United States Patent

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[31] V 31514;
Dec. 17, 1966, Germany, No. G 48768

[54] **PROCESS AND APPARATUS FOR FORMING CROSS MESH REINFORCED SHEETS OR FOILS**
20 Claims, 18 Drawing Figs.

[52] U.S. Cl. 156/441, 156/181, 156/434
[51] Int. Cl. D04h 3/04, D04h 3/02, D04h 3/12
[50] Field of Search 156/441

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ABSTRACT: Apparatus for the manufacture of wide meshed textile layers of crossing threads or for the reinforcement of material sheets, especially plastic foils or sheets, where the textile layer is inserted between two sheets or into an unsolidified plastic sheet forming mass, characterized by rotating thread guides which are on one or several thread depositing devices, always in the same even number on each device, and which deposit yarns or threads on two pin chains which are parallel to one another in the area of the deposit and have their pins in the plane of the rotating thread guides; the cross thread groups preferably are laid down at a right angle to the direction of travel of the pin chains and continuously brought together or otherwise combined with the longitudinal thread group; and the mesh enters into or between the two material sheets, preferably foils, at least one foil having an adhesive coating whereby the mesh is bonded together with the foils or solidified therein and whereupon the cross thread group lifts off of the pins of the pin chain or is separated therefrom in known fashion, and further characterized by a dependence of the pin chain velocity from the rate of rotation for all thread depositing devices and their thread guides according to the equation:

$$v_K = a \times n \times T \times F$$

wherein v_K represents the pin chain velocity in meters/minute, a number of thread depositing devices, n the same number of revolutions of the thread guide for all thread depositing devices in r.p.m., T the pin chain pitch or distance between the chain pins in meter, and F the number of thread carriers per thread depositing device which is always the same for all thread depositing devices.

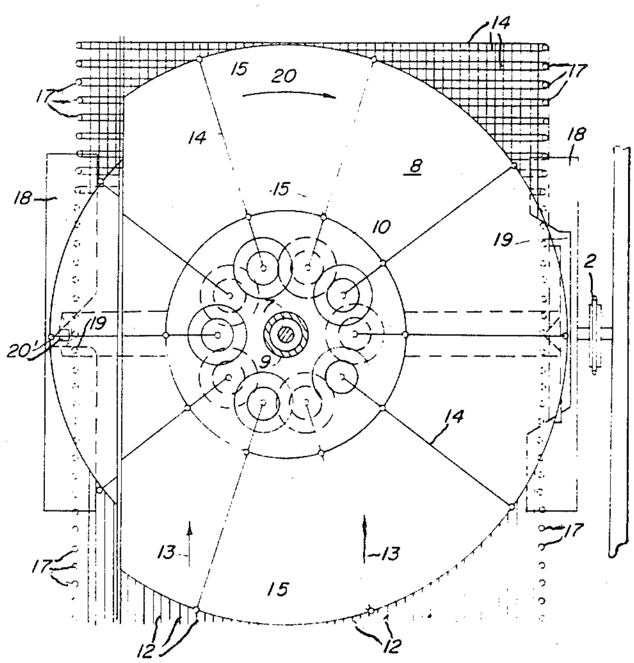

FIG. 1

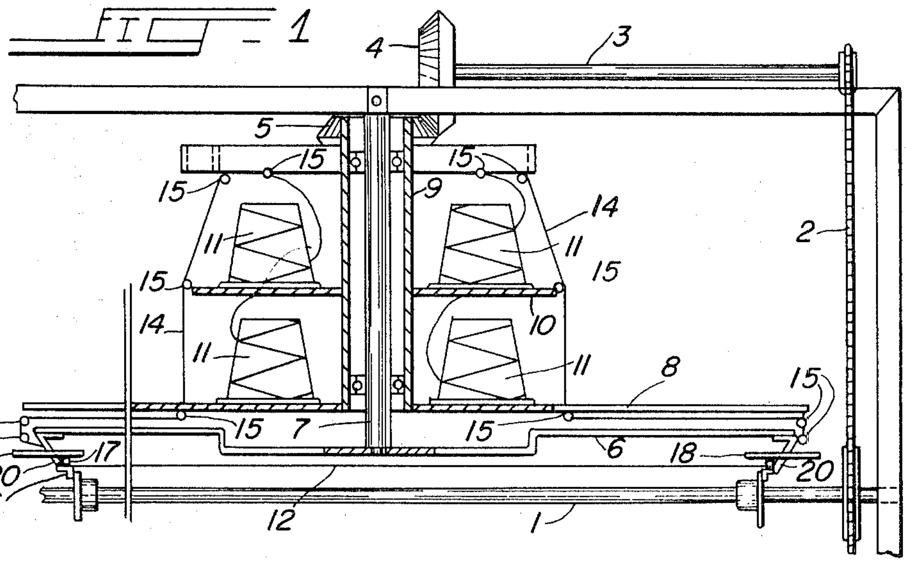

FIG. 2

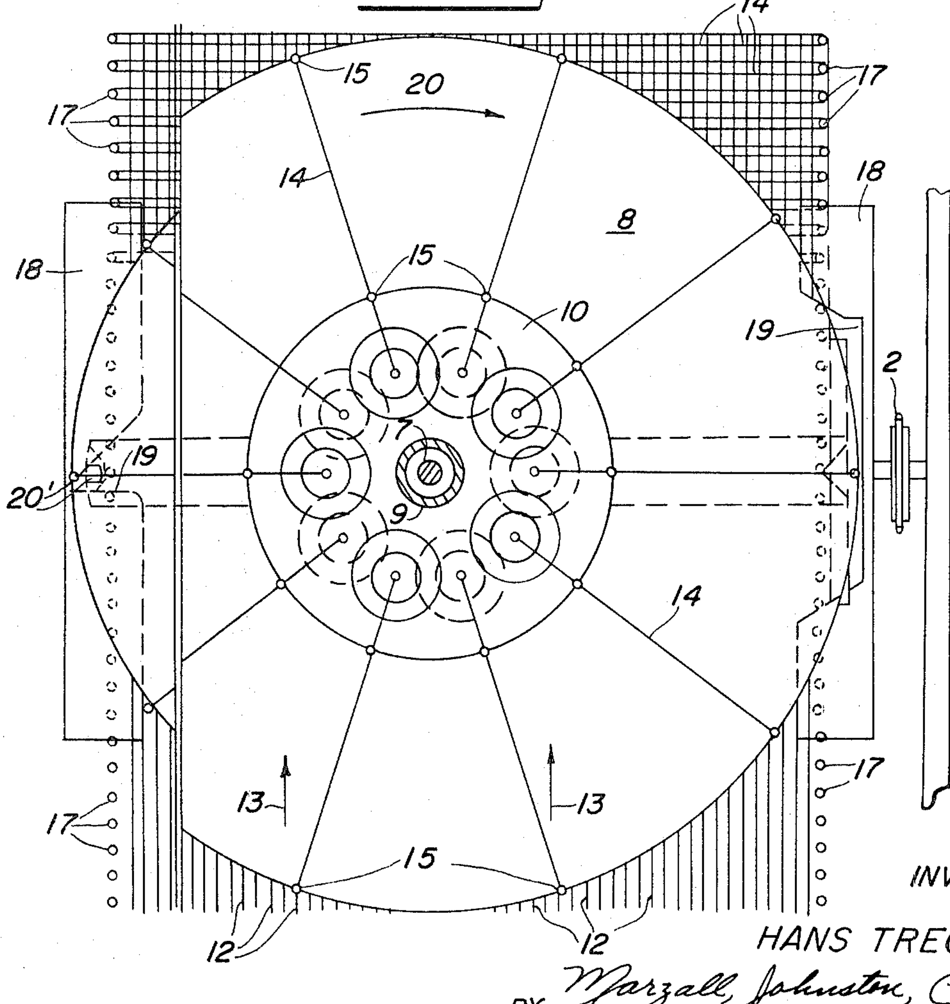

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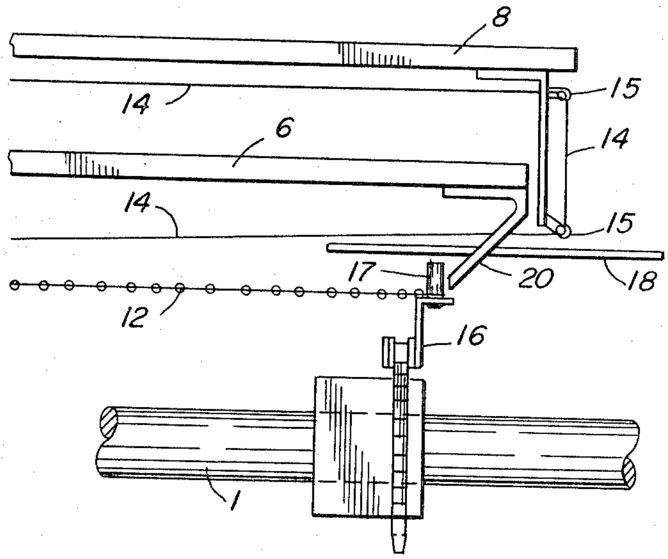
FIG. 3



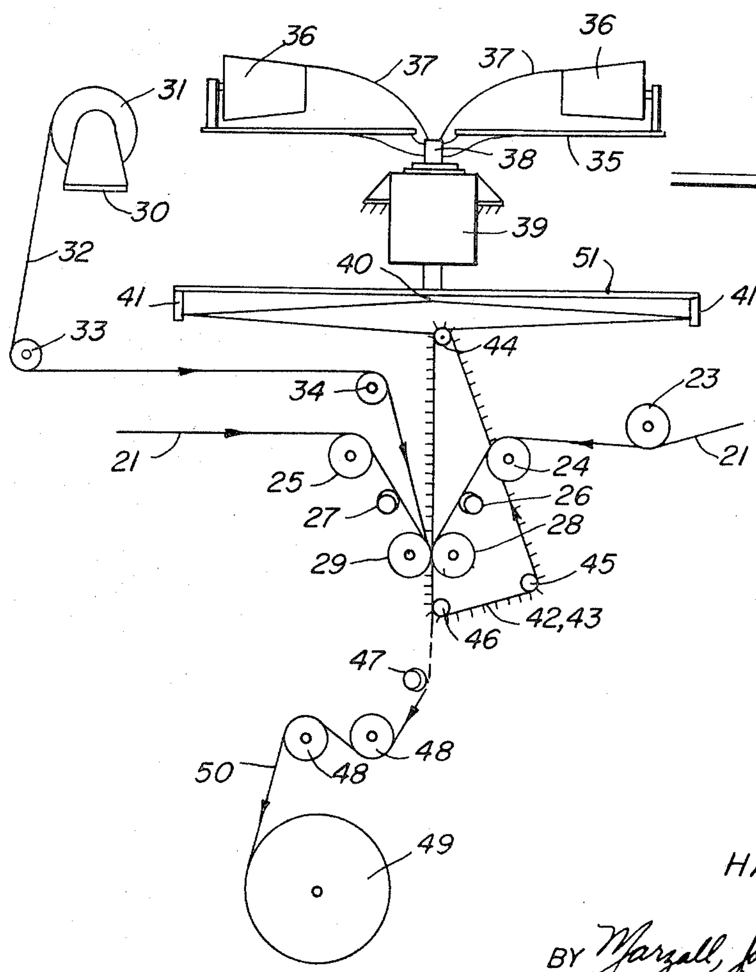


FIG. 4

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FIG. 5

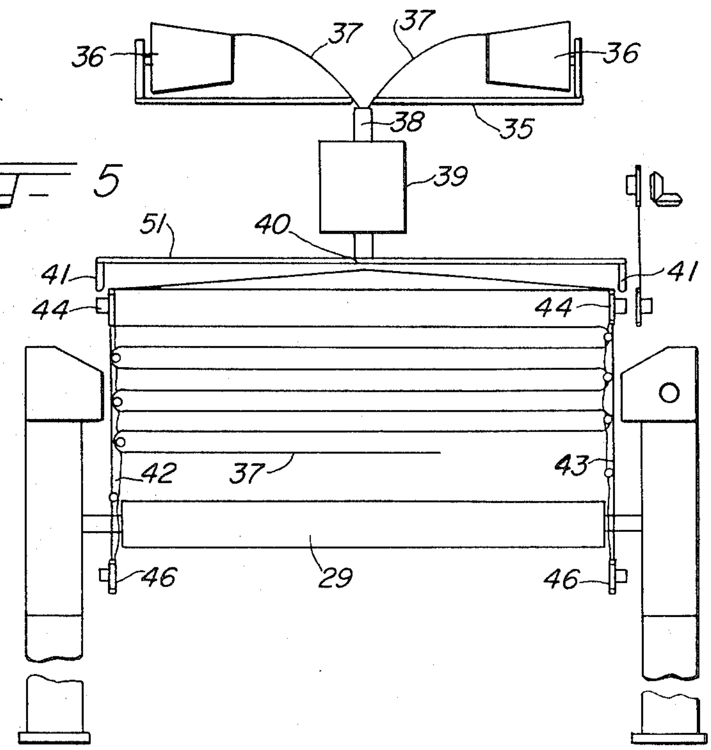

FIG. 5

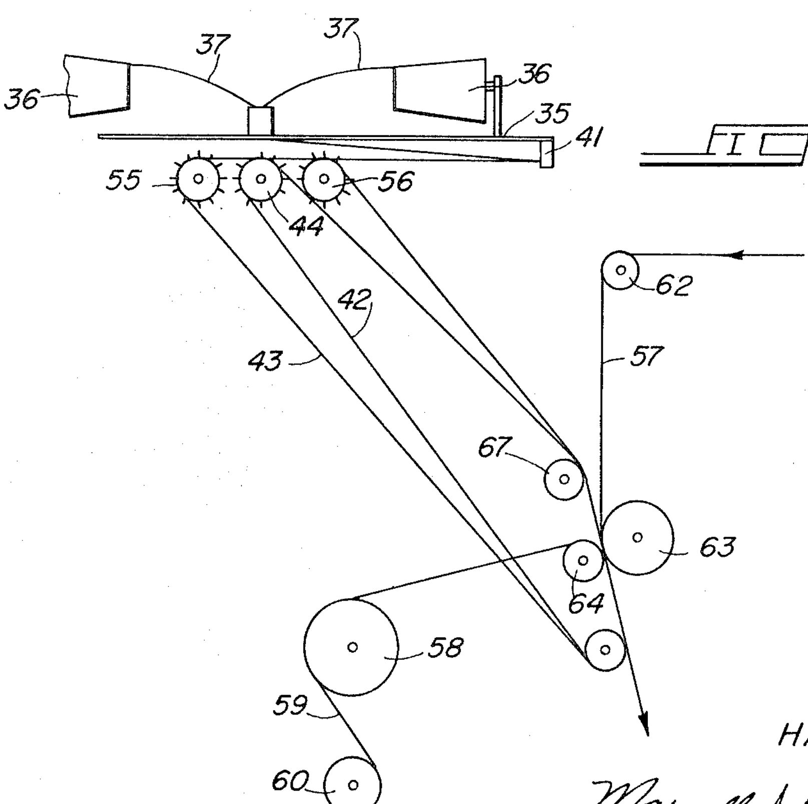

FIG. 6

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FIG. 7

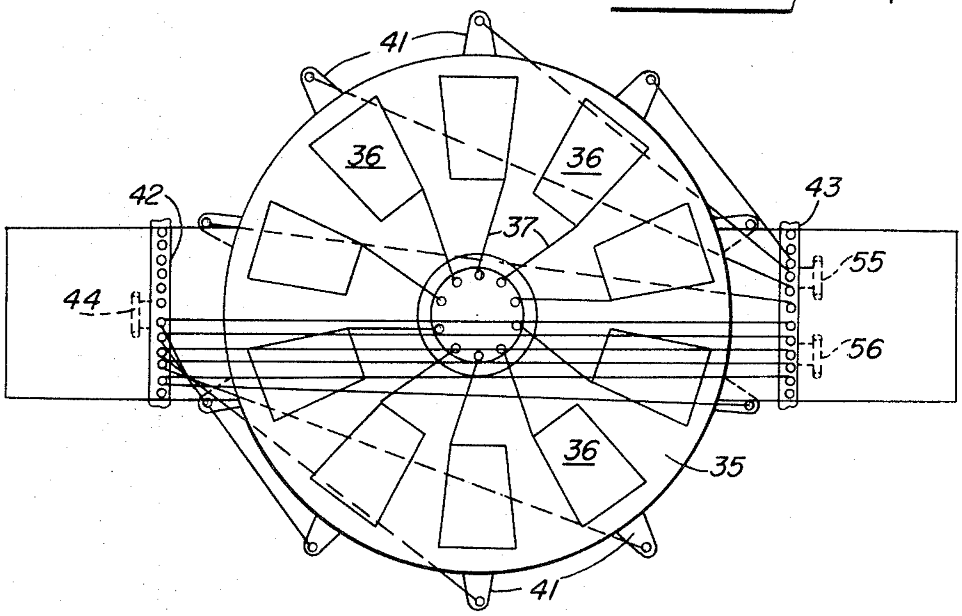

FIG. 10

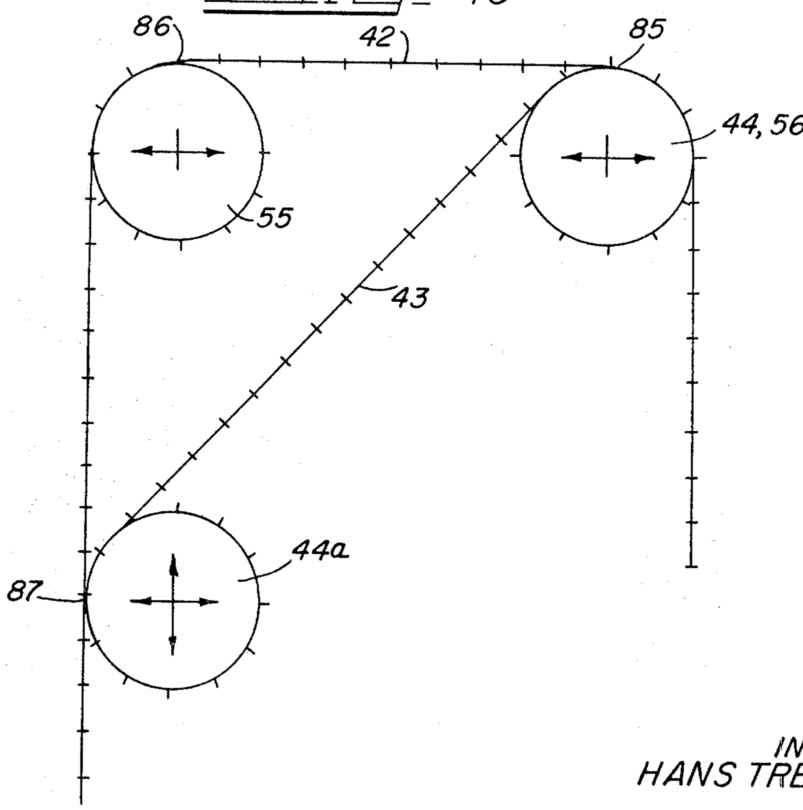

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FIG. 12

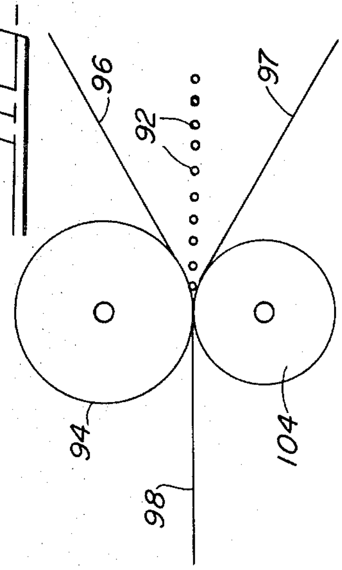

FIG. 8

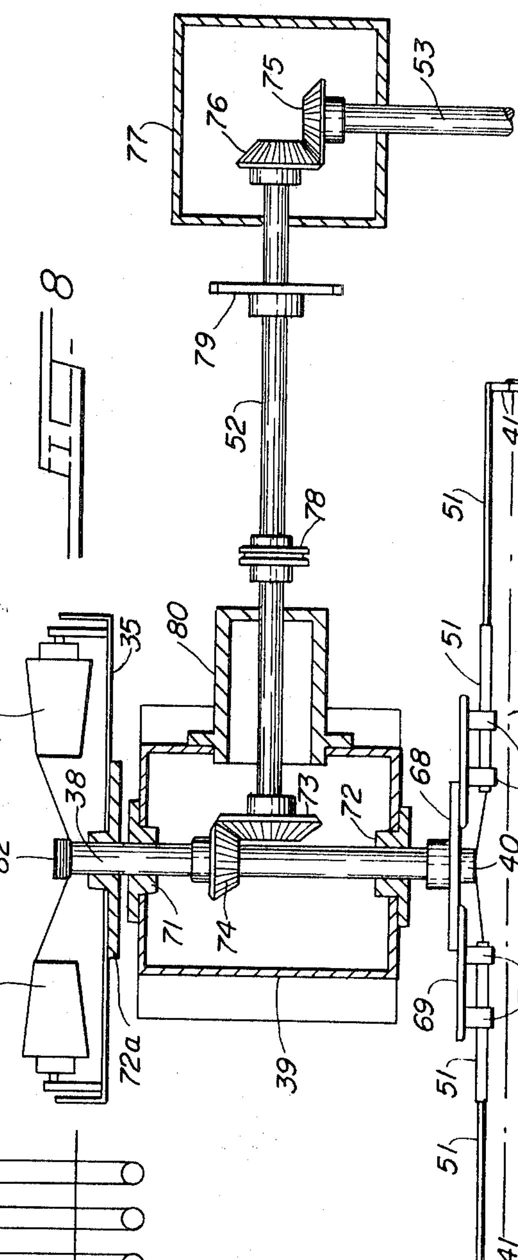

FIG. 11

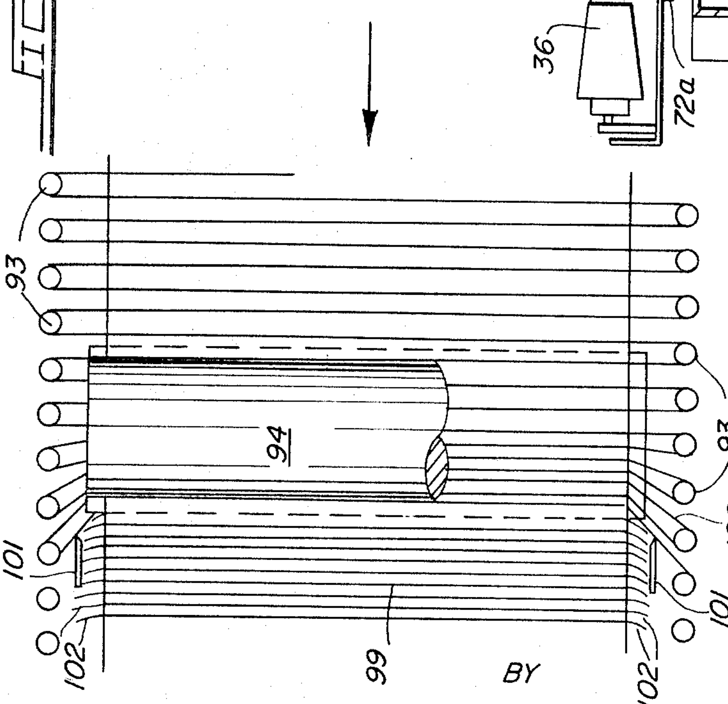

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FIG. 9a

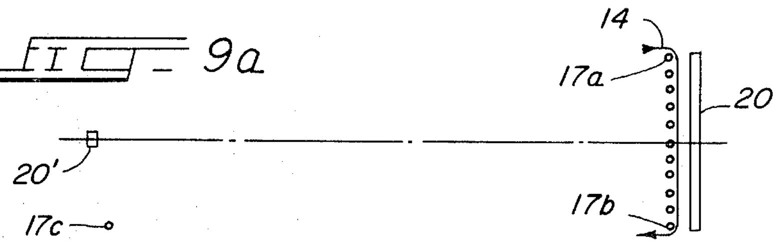

FIG. 9b

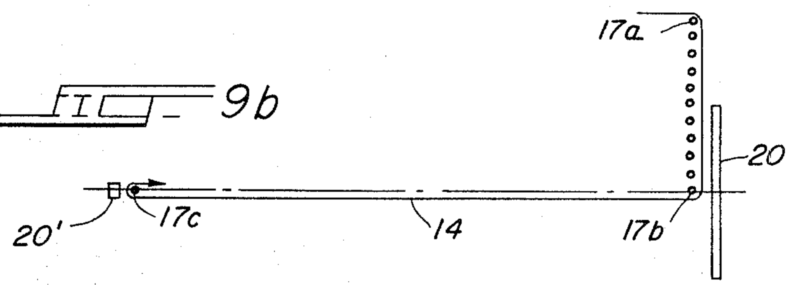

FIG. 9c

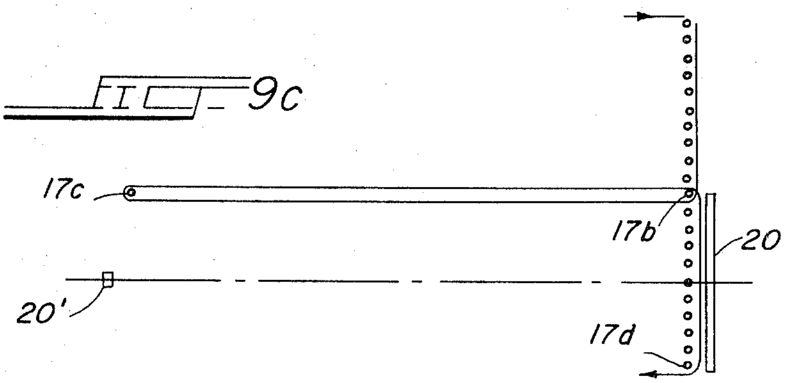

FIG. 9d

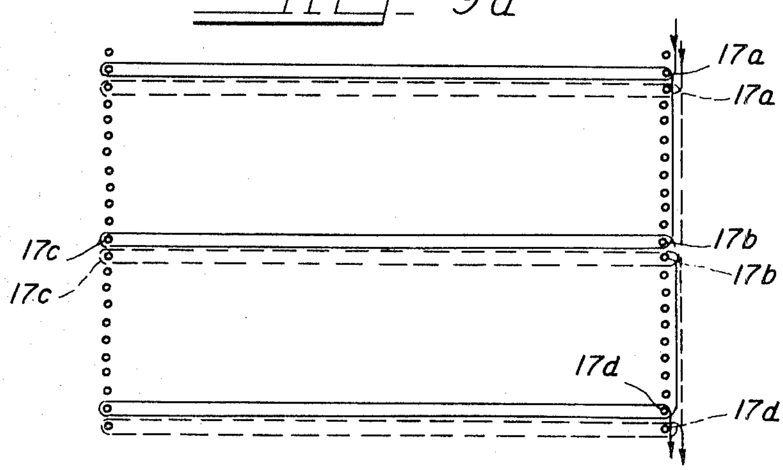

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FIG. 13

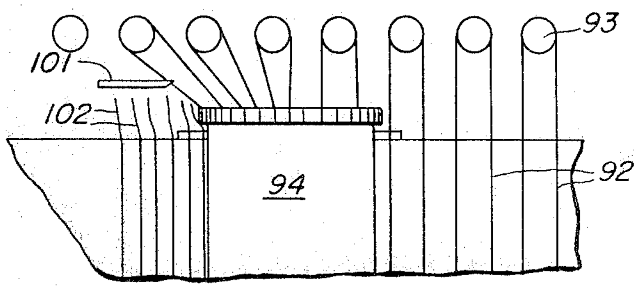


FIG. 14

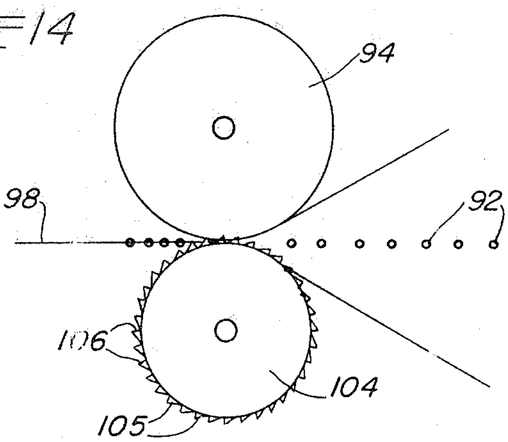
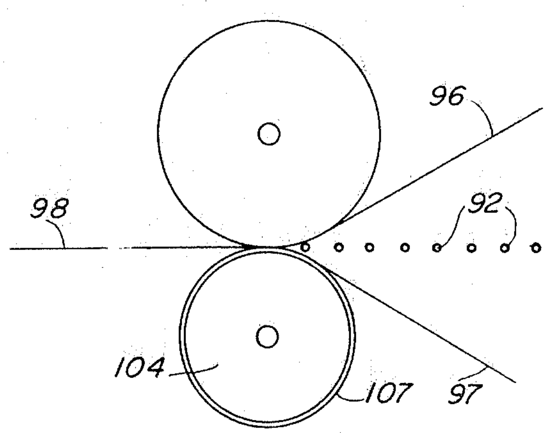


FIG. 15



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PROCESS AND APPARATUS FOR FORMING CROSS MESH REINFORCED SHEETS OR FOILS

BACKGROUND OF THE INVENTION

This invention relates to apparatus for the manufacture of sheets reinforced by an open mesh of crossing yarns or threads, hereinafter called threads, especially plastic foil sheets with the threads inserted between two layers or worked into an unsolidified sheet material and machines for the production of mesh-reinforce foils.

Textile layers of wide mesh, not woven threads, are used in an increasing amount for the reinforcement of material sheets such as plastic foils, paper sheets, etc. The previously common method for this objective employed a thread layer which featured threads that were bonded at their crossing points and were rolled on a spool for a later joining with the sheet material. Such a method has considerable disadvantages. The manufacture of these sheets in two working cycles requires a considerable amount of more working space and investment for the necessary machines. Two bonding processes are required, one for the bonding of the thread and one for the bonding of the thread sheet between the material sheets. It is also extremely difficult to insert the textile sheet as it comes from the spool into the material sheets in such a way that the longitudinal and cross threads receive the same stretch. The textile sheet is then of a very loose condition without any shear strength. The same stretch is important because the later function of the threads is taking of the cross and longtiudinal forces on the finished sheet.

A number of different fixtures are known for the manufacture of wide mesh textile layers. One method for example has parallel, longitudinal threads which are bound on both sides by metal bands. Cross directional threads are laid while the longitudinal threads and metal bands feed in the longitudinal direction, the metal bands preventing a reduction in width of the longitudinal threads.

Also known are fixtures which guide longitudinal threads in hose form over a body of round cross section while the cross threads from spools wrap around the body. The spools are mounted on a ring-shaped disc which rotates around the longitudinal threads.

Known is also a device which guides the longitudinal thread group over a layout table which features edges in the form of chains which travel with the threads. An endless belt carries the spools and the thread from these spools and moves around the layout table and the longitudinal threads.

There have also been devices which facilitate the transport of the longitudinal threads in steps. A cross thread is laid down during each dwell and cut off flush on each end.

All known devices for the manufacture of wide mesh textile sheets have other problems not mentioned above. In order to obtain a tolerable economical working velocity, the cross thread spools have to be of a very light weight. This is because of the long travel of the spools for one revolution. Therefore, the thread length can only be relatively short because the forces would otherwise be too great. Also the ends of the thread which wrap around the metal bands have to be cut for the removal of the material from the machine, or the hose has to be cut in one or several places. With the use of a layout table the textile layer, for later use between two plastic foils or paper sheets, has to be made somewhat longer than the table where it is without guide. The result is a textile layer that pulls together in the cross direction.

All known devices have the problem that the threads lie in one plane after the bonding. It is therefore not possible to work the layer between two fairly weak sheets or even papermache without the previous bonding process and without separation from the guide bands. A combination of such a device for the processing of two material sheets is not possible or very difficult for these reasons.

Another disadvantage of the known continuously operating devices is that the threads do not cross at a right angle which is desired as reinforcement in foils, paper sheets, etc.

BRIEF DESCRIPTION OF THE INVENTION

The purpose of the invention is the manufacture of wide meshed textile layers with crossing threads for the reinforcement of material sheets and the manufacture of the wide meshed textile layers and joining the mesh with the material sheets to be reinforced combined in one work cycle. The technical advancements of the invention reside in processes and machines which lay cross threads on the longitudinal threads in one plane during a continuous feed motion of the longitudinal thread group. It is preferred to have the cross threads lie on the longitudinal threads at a 90° angle. The sheets or foils to be reinforced or the unsolidified mass of a sheet joins the textile mesh immediately after the cross threads are laid so that the longitudinal and cross threads enter the sheet forming mass in the stretched condition.

The method for the manufacture of wide mesh textile layers of crossing threads for the reinforcement of material sheets, especially plastic foils, with the textile layer between two sheets or between the unsolidified sheet mass according to this invention consists of rotating thread guides which exist at one or more thread deposit positions and always have an even number. These guides carry the cross threads to pin-grasping position with two parallel pin chains. Thread guide members deposit the threads on the pins and lay them preferably at a right angle to the travel of the pin chains. There they join a group of longitudinal threads lying in the horizontal plane of the pins and the resultant cross-mesh enters the unsolidified material sheet or preferably the foil sheet which has an adhesive application or which are bonded or fastened together with the mass or foils in already known devices. Then the cross thread group lifts off of the pins of the pin chain or is separated from them in known fashion.

According to the invention, the velocity of the pin chain has the following relation to the only or to all of thread deposit device revolutions:

$$v_K = a \times n \times T \times F$$

v_K is the pin chain velocity in meter/minute, a is the number of thread depositing devices, n is the number of revolutions of the thread guides per minute, which is the same for all thread depositing devices, T is the pitch of the pin chain or the distance between the chain pins in meter, and F is the number of the thread carriers which is the same for all thread deposits.

If the cross threads run at a 90° angle to the travel of the pin chains, then the invention provides that the thread wraps around as many pins as thread deposits exist on the side where the pin chain moves in the same direction as the thread guide; while the number of wrapped pins on the side of opposite, relative motion is one more than the total number of all thread guides. In case where the thread wraps around as many pins, on each side, as there are thread deposit devices, then a textile layer with threads at a cross angle results.

The machine and the process according to this invention is identified by one or more thread laying devices which deposit cross threads in the pins of two chains parallel to one another running and parallel to the plane of rotation of the thread deposit or deposit members for the running pin chain. If one views in the direction of the travel of the pin chain behind or below the thread depositing device, there is a relatively known device for the joining of two material sheets or a device for the feeding of an unsolidified material providing sheet forming mass. In front of the thread laying device or devices or between the thread laying device or devices and the joining points of the mesh and foils, etc. are units for the feeding of the longitudinal thread group and for guiding the cross thread-carrying pin chains to a point beyond the joining point of the material sheets or the solidifying point of the material sheet forming mass.

One design of the device according to this invention is identified by a thread carrier with spools, which carrier is mounted in a rotating arrangement above a group of longitudinal threads which runs between a pair of pin chains. A thread guiding device for the positioning of the threads from the thread laying device onto the proper pins on the chains is provided for each pin chain, and a driving connection between pin chains and thread laying device controls the pin chain velocity according to the number of revolutions of the thread laying device in such a way that the pin chain velocity, as well as the longitudinal thread velocity, is such that they advance by as many pins per revolutions of the thread laying device as there are thread carriers on the thread laying device.

Cover devices for permitting the positioning of the threads over the pins of the two chains are parallel to the plane of the thread laying device and are associated thread guiding parts for the lowering of the threads onto the pins. These are so arranged that the cover parts and thread guide parts can be of two parts and that the width of the openings in the cover for the number of exposed chain pins to be wrapped by the cross threads and the length of the thread guide parts is adjustable.

For a right-angle crossing of the longitudinal and cross threads there is an opening in one cover device of such a size that on its side a number of pins that correspond to the number of thread laying devices are exposed. On the other side the number of pins which correspond to the total number of thread carriers on all thread laying devices are exposed by the opening, and the number of the wrapped pins in the last case is one greater than the total number of thread carriers. The thread guiding parts correspond to the length of the opening of the respective cover parts. When the cross threads have to cross one another then the cover device is so adjusted that each side releases a number of pins which corresponds to the number of laying devices.

Another design for this process according to the invention is identified by pin chains which are arranged in a plane which slopes relatively to the thread laying device or is in a vertical arrangement. The pin chains change their direction in the area of the thread laying device and the pins in the direction change area are in the plane of the thread laying device. A preferred design for the manufacture of thread layers with thread that crosses at right angles has the feature wherein the direction change area of the pin chain and the plane of the thread laying device which provides that pins on the side of equal direction for chain and thread guide motion and pins on the other side of a number as described earlier are simultaneously in the plane of the thread guides. An embodiment for the manufacture of slanted, crossing cross threads features a direction change area with only one pin on each side in the plane of the thread guide.

The distance between the chain sprockets may be adjustable just like the adjustment of the upper direction change wheels of both pin chains relative to each other.

In order to obtain different widths of the textile layer, the distance between the pin chains and the corresponding length of the thread guide is adjustable.

A fixture on each side, in front of the lower direction change wheel, serves for the removal of the thread loops from the pins on the chains or a separating knife of well known design cuts the loops here.

DESCRIPTION OF THE DRAWINGS

The invention is described in further detail with the aid of the drawings wherein:

FIG. 1 is a broken rear elevation, partly in cross section, of a first embodiment for the manufacture of yarn mesh layers;

FIG. 2 is a broken, top plan view thereof in fragment;

FIG. 3 is an enlarged detail view of the lower, right-hand portion of FIG. 1;

FIG. 4 is a schematic side view of an embodiment for the manufacture of mesh-reinforced material sheets according to the invention;

FIG. 5 is the same embodiment in top plan view;

FIG. 6 is a side elevation of another embodiment for the manufacture of reinforced material sheets;

FIG. 7 is a top plan view of a thread laying device;

FIG. 8 is a cross section of a thread laying device;

FIGS. 9*a*–9*d* are schematic views of steps for laying of the cross threads for the manufacture of a textile layer with rectangular or square mesh;

FIG. 10 is a schematic view of the adjustment of the upper direction change wheels of the pin chains in a side view;

FIG. 11 is a top plan view showing a pushing together of the threads at the entering of the mesh and foils into the joining point;

FIG. 12 is a cross section through the view of FIG. 11;

FIG. 13 is a top plan view similar to FIG. 11 with a gear with saw teeth on both face ends of the pressing roller.

FIG. 14 is a cross section through FIG. 13; and

FIG. 15 is a side elevation of a similar arrangement with rings on the edges of one of the two pressing rollers, the ring being of a material with a high coefficient of friction such as rubber.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

In the embodiment of FIGS. 1–3, a frame carriage 6 supports the post 7, which supports the thread laying device itself on a vertical axis of rotation. The thread laying device consists of a disc 8, a tube 9 and a second disc 10. Close to the axis and just far enough from it to allow thread clearance are the thread carriers 11, in this case 10 of them. The drive of the rotating thread laying device is obtained via the shaft 1 and the chain 2, and is timed with the pin chains. The shaft 3 and the two bevel gears 4 and 5 drive tube 9, which rotates about post 7.

The thread guides 15 are mounted on the rotating discs and guide the cross threads 14 from the thread carriers 11. The longitudinal thread group 12 is limited in width at the sides by the chains 16 with the pins 17. The velocity of the chains is equal to that of the longitudinal thread group 12. The chain is covered on both sides by the cover parts 18, at the place where the threads 14 enter the area of the chain pins 17. Where the threads are guided by the outer rim of the disc 8, the cover parts 18 have openings or recesses 19 at the places where threads 14 are to be deposited on the corresponding pins. The guide member 20 is better seen in FIG. 3. Its lower edge is close to the longitudinal thread group 12 but below the upper end resulting pins 17, and lets the threads slide through the openings 19 into the area of the pins.

The distance between the chain pins, their diameter and the size of the openings or recesses 19 in the cover part 18 and the distance of the threads from one another are shown in FIG. 2 in an enlargement of a 1:10 scale in order to show the process of insertion of the threads on the pins. On the left side the direction of travel of the thread guide is the same as the pins' direction of movement. The recess 19 in the cover part 18 guides the thread in one pin. On the right side the recess 19 facilitates the contact of the threads in such a way that the so formed loop wraps along eleven pins. The thread guide parts 20 and 20′ are of a corresponding dimension. The schematic layout in the upper part of FIG. 2 shows the resulting pattern. The cross threads 14 run at right angles to the longitudinal threads 12. If however the slot 19 on the right side is made as small as on the left side, and also the thread guide part 20 as narrow as the guide part 20′, then only one pin on each side is wrapped and a textile layer of slanted cross threads results. The angle of slant results from the adjustment of both sides by 10 pins each, the adjustment has to be the same on both sides. The covering has to be positioned so that the pins released at the proper time are at the same height, that is are on an axis vertical to the longtiudinal thread group, the axis of the turning disc 8.

The previous description is based on the premise that only one thread laying device is employed. With more, the chain velocity increases. If there are two thread laying devices the velocity doubles, with three it triples, etc. The left-hand guide 20′ releases as many pins between the laid threads as there are laying devices. These are so located that they fill the existing openings.

The required tension of the threads for a proper deposit is produced by generally known and hence unillustrated thread brakes in the area of the thread carrier. The arrows 13 and 20 in FIG. 2 indicate the required feed motion and rotation for the attainment of a layout pattern as shown in FIG. 9.

FIGS. 9a–9d show the layout of the threads. According to FIG. 9a, a thread 14 was deposited by means of the guide part 20 and on the pins 17, the thread is wrapped 90° around the pin 17a, and the ten units beyond pin 17b are wrapped thereabout by 90°. By the time that the thread guide on the disc 8 reaches the opposite side of the thread layer, the pins have moved as above described, by 5 units, as is shown in FIG. 9b. In the area of the guide 20' is the pin 17c which is opposite of the pin 17b. The guide 20' is the width of one pin so that the thread 14 wraps around the pin 17c only. When the thread guide of this particular thread 14 travels to the other side, then the pins have moved on 5 more units into the position shown in FIG. 9c. The thread is laid over eleven pins as shown in FIG. 9a, so glue one work cycle is completed.

Other embodiments of the invention are shown in FIGS. 4 to 8. FIGS. 4 and 5 show a machine for the manufacture of wide-mesh textile layers of crossing threads for the reinforcement of foil sheets. Two foil sheets 21 and 22 are guided on both sides between the pressing rollers 28 and 29. They run over the rollers 23, 24 and 25 and the two width holders 26 and 27. The last mentioned members serve to keep the foil smooth. One of the foil sheets, for example the sheet 22, has an application of adhesive on the top side which is toward the inside after the bonding. The glue is applied by a generally known method and is not illustrated.

A longitudinal thread carrier 31 is mounted rotatably on a bracket 30. The longitudinal threads are wound on the carrier. From here the longitudinal threads 32 lead over the rollers 33 and 34 to the rollers 28 and 29 and are held during this transfer in parallel and constant distance by a generally known guide device (not shown). Above the pressing rollers 28 and 29 is the apparatus according to this invention for the laying of the cross threads. The rollers 28 and 29 press the two foil sheets with the mesh textile layer to provide the finished reinforced foil sheet.

The gear box 39 is mounted on the machine frame. It has a rotating disc 35 at the top side. The thread carriers 36 are mounted on the disc in an arrangement that allows removal of thread therefrom toward the center of rotation of the disc 35. The threads 37 run through the hollow shaft 38 and leave at 40 below the gear box 39. From here they are guided to the corresponding thread guide arms 51 with the thread eyelets 41. Below the rotating plane of the thread guide arms 51 are the pin chains 42 and 43 in such an arrangement that they pass at the side of the contact point of the two rollers 28,29 and below the roller over the direction change sprockets 45 and 46 back toward the top.

In FIG. 5, the rotating disc 35, the thread carrier arms 51 with the thread guide eyelets 41 and the two pin chains 42,43 are driven simultaneously. The method of timing is described in the explanation of FIG. 8.

The rotating disc 35 with the thread guide arms 51 is timed with its r.p.m. to the movement of the pin chains 42,43 from top to the bottom in such a way that one complete revolution corresponds to an advance of the chain by a number of thread carriers that correspond to the number of pins. This method produces the thread layer described in detail in FIGS. 9a–9d.

These cross threads 37 inserted on the pins of the pin chains 42, 43 at the top sprockets 44 now travel to the two rollers 28 and 29 also and are glued together with the foil sheets 21 and 22 and the longitudinal thread group 32. The two foil sheets cover the longitudinal and cross threads on opposite sides. The finished foil sheet 50 travels now to the winding spool 49, and passes over the width guide 47 and the two rollers 48 on the way. The position of the cross thread group before entering between the two rollers 28 and 29 is shown in FIG. 5 in a schematic view with enlarged thread spacing.

FIG. 6 shows another embodiment according to this invention. The joining point is here between the two pressing rollers 63 and 64. A foil sheet 57 enters this area from directly above roller 62. The second glue sheet rolls off the roller 58 and is now guided together with the longitudinal thread group 59 which rolls off the roller 60. The two pin chains 42 and 43 run slanted from the top to the bottom and are lifted by the two chain sprockets 67 to a common plane, this is shortly before the laid down cross threads enter between the two pressing rollers 63 and 64.

The foil sheet 57 is here preferably covered with adhesive, but the adhesive can instead be applied to the left foil sheet 58 which already carries the longitudinal threads. A prerequisite for this method is a glue that does not require a predrying. The upper chain wheels, which serve the direction change, are not shown individually in FIG. 4. As shown in FIG. 6, their arrangement can be such that the pin chain 42 runs over the chain wheel 44 on the side of only one pin wrap, while the other side has the chain wheels 55 and 56 for the guide of the pin chain 43. The distance between the chain wheels 55 and 56 is so that the wrapping process includes as many pins as there are thread carriers plus one. The chain wheel 44, 55 and 56 are adjustable to the side, and the chain wheel 44 especially is adjustable vertically.

FIG. 7 shows a top view of the schematic of the thread laying device. Ten thread carriers 36 are mounted on the rotating disc 35 at an equal spacing in a way that they can be withdrawn toward the disc axis and over the ends thereof. The individual threads 37 travel through the hollow axis of the rotating disc 35, through vertical thread guides, preferably tubes, and from there to the exit to the outside to the corresponding thread guide eyelets 41. Left and right of the rotating disc are the two pin rows 42 and 43 and also the chain sprockets 44 on one side and 55 and 56 on the other side.

In the example shown in FIG. 7, the rotating disc 35 runs in clockwise direction, while the pin chains move correspondingly from the top to the bottom. Therefore, as shown in the drawing, on the left side one pin is wrapped and on the right side eleven pins are wrapped simultaneously corresponding to the ten thread carriers.

A special design of the thread laying device that can be used in a device according to the embodiment of FIGS. 4, 5 and 6 is shown in FIG. 8. A hollow shaft 38 is mounted in the bearings 71, 72 in the gear box 39. At its inside wall are a number of thread guides which correspond to the number of spool carriers. They are not shown in the drawing, an these thread guides are preferably made in the form of fine tubes which lead down to the exit end 40. The threads there leaving, lead through the thread guide arms 51 which are also made of tubes and then lead to the thread guide eyelets 41 from where they are laid onto the pins of the pin chains. The plane of the thread deposit is identified by the dash-dot-dash line 81. Only those pins are wrapped that protrude beyond the level of the plane 81.

The thread guide arms 51 are for example fastened to the hollow shaft by means of the clips 70 and on the flange 68 on the shaft disc 69 and can be adjusted in such a way the the diameter of the thread guide eyelet or rather the diameter described by it can be adjusted to any desired limit. To increase this adjustment the thread guide arms 51 can be so arranged that they telescope, one in another as shown in FIG. 8. On a flange 72a at the upper end of the hollow shaft is the rotating disc 35 with the already described thread carriers 36. The threads 37 are slowed down on their way from the thread carriers 36 before they enter the vertical thread guide tubes by means of a simple weighted thread brake disc 82 sufficiently to insure the proper tension in the area of the thread layout.

The drive to the rotating disc 35 and the thread guide arms 51 is facilitated by the two bevel gears 75 and 76 and the drive shaft 53. The gears in a gear box 77, the shaft 52 and the two bevel gears 73 and 74 connect the drive and the gear 74 is fixed to the hollow shaft 38. The shaft 52 is mounted on the bearings 80. The design shown in the drawing shows a shaft 52 of two parts which are coupled with the coupling 78. The sprocket 79 is mounted on the shaft 52. A chain corresponding to the chain in FIG. 1 serves the drive of the pin chains.

A special form of chain directional change in the upper area of the thread inserting device is shown in FIG. 10. This design varies from the schematic in FIG. 6. The arrangement in FIG. 10 employs both sprockets 44 and 56 on one shaft and can both serve as the drive to the two chains. A drooping of the chains weighted down by the thread load can be avoided by the chain tension takeup. In order to obtain a position of the cross thread that is at 90° to the longitudinal threads at the joining point and if for example ten thread carriers are used, then that part of the chain 43 between 85 and 87 has to have five pitches, that is, five pin distances more than that piece of the chain 42 between the points 85 and 87. To ease this adjustment and especially in consideration of the exchangeable chains 42 and 43 for different mesh sizes, the two chain sprockets 55 and 44*a* are adjustable as indicated by the arrows near their point of rotation. This way the layout of the cross thread can be inspected after a short test run and adjusted if necessary. In FIG. 10, for example, the chain 42 shows one pitch too many. This can be taken care of during the setup of the machine by adjustment of the wheel 44*a*, for example at the top.

For a change in width of the textile layer, the distance between the two chains can be changed correspondingly and the thread guide arms 51 can be shortened in same fashion. For very wide layers it is recommended to apply thread guide brackets on the outside, along the pins. They prevent the threads from falling into the chains. This is because the thread tension sometimes reduces at the wrapping points. To obtain higher r.p.m. it is possible to make the rotating disc 35 so that the spools sit for example at a slant and they can be in two rows one on top of the other and closer toward the center point.

If it is desired to produce a layer of slanted cross threads and have them cross themselves, as is possible in the arrangement shown in FIG. 4, with that arrangement of the upper chain sprockets, then care has to be taken that the chain on both sides allows only the wrapping of one single pin; in this case the chain sprocket 55 in FIG. 10 would have to be lowered to the height of the chain sprocket 44*a*. Otherwise nothing would have to change in the arrangement.

The distance between the cross threads of the textile layer according to this invention depends on the chain pitch, that is, the distance from pin center to pin center, and the diameter of the pins.

It is equal when

$$D=\tfrac{1}{2}(T-2d)$$

where D = pin diameter, d = thread diameter, and T = chain pitch (all dimensions in mm). A variation of the pin diameter from the so determined dimension makes the distance between two neighboring threads different so that a corresponding dimension of D relative to T results in a simple pattern. This can further be varied by use of different pin diameters. Such methods are within the scope of the invention.

It has been found that the distance between the cross threads is variable within wide limits by variation of the ratio between pin chains and longitudinal thread group velocity and without exchange of the pin chains.

According to the invention, this can be accomplished in this method for the production of a textile layer of crossing threads for the reinforcement of material sheets as outlined above by variation of the velocity of the feed of the cross threads relative to the velocity of the material sheets to be reinforced, so that both velocities like the cross thread distance immediately ahead of the entrance into the sheets relative to the velocity of the finished sheet is in a fixed relation According to the invention this can be accomplished without danger of thread breakage or cross thread damage in a ratio in an area between 2.5:1 to 1:2.5.

It has been shown that such measures with the help of a device according to the foregoing are very well possible without further change of the ratio between pin chain velocity and longitudinal thread or material sheet velocity is in the area of about 1.5:1 to 1:1.5 and that this ratio can be increased to about 2:1 to 1:2, if the distance between the wheels of the material sheet to be reinforced and the pin chains increases somewhat.

Also a short distance between pin chains and material sheet wheels allows an increased difference between the velocities if additional devices according to the invention are used. It is possible, for example, to mount a gear on one of the pressing rollers with the gear on the outside of the sheet width and the tooth root diameter equal or slightly smaller than the diameter of the roller. The cross thread spacing is equal to the gear tooth pitch or whole multiple thereof. It is of advantage to make the teeth in the shape of saw teeth, their steep flank to oppose the in-feeding cross threads for a reduction of the cross thread spacing relative to the chain pitch and the other way around for an increased spacing.

For the same aim it is possible to mount a disc or ring, of a material with a high friction coefficient such as soft rubber, on both sides of the pressing rollers.

If the textile layer is to be worked into an unsolidified mass, then the described arrangement with the tooth gears is preferred even when the surface with the high friction coefficient can be used. In the case of the rubber wheel, the diameter has to be larger in diameter by twice the selected insertion depth as measured from the roller surface. The root diameter of the tooth gear also has to be dimensioned larger than the roller diameter.

The possible velocity ratio in the arrangement according to FIG. 11 can be in the range between 2:1 to 1:2, i.e., the difference in velocity between the pin chains and the material sheet edges. Beyond the limits 1.5:1 to 1:1.5 it has been found that the cross threads 99 near the edge of the sheet divert at 100 in the direction of the chain motion (relative to the velocity of the material sheet 96,97). However, this is practically without importance because the material sheet is usually made with an extra margin for trimming after the textile layer has joined the sheet.

In order to obtain a straight and parallel position of the cross threads in the finished sheet, one can increase the distance between the pin chains 93 from the sheet edge, this way the possible thread dislocation will be minimized in the sheet. In the case of a wider difference in velocity it is possible to obtain a perfect cross thread layout by the use of gears or tooth rings on both face ends of one pressing roller 94,104 as is shown in FIGS. 13 and 14. The pitch of these teeth has to be such that it is equal to the desired thread spacing or that the desired thread spacing is divisible by the tooth pitch in a whole number. It is of advantage to make the teeth of a saw tooth shape, with the steep flanks 106 facing the direction of movement of the pin chains 93, that is, in the direction of the in-feeding cross threads 92 when the chain velocity is higher than the sheet velocity and in the direction of the exiting foil sheet 99 when the velocity of the sheet is higher than the chain velocity. The inside diameter of the teeth 105 should be at the most equal to the diameter of the pressing roller 104, preferably somewhat smaller. In the case of the insertion of the cross threads in an unsolidified mass for the sheet, the inside tooth diameter should preferably be larger than the double inserting depth of the textile layer as measured from the outside contact surface of the roller. The arrangement of the tooth rings or gears 105 prevents a diversion of the threads 99 over the entire width of the pressing roller 104 including the width of the gears or gear rings 105. It is better, though not required, to increase the distance between the sheet edges and pin chains 93 somewhat. With the mounting of gears or gear rings 105 on both sides of one pressing roller 94, 104 it is possible to vary the ratio between the two velocities between 2.5:1 and 1:2.5.

Each cross thread 92 then runs against a corresponding steep tooth flank 106 and is held from the previous thread by the distance of exactly one tooth pitch and is held back against the relative velocity of the chain 93.

It is possible to select the tooth pitch so that the desired cross thread distance in the finished layer is a whole multiple of the pitch of the teeth. In consideration of the possible tooth depth, however, it is suggested to make the pitch equal to the desired thread spacing or make the pitch no smaller than half of the selected cross thread spacing. This is true, of course, if no other reasons prevail against it (frequent change of the desired cross thread distances).

The arrangement of gears or gear rings 105 with saw teeth, so that the cross threads 92 are straight between the gears, has the disadvantage that a change of the cross thread spacing may require new gears or gear rings 105. A stepless change of the cross thread spacing is not possible. It has to be done by a change of the tooth pitch. Otherwise this is possible by a change gear transmission between the drive of the chains 93 and the foil sheets 96,97.

The embodiment of FIG. 15 eliminates this problem by use of the ring 107 on both ends of one pressing roller 104. The ring has a high coefficient of friction, and can be of a material such as soft rubber. In the case of high velocity differences, this device cannot completely eliminate cross thread diversions inside the area of the pressing rollers 94, 104, but reduces it considerably so that the diversion in the finished material sheet, of the threads 99 and at the edges, and against the relative velocity, is negligible. A stepless variation of the cross thread spacing in the finished foil is possible.

Immediately following the rollers 94, 104, the cross threads may be cut by a knife or blade 101, leaving projecting cross thread end 102.

EXAMPLE 1

For the manufacture of a reinforced material sheet the velocity of the material sheet was 30 meters/minute, the chain pitch was 16 mm., the pin diameter 8mm. The device according to FIG. 6 was used, the velocity of the pin chains was increased to 45 meters/minute. Additional devices according to FIGS. 13, 14 and 15 were not used. The finished sheet has a cross thread spacing of 5.6 mm. A cross thread diversion at the edges was practically nonexistent.

EXAMPLE 2

The setup according to example 1 was changed by using a velocity of the pin chains of 20 meters/minute. The cross thread spacing obtained was 12 mm. A cross thread diversion in the finished, reinforced sheet was practically nonexistent.

EXAMPLE 3

In a device according to examples 1 and 2, the pin chain velocity was increased to 60 meters/minute. The spacing between cross threads was 4 mm. A diversion 100 of the cross threads a t the sheet edges was visible. A gear according to FIG. 14 was arranged on both sides of the pressing roller, the steep flanks were positioned against the general direction of the run. The adjustment as listed above was chosen so that the pin chains moved at 60 meters/minute and the foil sheets at 30 meters/minute. A trouble free run of the working cycle showed no diversion of the cross threads at the sheet edges.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being preferred embodiments for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. A machine for laying cross threads across longitudinal threads at right angles thereto to provide a cross mesh for sheet or foil reinforcement which comprises rotatable support means providing thread supply carriers and orbiting thread guides, two parallel chains having projecting, thread wrapping pins, said pins travelling into the vicinity of said thread guides, and means for placing said cross threads from said thread guides onto said pins in a predetermined pattern with said cross threads laid across said longitudinal threads at right angles thereto, said thread guides orbiting in a plane parallel to the direction said pins are moving at the time said cross threads are placed on said pins.

2. A machine as claimed in claim 1, and means for conveying said cross mesh between two foils and receiving said mesh between said foils.

3. A machine as claimed in claim 1, and a drive connection between said rotatable support means and said chains providing an advancement of number of pins of each chain per revolution of said support means equal to the number of thread carriers.

4. A machine as claimed in claim 3, cover devices over said chains in the vicinity of said thread guides, said devices respectively having openings and thread guide means immediately below said openings for guiding thread passing from sad rotating thread guides through said openings and onto said pins.

5. A machine as claimed in claim 1, means for driving said chains at a velocity of said chains according to the equation:

$$V_K = a \times n \times T \times F$$

wherein v_K represents the pin chain velocity in meters/minute, a the number of thread depositing devices, n the number of revolutions of the thread guide for all thread depositing devices in r.p.m. T distance between the chain pins in meter, and F the number of thread carriers per thread depositing device which is always the same for all thread depositing devices.

6. A machine as claimed in claim 4, wherein said cover device over one chain has an opening of a length sufficient to lay thread along as many pins as there are thread supply carriers and said cover device over the other chain has an opening of a length sufficient to lay said thread about one pin per rotatable support.

7. A machine as claimed in claim 4, wherein said cover devices each have an opening of a length sufficient to lay said thread along as many pins on each respective chain as there are rotatable support means.

8. A machine for laying cross threads across longitudinal threads to provide a cross mesh for sheet or foil reinforcement which comprises rotatable support means providing thread supply carriers and rotating thread guides, two parallel chains having projecting, thread wrapping pins, said pins travelling into the vicinity of said thread guides, and means for placing said threads from said thread guides onto said pins in a predetermined pattern to lay said cross threads across said longitudinal threads, said pin chains being inclined to vertical relative to the plane of rotation of said rotatable support means, and means for changing the direction of said pins adjacent said rotatable support means to position the pins of the pin chains in the plane of rotation of said thread guides.

9. A machine as claimed in claim 8, wherein one of said chains is in the plane of rotation of the thread guide on the side wherein the chain and thread guide move in the same direction and the other of the chains is in said plane for a length providing a number of pins greater by one than the number of said thread supply carriers.

10. A machine as claimed in claim 8, wherein each chain provides only one pin in the plane of rotation of said thread guides.

11. A machine as claimed in claim 1, wherein said chains travel beneath and parallel to the plane of rotation of said rotatable support.

12. A machine as claimed in claim 8, and means for adjusting the chain sprockets in the vicinity of the plane of rotation of said thread guides.

13. A machine as claimed in claim 1, wherein the diameter of said pins is: $D=\frac{1}{2}(T-2d)$ wherein D is the pin diameter, d is the thread diameter and T is the distance between pins.

14. A machine as claimed in claim 1, a pair of pressing rollers for pressing and uniting the cross-mesh and the foils or sheets, and a cross thread guiding device on each side of one of said rollers.

15. A machine as claimed in claim 14, wherein said guiding device is a gear ring with a tooth pitch equal to the cross thread spacing.

16. A machine as claimed in claim 14, wherein said guiding device is a gear ring mounted on opposite ends of one of said rollers, said gear rings having a tooth pitch evenly divisible into the spacing of the cross threads of the finished sheet.

17. A machine as claimed in claim 15, wherein said gear ring has saw tooth shaped gear teeth.

18. A machine as claimed in claim 14, wherein said guiding device is a ring on each end of one of said rollers, the peripheral surface of said ring being of a material of high coefficient of friction and adapted to engage the cross threads passing through said pair of pressing rollers.

19. A machine as claimed in claim 18, wherein said ring is made of soft rubber.

20. A machine as claimed in claim 15, characterized by a gear tooth root diameter slightly smaller to equal to the roller diameter.

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