United States Patent

Cooke

[15] **3,675,446**

[45] **July 11, 1972**

[54] POSITIVE FEED SYSTEM FOR CIRCULAR KNITTING MACHINES

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[22] Filed: **June 16, 1970**

[21] Appl. No.: **46,736**

[30] **Foreign Application Priority Data**

June 20, 1969 Great Britain 31,214/69

[52] **U.S. Cl.** ..... **66/132 T**, 226/40, 226/41

[51] **Int. Cl.** **D04b 15/48**

[58] **Field of Search** ..... 66/132 T; 226/40, 41

[56] **References Cited**

UNITED STATES PATENTS

3,243,091	3/1966	Rosen	66/132 T X
3,327,499	6/1967	Schmidt et al.	66/132
3,478,945	11/1969	Cooke	66/132 T UX

FOREIGN PATENTS OR APPLICATIONS

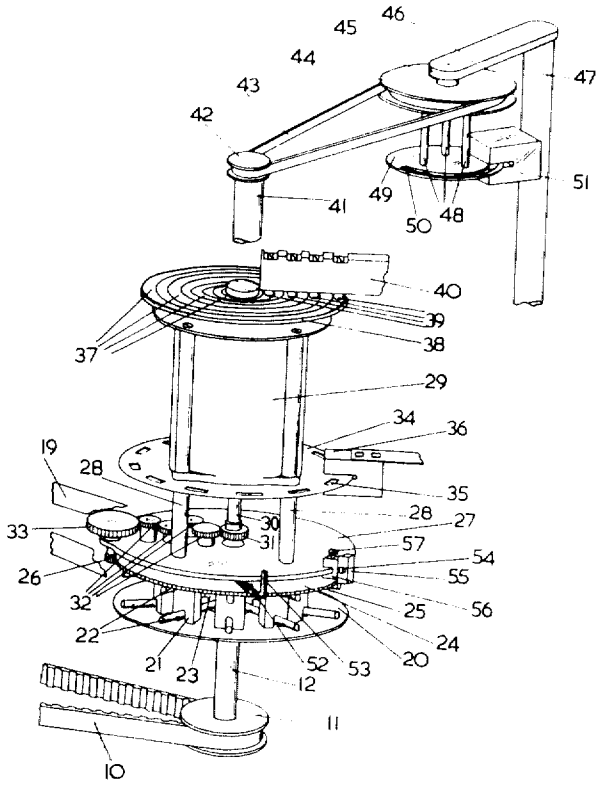
1,290,290	3/1969	Germany	66/132 T
300,138	4/1968	Sweden	66/132 T

Primary Examiner—Robert R. Mackey
Attorney—Larson, Taylor and Hines

[57] **ABSTRACT**

An adjustable positive yarn feed system comprises a variable diameter wheel used to drive a band, tape or the like by which positive feed is applied to a yarn or yarns, adjusting means for varying the wheel diameter a stepping motor for effecting incremental variation of the setting of the adjusting means, and a control device for actuating the stepping motor as and when required.

11 Claims, 3 Drawing Figures



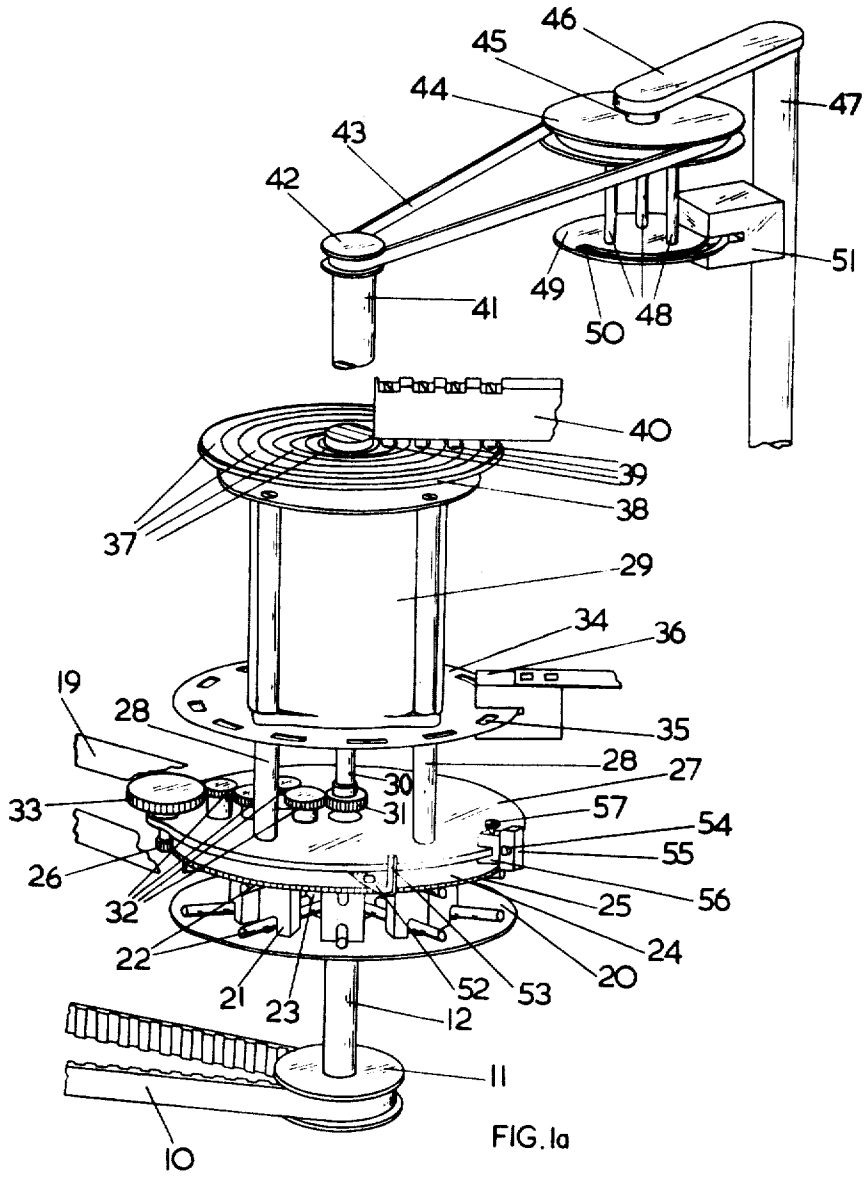

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FIG. 1a

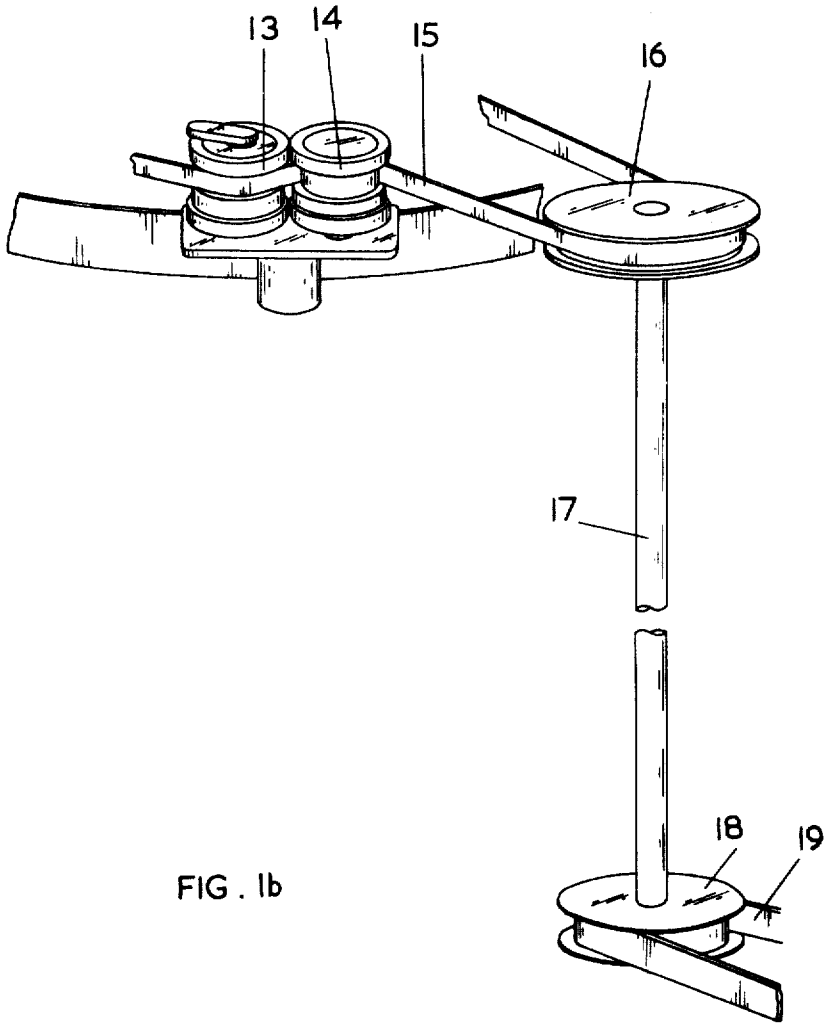

FIG. 1b

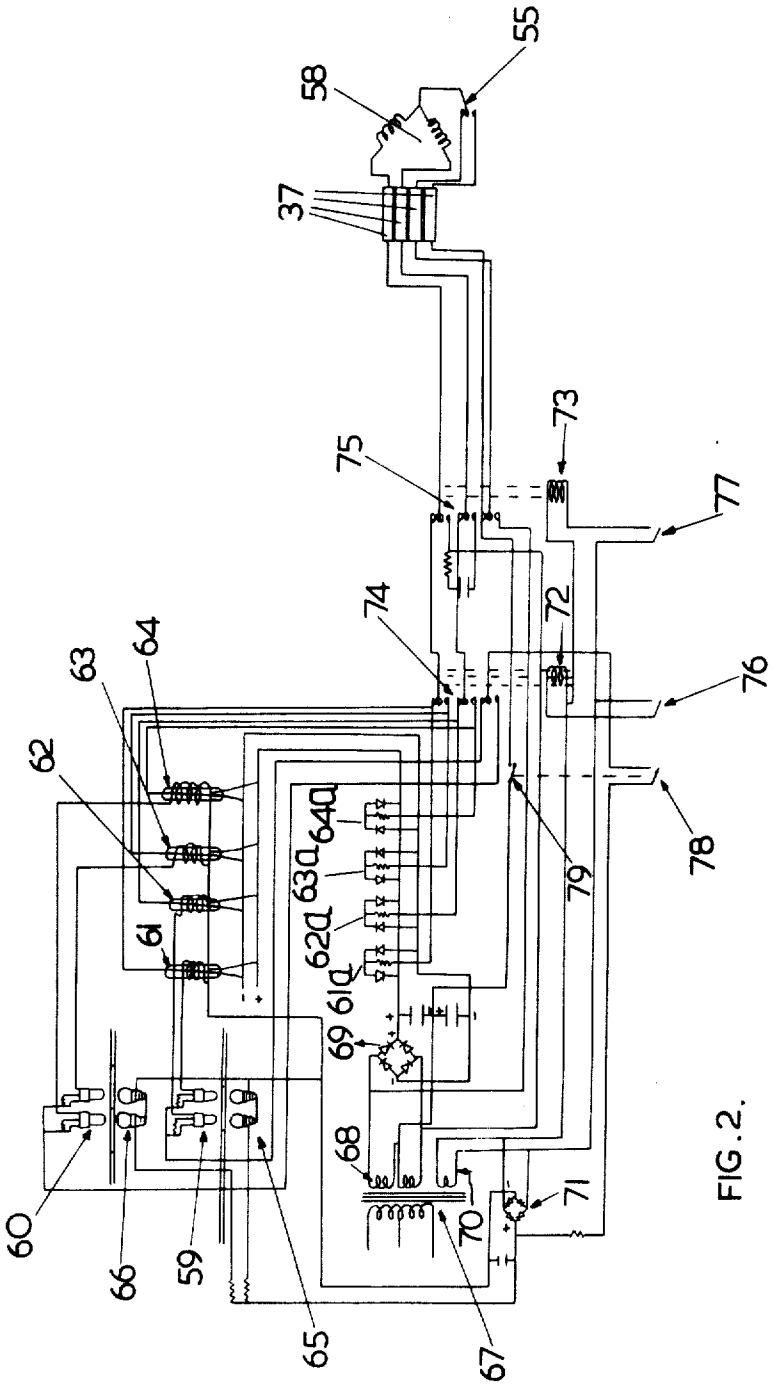
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FIG. 2.

POSITIVE FEED SYSTEM FOR CIRCULAR KNITTING MACHINES

This invention is for improvements in positive feed systems and is concerned more particularly with means for effecting required changes in the rate of positive yarn feed.

In accordance with the invention there is provided a positive yarn feed system, such as may be used on a circular knitting machine, wherein a variable diameter wheel is used to drive a band, tape or the like through the operation of which positive feed is applied to a yarn or yarns and having an adjusting means on the variable diameter wheel, to adjust its diameter, a stepping motor for varying the setting of the adjusting means and a control device for activating the stepping motor as and when required. The stepping motor is conveniently arranged to be activated in such manner as to vary the setting of the adjusting means in small increments forwardly or in reverse to provide for required changes in the ratio of the drive between the variable diameter wheel and the band, tape or the like whereby required changes in the rate of positive feed are effected smoothly and effectively in accordance with pre-determined requirements.

Heretofore it has not been practicable with circular knitting machines for producing stockings, tights, panty-hose or other garments of a shaped nature to provide an effective positive feed arrangement meeting requirements of changes in positive feed rate at different parts of the garments.

It is thought that this arises from the difficulty of providing an accurate and reliable method of varying the rate of supply according to a pre-arranged program and the complexity of control means required. The system in accordance with the invention has been devised with the object in view of largely or wholly meeting all the requirements involved in providing a satisfactory positive feed system in which required alterations in rate of feed can be effected accurately at appropriate times.

In practising the invention the variable diameter wheel conveniently has a cam disc which is arranged to control the radial positions of a series of blocks forming segments of the wheel periphery, and the cam disc is geared to the spindle of the stepping motor to be adjusted by the action of said motor. The variable diameter wheel may be constructed as described in my U.S. application, Ser. No. 46,340, filed June 15, 1970, based on British Application No. 31213/69. With this form of wheel the cam disc positioned at one side and arranged for turning movement to adjust the radial positions of the blocks is conveniently formed peripherally with gear teeth engaged by a pinion at one end of a train of gears driven from the spindle of the stepping motor.

The control device by which the operation of the stepping motor is governed may comprise a photo-electric or other sensing device responsive to indications on a disc which conveniently rotates with the variable diameter wheel and the mounting of the stepping motor, and/or in response to indications on a disc which is driven to rotate at a speed proportional to that of the variable diameter wheel. With such an arrangement the electrical supply to the stepping motor is conveniently provided by a stationary brush unit having brushes engaging with slip rings connected to the motor windings.

A convenient control device is one in which there is a scanning head fitted with two photo-transistors and an opposed lamp or lamps between which a disc as aforesaid is interposed, a single slot or a plurality of slots at circumferential intervals being formed in the disc to provide for exposure of the photo transistors to the light from the lamp or lamps. As each slot passes the scanning head a sequence of four different conditions of energization of the photo transistors occurs namely: exposure of first transistor only; exposure of both transistors, exposure of second transistor only; and non-exposure of both the transistors. Thereby a sequence of different impulses in a particular order is initiated at the scanning head and is used to advance the motor in a succession of four short step movements. The direction of movement of the motor may, if required, be controlled by a switch in an appropriate electrical control circuit through which the impulses are fed to the motor. Thus the stepping movements of the motor impart small adjustments to the variable diameter wheel.

The number of increments of adjustment of the wheel which occur during a rotation of the control disc can be varied in the case of a disc having circumferentially spaced slots by masking one or more of the slots to provide for the required number of energizations of the motor at each rotation of the disc. The incidence of adjusting movements imparted to the variable diameter wheel can be controlled by energization and de-energization of the scanning head and/or circuits controlled thereby, under the dictation of patterning means, e.g. a chain or drum on the knitting machine. Thus during the progress of the knitting operation the scanning head and the circuits controlled thereby will be de-energized during periods when no change in the rate of positive feed of yarn is required and energizing of the scanning head and its circuits will occur only during a period when change in the positive feed rate is needed.

The adjustment of the degree of change in rate is determined by the period of energization and the number of slots which are exposed in the control disc. In a case in which it is desired to provide a fine adjustment requiring less than four stepping impulses to be applied to the motor in each rotation of the variable diameter wheel, an auxiliary scanning head related to a disc having a single slot may be provided with such disc driven at a reduced speed from a spindle carrying the variable diameter wheel and the mounting of the stepping motor, for example at a rate of one turn for every four turns of the spindle of the variable diameter wheel. Thus the equipment may have two scanning heads one related to a disc as aforementioned with a circumferential row of slots and another related to a disc having only one slot which is driven at a slower rate of speed, either scanning head being caused to activate the motor as required.

A convenient form of improved positive feed system is illustrated by way of example in the accompanying drawings in which

FIGS. 1*a* and 1*b* together show in perspective view with certain parts broken away and mountings omitted, the driving arrangements in the system, and

FIG. 2 is an electrical circuit diagram.

Referring to FIGS. 1*a* and 1*b* there is shown a positive driving belt **10** for driving a gear pulley **11** on a vertical shaft **12** supported in fixed bearings not shown. The belt **10** is driven from a timing pulley on an appropriate shaft of a circular knitting machine which is equipped with positive feed mechanism comprising yarn feeding rollers **13** and **14** driven by a tape or band **15** from a master driving pulley **16** as described in my U.S. Pat. No. 3,478,945 issued Nov. 18, 1969. The pulley **16** is on a spindle **17** driven by a belt **19** which engages with a variable diameter pulley indicated generally at **20** and fixed to the shaft **12**. The belt **19** is equipped with a spring urged jockey pulley (not shown) to maintain it in a taut condition.

The variable diameter pulley **20** is constructed as described in my U.S. application, Ser. No. 46,340, filed June 15, 1970, based on British Application No. 31213/69 and comprises radially adjustable blocks **21** slidable on pairs of parallel radial spokes **22** radiating from a central holder **23**, and a cam disc **24**. By turning the disc **24** relatively to the holder **23** the blocks **21** are adjusted radially to vary the effective diameter of the pulley presented by the center parts of the blocks **21** engaged by the belt **19** between the projecting ends of the rods **22**. In practicing the present invention the cam disc **24** is formed with gear teeth **25** around its edge which are engaged by a pinion gear **26**, the turning of which causes adjustment of the disc **24** and of the effective diameter of the pulley **20**.

It will be understood that while the control holder **23** of the pulley **20** is fixed to the vertical shaft **12**, the cam disc **24** is mounted so as to be capable of turning on the shaft. Also fixed to the shaft **12** is a carrier disc **27** which supports on four pillars (two of which are seen at **28**) a stepping motor indicated at **29**. The motor **29** has a spindle **30** which carries a gear wheel **31** for driving through a train of gears **32** a gear wheel

33 secured to a spindle to which the pinion **26** is fixed. The gears **32** and **33** have their spindles carried by the carrier disc **27**. Also secured to the motor casing concentrically with the shaft **12** is a scanning disc **34** which thus rotates with the shaft **12** and which is formed with spaced slots **35** at a position to pass through a gap in a scanning head **36**. The latter is fitted with two photo-transistors side by side and an opposed lamp or lamps, the light from which can be transmitted through one of the slots **35** to energize the photo-transistors. As each slot passes the scanning head a sequence of different impulses is set up and according to the order in which these are applied to the stepping motor it is energized for forward or reverse stepping movements.

The stepping motor **29** receives its energization through slip rings **37** carried on an insulating disc **38** which rotates with the motor **29** and shaft **12**. Three of the slip rings supply power to the motor and the fourth is related to a switching circuit. These slip rings are engaged by brushes **39** on a stationary brush unit **40**.

Secured to the top of the motor assembly **29** in line with the shaft **12** is a further shaft **41** which carries a small pulley **42** driving through a belt **43** a larger pulley **44** supported for rotation by a spindle **45** carried by an arm **46** on a stationary post **47**. The pulley **44** has depending from it three symmetrically arranged rods **48** supporting a further scanning disc **49** formed with a single slot **50** to co-operate with a further scanning head **51** fixed to the post **47** and constructed similarly to the scanning head **36**.

In the operation of the apparatus illustrated the shaft **12** is driven during the operation of the knitting machine at a speed in synchronization with the machine. Assuming that an article such as a stocking or leg blank for a panty-hose is being knitted it is required that at different times the effective diameter of the variable diameter pulley **20** shall be changed accurately to vary the rate of positive feed of the yarn fed by the rollers **13** and **14**, in order to provide the required changes in yarn length or loop size. These changes must be very accurate as well as easy to program and these conditions are well met by the employment of the stepping motor **29** which when supplied with D.C. pulses with polarity changes in a specific sequence will turn in the required direction in minute intermittent steps. The motor used at **29** is one which can also be run on A.C, this facility being used for re-setting purposes.

When the knitting operation commences with the pulley **20** initially set for the required rate of positive feed the machine proceeds to knit with a loop size determined by the initial rate. So long as no change in the rate of positive feed is required the scanning head **36** will have its circuit switched off so that the rotation of disc **34** has no effect on it. When a change in the rate of positive feed is required control means on the machine will cause the scanning head **36** to be switched on for the required direction of movement of the motor spindle **30** to effect a small increment of change in the diameter of the pulley **20** to increase or decrease it as needed. Thereupon the scanning disc **34** on turning will cause its slots **35** to pass the scanning head **36** to give rise to energization of the motor for small increments of movement as each open slot passes through the scanning head. It will be predetermined how many energizations of the motor **29** are required for each rotation of the disc **34** and the number of effective slots **35** will be adjusted accordingly by covering a slot or slots in the disc **34** until the required number of effective exposures is left. The period of energization of the scanning head **36** is also controlled to provide for the required number of energizations of the stepping motor **29** to effect the change in pulley diameter.

If a finer degree of change in pulley diameter is required the scanning disc **50** and scanning head **51** are brought into action instead of the disc **34** and head **36**, by switching on the scanning head **51**. Four energizations of the motor will be caused during each rotation of the disc **49** and the disc is arranged to rotate at a reduced speed compared with the shaft **12**, the ratio being determined by the relative sizes of the pulleys **42** and **44** and being adjustable by substituting a different sized pulley at **42**.

Changes in the rate of positive feed are effected as above described by control mechanism of the knitting machine (e.g. the patterning chain) at required steps during the knitting of a stocking or leg blank and on completion of the article it is required that the variable diameter pulley **20** shall be restored to its original diameter for commencement of knitting the next article or blank.

To assist such resetting there may be a bracket **52** fixed to the cam disc **24** and having an upturned wing **53** arranged to trip a button **54** of a microswitch **55** supported by a bracket **56** having a clamping screw **57** by which it can be fixed to the carrier disc **27** at any desired position around the periphery thereof. By a switching circuit actuated by the knitting machine control means, stepping motor **29** may be caused to be operated in reverse to step the cam disc **24** round until the wing **53** of bracket **52** trips the micro-switch **55** so as to de-energize the motor **29** when the cam disc **24** has been reset. Advantageously, however, the resetting movement of the cam disc **24** is effected by energizing the motor **29** by A.C. for continuous movement in reverse and using the switch **55** to interrupt such energization. In each case the switch **55** will remain tripped until the wing **53** is moved away from the button **54**. This can be brought about by means of a control switch (not shown) which overrides the action of switch **55** for starting purposes.

One particular example of a suitable circuit arrangement for controlling the stepping motor is illustrated in FIG. **2**, the motor being shown by its windings at **58** and its slip rings at **37**. The photo-transistors of the scanning heads **36** and **51** are indicated at **59** and **60** and they are related to reed switches of change-over type indicated at **61**, **62**, **63**, and **64**. Surge suppression circuits **61***a*, **62***a*, **63***a*, and **64***a* are related respectively to the reed switches, and lamps **65** and **66** are related to the photo-transistors **59** and **60**. The circuit is energized from a mains transformer **67** having a center tapped secondary coil **68** connected to a rectifier bridge **69** from which the D.C. supply for the impulses is provided as well as a neutral line used in energizing the motor **58**. The transformer **67** has an additional secondary coil **70** related to a rectifier bridge **71** from which the D.C. supply for the lamps **65** and **66**, photo-transistors **59** and **60** and for operating switch coils is derived. The switch coils just referred to are shown at **72** and **73** and operate multi-contact switches **74** and **75** through which the generated impulses can be applied in required manner to the slip rings **37** through the brushes **39**. The circuit is controlled in operation by the switches **76**, **77** and **78** which are actuated by cams on the control chain or pattern drum of the knitting machine. The switch **78** is ganged with the switch **79** and controls the activation of the stepping motor adjustment sequence by controlling the D.C. supply to the photo-transistors **59** and **60**. The switch **79** controls the zero volts line to the motor **58**. The switch **76** together with switch **77** control activation of the switch coils **72** and **73**, respectively. The switch **76** in effect controls which of the scanning heads **59** and **60** is activated. If the switch **76** is open the reed switch pair **61** and **62**, pulsed by the phototransistors in the scanning head **59**, are connected to the motor **58**. If the switch **76** is closed, the reed switch pair **63** and **64**, pulsed by the photo-transistors in the scanning head **60**, are connected to the motor **58**. During scanning, the switch **77** must be opened. Thus, in the process of knitting a stocking, the switch **76** is kept open during the knitting of a stocking welt and panel and closed for narrowing while the switch **77** is open for forward energization of the motor coils **58**. The switch **77** controls reverse energization of the step motor **58**. To this end, the switches **76** and **78** already being open, the switch **77** is closed so as to connect an a.c. supply to the stepping motor over the switches **75**. Reverse energization of the motor **58** is automatically terminated by operation of the switch **55** as previously described.

What I claim is:

1. In a positive yarn feed system for a knitting machine, the combination comprising positively driven yarn feeding rollers, an endless band for driving said rollers, a variable diameter wheel through which said endless band is driven, means for

driving the variable diameter wheel, a rotary adjusting means for varying the effective diameter of said variable diameter wheel, a stepping motor, drive connecting means between said stepping motor and said rotary adjusting means, and a control device for activating the stepping motor in predetermined manner.

2. A combination according to claim 1 wherein said control device includes means for activating the stepping motor to vary the setting of the adjusting means in small increments forwardly or in reverse to provide for required changes in the ratio of the drive whereby changes in positive feed rate are effected smoothly and effectively.

3. A combination according to claim 1 wherein the rotary adjusting means includes a cam disc and said drive connecting means comprises gear means connecting said disc to the stepping motor and wherein the variable diameter wheel comprises a series of blocks forming wheel segments which are adjustable radially by the cam disc in response to actuation of the gear means by the stepping motor.

4. A combination according to claim 3 wherein the said cam disc is positioned at one side of the wheel and mounted rotatably for adjustment of the radial positions of said blocks and wherein the gear means include gear teeth peripherally formed on the cam disc and a train of gears driven from the stepping motor including a pinion gear engaging with the gear teeth on the cam disc.

5. A combination according to claim 1 wherein the control device comprises an indicator disc and a sensing device responsive to indications on the disc for controlling operation of the stepping motor.

6. A combination according to claim 5, comprising means mounting the disc to rotate at a speed related to the speed of the variable diameter wheel.

7. A combination according to claim 6 wherein the sensing device comprises a scanning head including two photo transistors and at least one light source and wherein the disc is interposed between the photo transistors and the light source and is formed with at least one indicator slot to provide for exposure of the photo transistors to the light source.

8. A combination according to claim 7 wherein the two phototransistors are mounted peripherally relative to the disc to position them for sequential exposure through a disc slot during rotation of the disc.

9. A combination according to claim 7 in a system for positively feeding yarn to a knitting machine having patterning means, including means for controlling energization and de-energization of the scanning head, said controlling means being constructed and arranged to be actuated under the dictates of the patterning means of the machine.

10. A combination according to claim 7 comprising an auxiliary scanning head and a related auxiliary disc with at least one slot formed therein for scanning by the auxiliary scanning head, and means for driving the auxiliary disc at a speed proportional to but slower than that of the indicator disc.

11. A combination according to claim 10 including means for causing either one of the two scanning heads to actuate the stepping motor in accordance with requirements.

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