The invention is directed to apparatus for producing parallel cross filaments or threads consisting of two simultaneously rotatable wheels disposed at an angle to each other. The peripheries of the wheels are adjacent to each other at a single point while the peripheries diametrically opposite that point are spaced apart. Threads are fed from bobbins mounted on the wheels to thread outlets spaced around the wheel peripheries. Thread gripping means are positioned on the peripheries between the outlets, and the rotational phasing of the wheels is arranged so that, at the point where the wheel peripheries are adjacent, an outlet on the periphery of one wheel is directly opposite gripping means on the other wheel periphery. Actuating means are provided at the adjacent point and the gripping means are thereby actuated to grip a thread extending from an opposite outlet. As the wheels rotate, the thread gripped by the gripping means is drawn from the outlet to extend between the wheel peripheries. As each outlet moves in turn through the adjacent point with simultaneous rotation of the wheels, the threads are picked up and are drawn from the outlets to produce a series of parallel cross threads. Cutting blades are provided to sever the drawn out threads from the wheels.
APPARATUS AND METHOD FOR LAYING CROSS FILAMENTS AND THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to an improved apparatus and method for continuously laying parallel series of cross filaments or threads. The terms filaments and threads are intended to include all single and multi-strand fibers, wires, yarns and threads whether natural or artificial.

The invention is concerned primarily with the production of cross filaments or threads in the manufacture of reinforced web materials, such as kraft paper or laminated foils, and in the manufacture of scrim and semi-woven material. Reinforced webs and scrim are produced with a longitudinal series of parallel filaments or threads and a series of parallel, or substantially parallel filaments or threads. The cross filaments or threads are usually disposed at approximately 90° to the longitudinal filaments or threads, although with apparatus previously used this angle may vary between 75° and 105°.

Apparatus at present used to lay across filaments or threads generally applies the cross filaments or threads to a web as the web is moved and relies on the relative motions and speeds of the web and the applied filaments or threads to ensure that they are applied at approximately 90° to the direction of motion of the web.

It is an object of the present invention to lay across filaments or threads directly onto a web or the like so that they are all parallel and at substantially 90° to the web direction.

It is a further object of the invention to provide apparatus for producing and laying a continuous series of parallel cross filaments or threads onto a web of material, such as paper, foil or the like, or onto a series of longitudinal filaments or threads, the cross filaments or threads being substantially 90° to the longitudinal direction of the web or the longitudinal filaments or threads.

A still further object of the invention is to provide means for producing a continuous series of parallel filaments or threads wherein the acceleration forces on the individual filaments or threads are relatively low whilst a high speed of application of the filaments or threads is obtained.

The invention comprises basically two wheels each mounted for rotation in a framework with the wheels disposed at an angle to each other so that their peripheries are adjacent at a single point (herein termed the adjacent point). Preferably, the angle between the wheels is adjustable, the normal working range being between approximately 40° and 130°.

A number of thread outlets are provided around the periphery of at least one wheel, and means are provided on the periphery of at least the other wheel to grip threads extending from the outlets when the outlets move, in turn, through the adjacent point. As the wheels rotate, thread is drawn from the outlets on one wheel periphery by the gripping means on the other wheel periphery so that the thread extends between the peripheries of the wheels. Severing means are provided to sever the drawn-out threads to provide cross threads of the desired length.

If desired, just prior to severing, the threads may be tensioned either mechanically or by heat treatment of the thread.

In order that the invention may be more readily understood and put into practical form preferred embodiments thereof will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a plan view of the apparatus of the present invention.

FIG. 2 is an elevational view taken along the lines 2—2 of FIG. 1.

FIG. 3 is a view taken along the lines 3—3 of FIG. 1.

FIG. 4 is a diagrammatical plan view showing the operation of the apparatus.

FIG. 5 is a detailed elevational view of the center portion of one wheel of the apparatus.

FIG. 6 is a view taken along the lines 6—6 of FIG. 5.

FIG. 7 is a detailed plan view taken along lines 7—7 of FIG. 3.

FIG. 8 is a further detail view taken along the lines 8—8 of FIG. 7.

FIG. 9 is a diagramatic detail view taken generally along the lines 9—9 of FIG. 7.

FIG. 10 is a detailed view showing filament or thread severing means and application of cut-off filaments or threads to a web of material.

FIG. 11 is a further diagramatic view showing the application of cross and longitudinal filaments or threads to a web of material.

FIG. 12 shows the appearance of the array of filaments or threads produced by application shown in FIG. 11.

FIG. 13 is a view similar to FIG. 11 showing the production of semi-woven scrim by the application of cross and longitudinal filaments or threads.

FIG. 14 shows the appearance of the semi-woven scrim produced by the apparatus as shown in FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the apparatus comprises two wheels 21 and 22 of equal diameter and mounted by means of axial shafts 23 and 24 on a framework 26. The wheels each comprise a rim section 17, four radial spokes 18 and a circular plate 19 mounted on the outer sides of the spokes by spacers 20. The wheels 21, 22 are disposed at an angle to each other with their peripheries adjacent at a single point indicated at 27. The framework 26 is formed of two sections pivoted together at a point 28 which is on a tangent passing through the adjacent point 27, each frame section supporting one of the wheels 21 and 22. The pivotal connection between the frame sections permits the angle between the wheels 21, 22 to be varied without variation of the spacing between the wheels at the adjacent point 27. A bar 14, shown in FIG. 4, is adjustably connected to the framework section to lock the wheels 21, 22 in the desired angular position. The framework 26 is supported on castors 16 so that the apparatus can be easily moved into an operating position. The castors may be retractable, or jacking legs 15 may be fitted to the framework so that the apparatus is securely supported in a working position.

Each axial shaft 23, 24 is mounted in bearings 29 carried by a main support 31 on each frame section outwardly of each wheel. The inner ends of the shafts 23, 24 are connected together by a connecting piece 32 and two constant velocity universal joints 33. The length of the connecting piece is selected to provide a
predetermined angle between the wheels 21, 22. A hydraulic motor 36 is connected to the shaft 24 to drive the wheels in a clockwise direction, as viewed in FIG. 2. Suitable controls (not shown) are provided for the motor to permit stepless speed control of the wheels, in a known manner.

A number of bobbin mounting tubes 37 (FIGS. 1 and 7) project outwardly from the outer face of each wheel 21, 22. The mounting tubes 37 are parallel with the axial shafts 23, 24 of the wheels. Bobbins 38 containing filaments or threads 39 are clamped co-axially over each mounting tube 37 and thread 39 from the bobbins 38 passes to and extends through the mounting tubes 37.

Each of the mounting tubes 37 connects with a conduit 41 on the inner face of the wheel. The conduit terminates at the periphery of the wheel at one of a number of equally spaced thread outlets 42. The same number of outlets 42 are provided on each wheel. The threads 39 pass through the conduits 41, from the mounting tubes 37, to project out of the outlets 42.

A number of gripping devices 43 are located around the periphery of each wheel between the spaced outlets 42, there being the same number of gripping devices 43 as outlets 42. The wheels 21, 22 are set up out of phase by one spacing interval so that, on rotation of the wheels 21, 22, each outlet 42 passes through the adjacent point 27 simultaneously with a gripping device 43 the other wheel.

As shown particularly in FIGS. 7 and 8, the gripping devices 43 each comprise a pair of fingers 44, 46, one finger 44 being fixed to the wheel periphery and the other finger 46 being pivotally mounted on a pin 47 extending from the periphery. The finger 46 is provided with a cam follower 48, and a spring 49 biases the finger into engagement with the fixed finger 44. Both fingers 44 and 46 are fitted with sleeves 51 formed of rubber, synthetic plastic material, or the like, to assist gripping of the thread.

A pair of cam tracks 52, 53 is mounted on the framework 26 adjacent to the peripheries of the wheels 21, 22 near the adjacent point 27. The cam tracks 52, 53 are positioned and shaped to engage the cam followers 48 of the gripping devices 43 as the wheels rotate. As shown in FIG. 8, the cam tracks 52, 53 thereby produce relative movement of the cam followers 48 so that the finger 46 moves away from the finger 44 as rotation of the wheels moves the fingers close to the adjacent point 27. Relatively sharp cut-off sections are provided on the cam tracks 52, 53, which allows the biasing spring 49 to cause the fingers 44, 46 to quickly engage at a location past the adjacent point 27, as shown in FIG. 9.

As previously stated and illustrated in FIG. 9, a gripping device 43 on one wheel is immediately opposite an outlet 42 on the other wheel at or near the adjacent point 27. The outlets are arranged so that a thread 39 extending therefrom extends between the opened fingers 44 and 46 of the gripping device 43. As the wheels rotate, the fingers 44 and 46 close on and grip the thread 39. Continued rotation of the wheels 21, 22 causes the outlet 42 and gripping device 43 to move apart as the peripheries of the wheels diverge thereby drawing thread from the outlet 42.

As each outlet 42 on each wheel passes the adjacent point 27, the adjacent gripping devices on the opposite wheel grip the threads 39 extending from each outlet, and a plurality of threads are sequentially drawn out. Threads 39 are drawn alternately from one wheel and then the other to provide a series of substantially parallel threads.

The cam tracks 52 and 53 are pivoted to the framework 26 at their upper ends and are movable into and out of the operative position by pivoted levers 50 and 55. The levers engage with the rear of the cam tracks and are operated to cause the cam tracks 52 and 53 to move out of the path of rotation of the cam followers 48. In this position, the cam followers 48 do not contact the cam tracks 52 and 53 so that the fingers are not opened as they approach the adjacent point 27. Thus, the operation of the machine is stopped whilst the wheels 21 and 22 continue to rotate. The levers 50 and 55 may be operated manually, pneumatically, hydraulically or electrically, by any suitable activating means. Manually operated levers are shown in FIGS. 1 and 2.

Severing means 54 are located between the wheels 21, 22 near the peripheries thereof diametrically opposite the adjacent point 27. The nature of the severing means 54 will vary with the nature of the filament or thread being used. In the present embodiment, using a fiber-glass thread, the severing means 54 consists of a pair of spring biased cut-off wheels 56 which rotate against a roller 60 having a rubber, synthetic plastic, or the like surface (see FIGS. 1 and 10). The threads 39 extending between the peripheries of the wheels 21, 22 engage with the roller 60 and are fractured at their ends by the wheels 56.

It will be seen in FIG. 4 that the length of the thread 39 drawn from the outlet 42 increases from the adjacent point 27 to a position 180° around the circumference of the wheels from the adjacent point. The severing means 54 can be located at any position along these arcs to cut threads of any desired length. Alternatively, the angle between the wheels 21, 22 can be varied to provide a cut-off at the position diametrically opposite the adjacent point 27 of any desired length consistent with the angle between the wheels 21, 22 and the diameters thereof.

The severing means 54 is positioned relative to the outlets 42 so that a small length of thread remains projecting from each outlet 42 after cut-off. This small length of thread is the thread end which is subsequently gripped by the gripping device 43 when it passes through the adjacent point 27.

The ends of the threads 39 which remain gripped between the fingers 44, 46 after cut-off are blown from the fingers when the finger cam follower 48 again contact the cam tracks 52 or 53 and the fingers 44, 46 open. Nozzles 70 and 71 are located near the start of the cam tracks 52 and 53 and direct streams of air onto the fingers 44, 46 on each wheel 21, 22. A container 65 is located between the wheels 21, 22 to collect the thread ends as they are blown from between the open fingers 44, 46.

The apparatus of the invention is suitable for handling most types of natural and artificial fibers or threads. However, some types of thread will not project from the outlets 42 in a manner which ensures con-
sistant pick-up by the gripping devices 43. The apparatus is therefore, provided with air blast means to ensure that the threads properly stand out from the outlets 42. The air blast means consist of annular plates 72, one located at the center of each wheel 21, 22 co-axial with the respective axial shafts 23 and 24. Each plate 72 is formed with a number of holes 73 extending radially inwardly from the circumferential surface 74 of the plate, the number of holes 73 corresponding to the number of outlets 42 on that wheel. The radial holes 73 communicate with axially extending holes 75 formed in the outer face of the plate 72.

Air conduits 77 are connected to each radial hole 73 and connect into the conduits 41 between the bobbin mounting tubes 37 and the outlets 42. A non-return ball-valve 78 is located in each air conduit 56.

Air is supplied only to those conduits 77 leading to outlets 42 approaching the adjacent point 27. The air is supplied from a source of compressed air (not shown) connected to an air delivery member 79 which slidably engages with the outer face of the plate 72. The member 79 is formed with a manifold slot 81 arranged to simultaneously communicate with a number of the axial holes 75 to supply air to these holes. As the wheels 21, 22 rotate, the axial holes 75 communicating with outlets 42 approaching the adjacent point receive air from the manifold slot 81 in turn. The member 79 is held against the plate 72 by a spring (not shown). As the wheels 21, 22 continue to rotate, the axial holes 75 receiving air pass from communication with the slot 81 so that the air supply to the corresponding outlets 42 is removed.

In operation, bobbins 38 containing thread 39, such as multi-strand fiber-glass thread, are clamped over the mounting tubes 37 on each wheel. The thread 39 from each bobbin 38 is inserted into the outer, open end of the associated mounting tube 37. An air jet directed into the mounting tube 37 carries the thread 39 through the conduit 41 to the outlet 42. The non-return ball-valve 78 in the associated air conduit 77 prevents an air flow in the reverse direction along the air conduit 77 and thereby ensures that the thread 39 is carried to the outlet 42. Threads 39 are thereby caused to extend from each outlet 42 on each wheel 21 and 22.

In the production of web material reinforced with longitudinal and transverse threads or fibers, the apparatus is arranged adjacent to a roller 60 around which the web 63 passes. The peripheries of the wheels 21, 22 are positioned adjacent the roller 60 with the pair of cut-off wheels 56 engaging the outer ends of the roller as shown in FIGS. 1 and 11. The web 63, preferably coated with an adhesive material, passes around the roller 60 as the wheels 21 and 22 are rotated. Threads 66 cut by the cut-off wheels 56 are picked up by the web 63 as it passes the cut-off point. Longitudinal threads 64 may either be pre-positioned on the web, or may be drawn onto the web 63 as it passes around the roller 60. These longitudinal threads 64 may be arranged to pass around a second roller located adjacent the roller 60 so as to be applied to the web over the transverse threads 66 as shown in FIG. 11. The web 63, having the array of longitudinal threads 64 and the evenly spaced cross threads 66 extending at right angles to the longitudinal threads 64, is illustrated in FIG. 12.

In an alternative arrangement shown in FIG. 13 for the production of scrim, either as a reinforcing for web material or for subsequent use, some longitudinal threads 67 are fed to the roller 60 from beneath the roller 60 and are positioned under the cross threads 66. Other longitudinal threads 68 are fed from above the roller 60 and are positioned over the cross threads, in an alternating sequence with the threads 67 to form a semi-woven scrim 69. The array of longitudinal and cross threads in the semi-woven scrim is shown in FIG. 14.

It will be evident that the method and apparatus provided by the present invention is particularly suitable for the rapid provision of a series of parallel cross threads or filaments. Such threads or filaments can be applied directly to a laminator for forming reinforced laminated web material, such as reinforced laminated foils, or to make scrim, with the cross threads being at substantially 90° to the machine direction. The speed of such application depends on the required filament spacing, but applications of the order of 7,200 threads per minute can be easily accommodated in apparatus of the form described. Additionally, the spacing of the cross filaments can be varied while running if required, with the range of spacing extending from continuous laid upwards. The thread spacing is controlled by the number of thread outlets on the wheels and the speed of rotation thereof in relation to the process speed.

Apart from direct application to laminated products the apparatus can be used in conjunction with longitudinal or machine direction filaments to make a scrim. The longitudinal filaments may be adhesive coated if desired. The semi-woven product having every alternate machine direction filament under the cross filaments and the other on top, may have the filaments resin bonded or heat sealed depending on the material, or it may be loose if the scrim produced is to be subsequently used as a web reinforcing.

The method of operation of apparatus provides that each filament is run out so that the acceleration forces are low and slowly applied, making the apparatus suitable for low strength filaments. As there is substantially no relative rotational motion between the outlet and gripping device, the range over which pick up of the threads by the gripping devices will occur is not critical. Therefore, the necessary actions for mechanical operations can be carried out without inducing high loads. The speed of the rotation of the wheels is believed to be limited only by the out of balance forces, some of which are caused by bobbins of unequal weight and practical operating speeds of the order of 10,000 threads per minute can be achieved.

It will be appreciated that the present invention provides a simple and efficient method and apparatus for the production of cross filaments suitable for a variety of applications. In particular there are products which require a basic fabric either as a reinforcement or as a backing, to support a cast on coating. The production rate of these products is such that a relatively fine semi-woven fabric may be directly applied by the present invention. This would represent a cost saving over the application of previously woven material.

I claim

1. Apparatus for forming a continuous series of substantially parallel cross filaments or threads comprising
two wheels mounted at an angle to each other with the peripheries of the wheels adjacent at a single point, means for rotating both wheels about their respective axes in the same direction, a plurality of filament or thread outlets spaced around the periphery of at least one of said wheels, means for supplying filament or thread to each said outlet, means on the periphery of at least the other wheel to pick up a filament or thread projecting from an outlet as each outlet rotates through the adjacent point and to draw the filament or thread from the outlet with continued rotation of the wheels, and means for severing drawn out lengths of filament or thread.

2. Apparatus as defined in claim 1 wherein outlets alternate with pick up means around the periphery of each wheel and an outlet on one wheel moves through the adjacent point adjacent pick up means on the other wheel.

3. Apparatus as defined in claim 1 wherein a plurality of tubes extend outwardly from the outer face of the said at least one wheel, the inner end of each tube being connected to one of the outlets by a conduit, and a bobbin containing filament or thread is mounted on each tube with the filament or thread passing down the tube to the associated outlet.

4. Apparatus as defined in claim 1 wherein the pick up means includes a plurality of pairs of fingers spaced around the periphery of the wheels between said outlets, cam follower means associated with each pair of fingers, and cam track means mounted near the adjacent point, the cam track means engaging the cam follower means to open and close the fingers to grip a filament or thread projecting from an adjacent outlet on the other wheel.

5. Apparatus as defined in claim 4 wherein one finger of each pair is fixed to the periphery of the associated wheel and the other finger of each pair is pivoted to the wheel periphery, the cam follower means being integral with the pivoted finger, and resilient biasing means are connected to the cam follower means to bias the fingers to a closed filament or thread gripping position.

6. Apparatus as defined in claim 4 wherein the cam track means are movable into and out of the path of rotation of the cam follower means.

7. Apparatus as defined in claim 4 wherein said wheels are rotatably supported by axial shafts in bearings on a framework, the framework being formed in two sections with one wheel supported by each section and the sections being pivoted together at a point on a tangent through the adjacent point, said framework also carrying the cam track means and operating means therefor.

8. Apparatus as defined in claim 4 wherein said means for supplying filaments or threads to each outlet includes air blast means comprising an apertured disc mounted on each wheel co-axially therewith, air conduit means extending from each aperture in said disc to each outlet on the respective wheel peripheries, and means for supplying air only to selected disc apertures at any one time to cause air to flow through the associated air conduits and issue from those outlets approaching the adjacent point.

9. Apparatus as defined in claim 4 wherein said means for severing drawn out lengths of filament or thread comprises cutting means positioned adjacent the peripheries of the wheels to sever predetermined lengths of filament or thread at a position between the adjacent pint and the point diametrically opposite.

10. Apparatus as defined in claim 9 and further including a roller located adjacent to the peripheries of the wheels, a cutting wheel located adjacent each wheel periphery and engaging with the surface of the roller to sever the lengths of filament or thread, and a web of material moving around the roller to pick up the severed threads and to engage with longitudinal filaments or threads to form a scrim.

11. A method of forming a continuous series of substantially parallel cross filaments or threads comprising the steps of maintaining a supply of filaments or threads to a plurality of outlet points around the periphery of at least one of a pair of angularly disposed wheels, rotating said wheels in the same direction and with the same peripheral velocity, gripping each filament or thread in turn at the outlet point to which it is supplied moves adjacent to the periphery of the other wheel, drawing the filament or thread to span between the peripheries of the wheels as they rotate, and severing each length of drawn out filament or thread adjacent to the periphery of each wheel to provide cross filaments of the desired length.

12. A method as claimed in claim 11 and further including the steps of actuating gripping means on the periphery of said other wheel at a position near to the adjacent point of the peripheries of the wheels, causing said thread projecting from an outlet on the periphery of the other wheel to engage with said gripping means, and operating the gripping means to grip said thread.