

Sept. 23, 1952

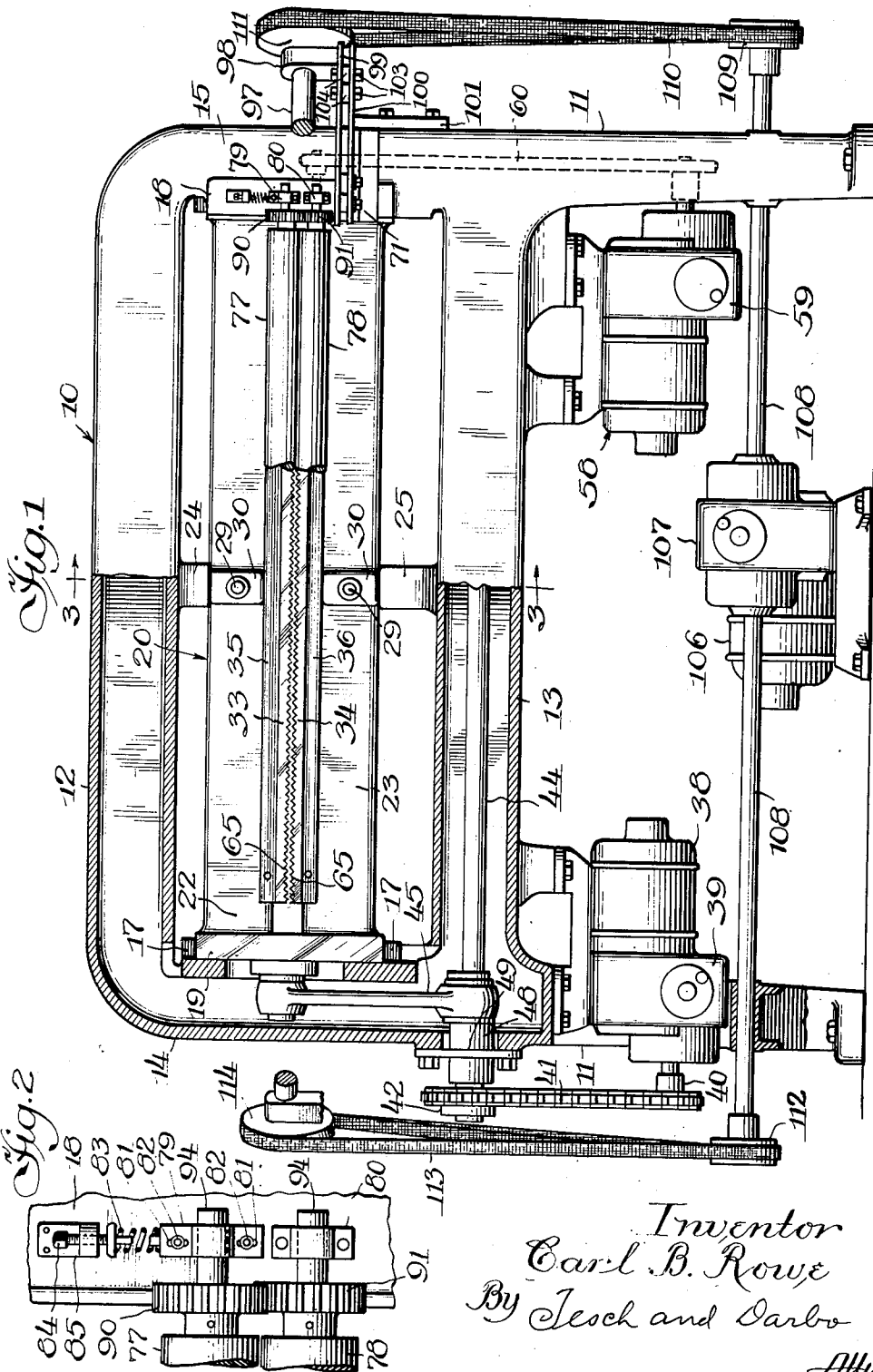
C. B. ROWE

2,611,298

APPARATUS FOR MAKING EXPANDED SHEET MATERIAL

Filed Jan. 19, 1949

3 Sheets-Sheet 1



Sept. 23, 1952

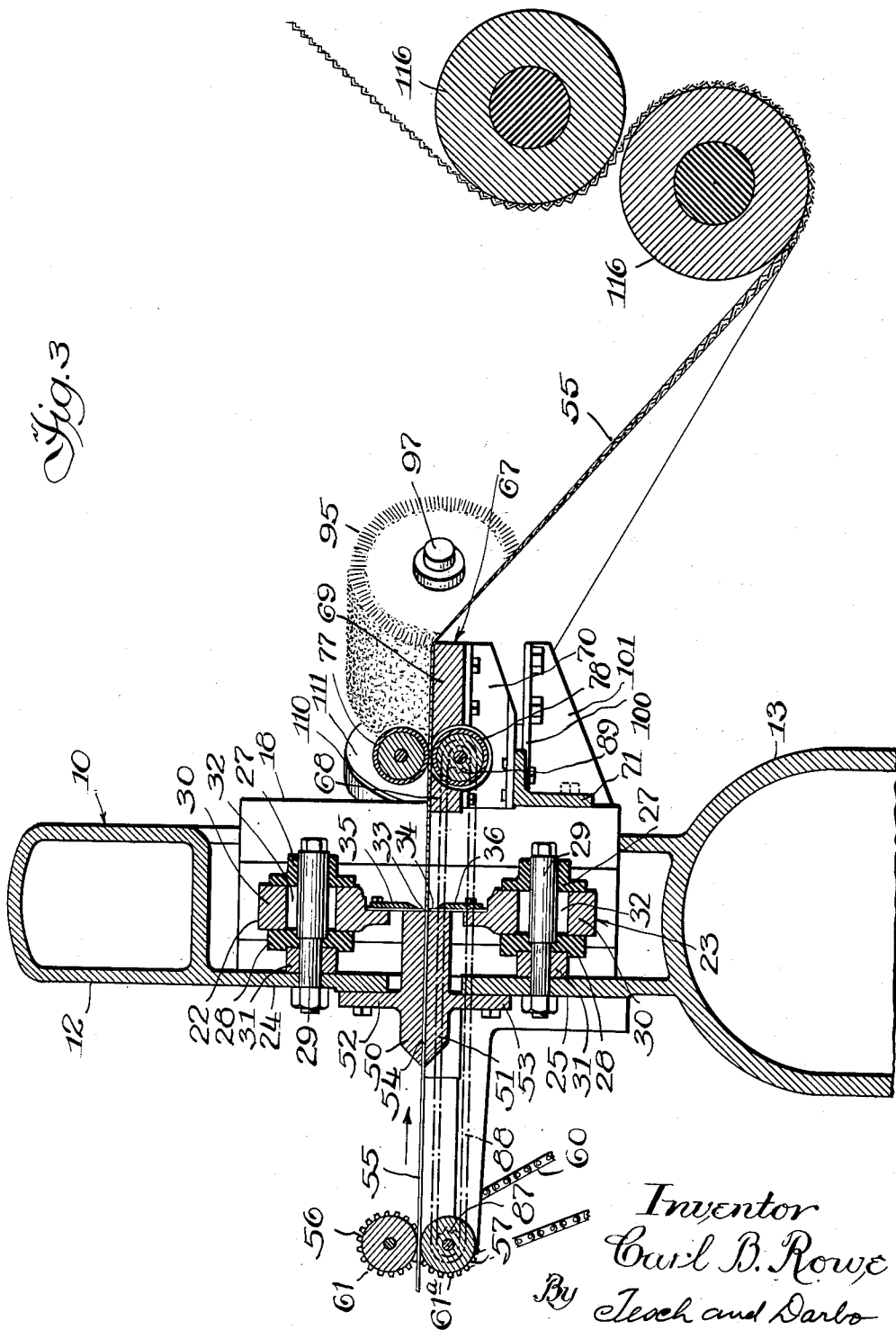
C. B. ROWE

2,611,298

APPARATUS FOR MAKING EXPANDED SHEET MATERIAL

Filed Jan. 19, 1949

3 Sheets-Sheet 2



Sept. 23, 1952

C. B. ROWE

2,611,298

APPARATUS FOR MAKING EXPANDED SHEET MATERIAL

Filed Jan. 19, 1949

3 Sheets-Sheet 3

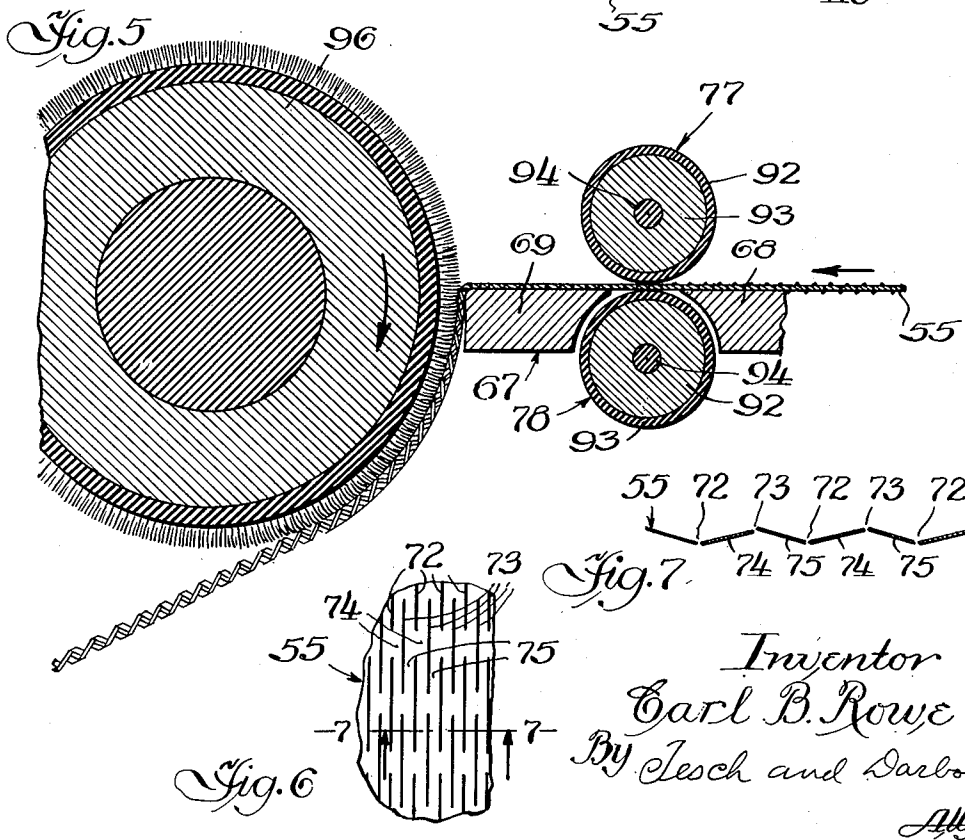
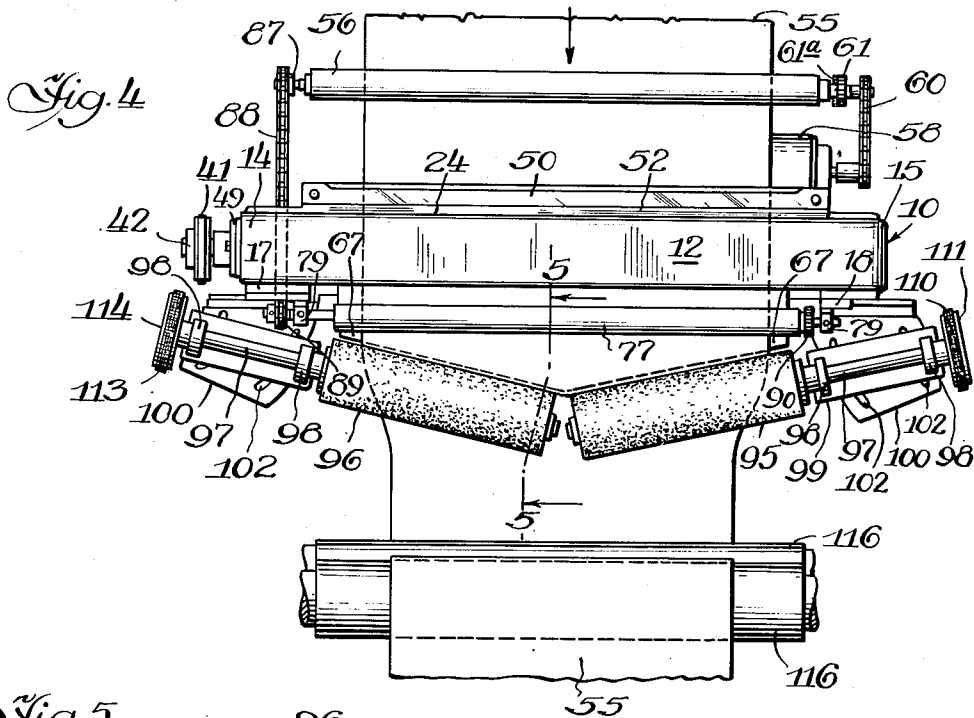


Fig. 6

UNITED STATES PATENT OFFICE

2,611,298

APPARATUS FOR MAKING EXPANDED
SHEET MATERIALCarl B. Rowe, Madison, Wis., assignor to Research
Products Corporation, Madison, Wis., a corpo-
ration of Wisconsin

Application January 19, 1949, Serial No. 71,621

4 Claims. (Cl. 93-1)

1

This invention relates to improvements in apparatus for making expanded sheet material and particularly to apparatus for expanding thin flexible sheet material such as paper, cloth, metal foil, etc. by slitting the material and then stretching it to convert the slits into openings.

In expanding slitted sheet material the webs of the material naturally turn so that their surfaces are at an angle to the general plane of the sheet and it is desirable that they all turn in the same direction or otherwise the expanded material has a non-uniform character. The present invention is directed to improvements in expanding apparatus which will insure that the webs are all turned in the same direction.

In the accompanying drawings:

Fig. 1 is a front elevation, partly in section and with portions removed, of the apparatus of the invention;

Fig. 2 is an enlarged detail view of a portion of the apparatus shown in Fig. 1;

Fig. 3 is a side sectional view, taken at approximately the mid-section of the apparatus;

Fig. 4 is a plan view of the apparatus;

Fig. 5 is an enlarged sectional view of the web orienting means, taken along line 5-5 of Fig. 4;

Fig. 6 is a plan view of a fragment of the slitted sheet before it is expanded; and

Fig. 7 is an enlarged sectional view taken along lines 7-7 of Fig. 6.

The apparatus consists of a main frame 10 which is supported upon the hollow legs 11 and has the hollow, horizontally extending top and bottom sections 12 and 13 which are joined by the two hollow side sections 14 and 15. Upon the interior wall of section 14 is a pair of vertical guide members 17 of a reciprocating cutter head 20, and a similar pair of guide members 18 is provided at the opposite side of the machine. Only one member of each of the pairs is seen in Fig. 1. The side pieces 19 of the cutterhead slide between the guide members. The cutterhead 20 extends across the apparatus and has horizontal top and bottom members 22 and 23 which are joined together at their ends by the side pieces 19.

As an additional guide for the intermediate portion of the cutterhead 20 a back member 24 extends downwardly from upper frame member 12 and back member 25 extends upwardly from lower frame member 13. Upon the member 24 two guide pieces 27 and 28 are supported by means of a bolt 29, said guide pieces being spaced apart to accommodate a thickened portion 30 of the cutterhead member 22. Two of the guides are shown, one for each of the cutterhead mem-

2

bers 22 and 23, and the corresponding part of the guides are designated by the same numerals. The rearward guide piece 28 is held in spaced relation to the vertical member 24 by the spacing member 31. An opening 32 is provided in the thickened portion 30 to accommodate the bolt 29. Each head member undergoes vertical reciprocating motion between the guide pieces 27 and 28, the openings 32 being elongated vertically to accommodate such motion.

A pair of top and bottom cutters 33 and 34 are mounted upon the top and bottom cutterhead members 22 and 23 respectively and are adapted to cut lines of slits across the advancing sheet. They are fastened to the members 22 and 23 by clamping bars 35 and 36 with their cutting edges in spaced apart opposed relation. Vertical reciprocating motion is imparted to the cutterhead 20 by suitable means comprising the electric motor 38, the reduction gear 39, sprocket 40, chain 41, sprocket 42 and drive shaft 44. Drive shaft 44 has an eccentric portion cooperating with a connecting rod 45, which imparts the reciprocating motion to the cutterhead. The reduction gear 39 may be of the well known adjustable speed ratio type as shown. The drive shaft is mounted rotatably in the bearing member 48 which is supported by the plate 49, which in turn, is bolted to the frame 10. The drive shaft extends to the other side of the apparatus as indicated and similar means for transmitting motion from it to the cutterhead may be provided at that side.

Means are provided for feeding and guiding the sheet material 55 through the apparatus, comprising top and bottom guide members 50 and 51 which are rigidly supported upon the frame 10 by means of the flanges 52 and 53 thereof which are bolted to the vertical members 24 and 25 as shown and also to the vertical side sections 14 and 15 of the frame. The guide members 50 and 51 are spaced apart vertically to form a horizontal guideway or slot 54 which is adapted to accommodate the sheet material 55. The sheet is fed forward in the direction indicated by the arrows in Figs. 3 and 4 by the feed rolls 56 and 57 which are driven at adjustable speed by means of the motor 58 which is supported upon the frame 10, the adjustable ratio reduction gear 59, and the chain 60. For convenience, the direction of travel of sheet 55 will be considered to be the forward direction and dimensions extending parallel thereto will be called the longitudinal dimension. The sheet 55 is composed of a thin flexible material, such as paper, cloth, metal foil or the like. Chain 60

transmits motion to the bottom feed roll 57 and a pair of gears 61 and 61a on the shafts of the two rolls transmits motion to the top roll 56, whereby both rolls are driven positively.

As is shown in Fig. 1, each of the cutters 33 and 34 has spaced apart teeth 65 thereon, the teeth of one cutter being in staggered relation to those of the other. During reciprocation of the cutterhead 20, the teeth move across the plane of the slot 54 and cut parallel lines of slits across the sheet 55, one line being cut by the top cutter 33 during downward movement thereof and the next line being cut by the bottom cutter 34 during upward movement thereof, and so forth. The slits in adjacent lines are in staggered relation to each other as shown in Fig. 6. The guide members 50 and 51 provide support for both sides of the sheet 55 against the vertical forces exerted upon it by the cutters as they pierce the sheet and withdraw from the slits.

The slitted portion of the sheet 55 advances from the cutters 33 and 34 and is carried upon the flat surface of a support or board 67 which is divided into two sections 68 and 69 to accommodate between them a pressure roll 78 which will be described hereinafter. The board 67 extends across the machine and is mounted upon a number of longitudinal angle pieces 70, which are cut away as shown in Fig. 3 to accommodate the pressure roll 78 and which are supported upon the transverse angle piece 71 which is bolted at its ends to the side sections 14 and 15 of the frame 10. The board 67 provides a supporting surface for the advancing slitted sheet 55 which surface is in the same plane as the surface of the lower guide member 51.

As will be described hereinafter, means are provided forwardly of the board 67 for stretching the slitted sheet longitudinally to convert it from the slitted to the expanded condition. As has been explained heretofore, the webs of the expanding network naturally turn at an angle to the general plane of the sheet and unless the turning is carefully controlled it is not uniform and the webs are turned in one direction in some areas and in the opposite direction in others, creating a non-uniform condition which is usually undesirable for one reason or another.

The principal cause of the non-uniform orientation of the webs is the turning moment imparted to the webs by the cutters 33 and 34. Considering the portion of the slitted sheet shown in Figs. 6 and 7, alternate lines of slits are designated by the numeral 72 and intermediate lines by the numeral 73, and alternate lines of webs by the numeral 74 and intermediate lines of webs by the numeral 75. The slits 72 are made by the downwardly moving cutter 33 and slits 73 are made by the upwardly moving cutter 34. The material at each edge of the slit is moved in the direction of the cutter, with the result that webs 74 are tilted in one direction and webs 75 are tilted in the opposite direction out of the general plane of the sheet. The tendency toward such tilting of the webs is greater with the less resilient materials such as aluminum and copper. The result of the tilted condition of the webs is that when the slitted sheet is stretched to open the slits and form the expanded product the webs of the expanded network are oriented heterogeneously and not uniformly, as has been explained above.

In accordance with the present invention, means are provided for flattening the slitted sheet comprising a pair of pressure rolls 77 and

78 between which the slitted sheet passes. The rolls extend transversely of the machine with their pressure surfaces in the plane of the advancing sheet. The supporting means for the rolls at one side of the machine are shown in Figs. 1 and 2 and comprise a pair of bearings 79 and 80, which are bolted to the outside of the guide member 18. The lower bearing is bolted rigidly in place while the upper bearing is bolted loosely so that it may undergo vertical displacement, elongated slots 81 being provided in the bearing member whereby the latter is slidable with respect to the bolts 82. A compression spring 83 urges the bearing member 79 downwardly, the pressure thereof being made adjustable by means of the bolt 84 which is threaded through the bracket 85 which is mounted upon the guide member 18. A similar mounting is provided at the opposite ends of the rolls 77 and 78. The vertically adjustable mounting for roll 77 adapts the rolls to accommodate slitted sheets of varying thickness, and the means for providing adjustable downward pressure upon the roll 77 makes it possible to obtain the desired pressure upon the sheet regardless of the thickness thereof.

The pressure rolls 77 and 78 are driven at a surface speed substantially equal to that of the feed rolls 56 and 57. Some variation is possible and a speed up to approximately 5% greater than that of the feed rolls may be used. A drive is provided between the feed rolls and the pressure rolls consisting of the sprocket 87 which is mounted on the shaft of the lower feed roll 57, chain 88 and sprocket 89 on the shaft of the lower pressure roll 78, the design of the rolls and the sprockets being such as to produce the desired surface speed at the pressure rolls. While chain 88 actually is not seen in the view shown in Fig. 3, it is indicated in broken lines for clearness. The upper pressure roll 77 is driven by the lower roll by means of the pair of gears 90 and 91 mounted on the shafts of the two rolls.

The surfaces of the pressure rolls 77 and 78 are composed of a substance which is preferably non-yielding, such as steel or other hard metal, or of other relatively hard material such as hard rubber, wood, or the like. In the embodiment of the invention shown in the drawings, the rolls are each composed of a hollow cylinder 92 of an unyielding substance such as steel with a plug of metal 93 at each end for mounting on the shaft 94. Roll 77 is mounted vertically above roll 78 and the said rolls flatten the webs of the slitted sheet into a condition in which their planes coincide with the horizontal plane of the sheet. The smoothing action is illustrated in Fig. 5 in which the slitted sheet is traveling in the direction of the arrow and has the webs thereof in the tilted condition upon the approach side of the pressure rolls 77 and 78 and has the webs flattened down into the plane of the sheet upon the exit side of the rolls.

The slitted sheet proceeds from the pressure rolls along the surface of the board 67 and at the forward edge of the board is turned downwardly. The board has substantial thickness and its forward or terminal end converges from the sides to an apex at the middle as shown in Fig. 4. The slitted sheet passes between the converging edges of the board 67 and a pair of cylindrical friction members 95 and 96 which are mounted for rotation each with a surface thereof in opposed relation to one of the converging edges of the board 67 and in mild pressure contact with the upper surface of the sheet 55. The friction

5

members 95 and 96 serve to impart an initial turning or tilt in a uniform direction to the webs of the sheet, and are the subject of the co-pending application Serial No. 692,080 filed August 21, 1946 of Dean L. Hunzicker and Clifford T. Walton, now Patent Number 2,537,764 dated January 9, 1951. They are in the form of cylinders having friction surfaces composed of bristles, pile fabric, sponge rubber, or other soft friction material. The mounting for the friction member 95 is shown in Figs. 1 and 4 and consists of a shaft 97, which is supported for rotation in bearing member 98, which is mounted rigidly upon an upper supporting plate 99. Said upper supporting plate is mounted in horizontally adjustable manner upon a lower supporting plate 100 which is mounted rigidly upon the frame 10 by means of the flange 101 thereof. The upper plate is made adjustable so that different boards 67 having varying degrees of convergence may be used interchangeably for reasons which will be explained hereinafter. Arc-shaped slotted openings 102 are provided in the lower plate 100 and bolts 103 pass through the upper plate and the openings 102 in the lower plate and are surrounded by the bushings 104 in the space between the two plates. With this arrangement, the upper plate can be swung horizontally so as to maintain the axis of the friction member 95 parallel with the adjacent converging edge of the board 67 regardless of the degree of convergence. The friction member 95 is driven by the motor 106 through the reduction gear 107, shaft 108, pulley 109, belt 110 and pulley 111, the latter being mounted upon the shaft 97. Friction member 96 is also driven by the motor 106 through the reduction gear 107, shaft 108, pulley 112, belt 113 and pulley 114. The friction members are driven at such a rate that the surfaces thereof move in the direction of the advance of the sheet at a rate more rapid than the rate of advance of the sheet. The friction members cooperate with the board 67 to impart a turning moment to the webs which give them an initial tilt in a uniform direction out of the general plane of the sheet with the result that when the sheet is then stretched to expand it the webs are all oriented uniformly. It has been found that if the slitted sheet passes between the board 67 and the friction members 95 and 96 with the successive webs tilted in opposite directions as illustrated in Fig. 7 the action of the board 67 and the friction members 95 and 96 does not produce uniform orientation of the webs in the final expanded sheet. The slitted sheet should reach the converging edge of the board in a substantially flat condition in order to obtain satisfactory results. The slitted portion of the sheet 55 advancing from the friction members 95 and 96 is drawn forwardly by the feed rolls 116 at a rate more rapid than its rate of travel up to this point, whereby the slits are opened and the sheet is expanded in a longitudinal direction.

The board 67 has its terminal edges converging because it is a property of a slitted sheet that when it is expanded it becomes narrower, that is, its transverse dimension becomes contracted. This is illustrated in Fig. 4, where the sheet 55 expands lengthwise and contracts crosswise as it passes underneath the friction members 95 and 96. The slits of the sheet do not open in a straight line across the sheet, but begin to open at the edges before they open at the middle so that if a line is drawn in each direction from the middle

6

of the sheet connecting the slits which are just beginning to open the lines will proceed diagonally rearward to the edges of the sheet. The terminal edges of the board 67 are shaped so as to follow the lines described. The angle of these lines depends upon the pattern of the expanded sheet, which may be altered by varying different factors, such as the width of the webs and the length of the slits. For this reason, the forward section 69 of the board 67 is removably bolted to the angle pieces 70 and a number of such sections are provided each having a different angle of convergence to adapt the machine to the production of various patterns of expanded sheet material.

While but a single embodiment of the apparatus of the invention has been illustrated and described, this is by way of example only and various changes and modifications thereof may be made by those skilled in the art within the scope of the invention as the same is set forth in the appended claims.

What is claimed is:

1. In apparatus for making expanded sheet material, the combination of means for advancing a sheet in the longitudinal direction, means for forming transverse lines of slits in said advancing sheet, means for flattening said slitted sheet, a feed member spaced forwardly of said flattening means and having a friction surface for engaging a surface of said slitted sheet, said friction surface moving forwardly at a rate more rapid than the rate of advance of said sheet to said slitting means whereby said sheet is expanded, said spacing being sufficient to leave the webs between the slits free to turn at an angle to the plane of the sheet, and means between said flattening means and said feed member for imparting an initial tilt to said webs in a uniform direction out of the plane of said sheet.

2. The sheet expanding apparatus as claimed in claim 1 in which the flattening means comprises cooperating pressure surfaces contacting opposite sides of said sheet and means for moving said surfaces forwardly at substantially the same rate as the rate of advance of the sheet to the slitting means.

3. In apparatus for making expanded sheet material, the combination of means for advancing a sheet in the longitudinal direction, means for forming transverse lines of slits in said advancing sheet, said slitting means causing the webs between the slits to tilt non-uniformly out of the general plane of the sheet, means for flattening the webs back substantially into the plane of the sheet, a feed member spaced forwardly of said flattening means and having a friction surface for engaging a surface of said slitted sheet, said friction surface moving forwardly at a rate more rapid than the rate of advance of said sheet to said slitting means whereby said sheet is expanded, said spacing being sufficient to leave the webs between the slits free to turn at an angle to the plane of the sheet, and frictional means between said flattening means and said feed member for contacting said sheet and imparting an initial tilt to said webs in a uniform direction out of the plane of said sheet.

4. In apparatus for making expanded sheet material, the combination of means for advancing a sheet in the longitudinal direction, means for forming transverse lines of slits in said advancing sheet, said slitting means causing the webs between the slits to tilt non-uniformly out

of the general plane of the sheet, means for flattening the webs back substantially into the plane of the sheet, a feed member spaced forwardly of said flattening means and having a friction surface for engaging a surface of said slitted sheet, said friction surface moving forwardly at a rate more rapid than the rate of advance of said sheet to said slitting means whereby said sheet is expanded, said spacing being sufficient to leave the webs between the slits free to turn at an angle to the plane of the sheet, and a supporting member for engaging said sheet located between and out of alignment with said flattening means and said feed member whereby said slitted sheet in

passing over said supporting member undergoes a change of direction.

CARL B. ROWE.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
884,714	Clark	Apr. 14, 1908
1,321,089	Clark	Nov. 11, 1919
2,294,478	Norris et al.	Sept. 1, 1942
2,537,764	Hunzicker et al.	Jan. 9, 1951