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(POS'S WPM)**A TAKE-UP SYSTEM FOR A KNITTING MACHINE** ✓

The present invention relates generally to knitting machines and more specifically to a drive assembly for a take-up system used in such machines.

- 5 The invention has particular application for use in a circular knitting machine and is herein described in that context. However, it will be appreciated that the invention is not limited to this particular use.

In a circular knitting machine, the fabric is formed on a needle bed and is subsequently pulled down from the bed by a take-up system whereafter it is wound onto a roller. In a conventional system, the take-up system includes a plurality of drive rollers located intermediate the needle bed and the roller. These drive rollers are driven by a transmission shaft of the knitting machine and are adapted to maintain the fabric coming off the needle bed in tension.

In producing quality fabric, it is important to maintain the fabric coming off the needle bed at a constant preselected tension. Any variation in this tension can reduce the quality of the fabric produced. A problem with previous systems is that the tension produced by the take-up system is directly dependent on the input torque of the transmission shaft. In operation of the knitting machine, this torque is found to vary considerably through continued operation of the machine or through poor adjustment of the drive arrangement of the knitting machine. Accordingly, in the past it has been very difficult to maintain the tension at the take-up system at its desired level.

An aim of the present invention is to provide an improved drive assembly for a take-up system for a knitting machine. A specific aim of the invention is to provide a drive assembly which is better able to maintain the fabric being taken off the needle bed at a substantially constant preselected tension.

Accordingly, in a first aspect the present invention provides a drive assembly for a take-up system for a knitting machine, the assembly including: two drive parts one of which is connectable to an input member of the system, the other connectable to the take-up system, the drive part being connected to form a drive connection between the input member and the take-up system, the input member being operable to impart an input force to the system and the drive connection enabling the input member to impart an actuating force to the

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take-up system in response to the input force; wherein the drive assembly further includes control means operable to influence the drive connection so as to control the actuating force imparted to the take-up system in response to the input force.

5 By incorporating a control means within the drive assembly, the invention enables the actuating force imparted to the take-up system to be controlled such that it is not solely reliant on the input force. Furthermore, by having the control means operable to influence the drive connection, it is possible to provide a system which is able to be self-adjusting.

10 In a preferred form, the control means is operable to influence the efficiency of the drive connection in being able to convert the input force to the actuating force. The efficiency of the drive connection relates to the power loss across the drive connection and is usually measured as an percentage of the input force.

15 In a particularly preferred form, the control means is adapted to maintain the actuating force at a substantially constant level by being operable to change the efficiency of the drive connection in response to changes in the magnitude of the input force. This arrangement has great practical benefit as the control means is able to compensate for any fluctuations in the magnitude of the input
20 force. In this arrangement, if the magnitude of the input force increases beyond a pre-determined level, then the control means is automatically adapted to reduce the efficiency of the drive connection so as to compensate for this increase in input force and thereby enable the actuating force to be maintained at a substantially constant level. Conversely, if the magnitude of the input force
25 decreases, then the control means is adapted to increase the efficiency of the drive connection so as again to compensate for the fluctuation in the input force.

A particular advantage of this arrangement is that this compensating action of the control means can be self-adjusting as the control means is
30 operable directly in response to changes in the magnitude of the input force.

In a preferred form, the drive assembly is in the form of a pulley arrangement wherein the drive parts include first and second pulleys which are



Interconnected by a flexible machine element. In this arrangement, preferably the control means is operable to influence the drive connection by determining the tension of the flexible machine element. In a particularly preferred form, the flexible machine element is in the form of an elastic belt and the efficiency of the drive connection is dependent on the tension in the belt.

Preferably, the tension in the belt is established by the control means by the spacing between the first and second pulleys. Specifically, in a preferred form, the control means is operable to establish a pre-determined spacing of the first and second pulleys in response to a pre-determined magnitude of the input force. In this arrangement, an increase in the magnitude of the input force causes a corresponding decrease in the spacing between the pulleys. Conversely, a decrease in the magnitude of the input force causes a corresponding increase in the spacing between the pulleys. In this way, a relationship between the magnitude of the input force and the efficiency of the drive connection is established to thereby enable the system to be self-adjusting.

In a preferred form, the drive assembly includes a frame and wherein the control means includes a mounting arm which is movable mounted to the frame. The first pulley is mounted on the mounting arm whereas the second pulley is secured to the frame. In this arrangement, movement of the mounting arm causes the first pulley to move relative to the second pulley.

Preferably, the input force is adapted to be applied to the first pulley and is adapted to apply a biasing force to the mounting arm. This biasing force is adapted to bias the mounting arm to move the first pulley in a direction towards the second pulley. Preferably the control means further includes a tensioning means which is operable to apply a resisting force to oppose this biasing force. With this arrangement, the position of the mounting arm and therefore the spacing between the first and second pulleys, is established when the biasing force and the resisting force are substantially in equilibrium. An increase in either the biasing force or the resisting force will cause the mounting arm to move to re-establish equilibrium of the system.

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Preferably, the tensioning means is adjustable such that the resisting force applied to the mounting arm may be varied. By being able to vary this resisting force, it enables variation in the influence the control means has over the drive connection.

5 Preferably the input member is in the form of a transmission shaft and is connected to the first pulley by a second flexible machine element. In a preferred form, this second flexible machine element is in the form of a chain and wherein both the transmission shaft and the pulley incorporates sprockets. Each of these sprockets is adapted to be mounted concentrically with the
10 respective axes of the transmission shaft and the first pulley.

With this arrangement, the input force imparted to the first pulley is in the form of a torque. Moreover by virtue of the torque applied to the first pulley, a static load is induced on the first pulley as a result of the engagement of the chain with the sprocket. This static load, which is directly dependent on the
15 magnitude of the torque, causes the biasing force to be applied to the mounting arm.

In a preferred form, the drive assembly further includes a tightener operable to engage the second flexible machine element. With this arrangement, the tightener is adapted to take up any slack in the second
20 flexible machine element caused by relevant movement of the first and second pulleys. With this arrangement, the tightener is operable to ensure that the drive connection between the transmission shaft and the first pulley remains constant.

In a preferred form, the second pulley is coupled to the take-up system
25 through a third flexible machine element. Preferably this third machine element is in the form of a chain and both the second pulley and the take-up system incorporates sprockets to which the chain is connected. With this arrangement, the drive connection formed between the second pulley and the take-up system is adapted to remain constant. Furthermore, preferably the take-up system
30 includes a drive roller which incorporates the sprocket connected to the third flexible machine element.

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It will be convenient to hereinafter describe an embodiment of the present invention with reference to the accompanying drawings. The particularity of these drawings is to be understood as not superseding the preceding broad description of the invention.

5 In the drawings:

Figure 1 is a schematic view of a take-up system for a knitting machine; and

Figure 2 is a plan view of a drive assembly according to an embodiment of the present invention for use in the take-up system of Figure 1.

10 Figure 1 illustrates a general arrangement of a take-up system 50 for a circular knitting machine. The take-up system includes a series of three friction rollers 51, 52, 53 and a winding shaft 54. Fabric 100 produced on a needle bed (not shown) of the knitting machine is pulled down off the bed by the rollers and then wound onto the shaft 54. With this arrangement, the fabric taken off the
15 bed is under tension and the magnitude of this tension applied is dependent on the torque imparted to the rollers.

In the illustrated form, drive is only imparted to the middle roller 52 whereas rollers 51 and 53 are idler rollers and rotate in response to the frictional engagement with the fabric. The purpose of the idler rollers 51 and 53
20 is to maintain the fabric in engagement with the driven roller 52.

Figure 2 illustrates a drive assembly 10 for imparting torque to the roller 52.

The drive assembly 10 includes a frame 11 having an input member 12 and an output member 13. The input member 12 comprises a transmission
25 shaft 14 of the knitting machine and includes a sprocket 15 mounted coaxially with the axis 16 of the shaft 14.

The output member 13 incorporates a central shaft 17 which is coupled directly to the roller 52. The output member 13 further includes a sprocket 18 which is mounted concentrically with the shaft 17.

30 The drive assembly 10 is adapted to impart a torque to the shaft 17 of the output member 13, in a response to a driving torque imparted by the transmission shaft 14. To impart this actuating force to the output member 13,



the drive assembly includes three drive connections, each including a flexible machine element.

The drive assembly 10 includes two intermediate pulleys 19 and 20 and first drive connection operates between the input member 12 and one of these intermediate pulleys 19. Specifically, the pulley 19 incorporates a driven sprocket 20 and a flexible machine element 21, typically in the form of a chain, interconnects the transmission sprocket 15 and the driven sprocket 20 of the intermediate pulley 19. With this arrangement, torque is imparted from the transmission shaft to the pulley 19 via the chain 21. This drive connection further includes guide pulley 35 and tensioner 23, both of which are engagable with the chain 21. The purpose of the tensioner 23 will be discussed in more detail later.

A second drive connection is provided between the intermediate pulleys 19 and 20. This type of drive is used as the second drive connection is arranged to have a variable efficiency which is dependent on the tension in the flexible machine element. An elastic belt is ideally suited as it functions in this way. Specifically, the efficiency of the belt to transmit power is dependent on the frictional engagement between the belt and the pulley. This in turn is affected by the tension in the belt. In a preferred form, the belt 23 has either a flat or round profile and typically consists of a strong elastic cord surrounded by chrome leather or an elastomer. Such belts exhibit continuous power transmission even when the belt slips to some degree.

A third drive connection is formed between the intermediate pulley 20 and the output member 13. In this drive connection, a driving sprocket 24 is mounted concentrically with the pulley 20 and a third flexible machine element 25 couples the sprocket 24 with the sprocket 18 mounted concentrically with the output shaft 17. A guide pulley 26 is engagable with the chain 25 to maintain the chain in correct engagement with the sprockets 18 and 24.

The drive assembly 10 further includes a control device 27 which is adapted to influence the drive connection between the input shaft 12 and the

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output shaft 13. Specifically the control device 27 is operable to influence the efficiency of the drive connection between the intermediate pulleys 19 and 20.

The control device includes a linkage arm 28 which is pivotally mounted to the frame 11 through pivot pin 29. The pulley 19 is mounted to the linkage arm so as to be movable with the arm. In this arrangement, movement of the linkage arm 29 causes the spacing between the intermediate pulleys 19 and 20 to be varied.

The control device 27 further includes a tensioning device 30 which is operable between the linkage arm 28 and the frame 11. In the illustrated form, the tensioning device 30 is in the form of a tension spring and is mounted so as to apply a force to the linkage arm 28 to bias the linkage arm to move in a generally upward direction as illustrated in Figure 2 so as to bias the two intermediate pulleys apart.

This biasing force imparted by the tensioner 30 is opposed by a force imparted to the intermediate pulley 19 by the torque force applied by the input shaft 12. Specifically, the chain 21 in imparting torque to the pulley 19 also causes a static load to be imparted to the pulley 19 by virtue of the engagement of the chain 21 with the teeth of the sprocket 20. This static load acts in the plane of the sprocket 22 and results from the loading induced on the sprocket from the chain 21. In the illustrated form of Figure 2 this static load acts generally downwardly and therefore biases the linkage arm 28 to move in a direction which will cause the spacing between the pulleys 19 and 20 to be reduced.

With this arrangement, the position of the linkage arm 28 is established when the moment applied to pivot 29 by virtue of the static load imparted by the chain 21 on the pulley 19 is equal and opposite to the moment generated by virtue of the tension in the spring 30. With this arrangement, an increase in the torque applied by the transmission shaft 12 and imparted to the chain 21 will cause an increase in this static load which in turn will cause the linkage arm to move out of equilibrium causing it to move towards the pulley 20 until equilibrium is re-established. Movement of the linkage arm in a direction which decreases the spacing between the intermediate pulleys 19 and 20 will cause



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the spring 30 to elongate thereby increasing its biasing force on the linkage arm 28. Equilibrium will be established when the moment generated at pivot 29 by virtue of this increasing biasing force imparted by the elongating spring 30 equals the increased static load produced by the chain 21.

5 Movement of the pulley 19 does not affect the drive connection between the input shaft 12 and the pulley 19 as any slack is automatically taken up by virtue of the operation of the tightener 23. Therefore the efficiency of this drive connection produced by the chain 21 is maintained at a constant.

10 In contrast, however, the efficiency of the drive connection between the pulleys 19 and 20 will vary depending on the position of the linkage arm 28 as it will directly affect the tension in the elastic belt 23. As mentioned above, the power transmission in an elastic belt drive is dependent on the frictional engagement between the belt and the pulleys. This in turn is directly affected by the tension in the belt. As a consequence, when the belt is at a higher
15 tension, the efficiency of the drive connection increases as there is less slippage of the belt relative to the pulley. In contrast, when the tension of the belt decreases the frictional engagement decreases and additional slippage occurs between the pulley and the belt thereby reducing the efficiency of the drive connection.

20 Accordingly, the control device 27 allows for control of the output torque generated at the roller 52 of the take-up system by controlling the efficiency of the drive assembly. Specifically by choosing the position and characteristics of the tensioning device 30, the position of the linkage arm 28 can be established for a specific input torque. This in turn will dictate the spacing between the
25 pulleys 19 and 20 and thereby the tension in the belt 23. The tension in the belt 23 in turn dictates the efficiency of the drive assembly 10.

In the illustrated embodiment, the control device incorporates an adjustment mechanism 31 which allows for fine tuning of the position of the linkage arm 28. This adjustment mechanism 31 incorporates a shaft 32 which
30 is coupled to one end 33 of the tensioning device 30. The shaft 32 is threadingly engaged to the frame 11 of the assembly 10 and therefore rotation of the shaft 32 causes the shaft to move relative to the assembly 11. To



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facilitate rotation of the shaft 32 the adjusting device 31 includes a handle 34. With this arrangement therefore, the control device 27 is operable to establish a specific efficiency of the drive assembly for a specific input torque. By being able to establish this efficiency, the control device enables the selection of a specific output torque for a particular input torque.

Furthermore, the control device 27 is self adjusting and is able to maintain this selected actuating force imparted to the output shaft 13. Specifically, the control device is operable to change the efficiency of the drive connection between the pulleys 19 and 20 in response to changes in the magnitude of the input force. An increase in the input force will cause the linkage arm 28 to move out of equilibrium which in turn will cause it to reduce the spacing between the pulleys 19 and 20 thereby reducing the efficiency of the drive connection. Conversely a decrease in the input force from the transmission shaft will cause the linkage arm 28 to move out of equilibrium and cause it to move under the influence of the tension spring 30 to increase the spacing between the pulleys 19 and 20. This in turn will increase the efficiency in the drive connection. Consequently the control device is adapted to compensate for these changes in magnitude of the input force to thereby enable a substantially constant output force to be maintained throughout the fluctuations in input force.

While a particular embodiment of the invention has been described, it will be evident to those skilled in the art that the present invention may be embodied in other specific forms without departing from the essential characteristics thereof. The present embodiment and examples are therefore to be considered in all respects as illustrative and not restrictive; all modifications which would be obvious to those skilled in the art are therefore intended to be embraced therein.

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**Claims:**

1. A drive assembly for a take-up system for a knitting machine, the assembly including:

two drive parts one of which is connectable to the input member of the system, the other connectable to the take-up system, the drive parts being connected to form a drive connection between the input member and the take-up system, the input member being operable to impart an input force to the system and the drive connection enabling the input member to impart an actuating force to the take-up system in response to the input force; wherein

the drive assembly further includes control means operable to influence the drive connection so as to control the actuating force imparted to the take-up system in response to the input force.

2. A drive assembly according to claim 1, wherein the control means is operable to influence the efficiency of the drive connection in being able to convert the input force to the actuating force.

3. A drive assembly according to claim 2 wherein the control means is adapted to maintain the actuating force at a substantially constant level by being operable to change the efficiency of said drive connection in response to changes in the magnitude of said input force.

4. A drive assembly according to any one of the preceding claims, wherein the drive parts include first and second pulleys interconnected by a flexible machine element, and wherein the control means is operable to influence the drive connection by determining the tension in the flexible machine element.

5. A drive assembly according to claim 4, wherein the flexible machine element is in the form of an elastic belt, and wherein the efficiency of said drive connection is dependent on the tension in said belt.

6. A drive assembly according to either claims 4 or 5 wherein the control means is adapted to establish the tension in the belt by controlling the distance between the first and second pulleys.

7. A drive assembly according to claim 6, wherein the distance between the first and second pulleys can vary and wherein the control means is operable to



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change the distance between the first and second pulleys in response to changes in the magnitude of the input force.

8. A drive assembly according to any one of claims 4 to 7, wherein the drive assembly further includes a frame and wherein the control means
5 includes a mounting arm which is movably mounted to the frame, the first pulley being mounted to the mounting arm whereas the second pulley being secured to the frame such that movement of the mounting arm causes the first pulley to move relative to the second pulley.

9. A drive assembly according to claim 8, wherein the input force is
10 adapted to impart a biasing force to the first pulley which biases the mounting arm to move the first pulley in a direction towards the second pulley; and wherein the control means further includes tensioning means which is operable to apply a resisting force to oppose said biasing force.

10. A drive assembly according to claim 9 wherein the tensioning means is
15 adjustable such that the resisting force applied to the mounting arm may be varied.

11. A drive assembly according to claim 10 wherein the tensioning means is in the form of a spring having a first end connected to the mounting arm and a second end connecting to the frame via an adjustment member, and wherein
20 the adjustment member is operable to move said second end of the tensioning means relative to the frame so as to be able to adjust the resisting force applied to the mounting arm.

12. A drive assembly according to any one of claims 9 to 11 wherein the input member comprises a transmission shaft and is connected to the first
25 pulley by a second flexible machine element, the second flexible machine element being in the form of a chain and wherein both the transmission shaft and the pulley incorporate sprockets adapted to interengage with said chain.

13. A drive assembly according to claim 12 wherein the input force imparted to the first pulley is in the form of a torque force and wherein the biasing force
30 applied to the mounting arm is in the form of loading induced on the first pulley as a result of engagement of the chain with the sprocket mounted on the first pulley.



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14. A drive assembly according to either claim 12 or 13 further including a tightener operable to engage the second flexible machine element, the tightener being adaptable to maintain a substantially constant tension in the second flexible machine element on relative movement of the first and second pulleys.
15. A drive assembly according to any one of claims 4 to 14 wherein the second pulley is coupled to the take up system through a third flexible machine element, the third flexible machine element being in the form of a chain and both the second pulley and the take-up system incorporates sprockets adapted to interengage with said third flexible machine element.
16. A take-up system for a knitting machine incorporating a drive assembly according to any one of the preceding claims.
17. A knitting machine incorporating a take-up system according to Claim 14.

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