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(54) **APPARATUS AND METHOD OF CONTROLLING LINEAR COMPRESSOR**

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(57) **ABSTRACT**

A linear compressor control apparatus including a position detecting unit to detect the position of a piston and a compensation unit to compensate for output distortion of the position sensor. The compensation unit compensates for output distortion of the position sensor, caused by internal temperature of the linear compressor and load variation. Further, the compensation unit separates a high frequency signal and a DC signal from the output of the position detecting unit, and simultaneously performs position and temperature detecting operations using the separated high frequency signal and the DC signal.

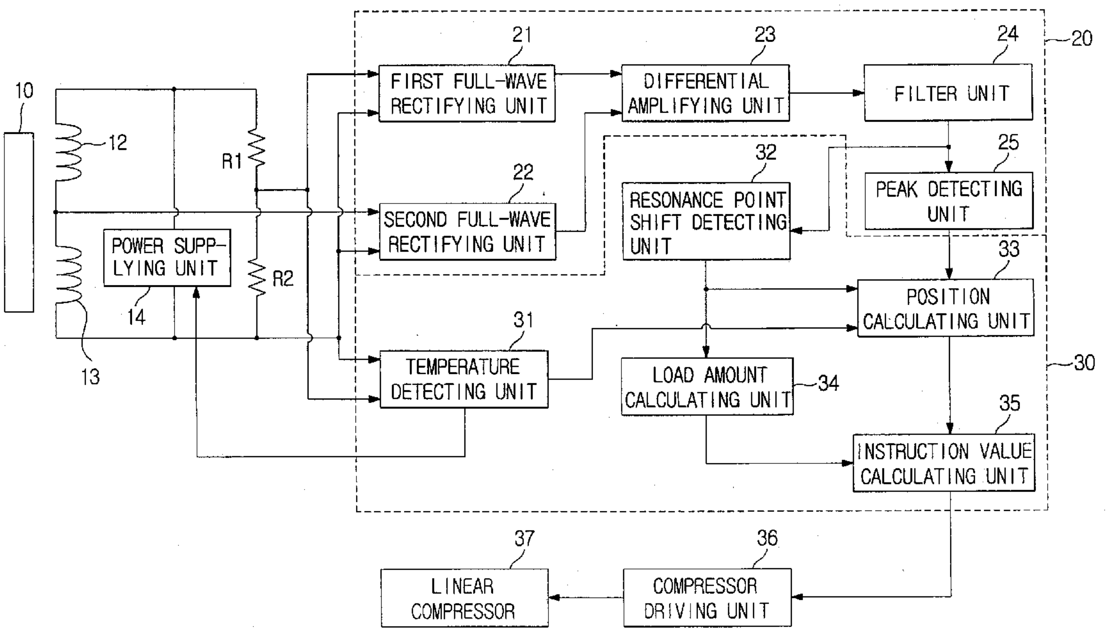


FIG. 1
(PRIOR ART)

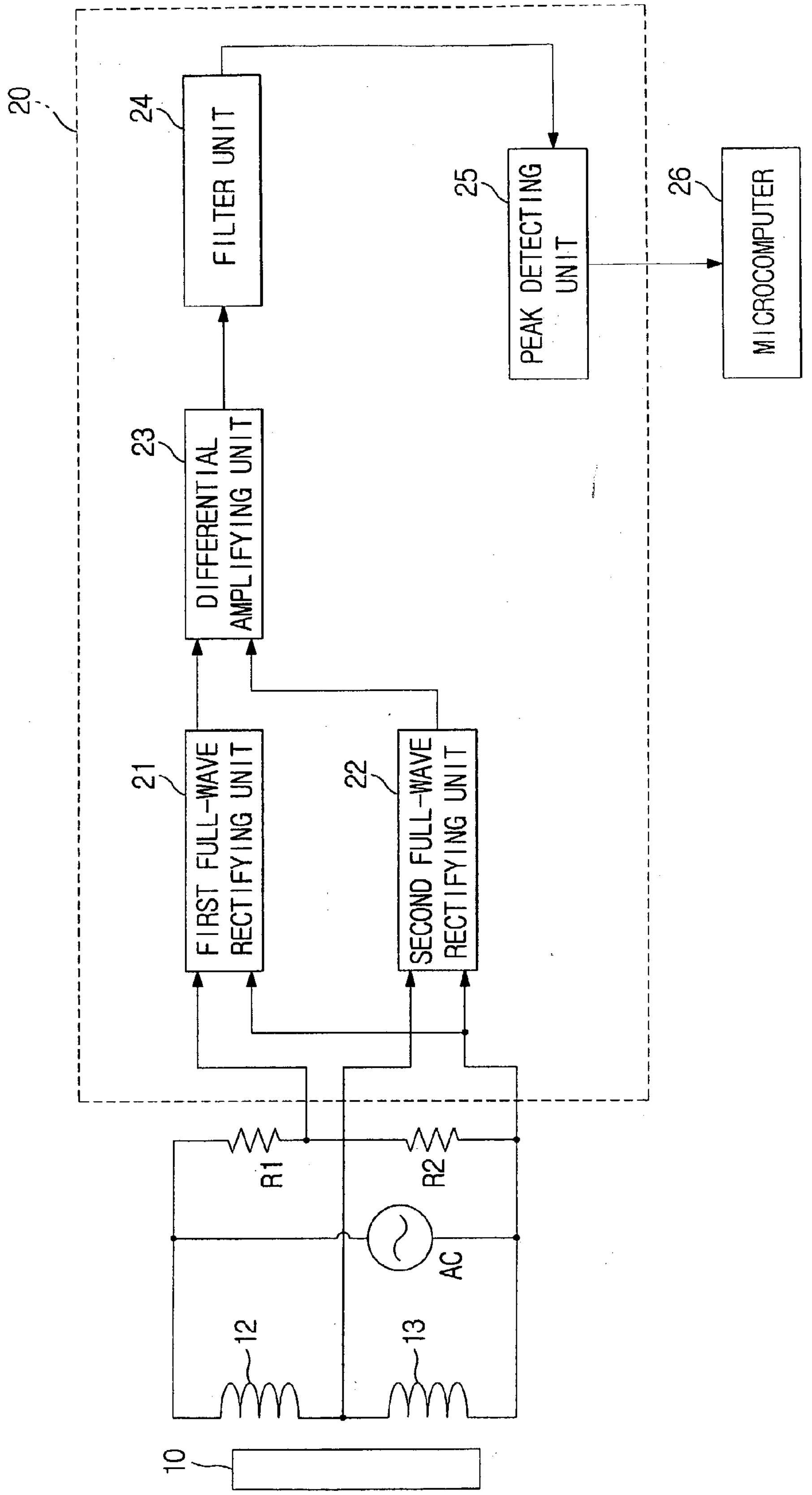


FIG. 2

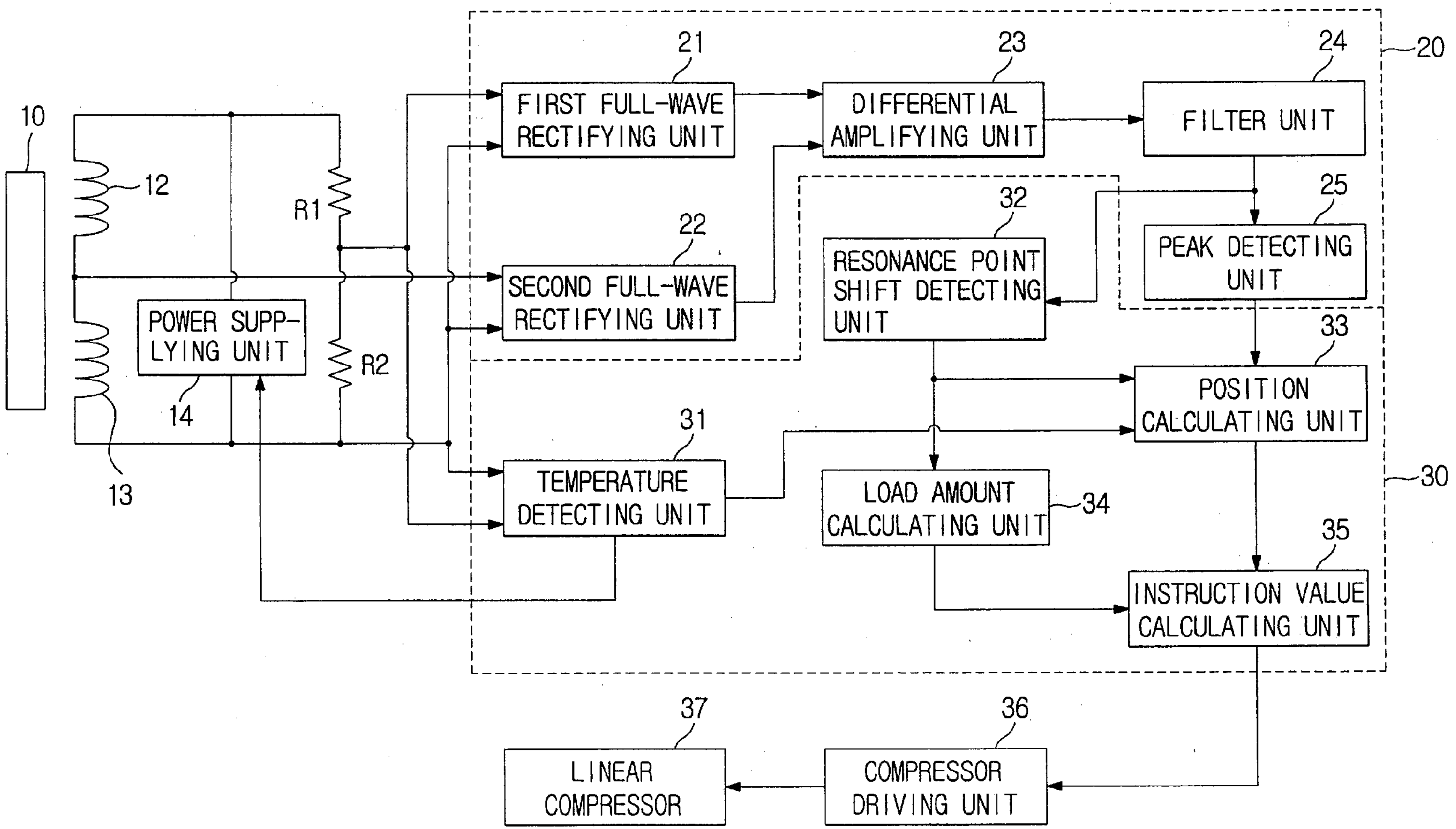

10
12
13
14
POWER SUPPLYING UNIT
R1
R2
20
30
21
FIRST FULL-WAVE RECTIFYING UNIT
22
SECOND FULL-WAVE RECTIFYING UNIT
23
DIFFERENTIAL AMPLIFYING UNIT
24
FILTER UNIT
25
PEAK DETECTING UNIT
31
TEMPERATURE DETECTING UNIT
32
RESONANCE POINT SHIFT DETECTING UNIT
33
POSITION CALCULATING UNIT
34
LOAD AMOUNT CALCULATING UNIT
35
INSTRUCTION VALUE CALCULATING UNIT
36
COMPRESSOR DRIVING UNIT
37
LINEAR COMPRESSOR

FIG. 3

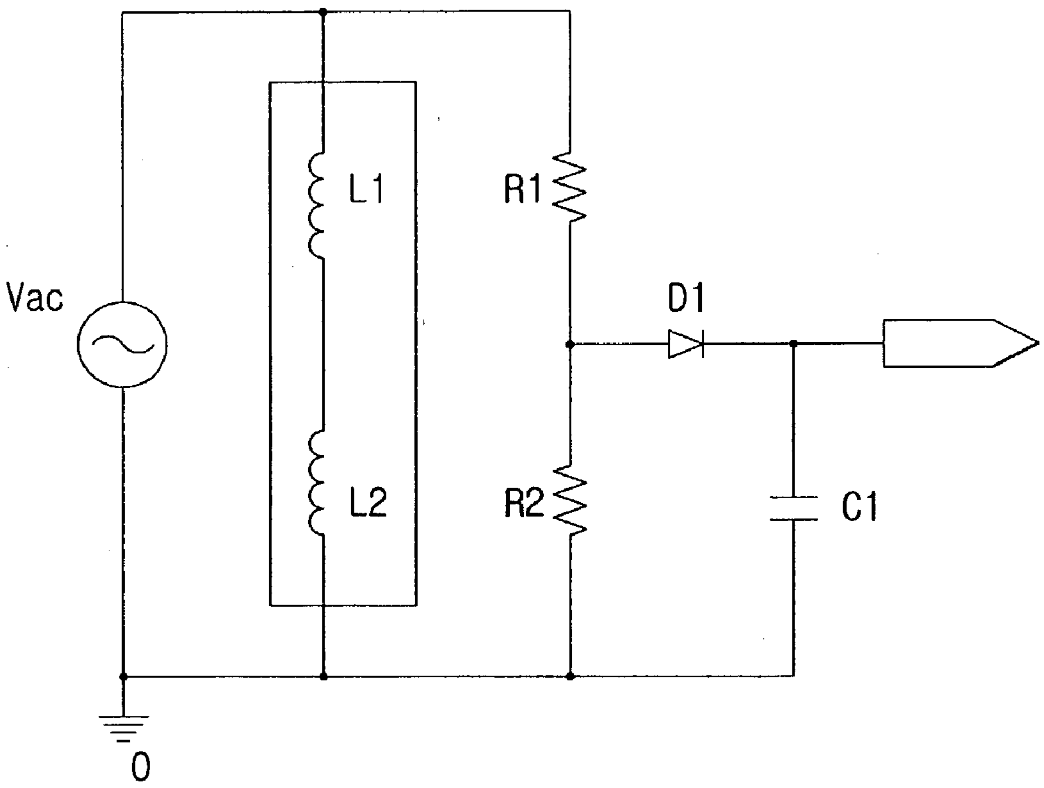


FIG. 4

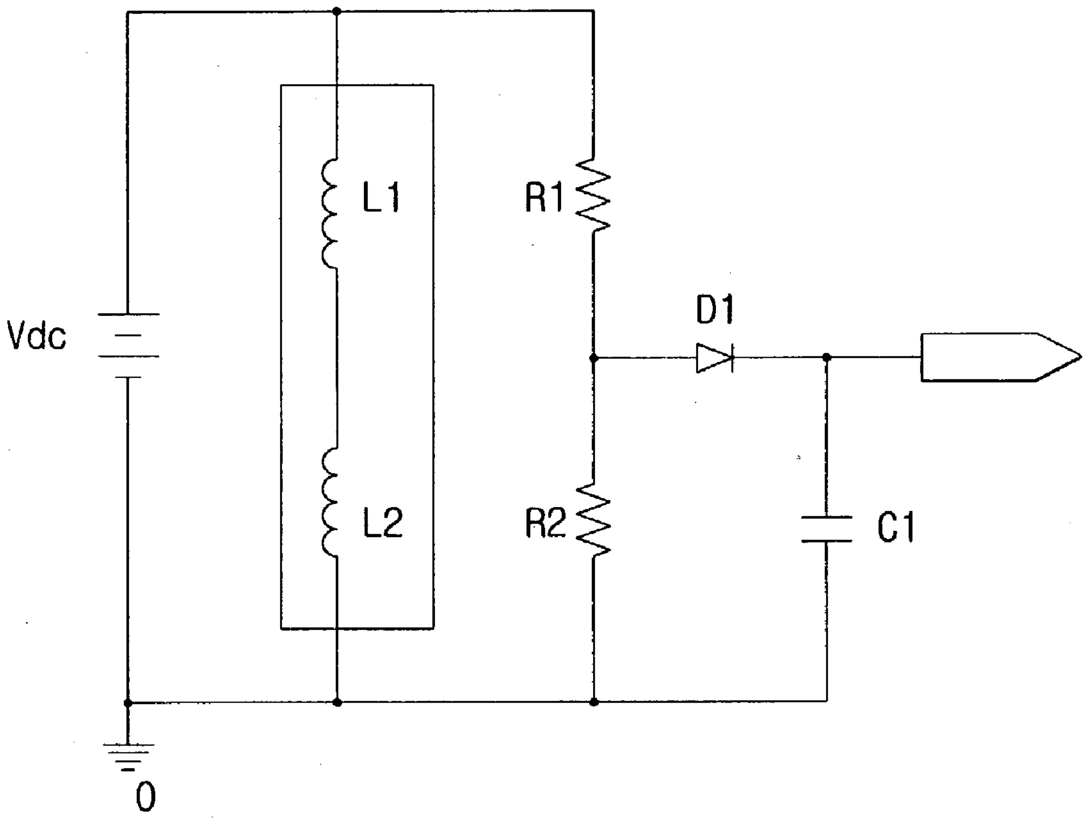


FIG. 5

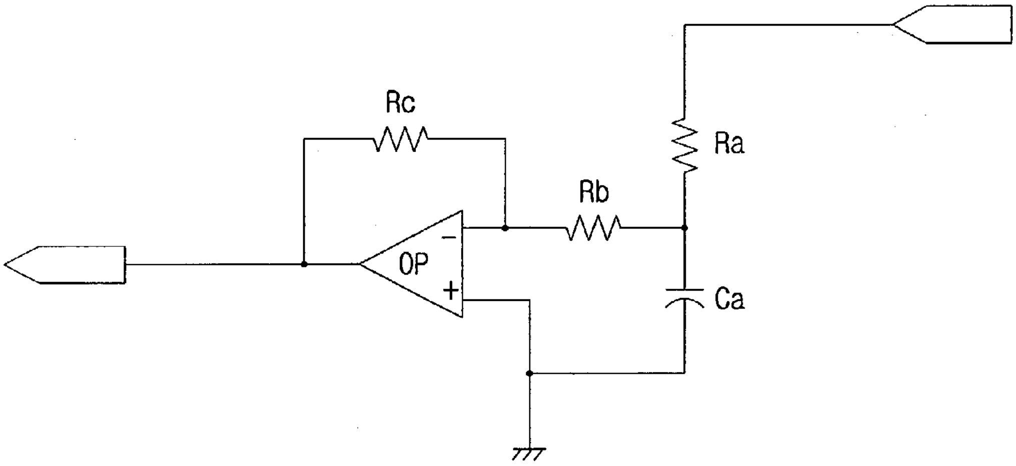


FIG. 6

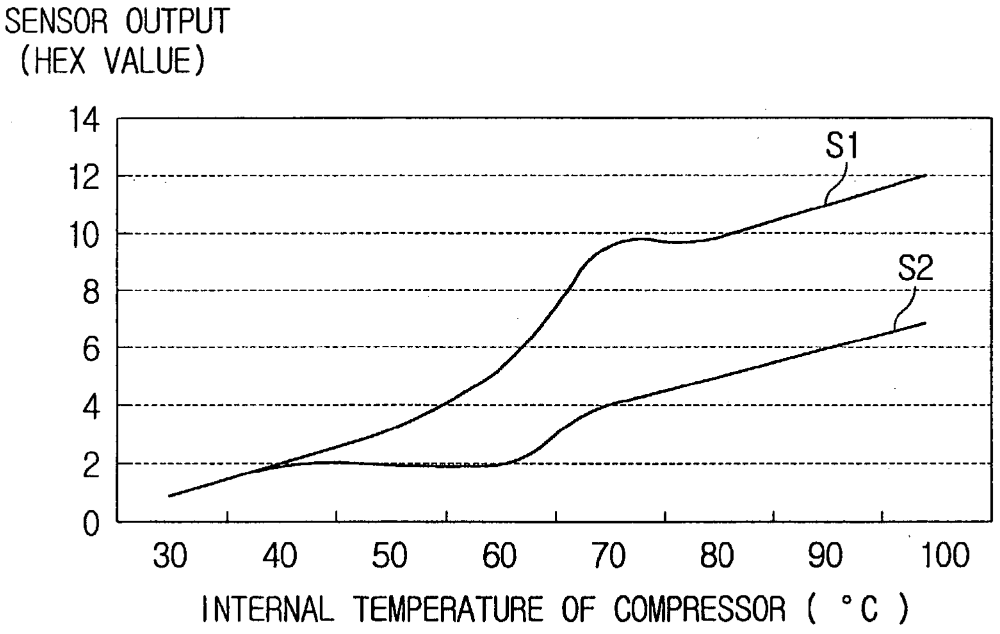

SENSOR OUTPUT
(HEX VALUE)
14
12
10
8
6
4
2
0
30
40
50
60
70
80
90
100
INTERNAL TEMPERATURE OF COMPRESSOR (°C)
S1
S2

FIG. 7

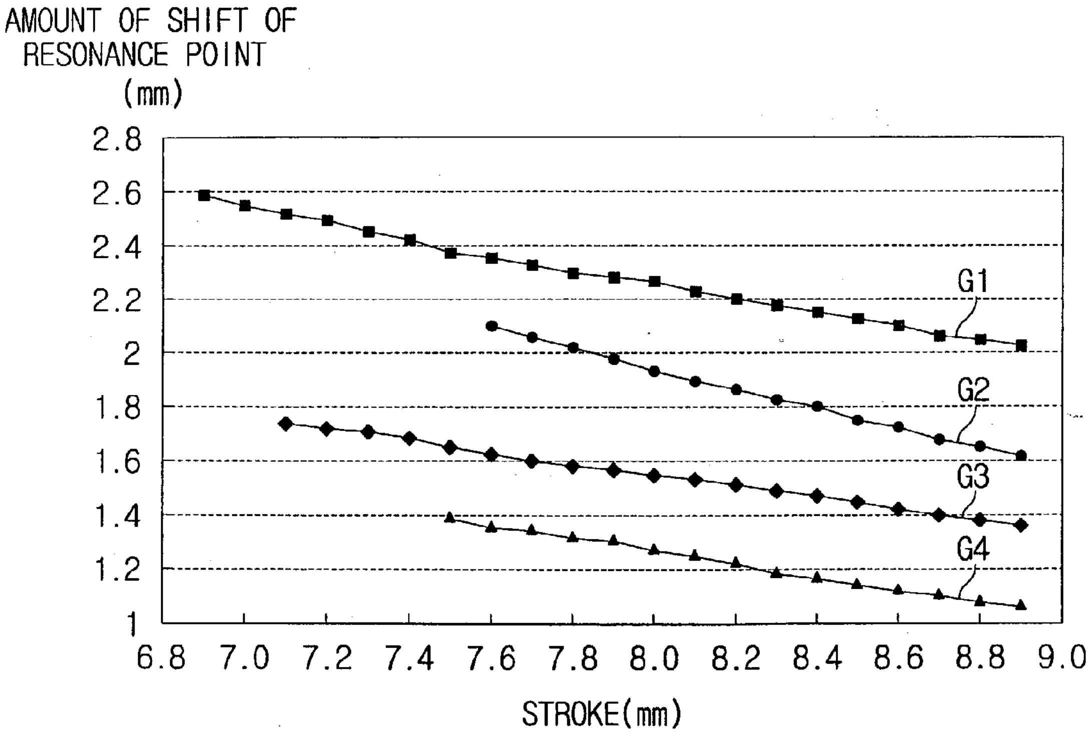

AMOUNT OF SHIFT OF
RESONANCE POINT
(mm)
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
STROKE(mm)
G1
G2
G3
G4

FIG. 8

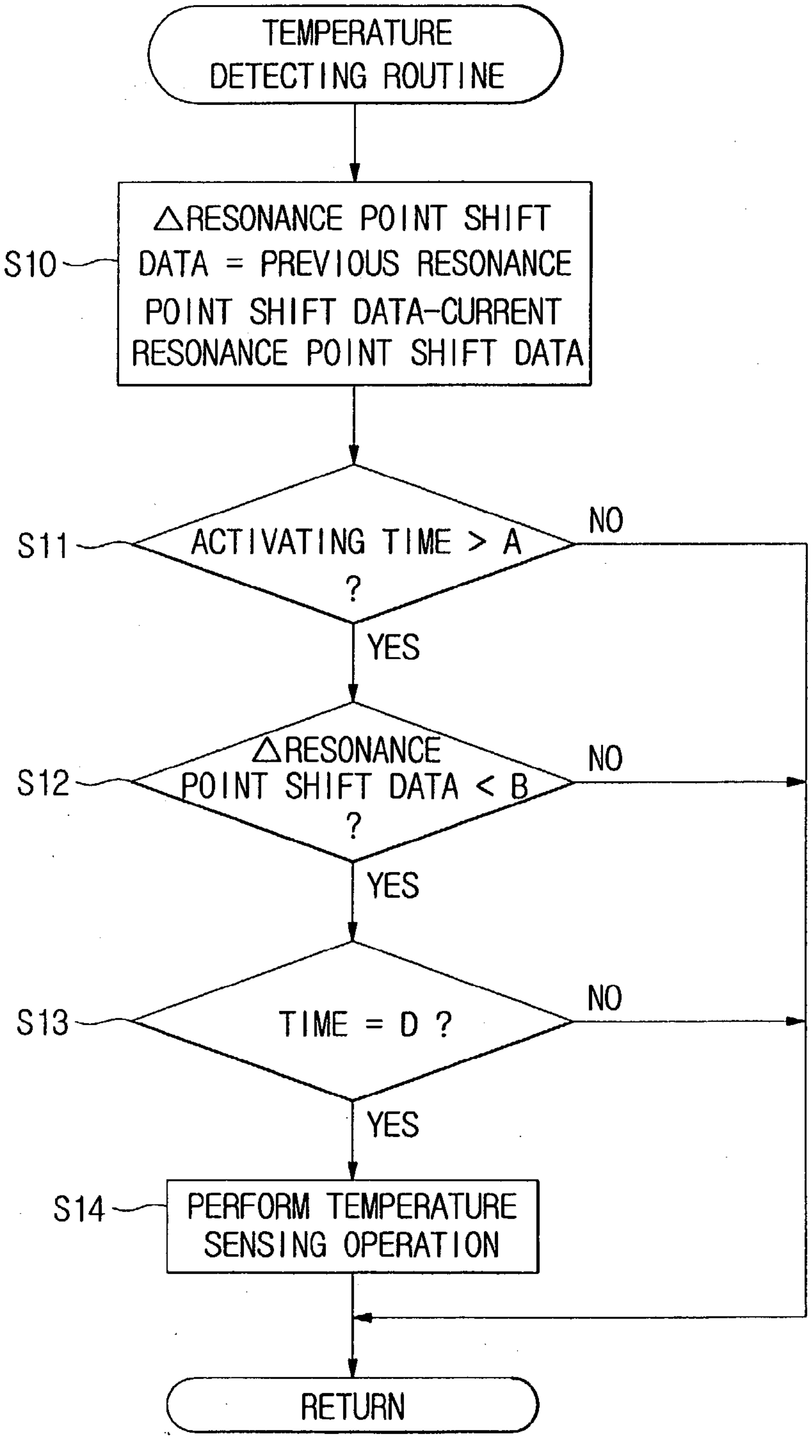

TEMPERATURE DETECTING ROUTINE
S10
△RESONANCE POINT SHIFT DATA = PREVIOUS RESONANCE POINT SHIFT DATA-CURRENT RESONANCE POINT SHIFT DATA
S11
ACTIVATING TIME > A ?
NO
YES
S12
△RESONANCE POINT SHIFT DATA < B ?
NO
YES
S13
TIME = D ?
NO
YES
S14
PERFORM TEMPERATURE SENSING OPERATION
RETURN

FIG. 9

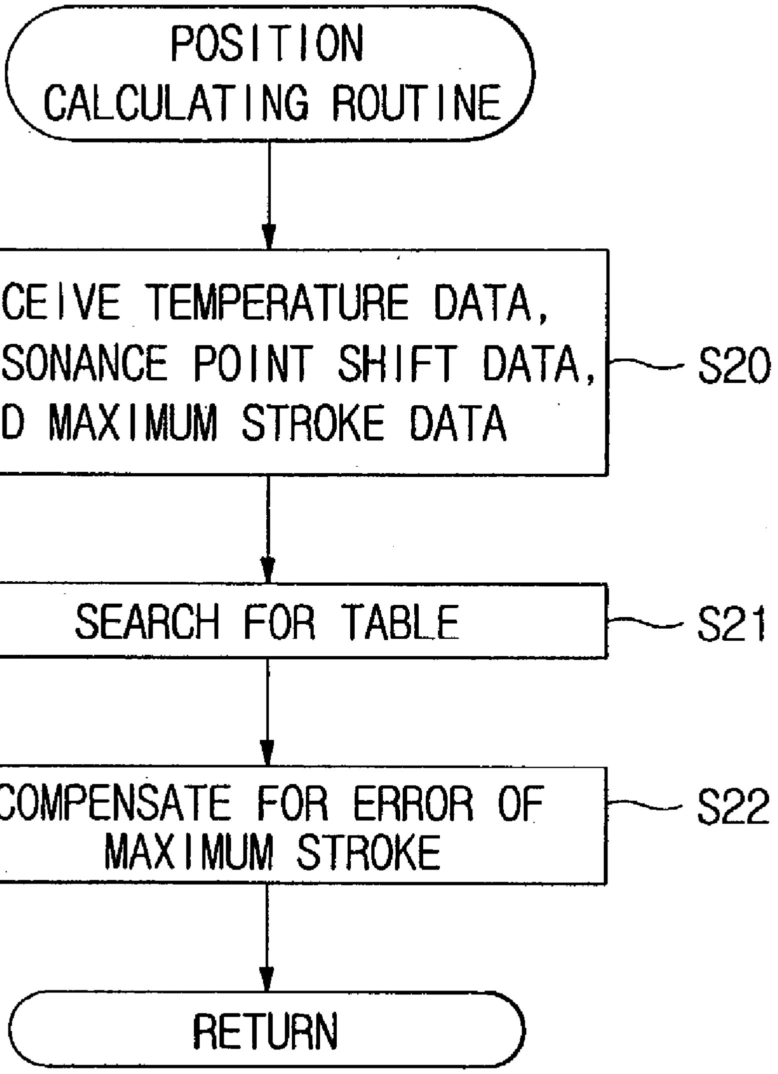

POSITION CALCULATING ROUTINE
RECEIVE TEMPERATURE DATA, RESONANCE POINT SHIFT DATA, AND MAXIMUM STROKE DATA
S20
SEARCH FOR TABLE
S21
COMPENSATE FOR ERROR OF MAXIMUM STROKE
S22
RETURN

FIG. 10

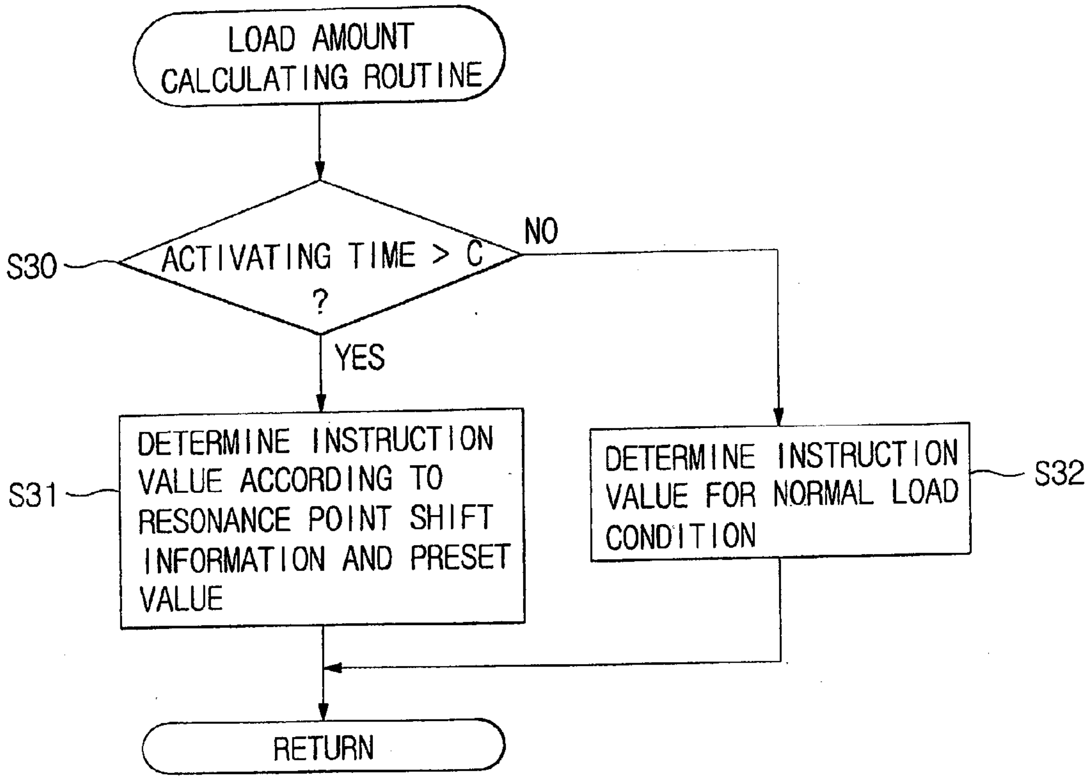

LOAD AMOUNT CALCULATING ROUTINE
S30
ACTIVATING TIME > C ?
NO
YES
S31
DETERMINE INSTRUCTION VALUE ACCORDING TO RESONANCE POINT SHIFT INFORMATION AND PRESET VALUE
S32
DETERMINE INSTRUCTION VALUE FOR NORMAL LOAD CONDITION
RETURN

FIG. 11

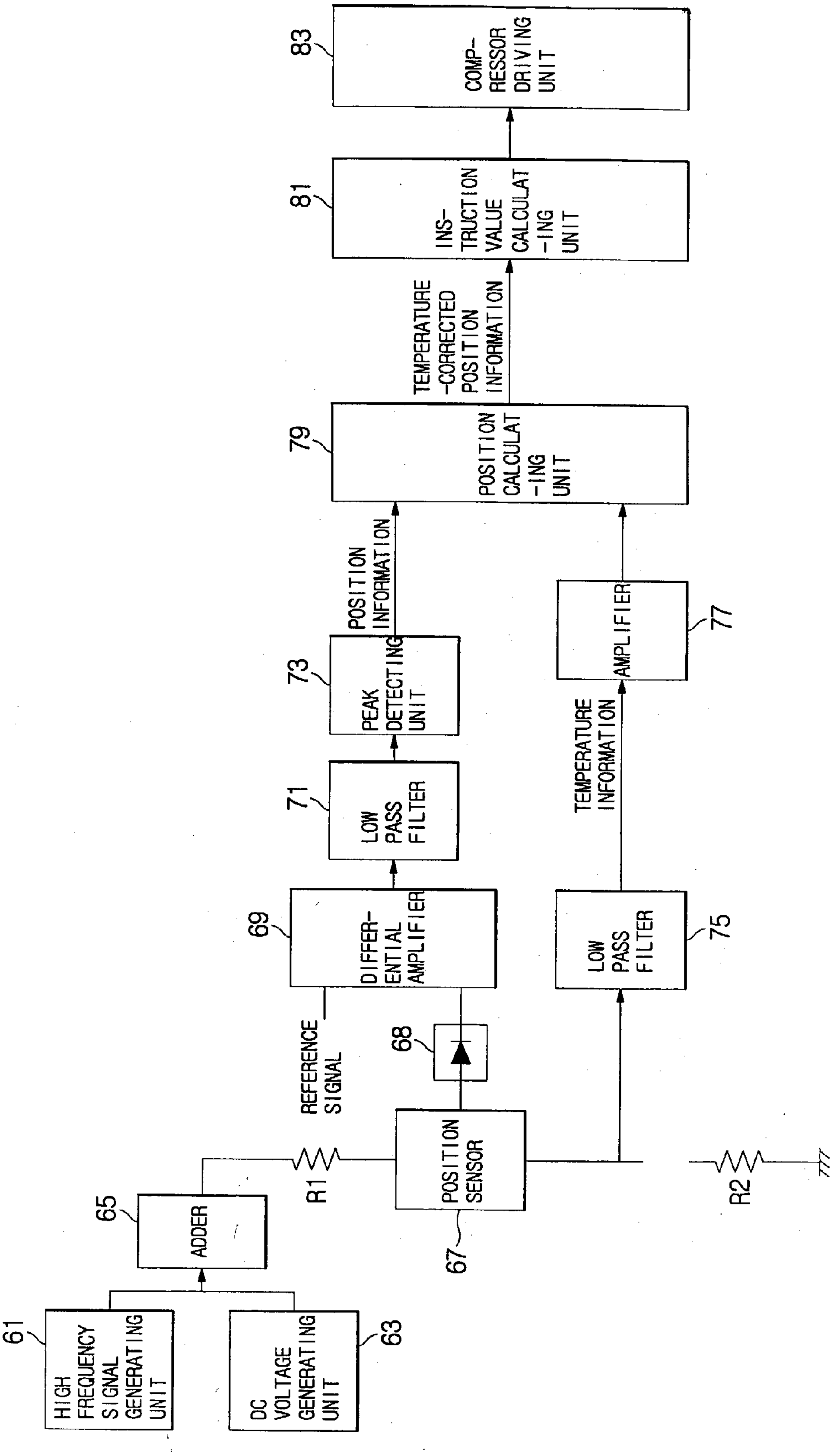
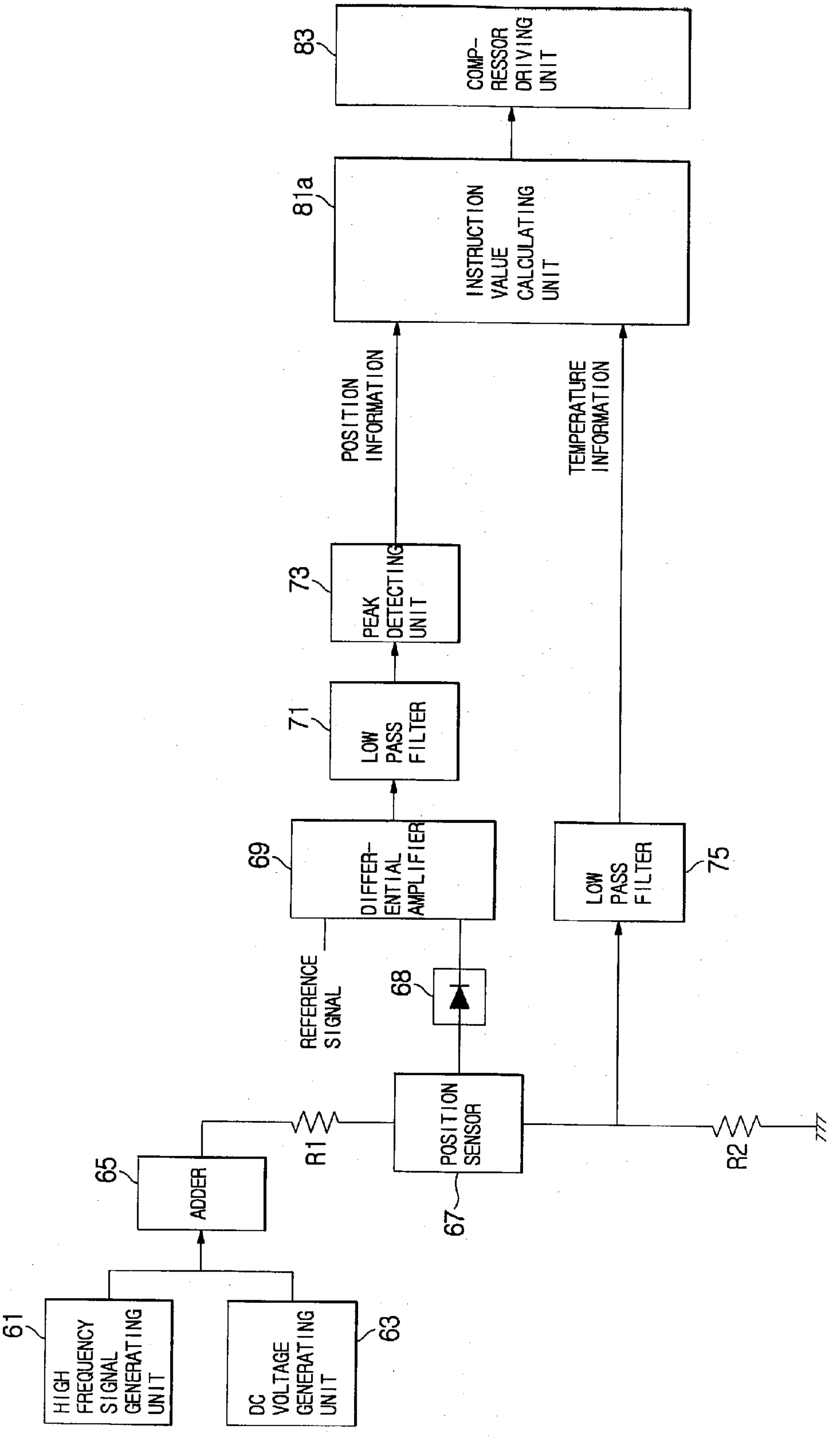

61
HIGH FREQUENCY SIGNAL GENERATING UNIT
63
DC VOLTAGE GENERATING UNIT
65
ADDER
R1
67
POSITION SENSOR
R2
68
REFERENCE SIGNAL
69
DIFFERENTIAL AMPLIFIER
71
LOW PASS FILTER
73
PEAK DETECTING UNIT
POSITION INFORMATION
75
LOW PASS FILTER
TEMPERATURE INFORMATION
77
AMPLIFIER
79
POSITION CALCULATING UNIT
TEMPERATURE-CORRECTED POSITION INFORMATION
81
INSTRUCTION VALUE CALCULATING UNIT
83
COMPRESSOR DRIVING UNIT

FIG. 12


61
HIGH FREQUENCY SIGNAL GENERATING UNIT
63
DC VOLTAGE GENERATING UNIT
65
ADDER
R1
67
POSITION SENSOR
R2
68
REFERENCE SIGNAL
69
DIFFER-ENTIAL AMPLIFIER
71
LOW PASS FILTER
73
PEAK DETECTING UNIT
75
LOW PASS FILTER
POSITION INFORMATION
TEMPERATURE INFORMATION
81a
INSTRUCTION VALUE CALCULATING UNIT
83
COMP-RESSOR DRIVING UNIT

APPARATUS AND METHOD OF CONTROLLING LINEAR COMPRESSOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[**0001**] This application claims the benefit of Korean Application No. 2002-11026, filed Feb. 28, 2002, and Application No. 2002-61895, filed Oct. 10, 2002, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[**0002**] 1. Field of the Invention

[**0003**] The present invention relates generally to an apparatus and method of controlling a linear compressor, which compensates for output distortion of a position sensor for detecting the position of a piston.

[**0004**] 2. Description of the Related Art

[**0005**] **FIG. 1** is a block diagram of a conventional apparatus to control a linear compressor.

[**0006**] Referring to **FIG. 1**, the conventional control apparatus is comprised of a magnetic core **10**, first and second coils **12** and **13**, a signal processing unit **20** and a microcomputer **26**. The magnetic core **10** operates in conjunction with a mechanism whose position is to be detected (not shown), the first and second coils **12** and **13** are symmetrically wound around the core **10**, and the signal processing unit **20** detects and outputs variations in position of the core **10** using voltages induced to the first and second coils **12** and **13**.

[**0007**] The signal processing unit **20** is comprised of a first full-wave rectifying unit **21**, a second full-wave rectifying unit **22**, a differential amplifying unit **23**, a filter unit **24**, and a peak detecting unit **25**. The first full-wave rectifying unit **21** full-wave rectifies voltage induced to the first coil **12**, the second full-wave rectifying unit **22** full-wave rectifies voltage induced to the second coil **13**, the differential amplifying unit **23** amplifies a difference between voltages full-wave rectified by the first and second full-wave rectifying units **21** and **22**, the filter unit **24** eliminates a high-frequency component from a signal outputted from the differential amplifying unit **23**, and the peak detecting unit **25** detects the maximum and minimum values of a signal outputted from the filter unit **24**, and transmits the detected values to a microcomputer **26**.

[**0008**] The operation of the conventional linear compressor is described below.

[**0009**] If the position of the core **10** is varied by a variation in position of the mechanism whose position is to be detected with alternating current (AC) having a frequency of several KHz applied to the first and second coils **12** and **13** from the outside, voltages in proportion to the variation in position of the core **10** are induced to the first and second coils **12** and **13**. The voltages induced to the first and second coils **12** and **13** are full-wave rectified by the first and second full-wave rectifying units **21** and **22** and the full-wave rectified voltages are inputted to input terminals of the differential amplifying unit **23**.

[**0010**] The differential amplifying unit **23** amplifies a difference between the voltages full-wave rectified by the first and second full-wave rectifying units **21** and **22**, and outputs the amplified difference to the filter unit **24**. The filter unit **24** eliminates a high-frequency component from the signal outputted from the differential amplifying unit **23**, and outputs the filtered signal to the peak detecting unit **25**. The peak detecting unit **25** detects a peak of the signal outputted from the filter unit **24**, that is, a maximum stroke, and outputs the detected maximum stroke to the microcomputer **26**. The microcomputer **26** controls the stroke of the linear compressor **1** according to the maximum stroke.

[**0011**] In the conventional linear compressor control apparatus, the output control of the linear compressor is performed by controlling the position of the piston on the basis of voltage values detected by the first and second coils **12** and **13**. However, as resistances of the coils are increased according to a temperature, the output value of the first and second coils **12** and **13** is also increased. Further, the center of a resonance point of the piston is shifted according to the variation of a load. At this time, if the center of the resonance point of the piston moves away from the valve relative to an initial assembled position, the output value is decreased, while if the center thereof approaches the valve, the output value is increased.

[**0012**] That is, the first and second coils **12** and **13** serve to detect the position of the piston. In this case, the output value of the first and second coils **12** and **13** is varied according to an internal temperature of the compressor. Further, if the load is varied unstably, the center of the resonance point of the piston is shifted, so the output voltage may change.

[**0013**] As described above, if the position of the piston is controlled using the voltage values detected by conventional first and second coils, the center of the resonance point is shifted due to the internal temperature of the compressor or the load variation, so the output value of the coils at the same top clearance is distorted, thus preventing an optimal top clearance from being maintained. In the worst case, abnormal phenomena, such as a collision of the piston of the compressor with the valve, etc., may occur.

[**0014**] If the top clearance is set to be larger to avoid the collision of the piston, the size of the compressor must be increased in proportion to the increased top clearance so as to obtain cooling power (output) of desired intensity, thereby causing a burden in manufacturing a compressor.

SUMMARY OF THE INVENTION

[**0015**] Accordingly, it is an aspect of the present invention to provide an apparatus and method of controlling a linear compressor, which may compensate for a sensor output distorted due to an internal temperature of the compressor or a load variation.

[**0016**] Additional aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[**0017**] The foregoing and/or other aspects of the present invention are achieved by providing an apparatus to control a linear compressor having a piston reciprocating in a cylinder of the linear compressor, comprising: a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor; and a compensating unit to compensate for output distortion of the position detecting unit due to internal temperature of the compressor and load variation.

[**0018**] The foregoing and/or other aspects of the present invention are also achieved by providing a method of controlling a linear compressor having a position detecting unit to detect a position of a piston of the linear compressor, comprising: supplying alternating current (AC) power to the position detecting unit, detecting the position of the piston according to an output of the position detecting unit, and detecting a load according to the detected position of the piston; supplying direct current (DC) power to the position detecting unit and detecting internal temperature of the linear compressor according to the output of the position detecting unit; and compensating for output distortion of the position detecting unit according to the detected internal temperature of the linear compressor and the detected load.

[**0019**] The foregoing and/or other aspects of the present invention are also achieved by providing a method of controlling a linear compressor having a position detecting unit to detect a position of a piston of the linear compressor, comprising: detecting internal temperature of the linear compressor; detecting the amount of shift of a resonance point of the piston; compensating for an error of a maximum stroke of the piston detected by the position detecting unit according to the internal temperature of the linear compressor and the amount of shift of the piston resonance point; and driving the linear compressor according to the compensated maximum stroke.

[**0020**] The foregoing and/or other aspects of the present invention are also achieved by providing an apparatus to control a linear compressor, comprising a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor; a power supply unit to supply drive power to the position detecting unit; and a compensating unit to compensate for output distortion of the position detecting unit due to internal temperature of the linear compressor.

[**0021**] The foregoing and/or other aspects of the present invention are also achieved by providing an apparatus to control a linear compressor, comprising: a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor; a power supply unit to supply drive power to the position detecting unit; and a compensating unit to calculate the amount of shift of a piston resonance point and a load from the position of the piston, and compensate for output distortion of the position detecting unit on the basis of the calculated load.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0022**] These and other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

[**0023**] **FIG. 1** is a block diagram of a conventional apparatus to control a linear compressor;

[**0024**] **FIG. 2** is a block diagram of an apparatus to control a linear compressor according to an embodiment of the present invention;

[**0025**] **FIG. 3** is a circuit diagram to receive AC power for detecting the position of a piston in the control apparatus of the linear compressor of **FIG. 2**;

[**0026**] **FIG. 4** is a circuit diagram to receive DC power for detecting the internal temperature of the compressor in the control apparatus of the linear compressor of **FIG. 2**;

[**0027**] **FIG. 5** is a circuit diagram of a resonance point shift detecting unit in the control apparatus of the linear compressor of **FIG. 2**;

[**0028**] **FIG. 6** is a graph illustrating errors of a sensor output due to an internal temperature of the linear compressor of **FIG. 2**;

[**0029**] **FIG. 7** is a graph illustrating compensated strokes corresponding to the amount of shift of a resonance point according to conditions of the control apparatus of the linear compressor of **FIG. 2**;

[**0030**] **FIG. 8** is a flowchart of a temperature detecting routine according to an embodiment of the present invention;

[**0031**] **FIG. 9** is a flowchart of a position calculating routine according to an embodiment of the present invention;

[**0032**] **FIG. 10** is a flowchart of a load amount calculating routine according to an embodiment of the present invention;

[**0033**] **FIG. 11** is a block diagram of another apparatus to control a linear compressor according to another embodiment of the present invention; and

[**0034**] **FIG. 12** is a block diagram of a further apparatus to control a linear compressor according to a modified embodiment of **FIG. 11** to illustrate the operation of correcting position information according to inputted temperature information by an instruction value calculating unit of **FIG. 11**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[**0035**] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[**0036**] A first embodiment is described with respect to a case where output distortion of a position sensor is compensated by considering both an internal temperature of a compressor and a load, and a second embodiment is described with respect to a case where output distortion of a position sensor is compensated by considering only an internal temperature of the compressor.

[**0037**] **FIG. 2** is a block diagram of an apparatus to control a linear compressor according to an embodiment of the present invention. The same reference numerals as those of **FIG. 1** are used in **FIG. 2** to designate the same or similar components.

[**0038**] Referring to **FIG. 2**, the linear compressor control apparatus includes a magnetic core **10** to operate in conjunction with a mechanism whose position is to be detected, and a position detecting unit having first and second coils **12** and **13** symmetrically wound around the outer side of the core **10**.

[**0039**] A position detecting unit **20** includes first and second rectifying units **21** and **22**, a differential amplifying unit **23**, a filter unit **24** and a peak detecting unit **25**. The first rectifying unit **21** full-wave rectifies a voltage induced to the first coil **12**, and the second rectifying unit **22** full-wave rectifies a voltage induced to the second coil **13**. The differential amplifying unit **23** amplifies a difference between voltages full-wave rectified by the first and second rectifying units **21** and **22**. The filter unit **24** eliminates a high-frequency component from an output signal of the differential amplifying unit **23**. The peak detecting unit **25** detects a maximum stroke from an output signal of the filter unit **24**.

[**0040**] The position detecting unit further includes a power supply unit **14** to supply a alternating current (AC) power or direct current (DC) power to one-side ends of the first and second coils **12** and **13** connected in series.

[**0041**] The linear compressor control apparatus of the present invention comprises a compensating unit **30** to compensate for output distortion of the position detecting unit due to the internal temperature of the linear compressor and load variation.

[**0042**] The compensating unit **30** comprises a temperature detecting unit **31**, a resonance point shift detecting unit **32**, a position calculating unit **33**, a load amount calculating unit **34** and an instruction value calculating unit **35**.

[**0043**] The power supply unit **14** serves to supply AC power to detect the piston of the piston, or DC power to detect internal temperature of the compressor. This power supply unit **14** supplies one of the AC power and the DC power according to an output signal of the temperature detecting unit **31**.

[**0044**] The temperature detecting unit **31** determines the variation of the load according to a shift change rate of a resonance point (Δ resonance point shift data) and provides an AC supply instruction to the power supply unit **14** when the load is unstable, so the power supply unit **14** supplies AC power, as illustrated in **FIG. 3**. On the other hand, when the load is stable, the temperature detecting unit **31** provides a DC supply instruction to the power supply unit **14**, so the power supply unit **14** supplies DC power, as illustrated in **FIG. 4**.

[**0045**] A case where the power supply unit **14** supplies AC power is modeled as illustrated in a circuit diagram of **FIG. 3**. AC power Vac is supplied to one-side ends of the first and second coils **12** and **13** connected in series. Inductance L1 of the first coil **12** and inductance L2 of the second coil **13** vary according to the variation of the position of the core **10**, which operates in conjunction with the piston. Therefore, a voltage proportional to the variations of the inductances L1 and L2 is outputted through resistors R1 and R2, a rectifying diode D1 and a capacitor C. The output voltage is induced to the first and second coils **12** and **13**, respectively. The induced voltages are provided to the first and second rectifying units **21** and **22** and the temperature detecting unit **31** as information used to detect the position of the piston.

[**0046**] A case where the power supply unit **14** supplies DC power is modeled as illustrated in a circuit diagram of **FIG. 4**. In this case, DC power Vdc is supplied to one-side ends of the first and second coils **12** and **13** connected in series. Inductance L1 of the first coil **12** and inductance L2 of the second coil **13** vary according to the temperature of the linear compressor (internal temperature of the linear compressor). Therefore, a voltage proportional to the variations of the inductances L1 and L2 is outputted through the resistors R1 and R2, the rectifying diode D1 and the capacitor C. The output voltage is induced to the first and second coils **12** and **13**, respectively. The induced voltages are provided to the first and second rectifying units **21** and **22** and the temperature detecting unit **31** as information used to detect the temperature of the linear compressor.

[**0047**] The temperature detecting unit **31** converts a temperature detecting signal corresponding to the induced voltages into digital temperature data, and outputs the temperature data to the position calculating unit **33**.

[**0048**] If the power supply unit **14** supplies AC power, voltages proportional to variation of the position of the core **10** are induced to the first and second coils **12** and **13**. The induced voltages are full-wave rectified by the first and second rectifying units **21** and **22**, and then inputted to input terminals of the differential amplifying unit **23**. The differential amplifying unit **23** amplifies a difference between the inputted voltages and outputs the amplified result to the filter unit **24**. The filter unit **24** eliminates a high-frequency component from the amplified output signal and outputs the eliminated result to both the resonance point shift detecting unit **32** and the peak detecting unit **25**. The peak detecting unit **25** detects a maximum stroke of the piston and outputs the detected result as maximum stroke data to the position calculating unit **33**.

[**0049**] **FIG. 5** is a circuit diagram of the resonance point shift detecting unit **32** according to an embodiment of the present invention. The resonance point shift detecting unit **32** comprises an operational amplifier OP, resistors Ra, Rb and Rc, and a capacitor Ca.

[**0050**] The resonance point shift detecting unit **32** detects resonance point shift data indicating a shifting state of the center of the resonance point from the signal provided by the filter unit **24**, and outputs the resonance point shift data to the position calculating unit **33** and the load amount calculating unit **34**.

[**0051**] As illustrated in **FIG. 6**, as an internal temperature of the compressor becomes high, a compensated sensor output S1, that is, each of voltages induced to the first and second coils **12** and **13**, becomes larger than a sensor output S2 which is not compensated. Therefore, as the internal temperature of the compressor becomes high, an error of the sensor output becomes larger, thus requiring a method of coping with such an error.

[**0052**] As illustrated in **FIG. 7**, the compensated strokes corresponding to the amount of shift of the resonance point increase. In this case, differences between suction pressure and discharge pressure of the compressor satisfy the relation G1>G2>G3>G4.

[**0053**] The position calculating unit **33** compensates for an error of the top clearance using the maximum stroke data obtained by converting the maximum stroke calculated on the basis of maximum values and minimum values of the output signal of the filter unit **24** into digital data, the temperature data obtained by converting the temperature detecting signal outputted from the temperature detecting unit **31** into digital data, and the resonance point shift data obtained by converting the resonance point shift signal outputted from the resonance point shift detecting unit **32** into digital data. Further, the position calculating unit **33** outputs compensated top clearance information to the instruction value calculating unit **35**.

[**0054**] The load amount calculating unit **34** outputs an instruction value determined according to the resonance point shift data outputted from the resonance point shift detecting unit **32** and a preset value to the instruction value calculating unit **35**.

[**0055**] The instruction value calculating unit **35** outputs a drive signal to drive the linear compressor **37** to the compressor driving unit **36** according to the top clearance outputted from the position calculating unit **33** and the instruction value outputted from the load amount calculating unit **34**.

[**0056**] The compressor driving unit **36** drives the linear compressor **37** according to the drive signal outputted from the instruction value calculating unit **35**.

[**0057**] A control method of the linear compressor control apparatus having the above construction according to an embodiment of the present invention is herein described below in detail.

[**0058**] **FIG. 8** illustrates a temperature detecting routine performed by the temperature detecting unit **31**. First, when the power supply unit **14** supplies AC power, the temperature detecting unit **31** calculates a shift change rate of the resonance point (Δ resonance point shift data) from the signal outputted from the circuit of **FIG. 3** at operation S**10**. In this case, the resonance point shift change rate is calculated by the following equation.

$$\Delta \text{ resonance point shift data} = \text{previous resonance point shift data} - \text{current resonance point shift data}$$

[**0059**] The temperature detecting unit **31** determines whether an activating time of the linear compressor, which is counted using a first counter (not shown), exceeds a preset time A at operation S**11**. If the compressor activating time exceeds the preset time A, the temperature detecting unit **31** determines whether the resonance point shift change rate (Δ resonance point shift data) is less than a preset change rate B at operation S**12**. A time after the time point of the determination is counted using a second counter (not shown).

[**0060**] If the resonance point shift change rate is less than the preset change rate B according to the determined result at operation S12, the temperature detecting unit **31** determines whether the counted time by the second counter reaches a preset time D at operation S**13**. If the counted time by the second counter reaches the preset time D, the temperature detecting unit **31** outputs a dc signal DC to the power supply unit **14** to allow the power supply unit **14** to supply DC power. In this way, as the DC power is supplied, the temperature detecting unit **31** performs an operation of providing temperature data obtained by converting a signal proportional to the voltages induced to the first and second coils **12** and **13** into digital data to the position calculating unit **33**, that is, a temperature sensing operation at operation S14.

[**0061**] If the compressor activating time does not exceed the preset time A at operation S**11**, if the resonance point shift change rate (Δ resonance point shift data) is not less than the preset change rate B at operation S**12**, and if the counted time does not reach the preset time D at operation S**13**, the temperature detecting unit **31** outputs an ac signal AC to the power supply unit **14** to allow the power supply unit **14** to supply AC power.

[**0062**] **FIG. 9** illustrates a position calculating routine performed by the position calculating unit **33**. First, the position calculating unit **33** receives the temperature data from the temperature detecting unit **31**, the resonance point shift data from the resonance point shift detecting unit **32**, and piston position information, which is outputted from the peak detecting unit **25** when the power supply unit **14** supplies AC power, that is, maximum stroke data at operation S**20**.

[**0063**] The position calculating unit **33** searches a lookup table for a maximum stroke corresponding to the temperature data and the resonance point shift data at operation S**21**. Then, the position calculating unit **33** outputs the searched maximum stroke, that is, a maximum stroke compensated according to the internal temperature of the compressor and the amount of shift of the resonance point, to the instruction value calculating unit **35** at operation S**22**. This means that an error of the sensor output due to the internal temperature of the compressor and the amount of shift of the resonance point is corrected when the linear compressor is driven with the compensated maximum stroke. Consequently, the error correction of the sensor output results in the compensation of an error of the top clearance.

[**0064**] The linear compressor has excellent characteristics in variance of its capacity compared with conventional AC motors. Therefore, the capacity of the linear compressor may be varied appropriately according to load information calculated by the load amount calculating unit **34**.

[**0065**] **FIG. 10** illustrates a load amount calculating routine performed by the load amount calculating unit **34**. First, the load amount calculating unit **34** determines whether the activating time of the compressor exceeds a preset time C at operation S**30**. If the compressor activating time exceeds the preset time C, the load amount calculating unit **34** compares resonance point shift information, that is, the resonance point shift data received from the resonance point shift detecting unit **32**, with a preset value, determines an instruction value corresponding to a load state, and outputs the determined instruction value to the instruction value calculating unit **35** at operation S**31**. If the compressor activating time does not exceed the preset time C, the load amount calculating unit **34** determines an instruction value for a normal load condition in an initial operation of the compressor and outputs the instruction value to the instruction value calculating unit **35** at operation S**32**.

[**0066**] As described above, the instruction value calculating unit **35** outputs a drive instruction to drive the linear compressor to the compressor driving unit **36** using the instruction value determined according to the maximum stroke compensated by the position calculating unit **33** and the load information calculated by the load amount calculating unit **34**.

[**0067**] The previous embodiment compensates for output distortion of the position sensor by considering an internal temperature of the compressor and the amount of a load, wherein the power supply unit must alternately supply AC power and DC power according to the condition of a load.

[**0068**] However, if a power supply period is short (for example, 120 Hz), a compensation process considering both of a temperature and a load is complicated. Accordingly, in the following embodiment as described below, drive power obtained by overlapping a DC voltage and a high frequency signal is supplied to the position sensor so as to simultaneously perform an operation of detecting the position of a piston and an operation of detecting the internal temperature of the compressor, a high frequency signal and a DC signal are separated from the signal outputted from the position sensor, the separated high frequency signal being used as a position detection signal, and the separated DC signal is used as a temperature detection signal, thus enabling position information and temperature info information to be simultaneously obtained.

[**0069**] **FIG. 11** is a block diagram of an apparatus to control a linear compressor according to another embodiment of the present invention. The linear compressor control apparatus of this embodiment uses a manner of overlapping a signal used to obtain position detection (signal with a frequency higher than several KHz) and a signal used to obtain temperature detection (certain DC voltage).

[**0070**] As illustrated in **FIG. 11**, the linear compressor control apparatus of this embodiment includes a high frequency signal generating unit **61**, a DC voltage generating unit **63** and an adder **65** which supply power to a position sensor **67**.

[**0071**] The position sensor **67** includes a magnetic core, and first and second coils symmetrically wound around the outer side of the magnetic core. The position sensor **67** is connected to resistors R1 and R2, and is connected to the adder **65** through the resistor R1.

[**0072**] The high frequency signal generating unit **61** supplies a high frequency signal (several KHz) to the adder **65**, and the DC voltage generating unit **63** supplies a certain DC voltage to the adder **65**. The adder **65** overlaps the certain DC voltage and the high frequency signal, and supplies the overlapped voltage to the position sensor **67**.

[**0073**] One output from the position sensor **67** is inputted to a differential amplifier **69** through a rectifier **68**. The differential amplifier **69** compares a sensor output signal rectified by the rectifier **68** and a preset reference signal. On the basis of the comparison result, a difference between the two input signals is calculated and a difference signal is outputted to a low pass filter **71**. A signal outputted from the low pass filter **71** is used as position information. Such position information is a signal (for example, 60 Hz) used to detect the position of the piston, which is provided to a position calculating unit **79** through a peak detecting unit **73**.

[**0074**] The other output from the position sensor **67**, having a characteristic that its value is decreased if a surrounding temperature is increased, is provided to a temperature detecting low pass filter **75**. In this case, a high frequency signal of the output value is varied according to the position of the piston. Therefore, a low pass filter having a cut-off frequency of several Hz is used as the low pass filter **75**. The low pass filter **75** separates only a DC signal from the inputted signal. The separated DC signal is amplified to an appropriate level by an amplifier **77** for the purpose of signal processing. The amplified signal is provided to the position calculating unit **79** as temperature information.

[**0075**] The position calculating unit **79** corrects the position information on the basis of the temperature information, and provides the temperature-corrected position information to an instruction value calculating unit **81**. The instruction value calculating unit **81** converts the temperature-corrected position information into digital information, and outputs a control signal to a compressor driving unit **83** to drive the compressor on the basis of the digital position information. Accordingly, the compressor driving unit **83** outputs a drive signal to the compressor to drive the compressor.

[**0076**] However, as a temperature increases, the value of the position information increases, while the value of the temperature information decreases. The temperature information and the position information must have a linear relationship in order for the position calculating unit **79** to employ a manner in which the position information is added to the amplified temperature information to correct the position information.

[**0077**] Therefore, a modified embodiment shown in **FIG. 12** is applied to the present invention to provide against a case where the temperature information and the position information do not have a linear relationship.

[**0078**] **FIG. 12** is a block diagram of another embodiment of an apparatus to control a linear compressor according to a modified embodiment of **FIG. 11** to illustrate the operation of correcting position information according to inputted temperature information by an instruction value calculating unit of **FIG. 11**.

[**0079**] Referring to **FIG. 12**, the linear compressor control apparatus employs a method in which a signal used to obtain position detection (several KHz), generated by the high frequency signal generating unit **61**, and a signal used to obtain temperature detection (certain DC voltage), generated by the DC voltage generating unit **63**, are overlapped by the adder **65**, and the overlapped signal is provided to the position sensor **67**. One output from the position sensor **67** passes through the rectifier **68**, the differential amplifier **69**, the low pass filter **71** and the peak detecting unit **73**, and is provided to an instruction value calculating unit **81***a* as position information. The other output from the position sensor **67** passes through the low pass filter **75**, and is provided to the instruction value calculating unit **81***a* as temperature information.

[**0080**] The instruction value calculating unit **81***a* converts the position information and the temperature information into digital information, respectively, and corrects the position information according to the digital temperature information. In this case, the instruction value calculating unit **81***a* uses a preset lookup table to correct the position information by the temperature information and the position information which have a non-linear relationship. Temperature-corrected position information is provided to the compressor driving unit **83**. The compressor driving unit outputs a drive signal to the compressor to drive the compressor.

[**0081**] Even though not described in the above embodiment, it is possible to compensate for output distortion of the position sensor by considering only a load variation, which may be easily appreciated by those skilled in the field from the embodiment of **FIG. 2**.

[0082] As described above, the present invention provides an apparatus and method of controlling a linear compressor, which compensates for distortion of a sensor output caused by the shifting of the center of a resonance point due to internal temperature of the compressor and load variation in driving the linear compressor according to the position of a piston, thus enabling the linear compressor to be controlled with an optimal top clearance and consequently improving control accuracy. Further, the present invention varies the capacity of the compressor appropriately on the basis of load information obtained according to resonance point shift data, thereby enabling the linear compressor to actively cope with load variation by itself, and consequently reducing power consumption.

[0083] Further, the present invention is advantageous in that a high frequency signal and a DC voltage are overlapped to be provided to a position sensor, a high frequency signal and a DC signal are separated from an output of the position sensor, and the separated high frequency signal and the DC signal are used as a position detection signal and a temperature detection signal, respectively, thus enabling position detection and temperature detection to be simultaneously performed, and easily implementing hardware for position and temperature detection.

[0084] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made to the above embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. An apparatus to control a linear compressor having a piston reciprocating in a cylinder of the linear compressor, comprising:

a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor; and

a compensating unit to compensate for output distortion of the position detecting unit due to internal temperature of the compressor and load variation.

2. The linear compressor control apparatus according to claim 1, wherein said position detecting unit detects the position of the piston when alternating current (AC) power is supplied and detects the internal temperature of the compressor when direct current (DC) power is supplied.

3. The linear compressor control apparatus according to claim 2, further comprising a power supply unit to selectively supply AC power and DC power to the position detecting unit.

4. The linear compressor control apparatus according to claim 3, wherein said power supply unit supplies the AC power to the position sensor if the load is unstable and supplies the DC power to the position sensor if the load is stable.

5. The linear compressor control apparatus according to claim 1, wherein said compensation unit comprises:

a temperature detecting unit to detect the internal temperature of the linear compressor;

a resonance point shift detecting unit to detect the amount of shift of a piston resonance point due to the load variation;

a position calculating unit to compensate for an error of a maximum stroke of the piston detected by the position detecting unit according to the internal temperature of the linear compressor and the amount of shift of the piston resonance point; and

an instruction value calculating unit to output a drive instruction to drive the linear compressor according to the maximum stroke compensated by the position calculating unit.

6. The linear compressor control apparatus according to claim 5, wherein said compensating unit further comprises a load amount calculating unit to calculate the amount of load according to the amount of shift of the piston resonance point and the instruction value calculating unit drives the linear compressor by considering the calculated load amount.

7. A method of controlling a linear compressor having a position detecting unit to detect a position of a piston of the linear compressor, comprising:

supplying alternating current (AC) power to the position detecting unit, detecting the position of the piston according to an output of the position detecting unit, and detecting a load according to the detected position of the piston;

supplying direct current (DC) power to the position detecting unit and detecting internal temperature of the linear compressor according to the output of the position detecting unit; and

compensating for output distortion of the position detecting unit according to the detected internal temperature of the linear compressor and the detected load.

8. The linear compressor control method according to claim 7, wherein said internal temperature of the linear compressor is detected when an activating time of the compressor is counted and a counted activating time exceeds a preset time.

9. A method of controlling a linear compressor having a position detecting unit to detect a position of a piston of the linear compressor, comprising:

detecting internal temperature of the linear compressor;

detecting the amount of shift of a resonance point of the piston;

compensating for an error of a maximum stroke of the piston detected by the position detecting unit according to the internal temperature of the linear compressor and the amount of shift of the piston resonance point; and

driving the linear compressor according to the compensated maximum stroke.

10. An apparatus to control a linear compressor, comprising:

a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor;

a power supply unit to supply drive power to the position detecting unit; and

a compensating unit to compensate for output distortion of the position detecting unit due to internal temperature of the linear compressor.

11. The linear compressor control apparatus according to claim 10, wherein said power supply unit supplies drive power obtained by overlapping a high frequency signal for detecting the position of the piston and a direct current (DC) voltage for detecting the internal temperature of the linear compressor.

12. The linear compressor control apparatus according to claim 11, wherein said power supply unit comprises:

a high frequency signal generating unit to generate the high frequency signal;

a DC voltage generating unit to generate the DC voltage with a predetermined level; and

an adder to overlap the DC voltage and the high frequency signal.

13. The linear compressor control apparatus according to claim 10, wherein said compensation unit comprises a low pass filter to eliminate a high frequency component from an output of the position detecting unit, and compensates for output distortion of the position detecting unit using a signal whose high frequency component is eliminated by the low pass filter.

14. The linear compressor control apparatus according to claim 13, wherein said compensation unit comprises:

a position calculating unit to amplify the internal temperature information and then correcting position information, if the temperature information whose high frequency component is eliminated by the low pass filter and the position information obtained from the output of the position detecting unit have a linear relationship; and

an instruction value calculating unit to output a drive signal to drive the linear compressor on the basis of the position information which is corrected by the position calculating unit.

15. The linear compressor control apparatus according to claim 13, wherein said compensation unit further comprises:

an instruction value calculating unit to receive temperature information and position information, respectively, correct the position information according to the temperature information using a preset lookup table, and output a drive signal to drive the compressor on the basis of the corrected position information, if the temperature information whose high frequency component is eliminated by the low pass filter and the position information obtained from the output of the position sensor have a non-linear relationship.

16. An apparatus to control a linear compressor, comprising:

a position detecting unit to detect a position of a piston reciprocating in a cylinder of the linear compressor;

a power supply unit to supply drive power to the position detecting unit; and

a compensating unit to calculate the amount of shift of a piston resonance point and a load from the position of the piston, and compensate for output distortion of the position detecting unit on the basis of the calculated load.

17. The linear compressor control apparatus according to claim 16, wherein said power supply unit supplies alternating current (AC) power to the position detecting unit.

18. The linear compressor control apparatus according to claim 5, wherein the temperature detecting unit determines the variation of the load according to a shift change rate of a resonance point (Δ resonance point shift data) and provides an AC supply instruction to the power supply unit **14** when the load is unstable so the power supply unit **14** supplies AC power, or the temperature detecting unit **31** provides a DC supply instruction to the power supply unit **14** when the load is stable so the power supply unit **14** supplies DC power.

19. An apparatus to control a linear compressor comprising:

a high frequency signal generating unit;

a DC voltage generating unit;

an adder to add the outputs of both the high frequency signal generating unit and the DC voltage generating unit; and

a position sensor to receive the output from the adder a provide two sensor output signals.

20. The linear compressor control apparatus according to claim 19, wherein the position sensor comprises:

a magnetic core; and

first and second coils symmetrically would around the magnetic core.

21. The linear compressor control apparatus according to claim 19, wherein the position sensor is connected at one end to the a high frequency signal generating unit through a first resistor and at another end to a potential through a second resistor.

22. The linear compressor control apparatus according to claim 21, wherein the adder overlaps DC voltage and the high frequency signal and supplies the overlapped voltage to the position sensor.

23. The linear compressor control apparatus according to claim 22, further comprising:

a rectifier to rectify one of the sensor output signals;

a differential amplifier to receive the rectified sensor output signal from the position sensor and compare the rectified signal with a preset reference signal to provide a difference signal;

a low pass filter to receive the difference signal and provide position information;

a peak detecting unit to receive the position information and output the position information; and

a position calculating unit to receive the position information from the peak detecting unit.

24. The linear compressor control apparatus according to claim 23, further comprising:

a low pass filter to receive the second sensor output signal having a characteristic that a value thereof is decreased if a surrounding temperature is increased, wherein a high frequency signal of the second sensor output signal is varied according to the position of the piston.

25. The linear compressor control apparatus according to claim 24, wherein the low pass filter has a cutoff of several Hertz and separates only a DC signal.

26. The linear compressor control apparatus according to claim 24, further comprising:

an amplifier to amplify the separated DC signal and provide the amplified signal to the position calculating unit as temperature information.

27. The linear compressor control apparatus according to claim 26, wherein the position calculation unit corrects the position information on the basis of the temperature information.

28. The linear compressor control apparatus according to claim 27, further comprising:

an instruction value calculating unit to receive the temperature-corrected position information and convert the temperature-corrected position information into digital information; and

a compressor driving unit driving the linear compressor based on the digital information output received from the instruction value calculating unit.

29. The linear compressor control apparatus according to claim 22, further comprising:

a rectifier to rectify one of the sensor output signals;

a differential amplifier to receive the rectified sensor output signal from the rectifier and compare the rectified sensor output signal with a preset reference signal to provide a difference signal;

a low pass filter to receive the difference signal and provide position information; and

a peak detecting unit to receive the position information and output the position information.

30. The linear compressor control apparatus according to claim 29, further comprising:

a low pass filter to output temperature information from determined from the second sensor output signal received from the position sensor, the temperature information output having a characteristic that a value thereof is decreased if a surrounding temperature is increased, wherein a high frequency signal of the second sensor output signal is varied according to the position of the piston.

31. The linear compressor control apparatus according to claim 30, further comprising:

an instruction value calculating unit to receive the position information from the peak detecting unit and the temperature information output from the low pass filter and converts the position information and temperature information signals into digital information, and corrects the position information according to the digital temperature information; and

a compressor driving unit to drive the linear compressor according to the information received from the instruction value calculating unit.

32. The linear compressor control apparatus according to claim 31, wherein the instruction value calculating unit uses a lookup table to correct the position information by the temperature information and the position information.

33. A linear compressor control apparatus comprising:

a high frequency signal generating unit to generate a high frequency signal;

a DC voltage generating unit to generate a DC voltage;

an adder to overlap the high frequency signal and the DC voltage signal; and

a position sensor to receive the output from the adder and separate a high frequency signal and a DC signal to be used as a position detection signal and a temperature detection signal, respectively, such that position detection and temperature detection are performed simultaneously.

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