Nov. 20, 1951 W. A. KNUDSON 2,575,666

REINFORCED WEB AND METHOD AND APPARATUS FOR FORMING SAME

Filed Sept. 9, 1948 6 Sheets-Sheet 1

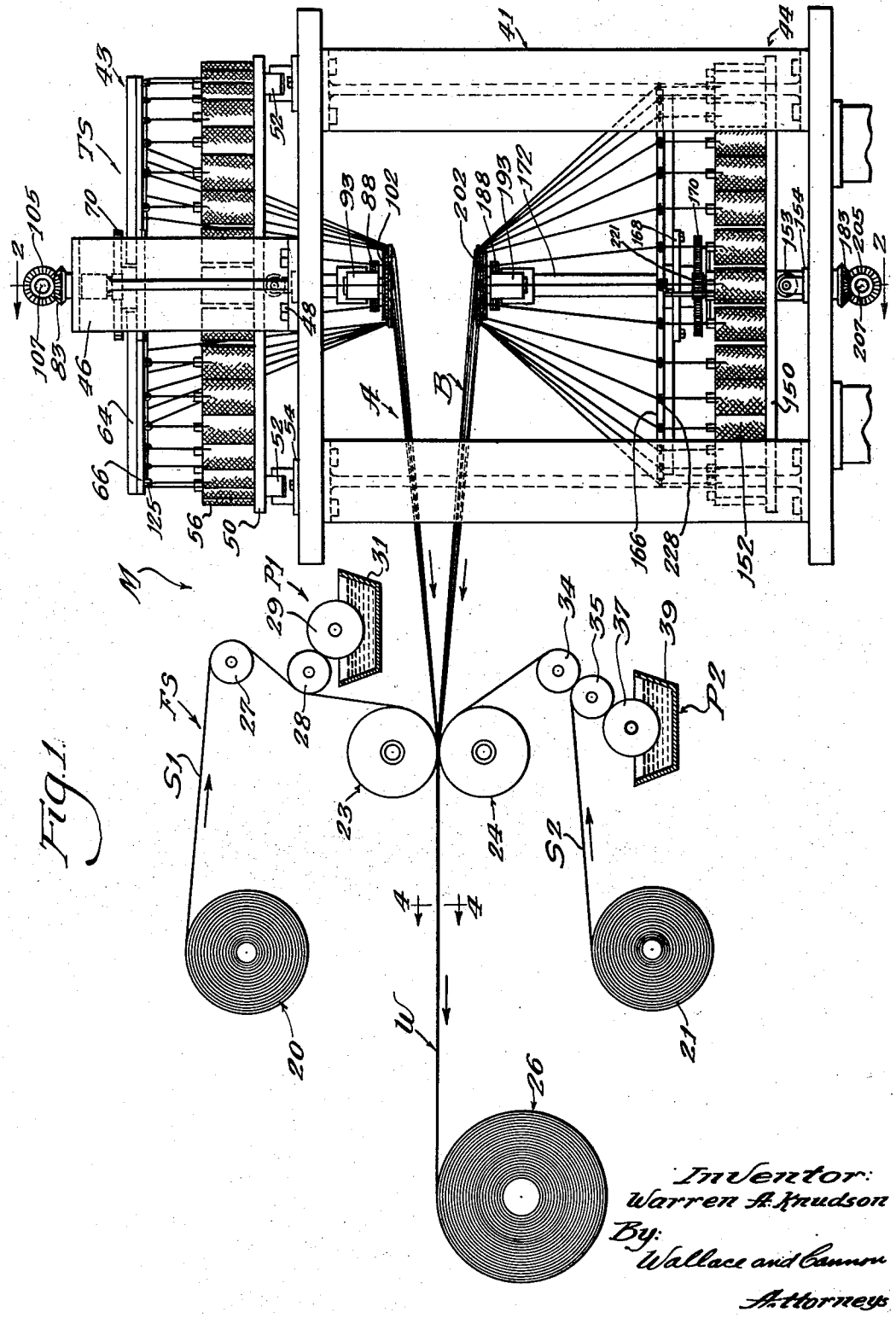

Fig. 1.

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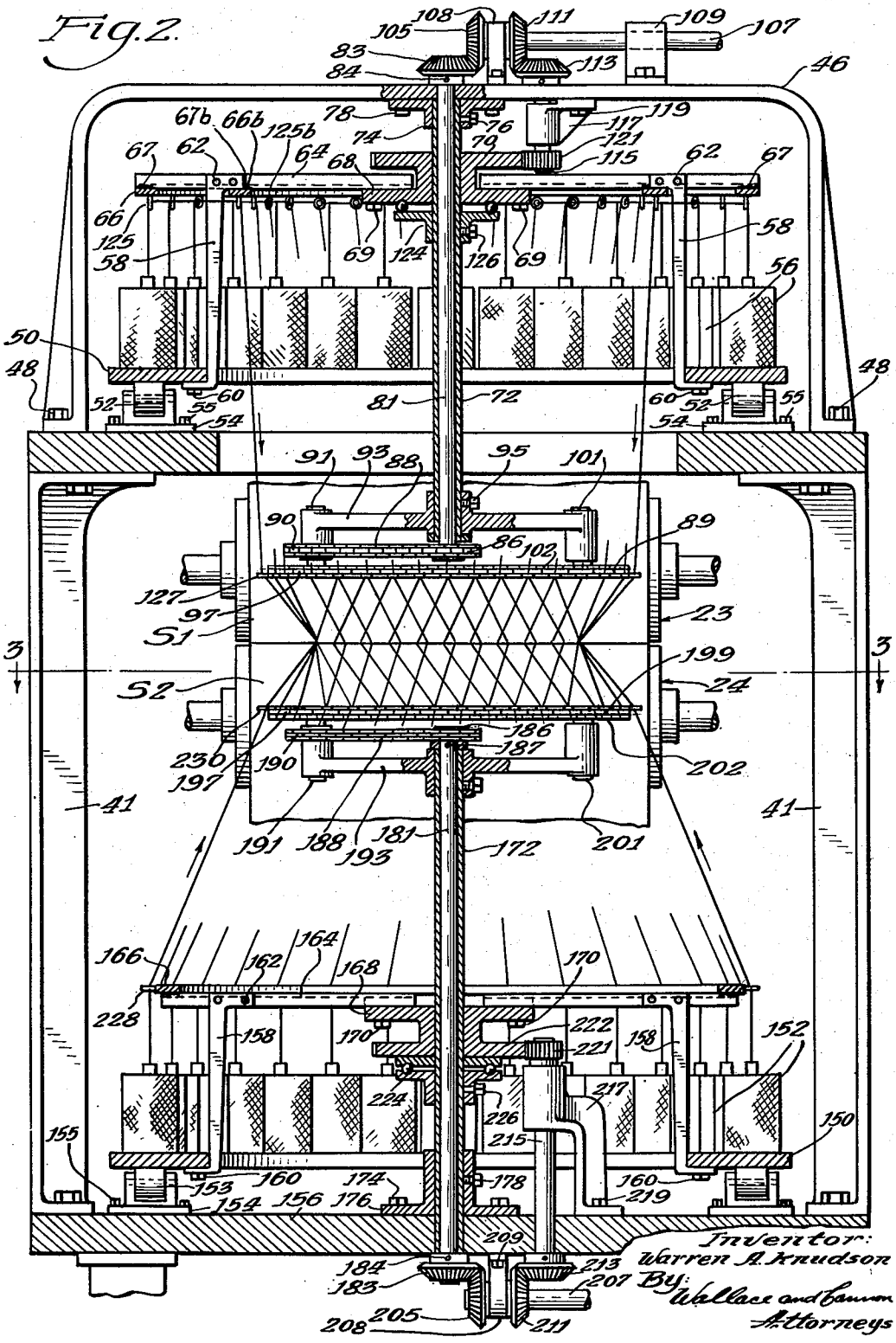
Fig. 2.



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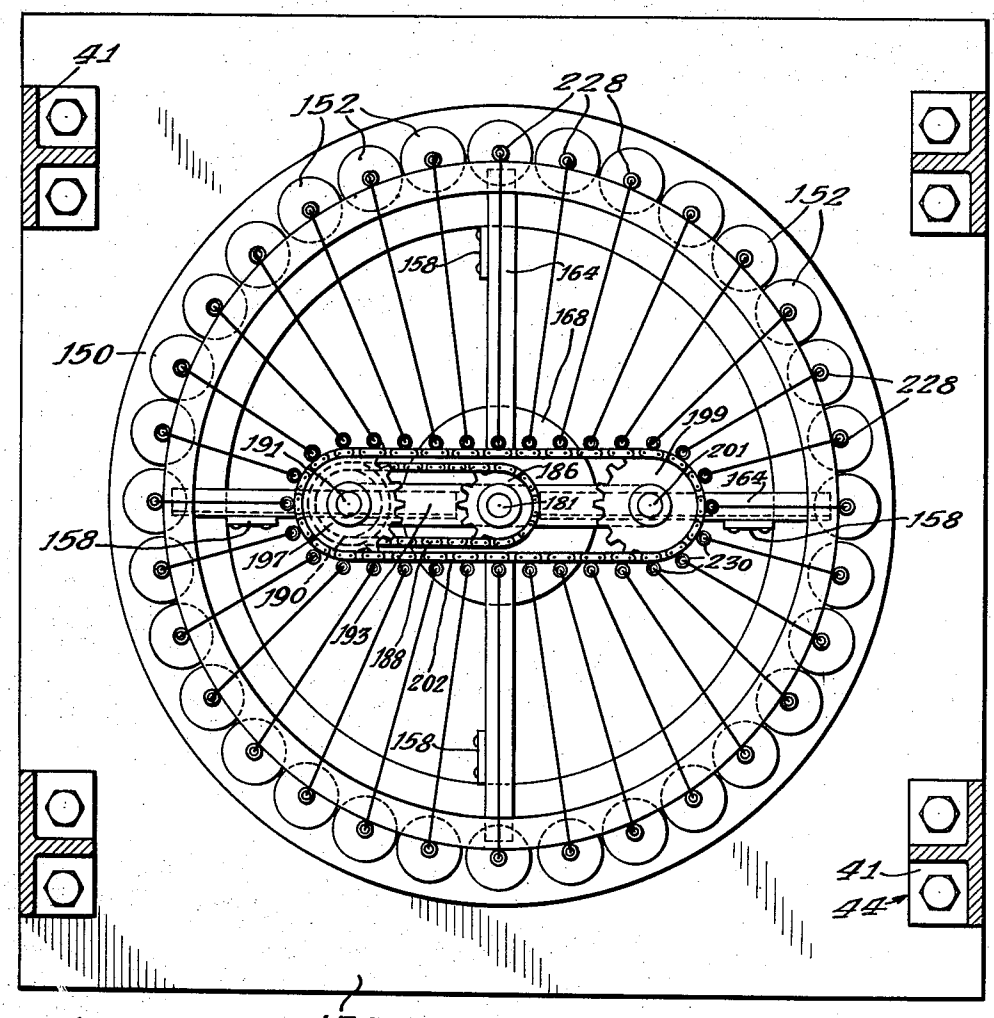

Fig. 3.

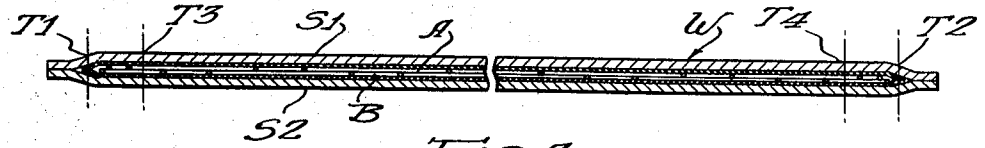

Fig. 4.

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REINFORCED WEB AND METHOD AND APPARATUS FOR FORMING SAME

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Fig. 5.

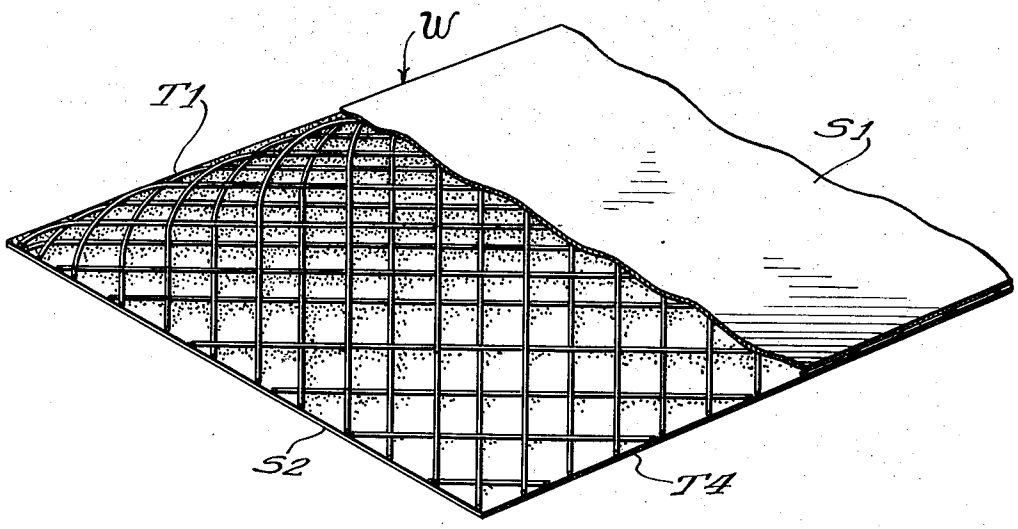
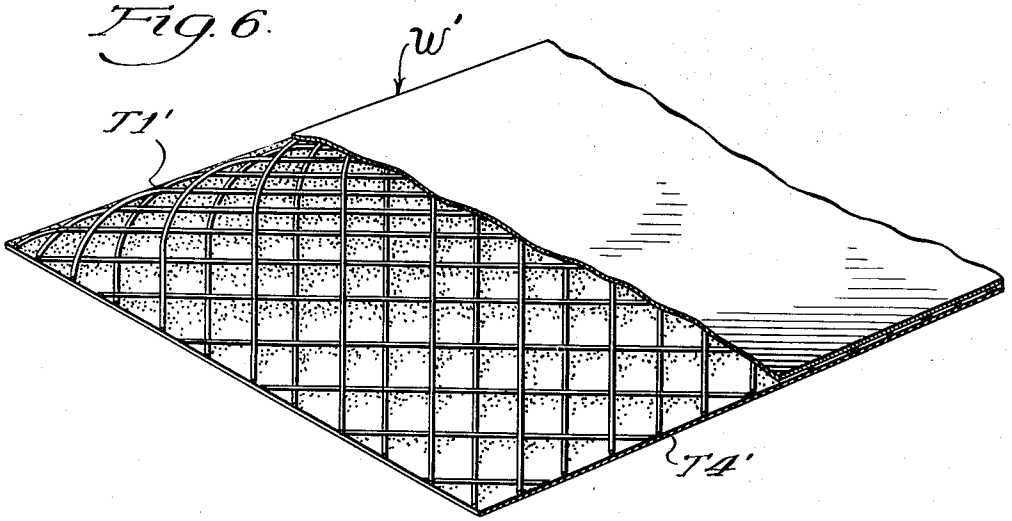


Fig. 6.



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REINFORCED WEB AND METHOD AND APPARATUS FOR FORMING SAME

Filed Sept. 9, 1948 6 Sheets-Sheet 5

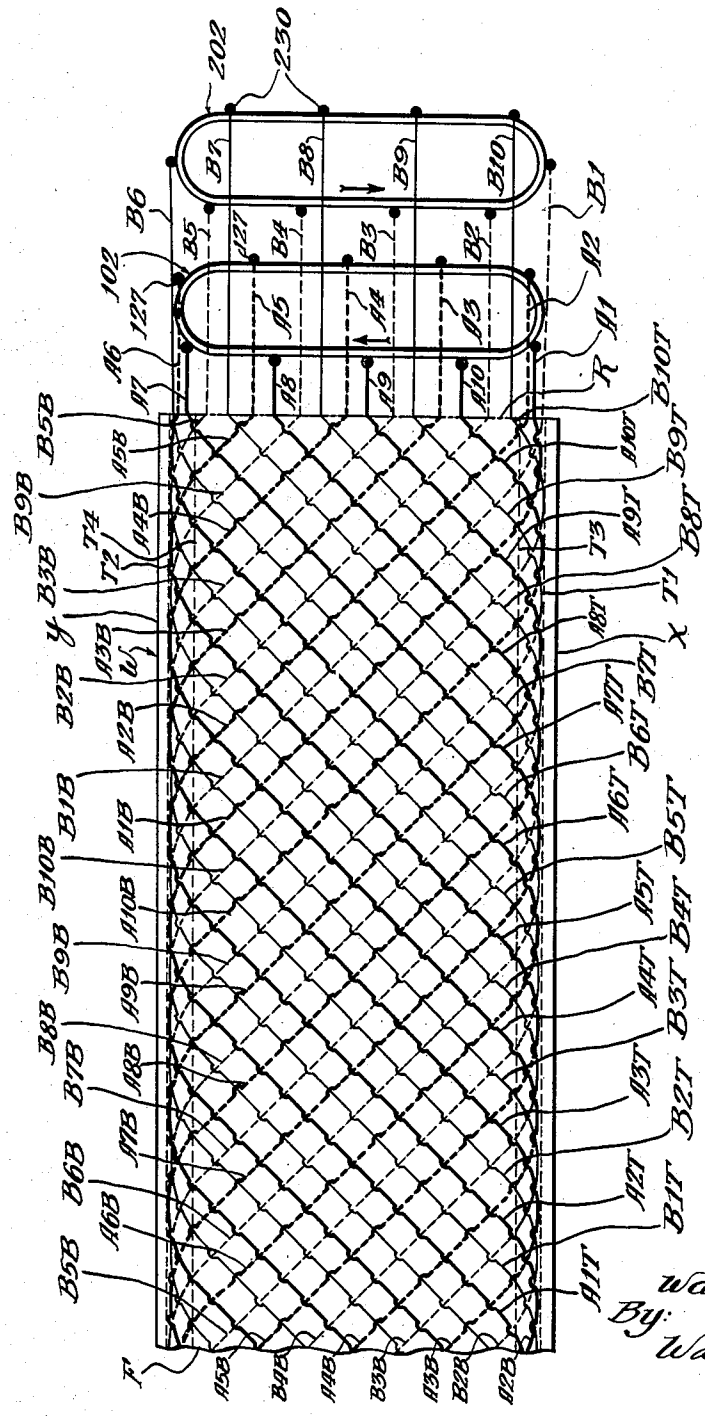

Fig. 7.

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REINFORCED WEB AND METHOD AND APPARATUS FOR FORMING SAME

Filed Sept. 9, 1948 6 Sheets-Sheet 6

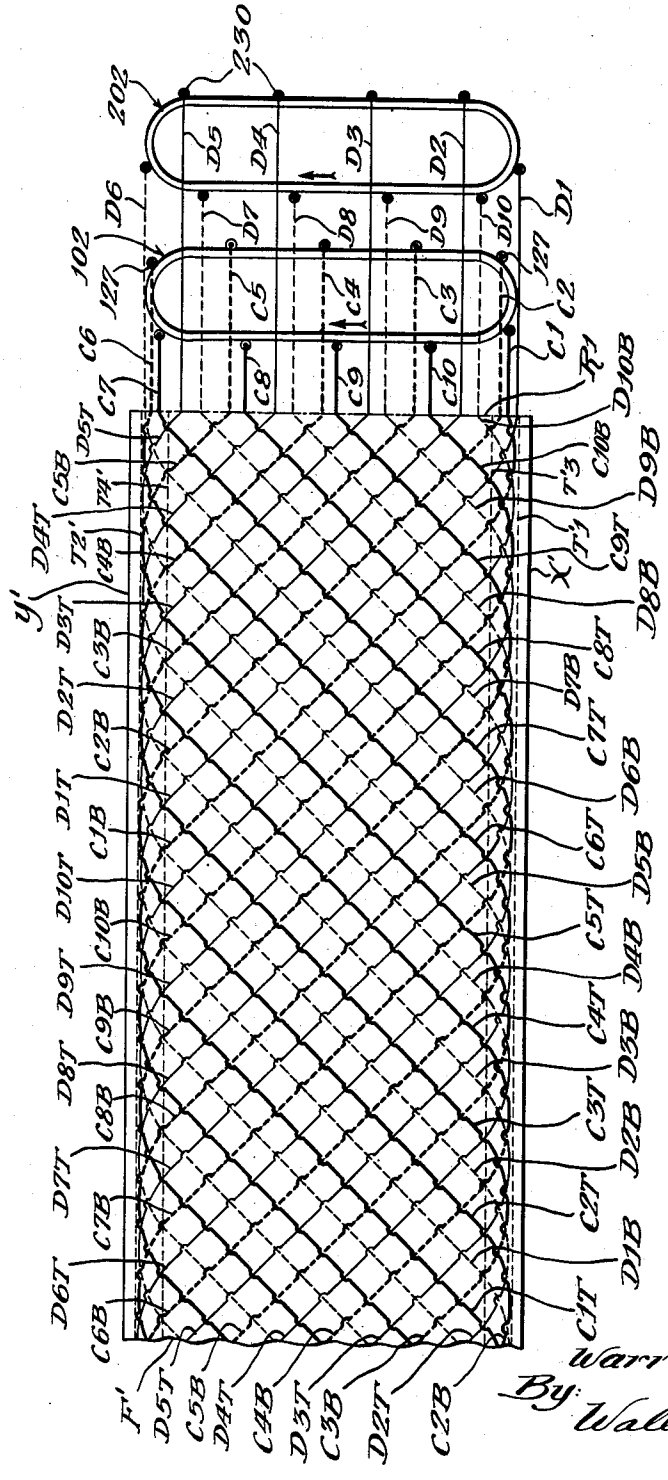

Fig. 8.

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Patented Nov. 20, 1951

2,575,666

UNITED STATES PATENT OFFICE

2,575,666

REINFORCED WEB AND METHOD AND APPARATUS FOR FORMING SAME

Warren A. Knudson, Chicago, Ill., assignor to Silvercote Products, Inc., Chicago, Ill., a corporation of Illinois

Application September 9, 1948, Serial No. 48,427

30 Claims. (Cl. 154—1.76)

1

This invention relates to reinforced web material and the method and apparatus for forming same.

A principal object of my invention is to enable a web of material to be reinforced in a novel and expeditious manner by embedding therein a plurality of strands of reinforcing material disposed in the body portion of the web in a novel zigzag and criss-cross pattern, with the individual strands not only extending back and forth across the body portion of the web but also crossing over and under other of the strands in a novel manner to afford a novel pattern of interlocked cross-strands of reinforcing material to thereby afford good tear resistance to the web of material.

Various machines and various methods of reinforcing webs of flexible material by embedding therein strands of reinforcing material in a zigzag, and even in criss-cross patterns have been known heretofore. One of such methods has been, of course, to weave the reinforcing strands together by an actual weaving process. Such a process does have the advantage of affording a pattern of reinforcing strands wherein the warp and weft threads are interlocked to afford relatively good tear resistance in substantially all directions. However, as is well known to those skilled in the art, such a process is relatively slow and expensive, and involves the use of relatively expensive and complicated equipment.

A more common method of applying reinforcing strands to a web of material has been to embed strands of material in the web in a criss-cross pattern wherein the strands running in one direction are all disposed in one plane and those extending in the other direction are all disposed in another plane, either above or below the plane of the strands running in the first mentioned direction. Such a pattern is disclosed in several earlier issued patents, such as, for example, the United States Letters Patent No. 285,838 issued to S. Pember and S. Bird on October 2, 1883, and the United States Letters Patent No. 1,460,949, issued to A. J. Currier on July 3, 1923, and has the advantage over the pattern produced by the weaving process of being capable of being relatively readily and rapidly applied to a web of material. However, this latter process also has a relatively serious disadvantage over the weaving process, namely, that the cross-strands are not interlocked with each other so that the strands are free to separate and afford low tear resistance as compared to the interwoven strands produced by weaving.

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An important object of my invention is to enable a novel reinforced web to be produced in a novel and expeditious manner whereby strands of reinforcing material are disposed in the web in a novel criss-cross and interlocked manner to impart good tear resistance to the web.

A further object of my invention is to provide a web of material reinforced with strands of reinforcing material embedded therein, wherein the strands of reinforcing material are disposed in a novel mesh pattern with predetermined individual strands disposed alternately over and under strands crossed thereby so as to be effectively interlocked therewith and thereby.

One of the inherent disadvantages of applying the reinforcing strands to a web by a weaving process is the fact that such a process requires excessive straight-line reciprocation of parts in the machine with which the weaving is performed, the harnesses, by which the warp threads are controlled, moving up and down in a substantially vertical direction, and the shuttles, by which the weft threads are laid between the warp threads, moving swiftly back and forth in a horizontal direction. Such excessive reciprocation of parts, as is well known to those skilled in the art, is undesirable for several reasons, one being that a relatively great amount of vibration is produced thereby so that the operation is relatively noisy; and another being that the abrupt changes of direction in the movement of the parts produces undesirable operating characteristics that increase the wear to the various parts of the machine and increase the maintenance problems thereof. As a result, as a practical matter, it has often been found preferable to sacrifice the beneficial results of the interlocking mesh produced by the weaving process for the better operating characteristics of the machines which produced the non-interlocking mesh by rotative movements such as that utilized in the aforementioned Currier Patent No. 1,460,949, even though the resulting pattern of reinforcing strands did not afford as good tear-resisting characteristics.

An important object of my invention is to afford a novel machine wherein strands of reinforcing material may be applied in a criss-cross pattern to a web of material by mechanism moving in a simple, rotative manner but which is effective to apply the strands to the web in a manner whereby certain of the strands are interlocked by and between strands running in another direction and crossed thereby.

An object ancillary to the foregoing is to pro-

vide a novel reinforced web having good tear-resisting characteristics in a plurality of directions.

Yet another object of my invention is to enable a novel laminated web of material, such as, for example, a web of reflective heat insulation material, to be formed from two sheets of flexible material adhered together by a suitable adhesive material into which a plurality of strands of reinforcing material has been laid in a criss-cross, interlocking pattern.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment and the principles thereof and what I now consider to be the best mode in which I have contemplated applying those principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

Fig. 1 is a side elevational view of a machine illustrating a preferred embodiment of my invention, part of the mechanism thereof being shown diagrammatically;

Fig. 2 is a sectional view taken substantially along the line 2—2 in Fig. 1;

Fig. 3 is a sectional view taken substantially along the line 3—3 in Fig. 2;

Fig. 4 is a detail sectional view taken substantially along the line 4—4 in Fig. 1;

Fig. 5 is a perspective view of a web of material comprising a preferred embodiment of my invention, parts thereof being broken away;

Fig. 6 is a perspective view, similar to Fig. 5 but showing a modified form of my novel web;

Fig. 7 is a diagrammatic view showing the manner in which reinforcing strands are applied to a web of material, and the pattern of such strands, in the preferred embodiment of my invention shown in Fig. 5; and

Fig. 8 is a diagrammatic view showing the manner in which strands are applied to a web, and the pattern of such strands, in the modified form of my invention shown in Fig. 6.

For the purpose of illustrating my invention, a machine M is shown in Figs. 1, 2 and 3, which embodies the principles of my invention, and which is operable to form a reinforced web in accordance with the principles of my invention, as will be discussed in greater detail hereinafter.

The novel machine M, Fig. 1, comprises, in general, means FS for feeding two elongated sheets S1 and S2 of suitable flexible material together and bonding the sheets S1 and S2 together with a plurality of threads or strands A and B of suitable reinforcing material disposed therebetween in a novel criss-cross and interlocking pattern, Figs. 5 and 6, to thereby afford a web of material W which is well reinforced against tear in a novel and practical manner, the strands A and B being fed into position between the sheets S1 and S2 by a thread-feeding mechanism TS.

The machine M, shown in the accompanying drawings is especially well adapted for the production of reflective heat-insulation comprising two sheets of reflective material bonded together in face-to-face relationship with strands of reinforcing material disposed between the two sheets. When the machine M is so used, the sheets S1 and S2 may be formed of any suitable material such as, for example, flexible paper sheeting having one face coated with suitable reflective material such as finely divided aluminum, or flexible paper having aluminum foil adhesively secured thereto; the adhesive material used to bond the two sheets S1 and S2 together may be any one of several adhesive agents but preferably is a relatively non-hygroscopic material such as, for example, asphalt, and is preferably applied to the uncoated faces of the sheets S1 and S2; and the reinforcing strands A and B may be constructed of any suitable material such as rayon, including both cellulose acetate rayon and viscose rayon, or the like.

The sheet feeding unit FS, shown diagrammatically in the drawings, comprises in general, a pair of compression rollers 23 and 24 between which a pair of elongated sheets S1 and S2 may be passed from supply spools 20 and 21, respectively, onto a wind-up or storage spool 26. Two adhesive applying mechanisms P1 and P2 are disposed between the spool 20 and the rollers 23 and 24, and the spool 21 and the rollers 23 and 24, respectively, and each is effective to apply adhesive material to one face of a corresponding one of the shets S1 and S2, respectively.

During an operation of my machine, the sheets S1 and S2 enter the bite of the rollers 23 and 24 wtih the adhesive-bearing faces thereof disposed in face-to-face relationship to each other. As the sheets enter the bite of the rollers 23 and 24 in this manner, a plurality of strands of reinforcing material are fed by the strand-laying unit TS into the adhesive between the sheets in a novel pattern, as will be discussed in greater detail presently. The sheets S1 and S2 are then passed on between the rollers 23 and 24, and are pressed together thereby so that the sheets S1 and S2 are bonded together by the adhesive material into a novel compact web W reinforced by the strnads A and B of reinforcing material disposed between the sheets in the aforesaid novel pattern. The web W, advancing from the rollers 23 and 24, may then be wound upon a roller 26 as shown in Fig. 1.

The adhesive applying mechanism used in my novel machine may be of any suitable type, the mechanism P1 shown diagrammatically in the drawings, Fig. 1, comprising a trough 31, within which is disposed a supply of suitable adhesive material, such as, for example, asphalt. A roller 29 is rotatably mounted in a manner whereby the lower peripheral surface thereof is disposed in the adhesive material in the trough 31. An idler roller 28 is rotatably mounted in parallel alignment with the roller 29, and is disposed in contact therewith so that during rotation of the rollers 28 and 29 adhesive material picked up from the trough 31 by the roller 29 is applied to the surface of the roller 28. The sheet S1, in passing from the spool 20 to the rollers 23 and 24 passes over an idler roller 27 and the roller 28, the latter roller being effective to apply adhesive to the adjacent face of the sheet S1 passing thereover. When the machine M is being used to produce a web of reflective heat-insulation in the manner previously set forth, the face of the sheet S1 to which the adhesive is applied is preferably, of course, the face opposite that on which the reflective material is disposed.

The adhesive applying mechanism P2 is substantially the same as the mechanism P1, comprising a trough 39, carrying a supply of adhesive material, such as asphalt, which may be applied to a roller 35 by a roller 37 disposed in such a

position that the portion of the peripheral surface thereof is submerged in the adhesive material in the trough. The sheet S2 passes over the roller 35 and an idler roller 34 in its movement from the spool 21 to the bite of the compression rollers 23 and 24, so that adhesive material is applied thereto by the roller 35.

Thus, it will be seen that, as previously mentioned, when the sheets S1 and S2 are fed into the bite of the rollers 23 and 24, the adhesively coated faces of the sheets are disposed adjacent to each other so that in passing between the compression rollers 23 and 24 the sheets S1 and S2 may be effectively bonded before being wound on the storage spool 26.

In applying the adhesive to the face of the sheets S1 and S2, I prefer to apply it to the center portion only, leaving a marginal edge portion on each side of each sheet which is not coated with adhesive so that, in passing between the rollers 23 and 24, the adhesive material is not extruded from the edges of the sheets. Therefore, in constructing my novel machine M, I prefer to use rollers 28 and 35 which are shorter in length than the width of the sheets S1 and S2, and I prefer to center the sheets S1 and S2 on the rollers 28 and 35 as they pass thereover so that adhesive is only applied to the sheets S1 and S2 between two outer trim lines T1 and T2, Figs. 4 and 7, which are disposed inwardly from the longitudinal edge portions of the sheets.

The thread-laying unit TS comprises, in general, an elongated frame 41 on the opposite end portions of which are mounted two strand-laying heads 43 and 44, Figs. 1 and 2. The frame 41 is preferably disposed in vertical position, with the two heads 43 and 44 mounted thereon in horizontal position, one above the other, in vertical alignment with each other.

Each of the heads 43 and 44, as will be discussed in greater detail presently, comprises mechanism for applying a plurality of threads or strands of reinforcing material in a zig-zag, criss-cross pattern between the sheets S1 and S2, as the sheets S1 and S2 advance into the bite of the rollers 23 and 24. Typical patterns of strands of reinforcing material which may be applied to the sheets S1 and S2 by the machine M are shown diagrammatically in Figs. 7 and 8 and will be discussed in greater detail hereinafter.

The heads 43 and 44 are so constituted and arranged that, during an operation of my novel machine, the strands fed thereby may be fed, by simple rotative movement of certain portions of the heads, into a novel criss-cross, interlocked pattern which, when embedded in the adhesive material disposed between the sheets S1 and S2, and compressed therein by the rollers 23 and 24, imparts good tear-resistance in a plurality of directions to the resulting web W.

The upper head 43 includes a U-shaped bracket 46 mounted on the upper end portion of the frame 41 and attached thereto by bolts 48. Within the bracket 46, a creel 50 is mounted on a plurality of rollers 52 journaled in suitable brackets 54 attached to the upper end of the frame 41 by bolts 55.

The creel 50 is annular in form, Figs. 2 and 3, and has mounted thereon a plurality of spools 56 for paying out strands A of suitable reinforcing material as will be presently discussed in greater detail.

A plurality of brackets 58 are attached at their lower ends to the inner peripheral edge portion of the creel 50 by bolts 60, and each bracket 58 extends upwardly from the creel 50 and is attached at its upper end by rivets 62 to the central portion of a corresponding one of a plurality of elongated bars 64. The bars 64 are radially disposed within a guide-ring 66 and are connected thereto, at their outer ends, by any suitable means such as welding 67. The inner end portions of the bars 64 are connected by bolts 69 to a plate 68, to which is attached a spur gear 70, Fig. 2. A second guide-ring 66b is disposed within the first mentioned guide-ring 66 and is attached to the bars 64 by suitable means such as welding 67b.

A sleeve 72, having a mounting plate 74 attached to the upper end portion thereof by a set screw 76, extends vertically through the upper end portion of the U-shaped bracket 46 and is non-rotatably connected thereto by bolts 78 extending through the mounting plate 74. The sleeve 72 extends vertically downwardly from the bracket 46 through the centers of the spur gear 70, the plate 68, the guide-rings 66 and 66b, and the creel 50, which rotate therearound during an operation of my machine, as will be presently discussed in greater detail. A bearing 124 is mounted on the sleeve 72 and is attached thereto by a set screw 126, and the plate 68, attached to the guide-ring 66 by the bars 64, rests on top of the bearing 124, to thereby afford additional support for the guide-rings 66 and 66b and the creel 50.

A shaft 81, having a bevel gear 83 attached to the upper end portion thereof by any suitable means such as a pin 84, is journaled in the sleeve 72 and extends therethrough. A sprocket wheel 86 is attached to the lower end portion of the shaft 81, below the sleeve 72, for rotation therewith, and is connected by a chain 88 to a sprocket wheel 90 fixedly secured to a shaft 91 which is journaled in one end of an arm 93 mounted on the lower end portion of the sleeve 72 and attached thereto by a set screw 95. Another sprocket wheel 97 is also mounted on the shaft 91 for rotation therewith, and a sprocket wheel 99 is mounted on a shaft 101 journaled in the end of the arm 93 opposite that in which the shaft 91 is journaled. A chain 102 is trained over the sprocket wheels 97 and 99 and is supported thereby in a substantially horizontally disposed position for a purpose which will be discussed in greater detail presently.

As will be seen from Figs. 1 and 2, the chain 102 is disposed on the sprockets 97 and 99 in a manner whereby, upon rotation of the sprockets 97 and 99, the chain 102 passes thereover in an elongated, substantially elliptical-shaped orbit, the major axis of the orbit being disposed in parallel alignment with the bite of the rollers 23 and 24 and the two long passes of the chain, extending between the sprockets 97 and 99, being preferably disposed in parallel horizontal position, with one of the passes disposed closer to the rollers 23 and 24 than is the other pass.

So as to simplify the reference to various parts of the machine M shown in the drawings, it will be understood that the left side of the machine, as viewed in Fig. 1, is the "front" thereof, and therefore, it will be seen that the one previously mentioned pass of the chain 102, which is disposed closer to the rollers 23 and 24 than the other pass disposed in parallel relationship thereto, constitutes the front pass of the chain 102, and the other pass of the chain 102 constitutes the rear pass thereof.

The bevel gear 83 on the shaft 81 is engaged

with a bevel gear 105 mounted on the end of a shaft 107 journaled in bearings 108 and 109 mounted on the upper end portion of the U-shaped bracket 46, the shaft 107 comprising the main drive shaft for the head 43. A second bevel gear 111 mounted on the shaft 107 is engaged with a bevel gear 113 mounted on the upper end portion of a shaft 115 journaled in a bearing 117 attached to the bracket 46 by suitable means such as bolts 119. A pinion gear 121 is mounted on the lower end of the shaft 115 and is engaged with the spur gear 70.

Thus, it will be seen that rotation of the drive shaft 107 is effective, through the bevel gear 105, the bevel gear 83, the shaft 81, the sprocket wheel 86, the chain 88, and the sprocket wheel 90 to cause the sprocket wheels 97 and 99 to rotate and thereby cause the chain 102 to pass around the sprocket wheels 97 and 99 in the aforementioned elliptical-shaped orbit. Also, it will be seen that rotation of the drive shaft 107 is effective, through the bevel gear 111, the bevel gear 113, the shaft 115, the pinion 121, the spur gear 70, and the plate 68 to rotate the bars 64, to thereby cause the guide-rings 66 and 66b to rotate, and also, because of the interconnection of the creel 50 to the guide-ring 66 by the bars 64 and the brackets 58, to cause the creel 50 to rotate. It will be noted that the parts of this mechanism are so constituted and arranged that the chain 102, the ring 66 and the creel 50 are all caused to rotate in the same direction by rotation of the drive shaft 107, and, of course, it will be understood that the gearing of this mechanism is such that the chain 102, the ring 66 and the creel 50 all rotate about the sleeve 72 at the same rate of rotation, when driven by the drive shaft 107.

The guide-rings 66 and 66b, and the guide-chain 102 each have a plurality of guide-eyes or grommets 125, 125b, and 127 mounted thereon, respectively. The same number of guide-eyes 127, 125, and 125b are mounted on the chain 102 and the rings 66 and 66b as there are spools 56 mounted on the creel 50. Thus, it will be seen that for each spool 56 there is provided a corresponding guide-eye 125, guide-eye 125b, and guide-eye 127. The corresponding spools 56 and guide-eyes are so disposed relative to each other that a thread of reinforcing material may be extended from each of the spools 56 through the corresponding guide-eyes 125 and 125b and into the corresponding guide-eye 127 in spaced relation to the threads extending from the other spools 56. During an operation of my machine M, each of the individual strands A are payed out through the corresponding guide-eyes 125 and 127 into the bite of the rollers 23 and 24 and are pressed by the rollers 23 and 24 into the adhesive material disposed between the two sheets S1 and S2, as will be discussed in greater detail hereinafter. The guide-eyes 125, 125b, and 127 are preferably constituted so as to afford a predetermined resistance to the passage of the strands therethrough, to thereby insure proper tensioning of the strands passing into the bite of the rollers 23 and 24.

The lower strand-laying head 44 is substantially the same as the head 43 with the parts thereof disposed in reversed position, and with the exception that only one guide-ring 166 is embodied therein as compared to the two guide-rings 66 and 66b embodied in the head 43. Thus, it will be seen that in the head 44, a creel 150 bearing a plurality of spools 152 is mounted on a plurality of rollers 153 journaled in bearings 154 mounted on the lower end plate 156 of the frame 41 and attached thereto by bolts 155. Elongated brackets 158 are attached to their lower end portions to the creel 150 by suitable means such as bolts 160 and extend upwardly therefrom and are attached at their upper end portions by rivets 162 to bars 164, the bars 164 being attached at one end to a guide-ring 166 by any suitable means such as welding, and the other end portions of the bars 164 being attached to a plate 168 by bolts 170.

A sleeve 172, which is similar to the sleeve 72, is attached to the end plate 156 of the frame 41 by bolts 174 which extend through a mounting plate 176 attached to the sleeve 172 by a set screw 178. A shaft 181 extends through the sleeve 172 and the end plate 156, and has a bevel gear 183 attached to the lower end portion thereof by suitable means such as a pin 184. A sprocket wheel 186 is mounted on the upper end portion of the shaft 181 and is connected thereto by a pin 187, and is connected by a chain 188 to a sprocket wheel 190 mounted on, and fixed to, a shaft 191 journaled in one end of an arm 193. A second sprocket wheel 197 is mounted on the upper end of the shaft 191 and is connected by a chain 202 to a sprocket wheel 199 mounted on a shaft 201 journaled in the other end of the arm 193, the chain 202 being trained over the sprocket wheels 197 and 199 in a manner whereby it passes thereover in an elongated, substantially elliptical-shaped orbit, Fig. 3, the two long passes of the chain, like the two long passes of the chain 102, being preferably disposed in parallel horizontal position and the major axis of the orbit of the chain 202 being disposed in parallel alignment with the bite of the rollers 23 and 24 below the major axis of the orbit of the chain 102.

The bevel gear 183, on the lower end of the vertically extending shaft 181, is engaged with another bevel gear 205 mounted on an end portion of a horizontally disposed drive shaft 207 journaled in suitable brackets such as, for example, a bracket 208 attached to the lower face of the end plate 156 of the machine frame 41 by bolts 209. Therefore, it will be seen that when the shaft 207 is rotated, the shaft 181 is driven thereby and is effective to cause the sprockets 186, 190, 197 and 199 to rotate and thereby effect rotation of the chain 202.

Another bevel gear 211 is attached to the shaft 207, for rotation therewith, and is engaged with a gear 213 mounted on the lower end portion of a shaft 215 journaled in a bracket 217 secured to the upper face of the end plate 156 by bolts 219. A pinion gear 221 is mounted on the upper end portion of the shaft 215 and is engaged with a spur gear 222 connected to the plate 168.

A bearing 224 is mounted on the sleeve 172 below the guide-ring 166 and is attached to the sleeve by suitable means such as a set screw 226. The spur gear 222 rests on, and is supported by the bearing 224 to thereby afford additional support for the guide-ring 166 and the creel 150.

Like the guide-rings 66 and 66b, and the guide-chain 102, the guide-ring 166 and the guide-chain 202 have a plurality of guide-eyes or grommets 228 and 230, respectively, mounted thereon through which the threads or strands of reinforcing material are threaded from corresponding spools 152 on the creel 150 into the bit of the rollers 23 and 24, and which constitute tensioning devices for insuring the proper tension

of the strands passing into the bite of the rollers 23 and 24.

From the foregoing, it will be seen that the guide-chains 102 and 202, and their associated guide-rings and creels, may be driven by the drive shafts 107 and 207, respectively, in either one of two directions. During an operation of my machine, the guide-chains 102 and 202 are simultaneously rotated, and, during such time, I prefer that the shafts 107 and 207 be driven in such a manner that the chains 102 and 202 are rotated at the same speed but in opposite directions. However, this is merely a matter of personal preference, the reinforcing strands applied to the web W in this manner assuming the pattern shown in Figs. 6 and 8, as will be discussed in greater detail presently, and it will be noted that the chains 102 and 202 may be driven in other ways such as, for example, in the same direction whereby the strands are applied to the web in the pattern shown in Fig. 8, as will also be discussed in greater detail hereinafter, and which comprises a modified form of my invention.

In preparing my novel machine M for operation, the sheet S1 may be extended from the spool 20, over the rollers 27 and 28 into the bite of the rollers 23 and 24, and the sheet S2 may be extended from the spool 21, over the rollers 34 and 35 into face-to-face relationship with the sheet S1 in the bite of the rollers 23 and 24. Thereafter, the strands A and B of reinforcing material from the heads 43 and 44, respectively, are threaded through the guide-eyes 125, 125b, and 127, and the guide-eyes 228 and 230, from the spools 56 and 152, respectively, and are extended into the bite of the rollers between the sheets S1 and S2.

In extending the strands A and B from the guide-chains 102 and 202, respectively, into the bite of the rollers 23 and 24, I prefer to do this in a manner, Fig. 1, whereby the strands extending from the front pass of the chain 102 are disposed above the strands extending from the rear pass thereof, and the strands extending from the rear pass of the chain 202 are disposed above the strands extending from the front pass thereof. Thus, it will be seen that the strands A and B extend from the guide-chains 102 and 202 into the bite of the rollers 23 and 24 in what amounts to four sets disposed one above the other, Fig. 1; the top set extending from the front pass of the chain 102; the next lowest set extending from the rear pass of the chain 102; the next lowest set extending from the rear pass of the chain 202; and the bottom set extending from the front pass of the chain 202. From this it will be seen that the two sets of strands A, which comprise the group of strands extending from the chain 102, enter the bite of the rollers 23 and 24 above the two sets of strands B, which comprise the group of strands extending from the chain 202.

During an operation of my novel machine M, the sheets S1 and S2 are advanced between the rollers 23 and 24, thereby causing the strands of reinforcing material A and B, embedded therebetween, to be pulled longitudinally outwardly through the guide-eyes 127 and 230 on the guide-chains 102 and 202, respectively. In a preferred operation of my machine M, the chain 102 is driven in a clockwise direction and the chain 202 is driven in a counter-clockwise direction, as viewed from the top thereof, and, therefore, it will be seen that during such an operation the strands A and B will not only be pulled out from the chains 102 and 202 by the movement of the sheets S1 and S2 between the rollers 23 and 24, but also the movement of chains 102 and 202 will be effective to move the strands back and forth across the sheets S1 and S2, each strand moving across the sheets in one direction with one pass of its guide-chain and then moving across the sheets in the other direction with the other pass thereof.

As previously mentioned, the group of strands A extends from the chain 102 into the bite of the rollers 23 and 24 in two sets, one set extending from the front pass of the chain 102 and the other set extending therebelow from the rear pass thereof. Thus, it will be seen that during an operation of my novel machine M, when those strands extending from the front pass of the chain 102 are being moved thereby across the sheets S1 and S2 from left to right, as viewed in Fig. 2, the set of strands extending from the rear pass of the chain 102 are being moved across the sheets S1 and S2 from right to left below the first mentioned set, so that the strands applied to the sheets S1 and S2 in one direction are disposed above those applied in the other direction. Similarly, it will be seen that the group of strands B extends from the chain 202 into the bite of the rollers 23 and 24 in two sets, one set extending from the rear pass of the chain 202, and the other set extending from the front pass below the first mentioned set. Therefore, it will be seen that during the rotation of the chain 202 in the counter-clockwise direction, as viewed in Fig. 2, the strands which extend from the rear pass thereof, and are being moved across the sheets S1 and S2 from left to right thereby, are applied to the sheets above the strands being simultaneously applied to the sheets from right to left by the front pass of the chain 202.

The simultaneous application of both of these groups of reinforcing strands to the sheets of material in this manner and in accordance with the principles of my invention is effective to produce the novel criss-cross pattern of reinforcing strands shown in Fig. 7, wherein alternate strands of the reinforcing material, extending in both directions across the sheets S1 and S2, extend alternately over and under adjacent strands crossed thereby, to thereby afford a novel pattern wherein alternate strands in both directions are effectively interlocked with the strands crossed thereby.

In Fig. 7, a web W produced in this manner, and the method of producing the same, is illustrated diagrammatically. Thus, it will be seen that in Fig. 7 is diagrammatically shown a length of the web W, onto which twenty strands A1—A10, and B1—B10 have been applied by the guide-chains 102 and 202 in accordance with the principles of my invention, the strands A1—A10 being applied thereto by the chain 102, and the strands B1—B10 being applied by the chain 202. It will be seen that the length of the web W shown in Fig. 7, and which extends from one end F to the other end R, comprises such a length of the sheets S1 and S2 as is fed between the rollers 23 and 24 during a complete revolution of the chains 102 and 202 so that, considering the end R to be disposed between the bite of the rollers 23 and 24 of my machine M, the chains 102 and 202 are shown in position to again begin the pattern previously begun at F and to repeat the same on the next length of the sheets S1 and S2 to be fed past the rollers 23 and 24.

Also, it will be noted that in Fig. 7 only ten strands A and B are shown as being applied to

the sheets S1 and S2 by the chains 102 and 202, instead of the thirty-two strands shown in Figs. 1, 2 and 3. However, it will be understood that the fewer number of strands are shown in Fig. 7 only to simplify the diagrammatic illustration of the principles of my invention, and that my invention is not limited to any particular number of strands but that various numbers of strands may be applied to a web in accordance with the principles of my invention.

In addition, it will be noted that in Fig. 7 the strands A1—A10 and B1—B10 are shown extending between the guide-chains 102 and 202 and the edge R of the web W in perpendicular relationship to the edge R, whereas, in actuality, that portion of the strands would be disposed at an angle to the left or right, as shown in Fig. 2, because of the movement of the chains 102 and 202 and the tension applied to the strands. However, it will be understood that the showing of the aforementioned portion of the strands A1—A10 and B1—B10 in perpendicular position in Fig. 7 is utilized so that the strands may readily be shown as clearly separated from each other at that point and thereby assist a person studying the diagram to follow each individual strand.

It will be seen that in order to assist in distinguishing the different strands of reinforcing material from each other, the strands A and B are represented, in Fig. 7, in accordance with a code wherein: the strands A are represented by lines of one thickness; the strands B are represented by lines of another thickness; the portions of the strands A which are applied to the web W by the front pass of the chain 102 are shown in solid lines, and are indicated by the reference members A1—A10, respectively, with the suffix, T, added thereto; the portions of the strands which are applied to the web W by the rear pass of the chain 102 are shown in broken lines having relatively large dashes, and are indicated by the reference numerals A1—A10, respectively, with the suffix, B, added thereto; the portions of the strands B which are applied to the web W by the rear pass of the chain 202 are shown in solid lines, and are indicated by the reference numerals B1—B10, respectively, with the suffix, T, added thereto; and the portions of the strands B which are applied to the web W by the front pass of the chain 202 are shown in broken lines having relatively small dashes, and are indicated by the reference numerals B1—B10, respectively, with the suffix, B, added thereto. However, it will be understood that this code is used merely to aid in distinguishing the various portions of the strands from each other, and that I do not limit myself to the relative sizes of strands shown therein.

As is best seen in Fig. 7, during each rotation of the chain 102, during an operation of my machine, each of the strands A1—A10, respectively, is moved in one direction across the other strands A on one side thereof and is then moved across the other strands A in the other direction and on the other side thereof. Thus, for example, it will be seen that between the ends F and R of the web W shown in Fig. 7, the strand A1 was first moved from left to right, as viewed in Fig. 2, across the sheets S1 and S2 as the guide-eye 127, through which it extended, moved across the front pass of the chain 102, and then moved from right to left across the sheets S1 and S2 as the guide-eye 127, through which it extended, moved across the rear pass of the chain 102. In this manner, it will be seen that the strand A1 was

first laid across the web W along the path A1T successively over the strands A2—10, respectively, as these strands were successively moved across the rear pass of the chain 102, and, then, as the strand A1 was moved back across the rear pass of the chain 102, it was laid along the path A1B successively under the strands A2—A10, respectively, as these strands moved across the front pass of the chain. This pattern, it will be noted, is repeated for each of the individual strands A1—A10, respectively.

With the strands A1—A10 extending through guides 127 which are equally spaced around the periphery of the chain 102, it will be seen that the strands A1—A10 will be pulled back and forth across the sheets S1 and S2 in substantially parallel relation to each other except toward the side edge portions of the web W adjacent to the trim lines T1 and T2, at which time in the application of the various strands A1—A10 to the web W, the guide-eyes 127 are moving around the ends of the orbit of the chain 102 so that the lateral movement of the strands across the web W is reduced, and, inasmuch as the movement of the sheets S1 and S2 through the rollers 23 and 24 remains constant, the path of the strands is caused to curve, Fig. 7.

What has just been stated with respect to the strands B1—B10. Thus, it will be seen that during each rotation of the chain 202, the group of strands B extending forwardly from the chain 202 is rotated upon itself, and each of the strands B1 and B10, respectively, is pulled across each of the other strands B1—B10 in two directions, crossing the other strands on one side and then the other. Also, it will be noted that, like the guide-eyes 127 on the chain 102, the guide-eyes 230 are equally spaced around the orbit of the chain 202 so that the strands B1—B10 are applied to the web W in equally spaced parallel relation in each direction except at the side edge portion of the web W where, like the strands A1—A10, they curve back toward the other direction.

In the preferred embodiment of my novel machine M, the chains 102 and 202 are preferably driven by the shafts 107 and 207 at the same rate of rotation, and the guides 127 and 230 are equally spaced thereon, so that those portions of the strands A1—A10 and B1—B10 which are applied to the web W in the same direction are disposed in substantially equally spaced, parallel relation at the mid-portion of the web, with each strand A and B disposed between an adjacent pair of the other group of strands B and A, respectively. However, it will be understood that variations in this arrangement may be made by those skilled in the art without departing from the purview of my invention.

It will be remembered that the chains 102 and 202 are rotated simultaneously during an operation of my machine M, and, therefore, it will be seen that with the strands A1—A10 and B1—B10 extending from the chains 102 and 202 in four sets, as previously discussed, the strands A1—A10 will always be applied to the web W along the paths A1T—A10T, respectively, above all the other strands crossed thereby; the strands B1—B10 will always be applied to the web W along the paths B1B—B10B, respectively, below all the other strands crossed thereby; but the strands A1—A10 will always be applied to the web W along the paths A1B—A10B, respectively, in a manner wherein they cross under the strand portions A1T—A10T and over the strand portions B1T—B10T; and the strands B1—B10 will

always be applied to the web W along the paths B1T—B10T, respectively, in a manner wherein they cross under the strands A1T—A10T but cross over the strand portions B1B—B10B. Thus, it will be seen that, although each of the strand portions A1T—A10T extend across all strands crossed thereby on one side thereof, each of the strand portions B1T—B10T, which comprise alternate strands, extending across the web W in the same direction as the strand portions A1T—A10T, extend alternately under a strand portion A1B—A10B and then over a strand portion B1B—B10B, so that at least every other one of the strand portions lying across the web W in each direction is interlocked between adjacent strands crossed thereby and is held thereby against displacement transversely to the face of the web W. Such construction, it will be seen, imparts good strength and tear-resistant characteristics to the web W produced in this novel manner. Also, it will be seen that such a web has far better strength and tear-resistant characteristics than do the webs produced in the manner heretofore commonly employed, wherein the reinforcing strands crossed each other in a manner wherein all the strands running in one direction crossed all the other strands on the same side thereof, such as, for example, in the webs shown in the aforementioned Pember and Bird Patent No. 285,838 and the Currier Patent No. 1,460,949.

Also, it will be seen that the webs formed in accordance with my aforementioned method may be produced in a much simpler manner and with much simpler machines than is possible if the strands are woven together with the usual weaving machine, as was heretofore considered necessary when it was desired to have interlocking crossed strands of reinforcing material.

Also, it will be noted that in some instances, such as, for example, in instances where the adhesive used is slow setting, or for other reasons the strands A and B are not firmly held in position between the rollers **23** and **24** against the tension applied thereto, it may be desirable to use guide means of any one of several types, which are well known to those skilled in the art, such as, for example, the guide rods **23** and **24** shown in the previously mentioned Currier Patent No. 1,460,949. However, it will be seen that such a guide device may be embodied in my novel machine by those skilled in the art without departing from the purview of my invention.

As was previously mentioned, in some instances it may be desirable to rotate the chains **102** and **202** in the same direction during an operation of my novel machine M. When this is desired, the drive shafts **107** and **207** may be driven in opposite directions, thereby causing the chains **102** and **202** to be rotated in the same direction. Also, of course, in that event, it will be understood that the relative positions of the chains **102** and **202** should preferably be re-adjusted so that the guide-eyes **127** and **230** will be re-positioned relative to each other in a manner whereby the strands applied to the web W' by the front passes of the chains **102** and **202**, and the strands applied to the web W' by the rear passes of the chains **102** and **202** will be disposed on the web in proper, substantially equally spaced relation. The pattern of strands produced by operation of the machine M in this latter manner is illustrated in Figs. 6 and 8, wherein parts of the web shown therein which are similar to those shown in Figs. 5 and 7 are indicated by the same reference numerals with a "prime" mark added thereto, and the strands of reinforcing material corresponding to strands A and B are indicated by the reference characters C and D, respectively.

In preparing the machine M for operation in this latter manner, as in preparing it for operation in the aforementioned preferred manner, the strands are extended from the chains **102** and **202** to the rollers **23** and **24** in four sets, with the top set extending from the front pass of the chain **102**, the next set extending from the rear pass of the chain **102**, the next set extending from the rear pass of the chain **202**, and the lowest set extending from the front pass of the chain **202**. Thus, it will be seen that with the two chains **102** and **202** rotating in a clockwise direction, as viewed in Fig. 8, the strands C1—C10 will be laid across the web W' along the paths C1T—C10T and C1B—C10B by the front and rear passes, respectively, of the chain **102**; and the strands D1—D10 will be laid across the web W' along the paths D1T—D10T and D1B—D10B by the rear and front passes of the chain **202** respectively.

Therefore, it will be seen that with the machine M operating in this latter manner the two outside sets of strands, namely, those applied to the web W' by the front passes of the chains **102** and **202**, respectively, will be applied thereto in substantially parallel spaced relation to each other; and the two intermediate sets of strands, namely, those applied to the web W' by the rear passes of the chains **102** and **202** will likewise be applied to the web W' in substantially parallel spaced relation to each other, in a direction transverse to that in which the aforementioned outside sets are applied. Thus, it will be seen that in a web produced in this manner, the strands C1—C10 and D1—D10 will be laid across the web in parallel paths C1T—C10T and D1B—D10B, respectively, with the strand portions C1T—C10T disposed above all the strands crossed thereby, and the strand portions D1B—D10B disposed below all the strands crossed thereby; and the strands C1—C10 and D1—D10 will be laid across the web in parallel paths C1B—C10B and D1T—D10T, transversely to the paths C1T—C10T and D1B—D10B, with each of the strand portions C1B—C10B and D1T—D10T, extending alternately over and under adjacent strands crossed thereby, and with adjacent strand portions C1T—C10T and D1B—D10B, respectively, crossing over the same strand on opposite sides thereof, for example, it will be seen, Fig. 8, that the strand C6T crosses over the strand D8T, and the strand D5B, which is adjacent to the strand C6T, crosses under the strand D8T. Thus, it will be seen that, as in the web W shown in Fig. 7, the reinforcing strands C and D embodied in the web W' shown in Fig. 8, are disposed therein in a novel interlocking pattern affording good strength and tear-resistant characteristics to the web W', and that although the patterns of the reinforcing strands in the webs W and W' formed by the two methods, respectively, are somewhat different in specific details, they are, in general, the same, each having predetermined strands extending across the web in at least one direction disposed alternately over and under adjacent strands crossed thereby, and each web having a pattern of reinforcing strands wherein good tear-resistance is imparted to the web in all directions.

From the foregoing it will be seen that in the practice of my invention, whether the guide-

chains are rotated in the same direction or in opposite directions, the two groups of reinforcing strands are applied to the sheets S1 and S2 by feeding the individual strands longitudinally onto the face of the sheets and simultaneously rotating each group of strands upon itself. By this method of applying the strands to the sheets, it will be seen that it has been made possible to produce an interlocking pattern of reinforcing strands by a novel method wherein the movement of the strands transversely to the sheets may be effected by a rotating member such as, for example, the guide-chains 102 and 202.

As previously mentioned, in forming the web W of reflective heat-insulation by either of aforementioned methods, I prefer to apply the adhesive material only to a limited portion thereof, leaving the side marginal edge portions uncoated so that these side edge portions are not bonded together. One of the reasons for preferring this procedure is that the adhesive then does not run out the sides of the sheets S1 and S2 when the latter are pressed together by the rollers 23 and 24 and, therefore, the rollers 23 and 24 and other similar parts of the machine M are kept free of adhesive material. However, it will be seen that this procedure results in the side marginal edge portions of the web W, Fig. 7, and the web W', Fig. 8, outside of the trim lines T1 and T2, and T'1 and T'2, respectively, not being bonded together and not having reinforcing strands disposed therebetween when the sheets S1 and S2 are passed between the rollers 23 and 24. As a practical matter, I prefer to trim off the side edge portions of the webs W and W' along the lines T1 and T2, and T'1 and T'2, respectively, as shown along the lines T1 and T'1 in Figs. 5 and 6, respectively, so that this unbonded and unreinforced edge portion is removed from the finished web.

It will be noted that, when the webs W and W' are trimmed along the lines T1 and T2, and T'1 and T'2, respectively, the curved ends of the strands of reinforcing material are disposed along the side edge portions of the trimmed web and, in effect, form a border therefor. In some instances, it may be desirable that this border be removed and, in such a case, the webs W and W' may, if desired, be trimmed along lines disposed further inwardly such as, for example, the lines T3 and T4, Fig. 7, and the lines T'3 and T'4, Fig. 8. This latter trimming will obviously result in webs wherein the strands extending across each other are unconnected at their ends as shown along the edges T4 and T'4 in Figs. 5 and 6, respectively.

While the invention has been shown and described as employed in the manufacture of reinforced reflective heat insulating material, it will be noted that other products such as, for example, reinforced building-paper, reinforced fabric, and other types of reinforced sheet material, both flexible and inflexible, may be produced in accordance with the principles of my invention and that reflective heat-insulation is set forth herein merely by way of illustration and not by way of limitation. Furthermore, it will be understood that materials other than those set forth above may be used in the machine M, and used in accordance with the principles of my invention without departing from the purview of my invention. Thus, for example, it will be seen that in the production of laminated webs or sheets other than the specific form of reflective heat-insulation material above, the sheets S1 and S2 need not be made from flexible paper sheeting coated with reflective material but may comprise any of several different materials, such as fabric, pressed cellulose-actate rayon sheets, uncoated paper, sheets of paper pulp, and the like; the adhesive need not be asphalt but other suitable adhesive may be used such as, for example, cellulose adhesives, animal and vegetable glues, including casein, naturally occurring and synthetic resinous adhesives, and the like; and the reinforcing strands need not be made of rayon but, under suitable conditions, may comprise any one of several suitable materials such as, for example, nylon, jute, glass fibers, and the like.

Thus, it will be seen that my invention is not limited to the production of any one article, or to the use of any specific materials, and that various types of reinforced webs or sheets may be made and various suitable materials may be used without departing from the purview of my invention.

From the foregoing it will be seen that I have afforded a novel reinforced web which may be produced in a novel and expeditious manner by methods which may be readily performed in machines which are practical in construction and efficient in operation and has good strength and tear-resistant characteristics not found in webs heretofore known in the art.

Furthermore, it will be seen that I have provided a novel reinforced web which has good strength and tear-resistant characteristics.

Also, it will be seen that, although it has long been the feeling of those skilled in the art that in the manufacture of reinforced webs, the reinforcing strands could not be applied thereto in a criss-cross, interlocking pattern by a method wherein the strands are payed out by a purely rotary motion, I have afforded a novel and expeditious method of so producing reinforced webs wherein the reinforcing strands are disposed in such a pattern.

In addition, it will be seen that I have also afforded a novel machine for producing the aforementioned novel web by the previously mentioned novel method.

Thus, while I have illustrated and described the preferred embodiments of my invention, it is to be understood that these are capable of variation and modification and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims:

I claim:

1. An article of manufacture comprising a web of material having two oppositely disposed side edges, a row of strands of reinforcing material attached to and extending across said web between the side edge portions thereof in spaced relation to each other, a row of other strands of reinforcing material attached to and extending across said web between the side edge portions thereof in spaced relation to each other and transversely to said first mentioned strands, each of said strands in each of said rows extending across a plurality of strands in the other of said rows between the ends of the latter strands, predetermined ones of said strands attached to said web being mounted thereon in a manner such that each of said predetermined strands is disposed on the same side of each strand it crosses, and predetermined other ones of said strands attached to said web being mounted thereon in a

manner such that each of said last-mentioned predetermined strands is disposed alternately on one side and on the opposite side of adjacent strands it crosses.

2. An article of manufacture comprising a web of material having two oppositely disposed side edges, a row of strands of reinforcing material attached to and extending across said web between the side edge portions thereof in spaced relation to each other, a row of other strands of reinforcing material attached to and extending across said web between the side edge portions thereof in spaced relation to each other and transversely to said first mentioned strands, each of said strands in each of said rows extending across a plurality of strands in the other of said rows between the ends of the latter strands, individual ones of certain of said other strands being disposed on the same side of all of said first mentioned strands that said individual strand crosses, and individual ones of said first mentioned strands being disposed alternately on one side and the opposite side of the adjacent ones of said other strands that said last mentioned individual strand crosses.

3. A web of reinforced material comprising two sheet members disposed in parallel stacked relation to each other and each having two oppositely disposed edge portions, adhesive material disposed between said sheet members and holding the latter together, two groups of elongated strands of reinforcing material embedded in said adhesive material, each of said groups comprising a plurality of elongated strands extending through said adhesive in a zig-zag course between said two oppositely disposed edge portions of each of said sheet members, each of said strands in both of said groups extending alternately in one direction and then another across a plurality of the other of said strands in both of said groups between the ends of the latter strands, each strand in one of said groups always extending across on the same side of said strands in the other of said groups when crossing said latter strands in either of said directions.

4. A web of reinforced material comprising two sheet members disposed in parallel stacked relation to each other and each having two oppositely disposed edge portions, adhesive material disposed between said sheet members and holding the latter together, two groups of elongated strands of reinforcing material embedded in said adhesive material, each of said groups comprising a plurality of elongated strands extending through said adhesive in a zig-zag course between said two oppositely disposed edge portions of each of said sheet members, each of said strands in both of said groups extending alternately in one direction and then another across a plurality of the other of said strands in both of said groups between the ends of the latter strands, each strand in each of said groups being disposed between a respective pair of adjacent strands in the other of said groups, each strand in each of said groups always extending across strands in the other of said groups on the same side thereof, and each strand in each of said groups always extending across strands in the other of said groups on the same side as that on which the other strands of the group in which said strand is located extends across said strands in the other of said groups.

5. A web of reinforced material comprising two sheets of flexible material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said sheets for attaching said sheets together, a plurality of strands of reinforcing material embedded in said adhesive material and extending across the adjacent faces of said two sheets in parallel relation thereto and transversely to said side edge portions, said strands being spaced transversely from each other between said side edge portions, a plurality of other strands of reinforcing material embedded in said adhesive material and extending across the adjacent faces of said two sheets in parallel relation thereto and transversely to said side edge portions, said last mentioned strands being spaced transversely from each other between said side edge portions, each of said last mentioned strands extending transversely across a plurality of said first mentioned strands between the ends of the latter, and each of said first mentioned strands extending transversely across a plurality of said other strands between the ends of the latter, predetermined alternate ones of said first mentioned strands always extending across each of said other strands crossed thereby on the same side thereof, and at least alternate ones of said other strands always extending across said first mentioned strands in a manner whereby each of said alternate ones of said other strands extends across adjacent ones of said first mentioned strands on opposite sides thereof.

6. A web of reinforced material comprising two sheets of flexible material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said sheets in contact therewith for holding said sheets together, a group of strands of flexible reinforcing material mounted in said adhesive material between said two sheets, said strands extending back and forth in a zig-zag path between said two sheets in parallel relation thereto and transversely to said side edge portions thereof, said strands being transversely spaced from each other between said side edge portions of said sheets, a group of other strands of flexible reinforcing material mounted in said adhesive between said two sheets, said other strands extending back and forth in a zig-zag path between said two sheets in parallel relation thereto and transversely to said side edge portions thereof, said other strands being transversely spaced from each other between said side edge portions, each strand in each of said groups being disposed between a respective pair of strands in the other of said groups, each strand in each of said groups extending across a plurality of strands in both of said groups between said side edge portions, each individual strand in one of said groups extending across said plurality of strands in both groups in one direction in a manner whereby each said individual strand extends across strands in the same group on one side thereof and extends across strands in the other one of said two groups on the opposite side thereof.

7. A reinforced web comprising two sheet members disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets and holding said sheets together, and two rows of elongated strands mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, predetermined alternate strands in one of said rows crossing adjacent strands in the other of said rows alternately on one side and

the side opposite thereto, other strands in said one row extending across all strands in said other row which are crossed thereby on the same side thereof.

8. A reinforced web comprising two sheets of flexible material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets and holding said sheets together, and two rows of elongated strands mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, predetermined strands in each of said rows crossing adjacent strands in the other of said rows alternately on one side and the side opposite thereto, other strands in each of said rows crossing all strands crossed thereby in the other of said rows on the same side thereof.

9. A reinforced web comprising two sheets of material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets and holding said sheets together, and two rows of elongated strand portions mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, predetermined strand portions in each of said rows being separated by other strand portions in the same row, said predetermined strand portions in each of said rows crossing adjacent strand portions in the other of said rows alternately on one side and the side opposite thereto, said other strand portions in each of said rows crossing all strand portions crossed thereby in the other of said rows on the same side thereof.

10. A reinforced web comprising two sheets of material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets and holding said sheets together, and two rows of elongated strands mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, said strands in one of said rows extending across adjacent strands crossed thereby in the other of said rows alternately on one side and the side opposite thereto, individual strands in the other of said rows extending across all strands crossed thereby in said one row on the same side thereof.

11. A reinforced web comprising two sheets of material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets for holding said sheets together, and two rows of elongated strand portions mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, said strand portions in one of said rows extending across adjacent strand portions crossed thereby in the other of said rows alternately on one side and the side opposite thereto, each of said strand portions in said one row extending across each individual strand portion crossed thereby in said other row on the same side as the other strand portions in said one row which extend across that individual strand portion.

12. A reinforced web comprising two sheets of material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets and holding said sheets together, and two rows of elongated strands mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, each of said strands in one of said rows extending across adjacent strands crossed thereby in the other of said rows alternately on one side and the side opposite thereto, and each strand in the other of said rows extending across all strands crossed thereby in one row on the same side thereof.

13. A reinforced web comprising two sheets of flexible material disposed in face-to-face relationship to each other and each having two side edge portions, adhesive material disposed between said two sheets for holding said sheets together, and two rows of elongated strands mounted in said adhesive material and extending transversely across said sheets and each other between said side edge portions, each of said strands in one of said rows extending across adjacent strands crossed thereby in the other of said rows alternately on one side and the side opposite thereto, and each strand in the other of said rows extending across all strands crossed thereby in said one row on the same side thereof, each individual strand in said other row crossing all said strands in said one row crossed thereby on the side opposite to that on which strands in said other row adjacent to said individual strand cross said strands in said one row.

14. A heat-insulation web comprising two sheets of flexible heat insulating material disposed in face-to-face relation to each other and each having two oppositely disposed edge portions, asphalt disposed between said two sheets in contact therewith and bonding said two sheets together, a plurality of strands of flexible material embedded in said asphalt, said strands being arranged in two rows with said strands in each row extending transversely across said sheets and said strands in the other row between said side edge portions, each of said rows of strands comprising two sets of strands, each of said sets comprising a plurality of strands, each individual strand in each of said sets in each row being disposed between adjacent strands in the other set in the same row, all of said strands in one set in one of said rows extending across adjacent strands crossed thereby in the other of said rows alternately on one side and the side opposite thereto, and all of said strands in one set in said other one of said rows extending across all strands crossed thereby in said one row on the same side thereof.

15. A web-forming machine comprising two rollers disposed in adjacent parallel position relative to each other and adapted to press sheet members between them, means for feeding elongated sheet members into the bite of the rollers in parallel face-to-face relationship to each other, means for applying adhesive to the adjacent faces of said sheets before said sheets enter said bite, and means for feeding elongated strands of reinforcing material into the bite of the rollers between said sheets of material, said last named means comprising a pair of continuous chains disposed in parallel relation to each other and each rotatable in an orbit substantially parallel to the plane of the portion of said sheets disposed between said two rollers and each having means thereon for guiding a plurality of said strands toward said bite of said rollers in spaced relation to each other.

16. A machine for forming reinforced webs of flexible material, said machine comprising two

pressing members mounted in parallel spaced relation to each other and adapted to press flexible material therebetween, means for feeding elongated sheets of material into the space between said members, and means for feeding strands of reinforcing material into the space between said members between said sheets, said last named means comprising two rotatable members each adapted to move a plurality of strands of reinforcing material in two planes transversely to said sheets of paper entering said space between said pressing members, said two planes in which said strands are moved by each rotatable member being different than the two planes in which said strands are moved by the other of said rotatable members.

17. A machine for forming a reinforced web of flexible material comprising two elongated rollers mounted adjacent to each other for pressing such a web therebetween, means for feeding two elongated sheets of paper into the bite of said rollers in face-to-face relation to each other, means for applying adhesive to the adjacent faces of said two sheets, means for feeding strands of flexible reinforcing material into the bite of said rollers between said sheets, said last named means comprising two feed units, each of said feed units comprising a supporting member and a plurality of strand guides mounted thereon in spaced relation to each other in a manner whereby a portion of said plurality of guides are disposed in one line parallel to the bite between said rollers and another portion of said plurality of guides are disposed in another line parallel to said one line, each of said supporting members being movable in a manner effective to move said guides disposed in said one line transversely across said sheets in one direction and to move said guides disposed in said other line transversely across said sheets in another direction.

18. In a machine for making reinforced webs and of the type including a pair of rollers disposed in operative position relative to each other for compressing sheets of flexible material therebetween, said rollers being disposed in position to afford a horizontally disposed bite, means for feeding two elongated sheets of flexible material into the bite of said rollers in parallel, face-to-face relationship, and means for applying adhesive material to the adjacent faces of said sheets before said sheets enter said bite of said rollers, the combination of a supporting frame, and means mounted on said frame for feeding strands of flexible reinforcing material into the bite of said rollers between said two sheets, said last named means comprising two continuous chain members disposed in parallel alignment one below the other, each of said chains being movable in an elongated orbit with the major axis of the orbit disposed in parallel alignment with the bite of said rollers, a plurality of guide members disposed on the outer periphery of said chains in spaced relation to each other, and means rotatable with said chains for feeding a plurality of strands of reinforcing material through said guides into said bite between said rollers.

19. A machine for forming reinforced flexible webbing and comprising a pair of rollers for squeezing material inserted therebetween, means for feeding two sheets of flexible material into the bite of said rollers in face-to-face relation to each other, means for applying adhesive material to the adjacent faces of said sheets before said sheets enter said bite, and means for feeding strands of flexible material into said adhesive material and into said bite of said rollers between said sheets as four sets of strands, said last named means comprising two rotatable members each having substantially annular portions through which said strands are fed in spaced relation to each other, said annular portions being disposed in position for rotation in planes substantially parallel to each other and to the bite of said rollers, and means for simultaneously rotating said rotatable members to thereby move said strands back and forth across a portion of the length of said bite with said four sets being disposed in different planes, certain of said sets being moved in one direction while the other of said sets are being moved in the opposite direction.

20. A machine for forming reinforced flexible webbing, a pair of compression rollers, means for feeding two elongated sheets of flexible material longitudinally into face-to-face relation to each other between said two rollers and for passing said two sheets between said two rollers, means for applying adhesive to the adjacent faces of said two sheets before said sheets pass between said rollers, said rollers being disposed relative to each other so as to be effective to press said sheets together during passage thereof between said rollers, and means for feeding a plurality of strands of flexible reinforcing material in a criss-cross pattern into said adhesive material between said two sheets as said two sheets enter between said rollers, said last named means comprising two rotatable feeding devices operative to simultaneously pay out such strands of flexible material in four planes of a plurality of strands each into said adhesive material between said sheets as said sheets advance into said rollers, and means for simultaneously rotating said feeding devices to thereby move said strands in each of said planes transversely to the length of said sheets as said strands are payed out with the strands in certain of said planes being moved in the opposite direction to the strands in the other of said planes.

21. In a machine for making reinforced webs and of the type including a pair of rollers disposed in operative position relative to each other for compressing sheets of flexible material therebetween, said rollers being disposed in position to afford a horizontally disposed bite, means for feeding two elongated sheets of flexible material into the bite of said rollers in parallel, face-to-face relationship, and means for applying adhesive material to the adjacent faces of said sheets before said sheets enter said bite of said rollers, the combination of a supporting frame, and means mounted on said frame for feeding strands of flexible reinforcing material into the bite of said rollers between said two sheets, said last named means comprising two pairs of sprocket wheels rotatably mounted on said frame, two continuous chains, each of said chains being trained over a corresponding pair of said sprocket wheels and movable therearound in an elongated orbit, the major axis of each of the orbits of said chains being disposed in parallel alignment with the bite of said rollers, two creels rotatably mounted on said frame, each of said creels being disposed in parallel relation to a corresponding one of said chains, two guide-rings, each of said guide-rings being connected to a corresponding one of said creels for rotation therewith, a plurality of guide members mounted on said chains and said guide-rings for rotation there-

with, driving means including two shafts journaled on said frame and operatively connected to said chains, guide-rings and creels for rotating said chains, guide-rings and creels in synchronization with each other, and means on each of said creels for paying out strands of reinforcing material through said guide members on said guide-rings and chains into the bite of said rollers during rotation of said creels, guide-rings and chains.

22. In a machine for making reinforced webs, a pair of rollers disposed in operative position relative to each other for compressing sheets of flexible material therebetween, said rollers being disposed in position to afford a horizontally disposed bite, means for feeding two elongated sheets of flexible material into the bite of said rollers in parallel, face-to-face relationship and for passing said sheets between said rollers in said relationship, means for applying adhesive material to the adjacent faces of said sheets before said sheets enter said bite of said rollers, a supporting frame, and means mounted on said frame for feeding a plurality of strands of flexible reinforcing material into the bite of said rollers between said two sheets as said two sheets advance into said bite, said last named means comprising two drive shafts journaled in said frame in axial alignment with each other, two creels rotatably mounted on said frame in parallel spaced relation to each other, each of said creels being connected to a respective one of said shafts for rotation therewith, two guide-rings rotatably mounted on said frame in parallel spaced relation to each other, each of said rings being connected to a respective one of said creels for rotation therewith at the same speed of rotation, two continuous chains rotatably mounted on said frame in parallel spaced relation to each other, each of said chains being connected to a respective one of said creels for rotation therewith at the same speed of rotation, a plurality of guide members mounted on and carried by each of said rings and said chain for rotation therewith, each of said guide members on each of said rings having a corresponding guide member on the chain connected to the same creel, means for rotating said shafts in timed relation to the advance of said sheets between said rollers to thereby rotate said creels, rings and chains in timed rotation to said advance of said sheets between said rollers, and means mounted on said creels for paying out individual strands of reinforcing material through said corresponding guide members on said rings and chains into the bite of said rollers during advance of said sheets into said bite.

23. The method of making a reinforced web which comprises progressively bonding two sheets of flexible material together while simultaneously feeding two groups of elongated reinforcing strands longitudinally between said sheets and at the same time rotating each group of strands upon itself.

24. The method of making a reinforced web which comprises simultaneously feeding four sets of strands in a zig-zag manner into the space between two sheets disposed in stacked relation to each other with certain of said sets being moved across said sheets in the opposite direction to that in which the other of said sets are moving, and bonding said sheets and said strands together.

25. The method of making a reinforced web comprising progressively bonding two sheets of material together in face-to-face relation to each other while simultaneously feeding four sets of strands disposed in different planes into the space between said sheets, said sets of strands being simultaneously moved across the faces of said sheets, and certain of said sets of strands being moved in the opposite direction to the other of said sets.

26. The method of making a reinforced web which comprises progressively bonding together, in a longitudinal direction, a predetermined longitudinally extending central portion of two elongated sheets of material, while simultaneously feeding two groups of elongated reinforcing strands longitudinally between said sheets and moving said strands back and forth across the full width of said central portion of said sheets by rotating each group of strands upon itself through an orbit having an axis parallel to the width of said sheet.

27. The method of making a reinforced web which comprises attaching one end of each strand of two groups of strands of flexible material to an elongated sheet, and pressing said strands upon said sheet in a predetermined pattern while rotating each group of strands upon itself through an orbit having an axis parallel to and the width of said sheet.

28. The method of making a reinforced web which comprises feeding two elongated sheets of flexible material longitudinally into face-to-face relationship, and simultaneously feeding elongated strands of flexible material, disposed in two groups, between said sheets under pressure while simultaneously rotating each of said groups of strands upon itself through an orbit one axis of which is parallel to the width of said sheets and which orbit overlaps the orbit of the other of said groups.

29. In the art of making a reinforced web of the type which is formed by passing sheets of flexible material between opposed pressure rolls, the improvement which resides in applying adhesive material to one face of an elongated sheet of flexible material, feeding said sheet and another elongated sheet of flexible material longitudinally into the bite between such rolls with said one face of said one sheet disposed adjacent to a face of said other sheet, and feeding a plurality of elongated strands of flexible material, disposed in two groups, longitudinally into the said bite and between said sheets in a direction transverse to the length of the said bite while simultaneously rotating each of said groups of strands upon itself through an orbit having an axis of rotation disposed tranversely to the length of the said bite and with said orbits overlapping each other in a direction extending across said sheet.

30. In the art of making a reinforced web of the type which is formed by passing sheets of flexible material between opposed pressure rolls, the improvement which resides in applying adhesive material to one face of an elongated sheet of flexible material, feeding said sheet and another elongated sheet of flexible material longitudinally into the bite between such rolls with said one face of said one sheet disposed adjacent to a face of said other sheet, and longitudinally feeding a plurality of elongated strands which are disposed in two groups into the bite of the said rolls between said two sheets while simultaneously rotating each of said groups upon themselves in an orbit disposed in parallel align-

ment with the orbit through which the other of said groups is rotated.

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