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[54] **METHOD AND MEANS FOR CIRCULAR KNITTING**

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

[58] **Field of Search**.....66/54, 55, 132, 146

[56] **References Cited**

UNITED STATES PATENTS

3,243,975	4/1966	Lawson et al.	66/132
3,324,685	6/1967	Schmidt et al.	66/132
3,361,317	1/1968	Levin	66/132
3,174,306	3/1965	Lawson	66/54
3,225,570	12/1965	Mishcon	66/132
3,307,378	3/1967	Warthen	66/54 X
3,451,603	6/1969	Helpper et al.	66/132 X
3,523,433	8/1970	Hatay	66/132

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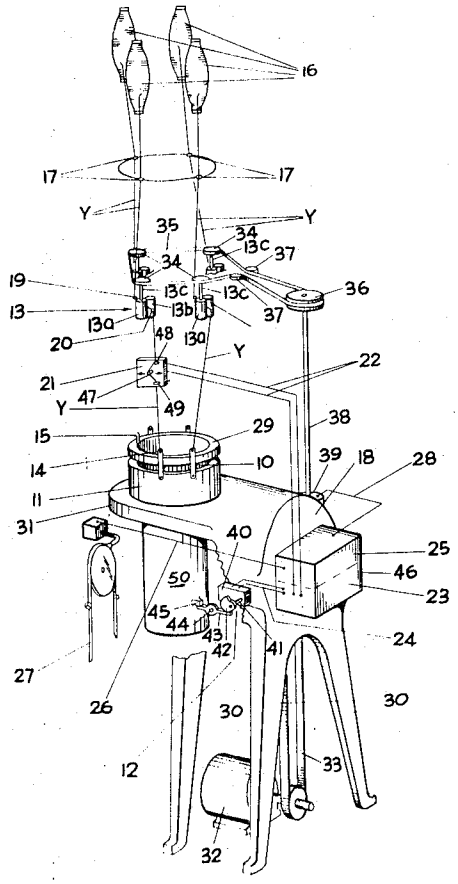
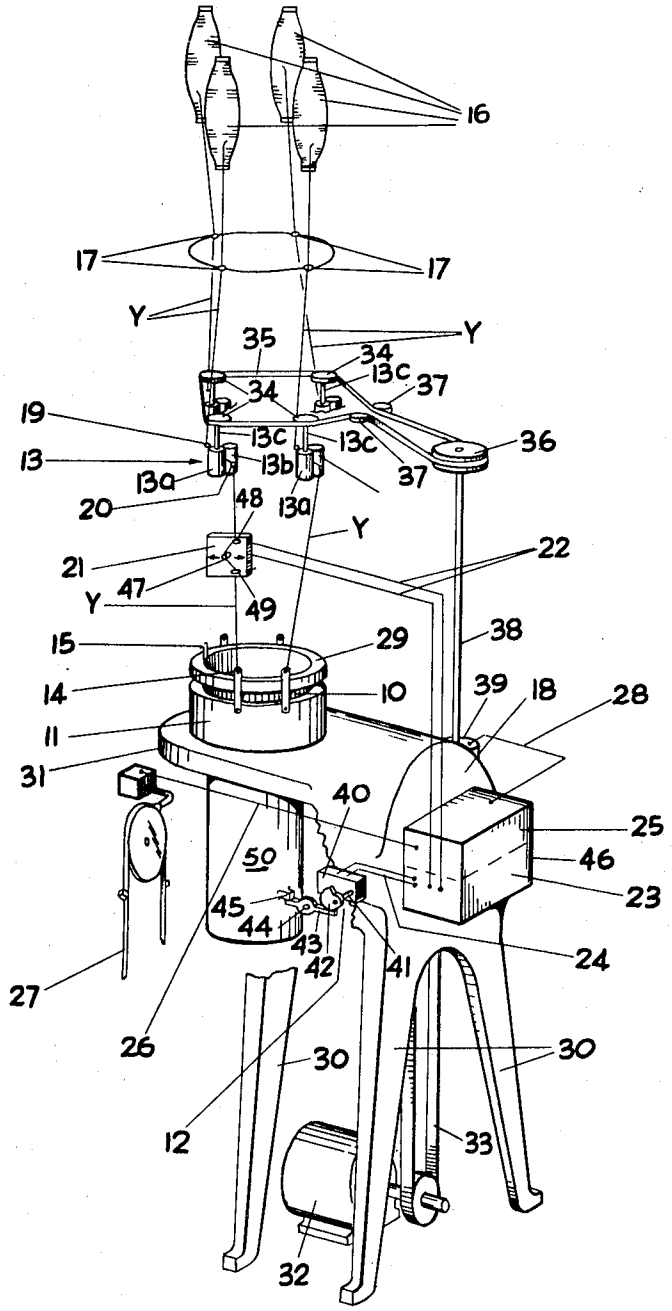
[57] **ABSTRACT**

A method and means are provided for controlling the operation of a circular knitting machine having a plurality of feeding stations with yarn positively fed to the needles at one at least of said stations, wherein the tension is a positively fed length of yarn extending to the feeding point from the positive feeding means at one of the feeding stations is maintained constant by adjusting the needle cylinder axially to adjust the stitch size at each station under control of a sensing device acting on said length of yarn, so as to compensate for any changes in tension from a normal value in the said positively fed length of yarn.

6 Claims, 1 Drawing Figure

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METHOD AND MEANS FOR CIRCULAR KNITTING

This invention is for an improved method and means for circular knitting and is concerned more particularly with the knitting of tubular fabric blanks which are required to be of substantially the same length and may need to have variations of "quality", i.e.stitch size, from place to place along the blank. Blanks for seamless stockings are examples of tubular knitted blanks with which the invention is particularly concerned. The invention has for an object to provide a method and means whereby tubular blanks can be knitted with a substantially greater uniformity in length and quality than is obtainable by methods and means at present in common use.

In the knitting of ladies seamless stockings on circular knitting machines it is well known that no complete solution has been found to the problem of producing the stocking blanks consistently to a specified length and quality. There are probably three main factors which give rise to inconsistency in length and quality of the product and any one or more of these factors may operate at any given time. Firstly there is a problem of varying yarn tension at the needles which arises mainly from variations of inbuilt tension of one form or another in the yarn package. The second factor is temperature changes in machines which can occur during the starting up periods and even under variable conditions during running periods, and which cause variable action on the part of the knitting instrumentalities of the machine. Thirdly when a plurality of machines are operated to produce quantities of the same product it is extremely difficult to organize them to operate in precisely the same way to produce identical products. The system known in the trade as "positive feed" which has the effect of feeding a yarn to a knitting point at a constant rate is only a partial answer to part of the problem involved in producing tubular knitted blanks of exactly constant characteristics of length and quality, and the invention seeks to provide a method and means whereby the problem involved can be largely or completely overcome.

In accordance with the invention there is provided a method of controlling the operation of a circular knitting machine having a plurality of feeding stations and provided with positive feed mechanism which comprises sensing the tension in the length of yarn extending between the positive feed point and the needles at one feeding station, and controlling the operation of the machine by axial adjustment of the needle cylinder and sinkers in such a manner as to vary the stitch size so as to compensate for any changes in the tension of length of said yarn. By this procedure the machine is arranged to knit yarn with a stitch size always corresponding to the rate at which yarn is fed to the machine by the positive feed mechanism.

The invention further provides a method as aforesaid wherein required changes in stitch size are caused to occur by controlling the positive feed mechanism so as to change the rate of positive feed at predetermined times in accordance with requirements. Thus changes in "quality" (i.e. the size of knitted loops) can be effected in a precise manner, the size of stitches formed on the machine being dictated by the speed of yarn feed effected by the positive feed mechanism.

The procedure in accordance with the invention will operate largely or wholly to overcome the disadvantages of previous knitting procedure as mentioned above. By causing the knitting machine to be adjusted in its operation simultaneously and to the same degree at each of the feeding stations to match the operation of the positive feed mechanism, not only are varying tensions in the yarn derived from inbuilt tension variations in the yarn supply package prevented from being passed on to the neighborhood of the needles but also any temperature changes occurring in the machine tending to vary the stitch size will be automatically compensated by adjusting the stitch forming mechanism of the machine at each feeding station strictly in accordance with the dictates of the positive feed mechanism, so that temperature variations in the machine will not affect the stitch size. Furthermore by determining the stitch size in accordance with the operation of the positive feed mechanism it is made more readily possible to match the performance of a plurality of machines required to knit identical products.

The invention also provides means for controlling the operation of a circular knitting machine having a plurality of yarn feeding stations and equipped with positive feed mechanism, comprising a yarn sensing device acting on yarn at a position between the positive feed mechanism and a yarn feeder directing the yarn to the needles at one of said feeding stations and means actuated by said sensing device to effect axial adjustment of the needle cylinder and sinkers so as to vary the stitch size on the knitting machine in such manner as to compensate for any changes in tension of the yarn sensed by the sensing device. There may also be provided means for controlling the positive feed mechanism in such manner as to vary the rate of operation of the positive feed mechanism to produce different yarn speeds in predetermined manner at different times in accordance with requirements. The control of the speed of the positive feed mechanism may be derived from signals produced from time to time by patterning mechanism related to the knitting machine,e.g. a pattern control chain or drum.

The provisions of the invention are illustrated by way of example in the accompanying drawing which shows diagrammatically an arrangement of parts for practising the invention.

The drawing illustrates somewhat diagrammatically a circular knitting machine having four feeding stations such as may be used for knitting ladies stockings. The machine frame which is shown partly broken away is indicated at **18** and has legs **30** and a bed plate **31** supporting a cam box **11** and a needle cylinder **10** having a sinker ring **29**. Yarn feeders or guides are shown at **14** one for each of the four feeding stations to feed yarn to needles **15** in the cylinder. In the machine shown knitting is performed as is usual with a machine for knitting hose, by rotating the cylinder **10** (and the sinker ring **29** with it) whilst the cam box **11** and feeders **14** remain stationary. It will be understood however that the invention may be applied to machines of other kinds. The drawing shows an electric motor **32** and belt **33** for driving the machine.

For practising the invention the machine illustrated is provided with a means shown at **12** to act on the

cylinder **10** (through a stationary sleeve) whereby it with the sinker ring **29** may be raised and lowered to extents to vary the length of the stitch drawing movement of the needles sufficiently to embrace an appropriate range of stitch sizes. Positive feed mechanism for each feeding station is shown at **13** comprising two rollers **13***a* and **13***b* at least on of which is positively driven at a controlled constant speed to feed a yarn Y between the rollers and supply it at a required rate (to suit the stitch size required) through the appropriate thread guide **14** to the needles **15** in the cylinder **10**. The yarns Y obtained for the four feeding stations are respectively from four supply packages **16** mounted above the machine and each yarn Y passes via a guide **17** to a guide **19** of the appropriate positive feed mechanism, the yarn being delivered from the latter through a further guide **20**.

For the sake of illustration the rollers **13***a* are shown as being driven positively all at the same speed through spindles **13***c* carrying pulleys **34** driven by a common belt **35** deriving its power from a master pulley **36** and guided by guide pulleys **37**. The master pulley **36** is fixed to an upstanding drive shaft **38** operated from within a drive box **39**.

In practising the invention there is provided at **21**, at a position between the positive feed mechanism **13** and the guide **14** associated with one of the feeding stations a sensing device which is responsive to the condition of the length of yarn at that position so that if it becomes excessively tensioned or slack (due to an over rate or under rate of take up by the needles **15**) a signal will be instigated by the device **21** and transmitted via electrical wires **22** to a control mechanism **23** acting through an electrical line **24** on the means **12** for varying the level of the needle cylinder **10**, and sinkers so as to bring about a compensating adjustment of the latter. The cylinder adjusting means **12** is shown as comprising a box **40** (to which the wires **24** extend) containing a two way driving means (e.g. a reversible motor) for a spindle **41** mounted to rotate in the box and carrying a cam **42**. The latter co-operates with one arm of a lever **43** pivoted at **44** the other arm of which engages a projection **45** on a non-rotating sleeve **50** by up and down movement of which the cylinder **10** is raised and lowered. By signals through the wires **24** the driving means in the box **40** is caused to turn the cam **42** one way or the other as required to raise and lower the cylinder **10** so as to adjust the stitch length at all the feeding stations.

The control mechanism **23** is contained in a control box **46** which also houses control means **25** adapted to derive signals through an electrical connection **26** from projections set up on a patterning control chain **27**. Such projections are arranged to operate to change the action of the positive feed mechanism **13** as and when required, at different stages in the knitting cycle. The positive feed mechanism has its drive means in the box **39** so organized as to be capable of instantly and accurately changing its rate of yarn feed in response to signals passed to it from the control means **25** through an electrical connection **28**, as a consequence of signals received through the connection **26**.

The sensing device **21** may take various forms. In the example shown it comprises a box of container in which there is a movable lightly biassed member **47** arranged to rest against the yarn and deflect it slightly out of its normal path between guides **48** and **49** when the yarn is under normal knitting tension. Variations in tension of the yarn will cause the lightly biassed member to move one way or the other and in so doing give rise to the appropriate one of two alternative signals which is transmitted to the control mechanism **23** through the wires **22** to bring about a compensating adjustment as aforementioned. The movement of the yarn away from its normal path or of part of the biassed member out of its normal position may be sensed by partial interruption of one or the other of two rays acting on photoelectric or similar cells or by generation of signal voltages by means of piezoelectric crystals, or simply by making or breaking electrical circuits by movement of contacts.

In the operation of the parts shown in the drawings, the positive feed mechanism **13** has its variable drive contained in the box **39** set for the required rate of yarn feed and knitting proceeds with the yarn fed to the feeders **14** taken up by the needles. Should the take-up by the needles for any reason exceed or fall short of the rate of yarn feed determined by the positive feed mechanism **13**, the sensing device **21** will pass a signal to the control mechanism **23** causing the latter to operate the means **12** so as to raise or lower the needle cylinder **10** until the out of balance condition has been correctly compensated, whereupon the signal from the sensing device **21** will cease. In this way it is ensured that the stitch size of the knitted fabric produced on the needles **15** of the cylinder **10** is maintained so as to correspond exactly to the size determined by the rate at which the yarn is fed by the positive feed mechanism **13**. An exactly constant length and quality of fabric tube is thereby produced and in accordance with the dictates of the positive feed mechanism **13**.

Assuming a blank for a ladies stocking is being produced it will be required at different stages of knitting to vary the loop size in the stitches knitted and this is accomplished by signals from the patterning chain **27** being passed to the control means **25** causing the latter to control the action of the driving means of the positive feed mechanism **13** to alter the rate of yarn feed to a different value to suit the changein stitch size required.

As will be seen from the drawing only one sensing device **21** acting on the yarn passing to one of the four feeding stations is sufficient to enable compensating adjustments of stitch loop lengths to made simultaneously at all four of the feeding stations. This arises from the fact that stitch length adjustments are made by raising and lowering the needle cylinder and sinkers which alters the stitch draw length to the same degree at all of the feeding stations.

By means of the method and means provided by the invention it is possible to produce batches of stocking blanks which are identical or substantially identical to one another as to length and quality of the knitted fabric, and a specified number of knitted courses can be caused to produce fabric of a predetermined length.

The invention is applicable to circular knitting machines of various types having a plurality or multiplicity offeeding stations with yarn positively fed to the needles at each feeding station, or at one only or some only of the feeding stations. As already indicated

a sensing device such as **21** need only be provided in relation to any one of the feeding stations having positive feed of the yarn thereat to control the means whereby compensating adjustments of the stitch loop length is made at all of the feeding stations.

Thus in cases in which it may be necessary or desirable to have positive feed of the yarn at one only or some only of the feeding stations the control of stitch length at all of the feeding stations by means of a feeler device **21** at a station at which positive feed occurs and the associated control means described, offers useful advantages by compensating for any tendencies for variable action of the knitting instrumentalities due to temperature changes in the machine. In many cases these tendencies to variation are the most important ones to eliminate and the fact that the effect of package tension variations is only counteracted at feeding stations at which positive feed occurs is of less consequence.

If positive feed of the yarns is required to be discontinued for any period (as for instance when knitting by reciprocation) the sensing device will be caused to be inoperative to change the loop size for the same period. This may be done for example by interrupting the circuit of the parts in the control mechanism **23** that are actuated by signals through the wires **22**.

It will be understood that in place of the patterning control chain **27** any other form of patterning means may be used, such as punched card or band.

What I claim is

1. A method of controlling operation of a circular knitting machine having a needle cylinder equipped with needles, a sinker ring attached to said needle cylinder and equipped with sinkers and having a plurality of feeding stations and a positive feed mechanism driven by a variable speed drive means for feeding yarn positively in measured lengths to at least one of the feeding stations, comprising the steps of:

sensing the tension in a positively fed length of yarn extending between a positive feed point and the needles at one of the feeding stations,

controlling the stitch draw length simultaneously at all of the feeding stations of the machine by operating a two-way power motor in response to a signal from the sensing means to move the needle cylinder and the sinkers axially both ways to effect axial adjustment of the needle cylinder and sinkers, and altering the rate of operation of the positive feed mechanisms by operating the variable speed drive means in response to an electrical signal transmitted from a stitch size control mechanism and representing a required change in stitch size for changing from one stitch size to another.

2. A method according to claim **1**, wherein the step of altering the rate of operation is operable in response to a patterning mechanism.

3. A circular knitting machine having a needle cylinder equipped with needles, a sinker ring attached to said needle cylinder and equipped with sinkers, a plurality of yarn feeding stations, a yarn feeder at each feeding station, a disengageable positive feed mechanism for feeding yarn positively in measured lengths to at least one of the feeding stations, variable speed drive means driving said positive feed mechanism, a yarn sensing device, means mounting said sensing device to sense the tension in a positively fed length of yarn, a two-way power motor mounted to move the needle cylinder and sinkers axially both ways to effect axial adjustment of the needle cylinder and sinkers to vary simultaneously the length of stitch draw to all of the feeding stations, said power motor being operable to effect said axial adjustment only in response to a tension signal received from said yarn sensing device, a stitch size control mechanism, means for sensing the stitch size control mechanism and transmitting an electrical signal representing a change requiring a change in stitch size, and means responsive to said electrical signal for varying the speed of said drive means to vary the speed of operation of said positive feed mechanism to change from one stitch size to another.

4. A combination as claimed in claim **3** wherein said stitch size control mechanism includes a device responsive to signals received from a patterning mechanism of the knitting machine.

5. A combination as claimed in claim **3** wherein said sensing device includes a yieldably urged yarn deflecting member movable opposite ways from a neutral setting in response to increases and decreases in yarn tension from a normal amount and means selectively responsive to opposite movements of said deflecting member to initiate appropriate signals to cause operation of the cylinder adjusting means.

6. A combination according to claim **3** said positive feed mechanism comprising yarn feeding rollers, an endless belt driving said rollers and a master wheel driving said endless band, said variable speed driving means driving said master wheel and said stitch size control mechanism actuated by a patterning device of the machine for actuating the speed varying means.

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