May 12, 1953 E. A. FEUSTEL 2,638,006

SPEED CHANGE AND CONTROL MECHANISM

Filed June 24, 1947 3 Sheets-Sheet 1

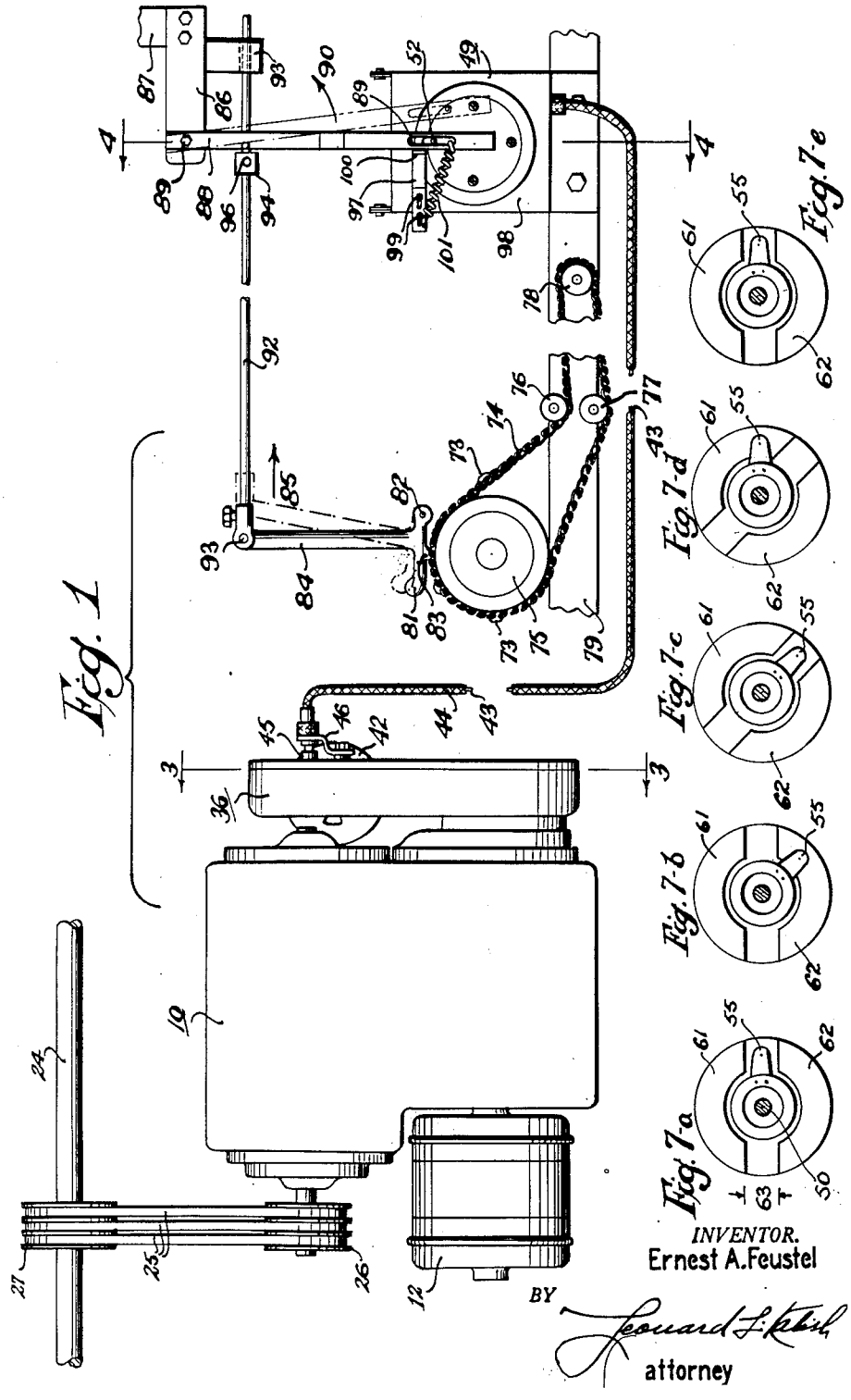

Fig. 1

Fig. 7-e, Fig. 7-d, Fig. 7-c, Fig. 7-b, Fig. 7-a

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SPEED CHANGE AND CONTROL MECHANISM

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Fig. 2

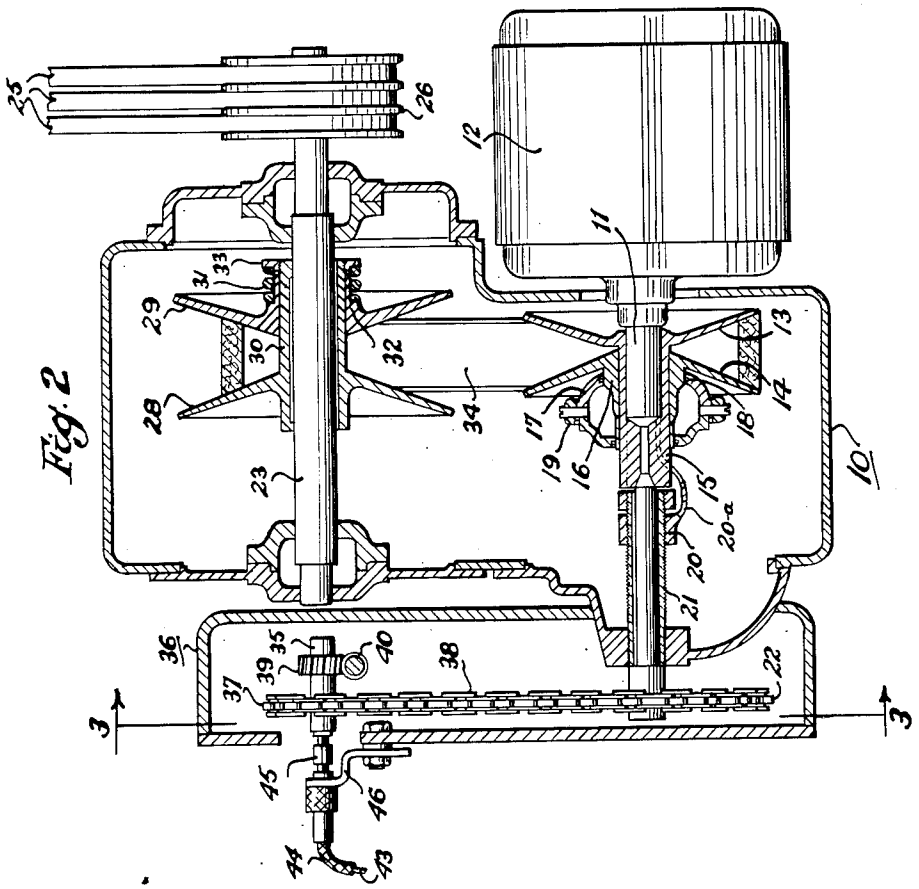

Fig. 3

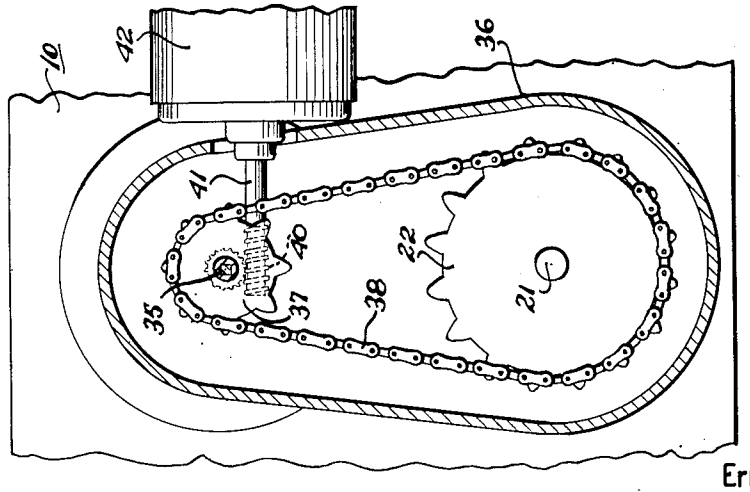

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Fig. 5

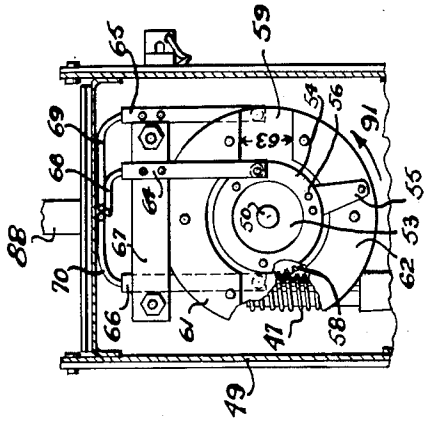


Fig. 4

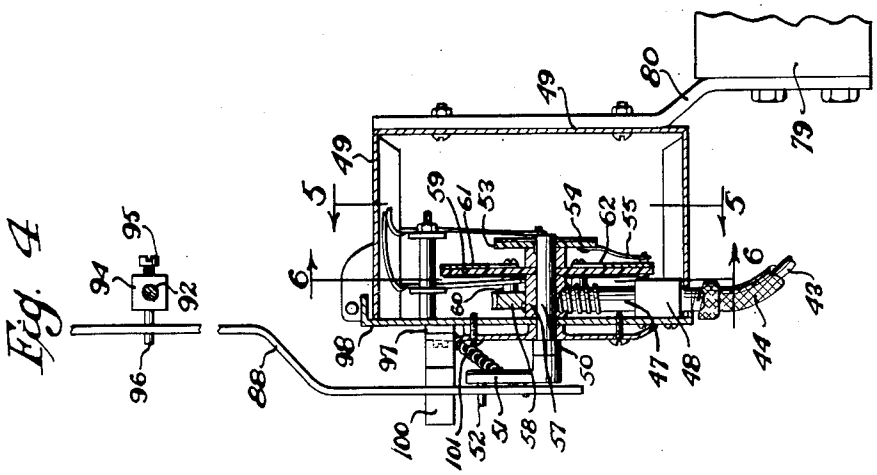
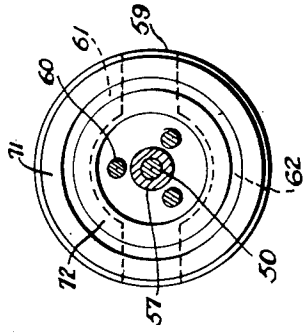


Fig. 6



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SPEED CHANGE AND CONTROL MECHANISM

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Application June 24, 1947, Serial No. 756,630

6 Claims. (Cl. 74—230.17)

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The present invention relates to certain new and useful speed-change and speed-control mechanism for full fashioned knitting machines, for changing the running speed of the machine from high-speed to low-speed, and back to high-speed, according to the particular part of the hose being knitted.

In the knitting of full fashioned hosiery, certain parts of the hose can be effectively knitted at a comparatively high speed as, for instance, the welt portion and the straight portions of the leg, while other parts of the hose are most effectively knitted at comparatively lower speeds.

Likewise, the character of the yarn also governs the most advantageous speed at which any particular part of the hose may be knitted. Thus, for instance, a very thin or fine yarn, for instance 10 denier silk cannot be knitted as rapidly as a 30 denier silk.

Likewise, in operating the welt turner on a full fashioned knitting machine, the speed must be reduced considerably, as for instance to 15 courses a minute, whereas, in knitting the welt portion and straight portion it is possible to run the full fashioned knitting machine at the speed of 75 courses a minute (more-or-less depending on the fineness of the yarn in the machine).

Likewise, the heel, sole and toe portions of the stockings can be effectively knitted at perhaps 60 courses per minute or less.

An object of the present invention is automatically to change the speed of the knitting machine (courses per minute) for the various parts of the hose, according to the most efficient speed which that operation or portion of the hose will permit. Thus, it may be desirable to run the machine at three or four different speeds during the making of a hose, as for instance 15, 45, 60 and 75 courses per minute.

A further object of the present invention is to effect these speed changes automatically when the machine enters various operating stages for parts of the hose, with an electric motor of constant speed, so that there will be no loss of power at the low speeds, but, on the contrary, the actual torque or turning power will be increased at the low speeds so as to insure smooth and flawless operation of the knitting machine at all speeds.

With the above and other objects in view, the present invention consists of a novel combination of speed-ratio changing mechanism intermediate a constant speed electric motor and the drive shaft of the knitting machine, and a reversible electric motor operating said ratio changer, and an electrical control operatively interposed between the pattern chain of the knitting machine and the ratio control motor, whereby lugs, or buttons, set on the pattern chain at suitably selected intervals (corresponding to the beginning and end of the various operations of the machine or the beginning or end of the various parts of the hose) will cause the ratio changing control motor to increase or reduce the speed ratio to any desired extent.

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The present invention consists of other novel features of construction which will appear more fully from the following description and accompanying drawings and the appended claims.

For the purpose of illustrating the invention, there is shown in the accompanying drawings one form thereof which is at present preferred, although it is to be understood that the various instrumentalities of which the invention consists can be variously arranged and organized and that the invention is not limited to the precise arrangements and organizations of the instrumentalities as herein shown and described.

In the accompanying drawings in which like reference characters indicate like parts,

Figure 1 represents a front elevational view of one embodiment of the speed control mechanism of the present invention, with the relevant parts of the knitting machine shown in fragmentary view, better to illustrate the relationship of the mechanism of the present invention to the knitting machine.

Figure 2 represents a vertical cross-sectional view through the ratio-changing mechanism, in a plane passing through the axes of the two main shafts therein.

Figure 3 represents a section on line 3—3 of Figure 2 and line 3—3 of Figure 1.

Figure 4 represents a vertical cross-sectional view on line 4—4 of Figure 1.

Figure 5 represents a vertical cross-sectional view on line 5—5 of Figure 4 with parts of the contact-bearing disc broken away, to expose to view the worm and gear by means of which the two contact segments are rotated, in either direction, by the setting of the ratio-changer.

Figure 6 represents a section on line 6—6 of Figure 4.

Figure 7–*a* represents a more or less schematic view showing the relationship of the segments and the brush of the control mechanism in the normal position wherein the brush is disposed adjacent the gap intermediate the segments whereby the control motor is stationary.

Figure 7–*b* represents a schematic view showing the brush rotated clockwise relative to the

segments whereby one of the circuits to the control motor is closed and the control motor is caused to rotate in one direction.

Figure 7–*c* represents a schematic view showing the segments rotated clockwise from the position of Figure 7–*b* to bring the gap back into line with the brush so as to stop the control motor.

Figure 7–*d* represents a schematic view showing the next phase of operation wherein the brush is rotated counterclockwise from the position of Figure 7–*c* back to the position of 7–*a*, whereby it is in contact with the other segment so as to close the other circuit to the control motor and to cause said control motor to rotate in the opposite direction.

Figure 7–*e* represents a schematic view showing the segments rotated counterclockwise from the position shown in Figure 7–*d* back to the position shown in Figure 7–*a* wherein the gap is once again in line with the brush so as to again stop the control motor thereby to cause the shaft **24** to resume its original speed.

The ratio-changer, designated generally by the numeral **10**, may be of any suitable construction, which permits the gradual change of the speed ratio between the driving shaft and the driven shaft in small and imperceptible increments. One form of such ratio-changer is that shown in Figures 1, 2 and 3 which is of the general type disclosed in U. S. Patents 1,949,975 and 2,089,711 and commercial forms of which are known as the Reeves Vari-Speed Moto-Drive, made by the Reeves Pulley Company of Columbus, Indiana.

While in the embodiment of the present invention shown in the drawings, the ratio-changer shown is that exemplified by the Reeves construction, it is to be understood, of course, that any similar ratio changing mechanism may be used as an element in my present invention.

Likewise, because the ratio-changer shown in Figures 2 and 3, is one of the conventional forms, many of its details of construction have not been shown in Figure 2; this figure and drawings being more-or-less schematic merely to illustrate the mechanism and its relationship to the whole of the combination which is my present invention.

Thus, the driving shaft **11**, which may be the shaft of the motor **12**, or an extension thereof or coupled thereto, carries a conical disc **13** fixedly mounted on said shaft and rotatable therewith and a conical disc **14** keyed to said shaft but movable axially therealong, which together constitute an axially separable V-pulley of variably effective diameter. The axially-stationary conical disc **13** is carried by any suitable elongated sleeve-like hub **15**, keyed to the drive shaft **11**, and to it is slidably keyed the hub **16** of the axially-movable or shiftable conical plate **14**. The hub **16**, in turn, is engaged by a nonrevoluble ring **17**, which is rotatably connected thereto by any suitable ball type thrust bearing race (indicated, but not shown in detail, at **18**), and to the ring **17** the thrust member **19** is pivotally secured, which in turn is connected, through an extension arm **20**–*a*, to the yoke **20** which is screw threaded on the external-threaded tubular shaft **21**, to the outer end of which the sprocket wheel **22** is keyed, so that the turning of the sprocket wheel **22** in one direction will advance the yoke **20** and hence will advance the axially-movable conical disc **14** toward the axially-stationary conical disc **13**, while the rotation or turning of the sprocket wheel **22** in the opposite direction will cause the yoke **20** and disc **14** to be moved away from the axially-

stationary conical disc **13**; thereby to increase and decrease, respectively, the effective diameter of the driving V-pulley formed by the discs **13** and **14**, thereby correspondingly to increase and decrease the speed of the driven countershaft **23** and hence of the handwheel shaft **24** of the full fashioned knitting machine, to which it is connected by multiple V-belts **25** and V-pulleys **26** and **27**. The countershaft **23**, in turn, carries one conical disc **28** fixed thereto by suitable keying and set screws, and another conical disc **29** keyed to the hub **30** of the disc **28**, but slidable thereon axially. A helical compression spring **31** seated against a collar **33** mounted on the end of the hub **30** bears against the hub portion **32** of the disc **29**, and serves to urge the axially-movable or shiftable disc **29** towards the axially fixed disc **28** at all times, so that the discs **28** and **29** will be brought as close to each other as the circumferential dimension of the V-belt **34** will allow for any spacing (and hence for any effective diameter) of the conical discs **13** and **14** on the driving shaft; so that as the effective diameter of the driving V-pulley formed by the discs **13** and **14** is increased (by these discs being brought closer together) the effective diameter of the V-pulley formed by the discs **28** and **29** is decreased by the spreading apart of these discs and vice versa.

A sprocket and gear shaft **35** (suitably journaled in a bearing, not shown, within the housing **36**) has a sprocket wheel **37** keyed thereto in operative alignment with the sprocket wheel **22** and a sprocket chain **38** extends over the two sprocket wheels **22** and **37**. A worm gear **39** is likewise keyed to the shaft **35**. A worm **40**, carried by and keyed to the shaft **41** of the control motor **42**, meshes with the worm gear **39**, so that the operation of the control motor **42** in one direction will increase the speed-ratio between driving shaft **11** and driven shaft **23**, while the operation of the control motor **42** in the opposite direction will decrease such speed ratio; the ultimate speed ratio achieved being dependent upon the length of time during which the control motor **42** is permitted to operate for effecting the change.

A flexible shaft or cable **43**, carried within a suitable flexible conduit or housing **44** is keyed or coupled to the shaft **35**, as, for instance, by suitable coupling at **45**, and the end thereof is held by suitable bracket **46**, or any other suitable means. The flexible shaft **43**, and its flexible housing or conduit **44**, extend from the shaft **35** to the front of the machine or to such location on the full fashioned knitting machine as may serve as a suitable location for the electrical contactor shown in external view on the right hand side of Figure 1 and shown in more detail in Figures 4 and 5; the flexible shaft **43** being coupled to a worm **47**, suitably journaled in any suitable bearing **48** carried by the housing **49** of said electrical contactor. The outer flexible conduit housing **44** is coupled to an extension of the bearing **48**. A brush-carrying shaft **50** is suitably journaled in the housing **49** on an axis generally at a right angle to the axis of the worm **47**, and has affixed to its outer end the arm **51** carrying a pin or other eccentric member **52**, and having secured to its inner end the insulating disc **53**, to which the metallic collector ring **54** is secured on one side, and to which the metallic leaf spring type brush finger **55** is secured on the other side, by metallic rivets or screws **56** which extend through it and through the collector ring **54**, so as to

establish permanent electrical connection between collector ring 54 and brush finger 55.

A hub 57 is journaled upon the shaft 50 or is otherwise journaled in co-axial relation thereto and has keyed thereto the worm gear 58 in mesh with the worm 47, to which is secured the insulating disc or plate 59 (by means of screw posts 60, or the like). The insulating disc 59, in turn, carries the two arcuate metallic contactor segments 61 and 62, each less than one half the circle so as to leave diametrically opposed intervening gaps 63 between the ends of the segments 61 and 62.

Three flat-spring brush fingers 64, 65 and 66 suitably mounted upon any suitable insulating block 67 and connected with three wires 68, 69 and 70, respectively, of the reversing circuit of the control motor 42, extend to and brushingly contact the collector ring 54 and collector rings 71 and 72, respectively; the collector rings 71 and 72 being carried on the opposite face of insulating disc 59; one of the collector rings being connected with one of the segments and the other collector ring being electrically connected with the other of the segments carried on the opposite face of the insulating disc 59. When the brush 55 of the supply line 68 rides on the segment 61, it sends the current through the field of the control motor 42, in one direction, while if the brush 55 rides the other segment 62 it sends the current through the field of the control motor 42 in the opposite direction, thereby causing the motor to run in one direction in one case and in the opposite direction in the other case.

The overriding of the brush 55 of either segment 61 or segment 62 is effected by both the positioning of the finger or brush 55 by the external arm 51 through the shaft 50 as well as by the setting of the segment-carrying disc 59, by the worm 47 and worm gear 58.

The arm 51 is operatively connected with the buttons or knobs 73 of pattern chain 74 or of any equivalent thereof, such as pattern wheel, each of which may carry a number of adjustably placed buttons or knobs, spaced in accordance with the various parts of the hose. The pattern chain 74, shown here merely schematically, rides over the driving wheel 75, and extends over toothed wheels or pulleys 76, 77 and any chain idler 78, to take up the slack.

The pulleys 76, 77 and 78 may be carried by the rail or other frame member 79 of the knitting machine. The control housing or box 49 may likewise be keyed or supported upon the rail or similar frame member to the knitting machine, through any suitable bracket.

The operative interconnection between the arm 51 and the buttons 73 on the pattern chain or wheel, is preferably effected through suitable magnifying mechanism, whereby the comparatively small rise, or displacement afforded by the passage of a button (past any suitable follower) may be magnified by suitable leverage, so that the brush 55 may be deflected a suitable distance so as to override one of the sectors 61 or 62 (from the neutral zone 63) to a suitable extent to effect the extent of speed change desired. One embodiment of such interconnection is shown in Figure 1, wherein a ball crank lever or L-shaped lever 81 is pivoted at 82, and has a follower projection 83 in the path of the buttons 73, and which normally rides on the chain, and is then elevated slightly by the passage of a button therebeneath. The rising of the follower 83, in turn, deflects the vertical arm 84 to the dash-dot position of Fig. 1. To a bracket 86, fixed to any suitable frame member 87 of the knitting machine, a pendant swing arm 88 is pivotally secured at 89. The lower end of the swing arm is slotted as at 89a, and the slot 89a extends over and embraces the eccentric pin 52 carried by the arm 51, so that the displacement of the arm in the direction of the arrow 90 serves to deflect the arm 51 in the same direction and serves to deflect the brush finger 55 in the direction of the arrow 91, thereby to cause the brush finger 55 to override one of the two segments 61 or 62.

A rod 92 pivotally connected at 93 to the upper end of the arm 84 is slidably mounted in a slightly oversize opening any suitable guide or bracket 93, and carries an adjustable set collar 94, the position of which upon the rod 92 may be adjusted by the set screw 95. The collar, in turn, carries a pin 96 in alignment with the arm 88 so that as the rod 92 is moved generally in the direction of the arrow 95, the arm 88 will be swung in the direction of the arrow 90 and the contact brush 55 will be deflected in the direction of the arrow 91; the extent of the deflection of the arm 88 and of the brush contact 55 being dependent upon the setting of the collar 94. Thus, the closer the pin 96 is set to the edge of the arm 88, the more the arm 88 will be deflected when a button 73 passes beneath the follower 83.

A stop member 97 is adjustably fixed to the lid 98 of the contactor housing 49, by means of screws 99, and the out-turned flange 100 thereof serves as a stop, against which the arm 88 is brought back to rest by a helical tension spring 101, which is the position of return of the arms 88 and 51 and of the contact brush 55.

In the preferred embodiment, the return position of the arm 88, shown in solid lines in Figure 1, is that of the low speed of the machine, while the deflected position of the arm 88, shown in dash-dot lines in Figure 1, is that of the high speed of the machine; the degree of such deflection being determinative of how high the high speed will be, because the greater the deflection of the arm 88 and hence of the arm 51 and contact brush 55, the longer it will take for the segment 61 or 62 to be revolved out of contact with brush 55 and hence the longer will be the interval during which the control motor 42 is kept running to effect the greater speed change.

As will be seen from the drawings, as the brush 55 rides on to one of the two segments 61 or 62, the control motor is set into operation in one direction or the other, so as to shift the movable conical disc 14 and thus change the speed ratio. At the same time, however, the rotation thus imparted to the shaft 35 is transferred to the worm 53 and segment-carrying disc 59, so as to revolve the segments out of contact with the brush 55, and when the segment has been revolved out of contact with the brush 55 then the control motor 42 stops, until the brush is deflected again, either back to its return position against the stop 100 or forward to its deflected position; riding onto one segment in one case and riding onto the other segment in the other case. The sequence of operations is illustrated in Figures 7–*a* to 7–*e*.

The speed-setting of the full fashioned knitting machine for any given stage of operations or for the knitting of a particular portion of the stocking may be varied to any desired number of courses per minute either by the setting of the collar 94, or by the rise of the button 73, or both.

When more than two speeds are desired in the knitting of a complete stocking, several lines of buttons 73 may be provided to engage adjacent and similar followers 83 carried by similar arms 81, which, in turn, actuate similar parallel rods 92, each carrying a similar collar 94 and a pin 96 to deflect the arm 88. By setting the collars 94 on the adjacent similar rods 92 at different distances from the arm 88, the raising of the adjacent similar followers 83 by buttons of adjacent lines will deflect the arm 88 to different distances, so that for the different parts of the stocking the speed of the machine will be different, according to the amount of the deflection. However, the running of the knitting machine at three or more different speeds may also be effected by a single line of buttons operating upon a single follower 83 and a single rod 92, by having the successive buttons in the same line of different height so that, through the one arm 84 and rod 92, and through the one collar 94 and pin 96, the swing arm 88 may be deflected to varying degrees for the various operational stages of the machine or for the various parts of the hose.

The rapidity with which a speed-change is effected (from low to any given high or from any high to the original low) may be changed by changing the ratio between sprocket wheels 22 and 37. In the particular illustration shown the ratio between driving sprocket 37 and driven sprocket 22 is one to two. If the more rapid speed-change is desired, the driving sprocket wheel 37 is increased in size and the driven sprocket wheel 22 is decreased in size correspondingly, while if a less rapid speed-change is desired the sprocket wheel 37 is decreased in size and the sprocket wheel 22 is further increased in size.

In any event, however, the speed change is a gradual one, and unlike shifting of belts from step pulley to step pulley and different from the shifting of gears where the speed-change is instantaneous or virtually so. Therefore, by the present invention, not only may the knitting machine be operated at any number of different selected speeds while knitting the different parts of the stocking but the change from one speed to the other may be effected smoothly and without loss of torque.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

Having described my invention, I claim the following as new and desire to protect by Letters Patent:

1. In a speed change and control mechanism for a knitting machine required to be driven at a number of different operational stages wherein a gradually variable ratio-changer including a pulley-half splined for axial movement along a shaft is operatively interposed between a prime mover and a driven shaft driving the machine and wherein an electrical contactor having rotatable contact elements governs the operation of a control motor which moves the pulley-half along the first named shaft, the combination with said mechanism of a movable pattern chain having thereon projections which are adjustable in accordance with the speed-change pattern desired, a follower comprising a rod adapted to reciprocate in response to movement of said pattern chain, and a pendant swing arm having one end pivoted to a fixed support and its other end portion connected to a rotatable contact element of the electrical contactor to rotate the same, said reciprocable rod being operatively connected to said pendant swing arm adjacent the pivoted end thereof so as to amplify movements of said rotatable contact element responsive to movements of the follower.

2. In a speed change and control mechanism for a knitting machine required to be driven at a number of different speeds through a number of different operational stages wherein a gradually variable ratio-changer including a pulley-half splined for axial movement along a shaft is operatively interposed between a prime mover and a driven shaft driving the machine and wherein an electrical contactor governs the operation of a control motor which moves the pulley-half along the first named shaft, the combination with said mechanism of a pattern device comprising a chain having thereon projections which are adjustable in accordance with the speed-change pattern desired, means for moving said chain, a follower movable in response to movement of said chain, and movement-amplifying mechanism operatively interposed between the follower and said electrical contactor including a pendant swing arm connected to said electrical contactor.

3. In a speed change and control mechanism for a knitting machine required to be driven at a number of different speeds through a number of different operational stages wherein a gradually variable ratio-changer including a pulley-half splined for axial movement along a shaft is operatively interposed between a prime mover and a driven shaft driving the machine and wherein an electrical contactor governs the operation of a control motor which moves the pulley-half along the first named shaft, the combination with said mechanism of a pattern chain including a plurality of projections which are adjustable in accordance with the speed-change pattern desired, a follower engageable by and movable in response to said projections, and movement-amplifying mechanism operatively interposed between the follower and said electrical contactor including a pendant swing arm connected to said electrical contactor.

4. An electric drive and speed-control for a knitting machine including an electric drive-motor, a variable ratio-changer operatively connected to said drive-motor, a reversible electric control-motor operatively connected to said ratio-changer, an electrical contactor having two mutually rotatable members one of which carries at least two spaced electrical contact segments insulated from each other and the other of which carries at least one electrical contact arranged to ride onto and off the aforesaid segments by relative rotation of said two members, one of said segments being electrically connected to said control-motor to cause rotation of said motor in one direction and the other of said segments being connected to said control-motor to cause its rotation in the other direction when the electrical contact of the other member engages one or the other of said segments, one of said members being connected to said control-motor through a fixed-ratio speed-reducer interposed therebetween to rotate said motor-connected member at a speed much less than the

speed of said control-motor, a pattern-chain having projections thereon, a follower in operative juxtaposition to said pattern-chain and means intermediate said follower and the other of said two mutually rotatable members for rotating the latter to and fro to an angular extent substantially less than 360° responsive to the presence and absence of a projection on said pattern-chain displacing said follower.

5. An electric drive and speed-control for a knitting machine including an electric drive-motor, a variable ratio-changer operatively connected to said drive-motor, a reversible electric control-motor operatively connected to said ratio-changer, an electrical contactor having two mutually movable members one of which carries at least two spaced electrical contact segments insulated from each other and the other of which carries at least one electrical contact arranged to ride onto and off the aforesaid segments by relative movement of said two members, one of said segments being electrically connected to said control-motor to cause rotation of said motor in one direction and the other of said segments being connected to said control-motor to cause its rotation in the other direction when the electrical contact of the other member engages one or the other of said segments, one of said members being connected to said control-motor through a fixed-ratio speed-reduced interposed therebetween to move said motor-connected member at a speed much less than the speed of said control-motor, a pattern-chain having projections thereon, a follower in operative juxtaposition to said pattern-chain and means intermediate said follower and the other of said two mutually movable members for moving the latter to and fro responsive to the presence and absence of a projection on said pattern-chain displacing said follower.

6. An electric drive and speed-control for a knitting machine including an electric drive-motor, a variable ratio-changer operatively connected to said drive-motor, a reversible electric control-motor operatively connected to said ratio-changer, an electrical contactor having two mutually rotatable members one of which carries at least two spaced electrical contact segments insulated from each other and the other of which carries at least one electrical contact arranged to ride onto and off the aforesaid segments by relative rotation of said two members, one of said segments being electrically connected to said control-motor to cause rotation of said motor in one direction and the other of said segments being connected to said control-motor to cause its rotation in the other direction when the electrical contact of the other member engages one or the other of said segments, one of said members being connected to said control-motor through a flexible-cable speed-reducer interposed therebetween to rotate said motor-connected member at a speed much less than the speed of said control-motor, a pattern-chain having projections thereon, a follower in operative juxtaposition to said pattern-chain and means intermediate said follower and the other of said two mutually rotatable members for rotating the latter to and fro to an angular extent substantially less than 360° responsive to the presence and absence of a projection on said pattern-chain displacing said follower.

ERNEST A. FEUSTEL.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
387,714	Fiske	Aug. 14, 1888
1,692,955	Rowley et al.	Nov. 27, 1928
1,964,909	Garity	July 3, 1934
2,139,482	Atz	Dec. 6, 1938
2,239,927	Morton	Apr. 29, 1941
2,321,556	Raskhodoff	June 8, 1943
2,355,587	Reeves	Aug. 8, 1944
2,493,828	Parsons	Jan. 10, 1950
2,521,185	Parsons	Sept. 5, 1950