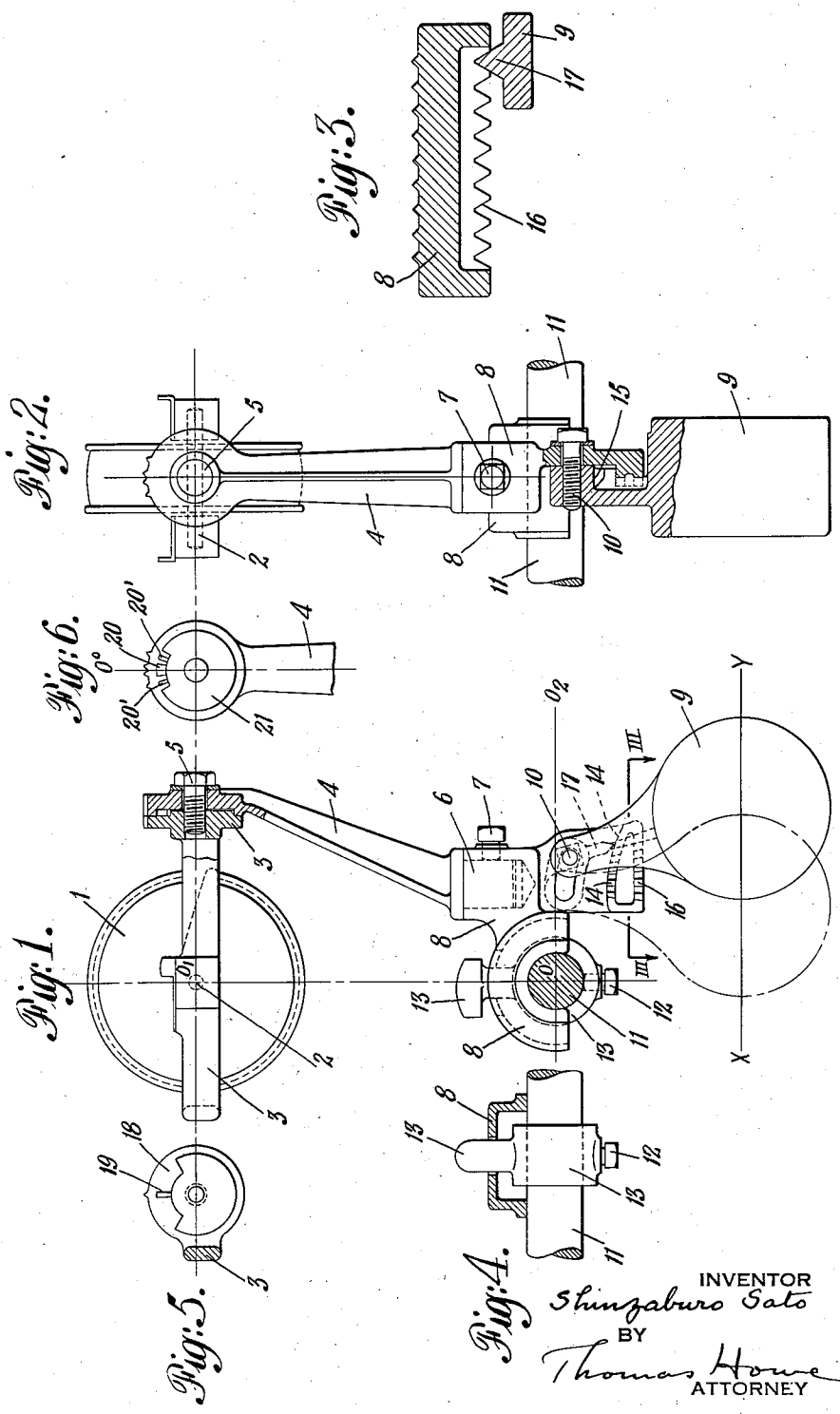
Sept. 29, 1942. S. SATO 2,297,250

TENSION APPARATUS

Filed Nov. 13, 1936 3 Sheets-Sheet 1



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Sept. 29, 1942. S. SATO 2,297,250

TENSION APPARATUS

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Fig: 10.

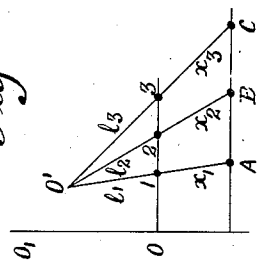


Fig: 11.

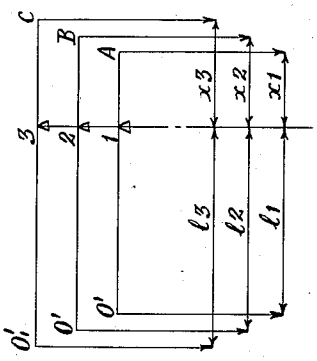


Fig: 8.

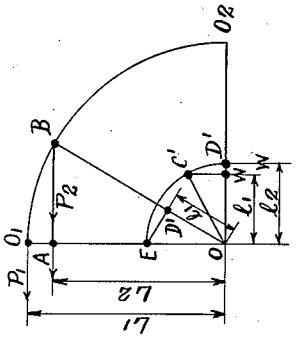


Fig: 9.

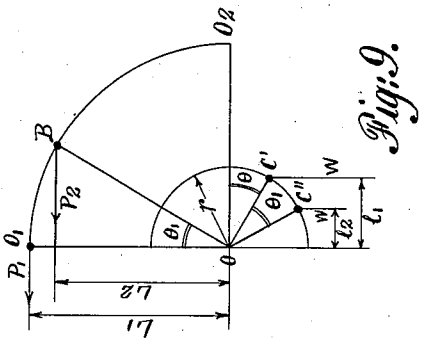
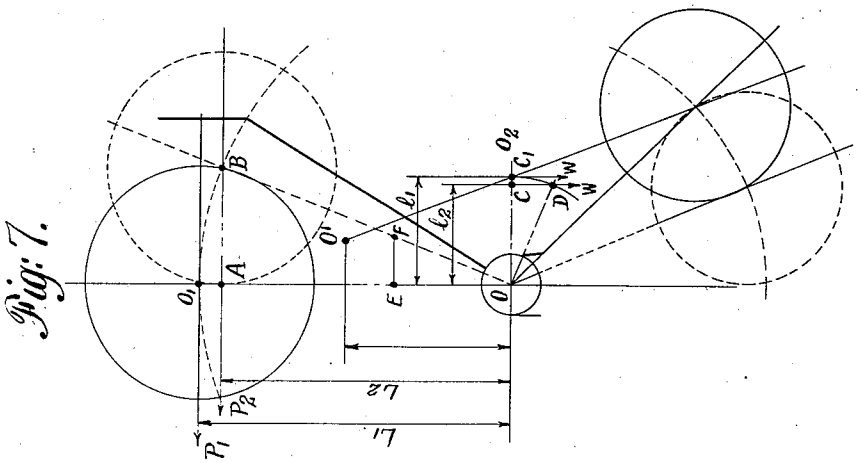


Fig: 7.



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Fig:15.

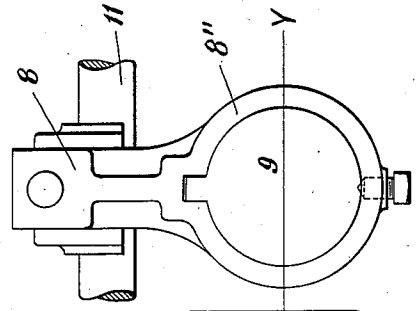


Fig:14.

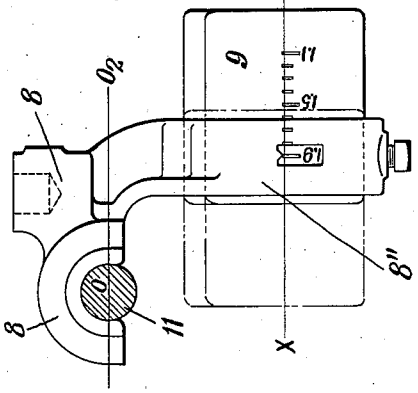


Fig:13.

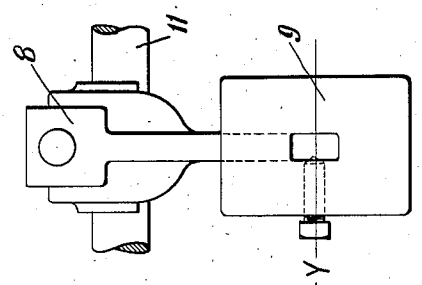
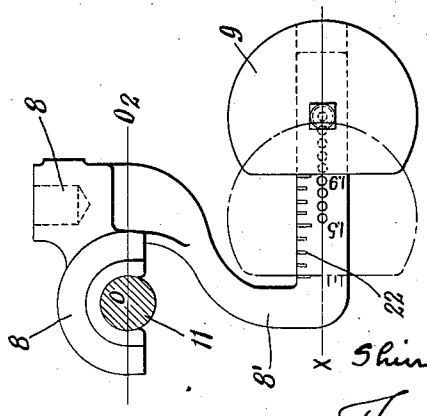


Fig:12.



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Patented Sept. 29, 1942 2,297,250

UNITED STATES PATENT OFFICE

2,297,250

TENSION APPARATUS

Shinzaburo Sato, Kojimachi-ku, Tokyo, Japan; vested in the Alien Property Custodian

Application November 13, 1936, Serial No. 110,583
In Japan March 14, 1936

4 Claims. (Cl. 57—105)

My invention relates to the tension apparatus for the spinning machine or/and yarn twisting machine.

In this kind of machine, the tape for transmitting power between the tin-roller and the spindle wharve, each rotatably mounted in its respective position, will be liable to slip, when an elongation is produced in this tape, with the result that the spindle will not rotate as is desired. Moreover, when the tape is worn and broken and then a lap joint is made on this point of breakage, the tape will be shortened so that the stress in the tape will become excessive, the power required greatly increased, and also the tendency of premature breakage of the tape enhanced. In order to eliminate these disadvantages, it has been proposed to use a tension adjusting apparatus (which we will, hereinafter, refer to simply as a tension apparatus) interposed between the tin-roller and the spindle in such a manner that the tightness of the tape may be adjusted and maintained in a suitable condition. However, the tension apparatus of that kind which has been, heretofore, usually employed for this purpose, and comprises a guide pulley capable of a rocking motion in a circular path described about the center of a pivot, is not satisfactory. It is rather incomplete in that the tension in the tape will become all the more increased when the guide pulley is caused to move away from the tin-roller due to an elongation of the tape, while that tension will be decreased when the guide pulley approaches the tin-roller owing to a shortening of the tape produced in some way. Thus the tension apparatus hitherto used has an apparent disadvantage that the tension in the tape will considerably vary whenever the tape contracts or elongates owing to various causes.

This invention has for its object to provide a tension apparatus in which any desired tension will be produced in the tape by a simple adjustment of the position of unassociated movable weight according to the variations of the weight as well as the rotational speed of the spindle, and moreover a desired constant tension can be maintained even when an extension or contraction may be produced in the power transmitting tape. According to a feature of the invention, the tension apparatus comprises a guide pulley so arranged that the same will move away from the tin-roller when an elongation is produced in the tape, and vice versa; but meanwhile a constant tension will be maintained in the tape. For the purpose of effecting this result, the center of gravity of the apparatus is so positioned that it always lies on a line passing through the center of the main pivot about which the whole apparatus performs the rocking motion and perpendicular to the line connecting said center with that of the guide pulley pivot. It can be proved theoretically that the tension in the tape can be kept constant, even when the position of the guide pulley changes, provided that the center of gravity of the apparatus is so positioned as above explained. And, indeed, this fact constitutes an essential feature of the invention.

According to another feature of the invention, the tension apparatus is provided with a movable weight so arranged that the center of gravity of the same can be shifted along a line parallel to said line that passes through the main pivot, with the result that the center of gravity of the whole apparatus may be shifted along the last mentioned line, whereby the moment of the weight is caused to change so as to produce a desired tension in the tape. The proof for this statement will be given later. It must be understood that although the tension in the tape will be varied by a shifting motion of the movable weight it is not affected by a displacement of the guide pulley.

In order that the invention may be more clearly understood, a preferred example will now be described with the aid of the accompanying drawings in which:

Fig. 1 is a side elevation of the apparatus embodying this invention.

Fig. 2 is an end elevation of the apparatus shown in Fig. 1.

Fig. 3 is a cross sectional view on the line 3-3 of Fig. 1.

Fig. 4 is a view showing a part of the hoop rest and cradle mounted on the main pivot.

Fig. 5 is a view showing a part of the pulley holder mounted on the top of the upright lever.

Fig. 6 is a view showing a part of the upright lever attached to one face of the pulley holder.

Fig. 7 is a diagram showing the principle of construction of this invention.

Fig. 8 is a diagram for finding the tension on the pivot of the pulley when the center of gravity of the whole apparatus is above the line passing through the center O of the main shaft and perpendicular to the line connecting that point with the center of the pulley pivot.

Fig. 9 is a diagram similar to Fig. 8 for finding said tension when the center of gravity of the apparatus is below said perpendicular line.

Fig. 10 is a diagram showing the fact that the locus of the center of gravity of the movable weight will be a straight line parallel to the line OO_2, when said weight is so displaced in order to change the tension acting on the pulley pivot that the tension thus changed may be maintained constant regardless of any movement of the pulley.

Fig. 11 is a diagram similar to Fig. 10, but the weight being at a different position.

Figs. 12 and 13 are a side elevation and an end view respectively of a modification of the means for moving said movable weight.

Figs. 14 and 15 are a side elevation and an end view of another modification of said means.

As shown most clearly in Figs. 1 and 2, the guide pulley 1 is rotatably supported on the shaft 2 fitted in a pulley holder 3 which is secured to the top of an upright lever 4 by means of a screw 5 in such a way that the general longitudinal axis of the holder may be substantially horizontal. The lower end of the lever 4 terminates as a short shaft 6 which is fitted, by means of a set screw 7, into the corresponding hole formed on the upper part of a cradle 8. At the lower part of the cradle 8, there is provided a movable weight 9 secured thereto by means of a set screw 10, said cradle being mounted on a hoop rest 13 at the right hand side of the former as seen in Fig. 1, which hoop rest in turn is secured to a long shaft 11 by means of a screw 12.

It will be easily understood that the pulley of the apparatus is capable of rocking to the right or left about the long shaft 11, as an elongation or contraction is produced in the tape, the arrangement of parts being such that this rocking motion is limited within a certain range. It is to be also noted that the weights of parts are so distributed and adjusted that the center of gravity of the whole assemblage comprising the pulley 1, pulley holder 3, upright lever 4, cradle 8, movable weight 9, and other associated parts may be always on the line OO_2 with the consequence that the tension in the tape can be maintained constant in spite of the rocking motion of the guide pulley. The proof for the truth of this statement will be given later (see Proof Nos. 1 to 3). In order that there may be no slipping or overload produced on the spindle it is necessary to adjust or vary the tension on the pivot 2 of the guide pulley in accordance with the change of weight or/and rotational speed of the spindle necessitated by the change of size of the thread to be spun and also with the variation of the frictional forces produced thereby. For this purpose, the lower part of the cradle is provided with a curved part 14 and a slot 16 formed therein, while the movable weight 9 with a jaw 15, such that the center of gravity of the weight 9 is thereby caused to move along a line XY parallel to the line OO_2 with the result that the center of gravity of the whole apparatus is always positioned on the line OO_2 producing various values of moment LW. The proof for the statement that the locus or the path of the center of gravity of the movable weight is the straight line XY parallel to the line OO_2 when the weight is so shifted that the center of gravity of the whole apparatus may be always on the line OO_2, will be given by the Proof No. 4. On the lower part of the cradle 8, there are formed a number of notches 16 that are adapted to engage with the ribs 17 formed in a face of the weight as shown in Fig. 3, whereby the position of the weight corresponding to a certain value of the tension is fixed. The locking means for these notches and the rib is constituted by the screw 10.

Proof No. 1

Suppose that the center O_1 of the pulley 1 moves along the arc described by itself about the point O and comes to some point such as B corresponding to a rocking motion of the apparatus about its main pivot 11 which is caused by an elongation of the tape and that the tension in said tape is thereby varied from a value P_1 to P_2. As the distance through which the center O_1 moves is small when compared with the length of the tape extending between the guide pulley 1 and the spindle wharve, being no longer than two inches, it can be assumed that the tensions P_1 and P_2 are parallel to each other and are perpendicular to the line OO_1. It then follows that the center of gravity of the whole apparatus must be on the line OO_2 that passes through the pivot center O and is perpendicular to the line OO_1, when it is desired to make P_1 equal to P_2, i. e., to maintain the tension constant. This can be proven as follows. Referring to Fig. 7, imagine that the point O_1 displaces to the point B, while the center of gravity C_1 of the apparatus moves to the point D on the line OD which is perpendicular to the line OB. Then we will obtain the following relations, when we consider the condition of equilibrium of forces about the point O:

$$P_1L_1=Wl_1 \quad (1)$$
$$P_2L_2=Wl_2 \quad (2)$$

in which P_1 and P_2 are the tensions acting at the points O_1 and B respectively, and W the weight of the apparatus.

From Eq. 2 we have

$$W=P_2L_2/l_2 \quad (3)$$

Hence

$$P_1L_1=WL_1=(P_2L_2/l_2)\times l_1 \quad (4)$$

When we turn the triangle OCD counterclockwisely about the point O through an angle of 90°, the line OC will coincide with the line OO_1 and the other, side OD also will coincide with the corresponding side OB of the triangle OAB so that the triangle OCD will become the triangle OEF, because these triangles OCD and OAB are similar. Hence we have the following relations—

$$OA/OB=OE/OF, \text{ that is } L_2/L_1=L_2/l_1$$

or

$$\frac{L_2}{L_1}\Big/\frac{l_2}{l_1}=1$$

or again

$$L_2/L_1\times l_1/l_2=1 \quad (5)$$

Substituting from (5) into (4), we obtain the final relation

$$P_1=P_2\times l$$

that is,

$$P_1=P_2$$

The equality of P_1 and P_2 is based on the assumption that $L_1=L_2$; for the difference will be very slight, say of the order of a fraction of an inch. As this relation holds good no matter what is the size of the angle LO_1 OB, it follows that P_1 is equal to P_2 provided that W, L_1, and l_1 are kept constant, and also that the line OA is always perpendicular to the line OC.

Proof No. 2

The relation $P_1=P_2$ does not hold when the center of gravity C' is above the line OO_2 which is perpendicular to the line OO_1. This can be proven as follows. Referring to Fig. 8, we have

$$P_1L_1=Wl_1 \quad (1)$$
$$P_2L_2=Wl_1 \quad (2)$$

Dividing (1) by (2), we get

$$\frac{P_1L_1}{L_2L_2}=\frac{l_1}{l_2}$$

or

$$P_1=P_2\times\frac{L_2}{L_1}\times\frac{l_1}{l_2} \quad (3)$$

But, as $L_2<L_1$ and also $l_1<l_2$, it follows that

$$L_2/L_1\times\frac{l_1}{l_2}<l$$

Hence we have

$$P_1=P_2 \text{ (a number less than unity)}$$

i. e., P_1 is not equal to P_2.

Proof No. 3

Referring to Fig. 9 which represents the case in which the center of gravity C' is below the line OO_2, we have

$$P_1L_1=Wl_1 \quad (1)$$
$$P_2L_2=Wl_2 \quad (2)$$

Dividing (1) by (2), we obtain

$$P_1L_1/P_2L_2=\frac{l_1}{l_2}$$

or

$$P_1=P_2\times L_2/L_1\times l_1/l_2 \quad (3)$$

It can be shown that the factor $L_2/L_1\times l_1/l_2$ of this expression is greater than unity, or $L_2L_1>l_1/l_1$, and hence that $P_2>P_1$. For this purpose, we may utilize the following relations—

$$L_2/L_1=\cos\theta\ l \quad (3')$$
$$l_1/r=\cos\theta \quad (4)$$
$$l_2/r=\cos(\theta+\theta_1) \quad (5)$$

Dividing (5) by (4), we obtain

$$\frac{l_2}{r}\Big/\frac{l_1}{r}=\frac{\cos(\theta+\theta_1)}{\cos\theta}=\frac{l_2}{l_1} \quad (6)$$

From Equations 3' and 6, it can be shown that $\cos\theta_1>\cos(\theta+\theta_1)/\cos\theta$ and hence that $L_2/L_1>l_2/l_1$. Rewriting the former inequality, we get

$$\cos\theta\times\cos\theta_1>\cos(\theta+\theta_1)$$

where

$$\cos(\theta+\theta_1)=\cos\theta\cos\theta_1-\sin\theta\sin\theta_1$$

Since the value of $\sin\theta$ varies from θ to 1 when θ varies from 0° to 90°, the corresponding value of $\sin\theta\times\sin\theta_1$ is a positive number. Hence it follows that

$$\cos(\theta+\theta_1)<\cos\theta\times\cos\theta_1$$

This gives the relation $L_2/L_1\times l_1/l_2>1$, as will be easily known from (3') and (6). Therefore, we obtain the final relation

$$P_1=P_2\times(\text{a number greater than unity})$$

or

$$P_2=\frac{P_1}{(\text{a number greater than unity})}$$

Proof No. 4

Suppose each of the points 1, 2, 3, etc., Fig. 10, to represent a position of the center of gravity of the apparatus corresponding to an adjustment of the tension in the tape, and the point O' (Fig. 7) to represent the center of gravity of the apparatus with the weight removed. Let us suppose further that the weight must be placed on such points as A, B, C, etc. Then we have as is shown in Fig. 11,

$$wl_3=Wx_3$$
$$wl_3=Wx_2$$

and

$$wl_3=Wx_1$$

in which

$$l_1=O'l,\ l_2=O'2,\ l_3=O'3$$
$$x_1=lA,\ x_2=2B,\ x_3=3C$$

and w=weight of the apparatus with the movable weight removed, while W=weight of the movable weight. Hence we have

$$l_3/x_3=W/w,\ l_2/x_2=W/w,\ l_1/x_1=W/w$$

or

$$l_1/x_1=l_2/x_2=l_3/x_3$$

In order that this relation may hold in Fig. 10, the line containing the points 1, 2, 3, etc. must be parallel with the line containing the points A, B, C, etc.

Recurring now to the construction of the apparatus, it will be noted that the upright lever 4 is mounted on the upper part of the cradle 8 in such a manner that the former can be rotated about its general vertical axis to facilitate the adjustment of inclination of the guide pulley in conformity with the direction of running of the transmission tape. The pulley holder 3 is also so arranged that the same can be rotated about a horizontal axis by means of a rack mechanism to be presently explained. On one end 18 of the pulley holder, there is formed (see Fig. 5) a rib 19 that is capable of engagement with the teeth 20, 20' of the co-operating rack formed on one face 21 of the top of the upright lever 4, said teeth being arranged on each side of zero index, each keeping an angular distance corresponding to an angle of 5 to 20 degrees as shown in Fig. 6.

The suitable angle through which the pulley holder should be turned about its horizontal axis may be taken as about 20° for the case of a tape of eight passages. That is, for this case, the rib 19 formed on the end 18 of the holder is caused to engage with a tooth 20' formed on the upper face of the lever, whereby the holder is rotated through an angle of 20° relatively to the lever. In the same way the holder will be turned through an angle of 5 degrees for a tape of 4 passages.

Thereafter, the set screw 7 at the joint of the upright lever with the cradle is now loosened so that the lever case be turned about the vertical axis of its pivot 6 in order to obtain a desired angle of displacement of the pulley relatively to the vertical plane O_1, OO_2 and conforming to the direction of passage of the tape.

In a modification shown in Figs. 12 and 13, the cradle 8 is provided with a leg 8' extending parallel to the line that passes through the center of the long shaft 11 and is perpendicular to the line OO_1, the movable weight 9 being slidably mounted on said leg so that the same can be shifted along a line perpendicular to the line OO_1, but parallel to the line OO_2 which passes through the center of the long shaft 11. The amount of shifting of the weight 9 can be read from the indices 20 formed on the leg 8'.

In another modification shown in Figs. 14 and 15, the cradle 8 is provided with a leg 8'' having the shape of a ring that embraces the weight

9 which can be shifted in this leg so that its direction of movement is parallel to the line OO_2 which passes through the center of the shaft 11.

Having thus described my invention what I claim is:

1. A tension apparatus for the purpose set forth, characterized by having a guide pulley adapted to tension a lengthwise moving tape, a pulley holder for said pulley and in which said pulley is rotatable around a transverse axis, an arm upon one end of which said pulley holder is mounted, said arm being rotatable around an upright axis, a cradle carrying the arm, pulley holder and pulley, and rotatable upon a suitable bearing, the axis of which defines the main pivot of the apparatus, and a weight adapted to act upon said apparatus to apply tension to said tape, said tension apparatus being further characterized by such disposition of its aforesaid elements that the center of gravity of the apparatus is positioned on the line passing through the center of the main pivot of the apparatus and perpendicular to another line connecting said center with the pivot center of the guide pulley with the result that the tension in the tape is thereby maintained constant regardless of the elongation or contraction produced in the tape.

2. A tension apparatus having the features claimed in claim 1, and further characterized by the fact that the path or locus of the center of gravity of the movable weight lies in a straight line parallel to another straight line that passes through the center of the main pivot of the apparatus and is perpendicular to still another straight line connecting said center with the pivot center of the guide pulley, whereby desired variations in the tension of the tape can be effected with accuracy by the adjustment of said weight, regardless of variations in the linear dimension of the tape.

3. In a spinning frame, the combination of a plurality of spindles mounted therein, a driving cylinder, a tape driven by said cylinder and driving one or more of said spindles, a take-up roll over which said tape runs, a pivoted arm supporting said roll for swinging movement in a path spaced vertically from the horizontal plane through the pivotal axis of said arm, a second arm mounted to swing about said axis, a weight mounted on said second arm, said weight being located at the opposite side of said plane from said roll, the weight being adjustable on its arm, and means for securing said weight in different positions of adjustment longitudinally of its arm, the effective moments of said roll plus its arm and that of said weight and its arm being so related that they act through the roll to maintain a substantially uniform tension on said tape in various working positions of said roll.

4. A tension apparatus for the purpose set forth, characterized by having a guide pulley adapted to tension a lengthwise moving tape, a pulley holder for said pulley and in which said pulley is rotatable around a transverse axis, an arm upon one end of which said pulley holder is mounted, said arm being rotatable around an upright axis, a cradle carrying the arm, pulley holder and pulley, and rotatable upon a suitable bearing, the axis of which defines the main pivot of the apparatus, and a weight adapted to act upon said apparatus to apply tension to said tape, said tension apparatus being further characterized by such disposition of its aforesaid elements that the center of gravity of the apparatus is positioned on the line passing through the center of the main pivot of the apparatus and perpendicular to another line connecting said center with the pivot center of the guide pulley, with the result that the tension in the tape is thereby maintained constant regardless of the elongation or contraction produced in the tape, said pulley holder having a rib formed on its end face and adapted to engage adjustably with co-operating teeth formed on the upper part of the upright lever so that the position of said pulley can be conformed to the direction of passage of the tape.

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