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2,537,764

APPARATUS FOR SLITTING AND EXPANDING SHEET MATERIAL

Filed Aug. 21, 1946

4 Sheets-Sheet 1

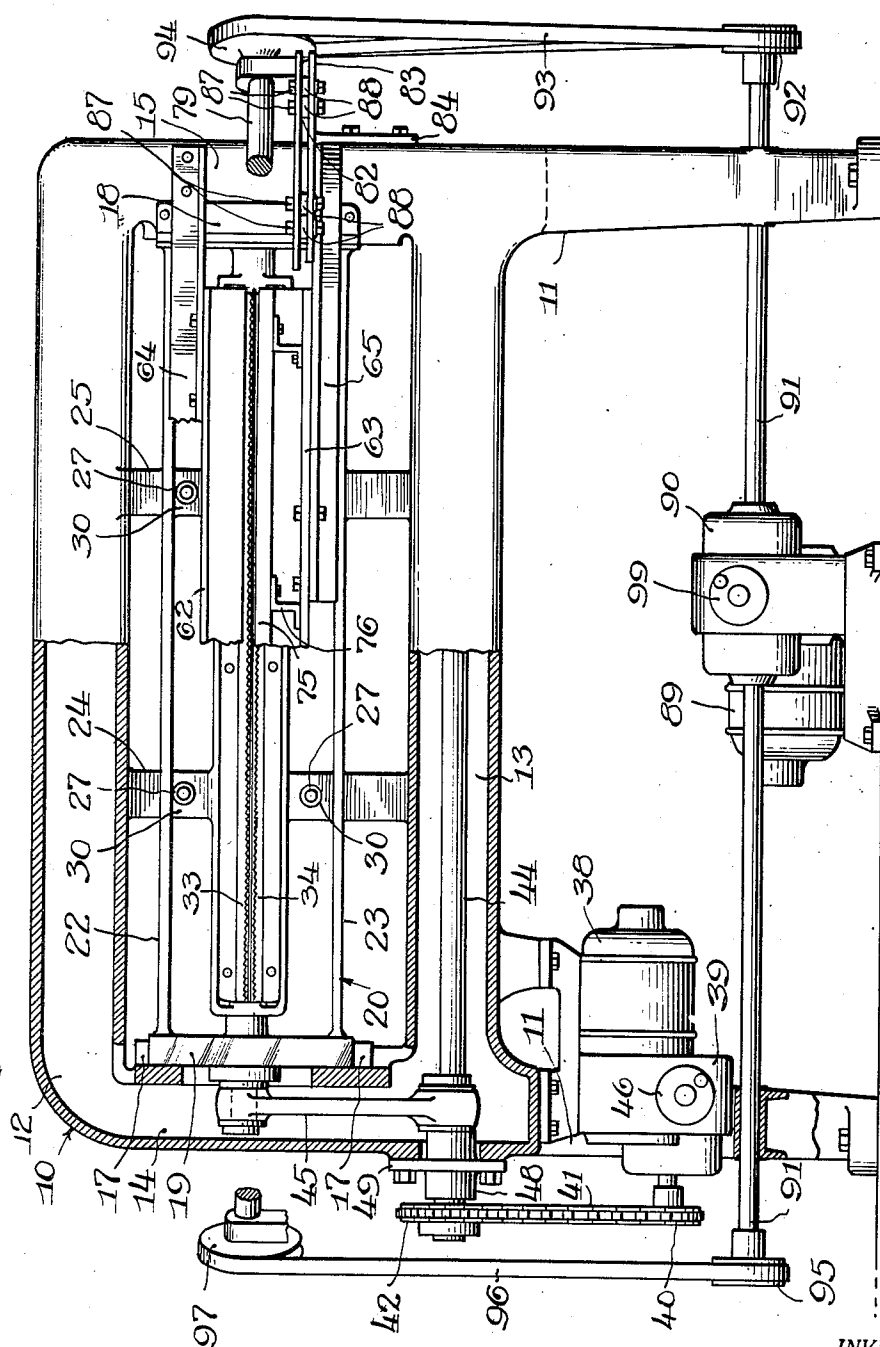


Fig. 1

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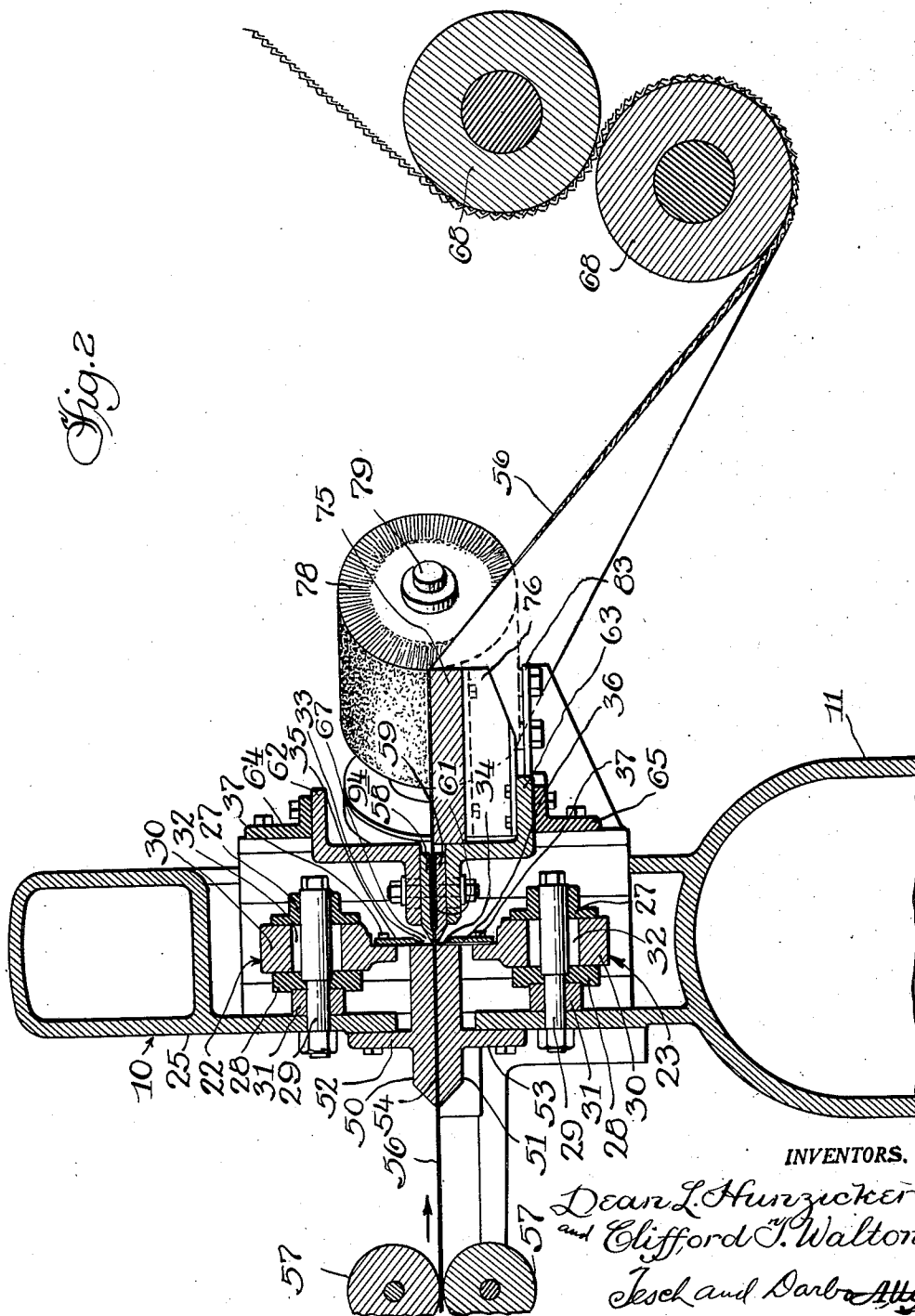
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4 Sheets-Sheet 2



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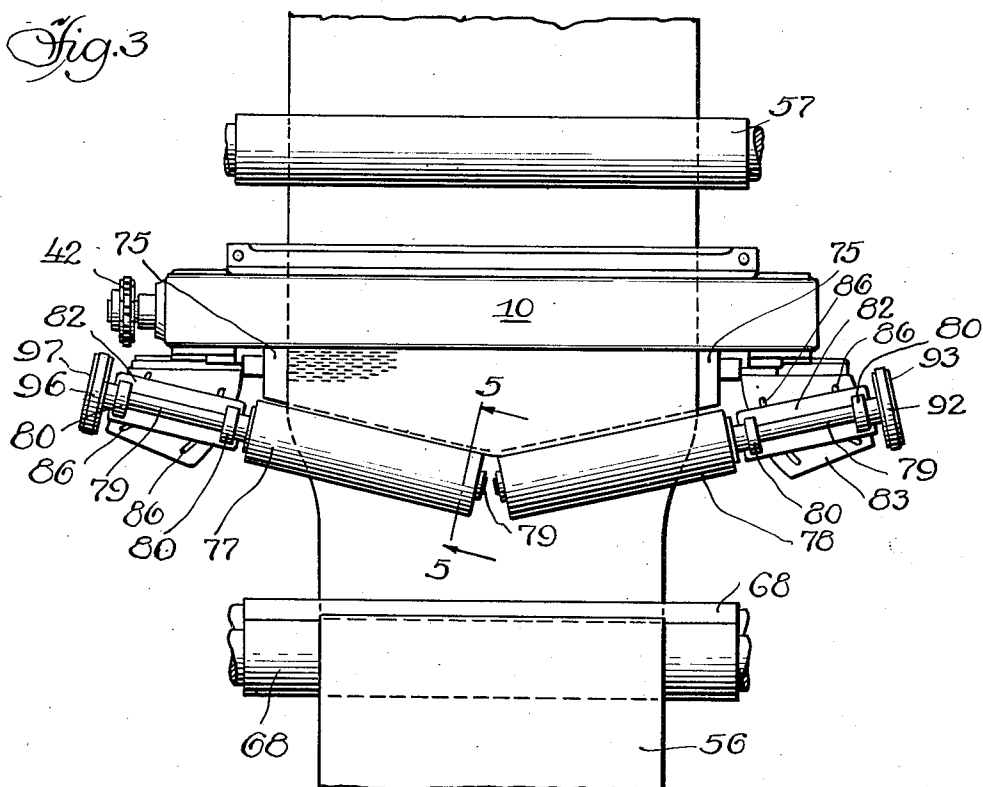
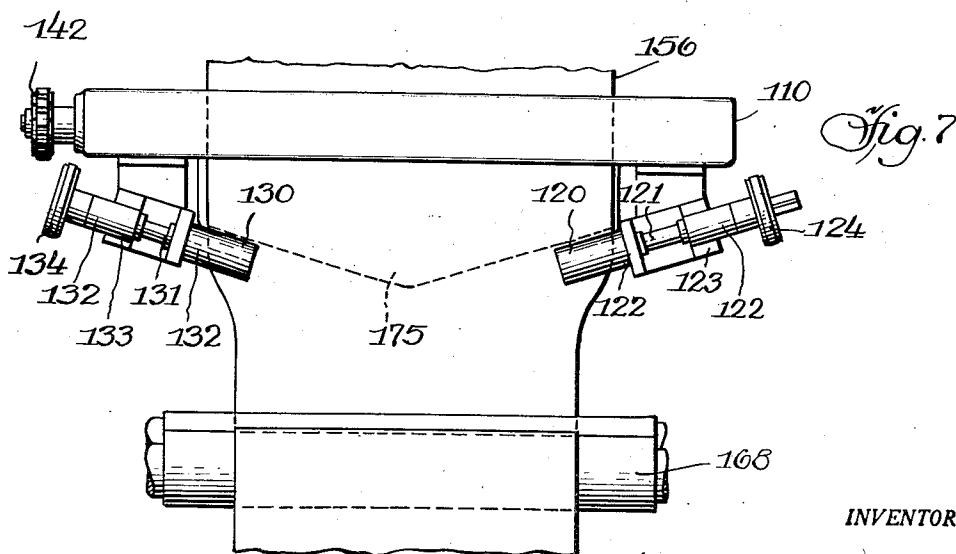
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4 Sheets-Sheet 3

Fig. 3



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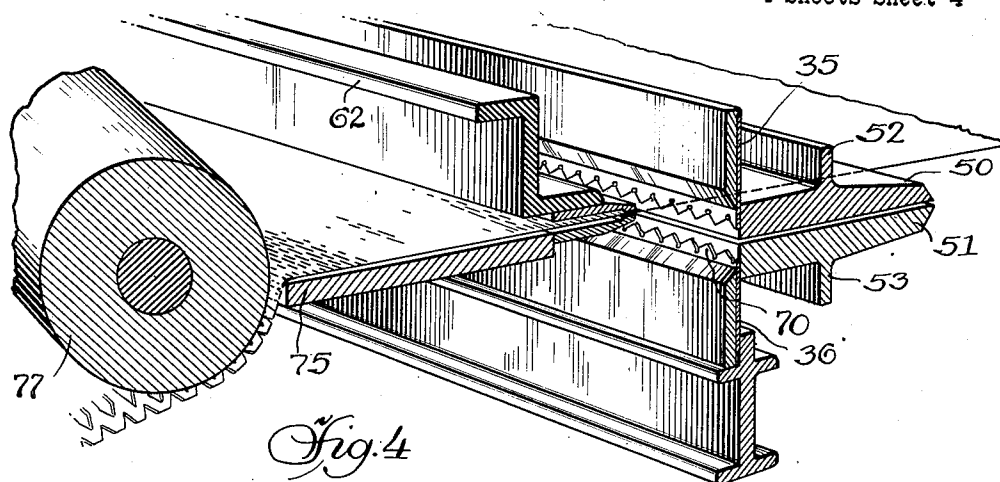
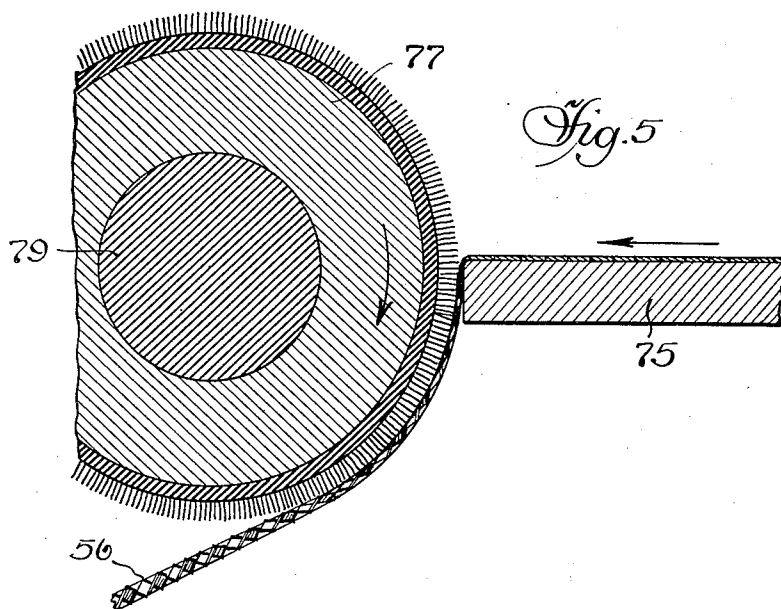
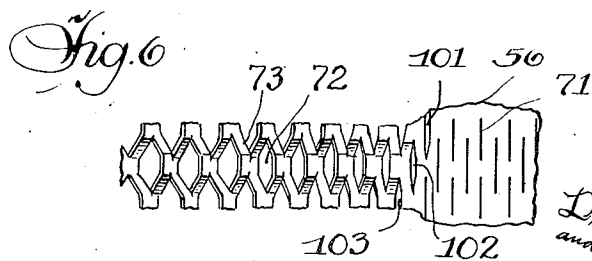
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APPARATUS FOR SLITTING AND EXPANDING SHEET MATERIAL

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17 Claims. (Cl. 93—1)

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This invention relates to improvements in apparatus for slitting and expanding sheet material, particularly thin, flexible sheet material, such as paper, cloth, metal foil, etc., which, after having been slitted, is adapted to be expanded by a stretching operation.

It is an object of the invention to provide an apparatus of the character mentioned in which the slits are cut or punched accurately in the desired location without tearing the sheet material and in which the narrow webs of the network of the final expanded sheet are all oriented similarly, whereby a uniform final product is obtained.

It is a further object of the invention to provide an apparatus of the character mentioned which is capable of rapid operation upon wide widths of sheet material to produce a large output of expanded product.

Other objects and advantages will become apparent as the following description progresses, which is to be taken in conjunction with the accompanying drawings; in which:

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

Fig. 2 is a side sectional view, taken at approximately the midsection of the apparatus;

Fig. 3 is a plan view of the apparatus;

Fig. 4 is a perspective view of a portion of the apparatus showing the principal elements of the slitting means and the means for orienting the webs of the expanded product;

Fig. 5 is an enlarged sectional view of the web orienting means, taken along line 5—5 of Fig. 3;

Fig. 6 is a fragmental view of the sheet as it goes from the slitted to the expanded condition; and

Fig. 7 is a plan view of a modification of the apparatus of the invention.

The apparatus comprises a main frame 10 which is elongated crosswise of the apparatus and is supported upon the legs 11. The frame 10 consists of hollow, horizontal top and bottom tubular sections 12 and 13 and vertical tubular side sections 14 and 15. Upon the interior walls of vertical sections 14 and 15 are guide members 17 and 18 between which the side pieces of a reciprocating cutterhead 20 slide vertically. Only one of the side pieces 19 is shown in Fig. 1. The cutterhead 20 extends crosswise of the apparatus and consists of top and bottom members 22 and 23 which are joined together integrally at the sides of the apparatus.

Additional guides for the intermediate portion of the cutterhead may be provided as shown in Figs. 1 and 2. These consist of vertical back members 24 and 25 extending between the top and bottom frame members 12 and 13. Upon the vertical member 25 guide pieces 27 and 28 are supported by means of a bolt 29, said guide pieces being spaced apart to accommodate a thickened

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portion 30 of the cutterhead member 22. The rearward guide piece 28 is held in spaced relation to the vertical member 25 by the spacing member 31. An opening 32 is provided in the thickened portion 30 of the cutterhead member 22 to accommodate the bolt 29. The head member undergoes vertical reciprocating motion between and in sliding engagement with the guide pieces 27 and 28, the opening 32 being elongated vertically to accommodate the reciprocating motion of the head member. There are four such means for guiding the intermediate portions of the cutterhead 20 upon the specific machine illustrated, and the corresponding parts of the various means are designated by the same numerals.

A pair of top and bottom cutters 33 and 34 are mounted upon the top and bottom cutterhead members 22 and 23 respectively, and extend transversely for the full width of the apparatus. Their cutting edges are arranged in spaced apart opposed relation as shown. They are fastened in place by clamping bars 35 and 36 which are held by stud bolts 37 which pass through openings in the clamping bars and the cutters and are screwed into threaded openings in the cutterhead. 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 is preferably of the well known adjustable speed ratio type in which the speed ratio is adjusted by turning the regulating wheel 46. The drive shaft 44 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 right of the apparatus, as the same is viewed in Fig. 1, and means similar to that described is provided at the right end for transmitting motion from the drive shaft to the cutterhead.

Means are provided for feeding and guiding the sheet material through the apparatus so that it may be slitted by the cutters 33 and 34. As is shown in Fig. 2, top and bottom guide members 50 and 51 are rigidly supported upon the frame 10 by means of the flanges 52 and 53 thereof which are bolted to the vertical frame 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 one or more thicknesses or the sheet material to be slitted. The sheet material is indicated at 56 and is adapted to be fed longitudinally forward in the direction indicated by the arrow in Fig. 2 by the feed rolls 57 which are positively driven at adjustable speed

by means which are not shown. For convenience, the direction of travel of sheet 56 will be considered to be the forward direction and dimensions extending parallel thereto will be considered to be the longitudinal dimension with respect to both the sheet and the apparatus. The sheet is preferably composed of a thin, flexible material, such as paper, cloth, metal foil or the like. The guide members 50 and 51 extend across the entire width of the apparatus and also extend forwardly and rearwardly substantial distances from the flanges 52 and 53.

A second pair of top and bottom guide members 58 and 59 are mounted forwardly and in spaced relation to guide members 50 and 51 and are arranged to provide a guideway or slot 61 between them which is in alignment with the slot 54. The guide members 58 and 59 extend across the entire width of the apparatus and are supported upon transverse angle members 62 and 63 which, in turn, are supported upon angle members 64 and 65 which are mounted at their ends upon the vertical sections 14 and 15 of the frame 10. The guide members 58 and 59 have their rearward ends in adjacent spaced relation to the forward ends of the guide members 50 and 51 to form the gap 67 between them, within which gap the cutters 33 and 34 reciprocate across the plane of the slots 54 and 61 and are adapted to cut or punch transverse lines of slits in the sheet 56 as the same advances in the said slots. A pair of pull rolls 68 draw the slitted portion of the sheet 56 forwardly at a rate more rapid than the rate of advance to the cutters 33 and 34 to expand the sheet, as will be described hereinafter. The rolls are driven at adjustable speed by means which are not shown. The arrangement of the cutters is such that when the cutter head 20 is at the median position, i. e., at the middle of the reciprocating stroke, the sheet 56 passes freely through the clearance space between the cutters, as shown in Fig. 2.

As is shown in Fig. 4, each of the cutters has spaced apart teeth 70 thereon, the teeth of one cutter being in staggered relation to those of the other. The teeth are adapted to cut transverse rows of spaced apart slits in the sheet 56 during the reciprocating movement of the head 20, one row being formed by the top cutter 33 during the quarter cycle while said cutter is moving downwardly below the median position. During the next quarter cycle, the said cutter 35 moves upwardly and is withdrawn from the slits just formed. The sheet is held substantially stationary by the cutter during the time the cutter penetrates the sheet, and again moves forwardly when the cutter moves free of the sheet. The slitted portion of the sheet undergoes longitudinal stretch to accommodate the momentary stoppage. During the third quarter cycle while the bottom cutter 34 moves upwardly above the median position, said cutter forms a second row of spaced apart slits across the sheet, this row being slightly to the rear of the first row, and the slits thereof being in staggered relation to those of the first mentioned row. During the fourth quarter cycle, while the bottom cutter is moving downwardly above the median position, said cutter is being withdrawn from the sheet. Again the sheet is held momentarily stationary while the cutter penetrates it, and moves forwardly when the cutter moves free of the sheet. Thereafter, the sequence of operations is repeated and a continuous series of rows of slits extending across the sheet is formed, the slits of each row being in staggered relation to those of the ad-

jacent row. The guide members 50 and 51 and 58 and 59 provide lateral support for both sides of the sheet 56 against the vertical forces exerted upon it by the cutters as they pierce the sheet and withdraw from the slits. The cutters preferably move in contact with the forward end surfaces of the guide members 50 and 51, and the teeth thereof pierce the slits into the sheet while the latter is held against vertical motion by the guide members. The slits are formed accurately and cleanly, and there is no tearing of the sheet material. The slitted portion of the sheet 56 is drawn forwardly from the cutters by the rolls 68 at a rate more rapid than that at which the unslitted sheet is fed by the rolls 57, and the slits are opened and the sheet is expanded in a longitudinal direction.

A fragment of the sheet 56 as it passes from the slitted to the expanded condition is shown in Fig. 6. The slits 71 are arranged in parallel rows. The slits of one row are spaced apart and the slits of adjacent rows are arranged in staggered relation to each other. In the expanded portion of the sheet, the slits have been opened up to form the diamond shaped openings 72 within a network of narrow webs 73 of the sheet material.

In accordance with the present invention, means are provided for orienting the webs in a particular manner. If the sheet 56 is drawn forwardly in a straight line from the cutters 33 and 34, that is, in a plane substantially coinciding with the plane of slot 61 between the forward guide members 58 and 59, the webs 73 do not orient themselves uniformly, but their orientation is heterogeneous, the webs being turned in one direction in some areas of the sheet and in the other direction in other areas. When a slitted sheet material is expanded, the webs thereof naturally turn so that their surfaces are at a substantial angle to the general plane of the sheet, and if the sheet is expanded by a stretching operation, some of them turn in one direction and others turn in the opposite direction. As stated heretofore, the present invention provides means for turning all of the webs in the same direction so that a uniform orientation is obtained throughout the sheet. This means comprises a supporting member 75 which is in the form of a platform bolted to angle members 76, which, in turn, are supported by the angle members 63. Member 75 presents a flat supporting surface for the advancing slitted sheet 56 adapted to carry the latter in substantially the same plane it occupied as it passed through the slots 54 and 61. The supporting member 75 is preferably relatively thick as shown so that its forward or terminal end has a surface of substantial area, which surface preferably extends perpendicularly to the top surface, as shown, but may be at a smaller angle to such surface, if desired. The terminal end of the supporting member 75 has edges which converge from the sides thereof to an apex at the middle, whereby it is bluntly pointed, as shown in Fig. 3.

A pair of cylindrical friction members 77 and 78 are mounted for rotation each with a surface thereof in adjacent opposed relation to one of the converging edges of the supporting member 75 and in mild pressure contact with the upper surface of the sheet 56. The friction members are preferably in the form of cylindrical brushes, having bristles of a material which will not injure the sheet material, such as fiber, metal, or the like. They may have friction surfaces of other material, such as sponge rubber, felt, mohair, or other pile fabric. The friction member

78 is mounted rigidly upon a shaft 79, which is supported for rotation in bearing members 80, which are mounted upon a supporting plate 82 (see Fig. 1). Said supporting plate is mounted in adjustable manner upon a second supporting plate 83 which is mounted rigidly upon the frame 10 by means of the flange 84 thereof. For reasons which will be explained hereinafter, the angle at which the terminal edges of the supporting member 75 converge is made adjustable, this being done by providing a number of interchangeable supporting members 75 having different angles of convergence. The friction members 77 and 78 are, therefore, arranged so that they are adapted to be swung in a horizontal plane, whereby the surfaces thereof may be maintained in parallel relation to the terminal edges of the various interchangeable supporting members 75. The top supporting plate 82 is arranged so that it can be swung in a horizontal plane, and this is done by providing arc-shaped slotted openings 86 in the lower plate 83 and providing round openings (not shown) in the upper plate 82, which register with the slotted openings 86. Bolts 87 are passed through the openings in both plates, with the bushings 88 surrounding them and arranged between the two plates. With this arrangement, the upper plate can be swung into any desired position and then clamped rigidly by tightening the bolts 87. The friction member 78 is driven by the motor 89 by means of the reduction gear 90, shaft 91, pulley 92, belt 93 and pulley 94, the latter being rigidly mounted on the end of shaft 79. The speed of friction member 78 is also preferably made adjustable by causing reduction gear 90 to be of the adjustable speed ratio type, the ratio being adjusted by turning the regulating wheel 95. Friction member 77 is also driven by motor 89, through the intervening reduction gear 90, shaft 91, pulley 95, belt 96, and pulley 97.

As is stated heretofore and is shown in Figs. 4 and 5, the friction members 77 and 78 are arranged in adjacent opposed relationship to the surfaces of the terminal edges of the supporting member 75. The slitted sheet is caused to turn downwardly at said edges and pass between the opposing surfaces of the friction member and the supporting member. The members 77 and 78 are arranged with their surfaces in frictional engagement with the top surface of the sheet 56, and the bottom surface of the sheet is in frictional contact with the edge surface of the supporting member 75. A retarding force is exerted upon the sheet by the supporting member. The friction members are rotated by the motor 89 in such manner that the surfaces thereof at the area of contact with the sheet 56 move in the direction of the advance of the sheet at a rate of travel more rapid than the rate of travel of the sheet. The surfaces of the friction members, by reason of their frictional contact with the surface of the sheet, exert a force tending to accelerate the forward motion of the sheet. As a result of the retarding force exerted by supporting member 75 the slitted sheet is not expanded until it reaches the friction members 77 and 78, when the latter, due to their accelerating force, exert a stretching action on the sheet which causes opening of the slits and expansion of the sheet. This action takes place uniformly across the sheet from the edges thereof and results in uniform orientation of the webs. It is believed that the bending of the slitted sheet as it turns downwardly over the edge of the sup-

porting member is a factor which assists in obtaining uniform orientation.

To explain the reason for having the terminal end of the supporting member 75 bluntly pointed, it is a property of a slitted sheet that when it is expanded by a stretching operation, it undergoes a narrowing, and it becomes narrower, or necks down, at the point where it changes from the slitted to the expanded condition. This is illustrated in Fig. 3. It is also a property of such a sheet that the slits do not open in a straight line across the sheet. They begin to open at the edges before they open in the middle of the sheet. If a line is drawn across the sheet connecting the slits which are just beginning to open, such a line will progress diagonally forward from the edges of the sheet to a point at the middle. The terminal end of the supporting member 75 is so shaped as to follow the last mentioned line, that is, it follows a line connecting the slits which are just opening, or the slits which are at the same stage of opening. It has been found that this line progresses from one to the next diagonally adjacent slit. Considering the fragment of sheet shown in Fig. 6 as having been taken from the portion of the sheet illustrated in Figs. 4 and 5, that is, the portion to the left of the middle of the sheet as the same is viewed from the front, the individual slits which have just begun to open are slits 101, 102, and 103, and they are at the same stage with respect to the degree of opening. The terminal edge of supporting member 75, for best operation, should preferably follow a straight line connecting corresponding points, for example, corresponding ends, of said slits 101, 102 and 103. Upon the right half of the sheet, the line connecting slits which are at the same stage in the process of opening extends at an equal angle to the longitudinal direction, and backwardly to the right instead of to the left from the middle of the sheet. The arrangement which has been described is illustrated in Fig. 3.

The pattern of the expanded sheet may be altered by varying the speed of operation of the cutters 33 and 34 or the rate of travel of the sheet 56. This changes the distance between the rows of slits, and consequently the width of the webs 73. As the web becomes narrower or wider, the diagonal lines which have just been described extend at a greater and smaller angle to the longitudinal direction. If the webs are narrower, the angle is greater, and if they are wider, the angle is smaller. To have the edges of the supporting member 75 conform to the said diagonal lines, a number of interchangeable supporting members are provided and the friction members 77 and 78 are made adjustable in position, as described heretofore. The belts 93 and 96 transmitting motion from the motor 89 to the brushes are sufficiently long to accommodate any adjustment of the position of pulleys 94 and 97 which occurs with adjustment of the friction members.

As stated heretofore, the friction members 77 and 78 are driven at a rate such that the surfaces in contact with the sheet 56 move forwardly at a rate faster than that of the sheet. It is preferred that the surface speed of the friction members be considerably greater than that of the sheet, for example $1\frac{1}{2}$ times that of the sheet or greater. A speed as great as 11 times that of the sheet has been used with success.

A modification of the apparatus is illustrated in Fig. 7, in which the friction members extend

across only a portion of the sheet. The apparatus consists of slitting mechanism similar to that which has been described heretofore, which is supported in a frame 110 and which is driven by the sprocket 142, similar to the sprocket 42 of the mechanism described. The sheet 156 is fed to the slitting mechanism by rolls similar to feed rolls 57, and the slitted sheet is drawn forwardly at a rate faster than its approach to the slitting mechanism by pull rolls 153. A supporting plate 175 is mounted on frame 110 and in contact with the lower surface of the sheet passing from the slitting mechanism. A cylindrical friction member 120, composed of sponge rubber or other frictional material, is mounted rotatably upon a shaft 121 which is supported in bearing members 122 which are mounted upon a plate 123 which is supported by the frame 110. The shaft 121 is suitably driven by a pulley 124 mounted on the end thereof, which pulley is driven by a source of power which is not shown.

The rotating friction member 120 is arranged in opposed relation to the edge of supporting member 175 and in mild pressure contact with the upper surface of one edge portion of the sheet 156, and is rotated in a manner such that the surface thereof in contact with the sheet moves forwardly at a rate faster than that of the sheet, as has been described heretofore in connection with the apparatus of Figs. 1 to 5. A second friction member 130 is mounted in a similar relationship to the opposite edge portion of the sheet, upon parts consisting of the shaft 131, the bearing members 132 and the plate 133. The friction members 120 and 130 are relatively short and extend from the edges of the sheet only a portion of the distance to the middle of the sheet. They cooperate with the supporting plate 175 in the same manner as described heretofore in connection with the apparatus of Figs. 1 to 5.

While the friction members 120 and 130 do not extend across the entire width of the sheet, the apparatus is surprisingly effective. It is believed that the members 120 and 130 create tension upon the edge portions of the sheet where the tension due to the pull rolls 169 alone is less than it is upon the interior portion of the sheet. A more uniform tension across the sheet is thus produced, which results in uniform orientation of the webs.

While only a few modifications of the apparatus have been described and illustrated, these are by way of example, and other changes and modifications may be made within the scope of the invention. For example, the friction members need not be of cylindrical shape but may be of other suitable shape as long as the surfaces thereof move forwardly in contact with the sheet at a suitable speed. They may be in the form of a belt having a suitable friction surface and running over two separated pulleys. Other modifications may be made within the scope of the invention as the same is defined in the appended claims.

What is claimed is:

1. Apparatus for making expanded sheet material, comprising top and bottom guide members forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, said guide members each having a gap therein extending transversely with respect to said sheet, said gaps coinciding with each other, a pair of cutters mounted for reciprocation within said gaps and across the plane of said

sheet, said cutters being arranged in opposed relation to each other, and each comprising a row of spaced apart teeth, the individual teeth of one cutter being in staggered relation to those of the opposite cutter, said cutters being so arranged that at each cycle of reciprocal motion thereof each cutter cuts a row of spaced apart slits across said sheet, means for imparting reciprocal motion to said cutters, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said cutters, a substantially flat supporting member for the slitted portion of said sheet advancing from said cutters, the terminal end of said supporting member converging to an apex substantially at the middle thereof, a pair of brushes each mounted for rotation with a surface thereof in parallel adjacent relation to one of said converging edges and in frictional contact with the surface of said slitted sheet remote from said supporting member, means for rotating said brushes in a manner such that at the area of contact thereof with said sheet the surfaces of said brushes move forwardly at a rate more rapid than does the sheet.

2. Apparatus for making expanded sheet material, comprising means forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, said guideway forming means having a gap therein extending transversely with respect to said sheet, a pair of cutters mounted for reciprocation within said gap and across the plane of said sheet, said cutters being arranged in opposed relation to each other and each comprising a row of spaced apart teeth, the individual teeth of one cutter being in staggered relation to those of the opposite cutter, said cutters being so arranged that at each cycle of reciprocal motion thereof each cutter cuts a row of spaced apart slits across said sheet, means for imparting reciprocal motion to said cutters, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said cutters, a substantially flat supporting member for the slitted portion of said sheet advancing from said cutters, the terminal end of said supporting member converging to an apex substantially at the middle thereof, a pair of members having soft friction surfaces each mounted for rotation with a surface thereof in adjacent opposed relation to one of said converging edges and in frictional contact with the surface of said slitted sheet remote from said supporting member, means for rotating said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move forwardly at a rate more rapid than does the sheet.

3. Apparatus for making expanded sheet material, comprising means forming a guideway adapted to provide lateral support for said sheet, means for advancing a sheet longitudinally forward in said guideway, said guideway forming means having a gap therein extending transversely with respect to said sheet, at least one cutter mounted for motion within said gap and across the plane of said sheet, said cutter being adapted to cut rows of spaced apart slits across said advancing sheet, means for imparting motion to said cutter, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said cutter, a substantially flat supporting member for the slitted portion of said sheet advancing from

said cutter, the terminal end of said supporting member having edges converging to an apex, a pair of members having friction surfaces each mounted for rotation with a surface thereof in adjacent opposed relation to one of said converging edges and in frictional contact with the surface of said slitted sheet remote from said supporting member, means for rotating said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move forwardly at a rate more rapid than does the sheet.

4. Apparatus for making expanded sheet material, comprising means for advancing said sheet, means for forming in said advancing sheet a series of transversely extending rows of spaced apart slits, the slits of each row being in staggered relation to those of the adjacent row, a supporting member for said advancing slitted sheet, said supporting member having a bluntly pointed terminal end having two converging edges, a rotating friction member in adjacent opposed relation to each of said converging edges, said slitted sheet passing between and in contact with said converging edges and said friction members, means in advance of said friction members for drawing said sheet forwardly at a rate more rapid than the rate of advance to said slit cutting means, means for rotating said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move forwardly at a rate more rapid than does the sheet.

5. Apparatus for making expanded sheet material, comprising means forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, means for cutting transverse lines of slits in said advancing sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means, a substantially flat supporting member for the slitted portion of said sheet advancing from said slitting means, the terminal end of said supporting member having edges converging to an apex, a pair of friction members each mounted for rotation with a surface thereof in parallel opposed relation to one of said converging edges and in frictional contact with the surface of said slitted sheet remote from said supporting member, means for rotating said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move forwardly at a rate more rapid than does the sheet.

6. Apparatus for making expanded sheet material, comprising means for advancing a sheet in a longitudinal direction, means for cutting transverse lines of slits in said advancing sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means, a supporting member for said sheet between said slitting means and said drawing means, the terminal end of said supporting member having converging edges, a pair of friction members each mounted for motion with a surface thereof in adjacent opposed relation to one of said converging edges and in frictional contact with the surface of said slitted sheet remote from said supporting member, means for moving said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move forwardly at a rate more rapid than does the sheet.

7. In apparatus for making expanded sheet material, means for advancing and simultaneously stretching in a longitudinal direction a sheet having lines of spaced apart slits extending transversely thereof, a supporting member providing a main supporting surface for said advancing slitted sheet, the terminal end of said supporting member having edges converging to an apex, the surfaces of said edges being at an angle to said main supporting surface, a pair of friction members each mounted for rotation with a surface thereof in adjacent opposed relation to the surface of one of said converging edges, said slitted sheet passing between and in contact with the surfaces of said converging edges and said friction members, and means for rotating said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move in the direction of advance of the sheet at a rate more rapid than does the sheet.

8. In apparatus for making expanded sheet material, means for advancing and simultaneously stretching in a longitudinal direction a sheet having lines of spaced apart slits extending transversely thereof, a supporting member providing a main supporting surface for said advancing slitted sheet, the terminal end of said supporting member having edges converging to an apex, the surfaces of said edges being at an angle to said main supporting surface, a pair of friction members each mounted for motion with a surface thereof in adjacent opposed relation to the surface of one of said converging edges, said slitted sheet passing between and in contact with the surfaces of said converging edges and said friction members, and means for imparting motion to said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move in the direction of advance of the sheet at a rate more rapid than does the sheet.

9. In apparatus for making expanded sheet material, means for advancing and simultaneously stretching in a longitudinal direction a sheet having lines of spaced apart slits extending transversely thereof, a supporting member providing a supporting surface for said advancing slitted sheet, the terminal end of said supporting member having edges converging to an apex, a pair of friction members each mounted for motion with a surface thereof in adjacent opposed relation to the surface of one of said converging edges, said slitted sheet passing between and in contact with the surfaces of said converging edges and said friction members, and means for imparting motion to said friction members in a manner such that at the area of contact thereof with said sheet the surfaces of said friction members move in the direction of advance of the sheet at a rate more rapid than does the sheet.

10. In apparatus for making expanded sheet material, means for advancing and simultaneously stretching in a longitudinal direction a sheet having lines of spaced apart slits extending transversely thereof, a supporting member providing a main supporting surface for said advancing slitted sheet, the terminal end of said supporting member having an edge extending diagonally forward with respect to the direction of advance of said sheet, the surface of said edge being at an angle to said main supporting surface, a friction member mounted for rotation with a surface thereof in adjacent opposed relation to the surface of said diagonal edge, said

slitted sheet passing between and in contact with the surfaces of said edge and said frictional member, and means for rotating said friction member in a manner such that at the area of contact thereof with said sheet the surface of said friction member moves in the direction of advance of the sheet at a rate more rapid than does the sheet.

11. Apparatus for making expanded sheet material, comprising means for advancing a sheet in a longitudinal direction, means for forming transverse lines of slits in said advancing sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means to expand said sheet, and means for orienting the webs of said expanding sheet comprising means providing separate frictional surfaces in contact with the opposite surfaces of said sheet respectively, the frictional surface in contact with one surface of said sheet being stationary and tending to retard the advance of said sheet and means to move the frictional surface in contact with the opposite surface of said sheet tending to accelerate the advance of said sheet, said last mentioned means being located between said slitting means and said drawing means.

12. Apparatus for making expanded sheet material, comprising means for advancing a sheet in a longitudinal direction, means for forming transverse lines of slits in said advancing sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means to expand said sheet, and means separate from said drawing means for contacting said expanding sheet and imparting a turning moment to the webs thereof, said last mentioned means being located between said slitting means and said drawing means.

13. Apparatus for making expanded sheet material, comprising means for advancing a sheet in a longitudinal direction, means for forming transverse lines of slits in said advancing sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means to expand said sheet, and means separate from said drawing means for orienting the webs of said expanding sheet comprising a frictional surface and means for moving said surface in frictional contact with a surface of said expanding sheet in such manner that at the area of contact thereof with said sheet said frictional surface moves in the direction of advance of the sheet at a rate more rapid than does the sheet, said last mentioned means being located between said slitting means and said drawing means.

14. Apparatus for making slitted sheet material, comprising top and bottom guide members forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, said guide members each having a gap therein extending transversely with respect to said sheet, said gaps coinciding with each other, a pair of cutters mounted for reciprocation within said gaps and across the plane of said sheet, said cutters being arranged in opposed relation to each other, and each comprising a row of spaced apart teeth, the indi-

vidual teeth of one cutter being in staggered relation to those of the opposite cutter, said cutters being so arranged that at each cycle of reciprocal motion thereof each cutter cuts a row of spaced apart slits across said sheet, and means for imparting reciprocal motion to said cutters.

15. Apparatus for making slitted sheet material, comprising top and bottom guide members forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, said guide members each having a gap therein extending transversely with respect to said sheet, said gaps coinciding with each other, a pair of cutters mounted for reciprocation within said gaps and across the plane of said sheet, said cutters being so arranged that at each cycle of reciprocal motion thereof each cutter cuts a row of spaced apart slits across said sheet, and means for imparting reciprocal motion to said cutters.

16. Apparatus for making slitted sheet material, comprising means forming a guideway adapted to provide lateral support for both sides of said sheet, means for advancing a sheet longitudinally forward in said guideway, said guideway forming means having a gap therein extending transversely with respect to said sheet, a pair of cutters mounted for reciprocation within said gap and across the plane of said sheet, said cutters being so arranged that at each cycle of reciprocal motion thereof each cutter cuts a row of spaced apart slits across said sheet, and means for imparting reciprocal motion to said cutters.

17. In apparatus for making expanded sheet material, the combination of means for advancing a sheet, means for forming lines of slits in said sheet transversely of the direction of advance thereof to form webs in said sheet, means for drawing the slitted portion of said sheet forwardly at a rate more rapid than the rate of advance to said slitting means to expand said sheet, a bearing member for said sheet located between and out of alignment with said slitting means and said drawing means whereby said slitted sheet in passing across said bearing member undergoes a change of direction, a contact member mounted for motion in adjacent opposed relation to said bearing member whereby said advancing sheet passes between and in contact with the surfaces of said bearing member and said contact member, and means for imparting motion to said contact member such that at the area of contact thereof with said sheet the surface of said contact member moves in the direction of advance of the sheet at a rate more rapid than does the sheet and imparts a turning motion to the webs of said sheet.

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