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KNITTING MACHINE AND METHOD OF KNITTING

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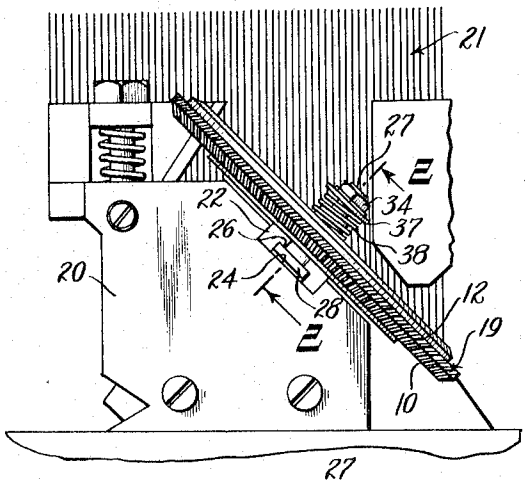


Fig. 1.

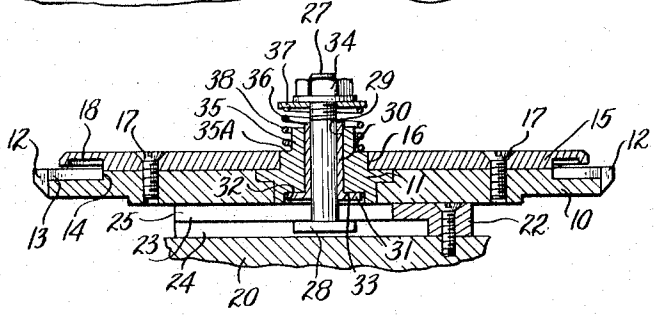


Fig. 2.

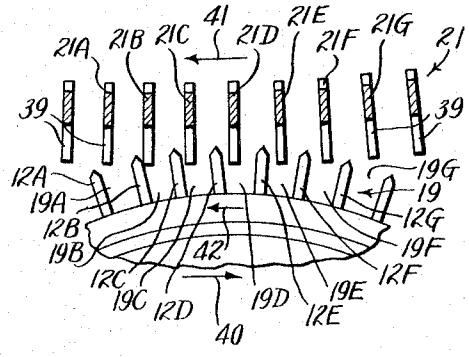


Fig. 3.

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KNITTING MACHINE AND METHOD OF KNITTING

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The present invention relates to a knitting machine and to a method of knitting. More particularly, the present invention relates to a pattern wheel and a method of using the pattern wheel.

Broadly, according to the invention, means are provided to prevent free rotation of a pattern wheel so that the rotation of the pattern wheel is constantly under control of the interengaging cooperating needles.

In the prior art pattern wheels are mounted so as to be freely rotatable, or free wheeling, so that the wheel is rotated by engagement with one or more needles. However, because of the free wheeling aspect of the prior art pattern wheels, the wheel will freely rotate to a significant extent even when cooperating needles no longer positively cause rotation of the wheel. This deficiency of the prior art causes irregularities in knitting patterns by frequently having wrong needles raised by the pattern wheel, by the pattern wheel skipping and even by causing such contact between the needles and the wheel as to damage either the wheel or the needle.

In addition to being mounted for free wheeling, the prior art wheels are mounted so that there is some lateral play of the wheel relative to the axis. In other words, the pattern wheel may move in a direction transverse to its plane to cause rocking or vibration of the wheel during use. These shortcomings of the prior art are eliminated, or at least greatly reduced by the present invention.

According to one aspect of the present invention, there is provided a combination of a pattern wheel mounted for rotation about its axis, the pattern wheel having circumferentially spaced apart teeth with the spaces between the teeth defining needle receiving slots and means for limiting free rotation of the wheel about its axis. The means for limiting free rotation of the wheel about its axis desirably limits free rotation of the wheel to the extent that the wheel only rotates during the time it is positively being rotated by engagement of a needle with a tooth of the wheel. Substantially as soon as such engagement ends the wheel stops its rotation unless urged by engagement with another needle.

According to another aspect of the invention, there is provided a combination of a pattern wheel mounted for rotation about its axis, said pattern wheel having circumferentially spaced apart teeth, the spaces between the teeth defining needle receiving slots, and a bank of needles cooperating with said wheel, the pitch of the teeth of the wheel being less than the pitch of the needles. Excellent results have been obtained when the pitch of the teeth of the pattern wheel is between about one-half to two percent less than the pitch of the needles. "Pitch," as used herein, refers to the spacing between the centers of the teeth or the centers of the needles. This structure serves to eliminate many of the deficiencies of the prior art when the free wheeling or free rotation of the wheel is substantially reduced or eliminated.

In the illustrated embodiment the free rotation of the wheel is limited by frictional means cooperating with the wheel and the wheel support. It is readily apparent that other means can be used which will be effective to limit or eliminate free rotation of the wheel.

In the illustrated embodiment the means for limiting the free rotation of the wheel comprises a compression spring interposed between the wheel itself and the support for the wheel to provide frictional engagement between them. This same spring serves another function, namely, that of eliminating or greatly reducing the tendency of the pattern wheel to rock or vibrate. This effect is obtained because the spring constantly urges the pattern wheel to remain in one plane and thereby reduce vibration or rocking of the pattern wheel in a direction transverse to the pattern wheel.

The structure of the present invention is particularly adaptable for use with fine gauge machines, whereas heretofore in the prior art pattern wheels created many problems when used on fine gauge machines.

It is an object of the present invention to provide a pattern wheel arrangement wherein the needles cooperating with the wheel only contact the teeth of the pattern wheel to drive or rotate the pattern wheel.

It is another object of the invention to provide a pattern wheel arrangement which greatly reduces or eliminates the tendency of needles to improperly frictionally engage a tooth of the wheel to cause elevation of said needle even though the slot which the needle enters has no jack therein.

It is another object of the invention to provide a pattern wheel arrangement which reduces rocking or vibration of the pattern wheel.

These and other aspects of the invention will be readily apparent from the following description which is by way of example, in connection with the accompanying drawings, wherein:

FIG. 1 is a diagrammatic vertical elevation showing part of a knitting machine on which is mounted a pattern wheel, the view being taken from the outside of the machine looking toward the axis, so that the pattern wheel is shown in front of the needle bank;

FIG. 2 is a cross section of the pattern wheel taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary diagrammatic top elevation, in developed form, showing the interaction of the pattern wheel and the cooperating needles.

The present invention will be described in connection with a circular knitting machine. As is well known in the art, there are two general types of circular knitting machines, the needle rotating type and the cam rotating type. In the needle rotating type, the needle actuating cams, or the cam ring, are stationary, and the needle bed (or beds) rotates. In the cam rotating type, the knitting cams, or the cam ring, rotate, while the needle bed (or beds) is stationary. In either case, there is relative movement between the needle bed (or beds) and the knitting cams.

In general, the cams rotate counterclockwise relative to the needles. As is also well known, a circular knitting machine may have more than one needle bed and, when two beds are used, needles of one bed are disposed at an angle to the needles of another bed. This type of construction is exemplified by the well-known circular knitting machines having a cylinder bank of needles and a dial bank of needles.

Since the present invention is applicable to any of these types of machines, for the sake of clarity and for the sake of avoiding an unduly long description, the drawings do not show an entire knitting machine, but merely show those portions of the machine which are specifically involved in the present invention. Furthermore, for the sake of simplicity, the invention will be described in connection with a circular knitting machine having one or two banks of needles. In either case, only the cylinder needles are shown.

In addition, the invention will be specifically described in connection with a machine of the rotating cam type.

It will therefore be appreciated that in the present application whenever reference is made to rotation of the cam ring or to rotation of the needle bank, such language is intended to encompass relative movement between the cam ring and the needle bank, no matter which one is actually rotating.

Furthermore, pattern wheels are well known in the knitting arts, and such wheels are usually used for cooperation with a cylinder bank of needles, although obviously they may be used with other needle banks. The operation and function of pattern wheels are well understood in the art, and the pattern wheel of the present invention functions substantially as do the prior-art pattern wheels, except as described hereinafter.

The present invention will be described only in connection with a single pattern wheel and a portion of the cylinder bank of needles. Nevertheless, it will be understood, that, generally, more than one pattern wheel is used, there being one pattern wheel for each knitting station. Therefore, although only one pattern wheel is described, the invention is applicable to any number of pattern wheels as conventionally used.

Referring specifically to FIGS. 1 and 2, the pattern wheel of the present invention comprises a main or supporting plate **10** in the form of a disc having a central hub **11** and circumferentially spaced apart radially extending teeth **12** around the periphery of the supporting plate **10**. As in the prior-art pattern wheels, the teeth are parallel to each other and are at an angle to the plane of the pattern wheel. The main plate **10** has on its upper surface, near its pheripheryy, an annular recess or groove **13** concentric with the hub **11**. The groove **13** extends radially from a shoulder **14** on the hub side of the groove to the rear of teeth **12**.

The pattern wheel includes a retaining plate **15** having a central opening **16** therethrough which is fitted around the hub **11**, so that the retaining plate **15**, also in the form of a disc, is concentric or coaxial with the main plate **10**. The retaining plate **15** is of lesser diameter than the main plate **10**, so that its periphery lies inward of the rear of the needles **21**. When the supporting plate and the retaining plate are assembled, the retaining plate **15** is superposed over and in abutting contact with main plate **10**, with the two plates being held together by bolts **17**. On the underside of retaining plate **15**, very close to its periphery, there is provided an annular groove **18** overlying groove **13** in the main plate and concentric therewith.

The spaces between the teeth define slots **19**, said slots being parallel to the teeth and, therefore, angularly disposed relative to the plane of the pattern wheel.

In order for the pattern wheel to perform its function in the knitting machine, jacks (not shown) are mounted in one or more, and sometimes all, of the slots **19**. The jacks each comprise a thin plate having a body portion mounted in the space defined by overlying grooves **13** and **18** with the effective portion of the jack extending into a slot. The jacks are placed in position in the supporting plate and then the retaining plate is fastened to the supporting plate to secure the jacks in position.

Since the present invention is not particularly concerned with the structure of the jacks or the mounting of the jacks, and since such structure and mounting are conventional, no jacks have been shown in the drawings, in order to simplify the drawings.

The pattern wheel is secured to the cam ring **20**, of which only a fragment is shown. The pattern wheel, as is conventional, is mounted on the cam ring at an angle to the plane of the relative rotation between the cam ring and the needle bank.

As is apparent from FIG. 1, the pattern wheel is also at an angle to the needles, which cooperate with the pattern wheel, which needles, in the instant case, are cylinder needles **21**.

In the illustrated embodiment, the cam ring rotates in a horizontal plane, while needles **21** are vertically disposed and reciprocate vertically during the knitting operation.

The pattern wheel is mounted on the cam ring **20** by means of a mounting bar or bracket **22**, said mounting bracket being secured in a conventional manner to the cam ring.

The mounting bracket may be the conventional bracket and is provided with a longitudinal slot **23** extending through the bracket. The slot **23** is generally T-shaped in cross-section, with the wider part of the slot, corresponding to the cross bar of the T, being on the underside of the bracket, as shown at **24**, and with the narrower portion of the slot **23** being on the upper side of the mounting bracket, as shown at **25**, to thereby provide a shoulder **26**.

The pattern wheel is secured to the bracket by means of a mounting bolt or stud **27** whose head **28** is received in the wider portion **24**. Because of the shoulder **26**, the head of the bolt will not pass through the mounting bracket.

The hub **11** of the wheel is provided with an axial bore **29**, in which there is mounted, coaxially with the wheel, a hollow sleeve or bushing **30** having a radial enlargement or head **31** on its underside. The hub **11** is provided with a counterbore **32** on its underside, said counterbore **32** having a greater diameter than bore **29** and communicating therewith, so as to provide a shoulder **33** which prevents the head **31** of the sleeve **30** from passing through the axial bore of the hub.

When a pattern wheel is to be mounted on the machine, the bolt or stud **27** is passed through the hollow or bore in sleeve **30** with the head **28** of the bolt **27** being positioned in the slot of the mounting bracket **22**. The bolt **27** is provided, at least on its upper end, with external threads for threadedly receiving a fastening nut **34**. The hub **11** extends upwardly above the upper surface of the retaining plate **15** to provide a hub extension **35**. The total height of the sleeve **30** from the bottom surface of the head **31** to the upper extremity of the sleeve is slightly greater than the height of the hub from its lowest surface to the upper edge of extension **35**. This construction provides the sleeve **30** with an upper portion **36** which extends above the uppermost extremity of extension **35** of the hub.

When the wheel is being mounted, a washer **37** is positioned around the bolt **27** below fastening nut **34**. The bore of the washer **37** has a diameter sufficiently large to admit the washer to be inserted over the end of the bolt, but sufficiently small so that the washer does not surround the upper extremity **36** of the sleeve **30**. Therefore, when the nut **34** is tightened, washer **37** abuts the uppermost edge of sleeve **30**, and because of the fact that the sleeve is longer than the height of the hub, the washer will not abut the upper surface of extension **35** of the hub.

Therefore, because of this construction, when the nut is tightened, the bolt **27** and the sleeve **30** are rigidly secured to the mounting bracket, but at the same time, the hub, and, therefore, the pattern wheel is free to rotate around sleeve **30**.

The pattern wheel, as described up to this point, is essentially identical with prior art pattern wheels. This described construction permits the pattern wheel to freely rotate about its axis as the pattern wheel is engaged by the needles, but more accurately, the butts of the needles, as is well known in the art.

Furthermore, this conventional mounting permits the pattern wheel to rotate to such an extent that it may be considered "free wheeling," because there is sufficient clearance between the external surface of the sleeve **30** and the internal surface of bore **29** of the hub to not significantly slow down rotation of the wheel as it is engaged by the needles.

In this prior art construction, therefore, the contact or engagement between the needles and the teeth of the pat-

tern wheel is sufficient to cause or permit the wheel to rotate after removal of the force against the teeth of the wheel when the needle does not contact a tooth of the wheel.

According to the present invention, the above construction is modified to the extent that a helical compression spring **38** is positioned about the upper extension **35** of the hub with the lower surface of the spring contacting the shoulder **35A** on the hub and with the upper surface of the spring contacting the lower surface of the washer **37**. Because the spring **38** is under compression, it constitutes a frictional connection between the pattern wheel and the sleeve **30**, since washer **37**, nut **34**, bolt **27** and sleeve **30** are rigidly secured to each other when the nut is tightened. This frictional action interconnecting the rotating portion of the wheel, i.e., the hub, supporting plate and retaining plate, and the fixed mounting means for the wheel prevents or at least retards to a significant extent the above described free wheeling action of the wheel. The tension of the spring is so adjusted that the wheel will substantially only rotate under the positive action of a needle engaging a tooth of the wheel. As soon as the force caused by the engagement of a needle with a tooth of the wheel is removed, the wheel no longer rotates.

By adding the spring **38** to the prior art pattern wheel, two significant effects are obtained. The first and most significant effect obtained is to avoid many of the problems resulting from the free wheeling pattern wheels of the prior art, as will be explained hereinafter. Secondly, the use of the spring **38** minimizes the rocking of the wheel, that is, unwanted vibration or movement of the wheel in a direction transverse to the plane of the wheel.

Before describing the effects obtained by the present invention, the use and function of a pattern wheel will be briefly explained. As is well understood in the art, the pattern wheel is mounted on the machine, in the illustrated embodiment, on the cam ring, at an angle to the horizontal. The angle of the pattern wheel depends on the particular structure of the wheel and other well known factors not affected by the present invention. Generally, the wheel is mounted at an angle between about thirty and thirty-five degrees, although the angle may be greater or less. The teeth of the wheel are cut at an angle to the plane of the wheel, the angle being such that the teeth of the wheel which are in the position to be engaged by the needles are parallel to the needles, and, therefore, in the instant described embodiment, the teeth would be vertical, since needles **21** are vertical. It will also be appreciated that the slots defined by the spaces between the teeth are also vertical.

Depending upon the effect which is desired to be obtained by the use of the pattern wheel, jacks are positioned in one or more or all of the slots, As the support for the pattern wheel rotates relative to the needle bank, the butts **39** of the needles enter the slots of the wheel in a manner analogous to the interengagement between teeth of a pair of gears. Therefore, as the relative movement between the needle bank and the pattern wheel continues, the entry of the needle butts into the slots of the wheel cause rotation of the wheel about its axis. When a needle butt enters a slot having no jack therein, the pattern wheel does not affect the vertical position of the needle, but the presence of the butt in the slot still causes rotation of the wheel.

On the other hand, when a needle enters a slot having a jack therein, the underside of the butt is positioned over the jack and as the pattern wheel rotates, because of its angular mounting, the jack will be elevated, and the elevation of the jack will elevate the needle to a new position. When the pattern wheel has rotated about its axis sufficiently to withdraw the jack from engagement with the needle held thereon, the needle will then be free of the pattern wheel and jack and will maintain its raised position until further acted upon by cams or other elements of the knitting machine, as is well known in the art.

The needles **21** are provided with butts **39**, the butts being acted upon by the cams, pattern wheels, etc., of the machine, to cause reciprocation of the needles during the knitting operation.

It will be understood that in the present invention, as in the pattern wheels of the prior art, only the butts of the needles enter into the slots between the teeth of the wheel. The interaction between the needle butts and the walls of the teeth cause rotation of the pattern wheel. In the instant description, reference will frequently be made to the interaction between the needles and the pattern wheel. It will be understood that although mention is made of "needles," it is actually the butts on the needles which interact with the pattern wheel.

The advantages obtained by the present invention will now be described, particularly in connection with FIGURE 3. FIGURE 3 is a diagrammatic view showing the interaction between the needles **21** and the teeth or slots of the pattern wheel. FIGURE 3 is a type diagrammatic plan view and is a developed view to the extent that the pattern wheel as well as the interacting teeth are shown in their horizontal plane, although it will be appreciated that in actual practice, the pattern wheel is at an angle to the horizontal.

Although as previously described, the teeth of the pattern wheel are cut at an angle to the wheel, the teeth, at the point where they interact with the needles, are vertical and parallel to the needles.

FIGURE 3 will be described by way of example, in connection with a machine which in the art is referred to as a ten cut machine, meaning that there are ten needles per inch, with the needles being spaced apart on 0.1 inch centers. The spacing of the needles will hereinafter be referred to as the pitch of the needles, and the spacing of the teeth of the pattern wheel will be referred to as the pitch of the pattern wheel. In other words, if the teeth of the pattern wheel are spaced apart on 0.1 inch centers, the pitch of the pattern wheel would be equal to the pitch of the needles. In the prior art construction, the pitch of the pattern wheel was the same as the pitch of the needles.

According to one aspect of the present invention, the pitch of the pattern wheel is slightly less than the pitch of the needles. By way of example, the pitch of the pattern wheel may be at least about one-half percent less, and generally between about one-half to two percent less than the pitch of the needles.

The distance between the teeth of the wheel, that is the distance between the wall of one tooth and the wall of the adjacent tooth is measured in a direction perpendicular to the plane of the teeth. This distance also defines the width of the slots defined by the spacing of the teeth.

Referring again to the exemplary ten cut cylinder machine having ten needles **21** per inch, the thickness of each needle, that is the distance between one side wall and the other side wall is about 0.030 inch. To properly accommodate needles of this thickness, the width of the slots of the pattern wheel would normally be about 0.010 inch to 0.015 inch greater than the thickness of the needles. By way of example, the width of each slot of the wheel is about 0.043 inch so that when a needle is in the slot, the total clearance between the lateral surfaces of the teeth and the walls defining the slot would be about 0.013 inch.

It will be appreciated that according to the present invention, as in the prior art, the slots must be slightly wider than the needles in order to receive the needles during the angular relative movement between the needle bed and the pattern wheel. The need for the slot to be wider than the needle is comparable to the situation involved when two spur gears engage, wherein the spacing between the teeth of one gear is somewhat greater than the the thickness of the tooth which enters the space.

In the present invention, as in the prior art, rotation of the pattern wheel is caused by the engagement of a side of the needle butt with a wall of a tooth. This engagement, because of the interfitting of the butts of the needles and the slots of the wheel, applies a force to the pattern wheel to rotate the wheel.

In the exemplary embodiment, the cam ring 20, and, therefore, the support for the pattern wheel move in a counterclockwise direction, as indicated by arrow 40. Since the cam ring rotates counterclockwise, the needle bank rotates relative thereto in a clockwise direction, as indicated by arrow 41. As the needles interengage the teeth of the pattern wheel, the pattern wheel will rotate about its axis in a counterclockwise direction, as indicated by arrow 42.

In FIGURE 3, there are shown successive teeth 12A, 12B, 12C, 12D, 12E, 12F and 12G. Teeth 12A and 12B define between them slot 19A. Teeth 12B and 12C define between them slot 19B and so on. The needles which cooperate are identified as 21A, 21B, 21C, 21D, 21E, 21F and 21G. Each of these needles is in or aligned with corresponding slots 19A through 19G.

It will be appreciated that FIGURE 3 shows the position of each of the enumerated teeth and slots at a particular moment during the operation of the machine. The figure can also be considered as showing the successive movement of the needle as it starts to cooperate with the pattern wheel until it is released by the pattern wheel.

In the position shown in FIGURE 3, needle 21G is about to enter slot 19G and the remaining needles are also shown in their respective relationship to their respective slots. Needle 21B is the last needle to actually be in a slot, since it is apparent that needle 21A is leaving or has actually left slot 19A.

As previously stated, in this embodiment, the distance between the centers of adjacent needles is 0.100 inch. The teeth are spaced apart on 0.099 inch centers because the pitch of the pattern wheel is less than the pitch of the needles.

In FIGURE 3, needle 21B is shown with its left side (when viewing the drawing) abutting the right hand wall of tooth 12B. Stated somewhat differently, slot 19B is defined by two walls, one being the right hand wall of tooth 12B, the other being the left hand wall of tooth 12C. For convenience sake, these walls are being considered as walls of the slot, and, therefore, slot 19B is defined by a left hand wall, which is the right hand side of tooth 12B, and a right hand wall which is the left hand side of tooth 12C. In FIGURE 3, the left hand wall of needle 21B is touching the left hand wall of slot 19B. Because of the movement of the needles in the direction indicated by arrow 41 and the relative movement in the direction indicated by arrow 40 of the pattern wheel support, the left hand wall of needle 21B touches the left hand wall of slot 19B and applies a force thereto which rotates the pattern wheel about its axis.

On the other hand, the next needle, 21C, has its left hand wall slightly spaced away from the left hand wall of slot C because of the difference in pitch between the wheel and the needles.

Using the relative dimensions set forth above, needle 21C will be about 0.001 inch away from the left hand wall of slot 19C. Similarly, left hand side of needle 21D will be 0.002 of an inch away from the left hand wall of slot 19D. In other words, the spacing between the left hand side of each successive needle and the left hand wall of its slot progressively increases until needle 21G is about at its midpoint of slot 19G.

In a ten cut machine, as now being described, each needle would be about 0.030 inch thick and the slots would be about 0.043 inch wide, so that the slot is about 0.013 inch wider than the thickness of the needle. In general, according to the present invention, the needles will have their standard thickness and the width of the slots would be the same as the prior art pattern wheel, even though the present pattern wheel has a lesser pitch.

From the above description, it will be apparent that on the needle 21B, namely, the needle just about ready to be released from engagement with the pattern wheel, is the only one contacting the wall of a slot to drive or rotate the pattern wheel. All of the other needles are clearly spaced away from the walls of the slot.

Since, according to the present invention, because of the removal or limitation of the free wheeling aspect of the wheel, the wheel only rotates when actually being urged to rotate by contact with a needle. Since only needle 21B contacts the wall of a slot, needle 21B is the only needle driving the wheel. It will be appreciated, of course, that if the wheel were free wheeling, as in the prior art, the force of engagement between needle 21B and tooth 12B would cause the wheel to rotate, even when the positive force caused by needle 21B is removed. Then, under these circumstances, the wheel would continue its rotation, and some of the needles would contact the right hand wall of its slot. Such contact is undesirable, and causes one of the defects of the prior art. In the prior art, because of the free wheeling aspect of the wheel, needles frequently abut the right hand wall of the slot, and this engagement is sufficient to cause elevation of such a needle even though no jack is in the slot.

Because the pitch of the prior art wheels is the same as that of the needles, and because there are always imperfections present in the width of the needles, in the spacing of the grooves of the needle bed in which the needles slide, etc., needles frequently undesirably contact either wall of a slot.

The frictional engagement in such cases between the teeth of the wheel and the needles is sufficient to cause the needle to be elevated, although there is no jack in the slot. Such variations also occasionally cause the wheel to skip and to damage the needles. Such defects of the prior art are obviously undesirable, since they cause irregularities in the knitting pattern.

These disadvantages are avoided in the present invention, because, normally, only one needle contacts the wall of the slot, and there is sufficient clearance between the other needles and the walls of the other slots to accommodate imperfections in the needles, in the needle groove of the needle bed, etc. Occasionally, according to the present invention, because of imperfections in the manufacture of the wheel producing variation in the spacing of the teeth, more than one needle may contact the wall of the slot. It is possible that as many as two or three may contact the wall of a slot. However, in the event more than one needle contacts the wall of the slot, the additional needles which contact the wall of a slot will be the needles adjacent the needle about to be released by the pattern wheel and not the needles entering the wheel. Normally, only one needle contacts the wall of the slot.

The present invention, therefore, assures proper entry of the needles in the slots of the pattern wheel and keeps the sides of the needle out of contact from the walls of the teeth except insofar as such contact is necessary to rotate the wheel.

In the prior art machines, frictional contact with the side walls of the slots of the pattern wheel will cause the needles to be improperly raised. In order to prevent this side wall friction from lifting the needles in the prior art machines, frequently the needles are flexed so as to resiliently mount them in the grooves of the needle bed. This resilient mounting serves to stiffen the needles to reduce the tendency of the needles being improperly raised by friction with the side walls.

It will be appreciated that this flexing, or resilient mounting, of the prior art needles places an additional

load on the machine and may more than double the load on the machine. In addition, this causes increased wear of the cams, needles and teeth of the pattern wheel.

The present invention, however, provides sufficient clearance between the needles and the walls of the slots to eliminate the need for resiliently mounting the needles in the needle bed and thereby reduces the wear on the machine.

Normally, because of the construction inherent in the prior art pattern wheels, the wheel is free to rock or to move in a direction transverse to its plane, this ability to rock is caused by the fact that there must be sufficient clearance between the sleeve and the wheel to permit free wheeling. The pressure caused by engagement of the pattern wheel with the needles and the ever present tension on the needles cause the pattern wheel to rock or vibrate in a direction transverse to its plane. Rocking of the wheel frequently causes the wheel to jump ahead.

Although the wheel of the present invention also has some play relative to the mounting sleeve, rocking is eliminated because the spring resiliently urges the wheel to lie in one plane. The resilient force of the spring is sufficient to overcome the tension of the needles which tend to rock the pattern wheel, and therefore, the present invention also reduces rocking of the wheel.

It will be appreciated that normally between five and seven needles engage the pattern wheel at one time. The needles engage the pattern wheel over a horizontal distance between about one-half to five-eighths of an inch. In other words, from the time the needle enters a slot to the time the needle leaves a slot, the needle will travel about five-eighths of an inch.

In the preceding description, it is stated that the spring limits the free rotation or free wheeling of the pattern wheel, so that the pattern wheel only rotates while it is being positively urged to rotate by a needle. It will be appreciated, of course, that the spring cannot apply so much of a frictional drag as to require undue pressure from a needle to cause rotation of the wheel. Therefore, according to the present invention, even when a needle ceases to positively rotate the wheel, the wheel may still rotate, ever so slightly, and it is understood, therefore, that in the appended claims, when reference is made to the wheel rotating only, or substantially only, when being positively urged by the needle, there may be a slight further independent rotation of the wheel, caused by inertia. Nevertheless, this movement is so slight that it clearly contrasts with the prior art, wherein inertia is sufficient to rotate the wheel a relatively great distance, and thereby causes skipping and other prior art defects. Even though the wheel of the present invention may rotate somewhat because of inertia, the rotation is not sufficient to allow the pattern wheel to jump ahead or skip. It will be appreciated, of course, that because of inertia it is impossible in any kind of machine to cause instantaneous cessation of movement upon removal of the force creating the movement.

The present invention also comprehends within its scope a method of knitting, or more precisely, a method of using a pattern wheel during knitting.

Although only one means is illustrated for limiting the free wheeling of the pattern wheel, it is apparent that other means, either frictional or otherwise, can be used to limit the free rotation of the wheel. The disclosed embodiment should, therefore, be considered as an exemplary one only.

I claim:

1. In a knitting machine, the combination of a pattern wheel mounted for rotation about its axis, said pattern wheel having circumferentially spaced apart teeth, the spaces between the teeth defining needle receiving slots, and a bank of needles cooperating with said wheel, the pitch of the teeth of the wheel which cooperate with the needles during a revolution of said wheel being less than the pitch of the said needles.

2. In a knitting machine, the combination of a pattern wheel mounted for rotation about its axis, said pattern wheel having circumferentially spaced apart teeth, the spaces between the teeth defining needle receiving slots, and a bank of needles cooperating with said wheel, the pitch of the teeth of the wheel being less than the pitch of the needles, the difference between the pitch of the teeth of the wheel and the pitch of the needles being such that normally only a single needle, at any one time, engages a tooth of the wheel to cause rotation of the wheel about its axis.

3. A combination according to claim 1, wherein the pitch of the teeth of the pattern wheel is between about one-half to two percent less than the pitch of the needles.

4. A combination according to claim 3, including means for limiting free rotation of the wheel about its axis, to the extent that the wheel substantially only rotates during the time it is positively being rotated by the engagement of one of said needles with a tooth of the wheel.

5. A combination according to claim 4, wherein the means limiting free rotation of the wheel comprises frictional means.

6. A combination according to claim 5, wherein the frictional means comprises resilient means frictionally interconnecting the wheel and its supporting means.

7. A combination according to claim 6, wherein the resilient means constantly resiliently urges the pattern wheel to remain in a single plane.

8. A combination according to claim 1, including means for limiting free rotation of the wheel about its axis, to the extent that the wheel substantially only rotates during the time it is positively being rotated by the engagement of one of said needles with a tooth of the wheel.

9. A combination according to claim 8, wherein the means limiting free rotation of the wheel comprises frictional means.

10. A combination according to claim 9, wherein the frictional means comprises resilient means frictionally interconnecting the wheel and its supporting means.

11. A combination according to claim 10, wherein the resilient means constantly resiliently urges the pattern wheel to remain in a single plane.

12. A combination according to claim 1, wherein the pitch of the teeth of the pattern wheel is at least one-half percent less than the pitch of the needles.

13. A method of utilizing a pattern wheel having a plurality of circumferentially spaced apart teeth, the spaces between the teeth defining needle receiving slots and a cooperating bank of needles comprising successively introducing needles into the slots between the teeth, maintaining the needles out of contact with the teeth as the wheel rotates until each needle is about to be released by the pattern wheel and engaging a tooth of the pattern wheel with the needle which is about to be released by the pattern wheel, said engagement rotating the pattern wheel, the pattern wheel rotating only during such engagement.

14. A method of utilizing a pattern wheel having a plurality of circumferentially spaced apart teeth, the spaces between the teeth defining needle receiving slots and a cooperating bank of needles comprising successively introducing needles into the slots between the teeth, maintaining the needles out of contact with the teeth of the wheel from the time the teeth engage the wheel until the needles have engaged the wheel through a significant portion of the wheel's rotation, said needles contacting the teeth of the pattern wheel prior to the time the needles disengage the teeth, said pattern wheel rotating substantially only as a result of contact between the needles and the teeth of the wheel.

15. A pattern wheel comprising a supporting plate having teeth about its periphery, a retaining plate superposed

thereover, means securing the retaining plate to the supporting plate, a central hollow hub coaxial with the plates, a sleeve rotatably mounted in the hollow of said hub, the sleeve having a length greater than the height of the hub, a bolt extending through the sleeve, means for fixedly securing the sleeve to a mounting bracket on which the wheel is to be mounted, and resilient means around the hub frictionally engaging the wheel and the sleeve to limit free rotation of the pattern wheel.

16. A pattern wheel according to claim 15, wherein said means for fixedly securing the sleeve includes a nut threadedly engaging one end of the bolt whereby when the bolt is tightened the bolt is fixedly secured to the sleeve with the wheel being free to rotate because of the greater length of the sleeve, and wherein said resilient means comprises a helical compression spring interposed between the nut and the retaining plate for frictionally interconnecting the sleeve and the pattern wheel.

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