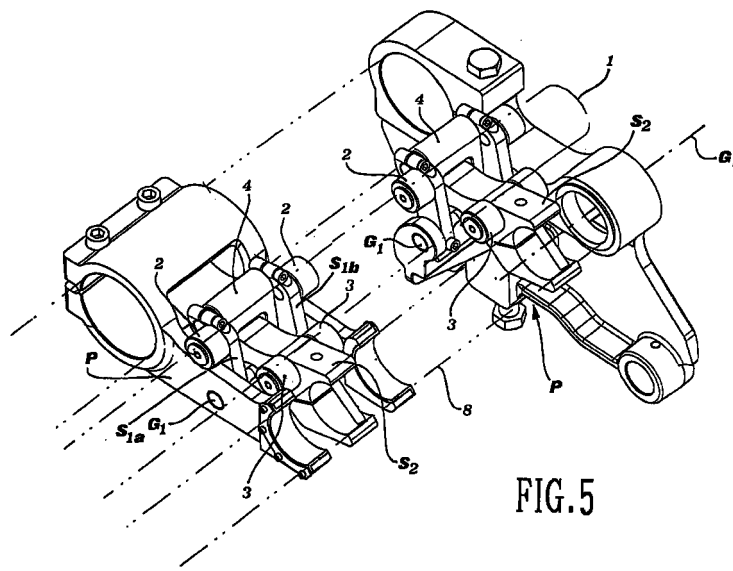


FIG. 5

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Description

[0001] The present invention relates to a warp tension device for a weaving loom. In particular it relates to a warp tension device with a gradual-action suspension.

[0002] As is known, in a weaving loom there exists the need to guide the warp yarns between the warp beam and the weaving zone. This is commonly performed using a yarn-carrying cylinder which extends over the entire width of the loom and by means of which the warp yarns are deviated from a substantially vertical plane - defined by the warp yarns which are supplied from the beam arranged in the bottom part of the loom - to a substantially horizontal plane - which corresponds to the weaving plane which is easily accessible by the operator and along which the warp-stop motion device is arranged.

[0003] Since, during operation of the loom, the healds cause the warp yarns to perform an alternating opening and closing movement of the shed for insertion of the weft yarn, a tensioning and slackening action is correspondingly exerted on the warp yarns themselves. These latter ones must be able to be correspondingly released or retracted so as to prevent them from being subject to excessive tension or from becoming too loose, respectively all of which adversely affects the quality of the processed fabric as well as the reliability of the loom owing to possible breakages of the yarns.

[0004] For this purpose, the yarn-carrying cylinder has the possibility of performing an oscillating movement in order to assist the movement of the warp yarns and is therefore referred to as a "compensating cylinder". Normally it is displaced from its balanced position by the tension applied to it by the warp yarns against the action of a series of resilient elements, such as prestressed springs acting by means of suitable lever mechanisms.

[0005] However, oscillation of the warp tension device gives rise to dynamic problems which cannot be easily resolved. Theoretically, it is desirable for the compensating cylinder to assist perfectly the movement of the warp yarns, so that the tension in the latter remains substantially constant. From a practical point of view, the mass forces applied to these mechanisms, especially in modern looms where very high weaving speeds (even greater than 800 cycles per minute) are reached, are to such an extent as to impose notable limitations due to problems associated with resonance and immediacy of response of the yarn/warp tension device/spring system and which prevent ideal condition of operation from being reached.

[0006] In order to overcome these drawbacks, a wide range of solutions have been proposed, aimed both at reducing the inherent inertia of the system and at providing a resilient opposing action which is suitably calibrated.

[0007] European patent EP-B-0,396,501 discloses a yarn-carrying cylinder which is supported on a plural-

ity of bearing places mounted on top of brackets oscillating on a single axis. The oscillating brackets are mounted on a common rotating support shaft which has, arranged inside it, a torsional bar which is also connected to all the oscillating brackets. Oscillation of the brackets is integral with the rotary movement of the common support shaft, while the resilient action is ensured by the torsional bar which can be blocked in position with respect to the loom in predefined positions. The resilient action is adjustable by means of a suitable adjusting mechanism which determines the angular working position of the torsional bar.

[0008] While the arrangement of the yarn-carrying cylinder supported on several brackets - also described in several prior publications - may be advantageous to obtain a slim profile of the yarn-carrying cylinder and therefore beneficial for a reduction of the moving masses, the resilient action exerted by the torsional bar on the compensating cylinder is always equivalent to that of a spring, namely is directly proportional to the angle of torsion. Moreover, the compensating cylinder moves along a simply circular path with the axis of rotation coinciding with the central axis of the support shaft.

[0009] In EP-B-0,694,638 the yarn-carrying cylinder is supported at several stations along the width of the loom by means of a cradle-type brackets which are free to oscillate. The brackets engage on a cam element, the rotation of which is opposed by a spring element. In this case the resilient action is gradual since it is exerted by means of a suitable cam element. However, the compensating cylinder, which is rotatable about its longitudinal axis, oscillates about the hinging axis of the cradle-type brackets and therefore also follows a simply circular path.

[0010] The Application PCT/EP97/00701 discloses a warp tension device in which the compensating cylinder is supported on a series of fixed support rollers and is able to roll freely thereon in opposition to another series of resiliently yielding rollers. In this case also, however, the compensating cylinder follows a simply circular path.

[0011] In order to obtain a correct behaviour of the yarn-carrying cylinder, with immediate response of the system and minimum tension overloads on the warp yarns, it is also necessary to give due consideration to the kinematics of the compensating cylinder, something which, hitherto, has been overlooked in the prior art. In fact, although a circular path may be easily obtained, it does not represent the best solution.

[0012] By observing that illustrated in Figs. 1, 1A and 1B - which show schematic cross-sectional views of a warp tension device and a warp yarn passing over it - it may be noted that, in a given instant, in order to obtain an infinitesimal displacement δ of the compensating cylinder 1 (displacement due to the recall force exerted on the warp yarns by opening of the shed), the sole degree of freedom allowed by the rigid constraint R - i.e. the displacement along a circular path - is opposed by the

resilient force $F = K\delta$ (where k is the resilient constant of the generic spring system)

[0013] In order to overcome this force F , an exemplar warp yarn Or must exert on the compensating cylinder 1 a force T - directed as the bisector of the angle α formed by the two sections of the warp yarn passing over the cylinder 1 - which is correspondingly greater the smaller the angle β between the direction of application of T and the rigid constraint R ; in particular:

$$T = k\delta / \sin\beta$$

[0014] It can therefore be understood that, from the point of view of the magnitude of the stress T , the situation of Fig. 1B - in which the rigid constraint R is substantially perpendicular to the directrix of the tension T - constitutes a favourable condition compared to those conditions illustrated in the other Figs. 1 and 1A. In other words, the condition whereby the instantaneous displacement of the yarn carrier is parallel to the direction of the force T involves a smaller degree of stressing of the warp yarns for the same displacement.

[0015] However, the solution schematically shown in Fig. 1B may be difficult to realize for various reasons, including that relating to the overall dimensions of the system. Moreover the ideal conditions exist only for a certain instant, whereas for all the other positions assumed by the compensating cylinder, during its displacement along the arc of a circle, the spatial relationship between the force of the tension T and the rigid constraint R of the yarn carrier will vary, resulting in less favourable conditions.

[0016] It must also be pointed out that it is not so important that the tension T should be minimal, but desirable that the tension should remain constant at its nominal value - something which certainly is not achieved with a kinematic mechanism of the type illustrated in Figs. 1, 1A and 1B.

[0017] From a practical point of view, in the art, compromise solutions substantially corresponding to the solution shown in Fig. 1 have been adopted.

[0018] The object of the present invention is that of providing a warp tension device which always works in conditions close to the optimum ones; in particular it is desired to provide a warp tension device in which a yarn-carrying cylinder is supported so as to follow at every point a path which can be controlled as required, preferably as tangential as far as possible to the direction of the force acting thereon.

[0019] A further object of the invention is that of providing a warp tension device which is able to perform a gradual movement, in opposition to a resilient element, so as to ensure also a gradual action while following the movement of the warp yarns.

[0020] These objects are achieved with a warp tension device as described in the accompanying claims.

[0021] Further characteristic features and advantages of the device according to the invention will

emerge, however, more clearly from the detailed description which follows of some preferred embodiments thereof, provided by way of an example illustrated in the accompanying drawings, in which:

Figs. 1, 1A and 1B, as already mentioned above, illustrate in schematic form the variation in the force upon variation in the arrangement of the constraint of a yarn carrier;

Figs. 2A and 2B are schematic side elevation views which show the warp tension device according to the invention in two successive positions;

Fig. 3 is a side elevation view of an embodiment according to the invention;

Fig. 4 is a side elevation view of the mechanism according to the invention in which the resilient element is shown;

Fig. 5 is a perspective view, with parts removed, of an end station and an intermediate station of the warp tension device according to the invention;

Fig. 6 is a perspective view of part of a textile loom in which the mechanism according to the invention is incorporated;

Fig. 6A is an enlarged view of the detail indicated by H in Fig. 6.

[0022] With reference to Fig. 2, a compensating cylinder 1 of a warp tension device is supported in a plurality of stations (at least two stations at the two ends of the yarn-carrying cylinder) arranged along the width of the loom, by means of a kinematic suspension system illustrated in detail below. For the sake of convenience, Figs. 2A, 2B, 3 and 4 show a single suspension mechanism, but it is obvious that one is envisaged in each support station along the width of the loom.

[0023] According to the invention, a first oscillating bracket S_1 , pivotably mounted on a support P at G_1 , and a second oscillating bracket S_2 , pivotably mounted on the support P at G_2 , are provided, the support P being fixed to the weaving loom.

[0024] The two brackets S_1 and S_2 terminate, in their upper part, with support seats, 2 and 3 respectively, which consist of rollers or bearings and on which the compensating cylinder 1 is supported. The compensating cylinder 1 is moreover retained on the two support seats 2 and 3 by the warp yarns Or which press on it owing to the action of the tension T .

[0025] According to a first embodiment, the two brackets S_1 and S_2 are joined to each other by means of a link rod 4 connected, via pivots 5 and 6, to the brackets S_1 and S_2 respectively. This results in the formation of an articulated quadrilateral with sides S_1 -4- S_2 hinged at G_1 , G_2 , 5 and 6. Therefore the relationship between the angular displacement of the bracket S_1 and that of the bracket S_2 is fixed and determined by the geometry of the quadrilateral. Correspondingly, the relationship between the displacements of the two support seats 2 and 3 is also predetermined and adjusted, as required,

on the basis of the geometry of the kinematic mechanism. In particular, the two seats 2 and 3 follow two separate circular paths with angular displacements in a fixed ratio.

[0026] By suitably choosing the geometry of the kinematic support mechanism it is possible, ultimately, to obtain a desired law of displacement for the compensating cylinder 1, a displacement which no longer occurs along an arc of a circle, with its centre along a fixed axis parallel to the width of the loom (as occurred in the known art), but rather along a path with a centre of instantaneous rotation which is movable.

[0027] Moreover, a resilient element 7 (Fig. 4), such as a helical spring, acts on one of the two support brackets, for example the bracket S_1 , in opposition to a restraint integral with the loom itself.

[0028] The various brackets S_2 which are pivotably hinged at G_2 and belong to the respective stations along the width of the loom, for example may be joined together by means of a rod which has suitable dimensions, so as to oppose in a rigid manner any torsional imbalance occurring along the width of the loom, and which in any case is rigidly connected - for example by means of a coupling of the torsional type - to the resilient opposition system, schematically shown in Fig. 4, not necessarily forming part of the compensation cylinder arrangement.

[0029] According to a preferred embodiment (Figs. 3 and 4), said brackets S_2 are joined to a deviating cylinder 8 which has an axis coinciding with the axis G_2 .

[0030] The warp tension device, in fact, may also comprise a deviating cylinder 8 which is arranged between the compensating cylinder 1 and the underlying warp beam U (Fig. 6) and is designed to keep as constant as possible the angle described by the warp yarn supplied by the beam U and passing over the compensating cylinder 1, i.e. the angle γ between the warp yarn and a vertical axis.

[0031] Should the deviating cylinder 8 have an axis which is separate from the axis G_2 , it could also be supported on two bearings which are also pivotably mounted on the bracket S_2 .

[0032] Moreover, according to an exemplary arrangement of the invention, the extents of the arm of the force acting along the line of action of the link rod 4 with respect to the fulcrum G_2 and the arm of the force pressing on the compensating cylinder 1 with respect to the same fulcrum G_2 , remain unchanged, with a good degree of accuracy, during the travel of the compensating cylinder 1. Preferably, the arm of the force transmitted by the link rod 4 is at least twice the arm of the force pressing on the compensating cylinder 1.

[0033] Finally, Fig. 5 illustrates a possible constructional solution of the embodiment schematically described with reference to Figs. 3 and 4. As can be seen, the bracket S_1 is in the form of a double lever, S_{1a} and S_{1b} respectively, which are pivotably mounted at G_1 and connected to a U-shaped link rod 4. The two sup-

port points of the compensating cylinder are in the form of bearings 2 and 3, while the lever S_2 is inserted between the brackets S_{1a} and S_{1b} and between the two arms of the U-shaped link rod 4.

[0034] The fulcrums G_1 and G_2 are formed, for example, on a series of small brackets, by means of revolving and or sliding bearing seats, formed by bushes made of thermohardening material to which lubricants, such as Teflon® or molybdenum bisulphide, have been added.

[0035] With the construction described above it has been possible to provide a kinematic system with a gradual-action suspension for the compensating cylinder 1.

[0036] With the device according to the invention the compensation cylinder 1 no longer follows a circular path, as in the known art, but a path which may be defined, as desired, by choosing the dimensional values of the kinematic mechanism described above, thereby achieving a first object of the invention.

[0037] Moreover, since the two support points 2 and 3 of the compensation cylinder follow two circular paths at different speeds, they move away from each other (Figs. 2A and 2B), also ensuring a gradual character for the action of the entire suspension system and thus also achieving another object of the invention.

[0038] Moreover, it has been found that an advantageous embodiment of the invention, by which the suspension system acts in a particularly gentle and gradual manner under any load conditions, can be obtained some specific rules of geometrical design are observed. With reference to Figs. 2A and 2B, the fulcrum G_1 shall lie in the vicinity of the line of action of the force acting on the compensating cylinder 1; the fulcrum G_2 shall be offset towards the outside (i.e. to the right in the figures) with respect to the line passing through the centre of the compensation cylinder 1 and the centre of the roller wheel 3; the locus described by the axis of the link rod 4 in its displacement interval lies approximately symmetrical with respect to the vertical. Moreover, preferably, the amplification value of the lever mechanism is 2.5/1 or greater.

[0039] The Applicant has found that, with the warp tension device according to the invention, the tension which is present in the warp yarns remains substantially constant also owing to the fact that the response of the suspension system is rapid and gradual.

[0040] According to another embodiment of the invention, in order to obtain the desired transmission ratio between displacement of the two support points 2 and 3 of the compensation cylinder 1, it is possible to envisage a gear-type coupling between the two brackets S_1 and S_2 (Fig. 6)

[0041] For example, a first toothed wheel, rotatable about the axis G_1 , is integral with the bracket S_1 , while a second toothed wheel, which is rotatable about the axis G_2 , is integral with the bracket S_2 . A connection chain C, or other type of coupling gearing, is provided

between the said two toothed wheels. By means of a suitable dimensional choice of the toothed wheels, within the reach of any person skilled in the art, it is possible to obtain the desired kinematic movement.

[0042] It is understood, however, that the invention is not limited to the particular configurations which are described above and which are only non-limiting examples of the scope of the invention, but that numerous modifications are possible, all of which within the reach of a person skilled in the art, without thereby departing from the teaching of the invention itself.

[0043] In particular, the proper adjustment of the kinematic mechanism may be achieved, not only by replacing the kinematic components with corresponding different-sized components, but also by providing the possibility of displacing the centres of rotation G_1 and G_2 , for example by fixing said axes of rotation in the appropriate position inside slots.

[0044] Moreover, in place of the rollers or bearings, the brackets may be provided, at the points where the compensation cylinder rests, with surfaces which are suitably shaped (if necessary with cam-type profiles) and coated with anti-friction material, such as bronze or Teflon[®] for example.

Claims

1. Warp tension device for weaving looms, of the type comprising a compensating cylinder supported on at least two stations arranged along the width of the loom and on at least two support elements for each station, movable by the action of a force exerted by the tension of the warp yarns passing over it and an opposing action of a resilient element, characterized in that the displacements of the two support elements of each station are in a respective relationship established by a predefined kinematic mechanism and in that said resilient element reacts to the displacement of at least one of said support elements.
2. Warp tension device as claimed in Claim 1, wherein said support elements are movable along separate circular paths by a predetermined displacement ratio.
3. Warp tension device as claimed in Claim 2, wherein said support elements are arranged at the top of a first and a second oscillating bracket joined together by means of a connection element which determines the ratio between the oscillations thereof.
4. Warp tension device as claimed in Claim 3, wherein said connection element is a link rod.
5. Warp tension device as claimed in Claim 4, wherein the oscillation pivot of said first bracket lies in the vicinity of the line of action of said force, said link rod has a longitudinal axis which is substantially vertical and the oscillation pivot of said second bracket lies externally with respect to its support element.
6. Warp tension device as claimed in any one of Claims 4 or 5, wherein said first bracket is pivotably mounted on the tines of the link rod in the form of a U-piece and said second bracket is in the form of two levers which are pivotably mounted on said link rod at the opposite end to said tines.
7. Warp tension device as claimed in Claim 3, wherein said connection element is a toothed-gear system.
8. Warp tension device as claimed in Claim 7, wherein said gear system is composed of a first toothed gear, with which said first bracket is fixed in rotation, and a second toothed gear, with which said second bracket is fixed in rotation, said first and second gears being coupled together by coupling means.
9. Warp tension device as claimed in any one of the Claims 2 to 8, wherein said displacement ratio is greater than or equal to 2.5:1.
10. Warp tension device as claimed in any one of the preceding claims, wherein a deviating cylinder is also present.
11. Warp tension device as claimed in Claim 10, wherein said deviating cylinder has a central axis coinciding with the axis of oscillation of said second bracket.
12. Warp tension device as claimed in any one of the preceding claims from 3 to 10, wherein the support elements consist of bearings or roller wheels which are mounted freely rotatable at the top of said brackets.

FIG.1

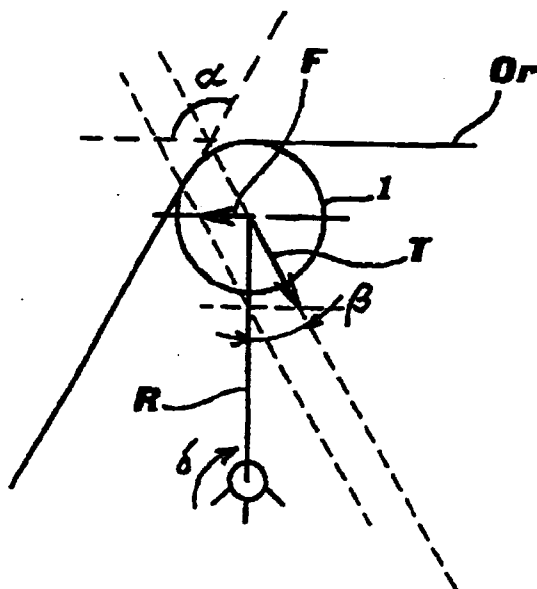


FIG.1A

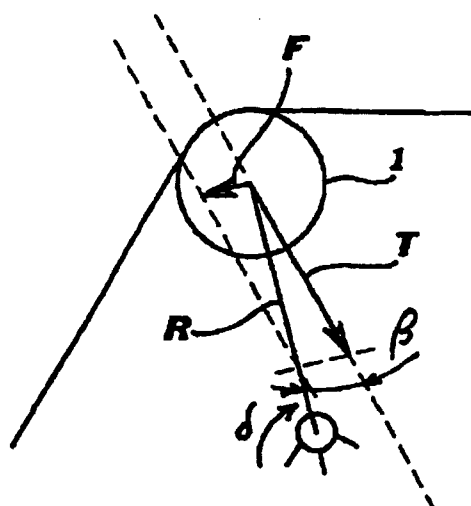
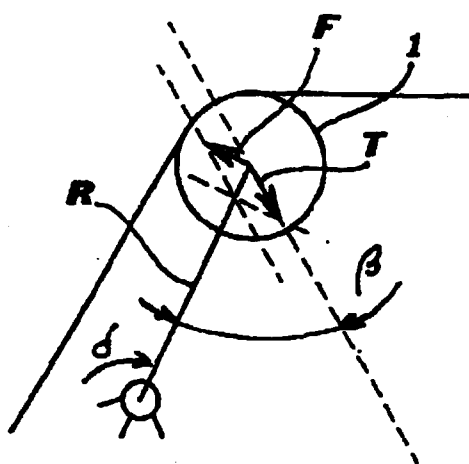


FIG.1B



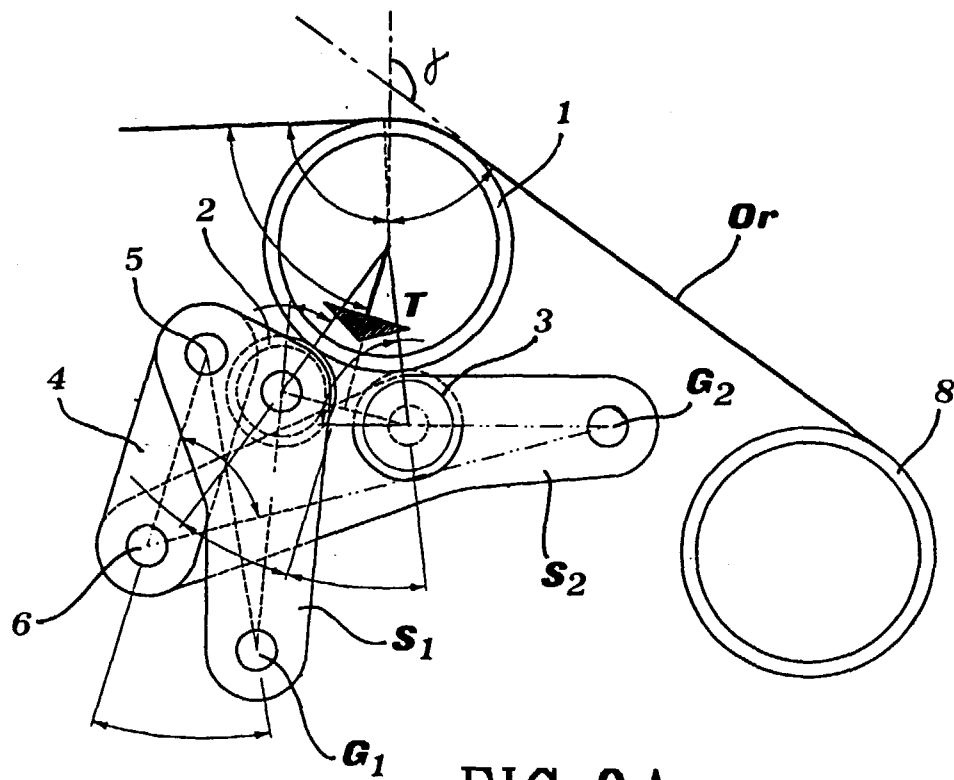


FIG. 2A

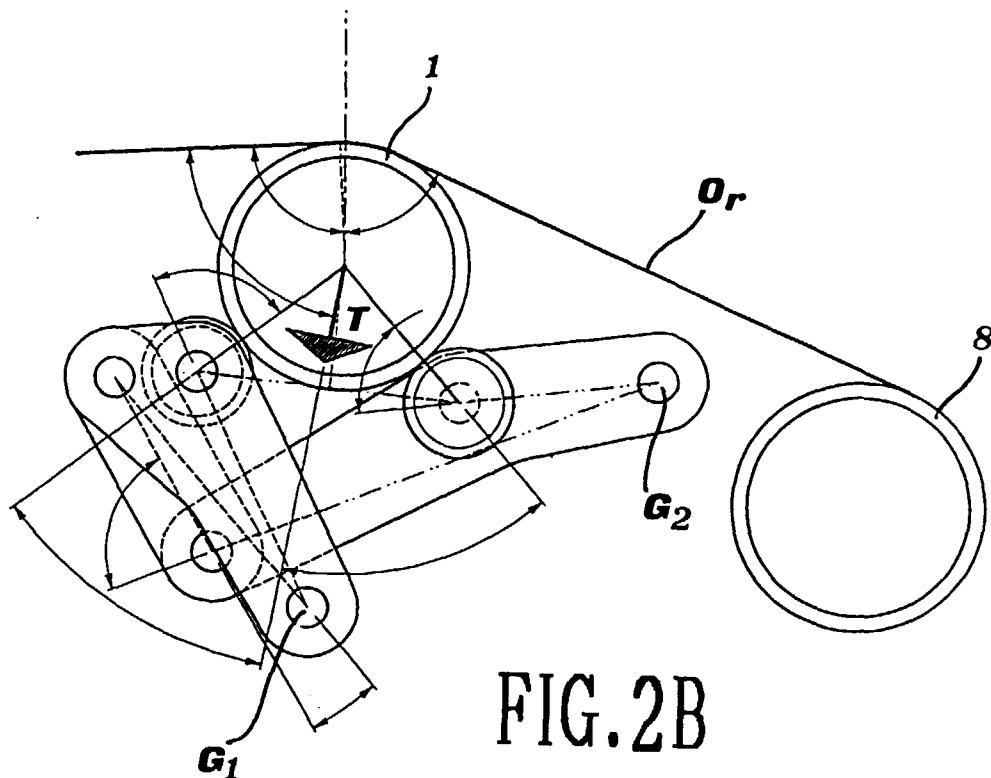


FIG. 2B

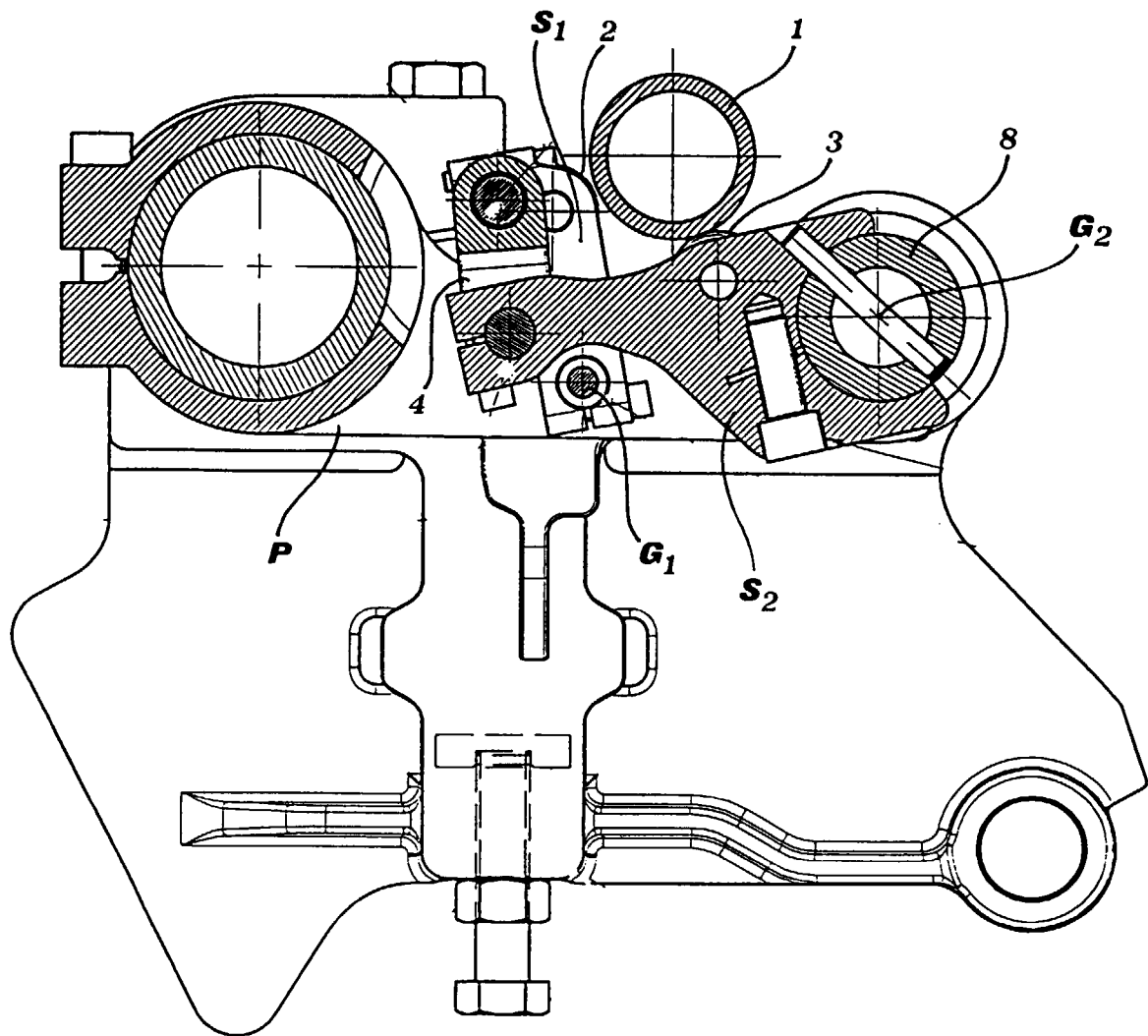
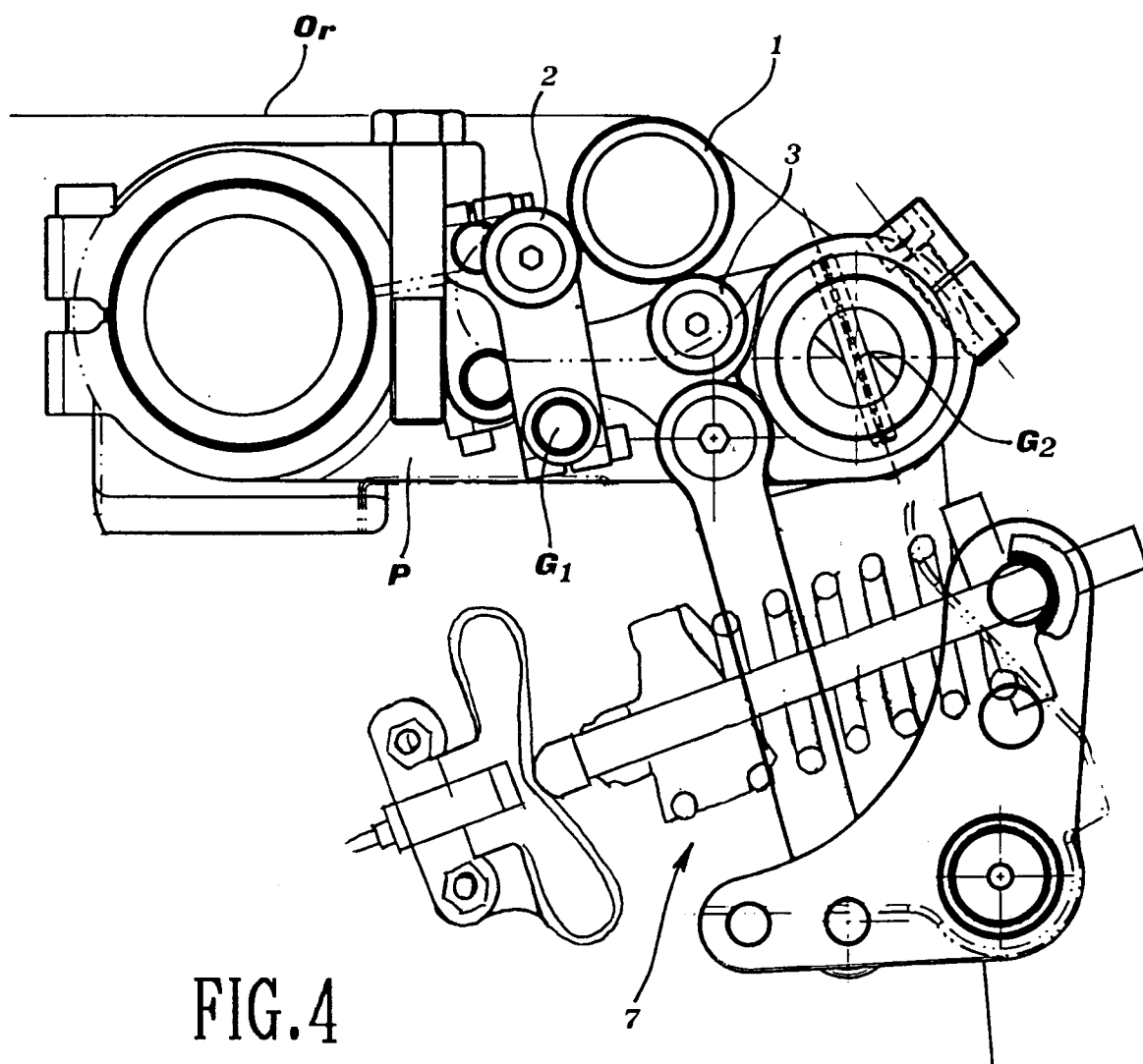


FIG.3



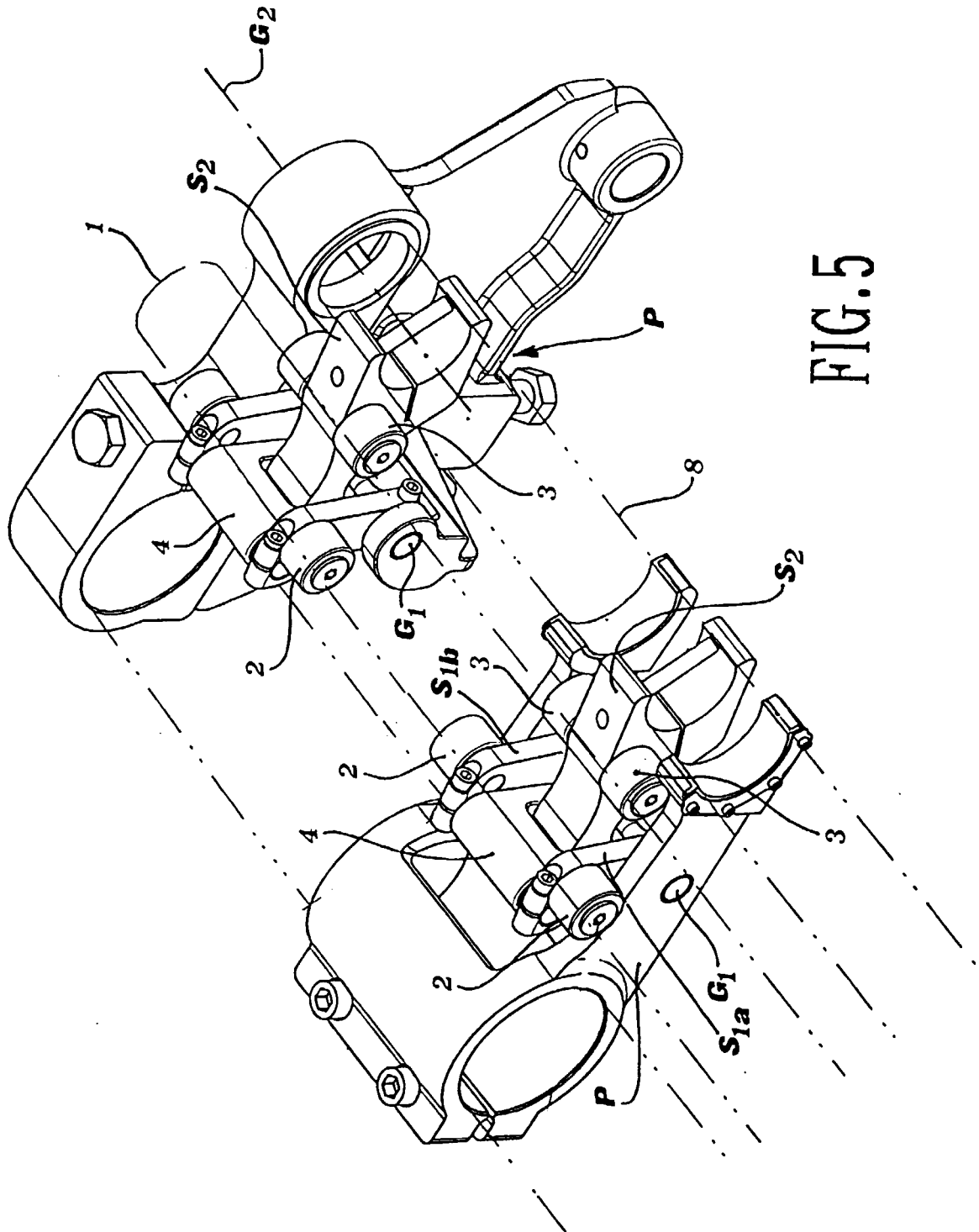


FIG. 5

