United States Patent [19]

Jones

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[54] **HANDLING ELONGATE MATERIALS**

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[52] **U.S. Cl.** **226/7**, 226/97

[51] **Int. Cl.** **B65h 25/06**

[58] **Field of Search** 226/97, 7; 34/156, 34/157, 236

[56] **References Cited**

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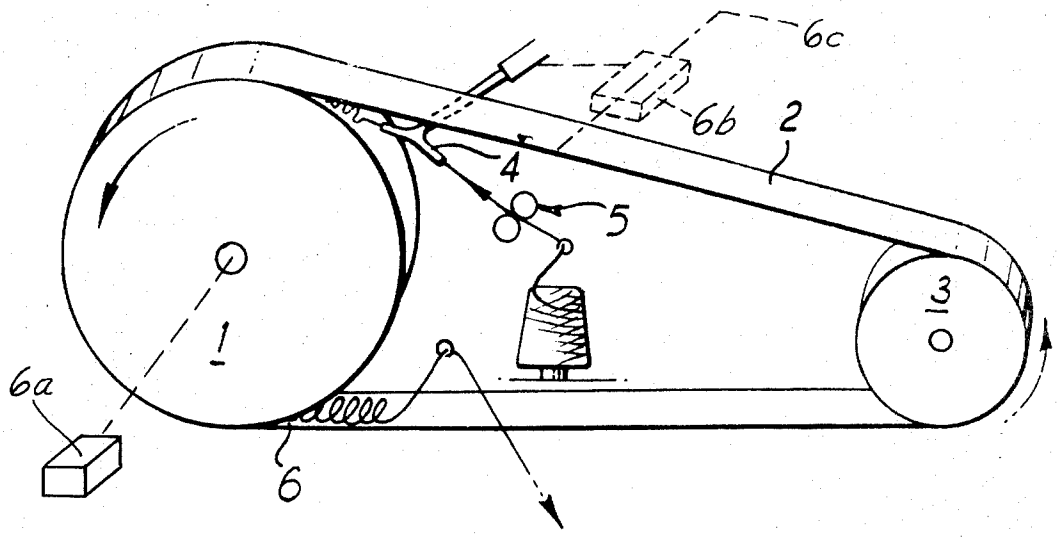
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[57] **ABSTRACT**

Apparatus for handling flexible elongate material such as textile yarn comprises feed rolls for feeding the material forwards, means for forming the material into folds, and for maintaining the folds for a determined period. The folds may be formed by successively displacing the yarn in opposite directions laterally of its line of travel. The yarn may be space printed in the folded condition.

16 Claims, 10 Drawing Figures



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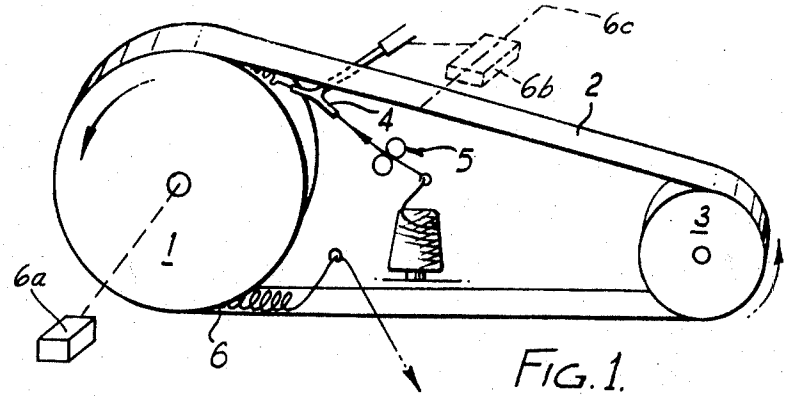


FIG. 1.

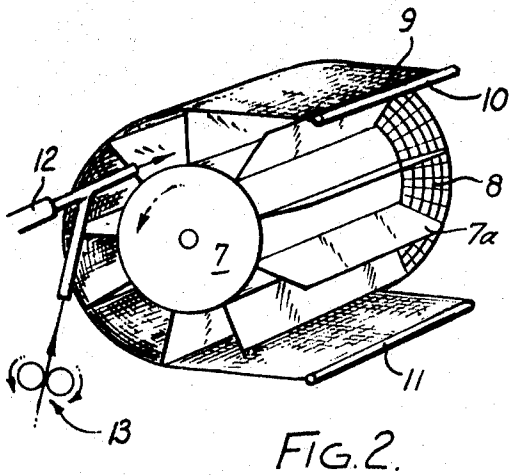


FIG. 2.

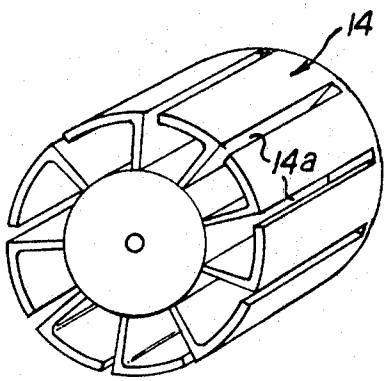


FIG. 3.

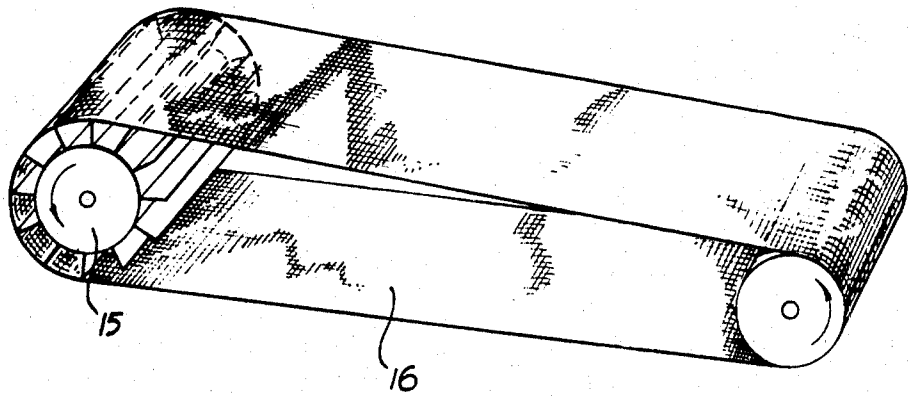


FIG. 4.

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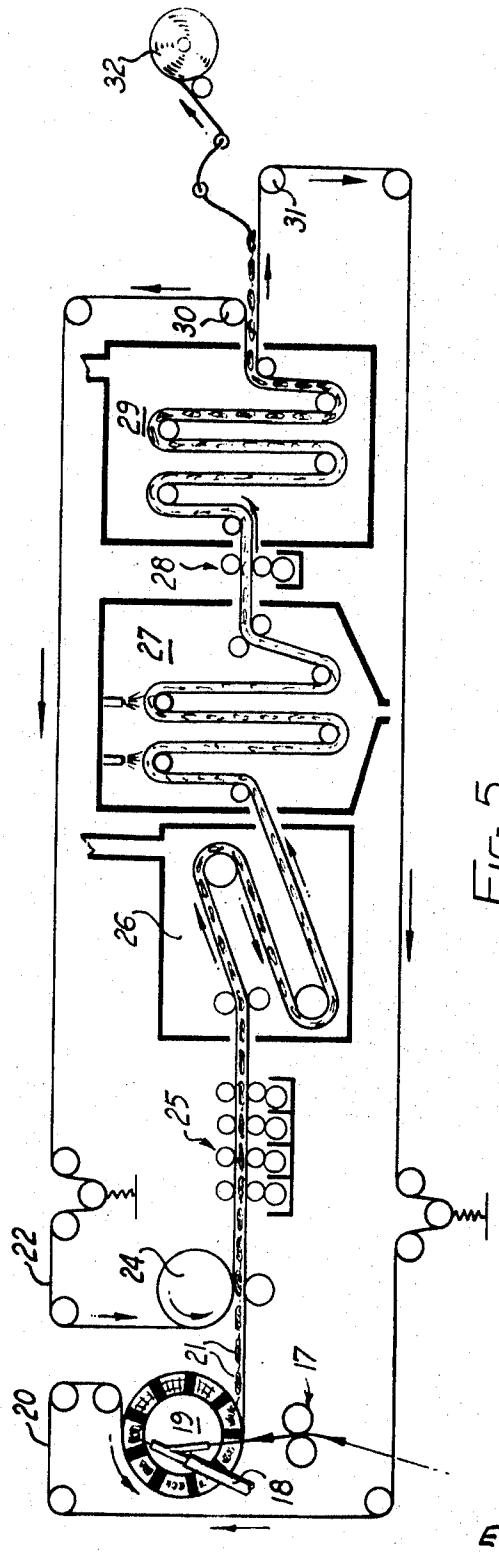


FIG. 5

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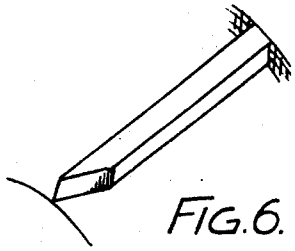


FIG. 6.

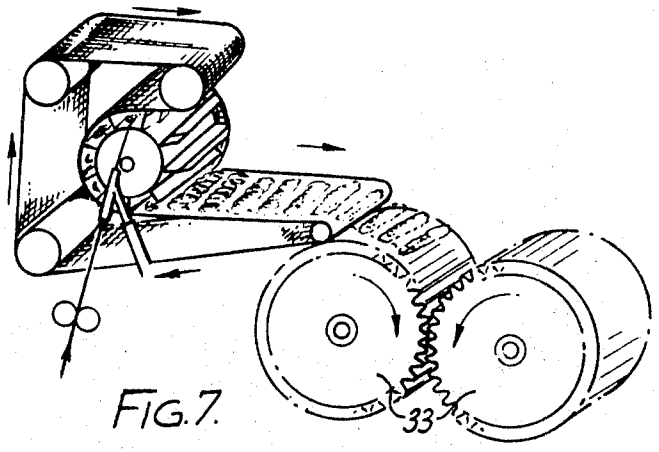


FIG. 7.

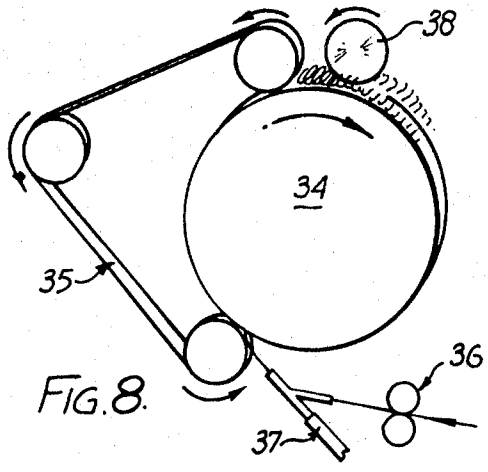


FIG. 8.

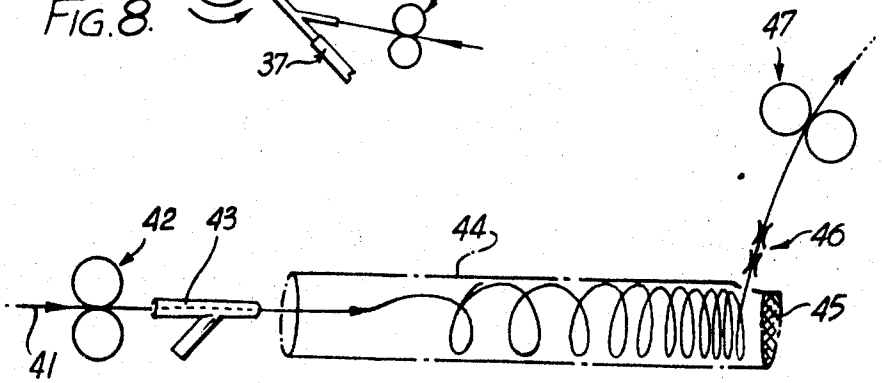


FIG. 9.

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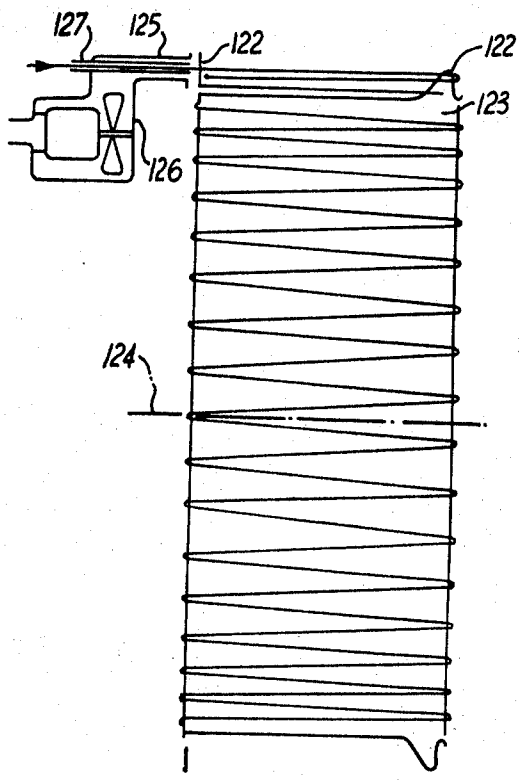


FIG. 10.

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HANDLING ELONGATE MATERIALS

The invention relates to flexible linear or elongated materials, that is materials whose length is considerably greater than their other dimensions of width and breadth, for example tapes, films, ribbons, yarns, filaments, tows, webs, cables, tubes and threads. For convenience all such materials will be referred to hereafter and in the appended claims as "yarn."

To be produced or processed economically yarns often have to be run at high linear velocity. This presents difficulties in handling, particularly between stages, and in accommodating the particular stages of processing in a reasonably small space while at the same time providing the dwell time necessary for effective treatment or treatments.

It is sometimes found either during the production or processing of the yarn that difficulties arise in relation to the speed at which the production or processing can be carried out, for example some materials can be produced rapidly but subsequent treatments in the same flow line may be relatively slow and thus production speed is of necessity reduced. Alternatively some treatments may be capable of being carried out more rapidly than production can take place. Speed limitations can, for example, be experienced in the coagulation during wet spinning, of viscose rayon or acrylic fibres; or in the subsequent relaxation, washing, neutralizing, desulphurizing, bleaching, soaping, oiling, drying and heat treatment, or in the usual stretch extrusion spinning of synthetic filaments. During attenuation by drawing, in crimping, shrinkage, shrink-stabilization, heat-setting and cutting into staple-fibre; or in the treatment of natural yarns with chemicals, such as the mercerization of cotton, the resin-impregnation of wool or other fibres; or in the continuous dyeing or space-printing of yarns, and subsequent dye-fixation, washing, finish application and drying; or the coating and drying of films or tapes it is sometimes found that speed limitations must be imposed.

In an attempt to overcome these deficiences, several appliances have been developed in recent years, such as those known under the term "self-threading self-advancing reels." However, these mechanical appliances are limited in their speed of operation to the peripheral speed of the yarn conveying surface. The efficiency of such appliances may also be limited because the yarn is laid thereon in its direction of progress, resulting in streamline flow. This necessitates longer treatment time, and even then the treatment may not be uniform.

It is an object of the invention to provide an improved yarn handling apparatus, particularly one which will be suitable for use space printing of carpet yarns such as multifilament nylon.

According to one aspect of the invention apparatus for handling yarn comprises feed rolls for feeding a single strand of yarn from a supply, and strand folding means arranged to receive the strand from the feed rolls and form folds in the yarn, the strand folding means comprising fluid means.

Further according to the invention there is provided a method of handling yarn comprising feeding a single strand by feed rolls from a supply to strand folding means arranged to form folds in the yarn, the strand folding means comprising fluid means.

According to a further aspect of the present invention apparatus for handling flexible elongated material comprises means for continuously feeding said material forward, means for positively and successively displacing said material laterally of its line of travel at discrete intervals of time as it passes a given station so as to form a succession of loops, and means for maintaining said loops for a determined period.

The invention may be performed in various ways and some specific embodiments will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

FIG. **1** is a perspective view of one apparatus according to the invention;

FIG. **2** is a perspective view of a further embodiment;

FIG. **3** is a perspective view of a modification of the embodiment shown in FIG. **2**;

FIG. **4** is a perspective view of a further embodiment;

FIG. **5** is a diagram of apparatus for colour printing of yarn;

FIG. **6** is a perspective view of a detail of FIG. **5**;

FIG. **7** is a perspective view of apparatus for crimping yarn;

FIG. **8** is a perspective view of apparatus for cutting continuous filament yarn into staple fibre;

FIG. **9** is a side elevation of a further embodiment of apparatus according to the invention; and

FIG. **10** is a diagrammatic view of one yarn handling and storage apparatus.

Referring to the drawings, FIG. **1** shows a wheel **1** two feet in diameter, having a recessed channel formed between two axially spaced rims, in a fashion similar to a bicycle wheel. An endless belt **2** of slightly greater width than the width of the wheel from rim to rim, runs over the wheel, in contact with the wheel rims, and over a driving pulley **3** to drive the wheel in a counter-clockwise direction. A stationary, air-operated, suction-gun **4** directs yarn from a positive-feed nip-roller system **5** into the gap or bight between the belt and the wheel rims. This gap is being continuously formed, by the rotation of the wheel, and the yarn forms successive folds or coils in this gap. The folded or coiled yarn is carried forward round the wheel circumference to emerge as a single layer of folded yarn at point **6**, where belt and wheel separate, so that the yarn can be fed to the next stage in the process. Means, shown diagrammatically at **6***a*, are provided for rotating the wheel.

With a gap formed between a 2-inch belt and the recess in the normal 24-inch bicycle wheel, 1½-inches wide, a yarn-to-wheel peripheral velocity ratio of 60:1 can be readily achieved. Thus, the wheel circumference is approximately 2 yards, so that 10 r.p.m. = 20 yards per minute wheel peripheral velocity = 60 × 20 = 1,200 yards per minute linear yarn velocity.

The arrest in the forward velocity of the yarn is quite considerable, in this instance being from a linear velocity of 40 miles per hour down to a bunch velocity of two-thirds of a mile per hour.

Furthermore, each coil or fold of yarn remains on the wheel for approximately 3 seconds to allow yarn treatment within a 1 yard span. To provide the same treatment time at the linear yarn velocity would require a span of 60 yards.

FIG. **2** shows a paddle wheel consisting of a 2-inch diameter axle or drum **7** and nine vanes **7***a* each ¾-inch high and 5 inches long located axially and at equal separation around the axle **7**, as shown. The gaps between

vanes are closed at one end by a wire-mesh gauze **8** and approximately two thirds of the circumference is closed by a nylon stockingette **9**, which is held stationary against the vanes by stays **10** and **11**. A stationary air-operated suction-gun **12** directs yarn from a positive-feed supply system **13** into successive compartments between vanes as the wheel is slowly rotated, the yarn forming a succession of folds and/or coils in each compartment in turn. The yarn is withdrawn at the exit end of the wheel to be fed to the next stage. Suitable control of the speed of the yarn and of the wheel enables the formation of a single loop in each compartment, or several loops in each compartment. For subsequent space printing it is preferable to have a single loop in each compartment so that the yarn is laid as a zig-zag on the belt **11** or **16**, or **20**.

FIG. **3** shows a modified paddle-wheel with a cap **14** on each vane in place of the band **9**. The caps thus rotate with the wheel, and slits **14***a* allow the yarn to be withdrawn radially without disturbing the performed folds or coils, and without withdrawing the contents of a compartment all at once.

FIG. **4** shows a similar paddle-wheel **15** with a continuous or endless stockingette band of a multifilament polyester yarn **16** surrounding the wheel. With this arrangement, the wheel can be rotated and the band can be driven either by the wheel or other means such as the pulley shown. The contents of each compartment can therefore remain on the band after separation of band and wheel to undergo the necessary treatment or treatments.

The velocity advantage of such a paddle-wheel, using 1,110 denier, 70 filament, crimped nylon 6 carpet yarn was found to be over 300:1, so that a wheel speed of 10 r.p.m. will accommodate a yarn speed of 900 yards per minute, again providing a 3 second dwell on half the wheel, this time in a volume of $5 \times 4 \times 4$ cubic inches.

FIG. **5** shows an apparatus for colour-printing yarn. The yarn is directed from positive-feed system **17** by means of a suction-gun into successive compartments of a vaned wheel **19** at the 12 o'clock position while the wheel rotates in an anti-clockwise direction. The vanes are, in this instance, double-walled, the two walls meeting at the front or entrance end of the wheel at a narrow angle, as shown in FIG. **6**. An endless band **20** surrounds part of the wheel and travels with it at the same speed along the arc of contact. At the 6-o'clock position it separates from the wheel and the contents of each compartment are deposited successively on the band, as shown at **21** to form a single layer of yarn in folds. Overlapping of the neighbouring layers of yarn is prevented by suitably proportioning the relative dimensions of the double-walled vanes and of the compartments on the wheel. The wheel is thus continuously discharging successive discreet portions of the yarn layer at predetermined intervals on to the band.

A second band **22** surrounds an arc of a pulley **24** which is rotating anti-clockwise, and the band leaves pulley **24** horizontally so as to contact the layer of yarn on the first band shortly after it leaves wheel **19**. Both bands travel forward together in this manner at the same speed through a colour-printer **25**, a print fixation stage **26**, and washing, finish-application and drying stages **27, 28, 29**. On emerging from stage **29** the topmost band is directed upwards round a pulley **30** to expose the yarn while the supporting band travels horizontally to a pulley **31**. The yarn is wound at high velocity on to a tube former **32** by means of a conventional textile wind-up assembly; and the two bands return along separate paths over suitable pulley and tensioning systems, to the wheel **19** and pulley **24** respectively.

For colour printing in the above manner it is preferable that both bands should allow maximum access of colourant, washing water, finishing agent and drying medium to the yarn, while still maintaining full protection and positional control over the yarn. They must also be flexible enough to traverse easily the circuits required, yet rigid enough to operate satisfactorily as stable supports for the yarn with no undue stretching, sagging, buckling or shrinkage. In addition they must withstand the rigours of the process, physical, chemical and thermal. For these several reasons bands having a gauze construction are recommended, gauze materials composed of either strain-resistant metal wire or mono- or multi-filament, or staple-fibre, yarn or thread being suitable. The structure and/or composition may be different for the two bands. It may also be found advantageous to have composite bands, having for example co-extensive side chains or belts on one or both sides for driving purposes.

The apparatus shown in FIG. **5** can be used for space-printing yarns to give multi-colour effects. For instance a number of surfaces can apply different pigments or dye-solutions to different yarn areas at the colour printing stage **25**. Suitable dyes are C.I. acid yellow 25; C.I. acid black 176; C.I. acid blue 72; C.I. direct red 37.

It is possible to operate apparatus according to the invention in several ways to give different colour pattern variations.

FIG. **7** shows an apparatus for crimping thermoplastic, heat-settable yarn after it has been laid by apparatus similar to that of FIG. **2**, the yarn being crimped by passing it through intermeshing gear-wheels **33** which are preferably heated before and during crimping, and cooled before the yarn is removed.

FIG. **8** shows an apparatus for cutting continuous filament yarn into staple-fibre, consisting of a large wheel **34**, belt and pulley system **35**, and yarn supply and directing systems **36, 37** directing the yarn at the inlet to the wheel and belt assembly to form folds or coils which are conveyed to the outlet where they are cut by a circular knife **38** before collection.

FIG. **9** illustrates an alternative to the wheel devices of FIGS. **1** to **8**. Yarn **41** is fed from a positive-feed roll system **42** into an air-jet assembly **43**. The air-jet conveys the yarn into a metal tube **44** at the end of which is fixed a wire-mesh gauze **45** to block most of the exit end of the tube. This restriction causes the yarn to collect in the tube while allowing the air to escape. When the yarn has partially filled the tube, its leading end is withdrawn through a tension gate **46** on to a positive take-up roll system **47** which withdraws the yarn at the same speed as the feed rate provided by roll system **42**. This ensures that the yarn is stored in the tube for a predetermined time and in a continuous manner.

If the air is heated the yarn can be heat-treated in the tube for a fixed period of time. Other treatments may also be applied.

If desired this apparatus could be used to cause the yarn to form flat and/or helical folds of controllable dimensions immediately prior to its passage to another compartment, such for instance as the moving compartments of FIGS. **1** to **8**.

Thus there is provided apparatus which enables various processes or treatments to be carried out on yarn which travels at high linear speed before and after treatment, but is slowed down during treatment, a relatively small space being required within which to carry out the treatments. The apparatus effectively provides temporary storage for the yarn during treatment and can also be used to temporarily stop a stage in a continuous process while some apparatus is attended to, for example while changing packages during winding.

It will be appreciated that various modifications may be made without departing from the invention. For example means other than air can be used to direct the yarn; the compartments could be only partly filled or part filled to varying extents; or a succession of liquid treatments could be given to the laid yarn by means of aqueous solutions.

In the various arrangements the air jet could be reciprocated from side to side to assist in forming the loops or folds in the yarn. For example, as shown diagrammatically in FIG. **1** and FIG. **2**, the air gun may be connected to a mechanism **6***b* arranged to gently oscillate the gun about an axis **6***c* through a limited angle.

Referring now to FIG. **10** it will be seen that there are provided circumferentially spaced apart yarn-receiving members **122** mounted upon the periphery of a circular drum **123** at each end thereof which drum is itself rotatable about an axis **124.** Adjacent one face of the drum is the nozzle **125** of an air blower **126** which as shown, includes a fan. Aligned with the outlet of the nozzle **125** and at the end of the blower tube remote from the nozzle is a yarn inlet tube **127.**

In use, a current of air from the nozzle **125** carries yarn across the drum and as the adjacent yarn receiving members **122** pass the nozzle **125** loops are formed, and the loops are retained by the members **122** just mentioned and those at the opposite face of the drum. The current of air is continuous. The members **122** at one end of the drum are circumferentially offset from the members **122** at the other end of the drum.

If the disc diameters are **24** inches and their spacing 5.5 inches with guides at 0.25 inch intervals then for a speed of 10 rpm a succession of loops will be formed as the wheel rotates and these loops will be 10 inches long (there being a 0.5 inch overlap to ensure correct interdigitation of the guides) so that a yarn to rim speed ratio of about 40:1 is achieved; since the discs are 24 inches in diameter this gives a rim speed of approximately 20 yds./min. and thus a yarn can be fed at 800 yds./min. It follows therefore that even for high yarn feed speeds only a low revolution rate is required for the discs.

Each of the successive loops into which the yarn is positively brought is completed before the next is begun. The yarn is maintained on the drum in its convoluted form for a determined period and may be drawn off by suitable means.

It will be appreciated that, since the storage apparatus is revolving slowly relative to yarn feed speed, the yarn can be caused to pass through a heat zone slowly and thus be subjected to controlled heat treatment. Clearly only part of the periphery of the disc assembly would be passed through the heat zone so that yarn feed and recovery can take place outside the heat treatment zone.

The apparatus described can be used for the treatment of yarn by, for example, space printing or dye fixation processes or for crimping in which case the yarn could either be treated when on the storage apparatus or fed from such apparatus to post treating devices.

When yarn is to be crimped on the apparatus it may be necessary to modify it by providing, adjacent and cooperating with the storage device, a serrated drum which would form crimps in the yarn. The drum or drums or the yarn would be heated to set the crimp.

I claim:

1. Apparatus for handling yarn comprising a plurality of surfaces, yarn feed means, a device spaced from said feed means adapted to receive both the yarn from said feed means and also a supply of fluid, and to direct the yarn and fluid towards said plurality of surfaces, and means for continuously moving said surfaces in a manner to define at least one yarn receiving zone, said device being spaced from said surfaces and disposed so as to direct the yarn and fluid into the zone, the arrangement being such that the yarn is folded subsequently to leaving said device, is located in the folded state in the zone, and is there so transported, wherein the surfaces comprise a yarn retarding surface and a support surface on which the yarn is received after contact with said retarding surface, and wherein there are a number of zones formed by vanes radiating from the surface of a rotary shaft or drum, the surface of the shaft or drum comprising said support surface, and an end closure member connecting the vanes at one end constituting said retarding surface.

2. Apparatus according to claim **1,** including an enclosure member extending around at least part of said drum at the free ends of said vanes.

3. Apparatus according to claim **2,** wherein said enclosure member comprises an endless conveyor belt which rotates the drum through contact with the free ends of said vanes and on to the lower run of which the contents of each zone are deposited in a single layer of folds for subsequent removel.

4. Apparatus according to claim **2,** wherein said enclosure member is comprised of a series of caps one secured to the free end of each of said vanes.

5. Apparatus according to claim **4,** wherein there are axially extending gaps between adjacent caps to permit of removal of yarn radially from said zones.

6. Apparatus according to claim **2,** wherein said vanes are double-walled and converge to a point at the entrance end of each zone.

7. Apparatus for handling yarn comprising a plurality of surfaces, yarn feed means, a device spaced from said feed means adapted to receive both the yarn from said feed means and also a supply of fluid, and to direct the yarn and fluid towards said plurality of surfaces, and means for continuously moving said surfaces in a manner to define at least one yarn receiving zone, said device being spaced from said surfaces and disposed so as to direct the yarn and fluid into the zone, the arrangement being such that the yarn is folded subsequently to leaving said device, is located in the folded state in the zone, and is there so transported, wherein said surfaces are moved so that they first come together to define at least one zone and then move apart again, and wherein there is one zone formed by a wheel having a recessed channel between axially spaced rims, an enclosure member extending around part of said wheel and contacting the outer edges of said rims, the device being arranged to direct the yarn substantially tangentially on to said wheel.

8. Apparatus according to claim 7, wherein said enclosure member comprises an endless conveyor belt which rotates said wheel through contact with said rims and on to the lower run of which the yarn is deposited from said wheel as a single layer of folds.

9. Apparatus according to claim 1, wherein said end closure member is a mesh structure.

10. Apparatus as claimed in claim 3, in which the conveyor belt is a mesh structure.

11. Apparatus as claimed in claim 8, in which the conveyor belt is a mesh structure.

12. Apparatus for handling elongated flexible material comprising means for continuously feeding said material forward, continuously movable means spaced from the feed means for positively and successively displacing said material laterally of its line of travel at discrete intervals of time so as to form a succession of loops, means for transporting the looped yarn for a determined period, and comprising a plurality of members spaced in succession around a closed curve, the members being arranged to engage in succession a continuous length of advancing flexible material to form successive loops.

13. Apparatus as claimed in claim 12, comprising a pair of spaced discs each having adjacent the periphery thereof material-engaging arms arranged to receive the material and draw it into looped form.

14. Apparatus as claimed in claim 12, comprising coaxial, rotatable, first and second circular series of material-engaging arms, the arms of the first series being circumferentially offset with respect to the arms of the second series, a continuous length of advancing material being arranged to be engaged by successive offset arms upon rotation of the two series of arms whereby the material assumes a looped form.

15. Apparatus as claimed in claim 14, in which the two series of arms are mounted one adjacent each peripheral edge of a drum, blower means being provided for causing the continuous length of material to pass across the drum into looped engagement with the arms.

16. Apparatus as claimed in claim 12, including fluid means for directing the yarn into engagement with successive ones of the members so that an end of a loop is held by each member.

* * * * *