DEPARTMENT OF COMMERCE

BUREAU OF STANDARDS

S W. STRATTON, Director

TECHNOLOGIC PAPERS OF THE BUREAU OF STANDARDS NO. 96

[Issued June 25, 1917]

COMPARATIVE TESTS OF STITCHES AND SEAMS

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The stitches produced upon sewing machines most commonly used to-day are of three types—the double-locked stitch; shuttle, also called lock stitch; and the chain stitch. The chain stitch is not employed to the extent that the others are, and no tests were made of it. As shown later in this paper the shuttle or lock stitch does not lock the thread, so hereafter it will be called the shuttle or plain stitch.

The double-locked stitch is produced without the use of a shuttle, and in the formation of a seam all threads are fed directly from original spools or bobbins without any rewinding. The plain stitch is produced by the use of a shuttle which supplies the under thread from a bobbin carried thereby while the upper thread passes through the needle. With this method of stitching the bobbin must be removed from the shuttle to replenish the supply, and sometimes it is necessary to remove the shuttle from the machine. Figs. 1 and 2 illustrate the formation of the two kinds of stitches, and the broken portions of stitching threads show more clearly what might be the effect upon the strength of a seam by the cutting or breaking of certain threads.

In the figures the upper thread is indicated by the letter *A* and the under thread by the letter *B*. The under thread of the double-locked stitch, Fig. 3, is called the looper thread and this particular illustration is to show more clearly the characteristic formation when a heavy understitching thread is used, as in the manufacture of bags, where a flat surface is not essential. If necessary, the looper thread can be made to lay with little or no

ridge on the surface, as shown in the upper illustration of Fig. 1. It is guided into place by a small metal arm, containing an eye through which the thread passes. This arm works back and forth, forming one part of the stitch as the needle works up and down through the fabric. The tension upon the upper thread may be increased to such an extent that the under thread will be partially drawn up into the needle hole, this being particularly true in the shuttle stitch, but in the illustrations the under thread lies flat upon the fabric. These stitches are also illustrated in Figs. 3 and 4.

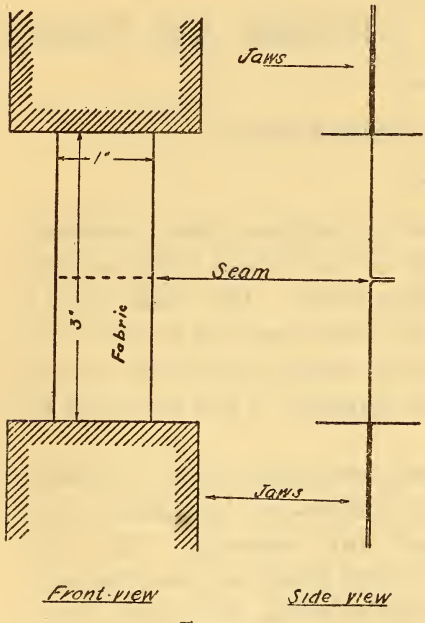
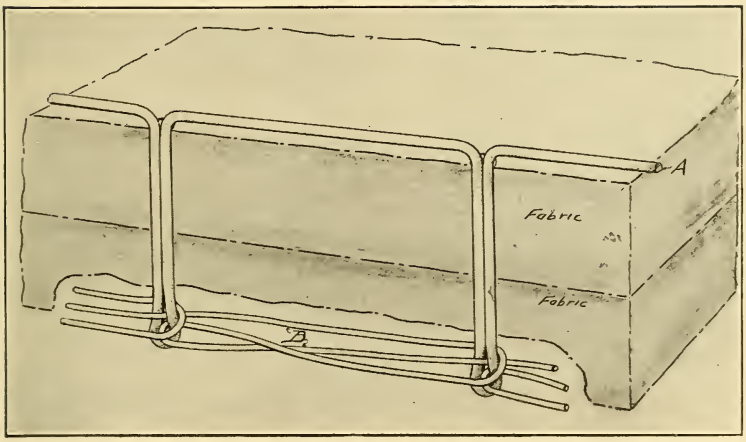


FIG. 5

The results obtained in testing the strength of a seam may depend upon the method used in testing. Factors which may affect the results obtained are the width of the test specimen, the width of the jaws of the testing machine, the length of the specimen between the jaws, and moisture content of fabric and thread. It is believed that the types of test specimens used were such as to give a fair comparison of the strength of the two types of seams tested. Furthermore, all test specimens were exposed at least four hours to an atmosphere containing 65 per cent relative humidity at 21° C (70° F) temperature, and then tested in this atmosphere.

Test pieces were prepared by stitching two large pieces of fabric together with alternate rows, about 4 inches apart, of the two kinds of stitches and then cutting the fabric between the rows. The same number of stitches per inch and, as nearly as is possible in commercial practice, the same tension upon the threads was used in the two methods. Several kinds of fabric and different combinations of thread sizes were employed in stitching to ascertain the effect of thread size on the strength of the seams.

From these seamed pieces tensile-strength test specimens were prepared by cutting the fabric at right angles to the seams, as shown in Fig. 6. The front and side views of the test specimen



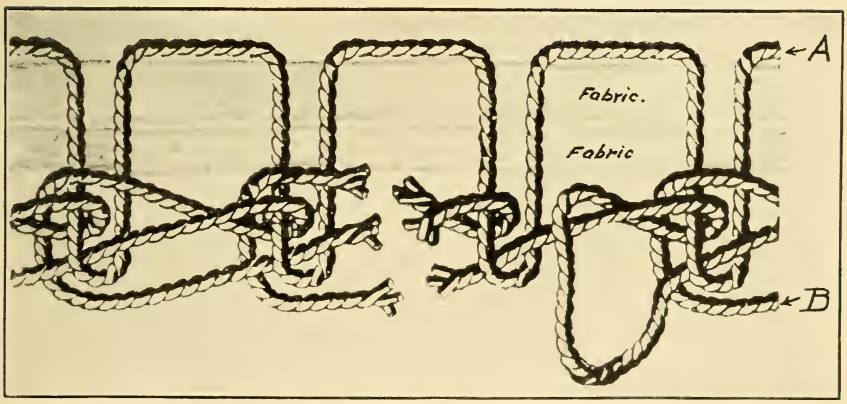


FIG. 1.—*Double-locked stitch*

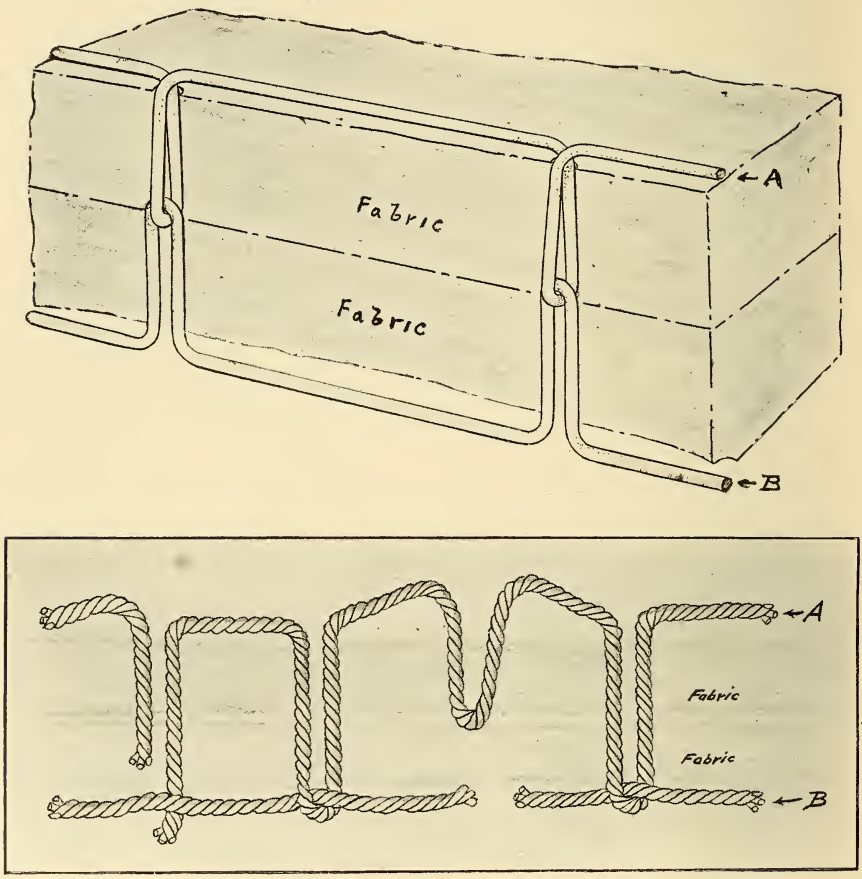
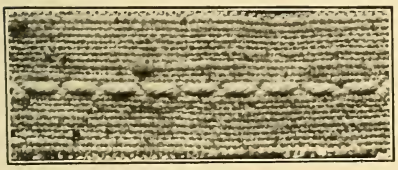
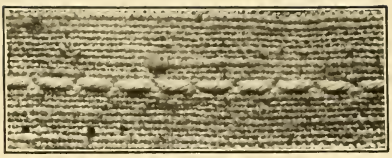


FIG. 2.—*Shuttle or plain stitch*

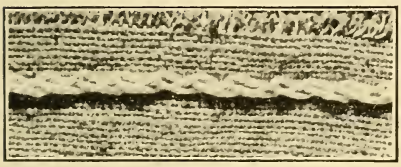


Upper Thread

A

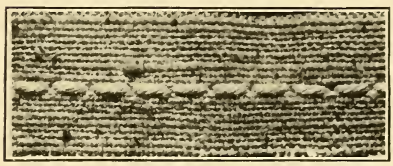


Upper Thread



Under Thread

B



Under Thread

FIG. 3.—*Double-locked stitch*

FIG. 4.—*Shuttle stitch*

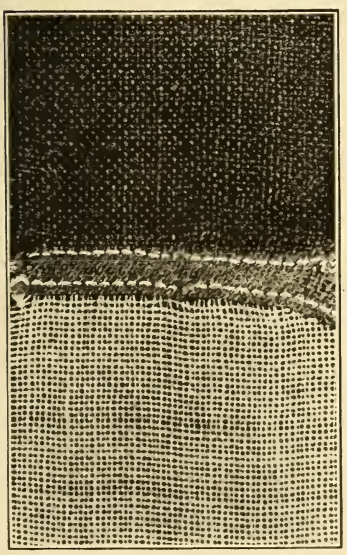


FIG. 6.—*Double-locked stitch seam*

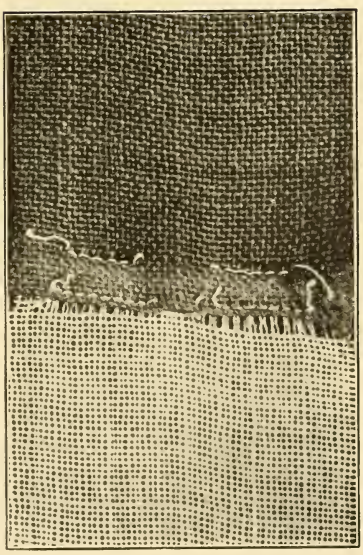


FIG. 7.—*Shuttle stitch seam*

when placed in the jaws of the testing machine are shown in Fig. 5. In Table 1 the average tensions required to separate the two pieces of fabric of the various kinds of test specimens are recorded, each result given being the mean of five tests.

TABLE 1

Tensile Strength of Seams

Test specimens 1 inch wide, 3 inches between jaws of testing machine

Stitch employed, and size of threads used	Seam tests	One stitching thread cut at center of specimen	Loss in strength by cutting of stitching thread
12-OUNCE WOOL UNIFORM CLOTH			
Shuttle stitch:	Pounds	Pounds	Per cent
No. 36 upper thread, No. 36 under thread	11.2	3.5	68.7
Double-locked stitch:			
No. 36 upper thread, No. 36 under thread	23.7	23.7	None
No. 36 upper thread, No. 70 under thread	23.8	22.1	Practically none
No. 36 upper thread, No. 80 under thread	24.2	22.8	Do.
4-OUNCE COTTON SHEETING			
Shuttle stitch:			
No. 36 upper thread, No. 36 under thread	8.6	2.2	74.4
Double-locked stitch:			
No. 36 upper thread, No. 36 under thread	20.0	12.0	40.0
No. 36 upper thread, No. 70 under thread	20.7	11.7	43.4
No. 36 upper thread, No. 80 under thread	23.0	12.1	47.0

In the seam tests of Table 1 the shuttle stitch failed by pulling out of the stitching, while the double-locked stitch failed by breaking of the upper thread. Under the conditions of the tests the shuttle-stitch seam had less than 50 per cent of the strength of the double-locked stitch seam.

By examining Fig. 2 it will be evident that both threads in the shuttle stitch should be of the same size. In the double-locked stitch the under thread is trebled, and it might, therefore, be expected that a much smaller under thread could be used without weakening the seam. That such is the case is shown in Table 1. The strength of the threads used are shown in Table 2.

TABLE 2

Tensile Strength of Threads Used

Thread sizes	No. 36/4[a]	No. 40/3	No. 70/2	No. 80/2
Pounds	3.5	1.9	1.8	1.5

[a] No. 36/4 means a 4-ply thread of size 36.

An examination of the test specimens having No. 80 under thread showed that this finer and weaker thread had been pulled up into the hole formed by the needle. For this reason it is very probable that with the freedom of movement, which is a characteristic of the under thread of the double-locked stitch, the tensions on the upper and under threads of the seam are more uniformly distributed, thereby causing a higher breaking strength of the seam than when a stronger under thread is used.

The relative values of the two types of stitching may be largely dependent upon the extent to which the strength of a seam is affected by the breaking of a thread. Table 1 shows that cutting one stitching thread at the middle of the seam weakened the double-locked stitch less than it weakened the shuttle stitch. Previous results of tests have shown, all other things being equal, that the resulting tensile strength of the seam is the same when either the upper or the under thread is cut. The weakening appeared to depend somewhat upon the kind of fabric used, which may have been due to the extreme narrowness of the test specimens. It is interesting to note that even though the double-locked seam was cut or broken it was still stronger than the uncut seam of the shuttle stitch.

Another series of tests was made on cotton bunting and awning cloth, using somewhat wider specimens than before and both single and double rows of stitching. Preliminary experiments had shown that equal test strengths were obtained when specimens 1½ inches and wider were used in the testing machine with 1-inch jaws. For these experiments specimens 1¾ inches wide were chosen. The results of these tests are given in Tables 3 and 4, which show as before a greater tensile strength for the seams sewed by the double-locked stitch. It was observed that when the tension was applied several stitches pulled out in the seams sewed by the shuttle stitch, but this did not happen in the case of the double-locked stitch. Each result is the mean of three observations.

Comparative tests were also made with specimens in which one stitching thread of each row was cut at the middle. It was found that the shuttle-stitch seam was weakened much more than the double-locked stitch and that the pulling out of the threads in the former stitch caused the seam to give way before the fabric was torn. Photographs of two of these test specimens are shown, Figs. 6 and 7. These illustrate how the threads of the shuttle stitch pulled out while the double-locked stitches remain intact

when the tension was applied. It appears from these tables and figures that the threads of the double-locked stitches are really locked while the shuttle stitches are not. The reason becomes apparent when reference is made to Figs. 1 and 2, which show the structure of the stitches.

TABLE 3

Tensile Strength of Seams of Cotton Flag Bunting

[Test specimens were 1¾ inches wide, 3 inches between jaws, jaws 1 inch wide]

	No. 50 upper thread, No. 50 under thread		No. 50 upper thread, No. 70 under thread		No. 70 upper thread, No. 70 under thread	
	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch
Two rows of stitching.....pounds..	33	38	32	37	23	36
Both rows of stitching were cut...pounds..	13	34	10	34	9	33
Loss in strength by cutting.....per cent..	61	11	69	8	61	8

TABLE 4

Tensile Strength of Seams of 8-ounce Cotton Awning Cloth

[Test specimens were 1¾ inches wide, 3 inches between jaws, jaws 1 inch wide]

	No. 50 upper thread, No. 50 under thread		No. 50 upper thread, No. 70 under thread		No. 70 upper thread, No. 70 under thread		No. 20 upper thread, No. 20 under thread	
	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch
One row stitching, pounds.....	21	49	22	51	14	44	34	52
Two rows stitching, pounds.....	62	63	51	68	52	73	43	62
Both rows stitching were cut..pounds..	48	63	30	64	29	67	24	62
Loss in strength by cutting...per cent..	23	None.	41	6	44	8	44	None.

TABLE 5

Tensile Strength of Seam, in Pounds

[The No. 20 upper and No. 20 lower thread seams were made with 7 stitches per inch; all other seams had 12 stitches per inch; each test specimen was 1¾ inches wide, 3 inches between jaws, 1 inch wide]

WOOL BUNTING

Fabric tests	No. 20 upper thread, No. 20 under thread		No. 50 upper thread, No. 50 under thread		No. 50 upper thread, No. 50 under thread		No. 70 upper thread, No. 70 under thread	
	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch	Shuttle stitch	Double-locked stitch
44	.....	.....	29	43	21	41	20	42

AWNING CLOTH

100	96	96	96	96	79	96	79	96

The figures given in Tables 4 and 5 illustrate some further results obtained from tests made on wool bunting and awning cloth, and show that by such a procedure the method could be utilized to determine the size of thread and kind of stitching which should be employed in order to have a seam approximately as strong as the fabric used. In these series of tests all seams contained two rows of stitching unless otherwise specified. The fabric was firmly clamped about 1 inch on either side of the double seam under test and the cloth extended beyond the width of the jaws of the testing machine about one-half inch on either side. (See Fig. 8.) Test specimens with and without seams were cut 3 inches wide because it had been found that no greater strength would be obtained if the test specimens extended more than one-half of an inch on each side of the jaws. The jaws of the testing machine in these experiments were 2 inches wide.

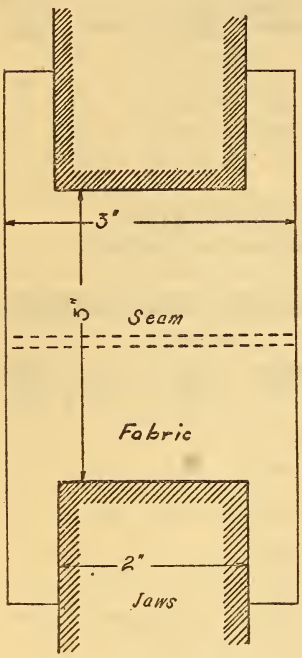


FIG. 8

The seam of the wool bunting made by the double-locked method of stitching and containing two rows of No. 70 upper and No. 70 under thread was practically as strong as the seam having stronger stitching threads. By the shuttle method of stitching the stronger No. 50 upper and No. 50 under stitching thread produced a seam which had about 30 per cent less strength than the double-locked stitched seam. This was true even when the weaker thread was used in the latter stitch.

In the case of the awning cloth, Table 5, the double-locked stitch seam containing the weaker threads was as strong as that produced by the stronger stitching threads, and it is possible that still weaker threads would have given the same result. In the shuttle stitch this was not true.

Under the best conditions of stitching, the fabric is slightly weaker at the seam than elsewhere.

Tests of the two kinds of stitching were also made to determine what tension along the seam was required to break the stitching thread. Test specimens were placed in the jaws of the testing

machine as shown in Fig. 9. Two pieces of wool suiting weighing 9 ounces per square yard were stitched several inches apart and in the biased direction of the fabric, so that when tension was applied along the seam the upper or under thread would break before the cloth. In other words, the cloth in the direction of the stress had a greater stretch than the stitching. Four-ply No. 24 thread which is commonly used in garment manufacturing and which had a tensile strength of 5.4 pounds was used. A tension of 6.8 pounds was required to break the thread in the specimens made with the shuttle stitch and 13.4 pounds was required for the double-locked stitch. This test is of value in showing that the double-locked stitch is more elastic and less likely to be injured by tension along the seam. This is due to the greater freedom of movement of the under or looper thread in this stitch and the smaller shearing action between the two threads.

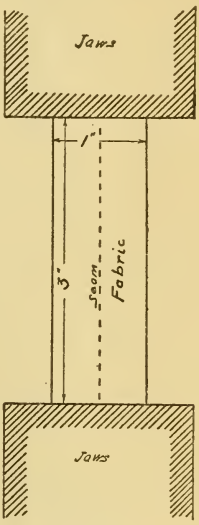


FIG. 9

CONCLUSION

Tests made with a variety of fabrics, thread sizes, and types of test specimens have shown that seams made with the double-locked stitch are stronger and are less weakened by thread breaks than seams made with the shuttle stitch. No attempt was made to compare the two types of stitching in other respects, such as production capacity of the two types of machines, cost of production with special reference to consumption of time, thread, and fabric, deterioration due to wear, etc., all of which must be considered in choosing between different types of stitching.

WASHINGTON, March 20, 1917.