(No Model.) 4 Sheets—Sheet 1.

A. D. EMERY.

METHOD OF WEAVING PLAIN ONE PLY FABRICS.

No. 415,139. Patented Nov. 12, 1889.

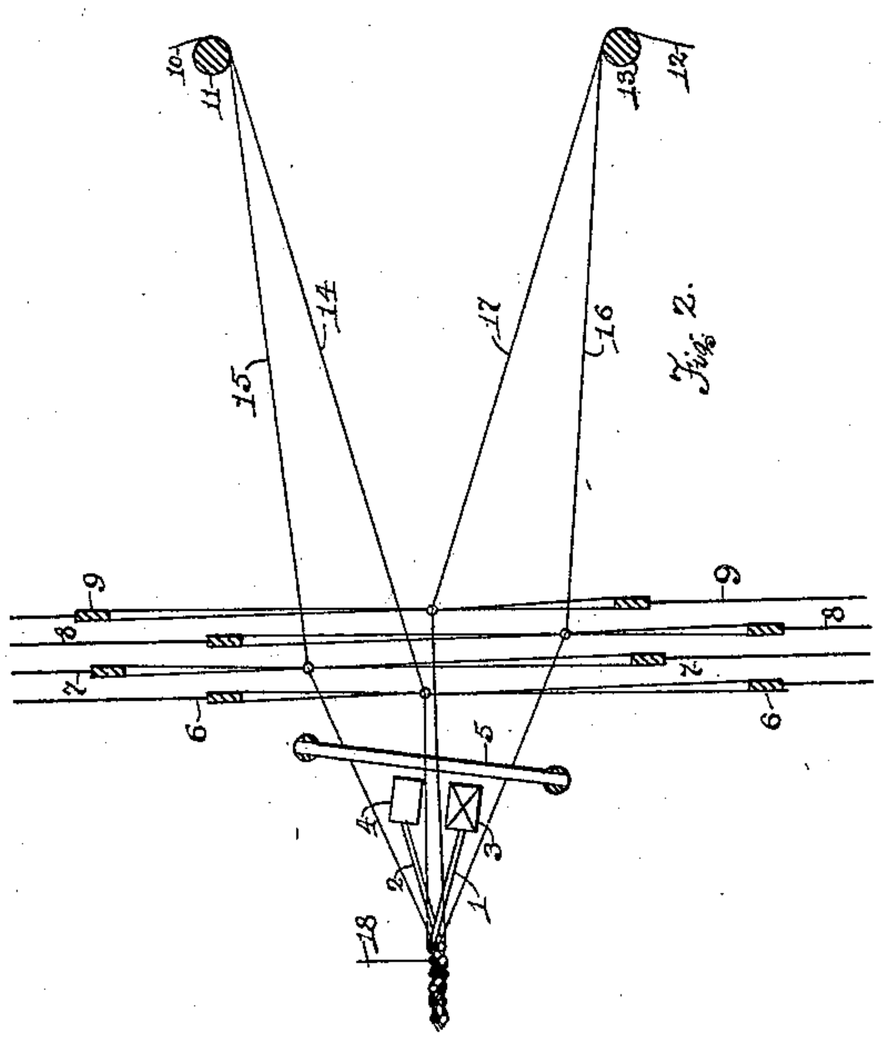

Fig. 2.

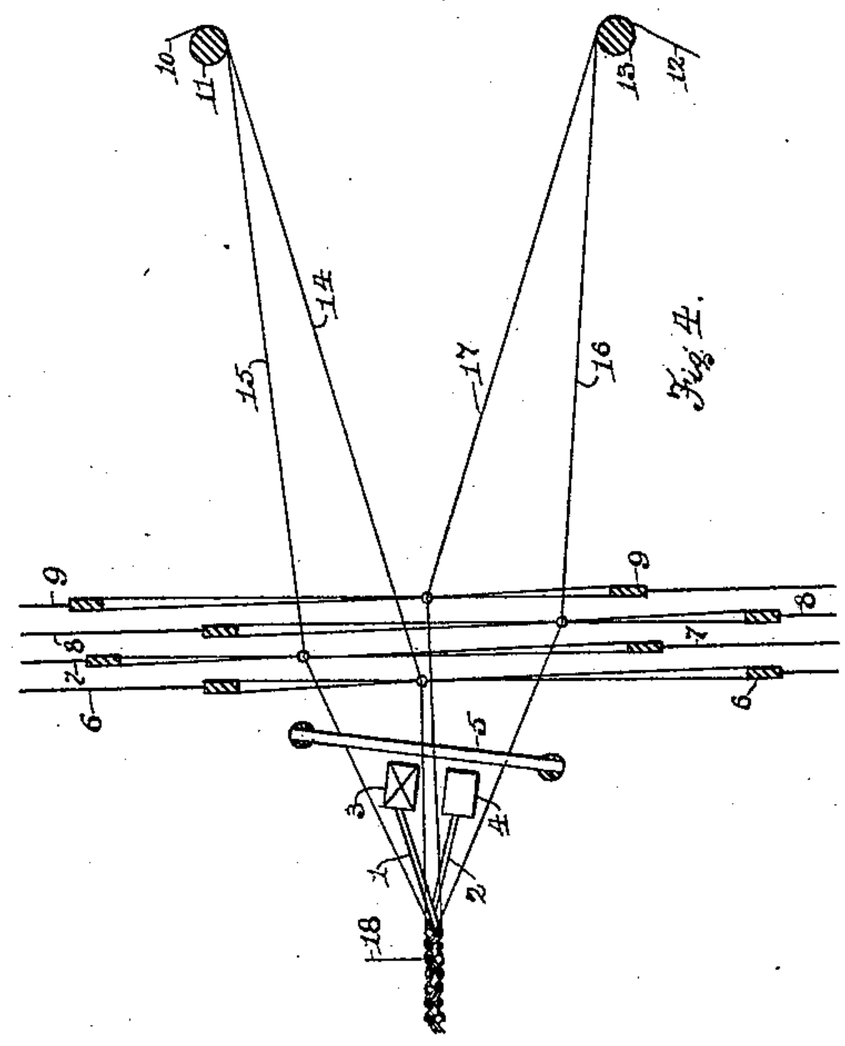

Fig. 4.

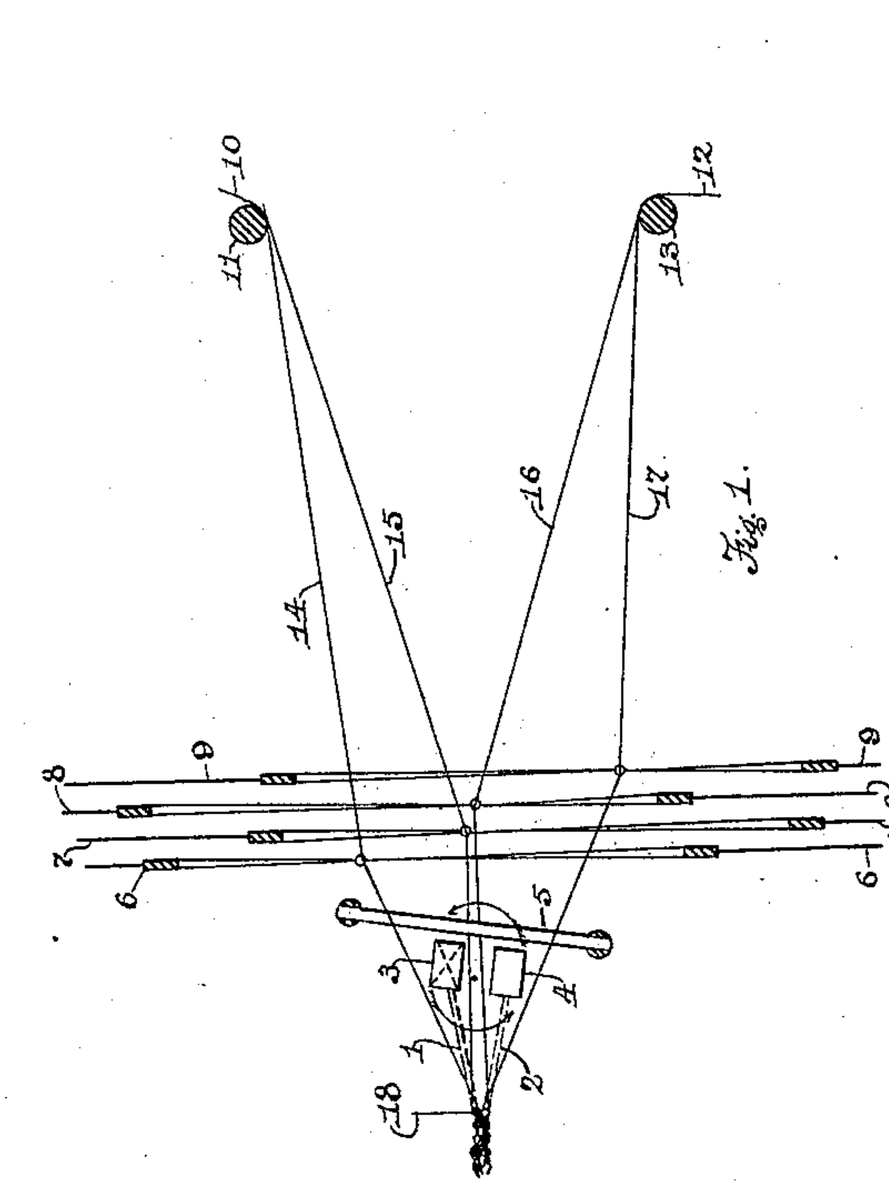

Fig. 1.

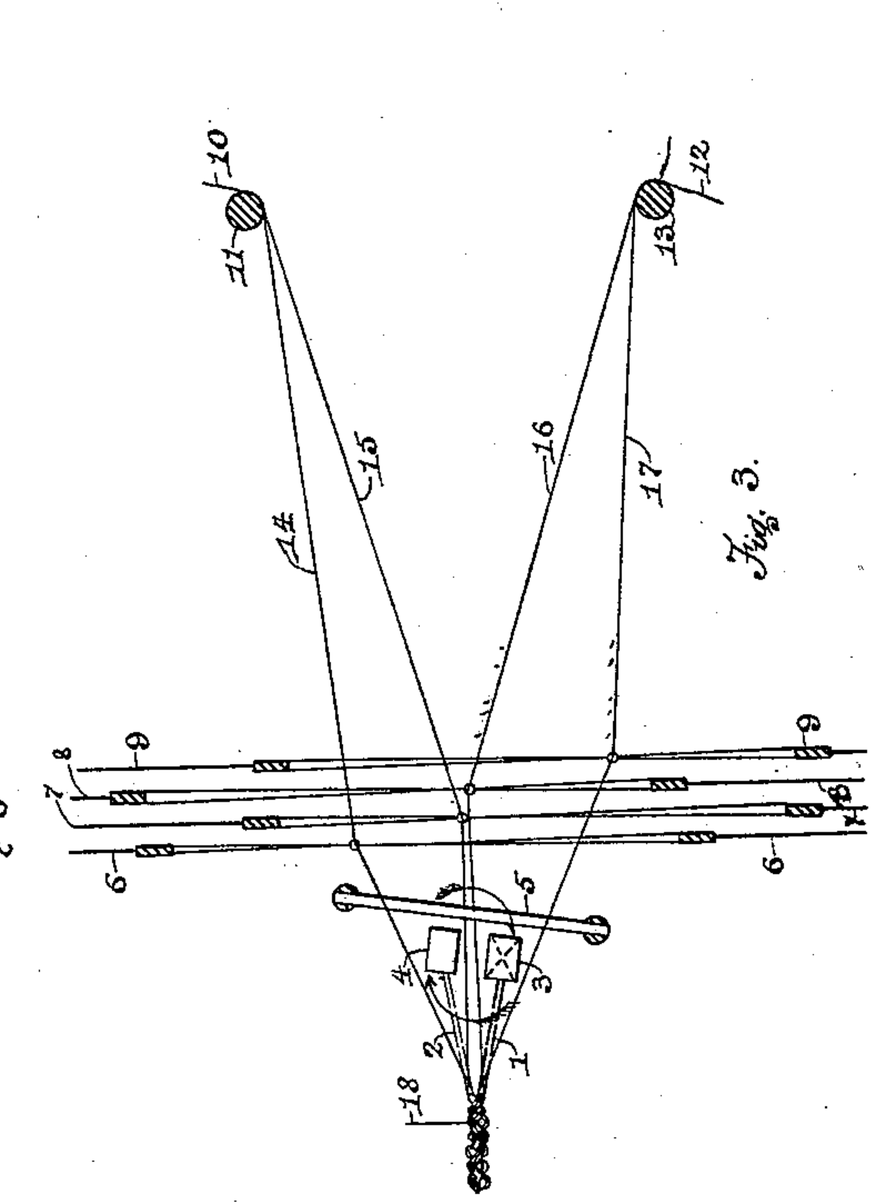

Fig. 3.

Witnesses —
Frans. MacArthur
Henry F. Campbell

Abram D. Emery Inventor —
by Townsend & MacArthur
Attorneys —

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 2.

A. D. EMERY.

METHOD OF WEAVING PLAIN ONE PLY FABRICS.

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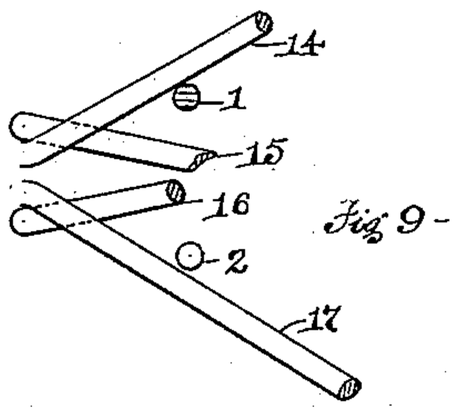
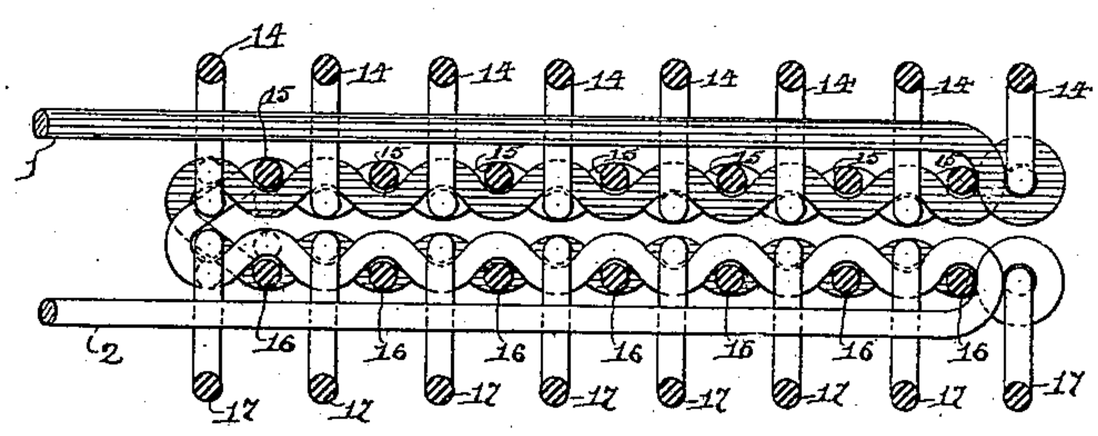


Fig 9-



-Fig. 5-

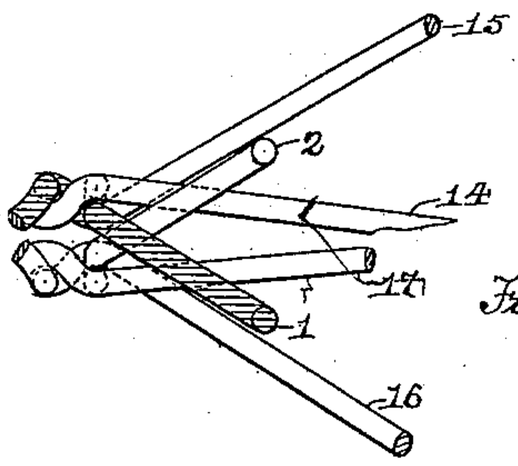


Fig 10-

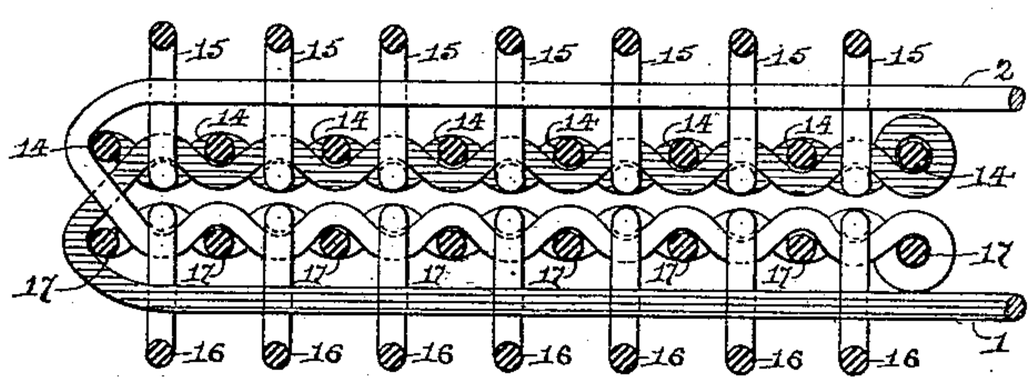


Fig. 6-

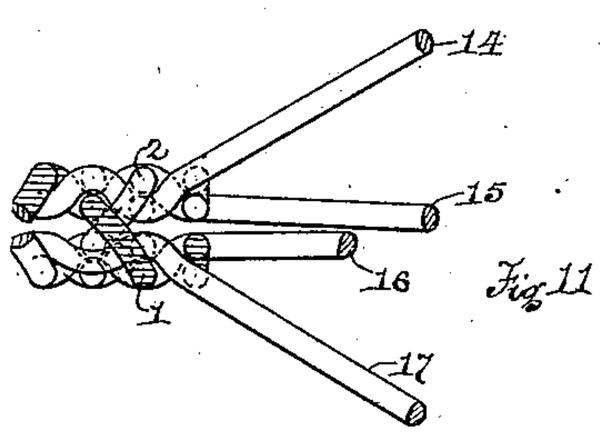


Fig 11

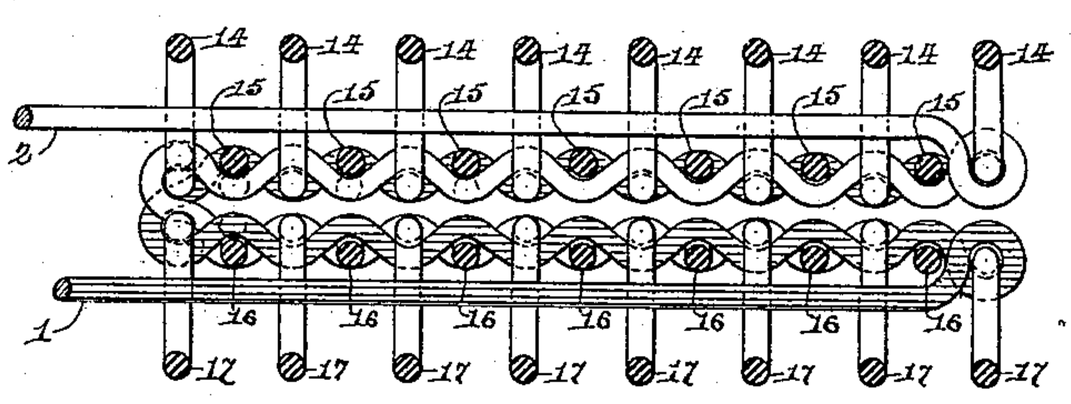


Fig 7-

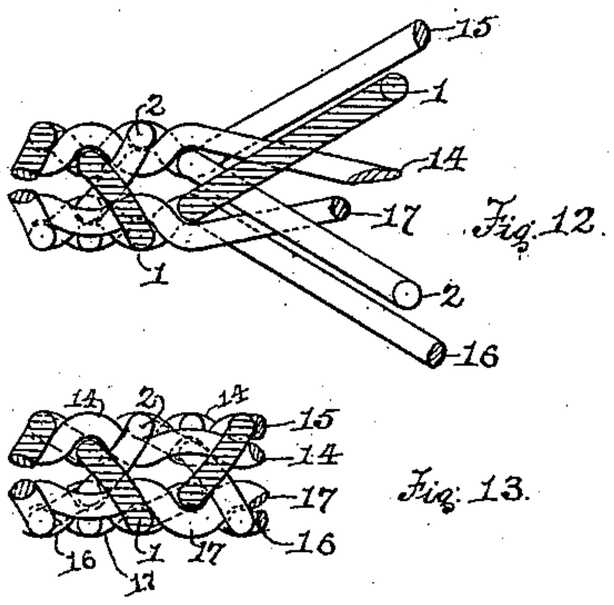


Fig 12.

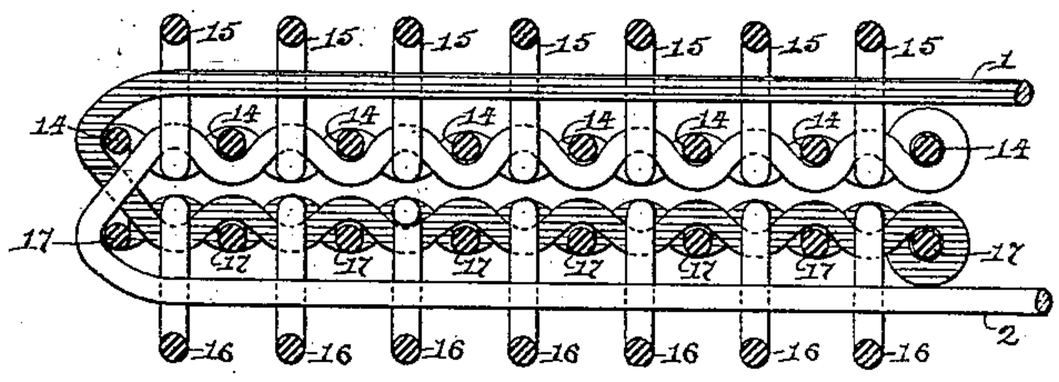


Fig. 8.

Fig. 13.

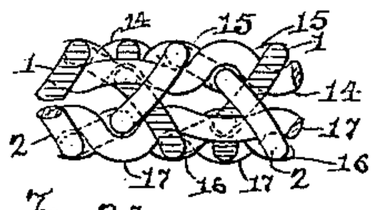


Fig. 24.

-Witnesses-
Francis MacBrien
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Abram D. Emery -Inventor-
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-Attorneys-

N. PETERS. Photo-Lithographer. Washington, D. C.

(No Model.) 4 Sheets—Sheet 3.

A. D. EMERY.

METHOD OF WEAVING PLAIN ONE PLY FABRICS.

No. 415,139. Patented Nov. 12, 1889.

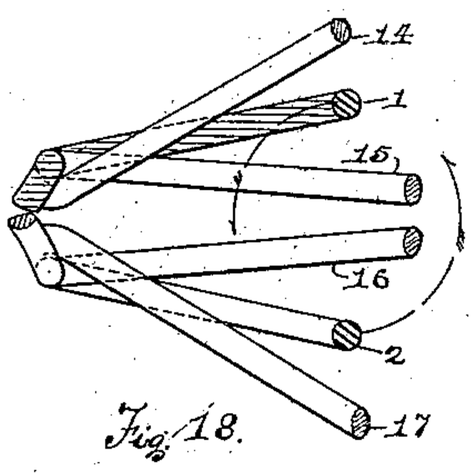

Fig. 18.

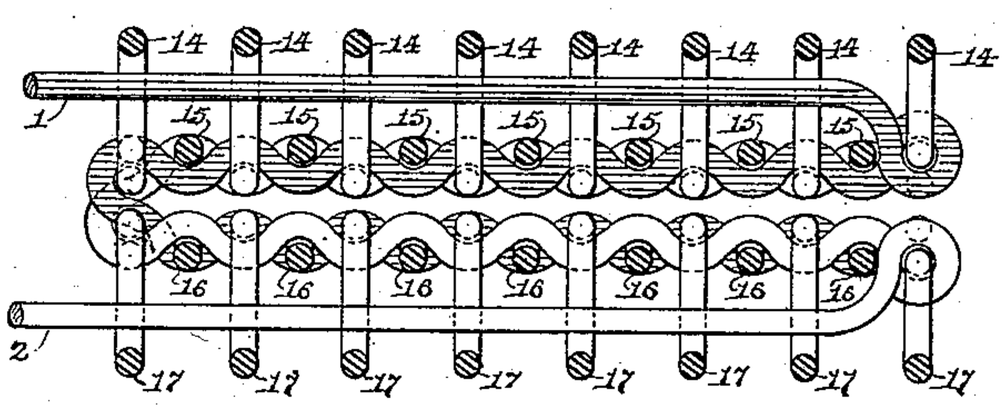

Fig. 14.

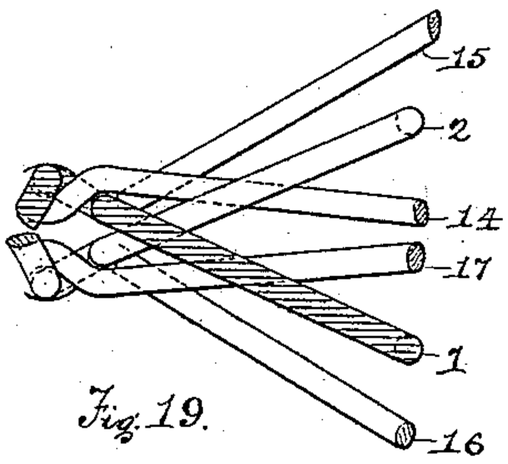

Fig. 19.

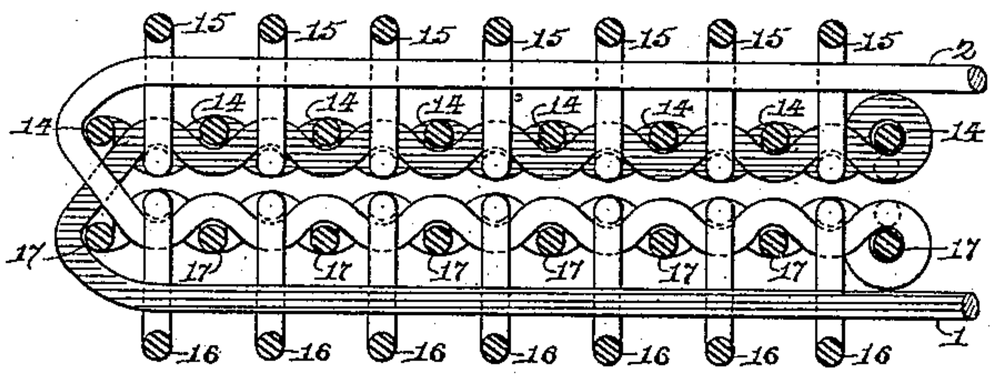

Fig. 15.

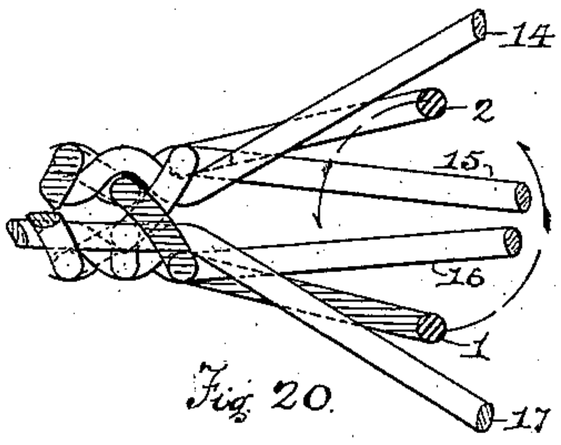

Fig. 20.

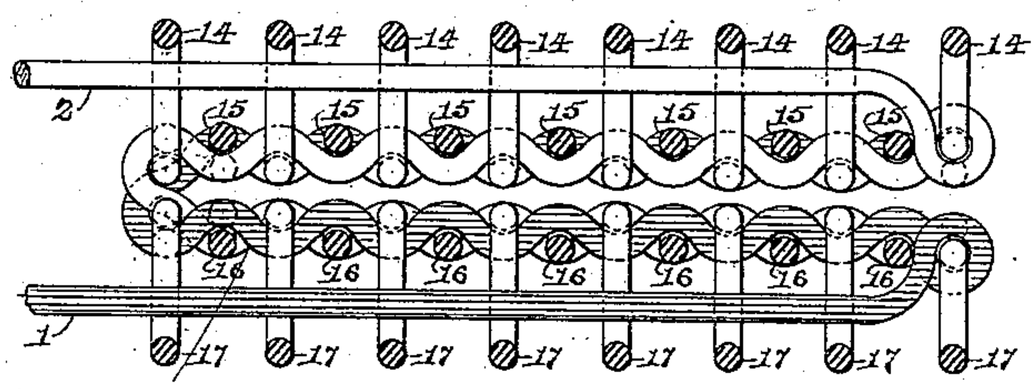

Fig. 16.

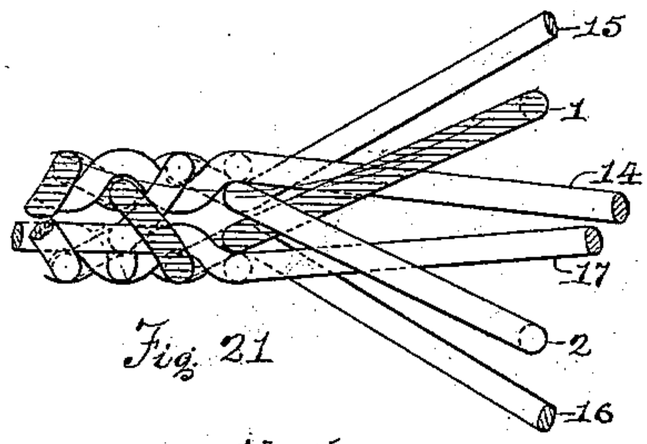

Fig. 21

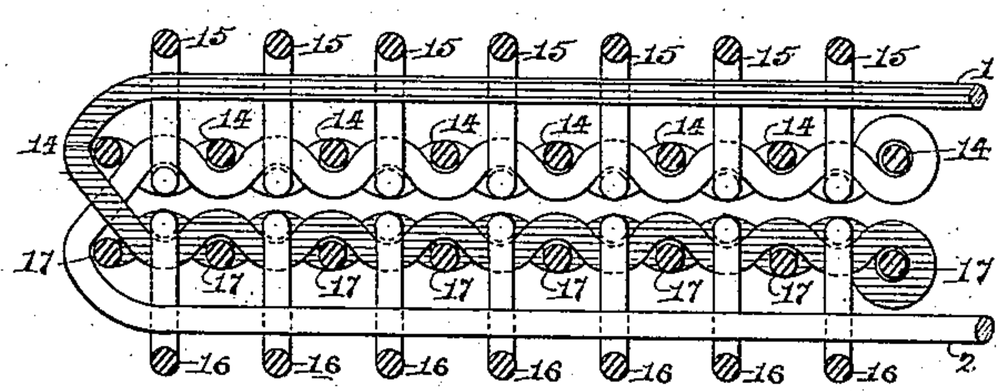

Fig. 17.

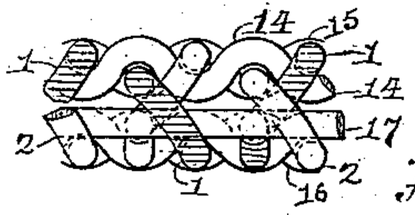

Fig. 22.

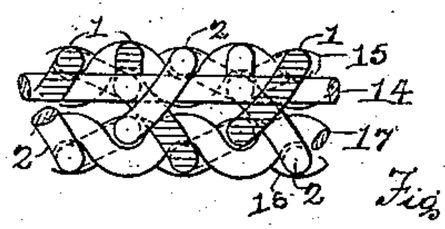

Fig. 23.

Witnesses—
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Thos. H. Cabell

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Attorneys—

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(No Model.) 4 Sheets—Sheet 4.

A. D. EMERY.

METHOD OF WEAVING PLAIN ONE PLY FABRICS.

No. 415,139. Patented Nov. 12, 1889.

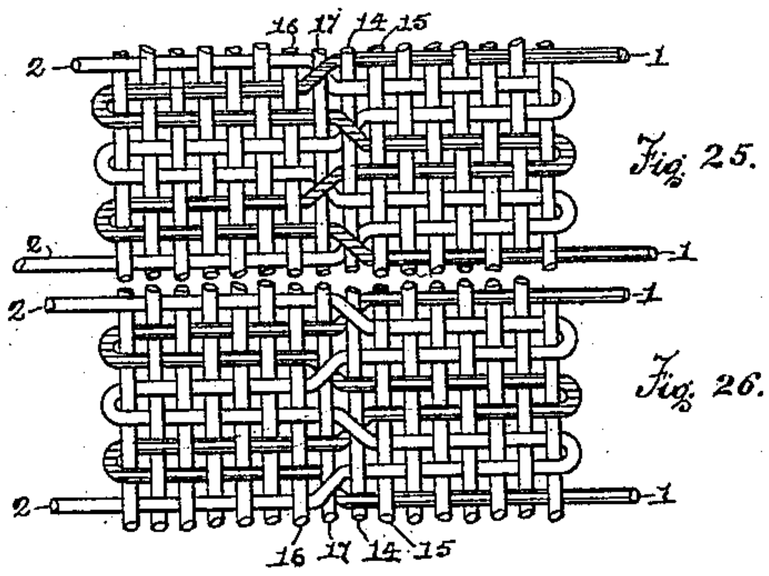

Fig. 25.

Fig. 26.

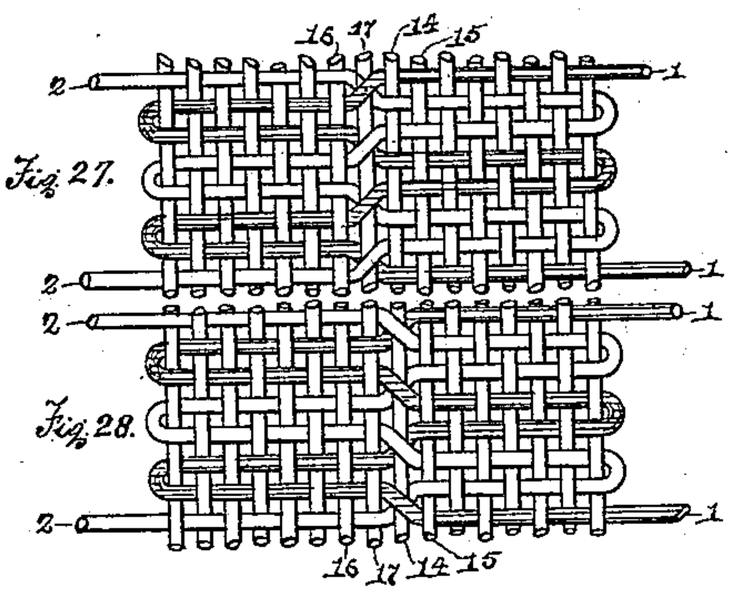

Fig. 27.

Fig. 28.

Witnesses—
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Wm. F. Capel

Inventor— Abram D. Emery
by Townsend & MacArthur
Attorneys

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

ABRAM D. EMERY, OF TAUNTON, MASSACHUSETTS.

METHOD OF WEAVING PLAIN ONE-PLY FABRICS.

SPECIFICATION forming part of Letters Patent No. 415,139, dated November 12, 1889.

Application filed February 28, 1888. Serial No. 265,639. (No model.)

To all whom it may concern:

Be it known that I, ABRAM D. EMERY, a citizen of the United States, and a resident of Taunton, in the county of Bristol and State of Massachusetts, have invented a certain new and useful Method of Weaving Plain One-Ply Fabrics, of which the following is a specification.

My invention relates to certain improvements in the art of weaving, and has for its object the production of woven fabrics provided with two selvage edges, as usual, and of a width considerably greater than the width of the reed employed in the loom, which by existing methods is the limit of the capacity of the machine in this respect.

According to the methods now in use very considerable practical difficulties are encountered in the use of wide looms for the production of extra-wide fabrics. In increasing the width of the loom the path of the shuttle is necessarily increased, and the number of picks per minute—*i. e.*, the number of times per minute the shuttle makes its passage through the chain-threads—is very much diminished, thereby reducing materially the speed at which the fabric is produced.

Another important objection to the use of wide looms is the difficulty encountered in handling the chain-threads in case of breakage or disarrangement. It is also found that there is a practical difficulty experienced in beating up a wide fabric evenly, due to the yielding of the lay-beam, and this is one of the reasons why duck and sail cloth and heavy woolen goods are woven narrow. Furthermore, the strain on the shuttle-thread increases in proportion to the distance it has to be thrown, in consequence of which it is necessary to use a higher grade of material in weaving wide goods than is required in the ordinary-width fabric. This is a considerable item of expense in woolen goods particularly.

It is apparent, of course, that wide looms occupy more space in a mill and are more inconvenient and expensive to handle in every way.

My invention is designed to overcome these objections, and to that end consists, broadly considered, in what I may term "double weaving," or weaving the fabric in two parts simultaneously, one over the other, or side by side, as the case may be, with the two selvage edges on one side of the loom and the turn or center of the fabric on the other side of the loom.

In my present application I shall describe my invention as applied to the production of one-ply fabrics; but it is to be understood that the invention is equally applicable to the production of other kinds of fabrics by modifications of the same, which will in detail form the subject of future applications.

In carrying my invention into effect I use two shuttles manipulated in a novel manner to weave the two parts simultaneously, the chain-threads being shed to form two paths for the two shuttles, the shuttles and weft-threads being passed by each other at the turn or center of the fabric in a novel manner; and accordingly my invention further consists in certain methods and steps of methods incidental and subordinate to the broad invention, as will be more fully described hereinafter, and particularly pointed out in the claims.

As preliminary to a more detailed explanation of my invention, I will again state that the object of my invention is the production of a plain one-ply fabric of extra width as compared with the width of the reed up to a possible limit of twice the width of the reed.

As the fabric lies in the loom it will form three sides of an inclosed space, considering the turn of the fabric as one side, and the open side being the space between the two selvage edges on the opposite side of the loom. When the fabric is opened out, it will be a continuous plain one-ply fabric, with the weft-threads extending from selvage to selvage and crossed at the center or turn of the fabric in a manner which will be hereinafter described. The fabric is practically a homogeneous piece of goods close woven at the center, as throughout its extent, the crossing of the weft-threads at that point being only discernible on a close inspection and not affecting its visual appearance or impairing its quality. The production of such a result according to my invention involves primarily the use of two shuttles and two weft-threads passed simultaneously through the two parts of the fabric and a single set of chain-threads

so manipulated as to form simultanously two paths for the two shuttles at each shedding, each pick or transverse line of weft being made up of two weft-threads, one passed through one path in the shedding to form one part of the fabric and the other passed through another path in the same shedding to complete the pick.

It is obvious that if the shuttles or weft-threads were simply passed back and forth in the same paths in the shedding the result would merely be the production of two fabrics, one over the other, or side by side, as the case might be, and accordingly to produce a single continuous fabric it is essential that the shuttles and the weft-threads should make continuously complete passages from selvage to selvage. This result is accomplished by passing the shuttles and weft-threads by each other at one side of the loom where the turn of the fabric is formed and continuing their respective passages onward to the opposite selvages.

The nature of my invention will now be readily understood if it be considered that it is proposed to pass two shuttles and two weft-threads simultaneously around a three-sided inclosure, the shuttles always making simultaneous passages through two opposite sides of that inclosure, the third side being formed by the operation of passing the shuttles and weft-threads by each other at that point which forms the turn or center of the fabric. Under these conditions it is obvious that the shuttles and weft-threads must always move in the same direction with respect to the loom—that is, they must both move from the selvage side to the center side of the loom, where they pass by each other in their passage to the opposite parts of the fabric, and they both must move away from the center side of the loom to the selvage side after passing by each other, and so on, moving together always in the same direction to and fro. Considered with respect to the fabric, however, the shuttles and weft-threads for the same reasons will always be moving in opposite directions—that is to say, the two weft-threads always leave the center and travel toward the selvage edges which lie in opposite directions from the center in the opened-out fabric. They then return in opposite directions toward the center and leave in opposite directions for the opposite selvages, and so on. Considering the opened-out fabric as made up of the two parts separately formed in the loom, each thread is transferred to the opposite part of the fabric on approaching the center of the fabric, or, which is the same thing, on approaching that side of the loom where the threads pass by each other and where the center of the fabric is formed. Both threads, furthermore, are simultaneously transferred at this point to opposite parts of the fabric. On the other side of the loom the threads are not transferred, but are returned to the center in the same path. The chain-threads are shedded in two pairs, so that at each movement of the shuttles from right to left or left to right there are formed two paths, one above and one below, or side by side, these two paths being in effect, so far as the fabric is concerned, one continuous path from selvage to selvage turned in one direction at the center or turn in the fabric, one-half of the path being filled by one weft-thread and the other half by the other weft-thread. At the succeeding shedding the chain-threads are crossed over the preceding pick and two paths are formed, as before. By this method the weft-threads, having made a passage through a part or half of the fabric, and having met at the center, and having there been passed by each other, will next make a passage through a succeeding shedding, so that at the center of the fabric the weft-threads are not only passed by each other, but are crossed, one over and one under, in their passage to the succeeding shedding, as will be more fully explained hereinafter.

I have discovered that the relation of the weft-threads in crossing of over and under may be varied at will by altering the relation of the threads in passing by each other at the center, as by causing one or the other to lie next the cloth and the other next the reed at that point, as hereinafter explained—that is, the thread which lies next the cloth at that point will pass over the thread lying next the reed in its passage to the next succeeding shedding. It will be understood, therefore, that the crossing of the threads at the center of the fabric is incidental to the fact that the weft-threads not only pass by each other at the center, but are then passed into a succeeding shedding. I have also discovered that the relation of the weft-threads in crossing the chain-threads forming the center of the fabric may be modified by varying the system or order according to which of the weft-threads pass over and under the chain-threads at the center.

In this specification I shall describe a system of shedding wherein a weft-thread uniformly passes under the last chain-thread of the part of the fabric which it is leaving and over the first chain-thread of the part of the fabric which it is entering. My invention is not, however, limited to that particular form of shedding, but consists, essentially, in this respect of crossing the weft-threads one over and one under.

It will be apparent from the description so far that there will be four sheddings and four flights of the shuttles to complete the passage of the shuttles from and back to an initial position. In a complete sequence of operations two shuttles will pass simultaneously, say, from an upper and lower selvage edge at the rear of the loom through the two halves of the fabric to the front of the loom, one shuttle carrying a weft-thread through the upper part of the fabric and the lower shuttle carrying a different weft-thread

through the lower part of the fabric. The threads are then passed by each other at the front of the loom, and are crossed one over and one under in their passage to the second shedding, in which the top thread is carried through the lower part of the fabric and the bottom thread through the upper part of the fabric. At the third shedding the threads are carried back to the center through the parts just traversed, and are then passed by each other and crossed as before by their passage through the fourth shedding to their original position.

My invention depends, essentially, on the simultaneous passage of the two shuttles in the same direction and their passage by each other on one side of the loom. This passage of the threads by each other may be effected in any convenient manner by hand or otherwise. Practically it amounts to a reversal of the shuttles in position, or a transfer of the shuttles from an upper to a lower position, or the reverse. The result may be conveniently obtained by imparting to the shuttles a relative movement with reference to each other approximating a movement of revolution upon a common center. This movement of revolution will result in transferring the bottom shuttle to the top and the top shuttle to the bottom, and thus passing the threads by each other and into position to make a passage through the opposite parts of the fabric. By this means, also, the relation of the threads in passing by each other with reference to the cloth and reed may be controlled so as to alter at will the order or system according to which the threads will cross in the completed fabric. Thus a particular thread would lie next the cloth or next the reed in passing, according as its shuttle-box and shuttle are revolved toward the cloth or toward the reed. It will be evident, of course, that the direction of revolution, assuming that a particular thread is to be placed next the cloth in passing, will be determined by the consideration of whether its shuttle is in the lower or upper position, the top shuttle being turned toward the cloth by a movement of revolution directly opposite to that by which a bottom shuttle will be turned toward the cloth.

The methods of weaving which I have now described generally are independent of the particular devices or instrumentalities by which they may be carried into effect, inasmuch as those devices and instrumentalities may be varied according to the circumstances of the case without departing from the spirit of my invention, and in detail will be made the subject of future applications for Letters Patent.

I have illustrated in the accompanying drawings, and will hereinafter describe, some of the ways in which my invention may be carried into effect.

In the accompanying drawings, forming a part of this specification, Figures 1, 2, 3, and 4 illustrate diagrammatically the component parts of a loom, so far as they are essential to the understanding of my invention, arranged to illustrate the four sheddings and flights of the shuttles which complete the sequence of operations in my method of weaving. Figs. 5, 6, 7, and 8 illustrate in cross-section the positions of the various threads of the fabric in the corresponding figures on the first sheet of drawings as they appear separated and enlarged. Figs. 9, 10, 11, and 12 are enlarged end views of the several sheddings, taken from the side on which the center of the fabric is formed, and are designed to illustrate more fully the crossing of the threads at that point. Figs. 13 and 24, Sheet 2, represent a side view of the middle edge of the fabric when completed, showing the position of the threads for a portion of the continuous fabric. Figs. 14, 15, 16, and 17 correspond to Figs. 5, 6, 7, and 8, respectively, and, as compared with those figures, show the result of altering the method of reversing the shuttles by always turning the shuttles in one direction—that is, over toward the fabric at the top and away from the fabric at the bottom. Figs. 18, 19, 20, and 21 correspond to Figs. 14, 15, 16, and 17, respectively, and are end views of the same, taken from the side on which the center of the fabric is formed, and enlarged to show the crossing of the threads. Fig. 22 is an edge view of a fabric formed by the method of reversing illustrated in the last preceding figures, enlarged to show the position of the threads. Fig. 23 is an edge view of a fabric formed by revolving the shuttles uniformly from the bottom toward the fabric and from the top away from the fabric, of which fabric Fig. 34 is a plan view of the same opened out. Fig. 24 is described above. Fig. 25 illustrates a full-width fabric opened out, which is seen in edge view, Fig. 13, and made by always revolving the same shuttle toward the cloth. Fig. 26 is a corresponding view of a fabric opened out, formed by reversing the action of the last figure, of which Fig. 24 is an edge view. Fig. 27 shows a full-width fabric opened out, of which Fig. 22 is an edge view, and made by always turning the shuttles over toward the cloth on top and away from the cloth on the bottom. Fig. 28 is a view of a full-width fabric opened out, of which Fig. 23 is an edge view, and formed by turning the shuttles uniformly from the bottom toward the fabric and from the top away from the fabric.

For the purpose of facilitating a detailed description of the operations of the devices one of the weft-threads is designated by the numeral 1 in all the drawings, and is shown as shaded. The other weft-thread is designated by the numeral 2, and is shown as plain.

Referring now more particularly to Figs. 1 to 4, the numerals 14, 15, 16, and 17 designate a series of warp-threads divided into an upper chain 10, which passes over a whip-roll 11, and a lower chain 12, which passes over a whip-roll 13. The series of threads which will

be outermost on the front and rear of the loom are designated by the numeral 14 in the upper shedding and by the numeral 17 in the lower shedding, as will be seen more clearly in Figs. 5 to 8 and 14 to 17. The series of warp-threads indicated, respectively, by the numerals 14, 15, 16, and 17 are controlled, respectively, by the heddles 6, 7, 8, and 9, the heddle 6 controlling one half of the upper chain, (designated by the numeral 14,) the heddle 7 controlling the other half of the threads, (designated by the numeral 15,) the heddle 8 controlling the one half of the threads of the lower chain, (designated by the numeral 16,) and the heddle 9 controlling the other half of the threads of the lower chain, (designated by the numeral 17.) The heddles move in pairs, shedding the upper chain and the lower chain simultaneously to form two paths for two shuttles, (indicated by the numerals 3 and 4.) The shaded weft-thread 1 is indicated as attached to the shuttle 3, and the plain weft-thread is indicated as attached to the shuttle 4.

Numeral 5 indicates the reed through which the chain-threads pass in the ordinary manner, and which is made deep enough to accommodate the two sheddings or paths for the shuttles.

18 indicates the completed fabric.

The numerals 3 and 4 indicate the shuttles, which are in practice received in shuttle-boxes located at the front of the loom, where preferably the turn or center of the fabric is formed, and in practice constructed so as to be reversible in position for the purpose of passing the shuttles and weft-threads by each other from the top to the bottom and from the bottom to the top, respectively, for the purpose of weaving a continuous fabric at that point. These reversible shuttle-boxes are one of the possible means of passing the threads by each other at the center, but form, of course, no essential part of my invention.

I have not deemed it necessary for the purpose of illustrating my present invention to show the shuttle-boxes or the mechanism for revolving the shuttle-boxes, it being understood that the mechanism is capable of reversing the position of the shuttles and passing the threads by each other by a movement approximating a movement of revolution, as described, so that the shuttles will be reversed in position and their respective weft-threads passed by each other at the center of the fabric, preparatory to the next passage of the shuttles. Thus the shuttle-boxes might be mounted on opposite ends of an axis pivoted half-way between the said boxes, or other means might be employed for producing substantially the same result. The opposite shuttle-boxes at the rear of the machine, where the selvage edges of the fabric are formed, may be stationary, as they are designed merely to receive and return the shuttles in the same paths.

As before said, the sequence of operations according to my invention consists of four successive sheddings and four passages of the shuttles to complete the passage of a weft-thread from and back to an initial position and through the two halves of the fabric. This sequence will be the same from whatever point it may be assumed to begin.

In the drawings I have assumed, for the sake of illustration, that the shuttles in Fig. 1 have just been driven from the rear selvage edge to the front of the loom. Preliminary to this passage of the shuttles and weft-threads the heddles 6 and 8 were raised, as shown, and the heddles 7 and 9 depressed, heddles 6 and 7 shedding the upper chain-threads 14 and 15 for the passage of the upper shuttle 3, and the heddles 8 and 9 shedding the lower chain-threads 16 and 17 for the passage of the lower shuttle 4. The shaded thread is represented as extending from the top selvage on the rear of the loom to the shuttle 3 at the front, and the plain thread 2 as extending from the bottom selvage on the rear to the shuttle 4 at the front. The threads are in position to be beaten up by the reed 5 into the fabric 18 and form the first pick—that is, there will have been shot through the fabric weft-threads extending from edge to edge, which will consist in the upper half of the shaded weft-thread 1 and in the lower half of the plain weft-thread 2. In this position the two outside chain-threads 14 and 17, as shown more fully in Fig. 9, are lifted and depressed, the weft-thread 1 passing under the chain-thread 14, and the weft-thread 2 passing over the chain-thread 17, in their respective sheddings. While the reed is beating up the shuttles 3 and 4 are reversed in position to pass the weft-threads by each other to the opposite parts of the fabric, as indicated in Fig. 2, the top shuttle being carried to the bottom and the bottom shuttle to the top by the movement of revolution indicated by the arrows in Fig. 1—that is, the movement is such that the shuttle 3 is turned over toward the cloth and the shuttle 4 is turned away from the cloth and toward the reed. The second shedding operation is then performed by depressing the heddles 6 and 8 and elevating the heddles 7 and 9, thereby forming, as before, two paths for the shuttles, one above and one below, the threads 15 being carried to the top of the upper chain and the threads 14 below, and the threads 16 and 17 of the lower chain being correspondingly changed in position, so as to cross the chain-threads of both sheddings over the pick of weft-thread which has been carried through the fabric by the previous operation. This forms a plain crossing by which the two outside threads of Fig. 1 are carried to the center and the two adjoining inside threads to the outside on the top and bottom, respectively.

In Fig. 2 the shaded weft-thread 1 is shown beaten up in place in the top half of the fabric, where it was laid by the passage of the shuttle 3, as indicated in Fig. 1, and the plain

thread 2 is shown in the bottom half, where it was laid by the passage of the shuttle 4 in Fig. 1.

In Fig. 2 the shuttles are shown as having passed from the front to the rear, and the threads are then beaten up into the fabric, as indicated in Fig. 3, with the shaded thread in the lower half and the plain thread in the upper half.

Referring now to the reversal of the shuttles and the passage of the weft-threads by each other at the center, it is evident that the weft-threads will pass by each other at this point, and that on their passage into the next shedding they will be crossed, speaking generally, between or about the chain-threads 14 and 17, which are the extreme threads to the front of the loom, and which form the center threads of the fabric. This crossing of the weft-threads will not affect their relation to the chain-threads in the respect that the weft-threads pass over and under the chain-threads in regular order—that is, the weft-threads will pass under 14 and over 17 in the next shedding, or vice versa, according to the predetermined sequence, for the reason that the shedding is such that a thread having passed under the thread 14 will pass over thread 17 of the next-succeeding shedding, or vice versa. This is seen in Fig. 25, which shows opened out flat the completed fabric made by the particular manner of turning the shuttles and crossing the threads which is now being described. By tracing the weft-threads in said Fig. 25 from right to left or left to right it will be observed that they pass over and under the chain-threads in regular order throughout the fabric at the center as elsewhere. In other words, the operation of passing the threads by each other and crossing them has no tendency to alter the sequence of the chain-threads, and it will be found that the same effect in this respect is produced by the several variations in the manner of reversing and crossing the threads, which will be hereinafter referred to as exemplifying my invention, as may be seen by inspection of Figs. 25 to 28.

In turning the shuttles by the movement so far described the shaded thread 1 is carried over toward the cloth and the plain thread 2 toward the reed, so that at the point of passing by each other the thread 1 is next the cloth and the thread 2 next the reed. From this it results that the shaded thread is laid over or crosses over the plain thread at that point in the finished fabric when the threads are beaten up in place, as indicated in Fig. 3, considering the outer faces of the fabric as it lies in the loom as the surface of the finished fabric. The turning of the thread in passing toward the reed is in effect a turning under with respect to the surface of the finished fabric, and the turning toward the cloth is a turning over or exposing of that thread in the same sense. The crossing and turning over and under of the threads are not due merely to the manner in which the threads pass by each other with respect to the cloth and reed, respectively, but also to the fact that in the further continuation of the weavings the threads are both carried toward the reed and away from the cloth already woven when inserted at the next pick, and will each be nearer the reed at the next pick by the thickness of the preceding pick. If it be conceived (it being of course impossible in actual practice) that the weft-threads after the change of position of the shuttles occasioned by the semi-rotation of the shuttle-boxes then passed backward through the fabric already woven, through the shedding next preceding that of their last passage, then an opposite result would be produced and the thread next the reed would be uppermost. If, on the other hand, the threads passed neither forward nor backward into adjacent sheddings in the fabric, but through the same shedding, then the threads would not cross at all, but would lie in parallel lines in the same vertical plane, one thread being above the other in the one portion of the fabric and beneath it in the other portion thereof as the fabric is formed in the loom, as will be clearly understood on reference to my application for Letters Patent for improvement in the art of weaving double-ply fabrics filed March 6, 1889, Serial No. 302,145.

The present process of weaving now described may be regarded as consisting, essentially, in winding two threads around a three-sided inclosure, the threads starting simultaneously from and returning to the opposite edges of the open side of the inclosure and meeting and crossing at the center or closed side of the inclosure in their passage to and from the edge of the open side of the inclosure from which they started. Under these circumstances it is evident that the thread which, as the threads are passed by each other at the point of crossing, lies nearer the plane containing the point of departure will pass over the other thread and be on the surface of the completed winding; but this is precisely the condition of things brought about by turning a shuttle toward the cloth. The weft-thread carried by that shuttle is placed nearest the plane of the point of departure, (which is on the cloth side,) and passes over the other thread in its passage toward the reed side in the next pick. It is evident that this holds true whether the shuttle is turned toward the cloth from above or below, as may be seen in Fig. 25. In the first crossing (shown at the top of this figure) the shaded thread 1 is shown as passing over the plain thread 2 in its passage from the right-hand side of the fabric, which is the uppermost half as it lies in the loom, to the left-hand side, which is the lower half as it lies in the loom. In the next crossing, which (as will be described) is made by turning the same shuttle from below toward the cloth, the shaded thread 1 is seen crossing over plain

thread 2 in its passage back to the top half of the fabric. (Shown in the figure on the right-hand side.) The same will hold true throughout Figs. 25 to 28, the varieties of fabrics shown in these figures being made by modifying the order or system according to which the shuttles are revolved toward or away from the cloth, and it will be seen that whenever a shuttle is turned toward the cloth its weft-thread will cross over the other thread. It will be noticed, however, referring now to Fig. 25, that in the first crossing, (shown at the top of the figure,) made by turning the top shuttle toward the cloth, the crossing takes place around the outside thread 17 of the lower shedding, the thread 14 being held in the crossing between threads 1 and 2, and that in the second crossing, made by turning the lower shuttle toward the cloth, the crossing takes place around the outside thread 14 of the upper shedding, the thread 17 being held in the crossing between threads 1 and 2. This will be readily understood from the explanations already made and from inspection of Figs. 5 to 12 and 14 to 21, where it will be seen that a thread in passing from one half of the fabric to the other always passes under the last thread—14 or 17, as the case may be—of the half of the fabric which it is leaving, and over the first threads 17 or 14, as the case may be, or the other half of the fabric which it is next to traverse. Thus a shuttle or thread turned toward the cloth from above will, as already explained, cross over the other thread; but by the arrangement of the shedding it must pass under the outermost thread 14 of the upper shedding which it is leaving. It must therefore in crossing over the plain thread cross over the chain-thread 17 of the lower chain, the plain thread, by the same reasoning, passing under the same. The same holds true throughout the modified fabrics, (shown in Figs. 25 to 28,) in all of which it will be seen, first, that the regular sequence of chain-threads of over and under alternately is preserved throughout; second, that the thread turned toward the cloth in reversing crosses over the other thread, and, third, that a thread in crossing over crosses over the outside thread of the next shedding and the other thread beneath the same, while the other chain-thread 14 or 17, as the case may be, is held in the crossing of the threads 1 and 2. Briefly, if a thread is revolved toward the cloth from beneath, it will cross over the other thread with the thread 14 between, and if it is revolved toward the cloth from above it will cross over the other thread with thread 17 between.

Referring again to Figs. 1 and 2 and to Figs. 6 and 10, illustrating the effect of the first reversal of the shuttles by turning the top shuttle toward the cloth, the shaded thread 1 is seen first to pass in regular order over and under the chain-threads—that is, over 15, under 14, over 17, and under 16. The thread 2 at the same time passes under 15, over 14, under 17, and over 16. The thread 1 is, furthermore, carried next the cloth at the point of crossing, as seen in Fig. 10, so that when Fig. 6 is opened out flat, as seen in Fig. 25, the thread 1 will cross over thread 2 and be uppermost in the fabric. So by the arrangement of the chain-threads the thread 1 passes under the chain-thread 14 of the shedding which it is leaving and over 17, and as thread 2 for the same reason passes under thread 17, which it is leaving, and over 14, as shown in Figs. 6 and 10, the fabric opened out, as seen in Fig. 25, will show that thread 1 crosses over thread 17, and thread 2 crosses under the same, and that thread 14 is held in the crossing between the two threads 1 and 2.

In Fig. 2 the shuttles are indicated as having passed from the front to the rear, where they are supposed to rest, with their corresponding threads extending from the front to the rear and in position to be thrown again to the front, as shown in Fig. 3. Preparatory to this traverse of the shuttles the chain-threads are shedded, as in Fig. 1—that is, heddles 6 and 8, with threads 14 and 16, are lifted, and heddles 7 and 9, with threads 15 and 17, are depressed. The preceding pick or traverse of the vertical threads is also shown in this figure as driven home, shaded thread 1 in the bottom half of the fabric and plain thread 2 in the top half, the plain thread 2 extending from the top selvage in the rear to the shuttle in front and the shaded thread 1 from the rear to the front.

It will be understood that in the enlarged views Figs. 7 and 11, Sheet 2, threads 14, 15, 16, and 17 occupy the same position as in Figs. 1, 5, and 9, while the weft-threads 1 and 2 occupy the same relative positions in reference to threads 14, 15, 16, and 17, only reversed in actual position—that is to say, of the said threads 1 and 2 each respectively occupies the positions with reference to the other and to the chain-thread that was formerly occupied by the other thread, thread 1 being between threads 16 and 17, and thread 2 being between threads 14 and 15. While the reed is beating up the shuttles are again transferred or passed by each other in the direction indicated by the arrows, Fig. 3, to the position as indicated in Fig. 4. The transferring in this case is the reverse of the direction taken in the first transferring, the shaded thread 1 being carried toward the fabric as before, Fig. 12, but in a reverse direction, being now the bottom shuttle, while the plain thread 2 at the top is carried backward toward the reed. This operation is shown in Figs. 3 and 12, Sheet 2.

The shaded thread 1, Fig. 8, passes from the bottom to the top over thread 16, and under thread 17 of chain 12, which it is leaving, and over thread 14 and under thread 15 of chain 10, which it is approaching, at the same time passing over thread 2, as shown in Fig. 12, bringing thread 14 of chain 10 between 1 and 2 and thread 17 of chain 12 in

the crossing of 1 and 2. Upon the beating up the sequence of the positions of the weft-thread is completed, and the same order of operations is repeated indefinitely in the production of the fabric. The shuttles are shown in Fig. 4 in proper position to be thrown through the next shedding, which would be the same as shown in Fig. 1.

The positions taken by the shaded thread 1 and the plain thread 2 are shown in Fig. 13, where it will be seen that in transferring thread 1 from top to bottom the outside thread 17 of the lower shedding, Figs. 6 and 10, is between weft-threads 1 and 2, while in transferring thread 1 from the bottom to the top the thread 14 of the upper shedding, as shown in Figs. 8 and 12, is between threads 1 and 2.

It will be noticed that while thread 17 is between 1 and 2 thread 14 is over and under threads 1 and 2, and while thread 14 is between 1 and 2 thread 17 is over and under threads 1 and 2.

Fig. 13 shows the edge of the fabric as it appears completed, representing the different positions occupied by the several threads.

Fig. 25 shows the completed fabric opened out, with the part formed in the upper shedding on the right and the part formed in the lower shedding on the left of the threads marked 14 and 17.

If the method of reversing the shuttles from the top to the bottom, as now described, were reversed, and instead of beginning at shedding 2 and turning the top shuttle over toward the cloth, the bottom shuttle should at this point be turned toward the cloth in the process of passing the threads by each other, and then continuing as before the fabric as shown in side view in Fig. 24, and shown in plan view, Fig. 26, would be produced. This would modify the operation as now described in this respect only, that whereas the shaded thread before was always in reversing turned toward the cloth now the plain thread is uniformly turned toward the cloth. This modification of the process will produce certain changes in the fabric, as indicated in Fig. 26.

By turning the plain thread toward the cloth it is of course made to pass over the shaded thread in the finished fabric, as shown; but it will be further observed that the crossing is over and under thread 14, where before it was over and under thread 17, and vice versa, the chain-thread which was before between the threads 1 and 2 now being held in the crossing. This reversal of the positions of the threads 14 and 17 with reference to the crossing is due to the fact, as already explained, that a weft-thread turned toward the cloth from an upper position passes under 14 and over 17, while a thread turned toward the cloth from below passes under the chain-thread 17 and over chain-thread 14.

The two selvage edges of the fabric are formed, as before, at the same time at the rear of the loom at picks in the sheddings, as shown in Figs. 1 and 3, while the two weft-threads are transferred to opposite parts of the fabric at the front by the turning or reversing of the threads at the picks and sheddings shown in Figs. 2 and 4. Thus each pick will contain, as before, both weft-threads, each extending through one-half of the fabric. The selvage is formed alternately by weft-threads 1 and 2, as before, and is shown in Figs. 5 and 7.

By always turning the shuttles in one direction of over toward the fabric at the top, or of always turning the top shuttle toward the fabric and the bottom shuttle toward the reed a fabric as shown on edge in Fig. 22 and as shown as opened out in plan view in Fig. 27 is produced. The sheddings and the position of the chain and weft threads when proceeding in this manner are shown in Figs. 14, 15, 16, and 17, and edge views of the same are shown in Figs. 18, 19, 20, and 21. These sheddings correspond in all general respects to those shown in Figs. 1 to 4 and 5 to 12. The only difference is in the manner of turning the shuttles at the center of the fabric, as explained.

In Fig. 14 the shaded thread 1 is seen between chain-threads 14 and 15 of the upper shedding and thread 2 between threads 16 and 17 of the lower shedding, with the shuttles in the front. The shuttles are then turned in the direction indicated by the arrows in Fig. 18, whereby the thread 1 is carried toward the fabric from top to bottom and over thread 2, with the same results as explained in connection with the first process described, as will be manifest on comparison of Figs. 25 and 27. In the second shedding the shuttles are driven to the rear, the upper thread 2 being carried between threads 15 and 14 of the upper shedding and the lower thread 1 between threads 17 and 16 of the lower shedding, thus placing thread 1 over thread 2 and chain-thread 17 between 1 and 2. In the third shedding (shown in Fig. 16) thread 2 is in the top shedding between threads 14 and 15 and thread 1 in the bottom shedding between threads 16 and 17, and are shown as being driven from the back or selvage side to the front, placing two picks from the same shuttle side by side. These being beaten up, the shuttles are turned in the direction indicated by the arrows in Fig. 20. The shuttles are thus turned in the same direction as before shown in Fig. 18. This time it is plain thread 2 that is turned toward the fabric and into position to be thrown through the fourth shedding, as shown in Figs. 17 to 21, shaded thread 1 in the top shedding between chain-threads 24 and 15, and thread 2 in the bottom shedding between threads 17 and 16, thus crossing the weft-thread 2 over thread 1 while chain-thread 17 is between 1 and 2. The weft-threads are now in position to be thrown in the next succeeding shedding, which will be as shown in Fig. 14, the sequence having been completed. By this manner of turning the shuttles it will

be seen that shaded thread 1 and plain thread 2 are alternately crossed over and under in the completed fabric, as shown in Fig. 27. By always turning the top shuttle toward the cloth the threads are alternately crossed over and under in the manner already described. As the thread which crosses over by this method is always leaving the top shedding and approaching the bottom shedding, it always passes under chain-thread 14 and over chain-thread 17, and the threads 1 and 2 will therefore always cross over and under thread 17 of the bottom shedding, the thread 14 of the top shedding being always held in the crossing, as shown in Fig. 27. If the direction of turning the shuttles were again reversed, and instead of turning from the top over toward the cloth the shuttles were always turned from the bottom toward the cloth, then the threads would occupy the positions shown in Figs. 23 and 28, where it will be observed that the threads 1 and 2 are alternately over and under in crossing, as before, but as they now uniformly leave the bottom shedding and pass thread 17 in crossing over, the crossing is uniformly about the thread 14 of the upper shedding, leaving the thread 17 of the lower shedding held in the crossing.

It will be understood that in my present specification I do not confine myself to any special mechanism for carrying out the methods described.

It will be understood that I do not confine myself in this specification to weaving the fabric in two parts, one over the other, and I have merely described that form of a loom by way of illustration. My invention as above described may be carried out equally well in a loom organized to weave the two parts side by side in a vertical position, the arrangement of the other parts of the mechanism being correspondingly changed in a manner well known to those skilled in the art, the essence of my invention in this respect consisting in weaving the fabric in two parts, which operation I designate, for the purpose of claiming my invention, as "double-weaving" or weaving in two parts side by side as distinguished from weaving a fabric in a single continuous breadth. It will also be apparent that my invention is not confined to weaving the fabric in two equal halves, as shown in the drawings, as either or both of the parts may be as much shorter as desired than the full width of the reed, or one part or the other may be woven larger than the other without departing from the spirit of my invention. It will furthermore be apparent that my invention as now described is not limited to the production of extra-wide fabrics, but is equally applicable to the weaving of narrow fabrics at an increased rate of speed and under more favorable conditions as compared with existing methods.

It is apparent that according to my methods of weaving as now disclosed I am enabled to turn out a fabric twice the width of the reed in the time now consumed by existing methods in turning out a single width, and it follows, therefore, that I will be enabled to double the product of the loom, whether it be desired to weave ordinary or extra-wide fabrics. In weaving comparatively narrow goods my invention presents measurably all the advantages set forth above as more particularly applicable to the weaving of wide fabrics. The loom will occupy correspondingly less space in the mill, the number of picks per minute will be greatly increased, the warp, being only one-half the width, will be more easily wound, the chain-threads will be more accessible in the case of breakage and disarrangement, and the reed will beat up more evenly.

I make no claim in this application to the fabrics described herein and illustrated in Figs. 25 to 28, as these fabrics form the subject of separate applications for patents filed as follows: May 18, 1888, Serial No. 274,255, and filed February 28, 1888, Serial No. 265,581.

It will be understood, as before pointed out, that my present invention is not limited to the production of one-ply fabrics, but embraces generally certain novel methods of weaving, as more particularly pointed out in the claims.

What I claim as my invention is—

1. The improved method of weaving, which consists in simultaneously forming an opening or shed in each of the two halves of a single set of chain-threads, then simultaneously introducing a weft-thread into each of the openings or sheds so formed from the selvage side thereof toward the center of the fabric, then repeating the shedding operation, and then again introducing the weft-threads, carrying each of the latter through the half of the chain-threads just traversed by the other.

2. The improved method of weaving, which consists in forming simultaneously in the chain-threads two openings or sheds side by side, then simultaneously introducing a weft-thread into each of the sheds or openings so formed and from the same side of the loom, then repeating the shedding operation, and then again introducing the weft-threads, carrying each of the latter through the half of the chain-threads just traversed by the other.

3. The improved method of weaving, which consists in forming simultaneously in a single set of chain-threads two openings or sheds side by side, then simultaneously introducing a weft-thread into each of the sheds or openings so formed and from the same side of the loom, repeating the shedding operation and reversing the position of the weft-threads at the other side of the loom with reference to the two openings or sheds, and then again introducing the weft-threads, carrying each through the half of the chain-threads just traversed by the other.

4. The improved method of weaving, which consists in simultaneously forming two openings or sheds in the chain-threads side by

side, then simultaneously introducing a weft-thread into each of the openings or sheds so formed and from the same side of the loom, then repeating the shedding operation, then reversing the position of the weft-threads on the other side of the loom by a movement approximating a movement of revolution, and then returning the weft-threads through the newly-formed openings or sheds in the chain-threads, each weft traversing the portion of the chain-threads just traversed by the other.

5. The improved method of weaving one-ply fabrics, which consists in simultaneously forming two openings or sheds in the chain-threads side by side, then simultaneously introducing a weft-thread into each of the openings or sheds from the same side of the loom, then simultaneously forming two openings or sheds in the chain-threads, as before, to receive a subsequent pick or layer of weft in the one-ply fabric, and then again introducing the weft-threads into the two newly-formed openings or sheds to form a subsequent pick or layer of weft, thereby crossing the weft-threads over and under each other.

6. The improved method of weaving, which consists in simultaneously forming two openings or sheds in the chain-threads side by side, then introducing a weft-thread into each of the openings or sheds so formed and from the same side of the loom, repeating the shedding operation and passing the weft-threads by each other at the opposite side of the loom, the weft-thread which is to be uppermost on the face of the fabric being passed next the cloth and the other thread next the lay-beam, and then again introducing the weft-threads and carrying each through the portion of the chain-threads just traversed by the other.

7. The improved method of weaving, which consists in simultaneously forming two openings or sheds in the chain-threads side by side, then throwing a weft-thread through each of the openings or sheds so formed and from the same side of the loom and out of the shedding and fabric on the other side of the loom, then reversing the position of the weft-threads on that side of the loom to pass them by each other, then repeating the shedding operation and throwing the weft-threads into the fabric and through the newly-formed openings or sheds, each weft-thread traversing the portion of the chain-threads just traversed by the other.

8. The improved method of weaving, which consists in simultaneously forming two openings or sheds in the chain-threads side by side, then simultaneously introducing a weft-thread into each of such openings or sheds and from the same side of the loom, repeating the shedding operation, reversing the position of the weft-threads on the other side of the loom, and again introducing the weft-threads, each traversing the portion of the chain-threads just traversed by the other, repeating the shedding operation, and then returning the weft-threads in the same portion of the chain-threads just traversed by them, respectively, repeating the shedding operation, again reversing the position of the weft-threads, and finally returning the weft-threads through the portion of the chain-threads first traversed, thereby forming the two selvage edges on one side of the loom and the center of the fabric on the other.

Signed at New York, in the county of New York and State of New York, this 15th day of February, A. D. 1888.

ABRAM D. EMERY.

Witnesses:
WM. H. CAPEL,
HUGO KOELKER.