TECHNOLOGIES OF FORMING THE DOUBLE THREAD CHAIN STITCH TYPE 401, WHERE THE LOOPER WEARS THE BOTTOM THREAD AND THEIR DEMERITS

The author of the article, Ph.D. Zarif Sharifovich Tadjibaev, Director of ZARIF Sewing Machine Co., Ltd. (www.zarif.uz), who in **1994** invented the world's first **ZARIF technology of forming the double thread chain stitch of the new type 401 using a rotary looper**, for which **US Patent No. 6095069** was issued in 2000.

Also, Ph.D. Zarif Sharifovich Tadjibaev in **2016 and 2019**, through the improvement of ZARIF double thread chain stitch technology from 1994, invented **new ZARIF double thread chain stitch technologies**, which are **the most advanced for sewing various materials and automation of sewing.**

The structure of double thread chain stitch type 401.

As know the double thread chain stitch type 401 consists of the top thread 1 (needle thread) and the bottom thread 2 (looper thread) (see **Fig.1**).

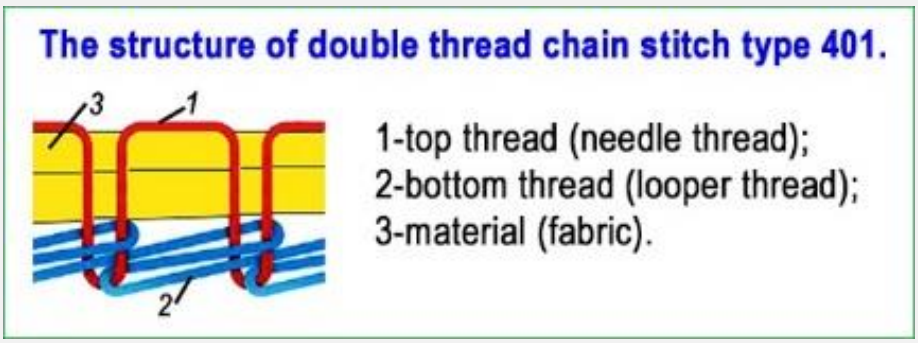

Fig.1.

To get the double thread chain stitch type 401 structure for joining material 3, need to perform the following actions on the threads 1 and 2 (see Fig.1):

1. The loop from the top thread 1 is conducted through the material 3 (in all stitch forming technology this process is carried out using a needle).
2. The loop from the top thread 1 is passed through a loop from the bottom thread 2.
3. The loop from the bottom thread 2 is passed through a loop from the top thread 1.
4. The loop from the top thread 1 is tightened to the lower surface of the material 3, and the loop from the bottom thread 2 is tightened on the body of the loop from the top thread 1.
5. Material 3 is feed to the stitch length and, all actions over the threads 1 and 2 are repeated.

The advantages of the above stages of action on the threads 1 and 2:

1. In the third stage, the loop of the bottom thread 2 can be passed through the loop of the top thread 1, by feeding the bottom thread 2 portions from a large coil, as is done in the second stage with the top thread 1.
2. When performing the fourth stage, the density of the joining of the material 3 mainly depends on the degree of tightening of the loop from the top thread 1 in the stitch, the stronger the loop from the top thread 1 is tightened, the tighter the joining of material 3 is obtained.

Advantages and demerits of double thread chain stitch type 401.

Advantages of double thread chain stitch type 401 (see Fig.1):

- Stitch type 401 compared with the stitch type 301 more stretchable under the action of the load along the stitch, due to the relatively large stock of threads in the stitch.
- Stitch type 401 has a relatively large strength under the action of large loads and cyclically (often) operating small loads directed across the stitch, because two branches of the bottom thread 2 is passed through the loop of the top thread 1.

Demerits of double thread chain stitch type 401 (see Fig.1):

- The upper and lower sides of the stitch type 401 on the surfaces of the material 3 have different appearances, since the threads 1 and 2 are interlaced on the lower surface of the material 3, on the upper surface of the material 3 one line of the top thread 1 is visible, on the lower surface of the material 3, there is a loop and one line from the bottom thread 3, a loop from the top thread 1 is visible.
- Interlacing threads 1 and 2 on the lower surface of the material 3 increases the thickness of the stitch on the lower surface of the material 3, which reduces the resistance of the stitch to wear on the lower surface of the material 3.
- The consumption of threads 1 and 2 per stitch type 401, more than stitch type 301.
- The seam from the stitch type 401 is easily unravel from the end of the seam and from the place of skipping the stitch towards the beginning of the seam, therefore, the technology of forming a double thread chain stitch type 401 should provide a reliable tacking of the end of the seam and sew without skipping a stitch.

Technologies of forming the double thread chain stitch type 401, where the looper wears the bottom thread and their demerits.

Nowadays, double thread chain stitch sewing machines use three double thread chain stitch of type 401 formation technologies, where the looper carries the bottom thread, which were invented is in the 19th century (see Fig.2):

1. With a looper making a complex spatial movement (oscillatory movements across and along the stitch).
2. With a looper making an oscillatory motion along the stitch and working together with the spreader.
3. With a looper making an oscillatory motion in the horizontal plane.

Where, 1-needle; 2-top thread; 3-looper; 4-bottom thread; 5-material; 6-needle plate; 7-spreader; 8-presser foot; t-stitch length.

Of the three technologies listed above, the formation of a double thread chain stitch type 401 is the simplest, with a looper making oscillatory motion in a horizontal plane, which was invented in **1858** by the American Inventors **W. O. Grover** and **W. E. Baker** (US Patent No. RE572E).

The principle of forming a double thread chain stitch type 401 for all three technologies, where the looper wears the bottom thread, is the same.

In the loop-overlap of the top thread formed by the needle when lifting it from the lowest position, the looper with the bottom thread enters, i.e. in the loop of the top thread enters the loop of the bottom thread (see Fig.2, a).

The looper with the bottom thread expands the top thread loop to eliminate friction between the top thread loop and the bottom thread, there is a long groove on the looper where the bottom thread moves on the looper body without friction with the top thread loop (see Fig.2, b).

The material feed to the stitch length «**t**» and the needle with the top thread makes the second puncture of the material, while the loop of the top thread is located on the looper body.

Now the loop of the top thread must enter the loop of the bottom thread, for this, a needle with the top thread must pass through the loop of the bottom thread.

To accomplish this (see Fig.2, c):

- Looper making a complex spatial movement, move to the other side of the needle and, thereby, the needle is entered into the loop of the bottom thread.

- Looper oscillating movement along the stitch in the vertical plane, the spreader engages the bottom thread and expands it across the stitch and thus provides the entrance of the needle into the loop of the bottom thread.
- Looper oscillating movement in the horizontal plane due to the arcuate shape of the looper is provided by the entrance of the needle into the loop of the bottom thread.

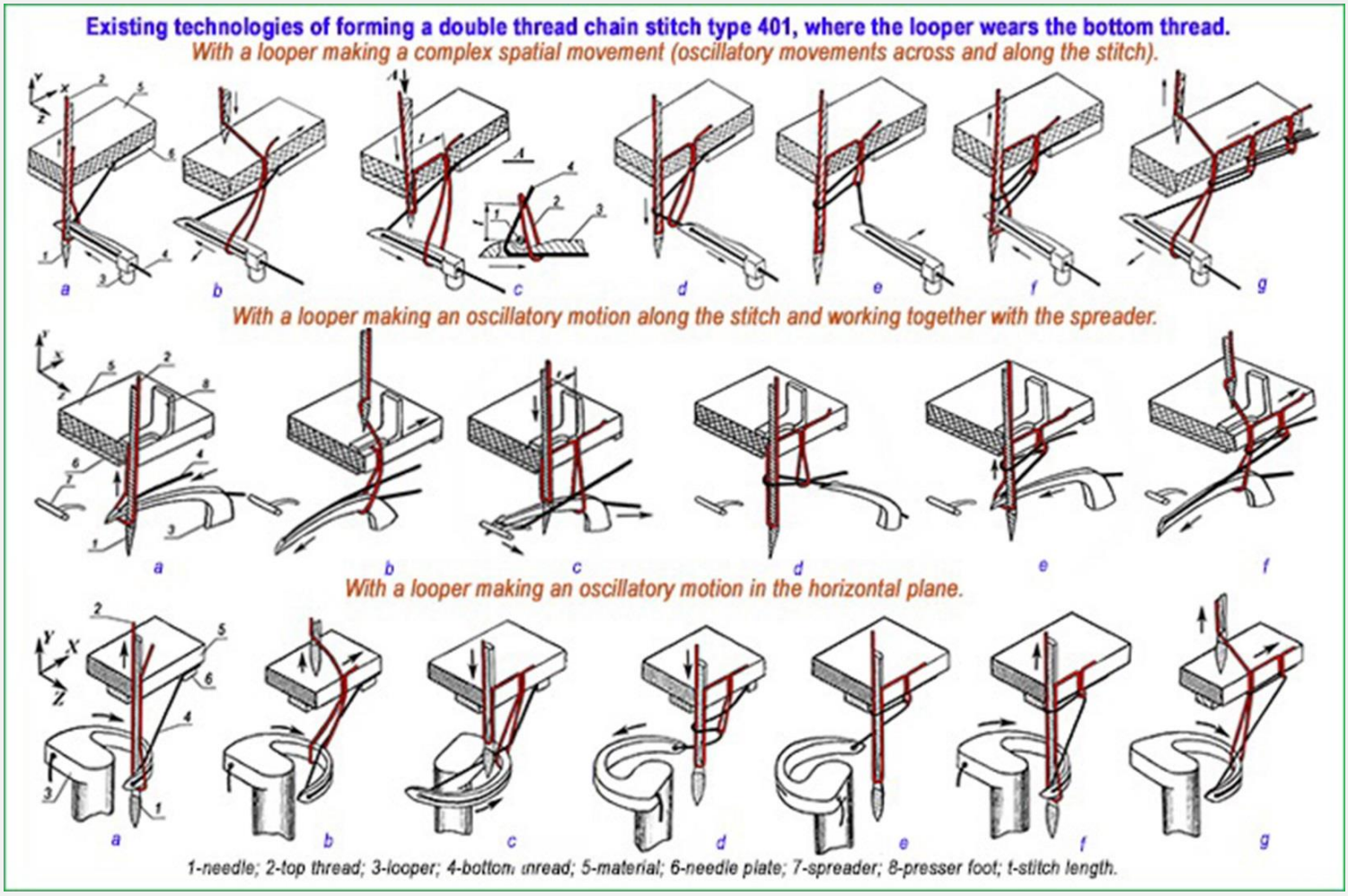

Fig.2.

After entering the needle with the top thread to inside the loop of the bottom thread, the loop of the top thread is reset from the body of the looper, which must be tightened to the bottom surface of the material, for this, two-stage tightening of the stitch threads is used (see Fig. 2, d).

In the first stage, the loop of the top thread, located in the previous stitch, is not tightened to the end, which from the branch of the bottom thread forms a loop of the bottom thread on the needle body (see Fig.2, e).

It should be noted that in the first stage, the loop of the top thread, located in the previous stitch, is not tightened to the end, so that in the second stage to provide free easy tightening of the loop of the bottom thread through the loop of the top thread.

In the first stage, the process of tightening the loop of the top thread not to the end, located in the previous stitch, is provided by the needle, while moving the needle down to its lowest position.

As you know, the total length of the top thread consumed by the needle is equal to twice the distance from the top surface of the cross-linked material to the upper edge of the needle eye when the needle is in the lowest position.

At the same time, the thread take-up lever for the top thread supplies the needle with the length of the top thread, sufficient only until the reset of the loop of the top thread from the body of the looper, as a result, the needle with further downward movement consumes the top thread from the previous stitch.

To reduce friction between the top thread and the material, when the needle continues to move down, it begins to consume the top thread from the previous stitch, a special needle with two long grooves is used.

It should be noted that the needle with two long grooves in comparison with the needle with one long groove used in lockstitch forming technologies is less resistant to longitudinal bending.

In addition, the second-long needle groove, inside which the top thread moves while tightening the loop of the top thread located in the previous stitch, reduces the friction between the top thread and the material where the needle moves down and it is technically impossible to reduce the friction between the top thread and the material in the previous needle puncture.

The friction between the material and the top thread will change dramatically during sewing combinations of different materials. For example, when sewing a textile-leather combination of materials, when switching to from textile material to textile-leather combination of materials, the friction between the top thread and the material will increase dramatically.

With such a sharp increase in friction between the top thread and the material, the needle begins to consume the top thread from the coil through the tensioner, where usually the top thread has a small tension, as a result, in the previous stitch, a large length of the loop of the top thread will not be tightened.

This long loop of the top thread, located in the previous stitch, it will be impossible to tighten to the end, even in the second stage, when there is a simultaneous tightening of the loop of the top thread and the loop of the bottom thread, during the feed of the material on the length of the stitch, due to the fact that the feed of the material and the movement of the looper with the bottom thread, which is put on the loop of the top thread occur in different directions (see Fig.2, g).

Therefore, all three technologies of forming a double thread chain stitch, where the looper wears the bottom thread and where the needle is involved in the first stage of tightening the loop of the top thread, located in the previous stitch, are not perfect technologies of forming a stitch for sewing various materials and combinations of different materials.

In addition, using the technologies of forming a double thread chain stitch, where the looper wears the bottom thread, it is impossible to obtain a dense and very dense join of materials using a double thread chain stitch type 401.

With the help of a double thread chain stitch type 401 can get a tight and very tight join of materials, if in stitch the loop of the top thread will be tightened strongly.

However, with the help of the second stage of simultaneous tightening of the loop of the top thread and the loop of the bottom thread, which occurs during the feed of the material, it is impossible to carry out a strong tightening of the loop of the top thread of the stitch.

Therefore, currently for a dense and very dense join of materials using lockstitch type 301 by lockstitch formation technologies, by adjusting the tension of the threads to ensure the interweaving of threads in the middle of the materials being sewn with a strong tightening of the stitch threads.

As mentioned above, any technologies of forming a chain stitch should work without skipping the stitch and ensure reliable tacking of the end of the chain seam, since all chain seams are easy to unravel from the place of skipping the stitch and from the end of the seam.

In these stitch-forming techniques, the skipping of the stitch occurs when the looper with the bottom thread does not enter the inside of the top thread loop (see Fig.2, a), and also when the needle with the top thread does not enter the inside of the bottom thread loop (see Fig.2, c).

To ensure the reliability of the inlet of the looper with the bottom thread inside the loop-inlet of the top thread, the gap between the looper point and the needle should be no more than **0.15 mm**, and the needle guard is used to straighten the needle when the needle is bent towards the looper.

By reducing the length of the stitch «t» decreases the reliability of the input needle with the top thread in the loop of the bottom thread, therefore, the minimum stitch length is limited to **1 mm**, that provides not very reliable tacking of the end of a chain seam by condensation of stitches with stitch length of **1 mm**.

Of all three technologies of forming a double thread chain stitch type 401, where the looper wears the bottom thread and makes a complex spatial movement, has a relatively complex looper mechanism.

For example, 1-needle, double thread chain stitch sewing machine, **Juki MH-481-4** and **MH-481-5** Series is a complex mechanism of needle looper and limiter (see Fig.3).

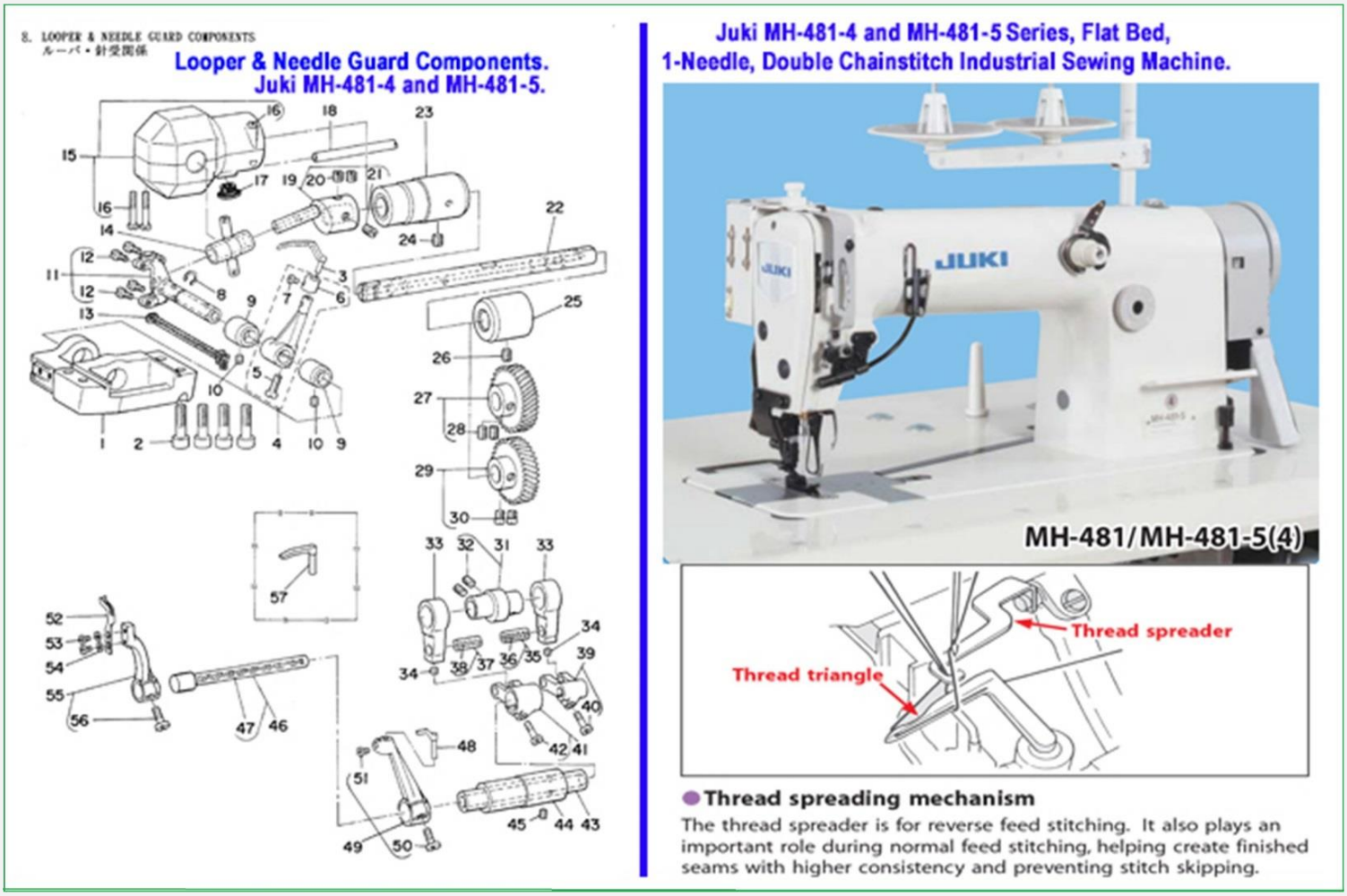

Fig.3.

These **Juki MH-481-4** and **MH-481-5** Series sewing machines are also capable of reverse sewing through the use of a thread spreader, working with a looper that performs a complex spatial movement.

It should be noted that tacking the end of the double thread chain seam with reverse sewing does not provide reliable tacking.

The most reliable tacking of the end of the chain seam from unraveling is, the condensation of stitches at the end of the chain seam, performing from **6** to **10** stitches with a stitch length of **0.5 mm**.

However, the existing technologies of forming double thread chain stitch type 401 are not capable of reducing the length of double thread chain stitch to **0.5 mm**.

All three technologies of forming a double thread chain stitch type 401, where the looper wears the bottom thread, there is a possibility of collision the needle with looper and needle guard, with a small bend of the needle when the needle moves down.

In this regard, the Company «**Groz-Beckert KG**» proposes to use a needle with an **RG-point**, which is more resistant to collisions with the looper and the needle guard, when the needle moves down (see Fig.4).

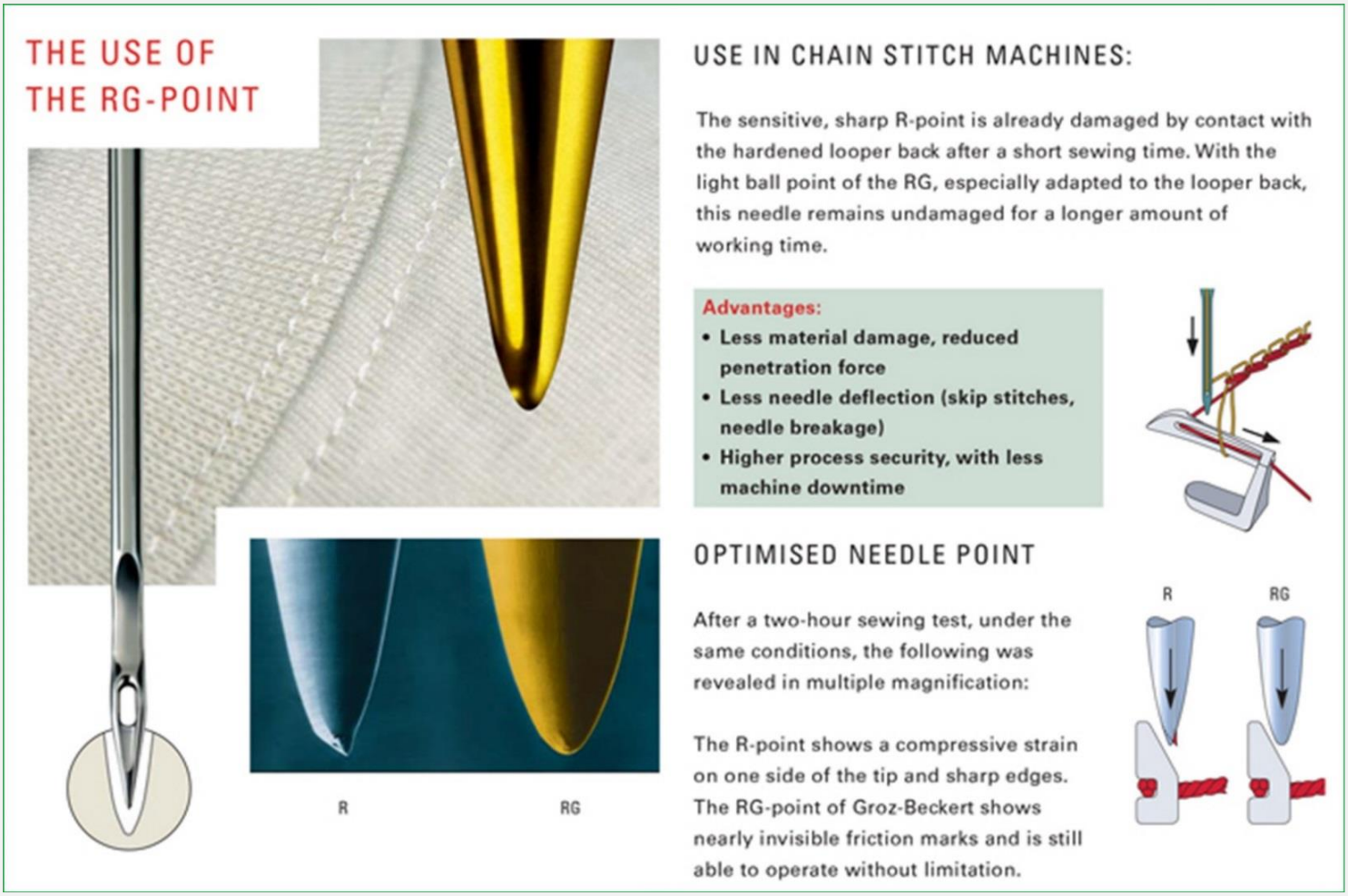

Fig.4.

Thus, the currently used technologies of forming the double thread chain stitch type 401, where the looper wears the bottom thread and which were invented in the 19th century, are not perfect technologies for sewing various materials and automation of sewing, because:

1. Sewing of various materials, can be realized, with the help of several sewing machines, with different needle bar strokes, with a small needle bar stroke for sewing light materials, and a large needle bar stroke for sewing heavy materials.

2. For sewing, a special needle with two long grooves is used, which is less resistant to longitudinal bending when sewing hard, dense materials, as well as when sewing through thick thickened seams, compared to a conventional needle having one long groove.

3. For high-quality sewing various materials, it is necessary to adjust the tension of the threads, that does not allow automatic sewing of various materials without adjusting the tension of the threads.

4. For sewing various materials, i.e. from heavy materials to ultra-light materials, needles from **No. 130** to **No. 60** are usually used, when switching to various materials, besides the correct installation of the needle into the needle bar, the looper with respect to the needle must also be adjusted, due to the maximum allowable clearance between the point of the looper and needle equal to **0.15 mm**.

5. Technologies of forming the double thread chain stitch type 401, where the looper carries the bottom thread, cannot provide a tight and very tight join of materials, which reduces the scope of the double thread chain stitch type 401.

6. Due to not tight join of materials, i.e. not strong tightening the loop of the top thread stitch, the lower side of the double thread chain stitch type 401 is thicker, which reduces the resistance of the lower side of the stitch to wear.

7. Technologies of forming the double thread chain stitch type 401, where the looper carries the bottom thread, cannot qualitatively stitching combinations of different materials, which reduces the scope of the double thread chain stitch type 401.

8. Technologies of forming the double thread chain stitch type 401, where the looper carries the bottom thread, cannot reduce the length of the stitch to **0.5 mm**, which does not allow to provide very reliable tacking of the end of a chain seam by condensation of stitches with stitch length of **0.5 mm**.

9. Technologies of forming the double thread chain stitch type 401, where the looper carries the bottom thread, cannot guarantee sewing without skipping a stitch.

10. A slight deflection of the needle, when passing the needle through thick, rigid, dense materials can cause the needle to collide with the loopr or with the needle guard, which may result in needle breakage or deformation of the needle tip, which lead to a sudden interruption of the sewing process automatic mode in automatic sewing systems.