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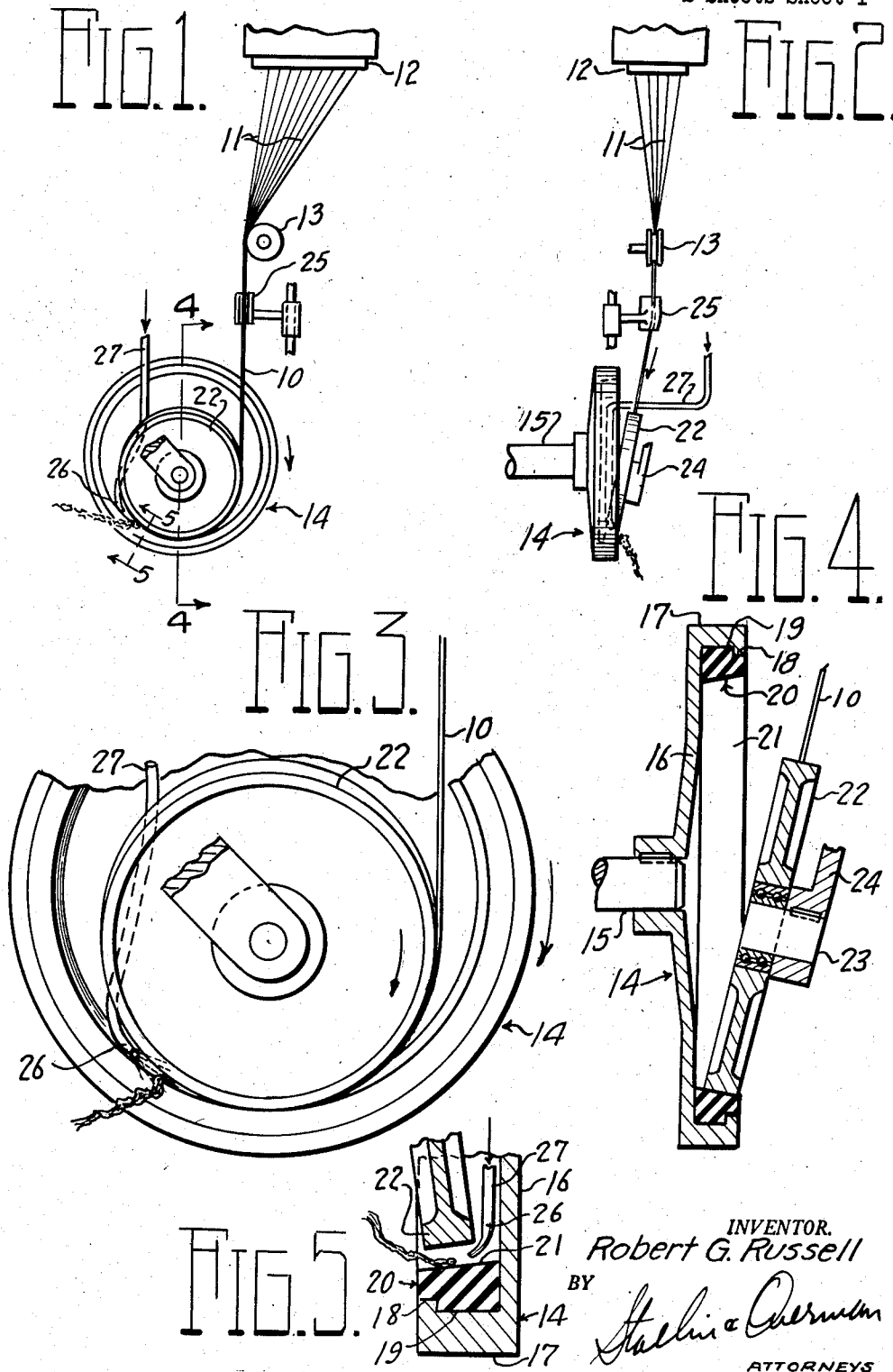
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APPARATUS FOR FEEDING A MULTI-FILAMENT CONTINUOUS STRAND

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2 Sheets-Sheet 1



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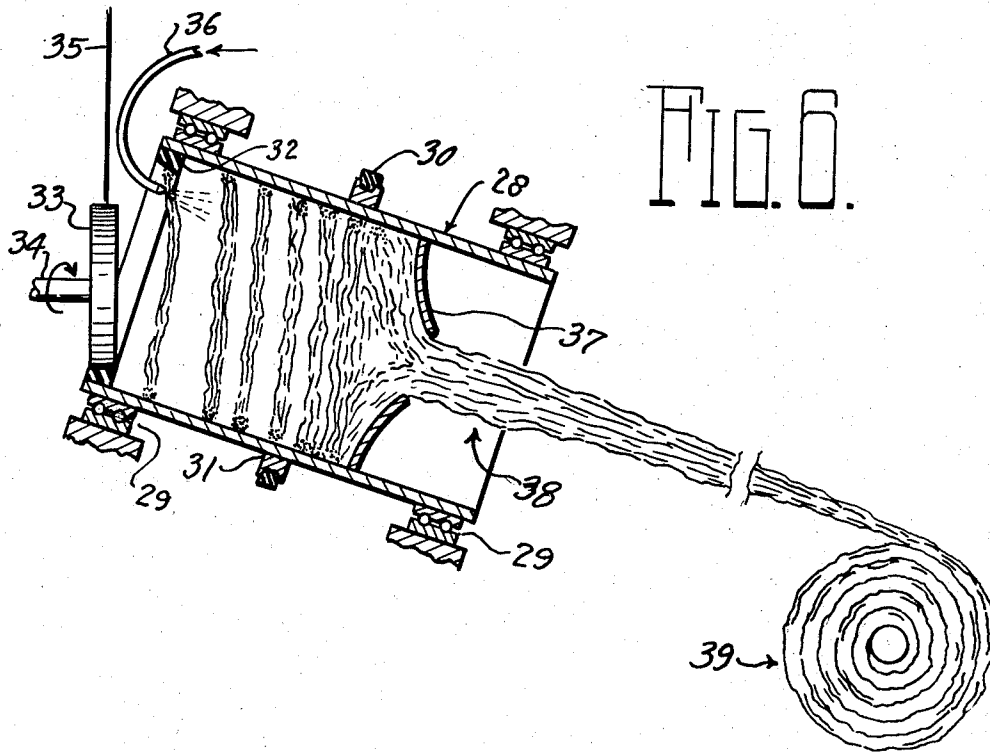


FIG. 6.

FIG. 7.

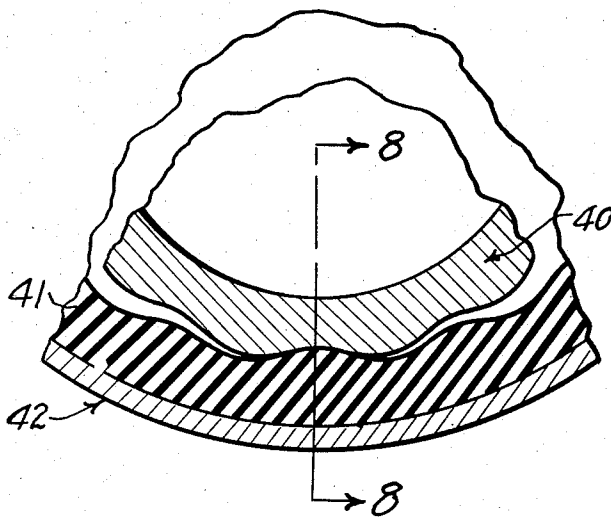
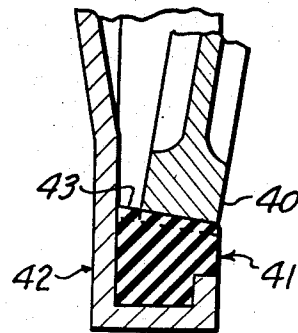


FIG. 8.



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APPARATUS FOR FEEDING A MULTI-FILAMENT CONTINUOUS STRAND

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8 Claims. (Cl. 203—220)

This invention relates to apparatus for linearly feeding a multi-filament continuous strand, for example, a strand comprising, say, 200 fine, continuous glass fibers, and thus it relates to apparatus which may advantageously be used for forming such a strand and for delivering it at a high linear rate to a point of subsequent use. While the apparatus of the invention has utility for the feeding of any continuous strand or strand-like material, it will be illustrated in connection with the attenuation of fine glass fibers from streams of molten glass, their association to form a multi-filament strand and the linear feeding of such a strand.

Continuous multi-filament glass fiber strands are known in the art as "textile" strands. Conventionally they are formed by flowing minute streams of glass through a multiplicity of stream forming orifices, mechanically grasping the ends of the streams as they cool to form fibers and pulling them for attenuating the streams into fine fibers by winding them at high speed on a spool or rotary package.

Many disadvantages result from this type of operation of which the significant ones may be listed as: increasing compression on the package resulting from the build-up of the strand accumulated thereon, increasing tension on the strand, increasing linear speed of movement due to increase in radius of the spool, the fact that for subsequent use of the strand it must be unwound from the package on which it is accumulated, the likelihood of sections of the strand clinging to adjacent sections on the spool, the difficulty of preventing the accumulated build-up of pressure on the spool from crushing the package of strands inwardly.

It has been suggested that the difficulties inherent in spool winding and attenuating might be overcome by pulling the associated group of fibers linearly between the peripheries of co-acting pulling wheels. Some types of co-acting pulling wheels mounted upon spaced parallel axes with their peripheries engaging with opposite sides of the strand and with each other around the strand have been successful for linear pulling speeds in the order of 10,000 feet per minute. In order that such a pulling wheel apparatus be not too bulky, the size of the wheels involved has been kept as small as feasibly possible and thus their speeds of rotation have been excessively high. Because most such wheels are provided with tires or rims of resilient material the centrifugal forces created by these high speeds of rotation form a definite limit upon the speed with which any such wheels can be rotated. When the speed of rotation becomes too high, centrifugal force throws particles and pieces of the tires or rims off the wheels, destroying them.

It would be desirable if even higher speeds of attenuation and feeding could be achieved. If speeds, say, twice as fast, in the order of 20,000 feet per minute, could be achieved without destructive forces being created in the attenuating instrumentalities, appropriate modifications in the constituents of the glass, the size of stream

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forming orifices, etc., could easily be made so that continuous fibers of controlled diameter could be produced at almost any speed.

It is, therefore, the principal object of this invention to provide pulling wheel apparatus capable of achieving extremely high peripheral speeds and wherein the destructive effects of centrifugal force are controlled by the structure of the pulling wheel instrumentality itself.

The apparatus of the invention is an embodiment of the concept that if a rotary structure fabricated, say, from metal and capable of resisting enormous centrifugal forces were constructed in such a manner that the metal could be located exteriorly of the strand contacting surface, the strength of the metal could be relied upon to prevent the rubber or other resilient material of the tread from being destroyed by centrifugal force. Apparatus embodying the invention comprises pulling wheels arranged not upon spaced, parallel axes with their peripheries contacting each other approximately in the plane of the axes but, rather, a rotary pulling wheel having an annular flange, the inner surface of which serves as the strand contacting surface and an idler wheel appropriately mounted with its periphery in contact with the annular strand contacting surface to hold the strand outwardly against the strand contacting surface, at least while the pulling instrumentalities are rotating at slower speeds, for example, when the mechanism is starting.

A more complete understanding of the invention and of apparatus embodying it will be realized from the specification which follows and from the drawings, in which:

Fig. 1 is a fragmentary view in front elevation of strand feeding apparatus embodying the invention and shown in its employment for the attenuation and feeding of a multifilament glass fiber strand.

Fig. 2 is a fragmentary side view in elevation of the apparatus illustrated in Fig. 1.

Fig. 3 is a fragmentary view in elevation on a considerably enlarged scale, of portions of the apparatus embodying the invention.

Fig. 4 is a vertical sectional view on an enlarged scale taken along the line 4—4 of Fig. 1.

Fig. 5 is a fragmentary vertical sectional view taken along the line 5—5 of Fig. 1.

Fig. 6 is a diagrammatic view in vertical section illustrating another embodiment of the invention.

Fig. 7 is a fragmentary vertical sectional view on an enlarged scale and illustrating a modification of portions of the embodiment of the invention illustrated in Figs. 1—5.

Fig. 8 is a fragmentary vertical sectional view taken substantially on the line 8—8 of Fig. 7.

A continuous glass fiber strand 10 is formed by the association of a plurality of individual glass fibers 11 which are attenuated from streams of glass emitted by stream forming orifices in a "bushing" or molten glass container 12. The individual fibers 11 are associated together into the strand 10 by a gathering wheel 13, being grouped in parallelism thereby. Although not illustrated in the drawings, coating and sizing materials are conventionally added to the fibers at the time of association into a strand, for example, by dripping them onto the wheel 13.

The linear force for attenuating and feeding the strand 10 is provided by a high speed rotary pulling wheel generally indicated at 14. The pulling wheel 14 is mounted upon a shaft 15 and has a generally disk-like web 16 with an annular flange 17 at its periphery. The flange 17 (see particularly Fig. 4) is relatively heavy, being constructed of metal which has sufficient strength to withstand the tremendous centrifugal force created by its high speed rotation without appreciable deformation. The flange 17 has a return lip 18 forming an annular

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groove which receives a shoulder 19 on a strand contacting tire 20. The tire 20 may have a conical inner surface 21 (shown in slightly exaggerated form in Figs. 4 and 5).

An idler wheel 22 having a cylindrical periphery is mounted upon a slightly inclined shaft 23 supported, for example, upon a swinging bracket 24, with its periphery in contact with the inner surface 21 of the tire 20. While the angle of the axis 23 of the idler wheel 22 is not critical and while it is shown in exaggerated position in Figs. 4 and 5, it will be appreciated that the idler wheel 22 must be mounted upon an axis so tilted with respect to the shaft 15 as to allow the strand 10 to enter between the periphery of the idler wheel 22 and the surface 21 where those surfaces are in contact. The strand 10 is guided onto the periphery of the idler wheel 22 and thus into the nip between the inner idler wheel and the surface 21 of the outer pulling wheel 14 by a shoe 25 (Figs. 1 and 2). The shoe 25 may be formed of graphite or similar smooth, relatively frictionless material over which the strand 10 will slide without appreciable resistance and which will not be rapidly destroyed by the strand 10 sliding over it.

With the pulling wheel 14 rotating at high speed in the direction of the arrows in Figs. 1 and 3, the idler wheel 22 is also rotated by its frictional contact with the surface 21. After an operator has led the strand 10 between the peripheries of the wheels 22 and 14, continued rotation of these wheels exerts tractive force on the strand 10 to attenuate all of the fibers 11 from their molten streams and to feed the strand 10 outwardly from between the periphery of the wheel 22 and the surface 21.

Delivery of the strand 10 from between the periphery of the wheel 22 and the surface 21 may be assisted, or at least started, by an air jet emanating from an air nozzle 26 formed on the end of an air line 27 which extends into the space back of the idler wheel 22 and downwardly to just forward of the nip between the idler wheel 22 and the surface 21. The strand 10 is pushed sideways after it leaves the nip by the jet of air from the nozzle 26 and thus it escapes out of the pulling wheel 14 and off the surface 21.

After the wheels have been operated for sufficient time to bring them up to the desired operating speed and the strand 10 is flying generally horizontally away from the nip between the idler wheel 22 and the surface 21, the kinetic energy of the portions of the strand which have departed from between the nip will become sufficient to pull the strand outwardly without the use of the jet of air from the nozzle 26. When this condition has been reached the air may be turned off and the strand will continue to fly generally horizontally away from the two co-acting wheels.

It should be observed that the action of the jet of air from the nozzle 26 not only displaces the strand sideways but that it also can be directed and adjusted to "open" the strand, separating its filaments somewhat.

In general the operations of attenuating and feeding the strand through the use of apparatus embodying the invention is similar to that which prevails where pulling wheels mounted upon spaced parallel axes with their peripheries in contact around and on opposite sides of the strand are used. Additionally, apparatus of the present invention has the added advantage resulting from the fact that the centrifugal force acting upon the strand itself by reason of its high speed movement through an arcuate path tends to throw the strand out of engagement with the idler wheel 22, thus obviating the tendency of the strand to wrap around the exterior of the idler wheel 22.

Because of the strong external flange 17 on the pulling wheel 14, the material from which the tire 20 is fabricated is placed in compression rather than tension by centrifugal force and its compression is restrained by the metal or other strong material forming the flange 17.

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There is, therefore, no possibility that the material from which the tire 20 is fabricated will be torn apart by the centrifugal force. Additionally, because the material is in compression rather than tension, its change in dimension under high speed rotation is much less. Resilient material such as natural or synthetic rubber is really not compressible but merely displaceable and since there is no place to which the material of the tire 20 can be displaced, its dimensions remain virtually stable even when rotating at speeds sufficient to produce linear speeds in the order of 20,000 feet per minute or higher.

The present invention may be embodied not only in an annular wheel of the type illustrated in Figs. 1-5 but also in an annular wheel formed as a portion of a rotating cylinder such as a cylinder 28 illustrated in Fig. 6. In this figure the cylinder 28 has a smooth interior surface and is mounted for rotation in at least a pair of bearings 29 and may be driven, for example, by a belt 30 engaged in a peripheral pulley 31. The cylinder 28 has an annular tire 32 mounted upon its interior surface near one of its ends, the tire 32 being mounted and shaped similarly to the tire 20 of Figs. 1-5. An idler wheel 33 mounted upon its shaft 34 is held in engagement with the tire 32 in a manner similar to that of the idler wheel 22 in Figs. 1-5.

In operating the apparatus of Fig. 6, an operator threads or leads a strand 35 around the periphery of the idler wheel 33 and into the nip between its periphery and the surface of the tire 32. Rotating the cylinder 28 applies tractive force to the strand 35 which attenuates its filaments (not shown) and feeds the strand 35 around the inner surface of the cylinder 28. As in the case of the embodiment of Figs. 1-5, an air line 36 may be so directed as to emit an air jet at an appropriate place to initiate movement of the strand 35 axially through the cylinder 28. By reason of the high speed of rotation of the cylinder 28 and the jet of air emitted by the pipe 36, the strand 35 assumes a helical form on the interior of the cylinder 28 progressing axially through the cylinder 28.

In Fig. 6 the cylinder 28 is illustrated as having a plurality of inwardly directed, bent pegs 37 through which the mass of opened fibers of strand 35 are carried. The fibers of strand 35 are separated from each other by the action of the jet of air from the pipe 36 and by the "spewing" or spraying of the strand 35 off of the tire 32. While the configuration of the fibers of the strand 35 shown in Fig. 6 may not be accurate, it is, in general, the shape and pattern through which they move when the apparatus is operated at high speed. The mass of fibers generally indicated at 38 is led axially away from the cylinder 28 and may be wound on the exterior of a ball or package 39 which is rotated to apply tractive force to pull away the mass of fibers 38. By reason of the high speed of rotation of the cylinder 28 the mass of fibers 38 is twisted gradually being tightened to form what might be termed a roving or, if the twist is tighter, a cord or rope.

When the operation of the apparatus of Fig. 6 is initiated the operator may have to begin the flow of the opened fibers axially out of the cylinder 28 by reaching inwardly through its outlet end with a pick or hook to engage the mass of fibers 38 and pull them axially. After the end of the mass of fibers 38 has been engaged with the wind up roll 39, however, the axial force exerted by the wind up roll 39 will keep the mass of fibers flowing out of the cylinder 28.

Figs. 7 and 8 illustrate a modification of the periphery of an idler wheel 40 and the surface of a tire 41 mounted upon a flanged pulling wheel 42. The apparatus fragmentarily shown in Figs. 7 and 8 is identical with the apparatus of Figs. 1-5 except that the periphery of the idler wheel 40 is scalloped and an inner surface 43 of the tire 41 is complementarily scalloped, being closely engaged with the exterior surface of the idler wheel 40.

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By thus shaping the periphery of the idler wheel 40 and the surface 43 of the tire 41 the linear length of the surfaces of engagement between the two wheels is increased and the length of engagement of the strand 10 with the surfaces of the wheel 40 and tire 41 is also lengthened so that a greater tractive force is applied to the strand being attenuated and fed. Such surface configuration may be desirable in order to provide for the greater traction mentioned and other surface configurations may be employed with the exterior of the idler wheels 22, 33 or 40 being complementary to and co-operative with the surfaces 21 and 43 of the tires 20 and 41 or the surface of the tire 32.

I claim:

1. Apparatus for feeding a multi-filament strand comprising, in combination, a rotary element having an annular inner surface and an idler wheel in peripheral engagement with said surface and means for guiding said strand circumferentially onto the periphery of said idler wheel.

2. Apparatus for feeding a multi-filament strand comprising, in combination, a rotary element having an annular inner surface and an idler wheel having its periphery engaged with said surface for rotative movement therewith and means for guiding said strand circumferentially onto the periphery of said idler wheel.

3. Apparatus for feeding a multi-filament strand comprising, in combination, a rotary element having an annular inner surface and an annular resilient tire supported by and located inwardly of, said annular surface of said element, and an idler wheel mounted for rotation with its periphery in frictional engagement with the inner surface of said tire, and means for guiding said strand into the bite between the exterior of said idler wheel and the inner surface of said tire.

4. Apparatus according to claim 3 in which said tire

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has a frusto-conical inner surface and the axis of said idler wheel is inclined to the axis of said rotary element.

5. Apparatus according to claim 3 in which the inner surface of said tire and the periphery of said idler wheel are complementarily formed.

6. Co-acting rotary pulling wheels for feeding a multi-filament strand, one of said wheels having an inner, annular surface of certain diameter and the other of said wheels having an external complementary surface, of smaller diameter, the surfaces of said wheels being frictionally engaged around and on opposite sides of the strand to be fed.

7. The combination of a rotary strand feeding element having an annular, axially extending rim, a hub and a web joining one axial end of said rim to said hub, an annular resilient tire located interiorly of said rim and a rotary idler wheel mounted on an axis lying in the plane of the axis of said hub and inclined thereto with the periphery of said wheel in engagement with the inner surface of said tire.

8. Apparatus for feeding a multi-filament strand comprising, in combination, a rotary hollow cylinder, an annular tire on the inner wall of said cylinder near one of its ends, an idler wheel rotatable on an axis inclined to the axis of said cylinder and with its periphery frictionally engaged with the inner surface of said tire and rotatable therewith and means for guiding said strand into the bite between said wheel and said annular tire.

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