Dec. 16, 1958 F. C. WIESINGER 2,864,248

KNITTING MACHINE DRIVE MEANS

Filed May 24, 1956 3 Sheets-Sheet 1

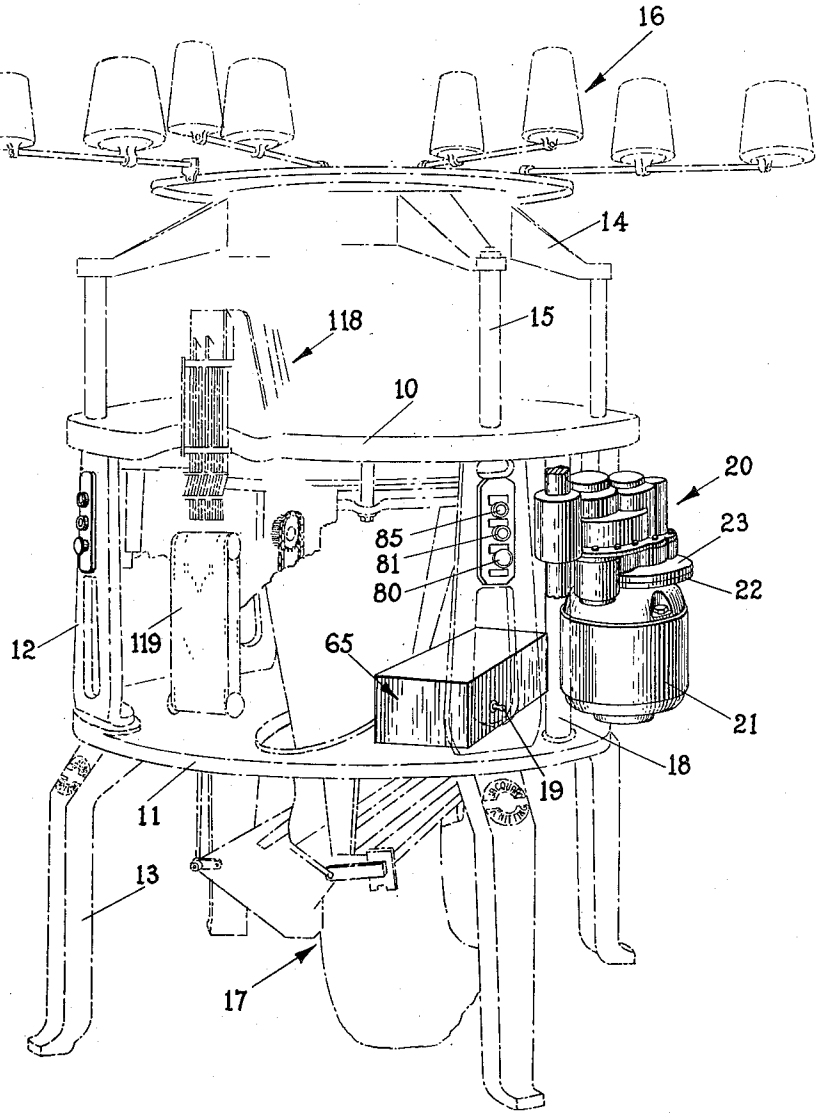


FIG. 1

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KNITTING MACHINE DRIVE MEANS

Filed May 24, 1956 3 Sheets-Sheet 2

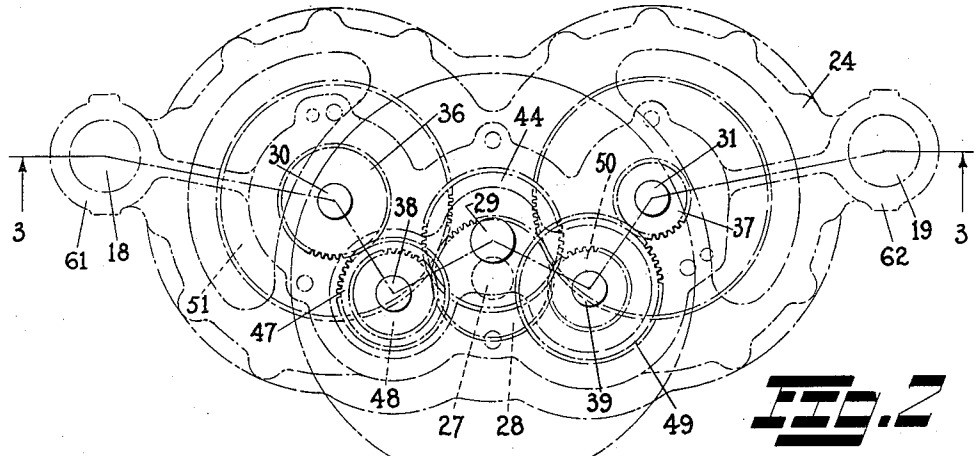


FIG. 2

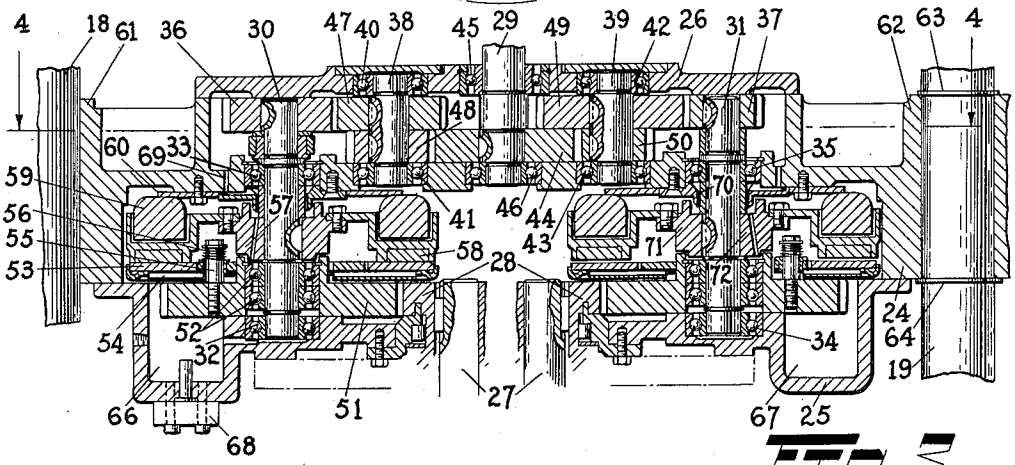


FIG. 3

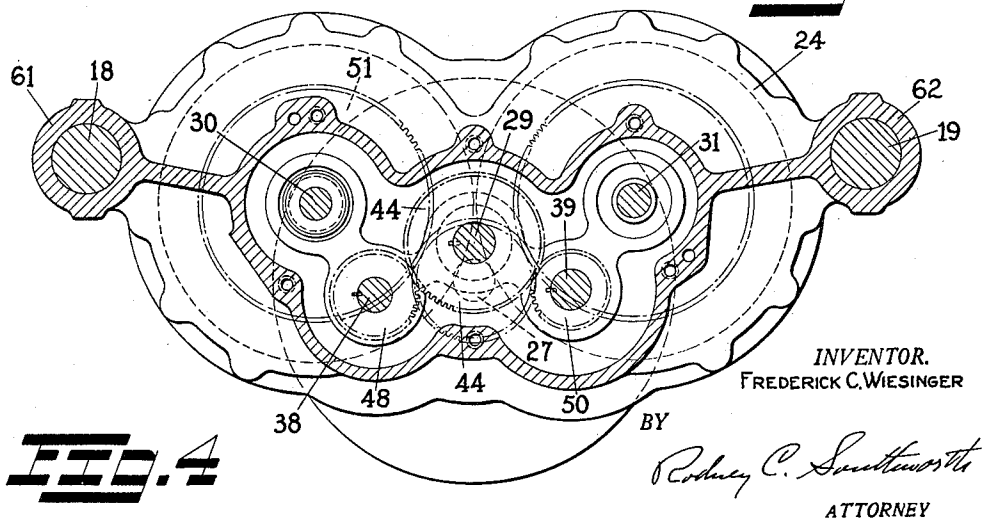


FIG. 4

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KNITTING MACHINE DRIVE MEANS

Filed May 24, 1956 3 Sheets-Sheet 3

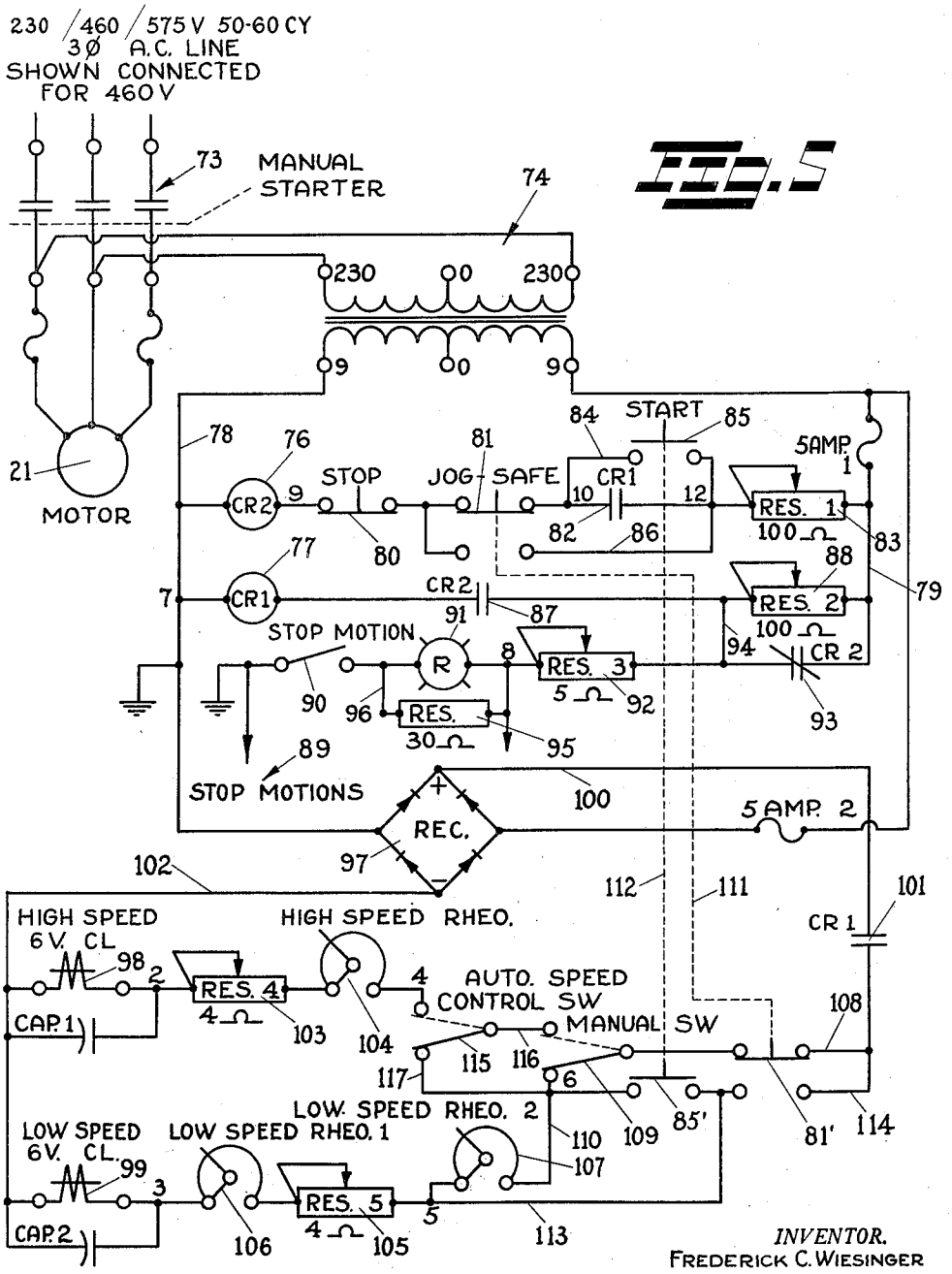


FIG. 5

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2,864,248

KNITTING MACHINE DRIVE MEANS

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Application May 24, 1956, Serial No. 586,959

14 Claims. (Cl. 66—56)

This invention relates to a novel drive for a knitting machine, especially for a circular, independent needle type machine of large diameter.

It is a general object of the invention to devise a more effective drive which shall require less space, that is, shall extend beyond the general circular confines of the machine to which applied to a much lesser extent than drives heretofore utilized.

A more specific object is that of providing a two speed drive which may shift automatically from high to low and vice versa and which will change the speed of the machine without shock or jerk.

Another object is that of providing a drive fully enclosed and automatically lubricated which shall be silent and trouble free in its operation over a very long period of use.

A further object is that of providing a drive which may be manually controlled in all its phases, that is, may be stopped, started and jogged, and which shall always be jogged in low speed no matter where other controls are set.

Another object is that of providing a circuit which shall serve through selectively energized electric clutches to start and to operate the machine at either of two speeds and which when dropping back from high to low speed, shall automatically cushion the drive against shock or jerk as the transition is made.

Another object is that of providing that the machine may stop safe, that is, when stopped through the stop motions, it cannot be started until there are no stop motions indicating a break.

Another object is that of providing for smooth change of speed with greater differential between high and low speeds.

Other objects will appear from the following more detailed disclosure.

Knitting machines of the type described, especially those adapted for knitting sweaters or other types of garments or material in which there is a transition from one form of knitting to another, for example, from plain to rib or the reverse, or when effecting any intricate function at the needles or other instrumentalities such as might more advisably be performed at a lower speed, are frequently provided with a two speed drive. These drives function through gearing and to this time, have involved one or more mechanically operated clutches. While they have functioned fairly well they have been bulky, have required a horizontally disposed motor, and have always been subject to too much shock or jerk in their transfer from one speed to another.

It is desirable that a drive be designed to extend radially of the machine frame as small a distance as possible so that the knitter in moving about the machine and in performing certain tasks at the various feeds shall be hampered as little as possible. It is also desired that the machine be provided for control by push buttons at several points about its peripheral extent and that the knitter be able to start, stop, set on "safe" or jog the

machine at will. A series of stop motions is also to be employed and these must perform their intended function in the circuit and also prevent starting of the machine so long as any imperfection or trouble remains uncorrected.

According to the invention, a vertically disposed drive with motor and reduction gearing combined with clutches disposed one above the other, is interconnected for driving the rotary members, either the cylinder, cylinder and dial, double cylinders, or cam rings or plates, as the case may be. The vertical arrangement as herein presented, is most compact and permits the use of simple spur or spiral gearing, and of electric clutches with effective lubrication for bearings and gears without adversely affecting the clutches.

A circuit is used in which all starting, stopping and jogging are provided for and in which the energization and control of the electric clutches is tied in so that all functions may be controlled manually, and also, when set on automatic control, the changes will be effected through the same devices but governed by a pattern or other means which is adapted to control the cycle through which the machine functions in the performance of its intended task.

The invention will be described in greater detail by reference of one specific embodiment thereof as illustrated in the accompanying figures of drawing, wherein:

Fig. 1 is a perspective view showing the invention as applied to one knitting machine of the type to which it pertains.

Fig. 2 is a plan view of the driving unit.

Fig. 3 is a section taken at line 3—3, Fig. 2.

Fig. 4 is a section taken at line 4—4, Fig. 3.

Fig. 5 is a diagrammatic view of the circuit employed.

Now referring to Fig. 1, the invention is shown applied to a knitting machine having an upper bed plate 10 and a lower bed plate 11 connected by uprights 12 and supported upon legs 13. The machine is of the dial and cylinder type although that is not necessary as the invention applies to all similar machines. A dial supporting bracket 14 is carried on posts 15 and also supports a yarn supply creel 16 in a well known way. The fabric knitted is drawn down as shown by a fabric take up 17 and the general aspects or details of the machine will not be described further here since they are set forth in detail in United States Patent 2,082,127.

The drive unit shown in position at the side of the machine is supported on vertical posts 18 and 19, Figs. 2 and 3 also, and has a casing generally indicated at 20 which houses all gearing shafts and clutches which serve to convey the driving torque of a motor 21 to the driven member or members of the machine. Motor 21 is vertically disposed and is connected by a suitable flanged attaching means to the lower side of the casing. The top flange 22 of the motor is bolted to a lower flange 23 of the casing.

Now referring more particularly to Figs. 2, 3 and 4, the casing is comprised of a central unit 24, a bottom section 25 and a cover 26. These bolt together conventionally to form a relatively tight housing. The motor 21 delivers its torque to the gearing and other parts of the transmission unit through its shaft 27 and motor pinion 28. As can be seen, the section at Fig. 3 is taken on a series of angularly disposed planes so that it is not a true section, however, it is thought to be simpler and more informative than would be any section taken at a single plane. However, since the input shaft is in front of the output shaft 29 at the top, it appears twice or at least with its halves separated in order to keep other centers and gear diameters in proportion.

At the outer wings of the casing shafts 30 and 31 are rotatably mounted in bearings 32 and 33 for the former

and 34 and 35 for the latter. At their upper ends these shafts have keyed thereto pinions 36 and 37. By these, either one or the other, depending on which is driving, will rotate shaft 29 through other gears on shafts 38 and 39 respectively. These shafts are rotatable in bearings 40 and 41 for shaft 38 and 42 and 43 for shaft 39. Output shaft 29 has a gear 44 keyed to its lower end and it, in turn, is carried in bearings 45 and 46. The manner in which the drive can be shifted from one side to the other will be explained in due course, but if the drive is through shafts 30 and 38 to shaft 29, then gears 47 and 48 keyed to shaft 38 convey power from pinion 36 to gear 44. If the opposite side becomes effective gears 49 and 50 perform the same function. As can be seen from an inspection of the gear diameters, the right hand side is the low speed drive while that at the left is the high speed side. By altering the sizes of the gears the driving ratios may be varied as desired. While ball bearings have been shown here, other anti-friction bearings, plain bushings or combinations thereof may be substituted if desired.

Neither side presents what is naturally a direct drive, but rather each is dependent upon a clutch which is preferably of electric type in that mechanical clutch elements are electrically caused to engage frictionally to complete the drive through one side or the other as desired. Here the particular clutch used is a Warner SF–825, but it is to be understood that others may be substituted. This particular model is preferred since its field magnets are stationary and thus the units require no slip rings or brushes.

Both clutches are alike so only one need be described in detail. Pinion 28 meshes with a gear 51 freely rotatable on bearings 52 on shaft 30 and this gear mounts the armature 53 of the clutch. This latter part is constituted as a magnetically attractable plate carried by a grid 54 of pressed steel, both parts being apertured for sliding vertically upon a plurality of spaced studs 55 threaded into the gear. Springs 56 tend to press the armature downwardly or out of contact with the driven rotor. Autogap regulators, a part of these clutches as built, maintain a minimum gap so that only reasonable current is required to engage the clutch.

The latter or driven part includes a hub 57, rotor 58 within which is annularly disposed a field magnet 59 held in place by plate 60 bolted to the casing member 24. There is an air gap or clearance between the rotor and magnet, but when energized, the latter pulls the armature up into engagement with the lower surface of the rotor thereby establishing a friction clutching drive so that gear 51 will drive rotor 58 through armature 53 and since the rotor hub is keyed to shaft 30 it will drive output shaft 29 through gears 36, 47, 48 and 44.

Of course, the rotor is of non-magnetic material and the clutching surfaces are of type for transmitting driving torque without unusual pressure. The voltage applied to the field may be varied within limits to provide an effective drive yet avoid too sudden gripping between the parts such as might cause jerking at the start or when changing speed.

The posts 18 and 19 support the unit since the integral hubs 61 and 62 are held in position on the posts by snap rings 63 and 64. These hubs are also set screwed to the posts.

The clutch fields are energized through electrical conduits (not shown in these views) which pass through the casing and extend back to other electrical parts of the device which are housed in a control box 65 mounted in a convenient place, preferably on lower bed plate 11.

The unit is lubricated by a drip feed from a pump as delivered by certain tubes (not shown) which introduce lubricant at the top. It is fed to bearings and gears and is kept from the clutch parts by certain plates and baffles. The excess of oil as it reaches the lower part of the casing at the connected pockets 66 and 67 is then collected for recirculation through a conduit 68.

Oil pumped to the top can descend through bearings 33 and 35 or holes 69 in the casing and then is constrained by baffles 70 and 71 to pass through holes 72 in the rotor hubs to bearings and gears at the lower part of the casing.

The clutch actually functions in an oily atmosphere and some oil at the friction surfaces helps the engagement making it smoother. Oil cannot adversely affect the electrical part of the clutch since there are no slip rings.

Now referring to Fig. 5, a circuit diagram will be explained, this circuit being one particular embodiment which has been very successfully employed, although other arrangements and variations are contemplated and would fall within the general requirements of the control functions according to the invention. Briefly, the circlit includes an A. C. starting circuit, conversion to D. C. and a D. C. clutch control circuit which is tied in with the starting circuit and with control automatically derived from the cycle determining means at the machine itself.

A three-phase A. C. line is employed to conduct current of proper characteristics to the motor 21 which is controlled by a manual push button switch 73 or other appropriate means for the purpose.

Single phase current is then tapped off this line to a transformer 74 by which voltage is reduced to about 9 volts for the remainder of the circuit.

First taking the starting circuit, current at 9 volts is conducted to two relays 76 and 77 in parallel across lines 78 and 79. Relay 76 is a starting relay and in line with a stop switch 80, a jog switch 81, clutch relay controlled points 82 and a variable resistance 83. Points 82 are shunted by line 84 in which is found the starter switch 85, also by a second shunt line 86 for the jog switch 81.

Relay 77 is a clutch relay and is in line with starting relay controlled points 87 and a variable resistance 88.

A third line also in parallel between the lines 78 and 79 contains a stop motion circuit 89 in which are to be found a plurality of stop motions controlled by the knitting yarns, fabric, latches of needles, etc., and of the usual type. Any one of these, if activated, will have the effect of closing a switch such as 90 to complete the circuit through ground. This stop motion line has in it a resistance in the form of a lamp 91, a variable resistance 92 and normally closed points 93 which open very shortly after current passes; then current to the clutch relay and to the stop motions must pass resistance 88 whereas initially it is conducted through points 93 and line 94. Reasons for this will be explained in due course.

A resistance 95 in a shunt line 96 about lamp 91 serves when the lamp burns out to prevent failure of the stop motion.

Current from the output side of transformer 74 is also supplied to a rectifier 97 which may be of the full wave selenium or any other satisfactory type to convert to direct current for the clutches. Voltage is reduced to about 6 volts which is appropriate for the particular clutches employed.

Current at the output of the rectifier is connected to the clutches 98 and 99 through a conduit 100 and normally open points 101 which are closed when the relay 77 is pulled in. It may be selectively directed to either clutch by means to be described. These clutches are in parallel and their circuits may be completed to the rectifier through line 102.

Clutch 98 is positioned at the high speed side while clutch 99 is in the low speed train, Fig. 3. In the high speed clutch circuit there are in series with it, a variable resistance 103 and a rheostat 104. Low speed clutch 99 also has a similar variable resistor 105 and rheostat 106 in series with it and also a second rheostat 107 for a purpose to be explained.

Current through points 101 may pass in line 108, jog switch 81' and through a manually controlled switch 109 which, in its full-line position, will complete the circuit through line 110, rheostats 107 and 106 and resistance 105 to the low speed clutch.

As shown by the dotted lines 111 and 112, the jog switch 81 is interlocked with the switch 81' in the clutch circuit, while starter switch 85 is likewise interlocked with its companion switch 85' in the clutch circuit.

A shunt line 113 bypasses the rheostat 107 when starting. At that time switches 85—85' will be temporarily closed and current passes through line 108, switches 81' and 109 and then through switch 85' and shunt line 113 to the clutch through resistance 105 and rheostat 106 to the clutch 99. As soon as the button at 85 is released the shunt line 113 is opened at switch 85' and current then passes in line 110 and rheostat 107 to the clutch through both resistance 105 and rheostat 106. Thus a higher voltage is available at the start to render the clutch more positive. When running at high speed, the clutch becomes effective only on a shift down from that high speed to low, and it is desirable then to reduce voltage so that a little slip may cushion the shock of the step down. Of course, when running at low speed continuously, it takes less voltage for the clutch than when starting.

A similar situation applies when jogging. The jog switch 81' permits the circuit for the clutch 99 to be completed through line 114 to 113, bypassing rheostat 107. The circuit through manual switch 109 is then opened at the jog switch so that all jogging must occur at low speed no matter where the other controls may be set.

An automatic speed control switch 115 serves to select the high or low speed circuits when starting or running. In full line position current must pass to the clutch 99 directly through manual switch 109 if it is set for low speed, or through line 116, switch 115, lines 117 and 110, etc., if the manual switch is in dotted line position.

When switch 115 is in dotted line position, it completes the circuit through the high speed side if the switch 109 is also at its high speed side.

Switch 115 is mechanically connected to be controlled by a pattern at a controller unit on the machine. This unit comprises a stand 118 and pattern 119 and need not be described in greater detail here since a disclosure thereof is available in the patent, above noted. By connections (not shown) the switch is moved to or from the high or low sides as the requirements for speed changes are indicated at the pattern or other control.

To summarize, the operation of the drive merely involves use of manual switch 109 and of stop button 80, jog-safe button 81 and starter button 85, once the motor has been started by its manual switch 73. The jog-safe button may be turned about 90° or more from a jog to a safe position in the latter of which the switch is locked in an intermediate position thus opening the line through the starting relay 76 so that it is then impossible to start the machine until the button has been turned back to start position. These controls are duplicated at four points about the machine and the same functions may be controlled at each of them.

Assuming the machine to be in condition to start, the starter button 85 is pressed down and completes a circuit around points 82 and the relay 76 will be pulled in. It controls points 87 and 93 so that the former close and the latter (normally closed) will open to permit current to pull in relay 77, the clutch relay. That relay controls points 82 to close them so that both relays are held in, points 82 and 87 closed and points 93 opened so that resistances 83 and 88 are both in circuit. From this point the voltage at the relays is only slightly more than enough to hold them in. Relay 77 also closed points 101 thereby completing a circuit through the rectifier 97 and the clutches and their control mechanisms.

At the latter, the interlocked switch 85' also completed a circuit through one or the other clutches depending upon the positions of manual control 109 and automatic speed control switch 115. Assume the manual switch to be at the low speed side (full line position). Current is shunted around rheostat 107 since it passes through line 108, jog switch 81', switch 109 to closed switch 85' and line 113 to resistance 105, rheostat 106 and the clutch. As soon as the starter button is released the circuit through the shunt line is broken, but then current flows to switch 109 and in line 110 to rheostat 107 and to the clutch.

If the manual switch is in the dotted position, the same thing happens except that current passed through that switch to switch 115 through line 116 and back through 117 and switch 85' to the shunt line 113 first, then as the starter button is released, directly to the clutch through both rheostats and resistance 105.

If the automatic speed control switch is in dotted position and the manual switch at low speed side, then the machine starts and runs at low speed, but if the switch 109 is also at the dotted (high speed) side, current can only pass in line 108, switch 81', switch 109, line 116 and by switch 115 to clutch 98 through resistance 103 and rheostat 104.

Of course, movement of the switch 115 from high to low while the machine is running shifts the power from one clutch to the other thus changing the rotational speed of the machine. At the down shift the fact that the extra rheostat 107 is in circuit, cuts down the voltage on clutch 99 to make it grip less positively and thus to smooth out the action.

To jog the machine it makes no difference what the position of switches 109 and 115 may be. The jog button 81 is pushed in and completes a circuit through shunt line 86 around points 82. Then the same functions take place in the A. C. circuit, points 101 close and D. C. is supplied to the clutch circuit. However, current flows in line 114, through interlocked jog switch 81', shunt line 113 and to the clutch 99. The machine runs at low speed as long as the button is held down, but stops when it is released.

To stop the machine at any time it is merely necessary to break the circuit by stop button 80.

If any one of the stop motions 89 functions, it has the effect of closing a switch 90 grounding the circuit so that current thus shorted drops the voltage at the two lines above releasing relays 76 and 77. The latter are merely holding since resistances 83 and 88 are so set. The lamp 91 has a relatively high resistance and pulls down the voltage very noticeably when lighted. It also serves as a signal. Resistance 92 is variable and is set to protect the fuse in line 79. A shunt line 96 and resistance 95 function only when the lamp burns out; at that time the stop motion would otherwise become ineffective.

The machine stops "safe" since with the stop motion circuit grounded, there cannot be sufficient voltage at relay 77 to pull it in. The machine cannot be restarted until all faults are corrected.

Resistance 103 and 105 are set to cut the current to 6 volts to protect the clutches.

Resistance 88 is set so that relay 77 can be pulled in, but drops the voltage sufficiently at that point so that once all of the circuit is functioning, a very small drop in voltage will cause relay 77 to drop out and open contacts 101, 82 and stop the machine.

By use of the invention herein described, it is possible to confine the dimensions of the machine exterior within bounds such that the operator may get at the various feeds and other parts of the machine at any point about its circumference without reaching past a bulky, projecting drive unit. The top speed may be increased considerably while keeping the same low speed so that the differential between the two is greater without introducing shock as the speeds are changed. That would not have

been possible if one or more mechanical clutches and/or gear shifts or the like were to be employed. The unit is self-contained and adjustments are mainly effected by the very simple expedient of voltage controls as explained.

While one embodiment of the invention has been disclosed, it is to be understood that the inventive concept may be carried out in a number of ways. This invention is, therefore, not to be limited to the precise details described, but is intended to embrace all variations and modifications thereof falling within the spirit of the invention and the scope of the claims.

I claim:

1. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, and clutch means in said casing which comprises two independent clutches, reduction gearing from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for selectively engaging the drive through said clutches and for changing the drive from one to the other.

2. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, and clutch means in said casing which comprises two independent, electric type clutches, reduction gearing from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for selectively energizing either of said clutches and for discontinuing the drive by deenergizing both clutches.

3. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, two parallel gear trains of differing speed ratio housed in said casing for conveying torque from the motor to the member to be rotated, a clutch in each train and means for selectively engaging either of said clutches.

4. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, two parallel gear trains of differing speed ratio housed in said casing for conveying torque from the motor to the member to be rotated, a clutch in each train and means for selectively engaging either of said clutches, which includes both a manually controlled and an automatically controlled means.

5. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, two parallel gear trains of differing speed ratio housed in said casing for conveying torque from the motor to the member to be rotated, an electrically controlled clutch in each gear train through which said train may be rendered effective or ineffective to complete the drive, and a circuit through which said clutches are controlled which includes means for selectively energizing either clutch and for deenergizing both upon stopping the machine.

6. Mechanism as defined in claim 5 wherein said circuit comprises a starting circuit and a clutch control circuit with push button control means interlocked to affect both parts of said circuit simultaneously.

7. Mechanism as defined in claim 5 wherein said circuit comprises a starting circuit and a clutch control circuit, means to start, stop and jog the machine forming a part of said circuit and other switch means for selectively energizing either clutch as required while the machine is running.

8. Mechanism is defined in claim 5 wherein said circuit comprises a starting circuit and a clutch energizing and control circuit, means to start, stop and jog the machine forming a part of said circuit, switch means for manually and for automatically controlling the energization of either clutch and a shunt circuit so devised that upon jogging the machine, only that clutch at the low speed side shall be energized.

9. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, and clutch means in said casing which comprises two independent, electric type clutches, reduction gearing from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for selectively energizing either of said clutches and for discontinuing the drive by deenergizing both clutches, said means including a circuit from a direct current source to said clutches, said circuit having two branches and means selectively to open either circuit independently of the other.

10. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, two parallel gear trains of differing speed ratio housed in said casing for conveying torque from the motor to the member to be rotated, a clutch in each train and means for selectively engaging either of said clutches, a variable resistor in each branch of the circuit and a means to shunt out that resistor at the low speed clutch circuit when starting.

11. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor vertically disposed at one side of said frame, a casing aligned with said motor attached to the frame and to which the motor is connected, two parallel gear trains of differing speed ratio housed in said casing for conveying torque from the motor to the member to be rotated, a clutch in each train and means for selectively engaging either of said clutches, a variable resistor in that branch of the circuit leading to the high speed clutch, two variable resistors in that branch leading to the low speed clutch and means including a shunt circuit for by-passing one of said resistors in the low speed circuit at starting.

12. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor disposed at one side of said frame, a casing adjacent said motor and supported at said frame, clutch means in said casing which comprises two independent, electric type clutches, a power transmission from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for

selectively energizing either of said clutches and for discontinuing the drive by deenergizing both clutches.

13. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor disposed at one side of said frame, a casing adjacent said motor and supported at said frame, clutch means in said casing which comprises two independent, electric type clutches, a power transmission from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for selectively energizing either of said clutches and for discontinuing the drive by deenergizing both clutches, said means including a circuit from a direct current source to said clutches, said circuit having two branches and means selectively to open either circuit independently of the other.

14. In a knitting machine the combination of a frame, a needle cylinder and a cam cylinder in said frame one of which is rotated relatively to the other and a drive means for that member which is rotated which comprises an electric motor disposed at one side of said frame, a

casing adjacent said motor and supported at said frame, clutch means in said casing which comprises two independent, electric type clutches, a power transmission from said motor to each clutch, gearing differing in ratio from each clutch to said member to be rotated, and means for selectively energizing either of said clutches and for discontinuing the drive by deenergizing both clutches, said means including a circuit from a direct current source to said clutches, said circuit having two branches and means selectively to open either circuit independently of the other, one branch of said circuit leading to a high speed clutch and the other to a low speed clutch, a variable resistor in that branch of the circuit leading to the high speed clutch, two variable resistors in that branch leading to the low speed clutch and means including a shunt circuit for by-passing one of said resistors in the low speed circuit at starting.

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