Aug. 9, 1966 G. E. SMOCK ETAL 3,265,481

APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

Filed Oct. 18, 1962 5 Sheets-Sheet 1

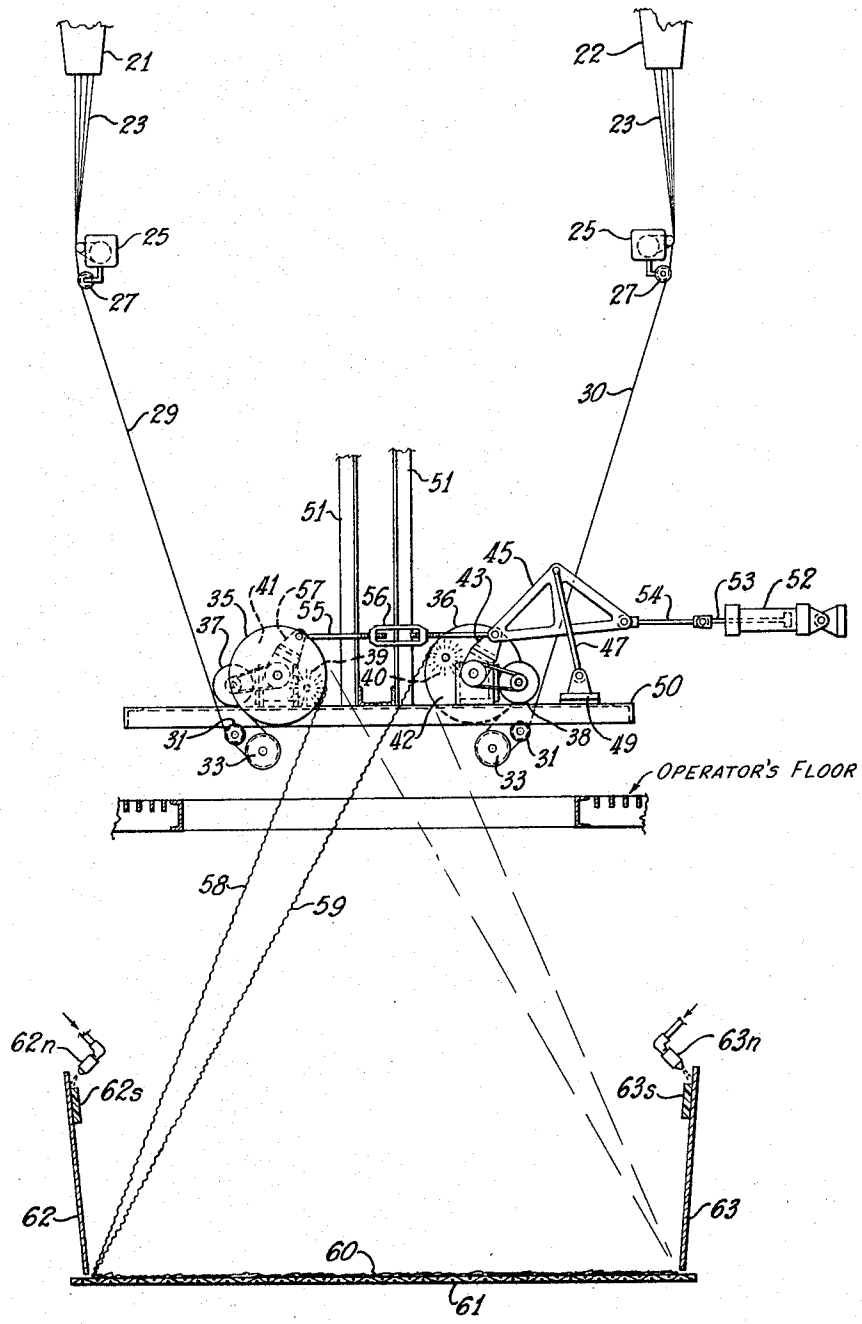


Fig. 1

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APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

Filed Oct. 18, 1962 5 Sheets-Sheet 2

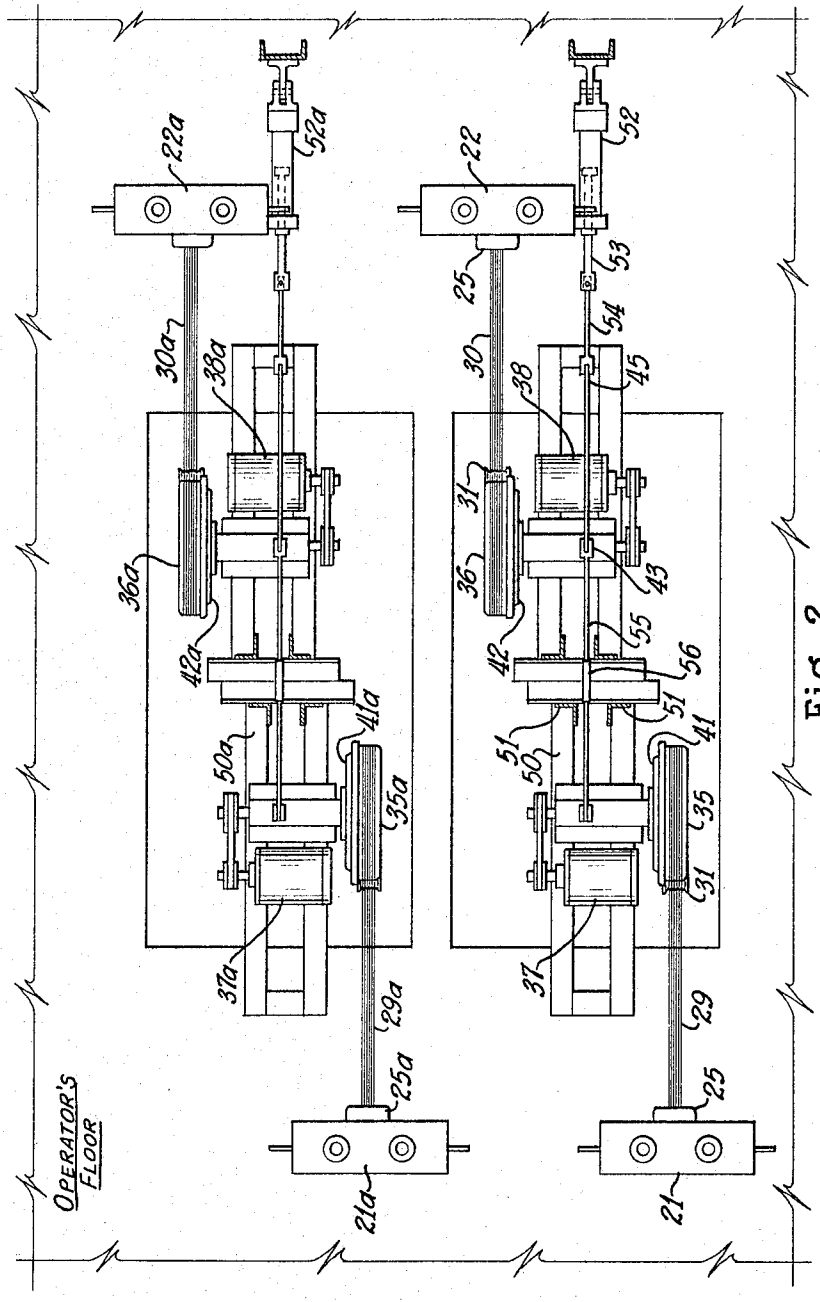


Fig. 2

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APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

Filed Oct. 18, 1962 5 Sheets-Sheet 3

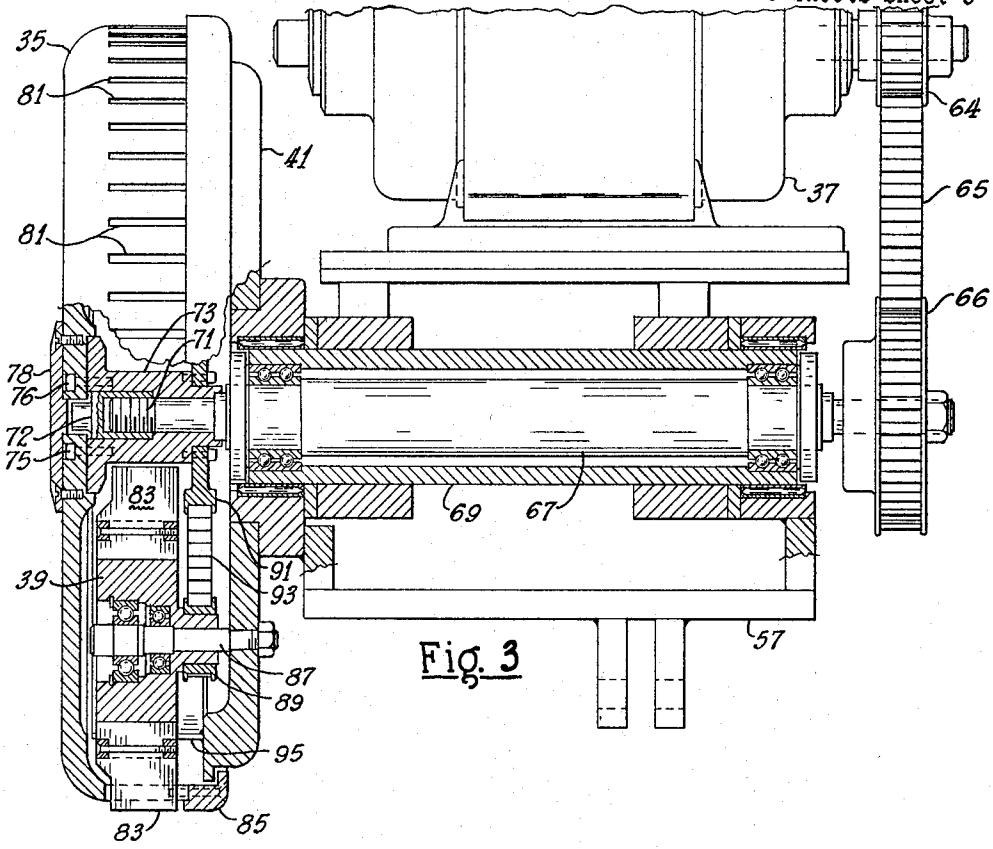


Fig. 3

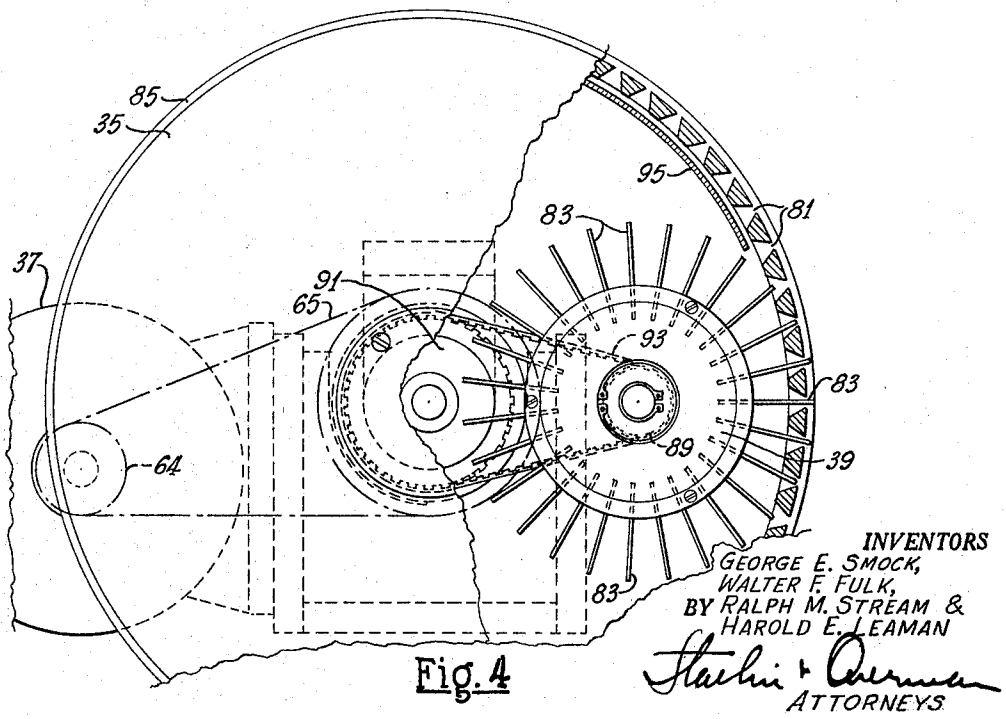


Fig. 4

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APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

Filed Oct. 18, 1962

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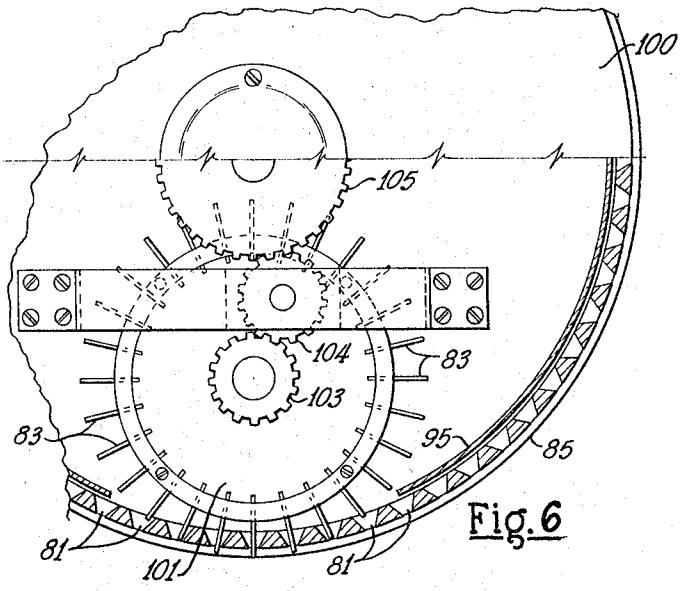


Fig. 6

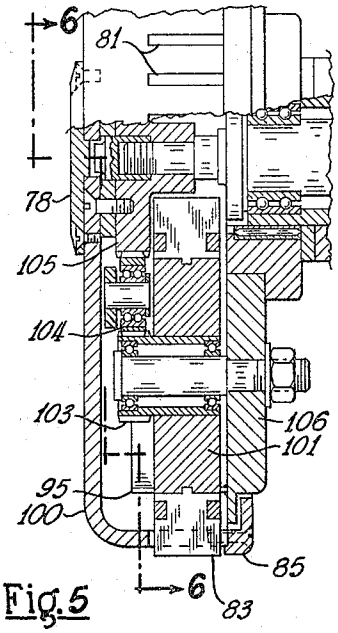


Fig. 5

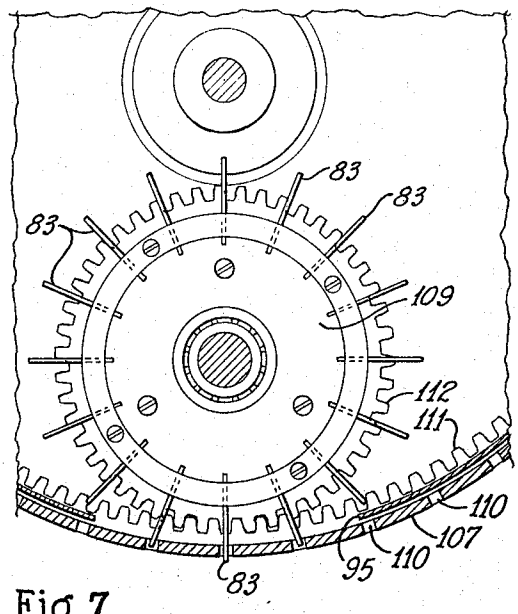


Fig. 7

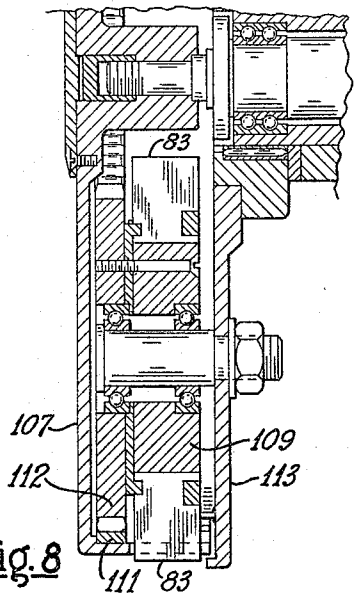


Fig. 8

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APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

Filed Oct. 18, 1962

5 Sheets-Sheet 5

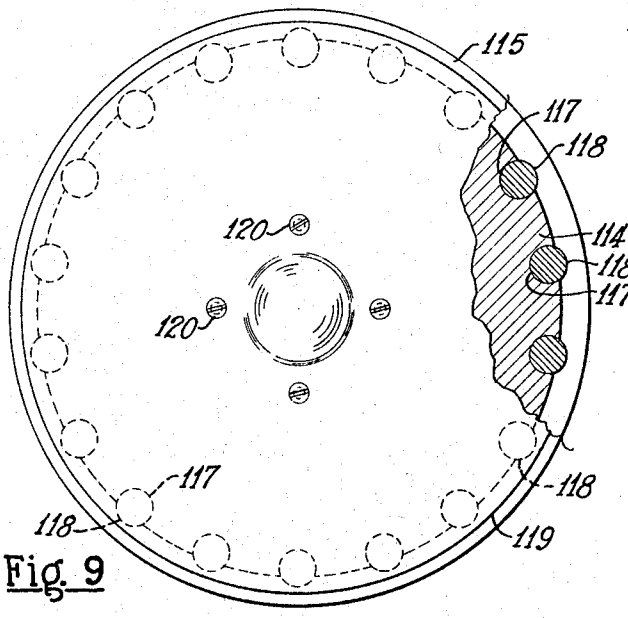


Fig. 9

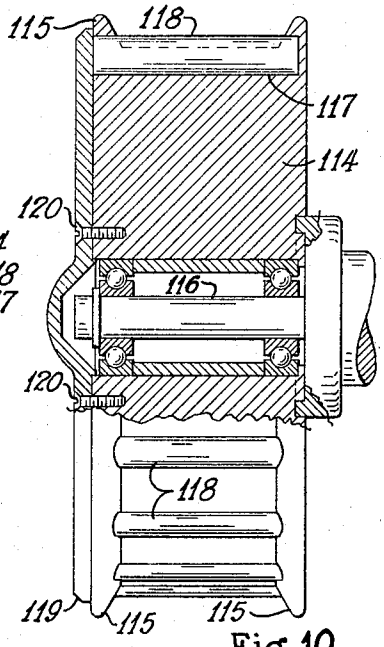


Fig. 10

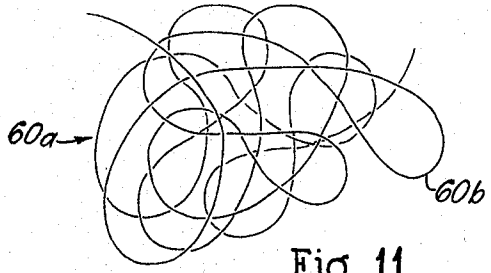


Fig. 11

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United States Patent Office 3,265,481 Patented August 9, 1966

3,265,481

APPARATUS FOR DELIVERING MULTI-FILAMENT STRANDS

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Filed Oct. 18, 1962, Ser. No. 231,363
9 Claims. (Cl. 65—9)

This invention relates to apparatus for forming a continuous fibrous mat with multi-filament strands, and more specifically to apparatus for drawing glass filaments, gathering the glass filaments into strands and accumulating the strands upon a receiving surface.

Mats of fibrous glass, because of their inherent properties, especially those of strength and inertness, have many uses. They have been employed as filtering, acoustical and thermal insulating media. They also serve effectively for roofing sheets, non-woven fabrics, and for reinforcing plastic products.

In some instances the mats are composed of short fibers held together by a binder. In others the mats are bonded webs of chopped fibrous glass strands. Bundles or strands of continuous glass filaments have also been disposed in mat form. Strands of filaments have superior strength because of the continuous nature of the filaments and their concentrated linear association in strand form. Accordingly, fibrous glass strands are a most desirable mat constituent where strength is a prime consideration.

However, there have been difficulties involved in the fabrication of strand mats as well as deficiencies in such mat products. Because of the comparative greater bulk of the standard fibrous glass strands, they are not inclined to become easily entangled to form an integrated mass. They also are not disposed to lie in a flat formation. A further objection has been that the production of such mats has been costly due to requirements of special equipment and slow and involved processing.

Also, in mats of conventional strands there is a lack of integrity, insufficient porosity, and a coarse appearance.

Some of these deficiencies have been overcome by partial filamentizing of the strands by impinging them against a deflecting surface before the strands are massed in mat form. The resulting fuzziness promotes interengagement of the strands or semi-felting action which tends to integrate the mat product. However, there is an attendent bulkiness and loss of strength which are undesirable for many end uses of the mat. In addition, areas where there is a concentration of dispersed or fuzzed strands resist desired penetration by a resin to be reenforced.

In view of the above, it is an object of this invention to provide apparatus for more expeditiously and economically producing mats of fibrous glass strands.

A further object is to provide apparatus for creating such mats with greatly improved characteristics.

More specifically, an object of this invention is to provide apparatus for drawing continuous filaments of glass, gathering the filaments into a plurality of strands, and projecting the plurality of strands in parallel and planer formation back and forth across a conveyor to form a mat of strands thereon.

These and other objects and advantages are secured through the novel apparatus disclosed herein incorporating a novel pull wheel for drawing glass filaments and grooved guide shoes for gathering them into a plurality of strands of a size below that of conventional strands, the strands being directed in closely aligned, parallel formation back and forth across a traveling conveyor, and collected as an integrated mat upon the conveyor.

The objects of the invention are further promoted and

attained through the particular design of the releasing means associated with the wheel, a tension equalizing idler wheel and other components of the subject apparatus.

In the drawings, FIGURE 1 is a front elevation of apparatus embodying the invention;

FIGURE 2 is an enlarged plan view of the apparatus of FIGURE 1, with an additional pair of pull wheels and associated equipment;

FIGURE 3 is a side elevational with portions in section of one of the pull wheels and the motor drive therefor incorporated in the apparatus of FIGURES 1 and 2;

FIGURE 4 is a fragmentary front view with parts broken away of the pull wheel and motor drive of FIGURE 3 with the assembly turned ninety degrees counterclockwise from the position of FIGURE 3;

FIGURE 5 is a fragmentary showing, mostly in vertical section, of a modified form of pull wheel;

FIGURE 6 is a fragmentary front elevation, largely in section, of the pull wheel of FIGURE 5 as viewed from the line 6—6 thereof;

FIGURE 7 shows a portion of still another form of pull wheel;

FIGURE 8 presents a vertical section of the portion of a pull wheel illustrated in FIGURE 7;

FIGURE 9 is a front view with a section broken away of an idler wheel comprising a feature of the apparatus of this invention;

FIGURE 10 is a partial vertical section and a partial side elevational view of the idler wheel of FIGURE 9; and

FIGURE 11 depicts a typical pattern which a strand may follow when deposited by the apparatus of this invention.

Referring to the drawings in more detail the apparatus of FIGURES 1 and 2 includes molten glass feeding bushings **21** and **22** depending from conventional glass melting tanks which are not illustrated. A second paired set of bushings **21***a* and **22***a* is depicted in FIGURE 2. The additional equipment of FIGURE 2 duplicates that of FIGURE 1 and will not be described separately. The main components carry the same identifying numbers as the like parts of the apparatus of FIGURE 1 but with the letter *a* following each number.

Continuous filaments **23** are drawn from the minute streams of molten glass issuing from orifices of the bushings. It will be considered that a bushing with 352 orifices is here utilized and the filaments are drawn to an average diameter of fifty hundred-thousandths of an inch.

Size is applied to the filaments as the latter pass over the traveling belts or aprons of the conventional size applicators **25**. The size may merely be water to reduce fricton between filaments as they are subsequently joined together in strand form. A more complex size or binder is however desired to promote coherence of the filaments when combined as strands, and adherence of the strands of filaments to the surfaces of the pulling wheels. Where the mat produced is to be ultimately combined with a plastic resin, it is also desirable to include a coupling agent in the size which facilitates wetting of the mat by the resin.

A preferred form of binder is one retaining sufficient cohesive properties when cured to contribute to the bonding of the strands in the mat or other form in which they are collected on the conveyor or the receiving surface. Such a binder has the dual purpose of holding the filaments together as strands, and bonding the strands into an integrated body.

As the mats are produced immediately below the glass filament forming stations, a commonly used lubricant component of the size may be omitted. The inclusion of such a lubricaing material has been found necessary for

improving the handleability of the strands where the strands go through subsequent operations such as plying and twisting, but it is not otherwise necessary and in fact interferes with effective wetting of the strands by a plastic resin.

The filaments from each bushing, after sizing, are grouped together to form a set of six strands individually segregated as they travel within six grooves over the respective gathering shoe **27**. Each strand contains about sixty filaments. The division of the filaments into strands is here accomplished manually at the start of operations.

The sets of strands **29** and **30** pass under the aligning shoes **31** which are grooved in the same manner as the gathering shoe **27**.

To help keep the pull wheels clean of size and to distribute the wearing action of the strands on the pull wheel the aligning shoes may be given a slight traversing action. This slowly shifts the strand position on the pulling wheel, moving back and forth about once in three minutes.

From shoes **31** the two sets of spaced strands **29** and **30** are led around the two idler wheels **33** and respectively travel around the pull wheels **35** and **36**. These wheels are similarly constructed but are relatively reversed in position and are on opposite sides of the center line of the receiving conveyor **61**.

Motors **37** and **38** respectively drive pull wheels **35** and **36**. The strands carried by pull wheel **35** are released therefrom by the successive projection of fingers of oscillating spoke wheel **39** through slots in the peripheral surface of the pull wheel **35**, while the fingers of spoke wheel **40** serve this purpose in connection with pull wheel **36**. The strands are kinetically projected in tangential paths from the pull wheels.

The rear side of each pull wheel is covered by an independently mounted, oscillatable back plate on which the associated spoke wheel is carried. Back plate **42** of the assembly including pull wheel **36** is arcuately oscillated through arm **43**. The latter is driven by functioning of the fluid cylinder **52** which sets through the triangular link **45**, which pivots upon bar **47** on the base **49**. The piston rod **53** extending from the cylinder is joined to the triangular link **45** by linking rod **54**. The base **49** is positioned on the platform **50** which also supports the pull wheels **35** and **36** and the equipment associated therewith. Platform **50** is suspended by angle iron hangers **51**.

Through the connecting assembly **55**, including the turnbuckle **56**, the transverse movement of the triangular link **45** is transmitted to arm **57** to arcuately oscillate the spoke wheel **39** within the pull wheel **35**. This oscillation is preferably in an arc of approximately fifty-seven degrees. With the single means effecting the oscillation of both spoke wheels their action may be closely synchronized.

The group of strands **58** thrown down by the pull wheel **35** and the group of strands **59** thrown down by the pull wheel **36**, and the strands from any other pull wheels preceding this pair are accumulated in mat form **60** upon traveling conveyor **61**, which is preferably of carbon steel chain construction. Side shields **62** and **63** define the edges of the mat **60** and prevent undesirable lateral overreaching of the strands. A two-foot height for these shields is generally sufficient.

To prevent adherence of the strands to the side shields **62** and **63**, strips **61***s* and **63***s* of open-cell foam or of other porous material, about one half inch thick are attached along the shields near the top edges thereof. Plain cotton rag material has been found to be satisfactory. Water nozzles **62***n* and **63***n* are arranged to feed water to the upper surface of the foam strips. The water seeps through the strips and is distributed uniformly to form a water film flowing down the surfaces of the shields. Tubing with a series of holes may be used instead of the nozzles **62***n* and **63***n* to deliver the water and may be employed for directly forming the water films.

The width of the conveyor covered by the mat in this case is four and one half feet, but this may be varied through a wide range by changing the oscillating arc length of the spoke wheels and the distance of the pull wheels above the conveyor. The side shields **62** and **63** are mounted to adjust their spacing to match the width of the deposited material. Ordinarily the width utilized would be between extreme limits of two and nine feet.

The pull wheel **35** and the drive therefor are shown in more detail in FIGURES 3 and 4. On the shaft of motor **37** is a toothed pulley **64** which has driving connection through the segmented timing belt **65** with toothed pulley **66**. The latter is mounted on the outer end of shaft **67**, on the other end of which is carried the pull wheel **35**.

The shaft **67** is journaled in the stationary casing **69** upon which the motor **37** is supported. The pull wheel is held upon the threaded stud **71** of the shaft **67** by the barrel nut **72**. The hub **73** of the pull wheel has a bored section fitting over the smooth portion of the stud **71** and held against a shoulder terminating the smooth portion by the barrel nut **72**. The main body of the pull wheel is fastened to the hub **73** by machine screws **75** and **76**. A cap **78** covers the outer end of the bore through the hub.

In a preferred embodiment the pull wheel **35** is twelve inches in diameter and has a series of peripheral cross slots **81**, approximately one and one-eighth inches long, three-sixteenths of an inch wide and spaced five-sixteenths of an inch apart. To reduce the wear, the strand receiving surface of the pull wheel is given a hard surface such as an electrolytic deposit of aluminum oxide or a coating of nickel phosphate.

The fingers **83** of the spoke wheel **39** within the pull wheel **35** are dimensioned and motivated to successively project through the slots **81**. The spoke wheel is mounted on shaft **87** projecting from the back plate **41** and carries the toothed pulley **89** on a rearward extension of the wheel hub **73**.

The main body of the spoke wheel **39** is in this instance about three and three-quarter inches in diameter with the fingers **83**, twenty-seven in number, radially extending slightly more than thirteen-sixteenths of an inch from the periphery of the main body. The exterior portions of the fingers are generally of rectangular blade form one inch wide with a thickness of .024 of an inch. About one-eighth of an inch of the outer end of the fingers extend out of the pull wheel slots at the point of their greatest projection.

The movement of the fingers **83** into the slots **81** and their momentary projection through the slots to release the strands is synchronized through the timing drive between the pull wheel and the spoke wheel. This includes the toothed pulley **91** fixed upon the hub **73** of the pull wheel, the cog timing belt **93** running over pulley **91**, and the pulley **89** on the shaft **87** upon which the spoke wheel is journaled.

The back plate **41**, oscillatable through yoke **57** to which it is attached, is mounted through bearings on the stationary casing **69**. Yoke **57** and therethrough back plate **41** and the spoke wheel **39** are oscillated in an arc of approximately 57° by functioning of fluid cylinder **51**.

Air movement into the interior of the pull wheel **35** is curtailed by the shroud ring **85** held to the inner edge of the wheel periphery by a series of machine screws. A baffle **95** interruptedly cylindrical in form, is carried by the oscillating back plate **41** and lies under the slots **81** except for an open section of the baffle in the region of the spoke wheel. This prevents air movement outwardly through the slots which is apt to irregularly release strands from the pull wheel. As the baffle oscillates with the spoke wheel, the open portion of the baffle is always in

the area where the fingers **83** enter the slots **81** of the pull wheel.

With the high peripheral speed of the pull wheel, the strands are forcefully projected in straight tangential lines from the oscillating point of disengagement effected by the fingers of the spoke wheel. The kinetic energy the strands thus acquire carries them in straight courses to the region of the conveyor surface. Here they are self-positioning in lazy whirl formation with each strand assuming an individualistic pattern but disposed in interengaging and interleaving relation with the other five strands of the set.

The distance of the pull wheels above the conveyor, and the rotational speed of the wheels are so selected, in relation to the specifications of the plurality of strands being deposited, that the strands are projected with sufficient kinetic energy to carry them as a band of generally constant form and in substantially regular paths to the surface of the conveyor or other collection surface.

The group of strands is thus deposited in a reciprocating strip disposed in a constant repeating pattern and with substantially stable dimensions.

Consequently, full control may be exercised to obtain a desired relationship between adjacent courses of the strip deposited from a single wheel and to complement or match the resulting pattern with that developed by the deposit of strips from associated pull wheels. The mat produced may thus be assured of having a thickness with a high degree of uniformity, or a definite repeated pattern of varying thicknesses, if such is required.

Variations in patterns can be imparted to the product by oscillating adjacent wheels in the system at different rates, or at different angles with respect to the line of travel of the conveyor. Also, the speed of the conveyor may be varied to alter the degree of pitch of the zig-zag strips being deposited.

Strands of filamentized strands as well as the generally preferred integrated strands can be included in the product by having one or more of the wheels provided with a deflecting surface in the path of the projected strands. The strands thus filamentized may be incorporated across the center portion of the mat or be positioned on the surfaces to provide a more finished appearance. A large range of relationships can be established between the strips laid by various pull wheels in the system, but any one product may be reproduced uniformly by locking the system into the dynamic relationship which has been found to produce the particular mat structure desired.

While a balance of the various factors involved is required to establish the proper kinetic energy for carrying the strands in a dependable, regular fashion to the conveyor surface, the projection of the strands in close array helps prolong the integrity of the band formation. Evidently each strand aspirates air during its high speed descent and this tends to pull or hold adjacent strands together. The group of strands will travel further than a single strand before losing momentum and directional regularity because the retarding effect of the thin wall of air separating strands is reduced by the joint pull of such strands upon the air.

The total resistance opposing the group is thus materially less than the total resistance that would be encountered by the same number of strands projected individually.

When the strands reach the proximity of the conveyor surface, their kinetic energy has been quite completely dissipated through air drag and possibly by a braking effect transmitted upwardly by the immediately preceding deposited strand portions. As linearly the strands greatly exceed the length of the course upon which they are laid, the strands must assume a looping formation. This irregular coiling is initiated above the surface of the conveyor and is characterized by irregularly shaped, figure eights with loops extending laterally as much as an inch or more from the preceding, comparatively straight path of each strand. The loops of adjacent strands and possibly of all the threads of a strip are variously interleaved to integrate the deposited strip.

A typical pattern of a single deposited strand **60***a* is depicted in FIGURE 11. The smooth easy curve **60***b* appears repeatedly in overlying loops and coils.

Under a stroboscope it has been observed that the strands leaving the pull wheel vibrate or pulsate at a uniform high frequency. This is believed a factor in the natural, smooth character of the looping deposit of the strands on the conveyor.

The binder applied to the individual filaments prior to their being gathered into strands may be of a composition retaining its adhesive nature until the strands are deposited upon the conveyor. On subsequent curing the binder then not only acts to hold the strands in integrated form but also bonds adjacent loops of the strands together in the mat structure.

The profile of the strip of looped strands is flat at the bottom and symmetrically curved across the top; the greatest elevation being at the center of the strip with a gradual diminution of the elevational dimension toward the edges of the strip. Thus, when such strips are overlapped by an amount generally in the order of one-half the width of the strips, the thickness dimension of the mat thus formed is substantially uniform for the full length of the mat. If the zig-zag sweep of the bands across the width of the collection zone is so arranged that the pitch or distance between deposited strips is greater than one-half the width of the strip, overlying layers must be supplied to fill in this gap and the overlap between different strips can be set to provide the desired uniformity in thickness of the mat. In this regard, the strips are overlapped in definite patterned relation to obtain the flat mat of uniform thickness or weight.

When adjusting reciprocation and conveyor speeds to establish less overlapping or greater spacing between successive strips or passes of a band, it is recommended that one half the width of the strip and an integer be taken as factors in determining the new strip advancing measurement.

Liquid binder is preferably first applied to the strands prior to projection by the pull wheels by the applicators **25**. Additional binder either in liquid or powdered form may be introduced to the accumulated mass of strands on the conveyor or to the strands while traveling from the wheels to the conveyor. With liquid binder already on the filaments, the need for the additional liquid or powdered binder is limited. The powdered binder, however, is scattered at localized points and spot bonds cross-over contacts between the strands in the mat.

The binder picked up by the filaments should be sufficiently sticky to seize and hold the subsequently applied powdered binder. The powdered binder thus assists the original liquid binder in forming a higher strength product and reduces the quantity of liquid binder that need be applied to the filaments. Without the presence of either one of the binders, more of the other binder is, of course, required. Overall, the total amount of binder needed is reduced by utilizing the combination of the two binders.

An additional feature in utilizing the powdered binder is that less water (in the order of twenty percent) is present in the mat thereby reducing the oven capacity needed to effect a cure of the binder. In contrast, in prior practice with both continuous strand mat and the chopped strand mat it has been necessary to utilize binders having a water content of over fifty percent of the mat weight as the mat reaches the curing oven.

The six strands of each set led over a pulling wheel, as previously stated, are composed of an average of sixty filaments with each filament having a nominal diameter of fifty hundred-thousandths of an inch. The individual strands are roughly six-thousandths of an inch in diameter and are delivered to the surface of the pull wheel closely arrayed in parallel relation and in a planar band. The

strands may be uniformly spaced apart about one-eighth of an inch. A strip of the peripheral surface of the pulling wheel no more than one-half of an inch wide is then occupied by the set of six strands.

If a greater number of strands are included in a set drawn over the pull wheel they are positioned more closely together. While probably twelve strands is about the maximum practical number, as many as thirty may be thrown down from a single wheel of the particular embodiment herein described. These could be spaced only one thirty-second of an inch apart. The number and spacing of the grooves on the stationary gathering shoes **27** and on the guiding shoes **31** are arranged to space and guide the particular number of strands utilized.

The traction between the strands and the surface of the pull wheel is ample to furnish the pulling force that attenuates the glass filaments formed from the minute molten glass streams issuing from the orifices of the furnace bushing. This adherence of the strands to the pull wheel is evidently due to the cohesive effect of the size carried by the strands and other not clearly understood air and surface forces of attraction.

The pull wheel is driven at a speed of about two thousand revolutions per minute to deliver the strands at a rate of six thousand feet per minute. This rate may feasibly range from two to twelve thousand feet per minute.

The fluid cylinder **51** is actuated sixty times a minute to cause the spoke wheels to oscillate at the same rate and to thus direct the strands released from the pull wheels back and forth across the conveyor sixty times per minute. Because of the high rate of deposit, even with sixty reciprocations of the strands across the conveyor per minute, ten inches of strand is delivered to the conveyor for every inch of the strand travel across the conveyor. This explains why the strand must repeatedly loop upon itself and upon the strands with which it is associated as it reaches the surface of the conveyor. High rates of reciprocation are feasible but, if raised substantially, should be coupled with higher feeding rates. Otherwise there is a decrease in the looping of the strands and less coherence of the deposited strips.

With a conveyor speed of seven feet per minute there will be one hundred and twenty overlapped cross strips of strand for every seven-foot length of the deposited mat, with an average overlap of about two-thirds of an inch between the composite strips laid down from each pull wheel. A succession of twelve pull wheels arranged in six pairs and handling strands assembled from filaments from twelve bushings is considered a desirable production system. This number is, of course, variable to meet any production requirements that may arise, and for lighter mats all of the pull wheels need not be utilized.

In FIGURES 5 and 6 is shown a pull wheel **100** and spoke wheel **101** with a modified form of driving means for the spoke wheel. In this arrangement a gear **103** is attached to the forward side of the spoke wheel. An intermediate gear **104** meshes with gear **103** and is driven by engagement with the gear portion **105** of the pull wheel hub. The spoke wheel **101** is carried by the back plate **106** as is also the intermediate gear **104**. The shaft of gear **104** is journalled in the flat bar **99** which is joined at its ends to the back plate **106** by foot posts.

Another modified form of drive for the spoke wheel is illustrated in FIGURES 7 and 8. In this structure the pull wheel **107** drives the spoke wheel **109** through an internal gear ring **111** set within the pull wheel forward of the slots **110**. Integrated with the spoke wheel **109** is a gear **112** engaging in a planetary manner the internal ring gear **111**. The spoke wheel is oscillated in an arc of fifty-seven degrees by its movement with the back plate **113** on which it is mounted.

In FIGURES 9 and 10 is shown the detailed construction of idler wheel **33**. In the same manner as a size carrying strand adheres to the metal surface of the pull wheel **35** or **36**, will such a strand attach itself to the metal surface of an idler wheel around which it may be led. Where a single strand is involved there is little objection to such adherence. However, when a plurality of strands pass around an idler wheel, the strand under the most tension grips the wheel firmly and controls its speed of rotation. At least some of the other strands then develop a slack or looseness that is amplified in time to a point where there occurs a misalignment or other sloppiness in the desired path traveled by these strands. An equalization is accordingly needed in the driving contact of the strands with the idler wheel.

To accomplish this purpose an idler pulley has been designed with cross contact lands spaced around the periphery of the wheel. If these lands are of sufficiently small area and spaced well apart the traction between the strand under the greatest tension and the wheel surface will be below that required to drive the wheel. Slippage between the strand and the wheel then develops to the slight degree that allows several of the other strands to adhere to the wheel so that they jointly drive the wheel. Such an idler wheel thus acts to equalize the tension of the strands and to deliver them in a uniform manner to the pull wheel.

As the strands adhere less readily to a graphite surface than to one of metal, the preferred form of idler wheel is that illustrated in FIGURES 9 and 10. As there shown, the wheel **33** has a main body **114**. A pair of flanges **115** project from the edges of the rim of the main body. Through ball bearing cages the body is rotatably mounted on the stationary shaft **116**.

There are transverse grooves **117** in the periphery of the body **114**. These grooves terminate at one side in blind bores in one of the flanges **115** and in open bores in the other of the flanges **115**. Positioned in the grooves **117** and projecting into the end bores are cylindrical graphite inserts **118** about one-quarter of an inch in diameter. A preferred graphite composition includes twenty percent molybdenum. The inserts are locked in position by the retainer plate **119** fastened to the body by machine screws **120**.

About one third of the circumferential area of the inserts is above the cylindrical surface of the main body. The strands driving the idler wheel accordingly have only point contact therewith as the strands span the spacings between the inserts and touch the inserts in a tangential manner.

Another less preferred form of wheel incorporating the basic idea is an all metal wheel having on its peripheral surface cross lands of rounded ridges one-sixteenth of an inch wide separated by grooves or depressed strips one-eighth of an inch across.

The gathering and aligning shoes are preferably of wheel form, as illustrated, because this shape is easy to manufacture, provides excess groove area to present new unworn surfaces when required, and avoids sharp lead and departure edges. Many other structural shapes upon which curved grooves could be machined or molded would function quite satisfactorily.

It should be noted that with the apparatus embodying this invention there is a smooth, regular movement of the filaments from the bushings, the gathering the filaments into strands, and the clean, unobstructed projection of the strands upon the conveyor. The integrity of the filaments and of the resulting strands is maintained throughout, and the strands arrive on the conveyor without any fuzziness or other disruption. The resulting mat of comparatively fine, continuous strands has consistently superior uniformity, unexcelled strength properties, low bulkiness, good porosity and attractive appearance. This combination of properties permits the mat to serve most satisfactorily for practically all the purposes for which such products may be employed.

The features of the invention which contribute to its success and effectiveness include the oscillating spoke the strands as they are directed back and forth across

the conveyor; the grooved gathering shoe and similarly grooved aligning shoe which group and guide the strands wheel responsible for the quick and uniform release of in an aligned and uniform manner; the idler wheel with the carbon inserts which evens out the tension of the strands; the organization of the pull wheel and associated equipment in synchronized, cooperating pairs or sets; and the air baffle oscillating with the spoke wheel to curtail strand dislodging air movement.

All of these features have importance in the attainment of the objects of the invention.

Possible modifications and substitutions for elements of the apparatus of this invention will easily occur to those skilled in the art, and such obvious changes are considered within the spirit of the invention of the scope of the accompanying claims.

We claim:

1. Apparatus for delivering a multi-filament strand to a receiving surface comprising a rotated pull wheel, a cylindrical, peripheral surface on the pull wheel adapted to receive a strand thereon and to carry the strand in following adhereing relation, there being regularly spaced cross slots in the peripheral surface below a strand carried thereon, a rotary device, means positioning the rotary device eccentrically within the rotated pull wheel, means driving the rotary device at a peripheral speed matching that of the rotated pull wheel, radially extending fingers mounted on the rotary device and spaced to successively project outwardly through successive slots in the peripheral surface on the pull wheel, the successive projections of the fingers raising a strand carried by the peripheral surface, and releasing the strand from its following adhering relation with said surface, means rotating the pull wheel at a speed to kinetically drive the strand in a tangential line therefrom toward a receiving surface, mounting means for the rotary device, said mounting means being oscillatable to move the rotary device back and forth along a linear path to effect a circumferential oscillation of the projection of the fingers through the slots in the peripheral surface of the pull wheel and a corresponding circumferential oscillation in the circumferential point of release of the strand, and means so oscillating the mounting means.

2. Apparatus according to claim 1 in which the peripheral surface on the pull wheel is broad enough to receive a plurality of strands in spaced side-by-side relation, and there is a strand guiding shoe adjacent to and positioned radially from the pull wheel having a plurality of parallel grooves adapted for holding a plurality of passing strands in spaced, side-by-side relation for delivery to the peripheral surface on the pull wheel.

3. Apparatus according to claim 1 in which there is a second pull wheel positioned adjacent to said first-mentioned pull wheel, and there are mechanical means synchronizing the oscillations of the mounting means of the rotary devices of the first and second pull wheels.

4. Apparatus according to claim 1 in which the pull wheel is rotated on a horizontal axis and there are means guiding the strand so that it is received by the peripheral surface of the pull wheel at a point angled about forty-five degrees from a vertical, diametric line of the pull wheel, with the strand following said surface in adhering relation over the top of the pull wheel for a portion about one hundred and eighty degrees of the circular orbit of said surface, and the projection of the finger elements through the slots in said surface is oscillated through a section of sixty degrees of the orbit immediately following said strand adhering portion of one hundred and eighty degrees.

5. Apparatus according to claim 1 in which there is an air baffle generally cylindrical in form lying closely below the slots in the peripheral surface of the pull wheel, said air baffle having an open area through which the fingers of the spoke wheel extend, and said baffle being mounted to turn back and forth with the spoke wheel to maintain the open area of the baffle adjacent the spoke wheel and between the spoke wheel and the adjacent portion of the peripheral surface of the pull wheel.

6. Apparatus for drawing continuous filaments of fibrous glass, gathering the filaments into a plurality of strands and forming a mat therewith including orificed means delivering molten glass in minute streams, a pull wheel drawing the minute streams into continuous filaments, means collecting said filaments in a plurality of strands and delivering the strands to the peripheral surface of the pull wheel, mechanical means mounted within the pull wheel and arranged to directly contact and raise the strands from the peripheral surface of the pull wheel thereby releasing the strands from the pull wheel, means rotating the pull wheel at a speed to tangentially project the strands when released by the mechanical means in closely arrayed formation, means reciprocating the mechanical means along a portion of the peripheral surface of the pull wheel, whereby the point of release of the strands is reciprocated and the direction of the projected strands is swung back and forth, and a conveyor adapted to receive and accumulate the strands in overlying formation.

7. Apparatus according to claim 6 in which the means gathering said filaments in a plurality of strands includes a gathering shoe having a plurality of parallel grooves, said shoe positioned in spaced relation above the pull wheel in the path of the filaments between the orificed means and the pull wheel.

8. Apparatus according to claim 7 in which there is a multiple grooved guiding shoe adjacent the pull wheel adapted to receive the strands from the gathering shoe, to maintain them in spaced relation in separate grooves and to lead them in such relation to the pull wheel.

9. Apparatus according to claim 7 in which there is an idler wheel adjacent the pull wheel, said idler wheel having narrow cross lands composed principally of graphite and depressed spaces of greater area between the cross lands, said idler wheel adapted to receive the spaced strands from the gathering shoe and to eqaulize the tension of the strands before the strands reach the pull wheel.

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