

[54] **KNITTING MACHINES AND LIKE FABRIC-PRODUCING MACHINES**

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[51] **Int. Cl.** **D04b 23/00**

[58] **Field of Search** 66/86 A, 146, 163, 165

[56] **References Cited**

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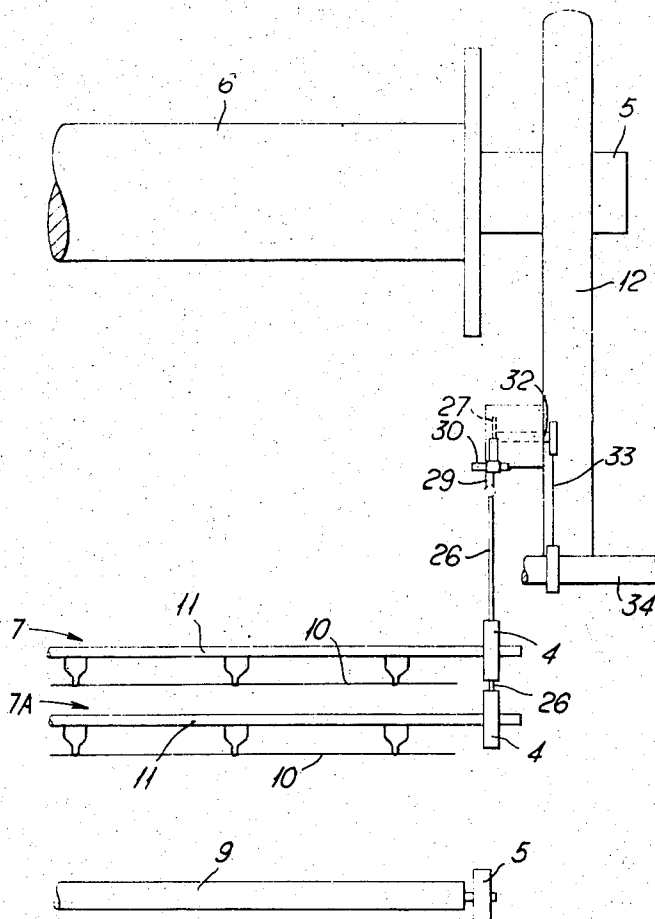
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[57] **ABSTRACT**

In a warp knitting machine, a power-operated tension bar over which the yarn sheet passes is cyclically oscillated in synchronism with the knitting elements to keep the yarn tension constant. On stopping of the machine this tension bar is automatically pushed out further than normal to increase the yarn path and thereby create a reserve length of yarn which is progressively taken up when the machine is restarted, so as to avoid a 'stop' line across the knitted fabric. Also on stopping, automatic clutch and brake means are actuated by control circuitry which allows the machine to slow down to a preselected speed, say 50 r.p.m., and then brings the machine to an immediate dead stop with the needles in the 'down' position.

14 Claims, 5 Drawing Figures



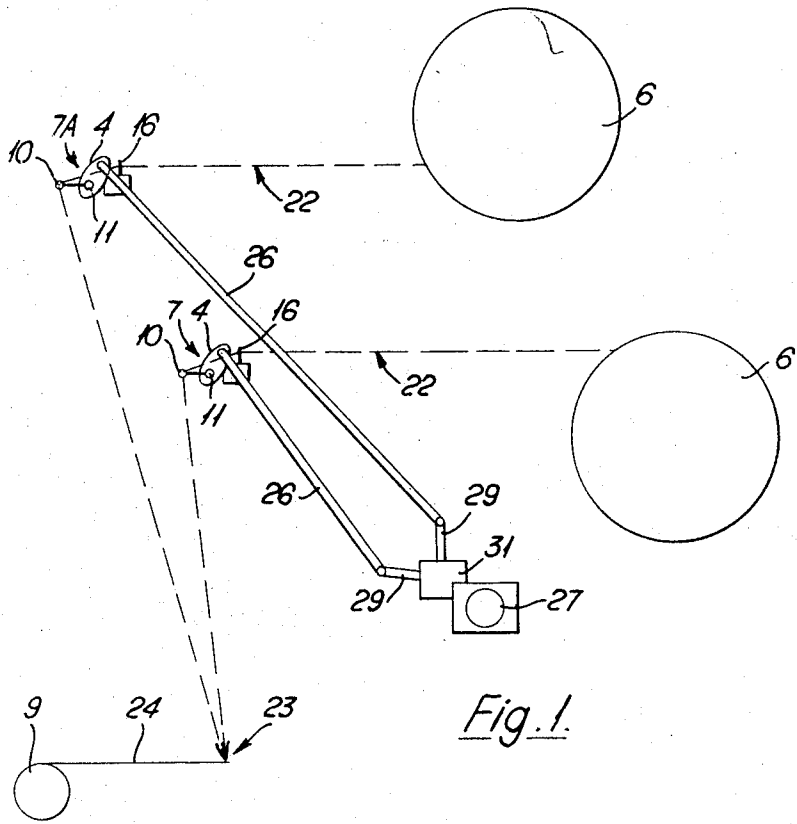


Fig. 1.

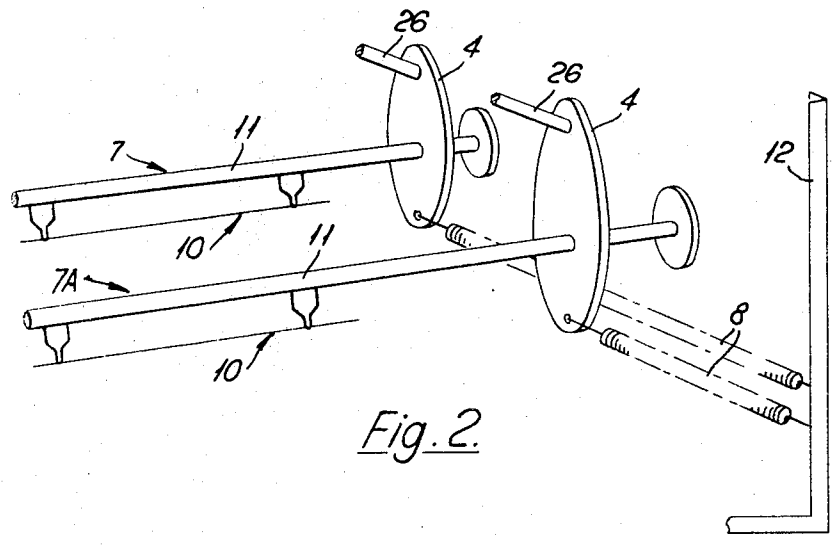


Fig. 2.

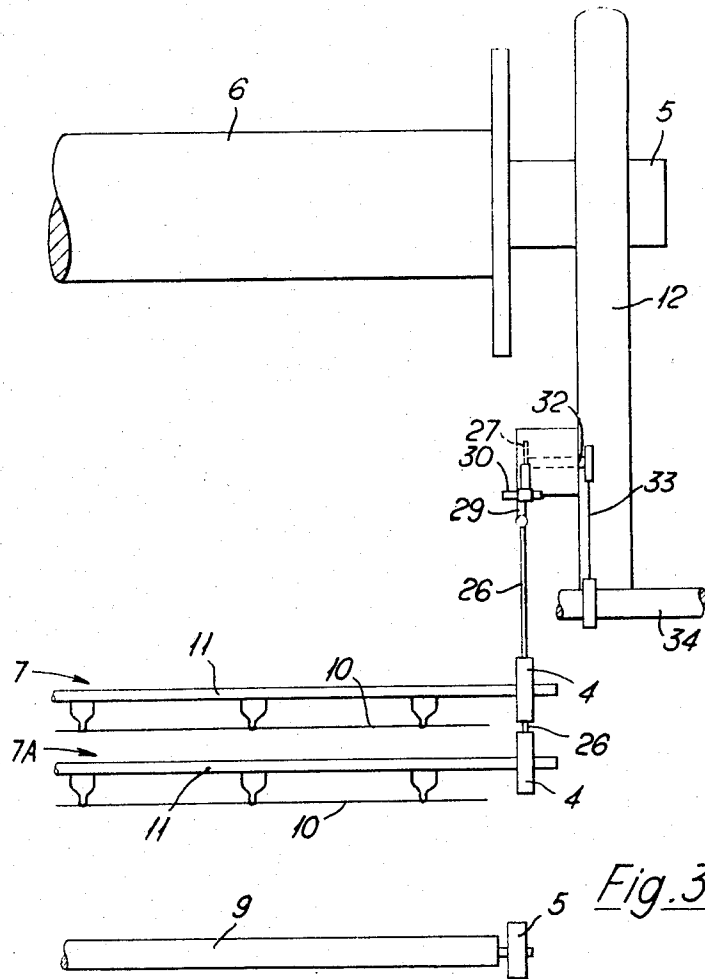


Fig. 3.

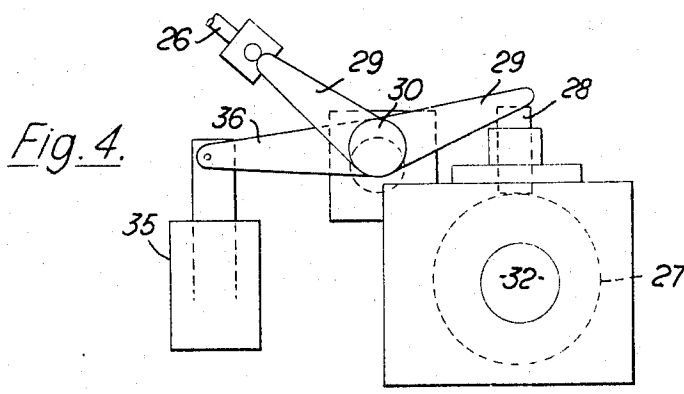


Fig. 4.

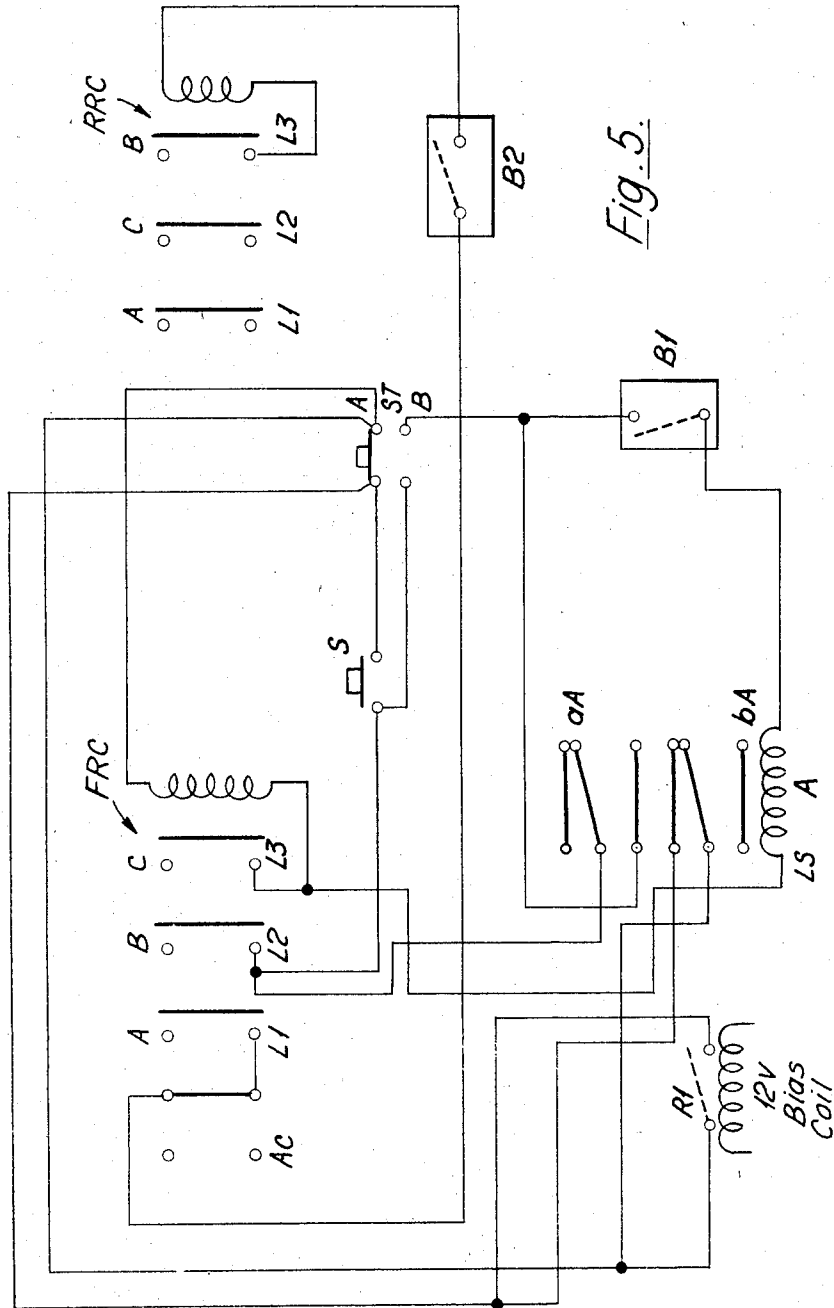


Fig. 5.

KNITTING MACHINES AND LIKE FABRIC-PRODUCING MACHINES

This invention relates to knitting machines and like fabric producing machines. More particularly, it is concerned with the avoidance of one or more of certain undesirable effects in the fabric produced by such machines which effects have hitherto led to much waste of machine production.

The first of these undesirable effects is the creation of "stop and start lines" in the fabric. As is well known, each time a warp knitting machine is stopped and subsequently restarted the fabric is "marked" across its width at the place of stoppage by a line or band of stitches of a different character, due to changing yarn tension, which constitutes an imperfection in the fabric that is usually clearly visible, if not when the cloth is in its grey state then after it has been dyed or finished. Consequently, the portion of the fabric containing this "stop line" normally has to be discarded as waste. It will be appreciated that a similar problem arises in connection with other machines manufacturing fabric from fibres. One typical example is the making of tufted carpets. It is therefore an object of this invention to achieve a system whereby the appearance of "stop lines" across the fabric can be prevented.

Another undesirable effect is the curling of the side edges of the web knitted fabric. Such selvedge curl is also a well known phenomenon, to counteract which it is customary to employ selvedge spreaders. However, these are liable to cause obstruction and also to damage the fabric near the selvedges. We have found that, at least in the case of some fabrics, our invention will overcome or alleviate selvedge curl, which is responsible for a high percentage of yarn breakages, without the use of the spreaders.

According to the present invention, the function of the conventional resiliently-mounted tension or flutter bar, over which the warp yarns pass on their way from the warp beam to the knitting elements, is supplemented or taken over by power-actuated yarn length control means arranged to maintain a precise control over the variable length of warp yarn running to the knitting elements, such that the warp tension at the knitting elements remains substantially constant.

In the hitherto conventional machine, the warp yarns leaving the warp beam commonly pass through a reed on a fixed rail and then down to the knitting elements, and between the reed and the knitting elements a tension bar is resiliently pressed against the yarn sheet to take up slack. The knitting action performed by the knitting elements demands an irregular yarn feed rate that varies cyclically in a manner depending on the pattern being knitted and since it is impossible to let off yarn from the warp beam at a corresponding irregular rate, a regular let-off rate is maintained and the rapid small fluctuations in the length of the yarn sheet caused by the cyclical irregularities in the rate of usage at the knitting elements are absorbed by the resiliently mounted tension bar. This tension bar therefore oscillates rapidly and is consequently often referred to as the flutter bar. Such a flutter bar is effective in preventing yarn breakages but we have discovered that it is not a satisfactory way of regulating yarn tension because the flutter bar is actuated by the yarn sheet instead of itself positively controlling the yarn sheet.

The present invention reverses this state of affairs, in that the powered yarn length control means acts on the yarn sheet to adjust the supply yarn length as necessary in a positive manner and thereby keep the yarn under the same controlled tension, even in circumstances where the operating speed of the machine is changing. For the avoidance of "stop and start lines" it is only necessary to maintain this yarn length control while the machine is actually stopping and starting; on the other hand, maintaining the same control during steady speed running helps to prevent selvedge curl with certain fabrics. Sometimes the yarn supply length will be increased and sometimes decreased but all the changes in length will now take place under a controlling influence that keeps the tension substantially constant. Preferably, the conventional resiliently-mounted flutter bar is removed entirely from the machine.

In a typical embodiment, the power-actuated yarn length control means may comprise a substantially rigid tension bar which is oscillated to and fro, toward and away from the local general plane of the yarn sheet, by a mechanism driven in synchronism with the knitting elements. Thus, the drive may be taken from the needle bar, or the pusher rods, or the pattern chain or pattern wheel, or indeed the main shaft that drives the knitting elements.

The uncontrolled perturbations of the conventional flutter bar are, by the technique described, replaced by precisely controlled movements of a driven solid tension bar which increase or decrease the yarn travel path to the knitting elements in exact accordance with the variations in yarn usage rate so as to keep the yarn tension closely controlled, either during steady state running of the machine, or specifically during stopping and starting periods, or at all times. Thus, the yarn tension need no longer fluctuate cyclically while the machine is operating; and according to individual machine users' requirements either stop and start lines can be eliminated, or with appropriate fabrics selvedge curl can be alleviated, even without the use of spreaders, or both objects can be achieved at the same time. Preferably, as well as the tension control as aforesaid, a tension bar is employed which is curved in the region of the selvedges to even out yarn tension throughout the entire width of the machine, thereby to deal even more effectively with selvedge curl.

Apart from the improvement in fabric quality the better yarn control may allow an increase in production because in many cases under present circumstances the machine cannot be run at the full speed of which it is capable, since to do so would cause increased risk of yarn breakage near the selvedge and possible massive tear-out of yarns.

It is to be understood that the invention extends not only to this novel yarn-length-control equipment per se but also to knitting or other fibre processing machines fitted with such equipment.

To effect complete elimination of "stop and start lines" it is preferred to fit the take-up roller receiving the knitted fabric with a declutching and braking system coming into operation automatically when the machine speed is running down or increasing. This may be an electrical, mechanical or pressure-fluid-operated system, although it is preferred to employ a magnetic hysteresis-type clutch. It may also be beneficial to fit a similar declutching and braking system to the warp beam. Most advantageously, substantially instantaneously

neous full braking is applied to bring the machine to a sudden stop when it has run down to a certain predetermined speed. This sudden stopping should always be effected with the needles in the same position, i.e., the "down" position.

Particular arrangements embodying the invention will now be described by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a diagrammatic side elevation of equipment according to the invention applied to a warp knitting machine,

FIG. 2 is a pictorial diagram of the tension bars of the machine and associated actuating mechanism,

FIG. 3 is a diagrammatic plan of the equipment of FIG. 1,

FIG. 4 is a diagrammatic elevation of a detail of the equipment of FIG. 1, and

FIG. 5 is a diagram of electrical circuitry associated with the equipment of FIGS. 1 to 4.

FIG. 1 shows, in side elevation, a conventional warp knitting machine having two warp beams 6 supplying warp yarns 22 to needles 23, from which the knitted fabric 24 passes to a take-up roller 9. In its path from the respective warp beam to the needles 23 each yarn sheet 22 passes first through a respective reed 16 carried by a fixed tension rail and then over a respective moving tension bar 7, 7A as shown in more detail in FIGS. 2 and 3, which presses upon the yarn sheet at a position between the reed 16 and the needles 23.

The tension bar arrangement 7 or 7A comprises a transverse rod 10 (FIGS. 2 and 3) of, say, three-eighths inch diameter solid steel, mounted on a parallel carrying spindle 11, which may be a 1½ inches diameter steel tube, at a selected radial distance from the axis of the carrying spindle. The spindle 11, which is supported at intervals of, for example, 42 inches across the machine, oscillates angularly so that the rod 10, which is the element that actually engages the yarn sheet, moves to and fro in an arc about the spindle axis and thereby increases and decreases the yarn path length cyclically. At one end of the spindle 11 there is a rocker plate 4 fast therewith and this rocker plate is coupled by a link rod 26 to a cam and solenoid actuating assembly best shown in FIG. 4. The link rod 26 produces rapid oscillation of the spindle 11 in synchronism with the movements of the needles 23, the rod pushing in one direction and the return stroke being effected by means of a return spring 8 connected between the rocker plate 4 and the machine frame 12.

As best shown in FIG. 4, the link rod 26 is actuated by a cam 27 via a cam follower 28 and a double-armed rocker 29, one arm of which cooperates with the cam follower while the other arm engages the link rod end. The rocker 29 is loosely pivoted on a shaft 30 which is eccentric in its bearings 31. The cam 27 is mounted on a shaft 32 (FIG. 3) which is driven by a chain drive 33 from the main drive shaft 34 of the knitting machine that bears the cranks or cams operating the knitting elements. By reason of the oscillations of the solid tension bar 7 or 7A produced by the cam 27 and associated mechanism, fluctuations in the yarn path length are caused that exactly match the cyclically varying rate at which the yarn is used at the knitting elements. The result is that the yarn tension remains controlled, in spite of the fluctuations in yarn usage rate, and this holds good whether the machine is running at a steady

speed, or slowing down, or speeding up. No attempt has been made to show the profile of the cam 27 since the cam profile needed to produce changes in yarn path length matched to the fluctuations in yarn usage rate during the knitting cycle will be different for different stitch patterns. A set of interchangeable cams can be supplied for each machine if the type of fabric knitted by the machine is to be changed from time to time. Not only must the cam profile be appropriate to the stitch pattern being knitted but also it must take into account various machine characteristics, the timing factor which is related to the yarn release, the location of the tension 7 or 7A and the motion of the needles themselves.

Although each tension bar has been shown as "straight," there is advantage in so shaping it that in the neighbourhood of the selvage the bar is curved or angled in such manner as to even out the tension throughout the entire width of the machine. That is to say, looked at from the front of the machine, the ends of the bar are further away from the observer than at the centre. The extent of the bent portion of the bar can be from 3 inches up to 12 inches or more from the selvage, depending on the type of machine and the fabric.

We have further discovered that, when the machine stops and restarts, it is commonly not sufficient for the tension bar merely to follow accurately the movement of the needles as reproduced by the cam 27; it is instead desirable that during stopping an extra amount of thread is taken into the yarn path by pushing out the tension bar 7 or 7A to a greater extent than would be obtained under the control of the cam 27 alone. Then, during starting up, this excess or reservoir of thread must be slowly released under controlled tension. Therefore, the eccentric shaft 30 (FIG. 4) is conveniently operated by a solenoid 35 which is controlled by the machine stop mechanism, the solenoid armature being pivotally connected to an arm 36 that is fast on the shaft 30. As the machine comes to a stop, the solenoid is energised and the eccentric shaft 30 moves angularly in a way which causes the total yarn path to be extended by the requisite distance, which normally is about 0.2 inches, this movement being superimposed on that due to the cam 27.

When the start button is depressed to restart the machine the solenoid 35 is deenergised. An important feature is that as the machine restarts the yarn release is progressive and controlled while the eccentric shaft turns back to its running position. This is in contrast to previous practice, according to which, on restart, the entire yarn surplus is suddenly released, which is a major cause of the imperfection in the fabric known as a stop line.

Whereas one particular way of achieving the desired result has been described, other devices for bringing about extra yarn take-up on stopping, and its progressive release on re-starting, may be employed without departing from the scope of the invention.

Machines normally have two or more warp beams supplying two or more yarn sheets to the knitting elements. A separate tension bar is therefore provided for each yarn sheet. The individual tension bars, of which two are shown in the example illustrated, may be driven by respective individual cams 27, or in some cases two or more tension bars can be driven from the same cam.

To achieve complete elimination of "stop and start lines," the take-up roller 9 is equipped with an automatic magnetic hysteresis clutch and brake control, as indicated at 5, that comes into operation at an appropriate machine running speed. Advantageously, the machine is allowed to run down to a certain speed and then full braking is automatically applied suddenly to arrest the machine instantaneously. A convenient way of achieving this is to control the brake by means of a photocell, or like sensitive electronic device, that monitors the passing of a marker spot carried by a shaft or other rotating part of the machine.

If desired, the warp beam 6 may be similarly equipped. Although not part of the present invention, electronically-controlled yarn let-off from the warp beam is available and may be employed in combination with this invention.

All the normal fail-safe characteristics may be built into the system. For example, the linkage transmitting the cam motion to the tension bar spindle 11 may be arranged so that if it is over-tensioned it actuates a machine knock-off micro-switch.

As will be understood, many modifications of the arrangement shown in FIGS. 1 to 4 are possible without departing from the scope of the invention. There are, for instance, numerous ways, alternative to that shown, of driving an oscillating tension bar in synchronism with the knitting elements.

For example, punched steel tapes can be used or electrical or electronic means can be employed to control the movement of the tension bar, either at all times or during stopping and starting periods, in appropriate synchronism with the movement of the knitting elements and the yarn feed.

We have further discovered that in the case of warp knitting machines the stop mechanism should be so controlled that the machine always comes to a full stop when the needles are in the "down" position, or not more than a short distance beyond the "down" position. This avoids the need for slow running or "inching" of the stopped machine under manual control before re-threading after yarn breakage, which "inching," apart from being time-wasting, would itself produce a stop line.

FIG. 5 shows an electrical circuit for achieving this result. When the machine is running normally the forward running contactor FRC is pulled in, the coil of this contactor being energised through the start and stop switches S and ST from supply terminals L2 and L3 when the start button is depressed. Depression of the stop button opens contacts A and closes contacts B of the stop switch ST which energises the coil of relay A from terminals L2 and L3. This pulls in a holding contact aA for the coil of the relay A; and the contact bA drops out which would result in the supply to the coil of the contactor FRC being interrupted except that a parallel circuit at this time exists through a reed switch R1.

Upon subsequent opening of the reed switch R1, the forward running contactor FRC de-energises which completes a circuit from terminal L1 through the contacts Ac of the forward running contactor for energising the reverse running contactor RRC. The machine therefore slows rapidly to a halt but before it actually reverses a dynamic relay B2, which opens at a predetermined low speed, say about 50 r.p.m., breaks

the reverse contactor energising circuit so that the motor is stopped.

It will be understood, therefore, that the actual position of stopping is primarily determined by the instant at which the reed switch R1 opens and this can be appropriately coordinated with needle position. The switch R1 has a biasing coil to prevent opening of the switch during normal running of the machine, which coil is fed from a transformer that is de-energised either through the relay A or another relay operating in conjunction therewith.

The switch B1 is another dynamic relay the contacts of which are open to disable the energising circuit of the relay A when the machine is running, but which close to bring this circuit into operative readiness at a suitable speed chosen to ensure that no electrical or mechanical damage can occur.

The circuitry shown in FIG. 5 serves to ensure stopping of the machine with the needles in the "down" position or a short distance beyond the "down" position. If more precise control of the stopping position is desired electronic control means can be employed.

In the arrangement so far described, it has been envisaged that the conventional flutter bar will be entirely removed from the machine. However, in certain instances it may be possible to adapt the flutter bar itself to give the desired yarn length control. Thus, a power-driven auxiliary yarn-engaging extension or assembly may be provided on or associated with the flutter bar to come into operation during starting and stopping of the machine. This auxiliary yarn-engaging means could be cam-driven, or driven in any other appropriate manner in synchronism with the knitting elements, to give the desired variations in yarn path length.

As already stated, an electronically-controlled drive for the positively-driven tension bar can be employed, instead of a purely mechanical drive as illustrated in the drawings. In one advantageous arrangement, the movements of the knitting bar are electronically monitored and corresponding motivation is applied to the tension bar through appropriate transducer equipment. Such electronic control has the advantage, over the mechanism described and illustrated, of not requiring the fitting of different cams for different work.

What we claim is:

1. Yarn handling and control apparatus in a knitting machine, including at least one warp beam supplying warp yarns, yarn length control means over which warp yarn supplied by said at least one warp beam pass, a row of knitting elements to which said warp yarns travel after passing over said yarn length control means, said warp yarns extending from said yarn length control means to said knitting elements in close mutually parallel relationship and all in a common plane so as to form a yarn sheet, a fabric take-up roller receiving fabric knitted by said knitting elements, said yarn length control means comprising a wholly rigid coupling including a rigid tension bar extending parallel to said yarn sheet plane and at right angles to the direction of travel of said yarns, said tension bar being mounted for only rigidly controlled oscillation to and fro in a direction toward and away from said yarns, poweractuated drive means oscillating said tension bar rigidly in said a direction in synchronism with the operation of said knitting elements, and means automatically responsive to stopping and starting of said machine to vary the stroke of oscillation of said tension bar such

that said bar is driven farther in the direction toward said yarns on stopping and withdrawn in the direction away from said yarns through an equivalent distance on starting of such extent as to create an excess of warp yarn length on stopping, and means for progressively reducing said warp yarn length under controlled tension in response to restarting of said machine.

2. Apparatus according to claim 1, wherein said tension bar is a solid rod oscillating in an arc of movement.

3. Apparatus according to claim 1, comprising a driving cam driven by said drive means and having a contour selected to suit a stitch pattern being knitted, and a cam follower driving mechanism for said tension bar actuated by said driving cam.

4. Apparatus according to claim 1, wherein is included a main drive shaft for said knitting elements, and means for driving said tension bar from said main drive shaft.

5. Apparatus according to claim 1, including electrical means for synchronizing movements of said tension bar drive means with movements of said knitting elements.

6. Apparatus according to claim 1, wherein said tension bar is curved or angled in the region of the selvages to even out yarn tension throughout the entire width of said machine.

7. Apparatus according to claim 1, including an eccentric shaft, means responsive to said stopping for angularly moving said eccentric shaft, and means responsive to said angularly moving for effecting said increase of movement of said tension bar.

8. The combination according to claim 7, wherein said means for angularly moving said eccentric shaft

includes a solenoid, and means for selectively energizing and de-energizing said solenoid under control of said starting and stopping.

9. Apparatus according to claim 1, wherein is included a declutching and braking means for automatically controlling the speed of said take-up roller in response to decrease of speed of said machine during machine speed decrease on stopping and increasing said speed of said take-up roller on start-up of said machine.

10. Apparatus according to claim 9, wherein is included a further declutching and braking system for automatically controlling speed of said warp beam in response to variation of speed of said machine during stopping and start-up.

11. The combination according to claim 10, wherein said declutching and braking means include clutch and brake means of the magnetic hysteresis type.

12. Apparatus according to claim 1, wherein is included means for substantially instantaneously fully braking said fabric take-up roller in response to running down of said machine to a predetermined speed during stopping of said machine.

13. Apparatus according to claim 12, comprising means to apply substantially instantaneous braking to said warp beam in response to running down of said predetermined speed during stopping of said machine.

14. Apparatus according to claim 1, comprising means so controlling said stop mechanism that said machine always comes to a full stop when said knitting elements are substantially in the "down" position.

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