Feb. 2, 1954 C. E. MILLER 2,667,964

YARN HANDLING DEVICE

Filed April 21, 1949 2 Sheets-Sheet 1

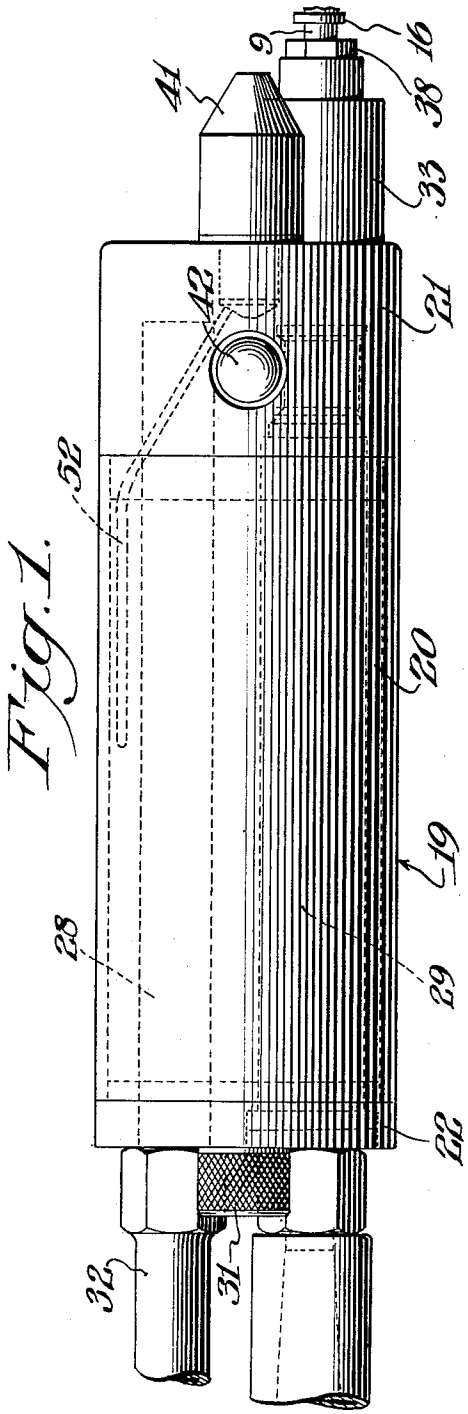


Fig. 1.

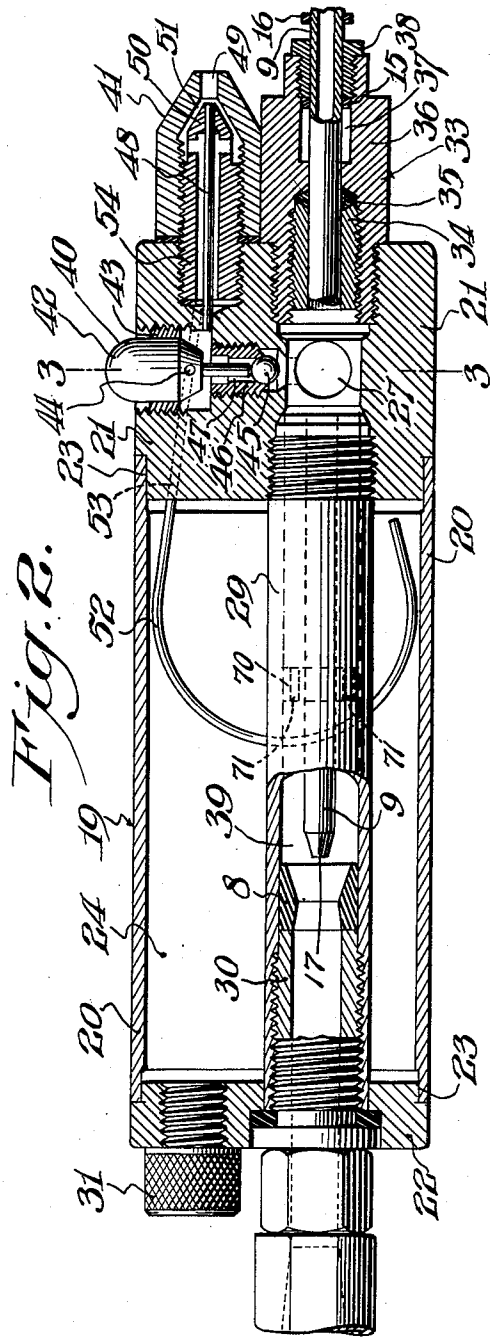


Fig. 2.

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Fig. 3.

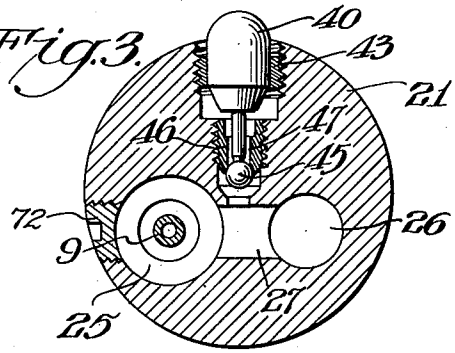


Fig. 4.

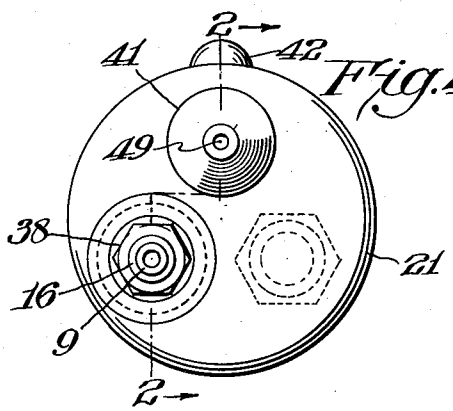


Fig. 5.

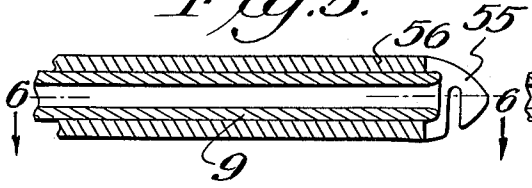


Fig. 6.

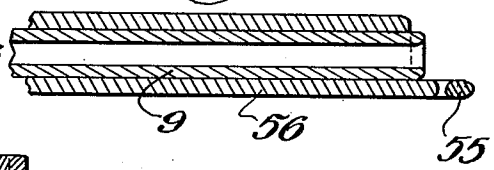


Fig. 7.

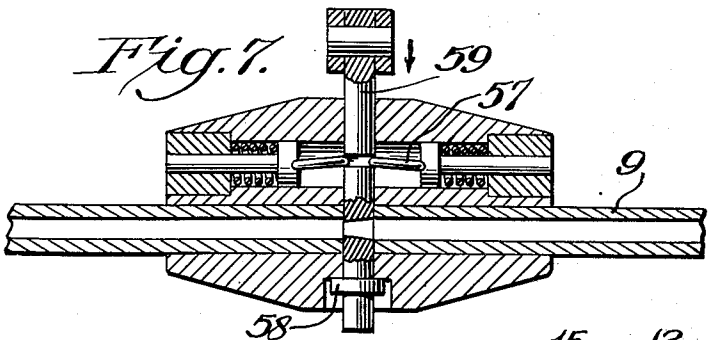
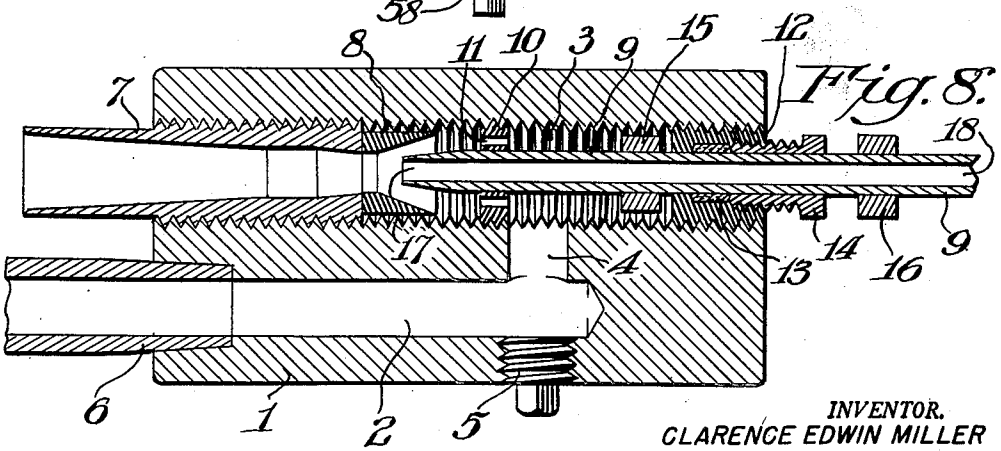


Fig. 8.



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Patented Feb. 2, 1954

2,667,964

UNITED STATES PATENT OFFICE

2,667,964

YARN HANDLING DEVICE

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Application April 21, 1949, Serial No. 88,781

9 Claims. (Cl. 203—100)

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This invention relates to a yarn handling device and, in particular, to a portable device capable of picking up a running length of yarn and maintaining the yarn under tension until it has been transferred to a yarn take-up or winding device.

In handling threads of either natural or synthetic origin, it is frequently desirable that the thread be collected temporarily by an auxiliary device rather than by the regular collecting apparatus. For example, Burkholder in U. S. 2,206,834 describes a waste collection apparatus comprising a tubular passageway positioned between two cap twisters, through which passageway a fluid carries waste yarn to a foraminous waste collector during doffing operations. A more useful portable vacuum tube for use in similar operations is described in British Patent 359,627.

In the production of synthetic yarns it is generally necessary to draw the yarn several times its original length to get great improvements in the tensile properties of the yarn. For economy it is desirable to conduct the drawing operations on a plurality of strands of yarn in the form of a warp. For uniformity the strands must be treated alike. In many cases it is desirable to carry out the drawing operation in the presence of a fluid such as steam under pressure. The principal difficulty attendant to the various forms of apparatus that have been designed for such a process has been in the string-up of the apparatus after a strand of yarn breaks during the process. It is best to have a bank of individual tubes, one for each strand, in drawing a warp of yarn. These tubes are most efficiently strung up by inducing a flow of fluid through the tube in the direction of the yarn passage, the fluid carrying the yarn through the tube. However, the orifices of the drawing tube must be small to maintain a satisfactory steam pressure. The use of wires either to pull the yarn through or push it through the cell is very unsatisfactory, especially with cells of considerable length. In the use of a jet for string-up it was found that a relatively large outlet orifice was required to permit sufficient flow of vapor to carry the yarn through the cell. Such devices similar to the tubes described in U. S. 2,206,834 and British Patent 359,627 are unsatisfactory because they do not produce enough tension to move the yarn through the tube faster than the input speed.

It is an object of this invention to provide a yarn handling device capable of picking up a running length of yarn and maintaining the yarn under tension until it has been transferred to a yarn take-up or winding device. It is a further object of this invention to supply a yarn handling device capable of providing a high vacuum for picking up a running length of yarn and thereafter producing a desired tension on the yarn until the yarn has been transferred to a suitable take-up device. A still further object is to provide a portable yarn handling device incorporating these features so that a running length of yarn may be transferred under tension for considerable distances. Other objects will become apparent from the descriptions hereinafter.

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The aforementioned objects are accomplished by this invention which provides a portable yarn handling device comprising an inlet for a fluid usually a gas such as air, under pressure and connected thereto an outlet for the fluid which outlet is aligned with a suction tube to form a passageway through the device for the yarn. Situated between the tube and the outlet, which serves also as a diffuser, is a variable annulus defined by the tapered outside wall of the suction tube and the inside wall of a funnel device located at the near end of the diffuser orifice. Expansion of the compressed air around the end of the suction tube induces a suction in the tube and a yarn end brought into the tube is sucked through the device. The variable annulus controls the extent of expansion. Increasing or decreasing the size of the annulus may be accomplished by moving the tube further out of the device or into the device, respectively. The device, then, comprises means forming a tubular passageway in combination with means defining a variable annular approach to an orifice and a diffuser tube or outlet, means for delivering fluid into the annular approach to the orifice at a point between the entrance end of the passageway and the orifice so that an air current will be induced through the entire length of the passageway and yarn brought to the entrance end thereof will be carried throughout the passageway, means for setting the annular approach to the orifice to induce maximum vacuum at the entrance end of the passageway or maximum tension on the yarn running through the passageway, and optional means at the discharge end of the diffuser tube for collecting the thread issuing therefrom.

In the figures, in which like numbers refer to like parts,

Figure 1 is a plan view of the device showing

the relationship between the air inlet tube, outlet tube, aspirator and suction tube;

Figure 2 is a central longitudinal sectional view taken on line 2—2 of Figure 4,

Figure 3 is taken on line 3—3 of Figure 2;

Figure 4 is a front view;

Figure 5 is a longitudinal sectional view of a cutter knife;

Figure 6 is taken on line 6—6 of Figure 5;

Figure 7 is a sectional view of another cutter device; and

Figure 8 is a sectional elevation of a suction device of different design than that shown previously.

In Figure 8 a suction device of this invention is shown. The block 1 is drilled to form two passageways 2 and 3 connected by a third passageway 4 made by cross-drilling. The entrance of 4 is closed by plug 5. Passageway 2 is appropriately connected at 6 to a supply of air which is under pressure. The passage 3 is threaded throughout its length and contains at one end diffuser tube 7 which is internally tapered, the wide taper being outside the body of the yarn handling device. In close proximity to the smaller entrance of the diffuser tube 7 is a funnel device 8. A suction tube 9 is slideably mounted in support 10 which has openings 11 to allow free movement of air. Tube 9 is slideably supported at the other end of the device by means of the stuffing box 12 containing packing 13 compressed by stuffing nut 14. Situated on tube 9 are two locking collars 15 and 16 which restrict the sliding motion of tube 9.

Air under pressure is released into passage 2 at 6. The stream of air flows through passage 4 into passage 3 and is forced into funnel device 8 and out diffuser tube 7 since the other end of passage 3 is sealed by the stuffing box elements 12, 13 and 14 in cooperation with tube 9. The rushing of the air stream past the yarn outlet orifice 17 of the tube 9 into funnel device 8 creates a suction within tube 9. If a yarn end is inserted inside the yarn inlet orifice 18 of tube 9 it will be sucked through tube 9 and into diffuser tube 7 and from there to a foraminous container attached to 7 by a flexible tube, the container and attachment not being shown. The closer the orifice 17 is to the tapered entrance of diffuser tube 7 the greater the suction exerted in tube 9. Once the yarn is sucked through the device the tube 9 is moved away from 8 and the tension on the yarn increases.

A preferred embodiment of the invention is illustrated in Figures 1, 2, 3 and 4. The body 19 of the yarn handling device is of a convenient size and may be held in one hand. It is prepared from any lightweight material, such as aluminum. It comprises a seamless tube 20, the ends of which are closed by front end plate 21 and back end plate 22. The seamless tube 20 fits snugly over the shoulders, shown at 23 of the end plates, forming chamber or liquid reservoir 24. The front end plate 21 is shown in detail in Figures 3 and 4. The plate 21 is made from solid aluminum stock at least 1½ inches thick. Hole 25 extends through the thickness of the front end plate and a second hole 26 is drilled parallel to hole 25 and is connected thereto by cross drilling 27. Plug 72 is threaded into the front end plate at the outer end of the cross-drilling to render it airtight at this point. The hole 26 is drilled from the back or shoulder end of the front end plate and extends the majority, but not all, of the way through the plate. Back end plate 22 contains parallel holes through its thickness of the same size and aligned with holes 25 and 26. The back end plate holes position air inlet tube 28 and air outlet tube 29. Air inlet tube 28 connects with hole 26 in the front plate and the tube 29 connects with hole 25 in the front plate. Contained in tube 29 is funnel device 8. This may be simply inserted in sliding contact with the inner walls of tube 29. Behind 8 is a diffuser section 30. Depending upon the desired length of the diffuser section 30, tube 29 may extend through the hole positioning it in back end plate 22. The diffuser section 30, corresponds to diffuser tube 7 in Figure 8 and is connected by a flexible hose to a foraminous container (not shown). The funnel 8 seats against the entrance end of the diffuser section 30 and need not be positioned firmly in tube 29 but can be a close fit held in place against the diffuser section by the air pressure.

Also contained in back end plate 22 is a threaded hole for insertion of plug 31. Liquid reservoir 24 is filled with the finish solution at this point. The position of plug 31 and the inlets to tube 28 and tube 29 can be seen in Figure 1. As shown in this figure, nipple 32 connects air inlet tube 28 with an air supply; a flexible hose (not shown) is normally used between the nipple and the air supply.

Threaded into hole 25 of front end plate 21 is packing gland assembly 33. This assembly contains stuffing box 34 and packing 35 and nut 36. This nut 36 contains recess 37. The assembly 33 supports the suction tube 9. Within the tube 29 is a support 70, such as shown in Figure 2, which in this embodiment is affixed to tube 9 by means of a set screw and which is in sliding contact with the inner walls of tube 29. This support or guide bushing 70 is a small collar with three equally spaced arms extending away from the collar and barely contacting the walls of the tube 29 and forming openings 71. Attached to suction tube 9 by means of set screws are locking collars 15 and 16. Collar 15 fits in recess 37 of stuffing nut 36. Its purpose is to restrict the forward movement of tube 9 which movement is limited by threaded bushing 38. The backward sliding movement of tube 9 is restricted by collar 16.

Air under pressure (40–100 lbs.) enters air passage or inlet tube 28, flows through the cross drilling 27 into air chamber or tube 29 and hence to the funnel 8. The air enters the annular space between the suction tube 9 and the orifice 8 and proceeds at high velocity out of the funnel into the diffuser section 30 where some of the kinetic energy is converted into a pressure head. At the mouth 17 of the suction tube 9 the pressure will be reduced by virtue of Bernoulli's principle, which in brief states that minimum pressure occurs when kinetic energy is maximum. The walls of tube 9 at this end location may be smooth or grooved or ridged. In the figures the mouth of the suction tube is shown for clarity drawn back away from the funnel. In actual operation the preferred positions are maintained by locking collars 15 and 16, which are positioned at fixed locations on tube 9 by tightening set screws (not shown) threaded through the collars to contact the tube, or which may be sweated or press-fit on the tube as desired.

The diffuser tube is an important element of the invention. It serves to transfer the kinetic energy of the air into static pressure. As the air

enters the diffuser section 30, it is at its maximum velocity and minimum pressure. The pressure must be converted in the diffuser section to superatmospheric pressure to enable the fluid to flow on through the hose and foraminous collector. In order to function properly, the included or total angle of taper of the diffuser should be at least 1° and not greater than 20°. A 7° taper has been found to be very satisfactory.

The length of the diffuser section determines in part the maximum tension that can be put on the yarn. Tension may be expressed by the Newton equation

$$F=\frac{CDV^2A}{2}$$

where C is a constant, D is mass density, V is relative velocity, and A is area of contact. It will be seen from this equation that in handling a specific yarn two things may be done to increase tension. First, the length of the exposure to high velocity air could be increased and, secondly, the velocity of the discharge could be increased. Both of these conditions may be obtained to some extent by correct design of the diffuser and orifice. A longer diffuser would increase the area of contact (A) but might decrease the relative velocity (V). On the other hand, a large orifice of optimum design and a higher pressure will increase V. However, care must be exercised to prevent loss of suction by building up a back pressure in the diffuser.

The funnel 8 as shown in the diagram has a total taper angle of 20°. While this is the preferred taper angle, it is not critical and may vary between 10° and 50°. Actually, since the purpose of this angle is to streamline the air flow, the shape should more properly be a curve. However, it has been found that the advantage to be gained is not worth the expense and the 20° angle is generally satisfactory. The exit end 17 of the suction tube 9 which forms the annular opening with funnel 8 should be smooth, square ended and tapered to insure a uniform and streamlined flow of air through the funnel. It serves a twofold purpose: First, to provide a passageway to low pressure zone and, second, to act as a valve when moved toward and away from the funnel, thereby regulating the air flow. The taper angle on the outside of the suction tube 9 should be not greater than the funnel taper angle. It may range from 5°–40° although a 20° included angle is preferred. The size and shape of this annular opening is determined by the geometry of the system and by the position of the suction tube 9 with respect to funnel 8. In general, a small annular opening increases the velocity of air going through the orifice accompanied by the lower pressure or higher vacuum in the suction tube. The geometry of the system determines the maximum vacuum that can be obtained in the suction tube. The yarn handling device of this invention will pull a vacuum in the suction tube equivalent to 25 inches of mercury. In actual practice the position of suction tube 9 with respect to funnel 8 to attain maximum vacuum in the suction tube is found by trial and error. The suction tube is moved toward and away from funnel 8 and when maximum vacuum is attained the proximity of the suction tube to the funnel 8 is set by means of locking collar 16.

The position of maximum vacuum is not the position of maximum tension on the yarn. As the size of the annular orifice is increased by moving the suction tube away from funnel 8, the tension on the yarn is increased. The maximum tension on the yarn is reached when the pressure at the orifice approximately equals atmospheric pressure. Again, this point is best determined by trial and error. This is done because yarn speed and denier and the degree to which the filaments stay in a bundle are factors which determine tension on the yarn. Since the suction tube 9 and packing gland unit 33 can be unscrewed readily from the body of the yarn handling device, locking collar 15 can be set at various positions and the tension on the running length of yarn measured with a tensometer. This feature of variable tension makes the yarn handling device useful in all yarn processing operations. The tension on the running length of yarn at any step in the spinning, drawing, relaxing, winding, twisting, or coning operations can readily be duplicated by the yarn handling device described by this invention and the proper tension maintained on the running yarn during string-up or doffing. When stringing up a steam drawing chamber for high tenacity yarn, such as nylon and polyacrylonitrile yarns, it is frequently necessary to apply the maximum tension afforded by the yarn handling device to the yarn to take up the slack in the steam tube caused by the softening of the yarn in the presence of high pressure steam. However, for some yarns this maximum tension may break the yarn and the locking collar 15 would be set for lower tension.

Air is the common fluid used to operate the yarn handling device, although other fluids may be used. The air may be supplied at a pressure ranging from 40–100 lbs./sq. in. or higher from a relatively constant pressure source of supply. Minor fluctuations in the air pressure have little or no effect on the vacuum and tension to be attained by use of the yarn handling device. The packing gland unit 33 is designed to allow the pressure in air chamber 39 to move the suction tube 9 as far away from the orifice 8 as permitted by locking collar 15. Thus, when in operation the yarn handling device automatically supplies the desired tension on the yarn. When a strand of yarn is to be picked up by the device of this invention, maximum vacuum is applied by holding locking collar 16 against bushing 38. As soon as the manual pressure holding the locking collar 16 against the packing gland nut is released, the air pressure slides suction tube 9 away from the orifice to the position determined by the setting of locking collar 15 and thereby applies the desired tension to the yarn. If desired, the suction tube 9 may be made stationary and the combination of diffuser section and orifice made movable with appropriate stops to attain the variation in vacuum and tension, or other equivalent means may be used to control the size of the annulus.

The yarn handling device of this invention is particularly useful in a drawing operation employing individual tubes as described previously. The drawing tubes are strung up by sucking the yarn through the tube with the aid of the yarn handling device and the yarn is taken up by the device under the proper tension as fast as it issues from the steam cell. The rapidly moving yarn may then be placed around the series of drawing rolls whose peripheral speed is several times that of the yarn speed.

The facility with which running lengths of yarn may be handled by means of the device of this invention can be greatly increased by in-

corporating with it two additional features, an atomizer for spraying finish on the take-up bobbin or pirn and a small yarn cutter. As shown in Figure 2 the main body of the yarn handling device can serve readily as a liquid reservoir for the finish solution. The front end plate 21 is equipped with a finger-controlled ball valve 40, as shown, which admits finish solution from the reservoir and air under pressure into the atomizer head 41. The button 42 forms a close sliding fit with bushing 43. A pin 44 extending through button 42 will contact bushing 43 and prevent the button from coming out. Air pressure in the yarn handling device seats ball 45 against the bottom of bushing 46 and air is prevented from flowing through passageway 47 and tube 48 and out of the atomizer head at 49. The conical piece 50 is attached to the end of tube 48 by a press fit and forms with the atomizer head a passageway 51 for the spray. Tube 52 extends to the bottom of the finish reservoir and continues as boring 53 to supply finish solution to the tubular duct formed by bushing 54 and tube 48.

Pressure of the finger on button 42 disengages ball 45 and permits air from cross drilling 27 to flow up through passageway 47 and tube 48. The exit of the air from tube 48 into the atmosphere through the opening 49 in the atomizer head creates suction in passageway 51 and thereby draws the finish solution from the reservoir into contact with the air leaving tube 48.

On the other hand, finish solution contained in a small auxiliary supply vessel may be sprayed on a roll or take-up bobbin by means of an atomizer substituted in place of plug 5 in the yarn handling device shown in Figure 3.

Yarn cutters are shown in Figures 5, 6 and 7. The cutter in Figures 5 and 6 in a simple sharp hook 55 extending from a sleeve 56 which forms a smooth sliding fit over suction tube 9. A length of yarn running through the yarn handling device described by this invention can be readily and efficiently cut at the entrance of the suction tube merely by turning the yarn handling device perpendicular to the yarn path and pulling on the cutter, thereby shearing the yarn off between the hook and the suction tube. Figure 7 illustrates a tubular knife cutter adapted to suction tube 9 so that the yarn may be cut inside the tube if desired. Springs 57 and collar 58 hold the plunger 59 in position for free passage of the yarn through the suction tube 9. The running length of yarn may be cut simply by pressing the plunger.

With the aid of these additional features an operator can carry out an entire string-up operation with one hand. Doffing operations are also facilitated. For example, in doffing a pirn the operator applies maximum suction to the suction tube 9, brings this tube into contact with the running length of yarn and cuts the yarn at the mouth of the suction tube by means of the small cutter and thereby almost simultaneously sucking the loose end of yarn through the yarn handling device. Suction tube 9 is then released from its high vacuum position and the desired tension is automatically applied to the yarn. While holding the yarn handling device in one hand, the operator can stop the revolving pirn by means of a knee-controlled brake and change the pirn with the other hand. The new pirn can then be readily strung up without touching the yarn. The yarn is cut, the cutting being accompanied by a blast of spray from the atomizer to tack the loose end down onto the pirn barrel.

The use of the device of this invention eliminates the need for expensive auxiliary take-up devices. In addition, a substantially steady tension can be maintained on the running yarn throughout the process.

The yarn handling device described by this invention is invaluable in the string-up of an individual steam drawing tube following a break of a strand of yarn in the continuous individual tube warp drawing process. The momentary change from high vacuum to high tension possible with the use of this yarn handling device is necessary to successfully and efficiently string-up the individual steam tube without temporarily shutting down the entire warp drawing process. This invention represents an outstanding improvement in yarn handling devices. It is, of course, recognized that by slight modifications the device can be adapted to handle other shaped articles such as ribbons.

Any departure from the procedure described herein which conforms to the principles of the invention is intended to be included within the scope of the claims below.

I claim:

1. A yarn handling device comprising an air inlet tube; an air outlet tube; a passageway between said inlet and said outlet tubes; at the exit end of said outlet tube a diffuser section; and in said outlet tube a suction tube slideably mounted to form with said outlet tube and said diffuser section a variable annulus.

2. A yarn handling device comprising an air inlet tube; an air outlet tube; a passageway between said inlet and said outlet tubes; at the exit end of said outlet tube a diffuser section; and a suction tube slideably mounted in said outlet tube comprising with said outlet tube and said diffuser section a passageway for said yarn through said device.

3. A yarn handling device comprising an air inlet tube; an air outlet tube; a passageway between said inlet and said outlet tubes; at the exit end of said outlet tube a diffuser section; and a suction tube slideably mounted in said outlet tube to form with said outlet tube and said diffuser section a variable annulus whose size is dependent upon the nearness of said exit end of said suction tube to the inlet of said diffuser section.

4. A yarn handling device comprising a cylinder fitted with a back end plate and a front end plate; an air inlet tube extending from said back end plate into and terminating in said front end plate; an air outlet tube extending from said back end plate into and terminating in said front end plate; in the front end plate a passageway connecting said inlet and said outlet tubes; in the outlet tube a diffuser section and adjacent funnel and a suction tube slideably mounted in said front end plate and extending within said outlet tube and beyond said front end plate, said suction tube comprising with said funnel and said outlet tube a variable annulus whose size is dependent upon the nearness of said suction tube to said diffuser section.

5. A device in accordance with claim 4 in which said diffuser section is internally tapered to a wide exit at an angle of from 1° to 20°.

6. A device in accordance with claim 4 in which said diffuser section has a taper of from 10° to 50° at the end near said suction tube.

7. A device in accordance with claim 4 in which said suction tube has an external taper

at its end within said outlet tube, said taper being from 5° to 40°.

8. A yarn handling device comprising a cylinder fitted with a back end plate and a front end plate; an air inlet tube extending from beyond said back end plate into and terminating in said front end plate; an air outlet tube extending from said back end plate and terminating in said front end plate; in said front end plate a passageway connecting said inlet and said outlet tubes; at the exit end of said outlet tube a section having an internal outward taper of from 1° to 20°; a suction tube slideably mounted in said front plate and extending within said outlet tube and beyond said front plate, said suction tube having at its end within said outlet tube an external taper of from 5° to 40°; located between said tapered end of said suction tube and the exit end of said outlet tube a funnel having a taper of from 10° to 50° forming with said suction tube and said outlet tube a variable annulus, the size of said annulus being dependent upon the nearness of said suction tube to said diffuser section; located between said funnel and the exit end of said outlet tube a

diffuser section having a flaring internal taper of from 1° to 20°; and on said suction tube an outward and an inward arresting device.

9. A device in accordance with claim 8, in which said back end plate contains an inlet for a liquid to the reservoir formed by said back end plate, said front end plate and said cylinder; and mounted on said front end plate an aspirator connected to said liquid reservoir by a tube and to said air inlet tube by a valve.

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