ABSTRACT OF THE DISCLOSURE

The present needle-bar speed changing mechanism is for use in zigzag sewing machines having a rotary upper shaft and a needle bar actuating mechanism including a balance crank fixed on said rotary upper shaft for turning therewith, a balance crank of said balance crank, a needle bar, crank pivotally connected to said shaft, a needle bar, a needle bar clamp connecting said needle bar to said needle bar crank and a reciprocating support carrying said needle bar whereby turning movement to said needle bar crank imparts a reciprocating movement to said needle bar to enable a needle attached to said needle bar to perform a stitching operation and said needle-bar speed changing mechanism is interconnected in said sewing machine needle bar actuating mechanism for delaying the upward movement of said needle-bar crank during the operation of the sewing machine providing for an extended period of deslination between the needle and sewing machine shuttle hook on either the right or left side of the zigzag stitch.

Detailed description of invention

The present invention relates to the needle-bar-moving speed changing mechanism for a sewing machine and its objective is to offer a zigzag sewing machine in which the thread loop can be reliably caught by the shuttle hook, even when the amplitude of needle bar oscillation is increased, thereby to obtain a beautiful zigzag stitching of big width.

It goes without saying that in a zigzag sewing machine, an enlarged amplitude of oscillation of the needle bar mounted with a needle will result in a broad zigzag stitching. The needle bar mounted with a needle makes a vertical movement and it becomes necessary to have the rotating shuttle hook catch the thread loop formed beside the needle when the needle penetrates the cloth to be stitched and again rises and passes a certain level, however, there is naturally a certain limitation to the zigzag movement of the needle in consideration of the thread loop catching of the shuttle hook.

Namely, assuming that the needle moves vertically at a constant speed, while the shuttle rotates at a constant speed, there is only one movement (one definite point) when a desirable condition occurs for the needle and the shuttle hook to come across. Moreover an increased amplitude of needle oscillation, i.e., an increased distance between right and left drop positions of the needle will inevitably give the desirable condition for the needle and the shuttle hook to come across. Thus, if you try to make the needle oscillate more widely to obtain a wider zigzag stitching, it is self-evident that there is a certain limitation. In order to eliminate such limitation to the thread loop catching, several proposals have been made to limit the rotating movement of the shuttle or the vertical movement of the needle-bar, thereby assuring the desirable crossing condition of the needle and the shuttle hook to obtain more increased width of zigzag stitch. In these proposals, the composition is rather intricate and the manufacture and assembling becomes difficult and expensive, while the motion loses smoothness. Thus, these proposals will not always be applicable for a sewing machine which is to be operated at high speed.

The present invention purports to eliminate this drawback of the conventional machine. Namely, the primary objective of this invention is to offer a relatively simple speed changing mechanism for the needle bar of a sewing machine. According to this invention even when the amplitude of needle oscillation is considerably enlarged, the appropriate crossing condition of needle and the shuttle hook can be accurately maintained thereby assuring a reliable catch of thread loop and in consequence precisely producing a beautiful, wider zigzag stitching.

For this purpose, according to this invention on the balance crank driven by the rotation of the main shaft is loosely fitted the connecting shaft of the connecting link connected to the needle-bar crank to drive the needle-bar; a forked member is fixed to said connecting shaft; and an equal-width eccentric cam fixed to the machine frame is fitted into the forked part of said forked member. In this manner, the connection between the needle-bar crank and the connecting link driven by the rotation of the balance crank drives the action of said equal-width eccentric cam; and in consequence the motion of the needle-bar vertically moved by said needle-bar crank can be changed in speed at a desirable point of time; and by matching this point of speed change with the crossing position of the needle and the shuttle hook a smooth catching of thread loop can be realized and the needle oscillation for zigzag stitching can be enlarged. Moreover, the composition is extremely simple with new additions of only an equal-width eccentric cam and a forked member; the manufacture and assembly are both easy; and a wide zigzag stitching can be realized without practically any rise in cost.

Another objective of this invention is to offer a smooth working speed changing mechanism as described above. Usually in the sewing machine the rotating mechanism is preferably adopted and this ensures effective utilization of inertia as well as high-speed, smooth action. According to this invention, the rotation of the balance crank is absolutely the same as that of the conventional machine; even when a forked engaging member is adopted, said member moves as a single body together with said balance crank; and even if an equal-width eccentric cam is employed, said cam is fitted to the machine frame and said forked member makes a simple harmonic motion as it rotates around said cam. Thus, the acceleration of motion is limited with good transmission but with no increase in the reciprocating mass; therefore, vibration does not increase, no noise is generated; and hardly any wear is caused, thereby ensuring very light movement for a long period.

More specific objectives and functional effects of this invention will be more clearly understood from the description of an actual embodiment referring to the attached drawings, in which:

FIG. 1 shows a front elevation of the needle-bar moving speed changing mechanism of this invention;
FIG. 2 shows a side view of the mechanism according to this invention with some parts in section and the front frame removed;
FIG. 3 shows an exploded oblique view of major component members of this invention;
FIG. 4 shows a diagram explaining the action of said mechanism of this invention; and
FIG. 5 shows a linear motion diagram of a needle bar equipped with the present invention and of the conventional needle bar, in reference to thread loop catching.
To explain an actual embodiment of this present invention, referring to the accompanying drawings and particularly to FIG. 1, the machine frame 50 holds a well known mechanism for vertically moving the needle-bar. In the illustrated embodiment, said mechanism for vertically moving the needle bar consists of an upper shaft bushing 9 fitted to the bearing 51 provided in one portion of said upper shaft 40, and another identical portion provided in the rear portion of said frame 50. A balance crank 5 fixed to one end of said upper shaft 4; a needle-bar crank 7 connected at one end to said balance crank 5 by means of a connecting link 6; and at the other end connected to the needle bar 10 by means of a needle bar clamp 8, pivoted to said other end of said needle bar 7. Said needle bar 10 is slidably supported by the support portions 11, 11 of the needle bar support 13, the upper end of which is swingably held by a pivot 14 at the forward edge of said frame 50. Said upper shaft 4, when rotated by a suitable motion generating mechanism, rotates said balance crank 5, which in turn causes the needle bar 10 to reciprocately move through said connecting link 6, said needle bar crank 7 and said needle bar clamp 8. At the midpoint of said needle bar support 13 is pivoted at 16 one end of an oscillation rod 15 extending from a well-known amplitude generating mechanism in the machine frame 50. Said oscillation rod 15 is oscillatory motion generated by said connecting link 6 which is to be described hereinbelow. Moreover, at the midpoint of said needle bar support 13 there is, as shown in FIG. 1, pivotted the tip of a restraining link 17, the base portion of which is pivotally mounted on the seat 52 of the machine frame 50; and as is well known, the thread sensor arm 12 serves to feed the upper thread to the needle bar 20 fixed to the lower end of the needle bar 10 and to tighten the stitch formed by the cooperation of the needle 20 and the shuttle (not shown).

In this present invention, to achieve the above-mentioned specific objects, the following members are added to the above-mentioned heretofore known arrangement. The upper shaft bushing 9 which is formed with a flange 21 for securely fitting this bushing 9 into said bearing 51, is extended to integrally constitute a centrally located eccentric triangular cam 1, which is fixed to said bearing 51 of the machine frame 11 in such a manner that, as indicated in FIG. 4, the shortest radius of said eccentric cam 1 may come around the rotation angle 200° of the upper shaft 4 while the rotation angle 0° of the upper shaft 4 corresponds to the upper dead point of said needle bar 10. Meanwhile, said pin 6A, fixed to said connecting link 6 is rotatably inserted into a hole 22 formed at one end portion of said balance crank 5, and is extended at 6A to project on the back side of said balance crank 5. On this extended projection a forked member 2 is mounted by the fitting hole 3 formed at the lower end thereof, and then fastened by a screw 3°. Said forked member 2 is arranged to receive said triangular cam 1.

In this present invention the aforementioned rotating angle 200° of upper shaft 4 usually corresponds to the time point when the favorable condition is offered for the needle and the shuttle hook to cross each other, especially when the needle is at the basic needle drop position of the zigzag seam, which position is on the left side in this present arrangement. Of course the phase of the equal-width eccentric cam can be varied to match a different phase of a given sewing machine. Even when the shortest radius of said equal-width eccentric triangular cam is positioned around the rotating angle 200° of said upper shaft 4, the thread loop catching by the shuttle hook at the left needle drop position will never be adversely affected. Accordingly, the secure the best condition for thread loop catching at the right needle drop, which is the objective of this invention, the shortest radius of said triangular cam may be positioned within the scopes up to 180° from 200° of upper shaft rotation angles.

Of course said equal-width eccentric triangular cam 1 may be replaced by any other means so far as it serves this object, however, the present eccentric cam 1 would be most effective to achieve such an object.

According to the arrangement of this present invention, a rotation of said upper shaft 4 causes said balance crank 5 to move the connecting pin 6A around said upper shaft 4 on the locus γ as indicated in FIG. 4, and, therefore, said needle-bar crank 7 connected at the upper end to the said link 6 by means of the connecting pin 6B is moved on a certain locus, thereby to put said needle bar 10 into reciprocating movement; and at the same time said needle bar 10 is subject to the oscillating movement effected by the aforementioned oscillation rod 15. In this manner a good zigzag stitching is obtained with the appropriate relative condition of the needle and the shuttle hook in which the thread loop is accurately caught by the shuttle hook. To explain more precisely the function of the illustrated embodiment of this invention, said forked member 2 is turned by said balance crank 5 around center 0, which is an integral part of said upper shaft 4 in the process of turning around said cam the forked member 2 is subjected to appropriate oscillation which turns said pin 6A in said fitting hole 22 of the balance crank 5 and thereby to appropriately displace the angle of said connecting link 6 with respect to said balance crank 5 which connecting link being fixed on the end of said cam 6A in an opposite rotation to said forked member 2. Such angular displacement of said connecting link 6 operates to vary the upward movement of said needle bar crank 7 by retaining the same in the lower position for a preselected longer period of time. Hence for 0A and said movement of the needle bar 10 is varied in speed to maintain the favorable crossing condition for the needle and the shuttle hook to coact with each other even in a wider zigzag stitching operation.

To explain this operation of the present invention in more detail, in FIG. 4 taking the center of the pin 6A of the connecting link 6 or the center of the fitting hole 22 of the balance crank 5 for 0, and the center of the pin 6B by which the upper part of the needle-bar crank 7 is connected to the connecting link 6 for 0A, and with the equal-width eccentric triangular cam 1 being fixed on the machine frame 11 in the angle φ, the following relation will be established: When the rotation angle φ of the upper shaft 4 is 200°, center 0A is still the same distance as is 0B, or in other words, center 0B is on the turning locus γ of the pin 6A; and while the upper shaft 4 rotates from point of φ=220°, the center 0C of the pin 6A will shift from 0B(a) to 0B(b), and 0B will take the position of 0B(b) as indicated by the solid line in FIG. 4, however, if this present invention is not applied, center 0B will move to 0B′(b) as it does at the conventional mechanism. According to this invention, however, since the forked member 2 transmits the oscillation of said triangular cam 1 to said pin 6A as it rotates around said triangular cam 1, said connecting link 6 is shifted counterclockwise by angle φ around the center 0B(b) when the upper shaft 4 rotates to angle 200°. Thus, the reciprocal rotation of the connecting link 6 restricts the rise of the needle-bar crank 7 to a specified extent as illustrated by angle φ in FIG. 4. Therefore the rising motion of the needle-bar 10 is varied as indicated by the solid line in FIG. 5. The rotating angle φ of the connecting link 6 may of course be arbitrarily chosen by varying the lift I of the eccentric cam 1, accordingly, the displaced decrement of the needle-bar movement at the right needle drop in FIG. 5 can be arbitrarily set. In FIG. 5, the broken line represents the conventional movement of needle-bar in comparison with the solid
line representing an example of the needle-bar movement according to this present invention. In the illustrated embodiment of this present invention, as is understood from FIG. 5, the needle at the left drop is at the position risen by $\Delta L$ from its lower dead point when the thread loop is favorably caught by the shuttle hook. This favorable condition for the needle and the shuttle hook to come across is generally obtained by the conventional sewing machine mechanism, because in the conventional mechanism, the upper shaft rotates 180° when the needle reaches the lower dead point, and the upper shaft rotates 200°, the needle rises by said $\Delta L$ from the lower dead point and at that movement the thread loop is caught by the shuttle hook. However, as stated before, to displace the movement of the needle bar by distance $\Delta h$ within the range from 200° to 220° of the upper shaft rotation angles is to reduce the rising movement of the needle from the lower dead point by distance $\Delta h$ to distance $\Delta R$ from distance $\Delta K$. This reduction in the rising movement of the needle bar is, of course, effected when the needle is at the right side drop for the purpose of arranging a favorable condition for the needle and the shuttle hook to come across, and the thread loop is ready to be caught by the shuttle hook. In this manner the needle is prevented from going far above the shuttle hook when the latter comes to catch the thread loop.

Thus, this present invention enables a wider zigzag stitching with high quality and smoothness.

Moreover, the present invention offers an extremely simple mechanism easy to manufacture at low cost, which is the conventional mechanism to which has been added an equal-width eccentric triangular cam 1 formed on the upper shaft bushing 9 and a fork member 2 fixed to the pin $\Delta K$ of the connecting link 6. The movement produced by said eccentric equal-width triangular cam is a simple harmonic one with a limited acceleration, and there is no increased reciprocating mass involved; accordingly, the transmission is excellent, the durability, which is most important from the industrial point of view, is assured, no noise is generated in position, and there is little wear of parts, so that an extremely long service life is guaranteed.

The present invention is also applicable to a straight stitch sewing machine; it will fully compensate for a certain error in the relative timing movement of needle and shuttle and assure an appropriate thread loop catching, thereby contributing to the undesirable elimination of the "stitch skip" phenomenon.

What we claim is:

1. In a needle-bar actuating mechanism of a sewing machine having a rotary upper shaft, said actuating mechanism including a balance crank fixedly mounted on said rotary upper shaft, a shaft mounted on said balance crank and adapted to be turned in accordance with the turning movement of said balance crank, a needle-bar crank pivotally connected at one end there-