Aug. 27, 1963 T. HINDLE 3,101,747

WARP TENSIONING DEVICES FOR LOOMS

Filed Feb. 21, 1961 3 Sheets-Sheet 1

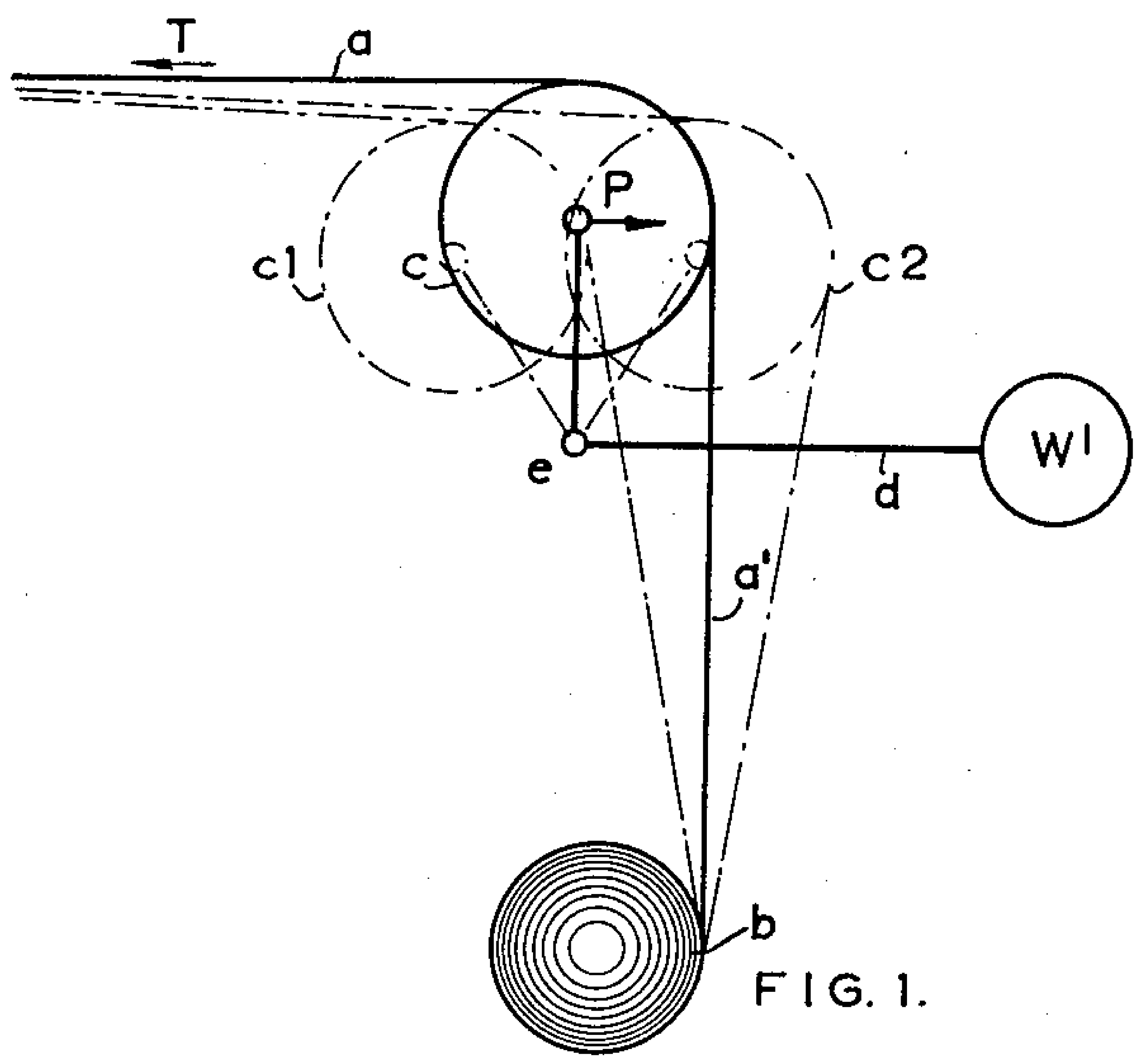

FIG. 1.

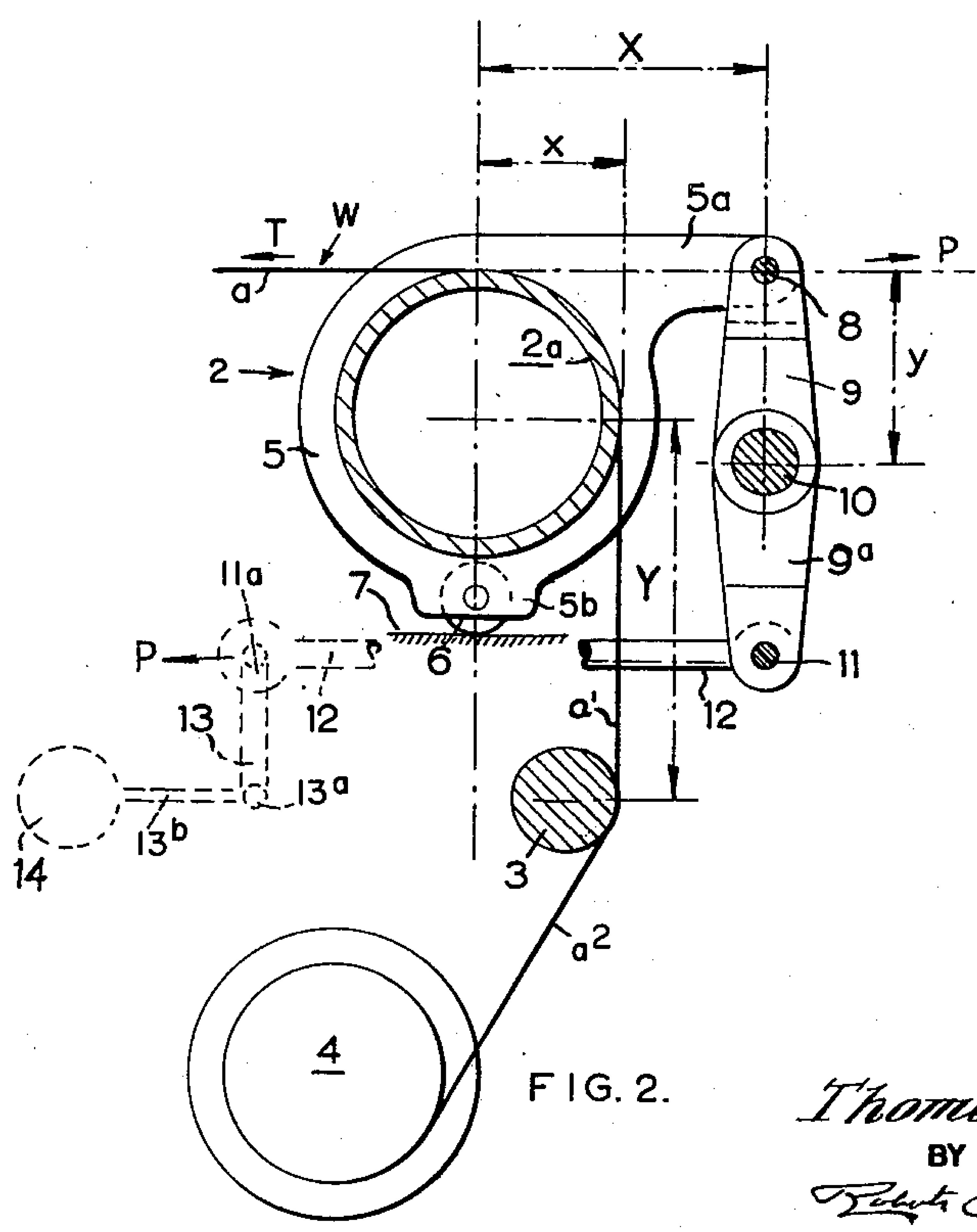

FIG. 2.

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WARP TENSIONING DEVICES FOR LOOMS

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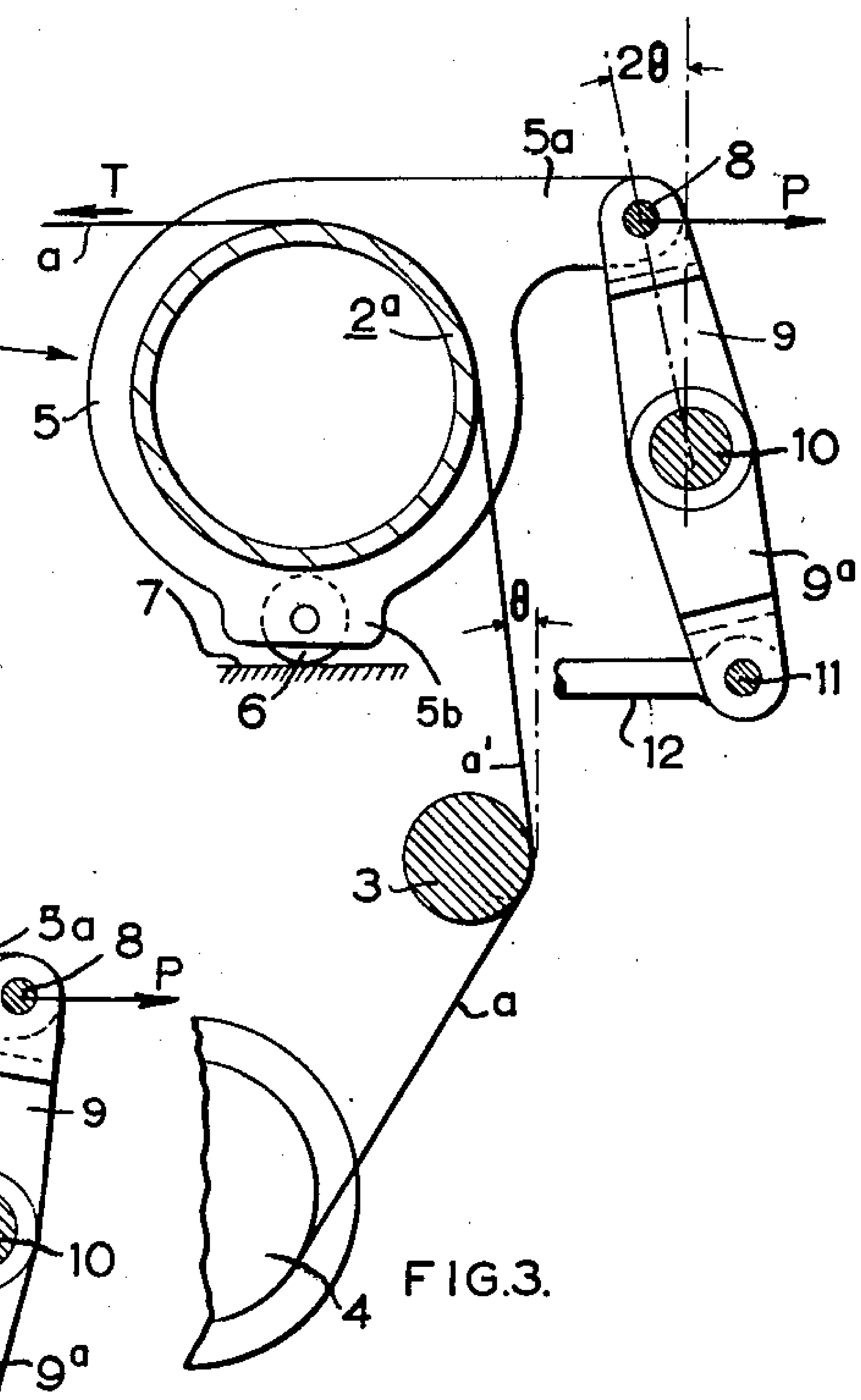

FIG.3.

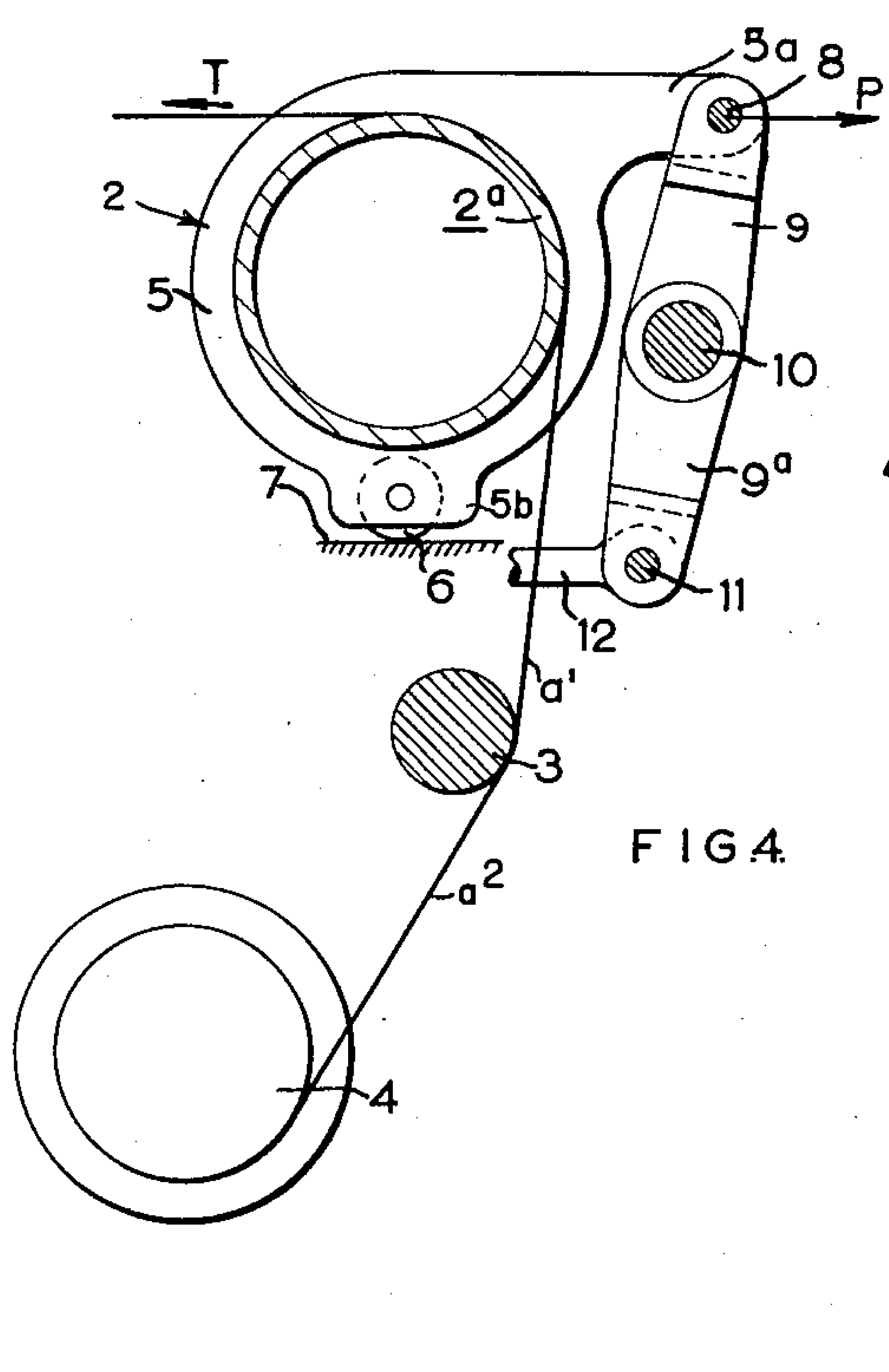

FIG.4.

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WARP TENSIONING DEVICES FOR LOOMS

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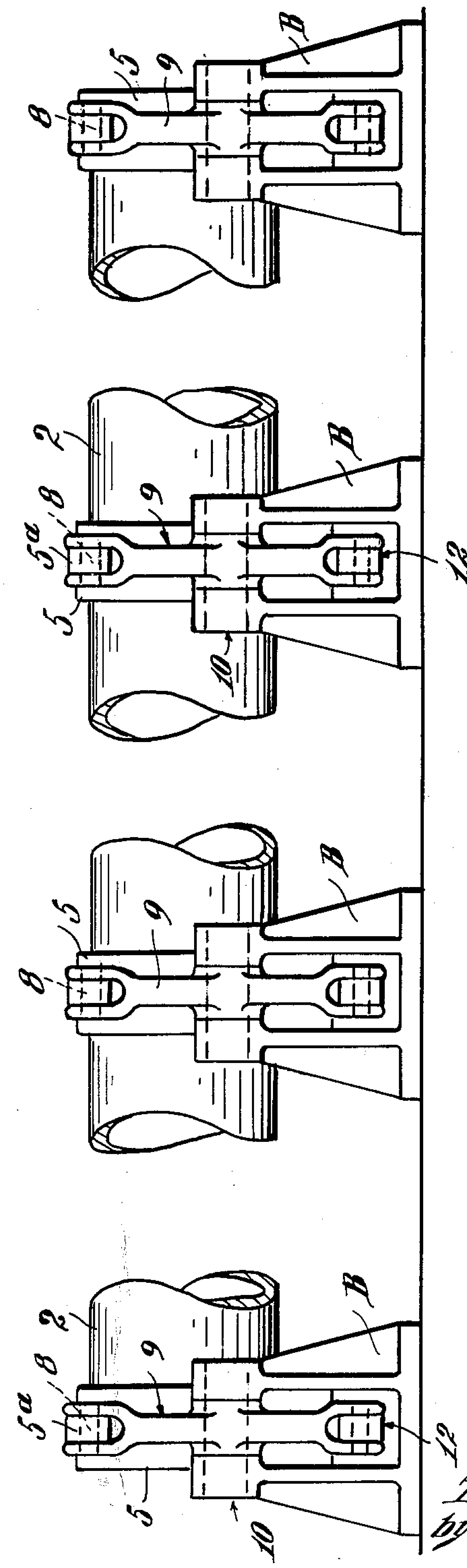

Fig. 5

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3,101,747
WARP TENSIONING DEVICES FOR LOOMS

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10 Claims. (Cl. 139—109)

This invention relates to warp tensioning devices for looms of the kind (hereinafter termed "the kind referred to"), having a sensitive back rest or whip roll over which the warp threads pass from the warp beam below it, with or without an intermediate guide bar, to the healds of the loom, thus forming a bight of the warp threads.

The expression "sensitive" is used in the art to define a back rest which is sensitive to change of position so as thereby to activate and de-activate a positive warp let-off motion for the warp beam.

With such devices, the bask rest is "weighted" by weights, springs or other means, so as to apply a constant force pulling it away from the loom healds and into the bight of the warp threads, which, in turn, are fed from the beam by a positive let-off motion arranged to rotate the beam. In action, as weaving progresses, the back rest or whip roll is drawn towards the loom healds by the take-up of the loom, and the let-off motion is inactive until the back rest has been thus advanced towards the loom healds beyond a predetermined position whereupon the let-off motion is activated and brought into operation until the back rest or whip roll has moved back to another predetermined position when the let-off motion is de-activated, such movement is stopped and the cycle of operation above described starts again.

It is always the aim of a warp tensioning device to maintain a constant tension on the warp threads and various mechanisms are known which attempt to achieve such result by ensuring a constant tensioning load on the back rest, and such known mechanisms do this with different degrees of success. Such a positive "let-off motion" is illustrated by way of example in the patent to Lakeland, 2,420,957, dated May 20, 1947.

There are, however, several factors which are responsible for variations of warp tension, but one factor, which does not appear at present to have received consideration, is the change of angularity of the run of the warp threads which extend between the back rest or whip roll and the warp beam. This change of angularity derives both from change of position of the back rest or whip roll in its movements to-and-fro between its predetermined advanced and retraced positions as aforesaid, and commonly from change of diameter of the warp beam as let-off progresses as between a full beam and one which is due for replacement. Thus, when the bight angle becomes obtuse, a lesser force on the back rest is required than when such angle is acute to provide the same tension, and therefore, also to maintain a constant warp tension.

Another factor which is responsible for variation of warp tension is the physical weight of the sensitive back-rest or whip roll, especially when this is mounted in the usual manner on pivoted upstanding arms. Such weight, by reason of the change of angularity of such arms with change of position of the back rest gives a varying component of force into the bight of the warp threads.

The object of the present invention is an improved warp tensioning device having compensation for the aforesaid factors affecting the maintenance of a constant tension.

According to the invention, a warp tensioning device of the kind referred to is characterised by compensating lever means between an applied constant force and the back rest so constructed as to have a change of angularity of leverage proportional to the change of angularity of the warp threads passing up to the back rest and thereby to apply to the back rest a force so varying with such angularity of the warp threads as to result in a substantially constant warp tension.

The warp tensioning device aforesaid may be further characterised in that the compensating lever mechanism is so constructed as to employ a component of force derived from the back rest as a function of the angularity of the run of the warp threads passing up to the back rest.

In the accompanying drawings:

FIG. 1 is a diagram showing the basic principle of forces operating on the movable back rest or whip roll of a warp tensioning device of the kind referred to;

FIG. 2 is a fragmentary vertical section through the axis of the whip roll illustrating one desirable and practical embodiment of the invention, the whip roll being shown in its normal position;

FIG. 3 is a view similar to FIG. 2, but showing the whip roll as having moved to the left of its normal position in response to increase in tension of the warp yarns;

FIG. 4 is a view similar to FIG. 2, but showing the whip roll as having moved to the right of its normal position; and

FIG. 5 is a fragmentary elevation, showing the whip roll and the multiple compensating lever as viewed from the rear end of the loom.

As shown in FIG. 1, the warp threads *a* from a warp beam *b* pass over a back rest or whip roll *c* which is movable between dotted extreme positions shown at c^1 and c^2. A weight W' on the end of a cranked lever *d*, pivoted at *e*, applies a force P to the back rest which force is substantially constant for the small changes of angle of the lever *d* normally obtaining. The positions c^1 and c^2 are exaggerated only to show a visible change of angularity of the run a^1 of the warp threads extending from the warp beam to the back rest or whip roll.

In operation, when the said run a^1 of the warp threads is vertical as shown by the full line, the tension T in the warps *a* forming the warp sheet W is equal to the force P, but, assuming that P remains constant, both in force and direction, the tension T is not equal to P when the back rest is displaced from such position. In fact, when displaced to the position c^1, the tension T is equal to P plus a component which is a function of the change of angularity, whilst at the position c^2 the tension T is equal to P minus such a component.

In the embodiment of the present invention illustrated in FIGS. 2, 3 and 4, and wherein the warp beam is shown at **4**, and the whip roll or back rest at **2**, a fixed yarn guide **3** (here shown as a round rod) is so arranged, relatively to the warp beam and whip roll that, in passing from the warp beam to the whip roll, a warp yarn forms a bight about the fixed guide **3**, the run a^2 of yarn, approaching the fixed guide **3**, making an angle with a run a^1 of the same yarn, leaving the guide **3**, which never exceeds 180°, regardless of the diameter of the yarn mass on the warp beam.

The whip roll or back rest **2** as here illustrated is an elongate, rigid, hollow cylinder or tube **2***a*, having its axis parallel to that of the warp beam and which is carried by a lever assembly comprising a plurality of like supports **5** (four being shown in FIG. 5, by way of example), the length of the tube **2***a* being at least as great as the width of the sheet W of warp yarns. Each of these supports **5** comprises a ring-like portion which tightly embraces and is fixed to the tube **2***a*. Each support also has a downwardly projecting lug **5***b* at its lower portion, in which an anti-friction roll **6** is journaled. The rolls **6** rest upon a fixed horizontal guide **7**, which may be a part of the loom frame, thus providing for bodily motion of the whip roll or back rest from front to rear of the loom. Each support 5 also comprises an integral elongate, normally horizontal arm 5a projecting rearwardly from the upper part of its ring-like portion and having, at its free or rear end an opening whose center (when the parts occupy the normal position illustrated in FIG. 2) is in the plane of the warp sheet W formed by the yarns *a*.

The tube 2a rigidly unites the spaced supports 5, and the several supports, including their arms 5a, the lugs 5b, and the rolls 6 are here for convenience referred to as the whip roll lever assembly or merely as the "lever assembly" and this assembly may rock about the points of contact of the rolls 6 with the guide 7, said points of contact defining a fulcrum axis about which the lever assembly may rock.

A lever 9 is associated with each of the supports 5, each lever being pivotally connected to the arm 5a of the corresponding support by a pivot pin 8 passing through the aforesaid aperture in the free end of the arm 5a of the support. Each of the levers 9 is pivotally supported by a corresponding stand or bracket B (FIG. 5) mounted on the loom frame, each bracket having a pivot element 10 on which the lever 9 is mounted, with its axis parallel to that of the warp beam. As shown in FIG. 2, the axes of the pivot elements 10 are below the horizontal plane of the axis of the whip roll 2. In the following discussion, the levers 9 are collectively referred to as the "compensating lever," their connection to the whip roll lever assembly constraining all of the several independent levers 9 to act as a unit. One at least of the levers 9 (and preferably each of them) has a rigid downwardly directed extension 9a.

To the lower end of each of the lever arms 9a there is attached, by means of a pivot pin 11, the rear end of a connecting rod 12 whose forward end (FIG. 2) is pivotally secured at 11a (as shown in dotted lines) to the vertical arm of a bell crank lever 13 pivotally secured at 13a to a part of the loom frame and whose horizontal arm 13b carries a weight 14. With the parts positioned as shown in FIG. 2, the fulcrum axis, defined by the points of contact of the rollers 6 with the horizontal support 7, is vertically below the axis of the tube 2a. In the practical embodiment of the invention, the parts may be so designed that a single weight 14 will suffice to apply a constant force to all of the levers 9, tending to rock their lower ends forwardly, thus providing a force which tensions the warps forming the sheet W.

The position of the whip roll 2, shown in FIG. 2, wherein the axis of the roll is vertically above the fulcrum axis (where the roll 6 contacts the support 7), and wherein the lever 9 is vertical, is herein referred to as the "normal" position of the parts, since, in this position, the turning moment about the fulcrum axis has no effect upon the lever 9 since the vertical component of said turning moment is normal to the shaft 10.

The aforesaid relative positions, shown in FIG. 2, are substantially maintained for all positions of the back rest within the permitted angle of movement of the levers 9. Tensioning force for the warp *a* to provide the pull T is applied to the end of each lever member 5 by the lever 9, pivotally mounted at its pivot 10, such pivot being stationary. In this normal position of the parts, as shown in FIG. 2, the vertical component of force at the pivot 8, resulting from the tension of the vertical run a^1 of the said warp threads has, therefore, no turning moment about the pivot 10 and the tension T in the warp threads between the back rest and the loom healds will be equal to the force P obtained from the weight 14. The proportional dimensions here shown are such that $X=2x$ and $Y=2y$.

If the whip roll 2 move to the right or left from the position illustrated in FIG. 2, then the turning moment about the fulcrum axis 6 has a component acting in the horizontal direction about the pivot 10. However, such motion of the whip roll, to the right or left, concomitantly varies the slope of the run a^1 of yarn extending from the fixed guide 3 to the whip roll, thus developing a horizontal component of the reaction force acting upon the whip roll, such that when the whip roll moves to the right of the position shown in FIG. 2, the reaction force on the whip roll, which opposes the force P, is increased whereas when the whip roll moves to the left of the position shown in FIG. 2, the reaction force opposing the force P is decreased, so that, in either event, there is a change in the tension T on the warp yarns extending from the whip roll to the cloth beam.

However, by the provision of the compensating lever, such variation in the force P, resultant from motion of the whip roll, is prevented since the downward component of force at 8 of the reaction force on the whip roll provides an additive or subtractive turning moment about the fulcrum axis of the compensating lever 9.

As shown, however, in FIG. 3, as the back rest or whip roll 2 is drawn to the position corresponding to the position c^1 of FIG. 1, the vertical component of force at 8, resolved about the pivot 10, exerts a turning moment in an anti-clockwise direction, which is a function of the angle 2θ of the lever from the vertical and which, in turn, is a function of the angle θ from the vertical of the run a^1 of the warp threads. This results from the proportions shown in FIG. 2 in which the length y of the lever between the pivots at 8 and 10 is half the length Y of the inclined run of the warp threads and the vertical component of force at 8 will be half the vertical component from such inclined run of the warp threads. Consequently, assuming the beam is held from rotation, the tension T in the position shown in FIG. 3 will remain constant because the horizontal component of force at the pivot 8 is equal to the force P applied by the weight less the turning moment of the vertical force component at the pivot 8 around the pivot 10, which deduction compensates for the horizontal force component due to the inclination through the angle θ of the hitherto vertical portion of the warp passing up from the guide bar to the back rest, by positioning the pivot 10 at a horizontal distance X equal to twice the radius x of the back rest.

Similarly, as is obvious from FIG. 4, the tension T will remain constant in spite of inclination of the vertical portion of the warp threads in the other direction because the sum of the horizontal forces at the pivot 8 will be equal to the force P derived from the weight 14, plus the horizontal component of force derived from the clockwise force couple about the fulcrum 6 from the vertical force component at the pivot 8 cancelling the equal horizontal component from the inclination of the previously vertical portion of the warp. In short, compensation is obtained when the proportions are such that

$$\frac{X}{x}=\frac{Y}{y}$$

In the example given, both these ratios are 2:1, but any other convenient ratio may be used. The above theory, of course, is of a "substantial" nature, that is to say, for the small angularities normally involved, the ratios are substantially of the order specified.

Thus, the warp tensioning device above described employs a change of angularity of the levers 9 so proportioned to the change of angularity of the inclined portion of the warp threads as to result in a substantially constant warp tension, and in so doing, it employs a component of force derived directly from the angularity of the levers as a function of the angularity of the inclined warp threads. The principle applies obviously to intermediate positions within normal requirements for movement of the back rest.

The invention is obviously not limited to the constructional details of the example above described which may be varied to employ the same principles of operation of leverage varying as a function of warp inclinations.

I claim:

1. In combination, in a weaving loom of the kind which

comprises a warp beam, warp "let-off" devices, a whip roll whose axis is parallel to that of the warp beam and which is bodily movable in a front-to-rear direction in response to variations in warp tension, and thereby controls the operation of the "let-off," and means for applying tension to the warps extending from the whip roll to the healds of the loom, characterized in having a fixed yarn guide which the yarns contact on their way from the warp beam to the whip roll, said fixed yarn guide being so located relatively to the warp beam and whip roll that the angle between the runs of yarn in approaching and leaving the yarn guide is always less than 180° regardless of the diameter of the yarn mass on the warp beam.

2. The combination according to claim 1, and wherein the whip roll is carried by a lever assembly whose fulcrum axis is parallel to and below the axis of the whip roll, proper, further characterized in that the fixed yarn guide is so positioned, relatively to the warp beam and whip roll that, when the axis of the whip roll is vertically above the fulcrum axis of said lever assembly, the run of yarn extending from the fixed guide to the whip roll is vertical regardless of the diameter of the yarn mass on the warp beam.

3. A warp tensioning device of that kind wherein a movable whip roll is located in a bight of the warp yarns leading from the warp beam to the loom healds and wherein variations in the position of the whip roll in response to varying warp tension controls "let-off" means for the warp, characterized in having a fixed guide over which the warp yarns pass on their way from the warp beam to the whip roll and which is so positioned that, in the normal position of the whip roll, the run of warp yarns extending between the fixed guide and the whip roll is substantially vertical, a lever assembly which supports the whip roll to rock about an axis below and parallel to the axis of whip roll proper, said lever assembly having a rigid, rearwardly extending arm, a compensating lever pivoted to rock about an axis parallel to that of the whip roll and whose free end is normally in the plane of the warp sheet extending forwardly from the whip roll, a pivot element connecting the free end of the compensating lever to the rearwardly extending arm of the whip roll lever assembly, and a weight and connections between the weight and the compensating lever operative to maintain the warp yarns under tension, the relative proportions of the parts when the whip roll is in normal position being expressed by the equation

$$\frac{X}{x}=\frac{Y}{y}$$

where X represents the distance from the pivot element which connects the compensating lever to the whip roll assembly lever and the vertical plane through the axis of the whip roll; x equals the radius of the yarn-contacting surface of the whip roll; Y equals the length of the run of the warp yarn extending from the guide bar to the whip roll; and y equals the length of the compensating lever between its fulcrum and the point at which it is pivotally connected to the whip roll lever assembly.

4. Warp tensioning means according to claim 3, further characterized in that the relative arrangement and dimensions of the parts are such that, when motion of the whip roll from its normal position, in response to increased warp tension, causes the run of warp extending from the guide bar to the whip roll to deviate from the vertical by an angle of θ, the compensating lever will be concomitantly rocked so that it will incline in the same direction as said run of warp, but will make an angle with the vertical of 2θ.

5. In combination, in a weaving loom of the kind which comprises a warp beam, warp "let-off" devices, a whip roll whose axis is parallel to that of the warp beam and which is bodily movable in a front-to-rear direction in accordance with varying warp tension, and by such bodily movement controls the operation of the "let-off," and means for applying tension to the warp yarns extending from the whip roll to the healds of the loom, characterized in having a fixed yarn guide whose yarn-contacting surface is parallel to the axis of the warp beam and which is so located, relatively to the warp beam and whip roll that, in the normal position of the whip roll, the warp yarns extend vertically up from said yarn guide to the whip roll, and means operative automatically to maintain the tension of the warp yarns between the whip roll and cloth beam substantially constant regardless of variations in the slope of the warp yarns extending from said yarn guide to the whip roll occasioned by bodily motion of the whip roll from normal position.

6. The combination according to claim 5, wherein the means for maintaining uniform tension upon a warp yarn comprises a lever assembly for supporting the whip roll, said assembly having its fulcrum parallel to, but spaced from and below that of the whip roll, the means for applying tensioning force to the warp yarns comprising a compensating lever which is normally vertical and whose free end is normally disposed in the horizontal plane of the warp yarns leading from the whip roll to the healds of the loom, means whereby a substantially constant force is applied to said compensating lever tending to rock the latter in a direction such as to apply tension to the yarn extending from the whip roll to the loom healds, and means connecting the lever assembly which supports the whip roll to the free end of said compensating lever whereby, as the whip roll moves bodily from normal position, said compensating lever is concomitantly rocked from vertical position.

7. The combination according to claim 5, wherein the length of the compensating lever is to the length of the warp yarn extending from the yarn guide to the whip roll as the angle of slope of the warp yarns extending from the yarn guide to the whip roll, resultant from motion of the whip roll from normal position, is to the angle of slope of the compensating lever.

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8. The combination according to claim 5, wherein the means for maintaining uniform tension upon the warp yarn comprises a lever assembly which supports the whip roll, said assembly having coaxial rollers which rest upon and may roll along a horizontal guide and whose contact with said guide defines a fulcrum axis, the whip roll being thereby supported for bodily movement and also for rocking motion about the fulcrum axis of the lever assembly, a compensating lever which is pivoted to rock about a fixed axis parallel to said fulcrum axis of the lever assembly, and pivot means connecting the free end of said compensating lever to the lever assembly at a point spaced from the fulcrum axis of the latter, the tensioning force being so applied to said compensating lever as to tend to rock the latter in a direction to tension the yarn extending from the whip roll to the loom healds.

9. The combination according to claim 5, further characterized in that the means for maintaining uniform tension upon the warp yarns comprises a lever assembly provided with coaxial rollers which rest upon a fixed horizontal guide and whose point of contact with the guide defines a fulcrum axis for the lever assembly, a compensating lever arranged to rock about an axis parallel to the fulcrum axis of the lever assembly and spaced from the latter a distance exceeding the radius of the whip roll, said lever assembly having a rigid, elongate, normally, substantially horizontal arm, pivot means connecting said rigid, elongate arm to the free end of the compensating lever, the latter comprising a rigid downwardly directed extension to which the tensioning force is applied, the lever assembly which supports the whip roll comprising means for so supporting the whip roll that the axis of the latter is parallel to the fulcrum axis of the assembly and between said fulcrum axis and that part of the lever assembly from which the elongate arm extends.

10. The combination according to claim 5, wherein the

parts are so dimensioned and arranged that, when the whip roll is in normal position, the axis of the whip roll is above the fulcrum axis of the lever assembly, the surface of the fixed guide from which the warp yarns extend to the whip roll is vertically below the end of a horizontal radius of the whip roll, the length of the compensating lever, between its pivot point and its connection to the lever assembly, is one-half the length of the warp yarn extending from the yarn guide to the whip roll, and the pivotal connection between the compensating lever and the lever assembly which supports the whip roll is spaced from the vertical plane of the fulcrum about which the whip roll rocks a distance equal to twice the radius of the whip roll.

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