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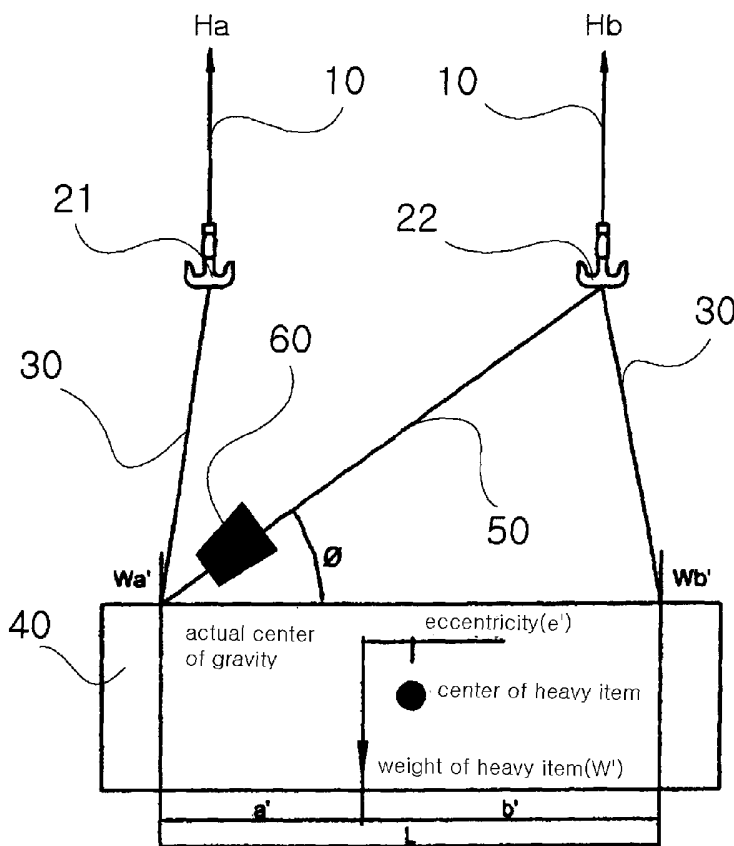
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(54) Title: METHOD OF LIFTING HEAVY ITEM USING DIAGONAL TENSION CONTROL UNIT



(57) Abstract: The object of this invention is to provide a method of lifting a heavy item (40) using two crane hooks (21 and 22). The method includes the step of coupling a predetermined portion of the heavy item close to a center of gravity of the heavy item, to a crane hook which is far away from the center of gravity, in a diagonal direction using both a tension control unit (60) and a connection wire (50) while controlling a tension of the connection wire by operating the tension control unit, thus controlling lifting loads to be borne by the crane hooks, as desired, and thereby allowing maximum lifting capacities of the crane hooks to be optimally utilized, therefore increasing operational efficiency of the crane hooks without changing a capacity of a crane, and immediately responding to variations in the weight of the heavy item to be lifted



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Description

METHOD OF LIFTING HEAVY ITEM USING DIAGONAL TENSION CONTROL UNIT

Technical Field

- [1] The present invention relates, in general, to a method of lifting a heavy item using a diagonal tension control unit and, more particularly, to a method of lifting a heavy item, which uses a diagonal tension control unit to control lifting loads of crane hooks when the heavy item is lifted using two crane hooks, thus allowing maximum lifting capacities of the crane hooks to be optimally utilized, and immediately responding to variations in weight and a center of gravity of the heavy item.

Background Art

- [2] A variety of land cranes and marine cranes have been used to lift heavy items in land and marine construction sites. When a heavy item is lifted by such a crane, the lifting load of the crane is determined by the weight and the center of gravity of the heavy item. Generally, the lifting capacity of a crane hook is determined according to the weight and the center of gravity of the heavy item, at a designing stage. In the case of using two cranes, the crane hooks are designed to have different lifting capacities, according to the lifting loads of the cranes. Further, when one crane having a plurality of crane hooks is used, the crane hooks usually have the same lifting capacity. Thus, a required crane is selected, based on the maximum lifting capacity of the crane hook. Since the weight and center of gravity of the heavy item which are determined at the designing stage may be changed due to a manufacturing process or a modification in design at an actual construction site, the lifting capacity of the crane hook must have a large allowance so as to immediately respond to variations in the lifting load. The crane has a structure to lift the heavy item only in a vertical direction. Thus, an actual lifting load which is larger than the designed lifting load determined at the designing stage, is applied to a crane hook which is closer to the center of gravity determined at the designing stage. On the other hand, another actual lifting load which is less than the designed lifting load of the designing stage, is applied to a crane hook which is far away from the center of gravity of the heavy item determined at the designing stage. In this case, a crane hook having a larger lifting capacity must be used at a position which is closer to the center of gravity of the heavy item. Or, the weight of the heavy item must be reduced so as to lift the heavy item. In order to use the crane hook having the larger lifting capacity, a new crane hook having the larger lifting capacity must be

prepared at a working stage, thus increasing the costs and complicating a manufacturing process of the crane. Thereby, it is undesirable to use the crane hook having the larger lifting capacity. Consequently, there has been proposed a method of reducing the weight of the heavy item.

Disclosure of Invention

Technical Problem

- [3] However, in order to reduce the weight of the heavy item, the heavy item must be divided into several parts and lifting operations must be performed many times. Such a conventional method causes wastes of time and costs. Particularly, when the heavy item cannot be lifted at a time in case of constructing a ship or marine vessel, repeated lifting operations are required, thus being complicated.

Technical Solution

- [4] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a method of lifting a heavy item without changing a capacity of a crane, which includes the step of coupling a predetermined portion of the heavy item close to a center of gravity of the heavy item determined at a designing stage, to a crane hook which is far away from the center of gravity, in a diagonal direction using both a tension control unit and a connection wire while controlling a tension of the connection wire by operating the tension control unit, thus controlling the lifting loads of the crane hooks as desired, and thereby allowing the maximum lifting capacities of the crane hooks to be optimally utilized, therefore increasing operational efficiency of the crane hooks, and immediately responding to variations in the weight and the center of gravity of the heavy item to be lifted.

Advantageous Effects

- [5] Such a method allows the crane to be most efficiently utilized, thus reducing the costs which are required to lift the heavy item and shortening the time which is required for a construction using the crane.

Description of Drawings

- [6] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

- [7] FIG. 1 is a schematic view to show a structure of lifting a heavy item using a conventional crane;

- [8] FIG. 2 is a schematic view to show a structure of lifting a heavy item using a

diagonal tension control unit, according to the present invention; and

- [9] FIG. 3 is a graph to show a variation in operational efficiency of crane hooks as a function of the operation of the diagonal tension control unit of FIG. 2.

Best Mode

- [10] Reference should now be made to the drawings, in which the same reference numerals are used throughout the different drawings to designate the same or similar components.

- [11] As shown in FIGS. 1 and 2, a heavy item 40 to be lifted by a crane is connected to first and second crane hooks 21 and 22, via main wires 30. According to the present invention, as shown in FIG. 2, the crane is provided with a diagonal tension control unit 60. The tension control unit 60 is coupled to both a predetermined portion of the heavy item 40 which is close to a center of gravity of the heavy item 40 determined at a designing stage and the second crane hook 22 which is far away from the center of gravity, in a diagonal direction. The tension control unit 60 is operated to control the tension of a connection wire 50 which will be described later herein, thus enhancing the operation efficiency of the first and second crane hooks 21 and 22. A hydraulic jack or an electric motor may be used as the tension control unit 60. In a detailed description, the tension control unit 60 and the connection wire 50 are diagonally coupled to both the predetermined portion of the heavy item 40 which is close to the center of gravity of the heavy item 40 determined at the designing stage and the second crane hook 22 which is far away from the center of gravity. When the connection wire 50 is tensioned by the tension control unit 60, the length of the connection wire 50 is reduced, thus controlling the lifting loads of the first and second crane hooks 21 and 22.

- [12] FIG. 1 shows the heavy item 40 lifted by a conventional crane which does not have the tension control unit 60. It is assumed that the weight of the heavy item 40 is W, a distance between the first and second hooks 21 and 22 is L, and an eccentricity is e. Then, lifting loads H_a and H_b imposed on the first and second crane hooks 21 and 22 are represented by the following Equation 1.

- [13]

$$H_a = W_a = \frac{W}{2} + W \frac{e}{L}, \quad H_b = W_b = \frac{W}{2} - W \frac{e}{L} \quad \dots\dots [1]$$

- [14] Generally, at the designing stage, the lifting capacities of the first and second crane hooks 21 and 22 are determined by the lifting loads H_a and H_b which are calculated

according to the Equation [1].

- [15] However, the actual weight and the actual center of gravity of the heavy item 40 may be different from the weight and center of gravity which are determined at the designing stage. When the weight W of the heavy item and the eccentricity e are changed, the lifting loads imposed on the first and second crane hooks 21 and 22 are represented by the following Equation [2].

[16]

$$H_a = W'_b = \frac{W'}{2} + W' \frac{e'}{L}, \quad H_b = W'_a = \frac{W'}{2} - W' \frac{e'}{L} \quad \dots\dots [2]$$

- [17] According to the Equation [2], when the actual weight W' of the heavy item is equal to the weight which is determined at the designing stage and the actual eccentricity e' is larger than the eccentricity which is determined at the designing stage, the actual lifting load H_a imposed on the first crane hook 21 becomes larger than the lifting load which is determined at the designing stage whereas the actual lifting load H_b imposed on the second crane hook 21 become smaller than the lifting load which is determined at the designing stage. In this case, a crane hook which has a larger lifting capacity than the first crane hook 21 having the lifting capacity determined at the designing stage, is required at the portion which is close to the center of gravity of the heavy item 40. On the other hand, a crane hook which has a smaller capacity than the second crane hook 22 having the lifting capacity determined at the designing stage, is required at the portion which is far away from the center of gravity of the heavy item 40.

- [18] FIG. 3 shows a relation between the operational efficiency of the first and second crane hooks 21 and 22 and the operation of the tension control unit 60.

- [19] When the tension of the connection wire 50 is controlled by the tension control unit 60, the lifting loads H_a and H_b imposed on the first and second crane hooks 21 and 22 are represented by the following Equation [3].

[20]

$$H_a = (W'_a)' - D \sin \phi = \frac{W'}{2} + W' \frac{e'}{L} - D \sin \phi$$

$$H_b = (W'_b)' + D \sin \phi = \frac{W'}{2} - W' \frac{e'}{L} + D \sin \phi \quad \dots\dots [3]$$

- [21] As shown in FIG. 2, the weight W_a' and the eccentricity e' are constants, and the tension D is a variable. Thus, the lifting loads H_a and H_b imposed on the first and second crane hooks 21 and 22 can be controlled by controlling the tension D . Such an

operation allows the first and second crane hooks 21 and 22 to bear the lifting loads which are determined at the designing stage, thus allowing the maximum capacity of the crane to be utilized, and immediately responding to the variations in the center of gravity of the heavy item 40.

- [22] The operational efficiency of the first and second crane hooks 21 and 22, which varies according to the operation of the tension control unit 60, will be described in the following with reference to an example.

Mode for Invention

- [23] Example

- [24] Assuming that the weight W of the heavy item 40 is 1500ton, the distance L between the first and second crane hooks 21 and 22 is 30m, the distance a between the first crane hook 21 and the center of gravity of the heavy item is 12m, the distance b between the second crane hook 22 and the center of gravity of the heavy item is 18m, and the eccentricity e is 3m, the maximum lifting loads imposed on the first and second crane hooks 21 and 22 which are calculated according to the Equation ?1? are 900ton and 600ton, respectively, at the designing stage.

- [25]

$$H_a = W_a = \frac{W}{2} + W \frac{e}{L} = \frac{1500}{2} + 1500s \frac{3}{30} = 900 \text{ (ton)}$$

$$H_b = W_b = \frac{W}{2} - W \frac{e}{L} = \frac{1500}{2} - 1500s \frac{3}{30} = 600 \text{ (ton)}$$

- [26] When the tension control unit 60 is not used, the maximum lifting loads of the first and second crane hooks 21 and 22 at the actual working stage are represented by the Equation ?2?. In this case, the weight W of the heavy item 40 and the maximum lifting loads of the first and second crane hooks 21 and 22 maintain the designed values without being changed. That is, the weight W of the heavy item is 1500ton, and the maximum lifting loads of the first and second crane hooks 21 and 22 are 900ton and 600ton, respectively. On the other hand, assuming that the distance L between the first and second crane hooks 21 and 22 is 30m, the distance a' between the first crane hook 21 and the center of gravity is changed to 10m, the distance b' between the second crane hook 22 and the center of gravity is changed to 18m, and the eccentricity e' is changed to 5m, the actual maximum lifting loads imposed on the first and second crane hooks 21 and 22 are calculated as follows by the Equation [2].

- [27]

$$H_a = W_b' = \frac{W'}{2} + W' \frac{e'}{L} = \frac{1500}{2} + 1500s \frac{5}{30} = 1000$$

$$H_b = W_b' = \frac{W'}{2} - W' \frac{e'}{L} = \frac{1500}{2} - 1500s \frac{5}{30} = 500$$

[28] In this case, the designed maximum lifting load of the first crane hook 21 is 900ton, but the actual maximum lifting load of the first crane hook 21 is 1000ton. Thus, the first crane hook 21 is not able to the heavy item 40.

[29] Meanwhile, when the tension control unit 60 of the present invention is used, the actual maximum lifting loads imposed on the first and second crane hooks 21 and 22 at the actual working stage are represented by the Equation 33. In this case, it is assumed that the weight W of the heavy item is 1500ton, the actual maximum lifting loads of the first and second crane hooks 21 and 22 are 900ton and 600ton, respectively, the distance L between the first and second crane hooks 21 and 22 is 30m, the distance a between the first crane hook 21 and the center of gravity of the heavy item is 10m, the distance b between the second crane hook 22 and the center of gravity of the heavy item is 20m, the eccentricity e is 5m, the angle θ between the heavy item 40 and the tension control unit 60 is 35°, and a tension of about 174ton acts on the connection wire 50 by the tension control unit 60. Then, the actual maximum lifting loads imposed on the first and second crane hooks 21 and 22 are calculated as follows according to the Equation[3].

[30]

$$H_a = (W_a)' - D \sin \phi = \frac{W'}{2} + W' \frac{e'}{L} - D \sin \phi$$

$$= \frac{1500}{2} + 1500s \frac{5}{30} - 174.4 \sin 35^\circ = 900 \text{ (ton)}$$

$$H_b = (W_b)' + D \sin \phi = \frac{W'}{2} - W' \frac{e'}{L} + D \sin \phi$$

$$= \frac{1500}{2} - 1500s \frac{5}{30} + 174.4 \sin 35^\circ = 600 \text{ (ton)}$$

[31] Thus, the first and second crane hooks 21 and 22 can lift the heavy item 40 with the maximum lifting loads which are determined at the designing stage.

[32] Table 1 shows the variations in the lifting loads, the maximum lifting capacities, and the operational efficiency of the first and second crane hooks 21 and 22 according to a variation in the operation of the tension control unit 60. As shown in table 1, when the heavy item 40 is lifted through the conventional method which does not use the

tension control unit 60, and the center of gravity of the heavy item 40 moves toward the first crane hook 21 by a distance of 2m, the first crane hook 21 must bear the lifting load of 1000ton. However, because the lifting capacity of the first crane hook 21 is 900ton, the first crane hook 21 is not able to lift the heavy item 40. In this case, the maxim lifting loads imposed on the first and second crane hooks 21 and 22 are 900ton and 500ton, respectively, so that the maximum lifting load imposed on the crane is 1400ton. However, when the tension control unit 60 according to the present invention is used, the lifting loads to be borne by the first and second crane hooks 21 and 22 are controlled, thus allowing the crane to lift the heavy item of 1500ton. Therefore, the crane can be operated while the first and second crane hooks 21 and 22 having operational efficiency of 100%.

[33]

Table 1

Conventional method						Present invention						
Hook A		Hook B		Max. lifting load	Eff. (%)	Dia. Ten. (D)	Hook A		Hook B		Max. lifting load	Eff. (%)
Cal. Val.	Max. Cap.	Cal. Val.	Max. Cap.				Cal. Val.	Max. Cap.	Cal. Val.	Max. Cap.		
1000.0	900.0	500.0	500.0	1400.0	93.3	0	1000.0	900.0	500.0	500.0	1400.0	93.3
						50	971.3	900.0	528.7	528.7	1428.7	95.2
						100	942.6	900.0	557.4	557.4	1457.4	97.2
						150	914.0	900.0	586.0	586.0	1486.0	99.1
						174.4	900.0	900.0	600.0	600.0	1500.0	100

*Cal.Val.=Calculated Value, Max.=Maximum, Cap.=capacity, Eff.=Efficiency,

Dia.=Diagonal, Ten.=Tension

[34]

Industrial Applicability

[35] As described above, the present invention provides a method of lifting a heavy item using two crane hooks, which uses a diagonal tension control unit, thus allowing the maximum lifting capacities of the crane hooks to be utilized, therefore reducing the costs which are required to lift the heavy items, and immediately responding to variations in the weight of the heavy item, and thereby minimizing the time required for construction.

[36] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

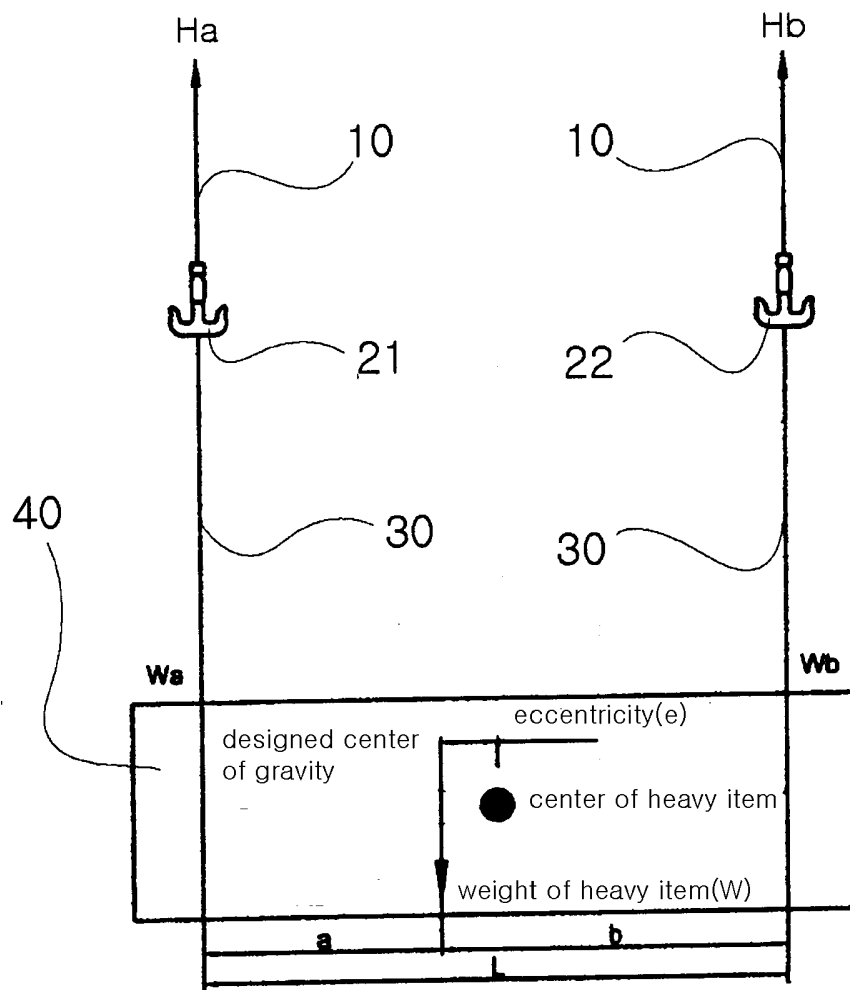
Sequence List Text

[37]

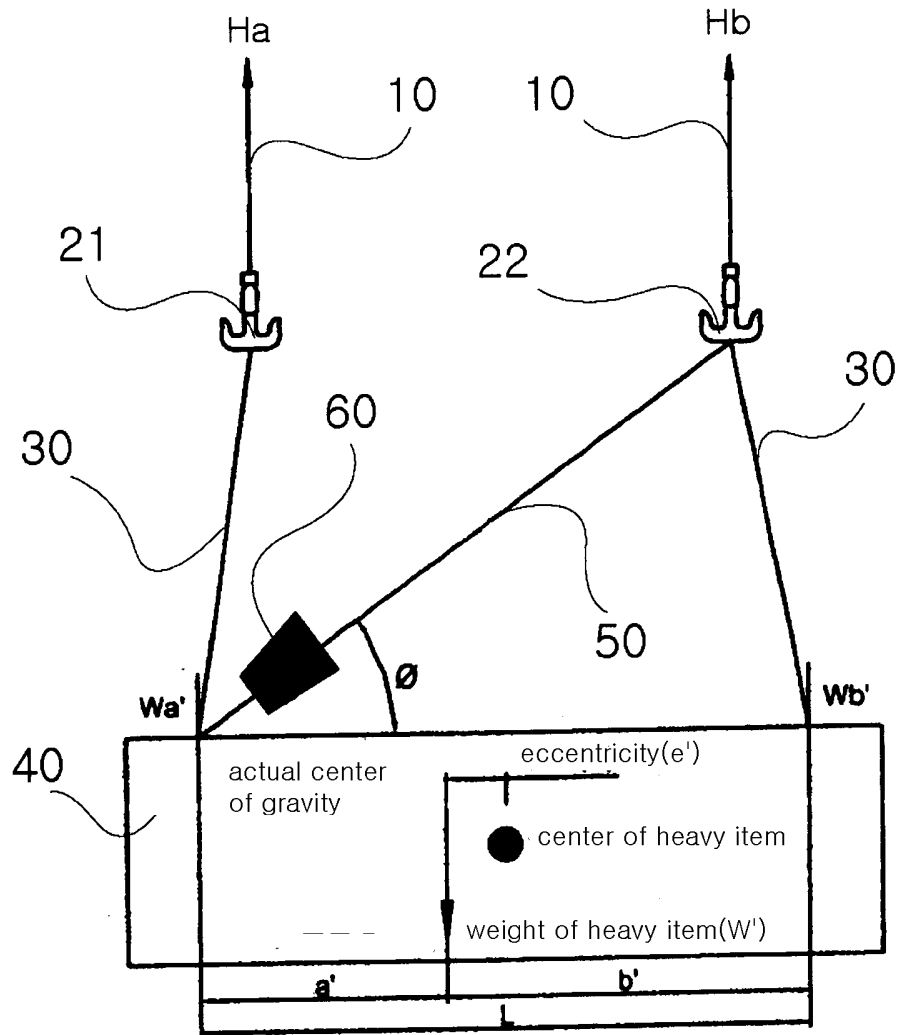
Claims

- [1] 1. A method of lifting a heavy item using two or more crane hooks, comprising the step of coupling a predetermined portion of the heavy item close to a center of gravity of the heavy item, to a crane hook which is far away from the center of gravity, in a diagonal direction using both a tension control unit and a connection wire while controlling a tension of the connection wire by operating the tension control unit, thus controlling lifting loads to be borne by the crane hooks, as desired, and thereby allowing maximum lifting capacities of the crane hooks to be optimally utilized, therefore increasing operational efficiency of the crane hooks without changing a capacity of a crane, and immediately responding to variations in the weight of the heavy item to be lifted.

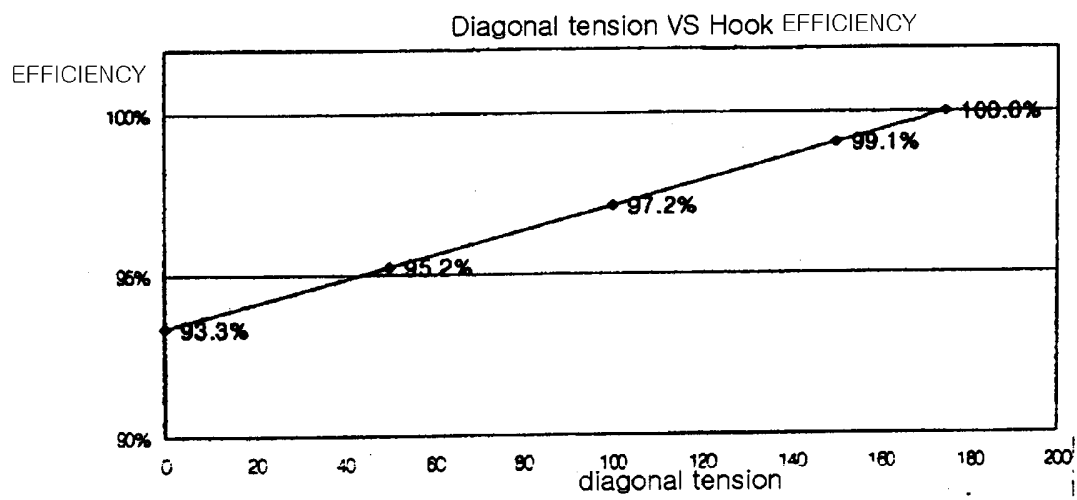
[Fig. 1]



[Fig. 2]



[Fig. 3]



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC7 B66C 13/10

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)

IPC7 B66C 13/10

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,476,263 A (ISHIKAWAJIMA-HARIMA KJUKOGYO KK.) 4 NOVEMBER 1969 See the whole document	1
Y	WO 97/19888 A (THE UNIVERSITY OF SYDNEY ET AL.) 5 JUNE 1997 See the figure 6, the pages 8-24	1
Y	US 3,532,324 A (CRITTENDEN) 6 OCTOBER 1970 See the whole document	1
A	US 4,353,471 A (PALMER) 12 OCTOBER 1982 See the whole document	1

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Further documents are listed in the continuation of Box C.

☐

See patent family annex.

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