

Nov. 1, 1949.

R. A. FUHRER ET AL

2,486,525

WARP KNITTING MACHINE

Filed March 25, 1948

4 Sheets-Sheet 1

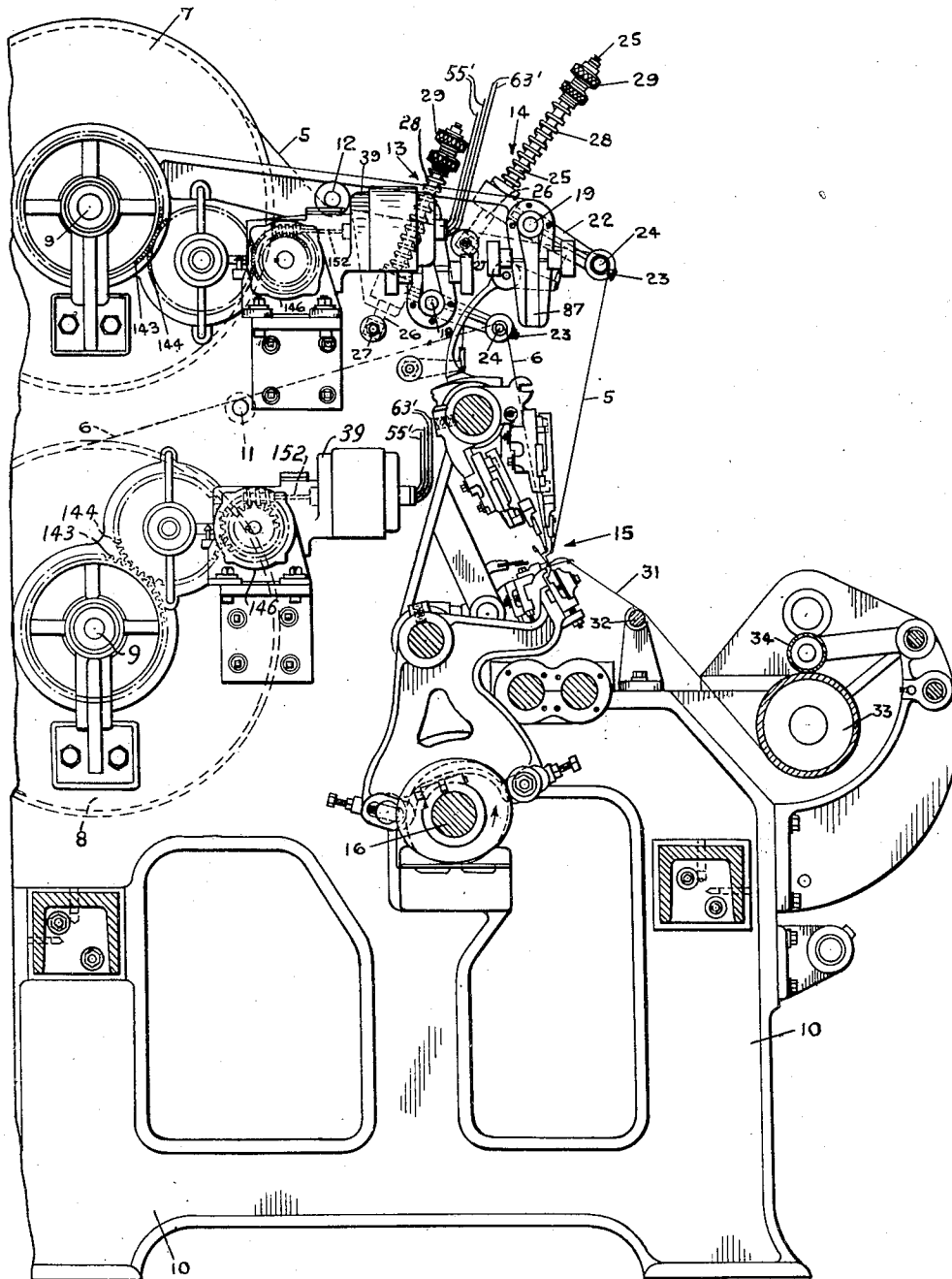


Fig. 1

INVENTORS

R. A. FUHRER,
R. H. ROUGHSEDE,
H. G. LUSTIG.

BY

L. Seligman & Co.
ATTORNEYS

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4 Sheets-Sheet 2

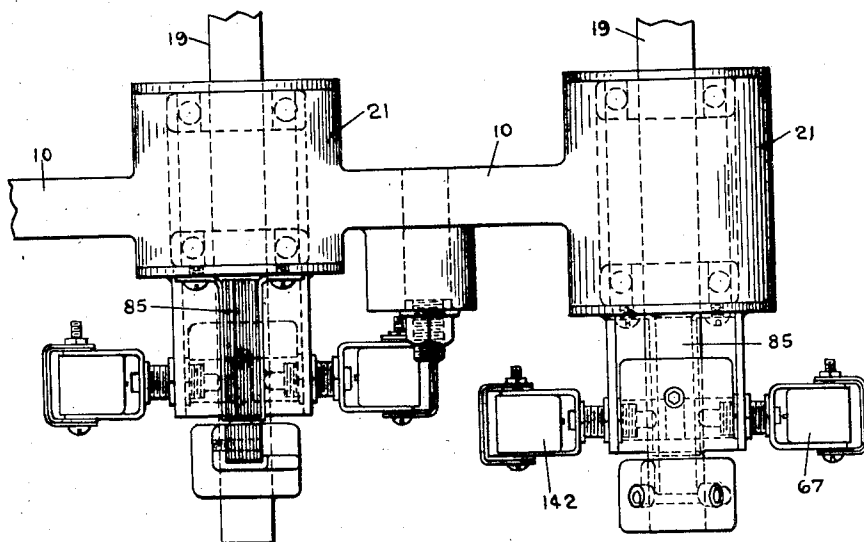


Fig 2

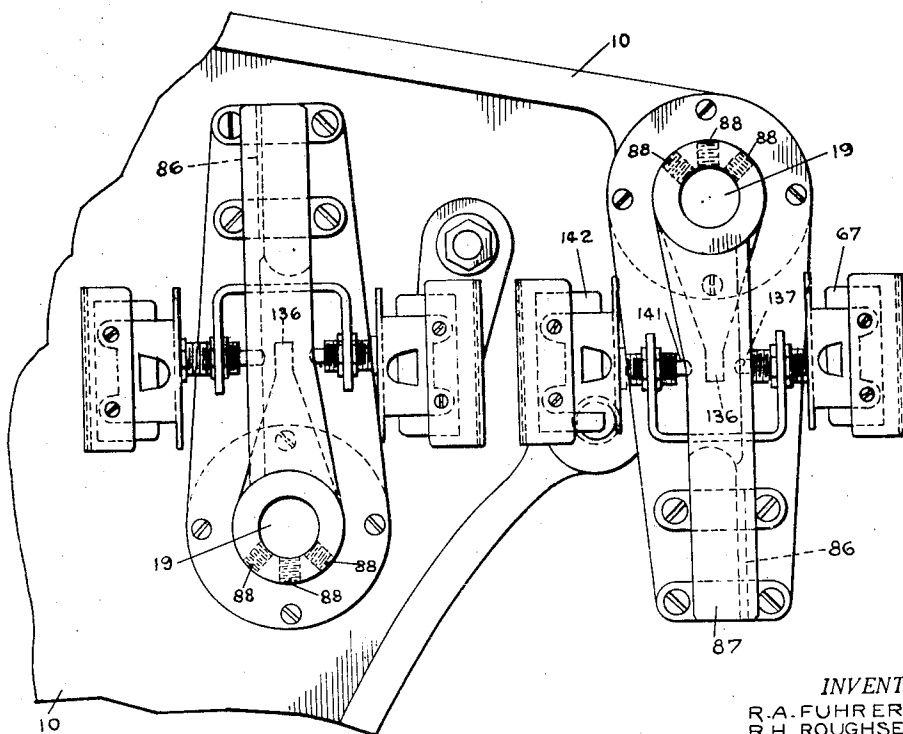


Fig-3

INVENTORS.

R.A. FUHRER
R.H. ROUGHSEGE.
H.G. LUSTIG.

BY

J. Seligman & Co. Inc.
ATTORNEYS

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4 Sheets-Sheet 3

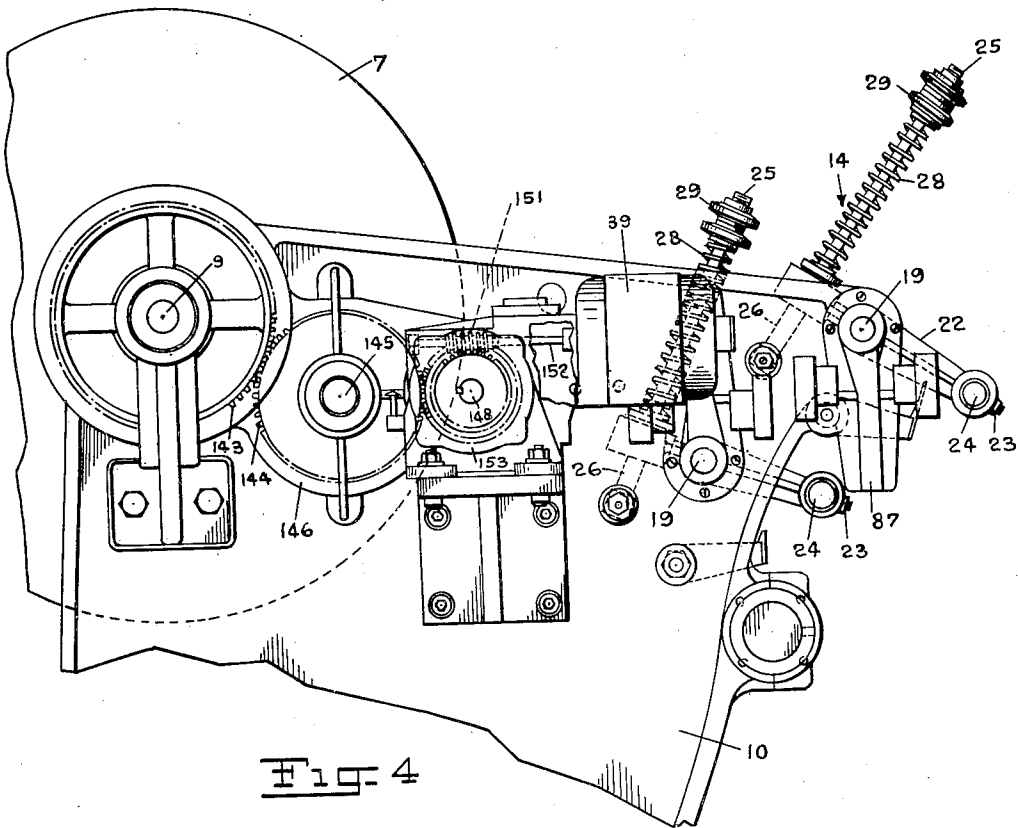


Fig. 4

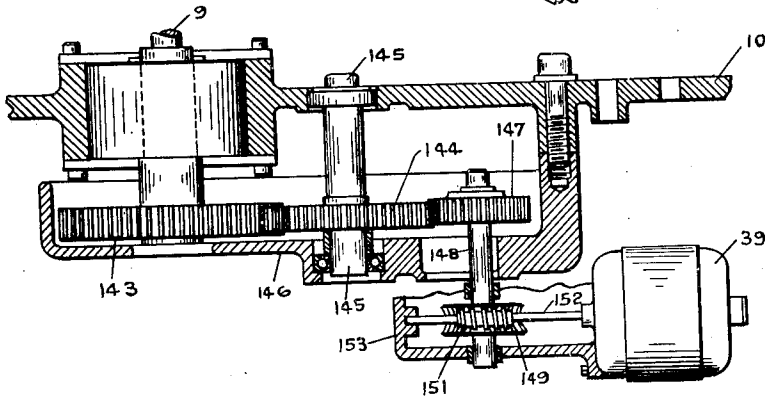


Fig. 5

INVENTORS

R.A. FUHRER.
R.H. ROUGHSEGE.
H.G. LUSTIG.

BY

J. H. McAlister
ATTORNEYS

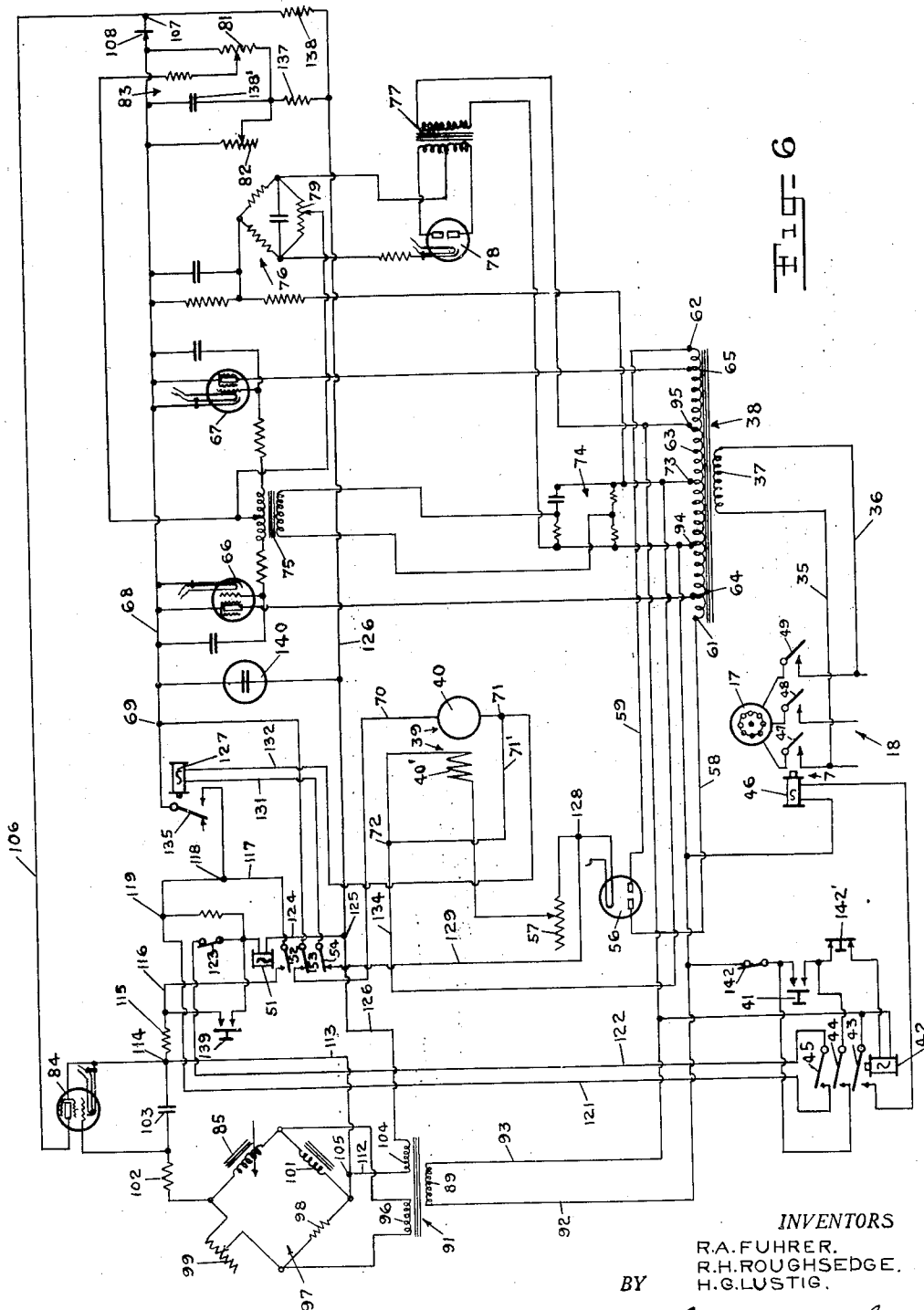
Nov. 1, 1949.

R. A. FUHRER ET AL
WARP KNITTING MACHINE

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4 Sheets-Sheet 4



INVENTORS

R.A. FUHRER,
R.H. ROUGHSEDE,
H.G. LUSTIG.

BY

J. H. L. & C. L. L.
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,486,525

WARP KNITTING MACHINE

Raymond A. Fuhrer, Malverne, N. Y., Robert H. Roughsedge, Ramsey, N. J., and Hans G. Lustig, New York, N. Y., assignors to Celanese Corporation of America, a corporation of Delaware

Application March 25, 1948, Serial No. 17,046

15 Claims. (Cl. 66—86)

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This invention relates to warp knitting machines, and relates more particularly to improved mechanism employed in connection with warp knitting machines for controlling the let-off of the thread from the warp beam.

In the usual method of producing warp knitted fabrics, that is, fabrics in which a number of warp threads are knitted together in each course, a number of warp threads are drawn off a beam or a number of sectional beams and, on their way to the thread guides and needles, are passed over a tension element. The tension element comprises a bar carried by arms pivotally mounted to allow the bar to oscillate under variations in the tension of the warp threads. The movement of the bar is used to control the mechanism for letting off the warp threads from the warp beam or beams. In prior warp knitting machines, the bar was connected by suitable mechanism to a clutch through which was driven a warp beam, or to a mechanical brake which controlled the rotation of the warp beam.

It was found that prior methods of feeding thread from the warp beam to the knitting elements caused variations to be introduced in the tension of the thread since the feeding of the thread did not synchronize with the taking up of the thread during each knitting course. This is particularly true in warp knitting machines operating at high speeds. It is, accordingly, an important object of this invention to control the thread let-off in a warp knitting machine so as to produce a uniform linear thread let-off speed so that the thread is delivered in the exact quantity required by the knitting elements and under substantially uniform tension throughout each knitting course.

Another object of this invention is the provision of a motor for positively controlling the warp beam or beams for letting off warp threads, including an electronic control device for regulating the speed of said motor and regulating the linear let-off speed of the warp threads.

A further object of this invention is to provide in a warp knitting machine novel means, including an electronic controller, for maintaining the tension bar within predetermined limits for maintaining a predetermined range of tensions on the warp threads being fed to the knitting elements.

Other objects of this invention, together with certain details of construction and combinations of parts, will appear from the following description and accompanying drawings.

According to this invention, which will be described in connection with a two-bar warp knit-

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ting machine although it is also applicable to a one-bar warp knitting machine, the torque which rotates the warp beams is substantially transmitted by the tension of the warp threads, said tension being applied to the warp threads by the knitting elements. Between the warp beams and the knitting elements are interposed tension bars which are provided with manually adjustable springs for placing on the warp threads a tension of the magnitude required for knitting. This tension is maintained during knitting by regulating the amount of warp thread let off the beams. In this manner, a fabric is produced which is uniform as regards the size of the loops and their shape since the quantity of thread fed to each loop is uniform.

Regulation of the amount of warp threads let off the beams is effected by connecting each of the shafts on which the warp beams are mounted to a direct current motor through suitable toothed gears to a worm wheel which meshes with a worm operatively connected to the output shaft of a direct current motor. In a two-bar warp knitting machine, in connection with which the present invention is being described, there is an upper warp supply and a lower warp supply. The basic let-off speed for each warp supply is different and, therefore, a separate direct current motor is employed for effecting the let-off of each warp supply. However, the regulation of the let-off speeds of both warp supplies must occur simultaneously. The control for each of said direct current motors is, as stated, electronic, providing a continuously regulated armature voltage thereon.

The speed of each direct current motor, and therefore the let-off speed of each warp supply, is effected by means of a variable reactor electronically connected to the motor and a reactor bar operatively connected to the tension bar. The movement of the tension bar causes the reactor bar to vary the air gap of the magnetic field of the coil of the variable reactor. The difference between the voltage drop of the variable reactor and a fixed reactor electrically connected thereto triggers a gas-filled tetrode tube. The firing of this tetrode tube, through suitable electric and electronic connections, causes additional voltages to be placed on the direct current motor armature, thus increasing the speed thereof to an extent depending upon the frequency with which the reactor bar enters the effective field of the variable reactor.

When the let-off speed is equal to or greater than the knitting speed, i. e. when the tension on the tension bar is below the present amount,

the reactor bar will not enter the reactor field; accordingly, the tetrode tube will not fire and the speed of the let-off motor will be reduced.

Means are provided adjacent to the reactor bar for stopping the operation of the direct current or let-off motors as well as the motor for operating the knitting elements when the tension on the warp threads is so great as to approach the breaking point of said warp threads. This means comprises two limit switches, one on each side of the reactor bar and a finger movable with said reactor bar for operating said limit switches.

The invention will now be described in greater detail with reference to the accompanying drawings, wherein

Fig. 1 is a side elevational view, partly in section, of a warp knitting machine embodying this invention,

Fig. 2 is a view showing in top plan the reactor and reactor bar as attached to the warp knitting machine,

Fig. 3 is a front elevational view of the elements shown in Fig. 2,

Fig. 4 is a detailed view on an enlarged scale of the gearing and motor arrangement for regulating the amount of warp threads let off the beams,

Fig. 5 is a cross-sectional view showing the gearing arrangement as operatively connected to the warp beam shaft and to the shaft of the direct current motor, and

Fig. 6 is a circuit diagram showing the electrical and electronic connections of one of the motor controls.

Like reference numerals indicate like parts throughout the several views of the drawings.

In Fig. 1, warp threads 5 and 6 are shown taken from warp beams 7 and 8, respectively, each of which is maintained on a shaft, such as shaft 9, suitably supported on frame 10 of a two-bar warp knitting machine. The frame 10 also supports guide rods 11 and 12 and tension devices, generally indicated by reference numerals 13 and 14, with which elements the warps 5 and 6 are in contact on their way to the knitting elements, generally indicated by reference numeral 15. The knitting elements, as is well understood in the art, are operated by means of suitable elements operatively connected to the cam shaft 16 which is rotated by an alternating current motor 17, see Fig. 6, normally placed on the floor supporting the warp knitting machine at the rear thereof. Motor 17 is supplied with 3-phase, standard cycle alternating current from supply lines, generally indicated by reference numeral 18.

The tension devices 13 and 14 each comprises a rod 19 pivotally mounted in and extending through bosses 21 in the frame 10 of the warp knitting machine. Rod 19 extends laterally across the machine and adjacent its ends has fixed thereto an arm 22 in one extremity of which is fixed, as by means of a set screw 23, a tension bar 24. The rearwardly extending portion of arm 22 is provided with an opening for the passage therethrough of a rod 25, the lower end 26 of which is connected at 27 to machine frame 10. Rod 25 has mounted thereon a compression spring 28. This spring acts between arm 22 and lock nuts 29 threaded on rod 25 and so resists downward movement of the tension bar 24 under the tension of the warp threads. The degree of resistance to the downward movement of the tension bar 24, and thus the amount of tension placed on the warp threads, may be adjusted by movement of the lock nuts 29.

The knitted fabric 31 passes over guide rod 32, under roller 33 and on to take-up roller 34.

The means for controlling the rate of let-off of warp threads will now be described, particularly in connection with the circuit diagram shown in Fig. 6.

As indicated above, 3-phase, standard cycle, alternating current from supply lines 18 supply the current of motor 17 of the warp knitting machine. Leads 35 and 36 from the alternating current power supply conduct current from one phase of the 3-phase supply lines to primary coil 37 of transformer 38. Transformer 38 will eventually provide the power for a direct current motor 39 consisting of armature 40 and its field 40', the function of which will hereinafter be described, after it is properly controlled and modified in the circuits to be described.

The control device of the present invention is initiated by operating push button 41 to cause relay 42 to be energized, thus closing contacts 43, 44 and 45. When contact 43 closes, relay 46 is energized and closes contacts 47, 48 and 49, thus putting full voltage across the knitting motor 17 causing it to operate at full speed for driving the warp knitting machine. Simultaneously, contact 44 causes relay 42 to be electrically locked in so that contacts 43, 44 and 45 remain closed even after push button 41 is released. The closing of contact 45 enables relay 51 to be energized in a manner to be hereinafter described, thus closing contacts 52 and 53 and opening contact 54. The function of these contacts will be described below.

The shunt field 40' is supplied through leads 55' (Fig. 1) with current rectified by the use of a full-wave rectifier vacuum tube 56 and is controlled by a field rheostat 57. The current is supplied to said rectifier tube 56 by leads 58 and 59 tapped from points 61 and 62 on secondary coil 63 of transformer 38.

The closing of contact 53 causes a rectified voltage to be impressed through leads 63' (Fig. 1) upon the armature 40 of direct current motor 39. This armature current is supplied by secondary coil 63 from contact taps 64 and 65. The armature current is rectified through gas-filled tetrodes 66 and 67, the rectified current entering lead 68. From lead 68 the rectified current passes through junction 69, contact 53, which is now closed, through lead 70 to the armature 40 of motor 39, to junction 71, through lead 71' to junction 72, and back to center tap 73 of secondary transformer coil 63. The basic running voltage across the armature 40 of motor 39 is controlled by means of the bias voltage impressed on the grids of tetrodes 66 and 67. This grid bias is basically supplied from secondary transformer coil 63, through the network generally indicated by reference numeral 74 which includes a transformer 75, serving to shift the phase of the grid bias voltage in relation to the plate voltage in such a manner as to give substantially constant rectified output voltage under various conditions of speed and load. This grid bias is further modified and controlled by a network generally indicated by reference numeral 76 including a transformer 77, a rectifier vacuum tube 78 and a potentiometer 79. The potentiometer 79 controls the grid bias within the tetrodes 66 and 67 in such a manner as to control the basic running speed of direct current motor 39. The arrangement above described drives the direct current motor 39 at a predetermined constant speed which moves substantially constant for all

values of motor load which may occur. The grid bias is additionally modified by an adjustable potentiometer 81 and rheostat 82 which are parts of a controlling network, generally indicated by reference numeral 83.

The speed at which the motor 39 is set to run is determined by the amount of warp threads on the warp beam. The initial basic speed at which the motor is set to run is predetermined when the warp beam is at full capacity. As the warp threads on the warp beam are run off, the diameter of the windings on the beam decreases. In order to keep the linear velocity of the thread being let off the beam constant, the rotational speed of the beam must be increased. This constant linear let-off speed of the warp threads is maintained as follows: when the tension of the yarn is slightly more than normal, the impedance of variable reactor 85 is increased due to a reactor arm 86 cutting deeper into the field of said variable reactor. The reactor arm 86 is fixed to reactor bar 87 which is mounted, as by means of said screw 88, on tension element pivot arm 19 for movement therewith.

The change of impedance in the variable reactor 85 serves to control the speed of direct current motor 39. To this end, primary coil 59 of transformer 91 is supplied with current to leads 92 and 93 which are tapped in secondary coil 63 of transformer 38 at contact points 94 and 95, respectively. The secondary coil 96 of transformer 91 impresses an alternating current voltage across a bridge circuit, generally indicated by reference numeral 97, which consists of a fixed resistor 98, a rheostat 99, a fixed reactor 101, and the variable reactor 85. This bridge through resistor 102 and by-pass condenser 103 controls the grid of gas-filled tetrode 84 in such a manner that when the reactor arm 86 does not enter the field of the variable reactor 85, tetrode 84 will not conduct current therethrough, but when the reactor arm 86 goes deeper into the field of variable reactor 85, the tetrode 84 will conduct current therethrough. The firing of tetrode 84 causes the voltage applied upon the terminals of armature 40 of motor 39 to be increased above the preset armature voltage by a superimposed increment of voltage, the magnitude of which is controlled by potentiometer 81. The duration of time during which these superimposed increments are supplied for each signal from tube 84 may be varied from $\frac{1}{2}$ to 8 cycles, depending upon the setting of rheostat 82. Moreover, if a new signal fires tetrode 84 while the circuit is still responding to a preceding signal, the succeeding voltage increments for both signals are added to one another, thus smoothing off all armature voltage changes gradually. This also holds true if more than two signals pile up.

The superimposed voltage increments referred to in the above paragraph are created by changing the phase relation between grid potential and plate potential in gas-filled tetrodes 66 and 67, thereby causing an additional voltage increment to be applied upon the armature 40 of direct current motor 39. This method of controlling the average value of direct current by varying the phase of the grid voltages is well known to the art. The network which controls the functions described above comprises secondary coil 104 of transformer 91, lead 126, resistors 137 and 138, potentiometer 81, rheostat 82, capacitor 138', rectifier 108, lead 106, gas-filled tetrode 84, and leads 113 and 112.

Means are provided in the control circuit for

preconditioning another circuit for initially energizing relay 51. Thus, upon the energization of primary coil 37 of transformer 38, relay 127 is energized by current taken from secondary coil 63 at taps 61, 65 and 62, the current passing through rectifier vacuum tube 56. The rectified current passes through junction 128 and lead 129 to normally closed contact 54, through lead 131, relay 127, lead 132 to junction 71, through lead 71' to junction 72, through lead 134 to center tap 73 in secondary coil 63. Energizing the relay 127 causes contact 135 to close.

This initial energization of relay 51 is possible only when reactor arm 86 is in such relative position to the adjustable reactor 85 as to cause gas-filled tetrode 84 to fire. This arrangement insures that the direct current motor 39 will not start running unless there is sufficient tension in the yarn to move the tension bar in a position which causes reactor arm 86 to enter the field of variable reactor 85, thus causing tetrode 84 to fire. When reactor arm 86 is in such a position the following takes place: one phase of the current from secondary coil 104 of transformer 91 passes through lead 126, to junction 125, through lead 124, relay 51, normally closed limit switch 123, through lead 122 to contact 45, through lead 121 to junction 119, to junction 118, through contact 135 to junction 69, through lead 68 and rectifier 108 to junction 107, through lead 106 to the plate of gas-filled tetrode 84, then passes through to the cathode of tetrode 84, through lead 113 and junction 105 back to secondary coil 104. Thus coil 51 is energized. When contact 52 is closed by the energization of coil 51 it causes said coil 51 to be sealed in by closing the circuit consisting of secondary coil 104, lead 112 to junction 105, lead 113 to junction 114, current limiting resistor 115, lead 116 to contact 52, lead 117 to junction 118 to junction 119, lead 121 to contact 45, lead 122 through normally closed limit switch 123, relay 51, lead 124 to junction 125 and lead 126 to secondary coil 104.

It is to be noted that the other half cycle of the alternating current going out of secondary coil 104 is cut off by the gas-filled tetrode 84. Therefore, the initial half cycle passing through relay 51 causes it to pick up and lock in through contact 52. Simultaneously, the energization of relay 51 in this sequence causes normally closed contact 54 to open, thus de-energizing relay 127 and effecting the opening of contact 135.

When yarn tension becomes excessively slack due to some faulty setting of the variable elements of the control, the position of the tension bar 24 causes reactor arm to move to the right, as shown in Fig. 3, to such an extent that finger 136, attached to and movable with reactor bar 87, comes into contact with push button 137 of limit switch 123 causing the same to open momentarily. This opening of the limit switch de-energizes relay 51, causing contact 53 to open which will slow down the speed of direct current motor 39. This slowing down of the speed of motor 39 causes the yarn tension to increase and the tension bar to be restored to its normal operating range. The de-energization of relay 51 also causes contact 54 to close thereby energizing relay 127 to close contact 135. Contact 52 is also opened by the de-energization of relay 51 unsealing the same.

When the tension on the yarn has been restored to its initial amount, the reactor arm 86 will again cut into the field of the variable re-

actor 85, causing the tetrode 84 to fire and re-energize relay 51 in the manner described above and to again place the control in normal operation. When the yarn tension becomes too great, the finger 136 on reactor bar 87 is caused to be moved to the left, thus coming in contact with push button 141 and opens limit switch 142 to stop the rotation of motor 17.

Push button 138 is placed in the circuit in order to permit the warp beam to be rotated without turning the knitting motor 17. Thus, when push button 139 is closed, relay 51 is energized by closing a circuit energized by secondary coil 104. The energization of relay 51 causes contact 53 to close and impress the rectified voltage derived from tetrodes 66 and 67, and further derived from secondary coil 63 to be impressed across the armature terminals of motor 39.

Glow discharge tube 140 is placed across lead 68 to lead 126. The glowing of said tube 140 indicates the firing of tetrode 84.

In order to halt the operation of the entire system, a push button 142' is supplied, the opening of said push button causing, through suitable electrical connections, the stopping of the operation of the control arrangement and also the stopping of the motors 17 and 39.

In Figs. 4 and 5, there is shown the means provided for regulating the amount of warp threads let off the warp beams, in cooperation with the reactor arrangement described above. Thus, each shaft 9 on which the warp beams are mounted has fixed thereon a toothed gear 143 which meshes with a toothed idler gear 144 fixed to a shaft 145 journaled in the frame 10 of the machine and in the housing 146. The idler gear 144 meshes with a toothed gear 147 fixed to one end of a shaft 143 on the other end of which is fixed a worm wheel 149. Meshing with said worm wheel is a worm 151 fixed to the output shaft 152 of direct current motor 39. The worm wheel, worm and shaft are housed in a casing 153 mounted on the housing 146 and the casing of motor 39.

The tangent of the lead or helix angle of the worm 151 is such that it is equal to or less than the coefficient of friction between the worm wheel and the worm. This makes for a worm-gearing which is self-locking. Accordingly, the worm wheel cannot drive the worm so that, when the motor is not rotating the worm, the worm wheel is braked or locked by friction. However, the rotation of the worm by the motor 39, which operates continuously during the knitting operation and is electronically controlled as described above, permits of the free rotation of the worm wheel and the toothed gears operatively connected thereto, thus allowing the warp beams to be rotated by the tension of the warp threads.

Since the tension on the warp threads is transmitted thereto by the knitting elements, it is apparent that the main knitting machine alternating current motor 17 indirectly exerts the torque on the warp beams, while the direct current motor or motors, merely controls the speed of rotation of the warp beam, or beams. Controlling the speed of rotation of the warp beams causes the amount of warp threads to be let off therefrom, which amount is sufficient to maintain the position of the tension bar, or tension bars, and, therefore, the tension on the warp threads within predetermined limits.

It is to be understood that the foregoing detailed description is merely given by way of illustration and that many variations may be made

therein without departing from the spirit of our invention.

Having described our invention, what we desire to secure by Letters Patent is:

1. In a warp knitting machine wherein the torque for rotating a warp beam is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a motor operatively connected to said warp beam, and electronic means operated by said reactor arm for continuously controlling the speed of said motor.

2. In a warp knitting machine wherein the torque for rotating a warp beam is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a motor, gearing operatively connecting said motor to said warp beam, and electronic means operated by said reactor arm for continuously controlling the speed of said motor.

3. In a warp knitting machine wherein the torque for rotating a warp beam is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a motor, gearing, including a worm wheel and worm, operatively connecting said motor to said warp beam, and electronic means operated by said reactor arm for continuously controlling the speed of said motor.

4. In a warp knitting machine wherein the torque for rotating a warp beam is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a motor, gearing, including a self-locking worm wheel and worm, operatively connecting said motor to said warp beam, and electronic means operated by said reactor arm for continuously controlling the speed of said motor.

5. In a warp knitting machine wherein the torque for rotating a warp beam, mounted on a shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a gear fixed to said shaft, a motor, gearing connecting said motor and said gear on said shaft, and electronic means operated by said reactor arm for continuously controlling the speed of said motor so as to cause said warp threads to be let off said warp beam in an amount sufficient to maintain the position of said tension bar within predetermined limits.

6. In a warp knitting machine wherein the torque for rotating a warp beam, mounted on a

shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, a reactor arm movable by said tension bar, a gear fixed to said shaft, a motor, gearing, including a worm wheel and worm, connecting said motor and said gear on said shaft, and electronic means operated by said reactor arm for continuously controlling the speed of said motor so as to cause said warp threads to be let off said warp beam in an amount sufficient to maintain the position of said tension bar within predetermined limits.

7. In a warp knitting machine wherein the torque for rotating a warp beam is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, means for adjusting the position of said tension bar, a reactor arm movable by said tension bar, a motor operatively connected to said warp beam, and electronic means operated by said reactor arm for continuously regulating the armature voltage applied to said motor.

8. In a warp knitting machine wherein the torque for rotating a warp beam, mounted on a shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for controlling the let-off of the warp threads from said warp beam, said means comprising a movable tension bar over which the warp threads pass on their way to said knitting elements, means for adjusting the position of said tension bar, a reactor arm movable by said tension bar, a gear fixed to said shaft, a motor, gearing connecting said motor and said gear on said shaft, and electronic means operated by said reactor arm for continuously regulating the armature voltage applied to said motor so as to cause said warp threads to be let off said warp beam in an amount sufficient to maintain the position of said tension bar within predetermined limits.

9. In a two-bar warp knitting machine wherein the torque for rotating the warp beams is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, a reactor arm movable by each of said tension bars, a motor operatively connected to each of said warp beams, and electronic means operated by each of said reactor arms for separately and continuously controlling the speed of each of said motors.

10. In a two-bar warp knitting machine wherein the torque for rotating the warp beams is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, an oscillating reactor arm movable by each of said tension bars, two direct current motors, gearing connecting each of said motors to its respective warp beam, and electronic means operated by

each of said reactor arms for separately and continuously controlling the speed of each of said motors.

11. In a two-bar warp knitting machine wherein the torque for rotating the warp beams is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, an oscillating reactor arm movable by each of said tension bars, two direct current motors, gearing, including a worm wheel and worm, connecting each of said motors to its respective warp beam, and electronic means operated by each of said reactor arms for separately and continuously controlling the speed of each of said motors.

12. In a two-bar warp knitting machine wherein the torque for rotating the warp beams is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, an oscillating reactor arm movable by each of said tension bars, two direct current motors, gearing, including a self-locking worm wheel and worm, connecting each of said motors to its respective warp beam, and electronic means operated by each of said reactor arms for separately and continuously controlling the speed of each of said motors.

13. In a two-bar warp knitting machine wherein the torque for rotating the warp beams, each mounted on a shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, means for adjusting the position of said tension bars, a reactor arm movable by each of said tension bars, a gear fixed to each of said shafts, two direct current motors, gearing connecting each of said motors to its respective gear on said shafts, and electronic means operated by said reactor arm for separately and continuously controlling the speed of each of said motors so as to cause said warp threads to be let off each of said warp beams in an amount sufficient to maintain the position of said tension bars within predetermined limits.

14. In a two-bar warp knitting machine wherein the torque for rotating the warp beams, each mounted on a shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let-off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, means for adjusting the position of said tension bars, a reactor arm movable by each of said tension bars, a gear fixed to each of said shafts, two direct current motors, gearing, including a worm wheel and worm, connecting each of said motors to its respective gear on said shafts, and electronic means operated by said reactor arm for separately and continuously regulating the armature voltage applied to each of said motors so as to cause said warp threads to be let off each of said warp beams in an amount

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sufficient to maintain the position of said tension bars within predetermined limits.

15. In a two-bar warp knitting machine wherein the torque for rotating the warp beams, each mounted on a shaft of said machine, is transmitted by the tension of the warp threads applied by the knitting elements, means for separately controlling the let off of the warp threads from said warp beams, said means comprising movable tension bars over which the warp threads pass on their way to said knitting elements, means for adjusting the position of said tension bars, a reactor arm movable by each of said tension bars, a gear fixed to each of said shafts, two direct current motors, gearing, including a self-locking worm wheel and worm, connecting each of said motors to its respective gear on said shafts, and electronic means operated by said reactor arm for separately and continuously regulating the armature voltage ap-

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plied to each of said motors so as to cause said warp threads to be let off each of said warp beams in an amount sufficient to maintain the position of said tension bars within predetermined limits.

RAYMOND A. FUHRER,
ROBERT H. ROUGHSEGE,
HANS G. LUSTIG.

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The following references are of record in the file of this patent:

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Certificate of Correction

November 1, 1949

Patent No. 2,486,525

RAYMOND A. FUHRER ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 9, for "buton 138" read *button 139* ;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.
Signed and sealed this 2nd day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

November 1, 1949

Patent No. 2,486,525

RAYMOND A. FUHRER ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 9, for "buton 138" read *button 139* ;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.
Signed and sealed this 2nd day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.