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(54) APPARATUS AND METHOD FOR CONTROLLING OPERATION OF LINEAR COMPRESSOR

VORRICHTUNG UND VERFAHREN ZUR STEUERUNG DES BETRIEBS EINES LINEARKOMPRESSORS

APPAREIL ET PROCÉDÉ DE COMMANDE DU FONCTIONNEMENT D'UN COMPRESSEUR LINÉAIRE

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Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor, and more particularly, to an apparatus and method for controlling an operation of a linear compressor by detecting a phase difference inflection point at a time point when a phase difference between a current and a stroke is placed within a certain region, and by recognizing the phase difference inflection point as a top dead center (TDC)=0.

BACKGROUND ART

[0002] Generally, a reciprocating compressor sucks, compressed, and then discharges refrigerant gas by linearly reciprocating a piston in a cylinder. The compressor is divided into a reciprocating compressor and a linear compressor according to a driving method of the piston.

[0003] In the reciprocating compressor, a crankshaft is coupled to a rotary motor and a piston is coupled to the crankshaft, thereby converting a rotation force of the rotary motor into a reciprocation force.

[0004] In the linear compressor, a piston connected to a mover of a linear motor is linearly moved.

[0005] The linear compressor is not provided with a crank shaft for converting a rotation motion into a linear motion thus not to have a frictional loss due to the crank shaft, thereby having a higher compression efficiency than a general compressor.

[0006] When the linear compressor is applied to a refrigerator or an air conditioner, a compression ratio of the linear compressor is varied by varying a voltage applied to a motor inside the linear compressor. Accordingly, a cooling capacity of the refrigerator or the air conditioner is controlled.

[0007] When the linear compressor is applied to a refrigerator or an air conditioner, a compression ratio of the linear compressor is varied by varying a stroke voltage applied to the linear compressor. Accordingly, a cooling capacity of the refrigerator or the air conditioner is controlled. Herein, the stroke denotes a distance between an upper dead point of the piston and a lower dead point of the piston.

[0008] The related art linear compressor will be explained with reference to FIG. 1.

[0009] FIG. 1 is a block diagram showing a driving controlling apparatus for a linear compressor in accordance with the related art.

[0010] As shown in FIG. 1, the related art driving controlling apparatus for a linear compressor comprises a current detecting unit 4 for detecting a current applied to a motor (not shown) of the linear compressor 6; a voltage detecting unit 3 for detecting a voltage applied to the motor of the linear compressor 6; a stroke calculating unit 5 for calculating a stroke estimation value of the linear compressor based on the detected current, the detected voltage, and a parameter of the motor; a comparing unit 1 for comparing the calculated stroke estimation value with a preset stroke command value, and outputting a difference value therebetween; and a stroke controlling unit 2 for controlling a turn-on period of a triac (not shown) serially connected to the motor based on the difference value so as to vary a voltage applied to the motor, and thereby controlling a stroke of the linear compressor 6.

[0011] Hereinafter, an operation of the driving controlling apparatus for a linear compressor will be explained with reference to FIG. 1.

[0012] The current detecting unit 4 detects a current applied to a motor (not shown) of the linear compressor 6, and outputs the detected current to the stroke calculating unit 5.

[0013] The voltage detecting unit 3 detects a voltage applied to the motor of the linear compressor 6, and outputs the detected voltage to the stroke calculating unit 5.

[0014] The stroke calculating unit 5 calculates a stroke estimation value (X) of the linear compressor by substituting the detected current, the detected voltage, and a parameter of the motor into a following equation 1. Then, the stroke calculating unit 5 applies the calculated stroke estimation value (X) to the comparing unit 1.

$$X = \frac{1}{\alpha}\int (V_M - Ri - L\bar{i})dt \quad \text{-------------------Equation 1}$$

[0015] The R denotes a resistance of the motor, the L denotes an inductance of the motor, the α denotes a constant of the motor, the V_M denotes a voltage applied to the motor, the *i* denotes a current applied to the motor, and the $\bar{i}$ denotes a variation ratio of the current applied to the motor according to time. That is, the $\bar{i}$ is a differential value of the *i* (di/dt).

[0016] The comparing unit 1 compares the stroke estimation value with the stroke command value, and applies a difference value therebetween to the stroke controlling unit 2.

[0017] The stroke controlling unit 2 varies a voltage applied to the motor of the linear compressor 6 based on the difference value, thereby controlling the stroke of the linear compressor 6.

[0018] FIG. 2 is a flowchart showing a method for controlling an operation of a linear compressor in accordance with the related art.

[0019] Referring to FIG. 2, a stroke estimation value obtained by the stroke calculating unit 5 is applied to the comparing unit 1 (S1). Then, the comparing unit 1 compares the stroke estimation value with a preset stroke command value (S2), and outputs a difference value therebetween to the stroke controlling unit 2.

[0020] When the stroke estimation value is smaller than the stroke command value, the stroke controlling unit 2 increases a voltage applied to the motor so as to control a stroke of the linear compressor (S3). On the contrary, when the stroke estimation value is larger than the stroke command value, the stroke controlling unit 2 decreases the voltage applied to the motor (S4).

[0021] Herein, the voltage applied to the motor is increased or decreased by controlling a turn-on period of a triac (not shown) electrically connected to the motor.

[0022] The stroke command value is varied according to a size of a load of the linear compressor. More concretely, when the load is large, the stroke command value is increased thus to increase the stroke of the piston, thereby preventing decrease of a cooling capacity.

[0023] On the contrary, when the load is small, the stroke command value is decreased thus to decrease the stroke of the piston, thereby preventing increase of the cooling capacity and preventing a collision between the piston and the cylinder due to an over stroke.

[0024] In the related art method for controlling an operation of a linear compressor, a stroke estimation value of the linear compressor is calculated based on a parameter of a motor, a resistance and a reactance. Then, a stroke control is performed based on the stroke estimation value.

[0025] However, when the stroke estimation value is calculated, an error occurs according to a deviation of the parameter and each component thus not to precisely perform the stroke control. Accordingly, the piston is not placed to TDC=0, thereby degrading a reliability of the apparatus.

[0026] In order to increase accuracy of the stroke control and place an operation of a piston near TDC=0, document US 2003026702 defines an operating range for the inflection point of the phase difference between a current and a stroke and adjusts the operation frequency and the stroke command. This document is regarded to represent the closest prior art.

DISCLOSURE OF THE INVENTION

[0027] Therefore, it is an object of the present invention to provide an apparatus and method for controlling an operation of a linear compressor by detecting a phase difference inflection point at a time point when a phase difference between a current and a stroke is placed within a certain region, and by recognizing the phase difference inflection point as a top dead center (TDC)=0.

judgement; and a stroke command value determining unit for determining a stroke command value based on the stroke command value controlling signal.

[0028] To achieve these objects, there is also provided a method for controlling an operation of a linear compressor, comprising: driving a linear compressor with a capacity corresponding to a certain stroke command value; detecting a voltage and a current applied to a motor, and calculating a stroke based on the voltage and current; detecting a phase difference between the stroke and the current; comparing the detected phase difference with a preset value, and detecting a phase difference inflection point based on a result of the comparison; and detecting a TDC according to whether the phase difference inflection point has been detected, and then varying a stroke command value according to a load.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a block diagram showing a configuration of a method for operating a linear compressor in accordance with the conventional art;

FIG. 2 is a flowchart showing a method for operating a linear compressor in accordance with the conventional art;

FIG. 3 is a block diagram showing a configuration of an apparatus for operating a linear compressor according to the present invention; and

FIG. 4 is a flowchart showing a method for operating a linear compressor according to the present invention.

MODES FOR CARRYING OUT THE PREFERRED EMBODIMENTS

[0030] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0031] Hereinafter, with reference to FIGS. 3 and 4, will be explained an apparatus and method for controlling an operation of a linear compressor by detecting a phase difference inflection point at a time point when a phase difference between a current and a stroke is placed within a certain region, and by recognizing the phase difference inflection point as a top dead center (TDC)=0.

[0032] In the present invention, a maximum driving efficiency is implemented when the phase difference between a current and a stroke is placed within a certain region and the phase difference inflection point is regarded as a top dead center (TDC)=0.

[0033] The TDC represents a 'Top Dead Center' point of the piston of the linear compressor, and denotes a position of the piston when a compression process of the piston is completed.

[0034] Since the linear compressor has the most excellent efficiency when the TDC is 0, the piston is controlled so as to be positioned at a point of TDC=0.

[0035] FIG. 3 is a block diagram showing a configuration of an apparatus for operating a linear compressor according to the present invention.

[0036] As shown, the apparatus for controlling an operation of a linear compressor according to the present invention comprises a stroke command value determining unit 100, a comparing unit 200, a PWM signal generating unit 300, an inverter 400, a current detecting unit 500, a voltage detecting unit 600, a stroke detecting unit 700, a controlling unit 800, and a phase difference inflection point detecting unit 900.

[0037] The current detecting unit 500 detects a current applied to a motor of a linear compressor, and the voltage detecting unit 600 detects a voltage applied to the motor of the linear compressor.

[0038] The stroke detecting unit 700 calculates a stroke by using the detected current and the detected voltage.

[0039] The controlling unit 800 detects a phase difference between the detected current and the stroke, and outputs a frequency varying signal or a phase difference inflection point detecting signal based on the detected phase difference.

[0040] That is, when the detected phase difference is within a preset range, the controlling unit 800 outputs a phase difference inflection point detecting signal. On the contrary, when the detected phase difference is not within the preset range, the controlling unit 800 outputs a frequency varying signal.

[0041] As another embodiment, the controlling unit 800 calculates a speed of a stroke by the stroke detecting unit 700, and calculates a phase difference between the speed and the current. Then, the controlling unit 800 compares the detected phased difference with a reference phase difference, thereby outputting a frequency varying signal or a phase difference inflection point detecting signal. That is, when the detected phase difference is within a preset range, the controlling unit 800 outputs a phase difference inflection point detecting signal. On the contrary, when the detected phase difference is not within the preset range, the controlling unit 800 outputs a frequency varying signal.

[0042] The PWM signal generating unit 300 generates a PWM signal for varying a frequency of a voltage applied to a motor based on the frequency varying signal, and the inverter 400 varies a voltage and a frequency applied to the motor of the linear compressor based on the PWM signal.

[0043] The PWM signal generating unit 300 analyzes the frequency varying signal. When the phase difference is more than a preset value, the PWM signal generating unit 300 generates a PWM signal to increase a frequency. However, when the phase difference is less than the preset value, the PWM signal generating unit 300 generates a PWM signal to decrease a frequency.

[0044] The phase difference inflection point detecting unit 900 judges whether to detect a phase difference inflection point according to the phase difference inflection point detecting signal outputted from the controlling unit 800, and outputs a stroke command value controlling signal based on a result of the judgement.

[0045] When a phase difference inflection point is detected by the phase difference inflection point detecting signal, the phase difference inflection point detecting unit 900 outputs a control signal to maintain a present stroke command value. On the contrary, when the phase difference inflection point is not detected by the phase difference inflection point detecting signal, the phase difference inflection point detecting unit 900 outputs a control signal to increase a present stroke command value.

[0046] When the phase difference is more than a minimum value within a preset range, the phase difference inflection point detecting unit 900 detects the time point as a phase difference inflection point.

[0047] The stroke command value determining unit 100 determines a stroke command value based on the stroke command value controlling signal.

[0048] An operation of the apparatus for controlling an operation of a linear compressor according to the present invention will be explained with reference to FIG. 4.

[0049] The linear compressor is operated with a certain stroke command value (SP11).

[0050] Then, the current detecting unit 500 detects a current of a motor of the linear compressor, and the voltage detecting unit 600 detects a voltage of the motor of the linear compressor (SP12).

[0051] Then, the stroke detecting unit 700 calculates a stroke by using the detected current and the detected voltage (SP13).

[0052] Then, the comparing unit 200 calculates a difference value between the stroke command value and the stroke. The PWM signal generating unit 300 generates a PWM signal corresponding to the difference value thus to apply it to the inverter 400. Then, the inverter 400 varies a frequency and a voltage according to the PWM signal, and applies them to a motor of the linear compressor (SP14 to SP16).

[0053] The controlling unit 800 detects a phase difference between the detected current and the stroke (SP17), and outputs a frequency varying signal or a phase difference inflection point detecting signal based on the detected phase difference.

[0054] As another embodiment, the controlling unit 800 calculates a speed of a stroke, and detects a phase difference between the speed and the current. Then, the controlling unit 800 outputs a frequency varying signal or a phase difference inflection point detecting signal based on the detected phase difference.

[0055] Then, the controlling unit 800 compares the phase difference between the stroke and the current with a preset phase difference (a value within an approximate range of 80°~100°).When the detected phase difference is within a preset range, the controlling unit 800 outputs a phase difference inflection point detecting signal.

[0056] Then, the phase difference inflection point detecting unit 900 judges whether a phase difference inflection point has occurred by the phase difference inflection point detecting signal. If it is judged that the phase difference inflection point has occurred (SP21), the phase difference inflection point detecting unit 900 judges a present stroke to be placed at a point of 'TDC=0' thus to maintain the present stroke command value (SP22). On the contrary, if it is judged that the phase difference inflection point has not occurred, the phase difference inflection point detecting unit 900 judges the present stroke as a stroke less than the'TDC=0' (SP23) thus to increase the present stroke command value (SP24).

[0057] When the phase difference between the stroke and the current is more than a preset range, the controlling unit 800 increases a frequency by increasing a duty ratio of the PWM signal (SP20). On the contrary, when the phase difference between the stroke and the current is less than the preset range, the controlling unit 800 decreases a frequency by decreasing a duty ratio of the PWM signal (SP19).

[0058] That is, in the present invention, a frequency is varied so that a phase difference between a current and a stroke may be placed within a certain region. If the phase difference between the current and the stroke is within a certain region, a phase difference inflection point is detected thus to be recognized as a 'TDC=0'.

[0059] The present invention has the following effects.

[0060] First, a phase difference between a current and a pulse width modulation (PWM) voltage is calculated, a phase delay value to compensate the phase difference is calculated, and a reference current is delayed by the calculated phase delay value thus to remove a distortion phenomenon of a current. Accordingly, a driving efficiency of the compressor is enhanced, and a TDC is precisely controlled.

[0061] It will also be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Claims

1. An apparatus for controlling an operation of a linear compressor, comprising:

a controlling unit (800) for detecting a phase difference between a current and a stroke, and outputting a frequency varying signal or a phase difference inflection point detecting signal based on the detected phase difference;
a phase difference inflection point detecting unit (900) for judging whether to detect a phase difference inflection point or not by the phase difference inflection point detecting signal, and outputting a stroke command value controlling signal based on a result of the judgment; and
a stroke command value determining unit (100) for determining a stroke command value based on the stroke command value controlling signal,
wherein the controlling unit (800) outputs a phase difference inflection point detecting signal when the detected phase difference is within a preset range, or outputs a frequency varying signal when the detected phase difference is not within a preset range, and
wherein if the phase difference is more than a minimum value within a preset range, the phase difference inflection point detecting unit (900) detects the time point as a phase difference inflection point.

2. The apparatus of claim 1, further comprising a pulse width modulation (PWM) signal generating unit (300) for generating a PWM signal based on a difference between the stroke command value and the stroke, or generating a PWM signal based on the frequency varying signal.

3. The apparatus of claim 2, further comprising an inverter for varying a voltage and a frequency applied to a motor of the linear compressor based on the PWM signal.

4. The apparatus of any of claims 1 to 3, wherein the phase difference inflection point detecting unit (900) outputs a control signal to maintain a present stroke command value when a phase difference inflection point is detected by the phase difference inflection point detecting signal.

5. The apparatus of any of claims 1 to 4, wherein the phase difference inflection point detecting unit (900) outputs a control signal to increase a present stroke command value when a phase difference inflection point is not detected by the phase difference inflection point detecting signal.

6. The apparatus of claim 2, wherein the PWM generating unit (300) analyzes the frequency varying signal, generates a PWM signal to increase a frequency when the phase difference is more than a preset range as a result of the analysis, or generates a PWM signal to decrease a frequency when the phase difference is less than a preset range as a result of the analysis.

7. The apparatus of any of claims 1 to 6, wherein the controlling unit (800) calculates a speed of the stroke thus to detect a phase difference between the speed and the current, and compares the detected phased difference with a reference phase difference thus to output a frequency varying signal or a phase difference inflection point detecting signal based on a result of the comparison.

8. A method for controlling an operation of a linear compressor, comprising:

driving a linear compressor (6) with a capacity corresponding to a certain stroke command value;
detecting a voltage (3) and a current (4) applied to a motor, and calculating (5) a stroke based on the voltage and current;
detecting (SP17) a phase difference between the stroke and the current;
comparing (SP18) the detected phase difference with a preset value, and detecting a phase difference inflection point based on a result of the comparison; and
detecting a top dead center TDC according to whether the phase difference inflection point has been detected, and then varying a stroke command value according to a load,
wherein the step of detecting a phase difference inflection point includes:

detecting the phase difference inflection point if the detected phase difference is within a preset range;
varying a driving frequency if the detected phase difference is not within the preset range; and

and wherein the step of detecting a phase difference inflection point further includes:

at the time point when the phase difference is more than a minimum value within the preset range, detecting the corresponding point as the phase difference inflection point, and recognizing the phase difference inflection point as the top dead center (TDC)=0.

9. The method of claim 8, wherein the step of varying the driving frequency includes:

increasing the frequency (SP19) when the phase difference is more than the preset range; and
decreasing the frequency (SP20) when the phase difference is less than the preset range.

10. The method of claim 8 or 9, wherein the step of varying a stroke command value includes:

if a phase difference inflection point is detected, maintaining a present stroke command value; and
if the phase difference inflection point is not detected, increasing the present stroke command value.

Patentansprüche

1. Vorrichtung zur Steuerung eines Betriebs eines Linearverdichters (6), aufweisend:

   eine Steuereinheit (800) zur Detektion einer Phasendifferenz zwischen einem Strom und einem Hub und zur Ausgabe eines Frequenzänderungssignals oder eines Phasendifferenzwendepunkt-Detektionssignals auf Basis der detektierten Phasendifferenz;
   eine Phasendifferenzwendepunkt-Detektionseinheit (900) zur Beurteilung, ob ein Phasendifferenzwendepunkt zu detektieren ist oder nicht, auf Basis des Phasendifferenzwendepunkt-Detektionssignals und zur Ausgabe eines Hubbefehlswert-Steuersignals auf Basis eines Ergebnisses der Beurteilung; und
   eine Hubbefehlswert-Bestimmungseinheit (100) zur Bestimmung eines Hubbefehlswerts auf Basis des Hubbefehlswert-Steuersignals,
   wobei die Steuereinheit (800) ein Phasendifferenzwendepunkt-Detektionssignal ausgibt, wenn die detektierte Phasendifferenz innerhalb eines vorgegebenen Bereichs ist, oder ein Frequenzänderungssignal ausgibt, wenn die detektierte Phasendifferenz nicht in einem vorgegebenen Bereich ist, und
   wobei an dem Zeitpunkt, an dem die Phasendifferenz mehr als ein Minimumwert innerhalb des vorgegebenen Bereichs ist, die Phasendifferenzwendepunkt-Detektionseinheit (900) den entsprechenden Punkt als den Phasendifferenzwendepunkt detektiert und den Phasendifferenzwendepunkt als das obere Totzentrum (TDC) = 0 erkennt.

2. Vorrichtung nach Anspruch 1, ferner mit einer Pulsbreitenmodulation (PWM)-Signalerzeugungseinheit (300) zur Erzeugung eines PWM-Signals auf Basis einer Differenz zwischen dem Hubbefehlswert und dem Hub oder zur Erzeugung eines PWM-Signals auf Basis des Frequenzänderungssignals.

3. Vorrichtung nach Anspruch 2, ferner mit einem Inverter (400) zur Änderung einer Spannung und einer Frequenz, die an einem Motor des Linearverdichters (6) anliegen, auf Basis des PWM-Signals.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei in dem Fall, dass von dem Phasendifferenzwendepunkt-Detektionssignal ein Phasendifferenzwendepunkt detektiert worden ist, die Phasendifferenzwendepunkt-Detektionseinheit (900) ein Steuersignal ausgibt, um einen aktuellen Hubbefehlswert beizubehalten.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, wobei in dem Fall, dass von dem Phasendifferenzwendepunkt-Detektionssignal ein Phasendifferenzwendepunkt nicht detektiert worden ist, die Phasendifferenzwendepunkt-Detektionseinheit (900) ein Steuersignal ausgibt, um einen aktuellen Hubbefehlswert zu erhöhen.

6. Vorrichtung nach Anspruch 2, wobei
   die PWM-Erzeugungseinheit (300) das Frequenzänderungssignal analysiert,
   als Ergebnis der Analyse ein PWM-Signal erzeugt, um eine Frequenz zu erhöhen (SP 19), wenn die Phasendifferenz mehr als ein vorgegebener Bereich ist, oder
   als Ergebnis der Analyse ein PWM-Signal erzeugt, um eine Frequenz zu verringern (SP20), wenn die Phasendifferenz weniger als ein vorgegebener Bereich ist.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, wobei die Steuereinheit (800) eine Geschwindigkeit des Hubs berechnet, um so eine Phasendifferenz zwischen der Geschwindigkeit und dem Strom zu detektieren (SP 17), und die detektierte Phasendifferenz mit einer Referenzphasendifferenz vergleicht (SP18), um so auf Basis eines Ergebnisses des Vergleichs ein Frequenzänderungssignal oder ein Phasendifferenzwendepunkt-Detektionssignal auszugeben.

8. Verfahren zur Steuerung eines Betriebs eines Linearverdichters (6), aufweisend:

   Antreiben eines Linearverdichters (6) mit einer Kapazität, die einem gewissen Hubbefehlswert entspricht;
   Detektieren einer Spannung (3) und eines Stroms (4), die an einem Motor anliegen, und Berechnen (5) eines Hubs auf Basis der Spannung und des Stroms;
   Detektieren (SP 17) einer Phasendifferenz zwischen dem Hub und dem Strom;
   Vergleichen (SP18) der detektierten Phasendifferenz mit einem vorgegebenen Wert und Detektieren eines Phasendifferenzwendepunkts auf Basis eines Ergebnisses des Vergleichs; und
   Detektieren eines oberen Totzentrums (TDC) je nachdem, ob der Phasendifferenzwendepunkt detektiert worden ist, und dann Ändern eines Hubbefehlswerts in Übereinstimmung mit einer Last,

wobei der Schritt zum Detektieren eines Phasendifferenzwendepunkts aufweist:

Detektieren des Phasendifferenzwendepunkts, wenn die detektierte Phasendifferenz in einem vorgegebenen Bereich ist;
Ändern einer Antriebsfrequenz, wenn die detektierte Phasendifferenz nicht in dem vorgegebenen Bereich ist; und

wobei der Schritt zum Detektieren eines Phasendifferenzwendepunkts ferner aufweist:

an dem Zeitpunkt, an dem die Phasendifferenz mehr als ein Minimumwert innerhalb des vorgegebenen Bereichs ist: Detektieren des entsprechenden Punkts als den Phasendifferenzwendepunkt und Erkennen des Phasendifferenzwendepunkts als das obere Totzentrum (TDC) = 0.

9. Verfahren nach Anspruch 8, wobei der Schritt zur Änderung der Antriebsfrequenz aufweist:

Erhöhen der Frequenz (SP19), wenn die Phasendifferenz mehr als der vorgegebene Bereich ist; und
Verringern der Frequenz (SP20), wenn die Phasendifferenz weniger als der vorgegebene Bereich ist.

10. Verfahren nach Anspruch 8 oder 9, wobei der Schritt zur Änderung eines Hubbefehlswerts aufweist:

Beibehalten eines aktuellen Hubbefehlswerts, wenn ein Phasendifferenzwendepunkt detektiert worden ist; und
Erhöhen des aktuellen Hubbefehlswerts, wenn der Phasendifferenzwendepunkt nicht detektiert worden ist.

Revendications

1. Appareil pour commander un fonctionnement d'un compresseur linéaire (6), comprenant :

une unité de commande (800) pour détecter une différence de phase entre un courant et une course et délivrer en sortie un signal de variation de fréquence ou un signal de détection de point d'inflexion de différence de phase sur la base de la différence de phase détectée ;
une unité de détection de point d'inflexion de différence de phase (900) pour juger le fait de détecter ou non un point d'inflexion de différence de phase sur la base du signal de détection de point d'inflexion de différence de phase et de délivrer en sortie un signal de commande de valeur de commande de course sur la base d'un résultat du jugement ; et
une unité de détermination de valeur de commande de course (100) pour déterminer une valeur de commande de course sur la base du signal de commande de valeur de commande de course,
dans lequel l'unité de commande (800) délivre en sortie un signal de détection de point d'inflexion de différence de phase quand la différence de phase détectée est dans une plage prédéfinie ou délivre en sortie un signal de variation de fréquence quand la différence de phase détectée n'est pas dans une plage prédéfinie, et
dans lequel, à l'instant où la différence de phase est plus qu'une valeur minimale dans la plage prédéfinie, l'unité de détection de point d'inflexion de différence de phase (900) détecte le point correspondant comme le point d'inflexion de différence de phase et reconnaît le point d'inflexion de différence de phase comme le point mort haut (TDC) = 0.

2. Appareil selon la revendication 1, comprenant en outre une unité de génération de signal de modulation d'impulsions en largeur (PWM) (300) pour générer un signal PWM sur la base d'une différence entre la valeur de commande de course et la course ou générer un signal PWM sur la base du signal de variation de fréquence.

3. Appareil selon la revendication 2, comprenant en outre un inverseur (400) pour faire varier une tension et une fréquence appliquées à un moteur du compresseur linéaire (6) sur la base du signal PWM.

4. Appareil selon l'une quelconque des revendications 1 à 3, dans lequel l'unité de détection de point d'inflexion de différence de phase (900) délivre en sortie un signal de commande pour maintenir une valeur de commande de course actuelle quand un point d'inflexion de différence de phase est détecté par le signal de détection de point d'inflexion de différence de phase.

5. Appareil selon l'une quelconque des revendications 1 à 4, dans lequel l'unité de détection de point d'inflexion de différence de phase (900) délivre en sortie un signal de commande pour augmenter une valeur de commande de course actuelle quand un point d'inflexion de différence de phase n'est pas détecté par le signal de détection de point d'inflexion de différence de phase.

6. Appareil selon la revendication 2, dans lequel l'unité de génération PWM (300) analyse le signal de variation de fréquence, génère un signal PWM pour augmenter une fréquence (SP19) quand la différence de phase est supérieure à une plage prédéfinie comme résultat de l'analyse ou génère un signal PWM pour diminuer une fréquence (SP20) quand la différence de phase est inférieure à une plage prédéfinie comme résultat de l'analyse.

7. Appareil selon l'une quelconque des revendications 1 à 6, dans lequel l'unité de commande (800) calcule une vitesse de la course pour détecter (SP17) ainsi une différence de phase entre la vitesse et le courant et compare (SP18) la différence de phase détectée avec une différence de phase de référence afin de délivrer en sortie un signal de variation de fréquence ou un signal de détection de point d'inflexion de différence de phase sur la base d'un résultat de la comparaison.

8. Procédé pour commander un fonctionnement d'un compresseur linéaire (6), comprenant :

le pilotage d'un compresseur linéaire (6) avec une capacité correspondant à une certaine valeur de commande de course ;
la détection d'une tension (3) et d'un courant (4) appliqués à un moteur et le calcul (5) d'une course sur la base de la tension et du courant ;
la détection (SP17) d'une différence de phase entre la course et le courant ;
la comparaison (SP18) de la différence de phase détectée avec une valeur prédéfinie et la détection d'un point d'inflexion de différence de phase sur la base d'un résultat de la comparaison ; et
la détection d'un point mort haut (TDC) en fonction du fait que le point d'inflexion de différence de phase a été détecté et, alors, faire varier une valeur de commande de course en fonction d'une charge,
dans lequel l'étape de détection d'un point d'inflexion de différence de phase comprend :

la détection du point d'inflexion de différence de phase si la différence de phase détectée est dans une plage prédéfinie ;
la variation d'une fréquence de pilotage si la différence de phase détectée n'est pas dans la plage prédéfinie ; et

dans lequel l'étape de détection d'un point d'inflexion de différence de phase comprend en outre :

à l'instant où la différence de phase est plus qu'une valeur minimale dans la plage prédéfinie, la détection du point correspondant comme le point d'inflexion de différence de phase et la reconnaissance du point d'inflexion de différence dé phase comme le point mort haut (TDC) = 0.

9. Procédé selon la revendication 8, dans lequel l'étape de variation de la fréquence de pilotage comprend :

l'augmentation de la fréquence (SP19) quand la différence de phase est supérieure à la plage prédéfinie ; et
la diminution de la fréquence (SP20) quand la différence de phase est inférieure à la plage prédéfinie.

10. Procédé selon la revendication 8 ou 9, dans lequel l'étape de variation d'une valeur de commande de course comprend :

si un point de différence de phase est détecté, le maintien d'une valeur de commande de course actuelle ; et
si le point de différence de phase n'est pas détecté, l'augmentation de la valeur de commande de course actuelle.

FIG. 1

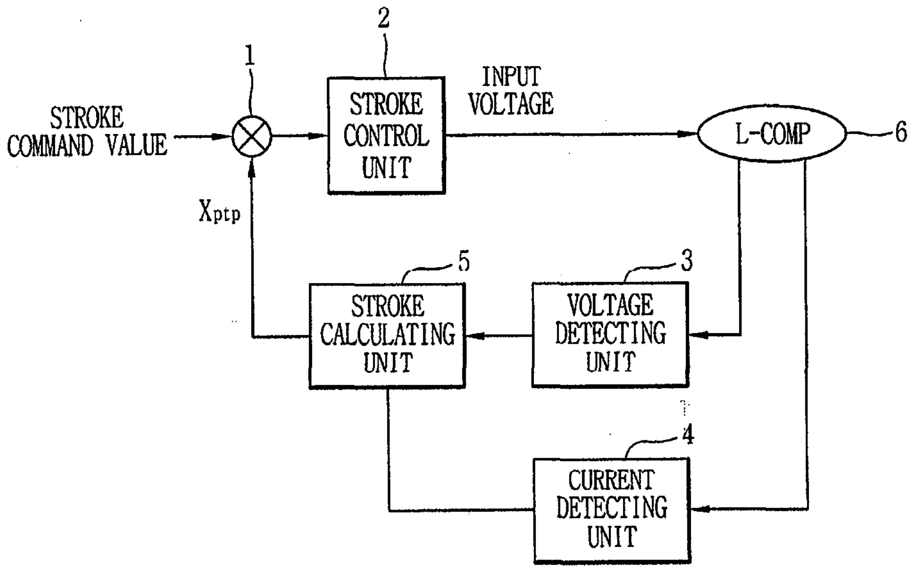

STROKE
COMMAND VALUE
1
2
STROKE
CONTROL
UNIT
INPUT
VOLTAGE
L-COMP
6
Xptp
5
STROKE
CALCULATING
UNIT
3
VOLTAGE
DETECTING
UNIT
4
CURRENT
DETECTING
UNIT

FIG. 2

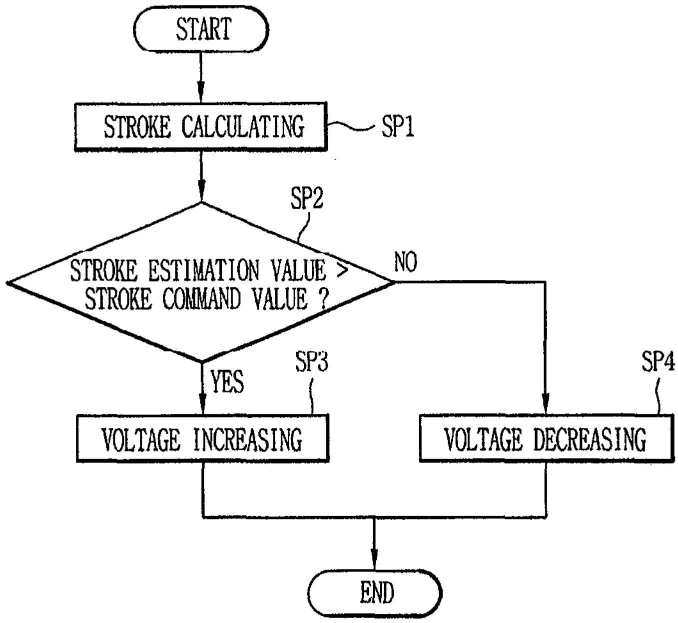

START
STROKE CALCULATING
SP1
SP2
STROKE ESTIMATION VALUE > STROKE COMMAND VALUE ?
NO
YES
SP3
SP4
VOLTAGE INCREASING
VOLTAGE DECREASING
END

FIG. 3

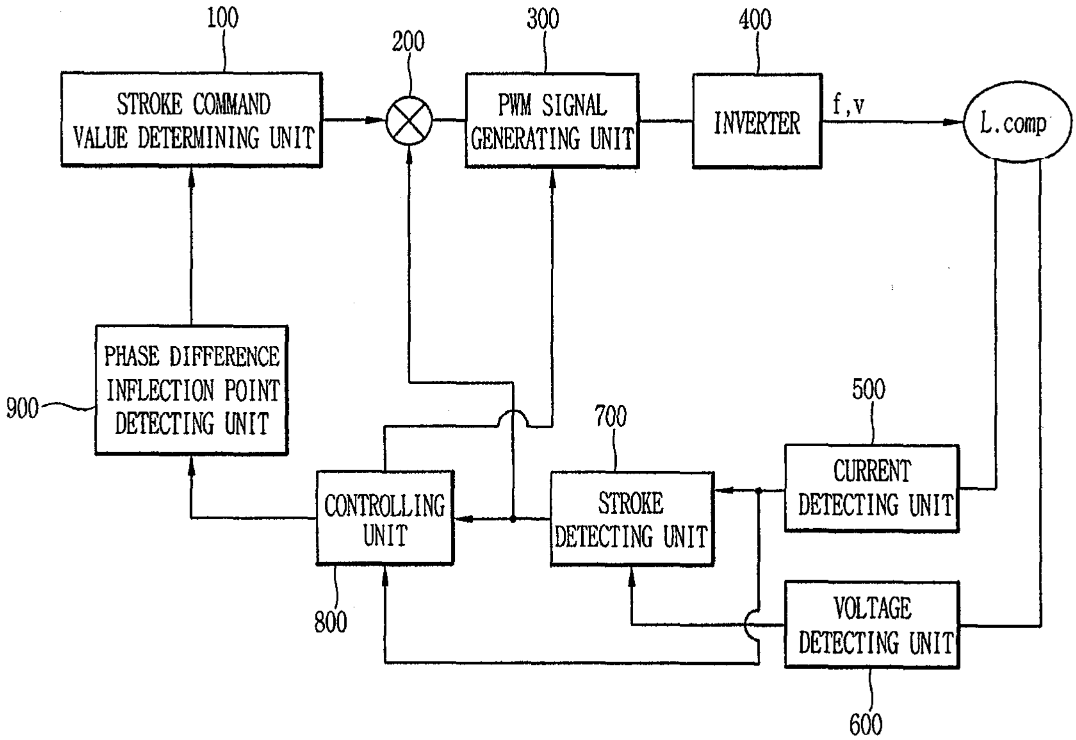
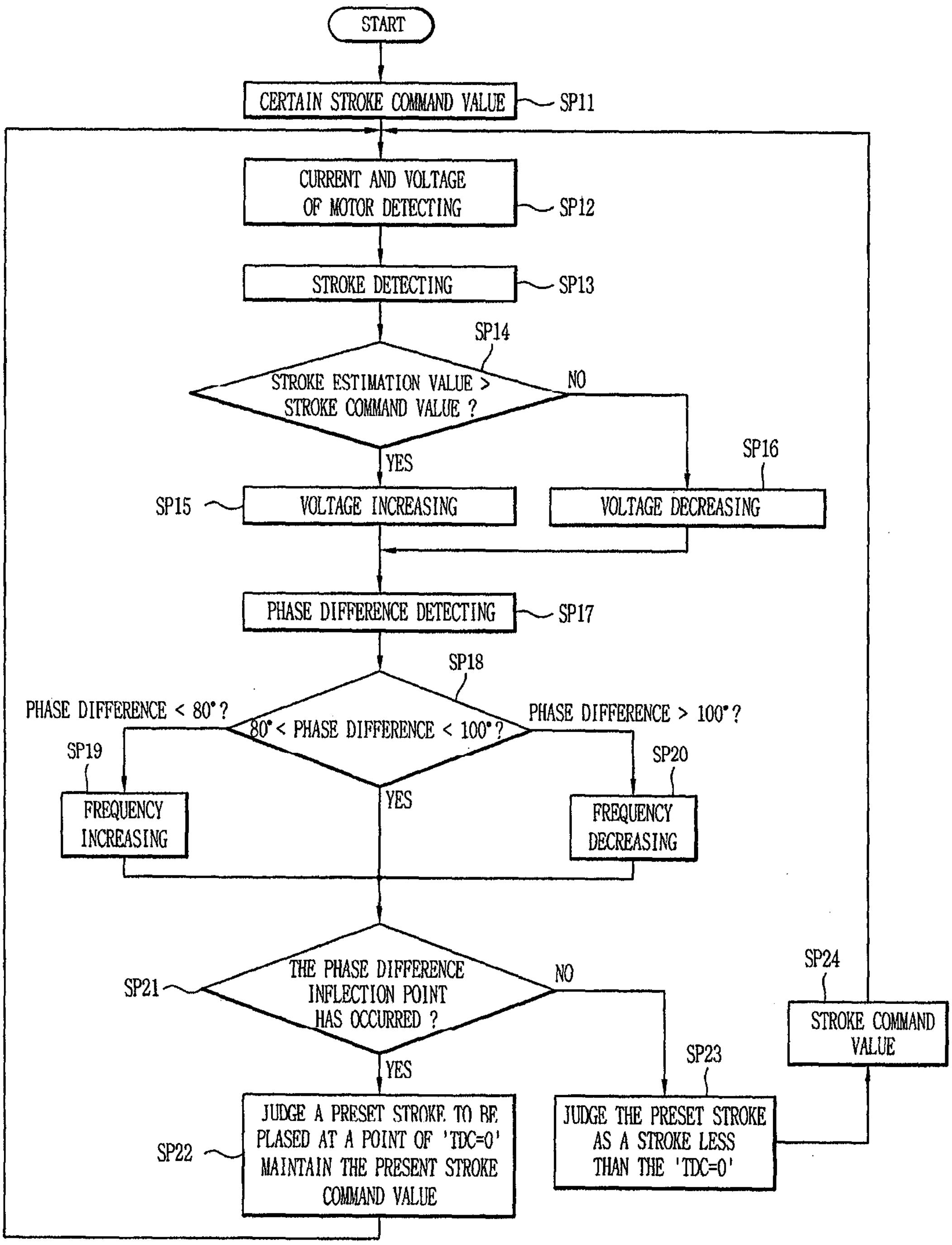

100
200
300
400
STROKE COMMAND VALUE DETERMINING UNIT
PWM SIGNAL GENERATING UNIT
INVERTER
f,v
L.comp
PHASE DIFFERENCE INFLECTION POINT DETECTING UNIT
900
500
700
CURRENT DETECTING UNIT
CONTROLLING UNIT
STROKE DETECTING UNIT
800
VOLTAGE DETECTING UNIT
600

FIG. 4


START
CERTAIN STROKE COMMAND VALUE
SP11
CURRENT AND VOLTAGE OF MOTOR DETECTING
SP12
STROKE DETECTING
SP13
SP14
STROKE ESTIMATION VALUE > STROKE COMMAND VALUE ?
NO
YES
SP15
VOLTAGE INCREASING
SP16
VOLTAGE DECREASING
PHASE DIFFERENCE DETECTING
SP17
SP18
PHASE DIFFERENCE < 80°?
80°< PHASE DIFFERENCE < 100°?
PHASE DIFFERENCE > 100°?
SP19
FREQUENCY INCREASING
YES
SP20
FREQUENCY DECREASING
SP21
THE PHASE DIFFERENCE INFLECTION POINT HAS OCCURRED ?
NO
YES
SP24
STROKE COMMAND VALUE
SP23
SP22
JUDGE A PRESET STROKE TO BE PLASED AT A POINT OF 'TDC=0' MAINTAIN THE PRESENT STROKE COMMAND VALUE
JUDGE THE PRESET STROKE AS A STROKE LESS THAN THE 'TDC=0'

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2003026702 A **[0026]**