May 15, 1962 C. J. GREINER ET AL 3,034,180

MANUFACTURE OF CELLULOSIC PRODUCTS

Filed Sept. 4, 1959 3 Sheets-Sheet 1

Fig. 9.

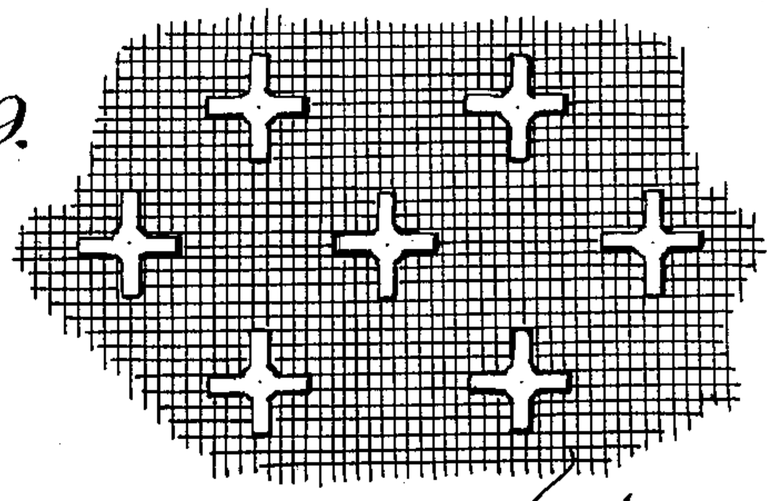


Fig. 1.

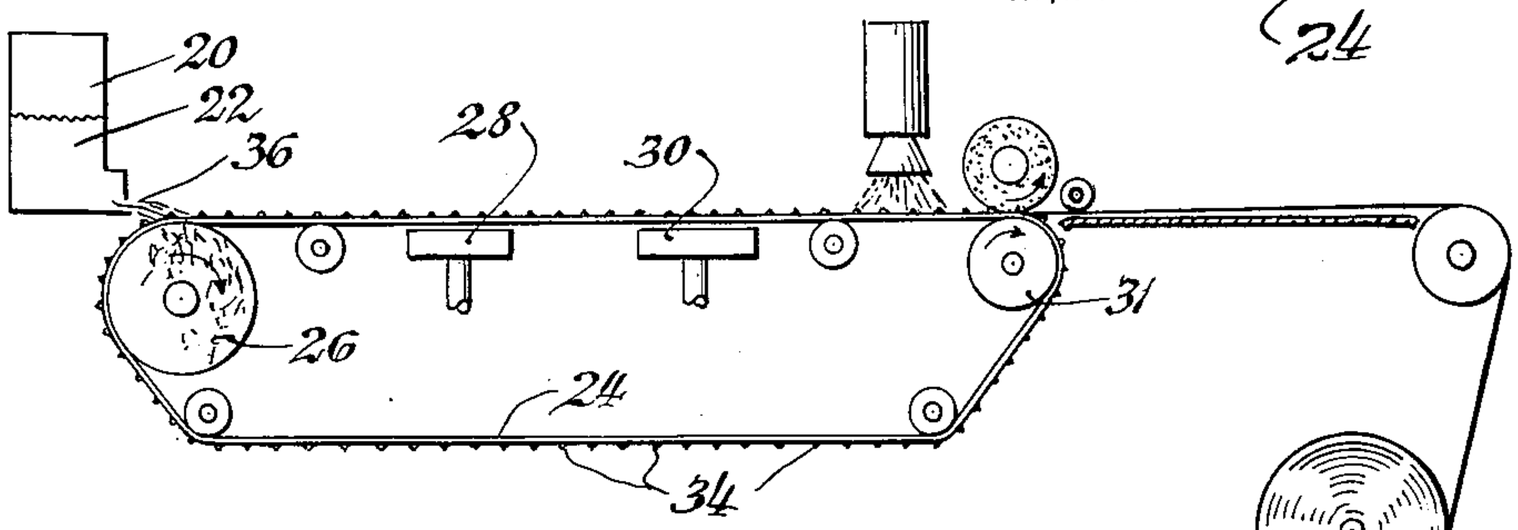


Fig. 4.

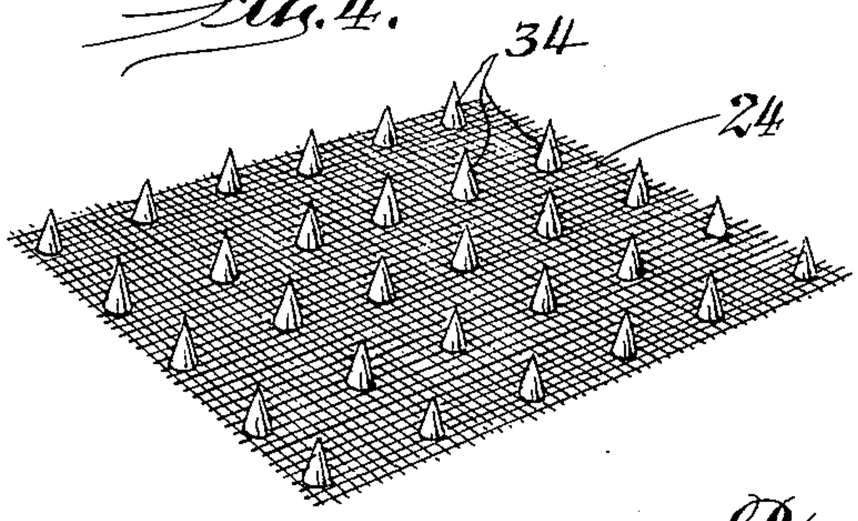


Fig. 6.

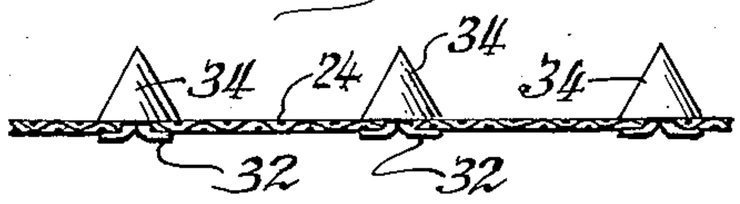


Fig. 7.

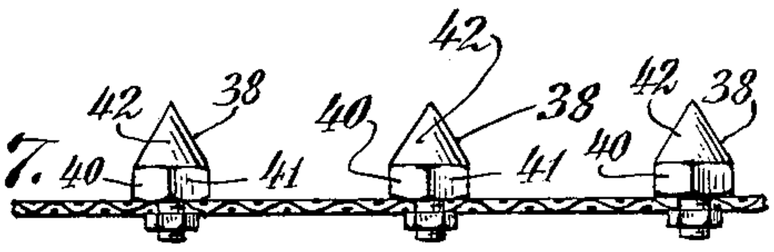


Fig. 5.

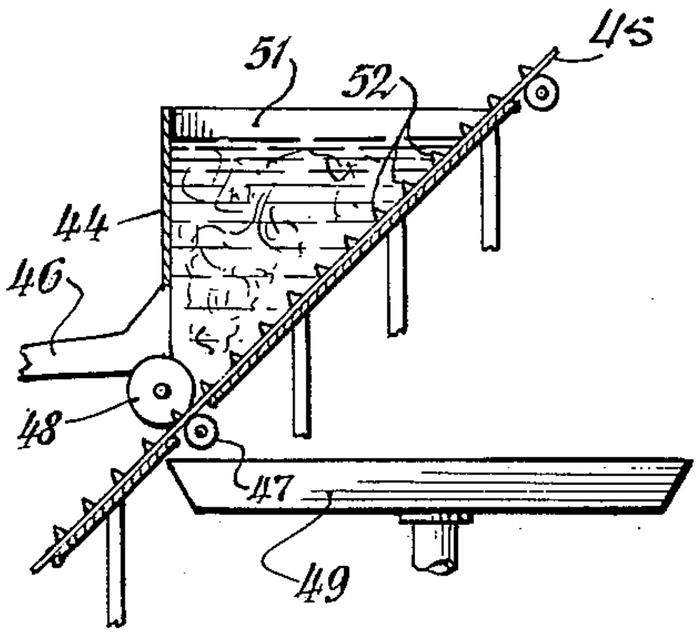
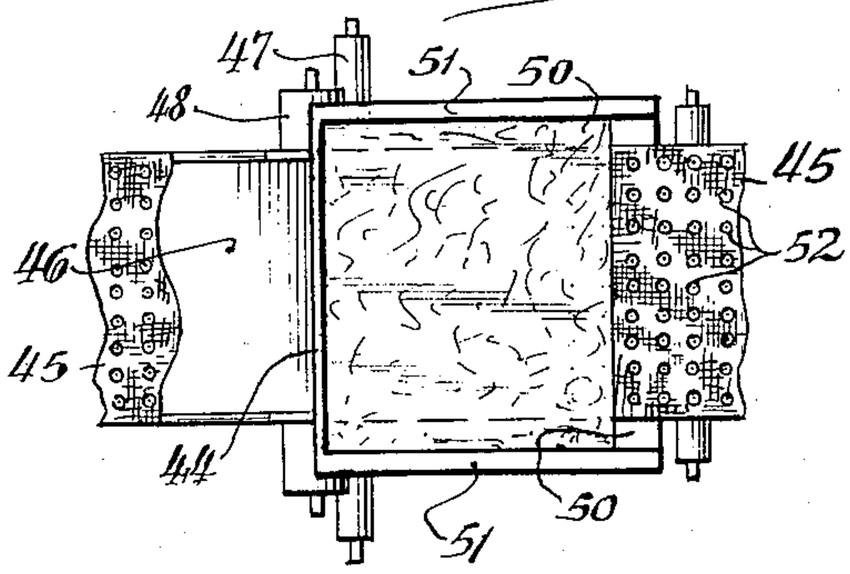


Fig. 8.



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MANUFACTURE OF CELLULOSIC PRODUCTS

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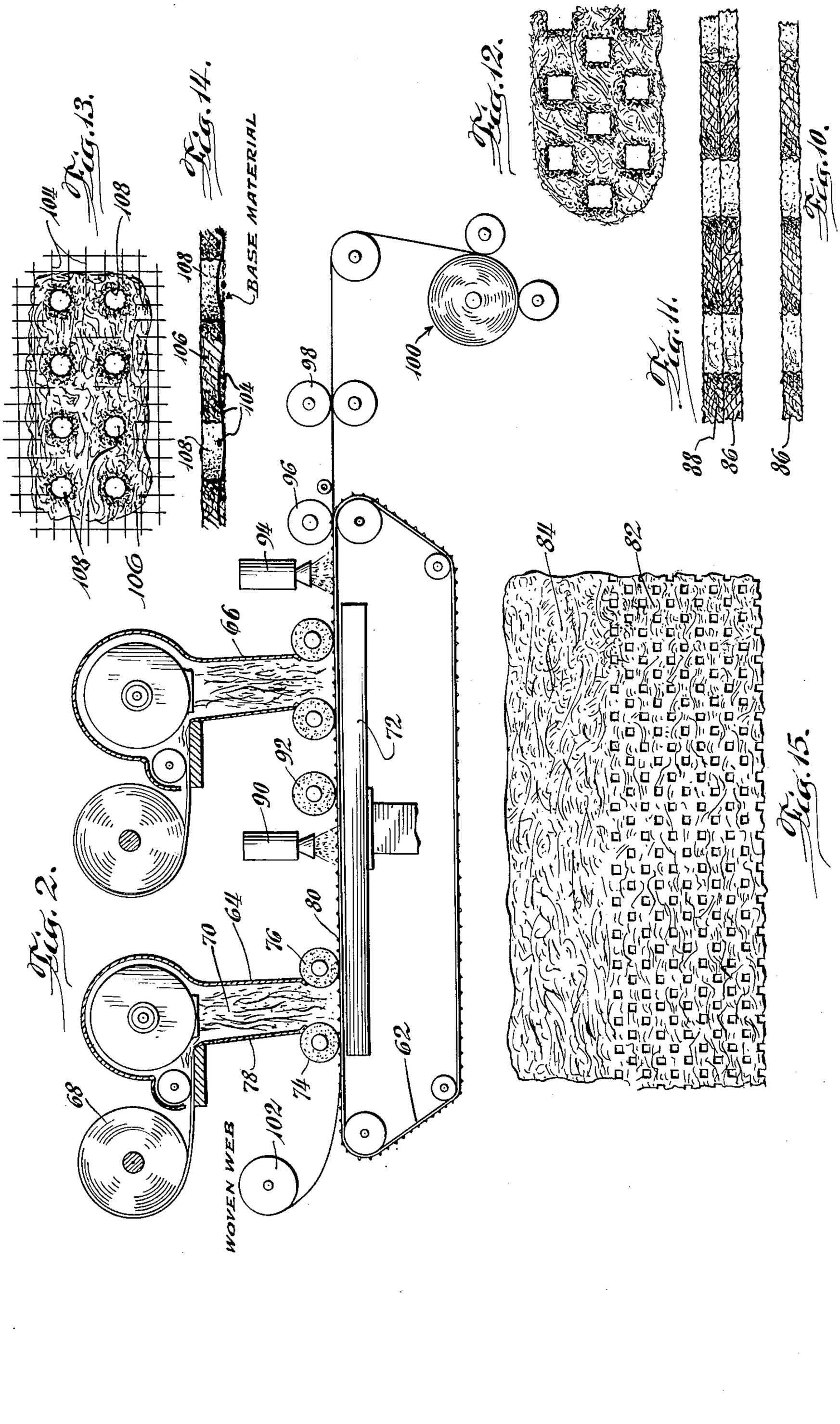

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MANUFACTURE OF CELLULOSIC PRODUCTS

Filed Sept. 4, 1959 3 Sheets-Sheet 3

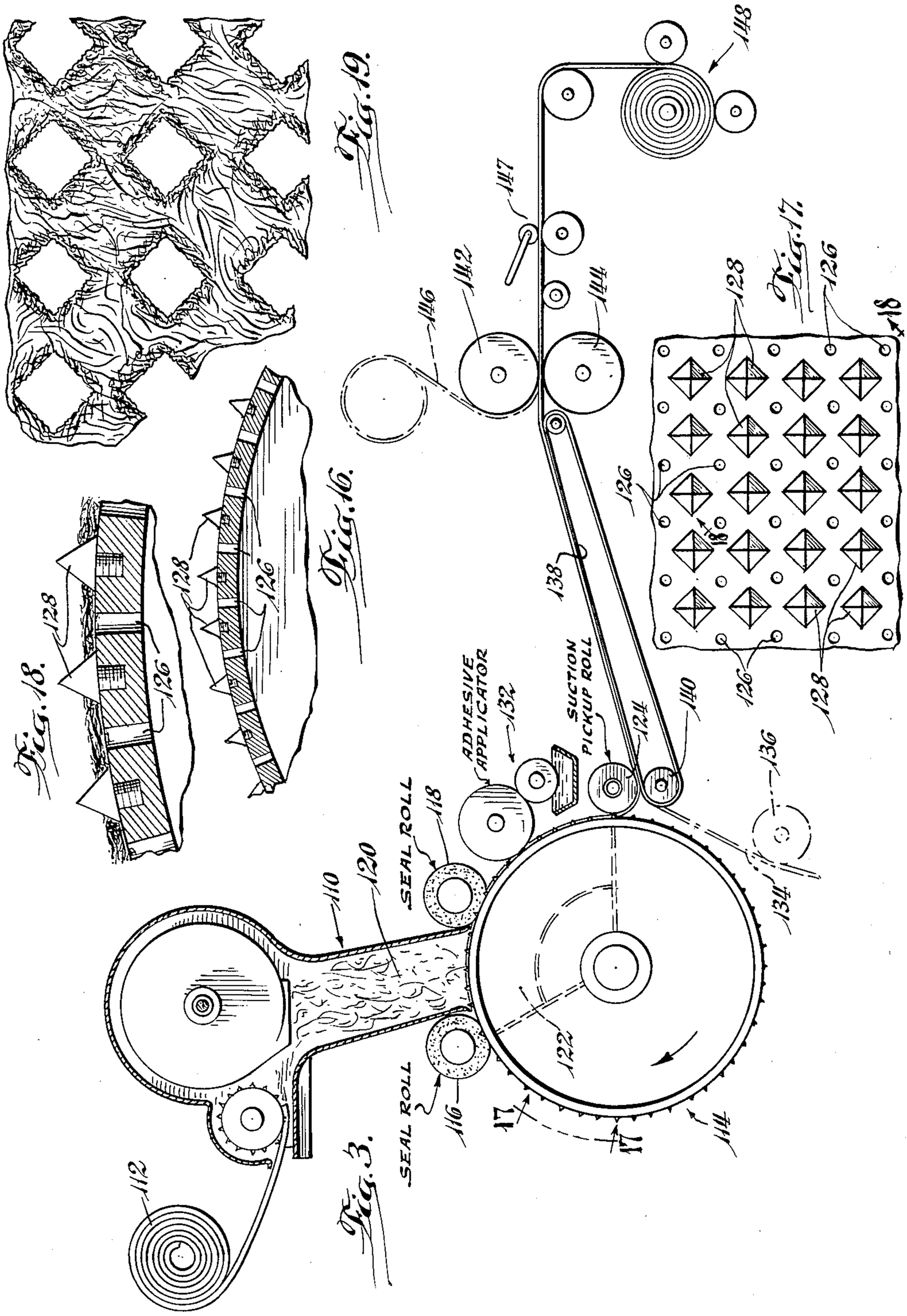

Fig. 3.

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MANUFACTURE OF CELLULOSIC PRODUCTS

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1 Claim. (Cl. 19—155)

This invention relates to an improved method of forming web-like material made wholly or partially of either natural or synthetic fibers or combinations thereof, to apparatus for carrying out the method, and to the product thus formed.

A major object of the invention is to provide an improved method of employing a fluid medium for laying fibers on a moving foraminous member in a manner to effect a substantially random inter-laying of the fibers for continuous production of a multiply apertured non-woven web-like material of attractive design and soft texture particularly adapted for use as a low cost sanitary napkin wrapper through which fluids may readily pass.

Another object is to provide such an improved fibrous web-like fabric wherein the fibers are disposed at random, for uniform strength in all directions throughout a major portion of the fabric, but which are geometrically arranged in certain spaced areas marginally to define apertures preferably disposed in patterned configuration.

Another object is to provide an improved method and apparatus for the high speed fluid laying of different types of fibers wherein a layer of fibers of one type may sequentially be applied to a layer of a different type to provide a laminated fabric having multiple apertures arranged in patterned configuration and extending through either all or a portion of the different layers thus formed.

Another object is to provide improved apparatus for carrying out the above method on a production basis.

A still further object is to provide an improved end product fabricated by the improved method and apparatus taught herein.

Other objects and advantages will become apparent to persons skilled in the art upon examination of the description, the drawings, and the claim appended hereto.

In the drawings,

FIGURE 1 shows in elevation a papermaking machine modified in accordance with the invention;

FIGURE 2 shows in elevation an air laying type of web forming apparatus incorporating the invention;

FIGURE 3 shows in elevation a web forming apparatus of the air laying type incorporating the inventive concepts;

FIGURE 4 is a fragmentary perspective of a Fourdrinier wire modified in accordance with the invention;

FIGURE 5 shows in vertical section the invention incorporated in apparatus wherein web formation is effected while the wire moves upwardly along an inclined plane;

FIGURE 6 shows in fragmentary vertical section the screen of FIGURE 4;

FIGURE 7 is a fragmentary section view of a forming wire of a further modified configuration;

FIGURE 8 shows fragmentarily in plan the device of FIG. 5 with parts broken away to illustrate constructional detail;

FIGURE 9 shows fragmentarily in plan a web forming screen incorporating a still further modification of the invention;

FIGURES 10 and 11 are fragmentary views of both single and double ply webs formed on the apparatus of FIGURE 2;

FIGURES 12 and 13 are fragmentary plan views of patterned webs produced by apparatus described herein;

FIGURE 14 illustrates in fragmentary vertical section

a thread reinforced patterned web produced in accordance with the invention;

FIGURE 15 shows in fragmentary plan a sanitary napkin wrapper material produced on apparatus described herein;

FIGURE 16 illustrates in vertical section a fragment of the web forming cylinder shown in FIGURE 3;

FIGURE 17 is a fragmentary plan view of the cylinder shown in FIGURE 16;

FIGURE 18 is an enlarged section taken along line 18—18 of FIGURE 17;

FIGURE 19 shows in plan an enlarged fragment of a patterned web formed on the apparatus shown in FIGURE 3.

The invention herein taught is primarily directed to the high speed low cost production of very lightweight fibrous webs composed of either cellulosic or synthetic fibers or mixtures thereof. Such webs may or may not be reinforced with a backing consisting of one or more sets of non-woven threads or with a woven gauze-like material upon which the web is formed. During recent years the increased demand for very lightweight but relatively strong materials having high fluid strike-through characteristics has progressively increased as manufacturers of sanitary napkins, medical bandages and the like have continuously sought to lower their manufacturing costs while maintaining or improving the quality and desirable characteristics of such material. The concepts herein taught permit the modification of existing production equipment in a manner to permit the very high speed fabrication of improved materials particularly adapted for the above stated end uses.

FIGURE 1 illustrates an otherwise conventional Fourdrinier type papermaking machine, with the forming wire or screen thereof modified in accordance with the invention. A headbox **20** delivers liquid entrained fibers as a furnish to a forming wire **24** which continuously moves in the arrow direction of a breast roll **26**, it being well understood that the fluid entrained fibers are deposited on wire **24** in and beyond the area of its support on breast roll **26** to form a web-like deposit thereon as the entraining liquid or "white water" passes through the wire. A major portion of the liquid may be drawn through the breast roll **26**, if of open construction, by suitable suction boxes and thereafter lesser portions of the fluid may be removed by the spaced suction boxes **28** and **30** as the wire continues its clockwise movement toward a couch roll **31**.

As shown in FIGURES 4 and 6, wire **24** has fixed thereto, as by rivets **32**, a plurality of upwardly extending spaced cones **34** arranged in patterned configuration. As wire **24** partially encircles the breast roll **26** it passes through a lip of slice **36** to receive at that position the furnish from headbox **20** for deposit of liquid entrained fibers upon wire **24** throughout the areas thereof between cones **34**. As shown in FIGURE 6, cones **34** are of a height substantially greater than the thickness of wire **24**, hence as the furnish flows down over the cones **34** to escape through the interstices of wire **24**, a portion of the entrained fibers are positively directed by the walls of the cones to a position at the bases thereof with the result that a substantial portion of such fibers assume a position of rest on the wire which is generally tangential to the cones at their bases. The fibers which are deposited intermediate the cones without contact therewith are disposed in more haphazard manner.

Due to the direction of wire travel under slice **36** and to hydraulic conditions involved in the feeding of the furnish through slice **36** a larger portion of the deposited fibers will be aligned in the machine direction than in the cross direction. The machine directional strength of the fibrous web thus formed therefor normally exceeds its

cross directional strength. However, a plurality of protuberances extending upwardly in patterned configuration from the wire as taught herein reduces fiber alignment in the machine direction. While the resulting web may still be stronger in the machine than in the cross direction, the ratio therebetween is somewhat reduced.

Cones **34** thus provide the wire with masked out areas, hence the web produced by the deposit of liquid entrained fibers thereon is provided with apertures corresponding in size and shape to the cone bases, substantially to increase the fluid permeability and improve the appearance of the web. Such a web presents an entirely different appearance and has a different feel than does a web produced in a somewhat similar manner on a forming wire provided with areas which are correspondingly masked out as by tape or in some other manner productive of a two dimensional effect. A patterned web produced on a wire blanked out in a two dimensional manner lacks both the pattern definiteness and feel of a web of similar pattern and weight produced on the three dimensional screen taught herein. As the furnish flows over a wire masked out in a two dimensional manner, those fibers deposited marginally of the masked out areas which define the web apertures lack symmetry at the aperture margins. The margin defining fibers are not positively directed to the marginal areas while liquid entrained just prior to wire deposit as are fibers deposited in accordance with the invention. The involved hydraulic conditions are substantially different, since the furnish is free to flow over the blanked out areas of a two dimentional wire while being prevented from such flow over corresponding areas of wires incorporating the invention. As the furnish flows over wire areas closed with tape or the like, fluid entrained fibers are largely deposited on portions thereof generally outwardly of the tape edges in a non-uniform manner productive of a web which tapers off in thickness at the aperture forming margins thereof. The aperture defining marginal portions of webs formed on two dimensional wires are of a density much less than the average density of the intervening web portions, and the apertures are ill-defined and quite ragged in appearance.

As the furnish flows over the three dimensional wire of FIGURE 4, more fibers per unit area are deposited marginally on cones **34** than throughout the areas therebetween. The fiber deposits marginally of the apertures of a web thus formed are also of a density somewhat in excess of the average density of the web throughout the intermediate areas. Since the protuberances serve as positive directioning means for those fluid entrained fibers which contact the sides thereof in their descent toward the wire, the deposit of such fibers on the wire at the base of the protuberances is controlled in a manner to assure symmetrical and well defined aperture margins.

While the wire protuberances shown in FIGS. 4 and 6 are of conical configuration, protuberances of widely differing configuration and patterned disposition may be selected for production of webs of various designs. It is important, however, that regardless of the configuration of the protuberances employed, they must be of sufficient height to extend substantially above the level of the furnish after it has flown outwardly of the headbox to form a liquid sheet, preferably at the wire speed, and over substantial areas of the wire prior to passage therethrough after deposit of entrained fibers on the wire. Protuberances of a height several times the web thickness are normally preferred. FIGURE 7 illustrates protuberances **38** having rectangular base portions shown by sides **40** and **41** of sufficient height to clear the furnish level and upwardly extending conical portions **42**. Such protuberances define clean cut rectangular openings in the web such as shown in FIGS. 12 and 19. If desired, protuberances may be formed as an integral portion of the forming wire.

FIGS. 5 and 8 illustrate the manner in which the invention may be incorporated in liquid formation apparatus of a type particularly adapted for liquid forming of long fibers, such as synthetic fibers of lengths up to 1½ inches, for example. While the forming apparatus of FIG. 1 has long been used without incorporation of the present invention for the manufacture of paper of various types, certain advantages are obtained by use of the apparatus of FIGS. 5 and 8 where a web consisting at least in part of long synthetic fibers is desired. The apparatus of FIGS. 5 and 8 includes a headbox formed between wall **44** and a forming wire **45** with the furnish in the box, which may or may not be maintained under pressure, at about the level shown by a continuous supply of furnish fed through conduit **46** as wire **45** continuously travels upwardly in the arrow direction. Wire **45** is caused to pass between a solid backing roll **47** and a resilient seal roll **48** to provide a headbox seal, with the furnish maintained in a trough-like container formed by partition **44**, two end walls **51**, FIG. 8, and wire **45**. Since there is substantially no flow of stock in the direction of wire travel as in the FIG. 1 apparatus, it is unnecessary that the protuberances extend above the stock.

During the continuous movement of wire **45** upwardly from the nip formed between rolls **48** and **47** the furnish flows through the wire interstices to fall by gravity into suitable collector pan **49** for return to the system. A suction box may be placed under wire **45** to facilitate fluid passage through the wire if desired. A seal is established between wire **45** and the end walls **51** by two sets of rubber-like sealing strips **50** forming channels through which marginal portions of the wire pass during its upward travel, those marginal portions of the wire being devoid of protuberances. Wire **45** is shown provided with conical protuberances **52** disposed in patterned configuration throughout a major central portion thereof inwardly of those marginal areas which pass through sealing strips **51**. The screen shown in FIG. 9 with protuberances, cross-shaped in plan, or protuberances of other configurations may of course be substituted therefor in any desired pattern. The fibers during formation of webs in this manner tend to align predominantly in the machine direction and as in the FIG. 1 apparatus the protuberances reduce the machine to cross directional strength ratio. The protuberances function as above described to direct contacting fibers to positions at their bases, hence the resulting web is slightly thicker and of greater density marginally of the web apertures than in the intervening areas.

The apparatus of FIGS. 2 and 3 incorporates concepts herein taught with equal effectiveness for air forming of fibrous webs. In FIG. 2, a continuously driven wire **62** is mounted to pass beneath one or more air formers **64** and **66** which may be of the type disclosed in U.S. Harwood Patent 2,719,337, the details of which form no part of this invention. Each such air former receives matted fibrous stock from a roll **68** for fiber separation and entrainment thereof in a downwardly directed air stream **70** for haphazard deposit of the individual fibers on forming wire **62**. A suction box **72** accelerates fibrous deposits on the wire and a pair of resilient seal rolls **74** and **76** confine such deposits to the projected area of a downwardly directed nozzle **78**.

Wire **62** is provided throughout a centrally disposed strip-like area with square shanked protuberances, FIG. 7, disposed in patterned configuration to present a three-dimensional partially blanked out foraminous surface to the downwardly directed stream of air entrained fibers as the wire moves between seal rolls **74** and **76**. FIG. 15 shows fragmentarily a sanitary napkin wrapper produced on wire **62**, the square shanked protuberances of FIG. 7 rendering the central web portion **82** highly fluid permeable and of attractive design. Integral lateral portions **84** are of uniform density since free of apertures. FIG. 12 shows in detail the disposition of fibers marginal-

ly of and intermediate the central area apertures of the web shown in FIG. 15.

Wire **62** may, as in liquid forming, be of alternate construction, and must be of sufficient height above the wire to extend substantially above the web thus formed to insure the desired disposition of fibers marginally of the web apertures. In common with the above described structure of FIG. 1 the air forming of a web by the apparatus of FIG. 2 results in fiber alignment in the machine direction somewhat in excess of that in the cross direction. However, the protuberances also serve to decrease the ratio between the machine and cross directional strengths of the resulting web. By alteration of the type and pattern of protuberances on wire **62**, various types of webs may be produced.

The second air layer **66**, FIG. 2, while not required for production of single layer webs as shown in FIG. 10, permits continuous low cost production of a double layer web shown in FIG. 11. Bottom layer **86** is applied in the above manner by air layer **64** and thereafter top layer **88** is applied to layer **86** by air layer **66**. Layer **88** may be bonded if desired to layer **86** by the application of adhesive to the top of layer **86** from device **90** prior to the deposit thereof of layer **88**, press roll **92** being employed if desired to increase the density of layer **86** prior to the application thereto of layer **88**. Layer **88** may likewise be adhesively treated by device **94** and the two layers further condensed by roll **96** following application of layer **88**. The adhesive applied by devices **90** and **94** may be of the thermoplastic type and then wound up in a known manner as shown at **100**. Additional air layers may be employed to produce thicker webs of three or more layers.

During the above described production of multiple layer webbing the aperture defining protuberances serve to insure registry of the apertures of both layers during both the adhesive application and the condensing stages. Webs of plural types of fibers may also be formed on the apparatus of FIG. 2. For example the fabric of FIG. 11 may comprise a base layer **86** of highly absorbent cellulosic fibers deposited from air layer **64** to which is applied by air layer **66** a layer **88** of relatively non-absorbent synthetic fibers. The synthetic fibers of layer **88** may be of a type considered highly desirable for use in sanitary napkin or bandage wrappers where body contact is involved but are seldom so used because of their hydrophobic characteristics.

Even though a wrapper of such fibers is multiply apertured, the low fluid permeability of such material causes undesirable fluid spread intermediate the apertures. However, those hydrophobic characteristics may be effectively neutralized and layer **88** rendered hydrophilic in character by a contiguously associated layer of highly absorbent fibers such as may be deposited by unit **64** to form layer **86**. The application of adhesive by devices **90** and **94** may be omitted and the relatively light required bonding between individual fibers obtained by adding to the fibrous stock fed into one or both of the air layers a small percentage of thermoplastic fibers.

Reinforced fabrics can be formed on the apparatus of FIG. 2 by feeding either a plurality of warp threads or a woven or non-woven gauze or the like directly onto wire **62** prior to its arrival at air layer unit **64**. Such a web **102** may be fed in any suitable manner to wire **62** to pass under sealing roll **74**, preferably of the resilient type. Roll **74** forces the web down over the protuberances of wire **62**, expanding the web when necessary to receive the protuberances and cause it to lie flat against the wire. Warp threads may be fed in a manner to avoid the protuberances if desired, but in any event neither the threads nor the presence of relatively open web affects the above described fiber laying during production of reinforced webs as shown in FIGS. 13 and 14. Such a web may comprise a woven or non-woven base material **104** to which is applied a fibrous layer **106** with both the base material and the fibrous deposit thereon

multiply apertured in patterned configuration as shown at **108**.

A further modification of the invention is shown incorporated in the apparatus of FIG. 3. An air laying unit **110** may be of the general type shown at **64** and **66**, FIG. 5, to deposit individual fibers separated from a stock roll **112** onto a peripheral portion of a revolving foraminous drum **114**, suitably driven in a clockwise direction as shown. A pair of seal rolls **116** and **118** confine deposit of air entrained fibers to the projected area of a depending nozzle **120**. A suction box **122** is disposed interiorly of drum **114** to extend from seal roll **116** to suction roll **124** for acceleration of fiber deposit. As shown in FIGS. 16, 17 and 18 drum **114** is provided throughout substantially the periphery thereof with a plurality of apertures **126** shown as bores disposed in patterned configuration and extending through the wall of the drum. A plurality of pyramid-like protuberances **128** are fixed to the drum to extend outwardly from the annular surface thereof, the protuberances being also disposed in patterned configuration but in areas defined intermediate apertures **126**. As the fiber entraining air stream moves downwardly through nozzle **120** under pressure established within unit **110** and accelerated by suction box **122**, the fiber entraining air passes through drum apertures **126** which are of a diameter substantially less than the average fiber length. The entrained fibers are therefor deposited on the surface of the drum, and protuberances **128**, being of a height substantially greater than the fibrous web thus formed, guide a portion of the fibers downwardly to positions adjacent their bases.

Since the web thus formed consists of rather loosely deposited fibers it offers no substantial resistance to passage of the air stream therethrough as the web is built up. In common with the structure of FIG. 2, the resulting web is slightly thicker in the areas adjacent the bases of the protuberances than in intervening areas due to the above mentioned rearrangement of those fibers which are guided down the sides of the protuberances which serve as ramps. Such an effect may be counteracted if desired since it is somewhat dependent upon the air stream velocities involved. By the employment of very high air stream velocities, some entrained fibers are drawn away from the protuberances and toward the air escape bores, hence fibrous deposits of substantially uniform thickness and density may be obtained in the areas intermediate the protuberances. While drum **114** as illustrated in FIG. 3 is of solid wall construction with plural bores provided therein for escape of the air stream, the invention contemplates an annular drum surface of wire screen or other foraminous materials to which protuberances of a desired configuration are fixed in patterned configuration to effect a like result.

In common with the apparatus of FIG. 2, the FIG. 3 apparatus readily lends itself to many modifications involving the concepts herein taught. For example, by placing additional units **110** in circumferentially spaced relation to drum **114** thicker webs as well as webs consisting of various layers of different fibers may be produced. The webs may have applied thereto, either during or after formation, suitable adhesives or other additives by known devices such as roll type applicator **132**. Reinforcing materials such as woven or non-woven fabric may be introduced either under seal roll **116** to be drawn around a portion of drum **114** during and after fiber application thereto (not shown) or such material as shown at **134** may be fed over a guide roll **136** and onto a conveyor belt **138** and through a nip formed between one of the conveyor guide rolls **140** and suction pick up roll **124**. As the web thus reinforced leaves conveyor **126** it may be fed between calender rolls **142** and **144** for the application to one side thereof of another element such as a thin plastic film **146**. Various laminate products now in wide use may thus be produced at high speed. The product may receive further treatment at **147** prior to final wind up at station **148**. Since liquid

formed webs normally have characteristics which differ quite widely from air formed webs, it is thus seen that the invention is of broad scope and one which may readily be incorporated in production apparatus of widely varying design for the fabrication of a wide range of products which differ substantially both in physical characteristics and appearance.

While the above described apparatus employs either liquid or air laying techniques in teaching the invention, the principles are equally applicable in respect to the formation of webs by known methods of electrostatic depositing fibers. Protuberances of insulating material fixed to an electrically conductive forming wire or alternately a plastic or other non-conducting forming wire with electrically conductive protuberances fixed thereto may be employed to advantage when electrostatic principles are substituted for either liquid or air forming. It is also contemplated that regardless of the fiber forming principle involved, either or both the forming wires and the protuberances may be of metallic or non-metallic materials.

We claim:

In apparatus for the production of a multiply apertured web, a foraminous member, means for continuously moving said member through a defined path, a plurality of outwardly converging rigid spaced protuberances fixed to said member to extend outwardly from a surface therefrom a distance substantially greater than the thickness of a web to be formed thereon, and means for continuously feeding a fiber entraining gaseous stream to said protuberant surface of said member for deposit of fibers on said member intermediate said protuberances as the entraining stream passes therethrough.

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