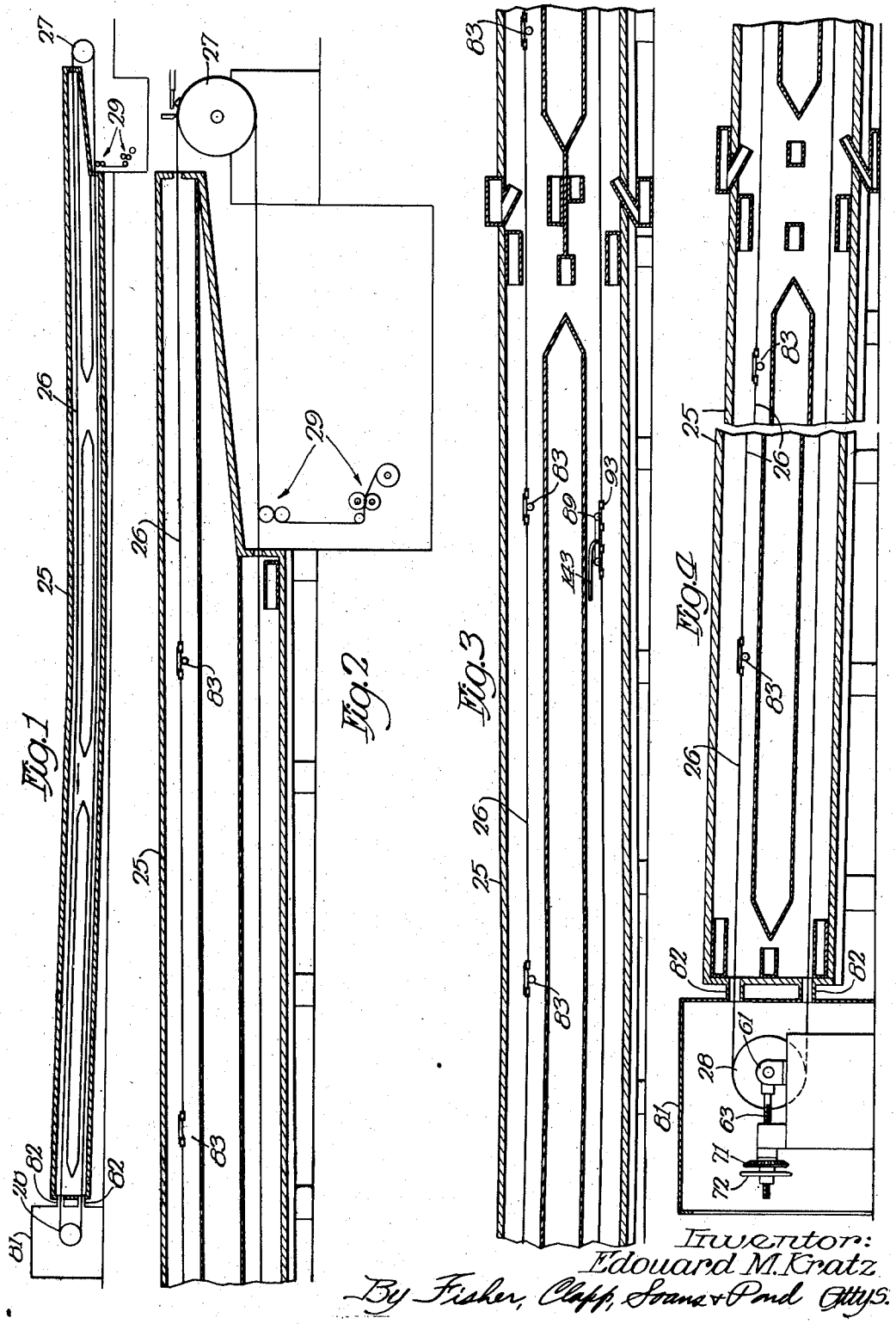
April 13, 1943. E. M. KRATZ 2,316,173

SHEET MAKING APPARATUS

Filed May 19, 1939 7 Sheets-Sheet 1



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SHEET MAKING APPARATUS

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Fig. 5

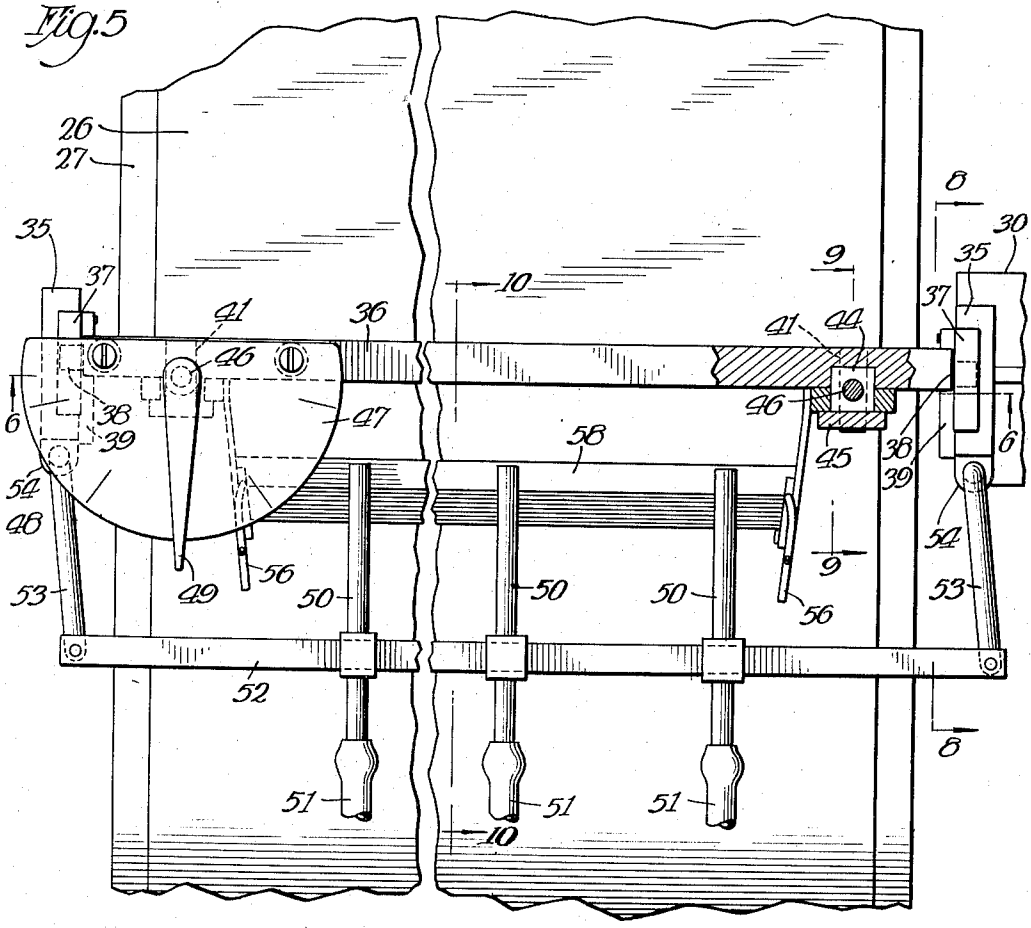
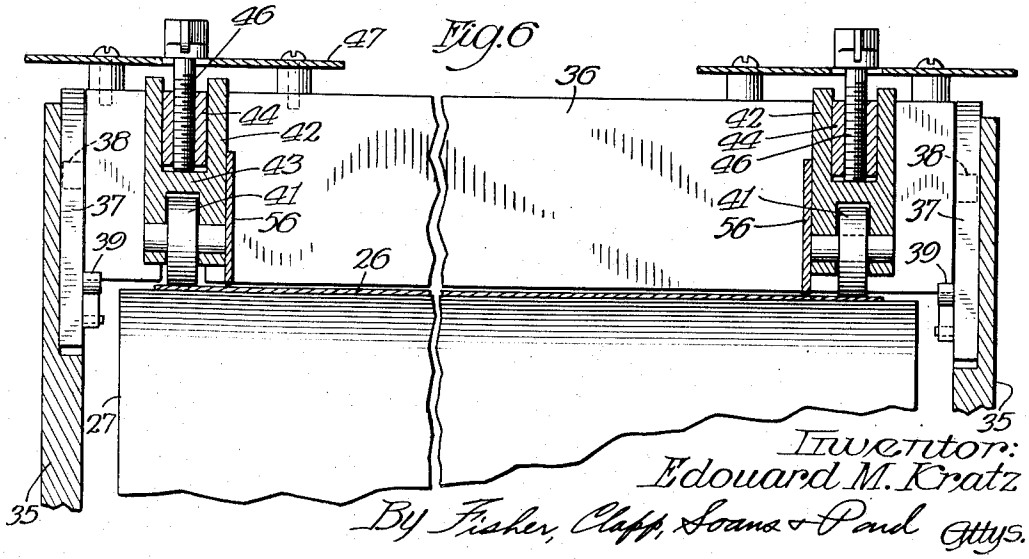


Fig. 6



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SHEET MAKING APPARATUS

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Fig. 7

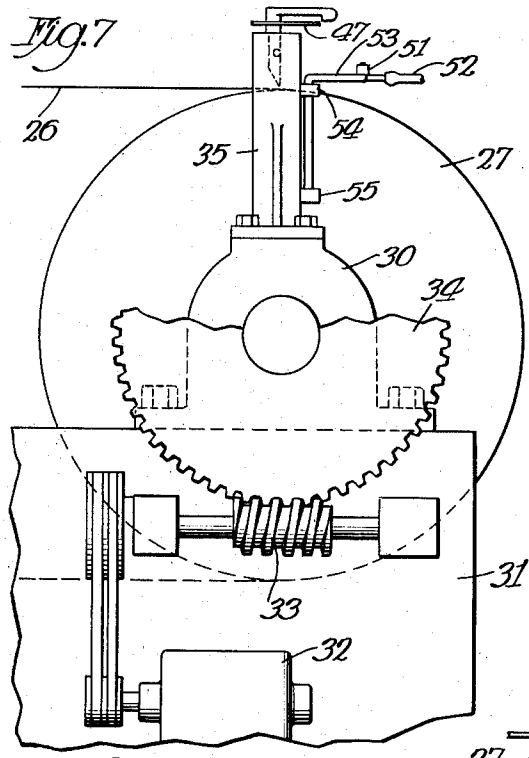


Fig. 8

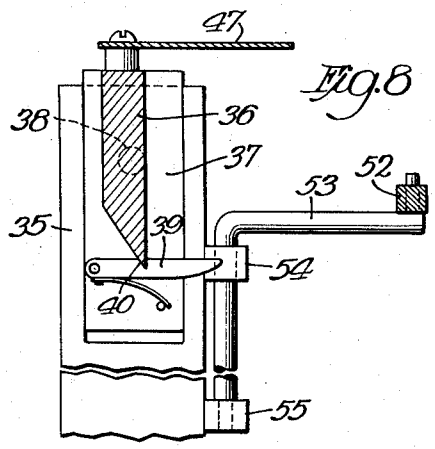


Fig. 9

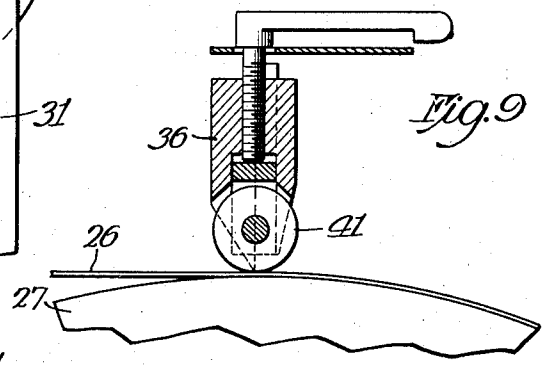


Fig. 11

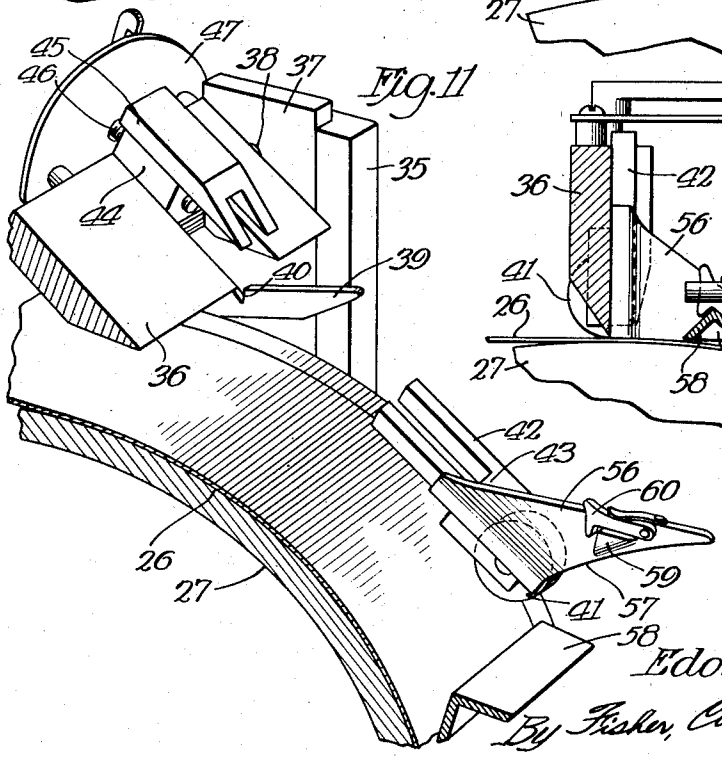
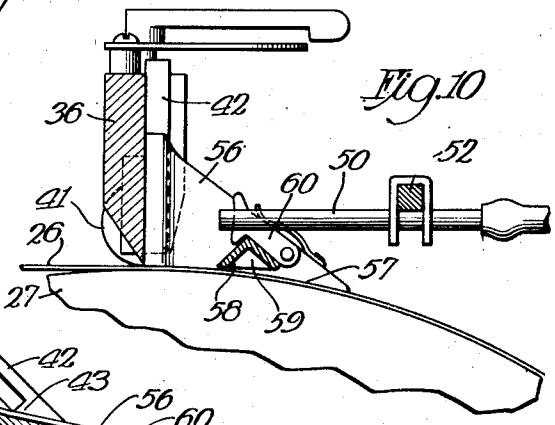


Fig. 10



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SHEET MAKING APPARATUS

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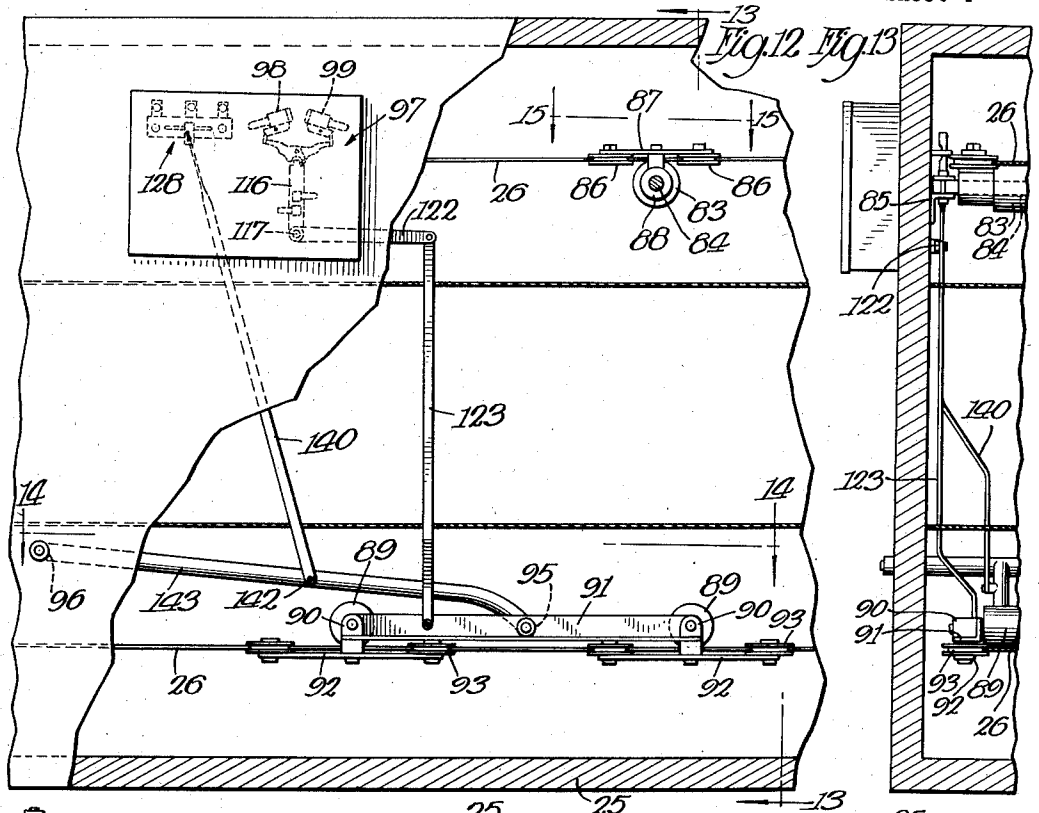


Fig. 12

Fig. 13

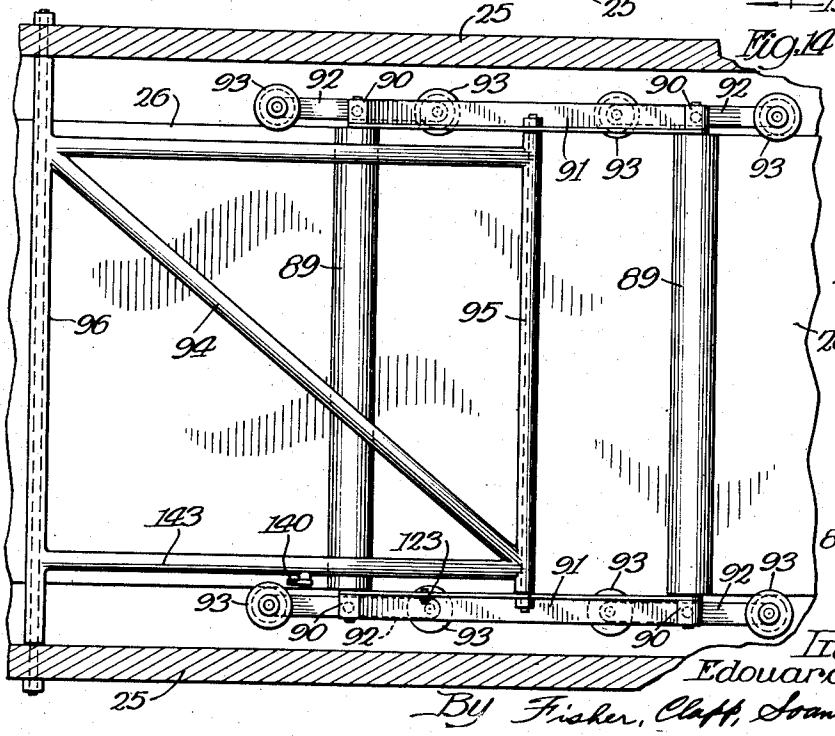


Fig. 14

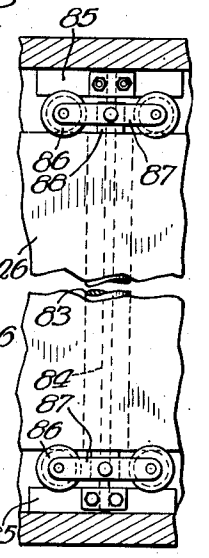


Fig. 15

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SHEET MAKING APPARATUS

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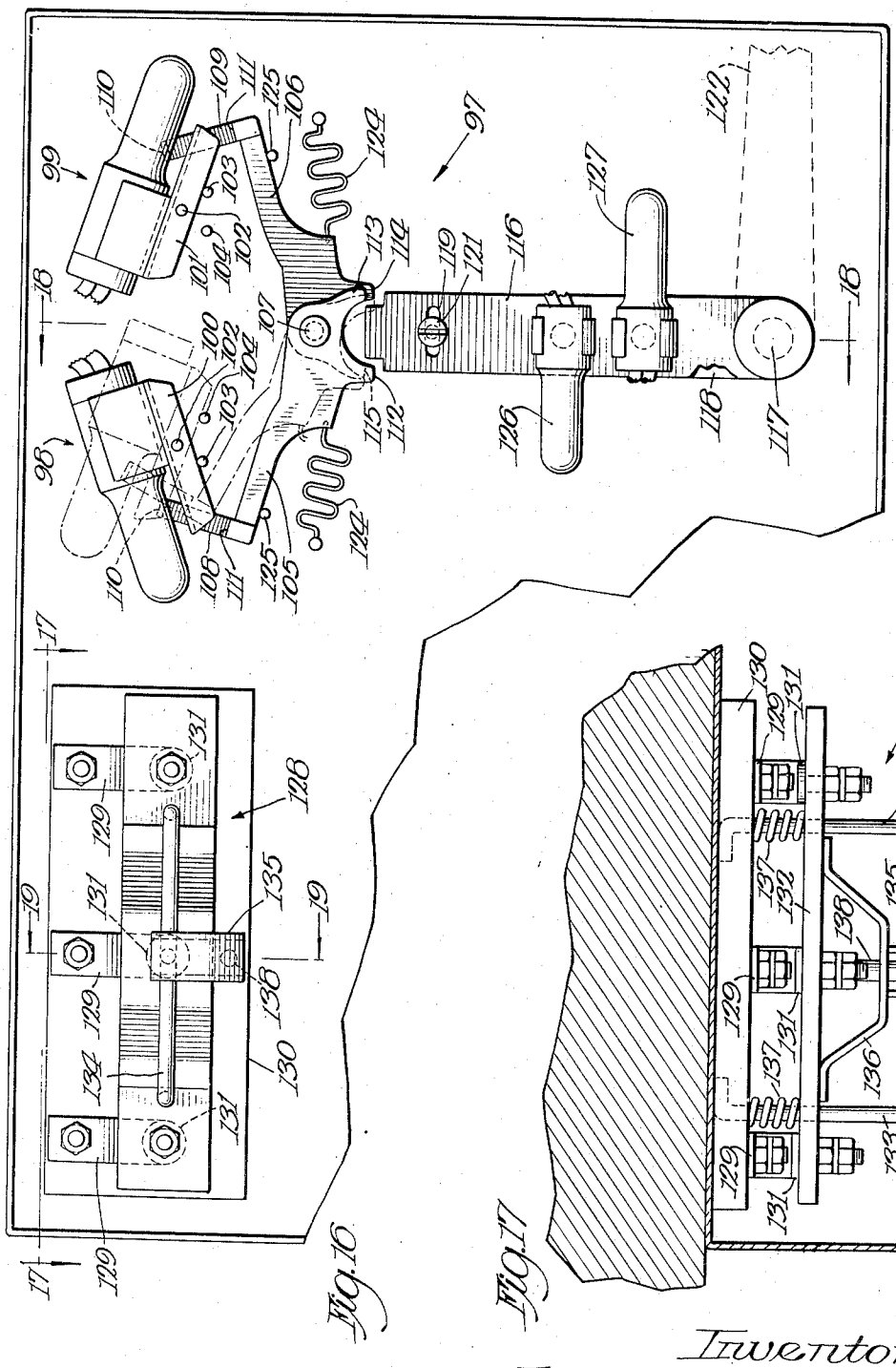


Fig. 16

Fig. 17

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SHEET MAKING APPARATUS

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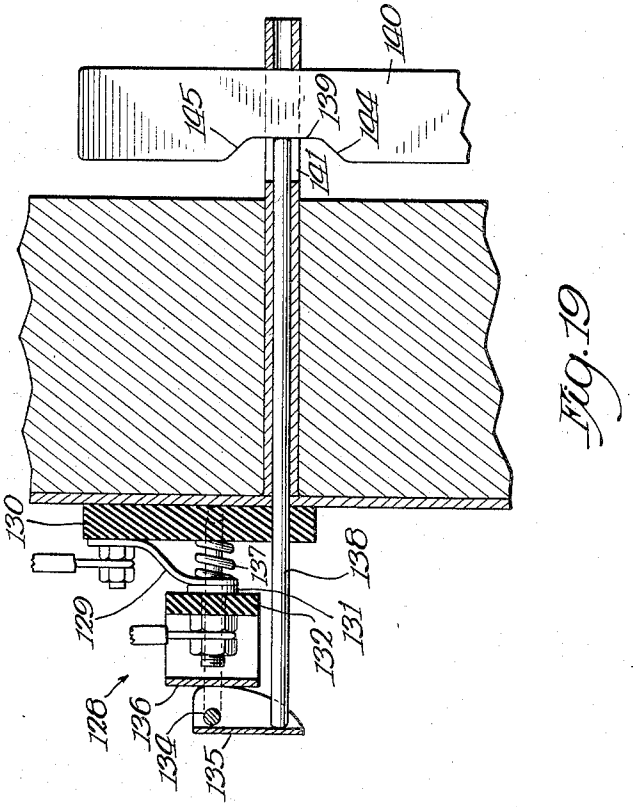


Fig. 19

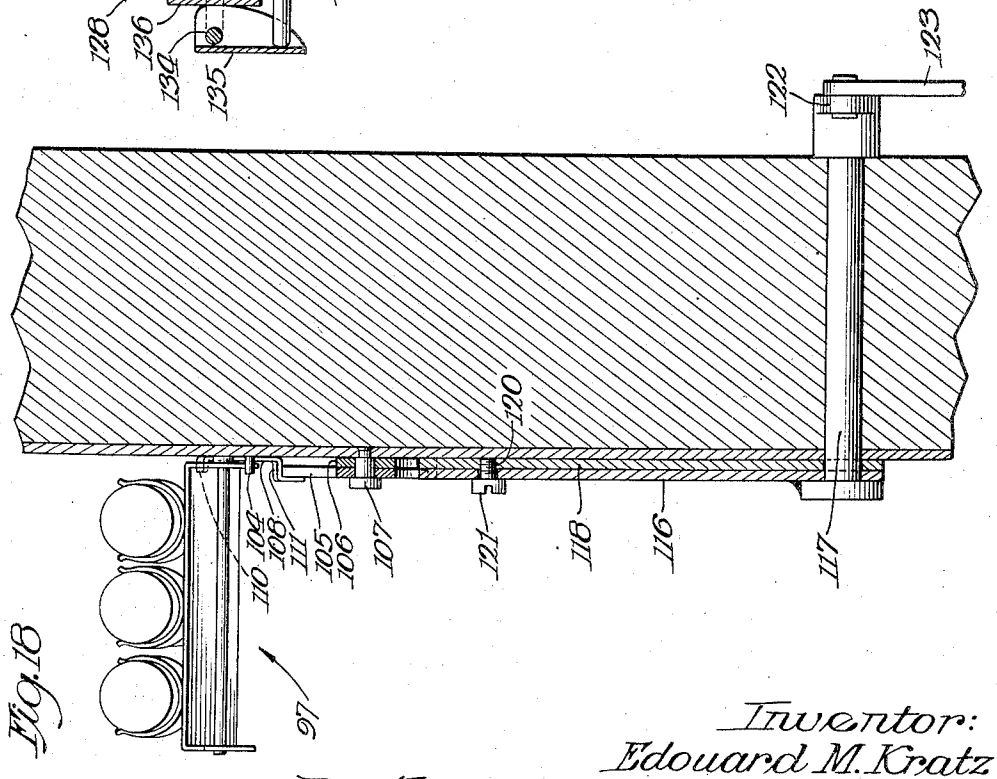


Fig. 18

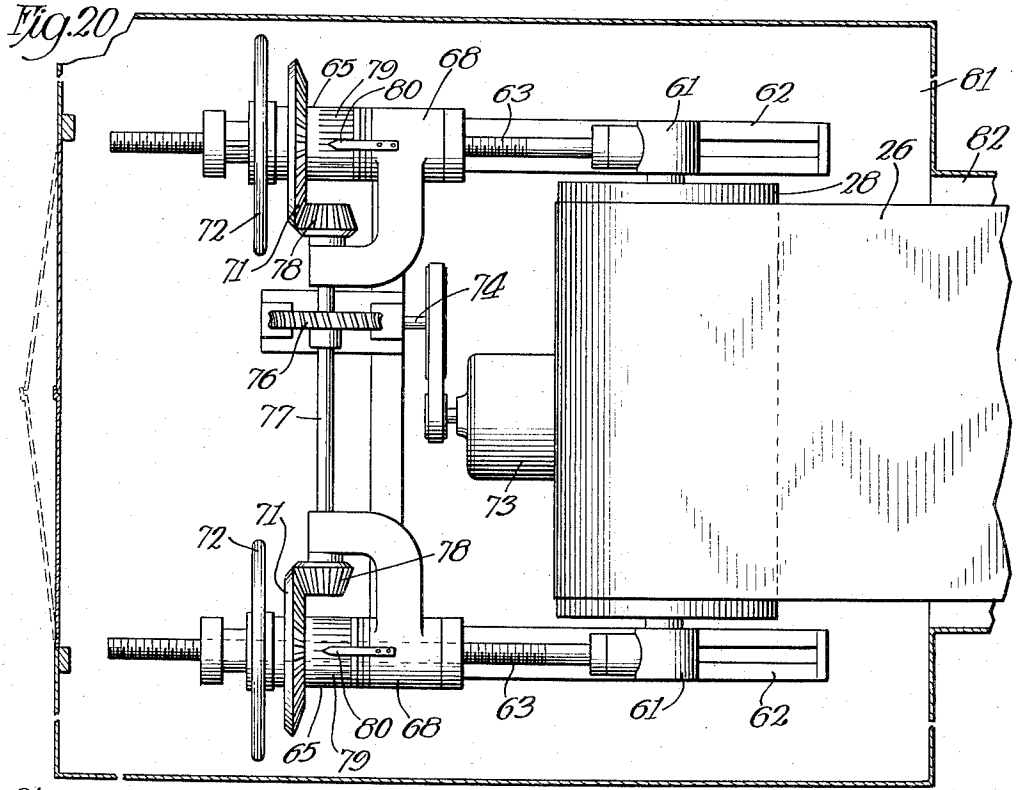
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SHEET MAKING APPARATUS

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Fig. 20



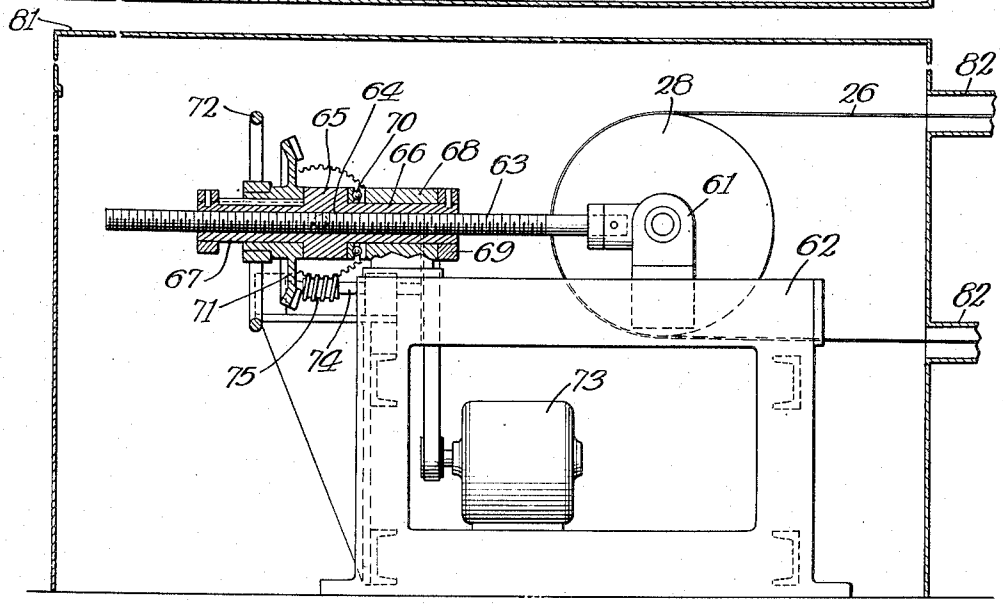


Fig. 21

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2,316,173

UNITED STATES PATENT OFFICE

2,316,173

SHEET MAKING APPARATUS

Edouard M. Kratz, Gary, Ind., assignor to Kraft Cheese Company, a corporation of Delaware

Application May 19, 1939, Serial No. 274,481

7 Claims. (Cl. 18—15)

This invention relates to apparatus for making webs or sheets and it is in part a continuation of my co-pending application Serial No. 229,509.

The main objects of this invention are to provide mechanism which will facilitate the production of sheets or webs of uniform thickness; to provide mechanism for automatically controlling the operating condition of mechanism which is subject to variation due to various causes, including changes in temperature; and, in general, to provide improved apparatus for the purpose set forth.

Other objects and advantages of the invention will be understood by reference to the following specification and accompanying drawings (7 sheets) wherein there is disclosed the improved apparatus of the character indicated.

In the drawings:

Figure 1 is a diagrammatic representation of the improved sheet-forming apparatus;

Figures 2, 3 and 4 are more or less diagrammatic illustrations on an enlarged scale of various portions of the apparatus as shown in Figure 1;

Figure 5 is a plan view of a portion of the receiving end of the apparatus;

Figure 6 is a sectional view on the line 6—6 of Figure 5;

Figure 7 is an end elevation of the receiving end of the apparatus;

Figures 8, 9 and 10 are sections, respectively, on the lines 8—8, 9—9 and 10—10 of Figure 5;

Figure 11 is a fragmentary perspective of the receiving end of the apparatus;

Figure 12 is a side elvation, of mechanism for automatically controlling the tautness and curling of a drying belt;

Figures 13, 14 and 15 are sections, respectively, on the lines 13—13, 14—14 and 15—15 on Figure 12;

Figure 16 is an elevation of electrical switch mechanism forming a part of the apparatus;

Figures 17, 18 and 18 are sections, respectively, on the lines 17—17, 18—18 and 19—19 on Figure 16;

Figure 20 is a plan of the rear end portion of the apparatus; and

Figure 21 is a side elevation of the apparatus shown in Figure 20, certain parts being shown in section to more fully illustrate the construction.

The apparatus herein contemplated is particularly designed for the production of sheet material from casein compositions but the construction herein disclosed may be employed for analogous purposes in the making of sheeting from other compositions. The apparatus is particularly advantageous in any situation where the sheeting is best produced on an imperforate belt of great length on which the sheeting is dried by being passed through an oven and in any instance where uniformity of thickness is difficult of achievement because of a normal tendency of the material from which the sheeting is formed to flow or run on the forming belt.

The apparatus herein shown comprises an elongated oven designated in its entirety 25, the same being preferably built to match the normal catenary curve of an elongated sheet-forming belt 26. The belt 26 is, in this instance, of stainless steel or the like having a highly polished or plated outer surface and the belt is supported at its opposite ends by rollers 27 and 28. The roller 27 is the receiving end of the machine to which the composition is delivered to the belt for forming the sheet and the roller 28 is adjustably mounted so as to permit adjustment of the tautness of the belt, so that its catenary curve may be maintained substantially constant, notwithstanding changes in the length of the belt due to expansion or contraction. The sheet formed on the belt is delivered from the lower reach of the belt and wound on suitable reels near the receiving end of the machine by suitable mechanism indicated generally at 29.

The oven 25 is supplied with hot air through suitable inlets and by suitable mechanism as more fully explained in my aforesaid pending application and suitable outlets and connections to permit re-circulation of the air are, of course, contemplated. Inasmuch as these are fully explained in my said co-pending application they will not be detailed herein.

The receiving end of the machine (see Figures 5 to 11, inclusive) comprises the roller or drum 27, journalled for rotation in suitable bearings 30 which are supported by side frames 31 of the apparatus. The drum 27 is rotated at suitable speed by means of an electric motor 32 which, through suitable driving connections, drives a worm 33 and a worm-wheel 34 which are carried by the shaft of the drum 27.

For supporting certain parts about to be explained, upstanding brackets 35 are mounted on the journal brackets 30 and rigidly bolted thereto so as to maintain a fixed relation to the drum 27. A doctor blade 36 is pivotally mounted at its ends in vertically elongated blocks 37 through the agency of short studs 38 which project from the ends of the doctor blade and fit suitable bearing openings in the said blocks 37. The blocks 37 are vertically slidably mounted in the brackets 35 by being fitted into ways provided in said brackets. For holding the doctor blade 36 in normal vertical position, there are provided latch members 39 pivoted on the respective blocks 37 and urged by suitable spring means as indicated to move toward the lower edge of the doctor blade so as to cause the latter to enter retaining notches such as indicated at 40 in the respective latches, thereby

to prevent the doctor blade from rocking on its pivot studs 38.

The doctor blade 36 is adapted to be supported with its lower edge in predetermined spaced relation to the surface of the belt 26 by means of rollers 41, 41 which are adjustably mounted on the doctor blade near its opposite ends and which rollers ride directly on the surface of the belt at a point where the belt is supported by the drum 27. Each roller 41 is rotatably mounted by means of a suitable shaft in a bracket 42, which, in front view, is of H-form so as to present a transversely extending cross-bar 43 and spaced legs extending upwardly and downwardly therefrom. The roller 41 is journalled between the depending pair of legs as clearly shown. Each bracket 42 is vertically slidably mounted on the front of the doctor blade 36 by having its upwardly extending legs fitted in ways formed on the front of the doctor blade by means of a forwardly extending block-like portion 44 and an outer cross-head portion 45. The block portion 44 and cross-head portion 45 may be formed of one piece or of separate parts suitably secured together by bolts, welding, or otherwise, and the block part 44 is rigidly secured to the doctor blade 36 in any suitable manner, but preferably by recessing the block into the doctor blade and then bolting or welding so as to insure permanent and fixed attachment. A set screw indicated at 46 is threaded vertically through the mounting block 44 and is adapted to engage the cross-bar 43 of the roller bracket 42, so that corresponding adjustment will be effected of the roller bracket 42 relative to the doctor blade 36.

To facilitate adjustment of the roller bracket 42 and the supporting roller 43 at each end of the doctor blade, there is provided in association with each of the adjusting screws 42 a plate 47 suitably mounted on the upper edge of the doctor blade and provided with a suitably graduated scale 48 which is adapted to be read in connection with the free end of a handle 49 which is secured to the adjusting screw 46 to facilitate turning thereof. It will be apparent that by adjusting each screw to the same extent as is made easy by the provision of the scales just referred to, the doctor blade will be uniformly adjusted throughout its length with reference to the surface of the belt 26. Similarly, in the event that it is discovered that the sheet being produced on the belt is either thicker or thinner than desired at one side than at the other, it is a simple matter to adjust the corresponding side of the doctor blade to the proper extent to eliminate the excess or deficient thickness.

A plurality of nozzles such as indicated at 50 are provided for delivering the sheet-forming liquid to the belt 26. Such nozzles are connected by hoses or the like as indicated at 51 to a source of supply and the nozzles are supported by being suitably clamped to a cross-bar 52 which is pivotally connected at its opposite ends to arms 53. The arms 53 are mounted for rocking movement in suitable supporting brackets 54 and 55 respectively the latter being suitably secured to the upstanding brackets 35. The attendant of the front end of the machine may occasionally shift the nozzles laterally such movement being permitted by the swinging arm supports for the cross-bar 52 and if desired power-driven means may be provided for maintaining a continuous lateral shifting movement of the nozzles.

For controlling the spread of the liquid delivered by the nozzles 50 to the belt 26 there are provided side guides 56 56 the same being suitably secured to the inside edges of the respective brackets 42. The lower edges of the said guides 56 are curved as indicated at 57 to fit the curvature of the belt 26 and the relationship of the said bottom edges 57 to the rollers 41 is such that the bottom edges of the guides will rest on or be close enough to the surface of the belt 26 to prevent the liquid from passing between the lower edges of the guides and the belt.

A further guide for controlling the supply of liquid to the belt is provided in the form of an angle iron member 58 the same extending transversely between the side guide members 56 56 and being positioned with its legs extending downwardly and in opposite directions as best shown in Figure 10. For supporting the transverse member 58 each of the side guides 56 is provided with a shoulder formation 59 adapted to receive the ends of the cross-member 58. A spring-pressed hook such as 60 is pivoted on each of the side guides 56 and is adapted to cooperate with the supporting shoulder 59 to retain the cross-member 58 in operative position. The said cross-member serves the purpose of preventing the liquid delivered from the nozzles 50 from flowing down the curved front portion of the belt 26 as it travels upwardly and rearwardly around the drum 27. In other words, the cross-member 58 serves with the side guides 56 to maintain a shallow pood of liquid in front of the doctor blade 36 so as to insure an adequate supply of the liquid at all times over the entire length of the doctor blade between the side guides 56.

For cleaning purposes, the doctor blade 36 is rocked on its pivot supports 38 to the position indicated in Figure 11, this being permitted upon disengagement of the latch members 39 from the lower edge of the doctor blade.

When the doctor blade has been rocked to a position such as shown in Figure 11, it is more accessible for cleaning and the roller bracket 42 and parts carried thereby may readily be separated from the doctor blade as clearly shown in Figure 11. Also, as shown in Figure 11, when the roller brackets 42 are disengaged from the doctor blade, the said brackets and their attached side guides 56 may readily be separated from the cross-bar 58. Also, it will be observed that without separating the side guides 56 from the doctor blade, the cross-bar 58 may be removed by releasing the anchoring hooks 60. Hence, cleaning of the apparatus is clearly facilitated.

The belt-supporting roller 28 at the rear end of the apparatus is journalled in suitable bearing brackets 61 which are slidably mounted on side frames 62. By adjusting the roller 28 toward or from the drum 27 at the front end of the apparatus, the tautness and position of the belt 26 within the oven 25 may be controlled. Such adjustment may be effected either manually or by power means. For this purpose there is provided in association with each of the slidably mounted bearings 61, a screw-threaded rod 63 which is suitably connected at one end to the slidable bearing member 61 or to the shaft of the roller 28 adjacent the slidable bearing 61. The screw-threaded rod 63 threadedly engages an internally threaded, elongated sleeve 64 which comprises an intermediate enlarged portion 65 and endwise extensions 66 and 67.

The endwise extension 66 is journalled in a bearing 68 formed integrally or rigidly secured in fixed position on the adjacent side frame 62.

A collar 69 pinned or otherwise secured to the extremity of the sleeve portion 66 serves to prevent withdrawal of said sleeve portion from the bearing 68 and a suitable anti-friction bearing 70 is interposed between the enlarged portion 65 and the adjacent end of said bearing 68. The other sleeve extension 67 has keyed to it a miter gear 71 which has rigidly connected to it a hand wheel 72. The miter gear 71 is adapted to be rotated manually through the agency of the hand wheel 72 to thereby turn the threaded sleeve to effect longitudinal movement of the screw-threaded rod 63 and thereby adjustment of the roller 28.

For effecting such adjustment by power means, there is provided an electric motor 73 having a suitable belt or other driving connection with a suitably journalled shaft 74, which carries a worm gear 75. The worm gear 75 meshes with a worm wheel 76 which is carried by a suitably journalled shaft 77 and the shaft is equipped at its opposite ends with miter gears 78, 78 which mesh with the respectively adjacent miter gears 71. It will be apparent that when the electric motor 73 is energized, the shaft 77 will be driven and the screw-threaded rods 63 caused to move forwardly or rearwardly in accordance with the rotation imparted to the threaded sleeves by reason of the miter gear connections 71 and 78.

The electric motor 73 is of the reversible type so that it may be selectively actuated in both directions to effect either forward or rearward adjustment of the roll 28. Normally, it is desired to effect uniform adjustment of both ends of the roll 28 so as to maintain the normal parallelism of the roll 28 with the front end roll 27. However, occasionally, as for example when installing a new belt 26, it is advantageous if either side of the roll 28 may be adjusted independently of the other side. To permit such independent adjustment, the gears 71 and the hand wheels 72 are keyed to the sleeve portion 67 as already explained, so that either hand wheel and its associated gear may be moved outwardly along the sleeve portion 67 sufficiently to disengage the corresponding miter gear 78. When the gear is thus disengaged, the motor 73 may be actuated to adjust the opposite side of the roller 28, or, in the alternative, the side of the roll corresponding to the disengaged gears 71 and 78 may be manually adjusted through the agency of the hand wheel 72. Such manual adjustment is facilitated when the gears 71 and 78 are disengaged, since by breaking the driving connection between the gear 71 and the gear 78 no part of the manual force applied to the hand wheel 72 would be transmitted to the shaft 77 and motor 73. The central enlarged portion 65 of each sleeve may advantageously be provided with graduated scale markings indicated at 79 for cooperation with a pointer 80 carried by the adjacent bearing 68 to facilitate measured adjustment of the screw 63 and corresponding end of the roll 28.

The roll 28 and the described adjusting mechanism are housed in an enclosure indicated at 81 (Figures 1, 20 and 21), the same being connected to the oven 26 by suitable passageways 82, 82 for the upper and lower reaches of the belt 26.

Inasmuch as the sheet is formed on the outside surface of the belt 26, it will be understood that on the upper reach of the belt the sheet is located on the upper surface thereof and that on the lower reach of the belt the sheet is on the lower surface thereof. Under these circumstances the upper reach of the belt may be supported from below by means of suitably journalled rollers 83 disposed at such locations as experience shows to be most desirable. In Figures 2, 3 and 4 of the drawings, such supporting rollers are indicated at spaced intervals throughout the length of the oven. Each of the rollers 83 may be supported on a shaft such as 84 which is suitably supported by means of brackets indicated at 85 forming a part of or secured to the oven framework.

Associated with each of the supporting rollers 83 are grooved rollers 86, 86 journalled on a bracket such as indicated at 87, supported from a bearing member 88 on the shaft 84. Each roller 87 receives in its peripheral groove an edge portion of the belt 26 (see Figures 12 and 13) and thereby serves to maintain the belt flat and in engagement with the roller 83 across the entire width thereof. By this means the normal tendency for the belt to curl transversely is overcome. By thus maintaining the belt flat (and in a substantially horizontal plane), there is no (or at least only a negligible) tendency for the sheet-forming liquid to run on the belt. Hence the production of sheeting of uniform thickness is facilitated. The bracket 87 is preferably pivotally mounted intermediate its ends on the bearing 88, so that the bracket arm 87 may pivot sufficiently to permit the rollers 86 to bear equally on the edge of the belt 26.

Control of curling tendency of the lower reach of the belt is of less importance than of the upper reach, since the sheet is well set by the time the sheet-forming material reaches the rear end of the belt and begins its return travel on the lower reach thereof. However, I have found that control of the lateral position of the belt, or in other words, control of migrating tendencies of the belt, may be advantageously effected by action on the lower reach of the belt. Preferably, such controlling action is effected on the lower reach of the belt at a point located about one-third of the distance from the front end of the apparatus to the rear end thereof. It is to be understood that the stated distance is not critical but it is advantageous in that it effectively maintains the belt within permissible limits of movement crosswise of the receiving end of the drum 27, which limits are somewhat less than corresponding limits on the roll 28 at the rear end of the apparatus.

The mechanism for controlling the belt by action on its lower reach comprises a pair of rollers 89, 89 which extend transversely over and in engagement with the upper surface of the lower reach of the belt 26. Said rollers 89, 89 are equipped with endwise extending shafts which are journalled in suitable bearing members 90, 90 to which are connected angle iron side members 91, 91. The angle iron side members 91 are thus supported by the lower reach of the belt 26 through the agency of the rollers 89, 89. Adjacent each end of each of the side members 91, there are, pivoted intermediate their ends, arms 92, each of which has rotatably secured to its ends peripherally grooved rollers 93. The rollers 93 receive in their peripheral grooves the marginal edge portions of the belt 26 so as to maintain the belt flat and in engagement with the surface of the rollers 89, 89 across their entire lengths.

The position of the supporting rollers 89 and of the edge-engaging rollers 93 in the direction extending transversely of the widths of the oven 25 is fixed by means of a frame 94 which has a

transversely extending bar 95 pivoted at its ends to the adjacent side members 91 approximately midway between the ends thereof. The said frame 94 also has a transversely extending member 96 pivoted at its opposite ends to the walls of the oven as best shown in Figure 14, so as to prevent shifting of the frame transversely of the oven chamber. By the same token, the roller-supported side members 91 are prevented from shifting transversely and hence, through the edge-engaging rollers 93, serve to maintain the belt in a substantially fixed path of travel.

Incident to temperature changes in the oven, especially when first commencing the operation of the apparatus and when stopping the same, the conveyor belt 26 expands or contracts to such an extent that the vertical position of the reaches of the belt may vary considerably. Most of such variation is reflected in the lower reach of the belt since the upper reach is positively supported by the transverse rollers 83. The extent of change in the length of the belt upon expansion is sufficient to cause the lower reach of the belt to very closely approach the bottom of the oven chamber unless the chamber is made much larger than is desirable for efficiency in respect of temperature control. Inasmuch as the formed sheet is on the bottom face of the lower reach of the belt, it is apparent that it is highly objectionable if the lower reach sags closely enough to the bottom of the oven to either touch the same or pick up dust or other foreign matter from the bottom of the oven chamber merely incident to the air currents induced by the travel of the belt. The vertical position of the lower reach of the belt may be controlled by adjusting the rear roller 28 to take up the expanded length of the belt and thereby maintain the lower reach in a predetermined normal position between the top and bottom of the oven chamber for the lower reach of the belt.

For this purpose, electrical switch mechanism indicated in its entirety at 97 is provided and connected to the lower reach of the belt 26 so as to be governed by the vertical position of the latter. The switch mechanism 97 is in turn connected to the electric motor 73 which, when energized, effects adjustment of the rear or belt take-up roller 28.

As best shown in Figures 16 and 18, the switch mechanism 97 comprises two gangs 98 and 99 of switch elements, in this instance mercury switch tubes, the same being mounted on suitable brackets 100 and 101, respectively, which are mounted for rocking movement on a supporting pivot pin 102. As shown in Figure 16, the switch members are in off-position, the mercury content of each switch unit being disposed in the outer ends of the respective switch tubes. The weight of the mercury content of the switch tubes is sufficient to maintain the tubes in their off-position in which they are supported by means of stop-pins such as indicated at 103. Additional stop-pins such as indicated at 104 are provided for supporting the switch units in their on-position as indicated in dotted lines with respect to the switch gang 98.

The switch gangs 98 and 99 are adapted to be controlled by means of rock levers 105 and 106, respectively, which are pivotally mounted on a common pivot pin 107. The free ends of the arms 105 and 106 are equipped with upwardly projecting extensions 108 and 109, respectively. The said extensions 108 and 109 have their upper ends bent to provide ears such as indicated at 110 which project over the top surface of the pivoted switch-supporting bracket members 100 and 101, respectively. Said extensions are also bent so as to provide shoulders 111 which extend transversely across the adjacent end flange of the respective members 100 and 101. It will be seen that as an incident to rocking movement of the arm 105 and 106, the corresponding extension 108 or 109 will, on upward movement of the free end of the arm, engage and move the outer side of the overlying switch-supporting bracket 100 or 101 upwardly so as to cause the mercury content of the respective switch tubes to flow to the other end thereof, to thereby close an electric circuit in a well-known manner.

Similarly, when the upwardly moved arm 105 or 106 is restored to its initial position, the ear 110 at the upper end of the upper extension will engage the top of the switch-supporting bracket to rock the same downwardly to its initial position.

The rock arms 105 and 106 are each provided with downwardly facing, forked extensions. As best shown in Figure 16, the arm 105 is equipped with a downwardly facing forked extension comprising a long arm 112 and a short arm 113. Similarly, the rock arm 106 is provided with a downwardly facing forked extension comprising a long arm 114 and a short arm 115. The forked extensions of the arms 105 and 106 cooperate with the upper end of a rock lever 116, which is secured at its lower end to a rock shaft 117 suitably journalled in the oven wall. The rock lever 116 is preferably so made or equipped that its upper end portions may be adjusted as to width so as to thereby permit regulation of the amount of play between the upper end of the rock lever and the cooperating forked arms of the levers 105 and 106. In this instance, such adjustment is provided by equipping the rock arm 116 with an underlying member 118 of substantially the same shape and size as the arm 116, the member 118, however, being pivotally mounted on the shaft 117 instead of fixedly secured thereto as is the arm 116. The arm 116 is provided with a slot 119 and the arm 118 is provided with a threaded hole 120, for receiving a clamping screw 121 which passes through the slot 119 and is adapted to clamp the member 118 in fixed position relative to the lever arm 116.

The rock shaft 117 is provided within the oven with an arm 122 and the free end of said arm 122 is connected by means of a link 123 to the adjacent belt-supported side frame 91. Hence, in the event that the belt expands and is lengthened, downward movement of the lower reach of the belt will produce a rocking motion in the rock shaft 117. Such motion will be transmitted to the rock arm 116. Assuming, for example, that the belt is lengthened so as to cause rocking movement of the shaft 117 in a clockwise direction as shown in Figure 16, the rock arm 116 will also rock in a clockwise direction so as to cause its free end to engage the long finger 114 of the forked portion of the rock lever 106, such movement thereupon causing the rock lever 106 to turn on its pivot 107 in a counter-clockwise direction. Incident to such movement, the shoulder 111 at the outer end of the rock lever 106 will engage the switch bracket 101 and when sufficient movement has been effected, the switch gang 99 will be adjusted to its on-position. The electric circuit controlled by the switch gang 99 is such that the motor 73 will be rotated in the proper direction to adjust the belt take-up

roller 28 outwardly to thereby tighten the belt and cause the lower reach thereof to be pulled upwardly toward its normal position.

As an incident to the restoration of the lower reach of the belt to a suitably elevated position, the rock shaft 117 is, of course, rotated in a counter-clockwise direction so as to permit lowering of the rock lever 106. A suitable spring 124 is provided for causing the rock lever 106 to follow the movement of the arm 116, and as an incident to the engagement of the lip 110 on the extension 109 of the lever with the switch-supporting bracket 101, said spring will ultimately restore the switch gang 99 to its initial or off-position, whereupon adjustment of the belt take-up roller 28 ceases. It will be observed that when the upper end of the rock arm 116 engages the finger 114 of the lever 106, the said upper end clears the arm 113 of the other switch lever 105 so that the switch gang 98 is not actuated. When the rock lever 106 is in an upwardly adjusted position, the shorter finger 115 of that rock lever is swung to a position in which it will be in the path of return movement of the arm 116. Hence, in the event that the spring 124 fails to effect return movement of the lever 106, such movement will be effected by engagement of the arm 116 with the said shorter finger 115 of the lever. A stop pin 125 is provided for limiting the downward or clockwise turning movement of the lever 106. A similar spring 124 and a similar stop pin 125 are provided in association with the other rock lever 105 for the same purpose.

Upon shutting down of the apparatus or cooling of the oven and hence cooling of the belt, and incident to shutting down of the apparatus for other reasons, the lower reach of the belt, incident to contraction, will move upwardly and through the described connections effect counter-clockwise rocking of the shaft 117. Under such circumstances, the arm 116 will actuate the rock lever 105 and the switch gang 98 to complete an electric circuit for causing the electric motor 73 to rotate in an opposite diretion for effecting an inward adjustment of the belt take-up roller 28 to slacken the belt. The slackening continues until such time as the rock arm 116 has been returned to a position wherein the lever 105 will have caused the switch gang 98 to be dropped to an off-position, to thereby open the circuit to the electric motor 73.

A pair of oppositely positioned mercury switch tubes 126 and 127 may be advantageously mounted on the rock arm 116 so as to control electric circuits for signal lights which will indicate to an attendant of the apparatus whether or not any adjustment of the belt is being effected and in which direction.

In the event that either of the switch units 98 or 99 should fail of operation and adjustment continue, considerable damage might result. In one direction of adjustment the belt 26 might be subjected to such excessive stretching as to cause distortion or other impairment of the belt if not actual breakage thereof. If the adjustment were to continue in the other direction, the belt might come into scraping contact with the bottom of the oven with the result that the sheet-forming surface of the belt might be scratched, dented, or otherwise impaired to such an extent that it may not even be possible to repair the belt and its replacement thus necessitated. In either event, the damage may entail considerable loss not only in respect of the cost of the belt itself, but in respect of the labor required for installation and the loss of production during the time required for repair or replacement.

For the purpose of preventing such a contingency, there is provided a safety device in the form of an electric switch indicated in its entirety at 128 (see Figures 12, 16 and 19), which switch, upon being opened, breaks the electric circuit to the motor 73 so as to prevent operation thereof to effect adjustment of the belt take-up roller 28 beyond predetermined limits.

The said switch 182 comprises a series of contact elements 129 which are fixedly mounted on an insulating base element 130 and respectively connected in the circuit wires of the electric motor 73. A corresponding series of electrical terminals 131 is carried by a strip 132 of insulation material and respectively connected to the electric wires of said circuit as indicated in Figure 19. The terminal-carrying strip 132 is slidably mounted on the side legs 133, 133 of a bail-like member 134 which is suitably anchored in the insulating material base element 130. A cam element 135 is mounted for rocking movement on the bail element 134 and acts against a saddle 136 which is carried by the slidably mounted terminal-supporting strip 132. In the normal position of the cam 135 as shown in the drawings, the strip 132 is held in an inwardly disposed position, wherein its contact terminals 131 are in engagement with the terminals 129 so as to maintain a circuit through said terminal elements. Suitable compression coil springs 137 are provided and normally tend to move the terminal-carrying strip 132 outwardly so as to separate said contact elements to thereby open or break the electric circuit.

The cam element 135 is adapted to be controlled by a push rod 138 which is slidably mounted in the oven wall. The inner end of the push rod 138 normally engages a recessed surface portion 139 of a vertically movable bar 140. The bar 140 is slidably mounted at its upper end in a slot 141 provided in an extension of the push rod guide element, and the lower end of the said bar is pivotally connected as shown at 142 to the adjacent side member 143 of the frame 94.

In the event that the frame 94 is caused to continue upward movement, for example, beyond a normal extent for effecting correction of the position of the lower reach of the belt 26, a cam surface 144 adjacent the lower end of the recessed seat 139 in the bar 140 will engage and move the push rod 138 outwardly to thereby rock the cam 145 so as to permit the springs 137 to move the contact-carrying member 132 outwardly, thereby breaking the circuit to the electric motor 73 and stopping its operation, notwithstanding the continued maintenance of a closed circuit by the switch gang 98 or 99. Similarly, in the event that the frame 94 continues downward movement beyond a predetermined limited extent, a cam surface 145 adjacent the upper end of the recessed seat 139 in the bar 140 will engage and move the push rod 138 outwardly to break the circuit to the motor 73.

The effective control by means of the above described adjustable supporting means for the doctor blade of the depth of film of sheet-forming liquid applied to the belt, and the effective control or prevention of curling of the belt constitute important aids in the production of sheet material of uniform thickness throughout its width. The described controls are of relatively simple construction and they are not likely to get out of

order, so that their effectiveness is enhanced by their durability and efficiency.

The described mechanism for controlling tautness of the belt is also of considerable importance in apparatus of the type described in view of the improved results obtained when the sheet formed on the belt is dried under conditions which may be maintained substantially constant within the selected operating zone of the belt. The said belt take-up mechanism is also of substantial importance because of its effect in safeguarding the relatively expensive belt from injury and attendant losses as already explained.

The electrical circuits herein referred to are not illustrated inasmuch as they form no part of the present invention and are well-known reversing motor circuits. Furthermore, it will be understood that the circuits for controlling the motor 73 may also be provided with manual switching means, although such manual means is not herein shown.

Changes in the described apparatus may be made without departing from the spirit of the invention, the scope of which should be determined by reference to the following claims, the same being construed as broadly as possible, consistent with the state of the art.

I claim:

1. In apparatus of the class described, the combination of a rotatable drum, a belt adapted to travel around said drum, means for delivering sheet-forming liquid to said belt, a doctor blade extending transversely of said belt for limiting the depth of sheet-forming liquid carried rearwardly by said belt, side guides extending forwardly from said doctor blade for controlling the spread of said liquid, a member extending transversely between said side guides in proximity to said belt for retaining the liquid in a pool in front of said doctor blade, and means for detachably mounting said transversely extending member on said side guides and said side guides on said doctor blade.

2. In apparatus of the class described, the combination of a rotatable drum, a belt adapted to travel around said drum, a doctor blade associated with said belt for limiting the depth of sheet-forming liquid carried rearwardly by the belt, adjustable means carried by said doctor blade and engaging said belt for supporting the doctor blade in predetermined, adjusted position relative to the belt, and means for mounting said doctor blade comprising relatively fixed frame members adjacent the opposite ends of said doctor blade, guide members vertically slidably mounted in said frame members, a pivotal connection between the respective ends of said doctor blade and the respectively adjacent guide members, and disengageable latch means for normally locking said doctor blade against rocking movement on its pivotal connection with said guide blocks.

3. In apparatus of the class described, the combination of a rotatable drum, a belt adapted to travel around said drum, a doctor blade associated with said belt for limiting the depth of sheet-forming liquid carried rearwardly by the belt, adjustable means carried by said doctor blade and engaging said belt for supporting the doctor blade in predetermined adjusted position relative to the belt, and means for mounting said doctor blade comprising relatively fixed frame members adjacent the opposite ends of said doctor blade, guide members vertically slidably mounted in said frame members, and means pivotally connecting the ends of said doctor blade with the respectively adjacent guide members.

4. In apparatus of the class described, the combination of a frame, a drum rotatably mounted in said frame, a belt travelling around said drum, means for delivering sheet-forming liquid to said belt, a doctor blade for limiting the depth of the liquid carried rearwardly by said belt, means for adjustably mounting said doctor blade on said frame, a roller adjustably and detachably mounted on said doctor blade for engaging a portion of said belt overlying said drum so as to support the doctor blade in predetermined position relative to said belt, and means for effecting adjustment of said roller relative to said doctor blade to thereby adjust the position of the doctor blade relative to the belt, the detachable mounting of said roller on said doctor blade serving to permit removal of the roller so as to facilitate cleaning of the apparatus.

5. In apparatus of the class described, a rotatable drum, a thin, flexible belt travelling around said drum, means for delivering sheet-forming liquid to the belt on said drum, a doctor blade for limiting the depth of the liquid carried rearwardly on said belt, and rollers respectively associated with the opposite ends of said doctor blade with their axes disposed within the cross-sectional area of the doctor blade, said rollers being operative to engage a portion of the belt overlying said drum for supporting said doctor blade in predetermined relation to said belt.

6. In apparatus of the class described, the combination of a rotatable drum, a belt travelling around said drum, means for delivering sheet forming liquid to said belt, a doctor blade extending transversely of said belt for limiting the depth of liquid carried rearwardly by said belt, a pair of brackets respectively associated with the opposite ends of said doctor blade and adjustably secured thereto, a roller journalled in each of said brackets for engaging said belt to thereby adjustably support the doctor blade in a selected position relative to the belt, side guides extending forwardly from said brackets for controlling the spread of said liquid, and a liquid-retaining member extending transversely of said belt between said guides and secured thereto so as to be thereby supported in predetermined, fixed relation to said belt.

7. In apparatus of the class described, a rotatable drum, a thin, flexible belt traveling around said drum, means for delivering sheet-forming liquid to the belt on said drum, a doctor blade for limiting the depth of the liquid carried rearwardly by said belt, and means associated with said doctor blade for engaging a portion of said belt overlying said drum to support the blade in predetermined spaced relation to the belt, said means being positioned relative to the doctor blade so as to engage the belt closely adjacent the plane of the operative edge of the doctor blade so as to transmit to the doctor blade, rises and falls in the surface of the belt substantially at the time said operative edge of the belt is in operative relation to any such rise or fall in the belt, thereby to facilitate the formation of a sheet having substantially uniform thickness.

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