Nov. 11, 1947. R. P. JACQUES 2,430,639

MEANS FOR CONTROLLING THE TENSION ON THE WARP IN LOOMS

Filed Oct. 12, 1944 2 Sheets-Sheet 1

Fig. 1.

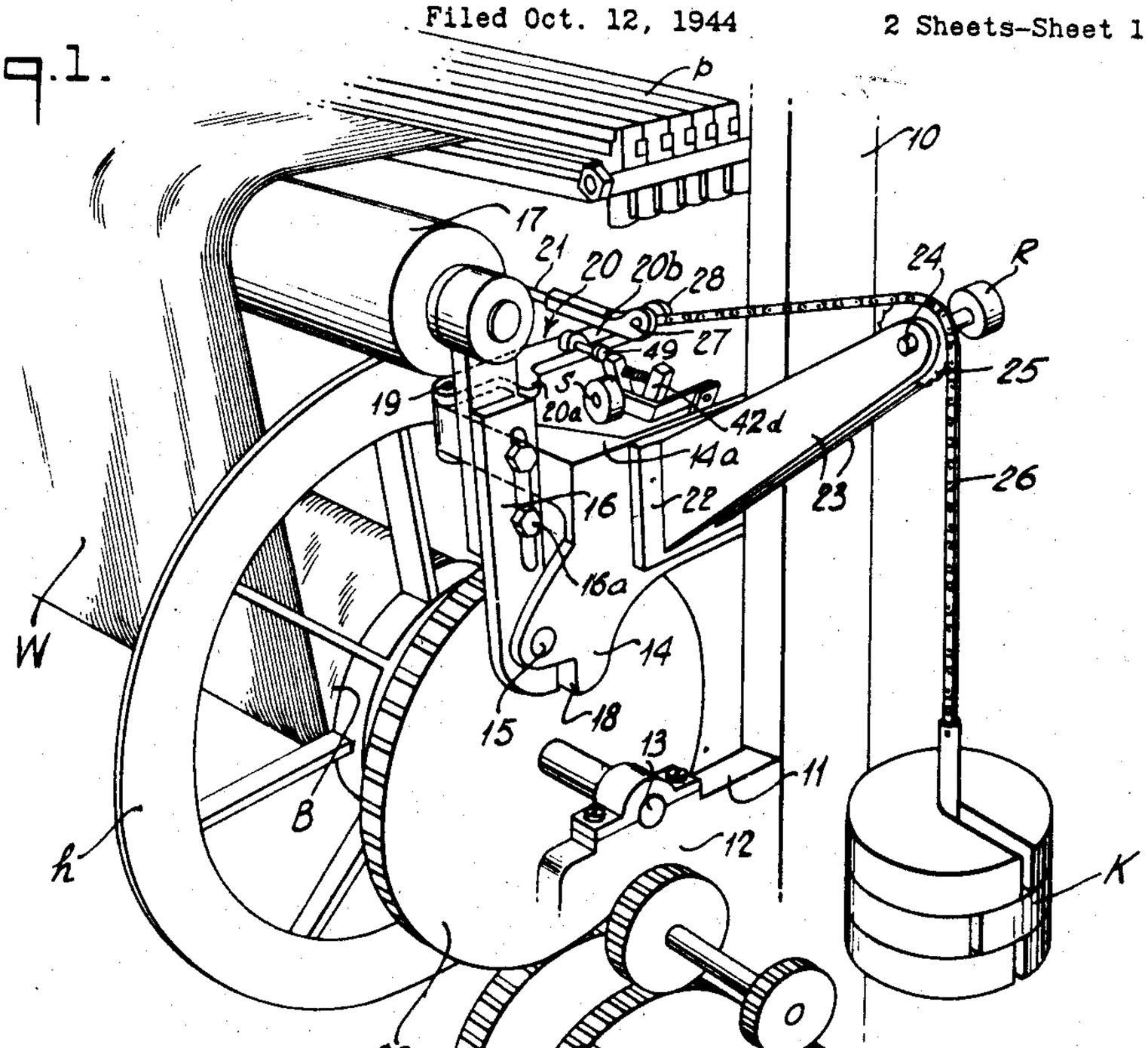


Fig. 2.

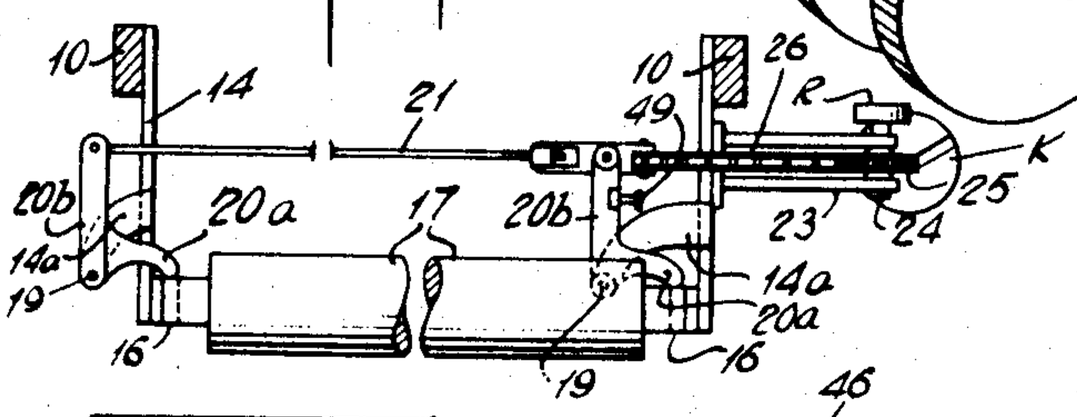
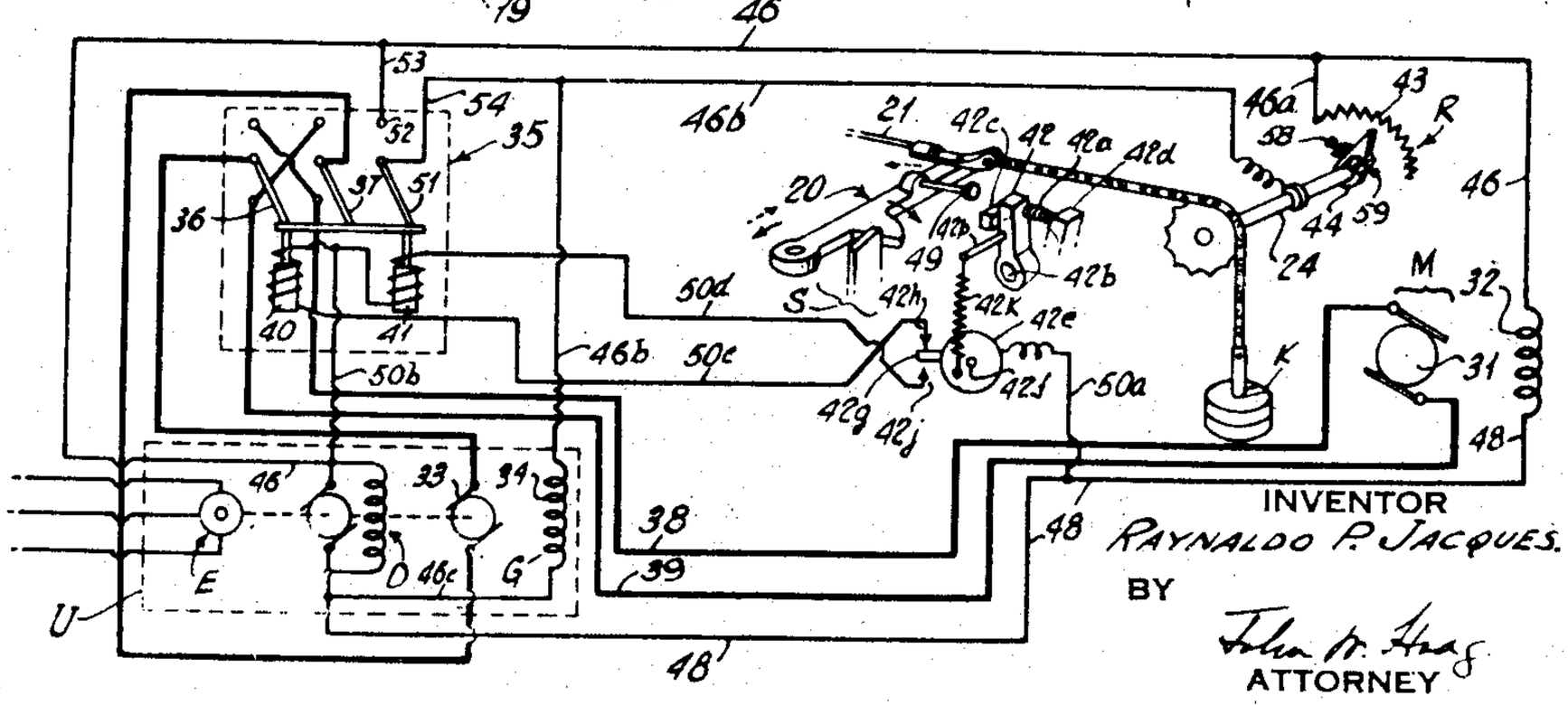


Fig. 3.



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Filed Oct. 12, 1944 2 Sheets-Sheet 2

Fig. 4.

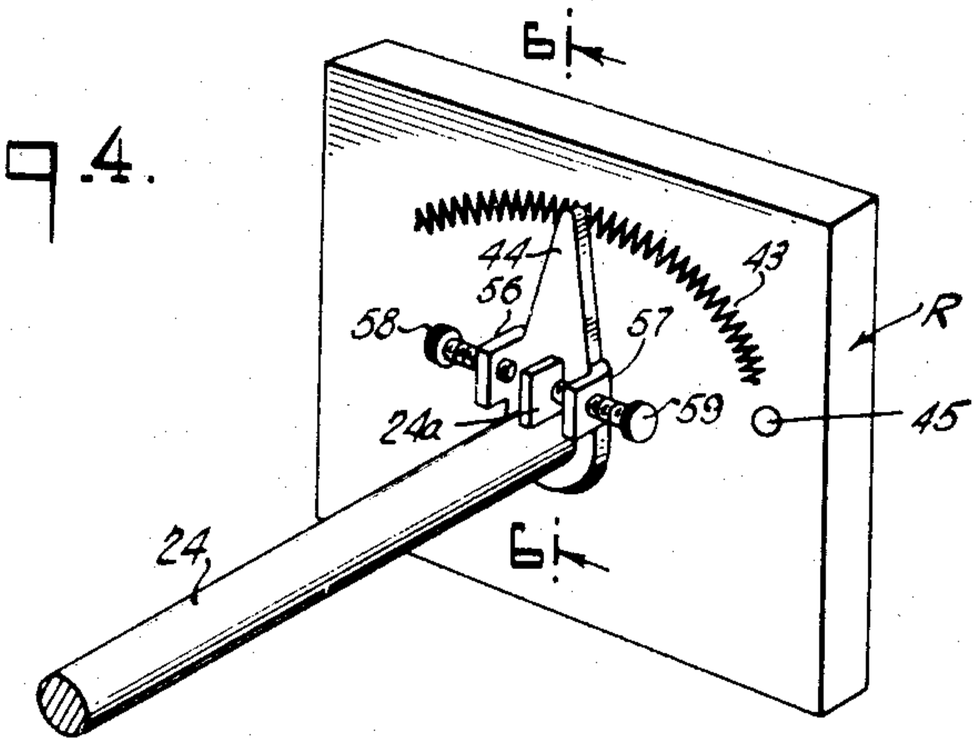


Fig. 5.

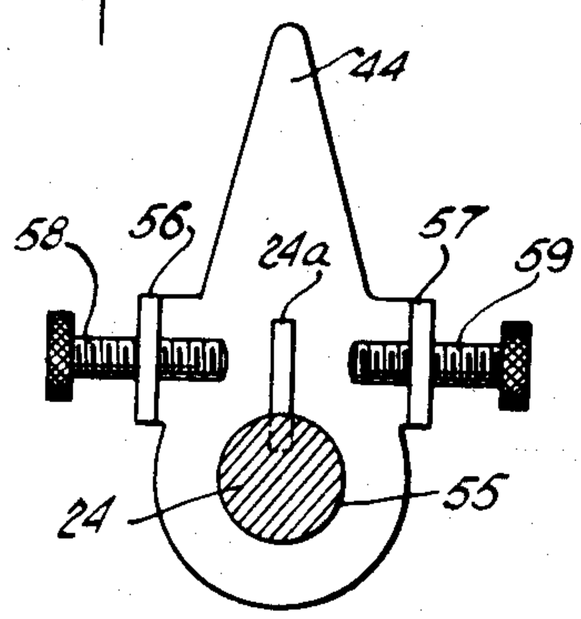
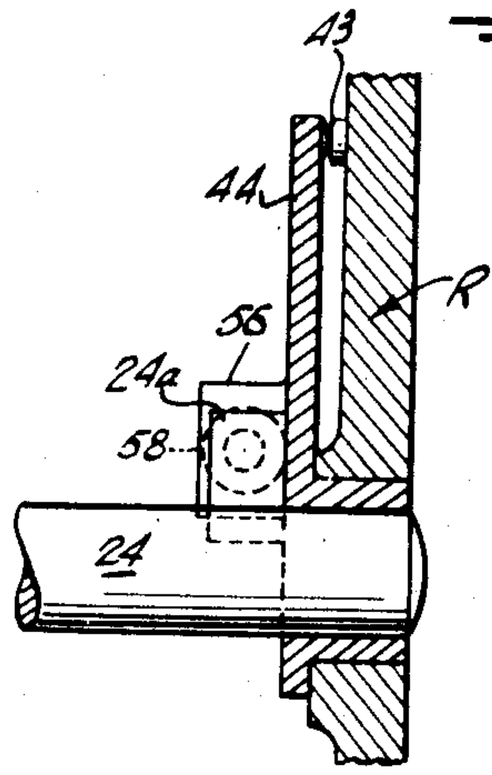


Fig. 6.



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MEANS FOR CONTROLLING THE TENSION ON THE WARP IN LOOMS

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Application October 12, 1944, Serial No. 558,313

9 Claims. (Cl. 139—110)

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This invention pertains to the art of warp let-offs, for example for looms or for loading the warp beam of a loom or other textile machine, and it comprises a warp let-off mechanism which operates to maintain a warp tension, which is constant within a range defining the optimum tension for all conditions of loom operation.

The invention embodies mechanism for positively driving a warp beam either forward or in reverse to let off or take up warp, as may be required to maintain a substantially constant warp tension, and to let off the warp at a varying speed to compensate for variable factors affecting the warp tension, such for example as the varying diameter of the warp mass on the beam, or variations in take-up requirements, due, for example, to the type of goods being woven, and variations in the speed of the loom, and it comprises means for renewing and maintaining a constant tension of the warp threads for all conditions of operation.

Prior art warp let-offs are defective and unsatisfactory, in that they cause or permit a wide variation in warp tension, often resulting in breaking of threads, and lessening the quality of cloth made from the warp, and because they are ineffective to rewind warp to increase warp tension, or to take up slack, caused, for example, by moving the warp backwards in a loom to remove broken picks. Such slack is taken up, according to long established practice, by a manual operation, which depends upon the skill or "hunch" of the operator for its effectiveness in restoring the desired tension.

An object of the invention is to provide simple, practical and effective means for controlling the aggregate tension of warp threads, as for example in a loom.

Another object of the invention is to provide means for positively driving a warp beam both forwardly and in reverse to control the tension on the warp.

Another object of the invention is to provide means for controlling a warp beam driving means to maintain the tension on the warp constant at all times including occasions when one or more picks become broken.

Another object of the invention is to provide means adapted to compensate for differences in warp tension resulting from change of angle of the warp threads between the warp beam and means responsive to the tension of the warp threads, such for example as a whip roll, as the warp beam becomes unloaded.

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Another object of the invention is to provide means for automatically driving the warp beam in reverse to take up slack in the warp, beyond the amount which can be taken up by the whip roll in moving to its rearmost position.

Another object of the invention is to provide means for controlling and tending to maintain the tension on the warp in a loom without the necessity of changing weights or applying brakes.

Another object of the invention is to avoid the intermittent increased strain on the warp threads, which occurs in the prior art practice wherein the let-off of the warp threads is controlled by brake means acting in opposition to the pull of the warp, and the brake is released at intervals when the braking force is overcome by the pull of the warp.

Another object of the invention is to provide automatic means, coacting with tension responsive means, such for example as a whip roll, serving to position the tension responsive means, at all times, including even when one or more filling threads break when the tension responsive means is in its rearmost position, so that the tension responsive means is operative to maintain the desired tension on the warp.

Other objects of the invention will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the feaures of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

The invention will best be understood if the following description is read in connection with the drawings, which illustrate a practical embodiment of the invention, and in which,

Figure 1 is a perspective view of a practical embodiment of the invention as it is applied to a loom;

Figure 2 is a diagrammatic plan view, on a reduced scale;

Figure 3 is a schematic view of control means illustrated as embodied in an electrical control circuit;

Figure 4 is a perspective view showing loss motion control means for the speed regulating means illustrated in Figure 3;

Figure 5 is a detail view of the loss motion connection shown in Figure 4; and

Figure 6 is a side view partly in cross section of the loss motion connection shown in Figure 5.

Referring to Figure 1, the upright frame members 10 of the loom support the let-off mechanism. Attached to the frame members 10 are rearwardly projecting brackets 11, for removably supporting the warp beam B rotatably. The brackets 11 are provided with bearings or seats 12, which receive trunnions 13 of the warp beam B. The beam comprises the drum which carries the warp W, and the heads *h*, there being a head on each end of the drum. Extending rearwardly from the frame members 10 are brackets 14, located above the brackets 11, for suitably supporting the whip roll 17 for movement toward and away from the lay of the loom. Thus, the whip roll 17 is rotatably supported in the upper ends of laterally spaced arms 16 pivotally supported at their lower ends, as by stud shafts 15, carried by the brackets 14. Whip roll 17 may thus move toward or away from the lay of the loom along an arc whose center is the axis of studs 15. Over the whip roll 17 are led the warp threads W, from warp beam B, through the loom head *p* to the loom take-up roll (not shown). The whip roll arms 16 are preferably each provided with the lengthwise adjustments 16ª for properly mounting the whip roll in relation to the axis of studs 15 and to the lay of the loom. Preferably there is a stop 18 on each bracket 14, to limit the swing of whip roll 17, rearwardly (to the left in Figure 1), the stops 18 lying in the path of whip roll arms 16 respectively.

Each bracket 14 has a horizontally extending portion 14ª and on each bracket 14ª, adjacent to a whip roll arm 16, a pivot 19 is provided, on which a crank 20 is pivotally mounted. Each crank 20 has a short arm 20ª which extends in front of and engages a whip roll arm 16, and a long arm 20ᵇ which extends forwardly, said long arms 20ᵇ being parallel and joined for movement together by the tie rod 21 extending across the loom and in front of the whip roll 17.

In the known structure so far described a weighted arm has been attached directly to one end of tie rod 21, to affect the position of the whip roll by acting thereon through the crank arms 20ª which press against whip roll arms 16, respectively, and brake means have been employed acting to oppose the pull of the warp and to resist the letting-off of the warp threads until the tension of the warp has been built up sufficiently to overcome the force of the weight and momentarily to release the brake means, permitting the warp beam to rotate forwardly, and thereby letting-off the warp threads and thus reducing the tension of the warp. The aforesaid braking is undesirable in a number of respects; for example, it creates an intermittent letting-off action with intervening periods during which tension is built up on the warp, thereby tending to cause breakage of one or more of the warp threads. This arrangement also is unsatisfactory because it limits the speed at which the loom may be run, and it is altogether ineffective if breakage of one or more filling threads occurs when the whip roll is in substantially its rearmost position and is thus unable to swing rearwardly to compensate for lessening in the tension of the warp threads resulting from said breakage and from the backing up of the loom to replace the broken filling threads.

Among the dominant aims of this invention is to provide a practical and efficient means for overcoming such deficiencies of prior structures as those above-mentioned.

Mounted on the right-hand bracket 14 is a bracket 22 having spaced upwardly and outwardly angularly disposed arms 23, and between said arms 23, adjacent their upper free ends, is rotatably mounted a sprocket 25, as by a spindle 24 rotatably supported in bearings in the arms 23. Over the sprocket 25 rides a chain 26. The inner end of chain 26 is attached to one end of tie rod 21, as by attachment to the cross pin 27 of the clevis 28 provided at the right-hand end of the tie rod and extending outwardly beyond the pivotal connection between the tie rod and the long arm 20ᵇ of the related crank 20. The chain 26 has at its free end a weight K which serves to insure drive by the chain 26 of sprocket 25 while exerting a pull on the tie rod 21 tending to swing or move the whip roll rearwardly (to the left in Figure 1) to tension the warp W. The weight K is initially selected or adjusted to establish a warp tension predetermined or known as substantially the optimum.

The beam B is driven preferably by an electric motor M, through the worm *w*, and the reduction gearing 30 which drives the bull gear 30ª, connected with the beam B. The beam drive, being through worm *w*, may thus be self-locking or irreversible to prevent the beam B, by its momentum, from overriding the drive of the motor M.

The motor M is of the variable speed type, to drive the warp beam at various speeds as desired to let off the warp, and it is also reversible to drive the beam to take up warp. As illustrated in Figure 3 motor M comprises an armature 31 and a field winding 32 and suitable provision is made to effect control of its speed of drive and also its direction of drive of the warp beam. Preferably and illustratively, its field 32 is separately excited, being supplied with energy from any suitable source of direct current, such as a generator of preferably fixed voltage, indicated at D, to which it is connected by conductors 46 and 48. The armature 31 is connected by conductors 38 and 39 to the armature 33 of a generator G through a reversing switch generally indicated by the reference character 35, and which has two switch blades 36 and 37, the contacts of which are appropriately connected, as shown, to effect reversal of current flow to the motor armature 31.

The switch 35 is preferably electromagnetically controlled, and illustratively and preferably may be of the kind which is actuated and held in one position upon energization of a winding 40 and is actuated into its other position upon energization of a winding 41, the windings conveniently being solenoids and operating upon suitable cores. Accordingly, when winding 40 is energized and winding 41 is de-energized, switch blades 36 and 37 are in a position to connect the armature 31 to drive the motor M in one direction, but when winding 41 is energized and winding 40 is de-energized, switch blades 36 and 37 reverse the connections to the armature 31, and motor M is connected to be driven in reversed direction.

Adjacent the spindle 24 is suitably supported a rheostat R arranged to be actuated in response to rotary movement of the spindle and hence according to the position of the whip-roll. The rheostat is arranged to vary the speed of motor M. For this purpose, I prefer to have the rheostat R vary the output of generator G and hence the field winding 34 of generator G is connected to the direct-current source D to be energized unidirectionally therefrom through the rheostat R

by which the generator field excitation may be varied so as in turn to vary the voltage or energy output of the generator G supplied to motor armature 31, and thus, since the source D fixes the excitation of motor field 32, to vary the speed of drive of the warp beam by the motor M; preferably the circuit arrangement employed is such that the rheostat may be cut out.

The rheostat R comprises a suitable variable resistance 43 and a suitable means, diagrammatically indicated as an arm 44, driven from the spindle 24, so as to vary the amount of resistance included in the generator field circuit; thereby the excitation of generator field 34 may be varied to correspondingly vary the generator output and the speed of the motor M and the warp beam.

The circuit of the field winding 34 of the generator G, when the rheostat R is included in it, extends from one side of the source D, conductor 46, conductor 46^a, resistance 43, arm 44, conductor 46^b, generator field winding 34, and then by conductor 46^c to the other side of the source D.

With switch 35 in Figure 3 in its downward position, it is positioned to arrange the circuits for driving the motor M in forward direction for warp let-off. The speed of the armature 31 and hence the drive of warp beam in let-off direction is variable by the rheostat 43—44 and its magnitude is determined by the position of the arm 44 relative to the resistance 43. The position of the rheostat arm 44 and hence the speed of drive of the warp beam in let-off direction is determined, during normal operation of the loom, by the position of the whip roll 17 within a certain range of movement of the whip roll 17 toward or away from the lay of the loom, that motion being, due to the above-described mounting of the whip roll 17 by the arms 16 in a direction generally lengthwise of the loom, and that movement of the whip roll 17 being translated into rotary movement of the spindle 24 and rheostat arm 44 by the above-described mechanism which includes the chain 26, sprocket 25, and the two cranks 20. As is later described, the speed of drive of the warp beam in let-off direction is thus varied so as to maintain substantially constant tension of the warp threads W and also to compensate for diminishing diameter of the warp mass on the beam B.

Provision, however, is made to cause the position of the whip roll also to control the direction of drive of the motor M and preferably one of the cranks 20 is arranged to control the switch 35 preferably in coacting relation with its control of the rheostat R and for this purpose I arrange the energization of the switch windings 40 and 41 to be controlled by the right-hand crank 20, preferably through a snap-switch mechanism generally indicated by the reference character S adapted to be actuated by a stud-like actuator 49 carried by the crank 20 and preferably adjustable as by providing the shank of the actuator 49 with threads whereby it is threaded into a suitable boss on the crank 20 and whereby the extent of its projection laterally from the crank 20 may be set at will.

The snap switch structure S is provided with an operating member 42 positioned in the path of lateral outward movement of the actuator 49 and preferably spring-biased as by spring 42^a in a direction toward the actuator 49 and suitably mounted for movement, as upon a pivoting stud 42^b, between two fixed stops 42^c and 42^d, spring 42^a biasing the member 42 toward the left and normally holding it against the stop 42^c.

Switch operating member 42 is provided with

any suitable mechanism to maintain the circuit of switch winding 40 closed so as to hold the switch 35 in position to effect drive of motor M in forward or let-off direction, so long as the actuator 49 does not materially move the switch member 42 in clockwise direction, and to maintain the circuit of switch winding 41 closed, so as to position the switch 35 to arrange the motor circuit for drive in reverse or warp take-up direction for such time as the actuator 49 holds the switch operating member 42 toward the right and against the action of spring 42^a. A so-called "toggle" type of operating mechanism may be employed for this purpose and is diagrammatically indicated in Figure 3 as comprising part of the switch mechanism S.

Thus a contact disc 42^e, pivotally mounted for rotary movement on an axis 42^f, carries a contactor 42^g movable between fixed contacts 42^h and 42^j which can function as stops to limit the rotary movement of the contact disc 42^e in either direction. Below the center or axis 42^f is secured one end of a spring 42^k the other end of which is secured to a stud 42^p carried by the switch operating member 42, the line of pull of the spring 42^k and the positions of the axes 42^f and 42^b being so inter-related that, so long as the operating lever member 42 is in a position to the left of its midpoint of its range of swing between the stops 42^c and 42^d, the pull of the spring 42^k is to the left of the axis 42^f and contactor 42^g is held in engagement with fixed contact 42^h, thus maintaining the circuit of winding 40 closed, while, if the lever member 42 is positioned, by the actuator 49 anywhere within the right-hand half of the range of swing of member 42, the pull of the spring 42^k is to the right of the contactor axis 42^f and contactor 42^g is held in engagement with fixed contact 42^j and the circuit of switch winding 41 maintained closed for reverse or take-up drive of the warp beam.

Energy for the switch windings 40 and 41 may be derived from the source D. Thus for example a conductor 50^a connects the switch contactor disc 42^e to conductor 48 and thus to one side of the source D while one terminal of each of the windings 40 and 41 is connected by conductor 50^b to the other side of the source D, the remaining terminals of the windings 40 and 41 being connected to fixed contacts 42^h and 42^j by conductors 50^c and 50^d respectively. Thus the switch 35 is positively held in one position or the other by maintenance of energization of the corresponding switch controlling winding.

Accordingly, so long as conditions of tension of the warp W are such as to position the actuator 49 of crank 20 out of contact with the switch operating member 42 or in contact with the latter only throughout substantially the left-hand half of range of movement, the winding 40 is energized, switch 35 is in its downward position, and motor M drives the warp beam in forward or let-off direction at a speed, as above-noted, determined by the rotary position of the spindle 24 and the rheostat arm 44. During this condition of operation substantial constancy of warp tension is maintained, in spite of change in diameter of the warp mass on the beam B, in that rearward movement of the whip roll 17 (to the left in Figure 1), and this movement would result from decrease in tension, effects clockwise rotary movement of spindle 24 and rheostat arm 44, thus to decrease the speed of drive of the beam B: in the illustrative electrical circuit arrangement, such actuation of the rheostat increases

the amount of resistance 43 included in the circuit of field 34 of the generator G, thus to lessen the amount of energy supplied by generator G to the motor M and thus decreasing the speed of drive of the latter. Should the warp roll 17 move inwardly or to the right in Figure 1, and this it would do upon increase in tension of the warp W, the spindle 24 and rheostat arm 44 move in counterclockwise direction, decreasing the amount of resistance 43 in the circuit of generator field 34, thus increasing the output of the generator G of energy supplied to the motor armature 31 and thus increasing the rate of let-off of warp from the beam B. In this manner, the speed of drive of the warp beam in let-off direction is controlled or varied in response to movement or change in position of the whip roll 17 caused by changes in tension of the warp W, and as the diameter of the warp mass on the beam B diminishes, this regulation for substantial constancy of tension of the warp threads continues but at a continuously increasing or higher standard of speed of drive of the warp beam in let-off direction.

Should conditions arise such as cause the whip roll 17 to move beyond a certain extent in a direction away from the lay of the loom and move the actuator 49 in clockwise direction beyond the above-described range for forward or let-off drive of the warp beam, the switch operating member 42 moves into the right-hand half of its range of movement between the stops 42^c and 42^d, thus snapping the contactor 42^g away from contact 42^h and into engagement with contact 42^j, thus de-energizing winding 40 and energizing winding 41 to thereby actuate the switch 35 into its upward position, and reversing the drive of motor M and thus effecting drive of the warp beam in take-up direction, this condition of drive persisting for a sufficient length of time to shorten the reach of the warp W from the beam B over the whip roll 17 toward the lay of the loom and thereby causing the whip roll 17 to be forcibly moved toward the right in Figure 1 to the desired extent and to bring it back into its normal range of movement for normal loom operation; such movement of the whip roll 17 toward the right or toward the lay of the loom, in Figure 1, causes the crank arm 20 of Figure 3 to be moved in counterclockwise direction, thus to move the actuator 49 in a direction to withdraw it from engagement with the switch operating member 42 which follows up this movement of the actuator 49 under the bias of spring 42^a and to an extent permitted by the stop 42^c. During this counterclockwise movement of operating member 42, contactor 42^e is given a clockwise rotary actuation, thus to engage contact 42^h instead of contact 42^j, thus de-energizing winding 41 and energizing winding 40 to restore the circuit of the motor M for forward or let-off drive under the control of rheostat 43.

During the drive of the motor M in warp take-up direction, it is preferred that the take-up proceed at maximum speed and hence I make provision for cutting out the rheostat R during the take-up drive of the warp beam. Thus I may provide the switch 35 with an additional blade or contactor 51 to coact with a fixed contact 52 which are respectively connected by conductors 54 and 53 to conductors 46^b and 46 whereby, when the switch 35 is actuated into its upper position for warp take-up drive, contactor 51 engages contact 52, thus short-circuiting or shunting out the rheostat 43 from the circuit of generator field

winding 34 so that the full output of the generator G, which may be fixed or manually set in any usual manner, is supplied to the armature 31 of the motor M so that the motor, for take-up drive, may be actuated at a speed not interfered with by the rheostat R. When the switch 35 is actuated for forward or let-off drive, this short-circuit or shunt about the rheostat R is opened by the switch contactor 51, thus restoring control of the speed of drive of the motor again to the rheostat R.

Thus, with switch 35 in downward position, it will be seen that, in response to increase in the tension of the warp, the whip roll 17 moves inwardly (to the right in Figure 1) and tie rod 21 is moved to the left in Figure 2, thus pulling chain 26 upwardly over sprocket 25, and thus rotating spindle 24 and also rheostat arm 44 in counter-clockwise direction, the speed of warp drive motor M is increased to increase the speed of let-off rotation of warp beam B and thereby maintain substantially constant, the tension of the warp; that similarly when tie rod 21 is moved to the right in Figure 2, in response to movement of the whip roll 17 rearwardly due to decrease in warp tension, spindle 24 and rheostat arm 44 are rotated in clockwise direction and the speed of let-off rotation of the warp beam is decreased, to thereby restore and thus maintain the desired warp tension. Motor M is reversed for take-up upon actuation of switch 35 into upward position by the finger or actuator 49, the position of which is controlled by the position of whip roll 17 throughout its range of movement toward or away from the lay of the loom. When finger 49 actuates switch S, as through the snap mechanism 42, just before the whip roll 17 reaches its rearmost position, the switch 35 reverses the motor M to rewind the warm beam B and to take up the warp until the restored tension on the warp causes the whip roll to move inwardly, away from its extreme rear position, thus also swinging cranks 20 inwardly and thus actuating switch S by moving finger 49 out of abutting relation with snap operator 42, thus to actuate switch 35 and restoring the motor drive to let-off direction and to the control of rheostat R.

During loom operation the warp W is constantly subjected to small variations or surges of tension incident to the weaving operation, caused by action of the shedding mechanism, and by the beat up particularly. My device operates to damp out such tension fluctuations so that they do not affect variations in let-off speed. Means for accomplishing this purpose are illustrated in detail in Figures 4, 5 and 6. The rheostat arm 44 is preferably actuated by the spindle 24 through a lost-motion connection; thus it is loosely mounted on spindle 24, the bore 55 of arm 44 being for this purpose of sufficiently greater diameter than spindle 24. Laterally spaced on arm 44, relative to bore 55, are lugs 56 and 57, through which are threaded toward each other adjustable screws 58 and 59 respectively, and spindle 24 is provided with an upwardly extending pin or lug 24^a projecting into the space between the inner ends of screws 58 and 59. Screws 58 and 59 may be adjusted so that the space between their ends and the spindle lug 24^a may be set so that minor fluctuations in the warp tension (lying within the range of optimum tension for a specific operation) are not transmitted from spindle 24 to arm 44, due to the reversible play between these parts, thus avoid-

ing hunting action and also preserving the life of the speed regulating means.

The operation of the apparatus will be clear from the foregoing but certain other features of action and control may be mentioned. Assuming that the loom is in normal operation, the whip roll 17 is in a position within a range of movement toward or away from the lay of the loom such that the actuator 49 is in turn in a position which, in Figures 1 and 3, is to the left of the snap-over position of the operating member 42 of the switch S, switch 35 being therefore in downward position and motor M driving the beam B in let-off direction at progressively higher standards of angular velocity or R. P. M. as the diameter of the warp mass on the beam decreases, but at any such standard of speed, the drive of the motor is varied in such upward or downward increments, determined by movement of the whip roll 17 in response to movements respectively to the left or right as viewed in Figure 1 and which movements are in turn responsive to changes or variations in the tension of the warp threads W. At any particular standard of speed for a correspondingly particular diameter of warp mass on the warp beam B, increase in tension on the warp threads W effects movement of the whip roll 17 inwardly or to the right in Figure 1, thus decreasing the resistance 43 in the generator field circuit 34 to an extent sufficient to speed up the drive of motor M, thus to restore the tension to the desired value; decrease in tension of the warp threads W has the reverse affect in that the whip roll 17 moves rearwardly or to the left in Figure 1, thus actuating the rheostat R to slow down the motor M and hence slow down the drive of the warp beam in let-off direction and again restore the tension to its desired value. Such lost-motion connection between the spindle 24 (Figures 4–6) and the rheostat arm 44 relieves the regulating apparatus from having to respond to small variations or surges in tension above-mentioned and thus makes for smoother operation and negative tendencies to hunt. It will therefore be seen that the speed of motor M is regulated to rotate the beam B to give a substantially constant rate of linear warp let-off and in coaction with the whip roll 17 to maintain substantially constant tension on the warp threads W.

Under certain conditions warp may be let-off faster than it is taken up, as for example due to possible over-speeding of motor M. Or for example it may be desirable to back up the loom to remove broken picks. In either case tension of the warp is decreased and the pull of weight K causes whip roll 17 to move rearwardly (to the left in Figure 1) to take up this slack. This movement in turn causes rheostat arm 44 to move clockwise, putting more resistance in generator field circuit 34, thus slowing down motor M. If this movement of roll 17 continues far enough or for any reason continues sufficiently, actuator 49 operates switch S to actuate switch 35 to energize the armature of motor M with opposite polarity of energy, and causing motor M to drive beam B in reverse direction, thus causing it to take up the warp instead of letting it off. This reversal of the direction of rotation of beam B takes place before the whip roll swing limiting stop 18 is reached, and well within the optimum warp tension range.

The reverse drive of the warp beam B continues until tension of the warp W has advanced the whip roll 17 (to the right in Figure 1) to move

the actuator 49 out of abutting relation with the snap mechanism 42, at which time the switch S operates to actuate switch 35, thus terminating the reverse drive, and thus setting switch 35 for forward drive of motor M. The control mechanism of the present invention thus operates to prevent the development of slack in the warp W, by operating to reverse the drive of the beam B to take up any such slack as it develops, at the same time maintaining a constant warp tension.

When the loom is set in operation, for example after having been left idle for several hours, days or weeks, and the condition exists of the whip roll 17 having retracted to the full limit of its movement as determined by the stop 18, the actuator 49 is in position to have actuated switch S and in turn also switch 35 for reverse drive of motor M, and the motor M operates immediately in reverse to take up slack until the restored tension of the warp advances the whip roll thus removing abutment finger 49 from contact with snap mechanism 42, causing the switch S to restore forward drive under control of rheostat R. As soon as the whip roll 17 has advanced to clear stop 18, optimum tension is re-established.

The generator G and the source D, the latter preferably in the form of a direct current generator of substantially constant voltage, may conveniently be and preferably are embodied in a single unit as indicated in Figure 3 by the reference character U, both generators being driven from any suitable source of power such as an electric motor E which can be a motor such as a three-phase alternating current motor deriving its energizing current from the same circuit from which the main driving motor or motors for the loom itself derive their energy.

It will now be obvious to persons skilled in the art that the described apparatus operates to maintain the speed of warp let-off constant, within limits of fluctuation which are well defined.

The apparatus thus operates in the manner disclosed to maintain a constant let-off tension well within the range of optimum tension. Warp tension within the optimum range is maintained under all conditions of loom operation, and after loom idleness, when the warp tension may relax, the warp tension is brought back to the optimum before weaving is resumed. Furthermore, the warp tension is automatically brought back accurately to the optimum for which the let-off was set to weave a given piece of fabric, without it being necessary to depend upon the skill of the operator.

The invention has been disclosed as it has been applied in actual practice to a loom. The invention is applicable, however, to any textile fabricating machine in which yarns of the fabric are supplied as a warp, fed to the machine from a warp beam.

It will thus be seen that there has been provided by this invention a method and apparatus, in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a loom, a warp beam, a whip roll movable

within predetermined limits in response to the warp tension, and drive mechanism comprising a source of driving power independent of the drive of the loom connected in driving engagement with the warp beam, means responsive to the position of the whip roll to control operation of the warp beam from said source, the control means operating to effect drive of the warp beam to respectively decrease or increase the warp tension responsive to the warp tension increasing or decreasing beyond predetermined optimum tension limits.

2. In a let-off for a device having a warp beam to supply warp threads which pass over a movably mounted whip roll the position of which is determined by the tension of the warp threads, the warp threads tending by their tension to turn the warp beam, a reversible electric motor connected to said warp beam to rotate said beam, an electric circuit including a rheostat for controlling the forward speed of said motor, and means movable with said whip roll for controlling the setting of said rheostat, a second circuit for driving said motor in reverse, and switch means controlled by the position of the warp beam for disconnecting said circuit including said rheostat, and closing said second circuit.

3. In a let-off for a device having a warp beam to supply warp threads which pass over a movably mounted whip roll the position of which is determined by the tension of the warp threads, the warp threads tending by their tension to turn the warp beam, an electric motor connected to said warp beam to rotate said beam, an electric circuit including a rheostat for controlling the speed of said motor, means movable with said whip roll for controlling the setting of said rheostat, and means operative while the whip roll is positioned within a given portion of its range of movement to reverse the drive of said motor thus causing said warp beam to serve as a take-up until the said whip roll moves out of said given portion of its range of movement.

4. In a let-off for a device having a warp beam to supply threads or the like which pass over a movably mounted whip roll the position of which is determined by the tension of the said threads, the threads tending by their tension to turn the roll, an electric motor connected to said beam to rotate said beam, an electric circuit including a rheostat for controlling the forward speed of said motor, means movable with said whip roll for controlling the setting of said rheostat, a second circuit for operating said motor in reverse, and means controlled by the position of said whip roll for opening said first circuit and closing said second circuit when said whip roll reaches a given position, and for opening said second circuit and closing said first circuit when said whip roll moves away from said given position.

5. In a device for transferring warp threads from a warp beam to other means exerting a variable tension on said threads, means responsive to the aggregate tension of said threads, means for driving said beam, and means actuated by said tension responsive means for controlling the speed of the forward drive of said beam including adjustable lost motion control means between said tension responsive means and said speed controlling means, and other means controlled by the position of said tension responsive means to reverse the drive of said driving means.

6. In a device for transferring warp threads from a warp beam to other means capable of exerting a variable tension on said threads, a movably mounted whip roll over which the threads from said beam pass, said whip roll having means urging it in a direction to take up slack in said threads, electromotive means adapted to effect drive of said warp beam in let-off and in take-up directions, electro-responsive means for effecting variable-speed drive by said electro-motive means of the warp beam in let-off direction, means responsive to changes in tension of the threads for controlling said electro-responsive means, and means, operating after said whip roll has passed beyond the limit of a predeterminable range of permissible movement in a direction to take up slack, for changing over the drive of said warp beam from let-off direction to take-up direction.

7. In a device for transferring warp threads from a warp beam to other means capable of exerting a variable tension on said threads, a movable whip roll over which the threads from said beam pass, said whip roll having means urging it in a direction to take up slack in said threads, electro-motive means adapted to drive said warp beam in let-off and in take-up directions, an electric circuit for controlling the drive of said beam in let-off direction including means for varying the speed of drive of said beam by said electro-motive means, means responsive to changes in tension of the threads for controlling said speed-varying means, an electric circuit for controlling the drive of said beam by said electro-motive means in take-up direction, and means operating at a point intermediate of the range of movement of said whip roll to make one of said circuits effective and the other ineffective whereby the drive in take-up direction operates to limit the extent of over-all movement of the whip roll in a direction to take up slack.

8. In a device for transferring warp threads from a warp beam to other means capable of exerting a variable tension on said threads, a movably mounted whip roll over which the threads from said beam pass and having means urging it in a direction to take up slack in said threads, electro-motive means adapted to drive said warp beam in let-off and in take-up directions, an electric circuit for controlling the drive of said beam in let-off direction and including means for varying the speed of drive thereof by said electro-motive means, means responsive to changes in tension of the threads for controlling said speed-varying means, an electric circuit for controlling the drive of said beam by said electro-motive means in take-up direction, stop means for limiting the movement of the whip roll in a direction to take up slack, and means controlled by said whip roll to maintain said second-mentioned circuit effective and said first-mentioned circuit ineffective until the resultant take-up drive of the beam has effected substantial restoration of thread tension and movement of the whip roll away from said stop means.

9. Apparatus for controlling the tension of a warp intermediate a warp beam and other means capable of exerting a variable tension on the warp comprising, means responsive to changes in the aggregate tension of the warp, means independent of the operation of said other means and operative at all times regardless of the cycle of operation of said other means for rotating said warp beam either to let off warp or to take up warp, means controlled by said tension responsive means for controlling the rotation of said warp beam in let off direction, and other means, the operation of which is also controlled by the operation of said tension responsive means, for controlling the ro-

tation of said warp beam in a direction to take up warp.

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