

- [54] KNITTING MACHINE YARN FEEDING APPARATUS

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242/45

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242/45

- [56]
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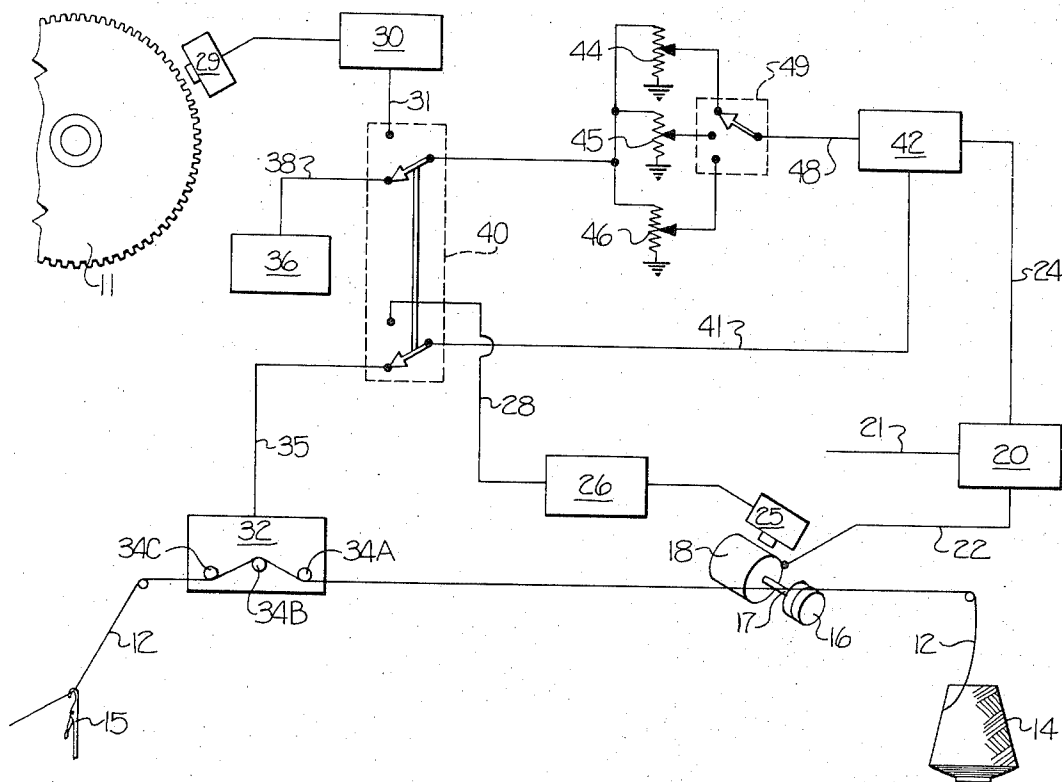
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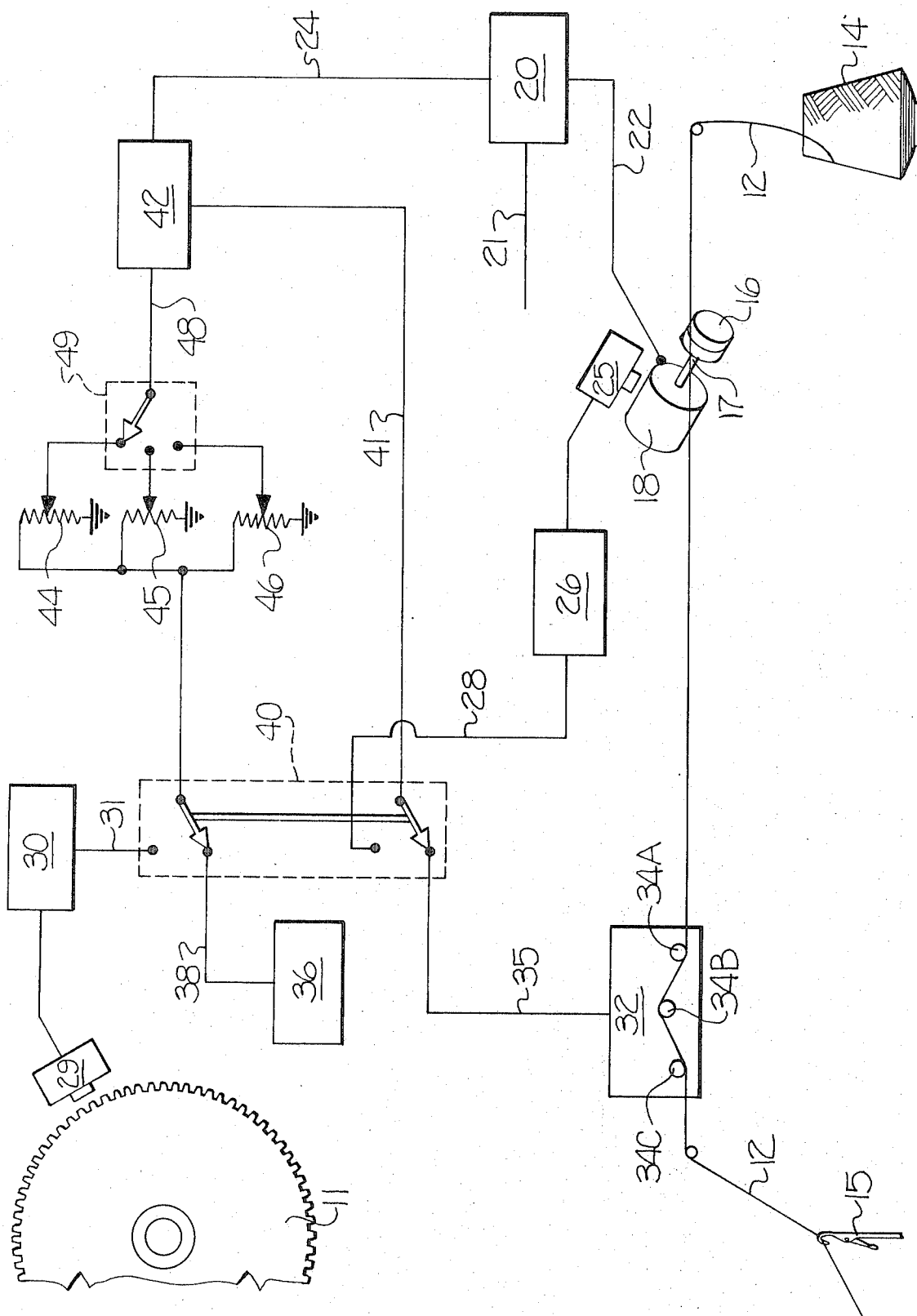
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[57] ABSTRACT

Textile yarn is withdrawn from a yarn package as demanded for knitting by a plurality of needles forming a portion of a knitting machine producing textile fabric, through selected correlation of signals indicating the speed of the knitting machine and the speed of yarn supply or indicating the tension of yarn being supplied and the desired tension level for yarn to be supplied.

7 Claims, 1 Drawing Figure





KNITTING MACHINE YARN FEEDING APPARATUS

Difficulties of supplying yarn to a knitting machine forming a textile fabric in such a manner as to assure desired uniformity in the finished knitted fabric have long been recognized and many attempts have been made at solutions for these problems. Generally, the approaches which have been proposed have related either to controlling the length of yarn delivered to a knitting position during a particular interval of time and thereby controlling the rate of yarn consumption or to controlling the tension condition of the yarn which is delivered and thereby controlling the tension imposed on the yarn as it is supplied to the knitting position. Each of these general approaches has found acceptance under certain operating conditions relating to the nature of the yarn supplied and the nature of the fabric being knitted.

Heretofore, it has been conventional for an operator of a knitting machine to determine the type of yarn feed control believed desirable for the machine and thereafter use the machine in knitting fabrics which may be produced acceptably pursuant to such control. Such choices frequently are related to the specific type of knitting machine employed as well as to the types of fabrics to be produced.

The limitations imposed by such yarn feeding control selection and the growing versatility and use of knitting machines have resulted in an increasing desire, on the part of knitting machine operators, for the availability of a choice as to yarn feeding controls and improved flexibility in such a choice.

In view of the difficulties and deficiencies which have been pointed out, it is an object of this invention to provide a ready selection of yarn feed in correlation with the rate of yarn consumption by a knitting machine or in correlation with desired tension conditions at a knitting position on the knitting machine. In realizing this object of the present invention, means are provided for sensing the rate of supply of yarn and the rate of yarn consumption by the knitting machine. Further, additional means are provided for sensing the tension of yarn being supplied and for indicating the desired level of tension for yarn to be supplied. With such indications available, selection is made as to the desired manner of yarn feeding control and a common variable speed drive means is then varied as required.

Yet a further object of this invention is to provide for selected uniformity of control over a plurality of textile yarns being supplied to a corresponding plurality of knitting positions on a knitting machine. Realizing this object of the present invention, selectivity is provided as to a plurality of levels of control for the plurality of yarns.

Yet a further object of this invention is to integrate control over interruption of operation of a knitting machine in the event of breakage of a yarn being supplied to a knitting position with yarn feeding controls as discussed above.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which a partly perspective, partly schematic illustration is presented of yarn feeding apparatus in accordance with this invention.

While the best mode presently contemplated for the practice of this invention will be described hereinafter

with particular reference to the accompanying illustration, it is to be understood at the outset of this description that the description and illustration are intended to be read broadly. It is contemplated that the present invention may be modified in detail while embodying the general arrangement of this invention and the description and illustration are accordingly to be read broadly and not as limiting upon the scope of this invention.

Referring now particularly to the illustration, the present invention will be described with particular reference to a circular knitting machine and to one yarn line by which a textile yarn is supplied to a knitting position of the circular knitting machine. It is to be understood that this invention is contemplated as being applicable to forms of knitting machines other than a circular knitting machine and is particularly contemplated as being applicable to a multiple feed circular knitting machine such a machine producing double knit fabric for outerwear. In common with knitting machines generally, the knitting machine with which the apparatus of this invention is illustrated includes rotating drive member here illustrated as a main drive gear 11. The main drive gear 11 rotates at a speed coordinated with rotation of the cylinder which carries a plurality of needles. As is known to persons skilled in the construction and use of circular knitting machines, the needles are moved during rotation of the cylinder for knitting textile fabric from yarn supplied to knitting position of the machine.

In the illustrated form of this invention, yarn 12 to be knitted into textile fabric is supplied from a suitable yarn package 14 to knitting machine positions generally indicated at 15 where the yarn 12 is received by needles and knitted into a fabric. Due to the accurate control accomplished by this invention, the package 14 may be of any type, including dyeing or dyed packages of types not normally suitable for knitting machine feeding. As is known to persons skilled in the construction and use of knitting machines, it is conventional for certain large circular knitting machines to have a large number of yarn packages 14 supplying a corresponding number of yarn 12 to a corresponding number of positions 15. The present illustration sets forth only a single yarn line, for purposes of simplicity, with it being understood that it is contemplated that parallel arrangements would be provided on other yarn lines.

In order to feed the yarn 12 from the package 14 to the knitting position 15 in a desired manner as brought out more fully hereinafter, means are interposed between each yarn package 14 and the needles for positively engaging the corresponding yarn 12. As illustrated, the yarn engaging means preferably comprises a positive grip feed pulley 16, supported for rotation with a drive shaft 17 which is included in and driven in rotation by a variable speed drive means generally indicated at 18. The variable speed drive means drives the positive pulley 16 in rotation at a controlled speed, and thereby withdraws yarn 12 from corresponding package 14 and feeds the yarn to the needles as required for knitting. It is to be noted that the yarn is fed without addition or removal of twist and thus the apparatus of this invention is advantageous for any yarn desired for knitting.

In the form illustrated, the variable speed drive means 18 preferably takes the form of an electrical servomotor which may be driven at variable rotational speeds by controlling the characteristics of electrical

current applied thereto. Several types of such electrical servomotors are known to persons skilled in the electrical control arts, including in motors whose speed is varied by controlling the characteristic of pulses supplied thereto and motors whose speed is controlled by varying the level of voltage applied thereto. It is contemplated by this invention that the electrical servomotor employed as the drive means 18 may be selected from among such known forms and will provide torque sufficient for withdrawing yarn from any type of package.

Operatively connected with the variable speed drive means 18 is a first control means generally indicated at 20 which controls the rotational speed of the drive means 18. In the form illustrated, the first control means 20 comprises a servomotor amplifier which receives electrical current from a suitable source through a supply conductor 21 and delivers such electrical current (modified as may be required) to the electrical servomotor through a conductor 22. As will be brought out more fully hereinafter, the motor amplifier receives an error signal through an error signal conductor 24.

In order to accomplish feeding of yarn 12 at a controlled linear rate, a tachometer means generally indicated at 25 is provided which is operatively responsive to the drive means 18 for sensing rotation of the drive shaft 17 and for generating a first electrical signal indicative of the speed of rotation thereof. Preferably, and in the form illustrated, the tachometer 25 takes the form of a shaft angle detector which generates a train of pulses coordinated to the angular positions and thus the rotation of the drive shaft 17. The pulse train thus originated by the tachometer means 25 is passed to a frequency to voltage convertor 26 which may be an appropriate circuit selected from among such circuits known to designers of electronics controls. The resulting output signal from the convertor 26 appears on an output conductor 28 as a voltage proportional to the rotational speed of the drive shaft 17. While not here illustrated, it is to be noted that the train of pulses from the tachometer 25 may be used to measure lengths of yarn fed or rates of yarn feed.

In a generally similar manner, the rotational speed of the rotating drive member of the knitting machine is sensed and a second electrical signal is generated which is indicative of the speed of rotation thereof. In instances, such as that illustrated, where a main drive gear 11 is employed, an electromagnetic sensor 29 of an appropriate type may be positioned adjacent the rotating teeth of the gear 11, to generate the pulse train which is supplied to a frequency to voltage convertor 30. The resulting output appearing at a conductor 31 would be in the form of a voltage proportional to the rotational speed of gear 11. As will be understood, the sensor 29 will take other forms, such as photoelectrical or the like.

In order to accomplish control in accordance with tension condition, the arrangement of this invention further provides a tension sensor 32 disposed along the path of travel of the yarn 12 and preferably near the knitting machine position 15. The tension sensor has a series of three pins 34a, 34b, 34c with the yarn 12 trained thereabout so that the tension in the yarn causes fluctuation of the center pin 34b. By means of a differential transformer or similar arrangement, an electrical signal appears on an output conductor 35 in the form of a voltage proportional to the level of tension in the yarn 12. A standard means 36 at the same

time provides a fixed voltage on an output conductor 38, indicative of a desired level of tension for the yarn 12.

In accordance with this invention, a switch generally indicated at 40 is provided for selecting between coordinated pairs of signals appearing on the conductors 28, 31, 35 and 38. In the particular position shown, the switch 40 is arranged for tension control of yarn feeding as receiving the third and fourth signals appearing respectively on the output conductor 35 from the tension sensor 32 and the output conductor 38 from the standard means 36. In the alternate position, the switch 40 would be connected to pass the voltages that are present on the conductors 28 and 31 and indicative of the rotational speeds of the servomotor and the main drive gear.

In either instance, certain signals passing through the switch means 40 are applied along a feed back signal line 41 to a second control means in a form of comparison circuit 42. Signals passing through the other leg of the switch means 40 are directed to three level setting potentiometers 44, 45, 46, which may be adjusted to give a desired offset or level shift to tension and speed control. A selected one of the three level setting potentiometers 44, 45, 46 is connected to an input line 48 of the comparison circuit 42 by means of a switch means generally indicated at 49. Thus, selection of inputs to the comparison circuits 42 may depend first upon selection of correlation between the rotational speed signals or correlation between tension condition signals and secondly to selection of particular level or range of such correlation.

The comparison circuit 42 may, by way of example only and not by way of limitation, take the form of a bridge circuit which compares voltage signals appearing on the input conductors 41, 48 and produces an error signal which is then applied to the conductor 24 to control the first control means or motor amplifier 20. By such a closed loop system, withdrawal of yarn 12 from the yarn package 14 as demanded for knitting by the needles of the knitting machine is accomplished.

The present invention further contemplates that the operative signal appearing on the conductor 35 from the tension sensor 32 may be employed as a stop motion control over the related knitting machine. That is, the absence or breakage of the yarn 12 would cause the level of this signal present on the output conductor 35 to become indicative of such absence or breaking and detection of change in the signal may be employed to interrupt the driving of the knitting machine so as to avoid improper formations of knitted fabric.

In adapting the single yarn arrangement heretofore described to a multiple feed knitting machine, as contemplated by the present invention, it is envisioned that an interconnection for the level setting potentiometers 44, 45, 46 might be provided whereby push button selection may be made for which of three level setting potentiometers is to be used in controlling feeding of yarn to particular knitting machine position. That is, the level set by the first potentiometer 44 might be selected for a first knitting position; with the level set by the second potentiometer 45 being selected for a second position; the level set by the third potentiometer 46 being selected for a third position, and the fourth position returning to the level set by the first potentiometer 44. Such an arrangement, with push button selection, would facilitate wide selectivity for yarn feeding con-

trol and thereby aid in furthering accomplishment of the object of this invention.

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed is:

1. In combination with a knitting machine having a rotating drive member, a plurality of needles moved by the drive member for knitting fabric and at least one yarn package from which yarn to be knit is supplied to the needles, yarn feeding apparatus comprising:
 means interposed between a yarn package and the needles for positively engaging a corresponding yarn to be supplied for knitting,
 variable speed drive means drivingly connected with said yarn engaging means for driving the same in rotation and thereby for withdrawing yarn from the corresponding package and feeding the yarn to the needles as required for knitting,
 first control means operatively connected with said drive means for controlling the rotational speed thereof,
 tachometer means operatively responsive to said drive means for sensing rotation thereof and for generating a first signal indicative of the speed of rotation thereof,
 rotation means operatively responsive to the drive member for sensing rotation thereof and for generating a second signal indicative of the speed of rotation thereof,
 yarn tension means operatively responsive to tension in the yarn between the needles and said yarn engaging means for sensing tension therein and for generating a third signal indicative of the level of tension therein,
 standard means for generating a fourth signal indicative of a desired level of tension, and
 means operatively connected with said first control means and operatively connected with said tachometer means, said rotation means, said tension means and said standard means and including switch means for selecting between correlation of said first and second signals and correlation of said third and fourth signals and second control means for varying the rotation of said drive means in ac-

cordance with any difference from a predetermined correlation between a selected pair of signals,

whereby yarn is withdrawn from the corresponding yarn package as demanded for knitting by the needles.

2. The combination according to claim 1 wherein said yarn engaging means comprises a positive grip pulley means for receiving and gripping yarn and further wherein said variable speed drive means comprises a drive shaft upon which said pulley means is fixed for driven rotation.

3. The combination according to claim 1 wherein said variable speed drive means comprises a electrical servomotor and said first control means comprises electrical circuit means for varying a characteristic of electrical current delivered to said servomotor.

4. The combination according to claim 1 wherein said tachometer means, said rotation means, said tension means and said standard means each generate a corresponding electrical signal as said first, second, third and fourth signals and further wherein said second control means comprises electrical circuit means for generating an error signal which accords with any difference from a predetermined correlation between a selected pair of signals.

5. The combination according to claim 1 wherein each of said tachometer means and said rotation means generate a train of electrical pulses as the respective first and second signals and further comprising means electrically connected with said tachometer means and said rotation means for connecting said trains of electrical pulses into analog signals.

6. The combination according to claim 1 wherein said knitting machine is a circular knitting machine having a cylinder and a main drive gear operatively connected with said cylinder and operating as said drive member for driving the cylinder in rotation and thereby for initiating knitting action of said needles and further wherein said rotation means comprises a sensor responsive to rotation of said main drive gear.

7. The combination according to claim 1 further comprising means operatively connected with said yarn tension means and responsive to excursions of sensed tension therein outside of a predetermined range for interrupting operation of said knitting machine.

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