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(54) **Inverter bridge unit and a procedure for its use.**

(57) The invention relates to a three-phase inverter bridge unit, containing for each phase a branch consisting of gate-controlled solid-state switches (T1'-T6'), said switches being used to convert a d.c. voltage into a three-phase a.c. voltage feeding a three-phase load (3'), and a control unit (5') for controlling the solid-state switches, and to a procedure for the use of the inverter bridge unit to prevent skewing of a lifting apparatus. The bridge unit comprises a parallel branch consisting of controlled solid-state switches (T7',T8') and connected in parallel with one of the branches of the bridge, said parallel branch being used along with the other phase branches feeding said three-phase load to feed another three-phase load (4').

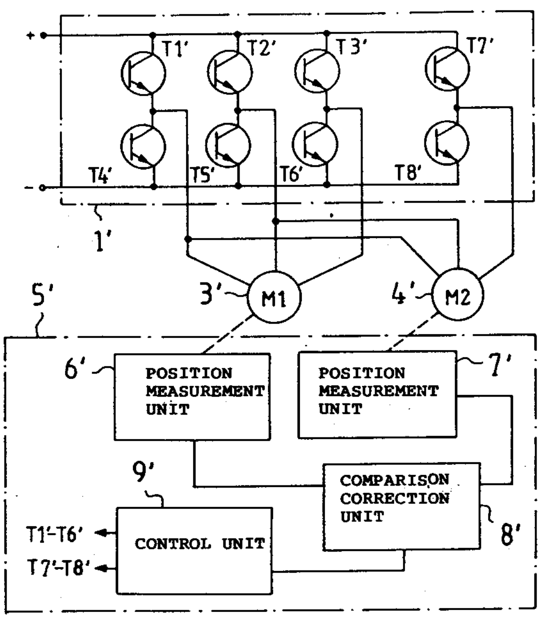

Fig.2

The present invention relates to an inverter bridge unit as defined in the introductory part of claim 1, and to a procedure for its use.

In cranes, skewing occurs in consequence of differences between the rotational speeds of the traversing motors of the crane, said differences being determined by the load moments of different motors, motor-specific slip relations and differences in feed cable impedances.

Skewing may also result from differences in the degree of wear or friction of the bearing wheels of the crane, from dirt accumulated on load-bearing surfaces, from slipping during braking, etc.

At present, correction of the skewing of cranes is effected by using separate frequency converters in which each inverter bridge feeds a different traversing motor. In a previously known solution, skewing is corrected as illustrated by Fig. 1 by using a control unit which performs the required measurements, comparison of results and the control functions required by each inverter bridge.

It is also possible to make the steel structures of the crane rigid enough to prevent skewing. This is sometimes the principle observed in mechanical design.

The drawbacks of previously known solutions include the following:

To achieve the structural rigidity required in each case, it is necessary to use either oversized crane structures or special designs instead of standard solutions.

Since no economic and reliable method to prevent skewing exists, crane designers may end up with more complex mechanical constructions than required by the basic function of the crane.

An increased use of remote control (in the case of both new cranes and modernisations) imposes additional demands on the prevention of skewing, because the immediate (local) supervision and control by the crane operator is either missing or insufficient. In this case, a fast and automatic procedure for the prevention of skewing is required.

In most cases, automatization is based on a predetermined positioning accuracy, which may be a decisive factor contributing to the costs of automatization. In addition to the prevention of the mechanical drawbacks resulting from skewing, these applications generally require precisely timed equalization between the ends of the crane to achieve a sufficient load positioning accuracy.

The object of the present invention is to eliminate the drawbacks of the previously known solutions. According to the invention, the rotational speeds of motors (or motor groups) fed by inverter bridges can be adjusted or corrected independently of each other by adding in the power stage of the inverter bridge a parallel branch to the switching component pair feeding one of the phases. Thus, in the three-phase system feeding each motor, two of the phases are identically arranged while the voltage of the third phase can be adjusted separately.

The invention provides the following advantages as compared to previously known techniques: its inverter bridge solution and its control system are compact, the number of solid state components used in it is smaller and their control simpler than in previously known solutions.

In the following, the invention is described in detail by the aid of an example by referring to the attached drawings, in which

Fig. 1 presents a solution based on previously known techniques, implemented using separate inverter bridges;

Fig. 2 presents the solution of the invention, implemented using a single inverter bridge;

Fig. 3 illustrates the measurement of skewing;

Fig. 4 illustrates another skewing measurement application.

Fig. 1 presents a previously known arrangement for the correction of crane skewing using inverters. It comprises two squirrel-cage motors 3 (M1) and 4 (M2), each of which drives its own traversing mechanism. Each motor is fed by an inverter producing a symmetrical three-phase supply, motor 3 (M1) being fed by inverter 1 and motor 2 (M2) by inverter 2. Inverter 1 is controlled by control unit 9 and inverter 2 by control unit 10. The circuits producing the d.c. voltage feeding the inverters are not shown in Fig. 1, and neither is the normal inverter control system.

The position of the crane part driven by each traversing mechanism is measured by a position measurement unit 6, 7. The information provided by each of these units is compared with that of the other in a comparison/correction unit 8, which issues a skewing correction command to control unit 9 and/or 10, which control the transistors T1-T6 and T7-T12 of the bridges.

The deviation resulting from skewing can also be measured in only one crane part, in which case no comparison is needed and the skewing can be corrected by controlling only one of the inverters.

In the solution of the invention presented in Fig. 2, a single three-phase inverter bridge 1' is used to feed both motors 3' and 4'. The bridge comprises transistors T1'-T6' like bridge 1 feeding motor 3 in Fig.1. Moreover, an additional branch consisting of transistors T7' and T8' has been connected in parallel with transistor pair T3',T6'. Thus, in two phases of the bridge the same branch and therefore the same transistors T1', T2', T4' and T5' are connected to both motors. In one phase, the transistors T3' and T6' of the first branch are connected to the first motor 3' while the transistors T7'and T8' of the second branch, which is parallel with the first branch, are connected to the second motor 4.

In Fig. 2, the position of the crane or its part is measured by position measurement units 6' and 7', whose outputs are compared in a comparison/correction unit 8', which issues a skewing correction instruction to the control unit 9', which controls the solid state switches of the bridge 1' as provided by the invention.

The difference with regard to previously known techniques is that the number of solid state switches in the bridge 1' is smaller than the total number of solid state switches in the bridges 1 and 2 in the previously known solution in Fig. 1. A further difference is that the bridge in the solution of the present invention requires only one control unit 9' whereas the previously known solution in Fig. 1 for the correction of skewing uses two control units 9 and 10.

The control of the bridge 1' can be implemented using separate adjustment to produce e.g. an asymmetric stator voltage limitation by reducing the voltage in one of the phases, in which case the rotational speed can be adjusted independently although the basic frequency remains the same. In this case, the adjustment of rotational speed is based on a reduction of the top moment and a flatter gradient of the moment curve of the motor.

Fig. 3 illustrates the measurement of skewing. The crane structure consists of an essentially rigid main carrier 11 and crane heads 12a and 12b. The crane moves on a pair of essentially parallel rails 13a and 13b. The crane is presented in a skew position, i.e. the whole crane has turned horizontally through a small angle relative to the rails. The lifting machinery of the crane is not shown.

The skewing of the crane is detected by measuring the position of head 12a or 12b relative to rail 13a or 13b or to some other fixed structure by means of approach detectors or approach switches 14.

The correction of skewing can be performed in the manner explained in the description of Fig. 2, e.g. by limiting the voltage fed to the traversing motor(s) driving the leading crane head until the skewing has been corrected, i.e. until the heads 12a and 12b are in a parallel position relative to the rails 13a and 13b.

Fig. 4 illustrates another principle of crane skewing measurement. In this case, the crane cannot turn horizontally as in Fig. 3. The crane heads 15a and 15b remain oriented essentially in the direction of the rails 13a and 13b, but the crane structures themselves now undergo deflections or changes of position due to skewing.

One or both of the crane heads 15a and 15b may be pivoted on the main support 16, and the difference between the positions of the main support 16 and the heads 15a and 15b is measured by means of displacement detectors 17a and 17b. Of course, this difference can also be measured by means of a rotation detector mounted in the joint between the main support and the head.

Skewing may also produce a state of strain in the crane structures, and this can be detected by means of suitable detectors mounted on the steel structure to measure the level of strain in the structure. The detectors may be mounted on the main support 16, or they may be attached to the supporting parts of the crane head or to a separate measuring rod placed in a position corresponding to that of the above-mentioned displacement detectors 17a and 17b.

The correction of skewing in the case of Fig. 4 is performed in the same way as in Fig. 3.

The cranes in Fig. 3 or Fig. 4 may be of various types as to their construction, e.g. semi-gantry or gantry cranes with e.g. A-gantry heads.

It is obvious to a person skilled in the art that different embodiments of the invention are not restricted to the examples described above, but that they may instead be varied within the scope of the following claims.

Claims

1. Three-phase inverter bridge unit, containing for each phase a branch consisting of gate-controlled solid-state switches (T1'-T6'), said switches being used to convert a d.c. voltage into a three-phase a.c. voltage feeding a three-phase load (3'), and a control unit (5') for controlling the solid-state switches, **characterized** in that the bridge unit comprises at least one parallel branch consisting of controlled solid-state switches (T7', T8') and connected in parallel with one of the branches of the bridge, said parallel branch being used along with the other phase branches feeding said three-phase load to feed another three-phase load (4').

2. Inverter bridge unit according to claim 1, **characterized** in that the loads are asynchronous motors and that the control unit is used to control the rotational speeds of the motors independently of each other, the motors being connected to parallel branches of the bridge.

3. Inverter bridge unit according to claim 1 or 2, **characterized** in that the control unit adjusts the rotational speed by means of an asymmetric stator voltage limitation involving reduction of the parallel branch voltage.

4. Inverter bridge unit according to claim 1 or 2, **characterized** in that the control unit adjusts

the rotational speed by means of single-phase braking, whereby two of the phases of the motor under adjustment are supplied with equal voltages.

5. Procedure for the use an inverter bridge unit as defined in any preceding claim for the prevention of skewing of a lifting apparatus, using a three-phase inverter bridge unit which contains for each phase a branch consisting of gate-controlled solid-state switches (T1'-T6') converting a d.c. voltage into a three-phase a.c. voltage feeding a three-phase asynchronous motor (3') or motor group belonging to a first traversing mechanism of the lifting apparatus, and a control unit (5') for controlling the solid-state switches, **characterized** in that the inverter bridge unit is provided with at least one parallel branch consisting of controlled solid-state switches (T7',T8') and connected in parallel with one of the branches of the bridge, said parallel branch being used along with the other phase branches feeding the first three-phase asynchronous motor to feed another three-phase asynchronous motor (4') or motor group serving as a traversing mechanism of the lifting apparatus, and that, to prevent skewing of the lifting apparatus, the rotational speeds of the motors are adjusted by controlling the solid-state switches of the bridge unit on the basis of measurment data obtained from units (6' ,7') measuring the position of the lifting apparatus or its parts.

6. Procedure according to claim 5, **characterized** in that skewing of the lifting apparatus is detected by measuring the position of the lifting apparatus relative to a fixed structure by means of position detectors (6',7').

7. Procedure according to claim 5 or 6, **characterized** in that skewing of the lifting apparatus is detected by means of displacement detectors (17a, 17b) measuring the change in the mutual positions of two parts of the lifting apparatus movable relative to each other, e.g. the main support and a head of the crane.

8. Procedure according to claim 5,6, or 7, **characterized** in that skewing of the lifting apparatus is detected by means of detectors (18) measuring the level of strain in a steel structure of the lifting apparatus, said detectors being placed directly on said steel structure or on a measuring rod attached to it.

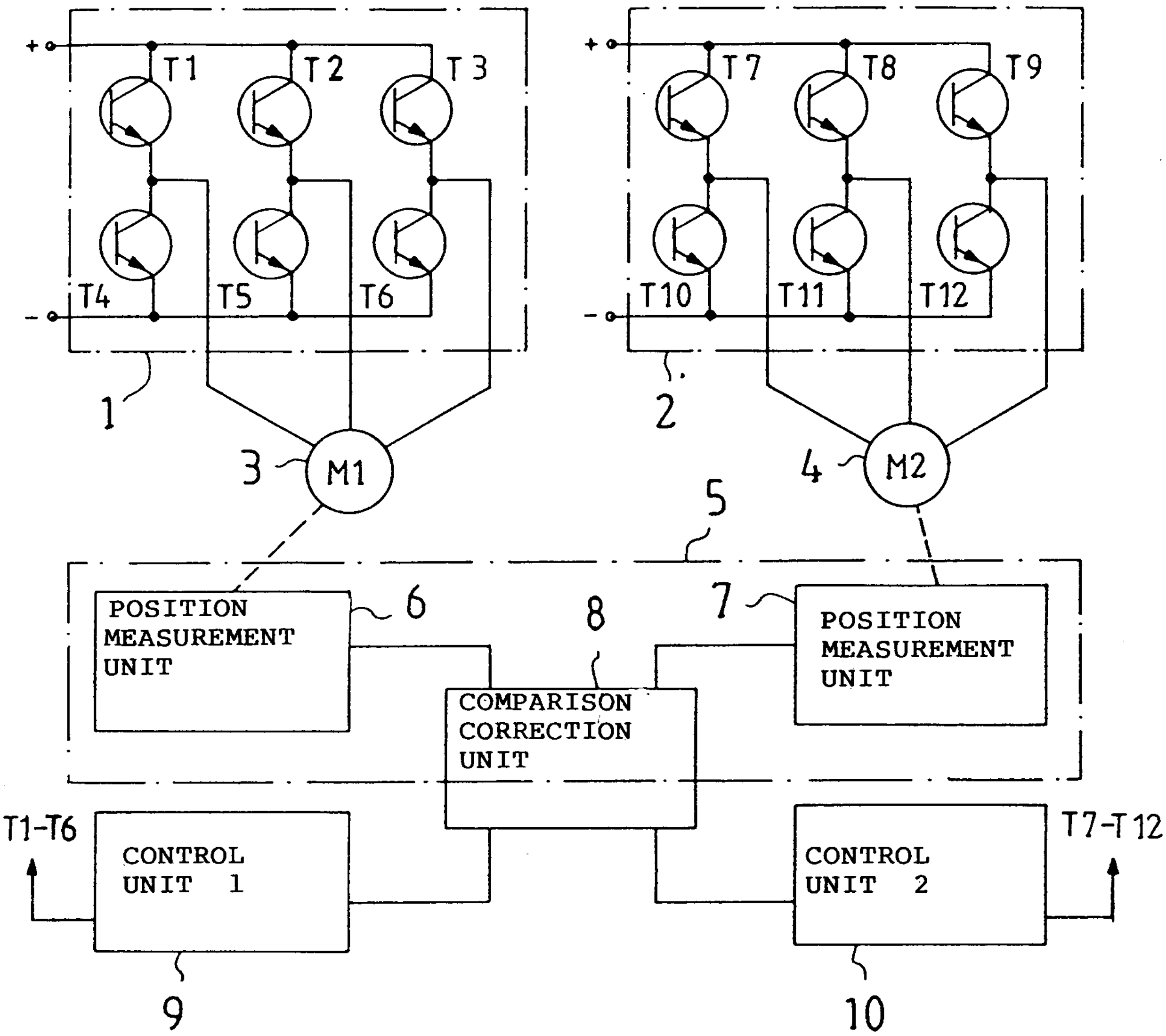
+
T1
T2
T3
T4
T5
T6
-
1
+
T7
T8
T9
T10
T11
T12
-
2
3
M1
4
M2
5
POSITION MEASUREMENT UNIT
6
8
7
POSITION MEASUREMENT UNIT
COMPARISON CORRECTION UNIT
T1-T6
CONTROL UNIT 1
CONTROL UNIT 2
T7-T12
9
10

Fig.1

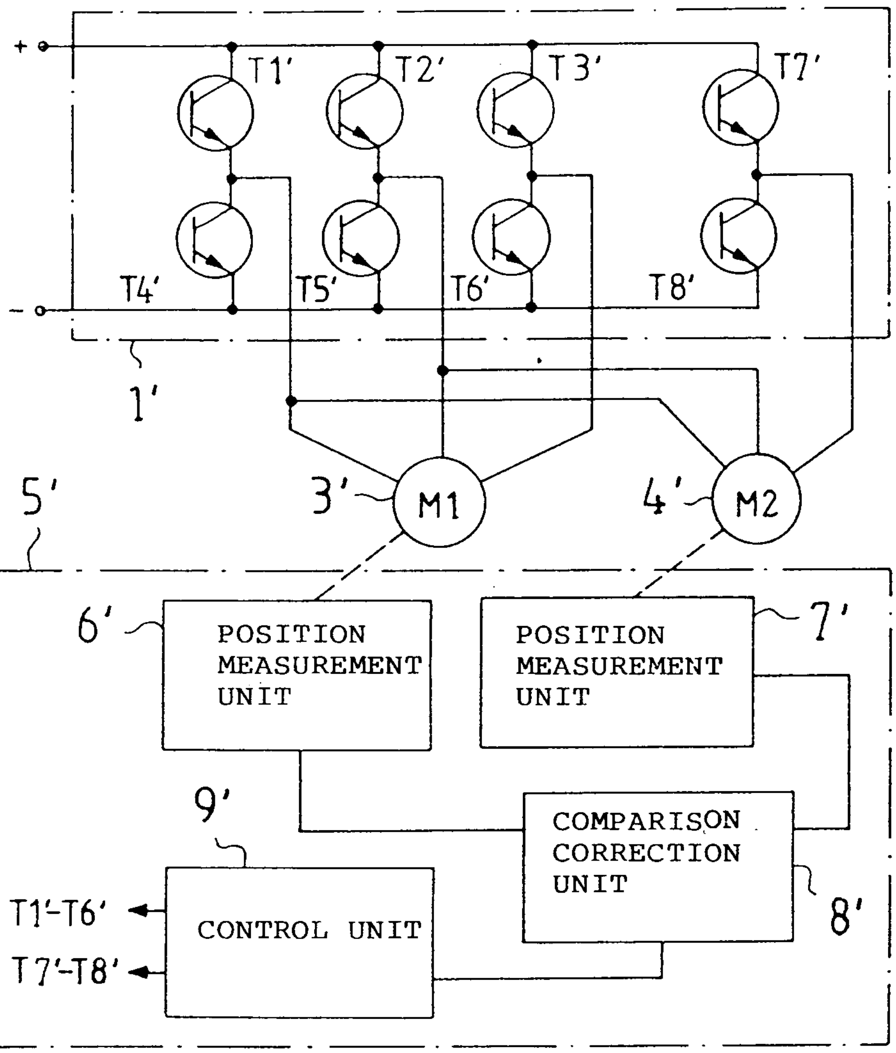

Fig.2

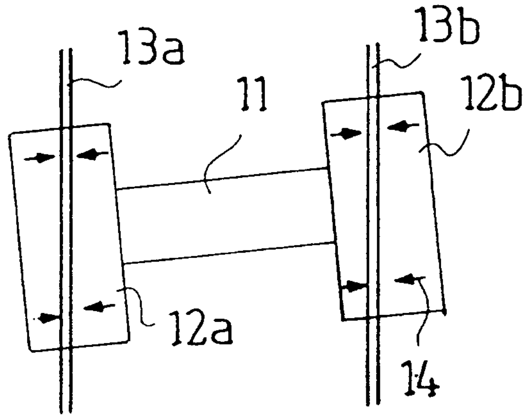

Fig. 3

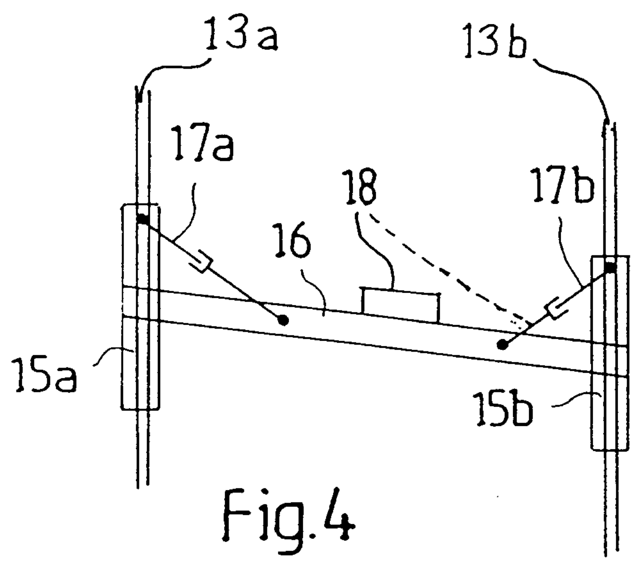

Fig.4

EUROPEAN SEARCH REPORT

Application Number

EP 91 12 0492

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	FR-A-1 119 845 (MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) * page 2, left column, line 25 - page 3, left column, line 12; figures 1,2 * -----	1	B66C9/16
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B66C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 MARCH 1992	CHLOSTA P.

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
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