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The Balloon Builder's Sewing Machine: Part III

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This is the last in a series of articles on sewing machines. In these snippets, we discuss theory, troubleshooting, adjustment and repair.

This is the third in a series of issues featuring the acquisition and use of a sewing machine for balloon construction. In this issue we feature segments on the theory, diagnosis of problems, adjustment, and repair of common problems for the Singer 112-type of sewing machine.

This issue is divided into sub-articles which I have called *Segments*. Each of these Segments is complete in its own, but may reference another segment to eliminate duplication.

Segment 1: Theory of Operation

This segment will examine sewing machine operation. An understanding of operation will make it easier for a builder to care for a sewing machine and to ensure continued smooth and proper operation. This understanding will also allow diagnosing, and in some cases, repairing a machine thus preventing expensive and sometimes long drives to a commercial machine repair shop.

Sewing Machine Functions

Let's begin by summarizing the operations of a commercial straight locking stitch sewing machine. In fact, our machine performs two basic functions.

1. The fabric is advanced between stitches. This is the operation, which creates the evenly spaced stitches. A feed dog, a serrated foot that compresses the fabric against the presser foot, typically performs this function. It moves the fabric backwards a fixed distance. That distance represents the stitch length.
2. The top and bottom threads are locked together, which makes the stitch. The needle perforates the fabric carrying the upper thread with it. A device, called a hook, passes the needle thread around the bobbin. This creates a half-knot in the top and bottom threads. Pulling this half-knot tight creates a stitch.

In a nutshell, those are the two functions a sewing machine performs. All the weight, the mechanism, the adjustments; all those things, simply go to support those two functions.

So that these operations can be better understood I have included the photos on page 3. These photos show the sequence of events, which occur, in the bottom of the sewing machine. This area, which is generally hidden from our view, contains the least understood operations performed in sewing.

We are looking at a double needle sewing machine from the rear quarter. You can see the *presser foot* with the two needles beyond it. Only the closest needle has been threaded. The *bobbin* is in the near *bobbin case*. Of course, the covers have been removed so we can see the operation. A narrow tape is fed through the machine in our example. We can see the top and bottom thread ends coming out the back of the machine toward the reader

In the first photo, upper left, the needle is penetrating the fabric. It carries with it the upper thread. That thread fits in a long vertical slot on the inside edge of the needle. The bobbin is the dark round object, in front of the pencil point.

We can see the bobbin thread running from the bobbin to beneath the needle. The *hook* is the metal assembly around the bobbin. The tip of the pencil points at the point of the hook. This sharp hook point is spinning clockwise around this bobbin. It makes two rotations for every stitch.

In the second photo, upper right, the needle has reached the bottom of its stroke and has started up. As it does so a thread loop is created next to the eye of the needle (look at the pencil point). The loop is formed because the thread is flexible and cannot slide back up with the needle.

At the proper time, the sharp point of the hook enters this loop. You can see this happening at the tip of the pencil. The hook passes very closely to the needle. Many needles have a *scarf*, a cutout above the needle eye, which gives clearance for the hook passing by it.

Remember why the scarf faces the hook and bobbin and you'll always know how to replace needles in this type of sewing machine.

In the third photo, bottom left, the needle is on its way up. The hook continues to rotate carrying with it the needle thread. In this photo you can see the needle thread passing around the bobbin case.

The *thread take-up arm* is dropping which gives up the thread for the passage around the bobbin case. The thread take-up arm is the bar on the front-top of the sewing machine that goes up and down. It goes down to make the thread available to pass around the bobbin case. It goes back up to take up this thread and to pull the stitch tight.

In the final photo, lower right, the needle is still up. The needle thread has passed completely around the bobbin. The thread take-up arm is now going up; to take up the length of thread required to pass around the bobbin case and to tighten up the knot (stitch).

If you look carefully, you can see the hook point passing under the needle, making its second rotation. But this time it doesn't pick up thread.

The 'J' shaped bar above the bobbin is called a *case opener*. You often find this on a commercial sewing machine but not on a home machine. Its function is to 'rattle' the bobbin case so the needle thread passing around the bobbin doesn't get caught.

Let's review some of the things we've learned.

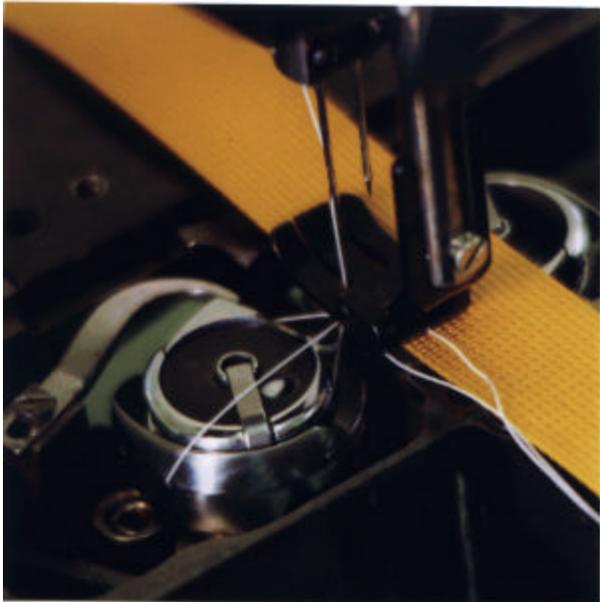
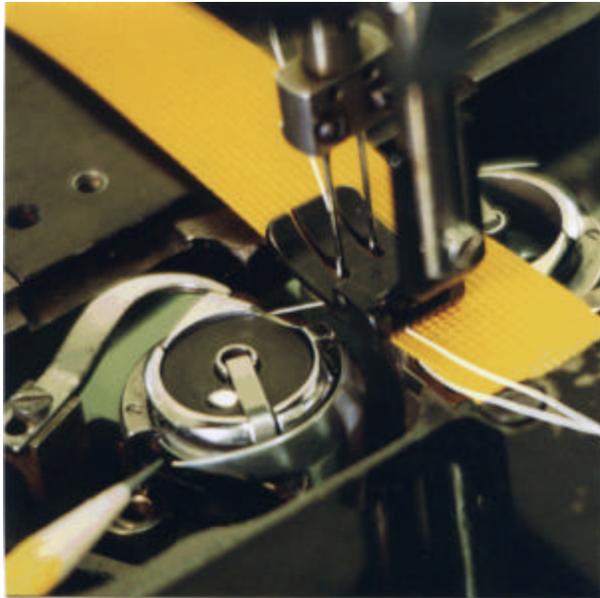
1. The needle has a long vertical slot. When a new needle is properly installed, that slot will face away from the bobbin. By the same token, a needle has a scarf above the needle eye for hook clearance. That scarf must face the bobbin. Understand this and you will always insert fresh needles properly.

2. Each time a stitch is made, six to eight inches of thread pass back and forth through the eye of the needle as the upper thread passes around the bobbin. Good thread and needles are important for consistent operation. Poor thread cannot take the repeated passages without fraying. Poor needles, with burrs or rough finishing will contribute to fraying.

3. On most single needle sewing operations, fraying is an inconvenience. But on a double needle machine it can be most frustrating as you have twice as many opportunities to fray. If fraying occurs while sewing on a circumferential tape with thirty feet of fabric rolled under the sewing machine arm, it can be very frustrating.

4. The real action takes place below the needle plate. Above the needle plate we have the tension assemblies and the thread take-up arm. The thread take-up arm performs two functions. It drops to make the thread available to pass around the bobbin. It also pulls the stitch tight. The tension assemblies provide the tension, which provides for consistent stitching. The tension is nothing more than two disks which are pressed together by a spring. The thread is run between the disks, which result in a drag on the thread.

5. The stitch length is set by the distance of feed dog movement. On simple machines, the fabric advance occurs while the needle is above the fabric. The Singer 112, shown in our example, is a needle feed machine. This means the fabric is moved while the needles penetrate it. The needle bar actually moves with the feed dog to move the fabric.



Segment 2: When Things go Wrong

The sewing machine has been sewing fine. Then you discover that the stitches aren't what they should be. Perhaps stitches are being skipped or the stitches aren't being pulled tight. Here is a general sequence of actions to take to fix the problem.

1. First check the thread path. Look for upper thread with an impeded path to the tension assembly. For example, it's common for a thread to get caught on part of the presser foot lifting assembly on the back of some sewing machines.

2. If all looks well, rethread the sewing machine. Remove the bobbins, make certain they aren't overfilled. An overfilled bobbin can rub against the bobbin case adding significant extra tension to the stitch action. Once the bobbins are installed, pull each loose thread end to check for proper tension.

'No tension' probably means the lower tension is not properly engaged. Slipping the loose thread end over the triangular tab next to the case opener helps ensure proper tension engagement. Heavy tension needs to be corrected using a screwdriver. See your manual for details. (A Singer 112W140 manual is found in the *Extras* folder on the CD.)

Rethread the upper threads. Make certain the thread path is properly followed. Refer to the manual if there is any uncertainty.

3. If things haven't improved, **replace the needles**. Make certain you are using the correct needle in the correct size. As we saw above, great precision is demanded between the placement of the needle eye and the hook assembly. A bent or dull needle is a common cause for skipped stitches. Needles are cheap and should be replaced no less than every 7 to 10 bobbin sets.

4. **If the problem is fraying, new needles may solve it.** But if it remains a problem, exchange your thread cones. Replace the thread on the fraying side with another cone. Sometimes full cones are less apt to fray. A problem cone of thread should be used for winding bobbins.

5. **Clean the sewing machine.** Disassemble the upper tensions and clean them out. If the tension disks are scored from the thread, replace them. As an interim fix, exchange them between tension posts.

Remove the bobbin cover plates and blow out the debris with a can of compressed air, purchased from the computer goods section of a large department store.

6. **Check the timing.** Open up the bobbin covers. Grab the thread ends, pull them out towards you and rotate the balance wheel to make a stitch. Look for the following things.

-As the hooks rotate in opposite directions, the hook points should be at the same point. For example both hooks should pass at the bottom (the six o'clock position) at about the same time. In like manner, when the left hook point is at 8 o'clock, the right hook should be at 4 o'clock.

-As the point of each hook passes by the needle, the needle should be heading up, about 1/8th of an inch up from the bottom of its stroke.

-As the hook continues on around, you should see the thread passing around the bobbin case.

-Look at the hook. The point should be sharp. If it has a burr, this might be gently stoned smooth with a fine sharpening stone or diamond hone. There may be some evidence of needle strikes, small pits in the hook surface. If these affect thread pickup, they should be polished out.

It is not uncommon for the hook and needle on a machine to get 'out of time'. This can cause skipping of stitches. If this appears to be a problem, study the section on timing.

Segment 3: Retiming the Hooks on the Singer 112 Sewing Machine

Timing refers to the movement of various sewing machine parts in relationship to each other. On the Singer 112 machine there are two basic groups of machinery. An upper horizontal shaft, with the balance wheel on one end, operates the needle bar and the thread take-up arm. The lower horizontal shaft operates the hook assemblies, the feed dog and the feed eccentric, which provides the needle bar front-to-back motion. The two horizontal shafts are kept in proper harmony with a timing belt.

A common cause of missed stitches is the loss of timing between the needle bar and hook assembly. Two right angle helical gears drive the hook assembly. Two screws keep each gear in proper position. A thread jam or other sudden stop can cause a hook to slip on its gear, putting the machine 'out of time.'

Putting a machine back in time involves the following operations:

First, check to see if your machine is in time:

1. Set the feed advance so no fabric advance occurs. After removing thread and bobbins, press and hold the stitch length adjustment button. Rotate the balance wheel so the stitch length gets smaller and smaller (8 to 12, to 20 to 30...). Once you get beyond the 30's it will stop. If fabric is placed under the presser foot, there will be no advance of the fabric.

2. Remove the feed dog plate. This is the plate immediately below the presser foot. Raise the presser foot. Remove the front screw on the plate and loosen the back screw. Lift off the plate. This plate captures two tabs, one on each bobbin case. These tabs keep the bobbin cases from rotating. Note the position of the tabs. They have to be reset, as this plate is re-mounted, later.

3. Make certain you have perfect needles in the machine. If there's any question of this, install new needles.

4. If you want a better view, you can remove the presser foot, but this is optional.

5. Locate the timing mark. Rotate the balance wheel until the needle is at the bottom of its stroke. Now look up the front of the needle bar where it enters the casting, the main part of the upper sewing machine arm. You should see a scribed timing mark across the front of the needle bar, approximately 3/32 of an inch down the shaft.

6. Rotate to the timing mark. Continue to rotate the balance wheel so the needle reaches the bottom of its stroke and comes back up until the timing mark just disappears up into the sewing machine. This is the critical point, the position at which all following operations are performed. Always make certain the needle bar is at this point for the following.

7. Examine the hook-needle timing. The point of the hook should be crossing over the center of the diameter of the needle, on each needle. As the hook passes, it should be about 1/16 of an inch above the upper end of the eye in the needle. Here are a few additional considerations:

7a. If your machine is worn, there may be some 'play' in the gears. Rock the hook assembly back and forth. If it moves slightly, the gears are worn and you have some play. Take out the play in the counter-clockwise direction for the left hook and the clockwise direction for the right hook.

7b. Typically, only one hook assembly goes 'out-of-time.' If only one side is stitching poorly, you can often use the good side for a timing mark. Set the point of the hook at the center of the needle diameter on the good needle. You may find that the position on the other hook is 'off.'

7c. If your machine has no timing mark: The needle rise from the bottom is .080 inches. This distance up is where the timing mark is placed. (For you techy types.)

If the machine is out of time correct it this way:

8. Lean the sewing machine head back so you can examine the bottom. Locate the two pair of helical gears under the hook assemblies. Each gear has two screws, which lock it to its shaft.

9. Your task is to loosen the two screws on the gear on the vertical shaft, which is the hook assembly shaft. Then rotate the hook until timing is correct and tighten up both the screws, nice and tight. This fixes the timing problem. Here are some considerations:

9a. The fit of the gear bore to the hook shaft is very precise. Even with the screws loosened you may find rotating the hook takes some force. My technique is to grab one hook assembly, while I rotate the other.

9b. Use a precisely fitting screwdriver. I prefer a 'T' handle driver with magnetic holder that takes hardened tips. One of these with a number of tips can be purchased for few dollars at an auto or hardware store. Choose a tip, which fits tightly into the screw. If necessary, grind or stone a tip to get good, tight fit.

9c. There is an alternative gear adjustment sometimes seen. (Don't try this method your first time out.) The gear on the horizontal shaft can be tapped sideways to adjust the timing. But if moved too far to the side, the gear engagement is reduced, which will result in excessive noise and wear. One of the screws on the horizontal shaft rides in a slot cut into the shaft. So, if you choose to adjust the timing in this manner, slide the gear sideways, don't rotate this gear on its shaft.

10. Reassemble. After the timing is corrected and the screws are made tight replace the feed dog plate. Set the plate back into position. Rotate the bobbin cases so each tab is placed back into its notch on the bottom of the plate. When properly placed, each bobbin case should rattle a bit in its locked position. Replace the front screw in the plate and tighten the back screw. Caution: If you fail to put the bobbin case tabs into their slots, you can bend them as you tighten down the feed dog plate.

11. Reset the feed length, thread the machine and try it out.

Once you have attempted to adjust the timing, it is a simple process. I can do it in less time than it takes to read the 11 steps above. In a nutshell the steps are, set stitch length to zero, set needle bar to timing mark, adjust hook to needle placement. The preceding steps are intended for someone who has never attempted the process before. Thus additional details are given.

A note about sewing machine wear: These instructions all work great, on paper. If you read these, and your sewing machine manual, adjustments are all 'cut and dried.' In real life it might not be this

simple. On a brand new machine it might be simple, but on a 50 year old sewing machine it might take some fiddling around to get things right. After thousands of hours of wear, your particular machine may take several tries at adjustment before it runs the way you want it. Don't give up; just keep trying.

Segment 4: Replacing the Timing Belt

This discussion is intended for readers facing a sewing machine timing belt about to break. If you have a rubber belt, it is cracked or otherwise deteriorated. The fabric belt will have broken strands or perhaps bent or fractured metal reinforcements.

You have checked the condition of your belt, haven't you? If not, the procedure is simple:

As this is being written, a timing belt costs about \$30. The installation costs about \$200. Two types of belts are available. The classic fabric belt is made from what appears to be string held together with metal staples. These staples, called metal reinforcements, fit the slots in the timing pulleys. These belts are reliable but tend to be noisier than rubber belts.

The rubber belt looks like the timing belt in a car. It has cogs, which ride in the timing pulley slots. Rubber belts are quieter than the fabric belts, but may be more susceptible to deterioration from oil. Expect a life of about 10 years for a rubber belt.

To check your belt, slide open the cover on top of the sewing machine, next to the balance wheel. Rotate the balance wheel to make the entire circumference of the belt available for visual inspection. Look for cracked rubber on the rubber belt or bent staples and broken strands on the fabric belt.

The procedure for replacement is as follows: To summarize; it involves removing the balance wheel and the bearing assembly on the shaft under the balance wheel. The timing belt can then be slid off the pulleys and pulled out around the upper shaft. A new belt is slipped back on with the top and bottom shafts in proper alignment. Then the parts are reassembled.

1. Preparation. Unthread the machine. Set the feed length to 'zero' feed as noted above in the timing instructions.

2. Belt Cover Remove the timing belt cover from the top of the machine.

3. Remove Spring Clip. There is a spring ring clip, which runs around the right side of the upper timing belt pulley. This spring clip keeps the timing belt in place. Rotate the balance wheel until the split in this clip is visible at the top of the machine. Insert a wide, flat blade screwdriver into the split. Twist the screwdriver to snap the ring off the pulley. Let it remain around the shaft.

4. Loosen the ball bearing inner race. To the right of the upper timing belt pulley is the main bearing assembly. Rotate the balance wheel to make visible each of the two screws, which lock the inner bearing race to the shaft. Loosen each screw with a properly fitting screwdriver.

5. Check the alignment before removing the belt: Lean the sewing machine back against its post, if you have one, or support it in a leaning back position. To the left of the bottom timing belt pulley is the lower bearing boss. On the left side of this bearing assembly is a metal plate with an arrow pointing to the right.

Rotate the balance wheel until this arrow is lined up with another arrow, a timing mark, on the lower shaft. When these two arrows are aligned, the thread take-up arm on the top front of the sewing machine should be at its highest point. Rock the balance wheel to determine whether the take-up arm has just arrived at the top, or is beginning to drop. Make a note of this position because the belt can sometimes appear to be properly installed in either of two positions.

6. Remove the balance wheel. This is the most difficult part of the whole process. Take your time and think it out. If the motor drive belt has not already been removed, do so now. Rotate the balance wheel. A setscrew next to the belt groove tightens the balance wheel to the shaft. Loosen this setscrew.

Pull off the balance wheel. This may be easier said than done. The balance wheel is aluminum, and may be tightly fitted to the shaft because of galling. A wheel puller, preferably with three legs can help. Be careful not to bend the balance wheel. A light break-free type lubricant may be helpful. Apply the lubricant and give it several hours to work.

Don't pound on the shaft or you could do damage to the other end of the shaft assembly. Remove the balance wheel.

7. Remove burrs on the shaft end to ease removal of the bearing. Check the shaft, especially the area under the balance wheel. Remove any burrs with light filing. Polish, if necessary, with 320-grit silicon carbide (wet or dry) paper.

8. Loosen bearing retention set screw. The bearing outer race is held in place with a setscrew, which can be reached from the back of the sewing machine. Loosen this setscrew.

9. Remove the bearing assembly. This is a flanged ball bearing assembly. Slide it off the shaft. Once the bearing unit is removed, be careful about the free end of the shaft. It has no support. Be careful not to bend the shaft or damage the suspension at the needle bar end of the shaft.

10. Ease off belt. At this point, the timing belt can be eased off the top and bottom pulleys. The easiest way to do this is to slide it sideways on the top pulley. Then do the same on the bottom. Repeat this process until the belt slips off. Rotating the shaft a part of a turn can help with belt removal.

11. Remove the old timing belt: Pull the belt out around the upper shaft and through the upper bearing hole.

12. Install the new belt. This is the reverse of the previous step. Slip the belt through the bearing hole and over the shaft. If the new belt is fabric with metal reinforcements, be careful about bending the metal reinforcements.

13. Slip the belt back on the timing pulleys. Line up the two arrows on the bottom pulley. Rotate the top shaft so the take-up arm is in its top position, as noted in step 5, above. You may find that either of two slot pulley positions will make the belt appear in time. Put the belt in what appears to be the best position.

14. Check for proper belt placement. Rotate the shaft until the needles go to the bottom and start back up, as though you were timing the hooks, as explained earlier. Look at the hook positions. They should be near the needles. If they are more than 20° of rotation off, your timing belt is in the wrong slot. Slide the belt off the lower pulley. Rotate the pulley one slot and re-install. When the installation is correct, the needle to hook timing should be very close. Don't move on to the next step until you have gotten the belt setting correct.

15. Complete belt installation. Make certain the belt is fully on both pulleys.

16. Reinstall the bearing assembly. Slip the bearing back over the shaft. Press it fully into place. Tighten the screw on the back of the sewing machine, which keeps the outer bearing race in place. Tighten the two screws on the inner race, which lock it to the shaft.

17. Re-install the locking ring. Here is a little trick. Find the round hole below the bearing race. Rotate the split ring until the split in the ring comes to the top. Pick up the lock ring with needle nose pliers. Hold the split in place over the top of the timing belt pulley with your hand. Slip a large, flat blade screwdriver through that round hole. Pry up on the handle, using the hole as a fulcrum while catching the bottom of the ring with the tip of the screwdriver. The ring will slide off the screwdriver as it snaps into place.

18. Re-install the cover on the top of the sewing machine.

19. Retime the hooks as explained earlier.

Segment 5: Checking the timing belt for proper installation.

Here is a simple test for proper timing belt installation. This test assumes your sewing machine is in time.

Open the bobbin plates. Grab the top threads and hold them out towards you. Slowly rotate the balance wheel. Watch as the top threads are picked up and pass around the bobbin case. Look for the following things:

Watch the position of the needle take-up arm as the thread passes around the bobbin case. The take-up arm should drop as the thread is pulled around the bobbin case. This action releases the thread length to allow the thread to go around the bobbin case. Watch to see when the thread take-up arm starts back up. It must not start back up until the thread has passed across the center of the bobbin case (9 o'clock for the left thread, 3 o'clock for the right thread).

The concern is this: If the thread take-up arm, starts pulling back up the thread before it is passed by the center of the bobbin, the only place for the thread to come from is the thread cone. Pulling thread off

the cone, at this point in the stitch cycle, results in too much thread being available for the take-up arm to pull the stitch tight. This results in loose stitches and inconsistent stitch construction.

This is not the way the machine is designed to operate. The thread take-up arm should pull up on the thread, taking thread from the cone or spool only when it has reached the top of its stroke. If thread comes off the cone at any other time, you should check out timing belt installation and check spring adjustment.

This problem is not uncommon. The sewing machine can operate acceptably in a shop, but produce unacceptable seams over a large project like a balloon. The instructions for belt replacement, as contained in the Singer manual, are fairly brief. Unless you frequent a repair shop with a really sharp repairperson you may run into someone who does it 'by the book' without regard for the subtleties which make for good operation.

Replacing or adjusting a timing belt according to the Singer manual, alone, does not insure proper operation.

If you suspect your timing belt may be off, do the following:

1. Confirm the needle to hook timing as explained earlier. Simply put, with the stitch length set to zero, the hook point should pass by the needle as the needle bar timing mark enters the head.
2. Readjust this timing if needed.
3. Repeat the test above to confirm the thread take-up arm is starting up at an improper time.
4. If the belt time appears to be off, perform the steps, which describe the belt replacement process, except for the actual removal of the belt.
5. Step 14 of the belt replacement sequence must be disregarded. Once the belt is changed by one slot, the hook to needle timing will be off by about 30° of rotation.
6. Retime the hooks.

If everything has been performed correctly, the needle bar will stop its descent and then start up as the thread traveling around the hook assembly is released.

Segment 6: Check Spring Adjustment

After the upper threads pass through the tensions, they pass over the check spring. This spring typically rests at the 8 to 9 o'clock position. Under tension, it rotates clockwise up to about 45°. The check spring has one basic function; to prevent the needle from penetrating its own thread during needle descent. But a spring, which is improperly adjusted, can affect the stitch quality by releasing thread from the cones at the wrong time during the stitch cycle.

Here is a basic review of check spring operation. Rotate the balance wheel so that the needles are descending. As the needles descend the check spring will tighten up, putting light tension on the thread. The check spring should return to its rest position as the needles touch the fabric. By keeping the thread under tension, it cannot inadvertently be punctured by the needle.

Adjustments on the machine allow the check spring tension and angle of swing to be adjusted.

The spring tension should not be so high that spring operation pulls thread from the cones. On the other hand tension should be increased if there is a tendency for the needles to penetrate their own threads.

The check spring angle of swing should not be constrained to the point that it releases thread from the cones.

In Closing

With an understanding of the preceding points you can keep your sewing machine working properly, even if you are far removed from a competent repair center.