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Harris

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(54) **PRECISION SHAFT ALIGNMENT SYSTEM**

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G01B 5/24 (2006.01)

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(58) **Field of Classification Search** **33/286,**
33/412, 529, 613, 645

See application file for complete search history.

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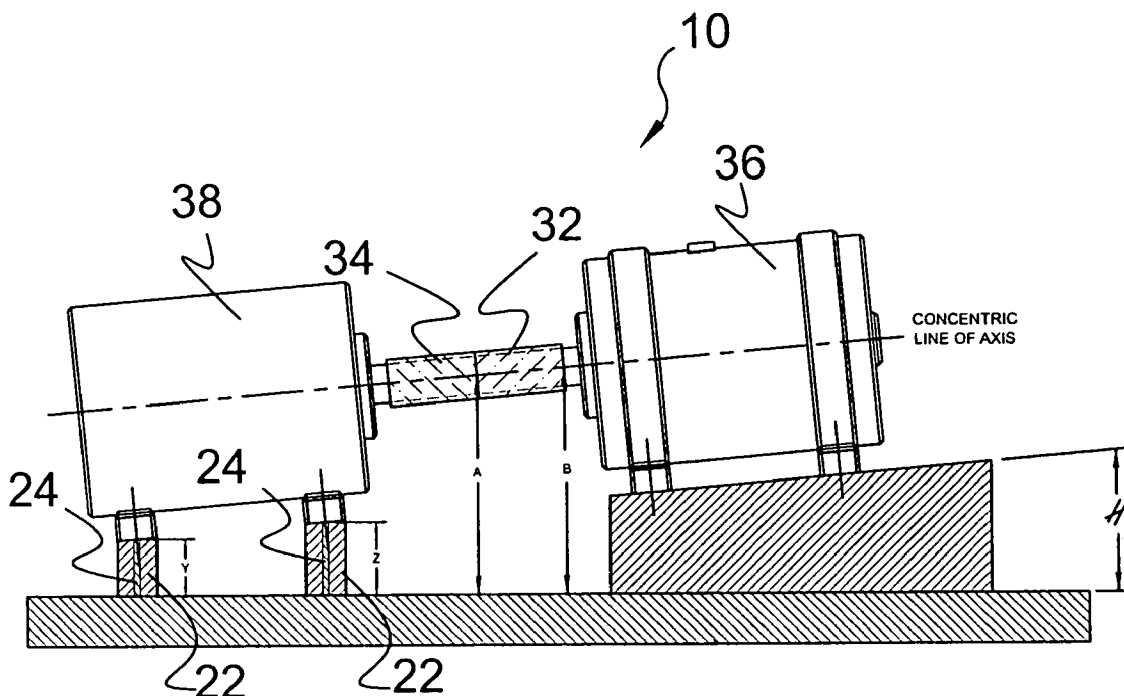
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(57) **ABSTRACT**

A precision shaft alignment system for establishing concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft that can be configured for stand-alone or retrofitted with an existing measuring system.

8 Claims, 15 Drawing Sheets



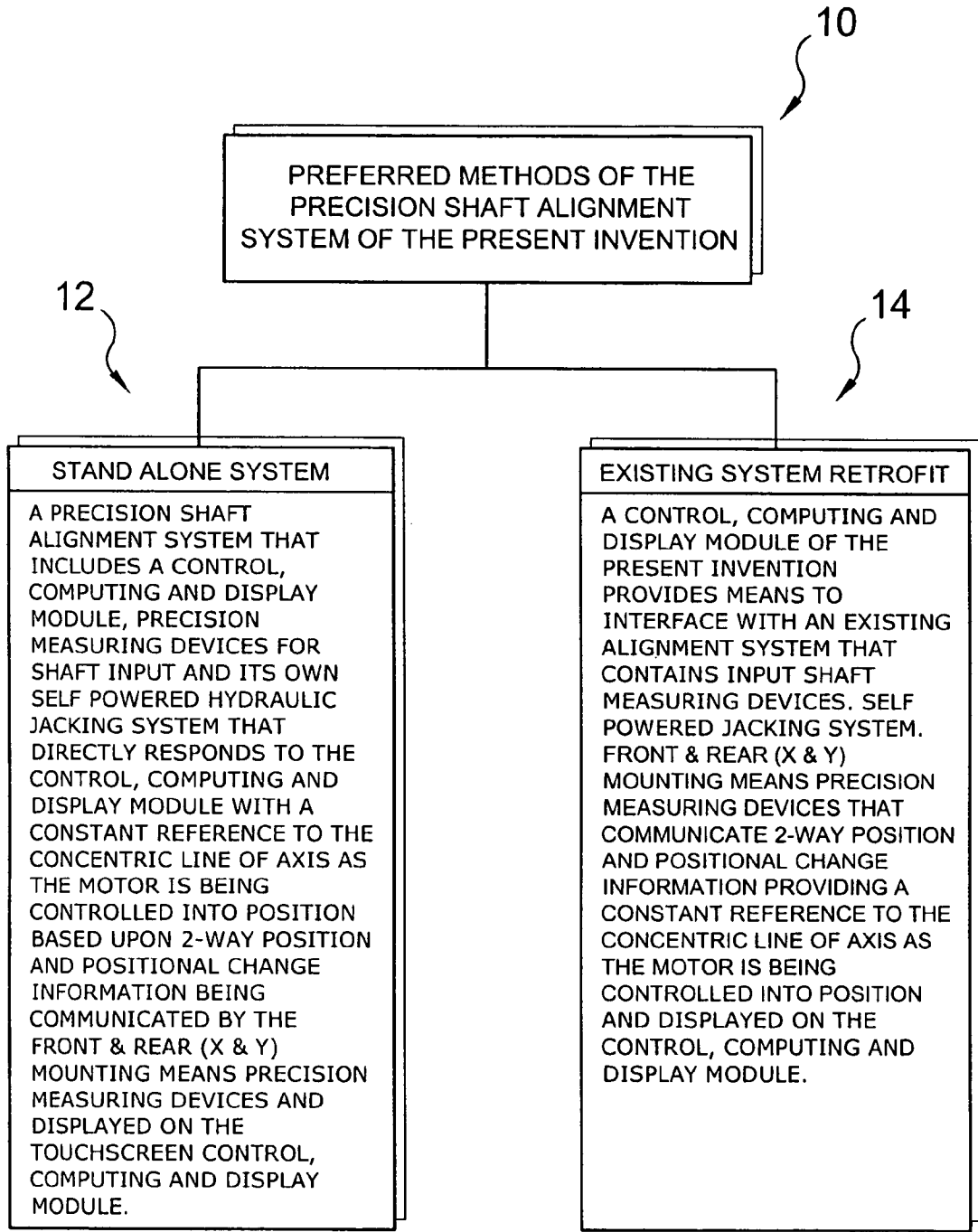


FIG. 1

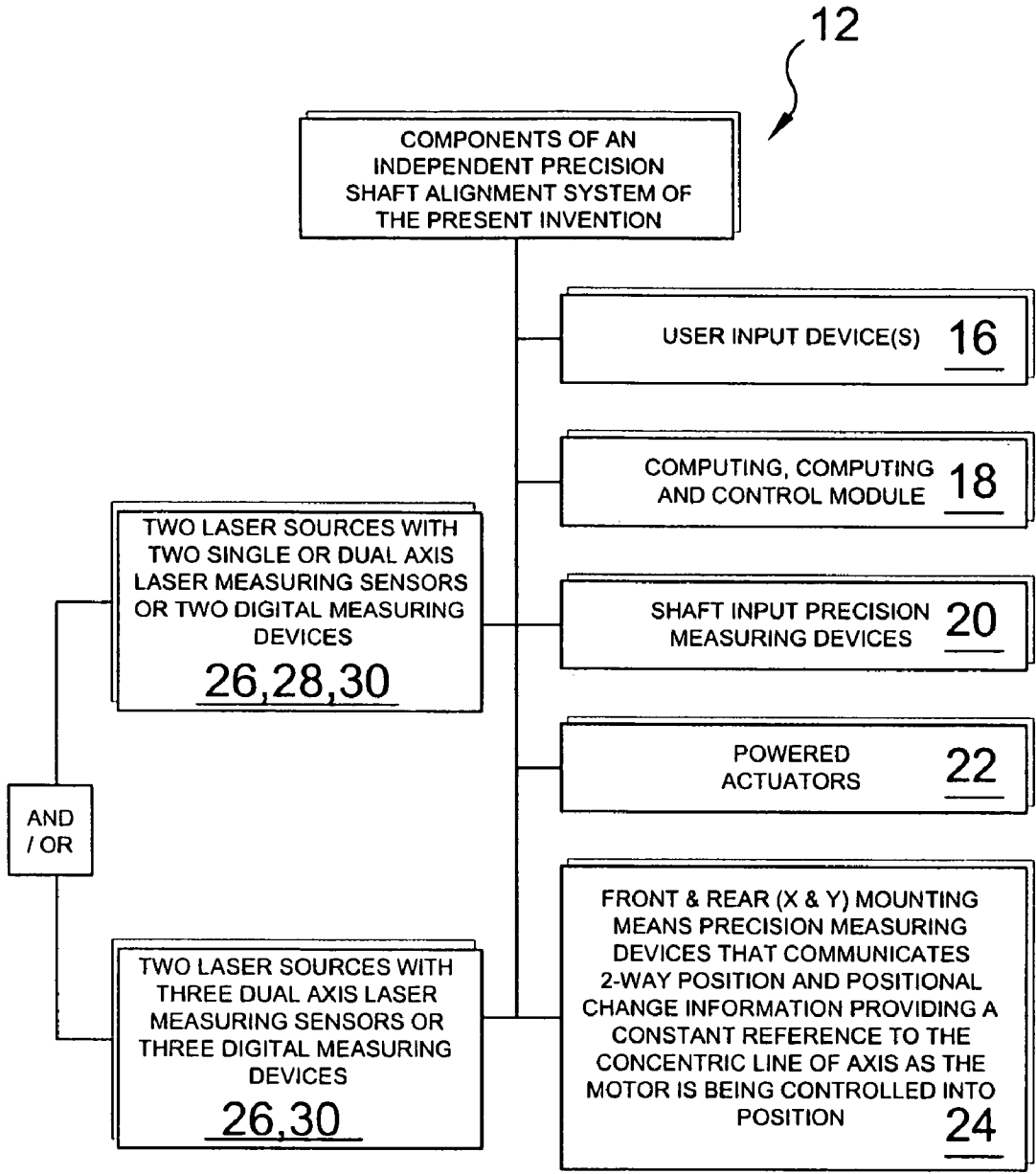


FIG. 2

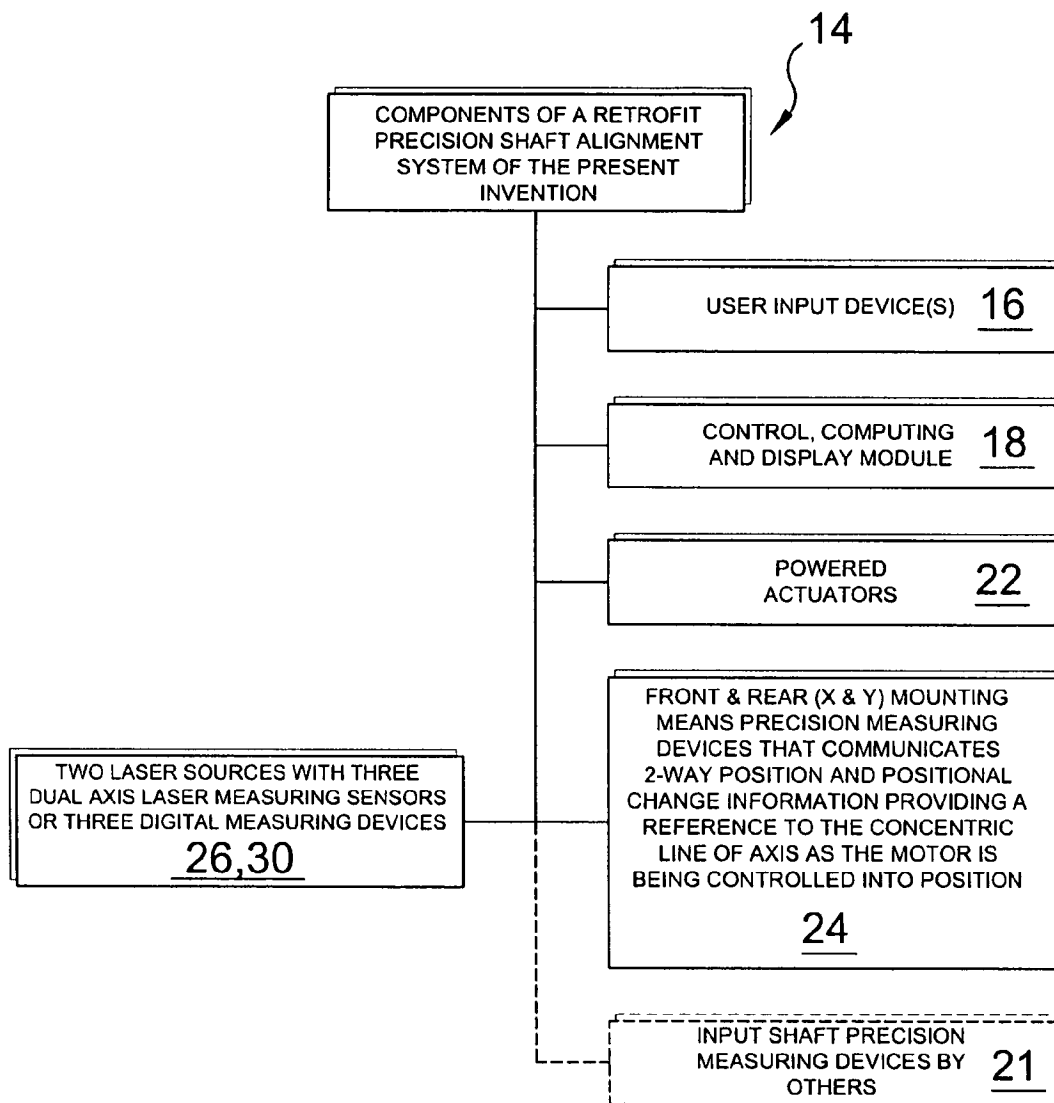


FIG. 3

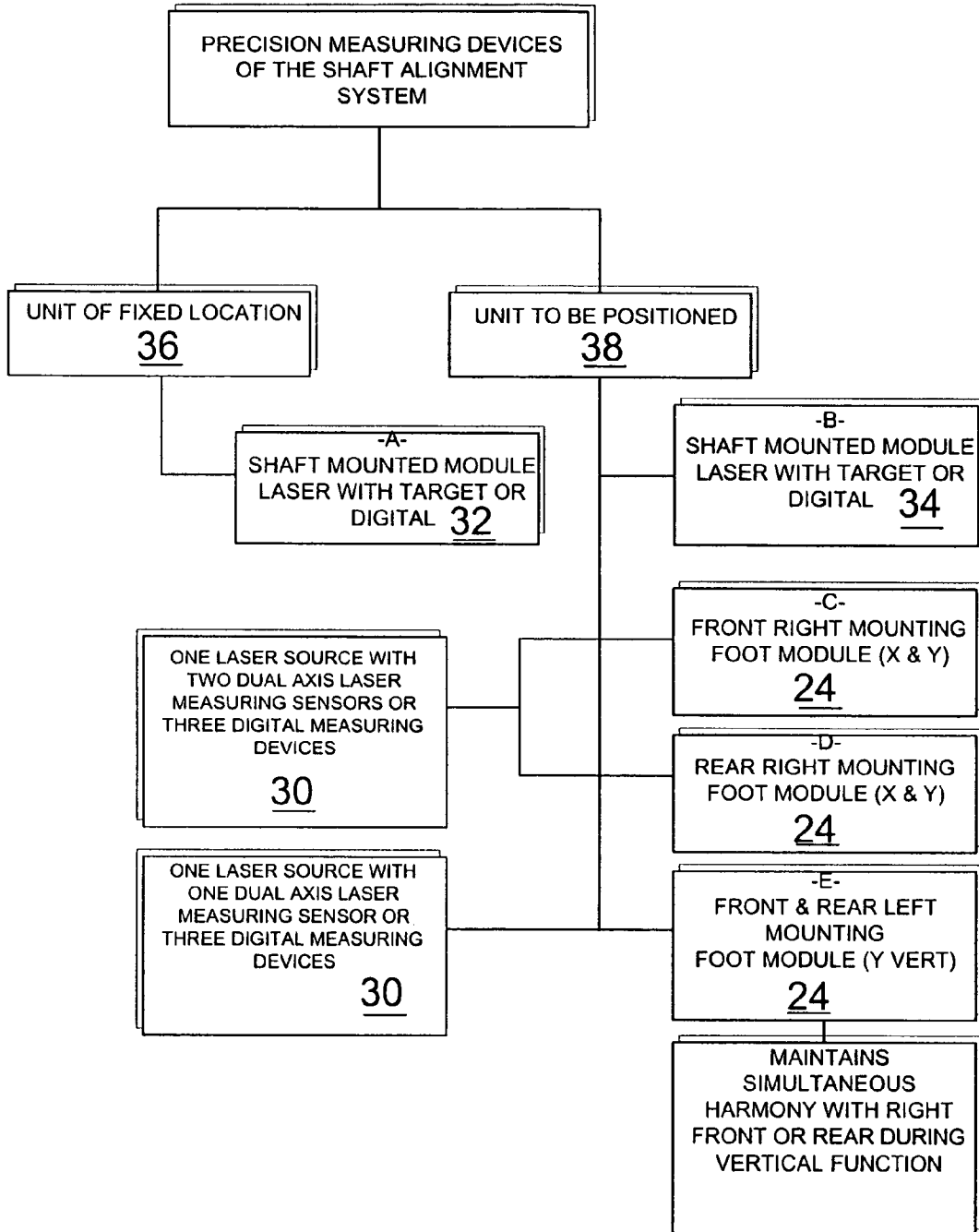
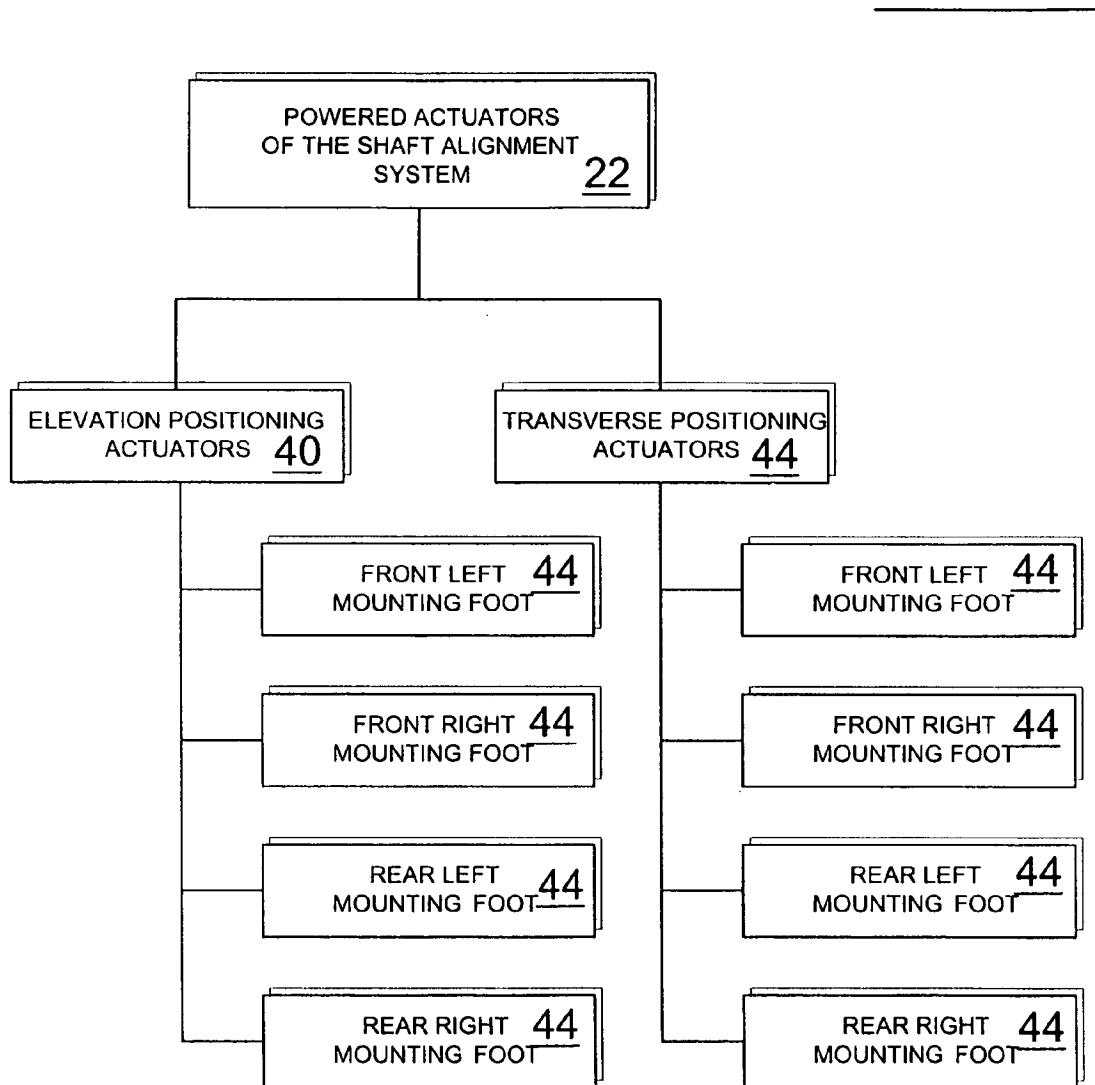


FIG. 4



NOTE: ALL OF THE ABOVE, CONTROLLED POSITIONING IS ACHIEVED BY TWO HYDRAULIC POWERED VERTICAL / HORIZONTAL JACKING ASSEMBLIES.

FIG. 5

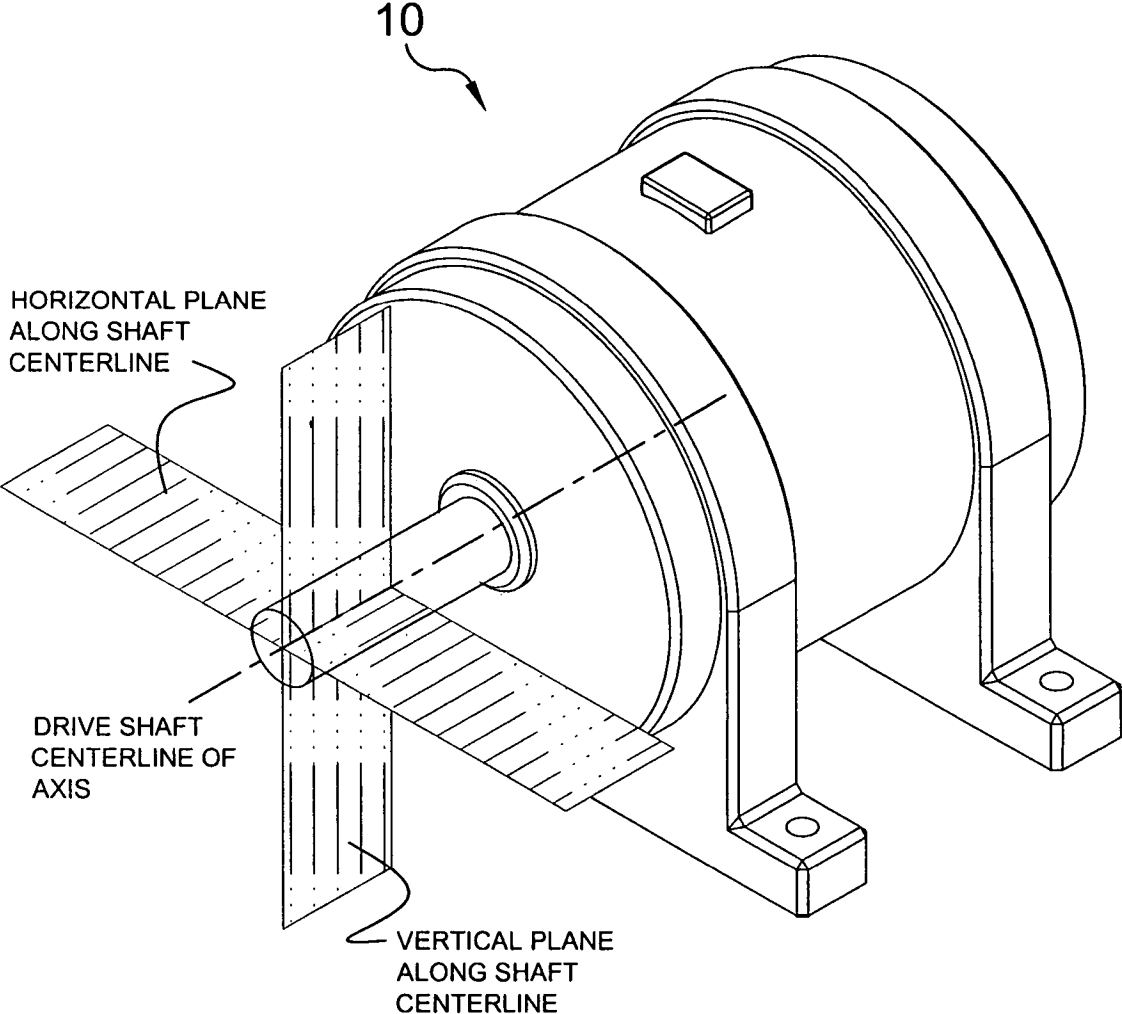


FIG. 6

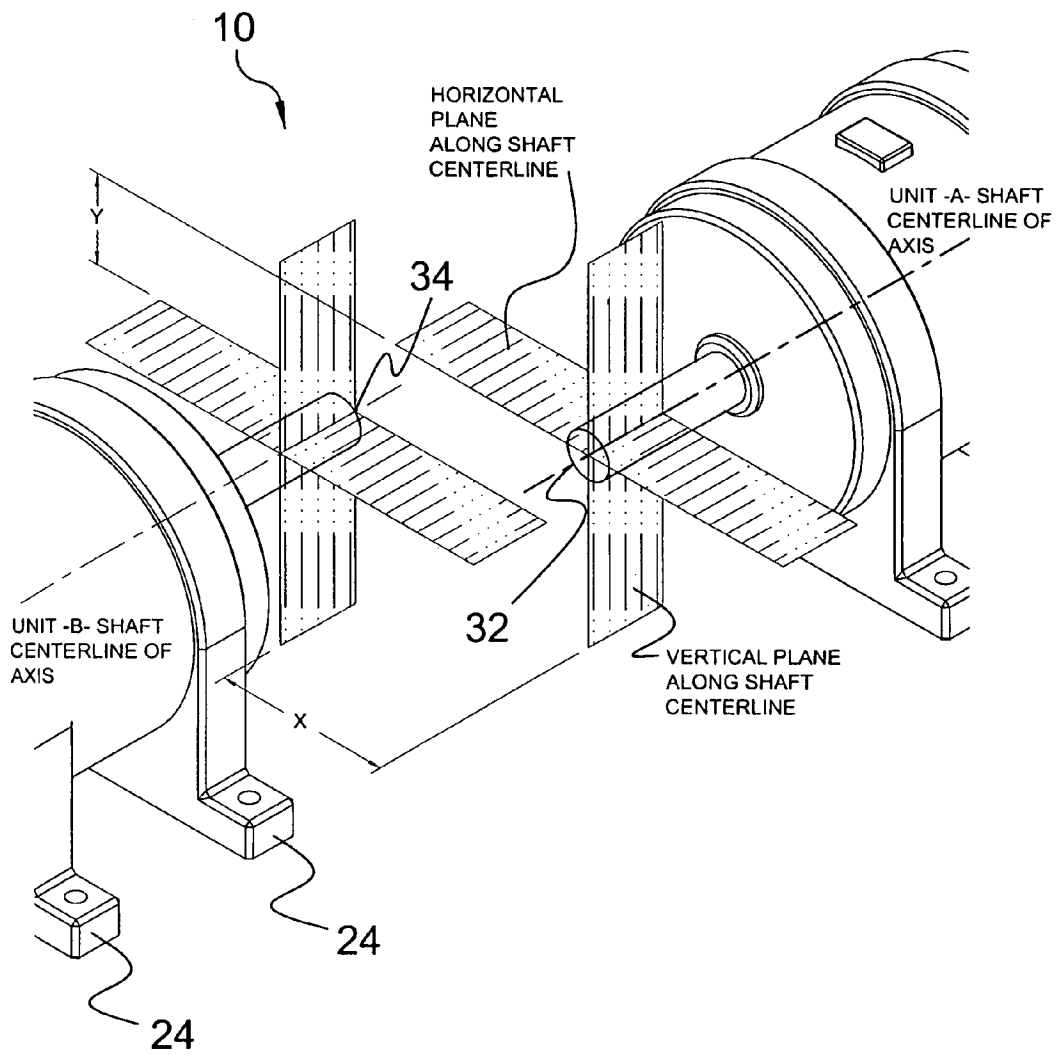


FIG. 7

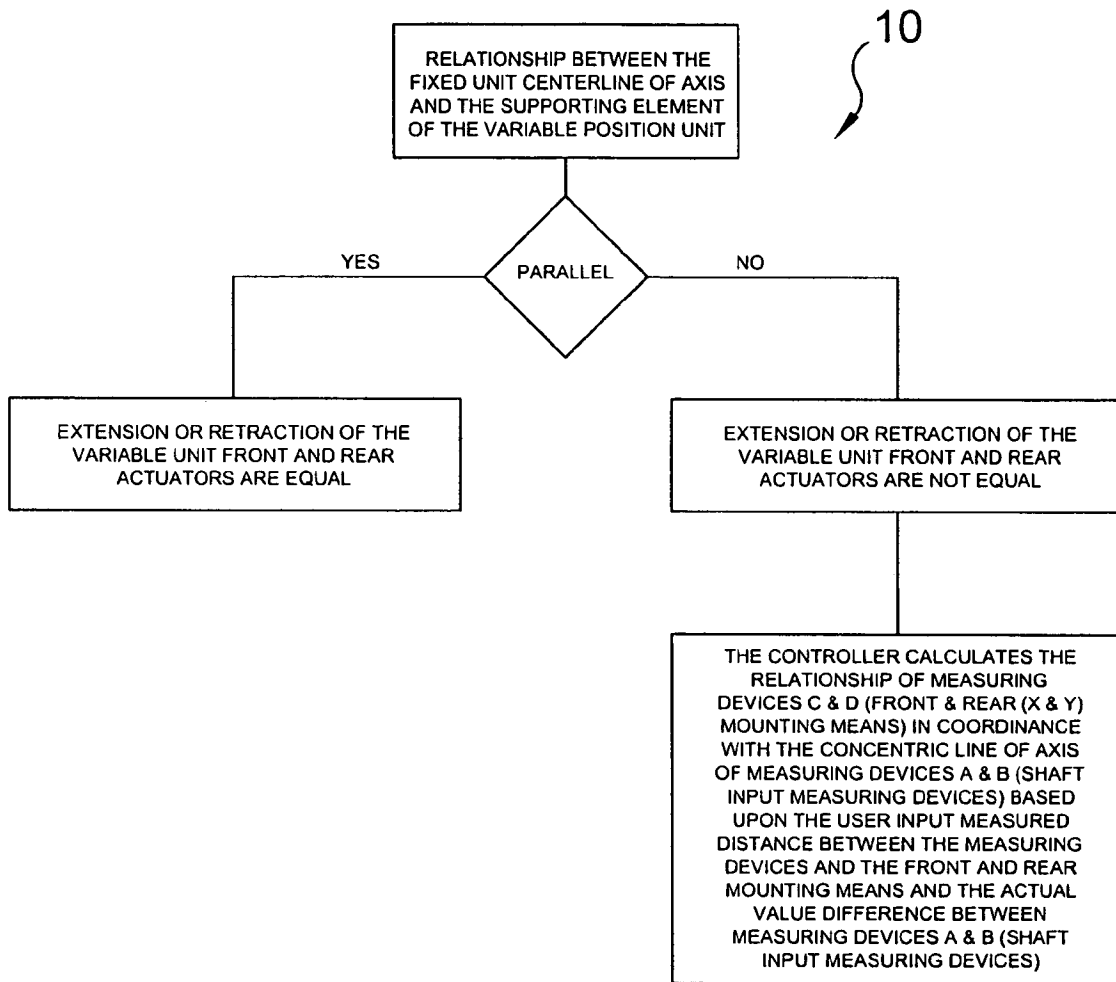


FIG. 8

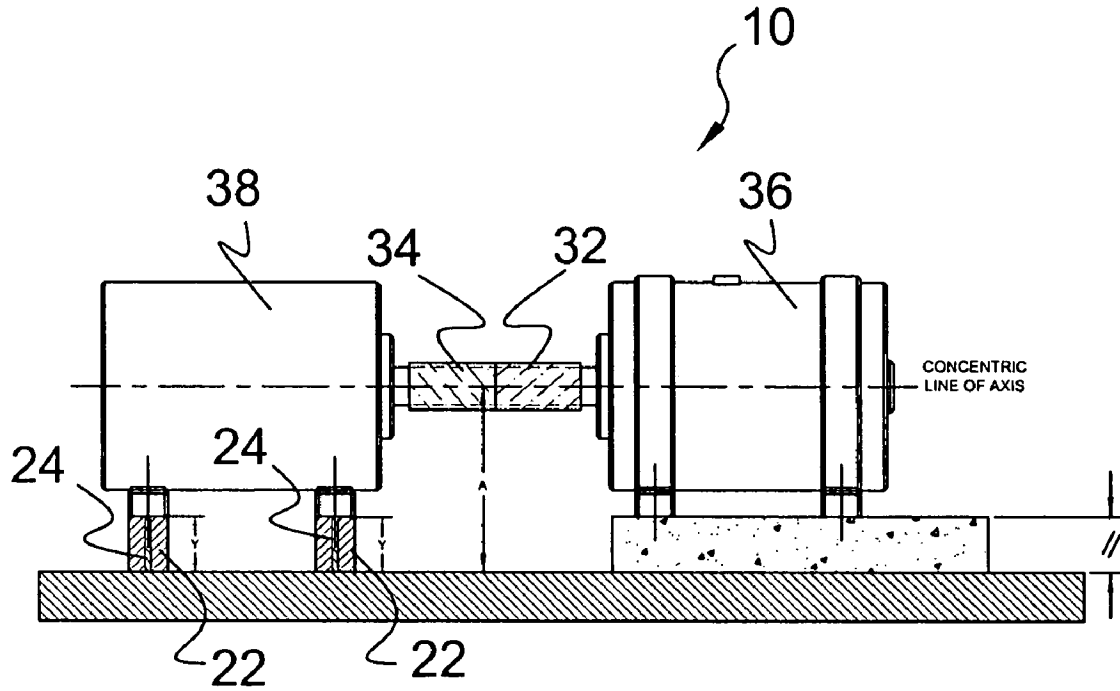


FIG. 9

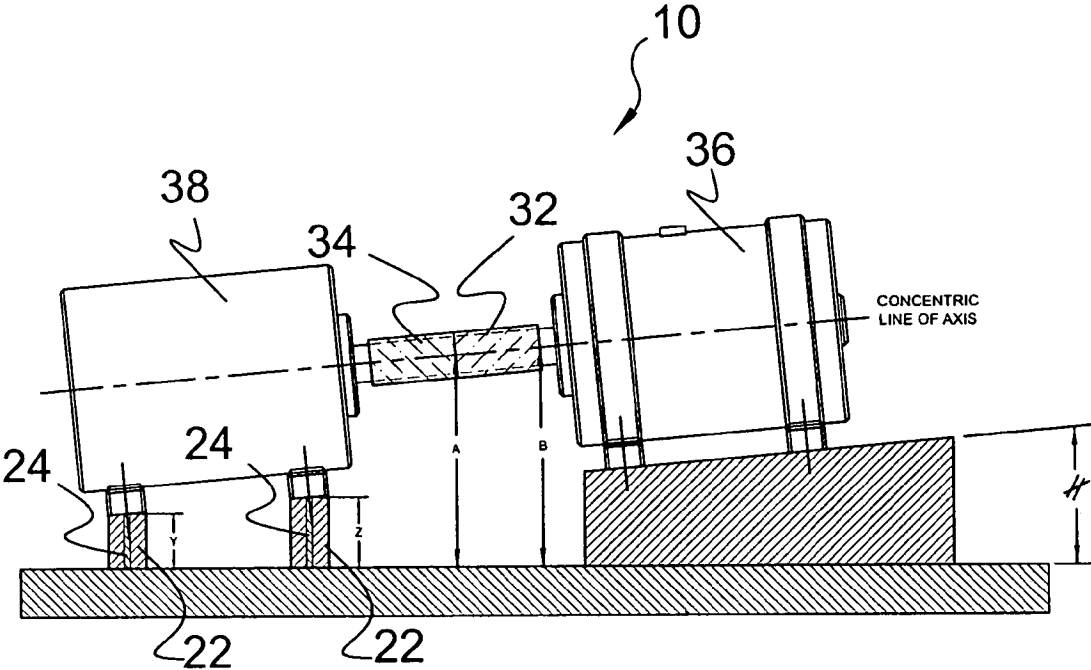


FIG. 10

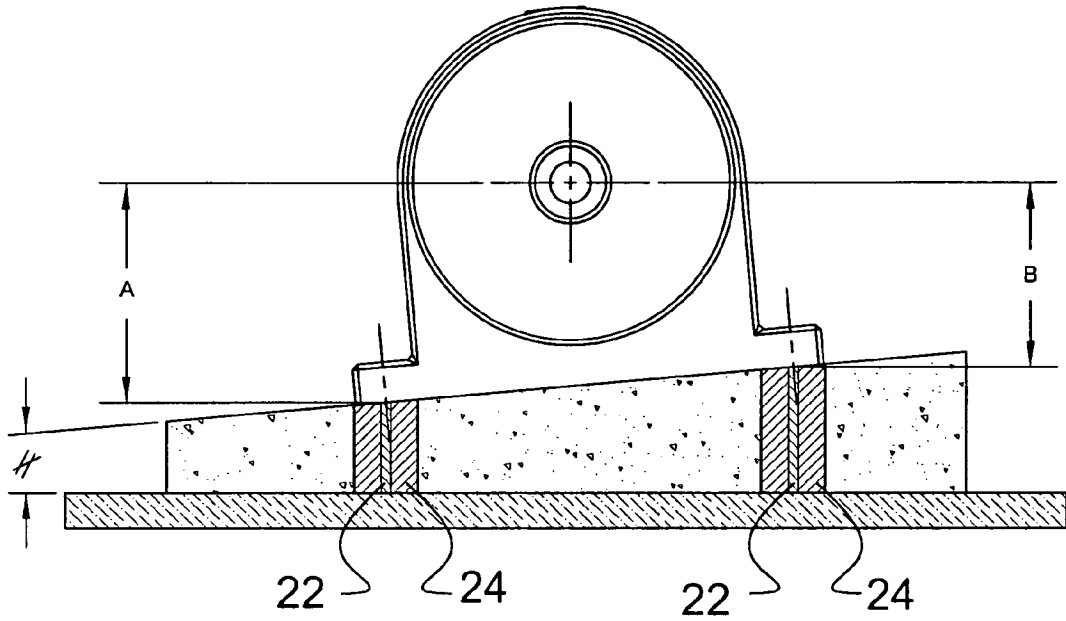


FIG. 11

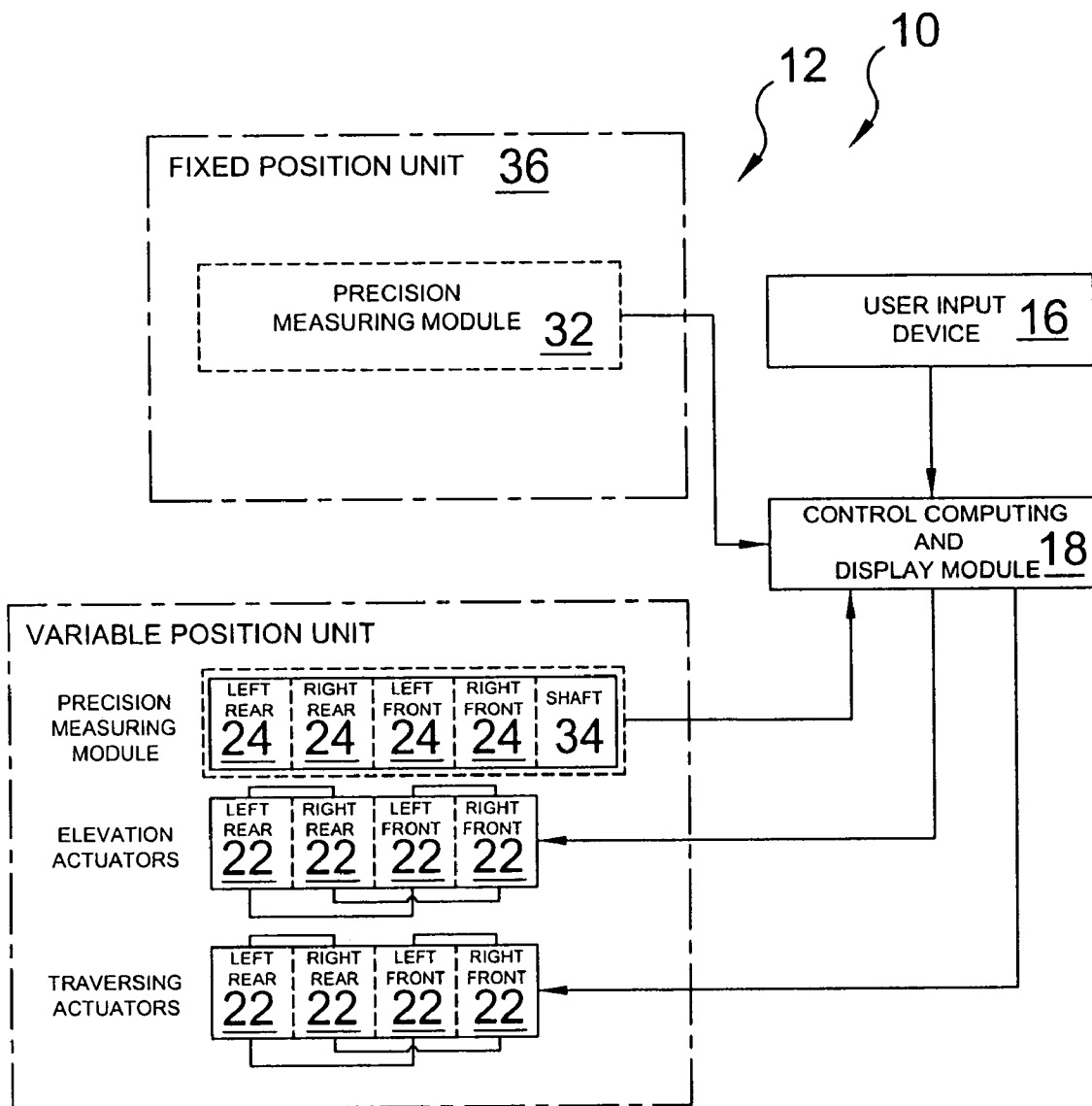


FIG. 12

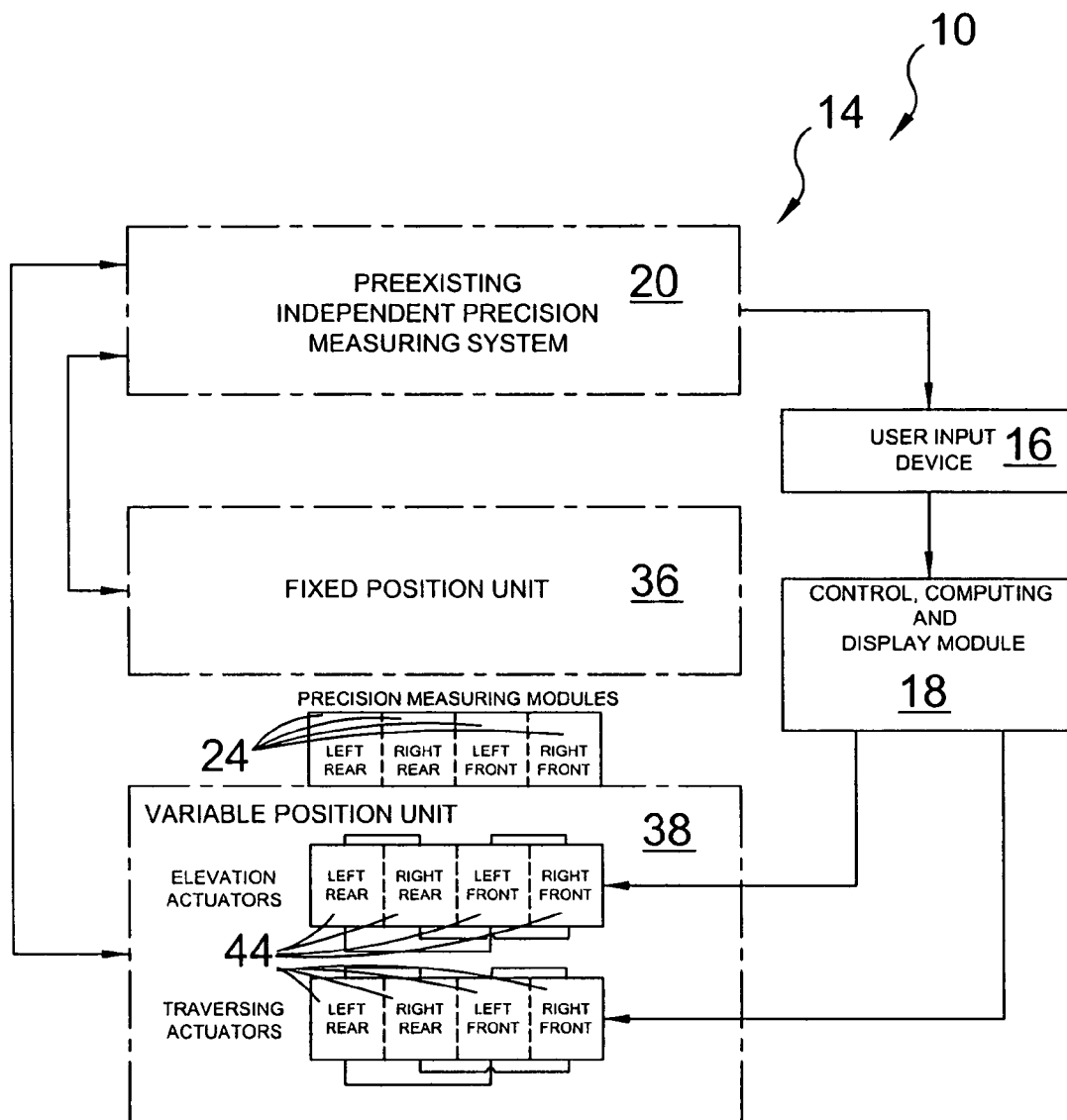


FIG. 13

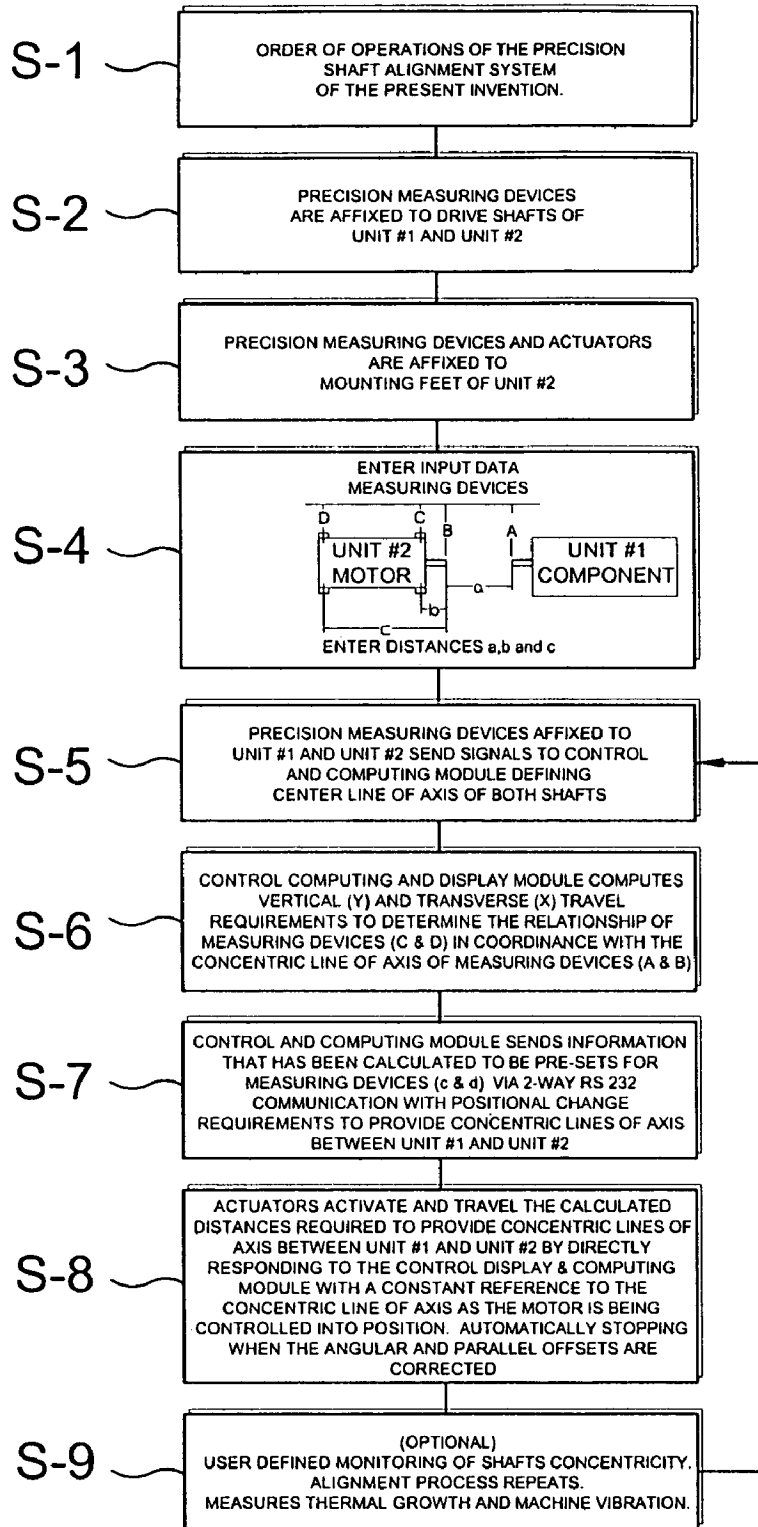


FIG. 14

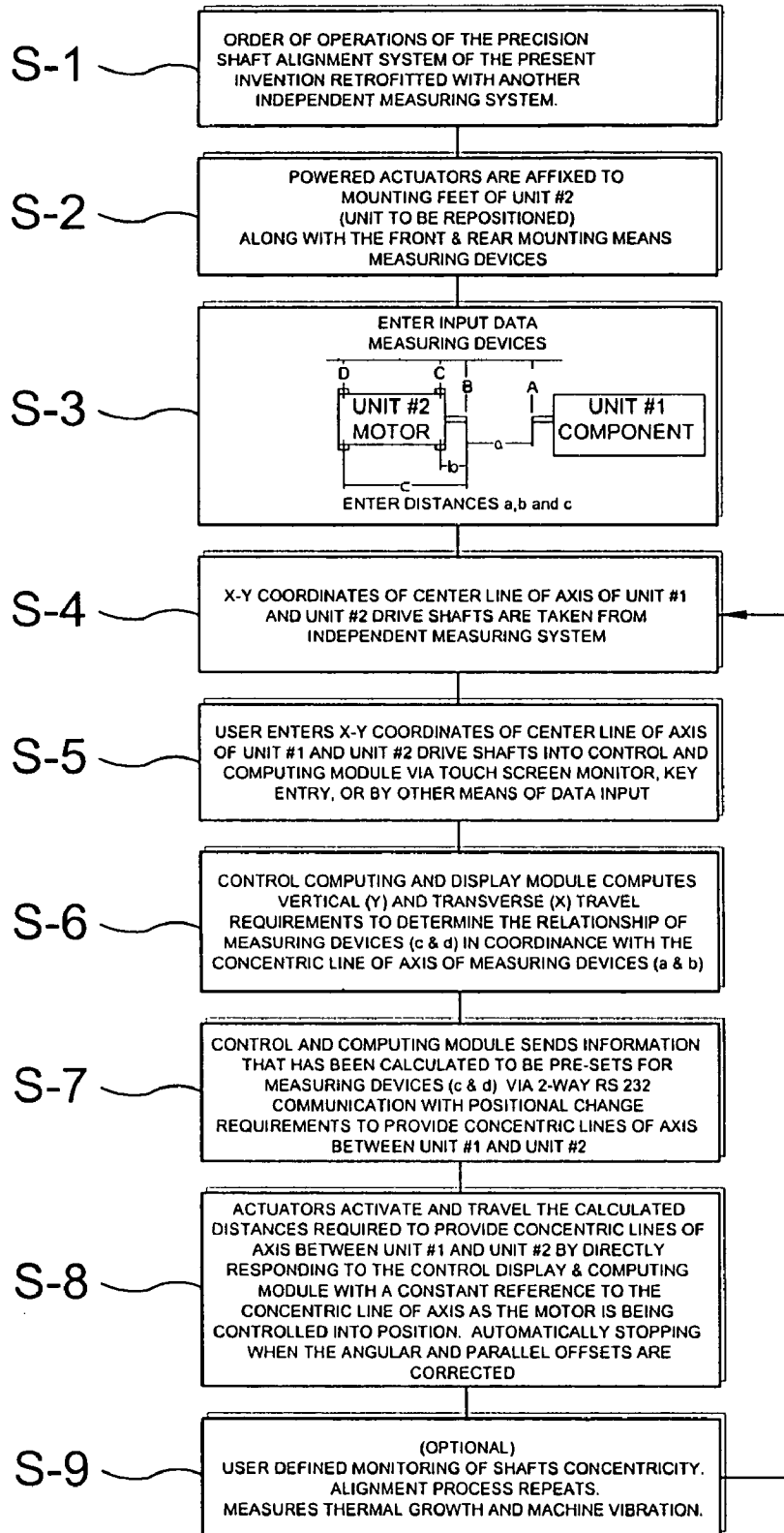


FIG. 15

PRECISION SHAFT ALIGNMENT SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to alignment systems and, more specifically, to a precision shaft alignment system for establishing concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft.

There is a known need in the art to properly align the shaft of a first torque producing unit with the shaft of a second loading (component) unit. The desired axial alignment, if true and precise, provides for the high efficiency coupling of torque from the first unit to the second unit. Often the shafts are associated with respective rotating members of the each unit. The misalignment of the shafts may provide an x,y angular alignment error where the center-lines of the two shafts intersect at an angle, or may be manifested by a x,y parallel offset misalignment error where the respective shafts are parallel but exhibit an axial offset with the center-lines of each shaft not concentrically or coaxially aligned. Of course, a combination of angular and parallel offset misalignments are certainly possible. If the units are not properly aligned, where the respective shafts are not axially aligned along a common center-line or axis, the result may be damage to various components including items such as bearings, seals, gears, couplings, and ultimately machine failure. In addition, energy lost via friction and "vibration" may be conserved with proper axial alignment and delivered to the load.

The precision shaft alignment system of the present invention meets these needs and provides means to ensure concentrically or coaxially aligned shafts.

The precision shaft alignment system of the present invention may be utilized as a stand alone system, or may be retrofitted with an existing measuring system. Both methods provide the user with a high precision and efficient means to align a motor drive shaft with the shaft of a motor driven machine or the like. The precision shaft alignment system of the present invention features a portable, removable user friendly automated approach to the alignment process. The system provides means for a much higher degree of positioning accuracy and results in reducing the amount of time required to achieve the alignment from hours to just minutes.

When utilized as a stand alone system, the precision shaft alignment system of the present invention includes a user input device such as a touch screen monitor, key entry, or other, a computing, control and display module that calculates and initiates control of the required positional travel, precision measuring devices that read and send the coordinates for the centerline of axis for each of the shafts and actuators that provide means for the unit to be repositioned. Based on the calculated position and directly responding to the positional change communication via 2-way RS 232 from measuring devices (C & D) placed at the front and rear mounting means.

A plurality of precision measuring modules are utilized to identify the X-Y coordinates of both units. The fixed unit is equipped with a digital measuring device or laser source with a single or dual axis laser measuring sensor on the drive shaft. The movable unit to be positioned is equipped with a digital measuring device or a laser source with a single or dual axis laser measuring sensors on the drive shaft. The mounting feet have two laser sources with three dual axis laser measuring sensors, or three digital measuring devices.

Additionally, a plurality of independently powered actuators is utilized to drive the unit to be positioned. Each of the mounting feet are equipped with elevation positioning actuators, as well as transverse positioning actuators providing means for horizontal positioning.

The precision measuring modules measure the X-Y coordinates along two points on the centerline of both drive shafts. These coordinates are signaled to, or data entered into the computing and control module. The computing and control module calculates the relationship of the measuring modules C & D (front and rear mounting means) in coordinance with the concentric line of axis of measuring devices A & B (fixed & movable shafts). To determine the necessary X-Y travel of the second unit to provide concentric shaft alignment.

Since the actuators are independently powered, parallel offset misalignment, angular misalignment, as well as a combination of angular and parallel offset misalignments can be corrected. Based on position and positional change communicated via two way RS 232 from and to measuring modules C & D placed at the front and rear mounting means.

When utilized as a retrofit system, the precision shaft alignment system of the present invention includes a user input device such as a touch screen monitor, key entry, or other providing means to enter shaft coordinates from the existing measuring system, a computing, control and display module that calculates and initiates and controls the required positional travel, and independently powered actuators that provide means for the unit to be repositioned. Based on information provided by (X & Y) C & D precision measuring modules that communicate 2-way position and positional changes with a reference to the concentric line of axis as the motor is being controlled into position.

Additionally, the precision shaft alignment system of the present invention provides means for a user defined and/or a continuous self monitoring for establishing and maintaining concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft including thermal growth and machine vibration by utilizing the dual axis laser measuring devices and targets.

SUMMARY OF THE PRESENT INVENTION

A primary object of the present invention is to provide a precision shaft alignment system for establishing concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft.

Another object of the present invention is to provide a stand alone or retrofit precision shaft alignment system with user input device such as a touch screen monitor, key entry, or other.

Yet another object of the present invention is to provide a stand alone or retrofit precision shaft alignment system with a computing, control and display module that calculates and initiates and controls the required positional travel for establishing concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft.

Still yet another object of the present invention is to provide a stand alone precision shaft alignment system with precision measuring devices that read and send the coordinates for the centerline of axis for each of the shafts.

Another object of the present invention is to provide a stand alone precision shaft alignment system with actuators that provide means for the unit to be repositioned and that directly responds to the control computing and display module with a constant reference to the concentric line of axis as the motor is being controlled into position based

upon 2-way via RS 232 position and positional change information being communicated by the front and rear (X & Y) measuring modules.

Still yet another object of the present invention is to provide a stand alone or retrofit precision shaft alignment system with independently powered actuators to correct offset misalignment, angular misalignment, as well as a combination of angular and parallel offset misalignments between shafts that directly responds to the control computing and display module with a constant reference to the concentric line of axis as the motor is being controlled into position based upon 2-way via RS 232 position and positional change information being communicated by the front and rear (X & Y) measuring modules.

Yet another object of the present invention is provide a retrofit precision shaft alignment system that utilizes an existing measuring system to define the required travel to achieve concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft that directly responds to the control, computing and display module with a constant reference to the concentric line of axis as the motor is being controlled into position based upon 2-way via RS 232 position and positional change information being communicated by the front and rear (X & Y) measuring modules.

Still yet another object of the present invention is to provide a user defined or self monitoring precision shaft alignment system for establishing and maintaining concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft including thermal growth and machine vibration by utilizing a plurality of laser sources with dual axis measuring sensors.

Additional objects of the present invention will appear as the description proceeds.

The present invention overcomes the shortcomings of the prior art by providing a precision shaft alignment system for establishing concentric alignment of a first rotatably mounted shaft and a second opposed, rotatably mounted shaft that can be configured for stand alone or retrofitted with an existing measuring system.

The present invention also overcomes the shortcomings of the prior art by providing a stand alone or retrofit precision shaft alignment system with independently powered actuators to correct offset misalignment, angular misalignment, as well as a combination of angular and parallel offset misalignments between shafts.

The foregoing and other objects and advantages will appear from the description to follow. In the description reference is made to the accompanying drawings, which forms a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments will be described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural changes may be made without departing from the scope of the invention. In the accompanying drawings, like reference characters designate the same or similar parts throughout the several views.

The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is best defined by the appended claims.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

In order that the invention may be more fully understood, it will now be described, by way of example, with reference to the accompanying drawing in which:

FIG. 1 is a block diagram of the precision shaft alignment system of the present invention's preferred methods;

FIG. 2 is a block diagram of the precision shaft alignment system of the present invention's component modules;

FIG. 3 is a block diagram of the precision shaft alignment system of the present invention's components;

FIG. 4 is a block diagram of the precision measuring devices of the shaft alignment system of the present invention;

FIG. 5 is a block diagram of the powered actuator devices for the shaft alignment system of the present invention;

FIG. 6 is an illustrative view of the precision measuring devices of the shaft alignment system of the present invention;

FIG. 7 is an illustrative view of the precision measuring devices of the shaft alignment system of the present invention;

FIG. 8 is a diagram describing the travel requirements based on the defined X-Y coordinates of both shafts;

FIG. 9 is an illustrative view describing the travel requirements based on the defined X-Y coordinates of both shafts;

FIG. 10 is an illustrative view describing the travel requirements based on the defined X-Y coordinates of both shafts;

FIG. 11 is an illustrative view describing the travel requirements based on the defined X-Y coordinates of both shafts;

FIG. 12 is a diagram of the precision shaft alignment system of the present invention's component modules;

FIG. 13 is a block diagram of the precision shaft alignment system of the present invention's component modules;

FIG. 14 is a diagram of the precision shaft alignment system of the present invention's order of operations; and

FIG. 15 is a diagram of the precision shaft alignment system of the present invention's order of operations.

DESCRIPTION OF THE REFERENCED NUMERALS

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, the figures illustrate the Precision Shaft Alignment Apparatus of the present invention of the present invention. With regard to the reference numerals used, the following numbering is used throughout the various drawing figures.

10 Precision Shaft Alignment Apparatus of the present invention

12 stand-alone system of **10**

14 existing system retrofit of **10**

16 user input device

18 computing and control module

20 shaft input precision measuring devices by others

22 powered actuators

24 mounting means precision measuring devices

26 digital measuring device

28 single axis laser measuring sensor

30 dual axis laser measuring sensor

32 shaft-mounted measuring device on fixed unit shaft

34 shaft-mounted measuring device on variable position unit shaft

5

36 fixed unit
 38 variable position unit
 40 elevation actuators
 43 first post of 40
 44 transverse positioning actuator
 46 shaft of 36
 48 shaft of 38

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following discussion describes in detail one embodiment of the invention (and several variations of that embodiment). This discussion should not be construed, however, as limiting the invention to those particular embodiments, practitioners skilled in the art will recognize numerous other embodiments as well. For definition of the complete scope of the invention, the reader is directed to appended claims.

FIG. 1 is a block diagram of the precision shaft alignment system of the present invention's 10 preferred methods. The precision shaft alignment system of the present invention 10 may be utilized as a stand-alone system 12, or may be retrofitted with an existing measuring system 14. Both methods provide the user with a high precision and efficient means to align a motor drive shaft with the shaft of a motor driven machine or the like.

FIG. 2 is a block diagram of the precision shaft alignment system of the present invention's component modules when utilized as a stand alone system 12, including a user input device 16 such as a touch screen monitor, key entry, or other, a computing and control module 18 that calculates and initiates the required positional travel, precision measuring devices two laser sources with two single or dual axis laser measuring sensors 28 or 30 or two digital measuring devices 26 that read and send the coordinates for the centerline of axis for each of the shafts and actuators 22 that provide means for the unit to be repositioned. Including front and rear (X & Y) precision measuring devices 24 (two laser sources with three dual axis laser measuring sensors 30 or three digital measuring devices 26) that communicate 2-way position and positional change information providing a constant reference to the concentric line of axis as the motor is being controlled into position by direct response to the controller.

FIG. 3 is a block diagram of the precision shaft alignment system of the present invention's component modules when utilized as a retrofit system 14 includes a user input device 16 such as a touch screen monitor, key entry, or other providing means to enter shaft coordinates from the existing measuring system 21, a computing, control and display module 18 that calculates and initiates and controls the required positional travel, and actuators 22 that provide means for the unit to be repositioned. Responding to the front and rear (X & Y) precision measuring modules 24 (two laser sources with three dual axis laser measuring sensors 30 or three digital measuring devices 26) for 2-way position and positional change information providing a reference to the concentric line of axis as the motor is being controlled into position.

FIG. 4 is a block diagram of the precision measuring devices of the shaft alignment system of the present invention. A plurality of precision measuring modules are utilized to identify the x-y coordinates of both units. The fixed unit 36 is equipped with a precision measuring module 32 along the drive shaft. The unit to be positioned 38 is equipped with precision measuring modules 34 on the drive shaft. Two laser sources with three dual axis laser measuring sensors 30

6

or three digital measuring devices 26 are the mounting means precision measuring devices 24 that are integral with each mounting foot.

FIG. 5 is a block diagram of the powered actuator devices 22 for the shaft alignment system of the present invention. A plurality of powered actuators 22 are utilized to drive the unit to be positioned. Each of the mounting feet are equipped with elevation positioning actuators 40 as well as transverse positioning actuators 44 providing means for horizontal positioning.

FIG. 6 is an illustrative view of the precision measuring devices of the shaft alignment system of the present invention 10. By measuring the x-y coordinates along two points on the centerline of the drive shaft, the precision measuring modules create a precise identification of the travel requirements of the second drive shaft. These coordinates are signaled to or data entered into the computing and control module.

FIG. 7 is an illustrative view of the precision measuring devices of the shaft alignment system of the present invention 10. The precision measuring modules 32,34 measure the x-y coordinates along two points on the centerline of both drive shafts 46,48. These coordinates are signaled to, or data entered into the computing and control module. The computing and control module calculates: the relationship of measuring modules 24 C and D (front and rear (X & Y) mounting means) in coordination with the concentric line of axis of measuring devices 20 A and B (shaft input measuring devices).

FIG. 8 is a diagram of the present invention 10 describing the travel requirements based on the defined X-Y coordinates of both shafts. If the drive shaft centerlines of the stationary unit and the reposition unit are parallel, the front and rear actuators affixed to the mounting feet of the reposition unit will extend or retract the same distance. If the drive shaft centerlines of the stationary unit and reposition unit are not parallel the rear actuators affixed to the mounting feet of the reposition unit will extend or retract until measuring devices C and D placed at the front and rear mounting means communicating the calculated concentric line of axis coordinates become equal to each other will then automatically stop. On occasion

FIG. 9 is an illustrative view describing the travel requirements based on the defined X-Y coordinates of both shafts as determined by their respective measuring modules 32,34. Depicted in FIG. 9 is a condition wherein the drive shaft centerlines of the stationary unit 36 and the reposition unit 38 are parallel. The front and rear actuators 22 affixed to the mounting feet respond to their respective measuring modules 24 of the reposition unit and will travel the same distance "y" then automatically stop.

FIG. 10 is an illustrative view describing the travel requirements based on the defined x-y coordinates of both shafts as determined by their respective measuring modules 32,34. Depicted in FIG. 10 is a condition wherein the drive shaft centerlines of the stationary unit 36 and the reposition unit 38 are not parallel. To create a concentric line of axis, the front and rear actuators 22 affixed to the mounting feet of the reposition unit extend at unlike distances according to their respective measuring modules 24.

FIG. 11 is an illustrative view describing the travel requirements based on the defined x-y coordinates of both shafts. Depicted in FIG. 11 is a condition wherein the drive shaft centerlines of the stationary unit and the reposition unit are not parallel. To create a concentric line of axis, the front and rear actuators 22 affixed to the mounting feet of the

7

reposition unit extend at unlike distances in response to their respective measuring modules 24.

FIG. 12 is a diagram of the precision shaft alignment system of the present invention's 10 component modules of the fixed unit 36 and the variable position unit 38. When utilized as a stand alone system 12, the precision shaft alignment system of the present invention includes a user input device 16 such as a touch screen monitor, key entry, or other, a computing and control module 18 that calculates and initiates the required controlled positional travel, shaft-mounted precision measuring devices 32,34 that read and send the coordinates for the centerline of axis for each of the shafts and additional precision measuring modules 24 in communication with the actuators 22 that provide means for the unit to be repositioned. Front and rear (x&y) precision measuring modules 24 that communicate 2-way position and positional change information providing a constant reference to the concentric line of axis as the driver motor is being controlled into position.

FIG. 13 is a block diagram of the precision shaft alignment system of the present invention's 10 component modules. When utilized as a retrofit system 14 to align a fixed unit 36 and a variable position unit 38, the precision shaft alignment system of the present invention includes a user input device 16 such as a touch screen monitor, key entry, or other providing means to enter shaft coordinates from the existing measuring system, a computing, control and display module 18 that calculates and initiates the required controlled positional travel, and actuators 40,42 that provide means for the unit to be repositioned. Based upon information provided by the front and rear (X & Y) precision measuring modules 24 directly responding to the position and positional change information providing a constant reference to the concentric line of axis as the motor is controlled into position.

FIG. 14 is a diagram of the precision shaft alignment system of the present invention's order of operations. Depicted is the present invention's order of operations when utilized as a stand-alone system. Step one is the order of operations of the precision shaft alignment system of the present invention. Step two involves affixing precision measuring devices to the drive shafts of unit #1 and unit #2. In step three the precision measuring devices and actuators are affixed to the mounting feet of unit #2. Enter input data for distances a, b and c in step four. In step five the precision measuring devices affixed to unit #1 and unit #2 send signals to control and computing module defining the center line axis of both shafts. Taking place in step six the control computing and display module computes vertical and transverse travel requirements to determine the relationship of measuring devices C and D in accordance with the concentric line of axis of measuring devices A and B. Advancing to step seven, the control and computing module sends information that has been calculated to be pre-sets for measuring devices (C and D) via 2-way RS232 communication with positional change requirements to provide concentric lines of axis between unit #1 and unit #2. Proceeding to step eight, the actuators activate and travel the calculated distances required to provide concentric lines of axis between unit #1 and unit #2 by directly responding to the control display and computing module with a constant reference to concentric line of axis as the motor is being controlled into position. Automatically stopping when the angular and parallel offsets are corrected. An optional step nine includes the user defined monitoring of shafts concentricity. The alignment process repeats thereby accounting for and compensating for thermal growth and machine vibration.

8

FIG. 15 is a diagram of the precision shaft alignment system of the present invention's order of operations. Depicted is the present invention's order of operations when utilized as a retrofit system. Step one is the order of operations of the precision shaft alignment system of the present invention retrofitted with another independent measuring system. The power actuators are affixed to the mounting feet of the unit to be positioned along with front and rear mounting means measuring devices C and D in step two and step three includes entering input data for distances a, b and c. Step four involves taking the x-y coordinates of the center line axis of the shafts of said fixed unit and said variable position unit from said independent measuring system. Step five has the user inputting said x-y coordinates of the center lines of the shafts of said fixed unit and said variable position unit into said control and computing module via touch screen monitor via said user input device. Step six includes said control and computing module calculating vertical (y) and transverse (x) travel requirements to determine the relationship of measuring devices C and D in coordination with the concentric line of axis of the respective measuring devices A and B locating the shafts of said fixed unit and said variable position unit. In step seven, the control and computing module sending information that has been calculated to be pre-sets for said mounting means measuring devices C and D via 2-way RS 232 communication with position and positional change requirements to provide concentric lines of axis between said shafts of said fixed unit and said variable position unit activating said actuators and traveling the calculated distances required to provide concentric lines of axis between the shafts of said fixed unit and said variable position unit by directly responding to said control and computing module with a constant reference to the concentric lines of axis as the motor is being controlled into position and automatically stopping when the angular and parallel offsets are corrected.

It will be understood that each of the elements described above, or two or more together may also find a useful application in other types of methods differing from the type described above.

While certain novel features of this invention have been shown and described and are pointed out in the annexed claims, it is not intended to be limited to the details above, since it will be understood that various omissions, modifications, substitutions and changes in the forms and details of the device illustrated and in its operation can be made by those skilled in the art without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

What is claimed is new and desired to be protected by Letters Patent is set forth in the appended claims:

1. A precision shaft alignment system for establishing concentric axial alignment of a first rotatably mounted shaft extending from a fixed unit with a second opposed, rotatably mounted shaft extending towards said first shaft from a variable position unit being positioned for use therewith, said precision alignment system comprising:

- a) a control and computing module;
- b) an input measuring means to provide precise x,y coordinates of the concentric line of axis of said

variable shaft and said fixed shaft, said input measuring means in communication with said control and computing module;

- c) a plurality of variable position unit mounting means precision measuring modules in communication with said control and computing module to receive and transmit x/y repositioning data therefrom required to align said shafts; and
- d) a plurality of powered actuators integral with said variable position mounting means, said actuators in communication with and responsive to said mounting means precision measuring modules to reposition said variable position unit vertically and horizontally accordingly to align the shaft thereof to the x-y coordinates of said fixed unit shaft.

2. A precision shaft alignment system as recited in claim 1, that is utilized as a retrofit system wherein said input measuring means comprises a pre-existing shaft alignment system or dial indicators utilizing the reverse alignment method and the shaft coordinates or alignment corrections from the existing system are entered manually and initiates and controls the required positional travel and said actuators that provide means for said variable position unit to be repositioned.

3. A precision shaft alignment system as recited in claim 2, wherein said input measuring means comprises laser source or sources with laser measuring sensor or sensors coupled with said shaft of said variable position unit thereby providing precise x-y coordinates of said variable position unit shaft respective to said fixed unit shaft, said measuring device in communication with said control and computing module and said user input device wherein coordinates are provided in accordance to said existing system.

4. A precision shaft alignment system as recited in claim 2, that is utilized as a retrofit system wherein said input measuring means comprises a pre-existing shaft alignment system or dial indicator utilizing the reverse alignment method and the shaft coordinates or alignment corrections from the existing system are entered manually and initiates and controls the required positional travel and said actuators that provide means for said variable position unit to be repositioned.

5. A precision shaft alignment system as recited in claim 4, wherein the order of operations of the precision shaft alignment system when retrofitted with another independent measuring system proceeds as follows:

- a) taking the x-y coordinates of the center line axis of the shafts of said fixed unit and said variable position unit from said independent measuring system;
- b) the user inputting data for distances a, b and c and said x-y coordinates of the center lines of the shafts of said fixed unit and said variable position unit into said control and computing module via touch screen monitor via said user input device;
- c) said control and computing module calculating vertical (y) and transverse (x) travel requirements to determine the relationship of measuring devices C and D in coordinance with the concentric line of axis of the respective measuring devices locating the shafts of said fixed unit and said variable position unit;

d) said control and computing module sending information that has been calculated to be pre-sets for said mounting means measuring devices via 2-way RS 232 communication with position and positional change requirements to provide concentric lines of axis between said shafts of said fixed unit and said variable position unit; and

e) activating said actuators and traveling the calculated distances required to provide concentric lines of axis between the shafts of said fixed unit and said variable position unit by directly responding to said control and computing module with a constant reference to the concentric lines of axis as the motor is being controlled into position and automatically stopping when the angular and parallel offsets are corrected.

6. A precision shaft alignment system as recited in claim 1, that is utilized as a stand-alone system wherein said input measuring means comprises one laser source with a single or dual axis laser measuring sensor related with the shaft of said fixed unit and one laser source with a single or dual axis laser measuring sensor related with the shaft of said variable position unit.

7. A precision shaft alignment system as recited in claim 1, that is utilized as a stand-alone system wherein said input measuring means comprises two digital measuring devices related with the shaft of said fixed and variable units and three digital measuring devices related with the mounting means of the variable position unit.

8. A precision shaft alignment system as recited in claim 1 that is utilized as a stand-alone system wherein the order of operations proceeds as follows:

- a) entering data input for distances a, b and c;
- b) sending signals from the precision measuring devices affixed to said fixed unit and said variable position unit to said control and computing module thereby defining the center line of axis of the respective shafts;
- c) control and computing module calculating vertical and transverse travel requirements to determine the relationship of measuring devices C and D in coordinance with the concentric line of axis of the measuring devices A and B related with the shafts of said fixed unit and said variable position unit;
- d) sending calculated positional data to be pre-sets for said measuring devices from control and computing module via 2-way RS 232 communication with position and positional change requirements to provide concentric lines of axis between the shafts of said fixed unit and said variable position unit; and
- e) activating actuators to travel the calculated distances required to provide concentric lines of axis between the shafts of said fixed unit and said variable position unit by directly responding to said control and computing module with a constant reference to the concentric lines of axis as the motor is being controlled into position and automatically stopping when the angular and parallel offsets are corrected.