

Oct. 31, 1950

G. MAY  
APPARATUS FOR BUILDING UP STRUCTURAL  
ELEMENTS FROM PAPER SHEETS

2,527,752

Original Filed Oct. 15, 1945

4 Sheets-Sheet 1

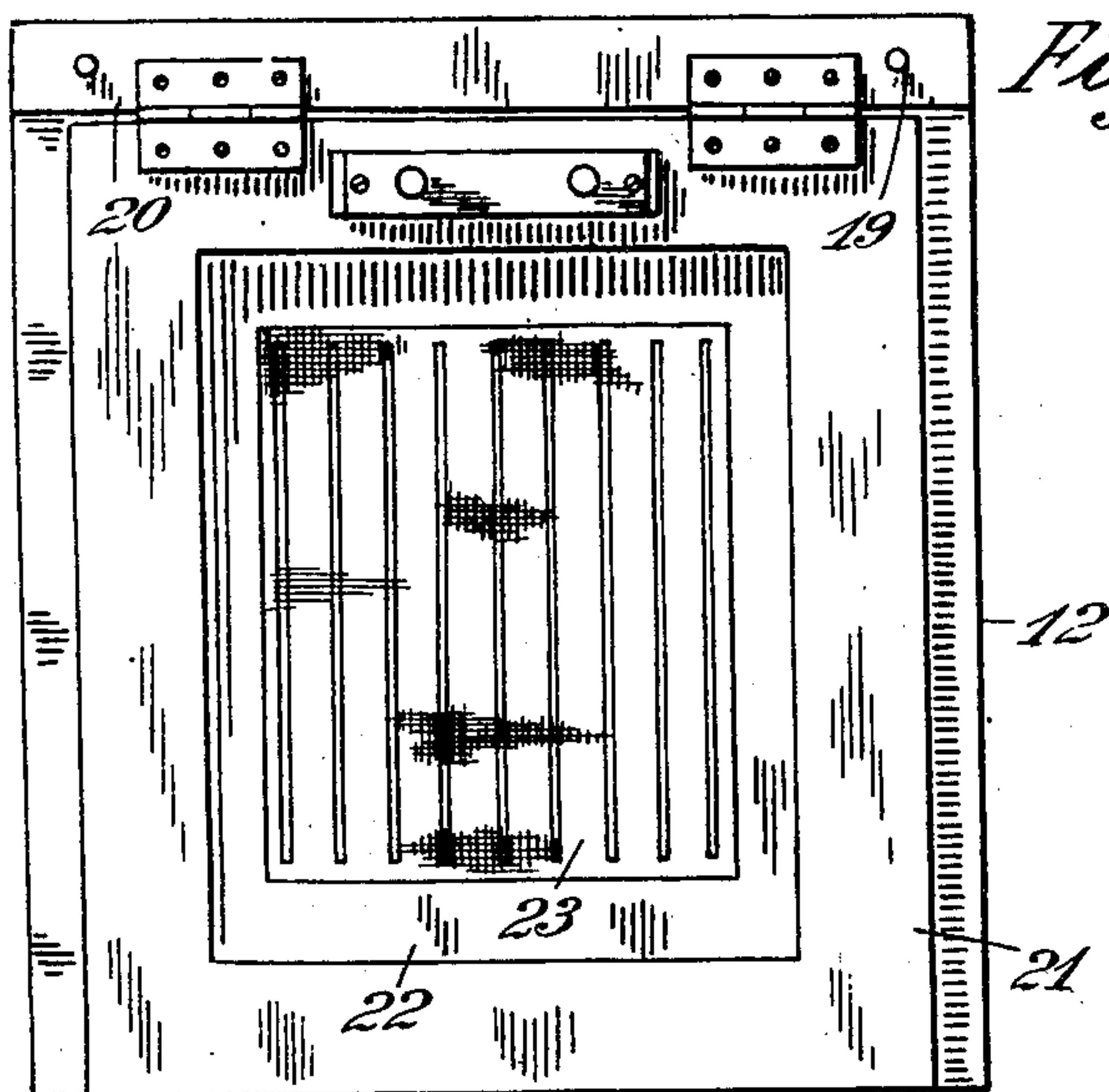
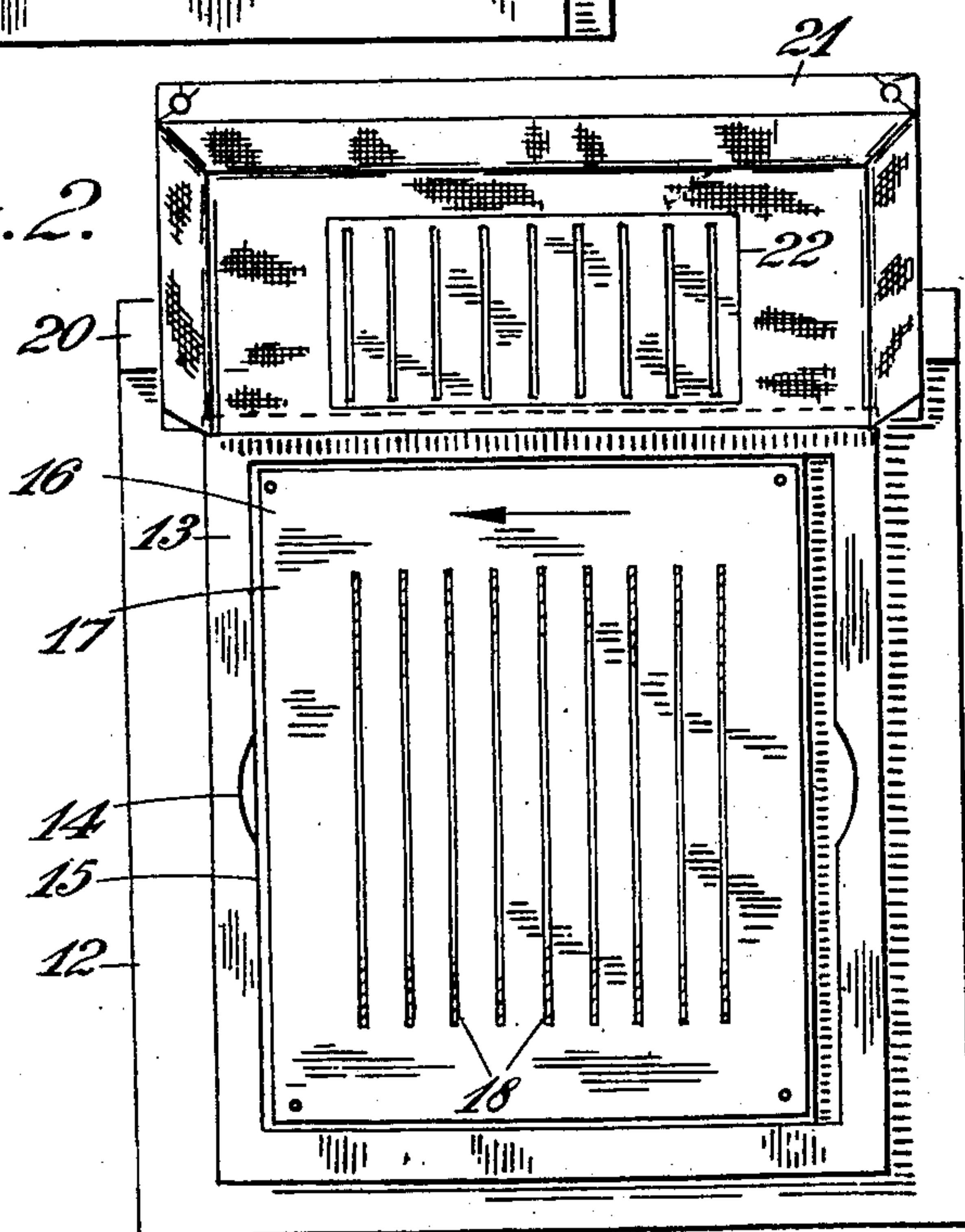


Fig. 1.

Fig. 2.



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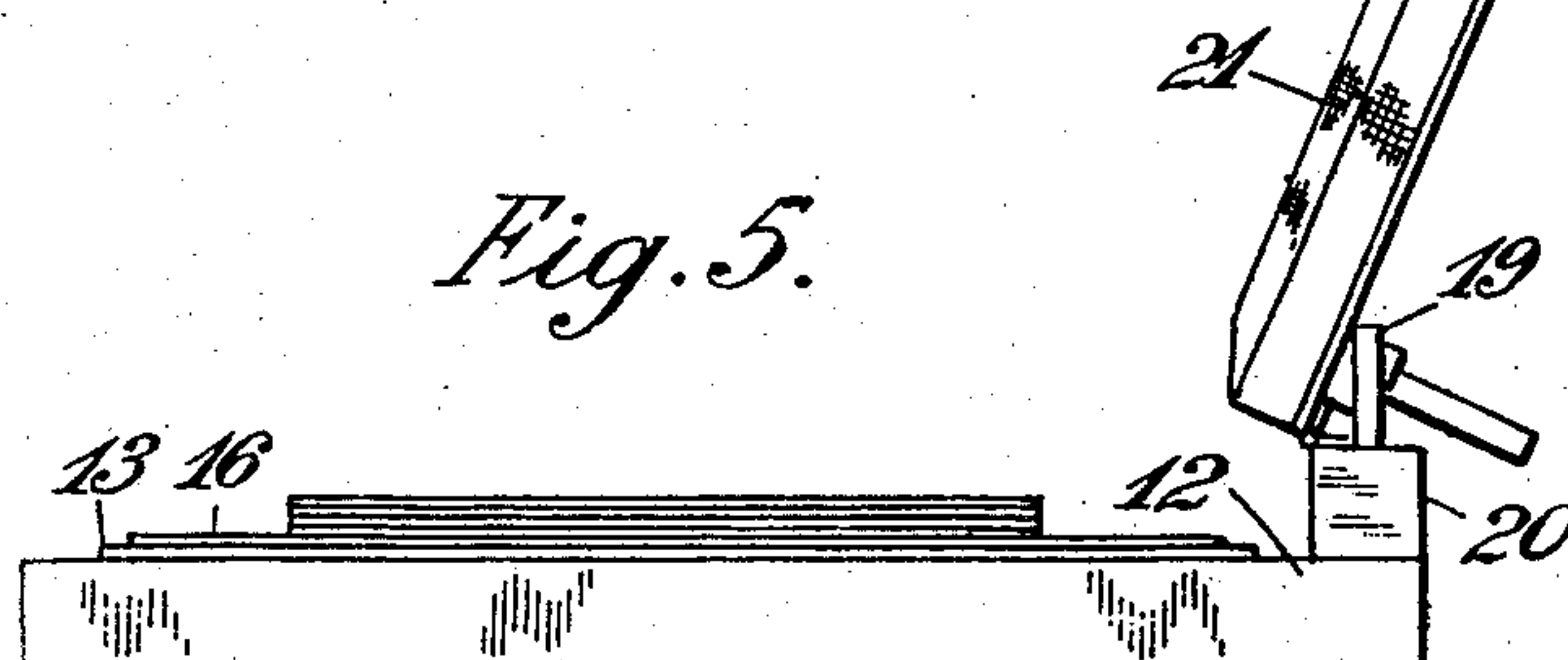
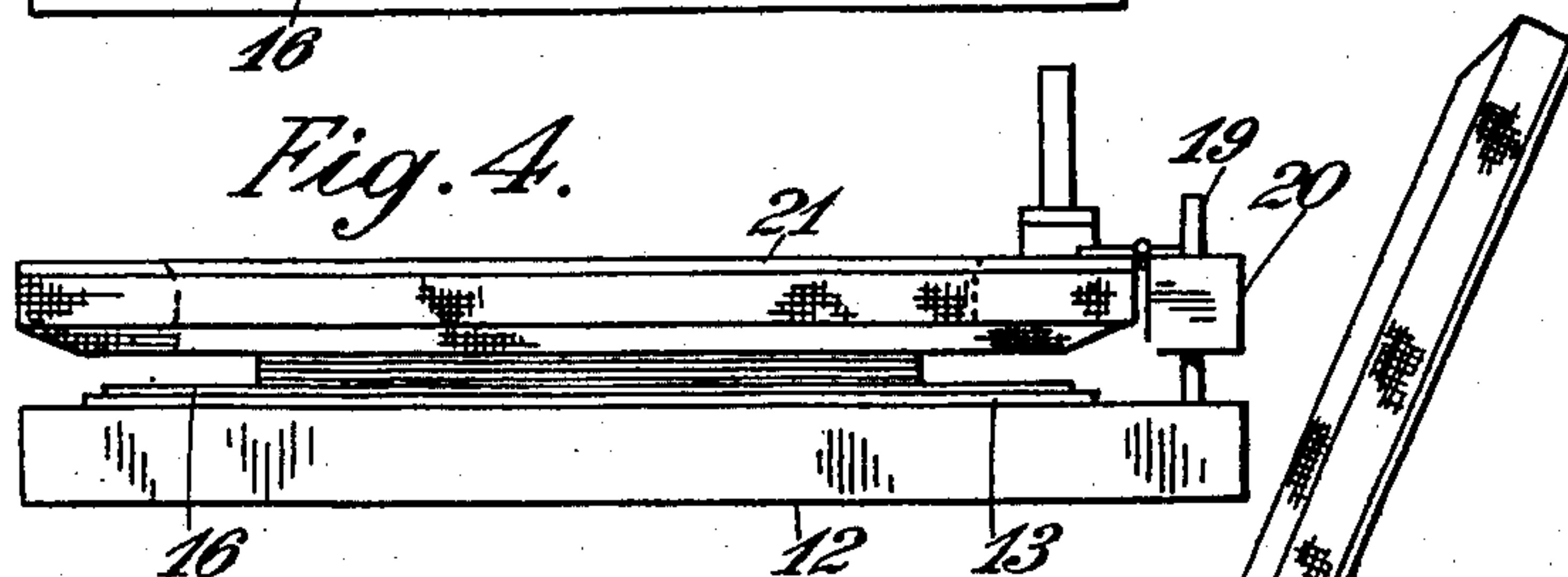
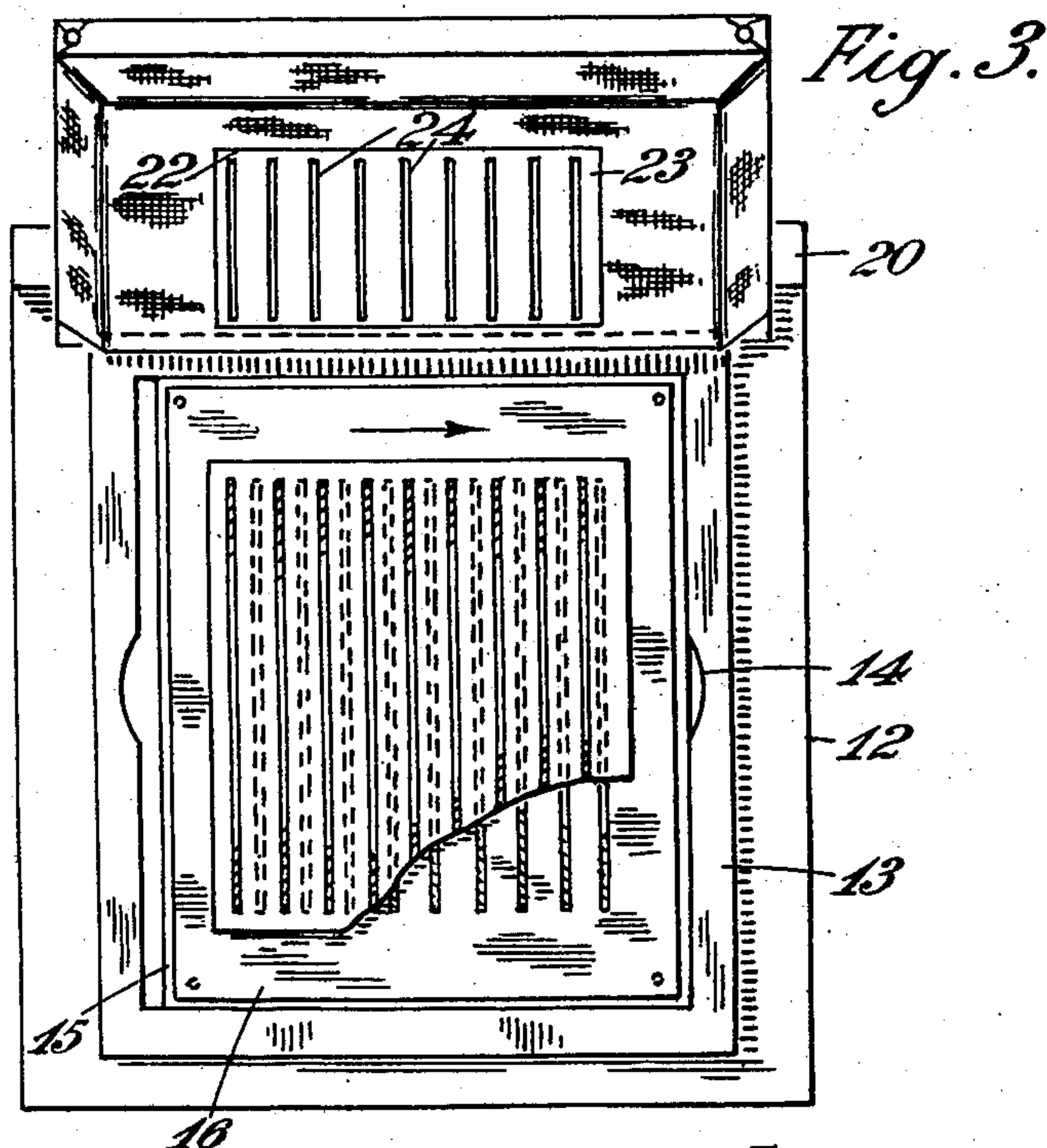
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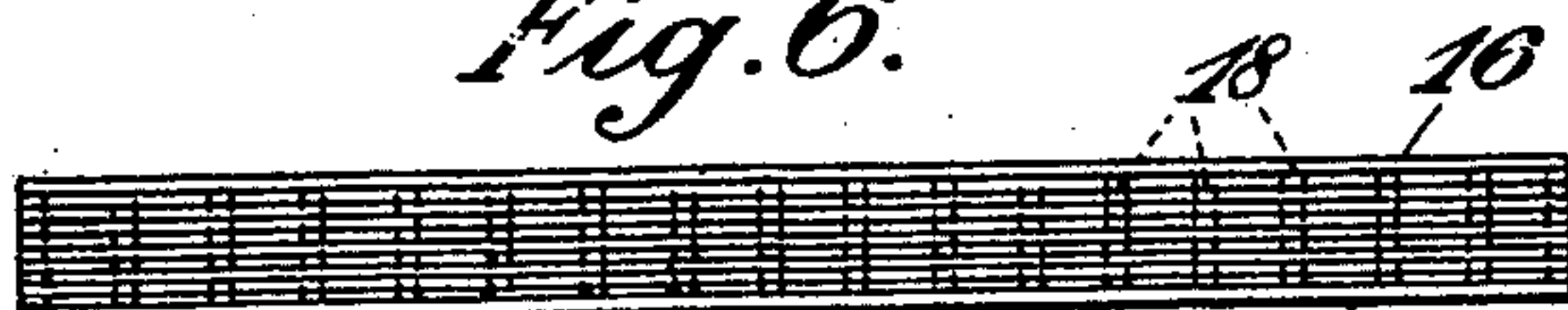
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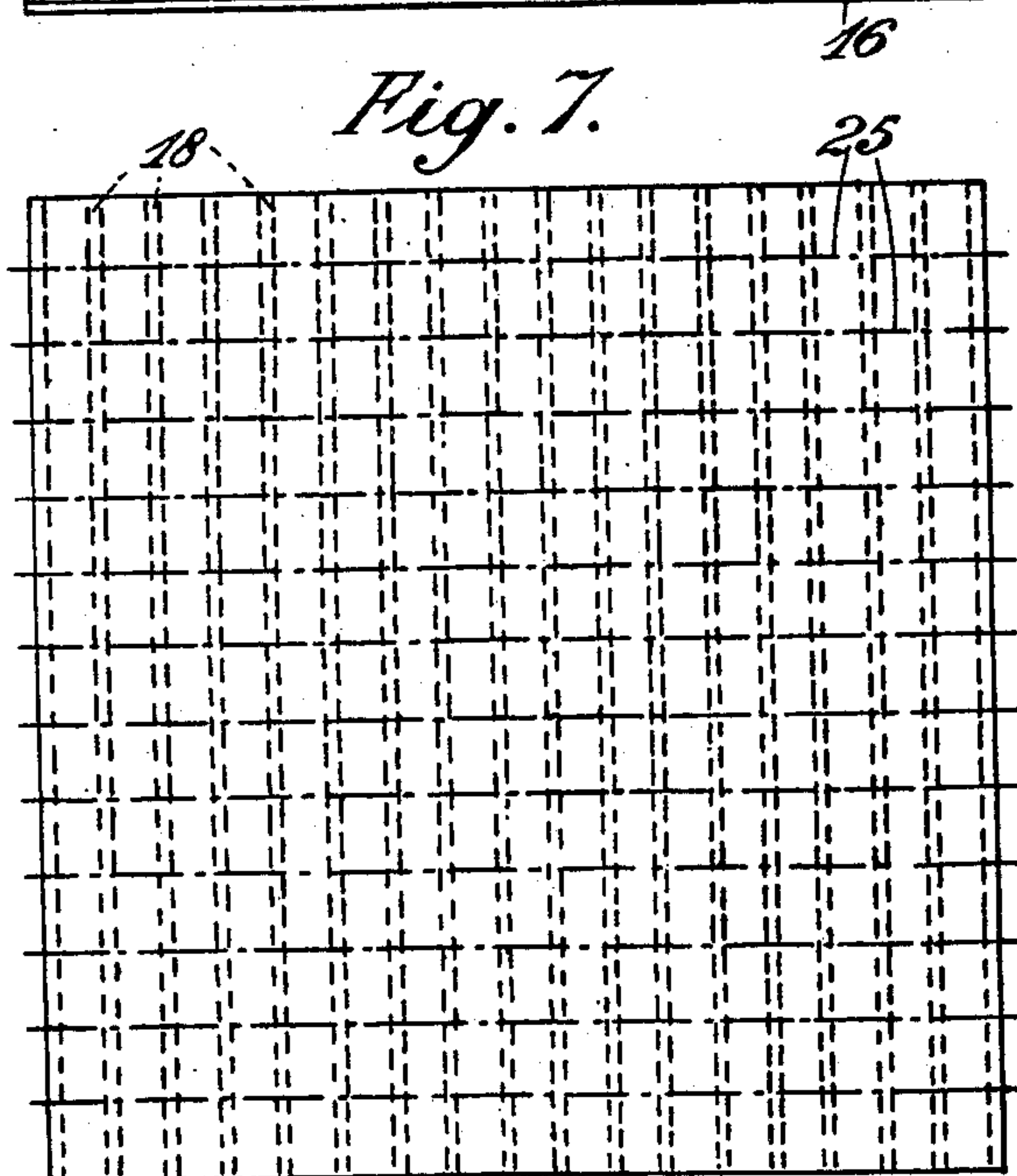
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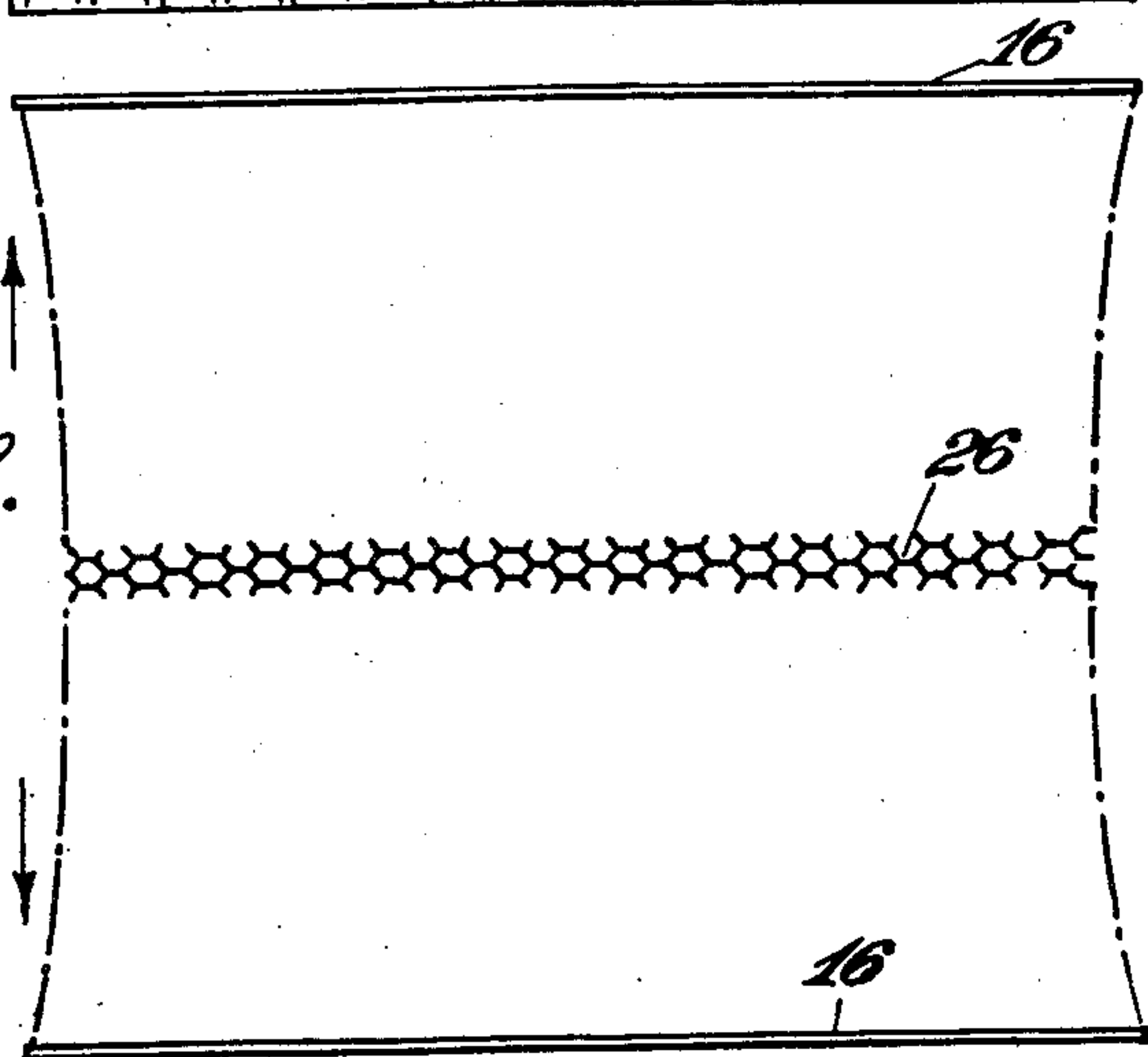
*Fig. 6.*



*Fig. 7.*



*Fig. 8.*



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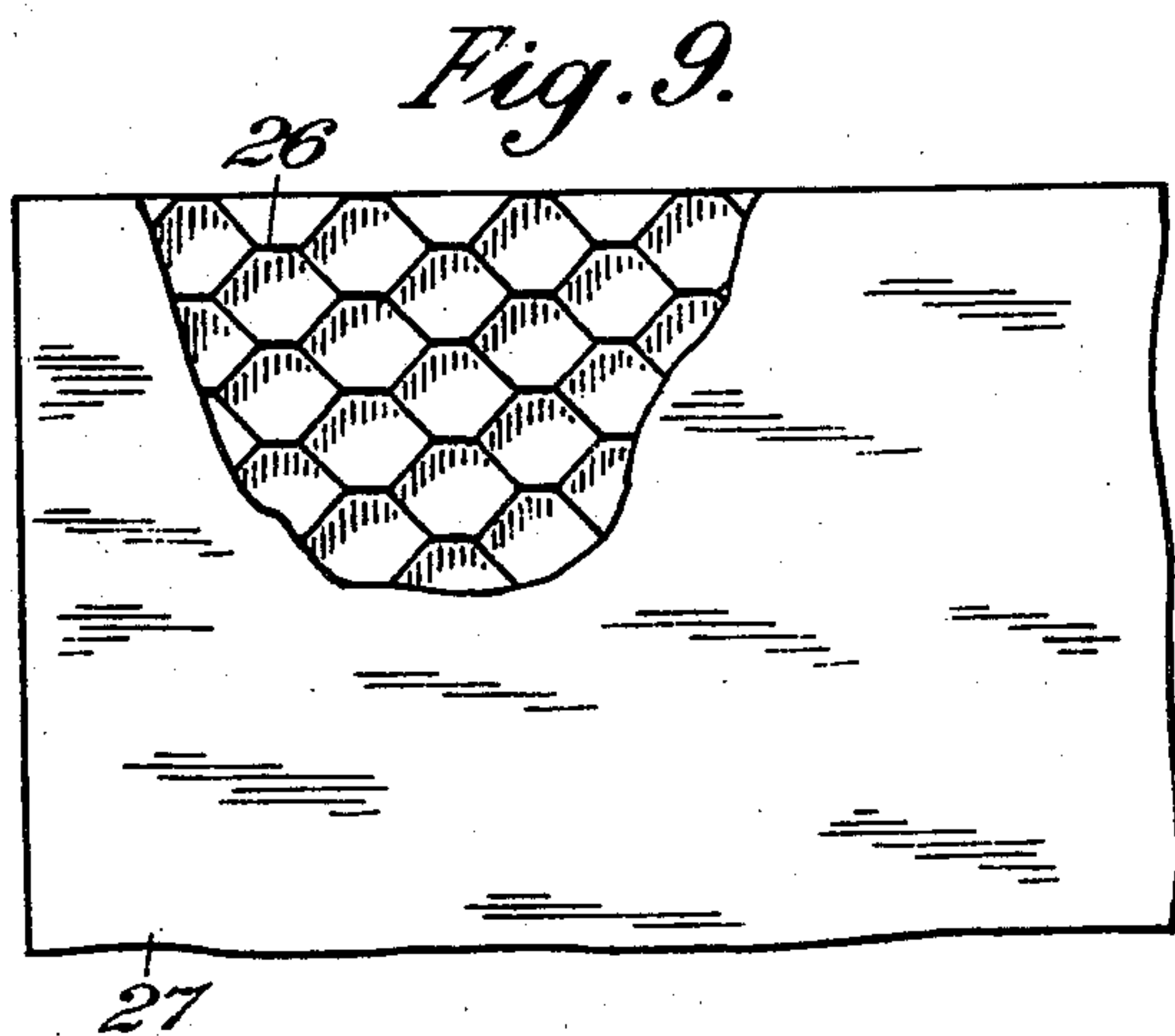
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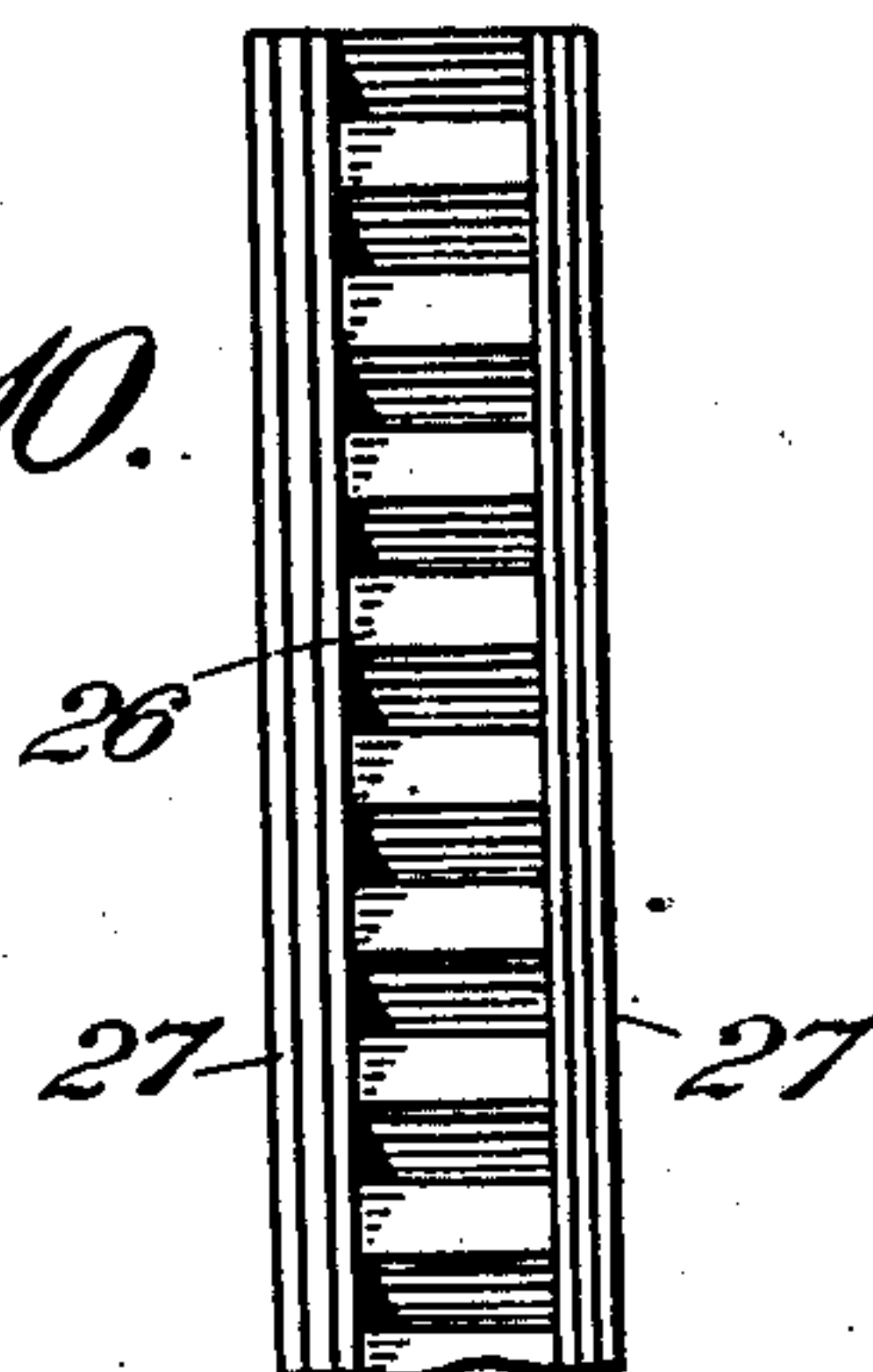
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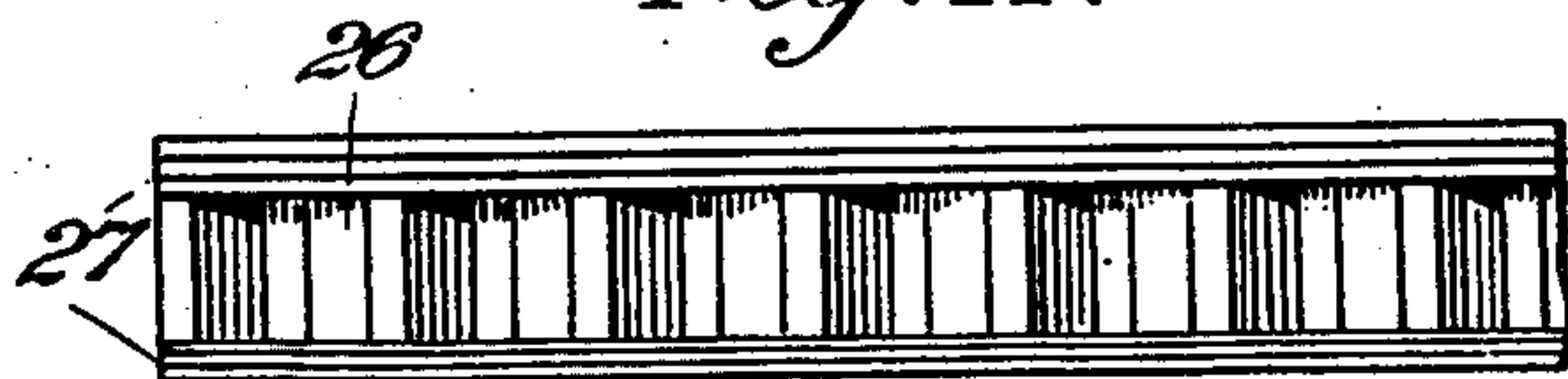
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*Fig. 10.*



*Fig. 11.*



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# UNITED STATES PATENT OFFICE

2,527,752

## APPARATUS FOR BUILDING UP STRUCTURAL ELEMENTS FROM PAPER SHEETS

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Original application October 15, 1945, Serial No. 622,454, now Patent No. 2,428,979, dated October 14, 1947. Divided and this application September 8, 1947, Serial No. 772,746. In Great Britain May 25, 1944

Section 1, Public Law 690, August 8, 1946  
Patent expires May 25, 1964

7 Claims. (Cl. 154—1)

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This invention relates to apparatus for the building up of structural elements from paper and like sheets. This application is a division of my United States Patent 2,428,979 in which is claimed a method of building up such elements and for producing double-skin structures with intermediate spacing. The elements may be flat or curved panels or may have double curvature or stream-line form, and may form doors, walls, partitions or parts or fittings for aircraft such as stream-line tanks or nacelles.

It is an object of this invention to provide novel and simple apparatus for building up the structural elements referred to above.

According to the invention, the apparatus comprises a base plate, a board located on said base plate on which board sheets to form said element may be placed, a frame carrying a fabric screen coated with a resist impervious to adhesive leaving a series of parallel lines on the screen without resist for the passage of adhesive, said screen being hinged to said base plate about an axis enabling said screen to take up a position parallel to and adjacent the upper surface of said board, said frame and said board being mounted for relative reciprocation in a direction at right angles to said lines when said screen is parallel to said board and through a distance equal to half the distance between adjacent lines.

In order that the frame may accommodate the thickening pile of sheets on the board, the apparatus may be provided with vertical pins secured to the base plate and a transom movable vertically on the pins, the frame being hinged to the transom. Thus, as the pile of sheets grows the transom moves on the pins away from the board.

In order to build up the cellular filling a first sheet is located on the board and lines of adhesive applied thereto through the screen; a second sheet is now superimposed on the first sheet and relative reciprocation of the frame and board effected. Lines of adhesive are again applied to the top sheet and the process continued, reciprocation being effected between each application of the lines of adhesive. By these means, the lines of adhesive applied to alternating sheets of the pile are staggered. When the pile has reached the desired dimensions, it is removed from the board, the adhesive allowed to dry and the pack, so formed, drawn out to form the filling.

The setting of the adhesive may be hastened by well-known means (e. g. heat and/or pressure). The cutting of the assembled pile of adhering sheets into narrow widths can be done be-

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fore or after opening out the sheets to the honeycomb or lattice form but preferably before opening out. The expansion may be assisted by the use of air currents. The filling (i. e. the expanded honeycomb or lattice) may be strengthened by dipping in a solution or suspension of an artificial resin or a solution of a cellulose ester plastic or other suitable setting plastic in liquid form.

The lattice or honeycomb when opened out may be metallised, i. e. may be coated by dipping, spraying or like operation with a varnish containing a very finely divided metallic powder (such as very finely divided aluminium) blended with cellulose acetate solution or a synthetic resin or plastomer. The result of this is to render the lattice or honeycomb proof against moisture and water vapour. It also tends to give the lattice or honeycomb a permanent set in its open position.

To build up a structural element, the filling above described is secured on both sides by adhesive to boards such as plywood, fibre board or plastic wood sheets or to sheets of paper or the like which sheets lie in contact with the edges of the open honeycomb or lattice. In a stream-line structural element the inner surface may first be built up on a mandrel or mould of appropriate shape say by sticking two layers or three layers of paper together over said mandrel.

Preferably the first sheet to be applied to the mandrel or mould is built up from laminations of paper or of thin fabric or of both. The paper or fabric may be of odd lengths and pieces or may be cut up into comparatively small squares and each piece is laid in position and secured by an adhesive. If desired a chemical setting adhesive can be employed, for example a mixture of a urea formaldehyde glue with a hardening agent or of casein and a paste made from starch. In building up this layer the pieces will overlap and may be rubbed down. The layer as a whole may on an average comprise two or three laminations. Then the filling (in pieces of suitable size) is applied and secured by adhesive to the inner skin thus formed, the walls of the filling being of course at right-angles to the inner skin at each point. Then the outer skin is again built up over the filling in the same way as the inner skin was built up.

In stream-line nacelles for certain electrical devices it is important to have a double-skin casing and it is also important that the spacing between the skins should be uniform. The above arrangement ensures such result.



The nature of this invention and of subsidiary features thereof and the manner in which the same is performed, will be appreciated from the following description of an example, reference being made to the accompanying drawings in which—

Figure 1 is a plan of the silk screen apparatus ready for squeegeeing the first lines of glue,

Figure 2 is a similar plan with the lid open, and with one set of lines of glue applied to a bottom sheet of cardboard or paper board.

Figure 3 is a plan similar to Figure 2 showing the lines of adhesive which have been applied to the first sheet of paper laid in register with the cardboard,

Figure 4 is a side view of the apparatus with the lid lowered indicating the gradual raising of the transom and of the lid hinged thereto, and

Figure 5 is a similar side view with the lid raised,

Figure 6 is a side view of a complete "book" or pile of paper sheets,

Figure 7 is a plan corresponding with Figure 6 and showing in transverse chain lines the position of the guillotine cuts,

Figure 8 is a plan view of a cellular filling opened out,

Figure 9 is a plan view partly broken away, and

Figure 10 is a side end view, and

Figure 11 a bottom end view of a structural element in which the cellular filling is covered on each side with plywood.

The base 12 of the silk screen apparatus has a rectangular upstanding frame 13 about a quarter of an inch high with finger recesses 14 on its inner lateral faces. A board 15 of the same thickness as the height of the frame 13 is capable of lateral movement in the frame 13 but by an amount equal to half the pitch of the lines of adhesive (the other edges being a sliding fit in the frame 13) and the first operation is to attach by tacks 16 to the board 15 a sheet of cardboard 17 which receives the first set of lines of adhesive 18. The base 12 at the back has upstanding pins 19 on which can slide vertically a transom 20 to which is hinged the lid 21 carrying the screen say of fabric 22 painted or coated with the impervious varnish or resist 23 leaving the parallel pervious lines 24 extending from front to back of the screen, the lines having the same length as the sheet to be treated. It will be appreciated that if a set of lines is applied by squeegee to the sheet of cardboard 17 as indicated in Figure 2 and if a sheet of paper is laid on the cardboard, and if the board 15 is then shifted laterally from the position shown in Figure 2 to the position shown in Figure 3 and then another set of lines is applied by squeegee on to said paper as indicated in Figure 3, the second set of lines will be staggered in relation to the first and so on. After an appropriate number of sheets (say 200) have been treated and piled up in this way a sheet of cardboard is laid on the top and pressed down so as to adhere to the top sheet with the adhesive lines on said sheet and the result is a book or pile as shown in Figure 6. This book or pile is cut in a guillotine along the chain lines 25 at right-angles to the lines of adhesive 18, and each slice can be opened out as indicated in Figure 8 to form a filling having a honeycomb or lattice structure as indicated at 26.

In Figures 9, 10 and 11 plywood boards 27 are shown stuck to each side of the filling. In making

an article such as a board or panel or door, the peripheral spaces between the plywood sheets may be cleared away for a short depth and filled up with a setting filler such as plastic wood. This filler may be of thermoplastic material and may be applied manually by a little trowel or equivalent. In place of plywood, glass fibre cloth may be used. As explained above, the filler may be treated with a metallised varnish to render it proof against moisture or water vapour.

I claim:

1. An apparatus for building up a cellular filling for a double-skin structural element comprising a base plate, a board located on said base plate for carrying sheets to form said element, and a frame carrying a screen having apertures in parallel lines for the passage of adhesive, said frame being hinged to said plate about an axis parallel to the plane of the board, whereby the screen can take a position parallel to and adjacent the board, and said board being mounted for reciprocation relative to said plate in a direction at an angle to the said lines when the screen is parallel to the board through an amount equal to half the distance in said direction between consecutive lines.

2. An apparatus for building up a cellular filling for a double-skin structural element comprising a horizontal base plate, a border member upstanding from said base plate having a rectangular inner wall, a board located within said border member on which board sheets to form said element may be placed and which board is of the same thickness as the height of the border member but less in width than the inside of the border member, and a frame carrying a fabric screen coated with a resist impervious to adhesive leaving a series of parallel lines on the screen without resist for the passage of adhesive, said frame being hinged to said base plate about an axis parallel to the width of said member, whereby the said screen is capable of taking up a position parallel to and adjacent the upper surface of the said board, and the difference in width between the board and the inside of the border member being half the distance between said parallel lines.

3. Apparatus as claimed in claim 2 in which the base is provided with vertical pins and the said frame is connected by a hinge to a transom movable vertically on said pins whereby said frame may accommodate itself to the height of the top sheet on said board, whatever the number of sheets.

4. An apparatus for building up a cellular filling for a double-skin structural element comprising a base plate, a board located on said base plate on which board sheets to form said element may be placed, a frame carrying a fabric screen coated with a resist impervious to adhesive leaving a series of parallel lines on the screen without resist for the passage of adhesive, said screen being hinged to said base plate about an axis enabling said screen to take up a position parallel to and adjacent the upper surface of said board, said frame and said board being mounted for relative reciprocation in a direction at right angles to said lines when said screen is parallel to said board and through a distance equal to half the distance between adjacent lines.

5. An apparatus for building up a cellular filling for a double-skin structural element comprising a base plate, a rectangular board located on said base plate, a frame hinged to said base plate enabling said frame to take up a position parallel to and adjacent the upper surface of said board, a



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fabric screen carried by said frame coated with a resist impervious to adhesive leaving a series of parallel lines on the screen without resist for the passage of adhesive, guide members secured to said base plate for guiding the movement of said board in a direction at right angles to the said lines when the frame is adjacent said board and stop members secured to said base and limiting the movement of said board between said guide members, the distance between said stop members exceeding the length of the board by an amount equal to half the distance between consecutive lines of said screen.

6. An apparatus for building up a cellular filling for a double-skin structural element comprising a base plate, a rectangular board located on said base plate, vertical pins secured to said base plate, a transom movable vertically on said pins, a frame hinged to said transom, a fabric screen carried by said frame coated with a resist impervious to adhesive leaving a series of parallel lines on the screen without resist for the passage of adhesive, guide members secured to said base plate for guiding the movement of said

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board in a direction at right angles to the said lines when the frame is adjacent said board and stop members secured to said base and limiting the movement of said board between said guide members, the distance between said stop members exceeding the length of the board by an amount equal to half the distance between consecutive lines of said screen.

7. Apparatus as claimed in claim 2 comprising also squeegee means for applying adhesive through said uncoated lines of the screen.

GEORGE MAY.

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The following references are of record in the file of this patent:

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