

SENSOR APPARATUS

The present invention relates to sensor apparatus.

5 Conventionally, a sensor is mounted in a predetermined position and has a maximum sensing angle of 180 degrees. In this respect, it is required to mount at least two sensors in individual positions in order to cover a desired sensing angle of 360 degrees. From the viewpoint of the above, a known sensor has a problem in that in order to electrically wire the sensors
10 one by one, it is necessary to use a plurality of wires as well as extra time and labour consumption. Hence, the installation cost of the sensors is inevitably increased. In addition, in wiring a building for the sensors, the wall of the building where the sensors are to be arranged should be partially broken and this requires the partially broken wall to be repaired after the sensor wiring
15 is completed. Therefore, the installation cost of the sensors is further increased. On the other hand, the sensors may be installed on the wall of the building in such a manner that the wires of the sensors are exposed to the outside of the wall. However, a problem of this type of sensor wiring is that the exposed wires may be easily short-circuited or disconnected due to several
20 causes and, furthermore, have a poor external appearance.

Preferred embodiments of the present invention aim to provide sensor rotating apparatus in which the above problems of the known sensor fixed to a predetermined position can be overcome and which simplifies the wiring of
25 the sensor and rotates the sensor at a rotational angle of 360 degrees without twisting wires of the sensor and, as a result, allows the sensor to have a sensing angle of 360 degrees.

According to one aspect of the present invention, there is provided sensor rotating apparatus comprising:

drive means for generating rotational output power;

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first and second reduction gear assemblies for reducing the rotational output speed of said drive means, said first and second gear assemblies cooperating with said drive means and having predetermined gear ratios;

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a sensor turntable for causing, using the reduced rotational output speed of said drive means, a sensor to rotate, said sensor turntable carrying said sensor at a predetermined position thereon and rotating at a predetermined rotating velocity which is determined in accordance with said gear ratios of the first and second reduction gear assemblies;

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a casing having a hub for rotatably supporting said sensor turntable;

a housing holder extending downwardly from said casing, opposite to said hub;

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a rotating shaft for rotating with said sensor turntable and transmitting a sensing signal of said sensor to a control circuit unit, said rotating shaft being inserted in both said hub and said housing holder and having a pair of longitudinal grooves for receiving a pair of input terminals for transmitting said sensing signal of the sensor and being fixed to said sensor turntable using
25 a first fixing member in order to rotate with said sensor turntable;

a bearing assembly for supporting rotation of said rotating shaft, said bearing assembly being electrically connected to said pair of input terminals of the rotating shaft and being arranged to surround said rotating shaft; and

5 support means for preventing said bearing assembly from undesirable separation from said rotating shaft due to rotational force of said rotating shaft, said support means being mounted on a lower end of said rotating shaft using a second fixing member.

10 Preferably, said first reduction gear assembly comprises a pair of spur gears.

Preferably, said first and second fixing members comprise set screws.

15 Preferably, said rotating shaft is made of an acrylonitrile-butadiene-styrene resin.

Preferably, said rotating shaft is made of a ceramic material comprising aluminium oxide and kaolin clay.

20 Preferably, said bearing assembly comprises a pair of ball bearing assemblies, each comprising:

a shaft washer being mechanically combined with a ring, said ring
25 being electrically connected to a respective one of said pair of input terminals of the rotating shaft;

a plurality of metal balls for causing said shaft washer along with said ring to rotate smoothly with said rotating shaft; and

5 an outer ring of which an inner surface is provided with a plurality of ball slots for respectively receiving said metal balls in order to maintain said metal balls in their places and an outer surface is integrally formed with a sensor output terminal; and

10 a bearing housing for supporting said outer rings of the pair of ball bearings as surrounding the outer surfaces of said outer rings, said bearing housing having at its outer surface a plurality of slots for receiving individual inner protrusions of said housing holder in order to prevent rotation of the bearing housing with said rotating shaft, said bearing housing also having through holes for permitting said sensor output terminals of the outer rings of
15 the ball bearings to pass therethrough.

Preferably, said bearing assembly is made of a conductive material.

For a better understanding of the invention, and to show how the same
20 may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a plan view of an embodiment of a sensor rotating apparatus in accordance with the present invention;

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Figure 2 is a sectioned view of the sensor rotating apparatus of Figure 1;

Figure 3 is an enlarged sectioned view of section A of Figure 2 for showing in detail a construction of a rotating shaft and a bearing assembly; and

5 Figure 4 is a sectioned view taken along the section line I-I of Figure 3.

With reference to Figures 1 and 2, showing a preferred embodiment of sensor rotating apparatus of the invention, the apparatus includes a main casing 3 in which a power supply 8 is arranged at a lower position. In the main casing 3, the power supply 8 is electrically connected, through a conductor (not shown), to a control circuit unit 9 having a sensor circuit and an alarm circuit. Above the power supply 8, the apparatus further includes a support 3b which horizontally inwardly extends from a side wall, for example, a left-side wall (as seen), of the main casing 3 in order to run parallel with an upper wall of the main casing 3. This support 3b supports a motor 7 at its lower surface. The motor 7 outputs its output power to a first reduction gear assembly comprising a pair of spur gears 4 and 5 having a predetermined gear ratio and engaging with each other. In this reduction gear assembly, the spur gear 4 is mounted on a motor output shaft 7a in order to cooperate with the motor 7. This first gear assembly 4 and 5 is adapted to reduce the rotational velocity of the output shaft 7a of the motor 7 and, as a result, to reduce the required output power of the motor 7. The spur gear 5 of the reduction gear assembly is in turn connected, through a shaft 5a, to a spur gear or a pinion 6 which is to engage with and drive an internal gear 2a which will be described below. At a centre of the upper wall of the main casing 3, a cylindrical housing holder 21 is integrally provided such that it

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extends downwardly from the centre of the upper wall and opens at its upper and lower ends.

Figure 3 shows the section A of Figure 2 for illustrating a rotating part of this apparatus. As shown in Figures 2 and 3, the upper wall of the main casing 3 also has an integral cylindrical hub 3a which extends upwardly from the centre of the upper wall in order to be concentric with the housing holder 21. On the top end of the hub 3a, a sensor turntable 2 of a circular shape is rotatably mounted. This turntable 2 is combined with the internal gear 2a in order to rotate at the same time of rotation of the internal gear 2a and has a circular centre opening for permitting a rotating shaft 1 to pass therethrough.

This rotating shaft 1 is inserted in the cylindrical centre opening of the sensor turntable 2, an inner cylindrical hole of the hub 3a and an inner cylindrical hole of the housing holder 21 in order. The rotating shaft 1 is integrally provided at its uppermost end with a base disc 1a which is combined with the sensor turntable 2 using a pair of set screws 13. In this respect, the rotating shaft 1 rotates at the same time of rotation of the sensor turntable 2 when the pinion 6 drives the internal gear 2a as well as the sensor turntable 2.

On the sensor turntable 2, a sensor 10, for example, an ultrasonic sensor or an infrared sensor, is mounted in a desired position using a mounting device (not shown). This sensor 10 is provided with a pair of output terminals 10a and 10b for outputting a sensing signal. Due to this construction, the sensor 10 is allowed to rotate at the same time of rotation of the sensor turntable 2 and, as a result, has a desired sensing angle of 360 degrees.

Figure 4 shows a construction of the rotating shaft 1 and a ball bearing assembly for supporting the rotation of the shaft 1 with respect to the housing holder 21. Referring to Figures 2 to 4, the rotating shaft 1 is preferably made of electrical insulation materials, such as ABS (acrylonitrile-butadiene-styrene) resins and ceramic materials of alumina (aluminum oxide) and kaolin (china clay), in order to insulate the shaft 1 from the peripheral members, such as the hub 3a and the housing holder 21. This shaft 1 is provided with a pair of longitudinal grooves which are diametrically oppositely formed in order to receive individual input terminals 12a and 12b. The shaft 1 permits the pair of input terminals 12a and 12b, which preferably comprise pin-shaped conductors made of conductive materials and are received in individual grooves of the shaft 1, to rotate at the same time of rotation of the shaft 1. Here, the input terminals 12a and 12b are connected to the output terminals 10a and 10b of the sensor 10 through individual lead wires 11a and 11b. Furthermore, one of the input terminals, for example, the terminal 12a, is shorter than the other input terminal, for example, the terminal 12b, as depicted in Figure 3. In addition, a pair of conductive rings 31 are arranged at lower positions of the shaft 1 in order to be connected to lower ends of individual input terminals 12a and 12b. Due to this construction, the input terminals 12a and 12b along with individual rings 31 rotate at the same time of rotation of the shaft 1.

With reference to Figure 4, the bearing assembly comprises a pair of radial ball bearings which are arranged at positions corresponding to the rings 31. Each of the ball bearings is made of a conductive material and includes an inner ring or a shaft washer 24 which is mechanically combined with a respective ring 31 and a plurality of metal balls 23 for causing the shaft washer 24 along with the ring 31 to smoothly rotate at the same time of

rotation of the shaft 1. In order to maintain these metal balls 23 in their places, the ball bearing also includes an outer ring 25 of which the inner surface is provided with a plurality of ball slots for receiving individual metal balls 23. This outer ring 25 is also provided with a pin-shaped sensor output terminal 27 or 28 at its outer surface. The bearing assembly also includes a cylindrical bearing housing 26 which supports the outer rings 25 of the ball bearings as surrounding the outer surfaces of the rings 25. On the outer surface of this bearing housing 26, three longitudinal slots are provided in order to be combined with individual inner protrusions 20a of the housing holder 21. Due to such a combination of the bearing housing 26 with the housing holder 21, this bearing housing 26 along with the outer rings 25 of the bearings does not rotate when the shaft washers 24 along with the rings 31 rotate at the same time of rotation of the shaft 1. In addition, this bearing housing 26 has a pair of radial through holes for permitting individual pin-shaped sensor output terminals 27 and 28 to pass therethrough.

In arranging the rotating shaft 1 and the bearing assembly in the main casing 3, the pinion 6 is mounted on the shaft 5a of the spur gear 5 of the first reduction gear assembly. Thereafter, the sensor turntable 2 is arranged on the hub 3a of the main housing 3 in such a manner that its internal gear 2a engages with the pinion 6. The rotating shaft 1 is, thereafter, inserted in the cylindrical centre opening of the sensor turntable 2, the inner cylindrical hole of the hub 3a and the inner cylindrical hole of the housing holder 21 in order. At this state, the base disc 1a of this rotating shaft 1 is combined with the sensor turntable 2 using the pair of set screws 13. The bearing assembly is then tightly fitted on the lower part of the rotating shaft 1 through the lower opening of the housing holder 21.

Thereafter, in order to prevent the bearing assembly from undesirable separation from the shaft 1 due to the rotational force of the shaft 1, the rotating shaft 1 and the bearing assembly are supported by a support member 1b which is mounted on the lower end of the shaft 1 using a set screw 1c. In accordance with the above assembly, the sensor turntable 2 along with the rotating shaft 1 rotates at the same time of rotation of the internal gear 2a which is driven by the output power of the motor 7.

Hereinbelow, the operational effect of the illustrated rotating apparatus will be described.

Upon powering on, the motor 7 outputs its output power, i.e. the rotational power, to the first reduction gear assembly 4 and 5 through its output shaft 7a. At the reduction gear assembly 4 and 5, the rotational speed of the motor 7 is reduced by as much as the gear ratio of the gear assembly 4 and 5. The reduced rotational speed of the motor 7 is in turn transmitted to the pinion 6 which is connected to the shaft 5a of the reduction gear 5. Here, since the pinion 6 engages with the internal gear 2a of the sensor turntable 2, the rotation of the pinion 6 causes the internal gear 2a to rotate in order to rotate the sensor turntable 2 at a predetermined slow rotating velocity. At this time, the sensor 10, such as the ultrasonic sensor or the infrared sensor mounted on the predetermined position of the sensor turntable 2, rotates at the same time of slow rotation of the sensor turntable 2 in a predetermined rotating direction. During rotation of the sensor 10, this sensor 10 emits ultrasonic wave or infrared rays in order to sense a moving object or infrared rays of the human body and outputs a sensing signal from its output terminals 10a and 10b. This sensing signal is applied to the input terminals 12a and 12b through the lead wires 11a and 11b and in turn to the

conductive rings 31. Here, the bearing assembly comprising the shaft washers 24, the balls 23 and the outer rings 25 is made of electrically conductive materials as described above and, in this respect, this bearing assembly transmits the sensing signal, which has been applied to the rings 31, to the output terminals 27 and 28. Thereafter, the sensing signal is transmitted from the output terminals 27 and 28 to the control circuit unit 9 having the sensor circuit and the alarm circuit through lead wires (not shown).

This sensor rotating apparatus rotates the sensor 10 at the desired rotational angle of 360 degrees without twisting wires of the sensor 10 and, as a result, allows the sensor 10 to have the sensing angle of 360 degrees and greater.

The bearing housing 26 is tightly received in the housing holder 21 in such a manner that the three longitudinal slots of the housing 26 receive individual inner protrusions 20a of the housing holder 21 as described above and this causes the bearing housing 26 to be fixed to the main casing 3. In this respect, the bearing housing 26 along with the outer rings 25 of the bearing assembly does not rotate when the shaft washers 24 along with the rings 31 rotate at the same time of rotation of the shaft 1.

The above-described embodiment of the present invention provides sensor rotating apparatus capable of rotating a sensor at a sensing angle of 360 degrees without twisting wires of the sensor. In this apparatus, a pair of pin-shaped input terminals other than lead wires are received in a rotating shaft of a sensor turntable in order to electrically connect the sensor to a control circuit unit. In this respect, a plurality of sets of lead wires are not necessary for the sensor wiring and this simplifies the wiring of the sensor and, as a

result, reduces the installation cost of the sensor. In addition, this apparatus does not cause twisting of the wires of the sensor, thereby preventing short circuit and disconnection of the wires of the sensor. Another advantage of the apparatus is that it has a simple construction.

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Although a certain specific embodiment of the invention has been shown, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the scope of the invention.

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CLAIMS

1. Sensor rotating apparatus comprising:

5 drive means for generating rotational output power;

first and second reduction gear assemblies for reducing the rotational output speed of said drive means, said first and second gear assemblies cooperating with said drive means and having predetermined gear ratios;

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a sensor turntable for causing, using the reduced rotational output speed of said drive means, a sensor to rotate, said sensor turntable carrying said sensor at a predetermined position thereon and rotating at a predetermined rotating velocity which is determined in accordance with said gear ratios of

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the first and second reduction gear assemblies;

a casing having a hub for rotatably supporting said sensor turntable;

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a housing holder extending downwardly from said casing, opposite to said hub;

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a rotating shaft for rotating with said sensor turntable and transmitting a sensing signal of said sensor to a control circuit unit, said rotating shaft being inserted in both said hub and said housing holder and having a pair of longitudinal grooves for receiving a pair of input terminals for transmitting said sensing signal of the sensor and being fixed to said sensor turntable using a first fixing member in order to rotate with said sensor turntable;



a bearing assembly for supporting rotation of said rotating shaft, said bearing assembly being electrically connected to said pair of input terminals of the rotating shaft and being arranged to surround said rotating shaft; and

- 5 support means for preventing said bearing assembly from undesirable separation from said rotating shaft due to rotational force of said rotating shaft, said support means being mounted on a lower end of said rotating shaft using a second fixing member.
- 10 2. Sensor rotating apparatus according to claim 1, wherein said first reduction gear assembly comprises a pair of spur gears.
3. Sensor rotating apparatus according to claim 1 or 2, wherein said first and second fixing members comprise set screws.
- 15 4. Sensor rotating apparatus according to claim 1, 2 or 3, wherein said rotating shaft is made of an acrylonitrile-butadiene-styrene resin.
5. Sensor rotating apparatus according to claim 1, 2 or 3, wherein said
20 rotating shaft is made of a ceramic material comprising aluminium oxide and kaolin clay.
6. Sensor rotating apparatus according to any of the preceding claims, wherein said bearing assembly comprises a pair of ball bearing assemblies,
25 each comprising:



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a shaft washer being mechanically combined with a ring, said ring being electrically connected to a respective one of said pair of input terminals of the rotating shaft;

- 5 a plurality of metal balls for causing said shaft washer along with said ring to rotate smoothly with said rotating shaft; and

an outer ring of which an inner surface is provided with a plurality of ball slots for respectively receiving said metal balls in order to maintain said
10 metal balls in their places and an outer surface is integrally formed with a sensor output terminal; and

a bearing housing for supporting said outer rings of the pair of ball bearings as surrounding the outer surfaces of said outer rings, said bearing
15 housing having at its outer surface a plurality of slots for receiving individual inner protrusions of said housing holder in order to prevent rotation of the bearing housing with said rotating shaft, said bearing housing also having through holes for permitting said sensor output terminals of the outer rings of the ball bearings to pass therethrough.

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7. Sensor rotating apparatus according to any of the preceding claims, wherein said bearing assembly is made of a conductive material.

8. A sensor rotating apparatus substantially as hereinbefore described with
25 reference to the accompanying drawings.