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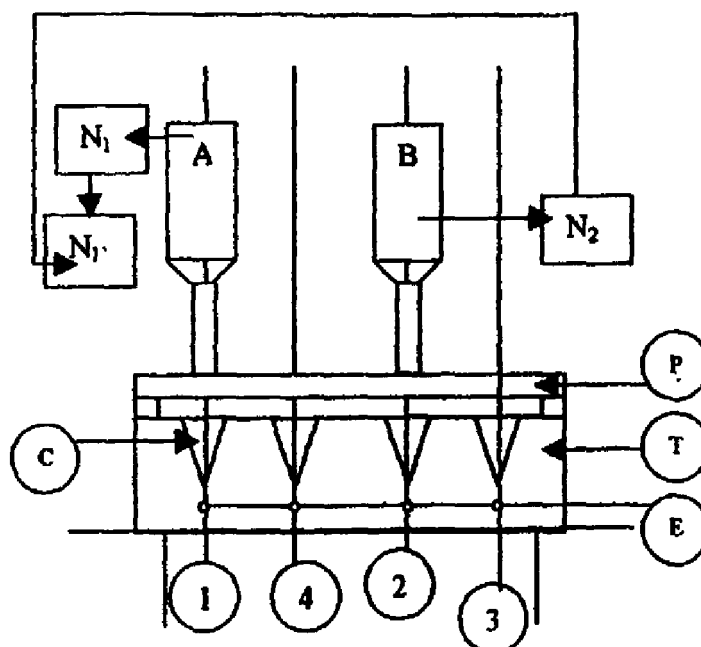
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(54) **A process and device for putting under tension a multielement cable**

(57) A process and device for putting under tension a multi-element or -strand (E,1,2,3,4) cable, comprising two or more tensioning devices or jacks (A,B) that are

applied to two or more elements (E,1,2,3,4) and successively to the individual elements (E,1,2,3,4).

Fig. II



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Description

[0001] The present invention relates to the process for putting under tension cables that are formed of a bundle of elements, whether they are strands, wires, bars or ropes, all of which will hereinafter be referred to as "elements" for the sake of brevity, that are used for making stays, tie-rods, prestressing cables, suspension cables, cables for anchorage to the underground, or for other uses, all of which will hereinafter be referred to as "cables" for the sake of brevity, the invention concerning the tensioning of the cable elements, independently of the use of the cable

[0002] When tensioning a cable, in order to assure that all of its elements are uniformly tensioned it is necessary to act onto all these elements with a multi-element drawing jack that hooks and puts under tension all of the elements simultaneously, starting from a null or uniform tension situation. The stronger the cable to be put under tension is, the bulkier and heavier a jack having such a capacity will be, and consequently the room it takes for possibly being attached to the cable can become remarkably large, and moving the jack can be quite a problem due to both its dimensions and weight. These factors can constrain the design of the works, because the designer has to take into account that is required for moving the jack in order to possibly put under tension the cable.

[0003] Therefore, the possibility of putting under tension the cables by acting onto their individual elements or uniform groups thereof (hereinafter collectively referred to with the term elements) with jacks, or more generally tensioning devices, said jacks or tensioning devices being easily-handled, having reduced dimensions and weight, and at the same time assuring uniformity of the applied tension, means a remarkable advance that provides numerous benefits from both a design and a construction point of view. A further conclusive benefit in carrying out the operation is provided by the possibility of individually installing the elements and provisionally lock them, without having to worry about them being uniformly tensioned, the levelling of their tension being postponed to when all the elements will have been installed. Yet it is not easy to individually put under tension each element while assuring that they are uniformly tensioned because, as is well known, several factors, including the reciprocal interaction, the elasticity of the structure, the variations of external loads, weather factors, give rise to remarkable, progressive tension differences among the successively tensioned elements.

[0004] In order to eliminate such differences, there have already been proposed tensioning solutions comprising single-element jacks, said solutions being based on the measurement of the stretching values detected upon tensioning, or on the application of tensions that are progressively changed based on theoretical calculations; such solutions, however, only allow to reduce, not

to eliminate, the tension differences, and, most of all, do not allow the uniformity of the applied force to be individually monitored.

[0005] Another solution proposed according to EP-0421862 comprises monitoring the first strand to be put under tension by means of a strain gauge that is not part of the tensioning jack, the "control" strand, which is used as a reference for tensioning all the subsequent strands, thus assuring their uniform tensioning. Yet at the end of all the tensioning operations the "control" strand is to be released for removing the strain gauge, and then put under the same tension as applied to the last-tensioned strand, thereby having no instrument verification about such tension value not having in the meanwhile changed.

[0006] The invention as described hereinafter is essentially characterised in that all the elements comprising the cable can be put under uniform tension by operation of only two single-element tensioning devices that are applied in an ordered succession to the individual elements, without need of pre-setting a fixed reference element, nor having to install and then remove strain gauges that are not part of the tensioning devices.

[0007] The invention is described hereinafter according to a preferred, non limiting embodiment thereof with reference to the enclosed drawing, wherein:

FIG. I represents a plan view on the anchorage of a cable, and

FIGS. II, III, IV and V diagrammatically show section X-X from figure I in the various steps of the procedure according to the invention.

[0008] The following items:

- a spacer element, also called calibrated tensioning plate, basis, nose ring, that, when placed onto the cable anchorage, allows wedges or clamping devices for the elements to be tensioned to be locked and unlocked;
 - two tensioning devices, also called jacks, that are apt to hook and put under tension each individual strand element said tensioning devices being consequently provided with measurement systems or instruments, as required for detecting the tensioning force applied;
- are essentially employed for constructing the tensioning arrangement.

[0009] In figure I there is generally represented the head of a cable with twelve strands that are anchored by means of wedges, this representation being merely indicative and non limiting, the invention being applicable to cables comprising any number and kind of elements (strands, wires, bars, ropes) that are blocked in any manner, with either parallel or diverging axes.

[0010] Referring now to figures II, III, IV, and to the generical four elements shown with E, comprising

strands 1,2, 3, 4, the uniform tensioning operation can be carried out as follows:

1. the cable strands are supposed to be properly anchored at a non represented end, and to be provisionally anchored at the other end to an anchoring member T as shown in figure II, the anchoring force, though different for each element, being determined according to the installing requirements;
2. the calibrated tensioning plate is mounted (figure II) to anchorage T to be put under tension, said calibrated tensioning plate retaining the clamping devices or wedges C but leaving them the minimally sufficient room that is necessary for possibly unlocking the elements E at the moment they are being put under tension and then locking them when they are released by the jack;
3. the first single-strand tensioning jack A is pulled (figure II) onto strand 1 and tensioned to the prescribed value N1;
4. the second single-strand tensioning jack B is pulled (figure II) onto strand 2 and tensioned until the tension value N2 shown by jack B is the same as the new value N1' shown by jack A. There will result, by construction, $N2=N1'$, that is the same tension in both of the tensioned strands;
5. strand 2 is clamped to anchorage (figure III), jack B is pulled onto strand 3 and put under tension until the tension value N3 shown by jack B is the same as the new value N2'; by construction, $N3=N2'$, that is the same tension in all of the tensioned strands;
6. strand 1 is clamped to anchorage (figure IV), jack A is pulled onto strand 4 and put under tension until the tension value N4 shown by jack A is the same as the new value N3' that is present in strands 1, 2, and 3, and shown by jack B. There will result, by construction, $N4=N3'$, that is the same tension in all of the four tensioned strands.

[0011] This operation can be carried further on in the same way until all the elements comprising the cable are put under tension, thus assuring their final uniform tensioning to the same value.

[0012] Each element (1, 2, 3, 4) can be composed of several individual elements.

[0013] From the above-described example it should be evident that the two tensioning jacks A and B are interchangeable and neither of them is a preferred element for applying the invention. On the contrary, interchangeability is a novel special quality that characterises the present invention since it allows to pass indifferently from an element to another one, and also to return to an element that has already been previously put under tension, thus allowing also the dimensions of the tensioning devices to be kept in due consideration.

[0014] In the actually seldom case in which the ele-

ments forming the cable are so few that in any case one tensioning device is always adjacent to the other one, should this be an obstruction for them to be contemporarily installed, it will still be possible to carry out the whole above-described operation by interposing between the plate P and the two jacks A and B two equally inclined members D (figure V), hereinafter referred to as deflectors, which, by lightly uniformly biasing the pulling axis of the elements to be put under tension, would allow possible interference problems to be solved. The invention would still be applicable if the biasing was obtained by suitably shaping or machining the calibrated tensioning plate.

[0015] The application possibilities and variants of the invention, and consequently its utility features, also include:

- 1) the possibility of mounting the spacer member P with a different mechanical solution than as shown in figure II, for example, but without limitation, with distance washers or screw systems;
- 2) the possibility of substituting the spacing member P, in which the locking devices C for the elements to be tensioned are encapsulated, with a tensioning basis (one per each tensioning device), said tensioning basis being enclosed or having side windows, that only encapsulates one, or a group thereof, at a time and that, if necessary, is possibly coupled to a deflector D. This solution is especially useful for automatically, semi-automatically or manually tightening the locking nut of a screw-based system; or with the aid of the deflector in order to overcome interference problems caused by the dimensions of the jacks;
- 3) the possibility of coupling the tensioning basis or distance P with a wedging device, that is especially useful with the wedge locking systems;
- 4) the possibility of leaning the tensioning basis directly onto anchorage T or by encapsulating the anchorage, on a different support surface;
- 5) the possibility of employing at the same time further tensioning devices besides both devices A and B that are strictly necessary;
- 6) the possibility of employing different tensioning devices A and B than hydraulic jacks, such as mechanical devices, dynamometric wrenches or other device that is apt to apply the tension;
- 7) the possibility of measuring the value of the force that is applied onto the element through suitable measurement instruments that are applied or connected to the tensioning devices A and B, to the spacing members P (tensioning basis, nose or calibrated plate), to their supports or deflectors D;
- 8) the possibility of installing a device that would automatically stop the tensioning action of the second jack B when it reaches the same value as applied by the first jack A;
- 9) the use of the invention for levelling the tension-

ing of a cable assembly by means of two (or more) multi-element jacks (said jacks hooking and tensioning at the same time all the elements composing the cable), the individual cables forming said assembly being comparable with the individual element forming the cable.

[0016] The invention can be modified in various practical construction details, without departing from its range as defined hereinafter.

Claims

1. A process for putting under tension a cable, said cable comprising various elements or strands, thereby obtaining a same tension on the various elements, characterised in that the tensioning operation is carried out on said elements composing said cable by putting under tension two elements at a time and applying the tensions in an ordered succession to the various elements.
2. A device for carrying out the process of claim 1, characterised in that it comprises: two tensioning devices (A, B) for applying tension that are applied to two elements or strands and successively to the individual elements (1, 2, 3, 4) in such a way that the tensioning devices (A, B) can be indifferently moved from one element to another one.
3. A device as claimed in claim 2, characterised in that there are provided measurement instruments, said measurement instruments being applied to or connected with the tensioning devices (A, B) in such a way that device (A) on element (1) carries out tensioning to a value (N1) and the second device (B) on element (2) carries out tensioning to a value (N2) that will be the same as the new value (N1') indicated by tensioning device (A), the same tension being thus applied to both tensioned elements (1, 2), and so on for all the other elements that compose the cable.
4. A device as claimed in each of claims 2 and 3, characterised in that there are provided two inclined members or deflectors (D) that support the tensioning devices (A, B) in such a way that these have their tensioning axes slightly biased.
5. A device as claimed in each of claims 2, 3 and 4, characterised in that it comprises: a spacer or calibrated plate (P) that is interposed between the tensioning devices (A, B) and wedges or locking and unlocking devices (C) for the elements that are being put under tension.
6. A device as claimed in claim 5, characterised in that said spacer or calibrated plate (P) is so shaped as to obtain said slightly biased tensioning axes of devices (A, B).
7. A device as claimed in claim 5, characterised in that said spacer (P) consists of a shim or screw based system.
8. A device as claimed in claim 5, characterised in that it comprises a calibrated plate that is adapted for each individual tensioning device (A, B) and suited to encapsulate a locking device (C) at a time, or a group thereof.
9. A device as claimed in claim 8, characterised in that said plate (P) is coupled to a deflector (D) for each tensioning device (A, B).
10. A device as claimed in claim 5, characterised in that said spacer (P) is suited to be coupled to a wedging device.
11. A device as claimed in claim 5, characterised in that said spacer (P) leans directly on an anchorage (T) of elements (1, 2, 3, 4), or it leans on another support surface, thereby encapsulating anchorage (T).
12. A device as claimed in each of claims 4 and 5, characterised in that it comprises measurement instruments for measuring the value of the force that is exerted onto elements (1, 2, 3, 4) that are applied to or connected with said spacers or calibrated plates (P), their supports, or said deflectors (D).
13. A device as claimed in claim 3, characterised in that it comprises a device that is suited to stop tensioning by the second tensioning device (B) upon reaching the same value as exerted by the first tensioning device (A).
14. A device as claimed in each of claims 2 to 13, characterised in that it comprises two or more tensioning devices (A, B).
15. A device for putting under tension a cable assembly as claimed in claims 2 to 14, characterised in that it comprises two or more multi-element tensioning devices, said tensioning devices being adapted to simultaneously put under tension each individual cable of the assembly.
16. A device as claimed in each of claims 2 to 15, characterised in that the tensioning devices (A, B) are either hydraulic jacks, mechanical devices, dynamometric wrenches or similar devices that are apt to exert tension onto the various elements (1, 2, 3, 4).

Fig. I

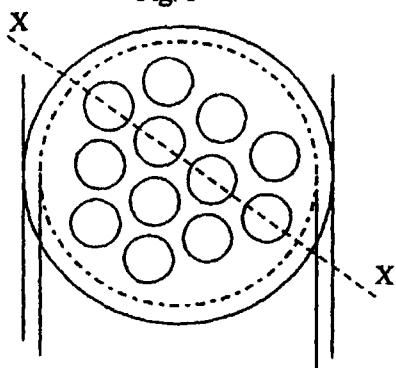


Fig. II

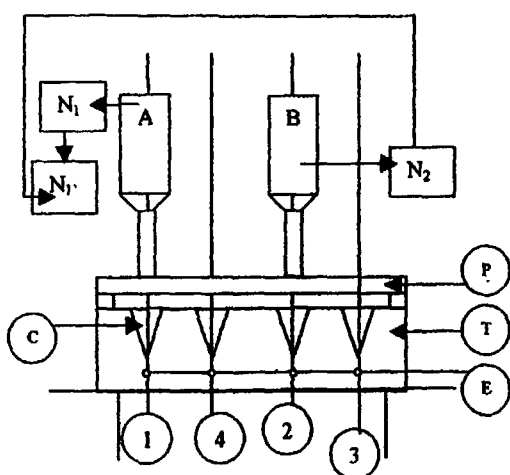


Fig. III

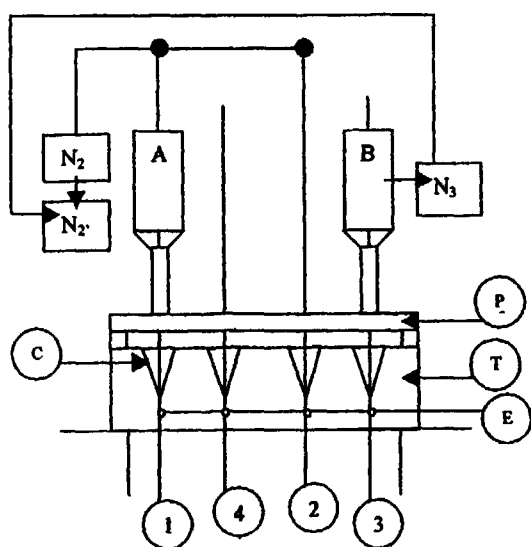


Fig. IV

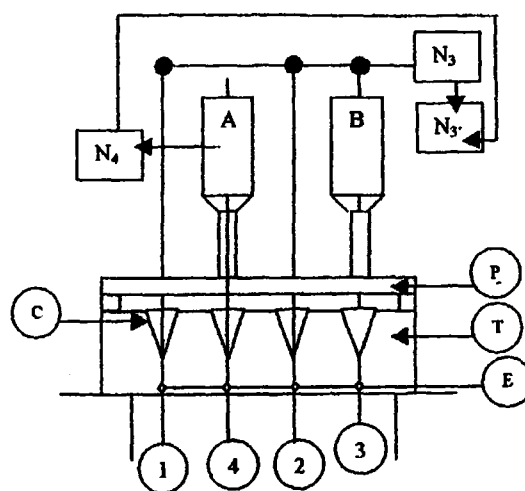
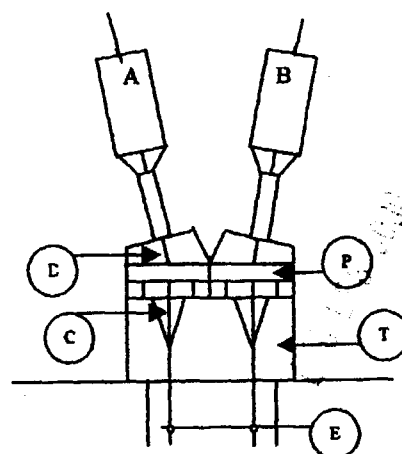


Fig. V





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EUROPEAN SEARCH REPORT

Application Number
EP 00 83 0090

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18 May 2000	Examiner Andlauer, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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