Title: COMPOSITE TELESCOPIC CRANE ARM WITH METAL ENDS ON TUBULAR SEGMENTS AND CRANE COMPRISING SAID ARM

Abstract: A telescopic arm for cranes able to lift a load comprises a plurality of tubular segments (12, 14, 16) extendable with respect to each other. At least one of said segments (12, 14, 16) comprises a central part (22, 28, 34) based on composite material, and head (18, 24, 30) and tail (20, 26, 32) terminal ends at least partly made of metal having high mechanical characteristics of strength.
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The present invention concerns a telescopic arm for cranes and cranes comprising said arm.

BACKGROUND OF THE INVENTION

It is known that cranes are work vehicles used to lift heavy loads, in the range of several tons, which generally comprise a truck on which a telescopic arm is mounted, consisting of a plurality of removable segments which can slide reciprocally one inside the other. A hook, or other lifting mean, is provided at an upper end of the arm, to lift the loads.

The arm can be angularly oriented, as well as lengthened telescopically, to carry the hook, or other lifting means, to the desired distance and height.

Generally the telescopic segments are made of metal material, typically steel, and have a tubular shape with a cross section of different shapes, such as rectangular, rectangular with a rounded bottom, hexagonal or other. The end part of each segment has reinforcement elements, of the band type, which also act as stopping means in a non-operative position.

The telescopic segments are guided with respect to each other by means of adjustable blocks made of a material able to absorb the local loads and to reduce the sliding friction.

Moreover, the arm of the crane in question is both able to rotate around a vertical axis, and can also be inclined on a plane perpendicular to the support plane of the crane, being able to pass from a horizontal position to a substantially vertical or sub-vertical position.

Such cranes can be provided with stabilizer support elements, which determine a controlled lifting of the cranes with respect to the support plane, so that they are able to operate in conditions of substantial planarity.

Moreover, ballasts can be provided which allow to balance and stabilize the crane, preventing it from toppling over.

The distances and height which can be reached are variable, as is the lifting capacity.
The distance which can be covered depends on the number of segments that make up the arm, and possibly also their length.

The need to lift loads means the metal segments must be robust, and therefore of a considerable weight, the bigger the loads to be lifted are.

Therefore, one disadvantage of known metal telescopic arms is that the weight of the arm increases as both the distance to be reached and the load to be lifted increase.

Therefore, in this field, there is an urgent need to reduce the weight of such telescopic arms, while still maintaining, and preferably increasing, the load-lifting capacity, as well as the distances and heights that can be reached.

Document FR-A-2.580.777 describes a lifter to lift a work station to operate on high voltage electric lines. The lifter comprises an articulated arm formed by an intermediate section, electrically insulating and telescopically mobile with respect to metal end sections. The intermediate insulating section is formed by a tube of epoxy resin reinforced with glass fibers. A closed-cell polyurethane foam in which optic fibers are drowned is provided inside the epoxy resin tube. The epoxy resin tube which forms the intermediate insulating section is covered at one end with an external bushing and, at the opposite end, with an internal bushing: the external and internal bushings are made of metal. This solution, which is provided for electric insulation of a work station which can be lifted, and not for cranes for lifting heavy loads of even several tons, does not deal with the typical problems of cranes and therefore does not provide any useful teaching for making an arm for cranes which is structurally resistant to heavy loads like those in question. In any case the solution taught by FR-A-2.580.777 does not provide, nor suggest to reduce the weight of the telescopic arm, inasmuch as there is in any case a considerable contribution to said weight given by the two end sections of the arm which, as in traditional solutions, are made of metal.

Document US-B-6,786,223 describes an articulated arm for the delivery of concrete, which is formed by sections which are articulated with respect to each other. The sections can be formed by a structure which, transversely, is the multi-layer type, with alternate layers made of composite material of different types overlapping from the inside to the outside, between which a layer of aluminum is also provided. The multi-layer structure is provided on the whole length of the
section. Since it is intended for arms for the delivery of concrete, for which the resistance to loads is not so important as in the case of cranes, this solution is not suitable to lift heavy loads either, as is on the contrary required for arms for the cranes in question.

Document JP-A-2002046993 describes the solution of an electrically insulating arm to lift a work station consisting of telescopic sections, formed by a three-layer structure which develops over the whole length of the arm and which includes an internal and an external layer, both made of composite material of plastic reinforced with fiber glass (GFRP), and an intermediate reinforcement layer formed by a steel plate, or an alloy of aluminum or plastic reinforced with carbon fibers. It is clear however that not even this solution, which is not developed for cranes for lifting heavy loads, in the range of several tons, provides any teaching useful for achieving arms for cranes of the type in question.

Document US-A-3,516,553 also describes an electrically insulating arm which includes a hollow tubular member made of dielectric material, formed by glass fibers drowned in epoxy resin, to which base support plates made of a composite material, also formed by glass fibers and epoxy resin, are associated.

Purpose of the present invention is therefore to achieve a telescopic arm for cranes which is both lighter than known telescopic arms and which allows, at the same time, to reach great distances, in any case guaranteeing robustness and mechanical resistance, both in the reciprocal coupling between the telescopic segments, particularly in the extended positions, and also in the overall capacity to lift heavy loads.

The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

In accordance with the above purpose, a telescopic arm according to the present invention can be used for a crane able to lift a heavy load.

The arm of the present invention comprises a plurality of tubular segments
which extend along a common central longitudinal axis. Each of the segments is able to slide in a telescopic manner inside or outside another adjacent segment and consecutive along the central longitudinal axis, between a retracted position and a completely extended position, being thus able to selectively determine one or more extended conditions of the arm.

According to the present invention, each of the segments comprises an oblong tubular central part, internally hollow and made of a composite material with a base of reinforcement fibers and thermostetting resin.

Moreover, each of the segments has at least a head and/or tail terminal end made of metal, with high mechanical characteristics of robustness and internally hollow in a manner mating with the tubular central part. The metal used is advantageously steel or its alloys, or other metals or metal alloys with adequate mechanical resistance.

The head and/or tail terminal end is connected to the external, front or lateral edge of a corresponding end of the tubular central part.

Moreover the head and/or tail terminal end, in the completely extended position of the segment, is coupled directly overlapping with the lateral, internal or external surface, of a corresponding tail and/or head terminal end of another adjacent segment consecutive along the central longitudinal axis, so that, in a coupling and overlapping region between the segments in the completely extended position, the transverse stresses on the segments due to the heavy load are discharged only on the tail and/or head terminal ends.

In this way, the head and tail terminal ends are destined to cooperate with corresponding tail and head terminal ends in the condition of reciprocal maximum extension of two pairs of contiguous segments and the provision to make them in metal as defined above gives the necessary mechanical resistance to the arm.

In particular, since in the completely extended position there is a considerable mechanical stress in the coupling and overlapping region between the sections also due to loads transverse to the same sections, and since the composite material with a fiber base does not generally adequately support these transverse loads, the present invention, providing a direct coupling and cooperation between the terminal elements in metal in the coupling and overlapping region, allows to
adequately support the transverse loads, thus achieving, overall, a less heavy structure compared with the state of the art.

The making of the tubular central part, which has a much greater extension in length than the head and/or tail terminal ends, with its base of composite material, makes the arm in question much lighter overall than known arms, which are made completely of metal.

Thus, the use of composite material to make the tubular central part of the telescopic arm of the crane in question allows to increase the length and/or the number of segments used given the same overall weight; alternatively, the invention allows to reduce the overall weight given the same length and/or number of segments.

The composite material in question reacts well, in mechanical terms, to tangential stresses, that is, parallel to the fibers, while, where the composite material may have little mechanical resistance to transverse stresses, generally perpendicular, that is, orthogonal to the fibers, as in the case of the terminal ends of the segments, metal is used, which on the contrary offers more guarantees to that effect.

It is extremely advantageous, therefore, to make the tubular central part of the segment, which is subject to bending, of a composite material, while the terminal ends, where the exchange of loads perpendicularly to the segment occurs, are made of metal.

The achievement of much lighter telescopic arms allows to use less powerful movement vehicles compared to those conventionally used for arms made according to the traditional art, both with regard to the engine of the vehicle which transports the arm and also the auxiliary engines for the movement of the arm itself.

The tubular central part in composite material can have different lengths, depending on different factors, such as distance to be reached and the length which must guide the extendable segment.

In some forms of embodiment of the present invention, the segments have a box-like section of a rectangular type, rectangular with rounded bottom, rectangular with rounded edges, hexagonal, oval or other.

In some forms of embodiment, the cross section of the segments is constant in
correspondence to the tubular central part. In particular both the external cross section and the internal cross section of the segments can be constant.

In other forms of embodiment, the external cross section of the segments can also be rounded, that is, with a progressive reduction of the section, in correspondence to the tubular central part, while the internal cross section is advantageously constant, so as to prevent the formation of steps or jamming points which could impede the telescopic movement of the segments.

In one solution of the present invention, the composite material used to make the tubular central part is based on carbon fibers.

According to a variant, the composite material used to make the tubular central part is based on aramid fibers (Kevlar®), or other similar or comparable fibers, having characteristics substantially similar to carbon in terms of resistance and rigidity.

According to some forms of embodiment of the present invention, the composite material is made with unidirectional fibers, or, according to a variant, is made with interwoven and/or interlaced fibers, or fibers with a random distribution.

In some variants, the composite material is made with a mixture of long fibers and short fibers, with a random or predetermined disposition.

According to a variant of the invention, the composite material used to make the tubular central part is the multi-layer type.

In some variants, in correspondence with the regions of association with the metal terminal ends, the tubular central part has same-shape coupling means, such as joint elements drowned in the composite matrix and partly protruding, able to cooperate mechanically with coupling counter-means, such as for example mating coupling seatings, provided on the metal terminal ends. Obviously, also the equivalent configuration of coupling seatings on the tubular central part in composite material could also be provided, and protruding joint elements on the metal terminal ends.

In other variants, it is provided to glue together the final region of the tubular central part in composite material and the metal terminal ends.

The tubular central part in composite material can be made as described in the European patent applications EP-B-1.970.344 and EP-B-2.039.498 and the Italian patent for industrial invention M12011A000273 in the name of the
Applicant, wholly incorporated here by reference.

The present invention also concerns a method to make a telescopic arm for a crane able to lift a heavy load and comprising a plurality of tubular segments which extend along a common central longitudinal axis. Each of the segments is able to slide telescopically inside or outside another adjacent segment and consecutive along a central longitudinal axis, between a retracted position and an extended position.

The method of the present invention provides to make each of the segments with an oblong tubular central part, internally hollow and consisting of a composite material based on reinforcement fibers and thermosetting resin and head and/or tail terminal ends of each of the segments made of metal with high mechanical characteristics of robustness and internally hollow in a manner mating with the tubular central part. According to the invention, each head and/or tail terminal ends is connected to the external, front or lateral edge of a corresponding end of the tubular central part.

Moreover, according to the invention, the head and/or tail terminal end, in the completely extended position of the segment, is coupled directly overlapping with the lateral, internal or external surface of a corresponding tail and/or head terminal end of another adjacent segment and consecutive along the central longitudinal axis, so that in a coupling and overlapping region between the segments in the completely extended position, the components of force transverse to the segments, due to the stresses deriving from the heavy load lifted by the arm, are discharged only onto the tail and/or head terminal ends.

One form of embodiment of the segments of the telescopic arm in question provides a first step in which a suitable quantity of layers of fiber which can already be impregnated or impregnated in a subsequent step, is deposited inside the volume of appropriate female molds.

An alternative form of embodiment provides a first step in which one or more layers of fiber are distributed, together with or without the resinous matrix (that is, pre-impregnated or dry fibers) on the external surface of a mold of the male type.

The method then provides a possible second step in which the composite material is subjected to a heat treatment process, typically in autoclave, a third
step in which the necessary refining mechanical workings are carried out on the
segment obtained, and a fourth step of connecting the segment obtained and the
corresponding head and tail terminal ends.

The production method of the composite telescopic arm, while not being
restrictive, is preferably selected between one or another of the techniques of
filament winding, manual deposition of pre-pregs with polymerization in
autoclave, poltrusion, hot vacuum, RTM (Resin Transfer Molding), the infusion
technique or other similar or comparable method to one or another of the
methods indicated above.

In some forms of execution, during the course of the first step, or between the
first and the second step, in correspondence to the regions of association to the
corresponding head and tail terminal ends, same-shape coupling means are
located, able to cooperate mechanically with coupling counter-means made on
the head and tail terminal ends.

In other forms of execution, the method provides to glue the tubular central
part in composite material to the corresponding head and tail terminal ends.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other characteristics of the present invention will become apparent
from the following description of a preferential form of embodiment, given as a
non-restrictive example with reference to the attached drawings wherein:
- fig. 1 is a schematic view of an arm according to the present invention;
- fig. 2 is an enlarged detail of a section of one part of fig. 1;
- fig. 3 is a schematic detail of a segment of the arm in fig. 1;
- fig. 4 shows schematically in partial section a first form of embodiment of
  the coupling between central part and terminal end of the telescopic arm of
  the present invention;
- fig. 5 shows schematically a second form of embodiment of the coupling
  between central part and terminal end of the telescopic arm of the present
  invention.

To facilitate comprehension, the same reference numbers have been used,
where possible, to identify identical common elements in the drawings.

DETAILED DESCRIPTION OF SOME PREFERENTIAL FORMS OF
EMBODIMENT
With reference to the attached drawings, a telescopic arm according to the present invention is indicated with the number 10, and can be used in a crane for lifting loads, only schematically shown in fig. 1, for example in the building or construction sector.

The telescopic arm 10 comprises a plurality of segments 12, 14, 16 sliding one inside the other, which can be extended linearly to assume an extended operating condition, or retracted one inside the other in a non-operative condition or when the machine is stopped.

The segments 12, 14, 16 have a box-like cross section, defining corresponding axial positioning seatings 25, 27 inside, to accommodate the segments in their retracted position.

The segments 12, 14, 16 have mating reciprocal section shape and size so as to be able to be inserted axially, where possible or required, in the respective axial positioning seatings 25, 27, according to the usual telescopic configuration.

In this case, a telescopic arm 10 is shown comprising:
- a first lower segment 12, angularly constrained to a support plane by hinging means 42 and associated to a hydraulic cylinder, or other linear actuator 44, which allows the movement of extension/retraction of the corresponding segment of the arm;

- a second segment 14 in an intermediate position;
- a third upper segment 16, which has an end to which a hook 29 is associated to lift the load 31.

According to the present invention, each segment 12, 14, 16 comprises a tubular central part 22, 28, 34, oblong and internally hollow, and corresponding head 18, 24, 30 and tail 20, 26, 32 terminal ends, which are also hollow shaped so as to mate with the central part 22, 28, 34, for example tubular shaped, such as bushings, rings, annular strips, cylinders or similar or comparable shapes.

According to the present invention, the central parts 22, 28, 34 of the segments 12, 14, 16 are made of composite material, in this case based on carbon fibers distributed in a thermosetting resin.

Moreover, according to the present invention, the head 18, 24, 30 and tail 20, 26, 32 terminal ends are made, in this case completely, of metal with high mechanical resistance, for example steel. In other variants, the head 18, 24, 30
and tail 20, 26, 32 terminal ends are made only partly of metal, suitably sizing the metal parts to achieve the necessary mechanical resistance.

In particular the first segment 12 has a central part 22, an upper terminal end 18 and a lower terminal end 20 associated to hinging means 42 and the jack 44.

The second segment 14, shown as an example in fig. 3 (in which the dimensional proportions are deliberately not shown, for convenience of representation) has a central part 28, an upper terminal end 24 and a lower terminal end 26, destined to cooperate, in the extended condition of the telescopic arm 10, with the upper terminal end 20 of the first segment 12.

The third segment 16 has a central part 34, an upper terminal part 30 associated to the hook 29, and a lower terminal part 32, destined to cooperate, in the extended condition of the telescopic arm 10, with the upper terminal end 24 of the second segment 14.

According to one form of embodiment, the upper terminal end 30 of the third segment 16 can be associated to reinforcement elements, of the strip type, which also act as stopping means in the non-operative position.

Traditional guide elements can be provided between the segments 12, 14, 16 to facilitate their reciprocal sliding, such as for example sliding blocks situated inside and outside the segments 12, 14, 16 themselves.

It should be noted that in the extended condition of at least one part of the telescopic arm 10, the corresponding head 18, 24, 30 and tail 20, 26, 32 terminal ends of the segments 12, 14, 16, which cooperate in coordinated couples, are those destined for the exchange of loads perpendicularly to the segment itself, as shown by the arrows V in fig. 2, whereas, instead, flection loads, indicated by the arrow F in fig. 2, affect the central part 22, 28, 34 of the segments 12, 14, 16.

In particular, the exchange of loads between the head 18, 24, 30 and tail 20, 26, 32 terminal ends occurs on the so-called upper or lower platbands, that is, the surfaces of the segments which are transverse to the component of the load lifted perpendicular to the arm, while the lateral flanks, that is, the surfaces of the segments which are parallel to the perpendicular component, are substantially not affected by the exchange of loads.

Consequently, as noted above, in some variants, it can be hypothesized that the head 18, 24, 30 and tail 20, 26, 32 terminal ends are not made completely of
metal, such as steel, but only partly, that is, providing only some portions, or rigid inserts, made of metal, suitably placed where the loads have the most influence on the structure, for example on the platbands, while the remaining parts could be made with the composite material of the central parts 22, 28, 34.

It is thus possible to have variations of material from metal to composite both in an axial direction and also in a tangential direction, that is, along the perimeter.

For example, it is thus possible to define configurations in which the metal portions and those of composite material interpenetrate with each other axially on the whole perimeter of the cross section of the head 18, 24, 30 and tail 20, 26, 32 terminal ends, or other configurations in which only some tracts, or sides of the perimeter of the cross section of the head 18, 24, 30 and tail 20, 26, 32 terminal ends, are made of metal, while others are of composite material.

Some methods of coupling the central parts 22, 28, 34 of the segments 12, 14, 16 and the corresponding head 18, 24, 30 and tail 20, 26, 32 terminal ends are described hereafter, as a non-restrictive example within the field of the present invention.

Particular reference is made to figs. 4 and 5 where, as a non-restrictive example, the coupling between the central part 22 and the upper terminal end 18 in metal of the first segment 12 is shown; however, this description is valid in general for the couplings between the central parts 22, 28 and 34 and the corresponding head 18, 24, 30 and tail 20, 26, 32 terminal ends.

In particular in fig. 4, according to a first type of coupling, male joint elements 37 are provided, suitably sized, made on the termination of the central part 22.

In fig. 4 the male joint elements 37 are shown for example with a "T" section; however, this must not be understood in a restrictive sense of the field of protection of the present invention, in that other geometric conformations, equivalent and suitable to the purpose, can also be obtained, all of which shall come within the field of protection of the present invention.

The male joint elements 37 are partly drowned in the matrix of the composite material of the final zone of the central part 22 in composite material and protrude axially with one of their portions beyond the central part 22, as they are configured to couple in coupling seatings 38 made, by means of known working techniques, on the upper terminal end 18 in metal.
Mechanical attachment means 39, such as rivets or screws, can be used to render the male joint elements 37 constrained and solid with the upper terminal end 18 in metal. To this purpose, the terminal end 18 can have corresponding attachment holes 41.

Alternatively, the male joint elements 37 and the terminal end 18 of the segment 12 can be welded.

The male joint elements 37 can also be made of a different metal material from that of the terminal end 18 of the segment 12, for example titanium.

According to the form of embodiment in fig. 5, it is provided to glue together the final zone, indicated here for convenience by the reference number 22a, of the central part 22 in composite material, suitably shaped, and the terminal end 18. In particular the final zone of the central part 22 is shaped with a desired conicity, advantageously comprised between 2° and 5°, as indicated by the angle a.

In a correlated way, the corresponding coupling part of the terminal end 18 is shaped with a mating internal conicity, as indicated by the reference number 18a.

This form of embodiment provides to glue together the two shaped conical surfaces, that is, the final zone 22a and the coupling part 18a, therefore obtaining a substantially monolithic structure, even though formed by different materials.

The geometric and glued configuration of the two conical surfaces of the final zone 22a and the coupling part 18a is such that the segment, and therefore the telescopic arm in general thus obtained, have a constant cross section along the whole axis of development, thus preventing the formation of steps which can hinder the relative sliding of the different telescopic segments.
CLAIMS

1. Telescopic arm for a crane able to lift a heavy load, comprising a plurality of tubular segments (12, 14, 16) which extend along a common central longitudinal axis, each of said segments (12, 14, 16) being able to slide telescopically inside or outside another segment (12, 14, 16) adjacent and consecutive along said central longitudinal axis, between a retracted position and a completely extended position, characterized in that each of said segments (12, 14, 16) comprises a tubular central part (22, 28, 34) oblong and internally hollow and made of a composite material with a base of reinforcement fibers and thermostet resin, and in that each of said segments (12, 14, 16) has at least a head (18, 24, 30) and/or tail (20, 26, 32) terminal end made of metal with high mechanical characteristics of strength and internally hollow in a manner mating with said tubular central part (22, 28, 34), said head (18, 24, 30) and/or tail (20, 26, 32) terminal end is connected to the external, front or lateral edge of a corresponding end of said tubular central part (22, 28, 34), wherein said head (18, 24, 30) and/or tail (20, 26, 32) terminal end, in said completely extended position of said segment (12, 14, 16), is coupled directly overlapping with the lateral, internal or external surface of a corresponding tail (20, 26, 32) and/or head (18, 24, 30) terminal end of another segment (12, 14, 16) adjacent and consecutive along said central longitudinal axis, so that, in a coupling and overlapping region of said segments (12, 14, 16) in the completely extended position, the components of force transverse to said segments (12, 14, 16), due to the stresses deriving from the heavy load lifted by the arm, are discharged only on said tail (20, 26, 32) and/or head (18, 24, 30) terminal ends.

2. Arm as in claim 1, characterized in that said segments (12, 14, 16) have a box-like section of a rectangular type, rectangular with rounded bottom, rectangular with rounded edges, hexagonal or oval or other.

3. Arm as in claim 1 or 2, characterized in that both the external cross section and also the internal cross section of said segments (12, 14, 16) is constant in correspondence with said tubular central part (22, 28, 34), or the external cross section of the segments (12, 14, 16) is tapered in correspondence with said tubular central part (22, 28, 34), whereas the internal cross section is constant in correspondence with said tubular central part (22, 28, 34).

4. Arm as in claim 1, 2 or 3, characterized in that the composite material used to
make the central part (22, 28, 34) is formed by carbon, or aramid fibers (Kevlar®), distributed in the thermosetting resin.

5. Arm as in any claim hereinbefore, characterized in that the composite material is made with unidirectional fibers, or with interwoven and/or interlaced fibers, or fibers with a random distribution.

6. Arm as in any claim hereinbefore, characterized in that the composite material is made of a mixture of long fibers and short fibers, with a random or predetermined distribution.

7. Arm as in any claim hereinbefore, characterized in that the composite material used to make the tubular central part (22, 28, 34) is the multi-layer type.

8. Arm as in any claim hereinbefore, characterized in that, in correspondence with the regions of association with the corresponding head (18, 24, 30) and tail (20, 26, 32) terminal ends, the tubular central part (22, 28, 34) has same-shape coupling means (37) able to cooperate mechanically with coupling counter-means (38) provided on the head (18, 24, 30) and/or tail (20, 26, 32) terminal ends.

9. Arm as in any claim from 1 to 7, characterized in that the tubular central part (22, 28, 34) made of composite material is glued to the corresponding head (18, 24, 30) and/or tail (20, 26, 32) terminal ends.

10. Crane comprising a telescopic arm as in any claim hereinbefore.

11. Method to make a telescopic arm (10) for a crane able to lift a heavy load and comprising a plurality of tubular segments (12, 14, 16) which extend along a common central longitudinal axis, each of said segments (12, 14, 16) being able to slide telescopically inside or outside another segment (12, 14, 16) adjacent and consecutive along said central longitudinal axis, between a retracted position and a completely extended position, characterized in that it provides to make each of said segments (12, 14, 16) with a tubular central part (22, 28, 34) oblong and internally hollow and made of a composite material with a base of reinforcement fibers and thermosetting resin and head (18, 24, 30) and/or tail (20, 26, 32) terminal ends of each of said segments (12, 14, 16) made of metal with high mechanical characteristics of strength and internally hollow in a manner mating with said tubular central part (22, 28, 34), each head (18, 24, 30) and/or tail (20, 26, 32) terminal end being connected to the external, front or lateral edge of a corresponding end of said tubular central part (22, 28, 34), wherein said head (18,
24, 30) and/or tail (20, 26, 32) terminal end, in said completely extended position of said segment (12, 14, 16), is directly coupled overlapping with the lateral, internal or external surface of a corresponding tail (20, 26, 32) and/or head (18, 24, 30) terminal end of another segment (12, 14, 16) adjacent and consecutive along said central longitudinal axis, so that, in a coupling and overlapping region of said segments (12, 14, 16) in the completely extended position, the components of force transverse to said segments (12, 14, 16), due to the stresses deriving from the heavy loads lifted by the arm, are discharged only on said tail (20, 26, 32) and/or head (18, 24, 30) terminal ends.

12. Method as in claim 11, characterized in that it provides a first step in which, inside the volume of suitable female molds, or on the external surface of suitable male molds, a suitable quantity of layers of fiber is deposited, which can be already impregnated or may be impregnated in a subsequent step, a possible second step in which the composite material is subjected to a heat process, a third step in which the necessary workings of mechanical finishing are performed on the segment (12, 14, 16) obtained, and a fourth step of connecting the segment (12, 14, 16) obtained and the corresponding head (18, 24, 30) and tail (20, 26, 32) terminal ends.

13. Method as in claim 12, characterized in that in the course of the first step, or between the first and the second step, same-shape coupling means (37) are positioned in correspondence with the regions of association with the corresponding head (18, 24, 30) and tail (20, 26, 32) terminal ends, said same-shape coupling means (37) being able to cooperate mechanically with coupling counter-means (38) made on the head (18, 24, 30) and tail (20, 26, 32) terminal ends.

14. Method as in claim 12, characterized in that it provides to glue the tubular central part (22, 28, 34) made of composite material to the corresponding head (18, 24, 30) and tail (20, 26, 32) terminal ends.
### A. CLASSIFICATION OF SUBJECT MATTER

**INV.** B66C23/70

**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B66C B66F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPO-Internal**, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>US 3 516 553 A (RESKE ALBERT E) 23 June 1970 (1970-06-23) the whole document</td>
<td>1, 10, 11</td>
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<tr>
<td>A</td>
<td>US 2001/045405 AI (HIGGINS DAVID J [US]) 29 November 2001 (2001-11-29) abstract; figures 1-14</td>
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<td>A</td>
<td>JP 2002 046993 A (AICHI CORP KK) 12 February 2002 (2002-02-12) abstract; figures 1-10</td>
<td>1, 10, 11</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

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<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 3516553 A</td>
<td>23-06-1970</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1278695 A1</td>
<td>29-01-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2001045405 A1</td>
<td>29-11-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 0172624 A1</td>
<td>04-10-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2002046993 A</td>
<td>12-02-2002</td>
</tr>
</tbody>
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