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(71) Applicant: **Kabushiki Kaisha Toyota Jidoshokki**
Kariya-shi, Aichi-ken (JP)

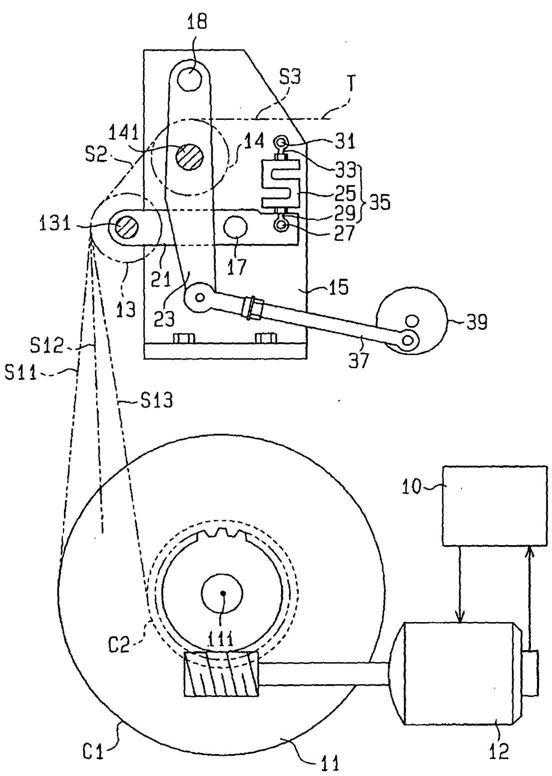
(72) Inventors:
- **Abe, Shinya**
  Kariya-shi Aichi-ken (JP)
- **Makino, Isao**
  Kariya-shi Aichi-ken (JP)
- **Murakami, Yasutaka**
  Kariya-shi Aichi-ken (JP)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) Warp tension detecting device for loom

(57) Warp T sent out from a warp beam 11 is guided by first and second rollers 13 and 14. The second roller 14 is positively swung through motion of a crank mechanism 39. The first roller 13 is supported by a back bracket 15 through the intermediation of a support lever 21 and a pivot 17. A load cell 25 included by a detection arm 35 connected to the support lever 21 detects a load applied to the first roller 13 by the tension of the warp T.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention:

[0001] The present invention relates to a warp tension detecting device for a loom.

Description of the Related Art:

[0002] Warp opening motion is a factor causing great fluctuations in warp tension during weaving. Restraining such fluctuations in warp tension is critical in obtaining quality woven fabric. JP 02-269841 A discloses a loom in which the spring force of a tension spring is imparted to a tension lever rotatably supporting a tension roller guiding warp fed out from a warp beam, and fluctuations in the tension of the warp are absorbed by the spring force of this tension spring. The tension of the warp is detected by a load cell through the tension roller. An rpm of a feed-out motor for feeding out the warp by rotating a warp beam is controlled on the basis of warp tension detection information obtained by the load cell.

[0003] In the loom as disclosed in JP 07-42046 A, a swinging displacement of an easing lever swung in synchronism with the running of the loom is transmitted to a tension detecting roller for detecting warp tension while guiding the warp fed out from a warp beam. The transmission of the swinging displacement of the easing lever absorbs fluctuations in warp tension. The warp tension is detected by a load cell through the tension detecting roller. The rpm of a feed-out motor for feeding out warp by rotating the warp beam is controlled on the basis of warp tension detection information obtained by the load cell.

[0004] As in the case of the loom disclosed in JP 02-269841 A, in a construction in which the warp tension is absorbed by utilizing the spring force of a tension spring, it is possible to achieve a proper tension fluctuation absorption in the case when the warp tension is low as long as the loop is not operating at high speed. On the other hand, when the loom is operating at high speed, the expansion and contraction of the tension spring do not properly follow the warp opening motion. That is, the fluctuations in warp tension are not absorbed in a satisfactory manner.

[0005] In contrast, in the case of the loom disclosed in JP 07-42046 A, in which the fluctuations in warp tension are absorbed through positive easing of the tension detecting roller, the swinging motion of the tension detecting roller properly follows the warp opening motion. That is, the fluctuations in warp tension are absorbed in a satisfactory manner. On the other hand, when the tension of the warp is low, the influence of the inertia of the easing motion of the tension detecting roller increases, making it impossible to detect the warp tension with high accuracy. When the accuracy in warp tension detection is not high, it is impossible to control the rpm of the feed-out roller with high accuracy, and it is difficult to cause the warp tension to converge to a desired level.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a warp tension detecting device of the type in which fluctuations in warp tension are absorbed by transmitting a swinging displacement of an easing lever to the warp, wherein the influence of the inertia of the easing motion is eliminated, making it possible to detect warp tension with high accuracy.

[0007] According to the present invention, there is provided a warp tension detecting device for a loom, in which fluctuations in tension of warp fed out from a warp beam are absorbed by transmitting to the warp a swinging displacement of an easing lever swung in synchronism with a running of the loom, and the tension of the warp is detected through a first roller for guiding the warp, including:

> a second roller rotatably supported by the easing lever and adapted to guide the warp and to transmit the swinging displacement of the easing lever to the warp; and
>
> a load detector adapted to detect the tension of the warp by detecting a load applied to a support mechanism rotatably supporting the first roller.

[0008] In the present invention, the tension of the warp refers to the sum total of the tensions of a large number of warps wound around the warp beam. A load detector detects through a first roller a load reflecting the tension of the warp. That is, the inertia of the easing motion of a second roller does not affect the load detection of the load detector, so that, even when the tension of the warp is low, it is possible to perform load detection (i.e., warp tension detection) with high accuracy. The fluctuations in the warp tension are absorbed through positive easing of the second roller, so that, even when the tension of the warp is low and the loom is operating at high speed, the fluctuations in the warp tension can be absorbed in a satisfactory manner.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

> Fig. 1 is a side sectional view of a warp tension detecting device according to a first embodiment of the present invention;
>
> Fig. 2 is a perspective view of a main portion of the warp tension detecting device according to the first embodiment of the present invention;
>
> Figs. 3 through 5 are enlarged side sectional views of a main portion of the warp tension detecting device according to the first embodiment of the

present invention, respectively;

Fig. 6 is a graph showing fluctuations in moment;

Fig. 7 is a side sectional view of a warp tension detecting device according to a second embodiment of the present invention; and

Fig. 8 is an enlarged side sectional view of a main portion of the warp tension detecting device according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

[0010] A first embodiment of the present invention will now be described with reference to Figs. 1 through 5.

[0011] In Fig. 1, a warp beam 11 is driven by a feed-out motor 12. Warp T fed out from the warp beam 11 is guided while being held in contact with a first roller 13 and a second roller 14. The second roller 14 is on a downstream side of the first roller 13 with respect to the movement route for the warp T.

[0012] In Fig. 1, the solid-line circled indicates a maximum winding diameter of the warp beam 11, and the broken-line circle C2 indicates a minimum winding diameter of the warp beam 11. In the state in which the winding diameter is minimum, all the warp on the warp beam 11 has been consumed.

[0013] The movement route S11 for the warp T shown in Fig. 3 (the movement route between the warp beam 11 and the first roller 13) corresponds to the case in which the winding diameter of the warp beam 11 is maximum. The movement route S12 for the warp T shown in Fig. 3 (the movement route between the warp beam 11 and the first roller 13) corresponds to the case in which the winding diameter of the warp beam 11 is medium. The movement route S13 for the warp T shown in Fig. 3 (the movement route between the warp beam 11 and the first roller 13) corresponds to the case in which the winding diameter of the warp beam 11 is minimum.

[0014] As shown in Fig. 2, back brackets 15 and 16 are fixed to right and left side frames (not shown). As shown in Fig. 1, pivots 17 and 18 are supported by the back bracket 15 in a cantilever-like fashion. As shown in Fig. 2, pivots 19 and 20 are supported by the back bracket 16 in a cantilever-like fashion. Support levers 21 and 22 are rotatably supported by the pivots 17 and 19, respectively. Easing levers 23 and 24 are rotatably supported by and dangle from the pivots 18 and 20, respectively. The first roller 13 is rotatably supported through the intermediation of a roller shaft 131 at the rear ends of the support levers 21 and 22 (In Fig. 1, the left-hand side corresponds to the rear side, and the right-hand side corresponds to the front side). A second roller 14 is supported through the intermediation of a roller shaft 141 at the intermediate portions of the easing levers 23 and 24. The first roller 13 is rotatable around the roller shaft 131, and the second roller 14 is rotatable around the roller shaft 141. Warp T fed out from the warp beam 11 moves along movement routes S2 and S3 indicated by a chain line in Fig. 1.

[0015] Load cells 25 and 26 serving as load detectors are connected to forward end portions of the support levers 21 and 22 through pin connection using shaft pins 27 and 28 and rods 29 and 30. Further, the load cells 25 and 26 are connected to the back brackets 15 and 16, respectively, through pin connection using shaft pins 31 and 32 and rods 33 and 34. The load cell 25 and the rods 29 and 33 constitute a detection arm 35 including the load detector as a part thereof. The load cell 26 and the rods 30 and 34 constitute a detection arm 36 including the load detector as a part thereof.

[0016] The support levers 21 and 22, the pivots 17 and 19, and the back brackets 15 and 16 constitute a support mechanism for supporting the first roller 13. The positions of the axial centers 171 and 191 of the pivots 17 and 19 are fulcrum positions for the support levers 21 and 22 rotatably supporting the first roller 13. The position of the axial center 132 of the roller shaft 131 is the connecting position of the support levers 21 and 22 and the roller shaft 131 of the first roller 13. This connecting position is the force application point for the support levers 21 and 22. The first roller 13 is arranged below and behind the second roller 14. The fulcrum positions for the support levers 21 and 22 (the positions of the axial centers 171 and 191 of the pivots 17 and 19) is set so as to be not lower than the height position of the axial center 132 of the first roller 13 and not higher than the height position of the axial center 142 of the second roller 14 and to be in front of the second roller 14.

[0017] The detection arms 35 and 36 including the load cells 25 and 26 as a part are connected to the support levers 21 and 22 so as to cross the line L (shown in Figs. 3 and 4) connecting the fulcrum point and the force application point as seen in the axial direction of the roller shaft 131 of the first roller 13. The crossing angle of the support lever 21 and the detection arm 35 is the crossing angle γ made by the line K1 (shown in Fig. 3) passing the centers of the shaft pins 27 and 31 and the line L as seen in the axial direction of the roller shaft 131. The crossing angle of the support lever 22 and the detection arm 36 is the crossing angle γ made by the line K2 (shown in Fig. 5) passing the centers of the shaft pins 28 and 32 and the line L as seen in the axial direction of the roller shaft 131. In this embodiment, the crossing angle γ is a right angle.

[0018] The winding diameter of the warp beam 11 varies from the maximum diameter indicated by the solid-line circle C1 to the minimum diameter indicated by the broken-line circle C2, shown in Fig. 1. Independently of this variation in the winding angle, a first angle α (shown in Fig. 4) made by the movement route for the warp T between the warp beam 11 and the first roller 13 and the line L is set to be larger than a second angle β (shown in Fig. 4) made by the movement route S2 for the warp T between the first roller 13 and the second roller 14 and the line L. The load cells 25 and 26 are arranged on the side of the second angle β smaller than the first angle α as seen in the axial direction of the roller shaft 131 of the first roller 13. That is, the load cells 25 and 26 are arranged above the support levers 21 and 22.

[0019] The easing levers 23 and 24 are operationally connected to a crank mechanism 39 through the intermediation of easing rods 37 and 38. The crank mechanism 39 rotates in synchronism with the running of the loom, with the easing levers 23 and 24 swinging around the pivots 18 and 20 in conformity with periodical fluctuations in tension during one rotation of the loom. That is, the easing levers 23 and 24 swing between the solid-line position of Fig. 3 and the solid-line position of Fig. 4 through the rotating operation of the crank mechanism 39 in synchronism with the running of the loom. The second roller 14 moves forwards and backwards by periodical swinging of the easing levers 23 and 24 in synchronism with periodical fluctuations in warp tension during one rotation of the loom. The periodical fluctuations in warp tension during one rotation of the loom are thus absorbed by the swinging of the second roller 14.

[0020] The load applied to the first roller 13 by the tension of the warp T is divisionally received by the load cells 25 and 26 through the support levers 21 and 22. The load cells 25 and 26 detect the load divisionally received by the support levers 21 and 22. That is, the load cells 25 and 26 detect a load reflecting the tension of the warp T. Information on the load detected by the load cells 25 and 26 is transmitted to a control computer 10. The control computer 10 compares a target load reflecting a pre-set target tension with the load detected by the load cells 25 and 26, and controls the rpm of the feed-out motor 12 in such a way that the detected load coincides with the target load. That is, the control computer 10 controls the rpm of the feed-out motor 12 so as to make the tension of the warp T corresponding to the load detected by the load cells 25 and 26 coincide with the target tension.

[0021] The first embodiment provides the following advantages.

(1-1) The load cells 25 and 26 serving as the load detectors detect through the first roller 13 a load reflecting the tension of the warp T. The swinging displacement of the easing levers 23 and 24 swung in synchronism with the running of the loom is transmitted not to the first roller 13 but to the second roller 14. That is, the inertia of the easing motion of the second roller 14 does not affect the load detection of the load cells 25 and 26. Thus, even when the tension of the warp is low, it is possible to perform warp tension detection with high accuracy. The fluctuations in warp tension are absorbed through positive easing of the roller 14, so that the fluctuations in warp tension can be absorbed in a satisfactory manner even when the tension of the warp T is low and the loom is operating at high speed.

(1-2) The diameter of the warp beam 11 around which the warp T is wound decreases as weaving is carried on, with the wrapping angle θ1 of the warp T with respect to the first roller 13 (shown in Figs. 3 and 4) undergoing changes. However, the wrapping angle θ2 of the warp T with respect to the second roller 14 undergoes no change, so that the change in the diameter of the warp beam 11 does not adversely affect the absorption of the fluctuations in tension through positive easing of the second roller 14.

(1-3) The detection arms 35 and 36 are connected to the support levers 21 and 22 so as to cross the line L connecting the fulcrum position for the support levers 21 and 22 and the force application position for the support levers 21 and 22 as seen in the axial direction of the roller shaft 131 of the first roller 13. The connecting positions of the detection arms 35 and 36 and the support levers 21 and 22 (i.e., the positions of the pivots 17 and 19) constitute a point of action with respect to the fulcrum position. The tension of the warp T reaches the load cells 25 and 26 as a moment around the fulcrum position for the support levers 21 and 22.

[0022] In Fig. 5, arrows Ro, R1, R2, and R3 indicate tensions of the warp T. The values of the tensions Ro, R1, R2, and R3 are equal to one another. The tension R1 corresponds to the case in which the winding diameter of the warp beam 11 is maximum, that is, the case in which the movement route for the warp T is S11. The tension R2 corresponds to the case in which the winding diameter of the warp beam 11 is medium, that is, the case in which the movement route for the warp T is S12. The tension R3 corresponds to the case in which the winding diameter of the warp beam 11 is minimum, that is, the case in which the movement route for the warp T is S13.

[0023] In Fig. 5, the arrow Q1 indicates the resultant force of the tension Ro and the tension R1, the arrow Q2 indicates the resultant force of the tension Ro and the tension R2, and the arrow Q3 indicates the resultant force of the tension Ro and the tension R3. The resultant forces Q1, Q2, and Q3 act on the first roller 13 so as to pass through the axial center 132 of the roller shaft 131. In this embodiment, the lines of action of the resultant forces Q1, Q2, and Q3 are in lines deviated from the fulcrum positions for the support levers 21 and 22 (i.e., the axial centers 171 and 191 of the pivots 17 and 19).

[0024] In the graph of Fig. 6, the curve E represents changes in the product of the resultant forces Q1, Q2, and Q3 changing according to the change in the winding diameter of the warp beam 11 and the distances z1, z2, and z3 between the arrows indicating these resultant forces and the axial centers 171 and 191 of the pivots 17 and 19, that is, changes in moment. In the example shown, the moment M2 is minimum when the winding diameter of the warp beam 11 is the medium winding diameter r2. When the winding diameter of the warp beam 11 is the minimum diameter r1, the moment M1 is maximum, and the moment M3 when the winding diameter of the warp beam 11 is the maximum diameter r3, the moment is somewhat smaller than the maximum moment M1. That is, the moments M1, M2, andM3 are in the relationship: M1 > M3 > M2.

[0025] The way of moment change as indicated by the curve E of Fig. 6 results when the position of the roller shaft 131 of the first roller 13, the position of the roller shaft 141 of the second roller 14, and the positions of the pivots 17 and 19 for the support levers 21 and 22 are determined as in this embodiment. That is, by setting the positions of the roller shaft 131, the roller shaft 141, and the pivots 17 and 19 in such a way that the first angle α made by the movement route S11, S12, S13 for the warp T and the line L is larger than the second angle β made by the movement route S2 for the warp T and the line L, the moment tends to change as indicated by the curve E.

[0026] Suppose the positions of the pivots 17 and 19 for the support levers 21 and 22 are upwardly changed in such a way as to maintain the relationship: $\alpha > \beta$ between the first angle α and the second angle β, with the positional relationship between the rotation center 111 of the warp beam 11, the roller shaft 131, and the roller shaft 141 being the same as that of the example shown. Then, the moment tends to vary as indicated, for example, by the curve G1 of Fig. 6 . Suppose that the positions of the pivots 17 and 19 for the support levers 21 and 22 are downwardly changed in such a way as to maintain the relationship: $\alpha > \beta$ between the first angle α and the second angle β . Then, the moment tends to vary as indicated, for example, by the curve G2 of Fig. 6. That is, the winding diameter corresponding to the minimum value in the curve G1 is smaller than the winding diameter r2, and the winding diameter corresponding to the minimum value in the curve G2 is larger than the winding diameter r2. And, the moment changing amounts of the curves G1 and G2 corresponding to the changes in the winding diameters r1 through r3 are larger than that in the case of the curve E.

[0027] When the moment changes as indicated by the curve E, the moment changing amount during the change of the winding diameter of the warp beam 11 from the maximum diameter r3 to the minimum diameter r1 is very close to the minimum value. That is, the error in the detected tension of the warp is very close to the minimum value as in the case in which the warp tension is detected with the warp tension undergoing no change. As a result, the rpm control for the feed-out motor 12 utilizing the detected tension is effected with high accuracy so as to provide a desired warp tension.

[0028] Generally speaking, the rotation center 111 of the warp beam 11, the rotation center of the first roller 13 (the axial center 132 of the roller shaft 131), and the rotation center of the second roller 14 (the axial center 142 of the roller shaft 141) are determined first. When the axial center 132 of the roller shaft 131 and the axial center 142 of the roller shaft 141 are determined, the movement route for the warp T between the first roller 13 and the second roller 14 is determined. Further, the maximum diameter and the minimum diameter of the warp beam 11 are also determined beforehand, so that, when the rotation center 111 of the warp beam 11 and the axial center 132 of the roller shaft 131 are determined, the movement route for the warp T between the warp beam 11 and the first roller 13 is also determined. Thus, to achieve the manner of moment change as indicated by the curve E, the rotation centers of the support levers 21 and 22 (the axial centers 171 and 191 of the pivots 17 and 19) are finally determined. In this embodiment, the positions of the roller shaft 131, the roller shaft 141, and the pivots 17 and 19 are determined so as to achieve the above-described moment change as indicated by the curve E, that is, in such a way that the above moment is minimum when the winding diameter of the warp beam 11 is the medium winding diameter.

Second Embodiment

[0029] Next, a second embodiment will be described with reference to Figs. 7 and 8. The components that are the same as those of the first embodiment are indicated by the same reference numerals.

[0030] A rod-shaped balance weight 40 extends across and is supported by the support levers 21 and 22 at the forward end portions thereof. The balance weight 40 is arranged so as to be parallel to the roller shaft 131 of the first roller 13. The balance weight 40, the support levers 21 and 22, and the roller shaft 131 form a rectangular frame.

[0031] The balance weight 40 serves to prevent torsion of the roller shaft 131 and the support levers 21 and 22 connected together. Further, the balance weight 40 is provided to maintain balance in weight between the balance weight 40 and the first roller 13 supported by the pivots 17 and 19, preventing the weight of the first roller 13 and the roller shaft 131 from being applied to the load cells 25 and 26. This balance in weight is effective in eliminating the influence of the inertial force of the first roller 13.

[0032] In the present invention, the following embodiments are also possible.

(1) In the first and second embodiment described above, it is also possible to set the relationship: $\alpha < \beta$ between the first angle α and the second angle β, arranging the load cells 25 and 26 on the first angle α side. That is, the load cells 25 and 26 may be arranged below the support levers 21 and 22.

(2) It is also possible to arrange the first roller on the downstream side of the second roller with respect to the movement route for the warp.

(3) It is also possible to adopt a construction in which the load cell is only arranged on one of the back bracket 15 side and the back bracket 16 side. In this case, one of the detection arms 35 and 36 in the embodiment shown in Figs. 1 through 4 simply consists of a lever with no load cell.

(4) The angle at which the detection arms 35 and 36 cross the line L may be an angle other than a right angle.

[0033] As described above in detail, according to the present invention, there is provided a construction in which positive easing is effected on the roller guiding the warp, wherein the influence of the inertia of the easing motion is eliminated, thereby making it possible to detect warp tension with high accuracy.

Claims

1. A warp tension detecting device for a loom, in which fluctuations in tension of warp (T) fed out from a warp beam (11) are absorbed by transmitting to the warp a swinging displacement of an easing lever (23, 24) swung in synchronism with a running of the loom, and the tension of the warp is detected through a first roller (13) for guiding the warp, **characterized in that**
the warp tension detecting device comprises:

a second roller (14) rotatably supported by the easing lever (23, 24) for guiding the warp (T) and adapted to transmit a swinging displacement of the easing lever to the warp; and
a load detector (25, 26) adapted to detect the tension of the warp by detecting a load applied to a support mechanism (15, 16, 17, 19, 21, 22) rotatably supporting the first roller (13).

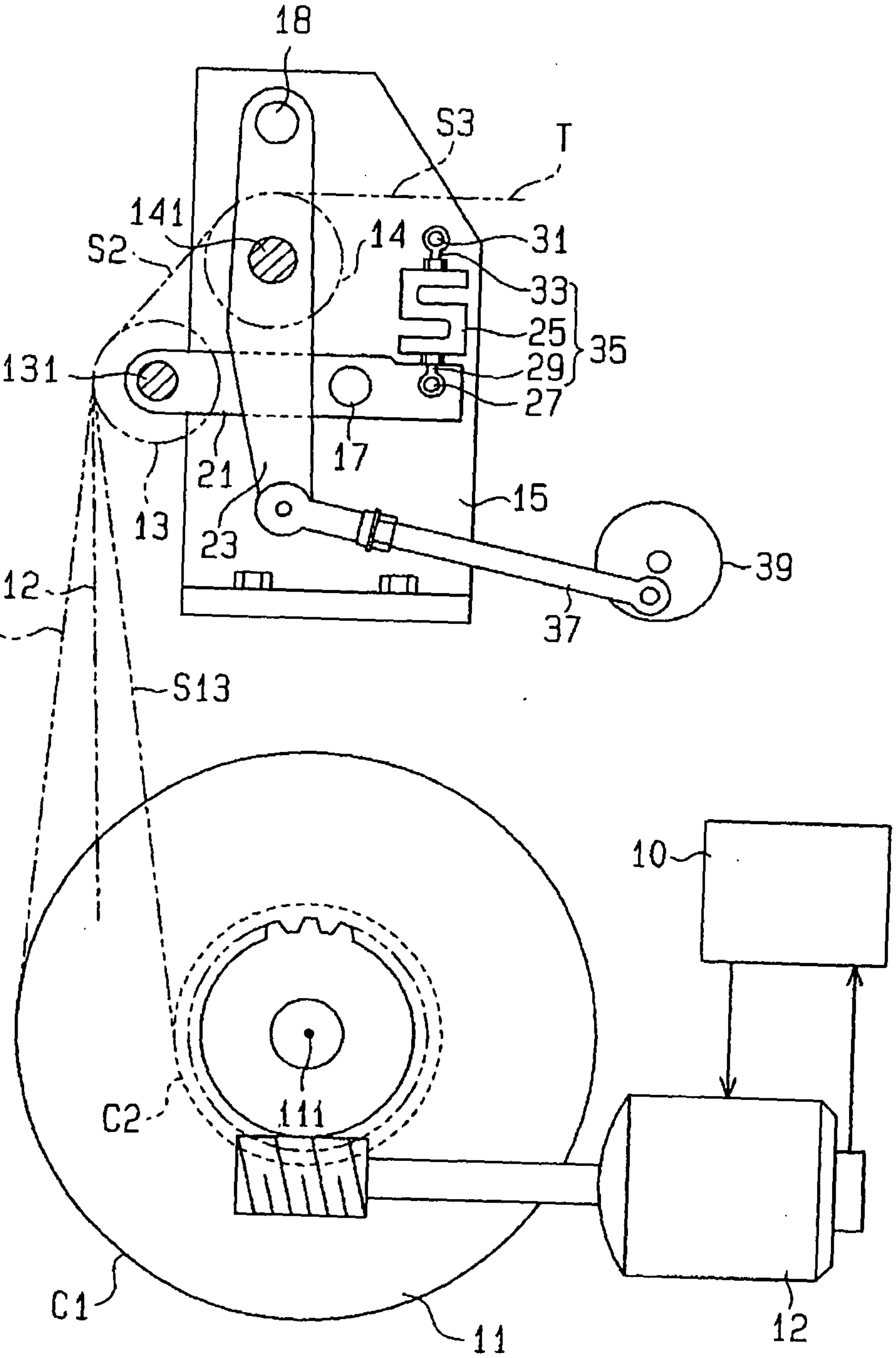
2. A warp tension detecting device according to Claim 1 wherein the second roller (14) is arranged on a downstream side of the first roller (13) with respect to the movement route for the warp (T).

3. A warp tension detecting device according to Claim 2 wherein the first roller (13) is rotatably supported by rotatable support levers (21, 22),
detection arms (35, 36) including the load detectors (25, 26) are connected to the support levers so as to cross lines (L) connecting fulcrum positions (171, 191) for the support levers (21, 22) and an axial center (132) of the first roller (13) on the support lever as seen in the axial direction of the first roller (13), a first angle (α) made by the lines (L) and the warp movement route between the warp beam (11) and the first roller (13) is different from a second angle (β) made by the lines (L) and the warp movement route between the first roller (13) and the second roller (14), and the load detectors (25, 26) are arranged on the side of the smaller of the first angle (α) and the second angle (β).

4. A warp tension detecting device according to Claim 3 wherein the second angle (β) is smaller than the first angle (α).

5. Awarp tension detecting device according to Claim 3 or 4 wherein a balance weight (40) is connected to one support lever on the opposite side of the first roller (13) with respect to the fulcrum positions (171, 191) for the support levers (21, 22).

FIG. 1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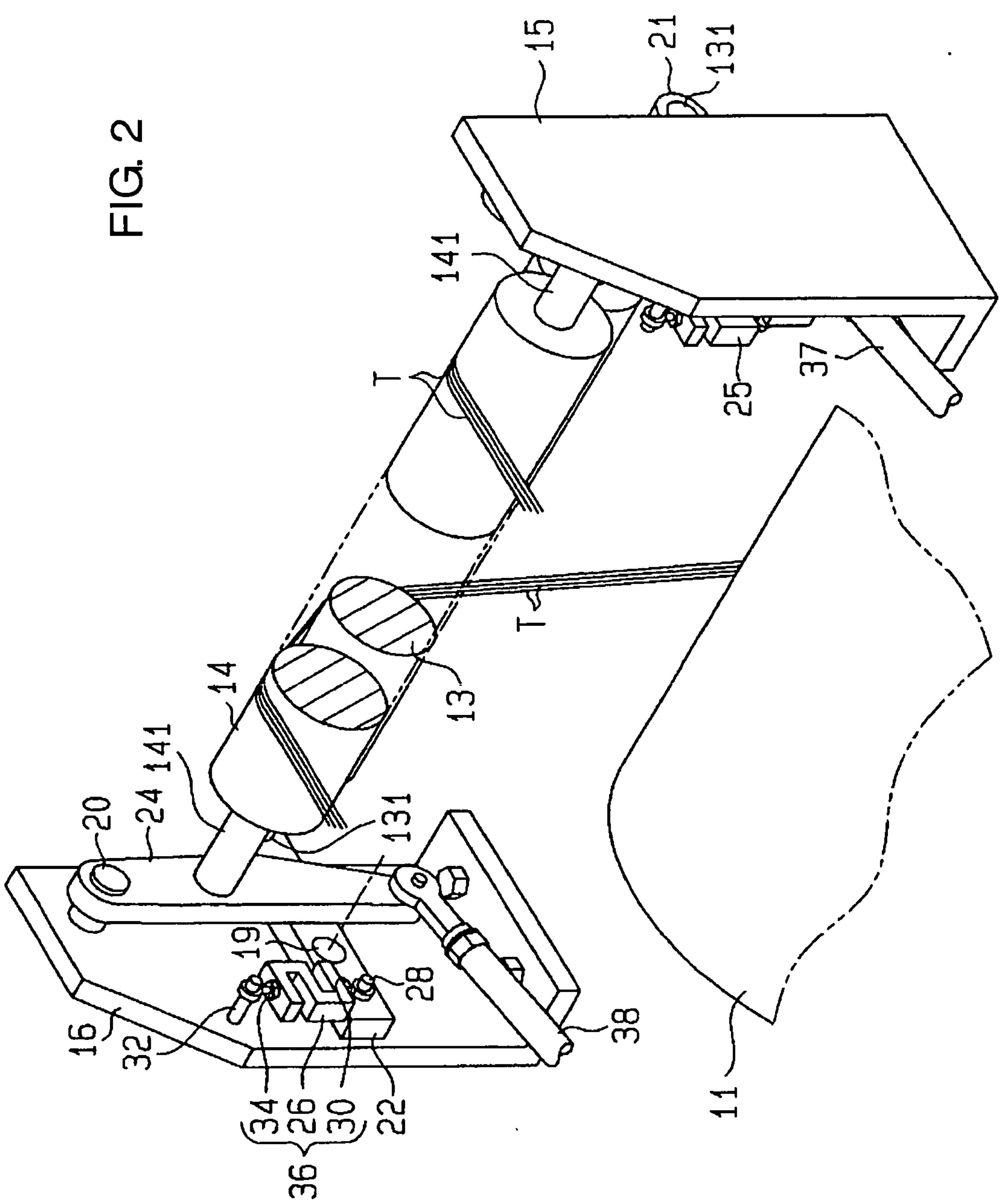
12

FIG. 2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30
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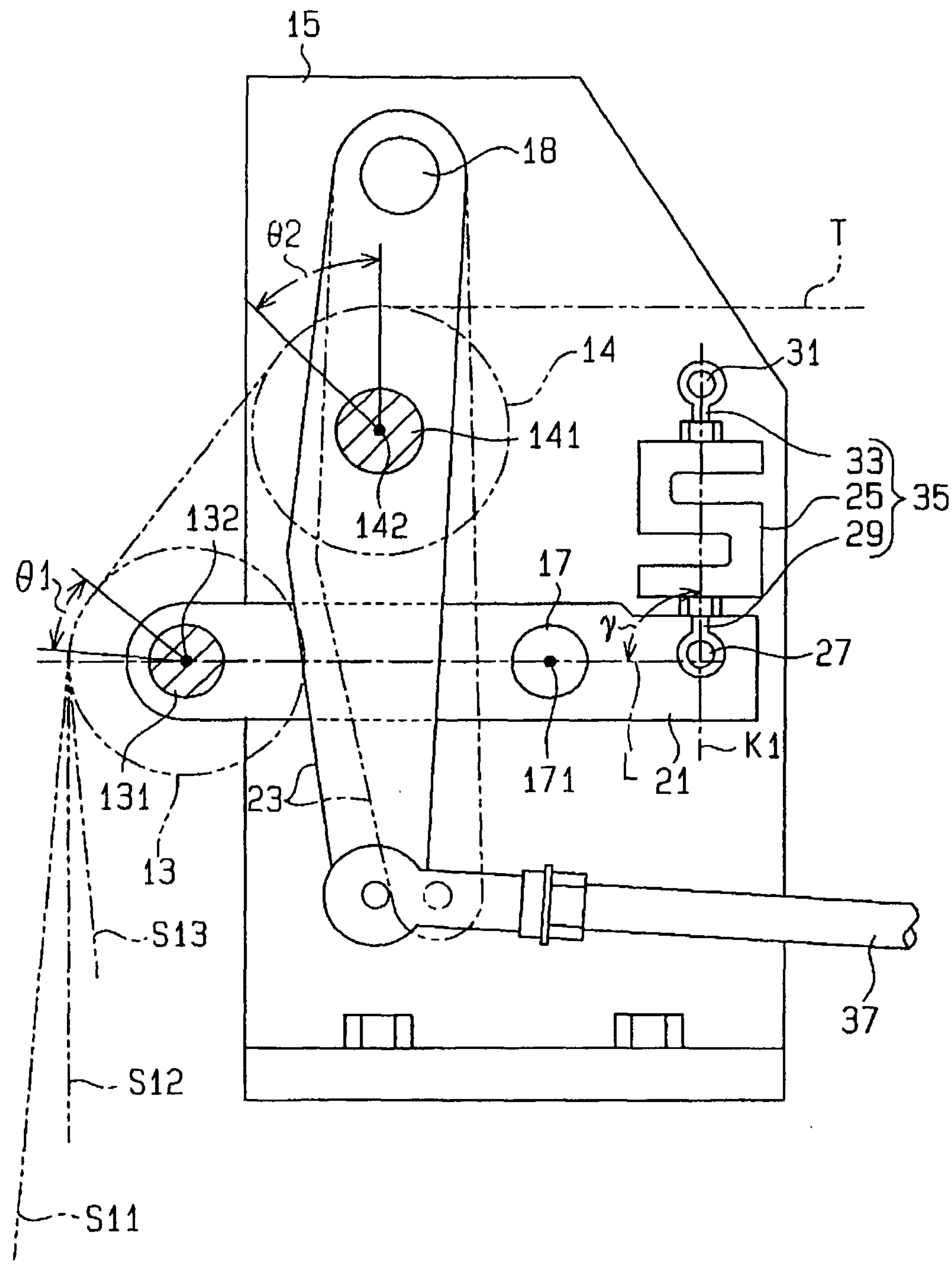
36
11

FIG. 3



15
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37
S12
S11

FIG. 4

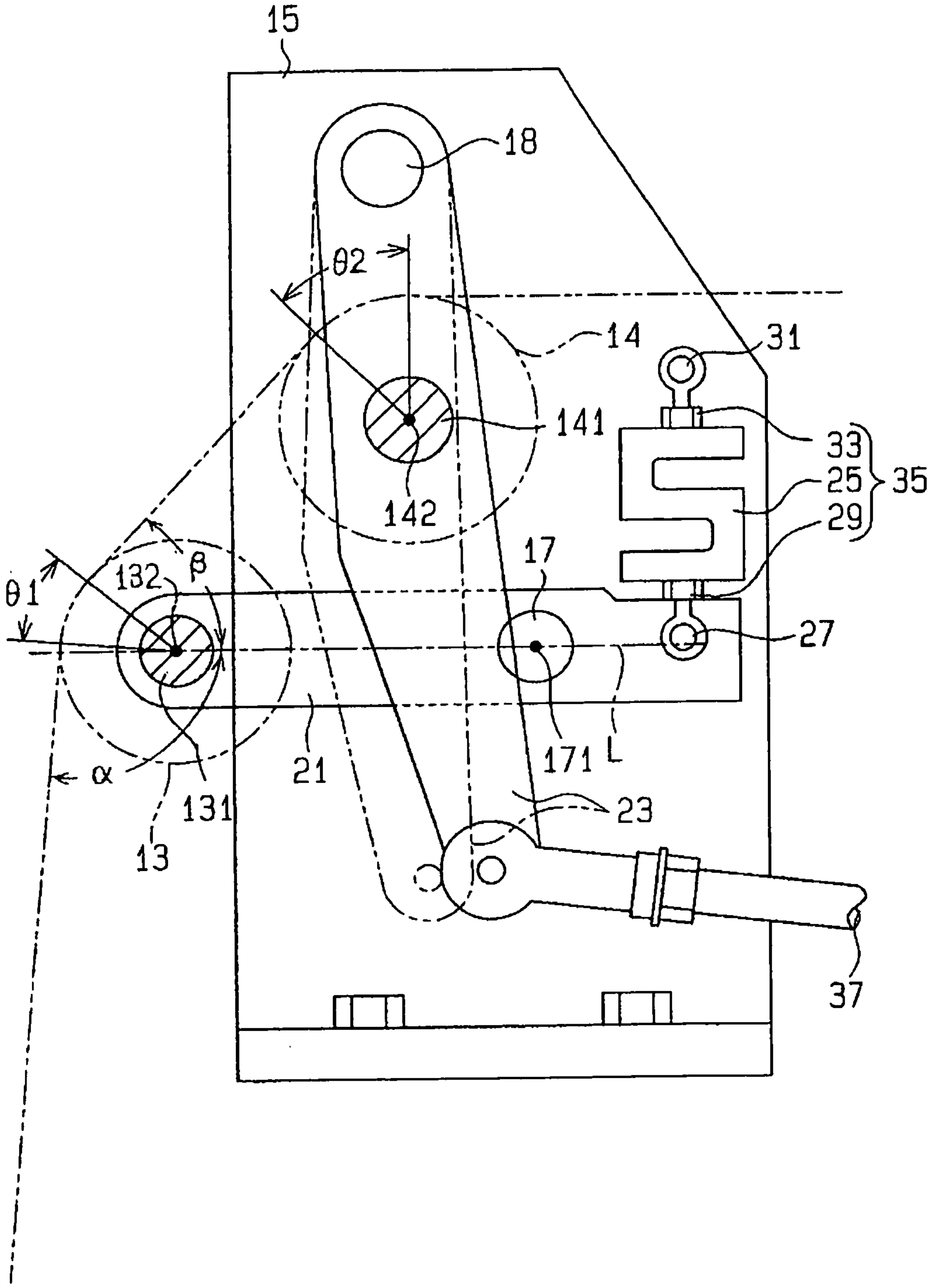
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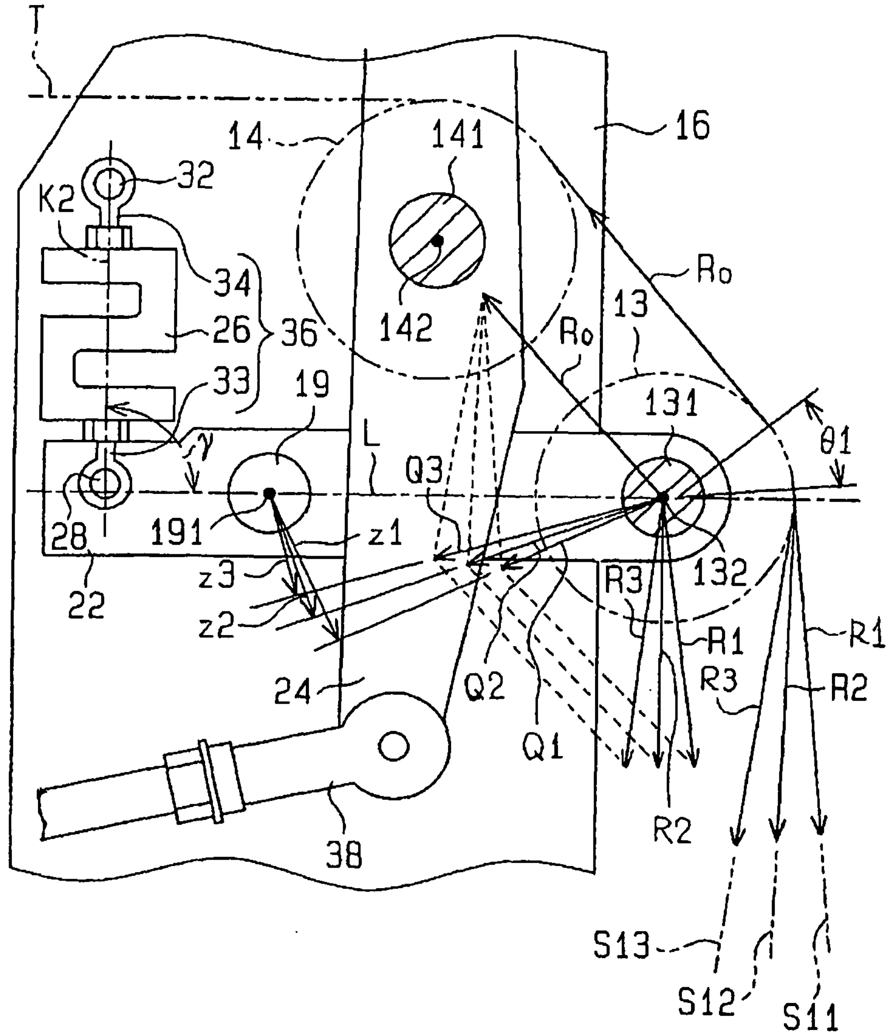
FIG. 5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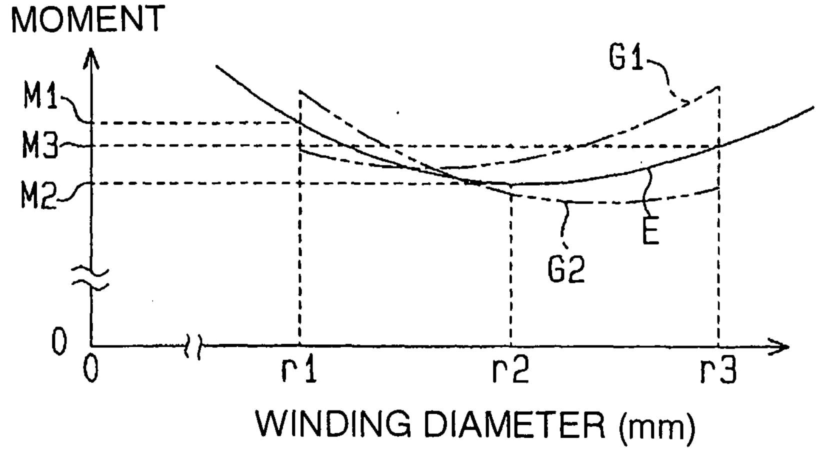
S13
S12
S11

FIG. 6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WINDING DIAMETER (mm)

FIG. 7

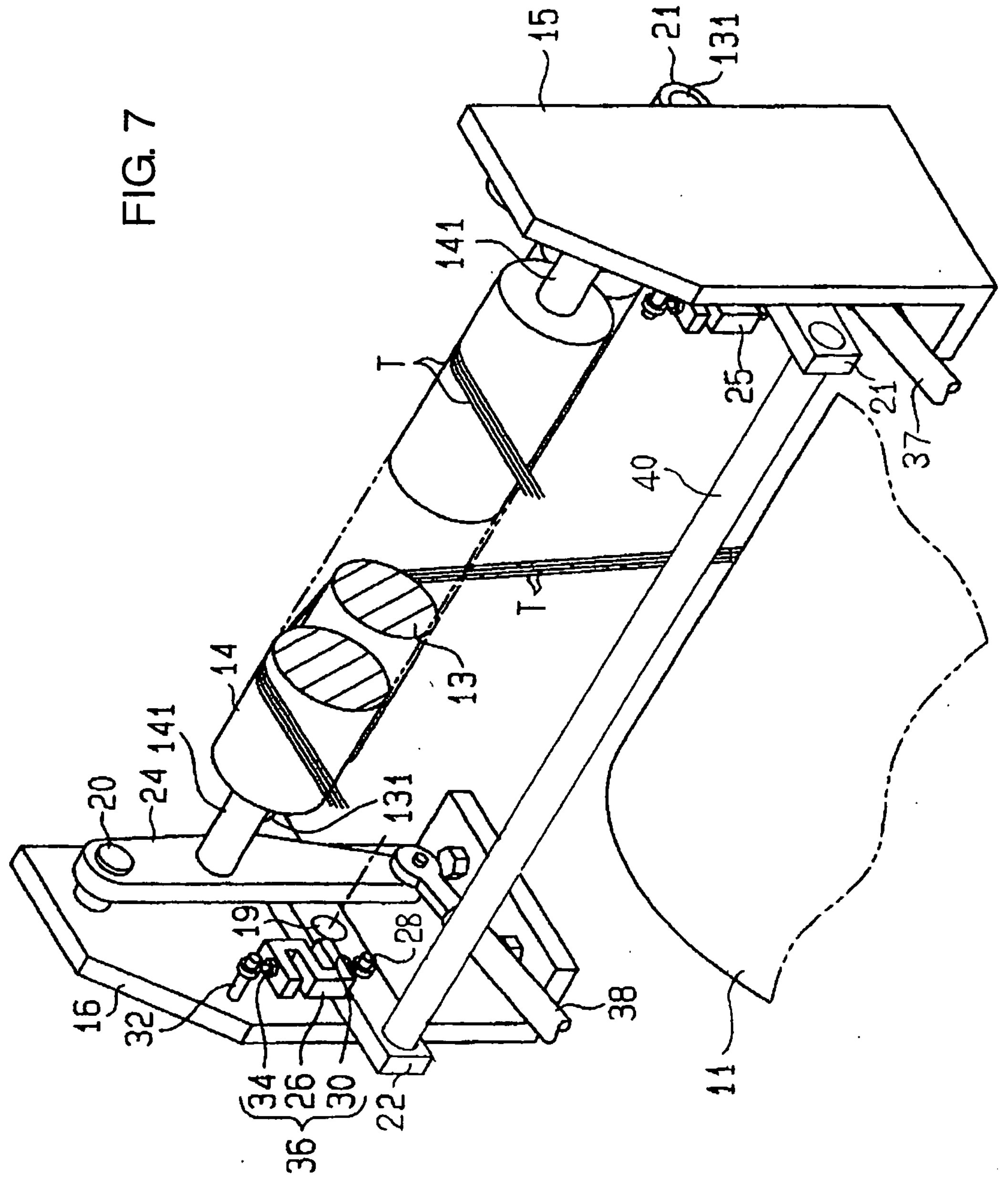
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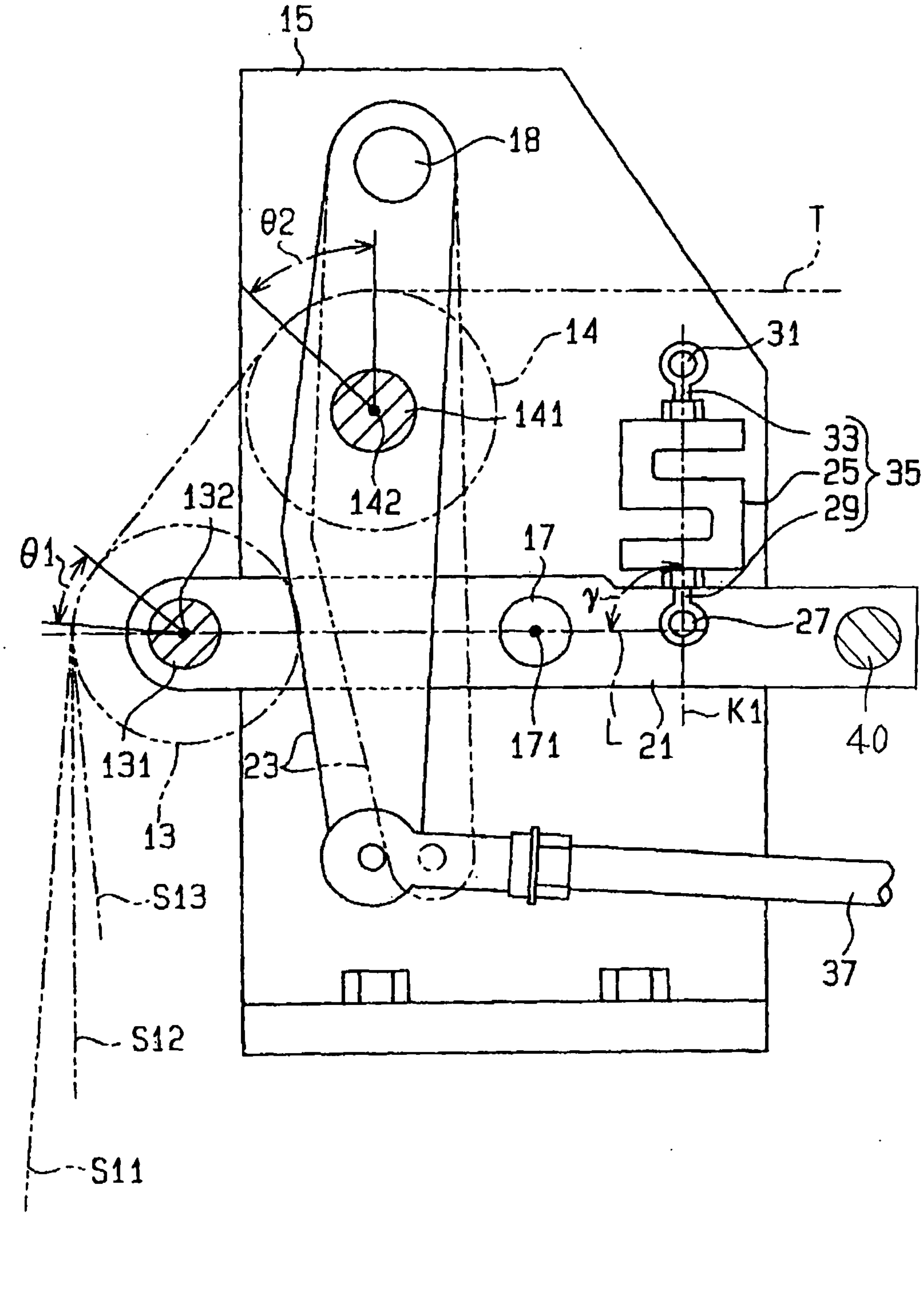
FIG. 8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