Aug. 25, 1970 C. D. ANTONI ETAL 3,525,205

YARN TWISTING, BULKING AND WINDING MACHINE

Filed March 4, 1968 4 Sheets-Sheet 1

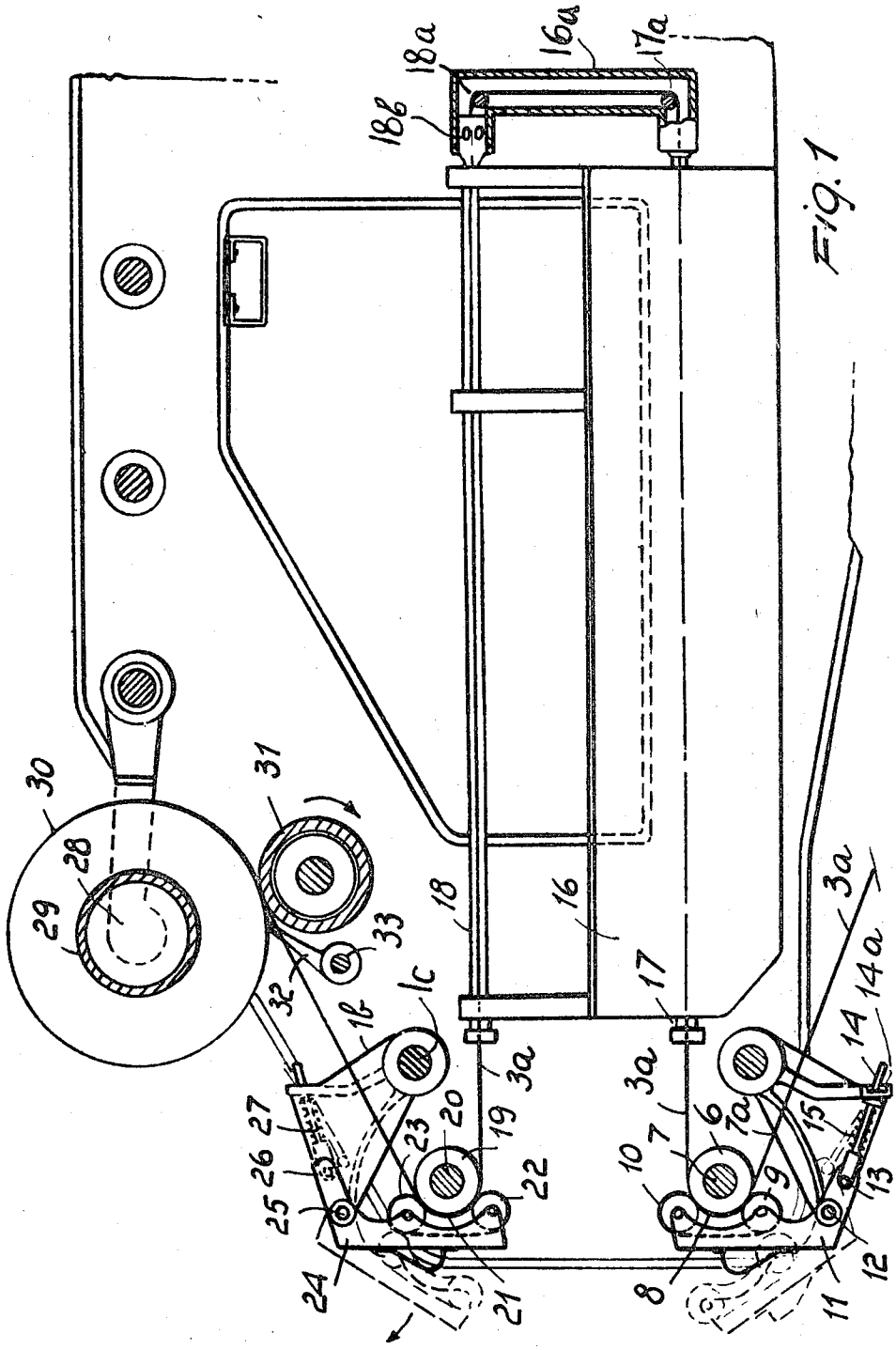


Fig. 1

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YARN TWISTING, BULKING AND WINDING MACHINE

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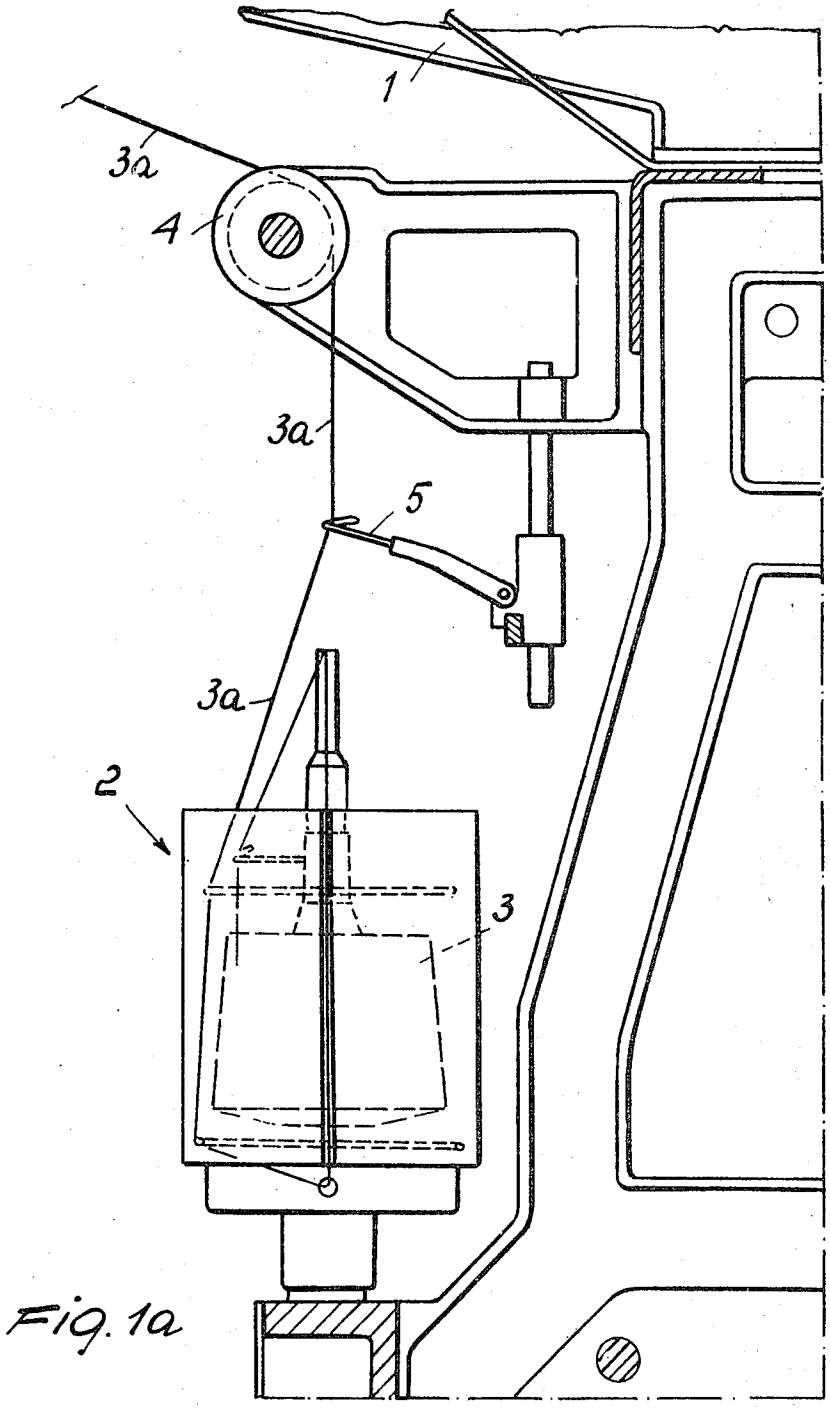


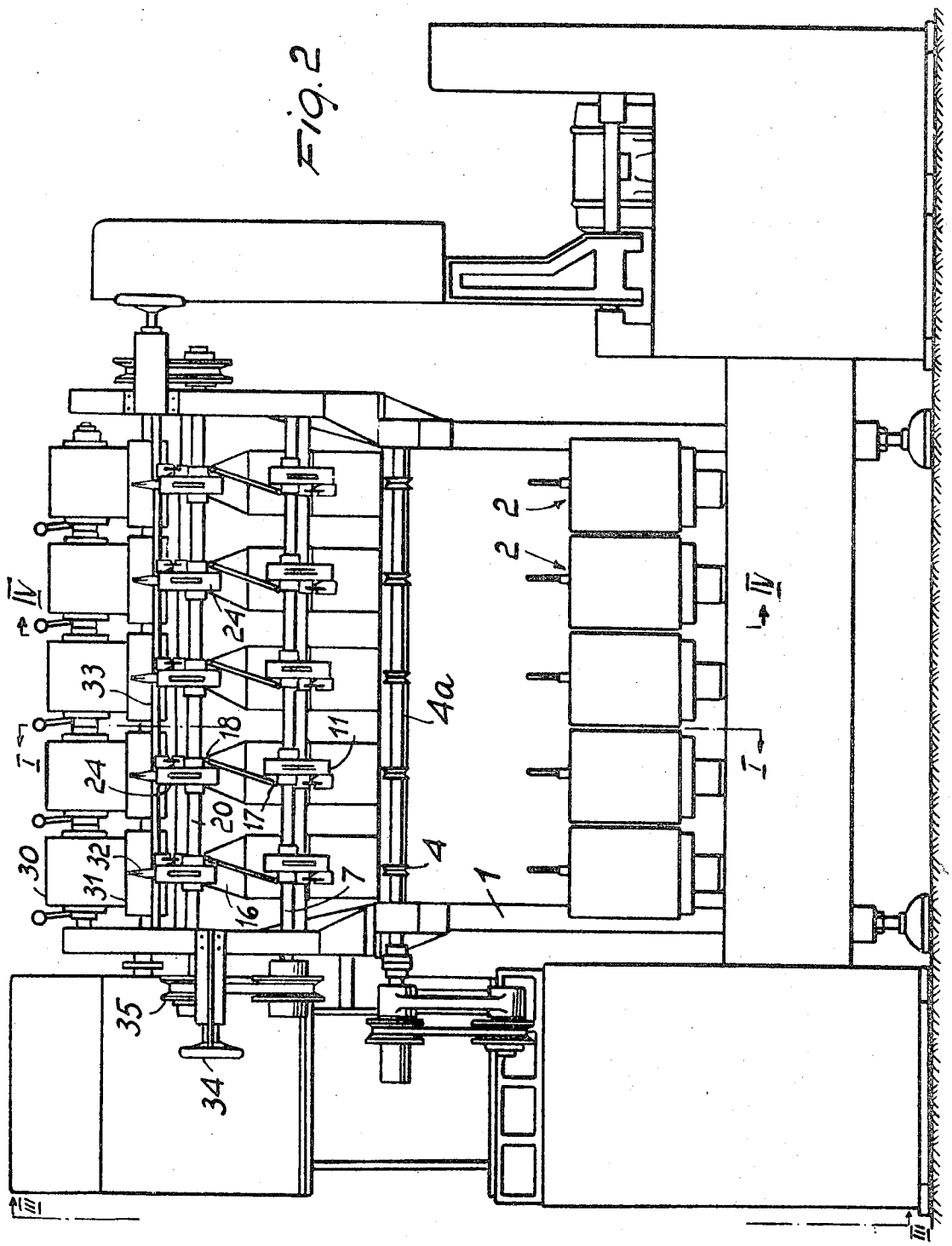
Fig. 1a

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YARN TWISTING, BULKING AND WINDING MACHINE

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Fig. 2



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YARN TWISTING, BULKING AND WINDING MACHINE

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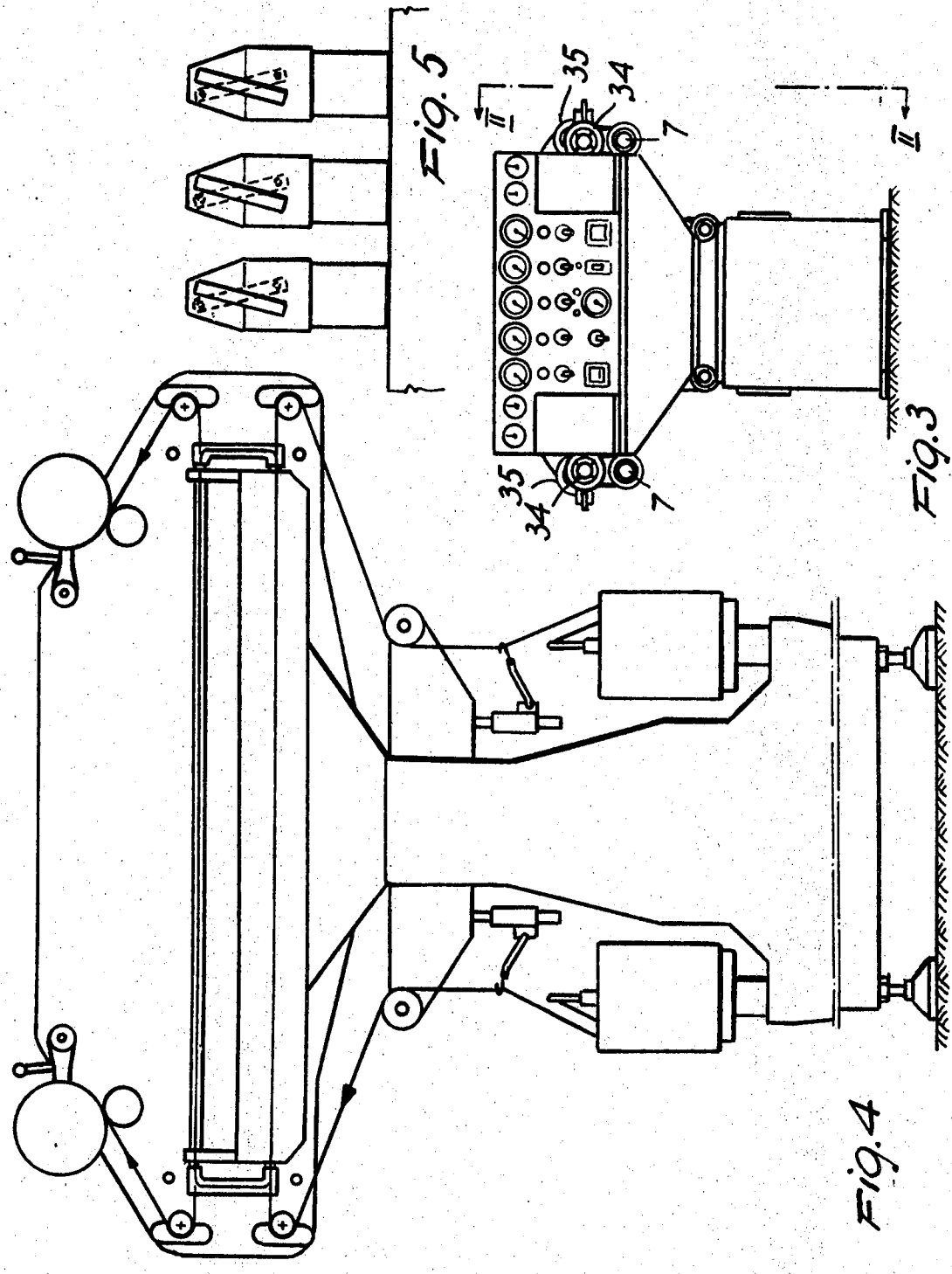


Fig. 5

Fig. 3

Fig. 4

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United States Patent Office 3,525,205 Patented Aug. 25, 1970

3,525,205

YARN TWISTING, BULKING AND WINDING MACHINE

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Continuation-in-part of application Ser. No. 499,796, Oct. 21, 1965. This application Mar. 4, 1968, Ser. No. 710,088

Claims priority, application Italy, Nov. 5, 1964, 23,641/64

Int. Cl. D01h *13/28;* D02j *13/00, 1/22*

U.S. Cl. 57—34 3 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure relates to a continuously operating yarn twisting, bulking and winding machine comprising a twisting device imparting a real twist to the yarn, a heater in the path of the yarn where the yarn is thermically treated to cause the bulking or relaxation thereof and cooled and a winding device through which the processed yarn is wound into bobbins, and a plurality of yarn guiding and entraining devices.

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part application of the parent application Ser. No. 499,796, filed Oct. 21, 1965, now abandoned.

The present invention relates to a yarn twisting, bulking and winding machine particularly adapted for synthetic yarns partly or entirely composed of shrinkable or bicomponent fibres, i.e., yarns composed of fibres or threads treated differently or having different behaviour under the action of heat. Included among the yarns considered are high-bulk type acrylic yarns and yarns based on acrylic, polyamide and/or polyester bicomponent fibres and/or yarns.

It is known that for twisting of yarns, particularly acrylic yarns, in which the twist imparted is not the so-called false twist, but a real twist, that is one which involves a permanent twist of one or more fibres or threads between each other, it is necessary to use machines which effect the twisting of the yarn. If it is desired to obtain the so-called "high bulk" type from these yarns, after the twisting in such machines the yarns must be successively thermically treated in order to obtain a differential contraction or shrinkage of the threads or fibers which form the yarn. To such purpose it has been until now necessary to transform the yarns into skeins or "cakes," and then thermically treat them, that is relax and finally reel or wind them. In fact, in order to obtain "high bulk" yarns, it has until now been considered indispensable to subject the yarn in the form of skein, or occasionally cake, to a heat treatment in water or steam which involved a discontinuity in the winding of the yarn. It was not, in fact, conceivable to subject linear extending or bobbin-wound yarn to heat treatment because it was necessary to permit the yarn to freely relax, that is to permit the differentiated contraction of the single threads and/or fibers in order to obtain the "high bulk" type. Loose skeins permitted however this relaxation and consequently the skein winding step was generally adopted. In fact the thread wound on a bobbin was too compact to permit the desired deformation thereof. These successive steps determine however an operative slowness and complicate the work cycle.

In the art, machines are also known which are intended to produce the succession of the twisting, heat treatment and continuous reeling or winding operations. Such machines, however, are generally applicable for continuous filament yarns subjected to a "false" twist. In this case the heat treatment is not comparable with the relaxation which lends to high bulk type yarn, or yarn based on bicomponent fibers, inasmuch as it serves to "set" the helical form conferred to the thread following the "false twist" and must be effected on the thread when it is taut and under twisting action. Until now not only was it never considered that such machines could be adopted also to obtain high bulk yarns, or bicomponent fibre yarns, but on the contrary the working of such machines engendered the belief that such adaptation was impossible.

As already pointed out, machines of this kind for continuously processing yarns do not lend themselves to processing yarns on which a real twist and a simultaneous heat induced shrinkage and bulking are effected.

The applicants have found that in machines used for such working it is necessary to provide, along the feed line of the yarn, at least one zone in which the heating of the yarn occurs, permitting at the same time and in the same zone also the bulking (so called relaxation) of the fibres forming the high bulk yarn. Moreover, the applicants have found that in order to obtain totally satisfactory results in the twisting and particularly in the successive relaxation of the described type it is indispensable that the twisting of the yarn occurs before the heating zone (heating tube) in order to obtain the relaxation of the thread after the twisting, so that also such twisting is stably "set" on the thread itself. The applicants have further found that it is necessary that, during the passage of the yarn through the heating tube, that is in the heating and relaxation zone, the thread is not maintained under tension, but on the contrary a difference of from 15 to 30% between the yarn feeding speed prior to the entrance into the heating zone and the yarn collecting speed after the heating zone be foreseen and calculated in order to allow the longitudinal shrinkage and simultaneous bulking of the yarn in order to obtain the high bulk type. For such reason it is not possible to obtain satisfactory results on threads of the said type with the use of machines which cannot use the methods or findings described above.

The main object of the present invention is consequently that of providing a yarn twisting, relaxing and winding machine particularly adapted for partially or completely shrinkable yarns (for example acrylic high bulk type yarns or yarns based on heat-relaxable bicomponent fibers) which enables the relaxation (bulking) of the thread after twisting, so that it may have a full and satisfactory touch, and that is without the skein or cake formation step.

Further characteristics and advantages of the invention will appear more clearly from the following detailed description of one embodiment of the yarn twisting, bulking and winding machine according to the invention illustrated by way of nonlimiting example in the accompanying drawing in which:

FIGS. 1 and 1*a*, which are complemental when placed in vertical alignment, show in vertical section along the line I—I of FIG. 2 the upper and lower parts respectively of said machine;

FIGS. 2 and 3 show in a reduced scale a front view along the line II—II of FIG. 3 and a side view along the arrow III of FIG. 2, respectively;

FIG. 4 shows a diagrammatic view according to the arrow IV—IV of FIG. 2 and

FIG. 5 shows a combination scheme of heaters in side-by-side arrangement.

With reference to the drawing reference numeral 1 indicates the frame of the machine. In the lower part of said machine per se known real twist producing devices are provided, for example double twist producing devices, in side-by-side relationship. The twisting devices may be advantageously of the type manufactured by the firm

Leesona of Warwick, Rhode Island (Roberts) U.S.A. These twisting devices are generally indicated with reference numeral **2**.

Each of said devices includes a bobbin **3** (FIG. 1*a*) which carries wound thereon two equal or different double threads. More particularly, at least one of said threads is formed of acrylic discontinuous or staple-fibres, of lengths also different from one another and with characteristics such as to react differently to heating or other physio-chemical treatment. It is also possible that both the double threads are formed of acrylic fibres as specified above.

The double yarn which passes from the device **2** and which has been subjected to a real twist and is formed of acrylic fibres suitable to obtain therefrom the high bulk type is indicated with reference numeral **3***a*.

Above each twisting device **2** is arranged a rotating roller **4**, provided with a peripheral groove and whose speed of rotation is chosen in suitable manner as will be described hereinafter. The yarn **3***a* is slidably engaged in the groove of said roller **4** in such manner that a desired speed is transmitted to the yarn from the roller. Reference numeral **5** indicates a tensioning device for the yarn. All the rollers **4** are mounted on a driven shaft **4***a* receiving motion from a conventional transmission system actuated by an electromotor (not shown).

In the part of the machine above the members just described is arranged a roller **6** which is keyed on a shaft **7** rotating with a suitable speed which will be defined hereinafter.

An endless belt **8** is arranged to slide against the roller **6**. Said endless belt **8** is wound on a pair of rollers **9** and **10** revolving idly on respective shafts carried by a support member **11**. Said support member **11** is pivoted, by means of a pin **12**, through an arm **7***a* secured to the frame **1** of the machine and articulated on it in **13** is the end of a tie-rod **14** whose other end is adjustably pivoted in **14***a* on the arm **7***a*. A helical spring **15** is coaxially mounted on the tie-rod **14**. Such spring is normally compressed, that is tends to expand, and is intended to maintain the support member **11** in the position illustrated in FIG. 1*a* in full lines. In fact the force of the spring **15** acts along a line which passes below the fulcrum **12** so that a moment is produced which tends to cause the support member **11** to rotate in clockwise sense.

It is also possible, by overcoming the opposing action of the spring **15**, to cause the support member **11** to turn to the position shown in dotted lines, in order to disengage the belt **8** from the surface of the roller **6**.

In such position the line of force of the spring **15** passes on the other side of the fulcrum **12** once the spring **15** tends to cause the rotation of the support member **11** in anticlockwise sense, that is to maintain such member in the turned position due to the suitable engagement or stop provided there.

In front of the roller **6** extends a horizontal heater **16** inside which, and longitudinally thereto is arranged a heating tube **17**. The interior of the heater **16** is heated for example by means of electrical resistances incorporated therein (not shown).

At the end of the heater **16** the tube **17** is connected with an elbow **16***a* which is in turn connected with a rectilinear cooling tube **18** parallel to the tube **17**.

The elbow **16***a* is movable in a direction parallel to the tubes **17**, **18** and may be displaced if necessary at a distance from the machine, thereby leaving free apertures **18***b* of the tube **18** and similar apertures (not shown) in the tube **17**. Through these apertures, which are advantageously of 5 or 10 cm. each, the yarn may suck the air while running into the cooling zone, thereby increasing the cooling rate thereof.

Yarn guiding discs **17***a* and **18***a* of porcelain are fixed in the corners of the elbow **16**. Instead of the apertures **18***b* the elbow **16***a* may be movably supported outside the tubes **17** and **18** and if desired may be moved away from the tubes **17** and **18** remaining aligned therewith, thereby leaving free a gap of about 10 cm. between the ends of the elbow and the corresponding ends of the tubes **17** and **18** through which the air may be sucked.

In front of the outlet of the tube **18** is arranged a roller **19** mounted on a shaft **20** which is rotated at a speed dependent upon the speed of rotation of the shaft **7** as will be described hereinafter. Analogously to what has been seen previously for the roller **6**, an endless belt **21** slides against a roller **19**. Said belt **21** is wound about a pair of rollers **22** and **23** which revolve on respective shafts supported by a support member **24**. The support member **24** is pivoted in **25** to an arm **1***b* secured to the fixed frame **1***a* of the machine by means of a rod **1***c*. Pivoted in **26** on the member **24** is the end of a rod **27**. Member **24** may rotate about said pin **25** and assume the position (shown with dotted lines) in which the belt **21** is disengaged from the surface of the roller **19**, in analogous manner to the rotation of the support member **11**.

The device **6–14** will be called hereinafter yarn feeding speed controlling device and the device **19–27** will be called hereinafter yarn delivery speed controlling device. It will be appreciated that these devices prevent any sliding of the yarn with respect to the respective rollers **6** and **19** against which the yarn is pressed, by the respective belts **8** and **21**, so that the yarn assumes in these points a speed exactly corresponding to the peripheral speed of the relevant roller **6** or **19**.

It will be appreciated that the device **6–14** and the device **19–27** are substantially equivalent to a first and a second pair of feed rolls, respectively.

Reference numeral **28** indicates the support of the bobbin tube, arranged in the upper part of the machine. On said support **28** is arranged the bobbin tube **29**, while reference numeral **30** indicates the bobbin proper. Reference numeral **31** indicates an entrainment roller and **32** a thread guide mounted on a shaft **33** provided with axial reciprocal movements. These bobbin winding members are per se known in the art and a more detailed description thereof is therefore omitted.

The yarn **3***a* passing from the twister **2** is entrained by the roller **4** and its speed is subsequently controlled between the roller **6** and the belt **8**. The speed of rotation of the roller **6** establishes the feeding speed of the yarn into the heater. On the contrary, the roller **4** over which the yarn may slide, has a rotation speed suitable to counterbalance with a suitable tension the centrifugal force acting on the yarn during the twisting process.

The yarn **3***a* is entrained in positive manner, and without sliding and slipping, by the roller **6** due to the presence of the belt **8** which presses the yarn **3***a* against the face of the roller **6**.

From the roller **6** the yarn passes through the horizontal rectilinear heater **16** and exits therefrom at the opposite end passing backwards through the cooling tube **18**, and is entrained in such movement by the roller **19**. This latter entrainment is also achieved without any sliding or slipping due to the presence of the belt **21** which behaves in the same manner as the belt **8**.

During the passage of the yarn within the heater **16** the shrinkable or bicomponent fibres which form the entire or part of the twisted yarn or yarn having an increased twist, undergo contractions. Such contractions, however, are not uniform but depend both on the nature of the single fibres and on their length. Due to such differential contractions the fibres, interconnected between each other, cause the diameter of the yarn to increase, thereby giving it a far greater consistency. For example, in case of high-bulk acrylic yarn the fibres which shrink entrain also the non shrinkable fibres, thereby causing them to bulk or crimp. The shrinkage of a part of the fibres or of all fibres during the heating stage causes a consequential shrinkage of the yarn within the heater and in the subsequent cooling zone.

The variation of the speed of rotation between the rollers **6** and **19** is obtained by adjusting, through the hand-wheel **34** the width of the groove of the V-belt pulley **35** or with suitable gear transmission systems.

When the yarn is "set" in its new structure, it leaves roller **19** and is wound on the bobbin **30**.

It has been established in practice that the machine according to the invention perfectly achieves the predetermined objects. It has been shown to be particularly suitable for working with double yarns to be twisted and simultaneously shrunk, or with single yarns the twist of which has to be increased, and which have to be shrunk and wound in bobbins or cakes. The arrangement of the twisting device before both of the heater and the roller **6** arranged in front of the heater inlet enables high bulk yarn to be obtained of a type which until now it was not possible to obtain with other machines.

Besides this, the difference between the speeds of rotation of the entraining rollers (particularly the rollers **19** and **6** arranged respectively at the inlet and outlet of the heater) avoids stretching of the yarn and at the same time an excessive shrinkage, so that the relaxation and bulking thereof occurs in a uniform and optimal manner.

It will be appreciated that in the conventional "bulking" or "relaxing" operation by immersing skeins or cakes either in water or in steam the shrinkage of the thread is not controlled, since the thread or yarn may freely shrink depending on the physical characteristics and behaviour thereof at the temperature used. This may lead to differences in the longitudinal shrinkage (and consequently in the degree of bulking) between one skein and the other.

The apparatus of this invention makes it possible, among others, to determine the axact desired shrinkage percentage.

It will be further understood that the peripheral speed of the roller **6** will be in general greater by 15 up to 30% than the peripheral velocity of the roller **19**. Since the yarn is clamped between the roller **6** and the belt **8** at the entrance into the heater and is likewise clamped between the roller **19** and the belt **21** at the exit of the heater, the shrinkage of the yarn within the heater cannot exceed the degree established by the above mentioned velocity difference.

On the other hand the temperature of the heater will be selected so that the entire yarn does not form undulations and maintains, within the zone of the heat treatment, a homogeneous and reduced tension.

In this way, within the heat treating zone the yarn runs within the heating tube without touching the walls of the heating tube. During the heat treatment the yarn passes first through the heating tube and then through the cooling tube where it is in contact with the air which increases the cooling rate. In order to maintain the yarn bulky and round and to avoid flattening thereof, it should reach the yarn delivery speed controlling device **19–21**, at the end of the cooling tube, and be wound over the collecting bobbin only when it is no more in thermoplastic condition. In addition, each fraction of the yarn should have at disposal a certain minimum time for its shrinkage, not less than one and a half second. Since the exit speed of the yarn, from the heating zone may attain 60 meters per minute, the path between the yarn feeding speed controlling device **6–8** and the yarn delivery speed controlling device **19–21**, has to be greater tahn 200 cm.

In the embodiment shown this distance has been chosen to be 300 cm. The heater of the embodiment shown may attain 260° C. but the operating temperature has to be determined in connection with the nature of the fibres and the yarn speed selected.

It has been found that the best results for acrylic yarns are obtained with a speed of the yarn of about 60 m./min. and with a temperature of about 250° C.

As already mentioned it is important that, in order to avoid flattening phenomena, the yarn should not touch the walls of the heating tube especially at the exit of the heating tubes **17**, where the yarn is bent twice by 90°. For this purpose yarn guides **17***a* and **18***a* are provided which are made of porcelain discs and which maintain the yarn at a distance from the walls of the heating tube. Consequently, the yarn is supported at the exit of the heater only in two points and it has been found that the quality of the yarn is not damaged by these two yarn guides.

The heaters are based on electric resistances and are permanently controlled so as to avoid any variation of the temperature greater than 0.5–1° C.

The cooling tube **18** may provide a better cooling by displacing the elbow **16***a*.

This increased cooling rate may be or may not be necessary in a number of cases depending on the fibres used.

Hereinafter the economical advantages of use of the machine according to this invention as compared to the conventional systems are pointed out.

Manufacture of twisted, high-bulked type yarns:

the expensive skein formation is avoided,
the shrinkage degree is controlled,
the extremely expensive unwinding of the skein is avoided and replaced by a bobbin to bobbin passage.

Manufacturing of single yarns:

the spinning costs are remarkably reduced, since a reduced initial twist may be imparted during the spinning (the output increases) to the starting yarn,
during the shrinkage the desired twist degree is attained,
a controlled shrinkage is obtained,
the unwinding from the skeins or from shrinked cakes is avoided with a passage from bobbin or from non-shrinked cake, to bobbin.

The temperature of the heater **16** may be regulated by any known temperature regulating device, such as of the controlled diodes temperature regulating apparatus manufactured by the Reactor Control Co. of San Francisco.

The yarn speed controlling devices may also be of any known kind such as the yarn speed controlling apparatus manufactured by the French firm ARCT-Ateliers Roannais de Construction Textile of Roanne, France.

What is claimed is:

1. Yarn twisting, bulking and winding machine including at least one real twist producing device and at least one winding device for winding the twisted yarn into bobbin and driving and transmission means for the moving parts of the machine, wherein according to the improvement the machine comprises further in combination between said twist producing device and said winding device a heat treatment device for the twisted yarn coming from said real twist producing device and near the entrance of said heat treatment device, a yarn feeding speed controlling device and near the exit of said heater a yarn delivery speed controlling device, said yarn delivery speed controlling device imparting a lower speed to the yarn than said yarn feeding speed imparted to the yarn by said yarn feeding speed controlling device, said heat treatment device comprising a rectilinear heating tube having an outlet end and a rectilinear cooling tube having an entrance end, said heating and cooling tubes being arranged in side-by-side relationship, a shiftable U-shaped elbow connector connecting the end of said heating tube with the entrance end of said cooling tube, said elbow connector slidably engaging said entrance end and said outlet end and being shiftable in a direction parallel to said cooling and heating tubes, thereby to discover openings providing communication at least between the interior of said cooling tube and the outside thereof, said elbow connector having thread guides in the corner thereof aligned with said heating and cooling tubes.

2. Yarn twisting, bulking and winding machine including at least one real twist producing device and at least one winding device for winding the twisted yarn into the

bobbin, a heat treatment device between said twist producing device and said winding device for the twisted yarn and driving and transmission means for the moving parts of the machine, wherein according to the improvement the machine comprises further near the entrance of said heat treatment device at least a yarn feeding roll and at least a first pressure roll cooperating therewith and having means in rolling engagement with said yarn feeding roll and clamping therebetween the twisted yarn during its motion, and near the exit of said heat treatment device at least a delivery roll for said yarn and at least a second pressure roll cooperating therewith and having means in rolling engagement with said delivery roll and clamping therebetween the yarn during its motion, said feeding and delivery rolls rotating at different speed to allow a shrinkage of said twisted yarn within said heat treatment device.

3. Yarn twisting, bulking and winding machine according to claim 2, wherein said means in rolling engagement with said yarn feeding roll and said yarn delivery roll, respectively, comprise each a pair of mutually spaced idle pressure rolls, an endless belt wound around said idle pressure rolls and having one strand thereof in rolling engagement with the respective of said yarn feeding and

yarn delivery rolls and clamping therebetween said yarn, swingable support means for each of said pairs of pressure rolls and spring means urging said pairs of pressure rolls against the respective of said feeding and delivery rolls.

References Cited

UNITED STATES PATENTS

2,453,984	11/1948	Gardner	57—157
2,859,472	11/1958	Wincklhofer.	
3,001,355	9/1961	Evans	57—34
3,159,964	12/1964	Kretsch	57—157
3,166,881	1/1965	Servage	57—34
3,333,409	8/1967	Servage	57—34 XR
2,459,345	1/1949	Sisson	34—153 XR
2,803,108	8/1957	Stoddard et al.	57—157
3,293,838	12/1966	Batsch	57—34
3,316,705	5/1967	Nava	57—34 XR
3,383,850	5/1968	Ratti	57—34 XR

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U.S. Cl. X.R.

28—62