Feb. 3, 1959 R. BASSIST 2,871,685

CONTROL METHOD AND ELECTRIC SYSTEM FOR TEXTILE MACHINES

Filed Dec. 6, 1955 3 Sheets-Sheet 1

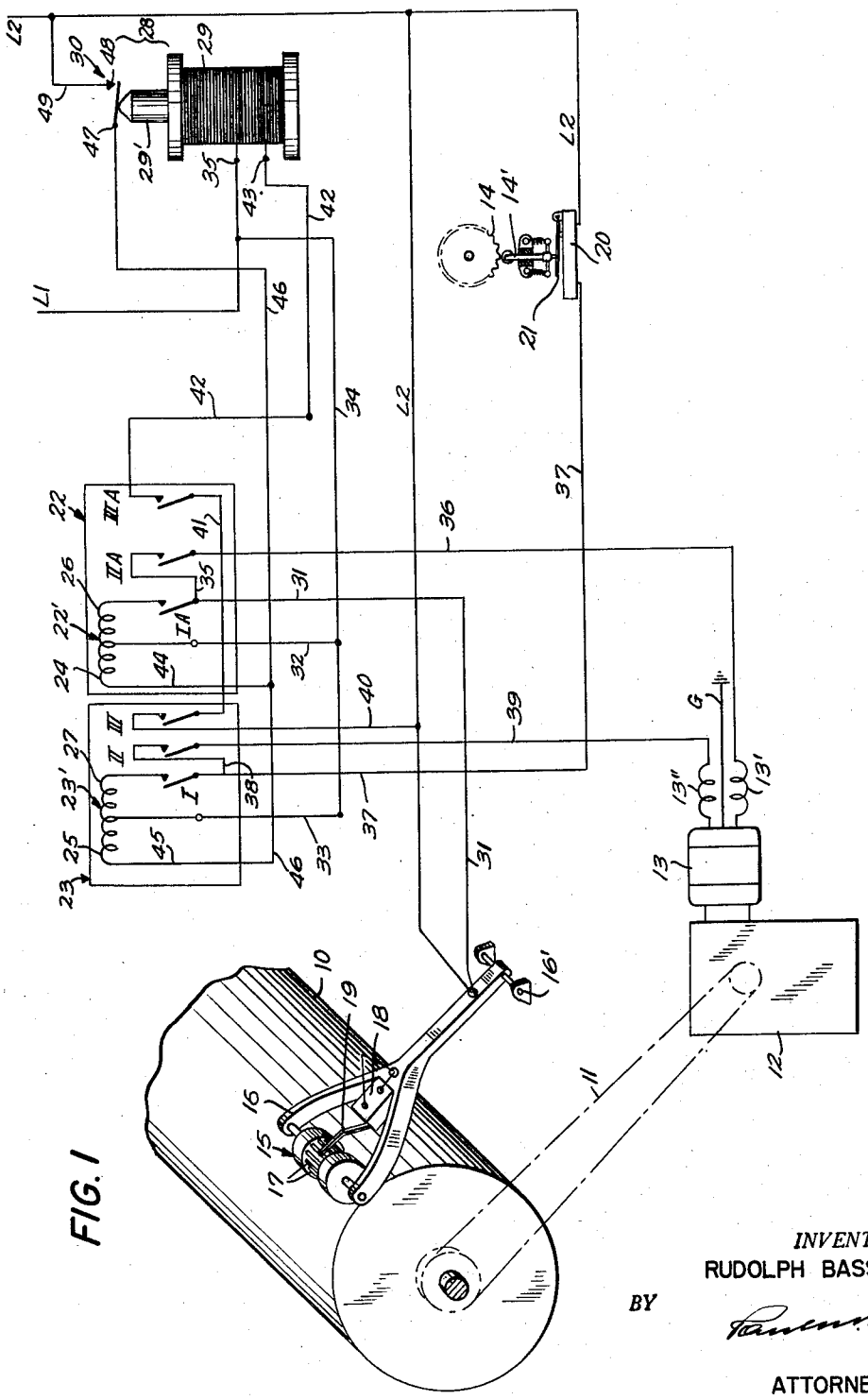



FIG. 1

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CONTROL METHOD AND ELECTRIC SYSTEM FOR TEXTILE MACHINES

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FIG. 2

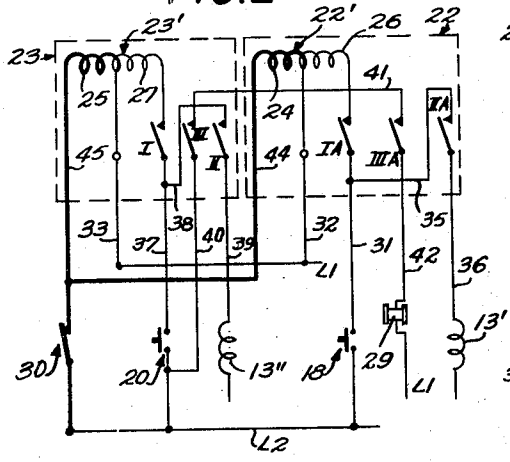



FIG. 3

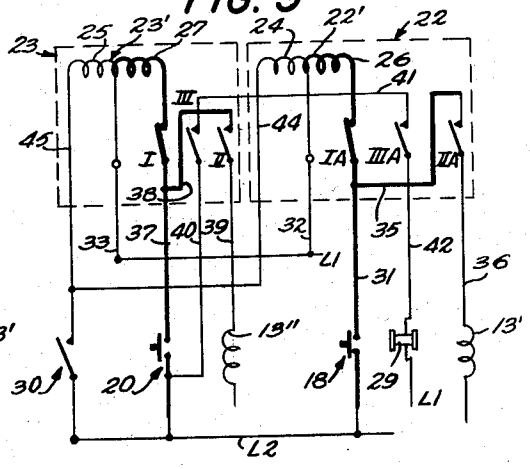



FIG. 4

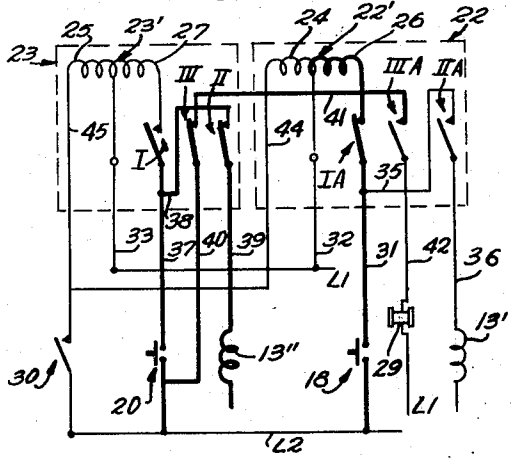
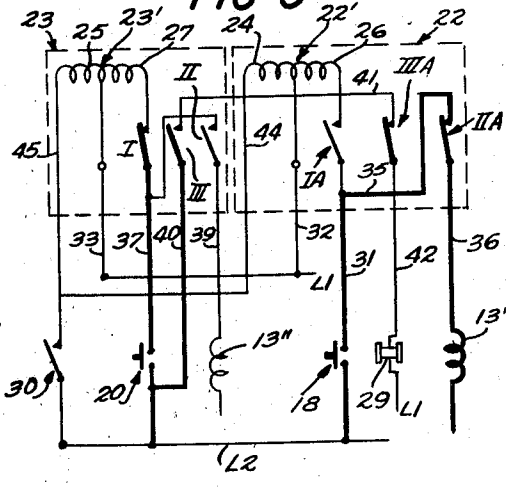



FIG 5



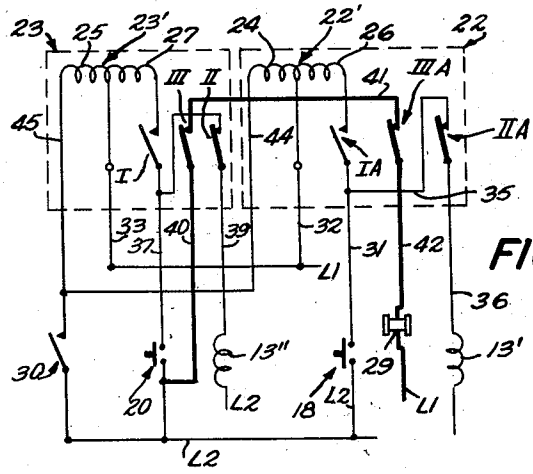




FIG. 6

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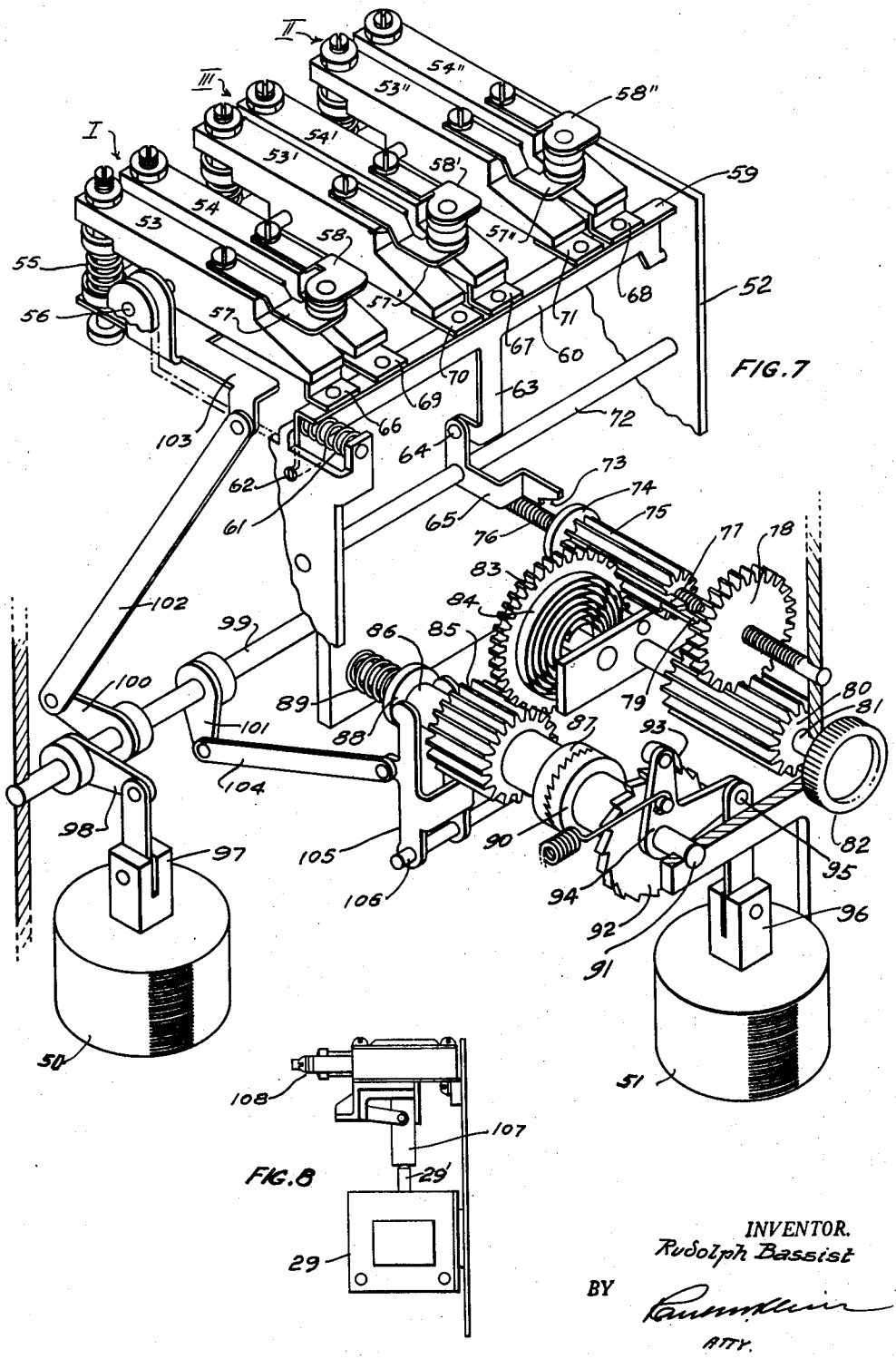



FIG. 7

FIG. 8

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# CONTROL METHOD AND ELECTRIC SYSTEM FOR TEXTILE MACHINES

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Application December 6, 1955, Serial No. 551,260

6 Claims. (Cl. 66—86)

This invention relates broadly to a method and a system for controlling the operation of textile producing machines similar to that disclosed in Patent No. 2,674,-109, for "Control Method and System for Knitting Machines" issued April 6, 1954, to Rudolph Bassist, the applicant.

The present method and system involve an all-electric control arrangement which constitutes a marked improvement over that disclosed in the aforesaid patent, and likewise pertains to the mode of correlating and governing in textile machines the yarn supply to the demand for the yarn by the textile-producing instrumentalities of such machine, and further pertains to the predetermined, successive timing of the operation of the electric yarn control arrangement for textile machines.

As applied to knitting machines, the present method is designed to correlate and govern the supply of yarn from one or more warp beams to the knitting instrumentalities, the latter including a bank of knitting needles and a pattern-controlling device so that the supply of yarn is continuously kept in balance with the demand for the yarn by the knitting instrumentalities.

In the aforementioned patent, the principal means for correlating the yarn supply with the demand by the textile-producing instrumentalities comprise a combination of both electrical and mechanical devices. Due to that combination there is caused an unavoidable operational lag in the action of the means which govern and correlate the supply of yarn with the demand by the knitting instrumentalities.

In order to overcome these shortcomings of the patented method, the system of the present invention utilizes a substantially fully electrical arrangement of control means which not only provide so-to-speak instantaneous response to any required adjustment in balancing the supply of yarn with the demand for yarn by the fabric-producing instrumentality, but such adjustment is more exact and the functions of the presently employed control means is far more flexible. Accordingly, these improvements and refinements in the present system are intended to and they do produce superior results evidenced by the final product of enhanced quality, that is the textile produced by the machine equipped with control means according to the present invention. Such textile is most uniform in structure and substantially without any "faults" throughout.

While the present control system may well be applied to most any textile fabric-producing machine, it is of particular benefit in connection with what is known as fine gauge "tricot" type knitting machines, wherein a substantially large number of knitting needles per inch are employed, and wherein the operation may be considered a "high-speed" operation at which upwards of 800 to 1200 courses or stitches per minute are produced.

It is the prime object of the present invention to provide a fully automatic electric control system for correlating the yarn supply to the yarn demand in a textile machine.



A further object of this invention is a substantially fully electric control system in high-speed, high-gauge knitting machine for correlating and balancing the yarn feed from a warp beam to the yarn demand by the knitting instrumentalities, in that an ever changing, automatic adjustment between the movement of a warp beam or warp beams, supplying the yarn, and the yarn demand by the knitting instrumentalities takes place, in consequence of which automatic adjustment a most uniform, faultless knitted fabric is produced.

These and numerous other objects and advantages of the present disclosure will become more fully apparent from the ensuing description in conjunction with the accompanying drawings, wherein:

Fig. 1 is a diagrammatical illustration of the present system;

Figs. 2, 3, 4, 5 and 6 represent diagrams of the major electric instrumentalities employed in the system and their wiring connections, shown at various stages of operation;

Fig. 7 is a perspective view of a typical pre-settable impulses-controlled counter; and Fig. 8 is an elevation of a typical pre-settable timing control.

In Fig. 1 there is illustrated but a single warp beam **10**. Obviously more than one of such warp beams can be employed in any textile-producing machine, however for the purpose of explaining the present invention, a single warp beam will suffice. Warp beam **10** is driven by means of a belt or chain **11** extending from speed changer **12**, which latter in turn is driven by a reversible electric motor **13**.

Inasmuch as the arrangement of a bank of knitting needles and pattern-controlling means, usually in the form of a "pattern" wheel, are well known, only pattern wheel **14** is shown, representing all of the knitting instrumentalities used in the machine. Pattern wheel **14** is actuated together with the kniting needles from a common cam shaft (not illustrated)

In frictional engagement with warp beam **10** is a roller structure **15** rotatably lodged in a fork-like supporting arm **16**, pivoted at **16'**. Roller **15** is composed of two disc members connected by spaced pins **17**. In supporting arm **16** there is mounted a microswitch **18**, equipped with an operating arm **19** which extends into the path of operation of pins **17**. As roller **15** rotates, switch-operating arm **19** alternately is engaged and released by pins **17**, whereby switch **18** is alternately closed and opened.

A similar switch **20**, actuated by pattern wheel **14**, is also provided with an operating arm **21**, the latter being located in the path of operation of plunger **14'** of the pattern wheel. The movements of plunger **14'** alternately opens and closes switch **20**.

Beam switch **18** is electrically connected with a pre-settable counter **22**, designated as "beam counter," whereas switch **20** of the pattern wheel is electrically connected with counter **23**, the "pattern wheel counter." Each of the counters include tapped coils **22'** and **23'**, respectively. The left-hand portions **24** and **25** of the respective coils are called "clutch" coils since they are adapted to hold a movable clutch at a desired pre-set position. The right-hand coils **26** and **27** are designated as "count" coils controlled by switches IA and I. These switches, when closed, will permit electrical impulses, generated in beam switch **18** and pattern wheel switch **20**, to pass into coils **26** and **27**. When the number of impulses received by coils **26** and **27** correspond in number to the setting of the respective clutches, the counters "count out," as will be presently explained in greater detail.

At the right-hand upper corner of Fig. 1 there is diagrammatically shown a timing relay **28** which is composed of a solenoid **29** with plunger **29'** and a switch **30**, the

latter being closed by plunger 29' when solenoid 29 becomes energized.

*Electric connections*

Designations L1 and L2 denote main supply lines to the different instrumentalities. There is also shown a ground connection "G" at motor 13. Starting from beam switch 18, supply line L2 passes through the hollow supporting arm 16 to the switch and from there conductor 31 leads to switch IA which controls the supply of current to count coil 26 of beam counter 22. From the taps between "clutch" coils 24 and 25 and "count" coils 26 and 27 there extend leads 32 and 33 to main lead 34, which passes to terminal 35 of solenoid 29, and from there to main supply line L1.

In the counters there will be observed, besides switches IA and I, switches IIA and II, IIIA and III. All of the switches are shown "open" in Fig. 1. From lead 31, extending between beam switch 18 and beam counter switch IA, there branches off a short lead 35 to switch IIA, and from that switch a lead 36 connects with "reverse" winding 13' of motor 13.

Pattern wheel switch 20 is connected at one of its terminals to main supply line L2 and from the other terminal of the switch extends a conductor 37 to switch I of pattern counter 23. From conductor 37 there extends a branch 38 to switch II and from that switch a lead 39 passes to "forward" winding 13'' of motor 13. One terminal of switch III is connected by lead 40 with main supply line L2, while from the other terminal of that switch extends lead 41 to one terminal of switch IIIA. From the other terminal of the latter switch passes a conductor 42 to terminal 43 of solenoid 29.

The left-hand or "clutch" coils 24 and 25 of the counters are connected by leads 44 and 45 to lead 46 which extends to terminal 47 of switch 30. The other terminal 48 of that switch is connected by lead 49 with main supply line L2.

In Figs. 2 to 6, inclusive, the two counters are diagrammatically indicated in broken lines. These illustrations also portray the forward and reverse windings 13', 13'' of motor 13. Switch 30 of the timing relay is shown separated from solenoid 29. Switches I, II and III and IA, IIA and IIIA of the pattern wheel and beam counters are placed somewhat differently to simplify the illustration of their wiring arrangement, but the latter corresponds exactly to that shown in Fig. 1.

In Fig. 2 relay switch 30 is shown closed, and the "clutch" coils of both counters are thus energized, as indicated by the heavy lines in that figure. At that stage of the counters, both are ready to be "set" or "re-set," that is the clutches (not shown) adapted to be held in set position by the clutch coils are set to the desired number of electric impulses to be received by their respective "count" coils from beam switch 18 and pattern wheel switch 20.

In Fig. 3 relay switch 30 is shown "open" and the count coils of both counters are shown energized (in heavy lines), since their respective switches I and IA are closed. Both counters are therefore in what can be termed a "count" position, that is, to receive impulses from switches 18 and 20, until the number of impulses passed to the count coils are equal to the desired number to which the clutches are set.

In Fig. 4 switches II and III of the pattern wheel counter are shown closed, whereas switch I is open. In that stage the pattern wheel count coil has received the number of impulses to which the clutch coil was set and the pattern wheel counter has "counted out" first, that is prior to the beam counter, the latter being still in counting position; thus the impulses from beam switch 18 are continuing to be impressed upon the count coil 26 of beam counter 22.

Fig. 5 shows an arrangement of switch positions in the counters wherein the pattern wheel counter can still receive impulses, whereas the warp beam counter is in a "counted out" position. In other words, in that figure it is shown that the warp beam counter "counts out" first.

In the diagram illustrated in Fig. 6 both counters are shown in "counted out" position. In other words, the count coils 26 and 27 have received the number of impulses corresponding to the setting of "clutch" coils 24 and 25. The heavy lines in that diagram indicate that switches IIIA and III are closed, whereby solenoid 29 of timing relay becomes energized and closes switch 30, although that switch is still shown in "open" position in that figure.

Referring again to Fig. 4, the heavy lines indicate that the pattern wheel counter has "counted out" first, while the warp beam counter is still in counting position. In consequence of this "counting out" of the pattern wheel counter, winding 13'' of motor 13 becomes energized and causes the motor to rotate in clockwise direction. This movement of the motor in turn causes speed changer 12 to increase the speed of warp beam 10, thereby increasing the supply of yarn delivered to the knitting instrumentalities. The energizing of motor winding 13'' can be clearly traced by following the heavy lines in Fig. 4. Main line L2 is connected through pattern switch 20, conductors 37 and 38 to closed switch II and hence through conductor 39 to motor winding 13''. As now pattern switch 20 alternately opens and closes, these impulses are impressed upon the motor winding 13'', and at each impulse the motor is caused to rotate in clockwise direction. Thus the number of impulses received by motor winding 13'' are controlled by pattern wheel switch 20, and these impulses continue until the beam counter has "counted out."

In a similar way Fig. 5 illustrates the energizing of the reverse or counter clockwise motor winding 13'. As the beam counter "counts out" switch IIA is closed and connection is now made from main line L2 through beam counter switch 18, conductors 31 and 35 to one terminal of switch IIA, while the other terminal is connected by lead 36 to reverse winding 13'. Switch 18 being alternately opened and closed by roller 15, rotated by the warp beam, causes electric impulses to surge through winding 13', thus energizing the motor and causing it to turn counter clockwise. In consequence of this movement of the motor, speed changer 12 slows down the speed of beam 10 and therefore reduces the amount of yarn passing to the knitting instrumentalities.

Reverting to Figs. 6 and 2, there is shown in Fig. 6 that solenoid 29 becomes energized, which in turn causes timing relay switch 30 to close, as shown in Fig. 2. The closing of switch 30 energizes coils 24 and 25 of the warp beam and pattern wheel counters, respectively, as said previously, thus rendering these counters ready to be "set" or "re-set," that is the clutches controlled by coils 24 and 25 can now be set to the number of desired impulses.

*Setting of counters*

When it is desired to produce a certain knitted fabric, the length of yarn required to produce an inch of fabric is predetermined. In order to produce such inch of fabric the knitting needles will have to make a definite number of stitches. Thus the length of yarn required for the number of stitches made by the needles to produce one inch of the fabric must be known. Accordingly the pattern wheel counter is set to the desired number of stitches, and the warp beam counter is set to the corresponding number of inches of yarn to produce the required number of stitches, the warp beam counter being a linear counter measuring the length of yarn delivered from the warp beam to the knitting instrumentalities.

For example, the warp beam counter is set for the delivery of say 250 inches of yarn, required for effecting of say 2500 stitches by the needles. Accordingly, the pattern wheel counter is set to 2500 stitches. The counters are designed to continuously control and balance the sup-

ply of yarn to the knitting instrumentalities so that for each 2500 stitches necessary to produce a certain desired length of the finished fabric there will always be delivered 250 inches of yarn from the warp beam.

When balancing the yarn supply with the yarn demand it will occur that one counter after the other "counts out." When both counters have "counted out," as shown in Fig. 6, solenoid **29** becomes energized and closes switch **30**, as shown in Fig. 2. At that moment the clutch coils **24** and **25** become energized and the re-setting of the counters takes place. However, at that moment, as also shown in Fig. 2, the count coils **26** and **27** are still de-energized. In other words, no counting can take place.

After a time period to which the time relay is set, armature **29'** will recede into solenoid **29**, whereby switch **30** is opened. The moment that switch is opened, clutch coils **24** and **25** become de-energized, whereas count coils **26** and **27** become energized, as shown in Fig. 3, and therefore are now ready for counting by both the beam switch **18** and pattern wheel switch **20**. Since the two counters automatically control the correct amount of yarn delivery to the knitting instrumentalities, even the slightest discrepancy between the supply of yarn and the demand for yarn by the needles is so-to-speak immediately corrected by either increasing or reducing the speed of the warp beam. This increase or reduction in speed of the warp beam is effected by the repeated impulses delivered to the two motor windings through the operation of either warp beam switch **18** or pattern wheeel switch **20**, respectively, whereby the motor, in cooperation with the speed changer, causes the required speed changes in the operation of warp beam **10**.

The aforementioned Patent No. 2,674,109 discloses the principle of balancing the yarn feed with the yarn demand, however the means for controlling the yarn supply to the knitting instrumentalities in that patent lag in their intended functions as compared with the electric conrol means of the present system, and which latter control means not only respond so-to-speak instantaneously, thus rendering the required speed variations in the warp beam far quicker and therefore more effective, but due to the arrangement of inducing such speed variations by a rapid succession of electric impulses, the speed changes in the warp beam are not only immediate but are progressive, and therefore far superior in effectiveness over the mostly mechanical control means shown in that patent, and which mechanical control means effect but a single function at one time which can be considered the equivalent of only one of the successive impulses provided for in the present system.

In addition to the superior effectiveness of the present control system for governing and balancing the supply of yarn from the warp beam in accordance with the demand or requirements by the textile-producing instrumentalities, there is included a timing control for the re-setting of the counters after each of their working periods during which such governing and balancing of the yarn supply to these instrumentalities is to take place. That timing control is vested in the function of the timing relay seen at the right-hand upper corner in Fig. 1.

That device is adapted to be "pre-set" for any desired time period during which an automatic "re-setting" to the original "pre-setting" values of the two counters takes place. For that purpose timing relay **28** is so constructed that when the switches and electric connections of the counters are in the stage illustrated in Fig. 6, that is, when both counters have "counted out," plunger **29'** of solenoid **29** closes switch **30**, but will, within the time period for which the timing relay is "pre-set," recede into solenoid **29**, thus causing switch **30** to open. By the closing of switch **30**, clutch coils **24**, **25** of the counters are energized and the counters are thus automatically "re-set" to their original "pre-set" position, see Fig. 2. When switch **30** opens, the "count" coils **26**, **27** are made ready for "counting." The time period for the aforesaid setting of the counters to 2500 stitches and 250 inches of yarn may correspond to say three minutes.

Obviously, the setting of the timing relay will vary with the production requirements for different fabrics and the patterns contemplated.

From the foregoing it becomes evident that the present system provides not only for the governing and balancing of the yarn supply in accordance with the demand for yarn by the textile-producing instrumentalities, but in addition there is controlled the lapse of time between the re-setting of the counters, an important function totally missing in the method and system exemplified by the aforesaid patent.

Moreover the effected flexibility of the yarn supply control arrangement of the present system achieved by substituting for a single control action of the patented system a series of successive control actions tends to produce superior end results in the form of really perfect, faultless and throughout uniform fabrics.

The counters and timing switch relays employed can be of any suitable make or design. The counters as well as the timing relay must be what is known as "presettable" either fully electrical or electro-mechanical instruments. The timing switch relays can be of either the pneumatic or dashpot type.

In Fig. 7 there is illustrated a typical arrangement of a pre-settable impulses-controlled counter. Two such counters are employed, one being responsive to impulses received from yarn switch **18**, the other to impulses from pattern switch **20**, both counters being connected in the circuit shown in Fig. 1. Solenoids **50** and **51**, seen in Fig. 7, form parts of each of the counters and are adapted to be energized by impulses from pattern switch **20** and yarn switch **18**, respectively. There is also shown a frame **52** which supports switches I, III and II. Each of the switches comprises bars **53**, **54**, **53'**, **54'**, **53''** and **54''**, all of which bars are supported by springs **55** and are pivoted at **56**. Bars **53**, **53'**, **53''** support lower switch contacts **57**, **57'**, **57''** while bars **54**, **54'**, **54''** carry upper switch contacts **58**, **58'**, **58''**. Switch bars **53**, **54** are designed to normally rest upon a ledge **59** of a trip bar **60** which is normally held in the position shown by a coil spring **61**. Trip bar **60** is pivotally mounted at **62** and is provided with a depending extension **63**, with which is pivotally associated at **64** a trip-yoke **65**. On top of the ledge **59** of the trip bar there will be seen angular lugs **66**, **67** and **68** adapted to normally support bars **53**, **54'** and **54''**, respectively. In addition ledge **59** carries plain lugs **69**, **70** and **71** adapted for normally supporting bars **54**, **53'** and **53''**.

In the position shown in Fig. 7 the switch arrangement corresponds to that indicated at the left portion of Fig. 3, wherein switch "I" is shown closed, whereas switches III and II are open.

Trip-yoke **65** is pivoted at **72** and the front end of the trip-yoke has a tapered surface **73** adapted to be engaged by a disc **74** at the end of pinion **75**. This pinion is internally threaded and is mounted upon and engages a stationary threaded spindle **76**. At the front end of pinion **75** there will be seen a stop lug **77**.

Operatively mounted upon threaded spindle **76** is also a gear **78**, also provided with a stop lug **79**. Both pinion **75** as well as gear **78** are adapted to not only turn upon spindle **76**, but progress in axial direction relative to that spindle. In operative engagement with gear **78** is a pinion **80** mounted on a shaft **81**, at the end of which there is provided an indicating or setting dial knob **82**. In operative engagement with pinion **75** is a gear **83** provided with a spiral spring **84** which is wound automatically by the rotation of gear **83** in counter-clockwise direction, that is while pinion **75** is turned in clockwise direction. This spring is designed, when released for unwinding, to rotate gear **83** in clockwise direction, which

gear movement in turn will cause the counter-clockwise rotation of pinion 75.

In operative engagement with gear 83 is a wide gear 85 mounted on a sleeve 86, provided at the front end with clutch half 87 and at the rear end with a clutch-releasing disc 88, normally urged forward by a spring 89 so that clutch half 87 will normally engage the other clutch half 90 mounted at the front half of sleeve 86. The two sleeve halves are supported by a common shaft 91. A ratchet wheel 92 is mounted at the front end of the front half of sleeve 86. Ratchet wheel 92 is engaged by pawl 93 supported by a ratchet lever 94, with which latter is connected at 95 the armature 96 of solenoid 51, which represents coils 26 and 27 shown in Figs. 1 to 6.

Obviously when solenoid 51 is successively energized by the closing of switch 18, see Fig. 1, each impulse will cause pawl 93 to move ratchet wheel 92 one tooth.

Armature 97 of solenoid 50 (Fig. 7) is connected by means of lever 98 with operating shaft 99. Mounted on shaft 99 are two other levers, lever 100 and lever 101. Lever 100 is connected by means of bar 102 to a rocker bar 103, which is pivotally supported at 56 as are bars 53 to 54". As both counters 18 and 20 have "counted out," switches III and IIIA are caused to close, as seen in Fig. 6, whereby solenoid 29 will become energized and closes switch 30, shown closed in Fig. 2. The closing of switch 30 energizes coils 24 and 25, represented by solenoid 50 in Fig. 7. Armature 97 of solenoid 50 will now turn shaft 99, whereby rocker bar 103 is operated. At the same time clutch-releasing disc 88 is moved against the tension of spring 89, as will be evident from the herebelow explanation.

Lever 101 is connected by means of bar 104 to a fork lever 105, pivoted at 106. The upper end of the fork lever engages disc 88 of sleeve 86. Disc 88 is urged forwardly by spring 89, whereby clutch half 87 is caused to normally engage clutch half 90. When solenoid 50 is energized, fork lever 105 is moved backwards and engages disc 88, thereby compressing spring 89 and moving clutch half 87 out of engagement with clutch half 90.

When tripper bar 103 (Fig. 7) is operated by the inward movement of armature 97 into solenoid 50, tripper or rocker bar 103 will lift the frontal ends of all switch levers 53 to 54, thus momentarily elevating them and moving them against the tension of their respective springs 55. Following that momentary movement of the front ends of the levers, the levers are released. While the front ends of the switch levers are momentarily elevated, trip bar 60 is freed to be moved rearwardly by the tension of its spring 61. In other words, trip bar 60 now moves freely beneath the momentarily elevated frontal ends of all switch bars. As these frontal ends of the switch bar are released, switch bar 53 will come to rest upon the inner, upturned end of lug 66 of trip bar 60, thus switch I is closed. At the same time switch bar 54' of switch III and switch bar 54" of switch II will also come to rest upon the upturned inner ends of their respective lugs 67 and 68, whereby switches III and II are caused to open. These respective switch conditions are indicated in Fig. 3.

The normal position of trip bar 60 is that illustrated in Fig. 7 and which position trip bar 60 assumes when trip bar 103 first momentarily elevates the frontal ends of all switch bars, thereby freeing trip bar 60 to be moved rearwardly by spring 61.

In operation, dial knob 82 is set to a desired number of "counts." The turning of dial knob 82 causes the turning of pinion 80, which in turn causes gear 78 to turn on fixed spindle 76, thus setting gear 78 to the desired position. The impulses received by solenoid 51 from either yarn-operated switch 18 or pattern wheel switch 20 (see Fig. 1), cause the operation of pawl 93 against ratchet wheel 92. It is of course assumed that clutch halves 87 and 90 are in engagement with one another. By the movement of ratchet wheel 92 gear pinion 85 is rotated in clockwise direction and in turn causes the rotation of gear 83 in counter-clockwise direction, at which rotation spring 84 is wound up.

At the same time pinion 75 is caused to rotate in clockwise direction. This rotation of pinion 75 causes the pinion to progress on stationary threaded spindle 76 toward tapered end 73 of trip-yoke 65 until disc 74 engages taper 73 and causes the movement of trip bar 60 in forward direction, that is against the tension of spring 61. This forward movement of trip bar 60 will cause lug 66 for switch bar 53 in switch I to move forwardly also, thereby freeing switch bar 53 so that its spring 55 will tilt the forward end of switch bar 53 in downward direction, whereby the switch contacts of switch I are separated. That forward movement of trip bar 60 will also cause the closing of switches III and II, in that lugs 67 and 68 of trip bar 60 will clear switch bars 54' and 54", respectively, so that their respective springs 55 will cause the forward ends of these switch bars to swing downwardly, whereby switches III and II are caused to close.

The above-stated respective positions of switches I, III and II are indicated in Fig. 6.

As stated, the movement of armature 97 of solenoid 50 will cause lever 101 to operate, which in turn will move fork lever 105, by means of connecting rod 104, against disc 88, thereby compressing spring 89 and at the same time moving rear clutch portion 87 away from clutch portion 90. By the opening of the clutch, gear 85 becomes free to turn. Wound up spring 84 of gear 83 will now cause the rotation of gear 83 in clockwise direction, whereby pinion 75 is turned in counter-clockwise direction and will progress in forward direction upon stationary threaded spindle 76. Thus pinion 75 will reassume its former position set by dial 82. While pinion 75 moves in counter-clockwise direction and progresses forwardly, its stop lug 77 will eventually engage stop lug 79 of gear 78 and cause the latter gear to also progress forwardly upon spindle 76. The forward progress of gear 78 causes the rotation of pinion 80 and thus the rotation of knob 82 to its starting position.

The moment solenoid 50 is de-energized, spring 89 causes the movement of sleeve 86 in forward direction so that the clutch halves 87 and 90 re-engage with one another. At the same time rocker bar 103 is moved to its original position by springs 55 and releases bars 53 to 54" so that these bars again rest against the lugs of trip-bar 60. At that point the counting procedure is repeated, depending upon the setting of switch 30 indicated in Fig. 1, the arrangement of which switch is illustrated in Fig. 8.

This switch is a time switch, operated either hydraulically or pneumatically, and, as stated previously, this switch can be pre-set for an automatic re-setting of the counters. As also stated, the switch contains a solenoid 29 provided with an armature or plunger 29'. Above the plunger there is a movable element 107 which actually operates the switch contacts which are not shown in Fig. 8. The movement of element 107 is governed by the adjustment of a screw 108. In other words, by means of that screw a time lag between the operation of solenoids 50 and 51 may be determined.

One of the most important features of the instant disclosure resides not only in the fact that when the present system is applied to knitting machines it will be instrumental in not only producing a perfect, "faultless" and throughout uniform fabric, but in addition will facilitate the production of fabrics wherein the length of the stitches can be readily varied, whereas in heretofore knitting machines the stitches are limited to a uniform length. This limitation is due to the fact that the supply of yarn to the knitting instrumentalities is controlled by the speed of the warp beam, whereas in the present system the yarn supply is governed by the linear measure-

ment of the yarn, irrespective of the speed of the warp beam. In other words, in heretofore used machines the problem is to keeping uniform the speed of the warp beam, whereas in the present system the speed of the warp beam can and will vary in accordance with length requirements of yarn.

The yarn length supply in the present system is governed by the cooperation of the two counters, that is the beam counter and the pattern wheel counter, and such length supply of the yarn to the knitting instrumentalities will be uniform irrespective of the number of stitches and the length of stitches to be produced. The present method renders possible the setting of the counters to a predetermined combination of various essential factors required for the production of specific fabrics, whereby not only different stitch length but also the number of stitches of different lengths can be accurately predetermined. In accordance with such setting of the counters to the predetermined number of stitches of different stitch lengths, the correct yarn supply to the knitting instrumentalities is thus correspondingly predetermined and correctly controlled. When the counters are thus set, they will positively govern the required supply of yarn to the knitting instrumentalities and they will be automatically reset after each "counting out" cycle by the timing relay to repeat their control operation.

Summarizing, the balancing of the yarn supply and yarn demand takes place in the following manner: if one of the counters "counts out," that is, when the number of impulses received by that counter corresponds to the number to which that counter is set, the impulses to that counter continue but are conveyed to the motor, which latter is caused to successively turn in a given direction with each impulse received by it, until the second counter "counts out." If there is a difference, small or large, between the number of impulses and the numbers to which the counters are set, the impulses to the counter which first "counts out" continue and are conveyed to the motor until the second counter "counts out." The significance in that system resides in the fact that if there is a large difference between the counter settings and the number of impulses "due" to the counters before both "count out," a large number of impulses will be conveyed to the motor. If there is a small difference, a correspondingly smaller amount of impulses are conveyed to the motor, and if there is no difference between the settings of both counters and the impulses received by them, that is when both counters "count out," the impulses to the motor stop.

While in the foregoing a specific arrangement of several specific devices and other instrumentalities are indicated, it is quite obvious that the illustrations are intended to serve merely for explanatory purposes and are not to be construed as limiting the present disclosure to the actual showing.

Having thus described the present disclosure, what is claimed as new is:

1. The combination with a knitting machine having yarn supply means, such as at least one warp beam, and yarn-demanding means, such as stitch-producing and pattern-controlling means, of a mechano-electrical control system for automatically correlating and balancing the yarn supply from said supply means to said yarn-demanding means, said system comprising in combination a reversible motor and a speed changer for driving said yarn supply means, two pre-settable impulses-controlled counters, one for the yarn supply means and a second for the yarn demanding means, two impulses-producing means, one actuated by the yarn supply means, the other by the yarn-demanding means for sending impulses to the respective counters, and pre-settable timing means for controlling the time periods of re-setting the counters, one of the counters governing the motor rotation in counter-clockwise direction, the other counter governing the motor rotation in clockwise direction, whereby the operation of the yarn supply means is either retarded or advanced by way of said speed changer.

2. The combination as set forth in claim 1, and wherein each of the pre-settable impulse counters have an electrically controlled, manually adjustable pre-setting mechanism settable for any desired number of impulses and further having an electrically controlled impulse counting mechanism, the pre-setting mechanism becoming de-energized when the number of impulses received by the impulse counting mechanisms of both counters reach the desired number of impulses to which the pre-setting mechanisms of the counters are adjusted.

3. The combination as set forth in claim 2, and wherein the impulses-producing means actuated by the yarn supply means comprise a normally open switch having a switch-operating lever, a rotary element in coaction with said yarn supply means, the switch-operating lever extending into the operating path of said rotary element, the latter having means for alternately engaging and releasing said switch-operating lever thereby alternately closing and opening the switch, whereby a series of electric impulses are impressed upon the impulses counting mechanism in the counter for the yarn supply means.

4. The combination as set forth in claim 2, and wherein said impulses-producing means of the yarn-demanding means comprises a normally open switch having a switch-operating lever extending into the operating path of and being alternately engaged and released by said yarn-demanding means, thus alternately closing and opening the switch, whereby a series of electric impulses are impressed upon the impulses counting mechanism in the counter for said yarn demanding means.

5. The combination as set forth in claim 2, and wherein said pre-settable timing means comprise a timing relay and a switch operative by the relay, the latter being adjustable for any desired time periods between the closing of the switch and its opening.

6. In a substantially mechano-electric system for making uniform, faultless textile fabric in textile machines having means for coordinating yarn supply means and fabric-producing means, said coordinating means comprising electric impulses-producing means operatively associated with and actuated by said yarn supply means and said fabric-producing means, pre-settable impulses-receiving counters for both the yarn supply means and said fabric-producing means located remotely from and being mechanically independent of either of said means, and pre-settable timing means for controlling the re-setting time between counting periods of said counters, located remotely from and being mechanically independent of said yarn supply means and of said fabric producing means, as well as of said counters.

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