

(No Model.)

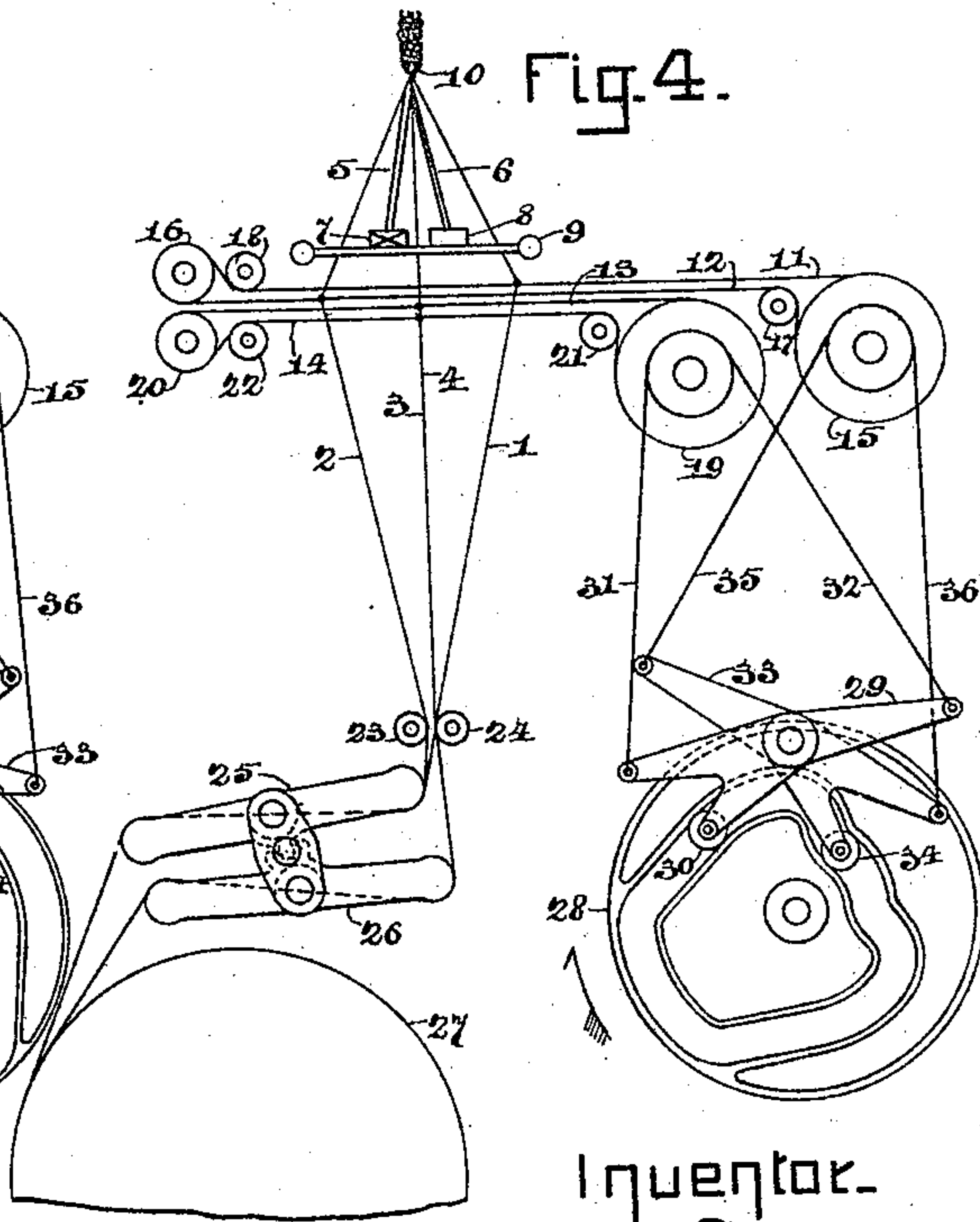
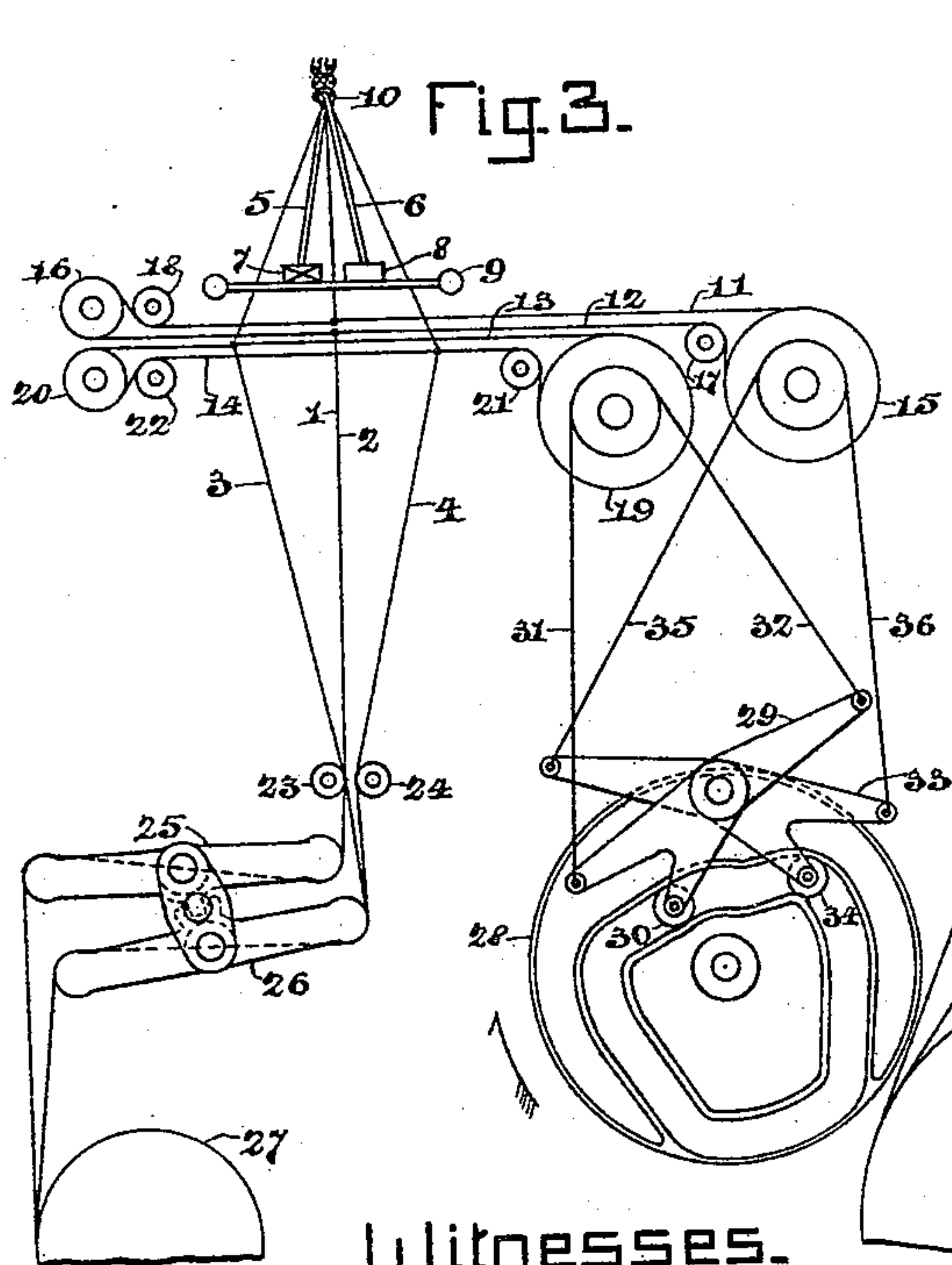
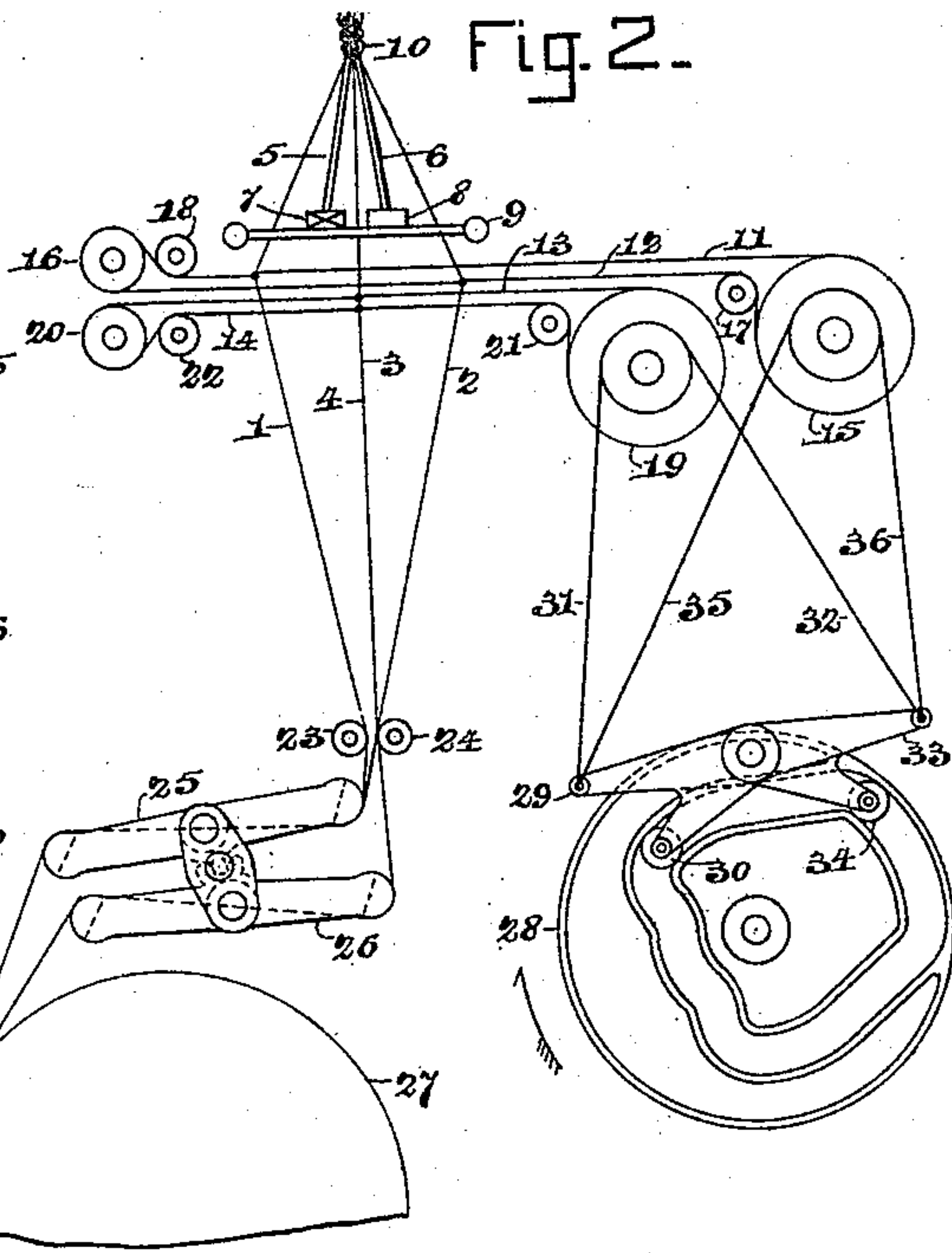
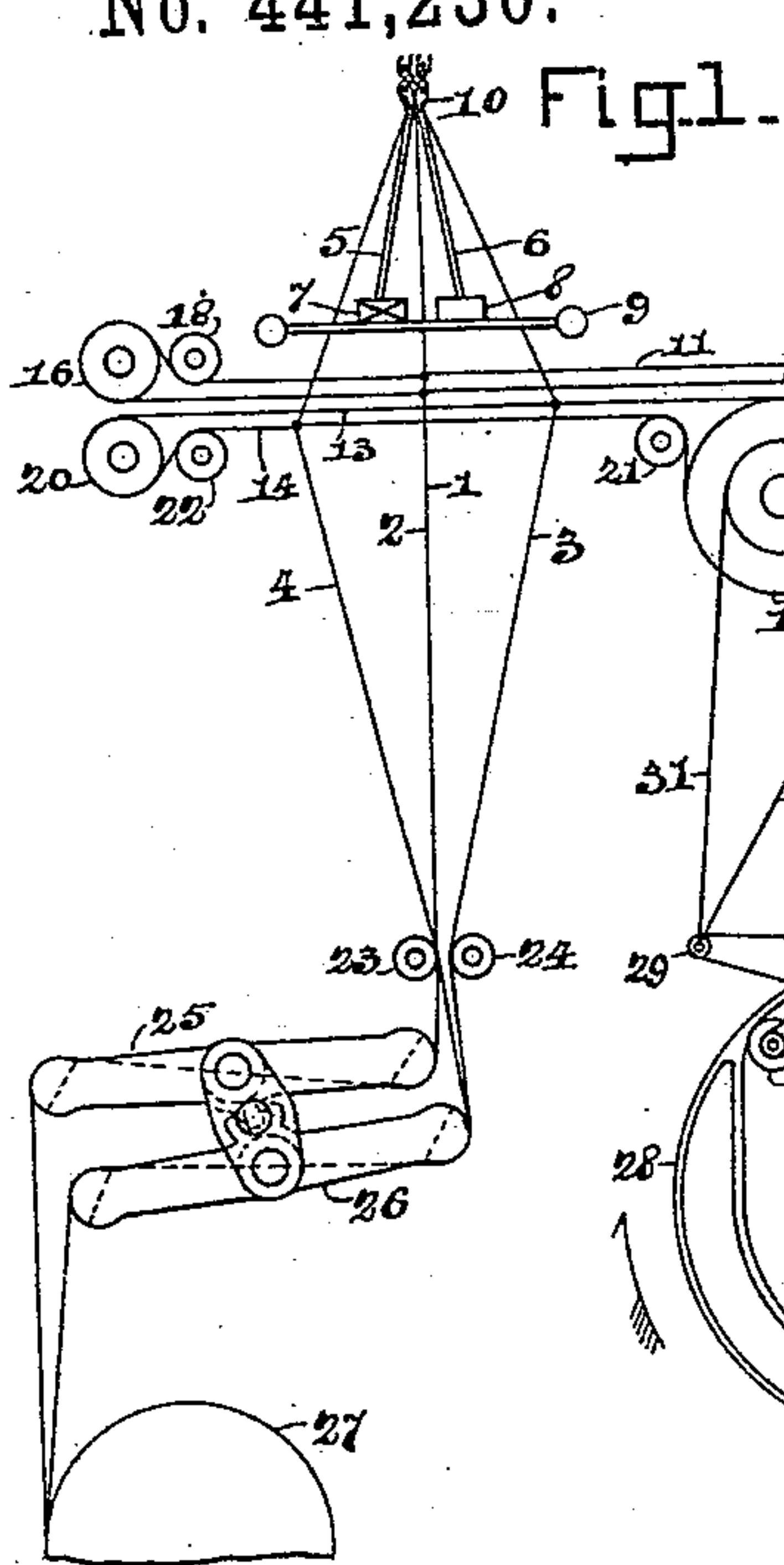
10 Sheets—Sheet 1.

A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.



Witnesses.

Wm. J. Donnelly.
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Inventor.

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Attorney.

(No Model.)

10 Sheets—Sheet 2.

A. D. EMERY.

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Fig. 5.

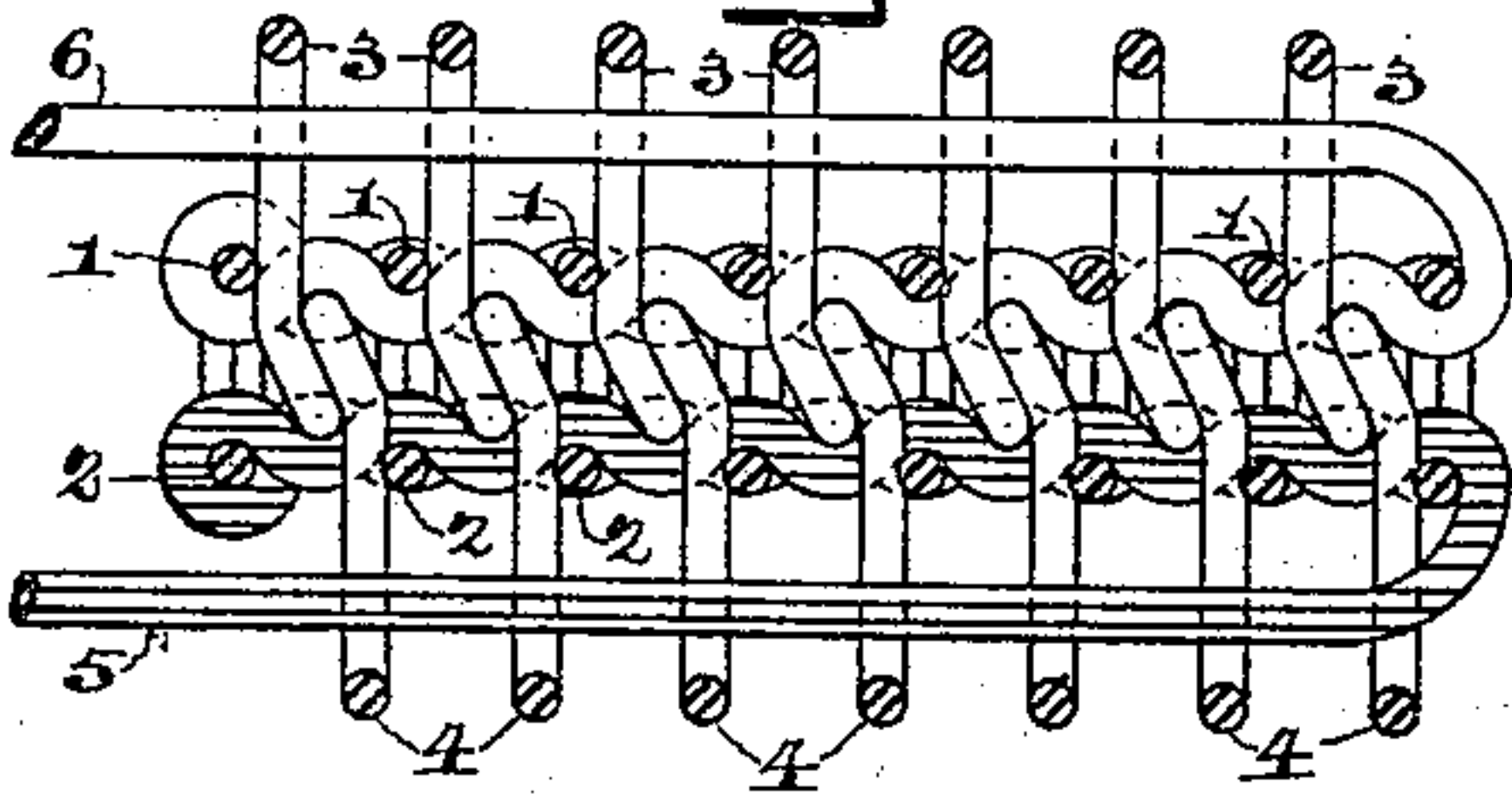


Fig. 6.

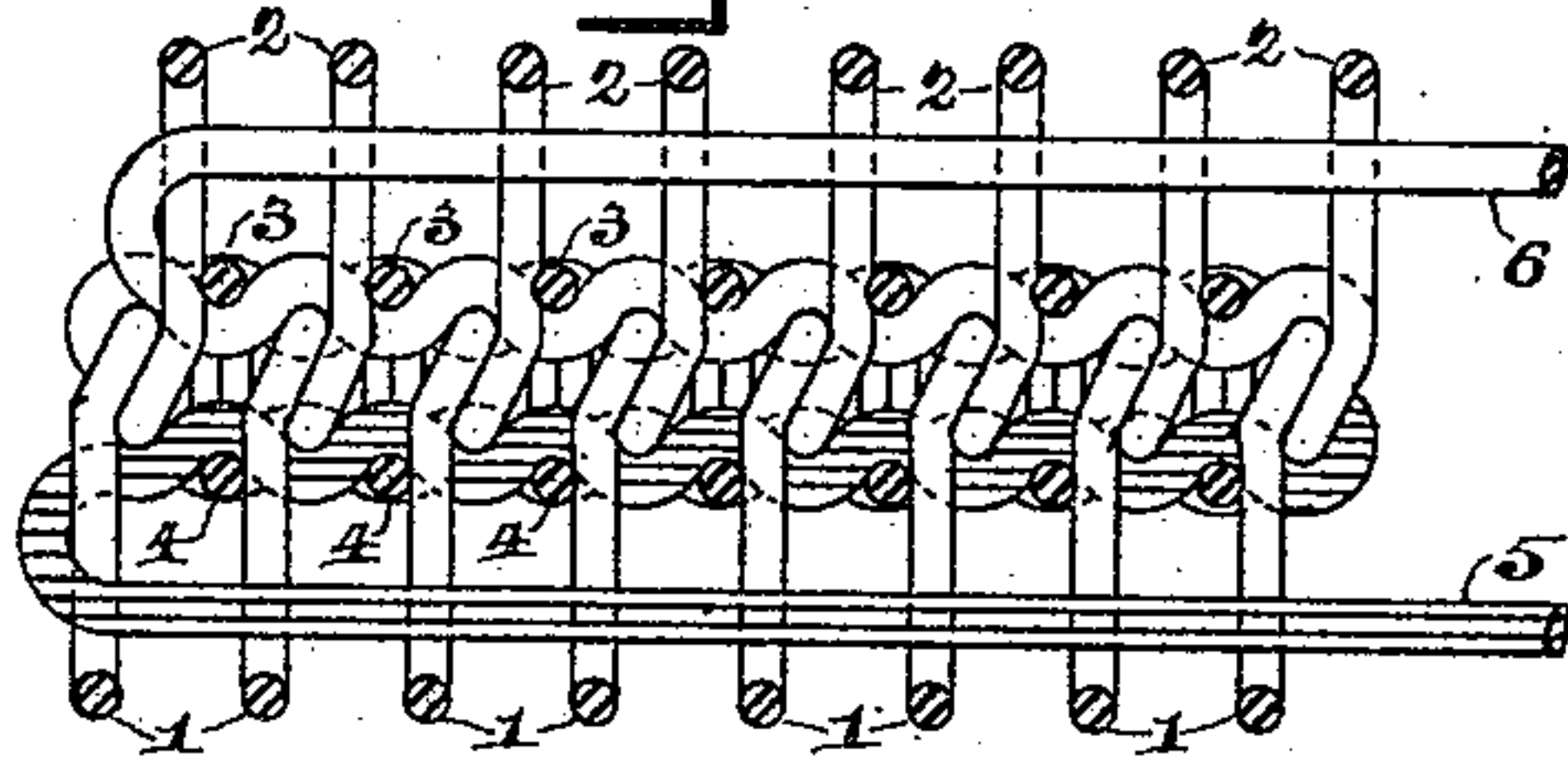


Fig. 7.

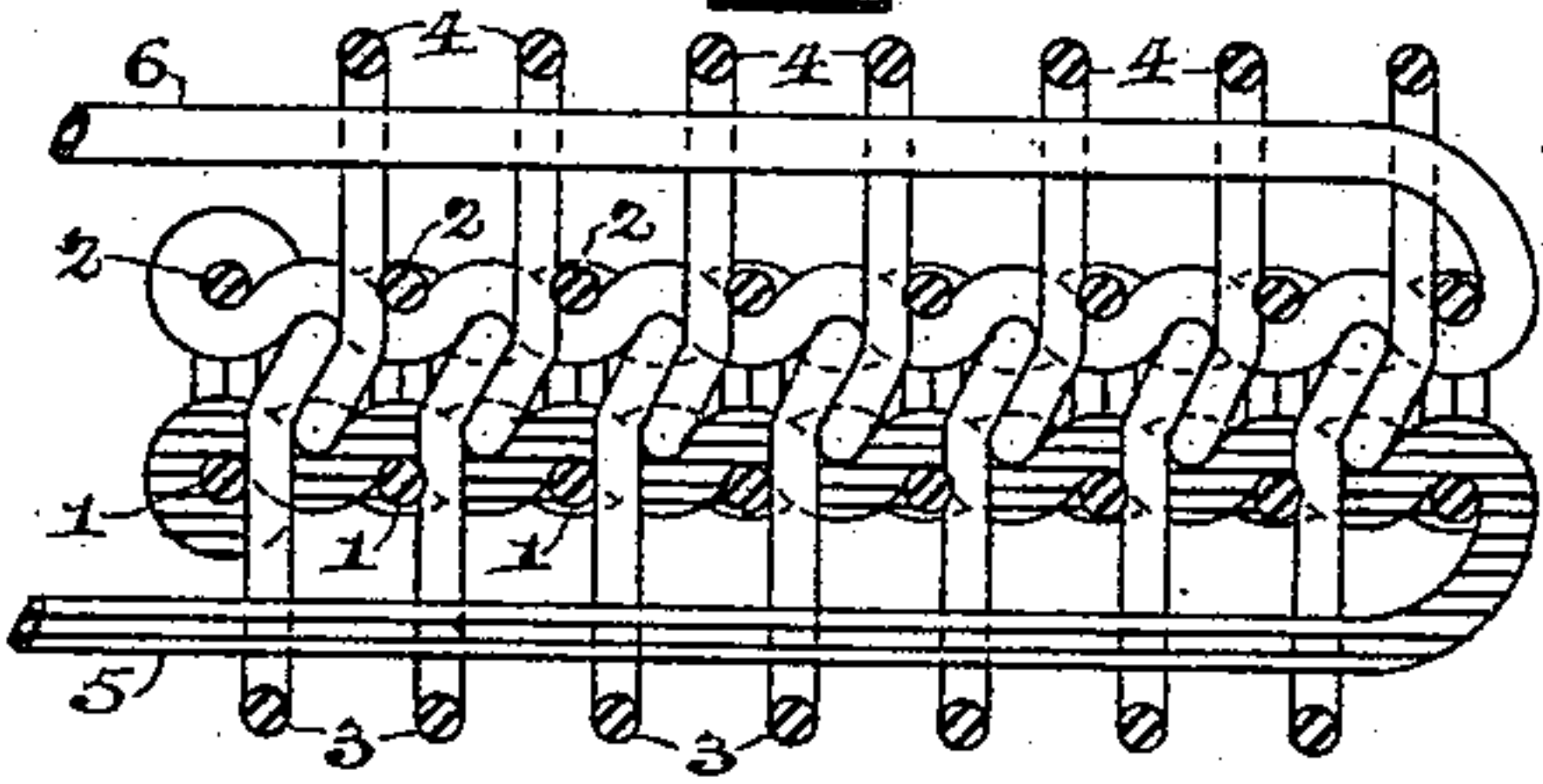


Fig. 8.

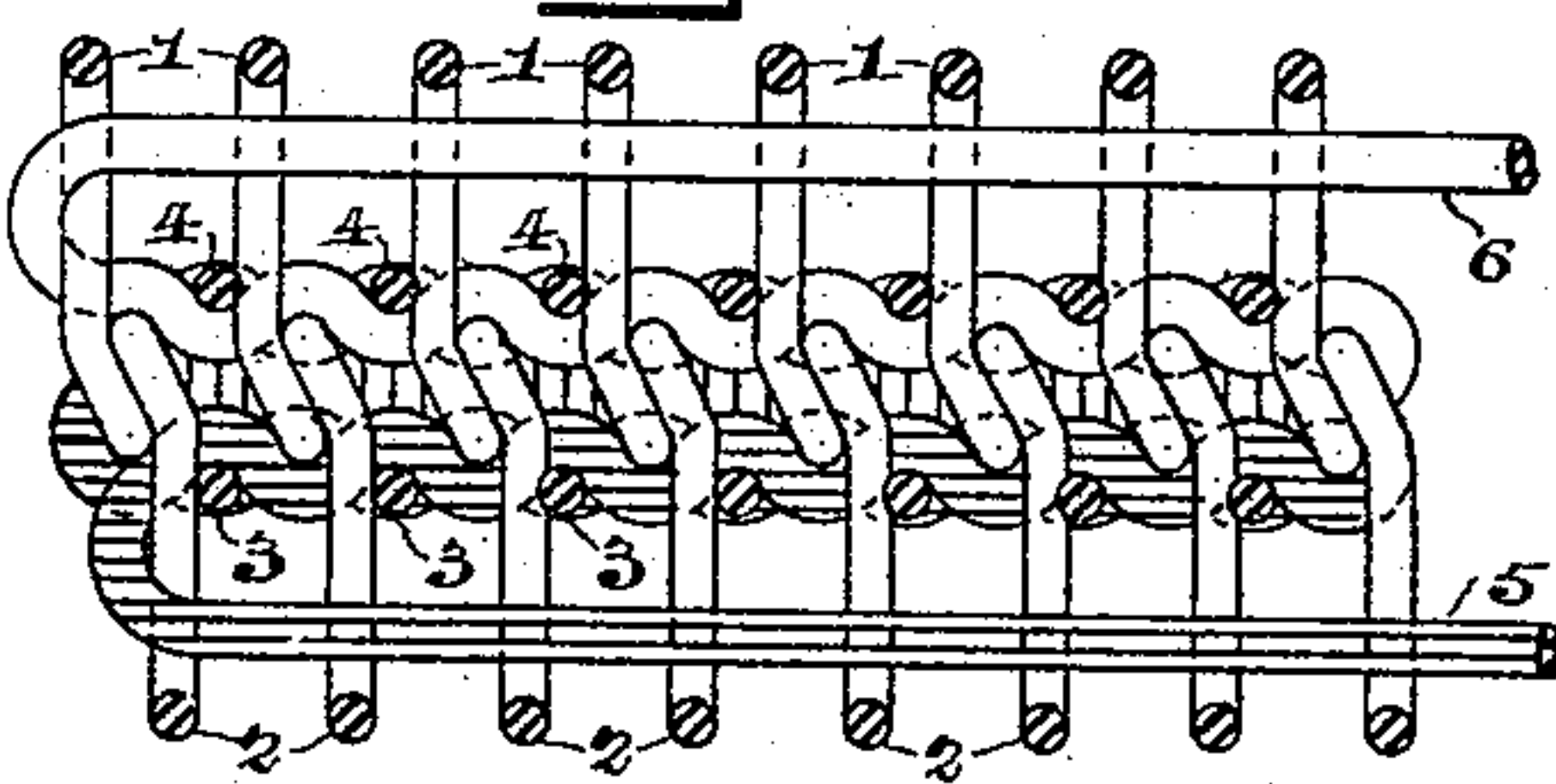


Fig. 9.

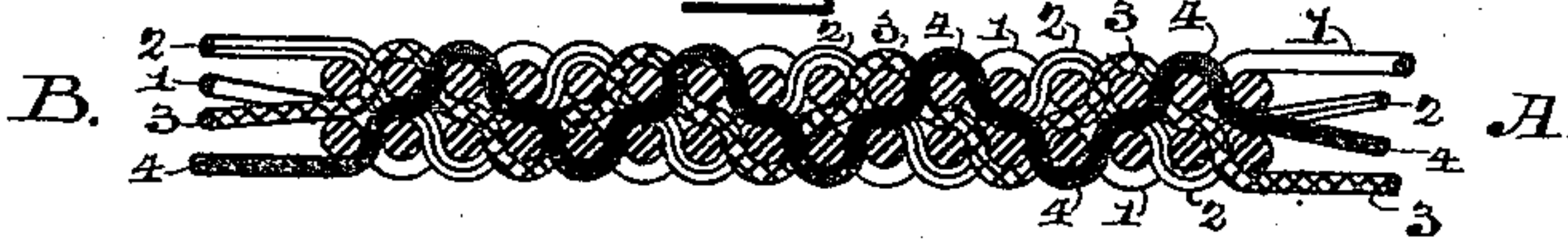


Fig. 10.



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No. 441,230.

Patented Nov. 25, 1890.

Fig. 11.

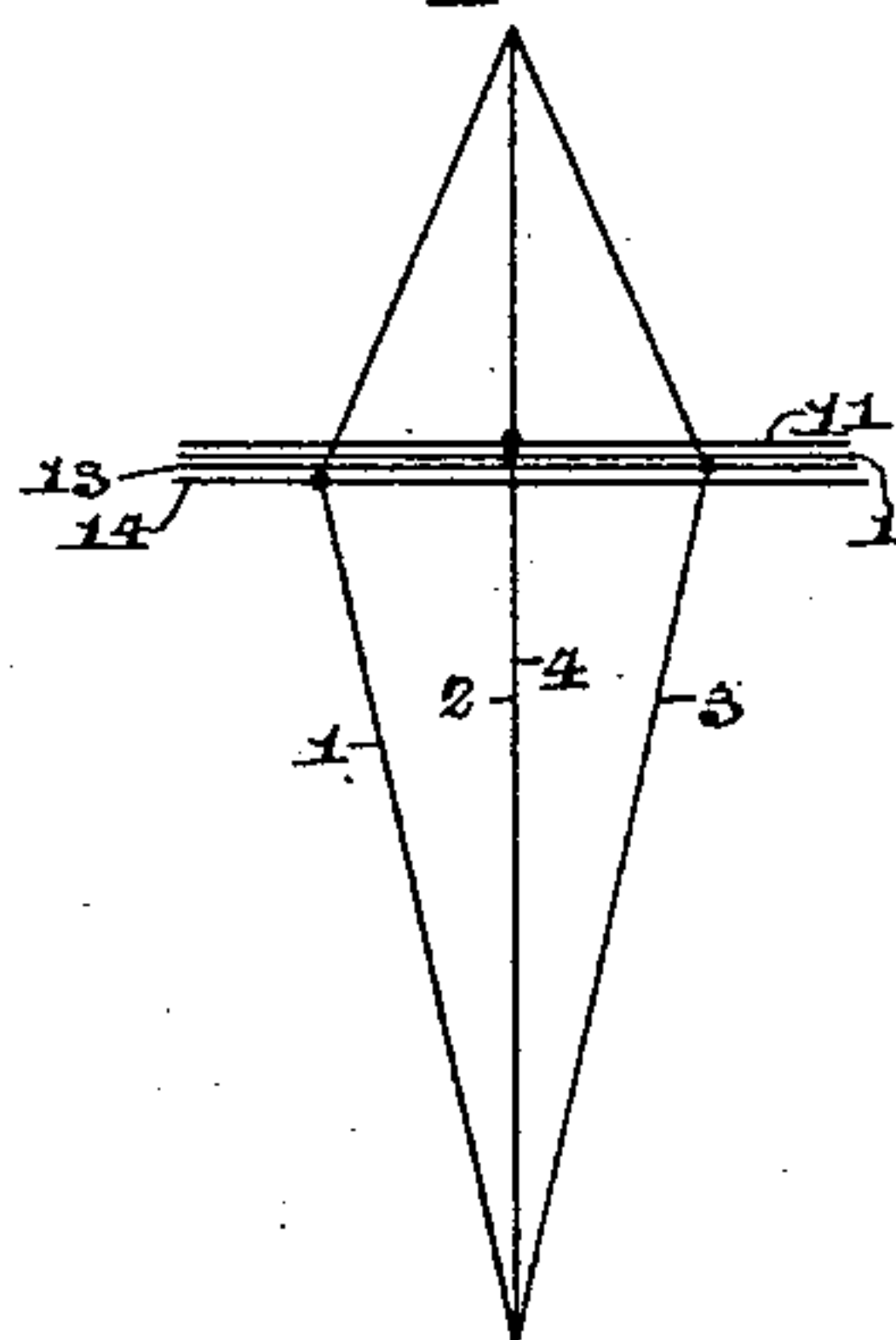


Fig. 12.

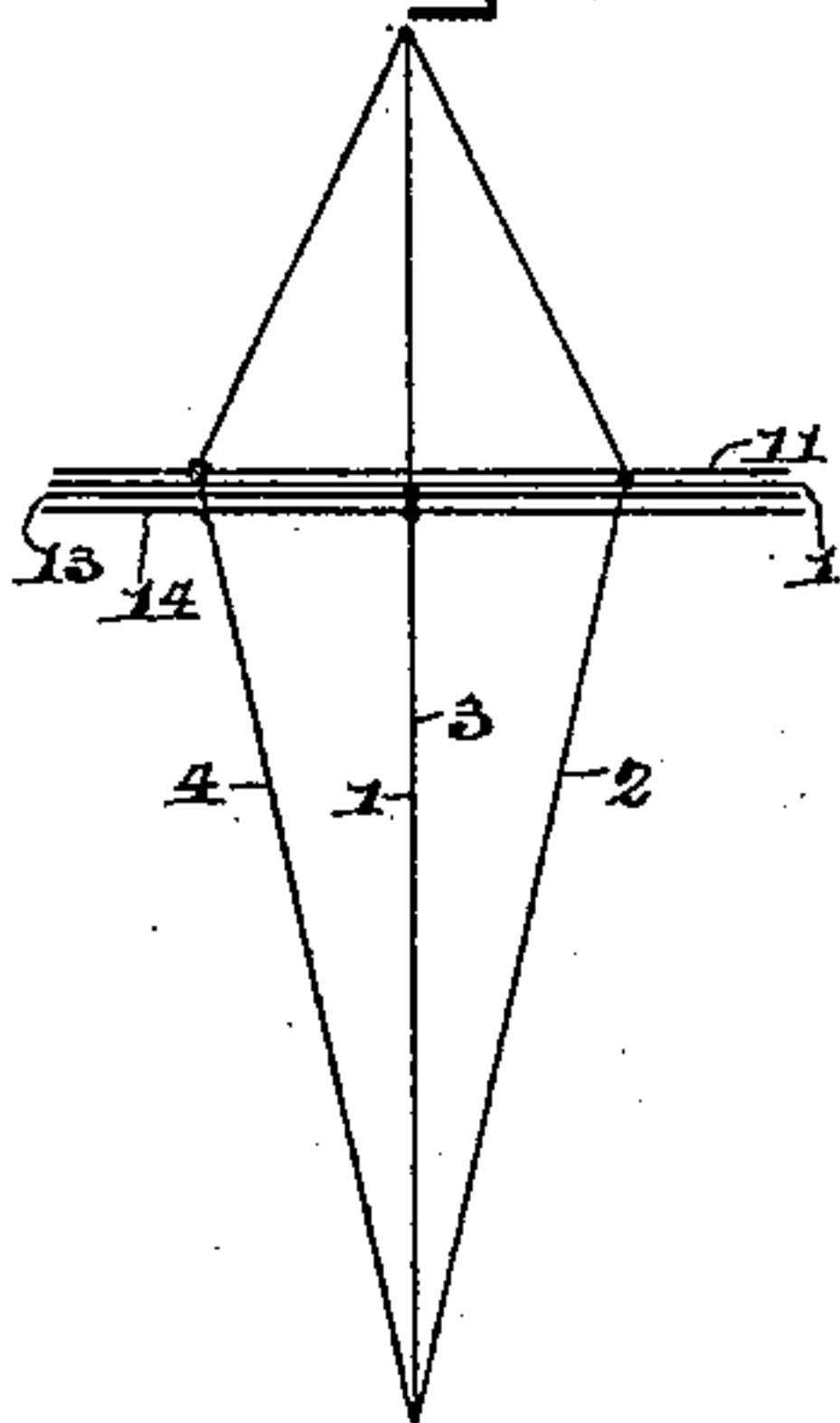


Fig. 13.

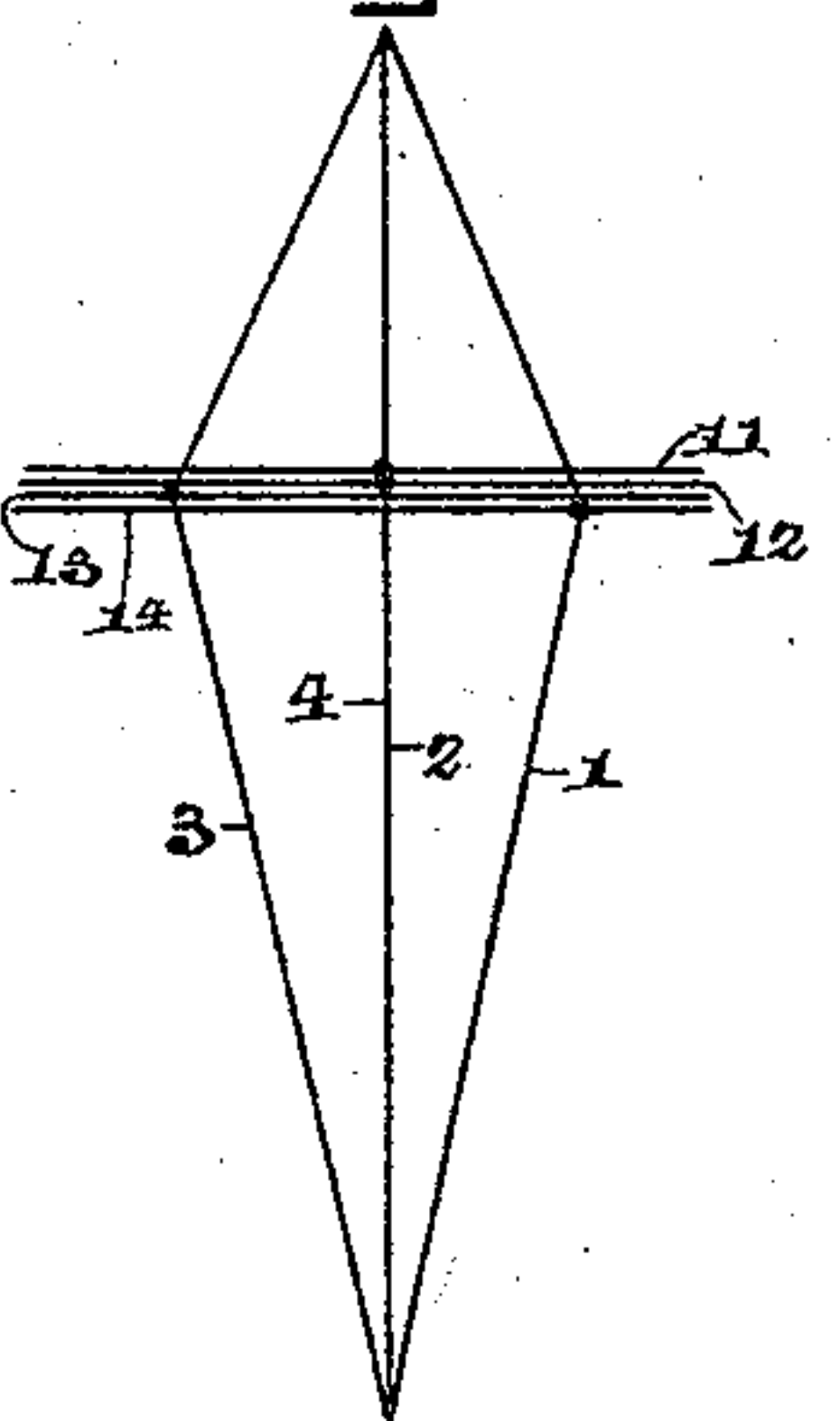


Fig. 14.

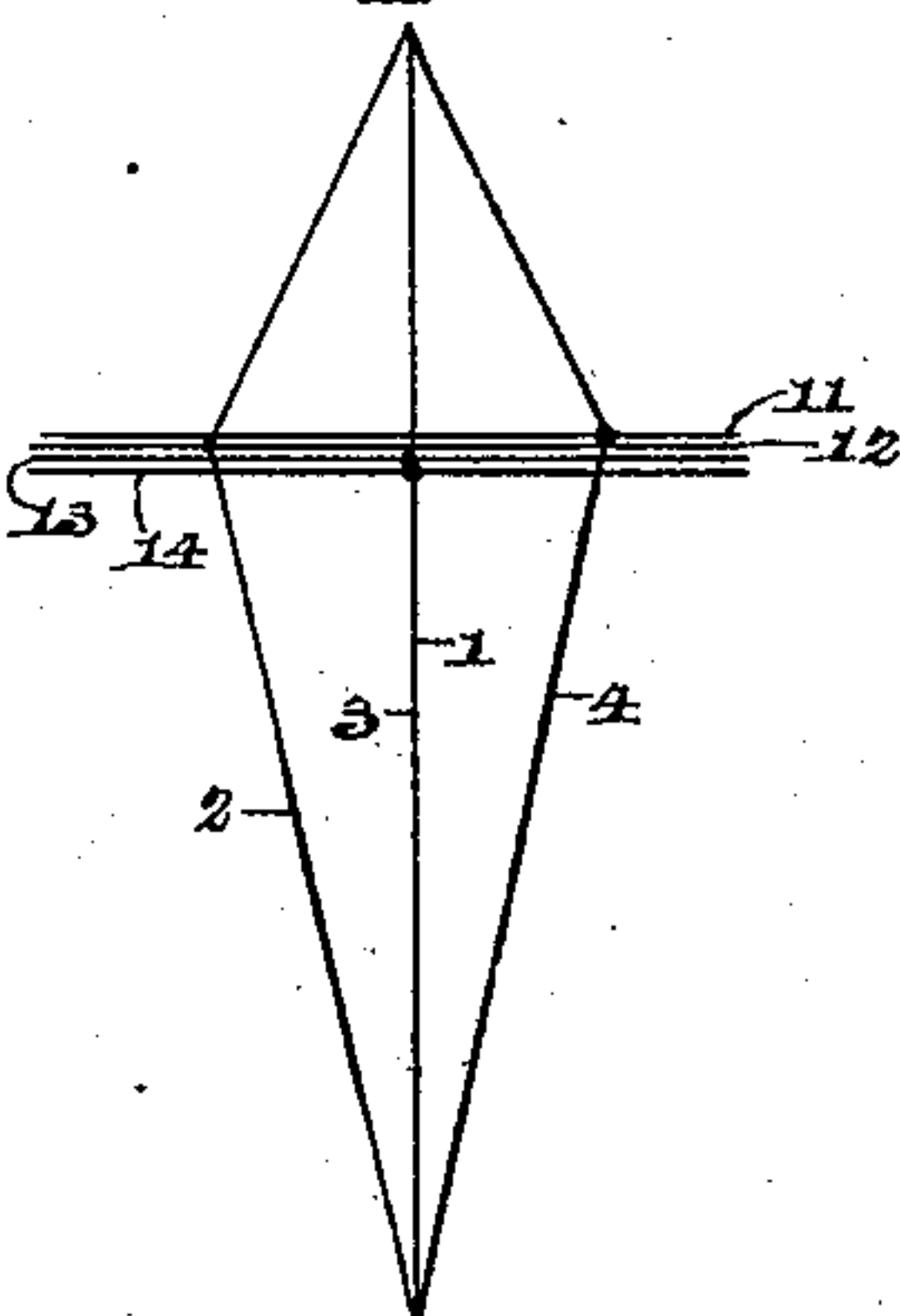


Fig. 15.

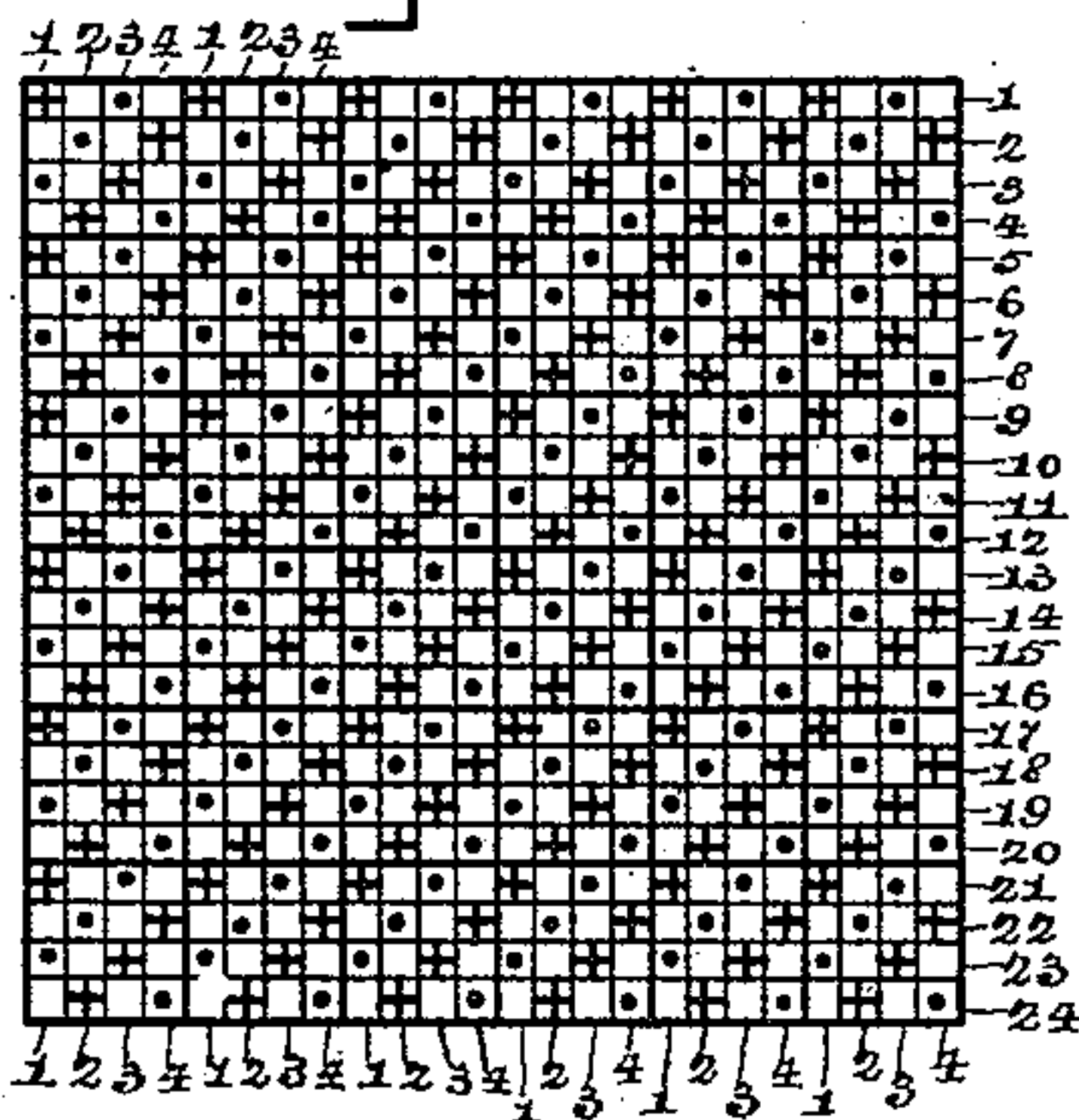


Fig. 17.

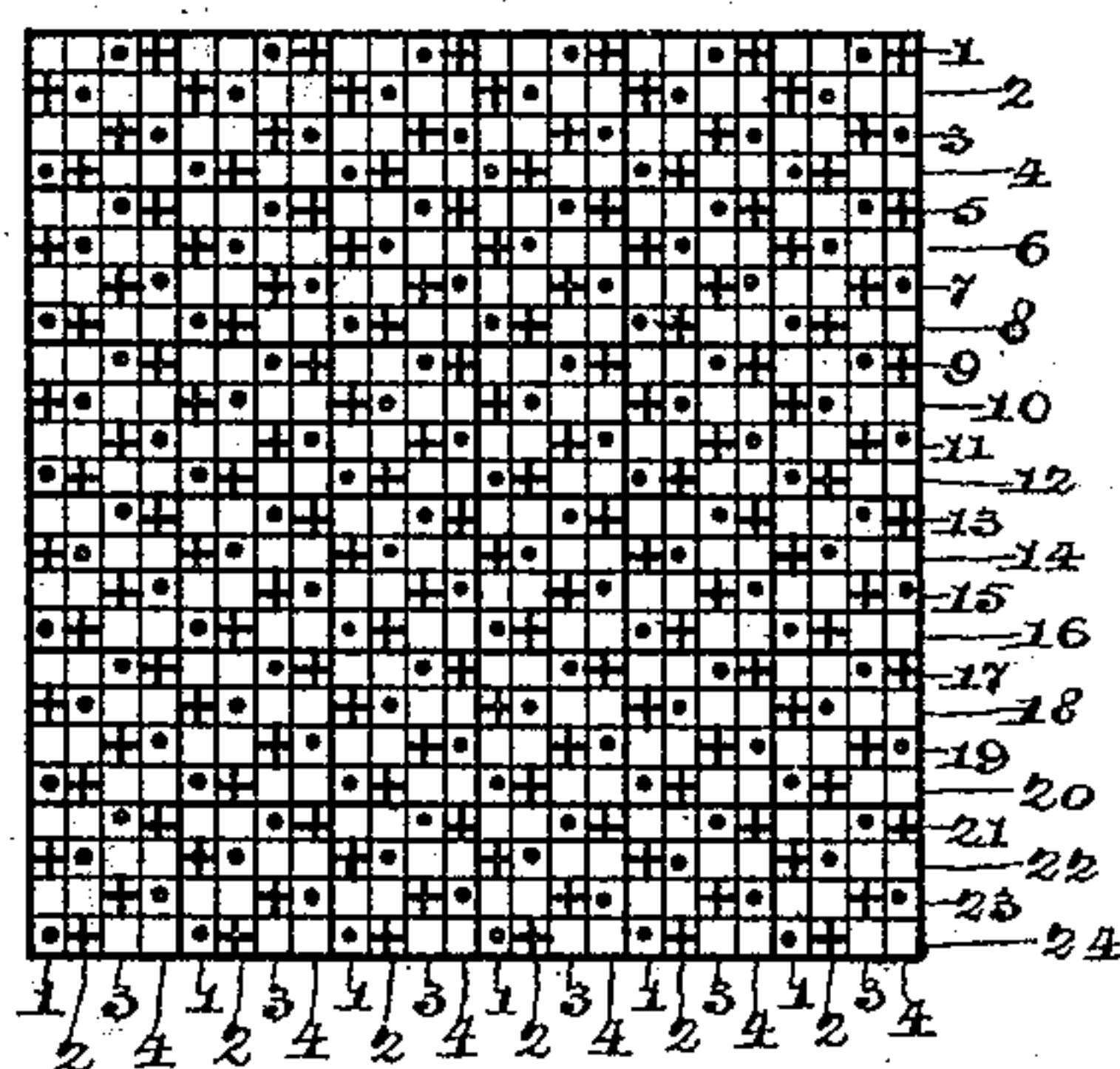


Fig. 16.

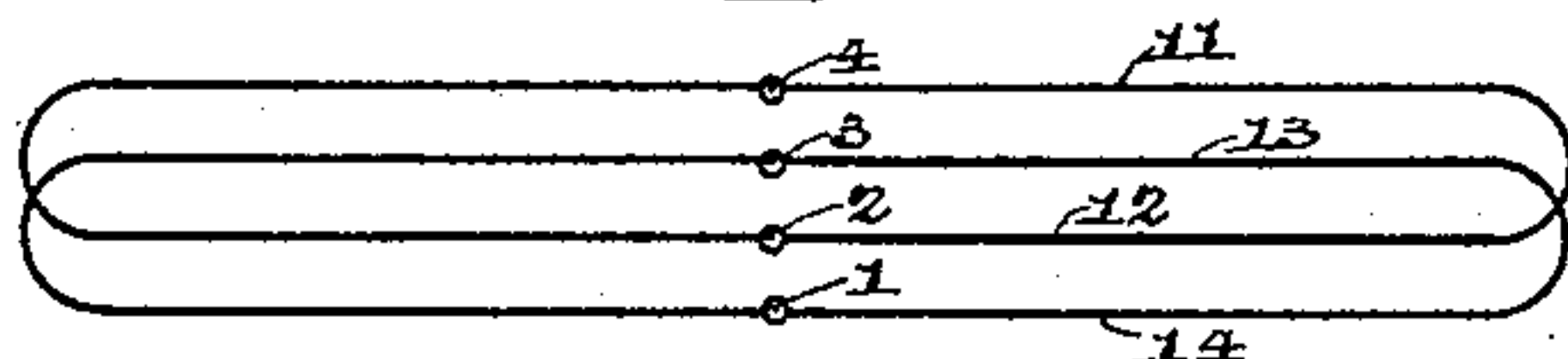
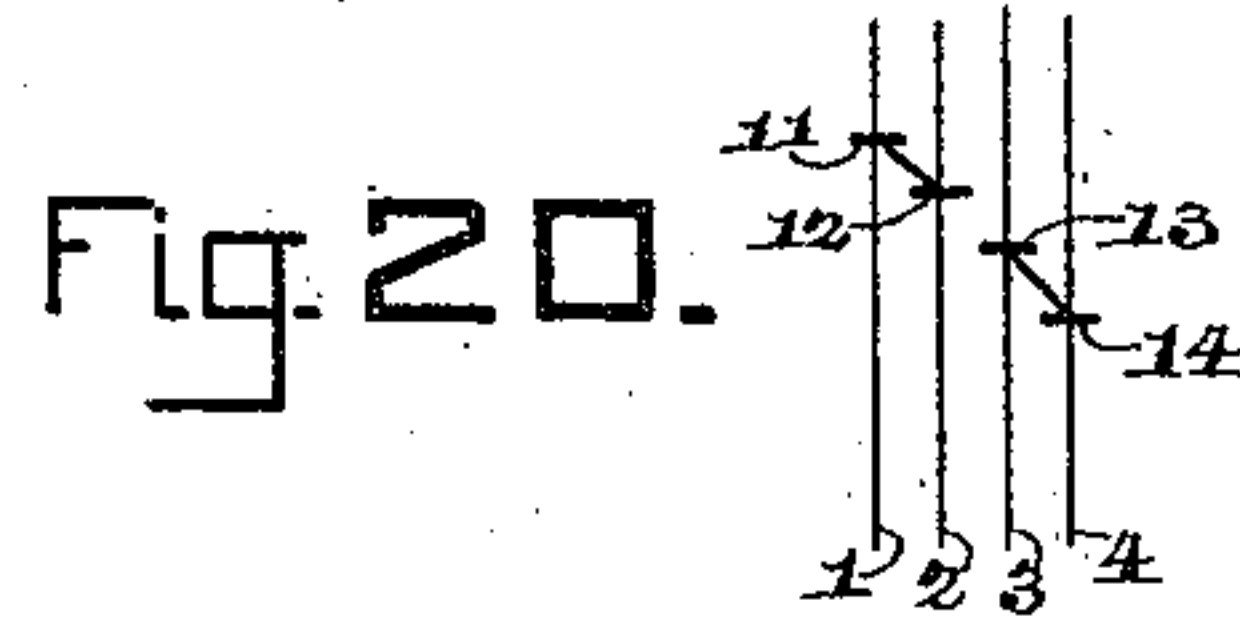
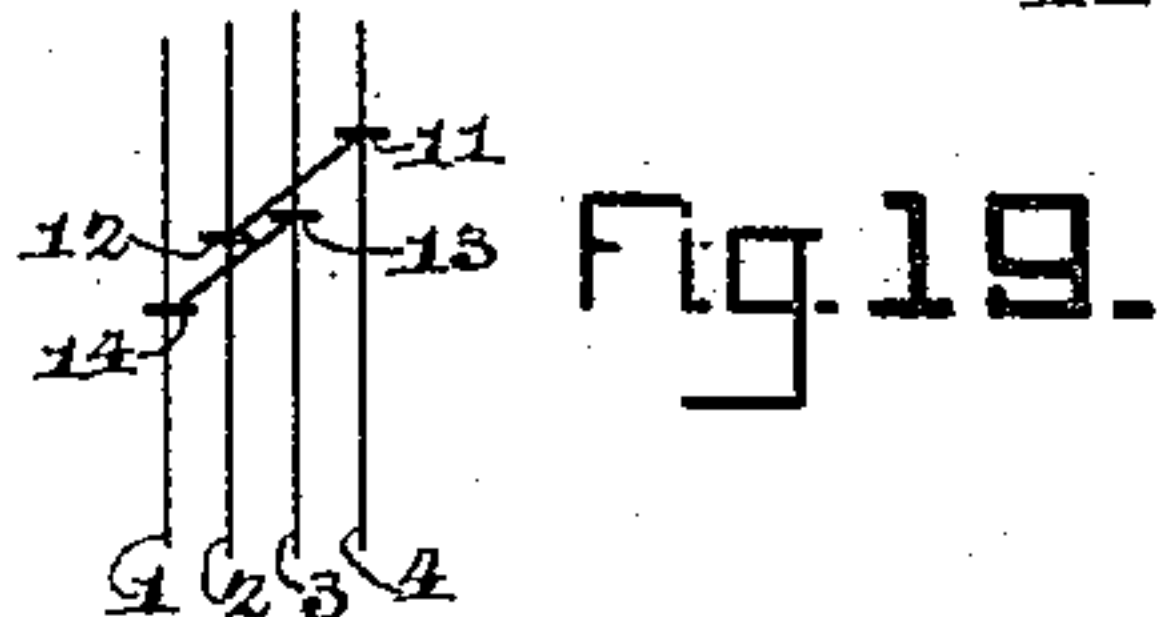
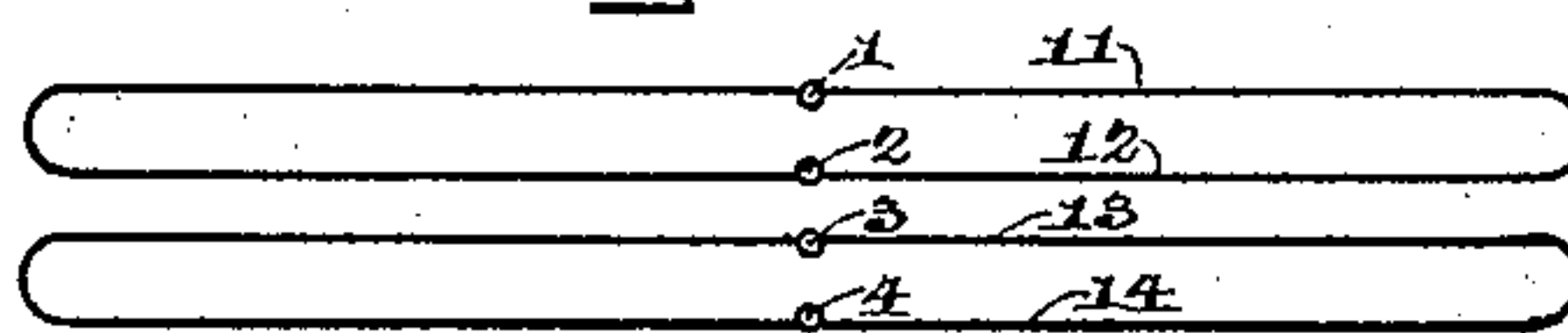


Fig. 18.



Witnesses.

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(No Model.)

10 Sheets—Sheet 4.

A. D. EMERY.

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Fig. 21.

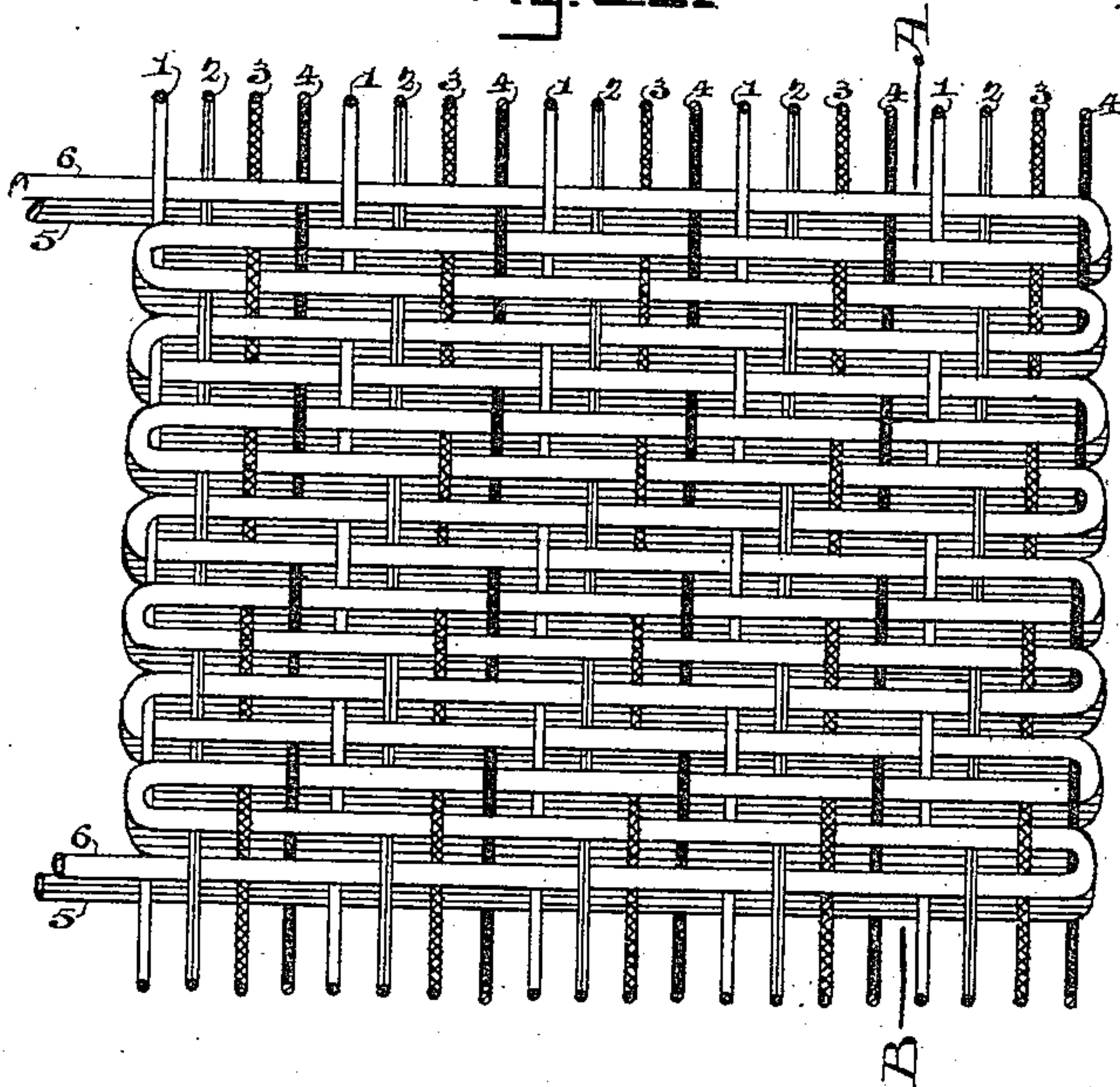
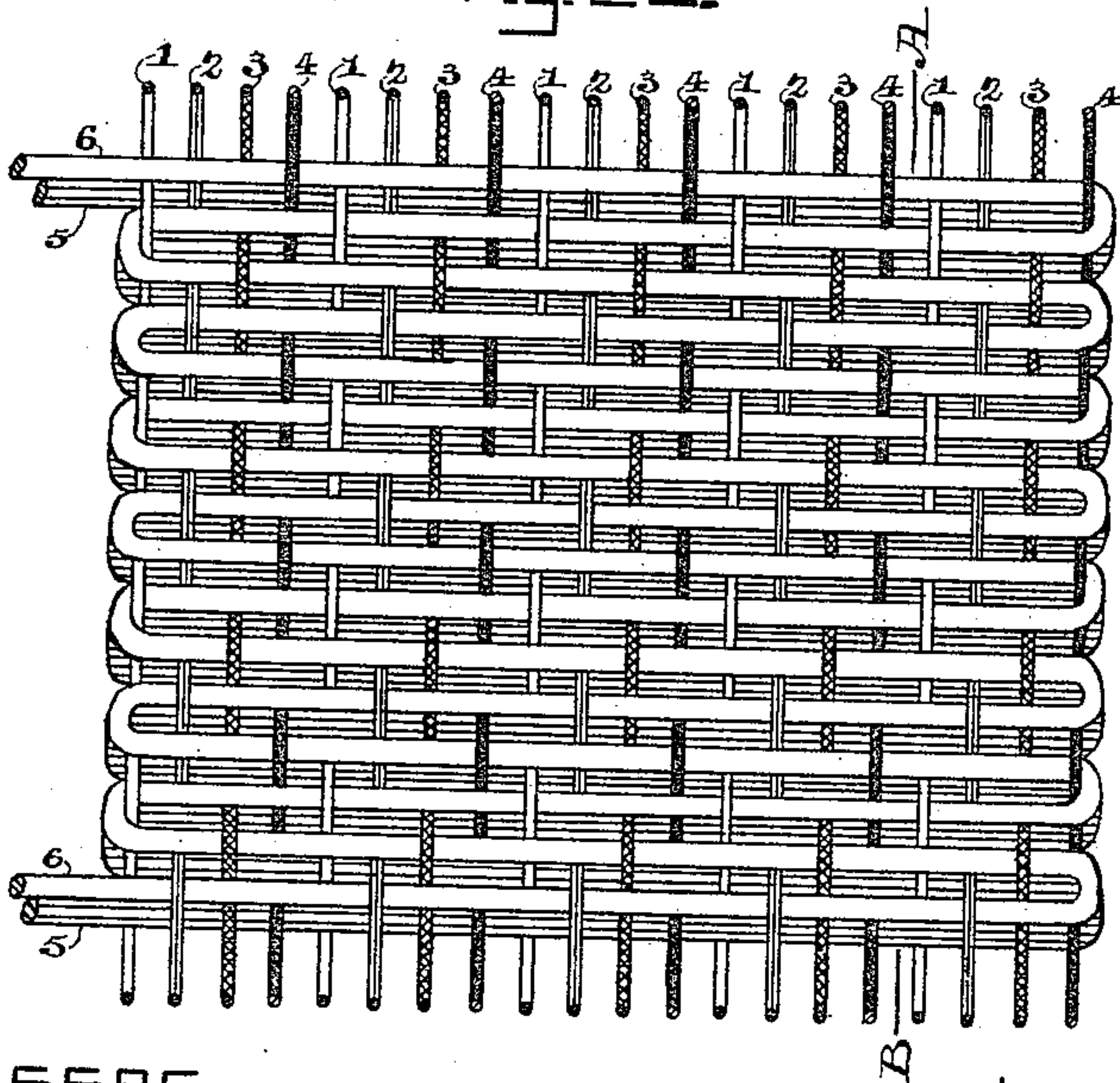


Fig. 22.



Witnesses.

Wm. J. Donnelly.

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(No Model.)

10 Sheets—Sheet 5.

A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

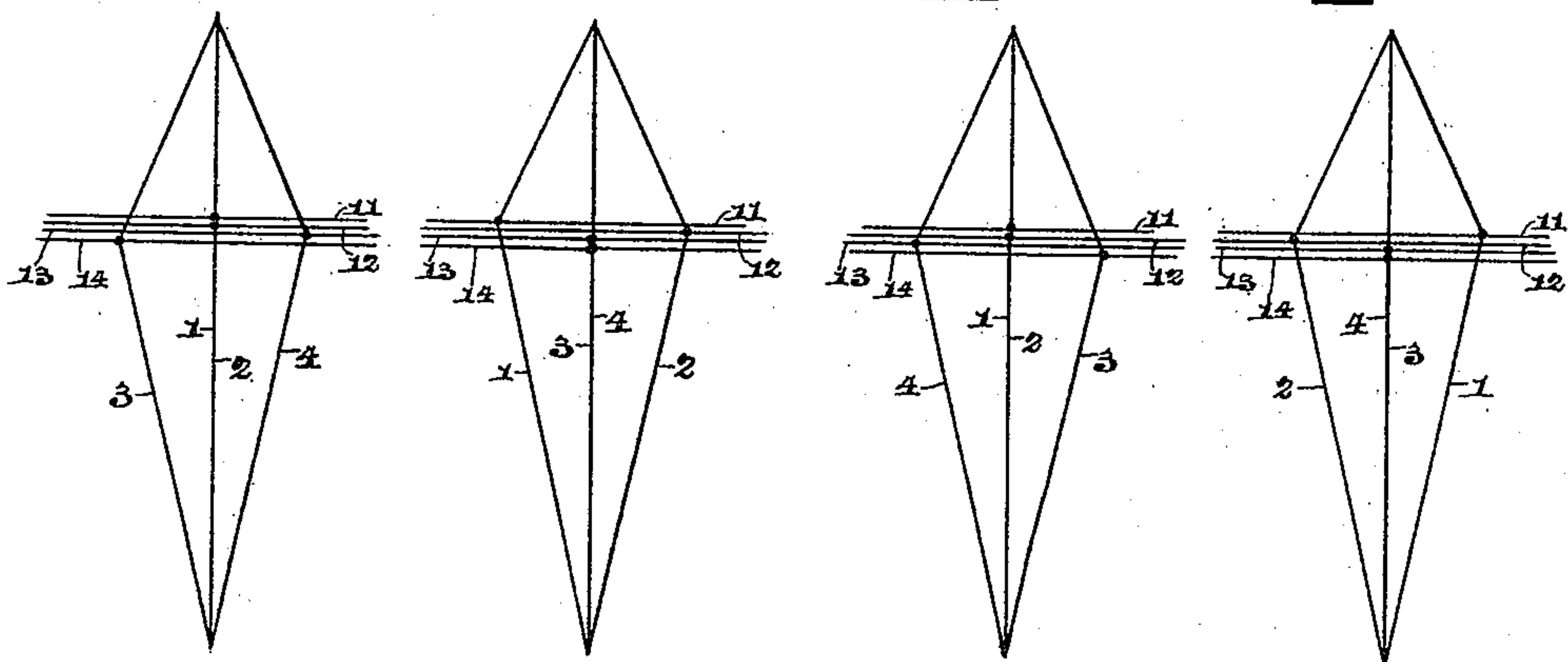


Fig. 29.

Fig. 27.

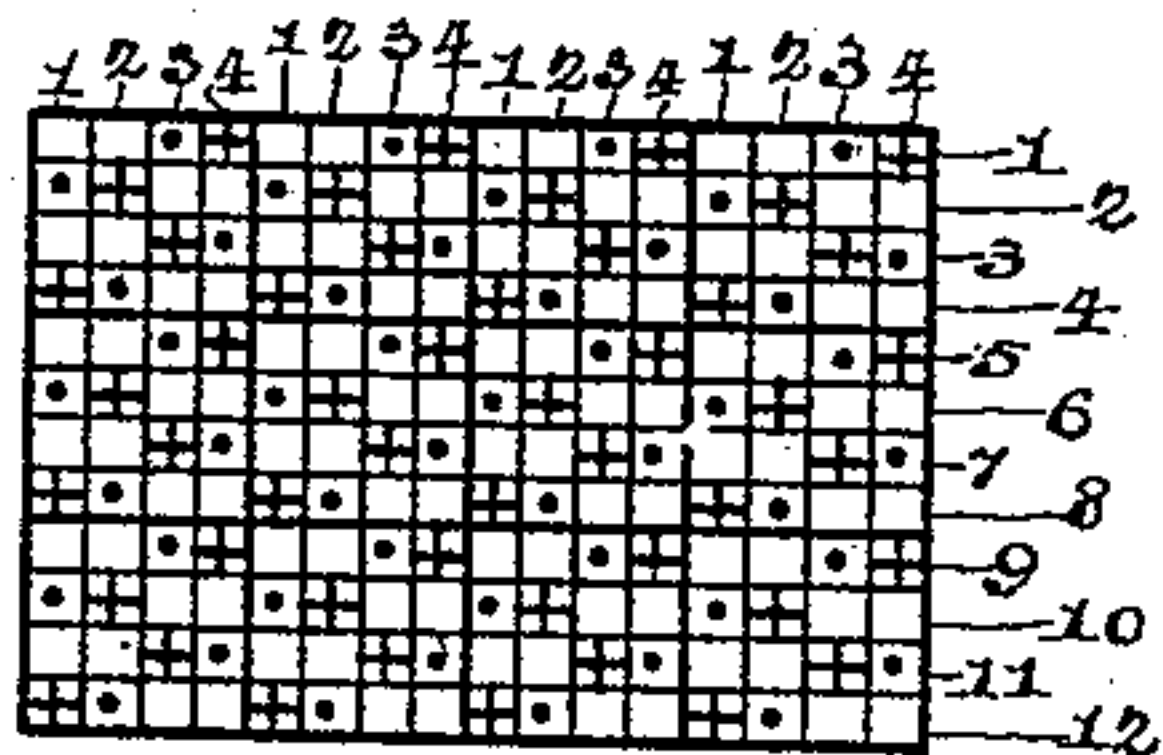
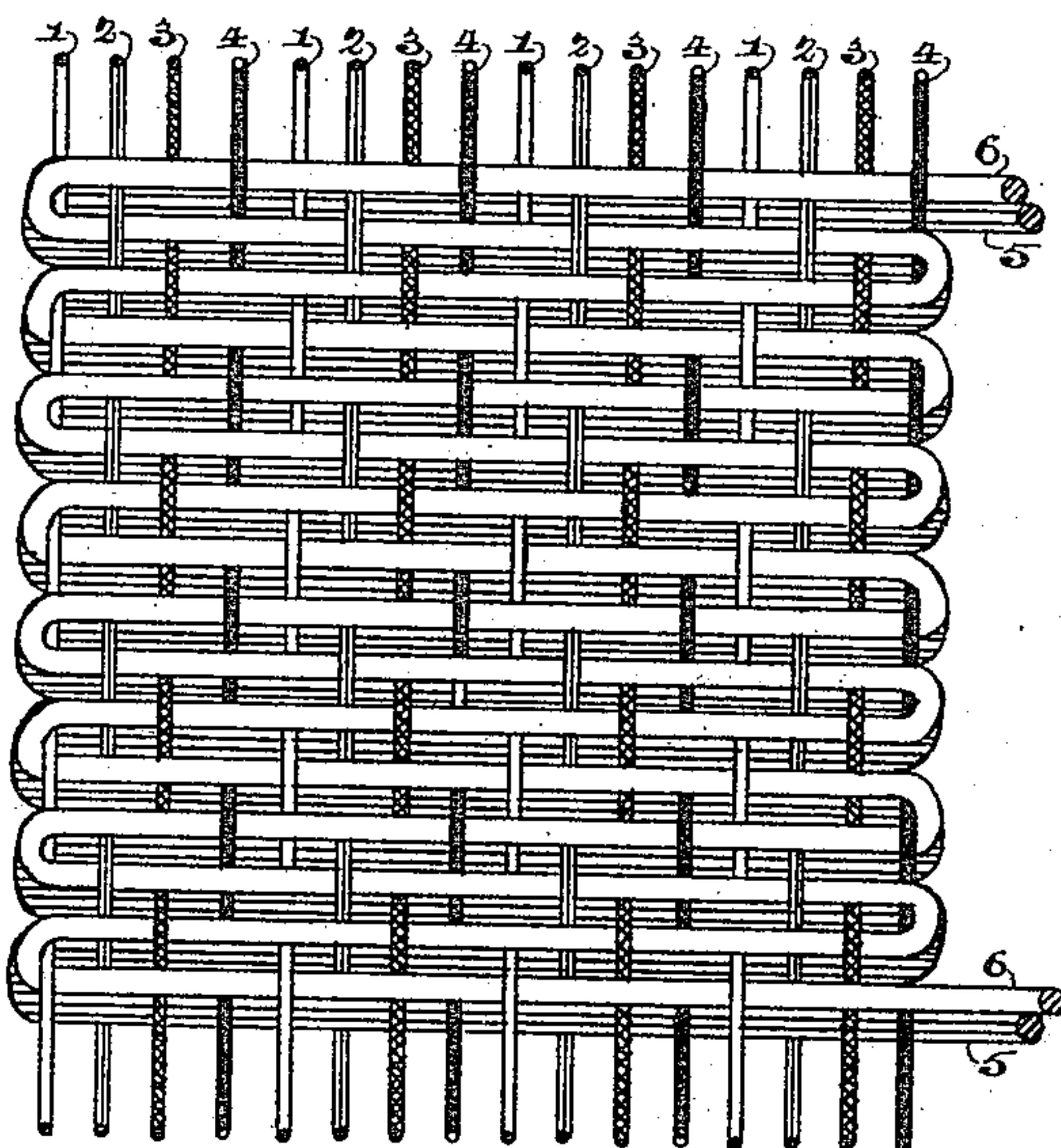
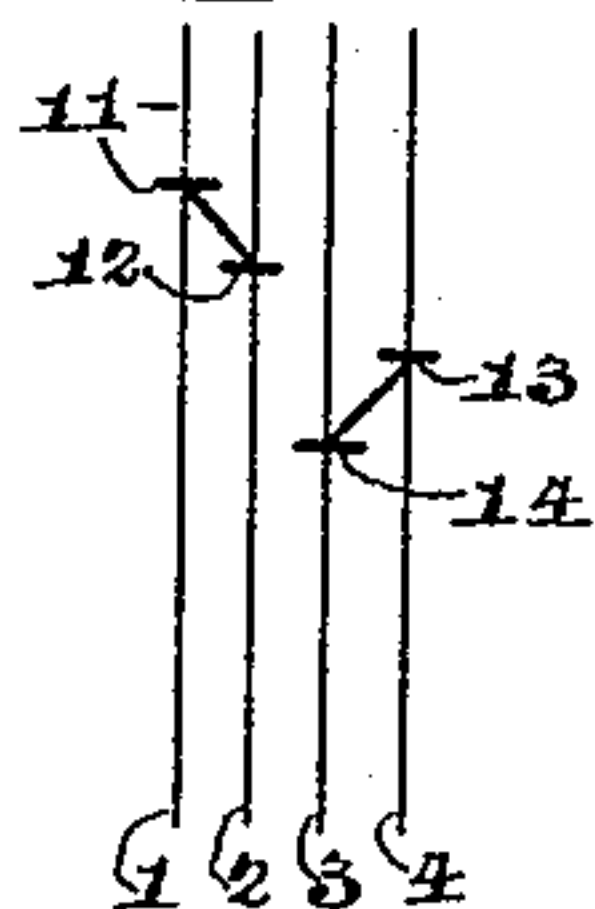


Fig. 28.



Witnesses.

Wm. J. Donnelly.

Walter J. Emery

Inventor.

A. D. Emery
by Frank MacArthur

Attorney.

(No Model.)

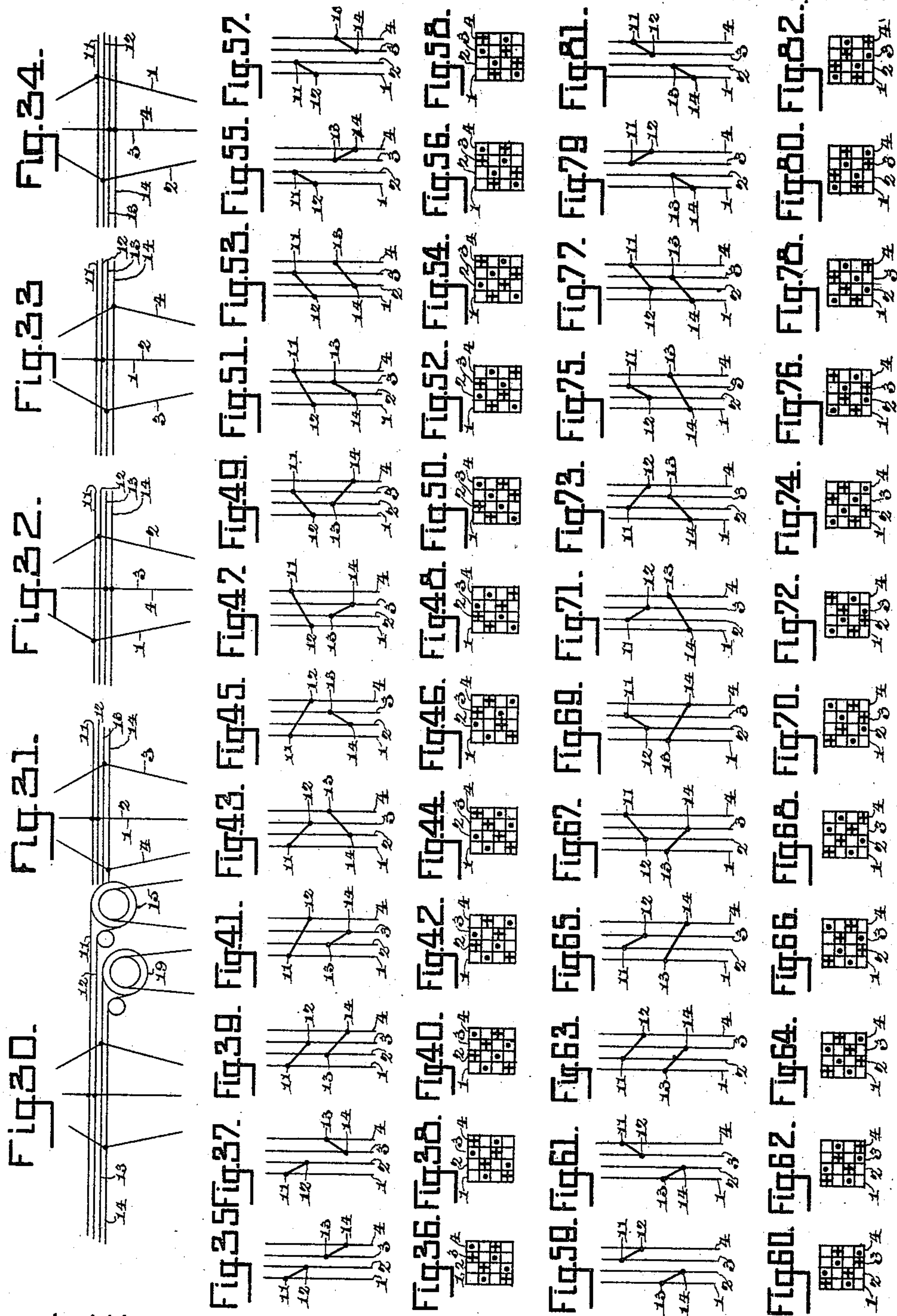
10 Sheets—Sheet 6

A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.



Witnesses.
Wm. T. Donnelly.
Hattie J. Emery.

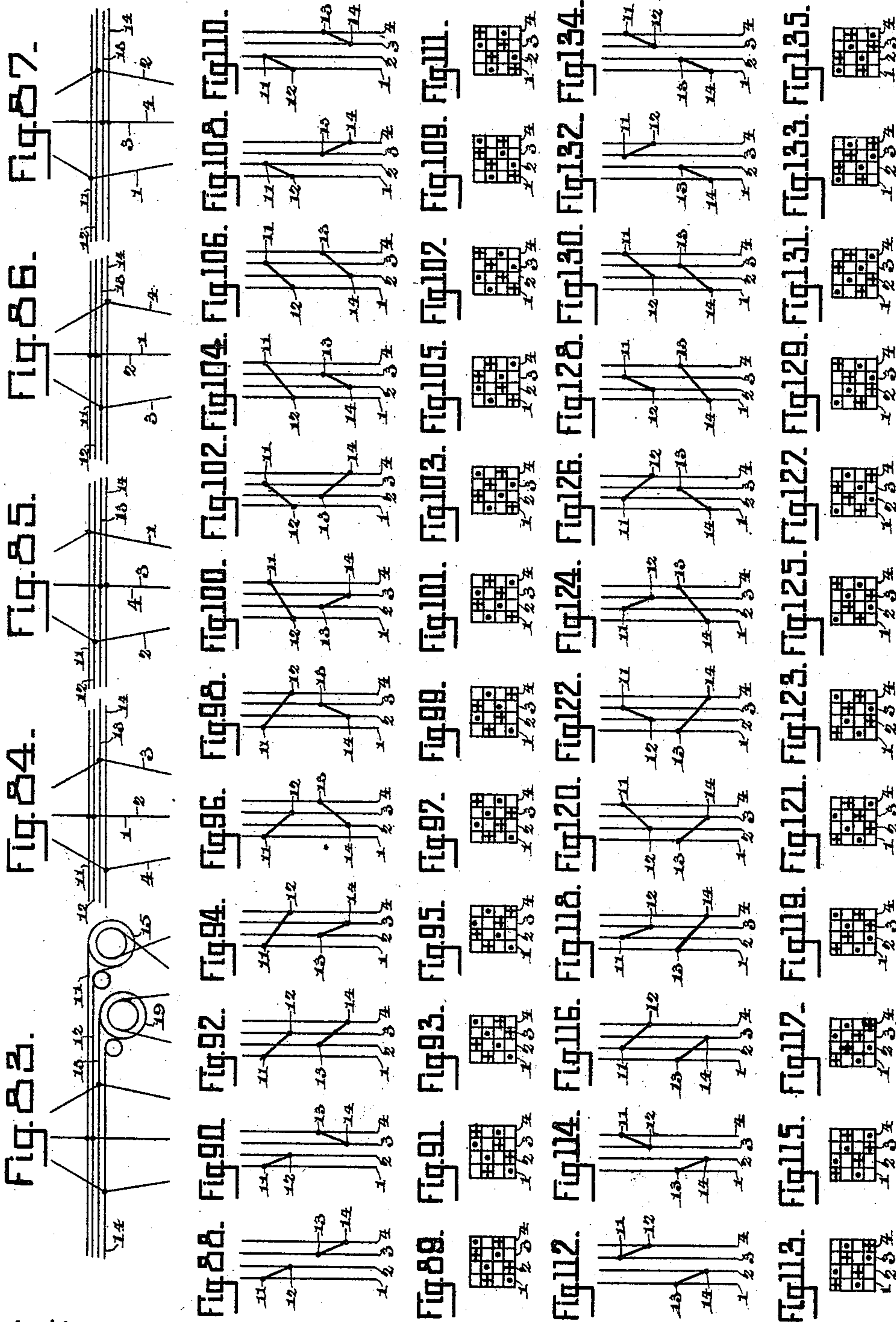
Inventor.
A. D. Emery.
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METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.



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Halter S. Emery

Inventor.

Abram S. Emery

by Frank MacArthur. Attorney.

(No Model.)

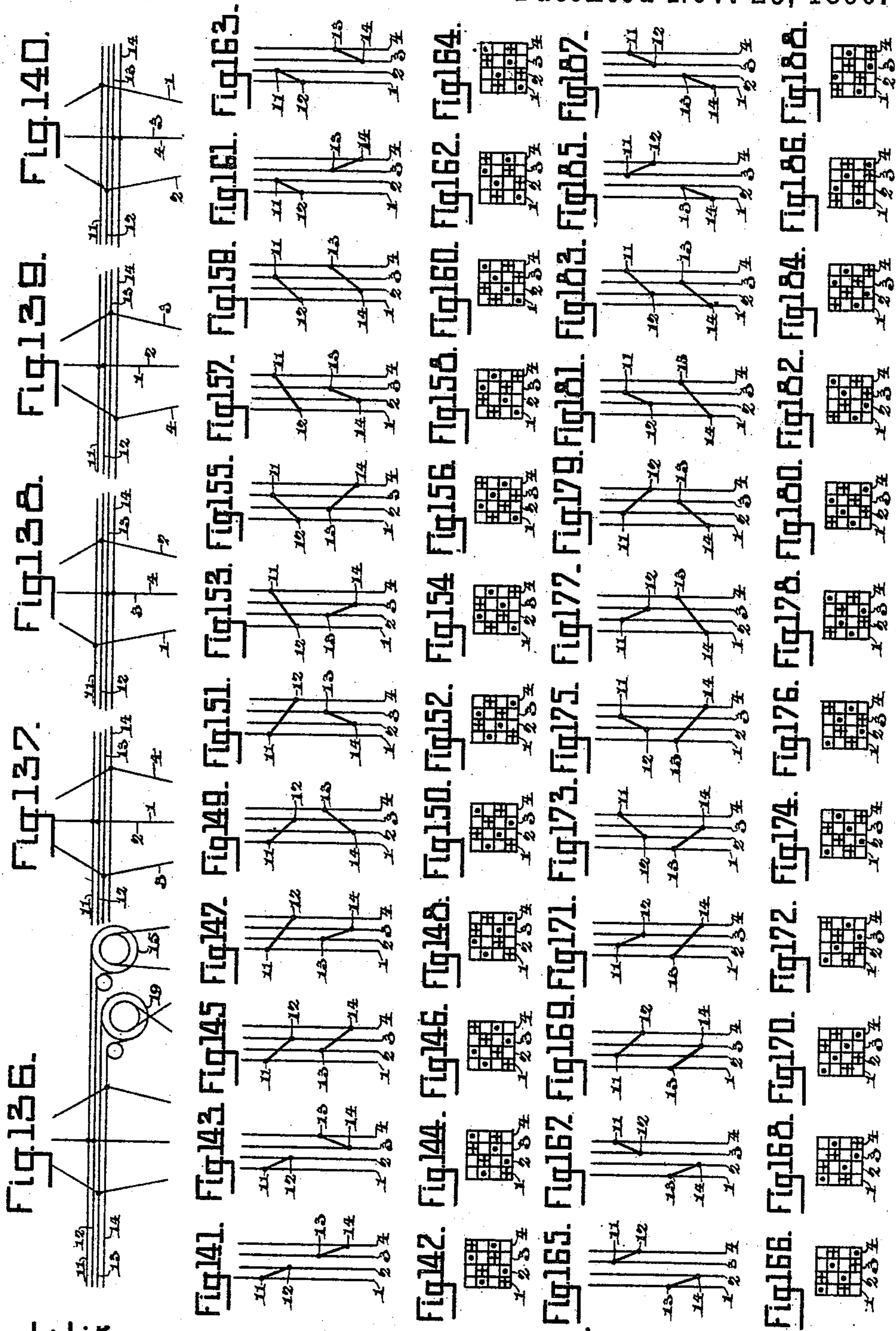
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A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.



Witnesses.

Wm. J. Donnelly.
Halter J. Emery.

Inventor.

Frank MacArthur. Attorney.

(No Model.)

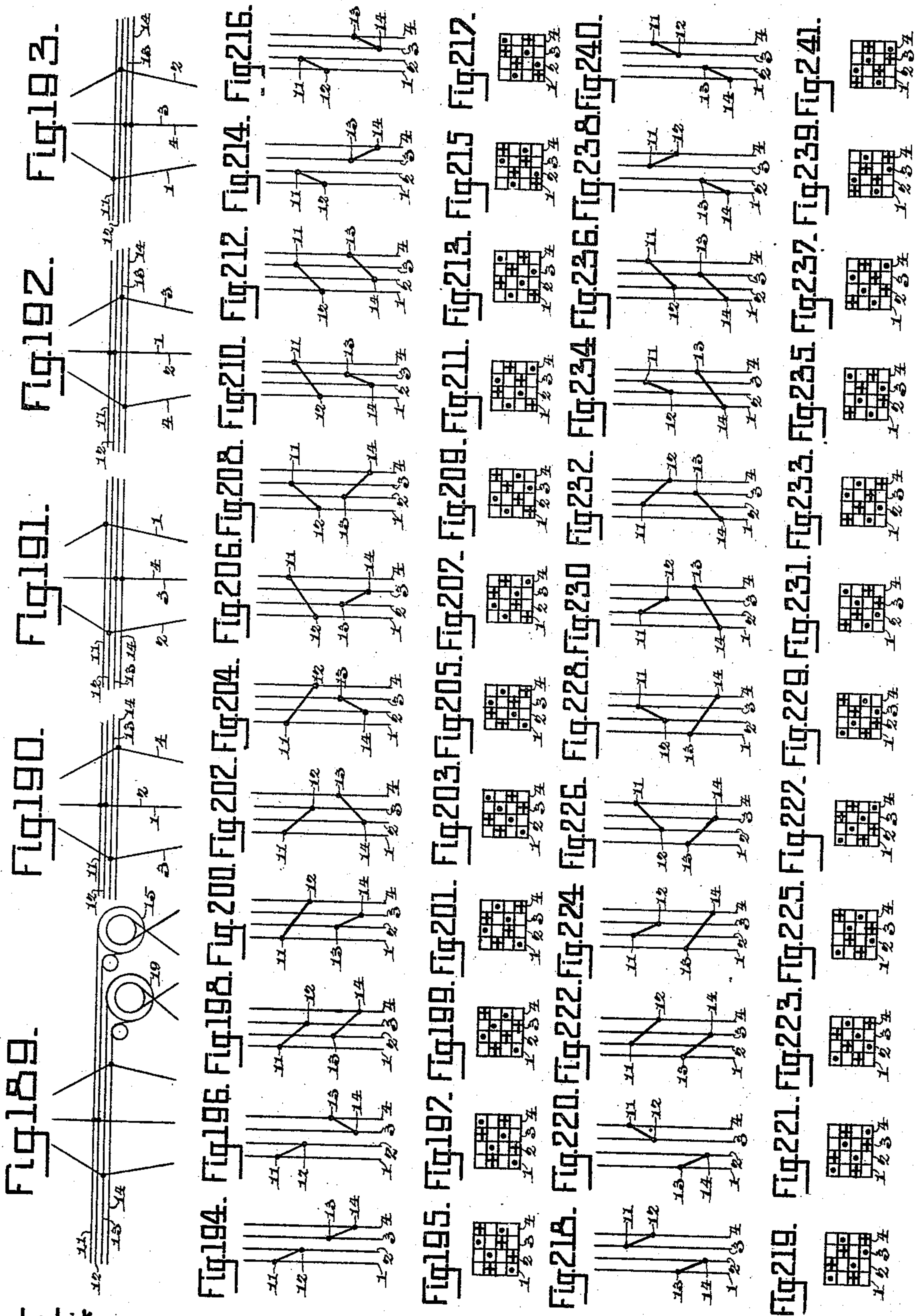
10 Sheets—Sheet 9.

A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.



Witnesses.

Wm. J. Donnelly.
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A. D. EMERY.

METHOD OF WEAVING DOUBLE WEIGHT GOODS.

No. 441,230.

Patented Nov. 25, 1890.

Fig. 242.

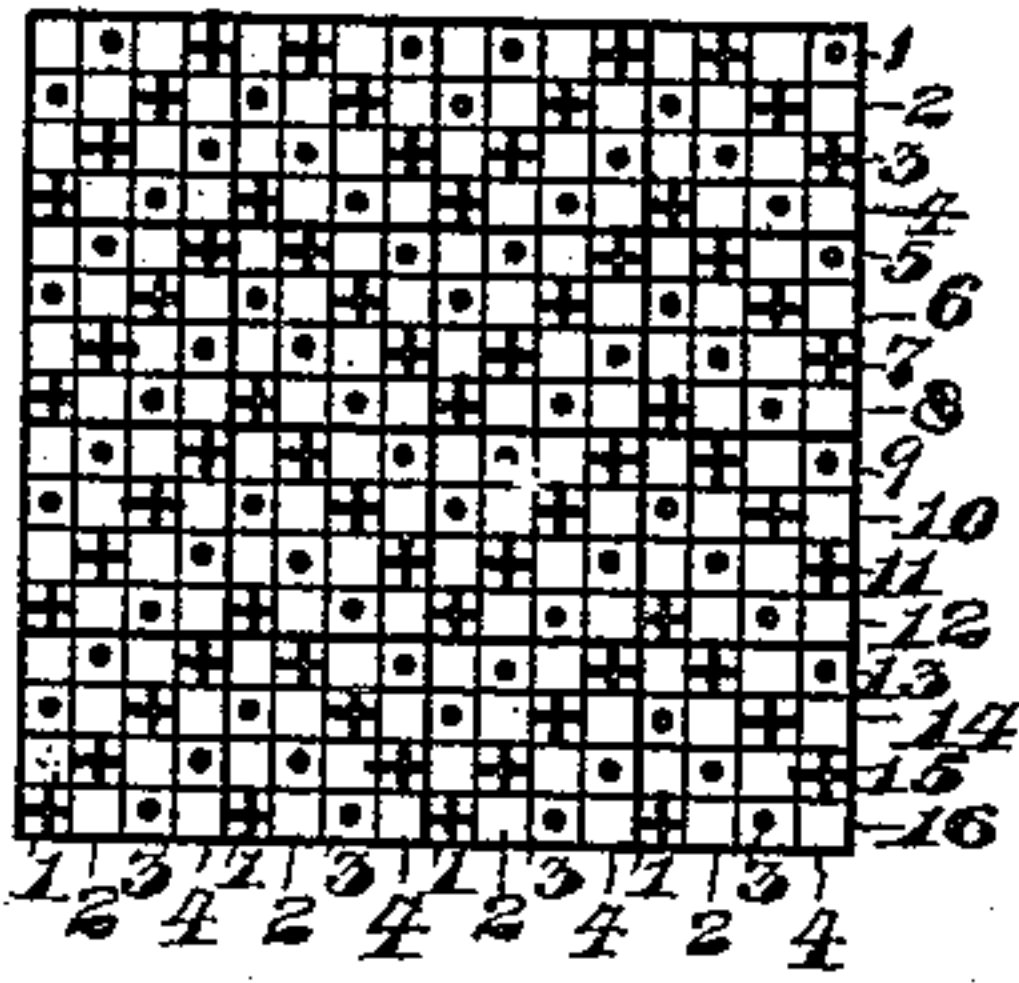


Fig. 243.

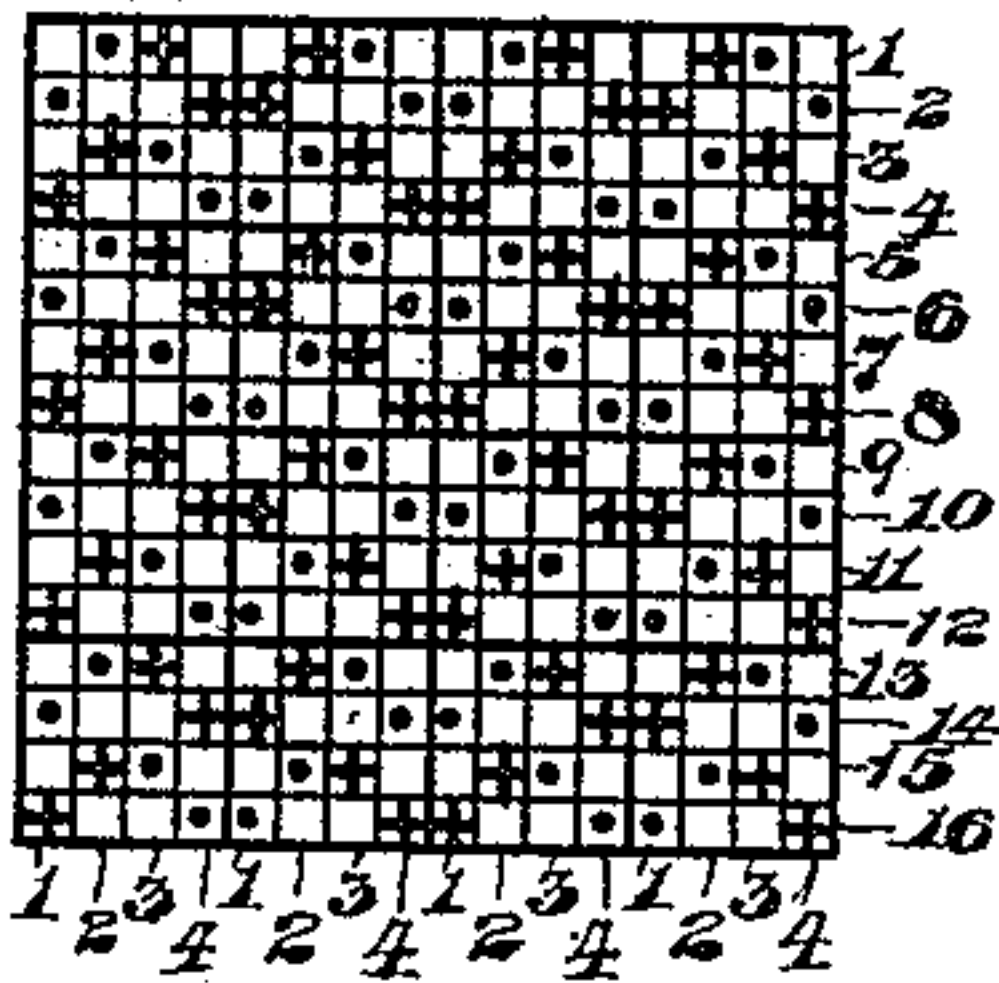


Fig. 244.

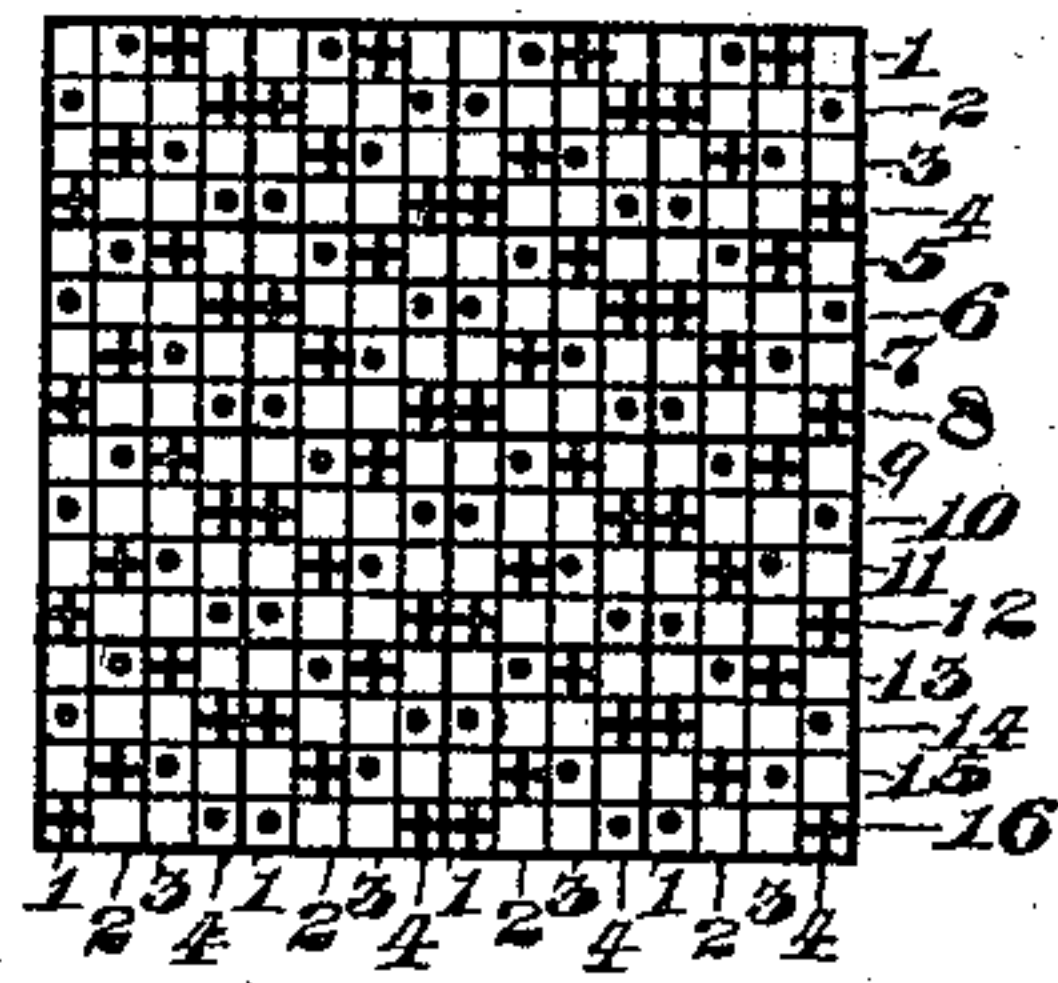


Fig. 245.

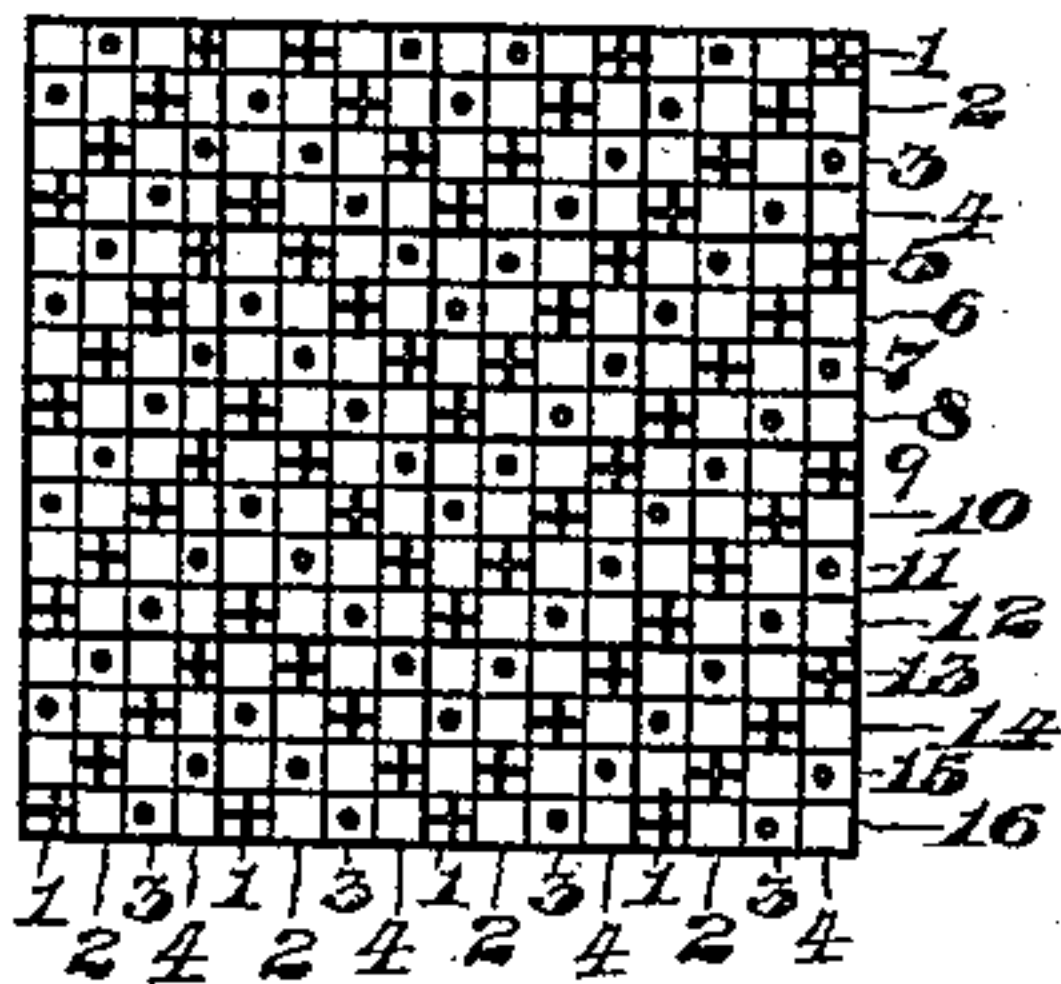


Fig. 247.

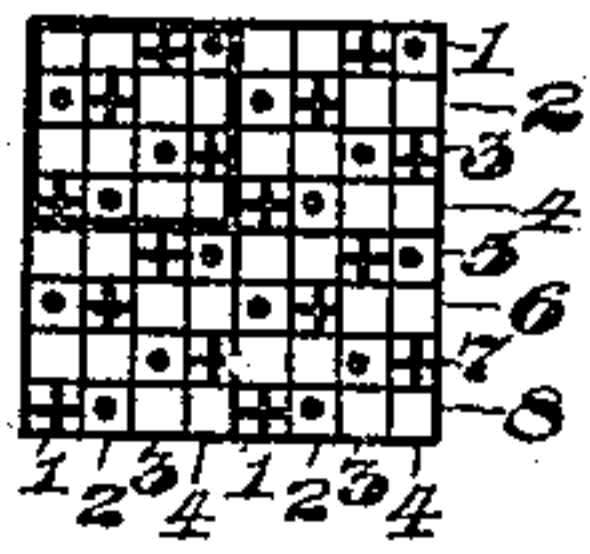


Fig. 246.

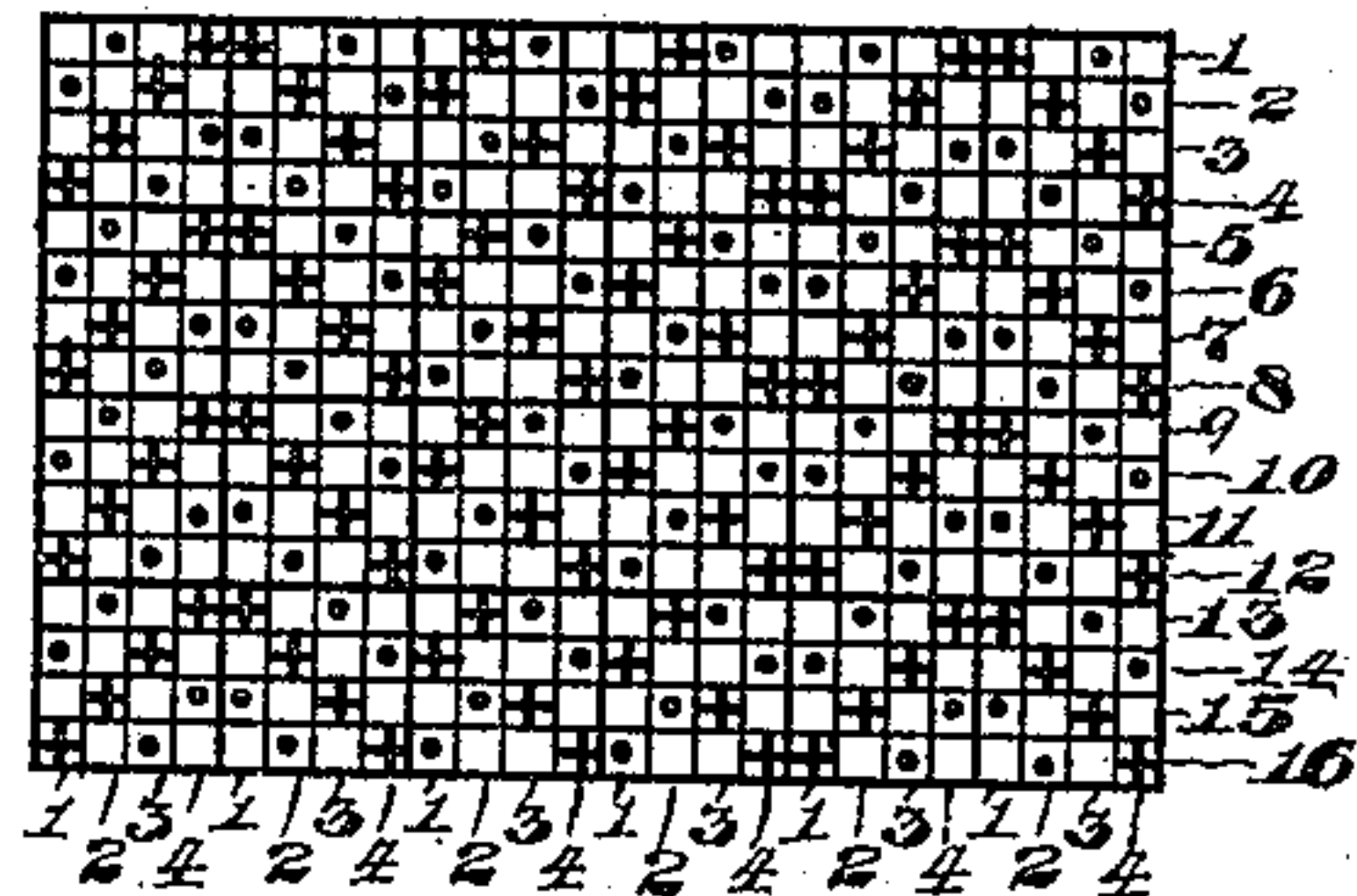


Fig. 248.

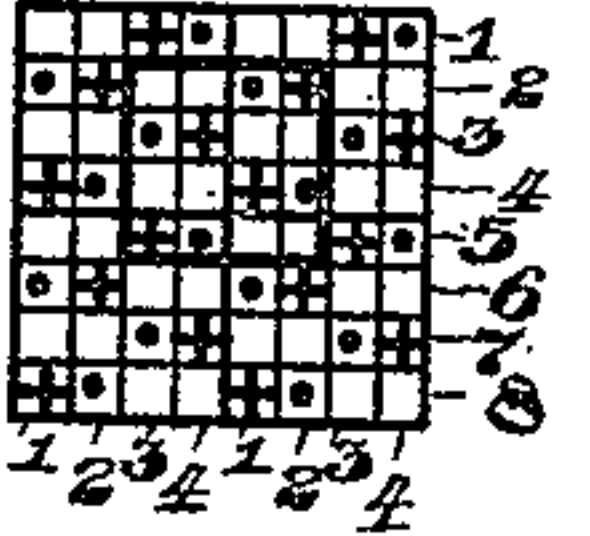


Fig. 251.

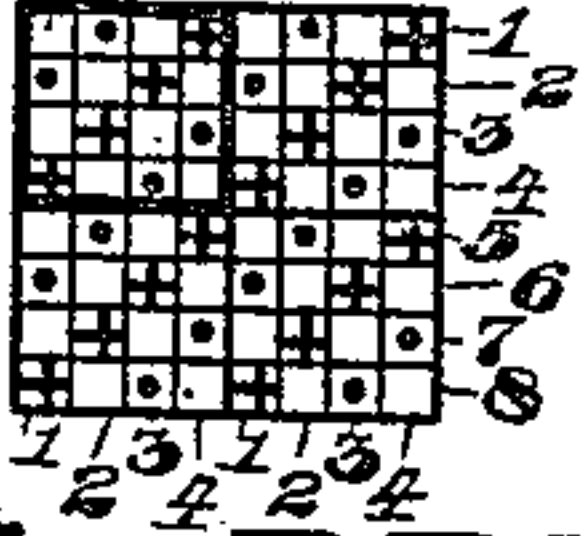


Fig. 249.

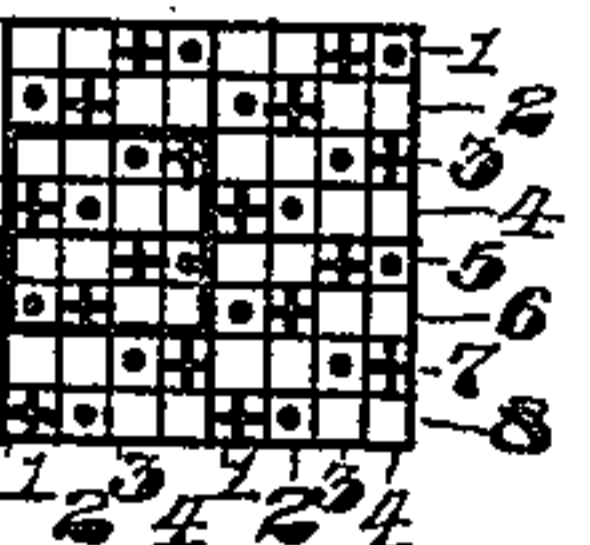


Fig. 253.

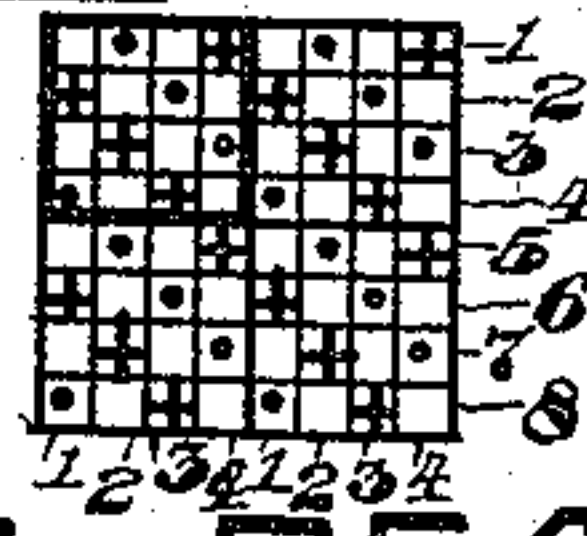


Fig. 252.

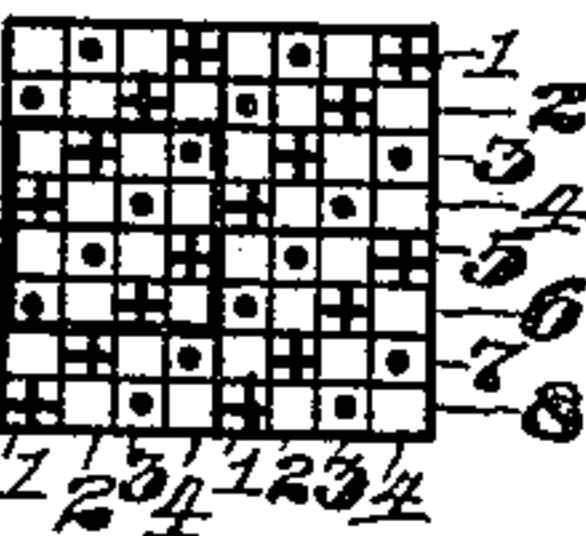


Fig. 250.

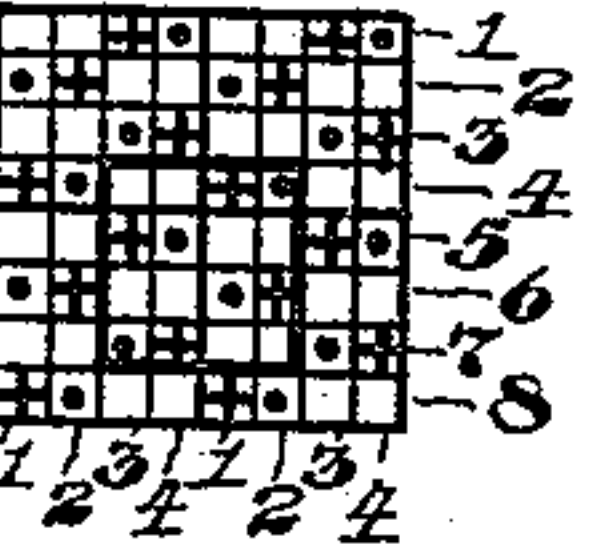
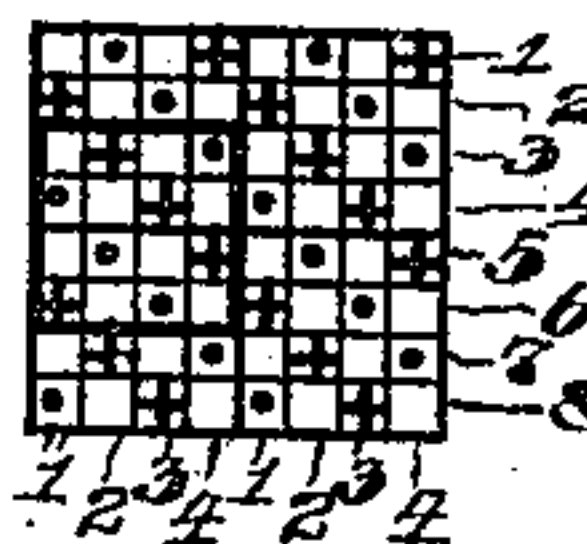


Fig. 254.



Witnesses.

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Attorney.

UNITED STATES PATENT OFFICE.

ABRAM D. EMERY, OF TAUNTON, MASSACHUSETTS.

METHOD OF WEAVING DOUBLE-WEIGHT GOODS.

SPECIFICATION forming part of Letters Patent No. 441,230, dated November 25, 1890.

Application filed October 7, 1889. Serial No. 326,247. (No model.)

To all whom it may concern:

Be it known that I, ABRAM D. EMERY, a citizen of the United States, residing at Taunton, in the county of Bristol and State of Massachusetts, have invented certain new and useful Improvements in the Method of Weaving Double-Weight Goods, of which the following is a full description.

My invention, which relates to a peculiar method of weaving double-weight goods by which such goods are produced with unusual rapidity, involves the employment of two shuttles; and it consists in the formation of a series of double sheddings, as hereinafter described, and in carrying two weft-threads back and forth across the loom and through the sheddings, respectively, always in the same direction at the same time, one weft through the face and the other weft through the back of the fabric. I term one side of the goods the "face" and the other side the "back," although both sides are the same in the completed fabric. At each shedding I form simultaneously two paths side by side in a single set of chain-threads—one over the other—in a horizontal loom, or the two paths side by side in a vertical loom, as may be desired. In this method of shedding there are four possible positions which a chain-thread may assume. It may be, first, extended on the outside, or, second, on the inside or middle, of one path, or, third, on the inside or middle, or, fourth, extended on the outside, of the other path. According to my method each and every chain-thread of the four series into which the chain-threads are divided at each shedding passes through all the possible positions in regular order, viz: Assuming that a chain-thread is on the outside of the right-hand path, as shown in the drawings, it will pass at the next shedding to the middle or inside position, thence to the outside of the other path, and thence to the inside or middle. The order in which the chain-threads pass through this regular sequence of positions may of course be varied in a great number of ways, producing different patterns in the fabrics, without departing from my invention. The practical difficulty encountered in forming two paths in a single set of chain-threads and passing the chain-threads through all

possible positions in said paths arises from the fact that without some specially-designed tension device a chain-thread which is subjected to the proper tension in its extended position would be slack in its middle position and the reverse. This inequality of tension is compensated for in the ordinary methods by so placing the whip-roller that the threads forming the shed are extended equally upon either side of an imaginary line drawn between the whip-roller and the fell of the cloth. In making two openings side by side this condition cannot be maintained, as the whip-roll to be in the best position possible would be, as before, midway between the two extended or outside threads; but this position is exactly in the line of the threads in the middle position, which would therefore hang slack and render it practically impossible to practice the method which is the subject of this application. This difficulty has been met by me by the invention of the special tension device which is the subject of application filed by me May 21, 1889, Serial No. 312,828, (Case 13.)

I will now proceed to describe a convenient form of apparatus for carrying my method into effect.

In the accompanying drawings, forming part of this specification, Figures 1, 2, 3, and 4 represent the component parts of a loom so far as necessary to an understanding of my invention, and illustrate the four sheddings and flights of the shuttles, which complete the sequence of operations. Figs. 5, 6, 7, and 8 are enlarged cross-sections of the four sheddings, as shown in Figs. 1 to 4. Fig. 17 is a draft of the chain-threads of the sheddings as shown in Figs. 1 to 4, and in enlarged views Figs. 5 to 8, and in which the crosses indicate the threads that are extended on the right-hand side and the dots those extended on the left-hand side, and the blank spaces the threads that are in the center in each of the sheddings. Fig. 18 is a side view of the heddles, as shown in Figs. 1 to 4, with the chain-threads contained in the eyes of the same. Fig. 20 is a cross-section of the heddles in Fig. 18 and shows the manner of drawing the threads through the eyes. The fabric produced by this method of drawing in the

chain-threads is shown in Fig. 22. Fig. 9 is a cross-section of the fabric, as shown in Fig. 22, taken on the line A B, and shows several positions taken by the weft-threads in forming the fabric. Figs. 11, 12, 13, and 14 illustrate four sheddings in which the heddles are worked over in the same order, as shown in Figs. 1 to 4. The chain-threads are, however, drawn through the heddle-eyes, as shown in Figs. 16 and 19. Fig. 15 is a draft of the chain-threads as they appear in the several sheddings. Fig. 21 is a plan view of the fabric produced by this threading in of the threads. It will be observed that it is a regular four-leaf twill, whereas the one shown in Fig. 22 is a four-leaf broken twill. Fig. 10 is a cross-section of the fabric shown in Fig. 21, taken on the line A B, and shows the relative position of the chain-threads in the fabric. Figs. 23, 24, 25, and 26 show the effect produced by threading in the chain-threads, as shown in Fig. 28, which is a cross-section of the heddles, as before. Fig. 27 is a draft of the chain-threads and designates the positions they occupy in the several sheddings. Fig. 29 is a plan view of the fabric produced by this method of threading in the chain-threads. Fig. 30 represents in diagram the position of the parts as shown in Fig. 1, with the exception that the heddle-cords are not crossed. Figs. 31, 32, 33, and 34 show the four positions of the heddles and the chain-threads which they govern, being diagrammatically the positions as shown in Figs. 1 to 4. Figs. 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, and 81 represent twenty-four ways in which the four chain-threads may be threaded through the heddles, each of these different manners of drawing through changing the order in which the chain-threads are raised, and consequently producing a different appearance of the face of the fabric, as will be seen upon an examination of the following views. Figs. 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, and 82 are drafts of the chain-threads as they appear on the face, the crosses indicating the threads raised on the right-hand side and the dots indicating the threads raised on the left-hand side. Fig. 83 is a diagrammatic view of the parts of the loom corresponding to Fig. 1, with the heddle-cords governing the heddles 11 and 12 crossed instead of straight. The effect will be seen in the following views. Figs. 84, 85, 86, and 87 show the effect of this alteration. The heddle 11 is moved and occupies the positions in the several sheddings that heddle 12 occupied in the views as shown in Figs. 31, 32, 33, and 34, and heddle 12 likewise occupies the positions held by heddle 11 in the above-mentioned views. Figs. 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, and 134 represent the manner of threading through the chain-threads, which is the same as shown in similar views on Sheet 6, with a different re-

sult, however, as shown in Figs. 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, and 135, which are drafts of the chain-threads as produced by this manner of crossing this particular heddle-cord. Fig. 136 is a diagrammatic representation of the parts of the loom shown in Fig. 1, with the heddle-cords that operate the heddles 13 and 14 crossed. This reverses the positions of the heddles 13 and 14 in all the several sheddings. Figs. 137, 138, 139, and 140 represent the several positions of the heddles and weft-threads due to this transposition of the heddle-cords governing the heddles 13 and 14. Figs. 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, and 187 represent the manner of threading through the heddles of the chain-threads. These several views are exactly like the similar views on Sheets 6 and 7, but the result is different. Figs. 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, and 188 illustrate the result of this crossing of the heddle-cord governing the heddles 13 and 14. Fig. 189 illustrates in diagram parts of the loom shown in Fig. 1, with both heddle-cords crossed. Figs. 190, 191, 192, and 193 show the position of the threads due to this crossing of the heddle-cords, as shown in Fig. 189. Figs. 194, 196, 198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, and 240 illustrate the method of threading in the threads, which is the same as is shown in Sheets 7, 8, and 9. The effect of this crossing of the heddle-cords is shown in Figs. 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, and 241. Figs. 242, 243, 244, 245, and 246 show the effect of different combinations of threading the threads through the heddles, as will be described farther on. Figs. 247, 248, 249, 250, 251, 252, 253, and 254 illustrate the respective effect of the crossing of the heddle-cords, and will be described in detail.

Referring now particularly to Figs. 1 to 4, the numerals 1, 2, 3, and 4 indicate the four chain-threads—that is to say, one each of the four series of chain-threads.

The numeral 5 indicates the weft-thread used to form the face of the fabric, and 6 the weft-thread used to form the back of the fabric.

7 indicates the shuttle carrying the thread 5, and 8 the shuttle carrying the thread 6.

9 indicates the reed, and 10 the fabric in process of construction.

The numerals 11, 12, 13, and 14 indicate the heddles. Thread 1 is drawn through heddle 11, thread 2 through heddle 12, thread 3 through heddle 13, and thread 4 through heddle 14. The heddles 11 and 12 are connected together, one end of the connection passing over the large roller 15 and the opposite end passing over the small roller 16. The small roller 17 aligns the heddle 12 with the heddle-

roller 16, while roller 18 aligns the heddle 11 with the roller 15. The heddles 13 and 14 are in like manner connected together, one end of the connection passing over the roller 19, the opposite end passing over the roller 20. The rollers 21 and 22 align the heddle 14, the heddle 13 being tangent to both rollers 19 and 20. The two small rollers 23 and 24 are placed close together and near the equalizing-levers 25 and 26 and serve to keep the outer chain-threads of the double shedding of the same length. The chain-threads that are governed by the heddles 11 and 12 pass over and under the ends of the equalizing-lever 25, and the threads that are governed by the heddles 13 and 14 pass over and under the ends of the equalizing-lever 26.

The numeral 27 is the roll of chain.

Motion is given to the rollers actuating the heddle-cords by the cam 28, which is a three-throw cam, or one that will place the rollers in either of the three positions. This cam is timed so as to make one complete revolution to four picks or sheddings.

The order of the positions of the rollers as produced by the cam are as follows: first, such as to place the chain-threads on the outside, then in the middle, then inside, and then in the middle. Thus it will be seen that there are two middle positions and one outside and one inside position represented by the different parts of the cam. Each roller in passing from the outside to the inside or from the inside to outside passes to one of the middle positions. The heddle-cords 31 and 32 pass around the end of the roller 19, and the ends of the cords are connected to opposite ends of the rocker 29, whose attached roller 30 travels in a groove in the cam. The cords 35 and 36 in like manner pass around the roller 15, and the ends of the cords are connected to the ends of the rocker 33, whose attached roller 34 also works in the same groove in the cam. The rollers 30 and 34 are so set that their mean angular separation with relation to the center of the cam which controls them is about ninety degrees—that is, they are in adjacent positions in the cam, there being four positions in the full circle. What may be termed the “center position” in the cam places the heddles in the center or common side of the two sheddings. The “outside” and “inside” positions of the cam place the threads on the outsides of the two sheddings. The roller 30, attached to rocker 29, in the outside position places the heddle 13 on the outside on the right and the heddle 14 outside on the left.

The terms “right” and “left” and “right hand” and “left hand” are descriptive of the positions of the parts to which they refer as those positions appear in the drawings. The rocker 33, with its attached roller 34, when in the outside position will place the heddle 12 on the right and the heddle 11 on the left of the double shedding. The roller 30, attached to rocker 29, when in the inside position of

the cam places the heddle 14 on the right and the heddle 13 on the left of the sheddings. The roller 34 in the rocker 33 when in the inside position of the cam places the heddle 11 on the right and the heddle 12 on the left of the double shedding. When the rollers 30 and 34 are in the middle position, the heddles are placed in the center or common side of the double shedding.

In Fig. 1 the roller 30 is represented as in the outside position of the cam, and places the heddle 13 on the right and thread 3, which it governs, on the outside on the right, and heddle 14 and thread 4 on the outside on the left of the double shedding. The roller 34 is in the center position, and places the threads 1 and 2 in the center of the double shedding. The chain-threads pass around the compensating-levers 25 and 26, as more fully explained in my application above referred to. The center threads 1 and 2 are passed around the lever 25, which has been moved in a direction to take up the slack of said center chain-threads by the outward movement of threads 4 and 3, which pass around the lever 26, causing the same to move in a direction to give out thread, and this motion of the lever 26 giving to the lever 25 a movement in the opposite direction, as described. At the succeeding shedding the threads 1 and 2 go to the outside, moving the lever 25 in a direction to give out thread, and the lever 25 causes the lever 26 to move in the opposite direction to take up the slack of the threads 3 and 4, which are now in the center. Through this first double shedding the shuttles are simultaneously passed in the same direction, the shuttle 8 laying the thread 6 in the right-hand side and the shuttle 7 laying the thread 5 in the left-hand side of the double shedding. The weft-threads being beaten up, form the first pick. The cam 28 is then moved in the direction indicated by the arrow in Fig. 1 to the position as shown in Fig. 2. This places the roller 34 on the rocker 33 in the outside position of the cam, thus placing the heddle 12, with thread 2, on the right and heddle 11, with thread 1, on the left of the outside position of the double shedding, while the roller 30, mounted upon the rocker 29, is passed to the center position of the cam, thus placing the heddles 13 and 14 and threads 3 and 4 in the center of the double shedding. Through this second shedding the shuttles are again simultaneously passed in the same direction, laying the weft-threads on the same sides of the fabric as in the previous pick. The cam is then moved in the direction indicated by the arrow in Fig. 2 to the position as shown in Fig. 3, in which the roller 30 on rocker 29 is passed to the inside position of the cam, placing the heddle 14, carrying thread 4, to the right and heddle 13, carrying thread 3, to the left of the outside of the double shedding. The roller 34 is at the same time passed to the center position of the cam, placing heddles 11 and 12, with threads 1 and 2, in the center or common side

of the third shedding. Through this shedding the shuttles are again simultaneously passed, laying the thread 6 in the right-hand side and thread 5 in the left-hand side, and the weft-threads being beaten up form the third pick. The cam is now moved to the position as seen in Fig. 4, wherein the roller 30 is seen in the middle position of the cam, thus placing the threads 3 and 4 in the center or common side of the shedding, and the roller 34 is in the inside position of the cam, placing the threads 1 and 2, governed by the heddles 11 and 12, on the outsides of the shedding. Through these openings the shuttles are again passed, laying the thread 6 in the right-hand side and the thread 5 in the left-hand side. The weft-threads being beaten up into the fabric form the fourth pick, and this completes the sequence of the positions assumed by the chain-threads due to the four positions of the cam.

It will be understood that the heddles in all the subsequent modifications always pass in this order, viz: Taking the right-hand side of the fabric, the chain-threads are extended in the following order: 3, 2, 4, and 1, the heddles being raised in the order of 13, 12, 14, and 11. The heddles on the left are extended as follows: 14, 11, 13, and 12. This follows from the manner in which the heddles are connected together. When the heddle 13 is on the right, 14 will be on the left, and when 11 is on the right 12 will be on the left, and vice versa. It will also be observed that the heddles 11 and 12 move together, and when one is on one outside the other is on the opposite outside, and when one is in the center the other is likewise in the center, and that they pass from the opposite outsides to the center, and at the next shedding they pass to the opposite outsides to that they previously occupied. This is also true of the heddles 13 and 14.

From the position in which the rollers 30 and 34 on the rockers 33 and 29 are placed the heddles follow each other in regular order in the following manner: extended on the side at the right, then in the middle, then on the outside on the left, and then again in the middle.

The positions of the threads in the four sheddings above described will be seen in enlarged cross-sections in Figs. 5 to 8 of Sheet 2, wherein Fig. 5 is an enlarged cross-section of the first shedding, as shown in Fig. 1, showing thread 6 contained between chain-threads 1 and 3, and thread 5 is between threads 4 and 2, which weft-threads, being beaten up, form the first pick.

Fig. 6 is an enlarged cross-section of the shedding shown in Fig. 2, and shows thread 6 on the same side of the fabric, as before, between chain-threads 2 and 3 and thread 5 between threads 1 and 4.

Fig. 7 is an enlarged cross-section of the shedding shown in Fig. 3, and shows thread 6 between threads 4 and 2 and thread 5 be-

tween threads 3 and 1. The weft-threads being beaten up form the third pick.

Fig. 8 is an enlarged cross-section of the shedding shown in Fig. 4, and shows thread 6 between threads 1 and 4 and thread 5 between threads 2 and 3, which, being beaten up, form the fourth pick.

It will be observed that the chain-threads are over the weft-threads 6 in the following order: 3, 2, 4, and 1, and form what I will designate as the "face" of the fabric, although both sides are, in fact, duplicates of one another.

This manner of interlacing will be more fully understood upon examining the draft of the chain-threads as shown in Fig. 17, and wherein the crosses represent the chain-threads that are raised or are over the weft-thread 6 on the face and the dots the chain-threads that are over the weft-thread 5 on the back of the fabric.

The fabric is shown in Fig. 22, and is what is called a "four-leaf broken twill," with the weft-threads flushed.

A cross-section of the fabric is seen in Fig. 10, taken on the line A B, and in which will be seen the positions of the weft and chain threads in each of the several picks, as already described.

The manner of threading in the chain-threads is shown in Figs. 18 and 20, wherein it will be seen that thread 1 is drawn through heddle 11, thread 2 through heddle 12, thread 3 through heddle 13, and thread 4 through heddle 14. This manner of threading being altered, as shown in Figs. 16 and 19, will produce a different result. Upon examining Fig. 19 it will be seen that thread 1 is drawn through heddle 14, thread 2 through heddle 12, thread 3 through heddle 13, and thread 4 through heddle 11. The heddles are worked over in the same order as before—that is, 3, 2, 4, and 1—but the threads are raised in the order of 3, 2, 1, and 4. This produces the sheddings as shown in Figs. 11, 12, 13, and 14, the heddles being in the same positions as seen in Figs. 1 to 4; but the chain-threads are seen to be raised in the order of 3, 2, 1, and 4. This forms a regular four-leaf twill, as will be seen upon examining the draft as shown in Fig. 15, and the fabric as shown in Fig. 21, wherein the chain-threads are over the weft-thread 6 in the order of 1 2 3 4.

The cross-section of the fabric on the line A B is seen in Fig. 9, wherein the weft and chain threads in their several positions in each pick are seen. By threading the chain-threads through the heddles in the manner now to be described a fabric is formed similar to that shown in Fig. 22 and draft Fig. 17, with this exception, that the chain-threads corresponding to the several positions in the pattern are moved three threads to the right and three picks ahead of that shown in the draft in Fig. 17. The several positions of the heddles are the same as before; but the threads

occupy the positions as seen in Figs. 23, 24, 25, and 26, wherein the threads are extended on the right in the order of 4 2 3 1. The method of threading in the threads is seen in Fig. 28, wherein thread 1 is drawn through heddle 11, thread 2 through heddle 12, thread 3 through heddle 14, and thread 4 through heddle 13. The draft of the same is seen in Fig. 27, where it will be seen that the threads are raised in the order of 4 2 3 1. The fabric as produced by this method is seen in Fig. 29, and in the finished state would not be distinguishable from that shown in Fig. 22; but it is by reason of this slight variation that I am enabled to vary the pattern so as to produce the figures hereinafter described.

In Fig. 30 is a diagram view of the position of the heddles and rollers 15 and 19 with their attached heddle-cords. These latter are not crossed, but extend to the ends of the levers, as seen in Figs. 1 to 4.

The several positions of the heddles and chain-threads are shown in Figs. 31, 32, 33, and 34, in which the heddles are extended on the right in the order of 13, 12, 14, and 11, while the heddles on the left are extended in the following order: 14 11 13 12.

The chain-threads are drawn through the heddles in the following order: thread 1 through heddle 11, thread 2 through heddle 12, thread 3 through heddle 13, and thread 4 through heddle 14.

The method of threading in is shown in Fig. 35, and the result of the same is seen in Fig. 36. Again, threading in the threads is shown in Fig. 37, where the thread 1 is drawn through heddle 11, thread 2 is drawn through heddle 12, thread 3 is drawn through heddle 14, and thread 4 is drawn through heddle 13. The result of this drawing in is seen in Fig. 38, which is, like Fig. 36, in part reversed.

In Fig. 39 the thread 1 is drawn through heddle 11, thread 2 through heddle 13, thread 3 through heddle 12, and thread 4 through heddle 14. The result is seen in Fig. 40, which is a regular twill running from left to right.

In Fig. 41 the thread 1 is drawn through the heddle 11, thread 2 through heddle 13, thread 3 through heddle 14, and thread 4 through heddle 12. The result is seen in Fig. 42.

In Fig. 43 thread 1 is drawn through heddle 11, thread 2 through heddle 14, thread 3 through heddle 12, and thread 4 through heddle 13. The result is a regular twill running from right to left, as seen in Fig. 44.

In Fig. 45 thread 1 is drawn through heddle 11, thread 2 through heddle 14, thread 3 through heddle 13, and thread 4 through heddle 12. The result is seen in Fig. 46. This completes the combinations that can be made with thread 1 in heddle 11 as a starting-point.

The next six combinations are made with the thread 1 in heddle 12.

In Fig. 47 thread 1 is in heddle 12, 2 in hed-

dle 13, 3 in heddle 14, and 4 in heddle 11. The result is seen in Fig. 48.

In Fig. 49 thread 1 is in heddle 12, 2 in heddle 13, 3 in heddle 11, and 4 in heddle 14. The result is seen in Fig. 50, which is a regular twill two picks later than that shown in Fig. 44.

In Fig. 51 the thread 1 is drawn through the heddle 12, 2 through heddle 14, 3 through heddle 13, and 4 through heddle 11. The result is seen in Fig. 52, which is like Fig. 38, but with the threads moved one thread to the right. The expressions "one thread" or "one space to the right or to the left" are herein used for the sake of brevity. Their meaning will be understood by a consideration of Fig. 38, and the similar figures representing groups of sixteen squares arranged in four tiers, each vertical column of the squares representing one thread or space. Hence to move Fig. 38 one thread or one space to the right would be to omit the tier of spaces under numeral 1 at the left-hand side of Fig. 38 and to take in a similar tier of spaces representing a corresponding arrangement of threads from the next adjoining group upon the right, in which case the resulting figure would be precisely the same as Fig. 52.

In Fig. 53 the thread 1 is drawn through heddle 12, 2 through heddle 14, 3 through heddle 11, and 4 through heddle 13. The result is seen in Fig. 54, which is a regular twill, left-handed, like that shown in Fig. 40, except that it is two picks back of the same.

In Fig. 55 thread 1 is drawn through heddle 12, 2 through heddle 11, 3 through heddle 13, and 4 through heddle 14. The result is seen in Fig. 56, which is like that shown in Fig. 42, but with the threads moved one thread or space to the left.

In Fig. 57 thread 1 is threaded through heddle 12, 2 through heddle 11, 3 through heddle 14, and 4 through heddle 13. The result is seen in Fig. 58, which is like that shown in Fig. 46, taken one space to the left. This completes the sequence of six, with the thread 1 drawn through heddle 12 as the first space.

In Fig. 59 thread 1 is drawn through heddle 13, 2 through heddle 14, 3 through heddle 11, and 4 through heddle 12. The result is seen in Fig. 60, which is like that shown in Fig. 36, moved two spaces to the right.

In Fig. 61 the thread 1 is drawn through heddle 13, 2 through heddle 14, 3 through heddle 12, and 4 through heddle 11. The result is seen in Fig. 62, which is the same as that shown in Fig. 42, moved one space to the right.

In Fig. 63 thread 1 is drawn through heddle 13, 2 through heddle 11, 3 through heddle 14, and 4 through heddle 12. The result is seen in Fig. 64, which is a regular twill, the same as shown in Figs. 44 and 50, but taken one square to the left of that shown in Fig. 44 or one square to the right of that shown in Fig. 50.

In Fig. 65 thread 1 is threaded through hed-

dle 13, 2 through heddle 11, 3 through heddle 12, and 4 through heddle 14. This result is seen in Fig. 66, which is like that shown in Fig. 52, moved two spaces to the right.

5 In Fig. 67 thread 1 is drawn through heddle 13, 2 through heddle 12, 3 through heddle 14, and 4 through heddle 11. The result is seen in Fig. 68, and is the same as that shown in Fig. 44, in an opposite direction, or in Fig. 10 54, moved one space to the right.

In Fig. 69 thread 1 is threaded through heddle 13, 2 through heddle 12, 3 through heddle 11, and 4 through heddle 14. The result is seen in Fig. 70, in which the threads are represented as occupying the positions which they occupy during the pick preceding that indicated in Fig. 42, Fig. 70 being the same as Fig. 58, taken one space to the left. This completes the combinations with thread 1 in 20 the heddle 13.

In Fig. 71 thread 1 is threaded through heddle 14, 2 through heddle 11, 3 through heddle 12, and 4 through heddle 13. The result is seen in Fig. 72, which is like that shown in 25 Fig. 60, taken one space to the right.

In Fig. 73 thread 1 is threaded through heddle 14, 2 through heddle 11, 3 through heddle 13, and 4 through heddle 12. The result is seen in Fig. 74, which is a regular twill, like 30 that shown in Fig. 54, taken one space to the right of the same.

In Fig. 75 thread 1 is threaded through heddle 14, 2 through heddle 12, 3 through heddle 11, and 4 through heddle 13. The result is seen in Fig. 76, which is like that shown in Fig. 42, but taken two spaces to the right or to the left of the same. 35

In Fig. 77 thread 1 is threaded through heddle 14, 2 through heddle 12, 3 through heddle 13, and 4 through heddle 11. The result is seen in Fig. 78, which is a regular twill, like that shown in Fig. 44, taken one space to the left. 40

In Fig. 79 thread 1 is threaded through 45 heddle 14, 2 through heddle 13, 3 through heddle 11, and 4 through heddle 12. The result is seen in Fig. 80, which is like that shown in Fig. 52, taken one space to the right.

50 In Fig. 81 thread 1 is threaded through heddle 14, 2 through heddle 13, 3 through heddle 12, and 4 through heddle 11. The result is seen in Fig. 82, which is taken two spaces to the right or left of that shown in 55 Fig. 58. This completes the sequence of positions with thread 1 in the heddle 14.

It will be seen that there are twenty-four combinations in all that can be made if we begin the combinations with the first shedding of each series in regular sequence. 60

In Fig. 83 is shown a diagram view of the heddles and the rollers that actuate the same, similar to Fig. 30, but with the heddle-cords that operate the roller 15 and which control 65 the heddles 11 and 12 crossed. This has the effect of reversing the positions of the hed-

dles 11 and 12 in all the several methods of threading. This alters the order of the lifting as heretofore described, as will be seen in the following views. 70

Figs. 84, 85, 86, and 87 show the four positions of the threads and their governing-heddles due to this crossing of the heddle-cord operating the roller 15. It will be observed that the heddles are now lifted on the right-hand 75 side in the following order: 13, 11, 14, and 12. The complementary heddles on the left are raised in the order of 14, 12, 13, and 11.

In Figs. 88 to 135 those with the even numbers represent the same method of 80 threading through as shown in the corresponding figures on Sheet 6, the same chain-threads being drawn through the same heddles. The results are seen in the odd-numbered figures from 89 to 135, which upon com- 85 parison with the similar figures of Sheet 6 will show the difference in the results. Thus Fig. 43 is threaded through the same as Fig. 96; but the result, as seen in Fig. 97, is different. Both are regular twills, but they point in op- 90 posite directions, one being a right-hand and the other a left-hand twill. The same is true of Figs. 40 and 93; also of Figs. 50 and 103; also of Figs. 54 and 107. Similar differences exist in the several figures throughout this 95 series, as will be seen upon an inspection of the same.

Fig. 189 is a diagrammatic view of the heddles, rollers, and heddle-cords like those already described, except that the heddle-cords 100 are both crossed. The effect of the same will be seen upon examining Figs. 190, 191, 192, and 193, wherein the heddles are raised on the right-hand side in the order of 14, 11, 13, and 12 and on the left-hand side in the order of 105 13, 12, 14, and 11.

Figs. 194 to 240 represent the method of threading, in which is the same as in the previous sheets shown. The results are, however, different. 110

The even-numbered figures from 194 to 240 illustrate the manner of threading in the chain-threads, which is the same as in the previously-described similar views. The odd-numbered figures from 195 to 241 show the 115 results obtained by crossing both the heddle-cords. The combinations are the same as before, and we now have on the face what we formerly had on the back of the design, as shown in the corresponding figures on Sheet 120 6, where neither of the heddle-cords were crossed. Thus it is possible to alter the design from face to back or the reverse, as we desire, without redrawing the threads, but simply by crossing the heddle-cords or not, as 125 desired.

In Fig. 136 the heddles, actuating-rollers, and heddle-cords are shown as in the similar views, the cords on roller 19, which operate the heddles 13 and 14, being crossed and the 130 other cords being left straight. This has the effect of altering the order of drawing in or

of the lifting of the heddles, as will be seen in Figs. 137, 138, 139, and 140.

The order of lifting the heddles on the right-hand side is as follows: 14, 12, 13, and 11, and on the left-hand side they lift in the order of 13, 11, 14, and 12.

Figs. 141 to 187 represent the manner of drawing in the threads and the results of thus altering the shedding due to this crossing the heddle-cords and consequent transposing of the positions of the heddles 13 and 14.

The odd-numbered figures from 141 to 187 illustrate the several different manners of threading the chain-threads through the heddles, and are the same as shown in similar corresponding views in the previous described combinations.

The results of the above method of threading and handling of the heddles is shown in the even-numbered figures from 142 to 188. The effect of this alteration of the positions of the heddles 13 and 14 is to reverse the direction of the design, as shown upon examination of the several figures of Sheets 6 and 8.

In Fig. 44 is seen a four-leaf right-hand twill. In the corresponding Fig. 150 is the same design, but left-handed. In Fig. 50 is a left-hand and in Fig. 170 is a right-hand design, exactly alike. Similar changes will be observed by inspection of other figures.

The effect of altering the sheddings by changing the heddle-cords will be readily seen by examining the first view of each series, as illustrated in Figs. 36, 89, 142, and 195, and it will be seen that all the combinations possible with the four threads in the four picks are made. This is also true of the other manners of threading, as will be seen upon comparing the complementary threading in and the results obtained.

Another feature of these combinations is that all the different single features are common to all the combinations, with the exception that there are different methods of threading. Thus the right-hand twill as seen in Fig. 44 is made by threading as shown in Fig. 43—that is, thread 1 in heddle 11, thread 2 in heddle 14, 3 in heddle 12, and 4 in heddle 13. The same design is seen in Fig. 107 made by threading as shown in Fig. 106, by threading thread 1 through heddle 12, 2 through heddle 14, 3 through heddle 11, and 4 through heddle 13. The same effect is produced in Fig. 146 by the manner of threading in as shown in Fig. 145—that is, by threading thread 1 through heddle 11, thread 2 through heddle 13, 3 through heddle 12, and 4 through heddle 14. This same effect is seen in Fig. 209, produced by the method of threading in as shown in Fig. 208, by threading 1 through heddle 12, 2 through heddle 13, 3 through heddle 11, and 4 through heddle 14. Similar repetitions will be noticed on inspection of the other designs.

By threading different parts of the chain

across the width of the same in different ways varieties of designs may be obtained.

In Fig. 242 is seen a design which is made by threading the first four threads on the left as in Figs. 43 and 44, the next four as shown in Figs. 39 and 40, the next four as in Figs. 43 and 44, and the next four as in Figs. 39 and 40.

The design as seen in Fig. 243 is produced by threading the first four threads as in Figs. 45 and 46, the next four as seen in Figs. 47 and 48, the next four as seen in Figs. 45 and 46, and the next four as seen in Figs. 47 and 48.

The design as seen in Fig. 244 is made by threading the first four threads as seen in Figs. 45 and 46. The second four threads are threaded as in Figs. 51 and 52, the next four as in Figs. 45 and 46, the next four as in Figs. 51 and 52.

The design shown in Fig. 245 is made by threading the first four threads as in Figs. 43 and 44, the next four as in Figs. 39 and 40, and the next eight as in Figs. 43 and 44.

The design shown in Fig. 246 is made by threading the first four threads as in Figs. 43 and 44, the second four as in Figs. 67 and 68, the third four as in Figs. 47 and 48, the fourth four as in Figs. 47 and 48, the fifth four as in Figs. 43 and 44, and the sixth four as in Figs. 67 and 68. All these variations are made out of one of the series of threading in as described, the heddles being worked over as illustrated in Figs. 30, 31, 32, 33, and 34. The same may be done in either of the other combinations, if so desired.

In Figs. 247, 248, 249, and 250 is illustrated the same pattern of eight threads wide and eight threads or picks in length. In each design is shown a heavy line, forming a square and inclosing a four-square of pattern. The small square inclosed in the heavy line in Fig. 247 is like that shown in Fig. 36. The similar square shown in Fig. 248 is that shown in Fig. 142. The square shown in Fig. 249 is that shown in Fig. 195. The square shown in Fig. 250 is that shown in Fig. 89. Thus it will be seen that the first figure of each of the four methods of working over the heddles produce the same design, but in different parts thereof. It is also possible to pick out these squares in the several individual combinations.

In Figs. 251 and 252 is shown the same design, which is a regular twill, right-handed, of eight threads in width and eight threads in length. The small heavy-lined square of four squares each way designates the portion of the combination used to form the figure. The block in Fig. 251 is the same as that of Fig. 44, and the block in Fig. 252 is the same as that of Fig. 50. Figs. 64 and 78 will also form this design, beginning the same in different parts of the pattern. It will be observed that in Figs. 44, 50, 64, and 78 the pattern is the same, and that, taking Fig. 44

as a beginning, that shown in Fig. 64 is the same moved one square to the left, that shown in Fig. 50 the same moved two squares to the left, and that shown in Fig. 78 the same moved three squares to the left.

Figs. 253 and 254 in like manner show the same effect, but in a left-hand twill. The small square in Fig. 253 corresponds to that shown in Fig. 54, and the small square in Fig. 254 corresponds to that of Fig. 40. There are two other squares that will form this design—viz., those shown in Figs. 68 and 74. Taking, as before, either of the four figures, the pattern can be commenced on either, as desired. Thus, taking the design of Fig. 40 as a starting-point, Fig. 68 shows the same taken one square to the right, Fig. 54 the same two squares to the right, and Fig. 74 the same taken three squares to the right. Thus it will be seen that it is possible to commence on any of the four threads in any part of either of the regular or broken twills, as desired, and by this means various combinations are made to form the patterns.

The patterns illustrated on Sheet 10 may be produced by the use of any of the four ways of handling the heddles as described. In the description I have used the combination illustrated on Sheet 6, but any of the others will do as well.

The mechanism made use of for manipulating the heddles may be varied from that shown without departing from the spirit of the invention so long as they produce the same effect.

The peculiar feature of the shedding is the manner of passing simultaneously the two outside threads to the center at each and every shedding.

Another feature of the shedding is that the threads which pass from the outside to the center will always pass to the opposite side at the succeeding shedding, and that, taking any of the threads individually, they pass from one side to the center and then to the opposite outside and then back to the center. The threads from either outside always pass to the center before passing to the opposite side. This is a feature peculiar to this manner of shedding, and takes up the chain-threads evenly as they all pass through the fabric in the same manner in regular order.

The peculiar feature of threading the chain-threads may be varied, as desired. I have shown regular twills and broken twills, the regular twills being either right or left handed, as desired. In the figure effects I have shown pointed twills and the same in combination with the broken twill; but no doubt other combinations can be advantageously made and various effects produced without departing from this manner of forming patterns by breaking up the order of lifting the threads across the fabric. It is to be understood that in each series of combinations these effects are produced without altering the order of

operating the heddles, which is the same in all cases, whatever method of operating the same is employed, as either of the ways shown will produce the same effects if the threads are threaded correctly to suit that particular order of working over the heddles. It is further seen that the pattern may be altered, as desired, by altering the arrangement of the heddle-operating cords, thus altering the order of lifting the heddles, but keeping the same order of drawing in. In this manner a right-hand twill can be altered to a left-hand twill at pleasure without disarranging any part of the mechanism, except changing the heddle-operating cords from one end of the lever to the other.

It will be understood that all the before-mentioned combinations, effects, and designs are rendered possible in the process of forming the two sides or faces of the cloth at the same time by dividing the chain-threads into two parts and applying a separate tension apparatus to each of the two parts, and so connecting these together, so as to have them rise and fall in regular order, so as to give out the proper amount of thread to compensate for the increased length of the same on the outsides of the sheddings and to take up the slack of the inside threads of the same.

Having thus described my invention, what I claim is—

1. The herein-described method of weaving double-weight goods, which consists in forming an indefinite series of double sheds from a single set of chain-threads by moving each one of four groups of chain-threads in succession into all possible positions in the following order, to wit: first, to the extended position on one side of the normal plane of the warp; second, to the middle position in proximity to the normal plane of the warp; third, to the extended position upon the opposite side of the normal plane of the warp; fourth, back to the middle position, and so on, and at each shedding simultaneously passing two weft-threads back and forth in the face and back of the fabric, respectively, through the two paths afforded by the double shed.

2. A method of weaving double-weight goods, which consists in simultaneously forming two openings in the chain-threads, one half of the chain-threads divided into two equal groups being moved to the outer sides of the openings or sheds, the remaining half of the threads being moved to the center or common side of the double shedding and passing the face and backing weft-threads through the two sheds, respectively, thereby forming the first pick, then forming two openings side by side by moving the chain-threads in two equal groups from the center in opposite directions, respectively, to the outer sides, and moving those on the outsides to the center and in returning the weft-threads, respectively, through the new paths thus presented, and thereby forming the second pick.

3. A method of weaving double-weight goods, which consists in simultaneously forming two openings in the chain-threads side by side by moving to the outer sides of the two
5 openings or sheds two groups of chain-threads and moving to the center the remaining half of the chain-threads, thus forming two sheds, one for the face and one for the back, through which the shuttles are
10 passed, laying the face-thread in the face side of the fabric and the backing-thread in the back of the fabric, thus forming the first pick, then forming two sheds by moving to the center the outer groups of threads and by
15 moving the threads from the center in two equal groups in opposite directions, respectively, to the outer sides and passing the weft-threads through the same, thus forming the second pick, then forming two openings by

moving the outer groups of threads to the center and again moving the center threads in two equal groups in opposite directions to the outer sides, respectively, and passing the weft-threads through the same, thus forming the third pick, and then shedding the weft-
25 threads, as before, by moving the outer groups of threads to the center and moving the center threads in two equal groups in opposite directions to the outer sides, respectively, and passing the weft-threads through the same, 30 thereby forming the fourth pick.

In testimony whereof I have hereunto set my hand this 27th day of September, A. D. 1889.

ABRAM D. EMERY.

Witnesses:

H. J. FULLER,
WALTER T. EMERY.