Aug. 7, 1951 L. M. COTCHETT 2,562,891

FORMING WEBS

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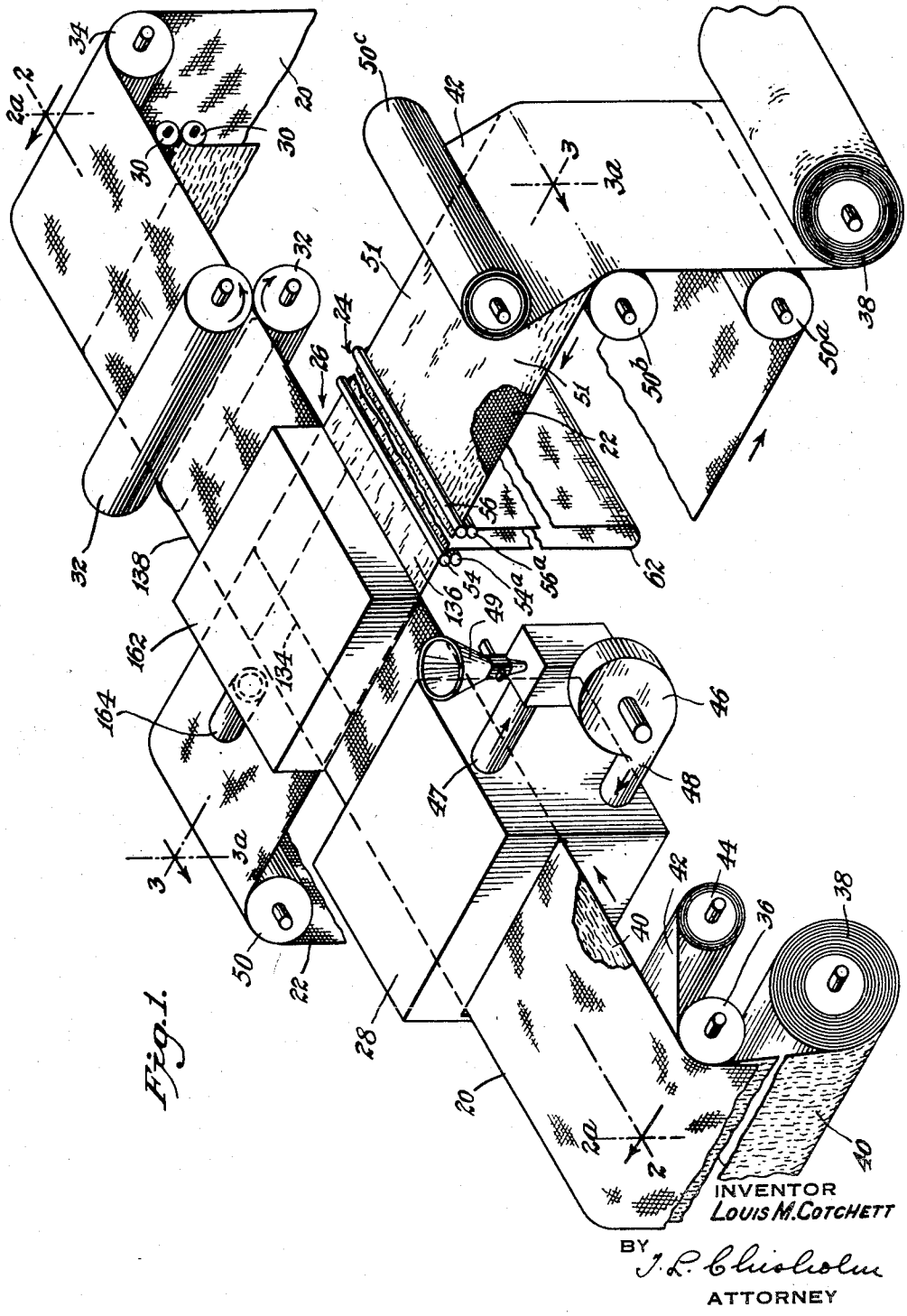


Fig. 1.

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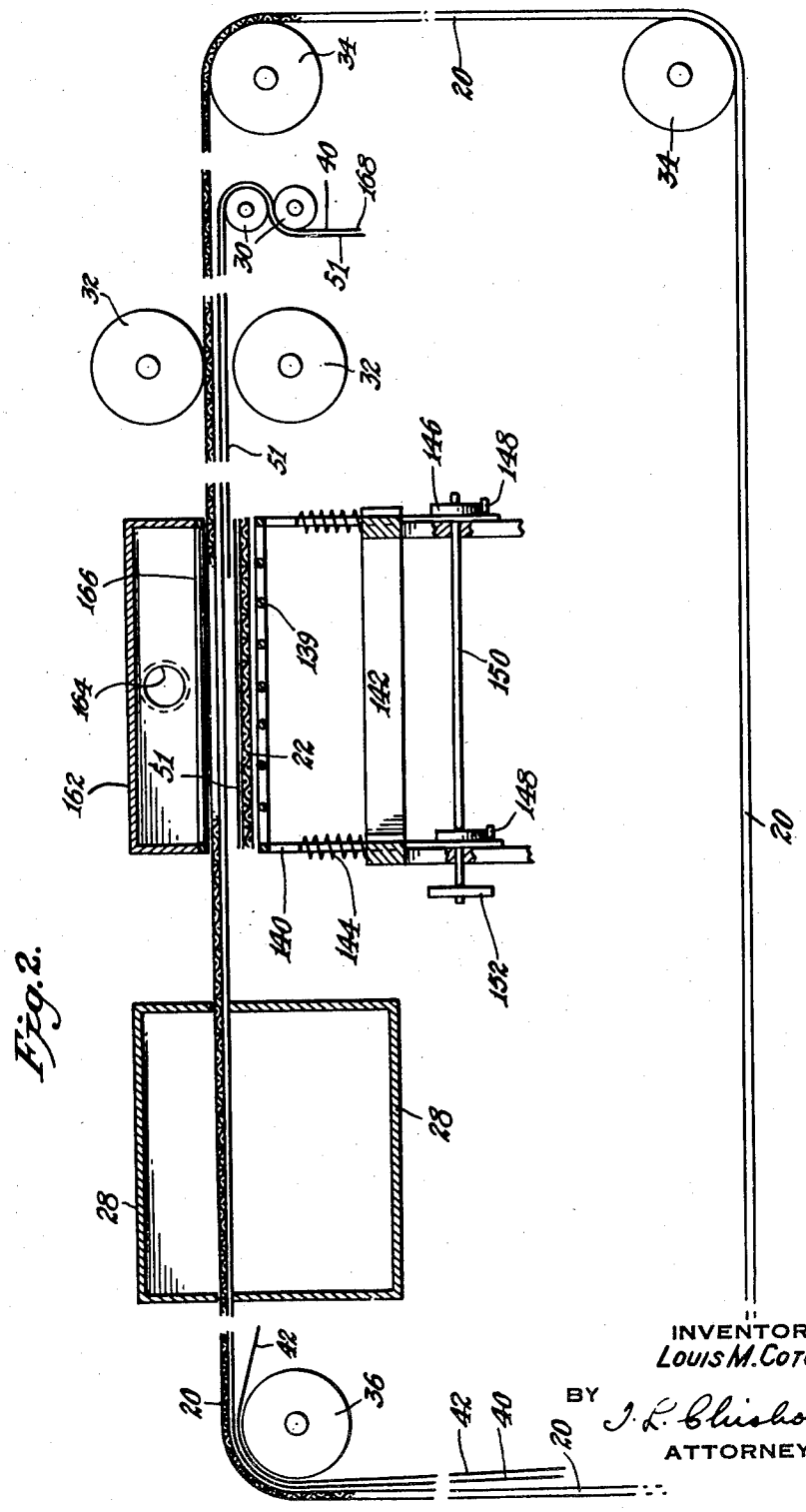


Fig. 2.

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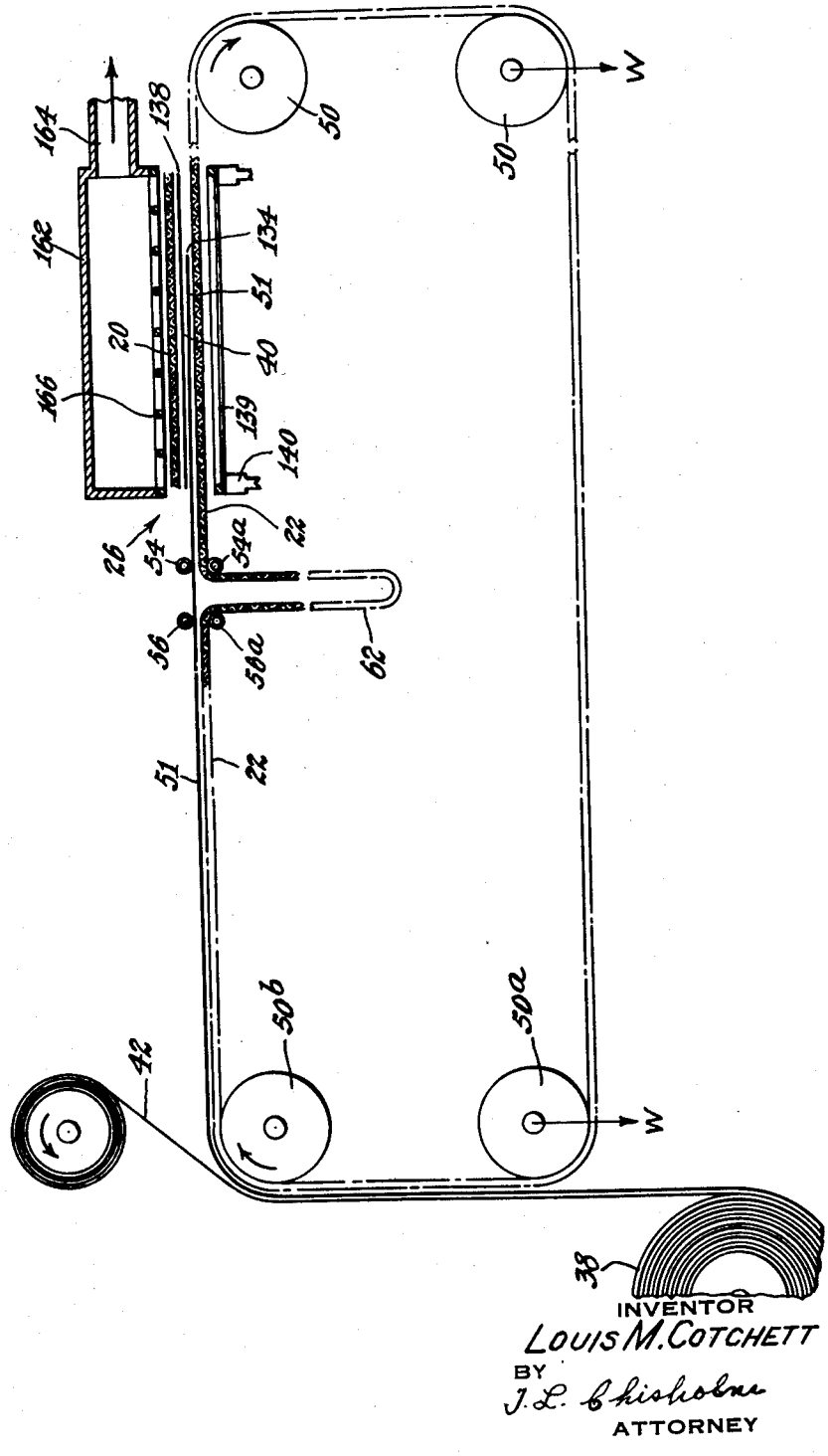


Fig. 3.

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FORMING WEBS

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Fig. 4.

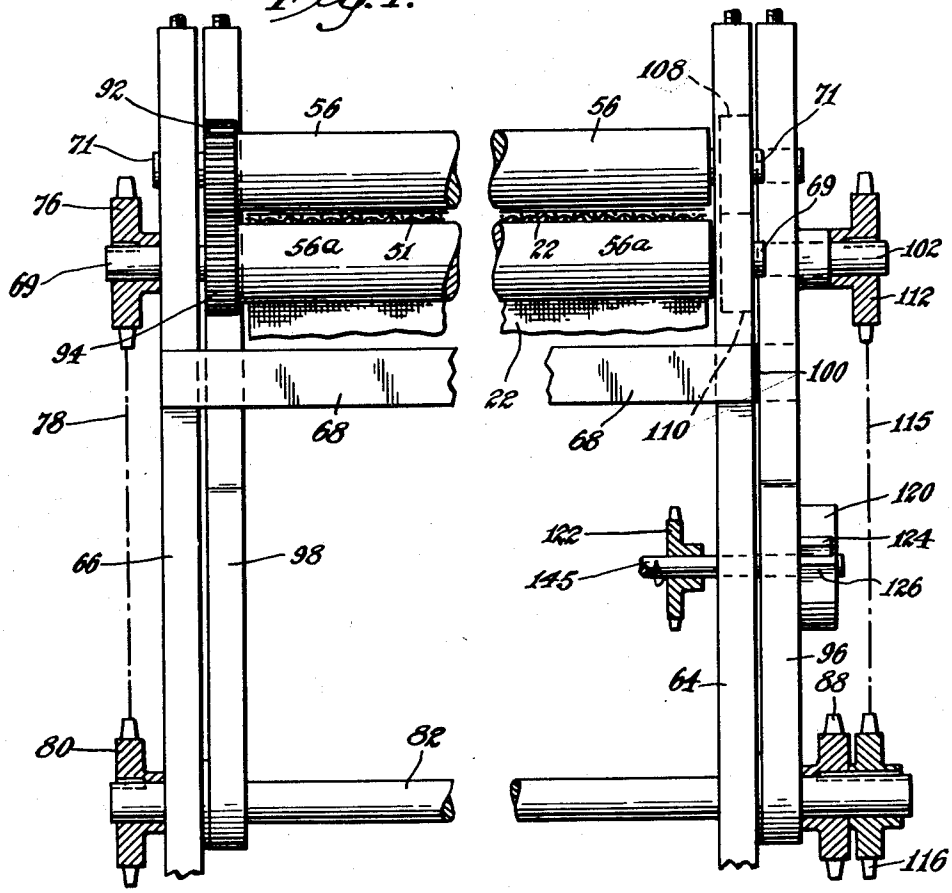
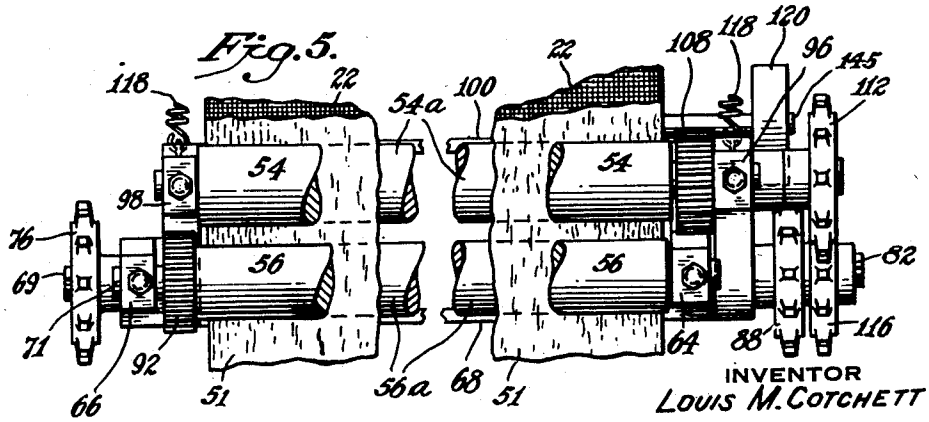


Fig. 5.



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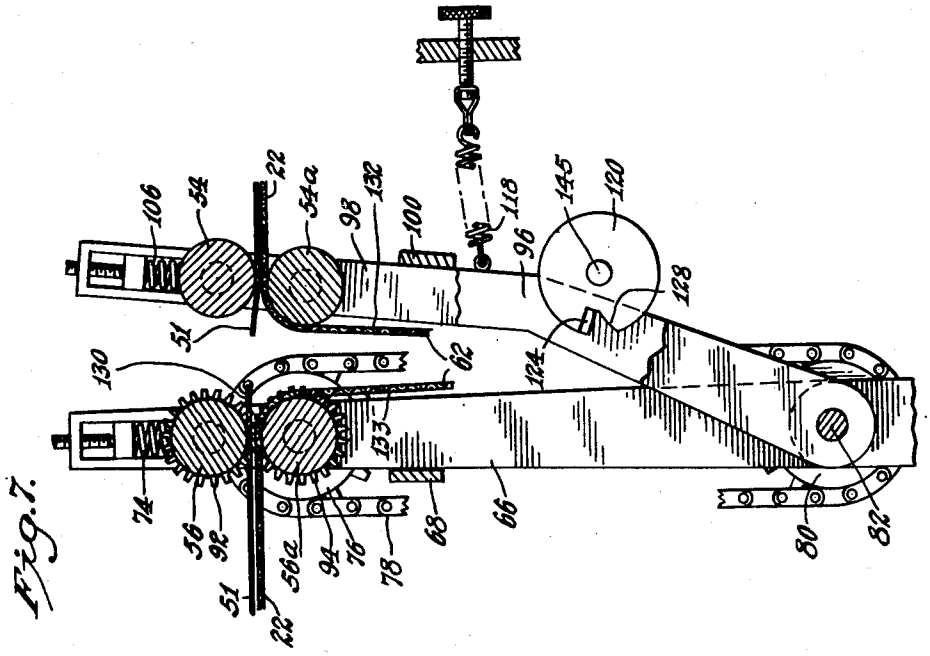


Fig. 7.

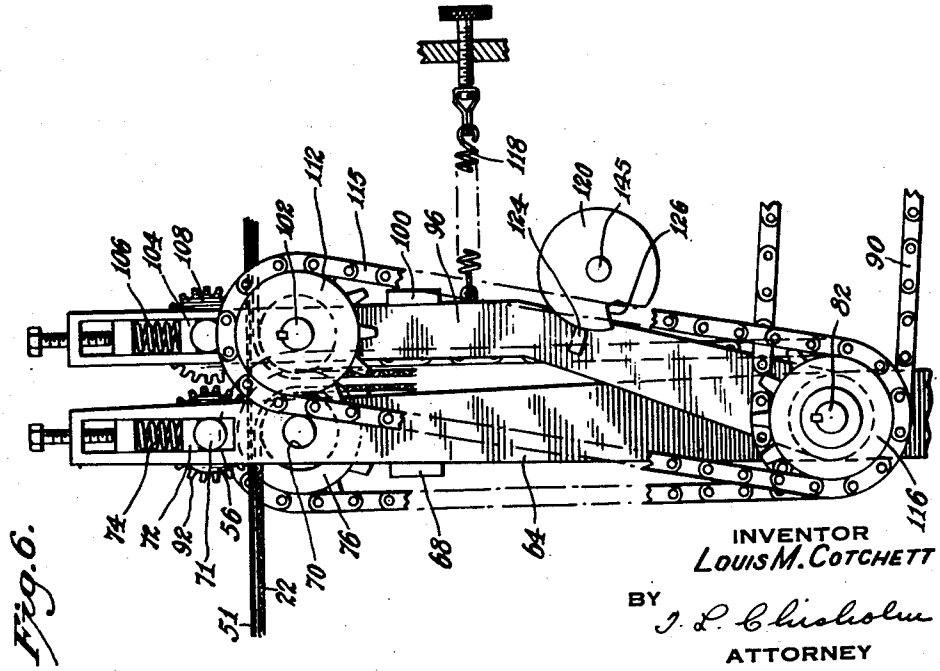


Fig. 6.

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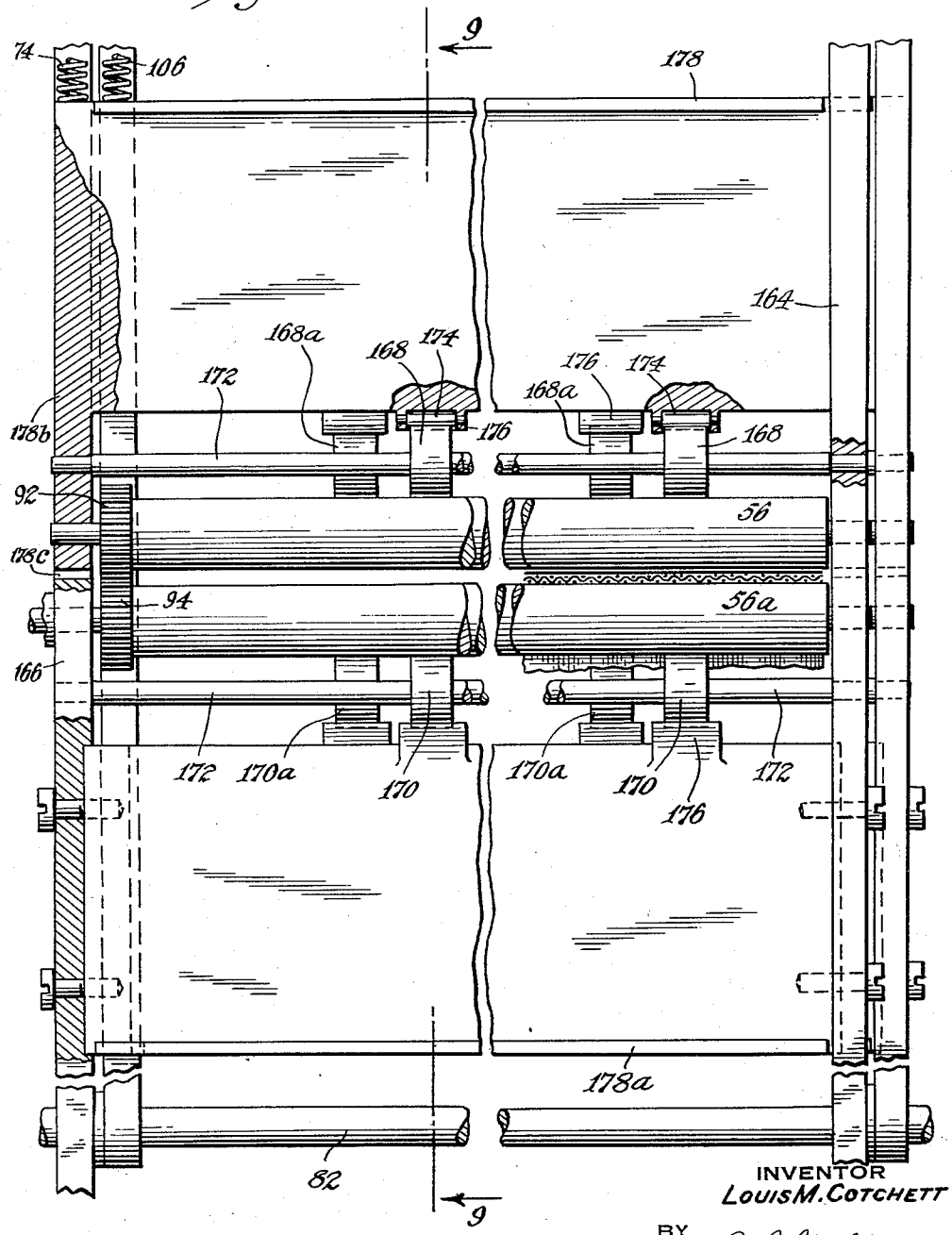
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Fig. 8.



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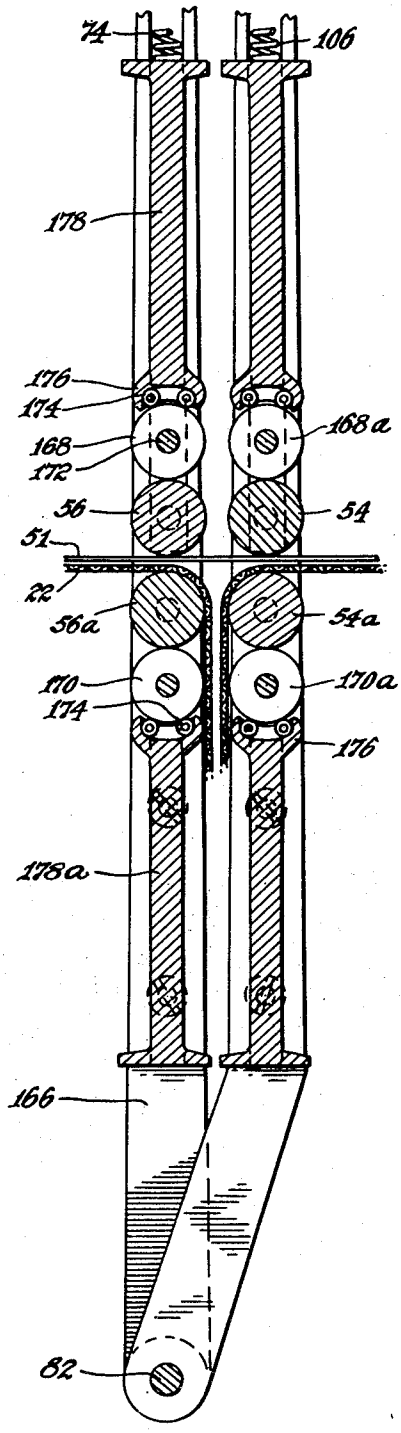
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FORMING WEBS

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Fig. 9.



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Fig. 12.

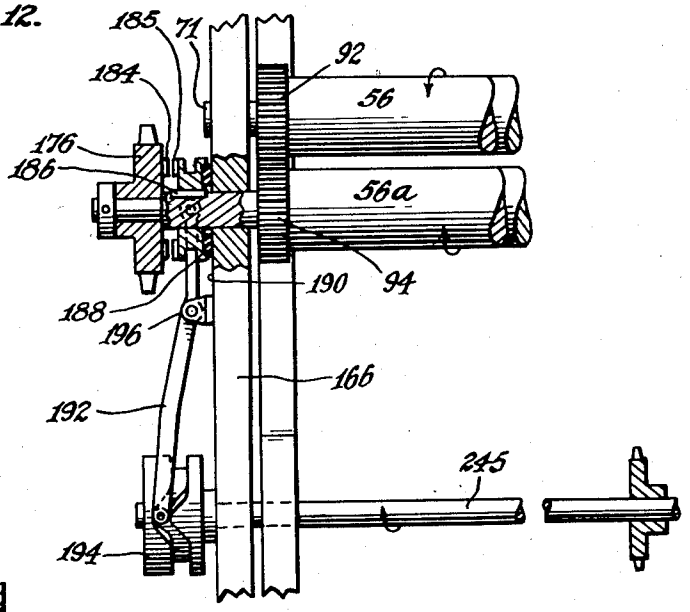


Fig. 11.

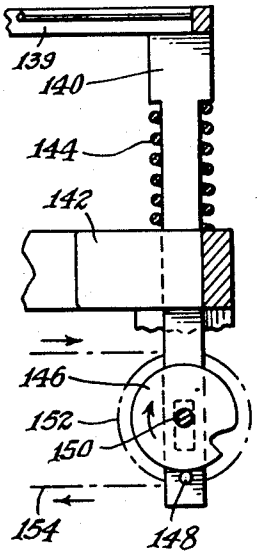
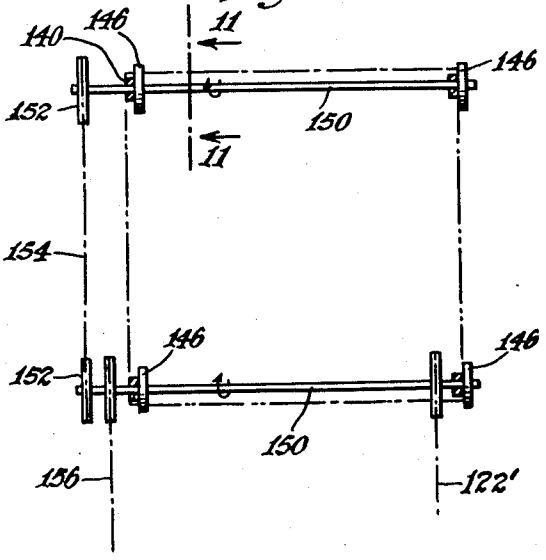


Fig. 10.



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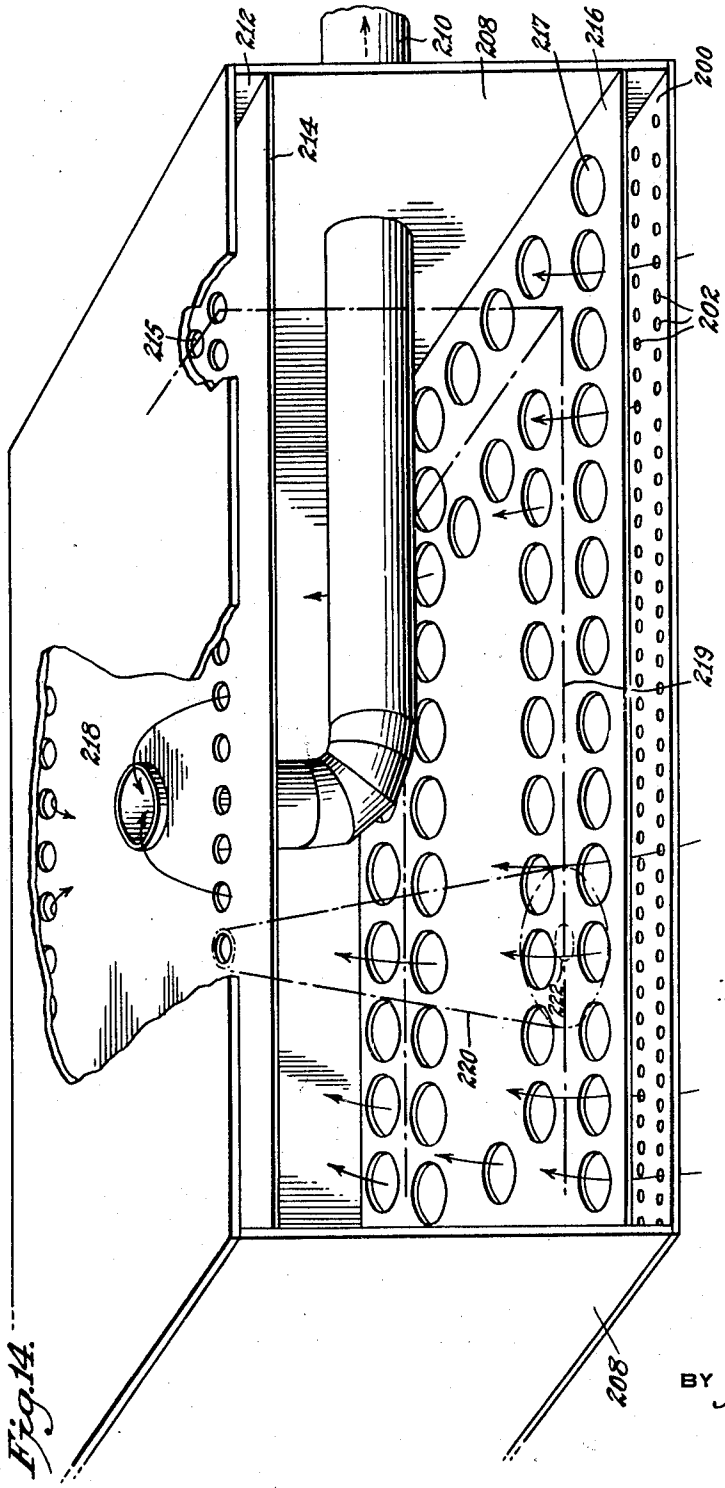


Fig. 14.

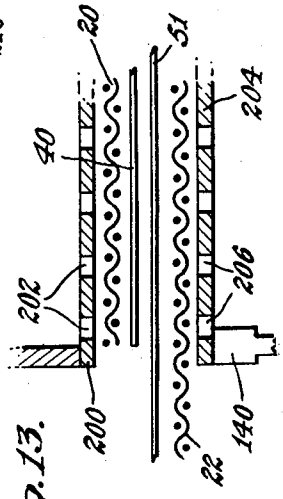


Fig. 13.

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Patented Aug. 7, 1951 2,562,891

UNITED STATES PATENT OFFICE

2,562,891

FORMING WEBS

Louis M. Cotchett, Hingham, Mass., assignor, by mesne assignments, to Chicopee Manufacturing Corporation, a corporation of Massachusetts

Application July 31, 1945, Serial No. 607,937

15 Claims. (Cl. 19—145)

1

This invention relates to fabrics of the nature of cloth which are formed of ordinary textile fibers without weaving, and preferably also without spinning.

In the usual manufacture of cloth, textile fibers are first carded to align them (more or less) and form a thin, fragile web or sheet, then the carded web is bunched into a roving which is drawn and spun into yarn and the yarn is subsequently woven into cloth. Many proposals have been made to produce a fabric which has the character of woven cloth without the expensive steps of spinning and weaving. One proposed method is to bind the fibers of card webs with adhesive as described in the patent to Goldman, No. 758,243. Such fabrics, when properly bonded, have appreciable tensile strength in the direction of alignment of the fibers, but a negligible tensile strength transverse to this alignment. This has suggested giving the bonded webs strength in both directions by cross-laying two webs, that is placing two webs together with the fiber alignment of one perpendicular to the fiber alignment of the other. An example of this cross-laid construction is shown in the Goldman patent, No. 2,039,312. While such cross-laid webs or sheets have been previously known, they have not come into any extensive use because it has been difficult, if not impossible, economically to manufacture satisfactory sheets having requisite transverse tensile strength.

One of the purposes of my invention is to provide an improved method and improved apparatus for efficiently and economically making cross-laid, unwoven bonded webs having the character of cloth. More specifically it is an object of the invention to provide improved means for severing a web into sheets and laying these sheets across a continuous web accurately side by side to form a continuous strip of cross-laid sheets upon the continuous web. Another specific object of the invention is to provide an improved method and an improved apparatus for bonding together the fibers of the superposed webs.

Other objects and advantages of the invention will be apparent from the accompanying description and from the drawings, in which

Fig. 1 is a schematic isometric projection of one form of apparatus embodying the invention,

Fig. 2 is a section on the plane determined by the lines 2—2*a* of Fig. 1 looking in the direction of the arrows,

Fig. 3 is a section on the plane determined by the lines 3—3*a* of Fig. 1 looking in the direction of the arrows,

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Fig. 4 is a side elevation of the structure of one form of means for severing a web into sheets,

Fig. 5 is a plan of the severing means shown in Fig. 4,

Fig. 6 is an end elevation, in one position of its operation, of the apparatus shown in Figs. 4 and 5,

Fig. 7 is an end elevation, partly in section, showing the mechanism of Fig. 6 in another position of its operation,

Fig. 8 is a fragmentary elevation, partly in section, corresponding to Fig. 4 showing a modified form of the feeding and severing means including an improved supporting means,

Fig. 9 is a section of the mechanism shown in Fig. 8, in the position corresponding to Fig. 6,

Fig. 10 is a schematic plan view of mechanism for periodically actuating a transfer device, which is a part of the apparatus shown in Figs. 2 and 3,

Fig. 11 is an elevation showing a detail of the mechanism in Fig. 10,

Fig. 12 is a fragmentary section corresponding to Fig. 4 of a modified form of web severing means,

Fig. 13 is a fragmentary section corresponding to Fig. 3, on an enlarged scale, showing a modified form of web transferring device, and

Fig. 14 is a perspective view, partly broken away, of one form of construction of the suction box diagrammatically illustrated in Fig. 3.

In general my improved process consists in continuously feeding a carded web (corresponding to a warp), and continuously feeding a second carded web (corresponding to a filling) across the warp web, severing the filling web into sheets, the length of which equals the width of the warp web, and then applying these sheets side by side along the warp web as it travels past the filling web. The two webs may be caused to adhere together temporarily by entanglement of the fibers and they are also preferably permanently bound together by any suitable binder or adhesive.

Apparatus for carrying out this process is shown in Fig. 1. This includes a warp conveyor **20**, running throughout the length of the machine, a filling conveyer **22** running across the warp conveyer, a filling severing device **24** for severing the filling web into sheets, a transfer station **26** where the severed filling is applied to the warp, a circulating box **28** for applying adhesive to the warp web, and bonding rolls **30** for bonding the two webs together. The conveyers are pervious screens, such as screen cloth woven from metal wire or plastic filaments. The warp conveyer **20**, which may be endless, passes suc-

cessively through the adhesive applying mechanism 28, the transfer station 26 and adjacent and above the bonding rolls 30. It is preferably positively driven by feed or driving rolls 32 and passes over suitable guide rolls 34 and 36 at each end of the machine. Webs are supplied to the conveyers in any suitable manner, either directly from cards or as illustrated herein, from rolls. The reference character 38 designates supply rolls of card web wound outside of a long sheet of smooth paper 42, in order to allow the card web to unroll easily. One supply roll 38 is placed near the guide roll 36 at the starting end of the machine. The card web forming the warp 40 and its associated paper 42 pass over this guide roll and under the screen 20, the screen picking up the web by adherence of the fibers to the screen, and the paper being peeled off the web and rolled on a take-up roll 44. The web adheres to the under side of the screen until it reaches the bonding rolls 30, as will be described.

The adhesive applying device is an air circulating box 28, divided into two chambers by the conveyor and web, having a blower 46, an air duct 47 leading from the space above the web, a discharge conduit 48 leading to the space below the web and a metering hopper 49 for feeding into the air steam controlled quantities of latent adhesive dust, such as powdered thermoplastic material. The web extends fully across the box 28, and acts as a filter to catch part or all of the adhesive in the circulating air stream, to distribute adhesive more or less uniformly over the lower surface of the web, to which it clings for subsequent bonding of the warp to the filling web.

The filling conveyer screen 22 passes over guide rollers 50, 50*a*, and 50*b*, through the severing device 24 and through the transfer station 26 close to and under the warp web on the warp screen. A filling web 51, identical with the warp web 40 is delivered to the upper side of the filling conveyer from the second supply roll 38. The filling web is in contact with the conveyer throughout the vertical flight between the guide rolls 50*a* and 50*b*, being held against the conveyer by the tension in the paper 42 passing over the guide roll 50*b* to the second take-up roll 50C. This roll is offset from the vertical flight to exert pressure over the guide roll 50*b*. The filling web adheres to the upper side of the filling conveyer, the paper is peeled off and the filling web travels on top of the conveyer through the severing device 24 and to the transfer station 26.

The web severing mechanism

The web severing mechanism is indicated diagrammatically in Figs. 1 and 3 and shown structurally in Figs. 4–7. It consists essentially of two pairs of feed rolls 54, 54*a* and 56, 56*a*, all of which are continuously driven at the same speed. The rolls 54, 54*a* are urged toward each other and the rolls 56, 56*a* are urged toward each other, and constitute pairs of driving rolls for moving both the conveyer screen 22 and the filling web 51. The conveyer screen falls in a bight 62, but the filling web passes directly across the space between the two pairs of rolls (see Figs. 5 to 7). At periodic intervals the pair 54, 54*a* are moved suddenly away from the pair 56, 56*a* and in the direction of travel of the conveyer and this tears the web along a line parallel to the axes of the rolls, as shown in Fig. 7, thus severing a sheet from the web. The bight of the screen permits this movement of the rollers while they are being continuously driven.

As seen in Figs. 4 to 7, the rolls 56 and 56*a* are mounted in a stationary rigid frame having uprights 64 and 66 held together by a cross member 68. The roll 56*a* has shafts 69 at each end (Fig. 4) mounted in stationary shaft bearings 70 (Fig. 6), while the roll 56 has its shafts 71 mounted in floating bearings 72, urged downward by adjustable springs 74 to urge the two rollers toward each other. Limit stops may be provided if desired to hold the rolls a minimum distance apart. This arrangement insures an adequate grip on the screen conveyer and the web. The roll 56*a* is driven by a sprocket wheel 76 (at the left of Fig. 4) rotated by the chain 78, driven by a sprocket wheel 80 on a shaft 82, mounted in the lower end of the uprights 64 and 66. The shaft 82 is driven by a main drive sprocket 88 driven by chain 90 (Fig. 6) suitably connected to the main drive of the machine so that the peripheral speed of the roll 56*a* is substantially equal to the linear speed of the warp web conveyer 20. Gears 92 and 94 keyed to the left ends of rolls 56 and 56*a* respectively (Fig. 7) drive the upper roll 56 at the same speed as the lower roll 56*a*.

The rolls 54 and 54*a* are mounted in a pivoted frame having a pair of uprights 96 and 98 and a cross member 100 (Fig. 7). This frame is pivotally mounted on the shaft 82. The rolls 54 and 54*a* are mounted in the frame in a manner similar to the mounting of rolls 56 and 56*a* in the uprights 64 and 66. The lower roll 54*a* is mounted in fixed pivot bearings 102, the upper roll is mounted on floating bearings 104 urged downward by springs 106, and the two rolls are connected by gears 108 and 110 (Fig. 4). The gears 92, 94, 108, and 110 are necessarily of greater diameter than the rolls. Therefore, in order to avoid interference and allow the pair of rolls 54, 54*a* to be placed as close as possible to the rolls 56, 56*a*, the gears 92 and 94 are mounted at the opposite end of the assembly from the gears 108 and 110. The roll 54 is driven by a sprocket wheel 112, a chain 115, and a sprocket wheel 116 keyed to the shaft 82 and thus rotating at the same speed as the sprocket wheel 80 which drives the pair of rolls 56 and 56*a*.

In order to tear or sever the web, the rolls 54, 54*a* are periodically pulled away from the rolls 56, 56*a* by rotating the frame slightly on its pivot. This may be accomplished by an adjustable spring 118 and a cam 120. The cam is mounted in any suitable stationary support and is rotated by a sprocket wheel 122 (Fig. 4) connected by any suitable means, not shown, to the main drive of the machine so that the cam rotates once during the period that the filling web travels a distance equal to the width of the warp web. As shown in Figs. 6 and 7, the cam normally holds a cam follower 124 on the frame 96 against the action of the spring 118, maintaining the frame in the position shown in Fig. 6. When the notch 126 permits the cam follower to move toward the center of the cam, the frame 96 moves to the position shown in Fig. 7. This action is sudden and movement of the frame tears the web 51 along a line between the two lines of contact of the rolls. The arrangement of the sprocket wheels 112, 116 and chain 114 permits this movement without affecting the rotation of the rolls 54, 54*a*. Since the diameter of the rolls is small, they can be placed very close together as shown in Fig. 6. The line of contact between rolls 54 and 54*a* is therefore very close to the line of contact between rolls 56 and 56*a* and this results in

tearing the web along a substantially straight line between these two lines of contact.

The web is torn instantly and the rolls **54**, **54***a* are quickly restored to their original position by the rise **128** of the cam. Since the rolls **56** and **56***a* continue to feed the web with the conveyer, the torn end **130** is immediately fed into the nip of the rolls **54** and **54***a* to be carried by the conveyer into the transfer station **26**. Any tendency of the end **130** to cling to the conveyer is prevented by the rising flight **132** of the conveyer in the bight **62**, which brushes against the falling flight **133** between the rolls **54***a* and **56***a*, when the parts are in the position of Fig. 6, brushing off the web and assuring that the end **130** will be fed into the rolls **54**, **54***a*.

The transfer mechanism

An instant after the filling web **51** has been severed, as described above, the front edge **134** of the severed sheet **136** reaches the far edge **138** of the warp web **40** (see Fig. 3). At this instant the severed sheet is applied or transferred to the lower surface of the warp web. This is accomplished by the transfer platform **139** and its operating mechanism. As shown in Figs. 2 and 3 the platform is disposed below the conveyers **20** and **22** and occupies the entire area of crossing of the two conveyers. As a matter of fact the platform may be in contact with the filling conveyer and may support it, although it is shown spaced from it in the diagrams, for clarity in illustration. The platform is pervious to the passage of air, and may consist of a series of parallel bars running in the direction of travel of the filling conveyer. The platform is mounted on four guide rods **140**, mounted in stationary support **142** and urged upward by springs **144**. As shown best in Figs. 10 and 11, the guide rods are held down against the action of the springs by cams **146** on which ride the cam followers **148** on the rods **140**. The cams are mounted in pairs on shafts **150**. The two shafts are driven synchronously by sprocket wheels **152**, chain **154** and the drive chain **156**, the latter being connected to the main drive of the machine in any suitable manner not shown, to provide one continuous rotation of the cams during each interval in which the web travels the distance equal to its width. When the leading edge **134** of the sheet **136** severed from the filling web reaches the edge **138** of the warp web, as shown in Fig. 3, the notches **160** on the cams permit the cam followers **148** to rise, allowing the springs **144** to thrust the transfer platform **158** upward to a position where the sheet is instantly picked up by the warp web. In this manner successive sheets are advanced under the warp web, raised to be picked up by the web, moved out of the transfer zone **26** so that the warp web by the time it reaches the rolls **30** is provided on its under face with a continuous series of filling sheets.

Preferably the warp web and the filling web are of the same width and each travels at substantially the same speed. However, it is necessary either for the filling web to travel at a very slightly greater speed than the warp web, or for the filling web to be very slightly wider than the warp web, in order to compensate for the very slight interval of time required to raise the transfer platform **139**. The whole mechanism is so timed that the filling sheets are placed accurately side by side on the warp web and thus provide a continuous series of filling sheets, preferably without appreciable gaps or overlaps.

The transfer from the platform **139** to the warp web is instantaneous. With the proper consistency of carded webs, the transfer may be effected by simple contact, since the fibers of one web will catch or entangle the fibers of the other web instantly upon contact, and the warp web will carry the filling web off from the conveyer screen **22**. However, in some instances it may be advisable to positively transfer the filling sheet to the warp web, as by means of air currents. Where this is necessary, I place a suction box **162** (diagrammatically illustrated in Fig. 2) above the transfer zone and continuously draw air through the suction box by any suitable apparatus represented by the suction conduit **164**. A pervious support or grid **166** covers the bottom of the suction box and holds the filling conveyer and warp web against the current of air entering the box. The conveyer screens and the webs are of course pervious to the passage of air, and the reduction of pressure above the warp web by the suction box also reduces the pressure throughout a shallow space below the warp web and causes a current of air to flow through the web. This shallow space of reduced pressure does not extend as far as the normal position of the transfer platform **139** when the platform is held down by the cams **146**. However, when the platform is raised, it comes into the space of reduced pressure and the current of air flowing through this space positively and instantly transfers the sheet to the under side of the warp web. If both webs are sufficiently pervious, a sufficient current of air will be sucked through both of them to entangle the fibers of both webs. This tangling holds them together even after they have moved out of the air currents. Such entanglement of the fibers is assisted by directing a number of jets or small currents of air through the webs. This can be accomplished by the modified form of transfer platform and suction box grid shown in Fig. 13.

In this arrangement, the grid covering the suction box is a sheet or plate **200** having any suitable number of suitably distributed small holes **202** (for example, one-half inch in diameter). The transfer platform is a similar plate **204** having its holes **206** register with the holes **202**. At the instant of transfer, the two webs are held between two closely spaced plates and jets or currents of air flow from holes **206** through the webs and holes **204**, both positively transferring the filling web to the warp web and entangling the fibers of both webs in the areas opposite the holes.

The feed rolls **32** also press the webs together insuring a firm mechanical attachment and providing a unitary web that can be handled for further processing. For example, webs made without adhesive can be bonded by the well known parchmentizing processes. However, I prefer to form the webs with deposited thermoplastic adhesive and bind the webs by the hot bonding rolls **30**. These bonding rolls activate the adhesive and press the two webs together to establish a firm and permanent bond. The finished cross-lay web leaves the machine at **168** (Fig. 2).

One of the features of the invention is making the feed and pressure rolls **54** and **56** of small diameter, in order that their nips or lines of contact may be so close together that the filling web tears along a substantially straight line between them. This requires slender rolls, which are necessarily flexible if long enough to be used in machines handling wide webs. For example, it is desirable to have the rolls of a diameter of less

than an inch, while they may have to be thirty-six inches or more in length. It is desirable that the rolls exert substantially uniform pressure across the width of the web and conveyer, otherwise bunching of the conveyer and web is apt to occur, and the rolls cannot exert this uniform pressure if they bend.

Figs. 8 and 9 show one arrangement for mounting and supporting the rolls 54, 54a, 56, and 56a to exert even pressure along their length. Rolls 56 and 56a are mounted in side frames 164 and 166 corresponding to the side members 64 and 66 in Fig. 4. Any suitable number of backing rolls 168 are spaced along the upper side of the roll 56 and similar backing rolls 170 are spaced along the lower side of the roll 56a. Each of the backing rolls is supported for rotation on a light carrying shaft 172, mounted in the side pieces 164 and 166. Each of the backing rolls bears against roller bearings 174 suitably mounted in a bearing housing 176 formed in a beam 178 or 178a. The beam is of deep section, as indicated in Fig. 9, so that it cannot bend appreciably within the limits of force occurring within this machine. The beam, roller bearings 174, and backing rolls 168 or 170, prevent bending of slender rolls 56 and 56a and cause them to exert sufficiently uniform force or pressure across the width of the web and conveyer to feed the web and conveyer smoothly and uniformly through the machine. Preferably the lower beam 178a is rigidly mounted in the side frames 164 and 166, while the upper beam 178 carries an elongated extension 178b, sliding in a slot 178c of each side frame. The extensions 178b carry the bearings for the upper carrier shaft 172 and the roll 56. The beam and its bearings may slide against the force of the springs 74 to provide the floating bearings for the roll 56.

The rolls 54 and 54a are similarly supported and backed by similar backing rolls and beams in side frame corresponding to side frames 164 and 166, (Fig. 9). The backing rolls 168a and 170a, which support the rolls 54 and 54a, are offset with respect to the backing rolls 168 and 170, as shown in Fig. 8, to permit the rolls 54, 54a closely to approach the rolls 56, 56a without interference.

In the apparatus shown in Figs. 4 to 7, severing is accomplished by moving the forward set of rolls away from the rear set of rolls while continuously rotating all rolls at the same speed. The same result may be accomplished by momentarily stopping or slowing the rear set of rolls while maintaining the drive of the forward set of rolls. Fig. 12 is a fragmentary section corresponding to the elevation in Fig. 4 showing one form of arrangement for slowing or stopping the rear rolls of the severing device. In this arrangement the shaft 245 corresponds to the shaft 145 in Fig. 4, and rotates once during each period that the filling web travels a distance equal to the width of the warp web. The sprocket wheel 176 corresponds to the sprocket wheel 76 in Fig. 4, and drives the rolls 56, 56a, the sprocket 176 being driven by a sprocket wheel identical with the sprocket wheel 88 of Fig. 4.

The sprocket wheel 176 can turn on the shaft of the roll 56a and carries on one face one-half 184 of a radial tooth clutch. The other half 185 of the clutch is splined on the shaft by a key or spline 186. The opposite face of the clutch-half 185 may carry a friction member 188 for cooperating with a brake surface 190 mounted on frame 166. The clutch is operated by a fork 192 disposed in a groove in the splined half of the clutch. The fork is suitably pivoted at 196 and the opposite end is operated by the cam 194 on the shaft 245 in synchronism with the travel of the filling web, to sever the filling web into sheets. During normal operation, that is when the web is not being severed, the clutch 184—185 is engaged and the sprocket wheel 176 rotates the rolls 56 and 56a. When it is desired to sever the web, the fork is shifted toward the position shown in Fig. 12, disengaging the clutch and allowing the rolls 56, 56a to slow or stop. If it is found that the action of severing the web is not sufficiently rapid upon disengagement of the clutch, the rolls may be stopped positively for an instant by moving the operating end of the yoke further to the left to the position shown in Fig. 12 to engage the brake surfaces 188, 190. The slowing or stopping of the rolls 56, 56a is accomplished immediately and the differential speed of the rolls 56, 56a, and 54, 54a is maintained only for an instant. Immediately upon severing the web, the clutch 184—185 is engaged again and the severed end of the web is again fed into the rolls 54, 54a.

When using this modified form of apparatus, the bight 62 of the filling web is gradually used up because the rising flight 132 is continuously fed through the rolls 54, 54a, while the falling flight 134 is periodically and momentarily interrupted. In order to provide for this, the guide rolls 50a in Fig. 3 are movable in suitable guides, not shown, under the action of weights W to keep the conveyer 22 taut.

Preferably the suction box 162 is constructed to draw air currents of equal velocity through the various portions of the webs. One form of such construction is shown in Fig. 14. The perforate plate 200 may cover the mouth of the suction box, or the form of grid shown in Fig. 3 may be used. The suction box proper 208 forms a conduit for the flow of air induced by any suitable device (not shown) connected to the suction pipe 210. The suction pipe withdraws air from an upper chamber 212 formed by a perforated baffle plate 214, having holes 215 arranged as shown. A lower baffle plate 216, having openings 217, is placed above the screen 202.

The holes 215 in the upper plate are arranged so that air is drawn through them at substantially the same velocity. Theoretically the holes should be placed in a circle centered at the center of the outlet opening 218 into the pipe 210. However, it has been found in practice, with a square suction box, that a sufficiently accurate result is obtained when the openings are placed in a square whose sides are midway between the center of the opening 218 and the sides of the box. With a thirty-six inch square suction box the holes 215 may be of the order of one inch in diameter.

The holes 217 in the lower baffle plate are larger than the holes 215, for example, about five inches in diameter, and are preferably arranged in two rows which rows are spaced equidistant from the square 219 which is the vertical projection of the square determined by the centers of the holes 215.

Air entering the holes 215 at substantially the same velocity travels to these holes from the baffle plate 216 in cones 220 whose bases are on the plate 216. If these cones are sufficiently high, that is, if the baffle plates 214 and 216 are far enough apart, air will travel at substantially the same velocity at all parts of the cross section of each cone. Equal length of paths, and resulting equal velocity of travel, can be approximated with

lower cones (resulting in a thinner suction box) by admitting air to the bases of the cones, principally at their edges, and this is effected or approximated by the arrangement of the holes 216 in relation to the holes 215. Since the vertical projection 222 of the holes 215 lies midway between the two rows of holes 217, air enters the cones 220 around the edges of their bases, because the holes 217 are at the edges of the bases and the centers are blocked by the solid portions of the plate 216. Therefore the paths of the air in the cones are approximately equal and air flows through all the holes 217 at approximately the same velocity through the numerous holes 202 in the screen 200.

Alternatively both conveyers instead of being endless and returning to the starting point of the webs may be made part of the rolls 38, which in this case will consist of screen, web, and paper stacked in that order, and rolled up with the paper inside so that the screen will constitute the outermost layer of the roll. The roll can then be placed as shown at the left of Fig. 1, so that the screen is on top and the warp web beneath it, or the identical roll can be placed as shown at the right of Fig. 1, so that the screen is on the bottom and the filling web on top, the paper 42 in each case being peeled off and rolled on the take-up roller 44. If this alternative form of supply roll is used with the alternative form of construction shown in Fig. 12 a sufficiently long lead of conveyer screen is fed through the rolls 56 and 56a to form a bight 62 which will last throughout the operation on the length of screen and web on the filling web roll 38.

The above described apparatus can be used to laminate and bond together cross-laid webs rapidly and economically, speeds of one hundred yards a minute being feasible. The bonded webs have equal strength in both length-wise and cross-wise direction, thus providing a fabric which can be made from cotton, wool, or other suitable fibers and used as a substitute for cloth. In fact, it may be given the appearance of various weaves and textures of cloth by suitable embossing.

The invention can also be used to provide a bonded web having substantially the appearance of woven cloth and being susceptible to patterns and coloring by using a conventional warp beam of spun yarns to provide the warp web 40 and by using a regular carded web for the filling sheets as described. The filling sheets give the warp adequate cross-wise strength and the spun yarns in the warp impart an appearance simulating that of woven cloth. The adhesive is applied to the under side of the warp threads by the dusting box and upon activation by the bonding rolls, forms a bond between the under side of the warp threads and the filling web. Where the spun yarn warp is used, the conveyer 20 is not necessary.

With either the carded warp web or with the warp of spun yarns, the adhesive may vary in character and amount depending on the properties desired in the finished web. For example, thermoplastic resins can be used in varying quantities or concentrations, to be activated and pressed by the rollers 30 to form bonds of varying degrees of stiffness. Also thermo-setting resins can be used and the size and number of the rolls 30 adapted to the required setting time. Likewise the thickness of the webs or amount of fibers in the webs can be varied, either independently of the adhesive, or with variation of the adhesive to provide widely varying properties in the finished web. Thus the webs may vary from thin, filmy sheets with a small amount of adhesive and having the drape and hand of thin cloth, to stiff or even rigid sheets with large amounts of adhesive in which the adhesive or resin may be the principal structural element, reinforced by the fibers. Such sheets may be given an initial set by the bonding rolls 30 and the sheets may thereafter be shaped or molded to form desired articles.

I claim as my invention:

1. Apparatus for forming webs comprising in combination means for moving a web horizontally and in the direction of its length, a conveyer below the web for moving a second web horizontally in the direction of its length and across the first web, the conveyer being disposed below the second web, means for severing the second web into sheets, and means for periodically raising the conveyer to transfer the sheets to the first web.

2. Apparatus for forming webs comprising in combination means for moving a pervious web horizontally and in the direction of its length, means for reducing air pressure above the web to provide a space of reduced air pressure below the web, a pervious conveyer below the web for moving a second web horizontally in the direction of its length and across the first web, the conveyer being disposed below the second web, means for severing the second web into sheets, and means for periodically raising the conveyer into the space of reduced air pressure to transfer the sheets to the first web.

3. Apparatus for forming webs comprising in combination means for moving a pervious web horizontally and in the direction of its length, means for reducing air pressure above the web to provide a space of reduced air pressure below the web, pervious means for supporting the web against air current due to such reduced pressure, a conveyer below the web for moving a second web horizontally in the direction of its length and across the first web, the conveyer being disposed below the second web, means for severing the second web into sheets, and means for periodically raising the conveyer into the space of reduced air pressure to transfer the sheets to the first web.

4. Apparatus for forming webs comprising in combination a pervious conveyer for moving a pervious web horizontally and in the direction of its length, the web being disposed beneath the conveyer, means for reducing air pressure above the conveyer to provide a space of reduced air pressure below the web, a second pervious conveyer below the web for moving a second web horizontally in the direction of its length and across the first web, the second conveyer being disposed below the second web, means for severing the second web into sheets, and means for periodically raising the second conveyer into the space of reduced air pressure to transfer the sheets to the first web.

5. Apparatus for forming webs comprising in combination means for moving a pervious web in the direction of its length, means for reducing air pressure on one side of the web to provide a space of reduced air pressure on the other side of the web and a current of air through the web, and means for holding a second pervious web, spaced from and parallel to the other side of the first web and for moving it while so held into the space of reduced pressure to apply the second web to the first web by the current of air.

6. Apparatus for forming webs comprising in combination means for moving a pervious web in the direction of its length, means for reducing air pressure on one side of the web to provide a space of reduced air pressure on the other side of the web and a current of air through the web, and second means for successively holding pervious webs, spaced from and parallel to the other side of the first web and for successively moving them while so held into the space of reduced pressure to apply the second pervious webs successively to the first web by the current, the operation of the holding means being timed in relation to the width of the second webs and in relation to the first web-moving means to produce a substantially continuous strip of second webs on the first web.

7. The method of joining a plurality of webs of fibrous material which consists in reducing the air pressure on one face of a pervious fibrous web to produce a space of reduced pressure on the opposite face of the web and a current of air through the web, and supporting a second pervious fibrous web parallel to, spaced from and adjacent the first web and moving it while so supported into such space of reduced pressure to apply the second web to the first by the current and entangle the fibers of both webs to secure the webs together.

8. Apparatus for forming webs comprising in combination a pervious support, a pervious fibrous web on the support, means for drawing air through the web and support to reduce the air pressure in a space adjacent the web, and means for holding a second pervious fibrous web parallel, spaced from and adjacent the first web and moving it while so held into said space to superpose the webs and entangle the fibers of the two webs to secure the webs together.

9. Apparatus for forming webs comprising in combination means for forming a pair of webs each having its fibers predominantly aligned in the direction of its length, means for superposing the webs with the fibers of one predominantly perpendicular to the fibers of the other, means for reducing air pressure on one side of the webs, and means for directing in currents of substantially uniform velocity, air flowing through the webs under the influence of the reduction of pressure.

10. Apparatus for forming webs comprising in combination means for forming a pair of webs each having its fibers predominantly aligned in the direction of its length, means for superposing the webs with the fibers of one predominantly perpendicular to the fibers of the other, means for reducing air pressure on one side of the webs, and means on one side of the webs for directing in currents of substantially uniform velocity, air flowing through the webs under the influence of the reduction of pressure.

11. Apparatus for forming webs comprising in combination means for forming a pair of webs each having its fibers predominantly aligned in the direction of its length, means for superposing the webs with the fibers of one predominantly perpendicular to the fibers of the other, means for reducing air pressure on one side of the webs, and means on both sides of the webs for directing in currents of substantially uniform velocity, air flowing through the webs under the influence of the reduction of pressure.

12. Apparatus for forming webs comprising in combination means for forming a pair of webs each having its fibers predominantly aligned in the direction of its length, means for superposing the webs with the fibers of one predominantly perpendicular to the fibers of the other, means for reducing air pressure on one side of the webs, and perforated means for directing in currents of substantially uniform velocity, air flowing through the webs under the influence of the reduction of pressure.

13. Apparatus for forming webs comprising in combination means for moving a pervious web horizontally and in the direction of its length, means for reducing air pressure above the web to provide a space of reduced air pressure below the web, a pervious conveyor below the web for moving a second web horizontally in the direction of its length and across the first web, the conveyer being disposed below the second web, means for severing the second web into sheets, and means for periodically raising the conveyer into the space of reduced air pressure to transfer the sheets to the first web, said last mentioned means being adapted to direct in currents of substantially uniform velocity, air flowing through the webs as the result of the reduction of pressure.

14. Apparatus for forming webs comprising in combination means for forming a pair of webs each having its fibers predominantly aligned in the direction of its length, means for superposing the webs with the fibers of one predominantly perpendicular to the fibers of the other, and means for directing a plurality of jets of air through the superposed webs to entangle the fibers and secure the webs together at isolated areas distributed throughout the webs.

15. Apparatus for forming webs comprising in combination means for superposing a plurality of pervious fibrous webs, a perforated member adjacent one side of the webs, a correspondingly perforated member disposed adjacent the other side of the webs, the perforations of the two members being in register, and means for flowing air from one member to the other through said perforations.

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