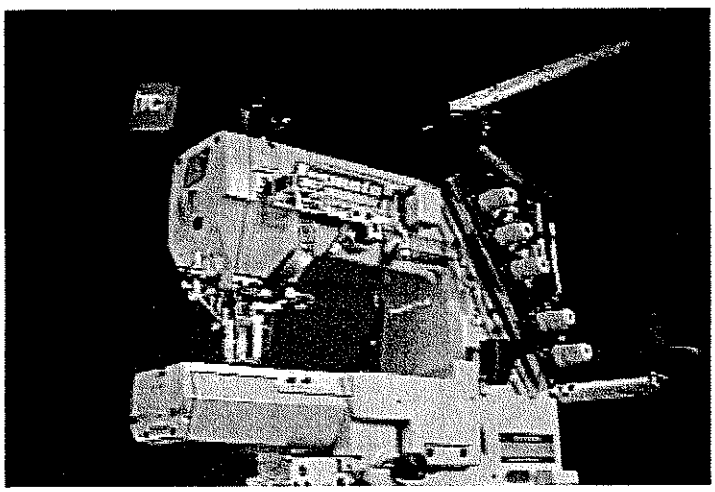
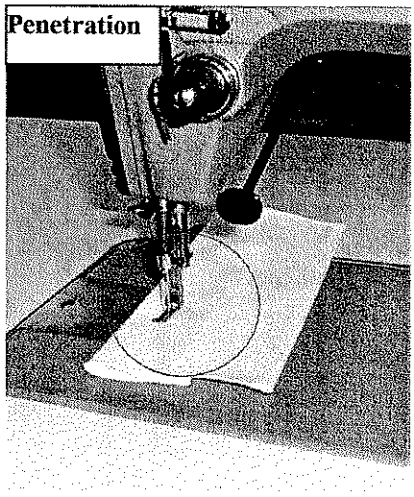
THE FUNDAMENTALS OF STITCH FORMATION

A sewing machine is a mechanical unit containing a system of predetermined and coordinated motions of thread handling and material feeding mechanisms designed to sew, mend, or fasten together two or more plies of material, or to ornament a fabric with a pattern of stitching. The value of the sewing machine is determined by the quality of the stitching produced.

Each stitch is a single unit in a series of thread arrangements continuously passed through the material and locked or inter-looped at uniformly spaced intervals. To accomplish this stitching process, each machine must have its own needle system, loop taking device, material feeding device, thread handling devices, and presser foot. These are coordinated through a myriad of mechanical devices designed to transmit motion to the various thread and material handling components of the sewing machine.

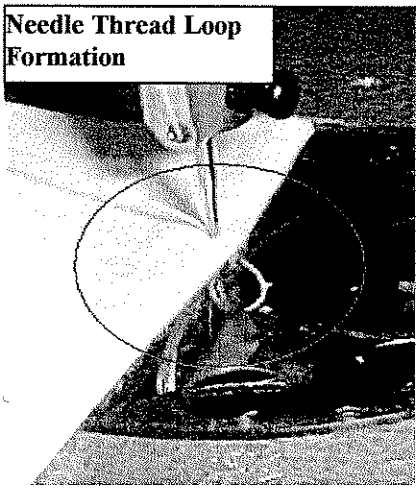


FUNDAMENTALS OF STITCH FORMATION

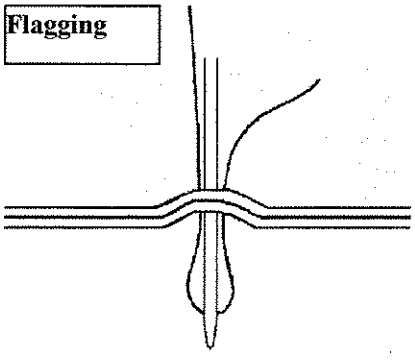


The **first step** in the formation of all stitches is called penetration. This occurs when the needle passes the needle thread through the material. Correct needle and thread selection is of great importance in determining the quality of the stitch.

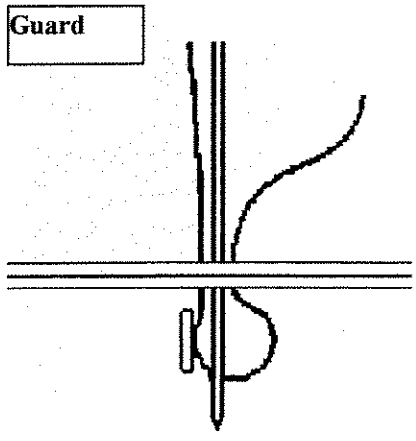
The **second step** in the production of all machine made stitches is the formation of the needle **thread loop**. This step is always the same for every type of stitch, regardless of the nature of the machine used. Correct formation is dependent upon the tendency of the thread to bulge away from the needle blade when the needle begins to rise, after reaching the lowest point of the downward stroke. **Inertia** and **friction** upon the needle thread cause it to loop. This loop must be under control insuring the entrance of the lower stitch-forming device.



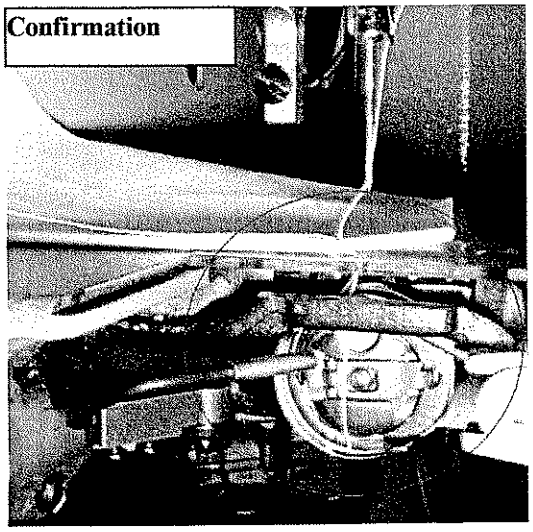
Any interference with the formation of the needle thread loop will result in faulty stitch formation. One of the most common disorders arises, when material being stitched is not firmly held down by the presser foot at the point where the needle passes through the material. As a result, the material **"flags"** or moves upward when the needle rises. Either no loop is formed at all or the loop forms too late. **Skipped** or **broken** stitches are the result.



Since the thread naturally tends to form an equal loop on each side of the needle, some form of a guard is often used to push the loop through to the side of the needle from which the thread is taken by the lower stitch forming mechanism. Correct setting of this guard is necessary for ideal loop formation.

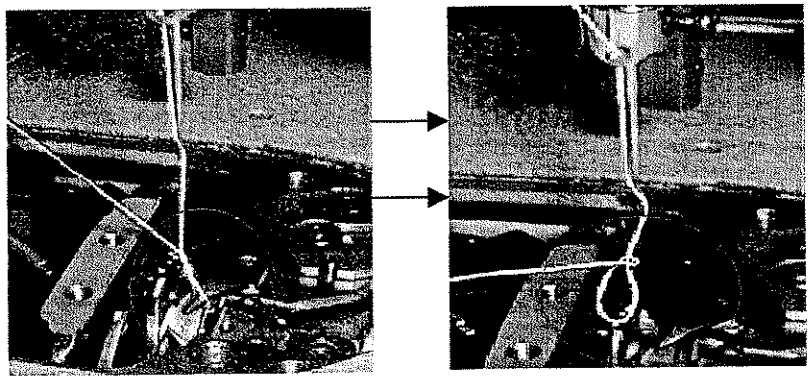


Correct setting of the needle is necessary for normal loop formation. At correct height, with eye of needle at 90° to the direction from which the point of the lower stitch-forming device enters the loop.



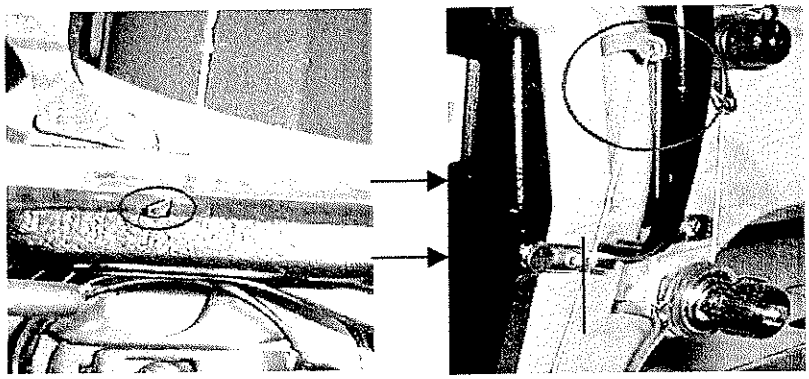
The **third step** for correct stitch formation is **confirmation**. This refers to the arrangement of threads above and below the material being stitched. It is here that the differences between the many patterns and styles of stitches originate. Each type of stitch has its own specific features of form and utility. These differences are accomplished by variations in design, position, and movement of thread handling instruments, such as take-ups, tensions, loopers, spreaders, shuttles and hooks.

Cast-off



The **fourth step** in stitch formation is known as **cast – off.** This occurs when the needle thread loop, after it has enclosed the lower thread (or its own previous loop of thread), is free from the lower stitch forming mechanism.

Setting the Stitch



The **fifth step,** threads are drawn upwards and tightened, fastening the stitch in the material, and the last step, setting the stitch, is complete as the next stitch begins.

ASTM Standard D 6193

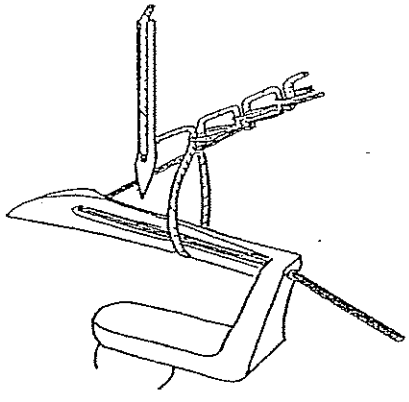
In order to provide a series of standards for all of the various stitches and seams, definitions and classifications are employed in the manufacture of sewn articles. These definitions are known as ASTM **D6193** and have been prepared by the **American Society for Testing and Materials Organization**. Originally, these standards were developed by the **Federal Government Board of Standards** and referred to as Federal Standard Catalog 751. Since the Government no longer supports 751, ASTM has assumed responsibilities for these Standards. You may purchase the Standard from:

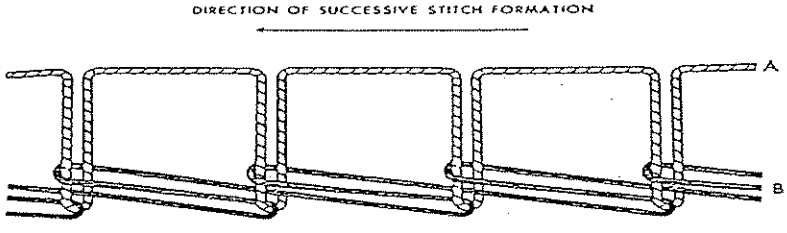
ASTM
100 Barr Harbor Drive
P.O. Box C100
West Conshohocken, PA 19428-2959
PH (610) 862-9585
www.astm.org

These specifications divide stitches and seams into standard classes. They have since proved to be such a convenient method of referring to many different stitches and seams, by identifying them precisely, they are know in general usage throughout the sewn products industry.

To aid the understanding of their formation and to simplify identification, the most commonly used Stitch Types are illustrated in this Standard by large-scale diagrams. Stitches are divided into seven general classes numbered 100 – 600. Stitch types within each class are assigned numbers in sequence (for example 501, 502, 503, etc.).

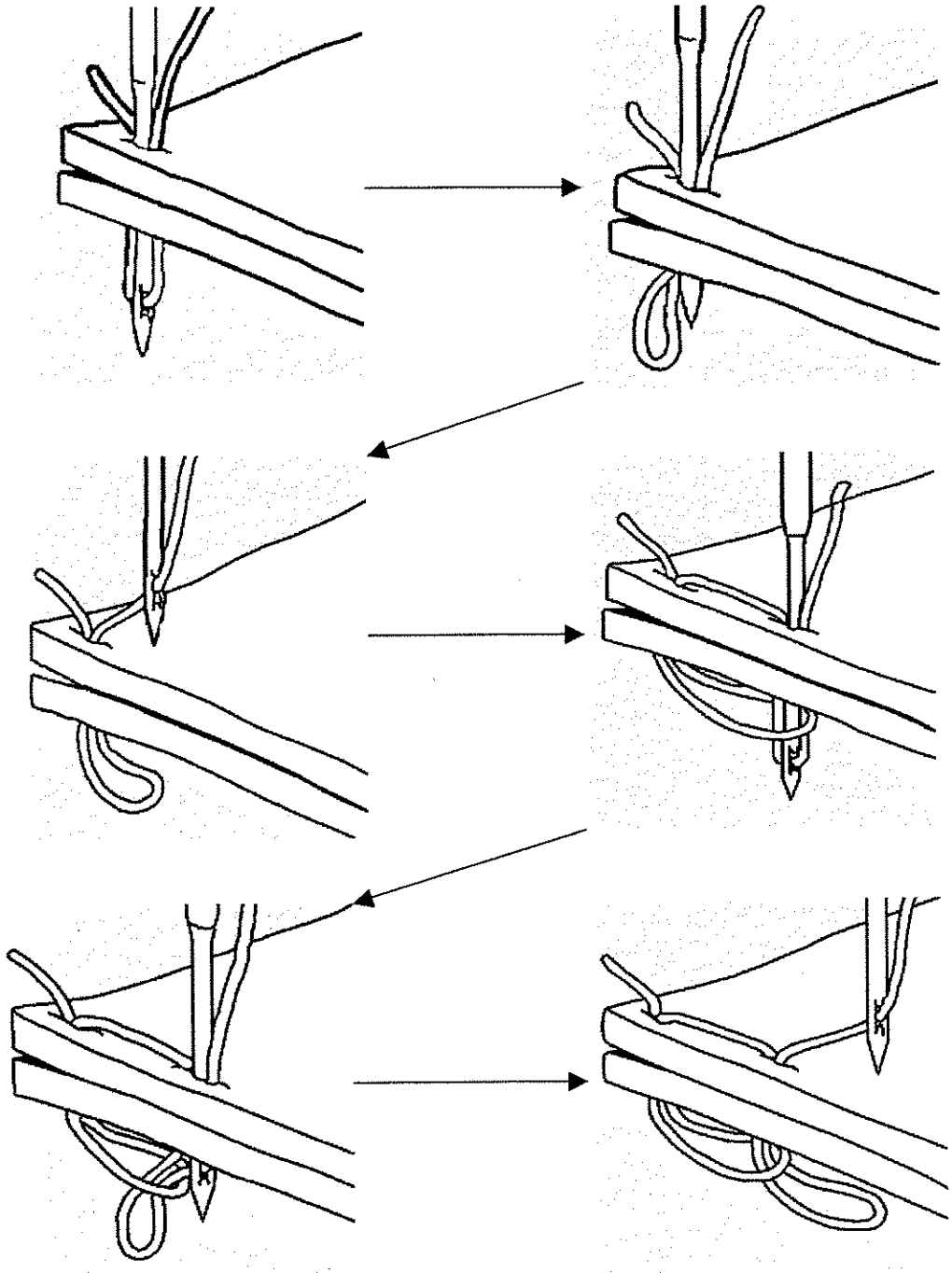
When viewing stitch diagrams, it should be noted that more than one stitch type is delineated in each diagram. In most cases a full comprehension of the manner in which each stitch is formed can more easily be grasped when the preceding and succeeding are also viewed. Also note that, with the exception of Stitch Type 201, the direction of stitch formation is always from right to left. Unless this fact is appreciated, confusion instead of understanding may result.





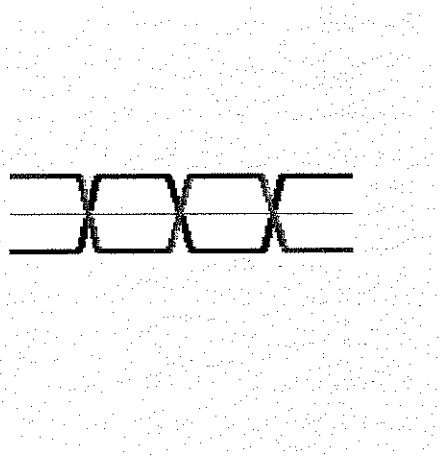
Formation of the Single Thread Chainstitch 101

Single thread chainstitch is used for joining together two or more plies of material wherever elasticity or easy raveling is desirable (basting). It is formed by a single thread carried by the needle, its loop being drawn ahead (usually beneath the material) from stitch to stitch, so that successive loops pass through each other to form a chain.



Formation of the Handstitch 201

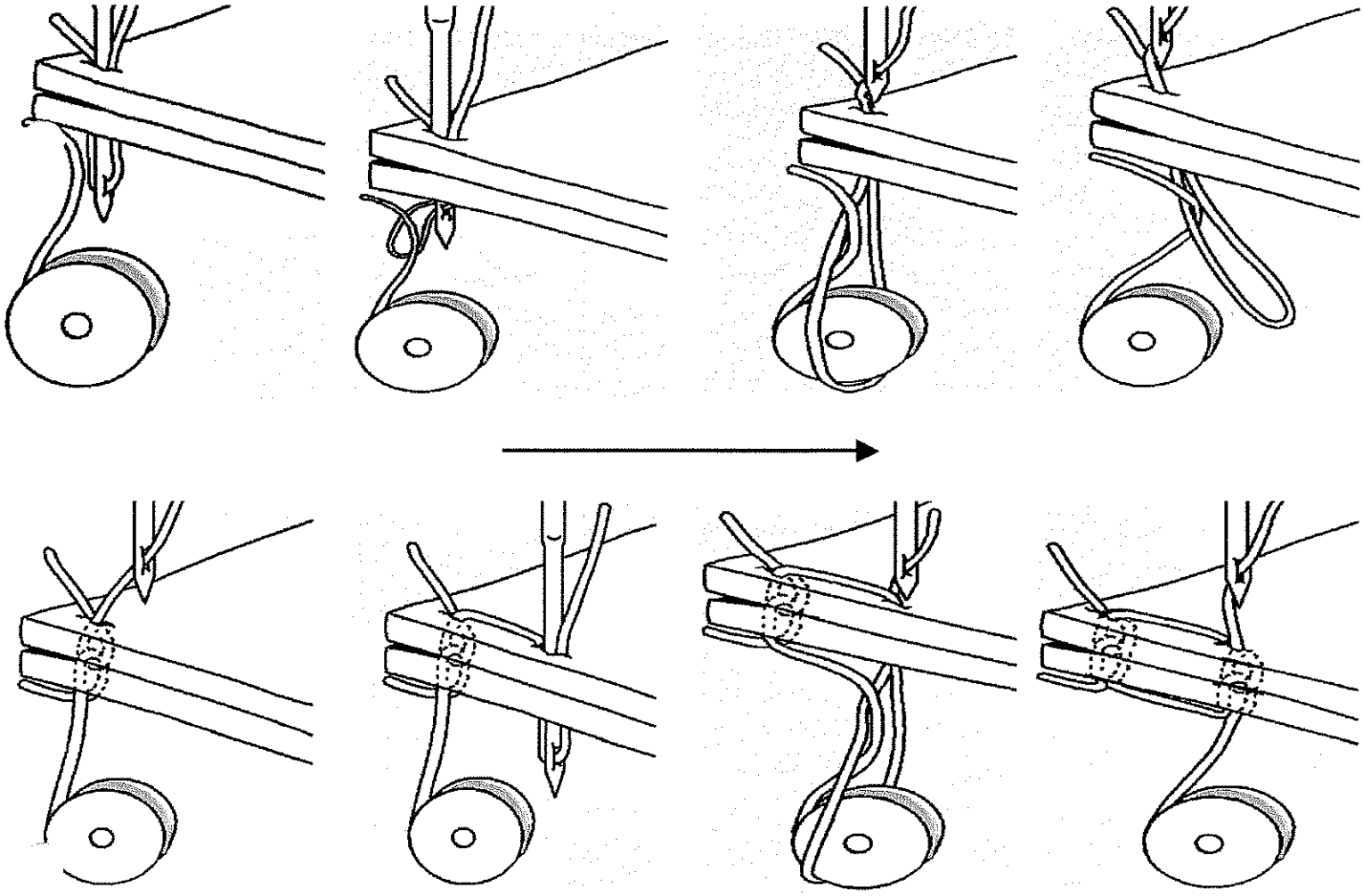
Stitch Type 201, is a HANDSTITCH and of minor importance to the observer of sewing machines. However, some attempts have been made to produce this stitch by machine. One of the more successful machines uses a needle pointed at both ends with an eye in the middle. This stitch is usually formed by hand with two needle threads, which pass through the material in opposite directions, but in the same perforations without interlacing or interlooping.



Formation of the Two-Thread Lockstitch 301

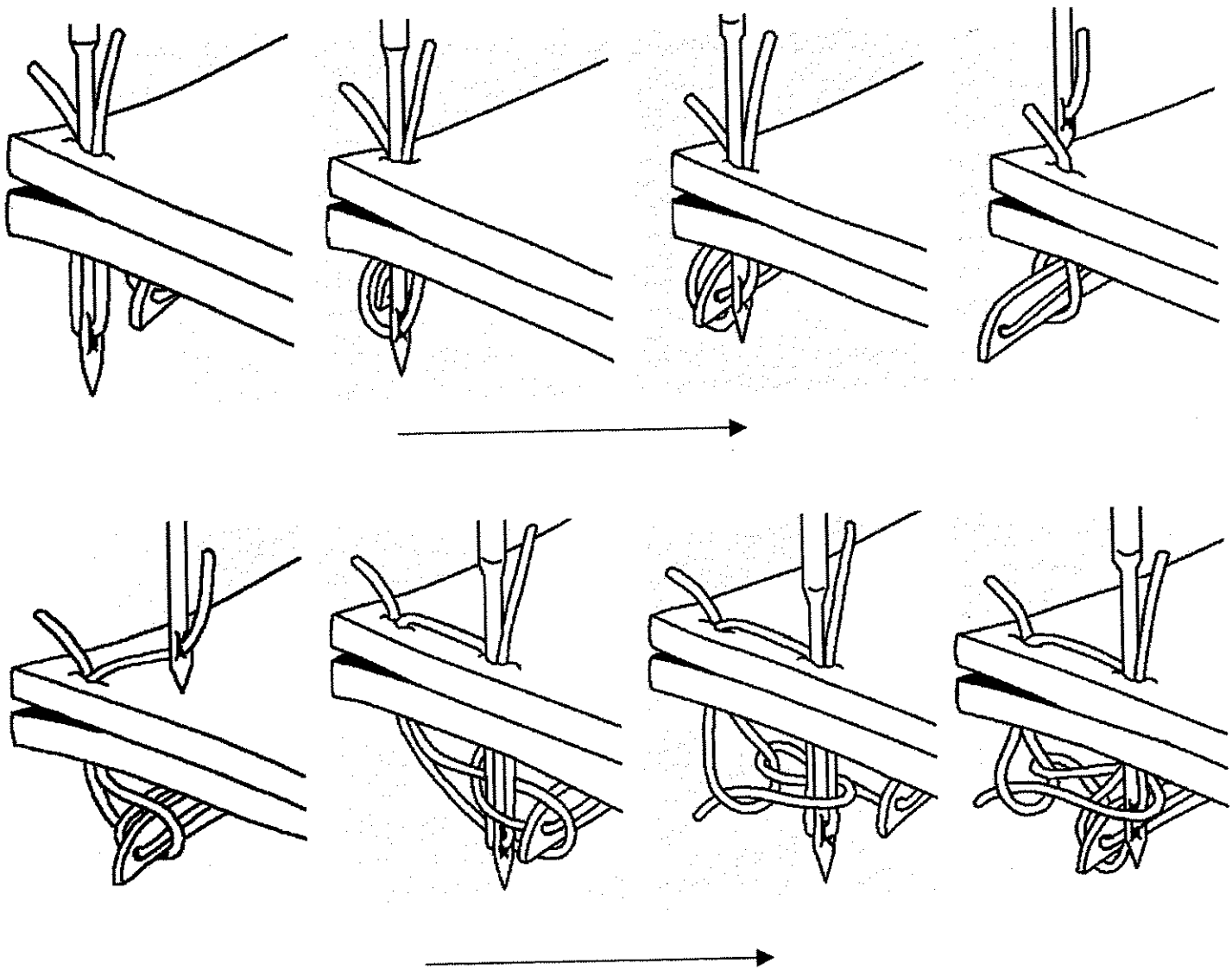
Two-thread lockstitch Stitch Type 301 is widely used for joining together two or more plies of material wherever it is desirable for the seam to have the same appearance at top and bottom. It is non-raveling but has less elasticity than other seam stitches. It is formed by an upper (needle) thread, and a lower (bobbin) thread, looped together so that **the lock of the threads is within the plies of material being stitched, equidistant from both the top and bottom surfaces of the material.**

Lockstitch formation process



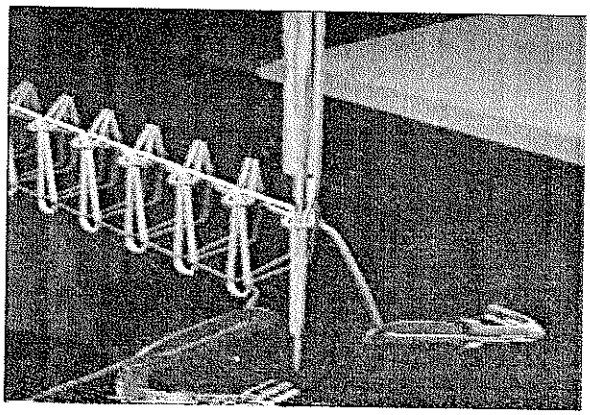
Formation of the Two-Thread Chainstitch 401

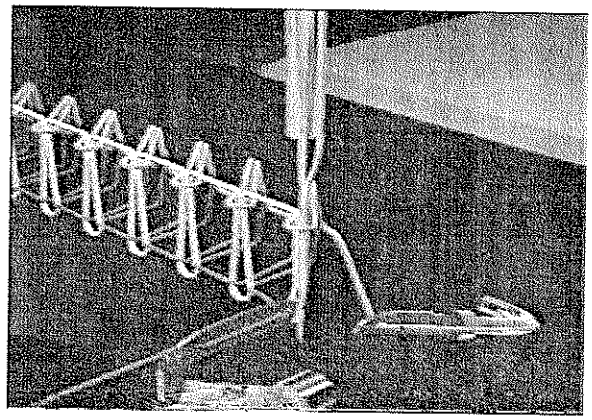
TWO-THREAD CHAINSTITCH Stitch Type 401 is used for joining together two or more plies of material wherever elasticity and strength are required. This stitch can be raveled, but not as easily as the single-thread chainstitch. It is formed by an upper needle thread, and a lower looper thread, which are laced together on the underside of the material to form a double chain.

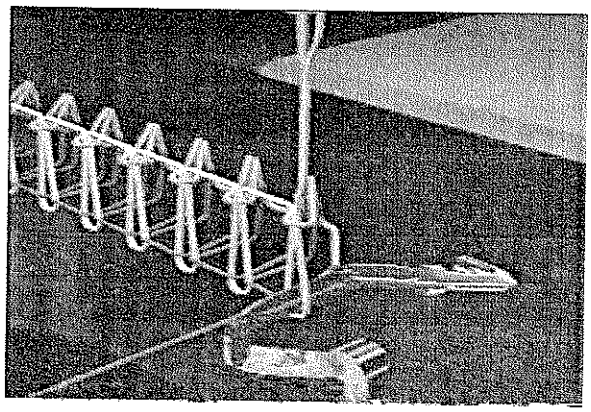


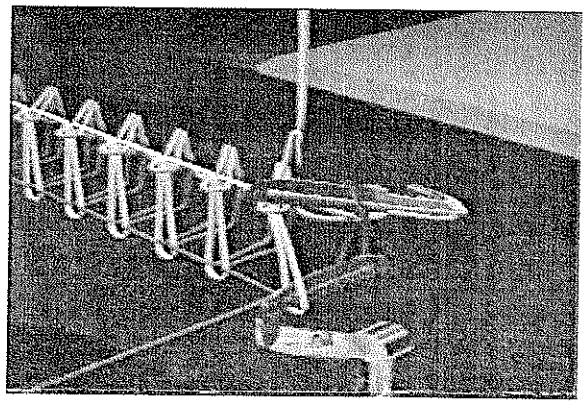
Formation of Overedge Stitch 500

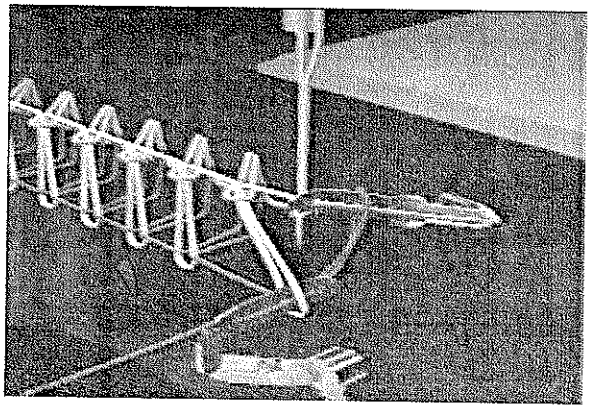
From the three basic stitch types 101, 301 and 401, all other stitch formations are derived. In addition to the handstitch and the three basic machine stitches, there are, at present, three other classes. Stitch Types of Class 500, known as OVEREDGE STITCHES, are formed like the basic chainstitch, except that one of the threads is passes around the edge of the material that is being stitched.

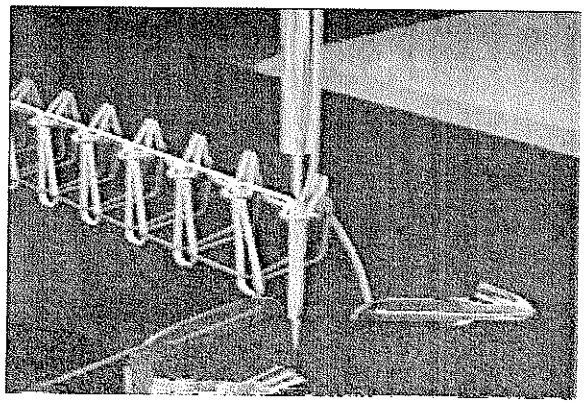






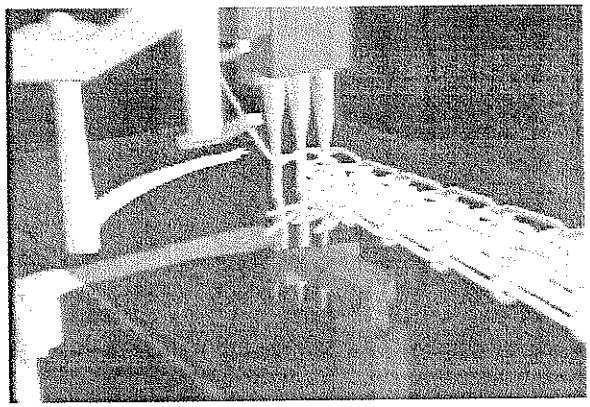


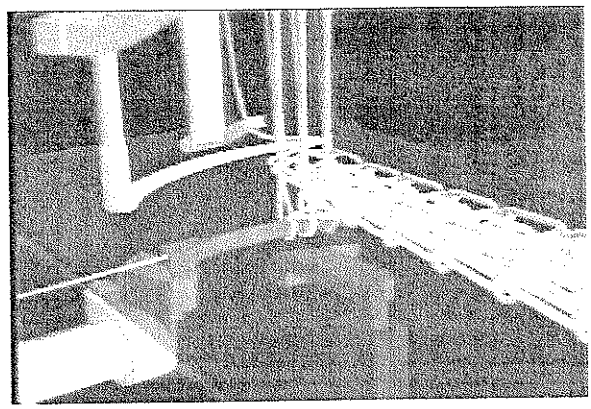


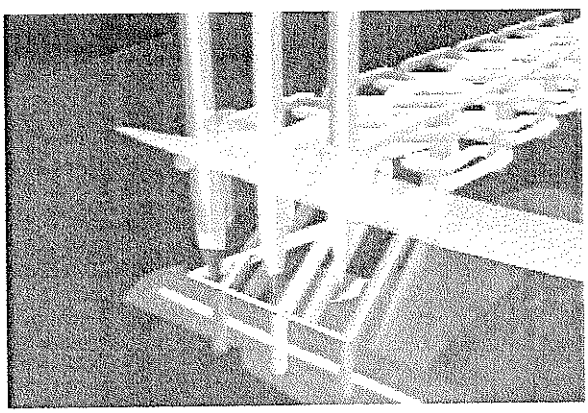


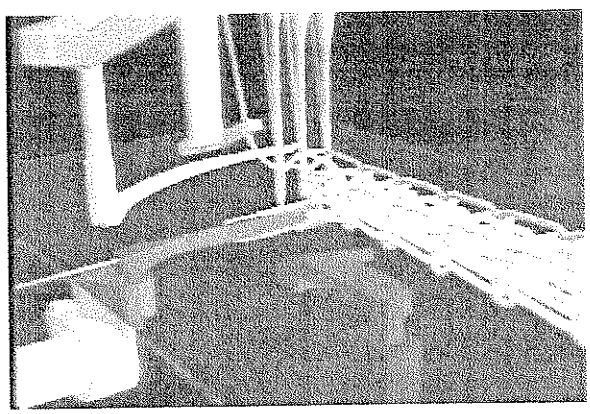
Formation of Top and Bottom Coverstitch 602

Top and bottom coverstitches are also modifications of the basic chainstitch. In the Stitch Type classification they appear in the 600 series. Two or more needle threads are interlaced with each other and a single looper thread. At least two of the threads, used to form this stitch, cover both sides of the material being stitched.









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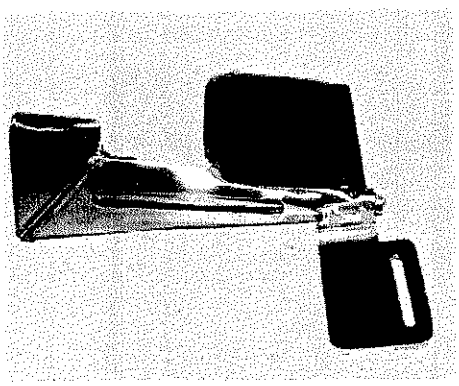
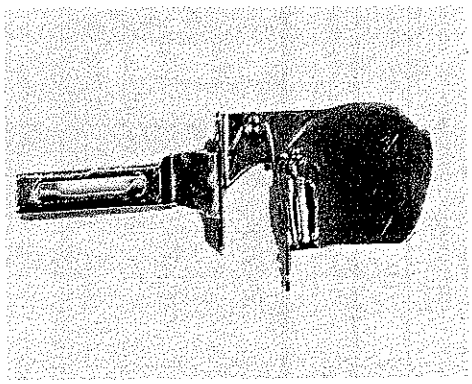
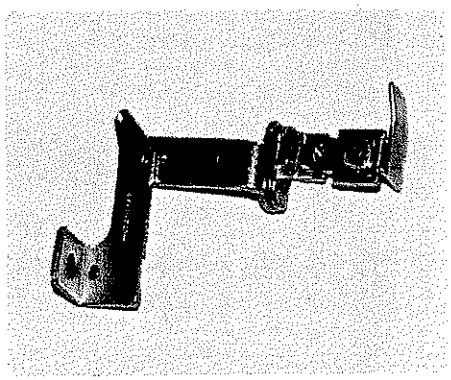
FITTINGS & ATTACHMENTS

An ATTACHMENT is an auxiliary device used in conjunction with presser and feed fittings to facilitate the handling of the work or to produce special effects. Attachments may be classified into several broad groups, such as edge folders, hemmers, edge guides, cord guides, lap seam guides, strip folders, lap seam folders, binders, corders, welters, tuckers, pipers or various combinations of these functions.

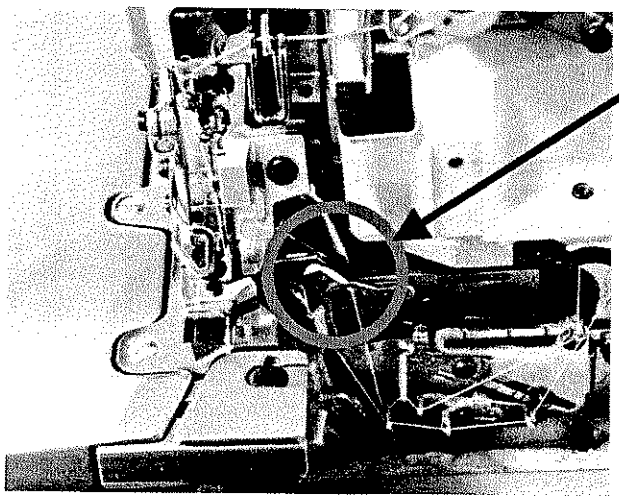
The use of attachments provides for economy of operation in the production of special effects, by performing automatically, certain manipulations of material that would be too laborious to perform by hand.

The attachment should be suitably designed to accommodate the materials it will handle without imposing strain or distortion upon them. It should not set up excessive friction or retard movement of work through machine. Attachment should not interfere in any way with sewing action of machine. Attachment, lower feed, needle and loop-taker should all be designed to work smoothly with one another.

Devices such as auxiliary puller feed mechanism, pinking cutters, picot edge formers, and others, which are not directly connected to the sewing mechanism, are nevertheless very often classified as attachments.

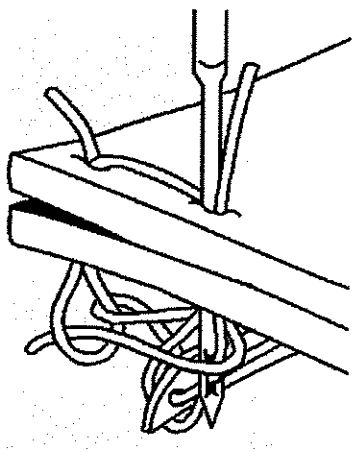
LOOP-TAKERS

Beneath the throat plate on the sewing machine is the loop-taker (the lower thread-carrying mechanism) called the looper, shuttle or hook.



CHAINSTITCH LOOP-TAKERS

A LOOPER is a blade, usually with an eye near its point, designed to carry the lower thread through the loop of needle thread, which is formed beneath the fabric. This action of the looper enables the needle thread loop to enclose the lower thread in the formation of the chainstitch.



A thread controller, known as a **RETAINER or SPREADER**, is used on some machines to expand and hold a thread loop sufficiently to permit the entrance of a needle or looper. Since a retainer does not have an eye, it is sometimes called a blind looper or a spreader.

An OSCILLATING LOOPER travels toward needle, carrying lower thread through needle thread loop on its forward stroke. The lower thread, enclosed by the needle thread loop, forms a triangle of thread, which is held by looper until penetrated by needle on its succeeding downstroke. The looper, then on backward stroke, casts off needle thread loop, whereupon the stitch is formed and set.

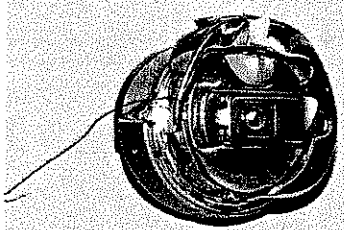
In sewing machines where the oscillating loopers move along-the-line-of-feed, any number of needles can be used in a straight line within the limits of machine design. However, since each looper moves to and from always on the same side of its corresponding needle, the looper thread loop must be held open for the descending

needle. This loop formation is assisted by a loop retainer or spreader. The retainer moves the looper thread loop away from the looper and into the path of the needle.

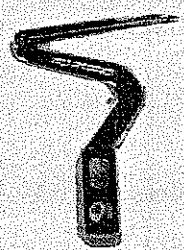
Spacing of the needles depends upon the minimum spacing of the loopers including the required width of the looper thread loop.

To simplify the components of the looper mechanism and to obtain more consistently perfect stitches, across-the-line-of-feed loopers are more frequently used in today's modern chainstitch machines. When this type of looper is used, an avoiding motion is designed into the mechanism to aid the formation of the triangle of thread.

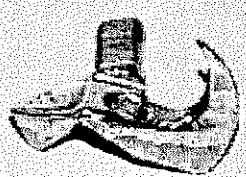
Rotary Hook



Looper

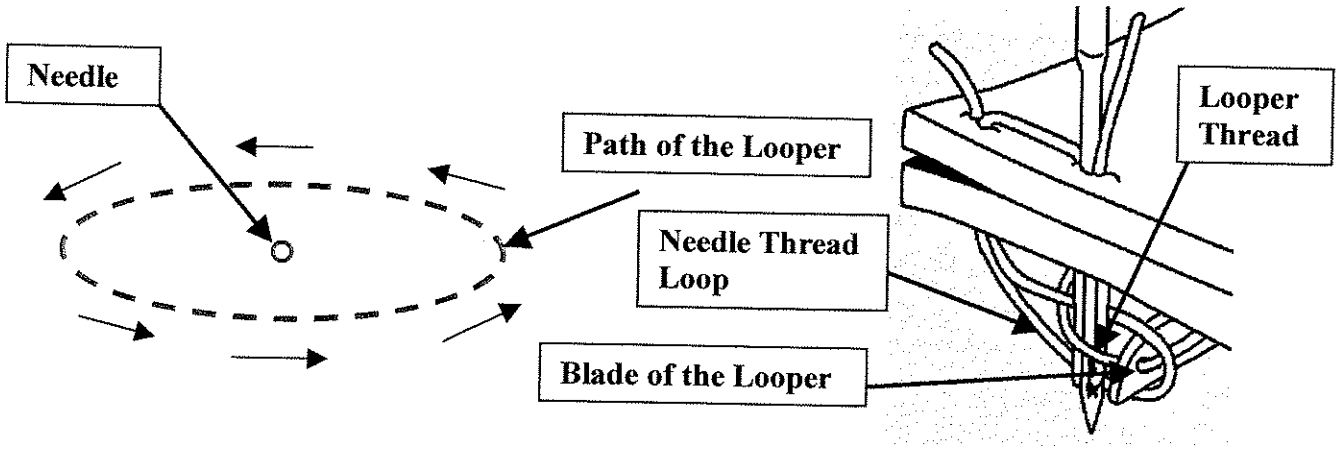


Rotary spreader



Spreader

AVOIDING MOTION: When the oscillating looper starts its forward stroke, the needle begins to rise from its lowest position forming the needle thread loop. During the forward stroke the looper passes behind the needle, just clearing the needle and picking up the needle thread loop. When the needle reaches its highest position, the looper completes its forward stroke and the needle thread loop encloses looper thread.

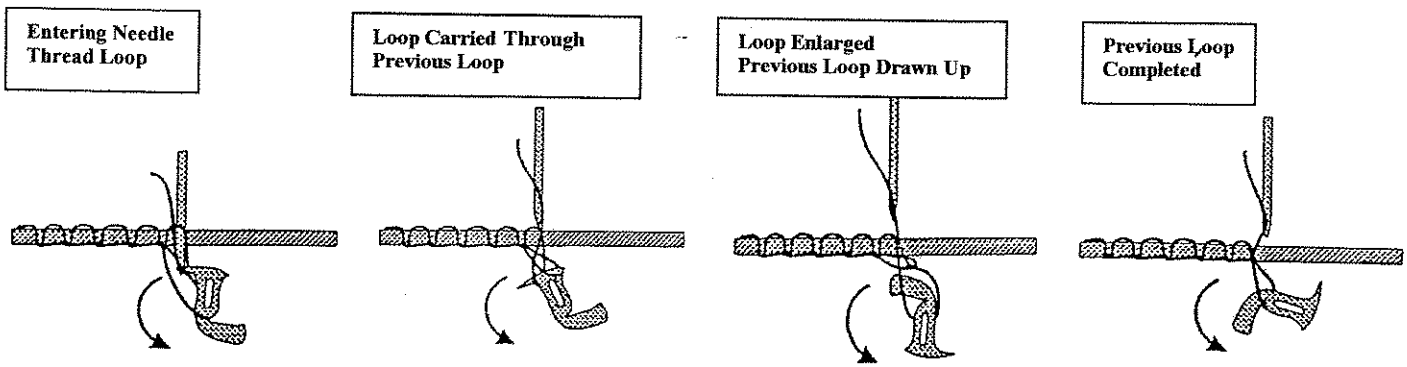


The feed moves the material to the next stitch position and the looper moves in front of the centerline of the needle path, forming a **triangle** of thread. One side of this triangle is formed by the needle thread loop. The looper thread and blade of the looper form the other side and the bottom of the triangle. As the needle descends to penetrate this triangle, the looper moves backward in front of the needle toward its starting position.

In its backward movement, the looper sheds original needle thread loop, which has now enclosed the previous loop of looper thread. Both thread loops are then drawn into a chainstitch, as the rising needle begins to form its next loop of needle thread.

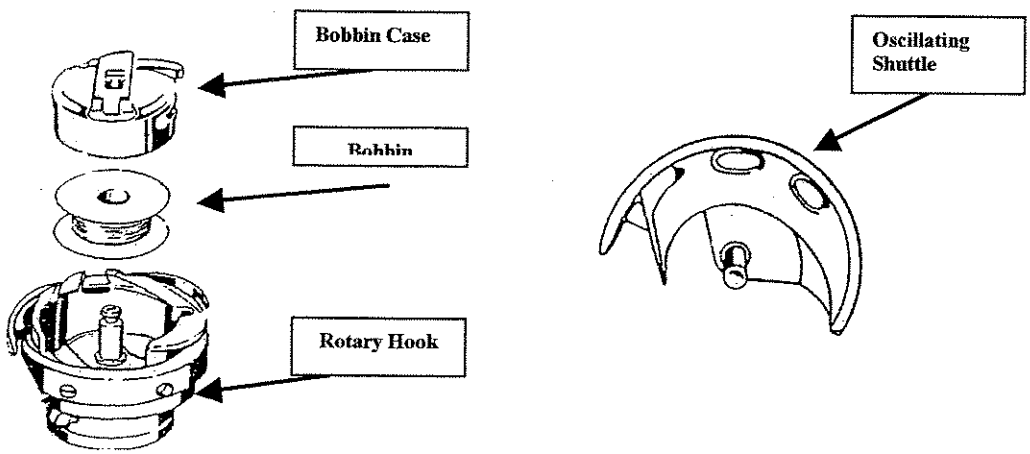
The obvious disadvantage to **across-the-line-of-feed loopers** is that in parallel stitching, needles must be staggered to permit spacing for avoiding motion. In most machine designs this would permit no more than three or four needles to be used together.

A ROTARY LOOPER penetrates a loop of needle thread and holds it, while rotating to penetrate the next loop of needle thread, passing the second loop through the first and casting off the first loop. The first loop is then drawn and tightened into a stitch. The rotary looper, still holding the second loop, then continues in its rotation toward the next stitch formation. A rotary looper without an eye is used for single-thread chainstitching.

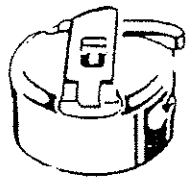


LOCKSTITCH LOOP-TAKERS

In the formation of a lockstitch the lower thread carrier is either a SHUTTLE or a HOOK. These devices contain a BOBBIN. The bobbin holds the entire mass of lower thread.

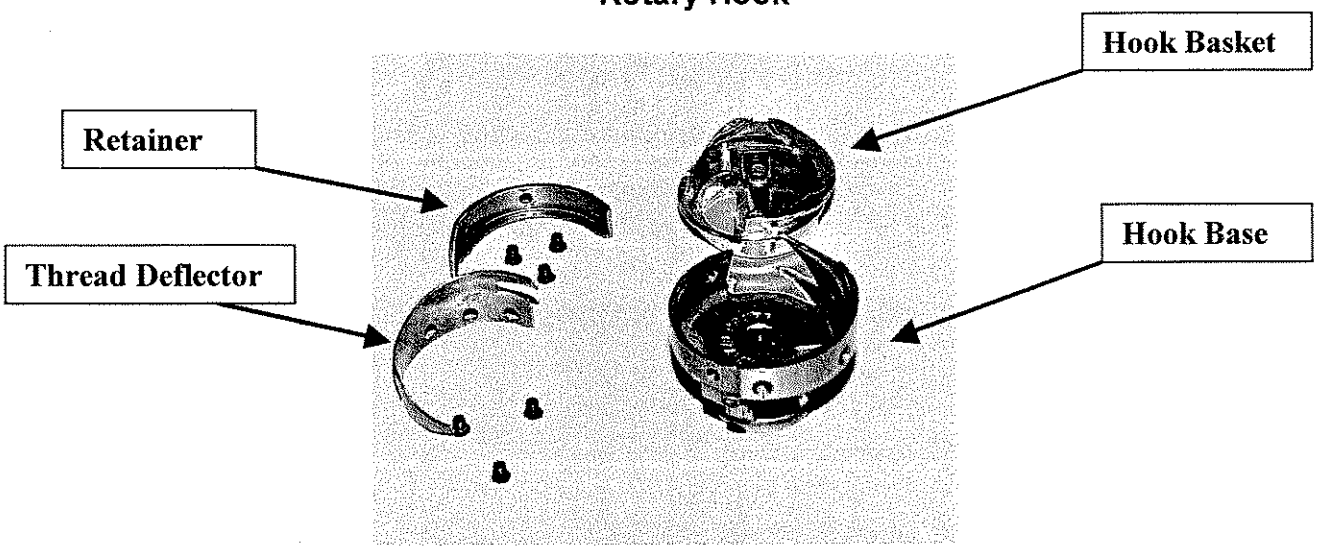


In most instances, the bobbin is contained in a **BOBBIN CASE**. This case permits the bobbin to unwind. It includes a tension spring that can exert the right amount of tension on bobbin thread in relation to tension on upper thread to form an ideal stitch. In some types of shuttles and hooks, the function of a bobbin case is designed into them, eliminating the need for a separate case or case holder.

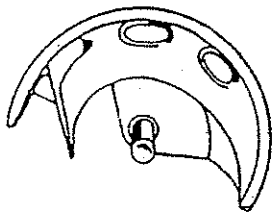


A BOBBIN CASE HOLDER (basket) is that part of a shuttle or hook that retains a bobbin case in a stationary position, permitting bobbin and shuttle or hook to revolve independently during stitch formation. Bobbin case holder is held within, but is not fastened to the shuttle or the sewing hook.

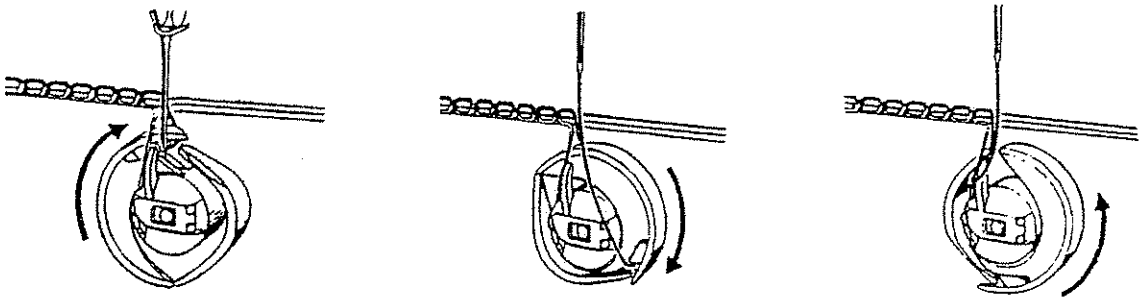
Rotary Hook



The main functional difference between all shuttles and all sewing hooks is the TRAVERSE or passage of the top thread over lower thread carrier during stitch formation. Also:
Every shuttle passes itself and the entire mass of lower thread through needle thread loop. The needle thread loop slips between shuttle and shuttle holder, enclosing lower thread.
On every sewing hook, the hook point passes the needle thread loop, not around itself, but around the stationary bobbin case containing the entire mass of lower thread. The thread loop is cast off, after it has enclosed the lower thread.



OSCILLATING SHUTTLE – travels to and for in a vertical, semi-circular arc, forming the lockstitch in the following manner:
After the needle has penetrated the material and as the needle starts to rise from lowest point of its stroke, the needle thread being flexible bulges away from the needle to form a loop which is entered by the point of the shuttle. As the needle continues its rise, and the shuttle progresses in its forward motion, the take-up lever is lowered to provide sufficient needle thread to be drawn down through the material to form a loop large enough to enclose the shuttle.
The shuttle, carrying the entire mass of lower thread with itself, passes itself completely through this loop of needle thread. As loop approaches the heel of the shuttle, the take-up lever starts its upward stroke to remove the slack thread, and the shuttle stops its forward motion, to commence its return movement. This reversal opens a clearance gap between the heel of the shuttle and the leg of the shuttle driver. The take-up draws the needle threads' loop through this clearance gap, carrying with it the bobbin thread, which has been enclosed by needle thread loop as it passes over bobbin case. The feed dog moves forward, feeding the material and the bobbin thread becomes taut as the take-up draws the remaining slack of needle thread up through the material. The stitch is thus set with the lock of needle and bobbin threads drawn snugly between the plies of the material being sewn.



ROTARY SHUTTLE – Revolves continuously in one direction, making two revolutions for each stitch. During the first revolution, the rotary shuttle passes itself and the entire mass of lower thread through the needle thread loop. At the end of the first revolution, the shuttle casts off the loop and continues on its second revolution, free of needle thread. While the upper and lower threads are being drawn, tightened and set into a stitch and the needle is again descending and rising to form next thread loop, the rotary shuttle is again rotating to enter a new loop to begin the next stitch formation.

Shuttles are also classified according to their construction or appearance, as follows:

A central bobbin shuttle carries a round bobbin over a post in its center, the bobbin being enclosed in a bobbin case with a latch for holding it in place on the shuttle post. The bobbin case is fitted with a position finger which engages in a slot to hold the bobbin case stationary, while the shuttle oscillates.
A long beak shuttle carries a round bobbin in a circular opening in the frame of the shuttle itself. Bobbin is held in place by a spring cover. The point or beak of the shuttle is long and curving, giving this shuttle its name. The unwinding of the bobbin during sewing is controlled by a pressure spring against which a **spring cover** holds the bobbin. The long point on this shuttle holds the needle thread loop until the needle has risen to the top surface of the material being stitched, before pulling the loop down to pass around the bobbin. In work on leather or similarly close-grained materials, this relieves the thread of considerable strain, and avoids making a larger needle hole in the material than the thread will fill.
A cylinder shuttle carries a long, spool-shaped bobbin in a cylindrical container hinged to the shuttle frame at one end. The container is held in the closed position by a spring latch. The chief advantage of the cylinder shuttle is its large thread capacity – an important feature, when heavy threads are required.

There are three types of hooks: **Oscillating, Rotary, and Variable Motion**.
OSCILLATING HOOK – travels to and for in a horizontal, semi-circular arc. During its forward motion, the point of the hook passes the needle thread loop around the bobbin case within the hook body. On its backward motion, the hook casts off the needle thread loop and returns to begin the next stitch cycle.
ROTARY HOOK – forms lockstitch by carrying the needle threads' loop around the bobbin, which contains the entire lower-thread supply, in the following manner:
The rotary hook revolves continuously in one direction, making two revolutions for each stitch. As the needle starts to rise from the lowest point of its stroke, the needle thread forms a loop, which is entered by the point of the sewing hook. As the needle continues its rise and the hook progresses in its rotation, the take-up provides sufficient slack needle thread to allow needle thread to be drawn through the material and to form a loop large enough to enclose the entire bobbin case.
On its first revolution, the hook point carries the needle thread loop around the bobbin case. The needle thread loop is reversed by the thread guard (twisted 180°), the inside of the loop sliding over the top of the bobbin case, while the outside of the loop (free end of thread, or thread coming from previous stitch) passes around the back of the bobbin case holder.
As the take-up starts to rise, the loop is drawn up through the cast-off opening of the hook before the revolution is completed. During the second revolution of the hook, the take-up completes its upward stroke, drawing the slack thread through the material and setting the stitch. Meanwhile the feed dog has moved forward, carrying the material ahead and drawing the required amount of under thread from the bobbin for the next stitch.

The exact instant at which needle thread loop is reversed or twisted 180° during the stitch formation will vary in different machines. It can be observed however, by slowly turning the sewing mechanism in its correct rotation while watching the passage of needle thread around the bobbin case. This reversal of the loop is necessary to obtain correct interlock in stitch formation with a continuously rotating hook. Without this twist, needle thread loops would merely pile up and jam the sewing mechanism.

It should be noted that in the movement of each lower thread carrier, some period of time must be allowed for each stitch to be drawn, tightened and set. In reciprocating devices, this function is performed during the backward (or return) stroke. In rotating devices it is usually accomplished during the second revolution, with the following exception:
VARIABLE-MOTION HOOK or SHUTTLE makes but one revolution for each stitch. It travels slowly, while the hook or shuttle point enters the needle thread loop. Rapidly, while the loop passes around the bobbin case and casts off to enclose the lower thread. Then slowly again while the stitch is being set and the point enters the next loop of needle thread. Steady rotary motion of the driving shaft imports a motion to the driven shaft that varies as described above.

Sewing hooks and shuttles are also classified according to their mounted position, as follows:

The Vertical-Axis Hook or a Shuttle rotates or oscillates in horizontal plane parallel with the bed of the machine and is mounted on a vertical shaft.

The Horizontal-Axis Hook or Shuttle rotates or oscillates in a vertical plane along line of feed and is mounted on a horizontal shaft.

The Transverse Horizontal-Axis Hook or Shuttle rotates or oscillates in a vertical plane across the line of feed. These loop-takers are used in some zig-zag stitching and vibrating needle bar machines. (Insert pictures of horiz. And vert. Hooks)

ASTM D 6193
SIX BASIC CLASSES OF STITCHES

100 SINGLE THREAD CHAINSTITCH (Spreader)

200 HAND STITCH

300 LOCKSTITCH (Hook & Bobbin)

400 MULTI-THREAD CHAINSTITCH (Looper)

500 OVEREDGE AND SAFETY STITCH

600 COVERSTITCH

STITCH TYPES

SIX CLASSES OF STITCH TYPES:

100 SINGLE THREAD CHAINSTITCH
(101-Basting, Buttonsewing, etc.; 103-Blindstitch; 104-Saddlestitch)

200 HAND STITCH

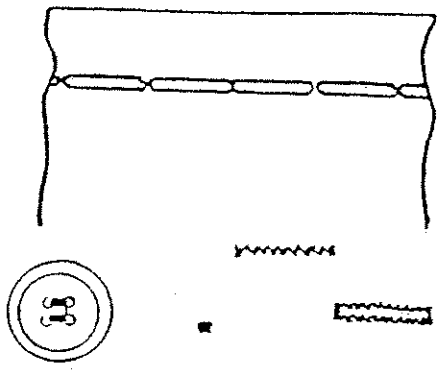
300 LOCKSTITCH (Formed with hook and bobbin)
(301-Plain stitch; 306, 313, 314-Lockstitch Blindstitch)

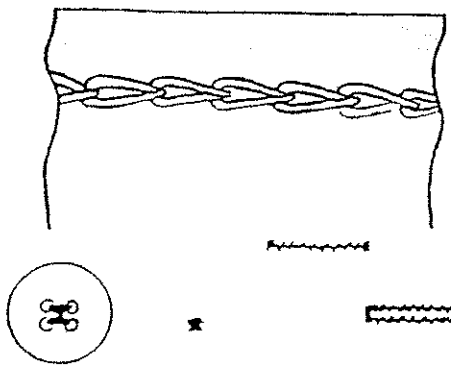
400 MULTI-THREAD CHAINSTITCH (Formed with a single looper)
(401-Double locked stitch; 402-Cording stitch; 404-Zig Zag stitch; 404-Mod. – Fagoting or Picoetta stitch; 406, 407-Three and Four thread chainstitch)

500 OVEREDGE AND SAFETY STITCH
(502, 503, 504, 505, 512, 514, 521-Overedge; 515, 516, 519-Safety stitch)

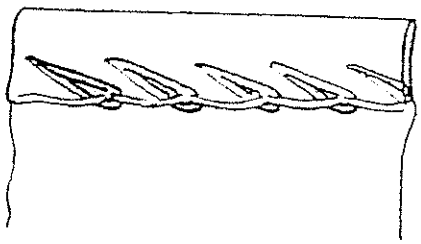
600 COVERSTITCH OR FLATSEAM STITCH
(602, 605, 607)

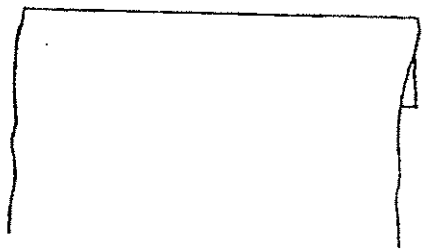
Top View **Bottom View**



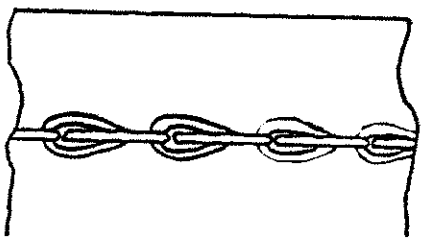


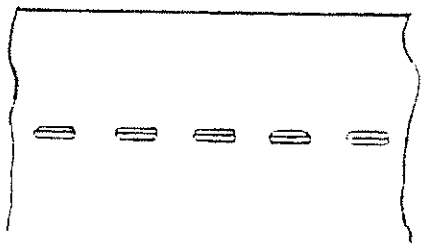
101 Single Thread Chainstitch



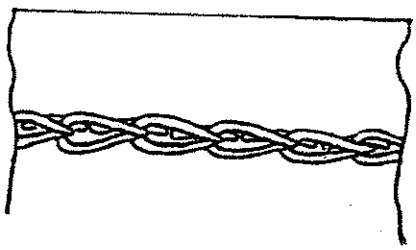


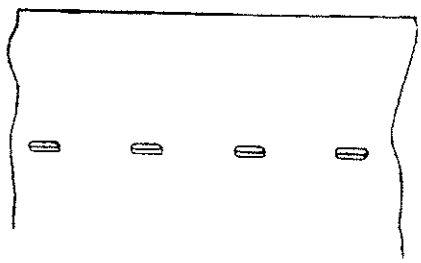
103 Single Thread Blind Stitch





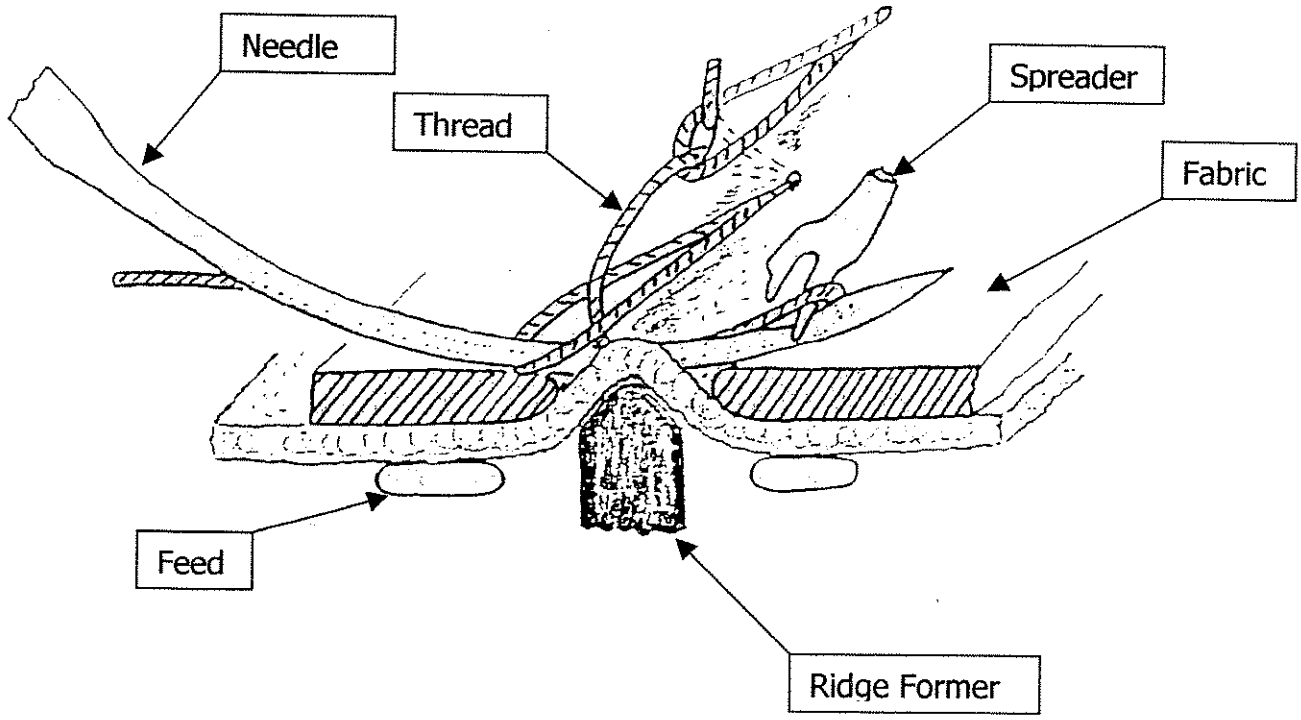
104 Saddle Stitch



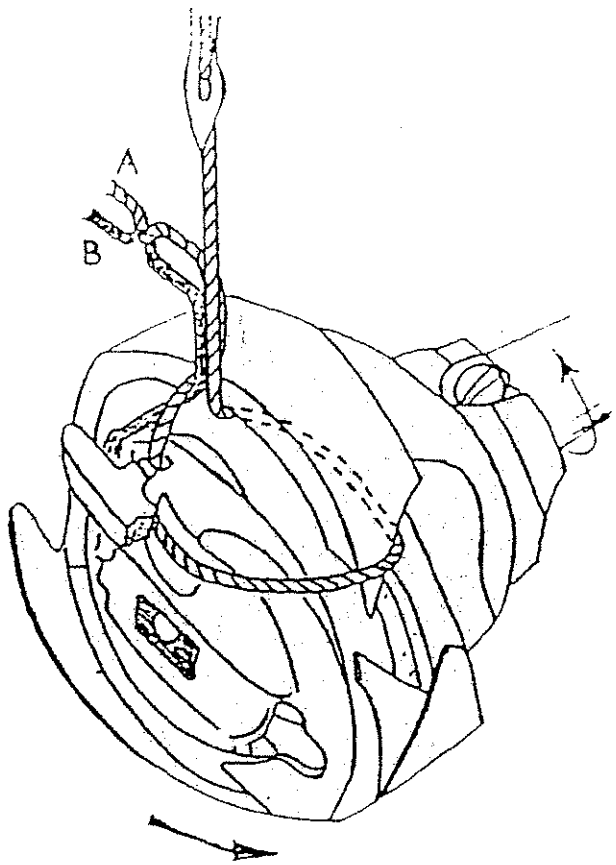


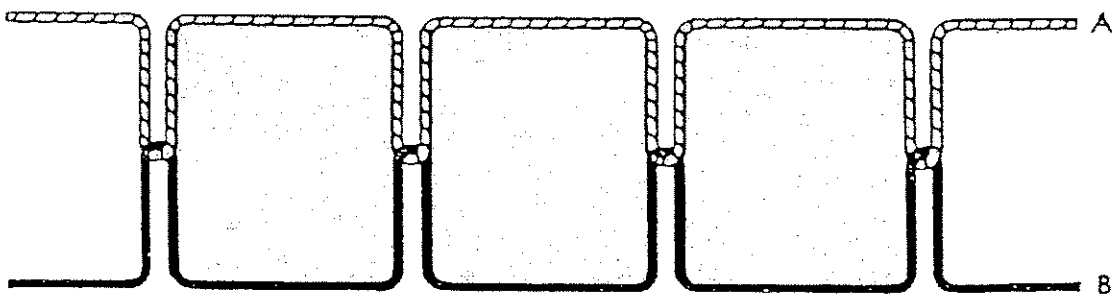
104 Modified Saddle Stitch

103



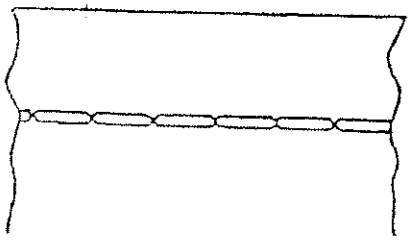
300

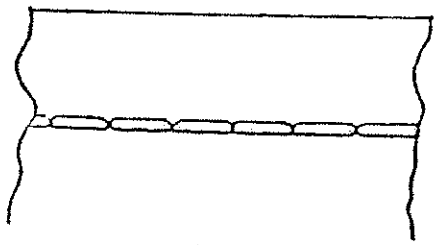




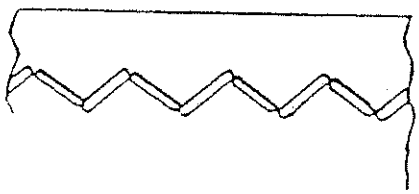
Top View

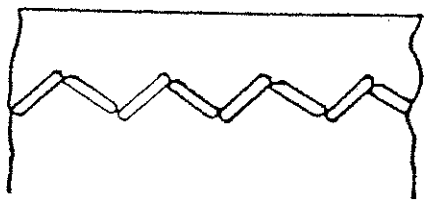
Bottom View



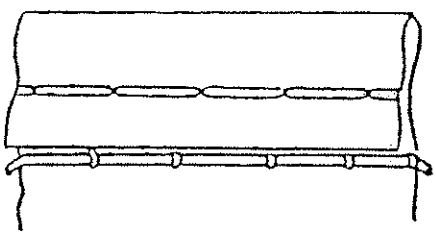


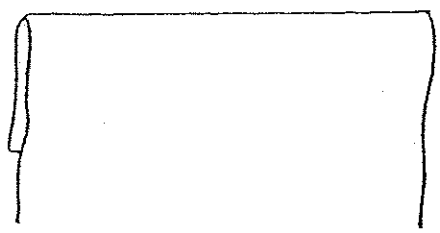
301 Lockstitch



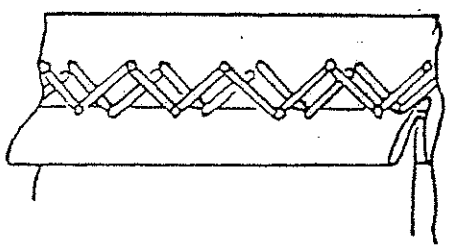


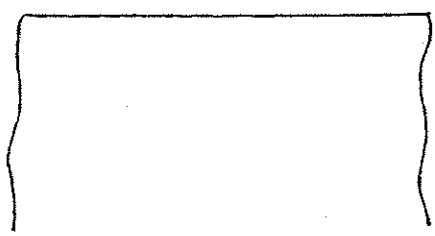
304 Zigzag Lockstitch



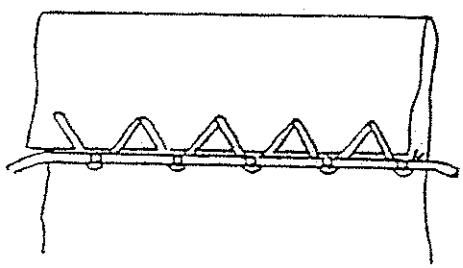


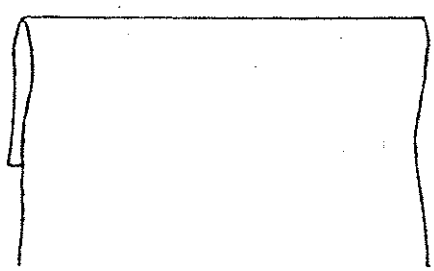
306 Lockstich
Blindstitch





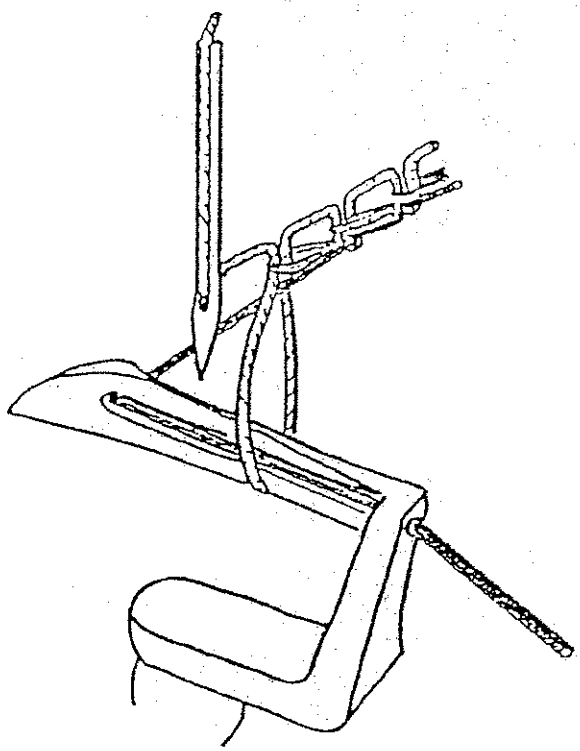
313 Lockstitch
Blindstitch



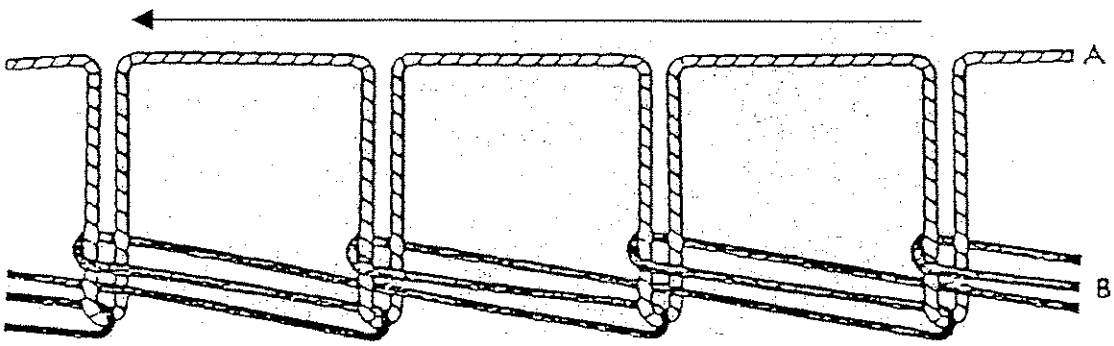


314 Lockstitch
Blindstitch with
Overcast

400

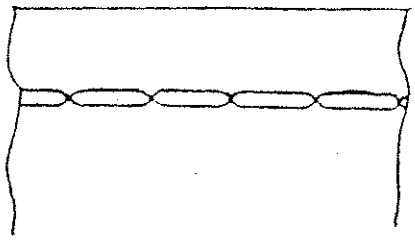


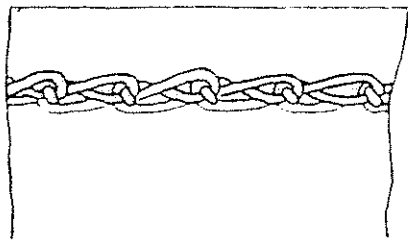
Direction Of Successive Stitch Formation



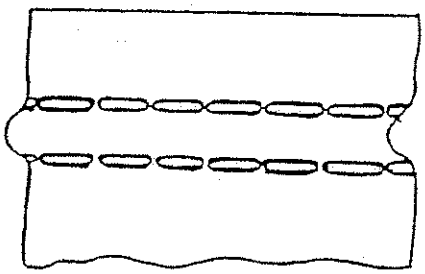
Top View

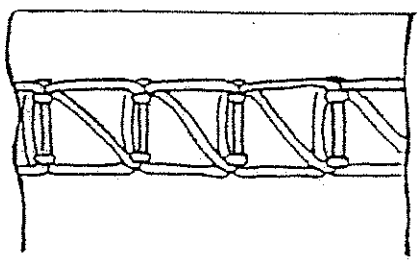
Bottom View



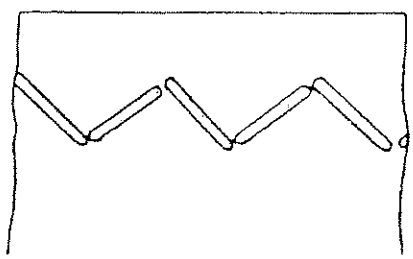


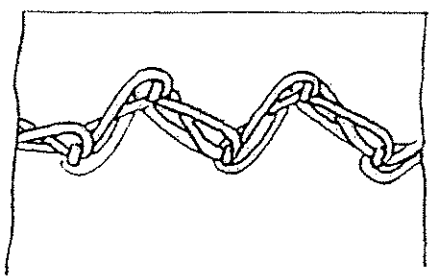
401 Two Thread Chainstitch



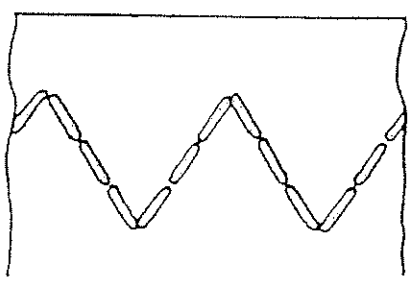


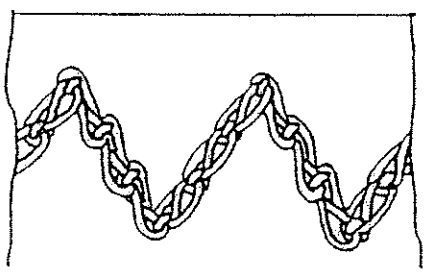
402 Cording Stitch



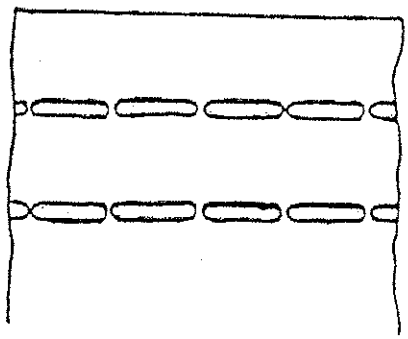


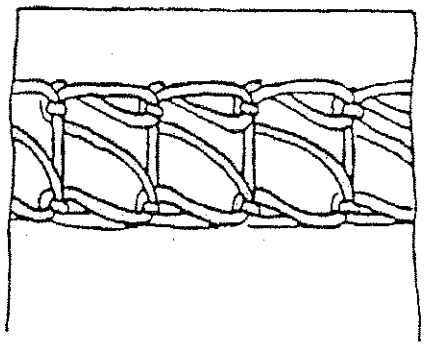
404 Zigzag Chainstitch



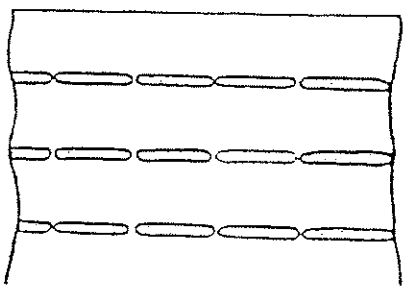


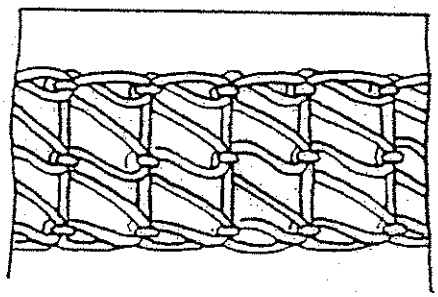
404 Modified Zigzag Chainstitch





406 Coverstitch



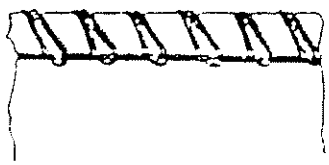


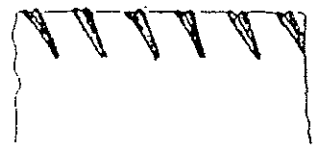
407 Coverstitch

500

Top View

Bottom View





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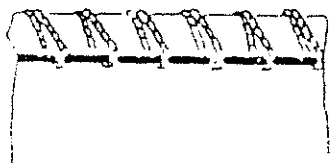

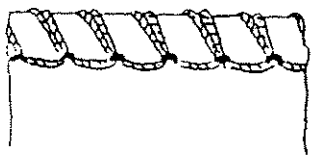

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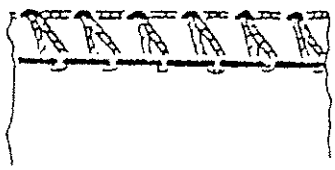

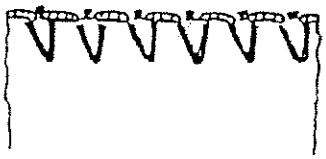

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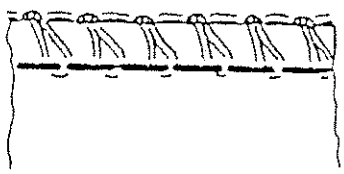

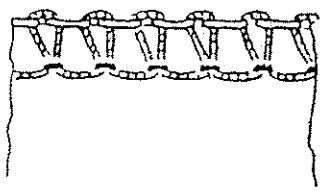

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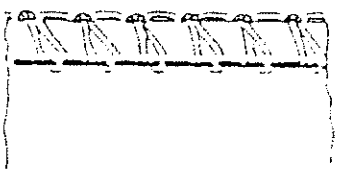

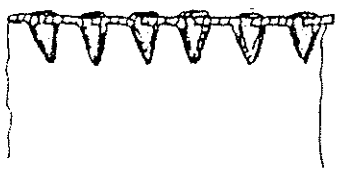

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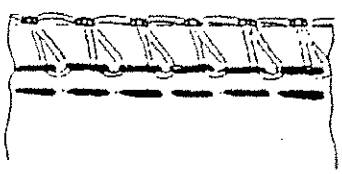

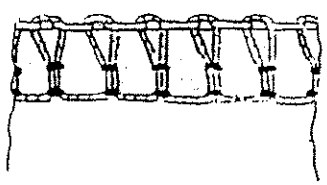

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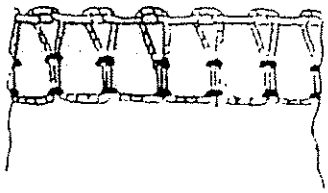

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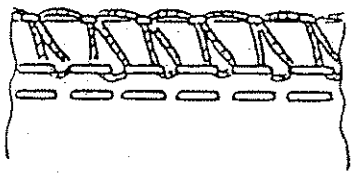

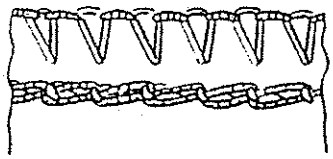

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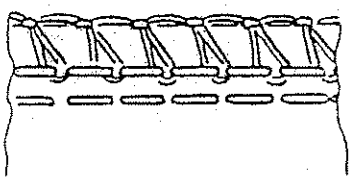

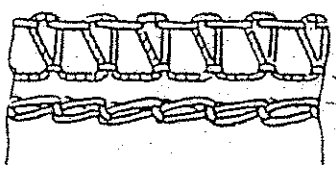

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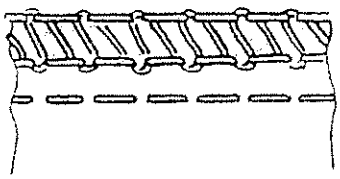

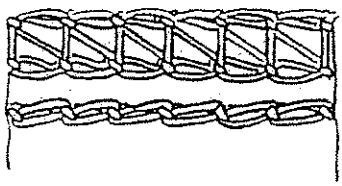

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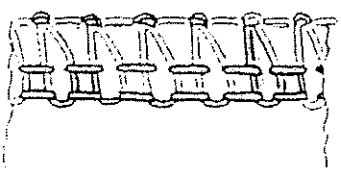

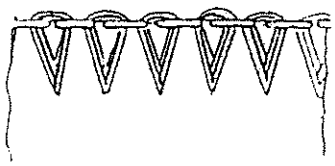

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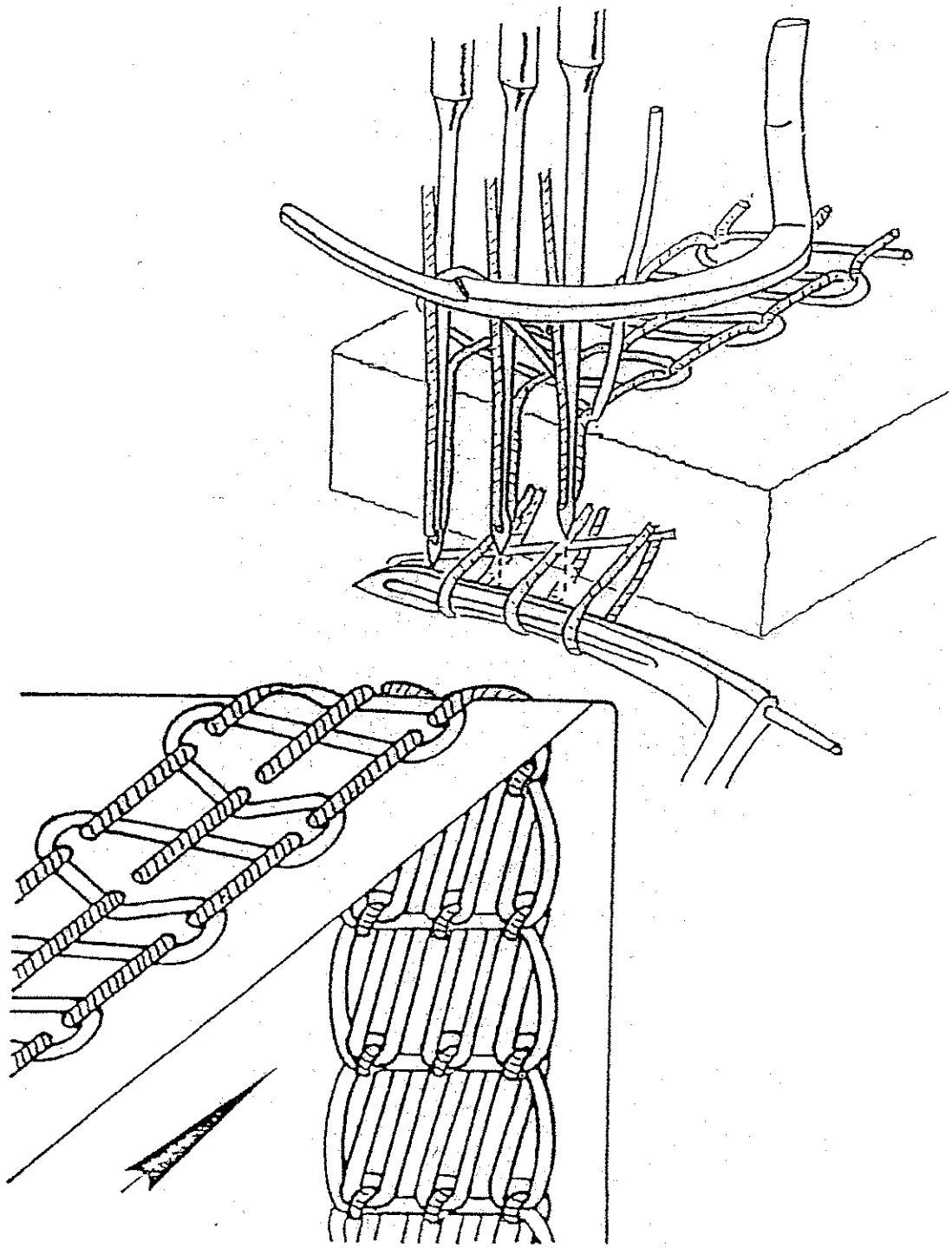
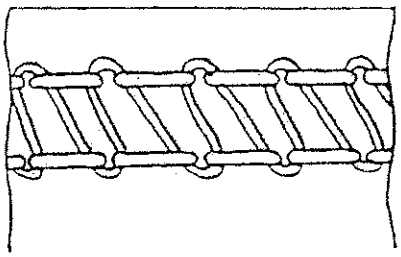
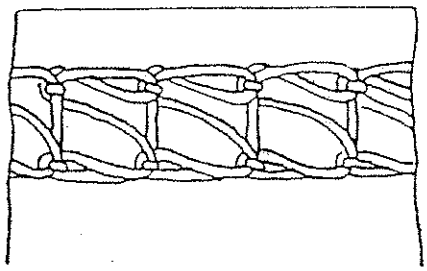
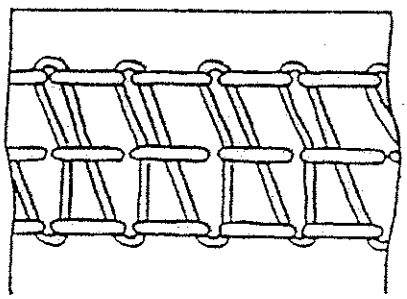
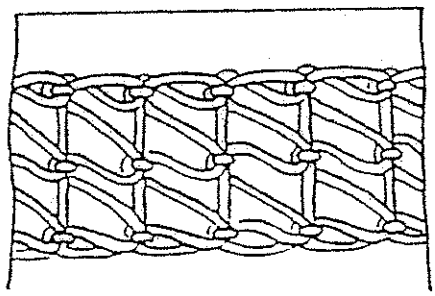




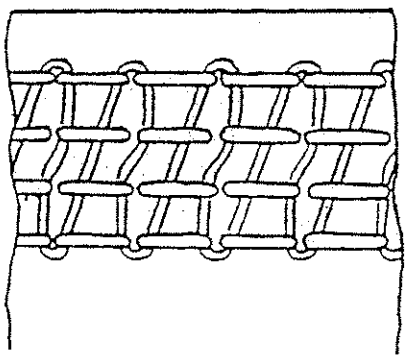


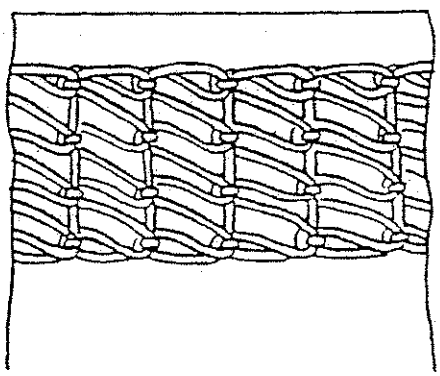
602 4 Thread
Coverstitch





605 5 Thread
Coverstitch





607 6 Thread
Coverstitch

Stitch Characteristics & Fundamental Machine Components

Federal Stitch Type 301

- Characteristics:

Economical, even thread consumption for needle and bobbin threads, tight.

Thread components

thread stand top frame thread eyelet front frame thread eyelet thread guide tension assembly tension post eyelet take up spring needle thread take up bracket take up lever	thread Eyelet needle bar bushing thread guide needle rotary hook assembly bobbin case bobbin positioning finger bobbin winder

Take Up Lever

- travels in an elliptical motion
- travels slowly downward giving thread to form a loop around the hook
- travels quickly upward to remove thread from around the hook and helps set the stitch
- pulls thread from the cone
- travels almost twice as fast upward as it travels downward

Needle

- single groove with ball eye .003" larger at the eye

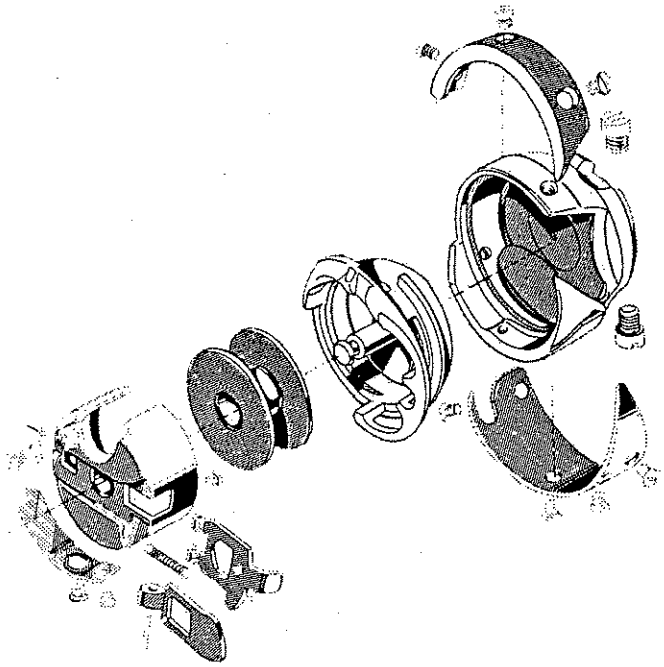
Needle Length

- most lockstitch machines can use two different length needles
- longer needles are used for thicker fabric

- short needles provide the most stability while sewing

Rotary Hook Assembly

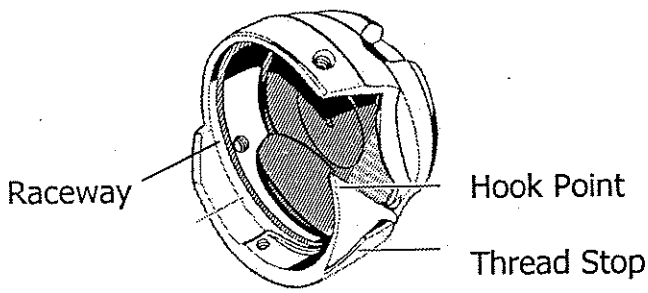
- makes two revolutions for each stitch
- hook assembly components



hook base retainer thread deflector	basket case holder bobbin bobbin case assembly

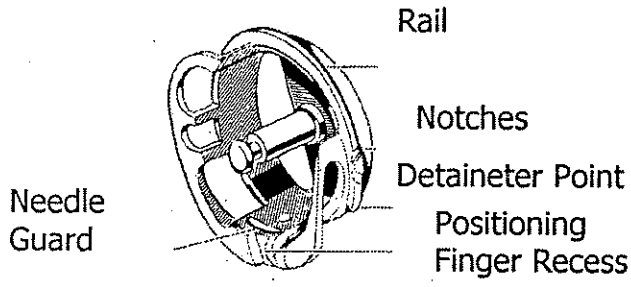
Hook Base Key Areas

- hook point
- thread stop
- raceway



Key Areas of Basket

- rail
- notches in the rail
- detainer point
- positioning finger recess
- needle guard



Feed Travel Type

- the material is fed when the needle approaches the top of it's stroke

Hand Wheel At the 0° Hook Point At 2 O'clock

- hand wheel usually rotates counter clockwise (when facing it)
- hook usually rotates counter clockwise (when facing it)

Hand Wheel At 0° Bottom Dead Center

- needle is at the lowest and has entered the needle guard slot in the basket
- the guard stabilizes the needle and prevents the hook point from striking the needle
- the hook point is at the 2 o'clock and the take up is descending giving thread
- the check spring is inactive (only active when force on thread exceeds tension)
- feed is below the needle plate and moving toward operator

Hand Wheel At 30°

- needle is rising and a loop is formed on the scarf side
- pinching action of material around needle blade and inertia help form the loop

- the hook point is at the 12 o'clock position and take up is descending giving thread
- the check spring is inactive and the feed is below the plate moving forward

Hand Wheel At 75°

- needle is rising and coming out of needle plate
- hook point is at 9 o'clock position
- the top side of the needle loop has slipped back against the thread stop
- the thread stop will carry the thread to the bottom of hook as it continues to rotate
- the deflector contacts the loop and twists the loop so that the side of the thread that passes the face of the hook runs to the previously formed stitch
- the underside of the loop passes under the hook point and across the race way placing the thread directly in front of the detainer point of the rail
- the detainer point acts as a pivot point allowing the thread to encircle the bobbin case which holds the bobbin
- the take up is descending giving thread
- check spring is inactive
- the feed is still moving forward under the plate

Hand Wheel At The 100°

- the needle is rising and is out of the material
- the hook point is at the 7:30
- the thread deflector is lifting the front side of the needle thread over the face of the face of the hook positioning the thread to slip into the positioning finger recess of the basket
- the bottom side of the needle loop has contacted the detainer point of the rail and is lying alongside the back of the rail (as the hook continues to rotate the loop is drawn around the basket)

- the take up is descending and giving needle thread
- the check spring is still inactive
- the feed is at the front of the plate and is starting to rise

Hand Wheel At 135°

- the needle is still rising above the material
- the hook point is at the 5 o'clock position
- the needle thread loop is being drawn down to the 6 o'clock position on both the front and back side of the basket (the needle loop encircles the basket)
- the front side of the needle loop slips off the deflector and into the positioning finger recess of the basket (rocking motion of basket)
- the take up lever is at the bottom of it's travel and has given all the thread it had
- the check spring now winks to loan thread into the system
- the feed is rising to feed the material

Hand Wheel at 180°

- the needle is at the top of it's travel (top dead center)
- the hook has made 1 complete revolution and is at the 2 o'clock position
- the needle thread has been pulled off the thread stop and off the hook point and is about to be pulled onto the retainer
- the front side of the loop is about to slip out of the positioning finger recess
- the take up is rising rapidly and pulling the needle loop away from the hook point and onto the retainer (travels 2 times faster moving upward)
- the check spring is inactive
- the feed is now feeding the material

Hand Wheel At 200°

- needle is descending
- hook point is at the 12:30 position
- the needle loop has moved out of the positioning finger recess and out from behind the rail of the basket and is held by the tip of thread retainer
- take up is rising rapidly and has taken up most of the thread below the plate
- the check spring acts as a shock absorber when needle thread contacts the retainer plate (cushions the force on thread caused by rapid upward movement of take up)
- the feed is moving the material rearward

Hand Wheel At 210°

- needle is descending
- hook is at 12 o'clock
- needle thread is released from the retaining point
- take up is rising and beginning to set the stitch
- the needle thread encircles the bobbin thread and carries it to the middle of the material
- the check spring moves as the thread contacts the bottom of the material and remains active until the take up moves downward to give thread
- remains active until the take up moves downward to give thread
- the tension, take up, feed, and check spring work to set the stitch in the middle of the fabric
- the feed is moving the material setting the stitch

Hand Wheel At 235°

- needle is descending
- hook point is at 10:30 position but carries no thread
- the take is still rising after setting the stitch the take up draws thread from the cone for the next stitch
- check is active (upward movement of take up)
- feed moves material and draws bobbin thread for next stitch

Hand Wheel At 360°

- needle has entered material and is at bottom dead center
- hook point is at the 2 o'clock position and preparing for the next stitch cycle
- take is descending giving needle thread
- check spring is inactive
- feed is below the plate and moving forward

Federal Stitch Type 401

- comprised of 2 threads (one or more rows)
- inter-looped on bottom side of material (very elastic)

Thread Handling Components

needle thread tension assembly	looper thread tension assembly
needle thread frame eyelet	looper thread frame eyelet
needle thread lever eyelet	cast off support plate
cast off wire	looper thread
needle bar eyelet	looper
needle	nipper spring assembly (optional)

Hand Wheel At 0°

- 0° needle is at bottom dead center

Stitch Formation References

- hand wheel, needle, looper, feeds, and thread control positions
- 0° needle is at bottom dead center and looper is at extreme right position

Hand Wheel At 0°

- looper thread take up is controlling looper thread
- needle thread is taught
- feed is at lowest position and moving toward operator

Hand Wheel At 60°

- needle bar is rising
- needle loop is formed
- looper is moving to the left and enters the needle loop

Looper Thread Take Up At Hand Wheel 60°

- allows slack in looper thread as looper moves to the left
- slack in the looper thread allows the hanging needle loop from the previous stitch to set against the bottom of the material with the least resistance
- needle thread give thread to form the needle loop
- feed is rising below needle plate
- needle used is a double groove to provide a path for the hanging needle loop

Hand Wheel At 120°

- needle is still rising
- looper continues to the left

Looper Thread Controls With Hand Wheel At 120°

- looper thread take up still allows slack for previous stitch setting while needle controls begin setting the previous stitch
- when the stitch is set a supply of thread is pulled from the cone for the next stitch
- feed is now above the plate and feeding the material to the rear (This action helps to set the stitch on the bottom of the fabric)
- note the plate needle hole is square on the left side to push the needle loop toward the heel of the looper

Hand Wheel At 180°

- the needle is at the highest position (top dead center)
- looper is at the extreme left position
- the looper is avoiding toward the operator in preparation of the triangle
- note the needle loop around the blade of the looper and the shape of the needle plate hole with the movement of the looper have placed the needle loop toward the heel of the looper

Looper Thread Controls Hand Wheel At 180°

- looper thread take up has given all the slack and is even with the cast off plate
- take up will begin to take up slack thread as the looper moves to the right
- between 120° and 180° the previous stitch is set and thread is drawn into the system for the next stitch
- the feed is still moving the fabric

Hand Wheel At 225°

- needle is descending above the plate
- the looper has avoided and continues to move to the right
- the needle loop now contacts the right side of the needle plate hole which is beveled (this helps hold the needle loop in the correct position on the looper)
- the movement of the looper, shaper of the looper blade, the shape of the needle plate hole, and thread handling components all help form the triangle

Looper Thread Controls Hand Wheel At 225°

- looper thread take up assembly removes slack and pulls thread into the system
- the needle thread components pull thread into the system as the needle descends
- the feed moves the material 1 stitch and begins it's descent below the plate

Hand Wheel At 270°

- looper thread take up is still controlling the looper thread and drawing thread into the system for the next stitch
- the needle controls are giving thread with the downward motion of the needle
- the feed has descended below the plate and feeding of material has ended

Hand Wheel At 285°

- needle is descending and has entered the triangle
- the looper is moving to the right
- the feed is descending and is moving to the front of the machine
- the point of the needle has entered the triangle and the looper thread take up has cast off the looper thread
- the needle thread controls are still giving slack

Hand Wheel At 315°

- the needle is still on the downward motion
- the motion of the looper to the right has caused it to withdraw from the loop

Thread Controls Hand Wheel At 315°

- looper thread take up now controls the looper thread while the looper finishes movement to the right
- the required amount of looper thread was drawn into the system before the take up cast off the looper thread
- the needle thread tightens, beginning to pull up the hanging needle loop
- the feed is returning toward the front below the plate

Hand Wheel At 360°

- the needle is bottom dead center
- the looper is at the right position and is avoiding toward the operator

Thread Controls Hand Wheel At 360°

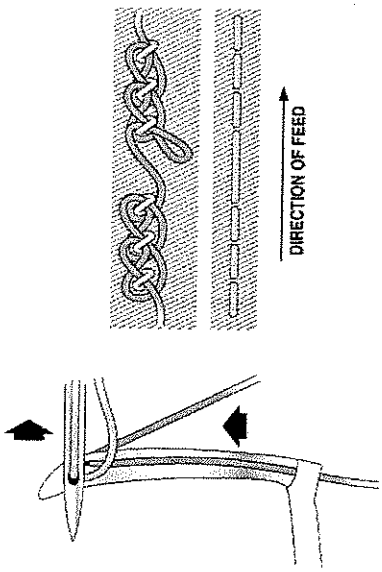
- the looper thread take up is controlling the looper thread giving the required slack as the looper moves left toward the needle
- the needle thread is taught as it moves upward a loop will form on the scarf side of the needle
- the feed is in the lowest position moving to the front of the machine
- during the formation of the next stitch the hanging needle loop will be set on the underside of the material

IDENTIFYING AND CORRECTING IMPROPER STITCHES

SKIPPED STITCHES

The 401stitch is formed by passing the looper loop through the needle loop and then the needle loop through the looper loop or triangle. Therefore, there are two basic types of skip stitches, the "needle loop" skip and the "triangle" skip.

NEEDLE LOOP SKIP



This type of skip may be identified by the needle thread laying tightly on the top side of the fabric and the looper thread twisted around the needle loop of the next properly formed stitch.

The looper missing the needle loop is the cause of this skip. The upward motion of the needle, the needle thread controls, and feed motion pull the needle loop to the top of the fabric.

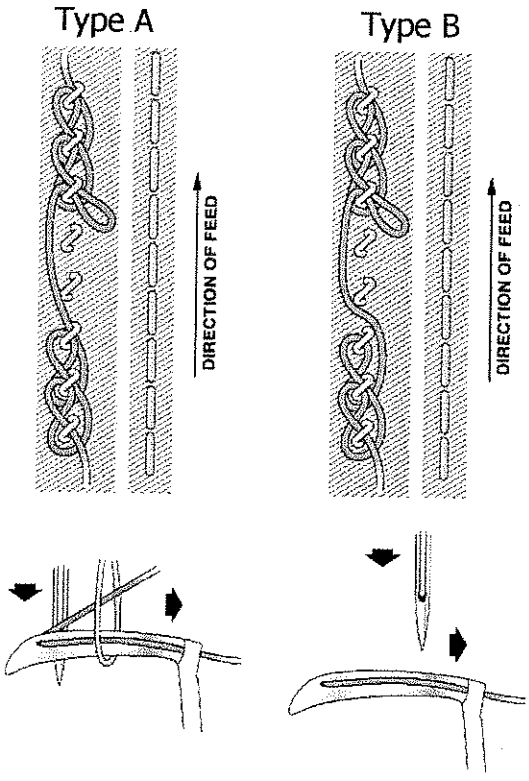
TRIANGLE SKIP

This type of skip can occur on either the "looper thread side" (A) of the triangle or the "needle loop side" (B). Both triangle skips are usually identified by the needle thread loop remaining in the material or lying loosely on the top of the fabric.

However, the looper thread of a skip to the "looper thread side" (A) is not twisted around the needle loop of the next properly formed stitch. The looper thread of a skip to the "needle loop side" (B) will be twisted around the needle loop.

The needle missing the looper loop or triangle at (A) or (B) is the cause of this skip. Because the looper on the motion to the left picked up the needle loop, the needle thread remains in the material or is loose on the topside of the fabric.

Triangle skips



MALFORMED STITCHES

Fig. 40A If the needle thread loop around the blade of the looper is not positioned properly, the needle on its downward travel can enter this loop forming a malformed stitch appearing as a "101" stitch.

Depending on the direction in which the needle loop is twisted on the blade of the looper, the looper thread may or may not be twisted around the needle thread loops.

TROUBLE SHOOTING:

This checklist is recommended to correct the problem in the lease amount of time. Be sure the operator is handling the fabric properly.

RAVELING THE STITCH

It is sometimes necessary to remove a stitch from a seam for repair or alteration. Stitch type 401 will ravel easily if the proper procedure is used. The stitch will only ravel in the direction of feed. The stitch must be raveled by pulling the looper thread. If only the needle thread is pulled the stitch will not ravel.

In pulling the looper thread you must also have the looper thread in the position of pulling its loop from the needle loop. When this position is reached and the looper thread is pulled you should be able to ravel the entire row of stitches by only pulling the looper thread.