

Oct. 5, 1948.

V. F. SEPAVICH ET AL

2,450,489

LETOFF FOR LOOMS

Filed July 26, 1946

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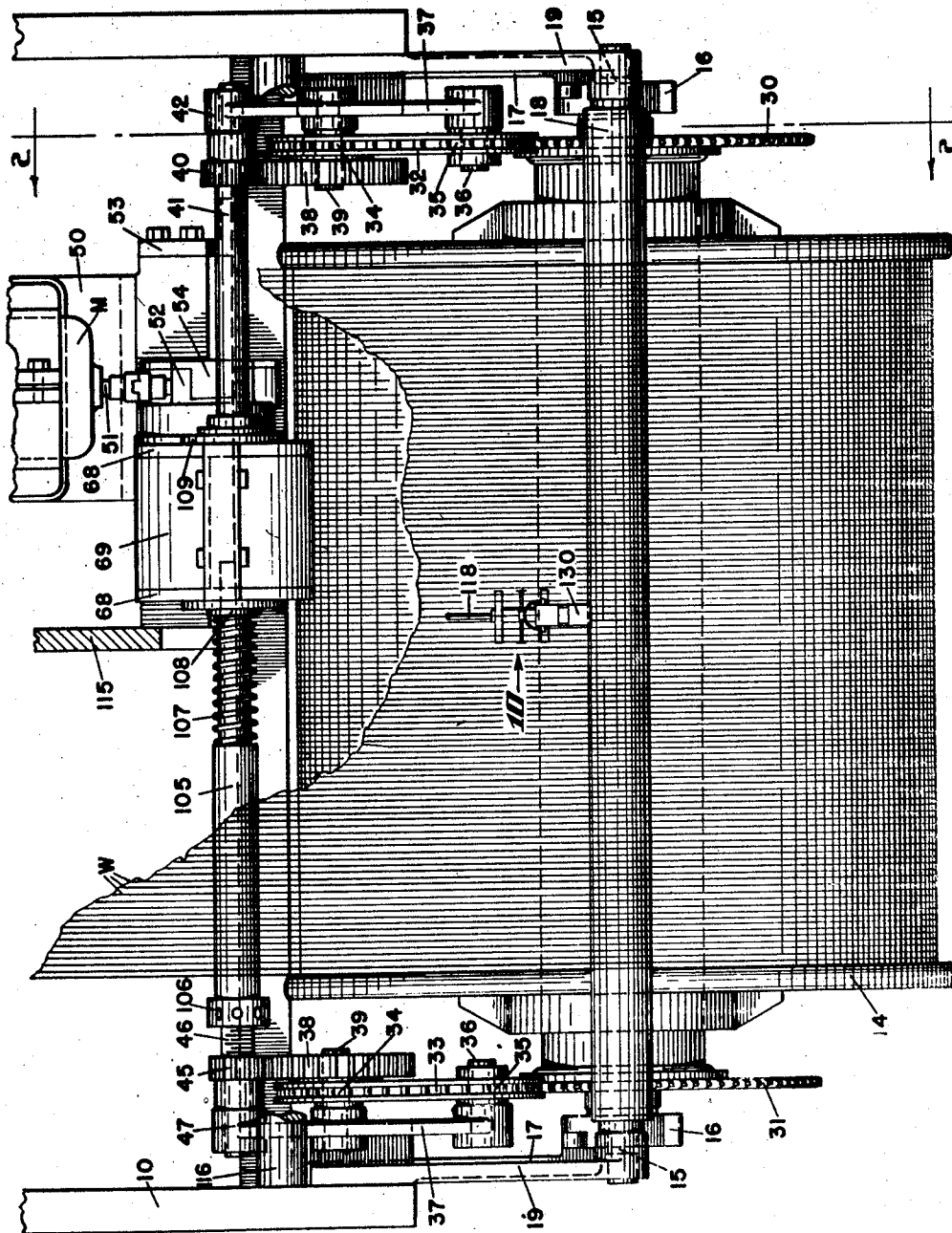


Fig. 1

Inventors
Victor F. Sepauck
Clarence R. Kronoff
Chas. T. Hawley
Attorney

Oct. 5, 1948.

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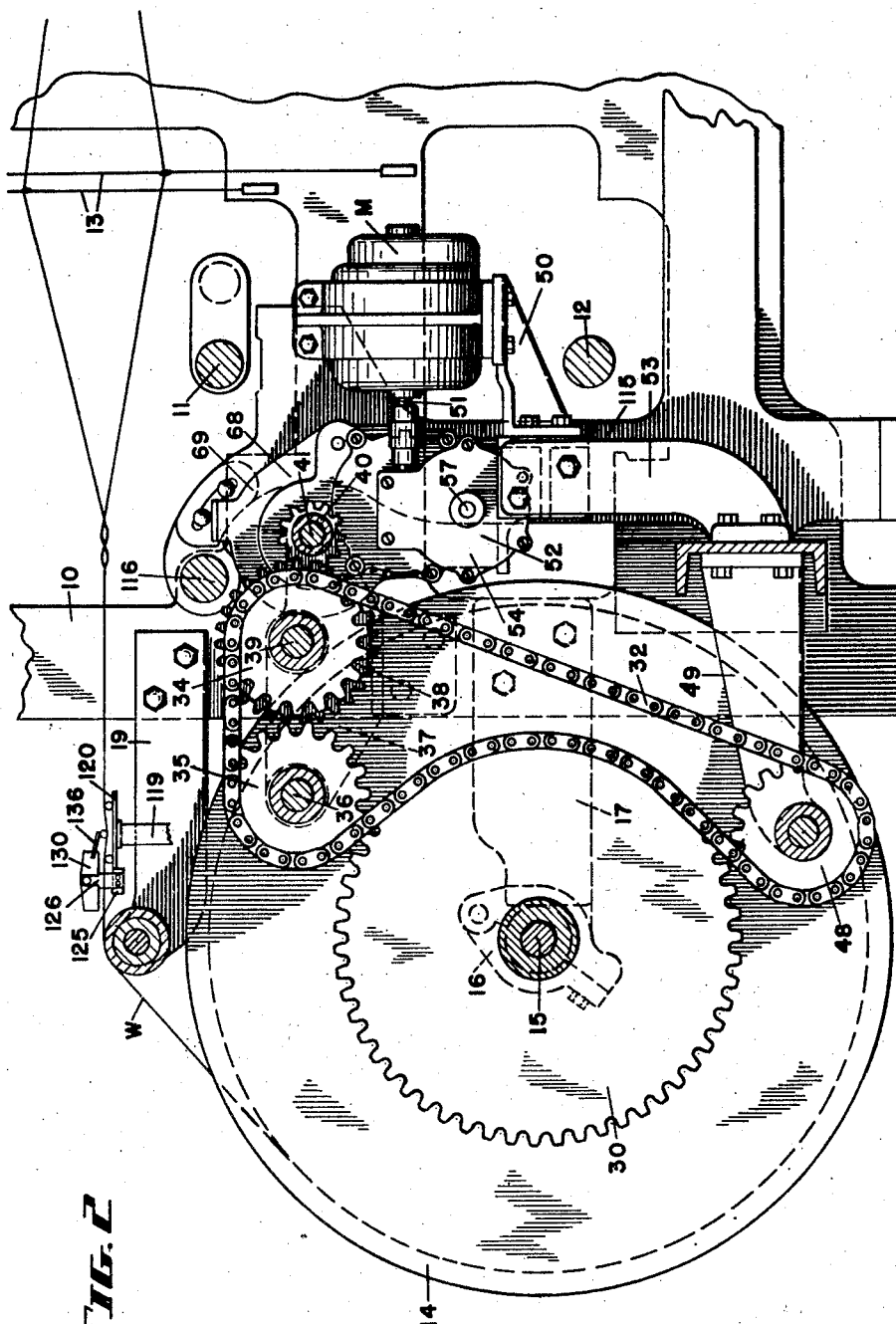


FIG. 2

Inventors
Victor F. Sepavich
Clarence R. Kronoff
Chas. T. Hawley
Attorney

Oct. 5, 1948.

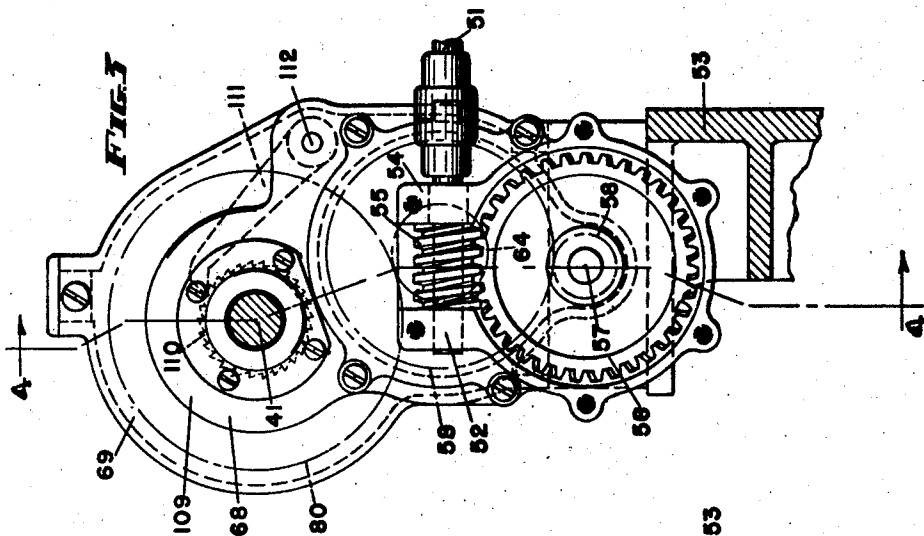
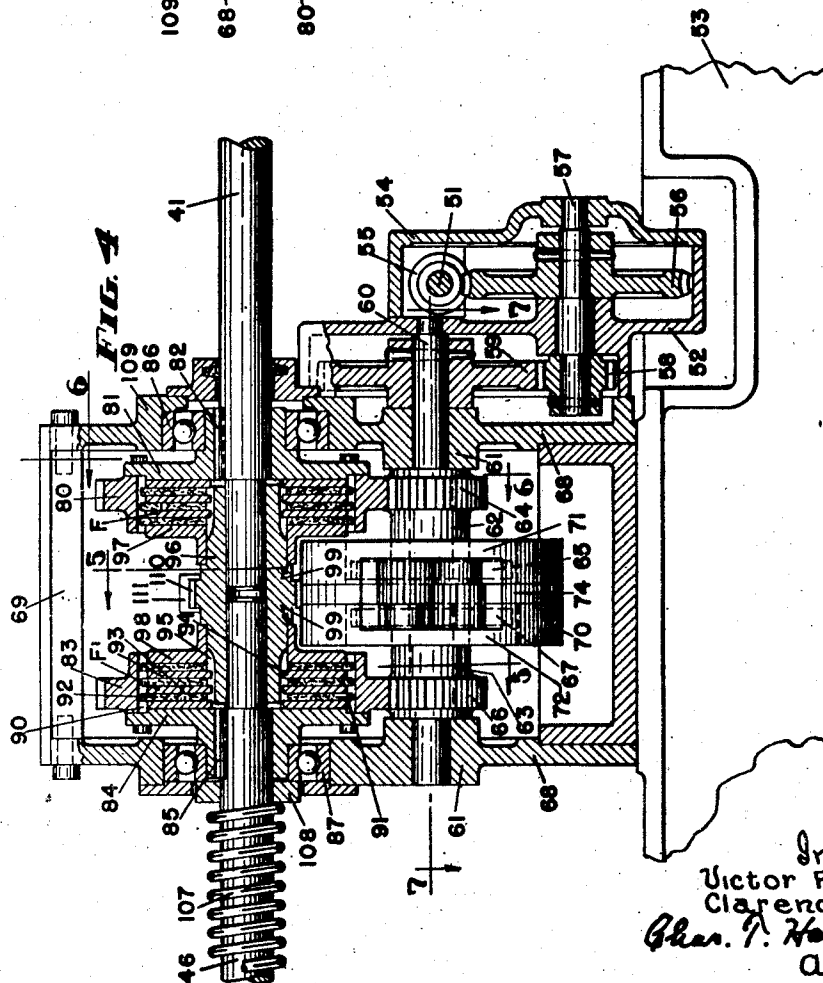
V. F. SEPAVICH ET AL

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6 Sheets-Sheet 3



Inventors
Victor F. Sepavich
Clarence R. Kronoff
Chas. P. Hawley
Attorney

Oct. 5, 1948.

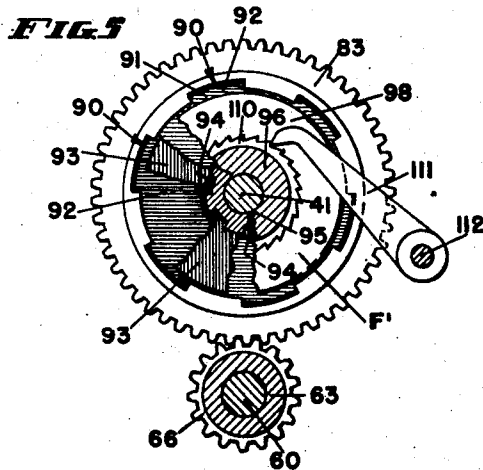
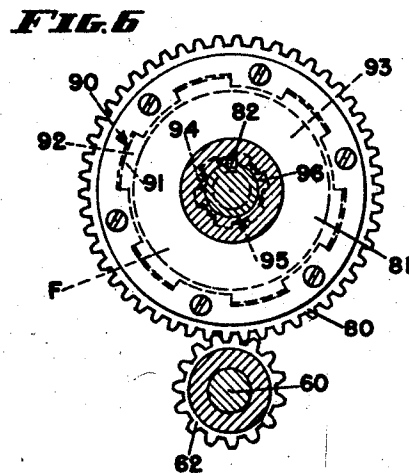
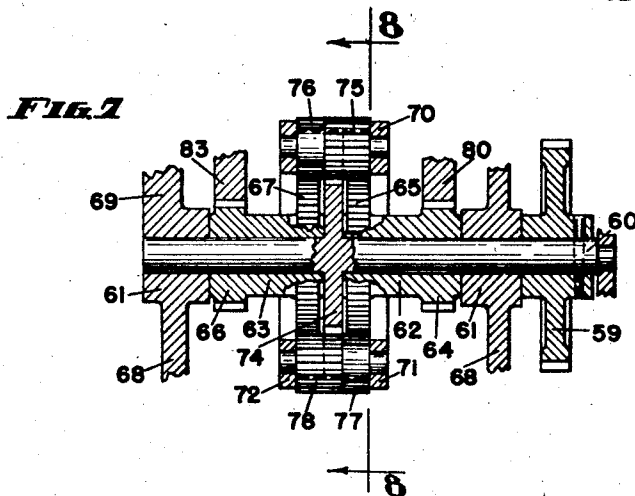
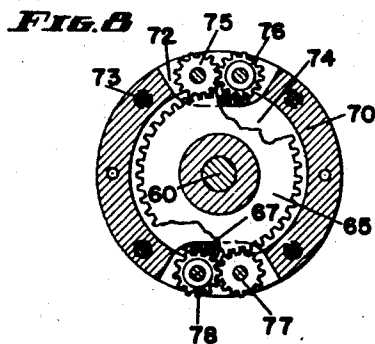
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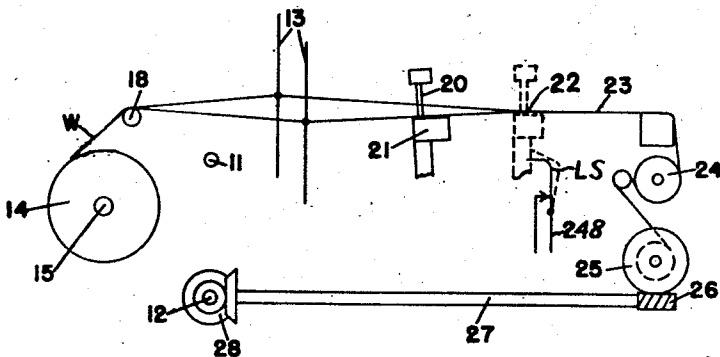
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Inventors
Victor F. Sepavich
Clarence R. Kronoff
Chas. P. Hawley
Attorney

2,450,489

6 Sheets-Sheet 5



Inventors
Victor F. Sepavich
Clarence R. Kronoff
D. Hawley
Attorney

Oct. 5, 1948.

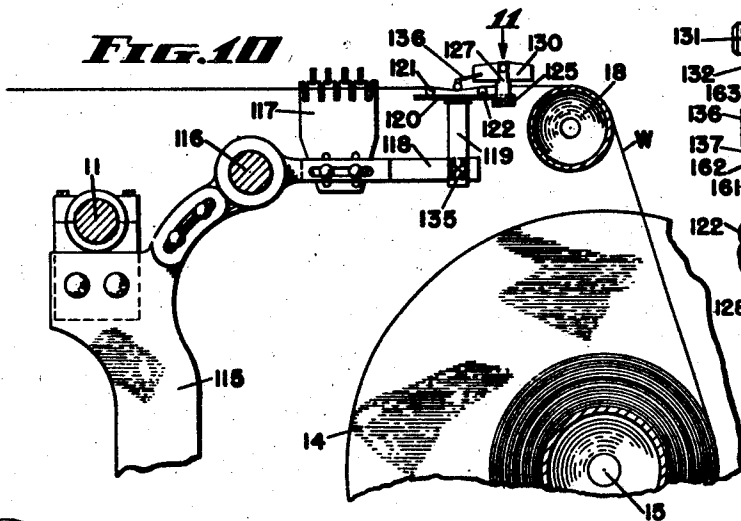
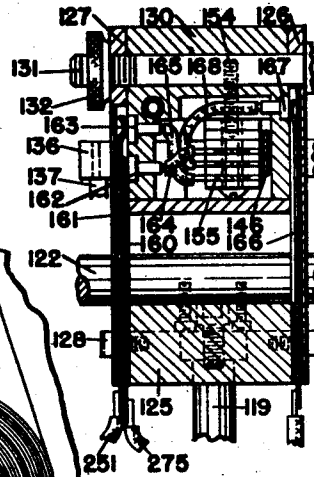
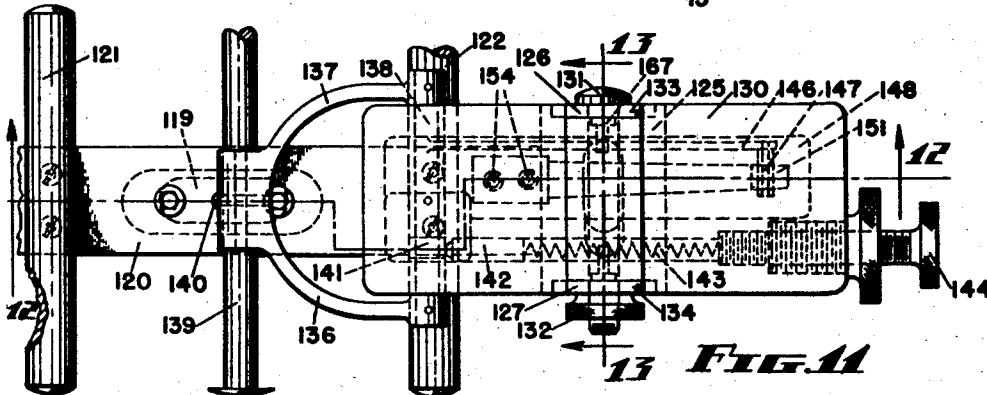
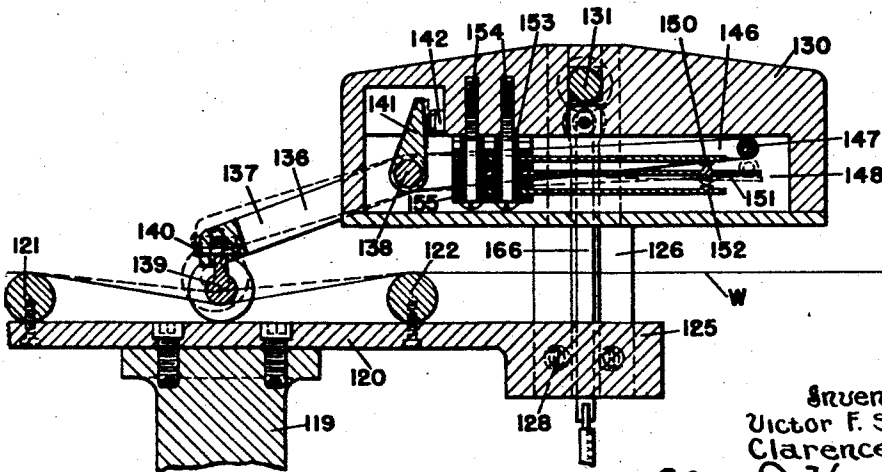
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LETOFF FOR LOOMS

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6 Sheets-Sheet 6



Inventors
Victor F. Sepavich
Clarence R. Kronoff

Chas. T. Hawley
Attorney

Fig. 12

UNITED STATES PATENT OFFICE

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LETOFF FOR LOOMS

Victor F. Sepavich and Clarence R. Kronoff,
Worcester, Mass., assignors to Crompton &
Knowles Loom Works, Worcester, Mass., a cor-
poration of Massachusetts

Application July 26, 1946, Serial No. 686,294

50 Claims. (Cl. 139—110)

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This invention relates to improvements in let-off mechanisms for looms and it is the general object of the invention to provide an electric motor connected to the letoff mechanism and operating under control of warp tension to turn the warp beam.

When heavy beams of large diameters are used the force required to turn the beam, if transmitted solely through the warp threads, would be high enough to create excessive tension in the warp. It is an important object of our present invention to provide a motor operatively connected to the beam in such manner as to turn the latter when the warp has attained a given desired maximum tension insufficient of itself to cause turning of the beam. The operating circuit for the motor is controlled by a contact responsive to increase in warp tension as determined preferably from a small group of warp threads and preferably independent of the whip roll which is preferably though not necessarily stationary.

We have found that heavy warp beams are subject to an axial twist if the driving means causing rotation of the beam is located at one side only of the beam. It is another object of our invention to connect the aforesaid motor to the two ends of the beam by means of equalizing mechanism, such as a differential, and locate the latter intermediate the ends of the beam so that equal forces are applied to each end of the beam.

When rotation of large warp beams is controlled by gearing part of which is fastened directly to the beam there is sufficient sag when the beam is full to change the axis of the gear on the beam with respect to the gear with which it meshes, resulting in breakage of gear teeth. In order to overcome this defect it is another object of our invention to provide chains for driving the warp beam through sprocket wheels fastened to the beam. Such a connection between the beam and its driving mechanism is not damaged by sagging of the beam.

We preferably wrap the chains around the forward parts of the sprocket wheels so that the beam can be readily removed from the loom by a backward motion without requiring disconnection of the chains from their guiding and driving sprockets. Since the chains are interconnected through the differential mechanism they can be moved independently of each other to fit the sprocket wheels secured to the ends of the beam.

The motor by which the warp beam is rotated is

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under control of electronic means including a signal circuit controlled by a warp tension contactor operatively connected to a small group of warp threads. When the warp is under a tension less than the maximum desired tension the contactor is idle and the signal or grid circuit is in a preventive condition which keeps the motor power circuit dead. As soon as the warp attains the maximum tension desired, however, the contactor closes a contact and alters the signal circuit, making it permissive and allowing the electronic power circuits to turn the motor in a direction to cause the beam to deliver warp for the weaving operation. The signal circuit can be operated by a very feeble current at the contactor and there is therefore no risk of fire.

It is still another object of our invention to provide manually controlled electric switches connected to the electronic circuits in such manner that the motor can be caused to turn the beam when the loom is at rest, even though the warp tension contactor be open. This manual control feature is utilized to effect both forward and reverse motions of the motor. After a pickout is made the motor is reversed to move the fell of the cloth rearwardly to the position which it should occupy for correct resumption of weaving. The tension contactor controls the reversing circuit and automatically opens it as soon as the desired maximum tension is reestablished in the warp.

Although the takeup exerts a continuous forward pull on the warp the latter is subjected to an additional forwardly directed force by the reed at each beatup of the lay. The beatup temporarily increases the warp tension above the normal or maximum desired tension, and is likely to close the tension controlled contactor even though the tension be correct both before and after the beatup. In order to prevent the motor from responding to the momentary increase in tension at beatup it is another object of our invention to open the signal circuit at each beatup of the lay.

We find under some conditions that it is desirable to operate the motor drive for the beam in cooperation with a friction device which opposes the forward pull of the takeup by a counter-force. The friction device, preferably adjustable to meet varying conditions of warp, is not essential to the operation of all features of our invention, but we have found it useful with certain types of warp.

When the warp beam is full and of large diameter the pull of the warp by the takeup is at a

relatively large distance from the beam axis and has considerable effect in turning the beam. When the beam is nearly empty, however, the warp pull is near the beam axis and has much less turning effect. Under the first condition when the torque is large the beam turns at a slow rate to supply the needed warp, due to its diameter, but under the latter condition the turning is not only much faster, but the torque is much reduced. It is another object of our invention to set the friction to exert a counter torque less than the forward torque of the take-up when the beam is full, but more than the forward torque when the beam is nearly empty. The motor is connected to the letoff gearing by a worm which supplements the friction when the beam is full by acting as a movable stop, the friction and worm jointly opposing the takeup. As the forward torque diminishes a time comes when it can be balanced by the frictional counter torque, and the worm ceases to act as a stop. Thereafter, as the forward torque continues to diminish it is supplemented by the motor which assists it to overcome the frictional counter torque.

The aforesaid friction mechanism and motor constitute two instrumentalities which jointly oppose the takeup to establish the desired maximum warp tension under normal loom operation, and under these conditions the motor itself is not required to supply enough force to create this desired tension. When the warp is to be reversed after a pickout, however, the motor is required to establish the maximum desired tension and should under these conditions be released from the load which the friction mechanism would impose on the motor. It is another object of our invention to provide means by which the friction mechanism is temporarily disabled to have no effect on loading the motor when the latter is reversed to establish the desired maximum warp tension.

With these and other objects in view which will appear as the description of our invention proceeds, our invention resides in the combination and arrangement of parts hereinafter described and set forth.

In the accompanying drawings, wherein a convenient embodiment of our invention is set forth,

Fig. 1 is a plan view of the letoff mechanism of a loom made according to our present invention, part of the warp being broken away to show the housing for the differential gearing and friction devices,

Fig. 2 is a vertical section on line 2—2 of Fig. 1,

Fig. 3 is an enlarged side elevation partly in section of certain parts shown in Fig. 2,

Fig. 4 is a vertical section on line 4—4 of Fig. 3,

Figs. 5 and 6 are detailed vertical sections on lines 5—5 and 6—6, respectively, of Fig. 4,

Fig. 7 is a horizontal section on line 7—7 of Fig. 4,

Fig. 8 is a vertical section on line 8—8 of Fig. 7, parts being broken away,

Fig. 9 is a diagrammatic view showing the electric control circuits,

Fig. 10 is an enlarged side elevation looking in the direction of arrow 10, Fig. 1, parts being in section,

Fig. 11 is an enlarged plan view of the controller looking in the direction of arrow 11, Fig. 10,

Fig. 12 is a vertical longitudinal section on line 12—12, Fig. 11,

Fig. 13 is a vertical transverse section on line 13—13, Fig. 11, and

Fig. 14 is a diagrammatic side elevation of a type of loom to which our invention can be applied.

Referring more particularly to Figs. 1, 2 and 14, we have shown a loom frame 10, top and bottom shafts 11 and 12, respectively, and harness mechanism 13 for the warp W. The latter is wound on a beam 14 having end gudgeons 15 rotatable in rearwardly opening cap bearings 16 carried by brackets 17 extending rearwardly from the loom frame. A stationary whip roll 18 is mounted on rearwardly extending arms 19 also secured to the loom frame. The whip roll may turn on its stationary axis and is located above the beam as shown in Fig. 2.

Referring to Fig. 14, the warp W extends forwardly from the harness frames 13 through the reed 20 of a reciprocating lay 21 and then to the fell 22 of the cloth 23. The latter passes partly around a takeup roll 24 which may be driven in a forward direction by a train of mechanism 25 including a worm 26 on a horizontal shaft 27. The latter is driven by bevel gear mechanisms 28 operatively connected to the bottom shaft 12. During loom operation the worm turns and advances the takeup roll so that the latter tends to pull the cloth and warp forwardly and continuously, preferably at a uniform rate. The reed beats up toward the cloth each pick of the loom and in doing so subjects the warp to a temporary increase in tension. The harness frames open the warp when the lay is on back center position and close or cross the warp when the lay is on front center.

The matter thus far described is of usual construction and of itself forms no part of our invention.

Referring more particularly to Fig. 1, the right and left gudgeons 15 of the beam 14 have secured thereto sprocket wheels 30 and 31, respectively, meshing with chains 32 and 33. The upper part of each chain, as shown more particularly in Fig. 2, is trained around front and back sprockets 34 and 35, respectively, the latter rotating on a stationary stud 36 on a bracket 37 secured to the loom frame. Each of the forward sprockets 34 is fast with respect to a gear 38 rotatable with its sprocket on a stud 39 on the bracket 37.

The right hand gear 38, see Figs. 1 and 2, meshes with a pinion 40 secured to a shaft 41 the right end of which turns in a bearing 42, see Fig. 1, formed as part of the bracket 37 at the right side of the loom. In similar manner, the left hand gear 38, see Fig. 1, meshes with a pinion 45 secured to a shaft 46 turning in a bearing 47 on the bracket 37 at the left side of the loom. The shafts extend toward each other but are separate, as will be set forth more particularly hereinafter.

The lower part of each chain extends around a guide sprocket 48 rotatable on bearing arm 49 extending rearwardly from the loom frame. Each chain is wrapped partly around the front part of its sprocket wheel 30 or 31. The cap bearings 16 are behind the chains and open rearwardly to permit backward movement of gudgeons 15 and wheels 30 and 31 away from their chains when the beam is removed from the loom.

From the matter thus far described it will be understood that when the shafts 41 and 46 turn the chains 32 and 33 will cooperate with their respective sprocket wheels on the warp beam to turn the latter. The mechanism by which rotation of the shafts 41 and 46 is controlled is shown more particularly in Figs. 2 to 8. A letoff motor M described more particularly hereinafter is

mounted on a stand 50 on the loom frame and has a shaft 51 extending rearwardly into a gear reduction unit 52 mounted on a stationary part of the loom, such as a bracket 53, and including a frame 54 shown in section in Fig. 4.

Unit 52 includes a worm 55 secured to and turning with shaft 51 and meshing with a worm gear 56 pinned to a shaft 57 rotatable in the unit, see Figs. 3 and 4. Worm 55 is held against substantial longitudinal movement by the frame 54 for a reason which will appear hereinafter. A pinion 58 secured to shaft 57 meshes with a gear 59 pinned to a shaft 60. As shown more particularly in Fig. 7, shaft 60 turns in stationary bearings 61 and has mounted thereon for free rotation right and left pinion-gear units 62 and 63, respectively. Unit 62 has a pinion 64 integral with a gear 65, while unit 63 has a similar pinion 66 integral with a gear 67. Bearings 61 are formed on the sides 68 of a stationary casing or housing 69.

A planetary gear case or assembly 70 extends around shaft 60 and has right and left side plates or rings 71 and 72, respectively, see Fig. 7, secured at 73 to a flange 74 integral with shaft 60. Two pairs of planet pinions extend between and are rotatably supported by the side plates 71 and 72, one pair comprising pinions 75 and 76, and the other pair comprising pinions 77 and 78. The pinions of each pair mesh with each other, see Fig. 8, one pinion of each pair meshing with the gear 65 and the other pinion of each pair meshing with the gear 67. While the pinion-gear units 62 and 63 are free to rotate on the shaft 60, they are interconnected by reason of the pairs of planet pinions and gears 65 and 67, and rotation of one of the units 62-63 in one direction will cause rotation of the other unit in the opposite direction if shaft 60 is stationary.

Pinion 64 meshes with a ring gear 80 mounted on a spider 81 keyed as at 82 to the left end of shaft 41, see Fig. 4. In similar manner, pinion 66 meshes with a ring gear 83 secured to a spider 84 splined as at 85 to the right end of shaft 46. Right and left ball bearings 86 and 87, respectively, are provided for the spiders 81 and 84, respectively, and are supported in their corresponding side plates 68 of casing 69.

Friction mechanisms F and F', shown more particularly in Figs. 4 and 5, are associated with the ring gears 80 and 83, respectively, and each of these mechanisms has disks turning with the ring gears between other disks which will ordinarily be held against rotation. Thus, the left ring gear 83 of mechanism F' has slots or notches 90 which receive lugs 91 on friction disks 92, the lugs and notches requiring the disks 92 to turn with the ring gear 83. Other normally stationary disks 93 have lugs 94 entering notches 95 in a holding member 96 supported by the adjacent reduced ends of shafts 41 and 46, see Fig. 4. Friction mechanism F is similar to the mechanism F' and a detailed description of it is not thought necessary. End plates 97 and 98 for the mechanisms F and F', respectively, abut stop shoulders 99 on the holding member 96.

Referring more particularly to Figs. 1 and 4, shaft 46 is surrounded by a sleeve 105 located between an adjusting nut 106 threaded on the shaft 46 and a relatively heavy compression spring 107 the right end of which as viewed in Fig. 4 presses against a collar 108 loosely surrounding the shaft 46. This collar bears against the left side of the ball bearing 87 which in turn is so constructed as to transmit a force to the

right as viewed in Fig. 4 against the left hand spider 84. The ball bearing 86 at the right of the mechanism, see Fig. 4, is of the end thrust type and is limited as to movement thereof to the right by a flange 109 on the right hand side plate 68 of casing 69.

The spring 107 exerts a force to the right against spider 84 and holds the disks 92 and 93 of friction unit F' in close engagement with each other, and by means of end plate 98, member 96, and end plate 97, forces the disks of the friction unit F against each other and toward the spider 81. The ball bearing 86 and flange 109 act as stops to limit motion of spider 81 to the right, Fig. 4. By varying the location of the adjusting nut 106 it is possible to vary the force exerted by the spring 107 against the friction mechanisms F and F'. The holding member 96 floats on the shafts 41 and 46 and equalizes the frictional forces resisting turning of them.

The holding member 96 is provided with a set of ratchet teeth 110, see Fig. 5, which cooperate with a hold pawl 111 pivoted as at 112 to the stationary casing 69 and tending to remain in the normal position shown in Fig. 5 due to gravity to prevent right hand turning of the member 96, Fig. 3, by forces transmitted through the friction disks during normal weaving. If a pick-out operation is necessary involving backward movement of the warp beam and reversal of shafts 41 and 46 the ratchet 110 can slip under the pawl by a left hand rotation as viewed in Fig. 5.

The previously mentioned warp tension controlled contactor is shown more particularly in Figs. 10 to 13. The loom to which the invention is applied includes a stationary center brace 115 supporting a carrier 116 for the warp stop motion 117. Extending rearwardly from the carrier 116 is an arm 118 to which an upright 119 is secured. The latter has a table 120 extending lengthwise of the warp and to which are secured laterally extending front and back stationary guides 121 and 122 under the warp and on which part of the latter rests.

The rear part of the table 120 is formed with a head 125 to which right and left side plates 126 and 127, respectively, are attached as at 128, see Fig. 13. These side plates support a switch housing or casing 130 made of insulating material and held in position on the plates by a bolt 131 and a thumb nut 132. The body has vertical side slots 133 and 134, respectively, which receive the side plates 126 and 127 and assist the bolt 131 to hold the casing 130 in fixed position. The casing 130 can be adjusted vertically by means of the bolt and vertical slot arrangement designated generally at 135.

A lever 136 has a yoked arm 137 pinned or otherwise secured to a rock shaft 138 mounted for angular movement on the casing 130. A tension cross bar 139 is secured at 140 to arm 137 and rests on a group of warp threads which extend between the guides 121 and 122. A short arm 141 is secured to the rock shaft 138 and bears against a spring plunger 142 urged toward arm 141 by a spring 143 in the casing 130. An adjusting screw 144 is provided to vary the pressure which spring 143 exerts on arm 141. By varying the setting of the screw 144 rocking of lever 136 in a clockwise direction as viewed in Fig. 12 can be regulated. The lever 136 can rock around its axis and is urged to move down under the action of spring 143 to the full line position shown in Fig. 12 when the warp is slack, but is raised to the dotted line position when the

warp tension increases to a desired maximum. A rear arm 146 of lever 136 is secured to rock shaft 138 and has a lateral stud 147 coated with insulating material.

The casing 130 has a cavity 148 containing arm 146 and also three resilient contacts or switch blades designated at 150, 151 and 152. These contacts are positioned by insulated bushings 153 held tightly in position by screws 154, and also by insulating washers 155. When the warp is relatively slack, full line position of Fig. 12, and the insulating stud 147 is in high position, the intermediate spring contact 151 will be up against contact 150. When the warp tension increases, dotted line position of Fig. 12, the stud 147 is lowered and moves the intermediate contact 151 away from top contact 150 and into engagement with bottom contact 152.

The three contacts are connected electrically to side electric current conducting springs, see Fig. 13, connected in turn to the electric circuit shown in Fig. 9. Side plate 127 is recessed to receive right and left spring contacts 160 and 161, respectively, which engage stationary contact buttons 162 and 163, respectively, fixed to casing 130. Spring contacts 160 and 161 are insulated from each other and side plate 127 and are held in place by screw 128. Buttons 162 and 163 are connected by wires 164 and 165 to the top and bottom spring contacts 150 and 152, respectively. The right side plate 126 is recessed to receive a single resilient spring contact 166 engaging a button 167 electrically connected to the intermediate spring contact 151 by wire 168. Contact 166 is mounted and insulated in a manner similar to that described for contacts 160 and 161.

Those parts of the warp contactor shown in Figs. 10 to 13 which respond to variations in warp tension and thus control the spring contacts 150, 151 and 152 are part of the present invention, but certain details of the contactor are not claimed herein, since they are the subject matter of a separate application Serial No. 686,292 filed July 26, 1946 by one of us and another, now Patent No. 2,440,958. Even though these details are not claimed by us, they are shown to complete the description.

The electric circuits and electric controlling devices for the letoff already described are shown diagrammatically in Fig. 9. We use a direct current shunt wound motor M, a full wave rectifier to supply direct current for the field of the motor M, and also various electronic grid or signal circuits controlled by the warp tension contact controller and controlling two power tubes which supply direct current for the armature of the motor. We also provide a gang switch normally in neutral or center position but movable manually from that position to either of two other positions to control the letoff motor to turn the beam either forwardly or backwardly.

Power for operating the circuits is derived from lines L and L' supplying alternating current. Transformer TR for the rectifying unit RU has its primary 175 connected to lines L and L' by wires 176 and 177, respectively. The secondary of transformer TR has a double power winding 178 and a low voltage winding 179. Full wave rectifier RU comprises a double diode gas filled electronic power tube 180 having plates 181 and 182 connected respectively to the right and left ends of the double winding 178. The cathodes or filaments 183 and 184 corresponding to the plates 181 and 182 are kept incandescent by the low voltage winding 179.

The field 185 of the letoff motor M is kept energized by direct current flowing in the following field circuit whenever wires L and L' are alive: Plates 181 and 182, one at a time, tube 180, cathodes 183 and 184, one at a time, wire 186 in the filament circuit, wire 187, resistance 188, wire 189, field 185, wire 190, and center tap 191 of winding 178. The strength of the field is determined by the resistance 188, which may be desired to be made variable for the purpose, and the field remains constantly excited so long as wires L and L' are alive.

A second transformer TA supplying current for the armature MA of motor M has its primary 193 connected to the power lines L and L' by wires 194 and 195. This transformer TA also has a double secondary winding 196 with a center tap 197, and a low voltage winding 198. Two gas filled electronic power tubes 200 and 201 have plates 202 and 203 connected one to each end of the double winding 198. The cathodes or filaments 204 and 205 are in a cathode circuit including wire 192 and are kept incandescent by the low voltage winding 198 whenever wires L and L' are alive. A wire 206 leads from center tap 197 and another wire 207 is connected to wire 192 and the cathodes 204 and 205. When lines L and L' are alive wires 206 and 207 are capable of supplying unidirectional current.

A third transformer TG for grids 208 and 209 of tubes 200 and 201 respectively has its primary 210 connected to wires L and L' by the following phase displacing circuit: Wires L and 211, primary 210, resistance R, and wires 212 and L'. The secondary 213 of transformer TG has a center tap 214 and two windings 215 and 216 which supply power at a relatively low voltage, such for instance as seven volts, for grids 208 and 209. The right end of winding 215 is connected by resistance R' and wire 217 to the grid 208 of tube 201, and in similar manner the left end of winding 216 is connected by resistance R2 and wire 218 to the grid 208. The resistances R and R' protect the tubes 200 and 201 and may be of the order of 40,000 ohms, and phase displacing resistance R may be of the order of 8500 ohms when the lines L and L' supply power at 110 volts at 60 cycles. A small condenser C' of approximately 0.5 microfarad connects wire 207 to wire 218 leading from center tap 214.

The lower right hand part of Fig. 9 shows a gang switch GS having an assemblage of switches and contacts which in actual practice are located in a box or housing not shown mounted for instance on the front arch of the loom and readily accessible to the weaver. The flexible contact blades of switch GS tend to assume the neutral or central position shown in full lines, and return to that position after being moved manually to either side of the central position. The switch blades are attached to an insulated cross bar 225 movable by a handle 226. As contemplated in the form of the invention which we illustrate herein, the field of the motor is not under control of the gang switch GS, and its polarity always remains the same regardless of the position of switch GS.

Switch GS has a top blade 230 and its forward and reverse contacts 231 and 232, respectively, an intermediate blade 233 and its forward and reverse contacts 234 and 235, respectively, and a bottom blade 236 and its forward and reverse contacts 237 and 238, respectively. The loom is provided with three switches, S', S2 and S3 which are in the full line position shown in Fig. 9 when

the loom is in operation and in the dotted line positions when the loom is stopped. These three switches S', S2 and S3 can be controlled in any convenient manner not shown, as by the shipper handle of the loom.

When the loom is running the motor M operates intermittently and always turns in such a direction as to advance the warp beam to deliver warp forwardly for the weaving process. During loom operation the armature is connected to the following automatic forward armature circuit: Wire 207, switch S2, wires 240 and 241, inductance H to choke back high frequency waves, up through the armature, wires 242 and 243, and switch S3 to wire 206. The blades 233 and 236 are out of engagement with their respective contacts under these conditions so that wires connected to wires 241 and 242 and leading to the switch GS will not be in closed circuits and the armature circuit just traced will be the only circuit completed through the switches S2 and S3. Because of the secondary winding 196 current will tend to flow in this armature circuit but will normally be prevented from doing so due to the fact that grids 208 and 209 are negative with respect to their cathodes and prevent flow of current through their respective tubes.

The grids 208 and 209 are under control of the warp tension contactor shown in Fig. 12. When the loom is running and the warp tension is less than the desired maximum tension contacts 151 and 152 will be separated, and the motor M will be temporarily at rest because of the electric condition of the grids as determined by the following automatic preventive grid circuit: Wire 189, wire 245, resistance R3, wire 246, junction 247, wire 248, high resistance R4, wire 249, resistance R5, and wire 250 to wire 190. Under these conditions the resistances R3, R4 and R5 will be so related that the junction 247 and the grids electrically connected to it through wire 219 will be at a low enough potential, or sufficiently negative with respect to the cathodes 204 and 205, to prevent flow of current through the tubes 200 and 201, and the motor will consequently be at rest. Resistances R3, R4 and R5 may have values, for instance, of 120,000; 1,000,000 and 250,000 ohms, respectively.

When the tension of the warp increases to the desired maximum contact 151 will be moved down into engagement with contact 152 and the following automatic permissive grid circuit will be closed: Wires 189 and 245, resistance R3, wires 246 and 248, lay controlled switch LS in wire 248 (described hereinafter), contacts 151 and 152, wire 251, button 252, switch S', wire 249, resistance R5, and wire 250 to wire 190. This permissive circuit short-circuits the high resistance R4 and resistances R3 and R5 alone determine the potential of the junction 247. These last two resistances are so related that they raise the potential of junction 247 and grids 208 and 209, or at least make the grids sufficiently less negative with respect to the cathodes to permit current to flow through the tubes 200 and 201 and the armature circuit, and the motor thereupon turns forwardly to supply warp with an attendant reduction in warp tension resulting in upward movement of contact 151 away from contact 152. Resistance R4 is thereupon again put in series with resistances R3 and R5 and the automatic preventive grid circuit is reestablished to stop the motor. This running and non-running condition of the motor continues during loom operation, the motor being

under control of the warp tension and causing the beam to deliver warp as it is used up in the weaving process. A resistance R6 of approximately 10,000 ohms bridges the wires 245 and 250 and is in parallel with a condenser C which may have a capacity of approximately 20 microfarads. A sliding contact 255 is provided for the resistance R6 and divides the latter into upper and lower parts for a purpose to be described.

The switch LS in wire 248 is closed at all times during the pick or cycle of the loom except when the lay beats up, at which time the switch is opened either by the lay or some loom part moving in time with the lay. The purpose of switch LS is to prevent the momentary increase in warp tension incident to beatup from shortcircuiting resistance R4. While switch LS is desirable under many conditions, we find that it is not essential to all applications of our invention. In Fig. 14 switch LS is shown closed in full lines, a condition existing when lay 21 is rearward of its beat-up position. When the lay moves to its front center or beat-up position, shown in dotted lines, Fig. 14, it pushes switch LS forwardly to the open position shown in dotted lines.

The foregoing preventive and permissive grid contacts derive their potential from the windings of secondary 213 of transformer TG. This secondary is isolated and the grids would float electrically, so to speak, without reference to the cathodes 204 and 205 unless connected to the latter in some manner. This connection is afforded by wire 256 which connects the sliding contact 255 to the wire 192 of the cathode circuit. The voltage of junction 247 shifts throughout a range from a minimum to a maximum thereof when resistance R4 is shortcircuited, but the amount by which the upper part of this range exceeds the voltage of the cathodes 204 and 205 will depend upon the zero level of the preventive grid circuit with respect to the zero level of the cathode circuit. The sliding contact 255 permits a relative raising or lowering of the zero levels of the grid and cathode circuits, and therefore affords a means for controlling the amount of current which can pass through the tubes 200 and 201 and armature MA.

If the cloth being woven is relatively coarse so that only 20 picks of filling are laid to the inch there will be a relatively fast feed of warp and the motor will need to turn relatively fast whenever called into action. Under these conditions the contact 255 will be set to produce a relatively small difference between the zero levels of the grid and cathode circuits, thereby causing the grids to go to a high value relatively to the cathodes whenever the resistance R4 is shortcircuited. If, on the other hand, a much finer cloth is being woven requiring, for instance 60 picks to the inch, the warp beam will turn much less for each pick of the loom and the motor must operate at a correspondingly reduced speed. This condition will be brought about by moving the contact 255 so that there is a considerable difference between the zero levels of the grid and cathode circuits, causing the grids to permit passage of less current through the tubes 200 and 201 when the resistance R4 is shortcircuited than in the previous instance.

It will be noted that the transformer TA is connected directly to lines L and L' and for this reason the secondary 196 will have a definite phase relation with respect to the line phase, and this phase determines the phase of the plates 202 and 203. Transformer TG, however, is connected to

the lines L and L' through the previously described phase displacing circuit and the phase of the grids will be displaced with respect to the phase of the plates due to the phase displacement of secondary winding 213 with respect to the phase of lines L and L'. This phase displacement will ordinarily remain fixed, so long as resistance R is unchanged, but can be altered by a change in the value of resistance R.

It will therefore be seen that the grids are under three controls, the first of which is due to the shift from preventive to permissive and back to preventive grid circuit conditions, the second of which is due to the difference in electric level or zero values of the grid and cathode circuits as determined by contact 255, and the third of which is due to the phase displacement caused by resistance R. Ordinarily the amount of shift in the potential of the junction 247 will not be subject to change, but the difference in zero levels of the grid and cathode circuits can be changed at contact 255 as already suggested.

The operation already described with reference to Fig. 9 is on the assumption that the loom is running and that changing conditions in the warp tension cause the motor M to run and stop alternately, and on the further assumption that the handle 226 of gang switch GS is in its center or neutral position. This operation of the apparatus may be considered as a first condition, but other conditions are provided for in the circuits shown in Fig. 9.

A second condition would grow out of the accidental movement of switch GS to forward position the effect of which would be to connect the blades 230, 233 and 236 with their upper or forward contacts. While this condition might occur only infrequently it is desirable that if it should occur no interference would result in the normal operations of the armature and grid circuits during loom operation. The only way in which the aforesaid accidental movement of switch GS might affect normal operation when the loom is running would be to create the conditions of a permissive grid circuit. It will be noted, however, that contact 152, wire 251 and button 252 are disconnected from button 260 of switch S' when the loom is running. This latter button is connected by wire 261 to the top blade 230 and it is therefore impossible for the latter to have any shortcircuiting effect on the resistance R4 so long as switch S' is in the running full line position. It will thus be seen that the second condition is amply guarded against and cannot alter normal operations.

A third condition would be that growing out of accidental lowering of handle 226 during loom operation so that blades 233 and 236 would engage their bottom reverse contacts. Here again, the button 260 would be disconnected from contact 152 and shortcircuiting of resistance R4 would be impossible.

The matter thus far described with respect to the second and third conditions has dealt primarily with the top blade 230, but it will be apparent from Fig. 9 that engagement of blades 233 and 236 with their respective contacts will cause no interference with the normal circuit operations during loom running due to the fact that the first of these blades is connected by wire 265 to button 266 which is out of contact with switch S2 during loom operation, and likewise the second blade 236 is connected by wire 267 to button 268 which is out of contact with switch S3 during loom operation.

The foregoing description of Fig. 9 relates to conditions when the loom is operating. It is desirable however to exercise certain controls over the letoff when the loom is at rest and these lead to additional conditions.

Under the fourth condition, when the loom has stopped, the control circuits should be inoperative provided switch GS is in its central position. As soon as the loom stops the switches S', S2 and S3 will be moved as already described from their full line to their dotted line positions shown in Fig. 9. Wires 206 and 207 therefore do not have direct connection with the armature except as such connection could be established through switch GS. Under this fourth condition, however, the three blades of switch GS are out of engagement with their contacts and no circuit can be completed from the wires 206 and 207 to the armature. It is also noted under this fourth condition that when switch S' moves to its dotted line position it disconnects contact 152 from the grid circuit and the preventive grid circuit is completed through the high resistance R4.

A fifth condition may grow out of desirability to advance the warp when the loom is stopped. To effect this condition the handle 226 will be raised the effect of which is to create the following manual forward permissive grid circuit: wire 245, resistance R3, wires 246 and 248, switch LS, wire 270, contact 231, blade 230, wire 261, button 260, switch S', (now in the dotted line), wire 249, resistance R5 and wire 250. This circuit short-circuits the high resistance R4 so that electric conditions at the junction 247 and the grids are such as to permit flow of current through tubes 260 and 201. The following manual forward armature circuit thereupon becomes operative: wire 207, switch S2, (in the dotted line position), button 266, wire 265, blade 233, contact 234, wires 271 and 241, choke coil H, up through the armature, wires 242 and 272, forward contact 237, blade 236, wire 267, button 268, and switch S3, (in the dotted line position), to wire 206. The motor therefore runs in a forward direction under manual control and will continue so to run as long as the handle 226 is held in raised position.

The sixth and last condition is that in which it may be desired to reverse the beam under manual control. Ordinarily this last condition will exist when the warp is slack and should be pulled back to reestablish the desired maximum tension. The intermediate contact 151 will therefore be up and in contact with contact 150. Lowering the handle 226 to move switch GS will close the following manual reverse permissive grid circuit: Wire 245, resistance R3, wires 246 and 248, switch LS, contacts 151 and 150, wire 275, contact 232, blade 230, wire 261, button 260, switch S', (in the dotted line position), wire 249, and resistance R5 to wire 250. This last traced circuit short-circuits resistance R4 and current can flow through the tubes 200 and 201. The following manual reverse armature circuit thereupon becomes operative: wire 207, switch S2, (in the dotted line position), button 266, wire 265, blade 233, contact 235, wires 272 and 242, down through the armature, coil H, wires 241 and 276, contact 238, blade 236, wire 267, button 268, and switch S3, (in the dotted line position), to wire 206.

This last traced reverse armature circuit depends of course for its operation upon the short-circuiting of resistance R4, but it will be understood that as the beam is turned backwardly by the motor warp tension increases and eventually when the maximum desired warp tension is at-

tained intermediate contact 151 will move down away from contact 150, thereupon opening the shortcircuit around resistance R4 and enabling the latter to become part of a grid preventive circuit which stops further running of the motor. It will thus be seen that during manual reversal of the motor during loom stoppage attainment of the desired maximum warp tension automatically stops the motor even though the weaver should continue to hold the handle 226 down.

We have already mentioned the relationship between the takeup, motor M and the friction mechanisms F and F' with respect to the manner in which they interact when weaving from a full to an empty warp beam and a more detailed description of this relationship will now be given. When the warp beam is full it requires a minimum of angular movement to deliver the warp required for a pick of the loom, but when the beam is almost empty a larger angular movement is required. The takeup roll 24 exerts a forward pull on the warp and is the part of the loom which is responsible for the forward feed of the warp threads and their tension. When the beam diameter is large takeup roll 24 exerts a maximum torque on the beam due to the diameter of the latter, but when the beam diameter is small the takeup torque is greatly reduced. Throughout the weaving operation in which the beam diminishes from a maximum diameter it is necessary to be able to preserve a desired maximum tension in the warp above which the warp tension will not rise.

The friction mechanisms F and F' retard movement of the beam and therefore exert on it a countertorque opposed to the forward torque of the takeup. The motor mechanism, particularly the worm 55 acts at times as a stop for the letoff mechanism, and when acting in this capacity the motor driving mechanism for the beam supplies an additional countertorque resisting forward movement of the warp by the takeup. When the motor turns forwardly worm 55 advances and this not only turns the beam but has the effect of advancing the stop for the beam.

We set the friction mechanisms F and F' so that their countertorque which resists turning of the beam lies intermediate the maximum takeup torque when the beam is full and the minimum takeup torque when the beam is nearly empty. Under the first of these conditions the takeup is able to overpower the countertorque of the friction mechanism and it is at this time that the worm 55 of the motor acts as a stop to counterbalance the excess of the takeup forward torque over the frictional countertorque until the desired maximum tension is attained. The motor then turns the worm to advance the worm thread and temporarily relieves the countertorque of the motor, whereupon the takeup is able to overcome the friction and the warp is advanced to permit a slight drop in the warp tension below the maximum desired tension.

As weaving continues the diameter of the beam diminishes and a time comes when the countertorque of the friction mechanism can just balance the torque of the takeup, at which time the motor is not called upon to exert a countertorque opposed to the takeup. As the beam diameter diminishes still further the decreasing takeup torque falls below that of the friction countertorque, and it then becomes necessary for the motor to supplement the takeup so that jointly they are able to move the beam against the coun-

tertorque of mechanisms F and F'. From this stage in the weaving operation on until the beam is empty the worm 55 ceases to act as a stop and serves only to turn the beam against the friction.

It is desirable that the friction be able to exert a countertorque which would develop a tension in the warp above the aforesaid desired maximum, although this is not essential in all applications which can be made of our invention. The resistance to turning of the warp beam due to the manner of its drive can be relied upon to contribute a countertorque which will permit attainment of the maximum desired warp tension. We have found in some applications of our invention that the frictional countertorque can be comparatively small, or omitted by release of spring 107 and full reliance placed on the motor drive to develop countertorque. The advantage of the friction mechanisms F and F' grows out of the fact that they permit the use of a smaller motor than would be necessary without them under certain weaving conditions. Whenever used as described the friction mechanism serves as a protector for the motor and its worm, absorbing as it does some of the forward torque of the takeup which would otherwise be transmitted directly to the worm 55.

During normal loom running the armature of the motor is never required to establish the desired maximum tension, since that tension is developed in part by the worm. When the loom is reversed, however, the armature MA is required to establish the maximum desired tension and it should at this time be relieved of any load which the friction mechanisms could impose upon it. The ratchet 110 and pawl 111 are provided for this purpose and enable the motor to run reversely without being required to overcome the frictional resistance of mechanisms F and F'.

From the foregoing it will be seen that we have provided a letoff mechanism operated by a normally idle motor which is called into action by a contractor independent of the whip roll whenever the warp tension attains a desired maximum. It will further be seen that we have provided differential mechanism between the motor and the beam to turn the ends of the latter by substantially equal forces. Also, the beam turns about a stationary axis but is driven by chains which are not materially affected by any sagging of the beam when the latter is full of warp. The chains engage the front of their respective beam sprockets and for this reason the beam can be removed from the loom by a backward motion without disturbing the chains. Furthermore, the normally idle motor is controlled by electronic circuits the operating parts of which are normally dead but are energized to cause motor turning when the desired maximum warp tension is attained. The manual switches permit operation of the letoff either forwardly or reversely when the loom is stopped, and when running backwardly the motor is automatically stopped as soon as the desired maximum warp tension is attained. The manual switches permit operation of the letoff either forwardly or reversely when the loom is stopped, and when running backwardly the motor is automatically stopped as soon as the desired maximum warp tension is attained. The loom switches S', S2 and S3 provide means for altering the electric circuit upon loom stoppage so that the manual switch is able to control the motor M. The lay operates to open the grid circuit at front center and therefore prevents operation of the motor when the warp tension is

temporarily increased at beatup. This feature is desirable in some instances but has been found unnecessary when weaving light-weight or loosely woven fabric. The motor and its worm 55 supplement the friction mechanisms to overcome the forward torque of the takeup when the beam diameter is large, but supplement the takeup to overcome the counterforce of friction mechanisms F and F' when the beam diameter is small. Under the first of these conditions the worm not only turns the beam but also serves as a stop, while under a latter condition the stopping feature is absent and the only function of the worm is to turn the beam. When the motor is reversed the pawl 111 temporarily disconnects the friction mechanisms from the motor so that the latter need exert only enough energy to establish the desired maximum warp tension.

Having thus described our invention it will be seen that changes and modifications may be made therein by those skilled in the art without departing from the spirit and scope of the invention and we do not wish to be limited to the details herein disclosed, but what we claim is:

1. In a loom having a warp beam supplying warp which passes over a whip roll and the tension of which varies during loom operation, a normally idle electric motor, driving connections between the motor and the beam causing the latter to turn in a direction to reduce warp tension when the motor is running, a controller operatively related to part of the warp independently of the whip roll and responsive to changes in warp tension and having a contact which is closed when the warp tension reaches a given maximum, and electric means controlled by the contact causing the motor to run when said contact is closed.
2. In a loom having a warp beam supplying warp which passes over a stationary whip roll and the tension of which varies during loom operation, an electric motor, driving connections between the motor and the beam effective when the motor is running to cause the beam to supply warp to reduce warp tension, a controller engaging part of the warp which passes over the whip roll and having a contact which is closed when the warp tension reaches a given maximum, and electric circuit means causing said motor to run when said contact is closed.
3. In a loom having a warp beam which turns to supply warp the tension of which varies during loom operation, a stationary whip roll over which the warp passes, a controller mounted stationarily with respect to the loom in front of the whip roll and having a contact which is closed when the warp tension reaches a given maximum, an electric motor operatively connected to the beam to cause turning thereof in a direction to reduce warp tension when the motor is running, and electric circuit means including the motor and contact effective when said contact is closed to cause the motor to run.
4. In a loom having a warp beam which turns to supply warp the tension of which varies during loom operation, a whip roll stationary with respect to the loom and over which the warp passes when leading from the beam, part of the warp leading from the beam to one side of the whip roll and part of the warp leading forwardly from the other side of the whip roll, an electric motor operatively connected to the beam and effective when running to turn the beam in such a direction as to reduce warp tension, a controller engaging the warp at one side of the whip roll with respect to direction of travel of the warp there-

over and having a contact which is closed when the warp tension reaches a given maximum, and electric circuit means effective to cause running of the motor when the contact is closed.

5. In a loom having a warp beam which turns to supply warp the tension of which varies during loom operation, the warp leading upwardly from the beam over a whip roll and then forwardly, a normally idle electric motor operatively connected to the beam and effective when running to cause the beam to turn in a direction to reduce warp tension, a controller engaging that part of the warp in front of the whip roll and having a contact which is closed when the tension of the warp in front of the whip roll reaches a given maximum, the tension in that part of the warp in front of the whip roll being due in part to frictional engagement of the warp with said whip roll, and electric circuit means causing the motor to run when said contact is closed.

6. In letoff mechanism for a loom having a warp beam provided with a gudgeon, a bearing on the loom for said gudgeon from which the gudgeon is removable by a rearward movement, a sprocket on said beam, an endless chain mounted for movement on the loom and meshing with said sprocket in front of said gudgeon only, and means permanently meshed with said chain to move the latter during loom operation in a direction to turn said beam to deliver warp.

7. In a letoff mechanism for a loom having a warp beam removable from the loom by a rearward motion, a chain sprocket on each end of the beam, a chain for each sprocket, guide means on the loom for each chain causing the latter to mesh with the forward part only of the associated sprocket, and driving means effective to move said chains in such a direction as to cause turning of both ends of the beam by said sprockets in a direction to deliver warp.

8. In a letoff mechanism for a loom having a warp beam removable from the loom by a rearward motion, a chain sprocket on each end of the beam, a sprocket system for each end of the beam, each system including a pair of sprocket wheels, one above and the other below the corresponding sprocket, each system including a driving sprocket wheel, a chain for each system extending around the sprocket wheels thereof and meshing with the forward part of the corresponding sprocket intermediate the associated pair of sprocket wheels, a shaft for each driving sprocket in front of the beam, and power driven mechanism operatively connected to said shafts and effective by power transmitted through said shafts and chains to turn both ends of the beam in a direction to deliver warp.

9. In a loom having a warp beam which turns to deliver warp the tension of which varies during loom operation, a controller responsive to variations in warp tension and having a contact which is closed when the warp tension attains a given maximum, a normally idle electric motor effective when running to cause turning of the beam in a direction to reduce warp tension, electronic circuit means including the motor normally tending to cause the motor to run, grid circuit means controlled by said contact preventing the electronic circuit means from causing the motor to run when said contact is open but permitting said electronic circuit means to cause the motor to run when said contact is closed.

10. In a loom having a warp beam which turns to deliver warp the tension of which varies during loom operation, a contact which is closed

when the warp tension attains a given maximum, a normally idle electric motor effective when running to cause turning of the beam in a direction to reduce warp tension, an electronic tube having a grid, motor circuit means including the motor and tube normally tending to cause the motor to run and effective to do so when current can flow through the tube, and grid circuit means under control of said contact normally effective when the latter is open to enable the grid to prevent flow of current through the tube and thereby maintain the motor idle but effective when the contact is closed to alter the electric condition of the grid to enable current to flow through the tube and effect running of the motor.

11. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, a contact capable of assuming two conditions in one of which the contact is closed and in the other of which the contact is open, said contact being under control of the warp and being in one condition when the tension of the warp is less than a desired maximum and being in the other condition thereof when the warp attains said desired maximum tension, motor operating electric circuit means including an electronic tube effective when current can flow through the tube to cause the motor to run, a controlling grid for the tube, and grid circuit means controlled by said contact and effective when the latter is in said one condition thereof to enable the grid to prevent flow of current through the tube and thereby prevent running of the motor and effective when said contact is in the other condition thereof to alter said grid and enable current to flow through said tube, whereupon said electric circuit means causes running of the motor.

12. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, said motor being of the shunt wound type and having an excited field and an armature, armature controlling electric circuit means including an electronic tube and effective when electric current is able to pass through the tube to energize the armature and cause running of the motor, a control grid in said electronic tube, and grid circuit means controlled by the warp tension and effective when said tension is less than a desired maximum to enable the grid to prevent flow of current in said armature controlling electric circuit means, said grid circuit means being effective when the warp tension attains said desired maximum to alter the electric condition of the grid in such manner as to permit passage of electric current through the tube and enable said electric circuit means to energize the armature and cause running of said motor.

13. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, said motor being of the direct current shunt wound type and having a field coil which is constantly energized during loom operation and having an armature independent of the field for intermittent energization, a transformer having a secondary provided with a center tap and constituting a source of alternating current, a pair of electronic gas containing tubes having plates one of which is connected to one end of said secondary and the other of which is connected to the other end

of the secondary so that said plates are alternately positive, electric circuit means including said tubes, secondary and motor and connected to said center tap and normally tending to cause running of the motor if electric current can pass through said tubes, a control grid for each tube, and grid controlling circuit means under control of the warp tension and effective when the warp tension is less than a desired maximum to enable the grids to prevent flow of current through their respective tubes and thereby prevent said electric circuit means from causing the motor to run, said grid controlling circuit means being effective when the warp tension attains said desired maximum to alter the electric condition of said grids to enable electric current to flow through said tubes, whereupon said electric circuit means causes said motor to run.

14. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, electric circuit means for the motor under control of the warp and ineffective to cause running of the motor when the tension of the warp is less than a desired maximum but effective when the warp tension attains the desired maximum to cause said motor to run, and a manually controlled switch independent of the warp and effective when closed during loom stoppage to cause said electric circuit means to effect running of the motor independently of the tension of the warp.

15. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, a contact which is open when the tension of the warp is less than a desired maximum but is closed when the warp tension attains the desired maximum, a manually operated switch independent of the warp tension, and electric circuit means effective during loom operation when said contact is closed to cause running of the motor, said contact when open during loom operation or loom stoppage normally preventing said electric circuit means from causing running of the motor, and electric connections between said switch and said electric circuit means effective when the loom is stopped and said switch is closed to cause said electric circuit means to effect running of the motor independently of said contact.

16. In a loom having a rotatably mounted warp beam, an electric motor operatively connected to the beam to cause rotation thereof, a contact responsive to variations in warp tension and closed when the tension is below a desired maximum but open when the tension attains said desired maximum, a manually operated electric switch, and electric circuit means including the motor and controlled by said contact and switch and effective when said contact and switch are closed to cause running of the motor in a direction to cause the beam to wind warp thereon and increase warp tension to said desired maximum tension, whereupon said contact is opened and said motor stops running.

17. In a loom having a warp beam rotatable in a direction to tighten the warp, an electric motor operatively connected to the beam and effective to rotate the beam in said direction, electronic circuit means for the motor, grid means controlling said electronic circuit means, grid controlling electric circuit means, a contact closed when the warp tension is less than a desired maximum and open when the warp is at said desired

maximum tension, and a normally open manually operated electric switch, said grid controlling circuit means including said contact and switch and effective when said contact and switch are closed to effect running of the motor by said electronic circuit means to cause the beam to increase warp tension to said desired maximum with resultant opening of said contact, said electronic circuit means being ineffective to cause further running of the motor after said contact is opened.

18. In a loom having a warp beam rotatable by an electric motor and in which the warp is slack and requires tightening to a desired maximum tension by reverse turning of the warp beam by the motor, a contact responsive to changes in warp tension and closed when the warp tension is less than the desired maximum and open when the warp tension attains the desired maximum, a manual electric switch, and electric circuit means including the motor effective only when the contact and switch are closed to cause running of said motor to effect reverse turning of the warp beam and thereby cause the warp to attain said desired maximum, whereupon said contact is open and said electric circuit means becomes ineffective to continue running of the motor.

19. In a loom having a warp beam rotatable in a forward direction to deliver warp for the weaving process and rotatable in a reverse direction to tighten warp which is too slack for the weaving process, an electric motor operatively connected to the beam and effective when running forwardly to cause forward rotation of the beam and effective when running backwardly to cause reverse rotation of the beam, electric circuit means effective when closed to cause forward running of the motor, other electric circuit means effective when closed to cause backward running of the motor, and manual switch means controlling both of said electric circuit means and movable to two different positions and effective when in one of said positions to cause the first named electric circuit means to be closed and effective when in the other of said positions to cause said other electric circuit means to be closed.

20. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, loom controlled electric switch means in one position when the loom is running and in another position when the loom is stopped, electric circuit means including said switch means effective when the latter is in said one position only to cause running of the motor when the warp tension attains a desired maximum, and manually controlled electric circuit means including a manually operated switch and said loom controlled switch means and effective when the latter is in said other position only and the manually operated switch is closed to cause running of the motor.

21. In a loom having a warp beam rotatable in a forward direction to deliver warp for the weaving process and rotatable in a reverse direction to take up slackness of the warp, an electric motor operatively connected to the beam and effective when running forwardly to cause forward rotation of the beam and effective when running backwardly to cause reverse rotation of the beam, electric circuit means effective when closed to cause the motor to run forwardly during loom operation when the warp tension attains a desired maximum, other electric circuit means effective when closed to cause the motor to run

backwardly, and loom controlled switch means for both of said electric circuit means and being in the first named electric circuit means only when the loom is running and being in said other electric circuit means only when the loom is stopped.

22. In a loom having a warp beam operatively connected to an electric motor and turning forwardly to deliver warp when the motor is running forwardly and turning rearwardly to take up slackness in the warp when the motor is running backwardly, manually controlled switch means normally in neutral position but movable to either of two other positions, electric circuit means effective when said switch means is moved to one of said two positions to cause the motor to run forwardly, other electric circuit means effective when said switch means is moved to the other of said two positions to cause the motor to run backwardly, and means controlled by the loom by which each of said electric circuit means is dependent upon stoppage of the loom to effect running of the motor.

23. In a loom having a warp beam rotatable in a forward direction to deliver warp for the weaving process, an electric motor operatively connected to the beam and effective when running to cause said beam to turn forwardly, a manually controlled switch, a loom controlled switch moving to a given position when the loom stops, and electric circuit means under the joint control of the manual switch and the loom controlled switch effective only when the manual switch is closed and said loom control switch is in said given position thereof to effect running of the motor to cause forward rotation of the beam.

24. In a loom having warp beam rotatable in a reverse direction to take up slackness in the warp, an electric motor operatively connected to the beam and effective to cause reverse turning of the beam, loom control switch means which moves to a given position only when the loom is stopped, a normally open manually operated switch, and electric circuit means for the motor under the joint control of said switches and effective only when said loom control switch is in said given position thereof and the manual switch is closed to cause the motor to effect reverse turning of the beam.

25. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, electronic electric circuit means including electronic tube means and effective when current is able to flow through said tube means to cause turning of the motor, grid means for the tube means, grid circuit means controlling the grid means and including a resistance, contact means for said grid control circuit means effective when the tension of the warp is less than the desired maximum to enable said grid circuit means to create an electric condition at the grid means which prevents flow of current through the tube means, and a loom controlled switch effective when the loom is running to enable said contact when closed to short-circuit said resistance and thereby cause said grid circuit means to effect a change in the electric condition of the grid in such manner as to enable electric current to flow through the electronic tube means and electronic circuit means to cause running of the motor, said loom controlled switch effective when the loom is stopped to prevent said contact means from shortcircuiting said resistance.

26. In letoff mechanism for a loom having a warp beam operatively connected to an electric motor which when running turns the beam to deliver warp for the weaving operation, electronic circuit means including electronic tube means effective when electric current can pass through the tube means to cause running of the motor, grid means controlling the flow of electric current through said tube means, grid circuit means controlling the grid means and including a resistance, a contact under control of the warp and open when the warp tension is less than the desired maximum and closed when the warp tension attains said desired maximum, a loom controlled switch in one position when the loom is running and in another position when the loom is stopped, electric means connecting said contact and switch in a series circuit which is in parallel with said resistance when said switch is in said one position thereof, said grid circuit means effective when the switch is in said one position thereof and said contact is open to enable the grid means to prevent flow of electric current through said tube means, said switch when in said one position thereof while said contact is closed shortcircuiting said resistance and causing said grid circuit means to effect a change in the grid means in such manner as to permit flow of electric current through the tube means, and said switch when in the other position thereof preventing said contact when closed from shortcircuiting said resistance.

27. In a loom having a warp beam rotatable forwardly to deliver warp for the weaving operation and rotatable reversely to take up warp when the latter is too slack for the weaving operation, an electric motor operatively connected to the beam causing forward rotation of the latter when the motor runs forwardly and causing reverse rotation of the beam when the motor runs backwardly, electronic tube means, grid means for the tube means controlling the flow of current through said tube means and normally preventing the flow of electric current through said tube means, a plurality of manual switches movable together and normally in a neutral position and movable from said neutral position to a forward position corresponding to forward running of the motor and to a reverse position corresponding to backward running of the motor, grid control circuit means controlled by one of said manual switches and effective whether the latter be either in the forward position or the reverse position thereof to cause the grid means to permit electric current to flow through the tube means, electric circuit means including the tube means and closed through other of said manual switches when the latter are in the forward position thereof to effect forward running of the motor, and other electric circuit means including the tube means effective when said other manual switches are in the reverse position thereof to cause the motor to run backwardly.

28. In a loom having a reciprocating lay which has a beatup motion each pick of the loom, the loom having a warp beam which turns to supply warp the tension of which varies during loom operation, an electric motor operatively connected to the beam effective when running to cause turning of the beam in a direction to reduce warp tension, a controller responsive to variations in warp tensions and having a contact which is closed when the warp tension attains a given maximum prior to or after the lay reaches beatup position, the tension of the warp due to beatup of

the lay being greater than said given maximum, electronic tube means having control grid means, a motor circuit including the motor and tube means and effective when current can flow through the latter to cause running of the motor, a normally closed switch opened by the lay when the latter beats up, and grid circuit means including said contact and switch connected to the grid means and effective when said contact is open to maintain said grid in normal condition to prevent electric current from flowing through the tube means and effective only when the contact and switch are both closed to alter the grid and enable current to flow through the tube, said switch when open during closure of the contact causing said grid circuit means to maintain the grid in the normal condition thereof.

29. In a loom having a reciprocating lay which has a beatup motion each pick of the loom, the loom having a warp beam which turns to supply a warp the tension of which varies during loom operation, a contact which is closed when the warp tension attains a given maximum, the lay at each beatup causing the warp to attain a tension greater than said given maximum, an electric switch normally closed but opened by the lay at each beatup thereof, an electric motor operatively connected to the beam and effective when running to turn the beam in a direction to reduce warp tension, electronic tube means having control grid means, motor circuit means including a motor and tube means and effective when current can flow through the tube to cause running of the motor, and grid circuit means including said contact and switch in series and normally effective to enable the grid means to prevent flow of current through the tube means when either the contact or the switch is open, said grid circuit means effective when the contact and switch are both closed to alter the condition of the grid means in such manner as to permit electric current to flow through the tube and cause running of the motor.

30. In a loom having a warp beam which turns to supply warp the tension of which varies during loom operation, a takeup which exerts a given forward force on the warp tending to move the warp forwardly during loom operation, and two mechanisms acting jointly and each normally exerting rearward counter-forces on the warp which balance said given forward force and prevent forward movement of the warp, one of said mechanisms providing a counter-force incapable by itself of preventing the takeup from moving the warp forwardly, and the other of said mechanisms including an electric motor operatively connected to the beam and effective when the warp tension attains a given maximum to turn in a direction to reduce the counter-force exerted thereby sufficiently to enable the take-up to move the warp forwardly.

31. In a loom having a warp beam which turns to provide warp the tension of which varies during loom operation, a takeup effective during loom operation to exert a given forward force on the warp tending to move the latter forwardly, friction means operatively connected to the beam and continuously exerting on the latter a counter-force less than said given force tending to resist turning of the beam and forward movement of the warp, and means supplementing the counter-force of said friction means by normally exerting an additional counter-force resisting turning of the beam in a direction to deliver warp forwardly when the warp tension is less

than a given maximum but effective when the warp tension attains said given maximum to turn the warp beam in said direction and aid the takeup to move the warp forwardly.

32. In a loom having a warp beam which turns to supply warp the tension of which varies during loom operation, takeup mechanism exerting a given forward force on the warp during loom operation tending to move the warp forwardly, an electric motor, means operatively connecting the motor to the beam and effective when the motor is at rest to prevent turning of the warp beam, friction means operatively connected to the beam and normally exerting on said beam a rearward counter-force opposed to said given force and resisting turning of the beam, said motor when at rest and said friction means counter-balancing said given force of the takeup to prevent turning of the beam when the warp tension is less than a given maximum, and means effective when the warp tension attains said given maximum to cause turning of the motor to overcome the normal counter-force of the friction means and enable the takeup to move the warp forwardly.

33. In a loom operating with a warp beam supplying warp the tension of which varies during loom operation, the beam diminishing from a maximum diameter to a minimum diameter as a result of continued weaving by the loom, a take-up mechanism exerting a given forward force on the warp and exerting a maximum turning torque on the beam when the beam diameter is maximum and exerting a minimum turning torque on the beam when the beam diameter is minimum, a motor operatively connected to the beam in such manner as to prevent beam rotation when the motor is at rest and cause beam rotation in a direction to deliver warp forwardly when the motor is running, friction means exerting a given resistance to turning of the beam which can be overpowered by said maximum torque but not by said minimum torque, and means causing the motor to run when the warp tension attains a given maximum due to forward pull of the take-up on the warp, the motor when at rest aiding the friction means to resist the maximum torque of the takeup and the motor when running aiding the minimum torque of the takeup to overcome said resistance of the friction means.

34. In a loom operating with a warp beam supplying warp the tension of which varies during loom operation, the beam diminishing from a maximum diameter to a minimum diameter as a result of continued weaving by the loom, a takeup mechanism exerting a given forward pull on the warp and exerting a maximum turning force on the beam when the beam diameter is maximum and exerting a minimum turning force on the beam when the beam diameter is minimum, a motor normally at rest but running when the warp tension attains a given maximum, driving connections between the motor and the beam, and friction means exerting a counterforce tending to prevent turning of the beam less than the maximum takeup turning force but greater than the minimum takeup turning force, said driving connections and friction means jointly resisting the takeup when the turning force of the latter is greater than the counterforce of the friction means and the motor is at rest, thereby enabling the takeup to develop said given maximum warp tension, and said driving connections and takeup jointly opposing the friction means counterforce when the latter is greater than the

turning force of the takeup and the motor is running.

35. In a loom operating with a warp beam supplying warp the tension of which varies during loom operation, the beam diminishing from a maximum diameter to a minimum diameter as a result of continued weaving by the loom, a take-up mechanism exerting a given forward pull on the warp and exerting a maximum turning force on the beam when the beam diameter is maximum and exerting a minimum turning force on the beam when the beam diameter is minimum, a motor normally at rest but running when the warp tension attains a given maximum, driving connections between the beam and motor causing the beam to turn in a direction to deliver warp forwardly when the motor is running, said driving connections including a worm wheel operatively connected to the beam and a worm for the worm wheel turning with the motor, stop means limiting longitudinal motion of the worm, and friction means exerting a resisting force tending to prevent turning of the beam, said resisting force being less than the maximum take-up turning force but greater than the minimum takeup turning force.

36. In a loom operating with a warp beam supplying warp the tension of which varies during loom operation, the beam diminishing from a maximum diameter to a minimum diameter as a result of continued weaving by the loom, the inertia of the beam diminishing as the diameter thereof diminishes, a takeup exerting a forward pull on the warp and tending to overcome the inertia of the beam and turn the latter, the take-up and beam being capable of cooperating to create a tension in the warp above a desired maximum when the beam inertia is relatively large but being incapable of creating said desired maximum warp tension when the beam inertia is relatively small, friction means resisting rotation of the beam and capable of cooperating with the takeup and beam when the inertia of the latter is relatively small to create a warp tension above said desired maximum tension, motor means operatively connected to the beam effective when running to turn the beam against the resistance of the friction means in a direction to reduce warp tension, and means effective to cause the motor to run when the warp tension reaches said desired maximum.

37. In a loom having a warp beam which rotates to deliver warp for the weaving process, an electric motor operative when running to supply power to turn the beam, a force transmitting member operatively connected to each end of the beam effective when moved to cause turning of the beam, differential mechanism operatively connected to the motor and said members and effective when the motor is running to exert substantially equal forces on the ends of the beam tending to turn the latter, a friction mechanism operatively connected to each member, and means causing said friction members to exert substantially equal forces on their corresponding members tending to resist motion of the latter.

38. In a loom having a warp beam which turns to deliver warp for the weaving process, a shaft operatively connected to each end of the beam, a motor supplying power to turn the beam, differential mechanism operatively connecting the motor to the shafts and effective to cause said shafts to exert substantially equal turning forces on both ends of the beam when the motor is running, a friction mechanism operatively connected

to each shaft tending to resist rotation thereof, and equalizing means for the friction mechanisms causing the latter to exert substantially equal forces on said shafts tending to resist turning thereof.

39. In a loom having a warp beam which turns to deliver warp for the weaving process, two axially aligned shafts one operatively connected to one end of the beam and the other operatively connected to the other end of the beam, said shafts when turning causing turning of the beam, a gear secured to each shaft, a motor supplying power to turn the beam, differential mechanism operatively connecting the motor to the gears and effective to cause said shafts to exert substantially equal turning forces on their corresponding ends of the warp beam, a friction mechanism operatively connected to each gear, and equalizing means for the friction mechanism movably mounted on adjacent ends of said shafts and causing said mechanisms to exert substantially equal forces on their corresponding shafts tending to resist motion of the latter.

40. In a loom having a warp beam which turns to deliver warp for the weaving process, a shaft operatively connected to each end of the warp beam, said shafts effective when turning to cause turning of the beam, a gear turning with each shaft, a source of power to turn the beam, differential mechanism between said source and said gears effective to cause said shafts to exert substantially equal turning forces on the beam, a friction mechanism operatively connected to each gear, means limiting movement of one of said friction mechanisms in one direction axially of one of said shafts, the other friction mechanisms being mounted for axial movement along the other shaft, a member intermediate said friction mechanisms operatively connecting the latter and causing the same to exert substantially equal forces on said shafts tending to resist turning of the latter, and mechanism urging said other friction mechanism and member toward said one friction mechanism.

41. In a loom having a warp beam which turns to deliver warp for the weaving process, a source of power, a member operatively connected to each end of the warp beam, said members when moving effective to cause turning of the beam, differential mechanism operatively connecting said source and said members causing a driving force from said source to be divided substantially equally between said members to the end that the latter exerts substantially equal turning forces on the beam, and friction means operatively connected to said members and exerting substantially equal forces on the latter tending to resist movement thereof by said source.

42. In a loom having a warp beam which turns to deliver warp for the weaving process, a shaft operatively connected to each end of the warp beam, a source of power, differential mechanism operatively connecting said source to said shafts and effective to transmit substantially equal forces from said source to said shafts to effect turning of the beam, a set of rotatable friction plates turning with each shaft, a member intermediate said shafts, a second set of stationary friction disks for each shaft held against rotation by said member, and means including said member forcing the rotatable disks of each set into frictional relation with the corresponding set of stationary disks and causing said friction disks to exert substantially equal forces tending to resist motion of said shafts.

43. In a loom having a warp beam which turns to deliver warp for the weaving process, a shaft operatively connected to each end of the beam, a source of power, a differential mechanism operatively connecting the source to the shafts and transmitting substantially equal turning forces from said source to said shafts to effect turning of the beam, a friction mechanism operatively connected to each shaft, a stationary member intermediate said friction mechanisms, each friction mechanism having a set of friction disks moving with the corresponding shaft when the latter turns and engaging another set of friction disks held against movement by said member, said friction mechanisms exerting substantially equal forces on said shafts tending to resist turning thereof by power derived from said source and transmitted through said differential mechanism.

44. In a loom having a warp beam rotatable forwardly to reduce warp tension and rotatable backwardly to increase warp tension, a motor capable of running either forwardly or backwardly, driving connections between the motor and the beam turning the latter forwardly when the motor runs forwardly and turning the beam backwardly when the motor runs backwardly, friction means for the beam, and control means for the friction means effective to cause the latter to resist forward movement of the beam but causing the friction means to be ineffective to resist backward movement of the beam.

45. In a loom having a warp beam rotatable forwardly to reduce warp tension and rotatable reversely to increase warp tension, a motor operatively connected to the beam and effective when running forwardly to effect forward turning of the beam and when running backwardly to effect reverse turning of the beam, friction mechanism, and control means for said friction mechanism causing the latter to be effective to resist forward movement of the warp beam but ineffective to resist reverse movement of the warp beam.

46. In a loom having a warp beam turning forwardly to reduce warp tension and turning reversely to increase warp tension, a motor operatively connected to the beam and effective when running forwardly to effect forward turning of the beam and effective when running backwardly to effect reverse turning of the beam, friction mechanism including parts operatively connected to the motor and moving when the latter runs and a member operatively connected to other parts of the friction mechanism frictionally engaging the first named parts, said member moving with said other parts, and control means for said member effective when the motor is running forwardly to hold said member stationary to cause the friction mechanism to resist forward movement of the beam and operative when the motor is running backwardly to enable said member to move with said other parts and cause the friction mechanism to be ineffective to resist reverse turning of the beam.

47. In a loom having a warp beam rotatable forwardly to reduce warp tension and rotatable reversely to increase warp tension, an electric motor capable of running either forwardly or backwardly, and operating connections between each end of the beam and the motor, said connections effective to rotate the beam forwardly when the motor is running forwardly and rotate the beam reversely when the motor is running backwardly, a friction mechanism for each of said connections, and control means for said

friction mechanism causing the latter to resist forward rotation of the beam but ineffective to resist reverse rotation of the loom.

48. In a loom having a warp beam rotatable to supply a sheet of warp threads, rotary driving mechanism for each end of the beam, differential mechanism connected to each of said driving mechanisms, an electric motor effective when running to cause said differential mechanism to effect rotation of both of said driving mechanisms to cause the latter to turn each end of the beam at the same rate, contact means controlled by and responsive to variations in tension of a small group of warp threads of said sheet located between the sides of the latter, and electric circuit means controlled by said contact means and effective when the tension of said group of warp threads increases to a given value to cause running of the loom.

49. In a loom having a warp beam rotatable to supply a sheet of warp threads, an electric motor, contact means controlled by a small group of warp threads of said sheet between the sides of the latter responsive to variations in tension of the threads of said group, electric means controlled by the contact means and effective when the tension of the threads of said group attains a given maximum to cause the motor to run, and force transmitting means including a differential mechanism operatively connecting the motor to each end of the beam and effective to cause turning of both ends of the beam at the same rate and in a direction to deliver said sheet of warp when the motor runs.

50. In a loom having a warp beam rotatable to supply a sheet of warp threads, a normally idle actuator, control means controlled by and

responsive to variations in tension of a small group of warp threads of said sheet located between the sides of the latter, force transmitting means including differential mechanism operatively connecting the actuator to each end of the beam and effective when the actuator operates to exert substantially equal turning forces on each end of the beam, and means controlled by said control means effective to cause operation of the actuator when the tension of the threads of said group attains a given value.

VICTOR F. SEPAVICH.
CLARENCE R. KRONOFF.

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