Sept. 6, 1966 F. G. NICKERSON, JR., ETAL 3,271,219

METHOD AND APPARATUS FOR CROSS LAYING REINFORCING STRANDS ON WEB MATERIAL

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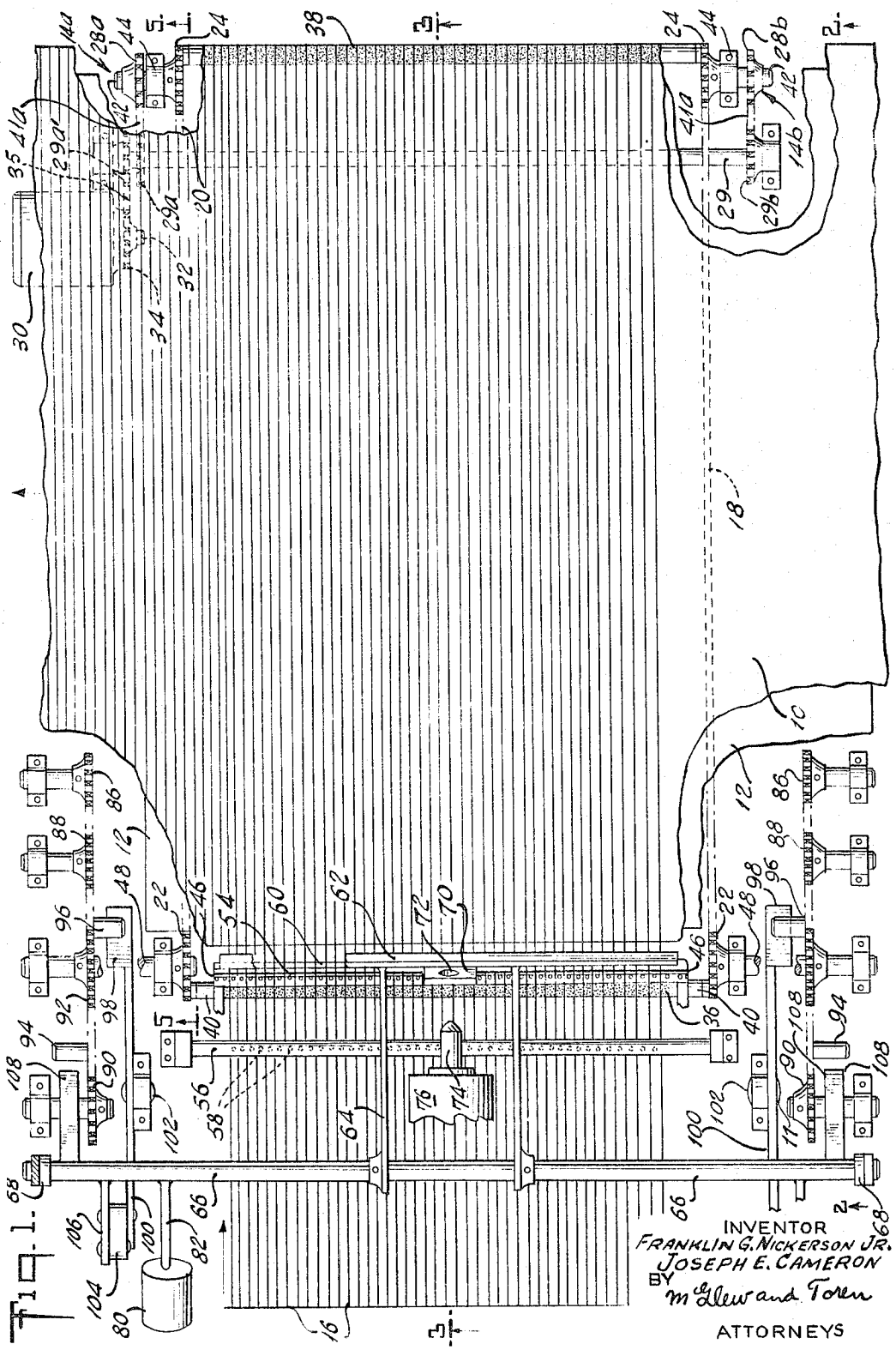


Fig. 1.

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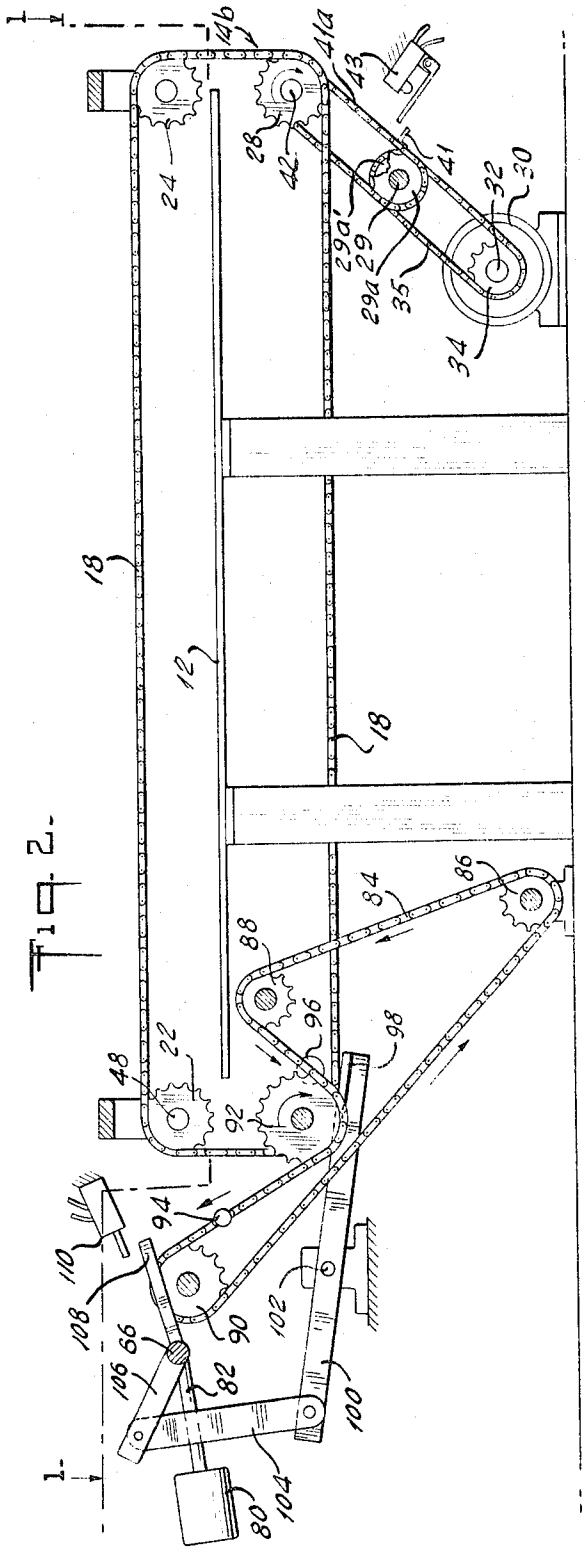


FIG. 2.

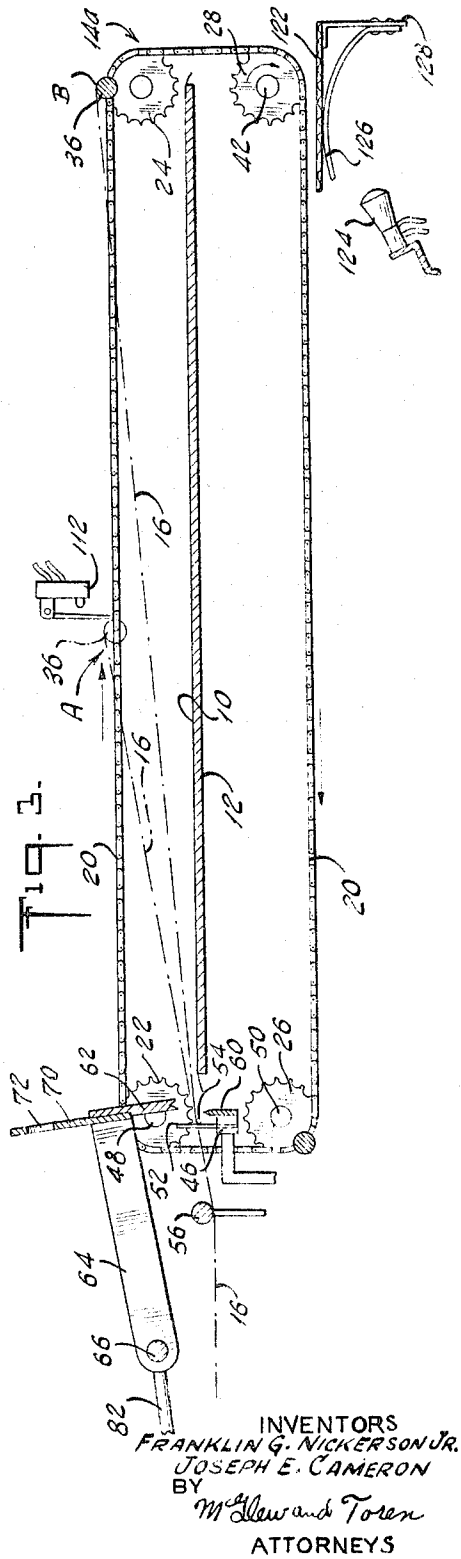


FIG. 3.

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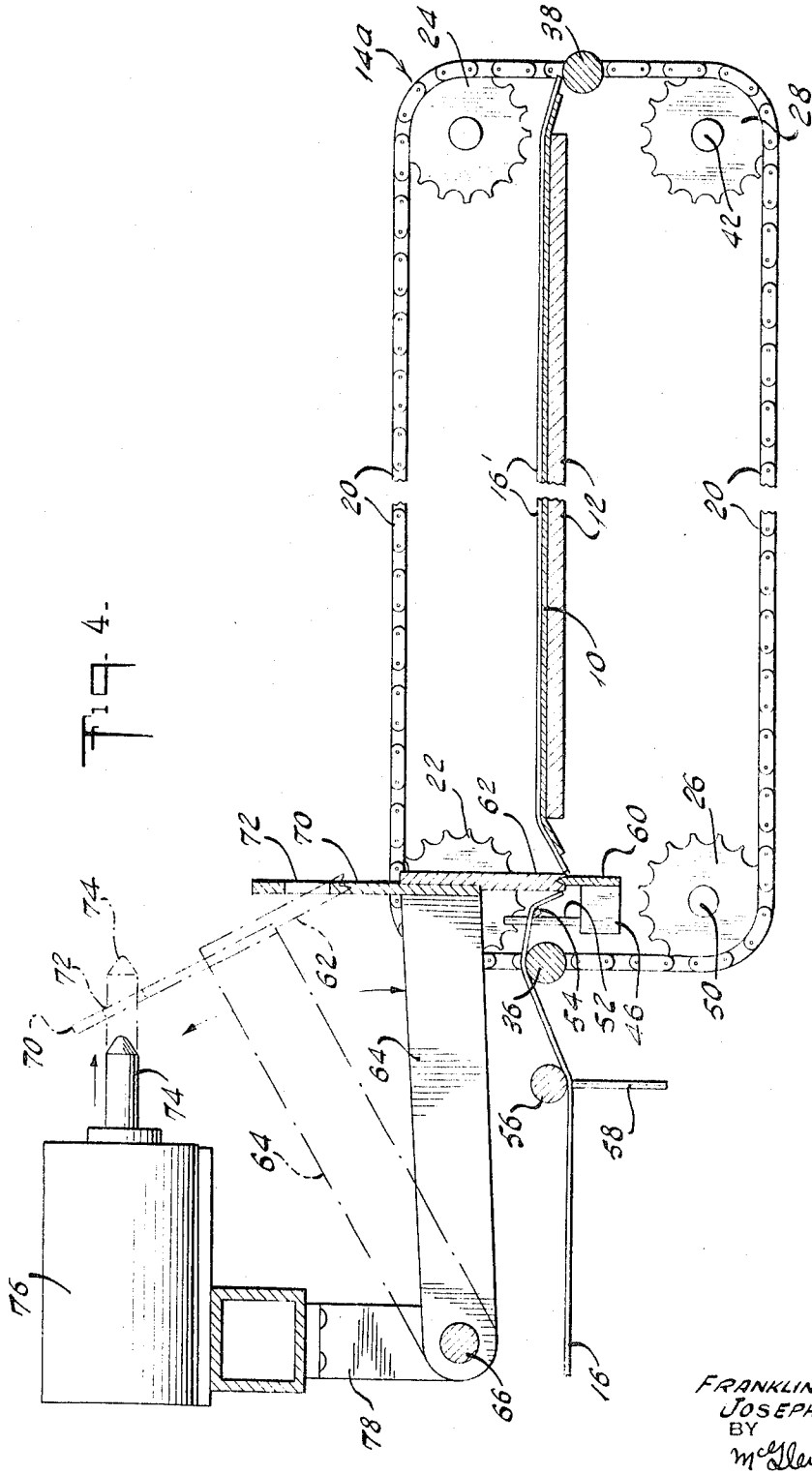



FIG. 4.

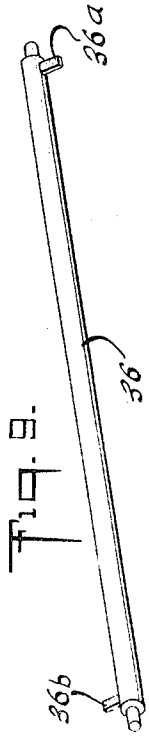



FIG. 5.

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FIG. 4a.

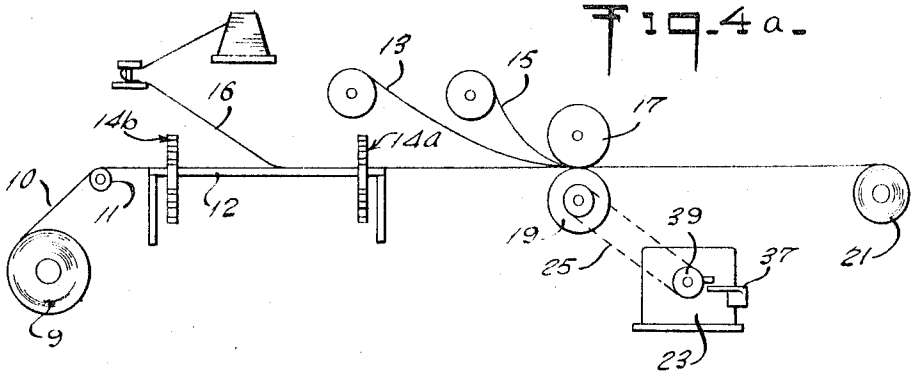



FIG. 10.

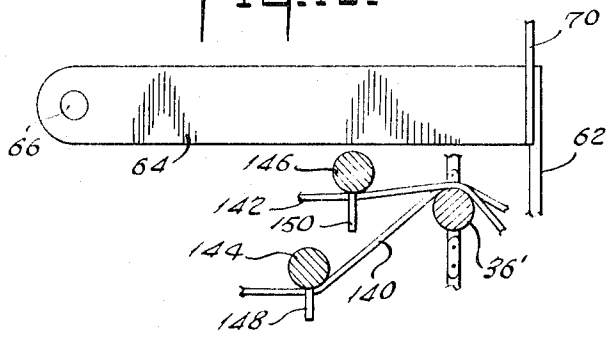



FIG. 11.

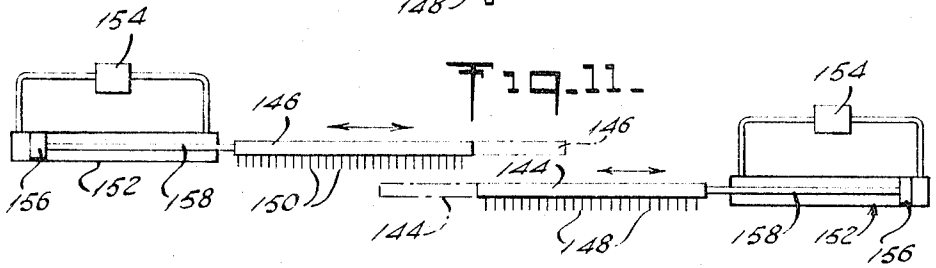
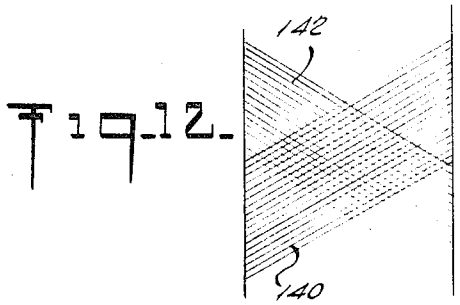



FIG. 12.




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FIG. 7.

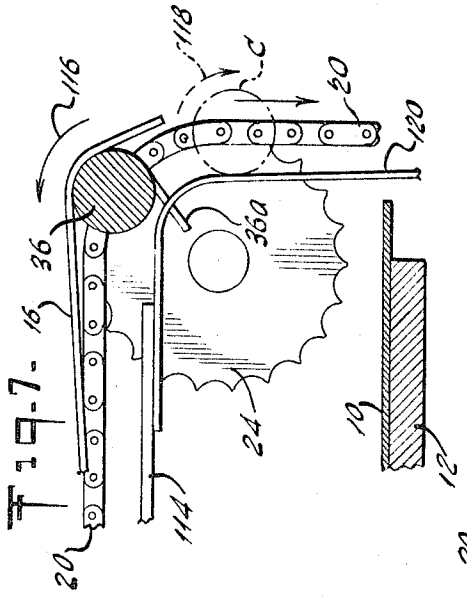



FIG. 8.

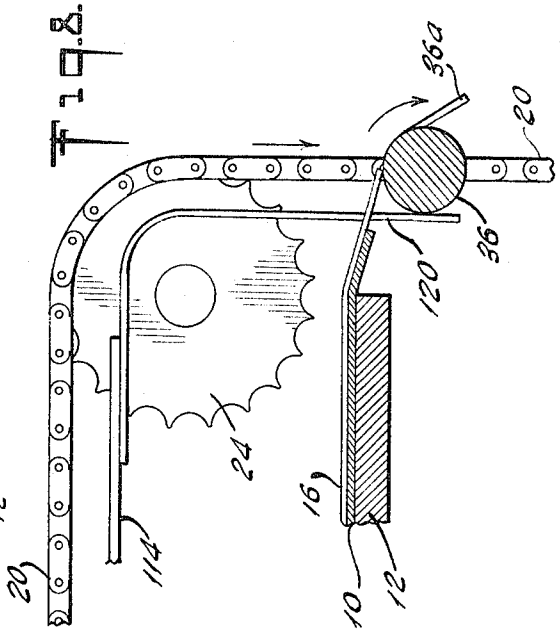



FIG. 5.

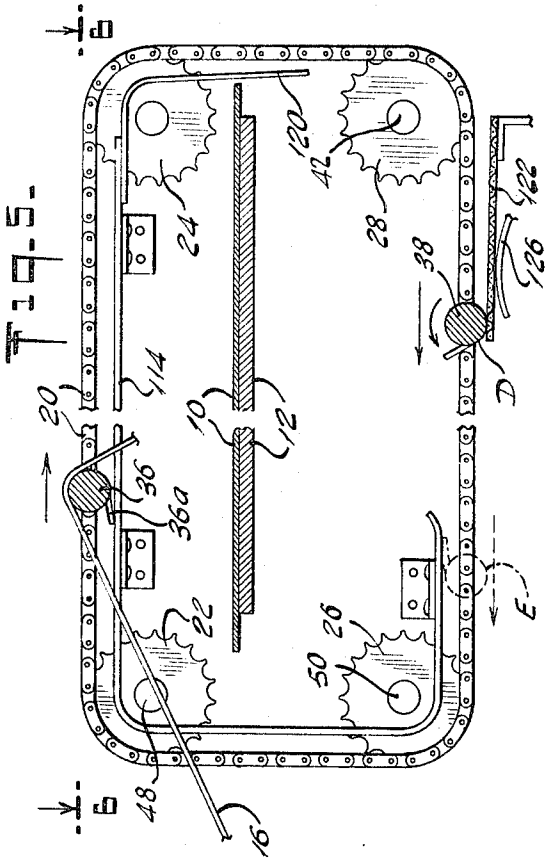
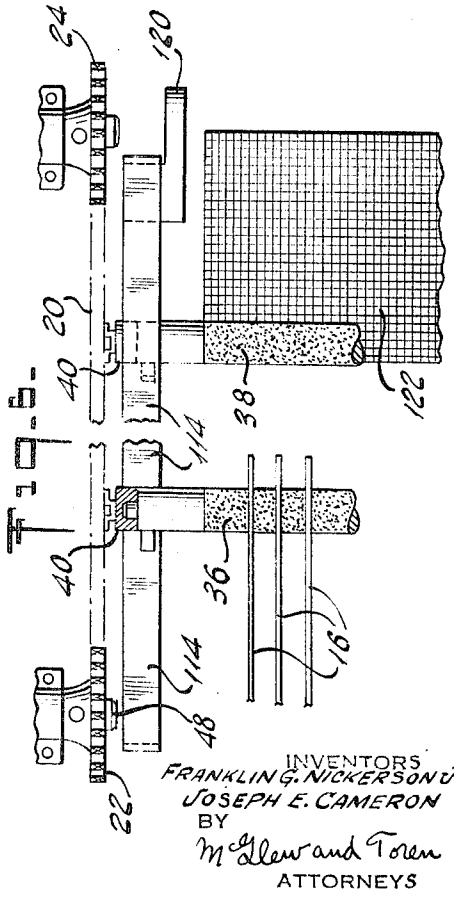



FIG. 6.




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3,271,219

# METHOD AND APPARATUS FOR CROSS LAYING REINFORCING STRANDS ON WEB MATERIAL

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22 Claims. (Cl. 156—177)

This invention relates in general to strand or element laying or mesh forming devices and a method for strand laying and in particular to a new and useful device and method for applying or laying cross-strands onto an element moved at an angle thereto.

The present invention has particular application in connection with the applying of reinforcing fibers on web material, such as paper, paper-board and the like. Machines are known which are capable of applying reinforcing strands or elements which run along the length of the web material and which are applied as the material is fed in the same direction as the reinforcing strands or fibers. Some complicated machinery has been provided for interweaving or laying on reinforcing strands which extend at an angle to the direction of feed of the web. Such machines operate by directing the strand material backwardly and forwardly across the web as it is advanced in a given direction. Much difficulty is encountered in the operation of such devices and in insuring that the fiber strands are uniformly spaced and that they are properly placed on the advancing web.

In order to provide devices for applying reinforcing fibers or strands across a web of material or other layer, attempts have been made to form a mat of such material and intermittenly interrupt the advance of movement of the web to permit the mat to be layed across a chosen length. However, this could only be done on small sizes of web material and not in those instances where the web is continuously advanced.

In prior art devices of this type, great difficulty has been experienced in providing a satisfactory device for contacting and holding the strand elements while they are moved to appropriate locations for overlaying on the moving web.

A further disadvantage in prior art devices of this type is the employment of feed-off wheels for the individual strand elements which must be loaded before each machine operation. It is necessary with devices of this sort to shut down the machine in order to rewind the strand elements onto the wheels for feeding off during the laying.

In accordance with the present invention, the individual strands are fed off continuous creel supplies in which the strand elements are successively connected to new creels as the creels are used up and hence continuous operation of the machine is possible. The present invention also includes novel means for picking up the strand elements which is an adhesively coated bar. A particular advantage of a bar of this type is that the strand elements may be orientated independent of the pick-up bar and, since the bar is uniformly coated with adhesive throughouts its entire periphery, it will engage the strand elements in any manner in which they are aligned in the path of movement of the bar.

In accordance with the present invention, there is provided means for advancing a continuous length of web material in one direction and for feeding a multiplicity of reinforcing strands or elements from one side thereof in a direction at a chosen angle in respect to web advance. Means, which in the preferred arrangement is a tar or grease coated bar, are provided to contact the strand material and move the ends through a path extending



over the web material and thence downwardly adjacent the opposite edge thereof to lay the strands on this edge of the sheet and subsequently (almost instantaneously thereafter) to press the area of the strands adjacent the opposite edge of the web sheet onto the sheet and then to make a cut adjacent this edge thus forming new ends. The arrangement and the timing are such that the web material may be fed continuously and the drop or laying of each section of fibrous elements is timed so that the spacing between elements over the complete length of the web is uniform.

In accordance with one feature of the invention, individual strands or similar elements for reinforcing, superimposing or other purposes are fed under a support element between vertical comb members and over another support element of a second set of vertical comb members spaced a relatively short distance away from the first element. Means are provided to direct a bar member upwardly between the comb elements in order to contact the fibers or strands prior to cutting and to adhere them to the tacky surface thereof for transportation after cutting across the carrier or web which is to receive these fibers. The pick-up bar is advantagaously coated with a sticky substance, such as a tar or thick grease, in a sufficient quantity and of such a nature to cause the strand elements to become instantly held and carried off thereby.

In accordance with another feature of the invention, a knife is arranged to cut between a comb element and the adjacent edge of the carrier which is to receive the strands. Since the bar element which picks up the strands must move in a direction past the knife over the carrier material, means are provided to raise the knife in timed relationship to the movement of the pick-up bar member. Such means include means for balancing the knife at a slight distance above the strand elements after the bar has passed through the plane of the operation of the knife.

A further feature of the arrangement is that timing means are provided on the means for moving the pick-up bar to cause movement of the knife and to effect the holding of the knife in a raised position to permit clearance of the strand elements as the bar is moved in a path beyond the plane of operation of the knife.

In accordance with a further feature of the invention, the pickup bar is rotatably mounted, but is guided so that it does not rotate as it moves the strand elements across the carrier which is being fed in a direction substantially prependicular thereto. The pickup bar is rotated by a camming arrangement in a direction to slacken off the strand material when the bar approaches the edge of the carrier sheet so that it may be moved downwardly over the edge so that the fibers are not wrapped around the pickup rod to an extent which would prevent easy release on the carrier. When the pickup bar approaches the edge in position for laying the strands onto this edge, it is rotated in an opposite direction to instantly tension the strand elements so that they are firmly positioned on the carrier therebeneath. Just after the pickup bar lays the strand elements on the carrier, the pickup rod laying the strands is released permitting reverse rotation and the feed off knife is effective to cut the opposite edge and to press these ends into engagement with the carrier. The knife always cuts below the level of the carrier and is operated to lay the strands on this edge of the carrier at a fraction of a second later than the far edge is laid in order to prevent the elements from snapping back in the direction of the pickup rod. Suitable adhesive or other material is provided on the carrier to insure that the strands once laid will remain in place.

In accordance with a further feature of the invention, the pickup bar surface is continuously renewed during each cycle of operation in order to insure that the grooves

which are defined in the adhesive coated surface thereof by the pickup of the strands will be recoated and offer sufficient binding power to carry the next lay of strands across the web. The spaced comb elements are provided so that, when the bar moves therebetween, the strand elements will always be disposed parallel so that they will be picked up in this manner by the pickup bar.

In one emobdiment of the invention, however, means are provided to laterally reciprocate at least one guiding comb during the cross feeding of the strands to effect a diagonal strand laying. This may be done on alternate strand layings to achieve an intricate pattern, or on every laying as desired. In a preferred arrangement, two combs are employed and they are moved in laterally opposite directions, one above the other, as the strands are moved across the web to form a crossing diagonal pattern.

Accordingly, it is an object of this invention to provide means for laying a multiplicity of cross-strands onto a web which is advanced at an angle to the direction of laying the web.

A further object of the invention is to provide a machine for laying cross-strands, such as reinforcing fibers onto a continuous length of web material, including a movable pickup arm arranged to pick ends of a plurality of strands and move them across the web material as it is advanced and thereafter moved downwardly to deposit the picked up ends on the carrier web at the edge thereof, and further including means for pressing these ends on the opposite edge of the web and thereafter severing the opposite ends of the strands.

A further object of the invention is to provide a method for applying cross elements to a carrier comprising the steps of advancing the carrier in a given direction and feeding the cross-strands between spaced comb elements, thereafter picking up the cross-strands by moving a pickup member between the elements, directing the pickup member across the carrier and downward past the edge of the carrier to deposit the ends of the strands on the carrier, pressing them on the carrier and severing the opposite ends of the strands.

A further object of the invention is to provide a machine for laying cross strands in which the strands are pulled off or drawn off from a stationary bobbin or creel supply which may be continuously renewed while the cross strand laying machine is operating.

A further object of the invention is to provide a cross strand laying machine having means for varying the member and position of the cross strands while the machine is operating.

A further object of the invention is to provide a cross strand laying machine having a single hammer type cutting knife whose axis of rotation is stationary and which includes two separate pickup rod members arranged to move through a path and to contact and pick up the strand elements and draw them over a moving web and through the plane of operation of the cutting knife after the knife has been moved to a location out of the way.

A further object of the invention is to provide a method of applying cross-strands of material to a web, including advancing the web and moving a plurality of strands either continuously or intermittently across the path of advance of the web, first directing the furthermost ends of the strands on the furthermost edge of the web and simultaneously pressing the area of the strands adjacent the opposite edge of the web in contact with the web and instantaneously thereafter cutting these strands.

A further object of the invention is to provide a machine for continuously applying reinforcing fibers and similar strand elements to a continuously moving web having an adhesive coating thereon including an endless chain conveyor having two pickup bar elements spaced equidistance on the path of the chain and movable between spaced comb elements between which individual reinforcing fibers are fed, one pickup bar being arranged to move across the path of movement of the web (either while the comb elements are stationary or moved laterally) and thence to move downwardly against its opposite edge to deposit the fibers just after the other rod moves into position between the comb elements to engage the strands, and including a reciprocating knife arranged to sever the strands on the near edge of the web after bringing the strands in contact with said near edge of the web.



A further object of the invention is to provide a device for depositing strand elements in either a straight, diagonal or cross pattern at a laying station.

A further object of the invention is to provide a device for applying cross-strands to a web or layer of fibrous material which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIG. 1 is a fragmentary top plan of a portion of a machine for laying reinforcing cross-strands of fibrous materials onto a paper web in accordance with the invention;

FIG. 2 is a transverse sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a transverse section taken along the line 3—3 of FIG. 1;

FIG. 4 is an enlarged section similar to FIG. 3;

FIG. 4*a* is a somewhat schematic indication of the overall web and reinforcing fiber feed mechanism;

FIG. 5 is an enlarged section taken along the line 5—5 of FIG. 1;

FIG. 6 is a section taken along the line 6—6 of FIG. 5;

FIG. 7 is an enlarged fragmentary section of a portion of the mechanism indicated in FIG. 5;

FIG. 8 is a section similar to FIG. 7, but with the parts in an advanced position;

FIG. 9 is a perspective view of the pickup bar;

FIG. 10 is a fragmentary section similar to FIG. 4 of another embodiment of the invention for diagonal cross laying;

FIG. 11 is an elevational view of the cross laying combs and their operating mechanisms; and

FIG. 12 is a top plan view of a laying station indicating the diagonal cross pattern.

Referring to the drawings in particular, the invention embodied therein includes means, such as a reel supply **9** (FIG. 4*a*) and rotating guide roller **11** for feeding a continuous length of web material **10** over a table **12** which is located between the reaches of chain sprocket elements generally designated **14***a* and **14***b* (FIGS. 1 and 2). In FIG. 4*a* and in a line parallel to web feed direction, a group of strand elements **13** are fed onto the web along with a covering web **15** between take-up pressure rollers **17**, **19** onto a reel **21**. Take-up roller **19** is continuously driven by a motor **23** through chain **25**.

In accordance with the invention, means are provided to direct a multiplicity of strand elements, such as reinforcing fibers **16** across a laying station which in the embodiment illustrated is defined by a portion of the movable carrier or web **10** and to thereafter lay the strand elements onto the web at the laying station after the web has been previously coated with an adhesive or other sticky substance, such as asphalt composition, for example. The web or carrier **10** may advantageously include only the strand elements, such as parallel groups which are coated by adhesive, rather than a solid sheet such as paper.

Opposite ends of the strand elements are formed by cutting after the adjacent portions of the strands are

pressed to this edge of the web. This mechanism includes the chain sprocket system 14*a* and 14*b* which include endless chains 18 and 20, as seen in FIGS. 1, 2 and 3. The endless chains 18 and 20 are arranged adjacent each end of the table 12 and they are continuously advanced over upper sprocket wheels 22 and 24 and lower sprocket wheels 26 and 28. A motor 30 (FIG. 2) has a shaft 32 with a sprocket 34 which drives through a sprocket chain 35, an intermediate sprocket set 29*a* and 29*a'* on intermediate shaft 29 which also carries sprocket 29*b* on its opposite end. Sprockets 29*a* and 29*b* rotate shafts which carry sprockets 28*a* and 28*b*, respectively, and sprocket 29*a'* are driven from motor 30.

As best seen in FIGS. 3, 5 and 6, the sprocket chains carry pick-up rod members 36 and 38 which are rotatably mounted in bearings 40 secured to the sprocket chains. In the embodiment indicated, the pick-up rod members 36 and 38 are arranged an equal number of chain links away to permit operations thereby to cause each to cooperate in picking up the strand elements 16 and to lay them onto the advancing web 10 during each cycle of operation. The pick-up rod members 36 and 38 cooperate inasmuch as one is always moved to be in a position as indicated by rod 36 (FIG. 4) to contact and hold the strand elements which will form the new lay just before the previous lay strands are cut. This is to permit continuous feeding without the elements 16 falling out of combs 58 and 52 (to be described more fully hereinafter).

The motor 23 driving roller 19 which regulates the speed of advance of the web is advantageously a variable speed motor, while motor 30 is advantageously a constant speed motor. The web may be advanced at a rate of up to 450 f./m. in the embodiment indicated and the strands will be laid in a width of five feet continuously as the web is advanced. The paper web width may be approximately from one to eight feet or so. A microswitch 37 is mounted adjacent motor 23 (FIG. 4*a*) and operated by rotation of a sprocket 39 to start motor 30 (FIG. 2) every time five feet of web material 10 is advanced by roller 19. The conveyor systems 14*a* and 14*b* thus may operate at reduced capacity and will be stopped when a contact lug 41 on sprocket 35 hits microswitch 43 (FIG. 2), to permit the web feed to progress until a new length web is positioned at a location for strand laying. Switch 43 is arranged to be operated by the lug 41 which is on a chain 41*a* having half the number of links as chains 18 and 20 to insure proper timing.

The strand elements in this embodiment are reinforcing fibers made of plastic, fiberglass or similar material which are drawn from a creel supply which permits the controlled, tensioned take-off thereof as the elements are picked up by the pick-up rod members 36 and 38.

Extreme lower right end sprocket wheels 28, 28 as viewed in the drawings are affixed to stub shafts 42, 42 which include extensions on which are affixed sprockets 28*a* and 28*b* which are driven by the motor 30. On the opposite side of the table 12, as best indicated in FIG. 4, there is disposed a supporting block member 46 which extends between sprocket elements 22, 22 and 26, 26. To provide clearance for the fibers carried by rods 36 and 38, sprockets 22, 22 are mounted on stub shafts 48, 48 and the sprockets 26, 26 are mounted on stub shafts 50, 50, respectively. The supporting block member carries an upstanding plurality of spaced comb elements 52 between adjacent ones of which the individual strand elements 16 are led. A cross rod element 54 is provided across the comb elements intermediate their height for the purpose of supporting the strands 16 thereon.

The rod element 54 is arranged at a slightly higher elevation than the lower surface of the supporting rod 56 which carries a plurality of depending comb elements 58. As clearly shown in FIG. 4 the strands 16 are directed below the support rod 56, each between adjacent comb elements 58 and then over the rod 54 between comb elements 52.

With the strands disposed between the comb elements 58 and 52, the pickup rod 36 moves between the combs 58 and 52 and picks up the ends of each of the elements 16 and begins to carry the elements upwardly and across the table 12. To insure that the strands 16 are picked up and moved by the rod elements 36, it is coated with a sticky substance, such as tar, heavy grease or similar material.

It is essential that, after the elements 16 are moved completely across the table 12 and laid on the web 10, they be severed at a location adjacent the edge of the web which is nearest the supporting block member 46. For this purpose, a fixed knife blade 60 is secured to an end of the supporting block member 46. In addition, a hammer-type knife member 62 is secured to an end of a double-armed yoke 64, each arm of which is pivoted on a cross rod 66 which is rotatably mounted in end bearings 68, 68. The yoke 64 carries at its outer end an upstanding plate member 70 having an opening 72 arranged to receive a plunger holding arm 74 of a solenoid 76 when the yoke is moved to a dotted line upper position, as indicated in FIG. 4. The solenoid 76 is mounted on an upstanding bracket 78 affixed to the cross rod 66.

Particularly in FIGS. 1, 2 and 3, there is indicated the timing mechanism for operating the movable knife blade 62, both for the purpose of effecting the cutting of the strands 16 and moving the knife out of the way of the strands when they are transported across the web 10. It has been found that it is not desirable to permit the knife to fall downwardly along the line of the strands 16 to sever them, since this does not effect a good cut and there is danger that the heavy falling impact will damage the parts. For this reason the knife is counter-balanced by a weight 80 which is fixed to an arm 82 secured to the rod 66. The weight is of a character to support the blade in a position intermediate the upper location held by the solenoid arm 74 and a downward location in which it extends to the stationary blade 60.

To time the operation of the knife with the movement of the pickup rod, there is provided an endless chain 84 which is trained to run around sprockets 86, 88 and 90, and a sprocket 92, affixed to the same shaft 50 which carries the sprocket 26. The sprocket chain carries two outstanding spaced timing lugs 94 and 96 which are arranged to operate the knife mechanism in timed relationship to the advance of the pickup rods 36 and 38.

In the positions of the parts indicated in FIG. 1, the timing lug 96 is moved through a path at which it intercepts a flat end 98 of a lever 100 which is pivotally mounted at 102. The lever 100 is connected at its opposite end by a link 104 to a crank arm extension 106 of the rod 66. Thus, the lug 96 causes clockwise rotation of the lever 100 and downward movement of the knife blade 62 to the stationary blade 60 to cut the strands 16 (FIG. 4). After this takes place, it is necessary that the knife be arranged to permit a pickup rod 36 to move through a plane intercepting the cutting position plane of the knife 62. This is effected by the timing lug 94 which strikes a crank arm extension 108 which is affixed to rod 66 to cause rotation thereof and upward movement of the knife blade 62. The movement continues until the edge of the crank arm extension 108 strikes a switch 110 to activate the solenoid 76 and cause the holding rod 74 to move outwardly into the opening 72 and hold the knife in a raised position clear of the path of movement of the pickup rod 36. It should be appreciated that there are two sets of timing chains 84 arranged on each side of the feed of the strands 16, and in the embodiment illustrated there is also another set of timing lugs operating identical mechanisms for the balanced control of the knife blade movement. The parts on each side have been similarly designated.

It should also be appreciated that the timing lug **96** depresses the flat portion **98** just before timing lug **94** rotates the crank arm extension counter-clockwise after the cutting operation has taken place. The position of the parts remain with the knife in the raised position held by the solenoid holding arm **74** until the strands **16** are pulled to a position approximately indicated A in FIG. 3. At this point the pickup rod **36** contacts a switch **112** to de-energize the solenoid and permit the knife blade **62** to move back to a neutral position, as indicated in FIG. 3, balanced by the weight **80**. It should be noted that in this position the strands **16** have moved to a position at which they extend at an angle below the edge of the knife **62** so that there is no danger that they will be cut as they are moved by the pickup rod **36**.

The pickup rod **36**, as indicated in FIG. 9, is provided with extending lugs or detents **36***a* and **36***b* provided at opposite ends which extend outwardly at diametrically opposite directions. As indicated, particularly in FIGS. 5 to 8, where the pickup rod **36** is in the upper reach of its movement when it is transporting the strands across the web **10**, one of the detents **36***a* or **36***b* engages a portion of a cam track **114**. The cam track **114** extends approximately three-quarters of the way around the path of the sprocket chain **18** on each side of the table **12** and underlies the edges of the pickup rods **36** and **38** at the location of detents **36***a* and **36***b*. As indicated in FIG. 5, the pickup rod **36** may not operate backwardly such as by the tension of pulling the strands **16** and, hence, the strands will not be able to be pulled off by rotating the pickup rod. At the position B in FIG. 3 and shown in detail in FIGS. 7 and 8, the cam track **114** is discontinued to permit a backward counter-clockwise rotation of the pickup rod **36**, as indicated by arrow **116** in FIG. 7. This backward rotation is to permit a slackening of the strands **16** to permit them to be fed at right angles downwardly without tearing them. At the location C the pickup rod is again rotated in a clockwise direction, as indicated by arrow **118**, by a spring element **120** which is disposed at this corner and bears outwardly against the pickup rod to cause the clockwise rotation thereof during further movement of the chain **18**. This clockwise rotation continues until the strands are positioned on the web **10**, as indicated in FIG. 8, in order to insure that the strands are not loosely laid but tightly positioned on the web **10**. The adhesive on the web causes these ends of the strands to become adhered to the sheets and fixed in position.

Pickup rod **36** contacts the next set of strands to be laid and begins to pick them up. Instantaneously thereafter the far ends of the strands are positioned on the web **10** and the timing mechanism effects the downward movement of the knife to sever the opposite strand ends and to lay strands **16'** fully across the web **10**. The knife blade **60** is located below the path of movement of the web **10** and the web is permitted to overhang the table so that cutting of the strands effects the tensioning of the strands against the web and insures a complete even line of laying of strand elements.

When the rod element is moved downwardly around the lowermost sprocket **28**, it contacts a wire screen **122** which is filled with a tarry substance with which the pickup rods are coated. A heat lamp **124** is directed toward the screen **122** to insure that the substance is sufficiently fluid to uniformly coat the pickup rod which is moved into association with the screen **122**. The spring element **126** is connected at one end to a bracket **128** and is biased upwardly against the screen element so that the pickup rod **36** must move the spring element during its path of travel. This insures that the pickup rods **36** and **38** will be freely rotated so that the surfaces are uniformly coated. This replenishing device for the pickup rod is necessary in order to prevent grooves to be defined in the tarry substance which would prevent pickup of the strand elements due to the wearing away of the tar. The pickup rods **36** and **38** are thus freely rotatable between the position D indicated in FIG. 5 to the position E indicated in FIG. 5. At the location E the cam track element **114** again prevents rotation of the pickup rod member because of the action of the tabs or detents **36***a* and **36***b*.

In FIGS. 10 and 11, another embodiment of the invention is indicated which includes guiding means for strand elements **140** and **142**. The guiding means comprise separate rod members **144** and **146** having a plurality of comb fingers **148** and **150**, respectively. Strand elements **142** are fed between fingers **150** above elements **140** which are fed between fingers **148**. In accordance with this embodiment of the invention, means are provided, such as a pressure operated piston and cylinder combination generally designated **152** which includes means **154** which is connected to the motor **30** for operation in timed sequence thereto to pressurize one side or the other of a piston **156** having a rod **158** which is connected to the comb rod **146**. The other comb rod **144** is connected to a similar means to effect lateral reciprocation thereof. The rod **144** is capable of movement to a location which would position it in vertical alignment with the rod **146** which, however, in the meantime, is moved laterally an equal amount in the oppoiste direction.

By providing one or more comb elements which move as the pickup rod member **36'** carries the strand elements across the laying station, it is possible to achieve a diagonal strand laying pattern. As indicated in FIG. 12, the upper strand elements **142** are laid diagonally, as indicated, across the lower strand elements **140** which are laid diagonally in an opposite direction. This arrangement permits a single diagonal laying or double diagonal laying as described in accordance with whether one or more combs are employed which are reciprocated. For example, the diagonal laying **140** is achieved by moving the guide rod to the right just before the strands are laid by rod member **36'** at the opposite side of the moving web. The strands **142** would then be laid by the next rod member **36** which deposits the strands at a later station on the moving web just after the guide rod **146** is moved to the left.

A feature of the present invention is that the timing arrangements for the operation are very simple and change to accommodate webs or carriers of various widths which may be easily effected by the simple addition or subtraction of an equal number of chain links from both of the sprocket systems **14***a* and **14***b* and the timing sprocket arrangement including the chain **84**. The set-up is such that the same number of links may be removed or added to the chains on each side of the carrying rods and to the timing chain mechanism to effect the timing change to accommodate different carrier widths.

An important consideration in the present invention is that the knife may be stationarily mounted, but is located in a manner to permit the feeding of the strands beyond the plane of operation thereof for successive layings. In FIG. 2 a timing mechanism and mechanical leverage system is indicated for moving the knife at a position to permit the fibers to be carried across each laying cycle. It should be appreciated that the timing mechanism may advantageously include an electrical system which would initiate all of the necessary movements of the knife to effect the same procedures.

Thus, the invention provides the means for laying straight rows of elements across a web member which may be moved continuously during the strand laying operation. The means for feeding the web in the present embodiment is provided with the switch element **37** along the path of movement to start the strand feed in those instances where the web feed is at a lesser rate than the strand feed and switch **43** stops the strand feed when the strand is progressed beyond the rate of speed of the web until a new web area is advanced to the laying station.

The apparatus is designed to work so that the web is advanced a length equivalent to the distance measured across the strand elements, plus margins on each side equivalent to the spacing between the strand elements. In this manner uniform cross-strands or reinforcing elements can be placed on a web at uniformly spaced locations and in a manner in which a minimum of strand material is wasted.

It should be appreciated that in most instances it is desirable to feed a slightly excess amount of strand material on each side of the web so that these portions can be cut off if desired without destroying the edge of the web. The machine of the present invention operates in a very satisfactory manner to effect the cross-strand laying with a minimum of wastage of the strands and the web material.

In some instances the machine may be operated to make a mesh or composite of strand layers where the strands are placed on similar strands therebeneath rather than on a movable web and applied either straight across, on a diagonal or crossed over. It should be appreciated that in many instances longitudinally extending reinforcing strands are applied to the moving web in addition to the cross-strands and these may be applied either over or under the cross-strands, as desired. The apparatus for applying the longitudinal strands merely consists of means for feeding the longitudinal strands down onto the sheet in the same direction as the movement of the sheet and without any special placement apparatus.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

It should be appreciated that the motion of the cutting knife **62** can be controlled by suitable means such as an air cylinder, electric solenoids or mechanical devices which are activated by suitable timing means such as the lugs on the chains **18** and **20**.

The motor which drives the chains **18** and **20** can advantageously be either a variable or a constant speed motor. The pickup rods **36** and **38** can advantageously include a separate coating or may be made of a material capable of contacting and drawing off the strand elements. In those instances where tarry substances are employed, the substances can be renewed by any suitable means such as spraying, dipping etc.

What is claimed is:

**1.** A device for laying cross-strands of material comprising guide means for guiding a plurality of laterally spaced continuous strand elements, means for feeding strand elements to said guide means, means defining a laying station adjacent said guide means including a near side and an opposite side spaced laterally therefrom, a pickup rod member of a length at least equivalent to the width of the strand elements and spacings therebetween, said pickup rod member having a tacky material coating for entraining and holding the strands thereon, means for moving the pickup rod member through a path intercepting said strand elements to pick up said elements and to move them across the laying station and down below the opposite side thereof to deposit the strands on said laying station, and combination knife and pressing means for pressing the strands adjacent the near side of said laying station onto said station and for severing said strands adjacent said laying station.

**2.** A device according to claim **1**, wherein said guide means includes a laterally movable element, and a fixed guide element between which the strand elements are aligned and between which the pickup rod member is movable, said movable element being movable to vary the angle at which the strand elements will be disposed when they are picked up

**3.** A device for laying cross-strands of material comprising guide means for guiding a plurality of laterally spaced continuous strand elements as they are fed including laterally spaced comb elements, means for feeding the strand elements to said guide means, means defining a laying station adjacent said guide means, including a near side and an opposite side spaced laterally therefrom, first and second pickup rod members of a length at least equivalent to the width of the strand elements and the spacings therebetween, and said pickup rod member having a tacking material coating for entraining and holding the strands thereto, means for moving the pickup rod members at evenly spaced increments through a path intercepting said strand elements, one being arranged to pick up said elements and to move them across the laying station and down below the opposite side thereof to deposit the elements on the opposite side of said laying station, and means adjacent the near side of said laying station to press said strands downwardly on said laying station and to sever said strands, said other pickup rod member engaging said strand elements for the next cycle after the previous ones have been laid by said one pickup rod member but before said serving means operates on the previous ones.

**4.** A device for laying a thin elongated element comprising guide means including first and second laterally spaced comb members having a plurality of equally spaced teeth, means for feeding a plurality of strand elements between respective teeth of said comb members, means defining a laying station adjacent said guide means including a near side and an opposite side space laterally therefrom, a pickup rod member of a length equivalent to the width of the strand elements and the spacings therebetween, said pickup rod member having a tacky material coating for entraining and holding the strands thereon, means for moving the pickup rod member through a path intercepting said strand elements to pick up said elements and to move them across the laying station and down below the opposite side thereof to deposit the strands on said laying station, and means for severing said strands adjacent the near side including a reciprocating knife and a stationary knife located adjacent the edge of said laying station but slightly therebelow, said reciprocating knife acting to press the strand ends downwardly on said laying station and to thereafter sever them.

**5.** A method of applying a plurality of strand elements to a continuous web comprising directing the individual strands between spaced guide elements to dispose them in parallel spaced relationship, moving an adhesive coated pickup rod member between the guide elements upwardly from below the strands to cause the strands to become engaged with the adhesive coating and to be lifted and carried thereby, thereafter moving the pickup bar with the strands across the web as the web is advanced, depositing the strands on the web by moving the pickup bar down below the plane of the web, and moving a cutting member downwardly against the strands to effect the simultaneous cutting of the opposite ends of the strands below the web and the pressing of the strands downwardly on the web.

**6.** A method according to claim **5**, wherein the pickup bar is directed through means for continuously renewing the adhesive material applied to its outer face.

**7.** A device for applying thin reinforcing strands to a moving web comprising means for advancing a continuous web along a prescribed path, said web having a near edge and an opposite edge laterally spaced therefrom, conveyor means transversely surrounding the path of feed of said web having a pickup rod member thereon movable in a path around said web, said pickup rod member having a tacky material coating for entraining and holding the strands thereon, means for directing a plurality of laterally spaced strands to a location intercepting said conveyor means, means to move said conveyor means to cause said pickup rod member to move below said strands, pick them up and carry them across

the web and deposit them adjacent the opposite edge of said web by moving below the web, and knife means adjacent the near edge of the web for severing the strands at such locations.

8. A device according to claim 7, wherein said knife means includes a member movable downwardly over the strands for cutting the strands and for pressing them downwardly against the web.

9. A device according to claim 7, wherein said knife means includes a fixed blade disposed adjacent and below said web edge and a pivotally mounted blade swingable through an arc downwardly adjacent said fixed blade to sever strands which are disposed thereover.

10. A device according to claim 8, including means for raising said movable knife as said pickup rod member is moved to lift said strands and transport them through the plane of operation of said knife.

11. A device according to claim 9, including means for holding said knife in a raised inactive position clear of the movement of said pickup rod member and said strands.

12. A dvicee according to claim 7, including timing means connected to said conveyor and to said knife to raise said movable knife to clear said pickup rod member when the latter is moved to a position at which it would cross the path of operation of said knife.

13. A device according to claim 7, including means for controlling said pickup rod member to prevent rotation thereof during transportation of said strands across said web and being effective to permit rotation thereof backwardly to slacken said strands as said pickup member is moved downwardly adjacent the far edge of said web.

14. A device according to claim 13, including means for rotating said pickup member to tension said strands just prior to their being laid on said web.

15. A device according to claim 14, including a cam track diposed adjacent said conveyor, said pickup rod member having a detent member disposed in engagement with said cam track to control the rotation of said pickup rod member.

16. A device according to claim 7, including a fixed knife blade adjacent and below the near of edge of said web at the location of the incoming strands and a movable knife blade means mounting said movable knife blade for movement downwardly toward said fixed blade to sever strand materials placed thereover, means to move said movable knife blade toward and away from said fixed blade, and timing means connected to said conveyor and to said movable knife blade moving means to time the lifting of said movable knife blade to permit passage of strand material on said pickup rod member therethrough and the lowering of said knife blade to effect severance of the strand material when the opposite edge is positioned on the web.

17. A device according to claim 16, wherein said timing means includes a lever mechanism to move said knife blade, and timing lugs movable by said conveyor to intercept said mechanism to operate said knife blade.

18. A device according to claim 16, including means for holding said knife blade in a raised position.

19. A device according to claim 18, wherein said means for holding said knife in a raised position includes a solenoid having a movable plunger member adapted to move to a position to hold said knife in an upward position.

20. A device according to claim 19, including switch means adjacent said conveyor disposed for operation thereby to activate and deactivate said solenoid.

21. A device for laying cross strands comprising guide means for holding a plurality of laterally spaced continuous strand elements, a laying station adjacent said guide means including a near side and an opposite side spaced laterally therefrom, means including a rod having a surface adhesively engagable with the strand elements for pulling said strand elements across said laying station to deposit the ends thereof onto said laying station adjacent the opposite side and means to press the areas of said strand adjacent the opposite end of said laying station down onto said station, said last named means including a knife which also severs the strand elements as they are pressed.

22. A device for laying thread elements on a longitudinally moving web comprising a pickup rod having a sticky material coating, means for feeding thread elements in laterally spaced relationship transverse to said web, means for moving said pickup rod beneath said threads to engage said threads with the sticky material coating and thereafter to transport the threads on said pickup rod across the moving web and then downwardly for deposit on said web sticky material coating means disposed in the path of feed of said pickup rod to renew the coating thereon after the rod deposits the threads on the web in preparation for picking up of a new set of thread elements, and means adjacent said thread elements feeding means movable to sever said thread elements and to press the thread elements down onto said web on the side of the web adjacent said threads element feeding means.

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