ABSTRACT

To join two threads consisting of fibres twisted together, a length of each thread is untwisted and broken by pulling its ends apart so that each thread has an end having untwisted threads. The fibres of one such end are separated from each other, preferably electrostatically, and the other such end after being inserted into the separated fibres is itself opened out, also preferably electrostatically so that its fibres are also separated from each other and cross the fibres of the first said end. Thereupon the interlaced ends are axially twisted together to form the joined thread. Apparatus for use in performing the method is also described and illustrated.

14 Claims, 11 Drawing Figures
METHOD AND APPARATUS FOR SPLICING YARNS AND ROVINGS

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

This invention relates to a method and apparatus for joining two threads, each consisting of a plurality of fibres twisted together, and is especially applicable in the textile industry.

2. DESCRIPTION OF THE PRIOR ART

The problems of joining threads are well known and although various means capable of effecting a join mechanically already exist, no solution has yet been found to the problem of effecting a join where the two threads are identical without a break in the continuity of the thread, that is to say effecting a join while maintaining the section of the thread and its mechanical characteristics.

SUMMARY OF THE INVENTION

In threads whose fibres are discontinuous filaments, the tensile strength of the thread is obtained through the static friction of the fibres, which is assisted by cohesion due to the twisting.

When the thread is untwisted, static friction is substantially reduced and a slight force between retention points spaced apart by a distance greater than the fibre length is sufficient to cause the fibres to slip apart to provide two ends each having a plurality of fibres untwisted from each other (these fibres form what may be called a beard).

Because of the random distribution of the fibres in the thread, all the planes situated between the maximum distance of the fibre length will intersect an equal number of fibres in each of the two opposite beards, so that there is the maximum specific surface of contact between them.

If the ends of the threads (which may be for example ends of balls of thread) are trimmed, and if the fibres are intercrossed and the defibrilised portion is twisted, a single thread can be obtained the joint of which will have the same nature, section, and mechanical characteristics as any length of the same thread.

Based on this principle, the present invention has as its object the provision of a process and an apparatus for joining thread by axial twisting, whereby high quality or even perfect reconstruction of the thread is achieved in the joint zone, with the aim that this zone has the identical section and mechanical characteristics as the remainder of the thread.

In one aspect, according to the invention there is provided a method of joining two threads each consisting of a plurality of fibres twisted together, including

a. gripping each of the threads at two spaced apart locations on the thread so as to define a length of the thread between the two locations,
b. twisting each said length so as to untwist fibres therein from each other,
c. drawing apart the two said locations of each of the threads so as to break the said lengths of thread and thereby provide each thread with an end having fibres which are substantially untwisted from each other,
d. separating from each other the fibres of a first one of the said ends,
e. inserting the other of the said ends into the separated fibres of the first said end,
f. separating from each other the fibres of the said other end so that fibres of the two ends are caused cross each other, and

5. imparting an axial twisting motion to at least one of the said ends so as to twist the fibres of the two ends together to form a join.

Preferably, the said length of each thread which is untwisted is of a length substantially equal to the length of the fibres in that thread. Similarly, it is preferred that after the fibres of the said other end are inserted into the said first end, the ends are respectively gripped at locations which are spaced apart by a distance substantially equal to the length of the fibres in the thread.

To open out the ends, i.e. to separate the fibres, electrostatic forces are preferably employed. Furthermore, it may be desirable that before being separated from each other, fibres of at least one of the said ends are laid parallel to each other by combing.

According to the invention in another aspect, there is provided apparatus for use in carrying out the above-described method, which apparatus includes a first thread guide having an axis and including as axial passage for thread, a second thread guide having an axis and an axial nozzle having a passage for thread therethrough, the nozzle being insertable axially into the said passage of the first thread guide and the two thread guides being mounted so as to be relatively movable for said axial insertion of the nozzle, the axes of the two guides being aligned in the inserted position, and first gripping means associated with each thread guide and adapted to grip a thread in the guide, the said second thread guide and the said first gripping means associated therewith being mounted so as to be rotatable about the axis of the second thread guide.

Suitably, the said passage in the first thread guide may be part-conical with a narrow end and a wide end, the said nozzle of the second thread guide being insertable into the narrow end.

Preferably, the apparatus has means for electrostatically charging thread in at least one of the thread guides so that fibres of an end of the thread which are untwisted from each other are separated electrostatically from each other.

Both thread guides should be of such a nature as not to modify undesirably the electrostatic field produced, and in them may be provided a longitudinal notch with a convergent mouth which constitutes the inlet for the arrangement of the threads in their interior and for the passage or sliding of means for combining the fibres held in the interior of at least the first thread guide.

Preferably, each thread guide has in addition to the said first gripping means associated therewith second gripping means also associated therewith, the first and second gripping means in each case being relatively rotatable to untwist thread gripped by them both and being relatively movable to break thread gripped by them both. Preferably also, each thread guide has in addition to the said first and second gripping means, third gripping means also associated therewith and in each case being arranged for gripping thread at a location beyond the first gripping means from the second gripping means and in each case the first and third gripping means being relatively rotatable.

It is particularly advantageous that the apparatus should make it possible to lay the threads in the joining positions and break the end of these threads, producing in them the necessary fibres so that when the opposite
ends of the defibred threads encounter one another

good reconstruction of the thread is achieved. In order

to achieve this reconstruction of the threads it is neces-
sary for some fibres to be inserted within others so that
they cross one another, and this insertion and crossing
is very advantageously brought about with the electro-
static effect which may be supplied by the apparatus by
means of which the fibres of the end of one thread are
opened to form an open bundle in which fibres are sepa-
rated from each other and into which are inserted the
fibres of the end of the other thread, so that once the
fibres of one thread have been inserted into the opened
bundle of the fibres of the other, the inserted fibres are
in turn opened or separated from each other so as to
form a new open bundle of fibres, thus giving rise to the
interlacing of the fibres of one bundle with the fibres of
the other bundle.

Once the fibres of one bundle have been interlaced
with those of the other bundle by means of the apparatu-
s, the thread is re-twisted without the position of the
fibres being changed, and once this twisting has been
completed, whereupon the electrostatic effect also ceases,
the thread joined in this manner is entirely re-
constructed and can be produced with a uniform sec-
tion and homogeneous mechanical characteristics

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described,
by way of non-limitative example and with reference to
the accompanying diagrammatic drawings, in which

FIGS. 1 to 7 inclusive show consecutive stages in the
joining of two threads by a method embodying the in-
vention;

FIG. 8 is a diagrammatic perspective view of parts of
an apparatus for use in joining threads embodying the in-
vvention; and

FIGS. 9 to 11 show in axial section several parts of
the apparatus of FIG. 8 and illustrate stages in a thread-
joining process performed in the apparatus.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIGS. 1 to 7 of the drawings, the method
illustrated in one in which respective end portions 1 of
two threads are joined together to join the threads. The
threads consist of twisted together fibres. The threads
might for example be yarns or rovings.

In FIG. 1 are shown two lines 1 in alignment, which
represent end portions of threads; for each of these
lines 1 two groups 2 of two triangles, with their apexes
facing one another, represent means for gripping the
thread. FIG. 1 illustrates diagrammatically a first stage
of the method in which a length of each of the threads
which are to be joined together is gripped at two spaced
apart points, which represent the ends of the said
length and are preferably spaced apart by a distance
equal to the fibre length; the distance between the
gripping means 2 thus depends on the length of the fibre
of the thread.

FIG. 2 illustrates a second stage of the method, in
which as the arrows 4 indicate one of the gripping
means 2 of each thread 1 is rotated to untwist the
thread so as to provide between the gripping means 2
untwisted lengths of thread 3 in which the fibres are
largely or entirely untwisted from each other.

In a third stage, illustrated in FIG. 3, the pairs of grrip-

ping means 2 holding the lengths 1 of thread are rela-
tively moved apart as shown by arrows 5 so as to break

the lengths 1, the breaking taking the form of sliding
apart of the fibres of the untwisted portions 3. This pro-
vides each thread with an end 4 consisting of a number
of fibres having loose ends at least some of which are
untwisted from each other. These ends 4 may also be
called beards. The now unattached portions of the
thread (i.e. what were previously the ends) having been
discarded, there remain two ends or beards 4 opposed
to each other and in alignment.

At the next stage, shown in FIG. 4, one of the beards
4 has been opened up to form a bundle 5 in which
fibres are separated from each other with gaps between
them. Before this one or both of the beards 4 may be
combed to lay the fibres parallel.

At a fifth stage (FIG. 5), the opened beard 5 is held
stationary, while the other end 4 is moved axially and
inserted into it.

Thereupon (FIG. 6) the inserted end is opened out
so that its fibres are separated from each other end
across the fibres of the previously opened end 5. The
two ends become interlaced as shown at 6. Twisting of
the two ends (by rotation of the gripping means) as
shown by the arrows in FIG. 6 reconstructs a thread in
the zone of join by twisting the crossed fibres of the two
ends together. The two ends may be both twisted simul-
taneously.

Finally (FIG. 7) the gripping means 2 release the
zone 7 of joined thread. It is preferred that after the
insertion of the unopened end into the opened end (FIG.
5) the gripping means 2 gripping the respective ends
are spaced apart by a distance equal to the length of the
fibres in the threads.

The apparatus shown in FIGS. 8 to 11 has a first or
receiving thread guide 8 for one of the two threads to
be joined and a second or inserted thread guide 9 for
the other thread. The two guides 8 and 9 each have an
axis in which the thread generally lies and as shown the
two axes are aligned. The first guide 8 has an axial pas-
sage formed by a slotted frusto-conical member 11,
whose narrow end is directed towards the second guide
9. The second guide 9 has a slotted nozzle 10 having an
axial passage and directed towards the first guide 8,
which is mounted for sliding axial movement so that the
nozzle 10 passes through the narrow end of the member
11. A gapped circular ring 12 of larger diameter than
the narrow end of the member 11 is positioned co-
axially adjacent the said narrow end.

Three thread grippers are associated with each
thread guide. In the case of the first thread guide these
are respectively a first gripper 13, 14 movable with
the guide and located axially behind the member 11 from
the second guide 9 and consisting of a thread support
13 and a pivoted gripper arm 14, a second gripper 17
which is movable by pivoting about an axis remote
from the axis of the guide 8 from a position in which it
is in front of the narrow end of the member 11 to a re-
tracted position, and a third gripper 20 located axially
beyond the first gripper 13, 14 from the member 11
and axially movable by sliding on a runner with the first
guide 8. Both the second and third grippers are rotat-
able so as to impart twist to thread gripped by them
and for this purpose have flywheels 18, 20.

The three grippers associated with the second thread
guide 9 are a first gripper 15 adjacent the nozzle 10 and
behind it from the first guide 8, a second gripper 16
which similarly to the gripper 17 associated with the
first guide 8 is movable by pivoting about an axis re-
mote from the axis of the guide 9 from a position in front of the nozzle 10 to a retracted position, and a third gripper 21 located behind the second guide 9 from the first guide 8 and serving the purpose of isolating the remainder of the thread from twist imparted to the end in the guide 9. The second and third grippers 16, 21 are non-rotatable, but the guide 9 including the nozzle 10 and gripper 15 is mounted so as to be rotatable about its axis to impart twist to thread gripped in it, and for this purpose has a flywheel 19.

The two said second grippers are mounted on shafts for their pivoting movement by axially adjustable bosses 22. They may be biased by conventional return means to their retracted positions.

The various arrows in FIG. 8 indicate the directions of rotation and displacement of the various parts in use. In order to apply electrostatic charge to the threads to carry out the joining process, the member 11 and the gripper 15 and nozzle 10 are electrically conducting, being of metal, and are both connectable as indicated by heavy broken lines to an electrical pole of one sign (in this case the negative pole), while the thread support 13 and the parting 12 are also electrically conducting and are connectable to the electrical pole of other sign (positive).

With reference to FIGS. 9 to 11 as well as FIG. 8, the operation of the apparatus of FIG. 8 in joining two threads by a method embodying the invention will now be described. This method is similar, but not identical, to that described with reference to FIGS. 1 to 7, and the reference numerals 4, 5 and 6 are used in FIGS. 9 to 11 to designate the thread in the appropriate stages corresponding to those of FIGS. 1 to 7, and the double triangle symbol is used to denote the gripper 13, 14.

A first thread is placed in the first guide 8 and gripped by the three grippers 13, 14, 17 and 20. Flywheel 18 is rotated to untwist the length of thread between it and the gripper 13, 14. The gripper 17 is retracted, thus moving away from the gripper 13, 14 thereby breaking the said length of untwisted thread and providing a thread end or bead 4 in the guide 8.

Similarly a second thread is placed in the second guide 9 and gripped by the three grippers 15, 16 and 21. The guide 9 is rotated to untwist the length of thread between the grippers 15 and 16 (and to impart extra twist to the length between grippers 15 and 21) and the gripper 16 is retracted so that it moves away from the gripper 15 and breaks the thread and leaves a bead 4 in the nozzle 10. Conventional combining means (not shown) moving along the slots in the two thread guides may then be employed to lay the fibres in the beards parallel.

With the various parts connected to the electrical poles as described above, the untwisted fibres in the member 11 become electrostatically charged and thus separated from each other and attracted to the member 11 and the ring 12 as shown in FIG. 9, so as to leave a mouth into which the fibres of the other thread end can be inserted when the thread guide 8, including the member 11, ring 12, and grippers 13, 14, 20, is moved axially so that the nozzle 10 with fibres protruding from it becomes inserted in the member 11. When they enter the member 11, the untwisted fibres of the end protruding from the nozzle 10 are in turn electrostatically caused to separate from each other so that the end opens out and fibres of the two ends become crossed and interlaced (FIG. 10).

At this stage the gripper 15 is released so that the extra twist in the length between it and the gripper 21 is transmitted to the interlaced ends, twisting them axially. Further axial twist is preferably imparted to the joint zone by rotation of the gripper 20 after release of the gripper 13, 14. When the join is completely formed as desired, the grippers 20, 21 are released and the joined thread can be removed. The slots in the thread guides 8, 9 and the gap in the ring 12 allow insertion and removal of the threads.

It will be noted that the ring 12 is electrically connected to a pole of different sign from that to which the member 11 is connected, so that the ends of the fibres in contact with the member 11 tend to move towards the ring 12 and the fibres repel each other, thus stretching the fibres and laying them separate and parallel to each other. FIG. 9 shows this and also illustrates how the member 11 has a polarity opposite to that induced in the fibres by the charge on the gripper 13, 14. After opening of the inserted thread and also under the influence of electrostatic forces, the relative rotation of the two ends, preferably (as shown in FIG. 11) together with relative axial displacement, causes the fibres of the two ends to become twisted together thus forming a continuous reconstituted thread in the zone of join.

The auxiliary mechanisms necessary for bringing about the movements of the various parts and also the means used for the supply and interruption of the energy producing the electrostatic effect are conventional, and their exact nature does not affect the essence of the invention. Consequently they have not been illustrated or described herein but the manner of their provision will be clear to an expert in this art.

While the invention has been illustrated above by reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes may be made without departing from the spirit and scope of the invention and it is intended to cover all such changes and modifications by the appended claims. Thus, the invention is in principle applicable to the joining of two dissimilar threads. Further, the operations which constitute the method of the invention may be performed in any logical sequence.

What is claimed is:
1. A method of joining two threads each consisting of a plurality of fibres twisted together, including a. gripping each of the threads at two spaced apart locations on the thread so as to define a length of the thread between the two locations,
b. twisting each said length so as to untwist fibres therein from each other,
c. drawing apart the said locations of each of the threads so as to break the said lengths of thread and thereby provide each thread with an end having fibres which are substantially untwisted from each other,
d. separating from each other the fibres of a first one of the said ends,
e. inserting the other of the said guide ends into the separated fibres of the first said end,
f. separating from each other the fibres of the said other end so that fibres of the two ends are caused to cross each other, and

5. imparting a twisting motion to at least one of the said ends so as to twist the fibres of the two ends together to form a join.
2. Method according to claim 1 wherein the said length of each thread is of a length substantially equal to the length of the fibres in that thread.

3. A method according to claim 1 wherein the ends of the said other end are inserted into the said first end, the ends are respectively gripped at locations which are spaced apart by a distance substantially equal to the length of the fibres in the thread.

4. A method according to claim 1 wherein to separate the fibres of at least one of said ends electrostatic forces are employed.

5. A method according to claim 1 wherein before being separated from each other, fibres of at least one of said ends are laid parallel to each other by combing.

6. Apparatus for performing the method of claim 1 including a first thread guide having an axis and including an axial pressure for thread, a second thread guide having an axis and an axial nozzle having a passage for thread therethrough, the nozzle being insertable axially into the said passage of the first thread guide and the two thread guides being mounted so as to be relatively movable for said axial insertion of the nozzle, the axes of the two guides being aligned in the inserted position, and first gripping means associated with each thread guide and adapted to grip a thread in the guide, the said second thread guide and the said first gripping means associated therewith being mounted so as to be rotatable about the axis of the second thread guide, each thread guide having in addition to the said first gripping means associated therewith second gripping means also associated therewith, the first and second gripping means in each case being relatively rotatable to untwist thread gripped by them both and being relatively movable to break thread gripped by them both, for leaving fibres at an end of each thread untwisted from each other, means cooperating with at least one thread guide for separating the fibres of the end of the thread associated therewith from each other, so that when said nozzle of said second thread guide is inserted into the passage of said first thread guide, the untwisted fibres at an end of one thread will extend across the separated and untwisted fibres at the end of the other thread, and means for then separating the untwisted fibres of said one thread to extend across the previously separated fibres of the other thread, so that upon rotation of said thread guides about the axis of the second thread guide said fibres of the two ends will be twisted together to form a joint.

7. Apparatus according to claim 6 wherein the said passage in the first thread guide is part-conical with a narrow end and a wide end, the said nozzle of the second thread guide being insertable into the narrow end.

8. Apparatus according to claim 6, said means for separating said fibres including means for electrostatically charging thread in at least one of the thread guides so that fibres of an end of the thread which are untwisted from each other are separated electrostatically from each other.

9. Apparatus according to claim 8 wherein an electrically conducting wall bounding the said passage of the first thread guide is connectable to an electric pole of one sign and the said first gripping means associated with the first thread guide is electrically conducting and is connectable to an electric pole of opposite sign.

10. Apparatus according to claim 9 wherein the first thread guide has an electrically conducting member spaced from and at least partly surrounding the axis and adjacent an end of the passage in the first thread guide into which end the second thread guide is inserted, the said member being electrically connectable to the said pole of opposite sign.

11. Apparatus according to claim 10 wherein the said nozzle of the second thread guide is electrically conducting and is electrically connectable to the said electric pole of one sign.

12. Apparatus according to claim 6 wherein at least one of said thread guides has a slot extending in the axial direction for the insertion of thread into the guide.

13. Apparatus according to claim 12 including combing means arranged to move along said slot for combing fibres of a thread end lying in the guide so as to render them parallel to each other.

14. Apparatus according to claim 6 wherein each thread guide has in addition to the said first and second gripping means, third gripping means also associated therewith in each case being arranged for gripping thread at a location beyond the first gripping means from the second gripping means and in each case the first and third gripping means being relatively rotatable.