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(54) **A satellite antenna alignment device**

(57) A satellite antenna alignment device includes a drive unit (1) adapted to move the reflector of a parabolic antenna (200) about two mutually perpendicular axes to aim the antenna at a selected satellite. A control unit (13) controls the drive unit; and an interface unit (15) provides a bidirectional transmission of signals with

the control unit and receives signals from a remote control (36) for actuating the drive unit. The drive unit, the control unit, and the interface unit are powered directly by the satellite receiver that is connected to the interface unit through a standard coaxial cable (21).

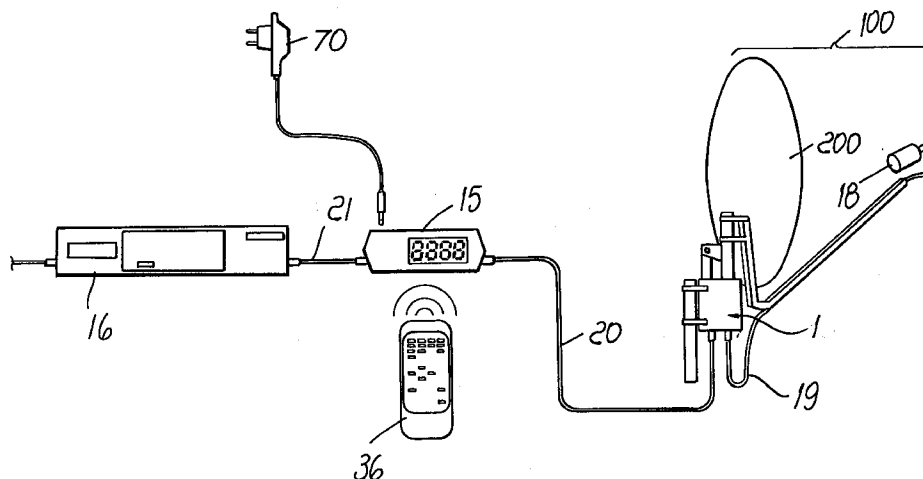


Fig. 5

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Description

The present invention relates to a satellite antenna alignment device, particularly for an offset satellite dish or a prime focus satellite dish.

In recent years there has been a considerable development in satellite broadcasting, with the launching of several geostationary satellites and the consequent increase in the channels that can be received by a user with an adapted antenna.

These antennas, called satellite dishes, generally include a parabolic reflector and a low-noise block (LNB) that is located in the focus of the parabolic reflector and receives the electromagnetic radiation reflected by the reflector.

Satellite dishes can be either fixed or movable. The fixed ones, can be aimed at one satellite and are therefore suitable to receive the electromagnetic waves that are transmitted in a direction that lies substantially parallel to the axis of the parabolic reflector. The movable dishes allow to receive transmissions of satellites that have different positions. The movements of these last antennas is provided by a drive unit that moves the parabolic reflector, varying the inclination of its axis with respect to the horizontal, so as to align the antenna with the various satellites in geostationary orbit. The possibility of having several satellites from which signals can be received has made it particularly useful to use these movable antennas.

A drawback of conventional drive units is that they are extremely complicated and require at least two cables for connection between the tuner (receiver), located inside the home of the user, and the antenna. A coaxial cable is used to transmit the signal received by the LNB, and a second multicore cable is used to power and control the drive unit.

The need for a power supply for the drive unit, due to the high current absorption of the motors used for movement, makes the entire device expensive.

Furthermore, the drive units of the polar type have the drawback that they require a very complicated assembly and aligning procedure. The various geostationary satellites can in fact be ideally linked by an interpolation curve (polar curve). The system must be aligned perfectly to the geographic South (North in the southern hemisphere) and the elevation and declination angles must also be adjusted according to the reception site.

The antenna then moves automatically so as to receive from various satellites, but with a certain margin of error. The alignment of an antenna that uses such a drive unit is very complicated and the device itself is also difficult to produce.

In practice, the intervention of a specialized technician is required for the correct alignment of the antenna, with a consequent financial expenditure on the part of the user.

A partial solution to this problem is provided by patent application no. TO-93A000913 in the name of this

same Applicant. This document discloses a system for multiple satellite reception, by virtue of which instead of moving the antenna, the low-noise block (LNB) is moved from the ideal focus of the antenna. The drawback of this solution is that it is impossible to aim at satellites that are widely spaced from each other, since the variation in the position of the LNB allows to cover, for reception, only short distances and therefore closely adjacent satellites.

The aim of the present invention is therefore to provide a satellite antenna alignment device that solves the above described problems.

Within the scope of this aim, an object of the invention is to provide an alignment device that allows easy and fully automated alignment of the antenna.

A particular object of the invention is to provide an alignment device that allows to move an antenna both on the horizontal plane and on the vertical plane.

Another object of the present invention is to provide an alignment device that is capable of storing the alignment positions for the various satellites in geostationary orbit.

Another object of the present invention is to provide an alignment device that can be powered directly by the receiver (tuner) by means of a single coaxial cable.

Another object of the present invention is to provide an alignment device that allows bidirectional exchange of information between the receiver and the drive means for moving the antenna.

Another object of the present invention is to provide an alignment device that can be adapted to already-installed antennas.

Another object of the present invention is to provide an alignment device that can be controlled by remote control by the user while staying inside the home.

Another object of the present invention is to provide an alignment device that is highly reliable, relatively easy to manufacture, and at competitive costs.

This aim, these objects, and others which will become apparent hereinafter are achieved by a satellite antenna alignment device as claimed in the appended claims.

Further characteristics and advantages of the invention will become apparent from a preferred but not exclusive embodiment of the device according to the invention, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a side view of the drive unit of the device according to the invention;

Figure 2 is a general block diagram of the satellite reception system, including the device according to the invention;

Figure 3 is a view of an example of an installation of an antenna and of the drive unit according to the invention;

Figure 4 is a view of a further example of an installation of an antenna and of the drive unit according to the invention; and

Figure 5 is a diagram of a satellite reception system that includes the device according to the invention.

With reference to the above figures, the device according to the invention includes a drive unit, illustrated in Figure 1, and a control and interface electronic means, shown in detail in Figure 2.

The drive unit, generally designated by the reference numeral 1 in Figure 1, has a support 2 suitable to support a rotatable part 3. Support 2 has a protrusion 4 that extends from its lateral surface and allows connection to a supporting post 6 by means of U-bolts 5 and brackets 10.

An L-shaped bracket 7 is hinged to rotatable part 3 and supports the antenna. A rod member 8 is connected to the L-shaped bracket, and a parabolic antenna (designated by the reference numeral 100 in Figure 2) is to be fixed on rod member 8 by means of its bracket.

Figure 1 shows, in dashed lines, two intermediate positions that can be assumed by rod member 8 by virtue of the movement of the parabolic dish supporting bracket about the point for pivoting to rotatable part 3.

This movement of bracket 7 is caused by the action of a microactuator 12 that is suitable to transmit a rotary motion in the vertical plane to protrusion 4, thus allowing to adjust the inclination of antenna 100 with respect to the horizontal plane. Microactuator 12 is pivoted to rotatable part 3 at one end and to bracket 7 at the other end.

Advantageously, microactuator 12 is a low-absorption DC ballscrew microactuator with high traction-pushing power.

A DC gearmotor 11 is accommodated inside support 2 and is of the type with low absorption and high output torque. The gearmotor transmits the rotary motion, in the horizontal plane, to rotatable part 3 by means of two gears, advantageously worm, screw/worm gears. Bearings minimize the friction of the rotary motion and of the motion of the microactuator 12.

The numeral 9 designates the power supply cable of microactuator 12.

The microactuator and the gearmotor are both provided with mechanical stroke limiters (not shown).

Proximate to the lower section of support 2 there is a control means, advantageously provided by an electronic board 13 with two female connectors 14 that protrude from the base of the support rotatable part 3.

Figure 2 is a detail view of the electronic part of the device according to the invention.

The above mentioned control means 13 is connected, on one side, to an interface means 15 that in turn is connected to a receiver 16 that sends the received signals to a conventional television set 17, and on the other side, to an LNB that is located in the focus

of the reflector 200 that belongs, together with the LNB 18, to the parabolic antenna 100. The drive unit shown in Figure 1 is, as already explained, connected to the antenna.

Control means 13 is connected to LNB 18 at one of the two female connectors 14. The connection is provided by a coaxial cable 19.

A similar connection with a coaxial cable 20 allows connection between control means 13 and interface means 15, which is in turn connected, by a coaxial cable 21, to receiver 16, which receives the received signal and decodes it into a television or radio signal.

Power is thus supplied to the drive unit according to the invention by receiver 16 by means of a single coaxial cable.

Control means 13 includes a first control unit 22, which advantageously includes a microcontroller that controls two electronic power circuits 23 and 24 that respectively drive motor 11 and motor 12 (for the sake of simplicity, the term "motor" is used hereinafter instead of "microactuator" and "gearmotor"). A detection means, advantageously two sensors (encoders) 25 and 26, for example Hall-effect sensors, which correspond respectively to motors 11 and 12, detect the angular positions of antenna 100 and are connected to microcontroller 22 through an adapted interface 27.

A first memory means 28 is connected to microcontroller 22 in order to store the angular positions reached by antenna 100.

Conveniently, first memory means 28 includes an EEPROM.

A demodulation means 29, suitable to interpret the commands and/or requests that originate from interface means 15, communicate with microcontroller 22, which in turn replies to interface means 15 through an oscillator 30 and an electronic circuit 31 that is conveniently constituted by a multiplier circuit.

A circuit 32 for monitoring the voltage level allows microcontroller 22 to detect any condition in which the power supply is interrupted during the movement of the antenna.

Control means 13 includes a means for interrupting the power supply, which advantageously includes a switch 33 that is suitable to interrupt the supply of power to LNB 18 during the operations for positioning antenna 100, so as to avoid overloading receiver 16.

Interface means 15, which is connected to control means 13 by coaxial cable 20, includes a second control unit, which is advantageously constituted by a microcontroller 34 that receives and interprets the signals received by a photoelectric receiver 35 that is suitable to receive signals from a remote control means that is conveniently constituted by an infrared remote control 36 used by the user. Photoelectric receiver 35 is conveniently constituted by a photoreceiver, for example a photodiode 50, and by an amplifier 60 that amplifies the signal that originates from the photoreceiver 50.

A second memory means 37 is suitable to store the information related to multiple angular positions of

antenna 100 that can be defined by the user and can be subsequently retrieved by means of remote control 36.

Microcontroller 34 also handles a display means 38 that is suitable to display information to the user.

An oscillator means 40 and an electronic circuit 41, conveniently constituted by a multiplier, send signals, which originate from controller 34, to control means 13.

A second demodulation means 39 decodes signals that originate from control means 13.

A means 42 for protecting against surges of current is connected to microcontroller 34 and between coaxial cable 21 and coaxial cable 20.

A supplementary power unit 70 may be connected to interface 15 to supplement the power output of receiver 16 if necessary. Power unit 70 is constituted by a conventional inverter connected to the means.

Figure 3 shows a possible installation of the drive unit according to the invention. In this case, antenna 100 is located on the roof of a house on a supporting member 43, on which the drive unit according to the invention is fixed.

Figure 4 shows a second possible installation of the drive unit according to the invention, using a wall bracket 44. Figures 3 and 4 show some of the most common installations, in addition to the post-mounted one shown in Figure 1, but of course the device can be used in any other type of installation.

Finally, Figure 5 is a schematic view of the connections between the various parts that constitute the satellite reception system that includes the device according to the invention.

With reference to the above figures, the operation of the device according to the invention is as follows.

The positioning of antenna 100 is performed by infrared remote control 36, which sends the codes that correspond to the various buttons pressed by the user. The signals sent by remote control 36 are received by photoelectric receiver 35, and interpreted by microcontroller 34, which handles the display devices 38 that display information such as the numeral of the pre-stored position recalled by the user, the degrees of the antenna, the visual confirmation that positioning has occurred during retrieval of the pre-stored positions, and real-time display of the two angular positions of antenna 100 during the fine adjustment operations that are possible through the remote control. The fine adjustment of the two types of movement that can be provided by antenna 100 is due to the low speeds that can be achieved by the two motors 11 and 12.

EEPROM memory 38 stores multiple positions that are predefined by the user and can be assumed by reflector 200 to aim at the desired satellites. Microcontroller 34 accesses this memory 38 when the user sets a preset position, on remote control 36.

By means of coaxial cable 21, interface means 15 communicates with receiver 17 while it bidirectionally exchanges signals with control means 13 by means of coaxial cable 20.

When it is necessary to send a command to control

means 13, microcontroller 34 injects into the coaxial cable, by means of oscillator means 40 and electronic circuit 41, a train of appropriately encoded power-line carrier waves that are decoded by microcontroller 22 by means of demodulation means 29. As a consequence of the decoding, microcontroller 22 drives electronic power circuits 23 and 24 that respectively actuate motors 11 and 12 for the desired adjustment of the position of reflector 100. The connection of control means 13 and of LNB 18 occurs by means of coaxial cable 11 for the supply of power to the LNB.

The motion of motor 11 is transmitted to rotatable part 3, allowing its rotation and therefore the desired adjustment about the vertical axis of antenna 100. The motion of motor 12 is instead transmitted to microactuator 9, which by means of its pivoting about rotatable part 3 and of the connection to bracket 7, produces a movement about the horizontal axis of antenna 100, thus varying its inclination with respect to the horizontal.

The two Hall-effect sensors 25 and 26 related to motors 11 and 12 detect the pulses produced by the rotation of the motors; these pulses are counted by microcontroller 22, which calculates the angular positions assumed by the antenna.

EEPROM memory 28 provided in control means 13, stores the angular positions assumed by antenna 100 at the end of the last performed movement. In this manner, even as a consequence of an interruption of the power supply, microcontroller 22 can determine the position of the antenna by reading the content of memory 28.

The voltage level monitoring circuit 32 allows microcontroller 22 to detect any voltage drop (power supply interruption) and to thus immediately write the current position of antenna 100 in EEPROM memory 28.

Control means 13 sends the information related to the angular position of antenna 100 and replies to the requests that originate from interface means 15 by injecting on coaxial cable 20, by means of oscillator 30 and electronic circuit 31, appropriately encoded power-line carrier waves that are received, as already described, by demodulation means 39 that is contained in interface means 15.

Electronic switch 33 allows to interrupt the supply of power to LNB 18 during the operations for positioning antenna 100, so as to avoid overloading receiver 16.

It has been observed in practice that the device according to the invention fully achieves the intended aim, allowing to position a satellite antenna by varying its position both about a vertical axis, for azimuth adjustment, and about a horizontal axis, for elevation adjustment, in an extremely simple and fast manner, by directly setting, with a remote control, the values in degrees that indicate the position of the selected satellite.

The device is also capable of storing the positions of the various satellites and of automatically moving the antenna when the button that corresponds to the satellite at which the antenna is to be pointed is pressed by

the user on the remote control.

Carrying the power supply and the signal on a single coaxial cable, eliminates the need for additional wiring, reducing costs and simplifying the assembly procedure to the maximum degree. The low absorption of the motors allows to supply power to the entire system directly from the receiver, by means of the coaxial cable.

The movements performed by antenna 100 are irreversible even when the positioner is not powered: therefore, the antenna cannot perform movements unless they are requested by the user through remote control 36.

Due to its configuration, the device according to the invention is suitable both for satellite reception systems installed in buildings and for systems that can be installed on recreational vehicles, mobile homes, trailers, etc.

It is also possible to automatically search for the signals that originate from the various satellites and to sequentially store the various positions of the antenna that correspond to the various received signals.

A further feature of the invention is that the system computes the azimuth and the elevation requested for aiming the antenna at a satellite of which the absolute longitude is known. The elevation is computed on the basis of the previously stored latitude and longitude of a reference satellite.

Once the position of the reference satellite is stored, the system according to the invention can compute the azimuth and the elevation of any other satellite and the antenna can be aimed at a satellite by simply inputting the longitude of the selected satellite, using the remote control.

Still a further feature of the invention is that the system shows the geographical coordinates (latitude and longitude) of the receiving location by simply inputting the postal code (ZIP code) of the receiving location using the remote control.

The application of rotational limits can be set by means of the remote control, which is also an advantage, as mechanical switches, which can easily malfunction, are eliminated.

Finally, all the details may be replaced with other technically equivalent elements.

In practice, the materials employed, so long as they are compatible with the specific use, as well as the dimensions, may be any according to the requirements and the state of the art.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A satellite antenna alignment device comprising a drive unit (1) that is connected to an antenna having a reflector (200), characterized in that said drive unit is adapted to move the reflector of said antenna about two mutually perpendicular axes for aiming said antenna; a control means (13) adapted to control said drive unit; and an interface means (15) adapted to provide a bidirectional transmission of signals with said control means and to receive signals from a remote control means (36) for the control of said drive unit; said drive unit, said control means, and said interface means being powered directly by the satellite receiver (16) that is connected to said interface means.
2. The device according to claim 1, wherein said drive unit comprises a microactuator (12) adapted to move said reflector about a horizontal axis and a gearmotor (11) adapted to move said reflector about a vertical axis.
3. The device according to either claim 1 or 2, wherein said microactuator (12) is connected to one end of a supporting bracket (7) for said reflector and is pivoted on a rotatable part (3) that constitutes the upper portion of a support that contains said control means, said bracket being pivoted to said rotatable part at its other end.
4. The device according to one or more of the preceding claims, wherein said gearmotor is connected to said rotatable part by means of a gear.
5. The device according to one or more of the preceding claims, comprising a rod member (8) connected to said bracket (7), said reflector being connected to said rod member.
6. The device according to one or more of the preceding claims, wherein said microactuator (12) is a ballscrew microactuator with low current absorption.
7. The device according to one or more of the preceding claims, wherein said gearmotor (11) is a DC gearmotor with low absorption.
8. The device according to one or more of the preceding claims, wherein said control means (13) comprises a microcontroller (22) that is suitable to drive power circuits (23,24) of said gearmotor and said microactuator according to the control signals received by said interface means.
9. The device according to one or more of the preceding claims, comprising detection means (25,26) for detecting the position of said microactuator and of

said gearmotor, said detection means generating pulses, said pulses being counted by said microcontroller to determine the angular position of said antenna.

10. The device according to one or more of the preceding claims, wherein said detection means comprises Hall-effect sensors that are suitable to send the pulses to an interface that is connected to said microcontroller.
11. The device according to one or more of the preceding claims, comprising a first memory means (28) that is suitable to store the angular position of said antenna after the last performed movement.
12. The device according to one or more of the preceding claims, comprising a first demodulation means (29) that is connected to said microcontroller and is suitable to demodulate signals transmitted by said interface means.
13. The device according to one or more of the preceding claims, wherein said control means is connected to said interface means through a single coaxial cable (20), said interface means being connected to said receiver through a single coaxial cable (21).
14. The device according to one or more of the preceding claims, comprising a first oscillator means (30) and a first electronic circuit (31), which is connected to said microcontroller, said means and said circuit being suitable to send encoded power-line carrier waves along the coaxial cable that connects said control means to said interface means.
15. The device according to one or more of the preceding claims, comprising a circuit (32) for monitoring the voltage level, which is connected to said microcontroller.
16. The device according to one or more of the preceding claims, comprising a means (33) for interrupting the power supply, which is connected to said microcontroller and to said coaxial power supply cable.
17. The device according to one or more of the preceding claims, comprising a voltage level monitoring circuit (32) that is connected to said microcontroller.
18. The device according to one or more of the preceding claims, wherein said interface means comprises a second microcontroller (34) that is suitable to receive signals from said remote control means and to provide a bidirectional transmission of signals with said control means.
19. The device according to one or more of the preceding

ing claims, comprising a receiver means (35) that is suitable to receive the control signals that are sent by said remote control means, said receiver means being connected to said second microcontroller.

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20. The device according to one or more of the preceding claims, wherein said receiver means comprises a photoreceiver (50) and an amplifier (60).
21. The device according to one or more of the preceding claims, comprising a second memory means (37) that is connected to said second microcontroller and is suitable to store the positions of multiple satellites.
22. The device according to one or more of the preceding claims, comprising a display means (38) that is connected to said microcontroller to display to the user information related to the operations for positioning said antenna.
23. The device according to one or more of the preceding claims, comprising a means (42) for protecting against surges of current which is connected to said coaxial cable and to said microcontroller.
24. The device according to one or more of the preceding claims, comprising a second oscillator means (40) and a second electronic circuit (41), which is connected to said microcontroller, said means and said circuit being suitable to inject encoded power-line carrier waves in said coaxial cable for communication with said control means (13).
25. The device according to one or more of the preceding claims, comprising a second demodulation means (39) that is suitable to demodulate the signal that originates from said control means to decode said signal.
26. The device according to one or more of the preceding claims, wherein said memory means comprises an EEPROM.
27. The device according to one or more of the preceding claims, wherein said remote control means comprises an infrared remote control.
28. The device according to one or more of the preceding claims, wherein said reflector has an LNB (18), said control means is connected to said LNB through a second coaxial cable (19).
29. The device according to one or more of the preceding claims, wherein said electronic circuit is a multiplier circuit.
30. The device according to one or more of the preceding claims, wherein said support is provided with a

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protruding portion (4) that is suitable to allow coupling to a supporting element (6) for the support of said antenna.

31. The device according to one or more of the preceding claims, wherein said control means (13) is accommodated inside said supporting means (2), at the base, said control means having two connectors (14) for said coaxial cable for connection to said interface means and for said coaxial cable for connection to said LNB, said two connectors protruding downward from said support.

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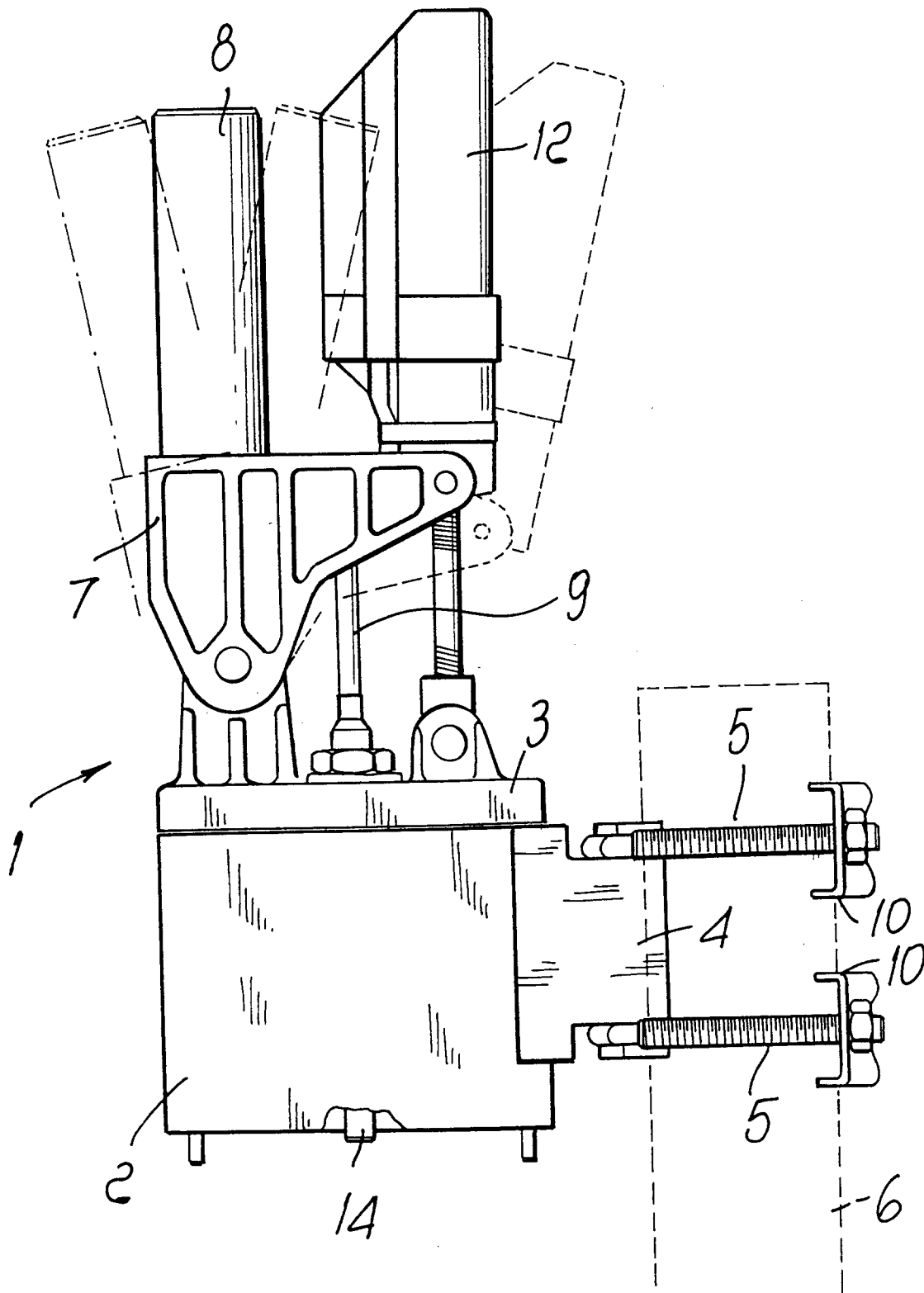


Fig. 1

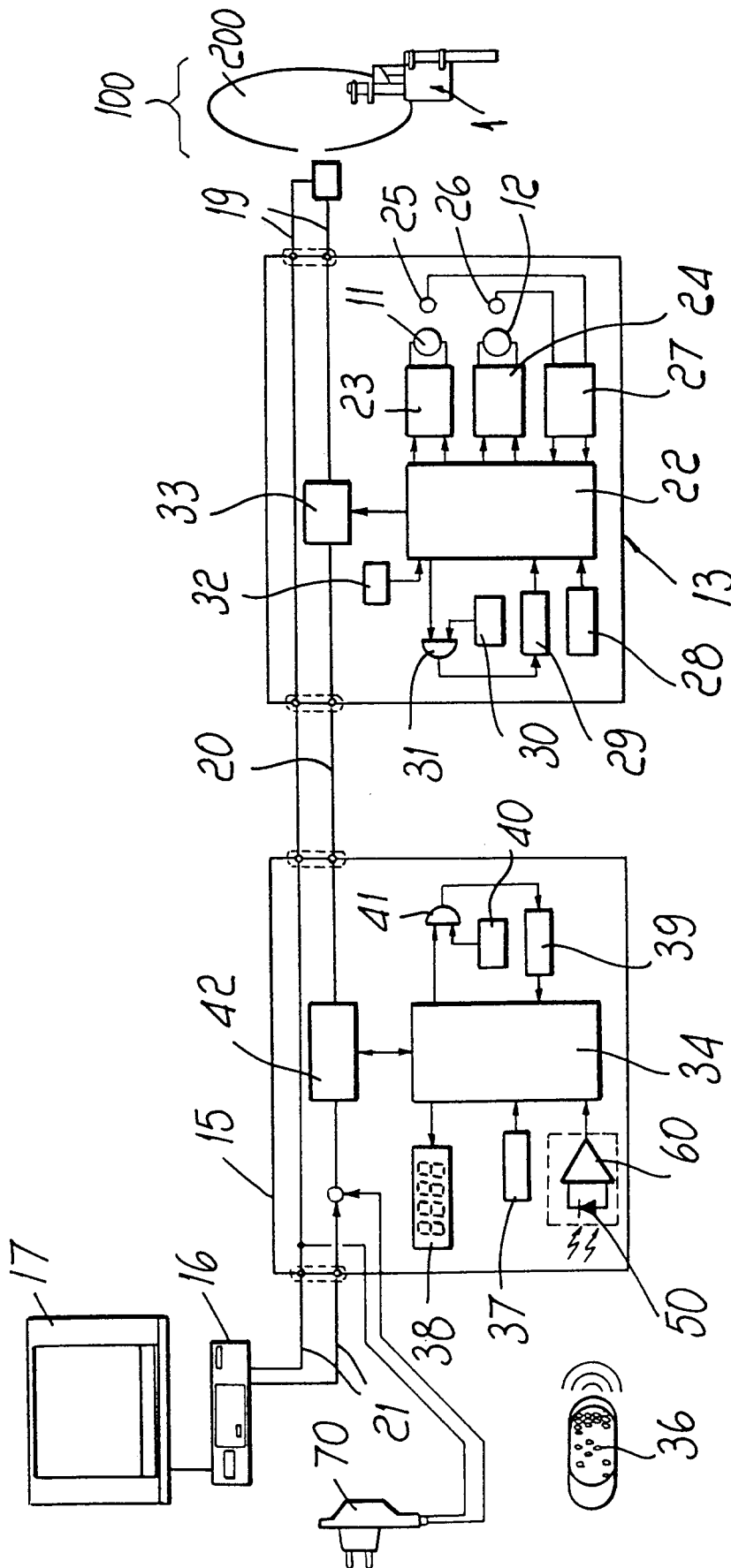


Fig. 2

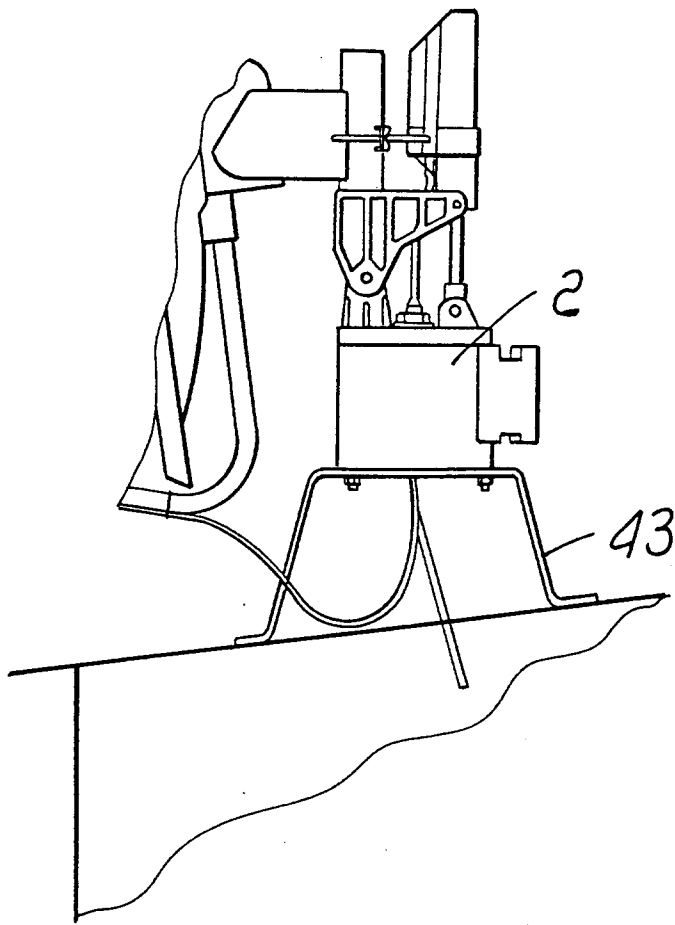


Fig. 3

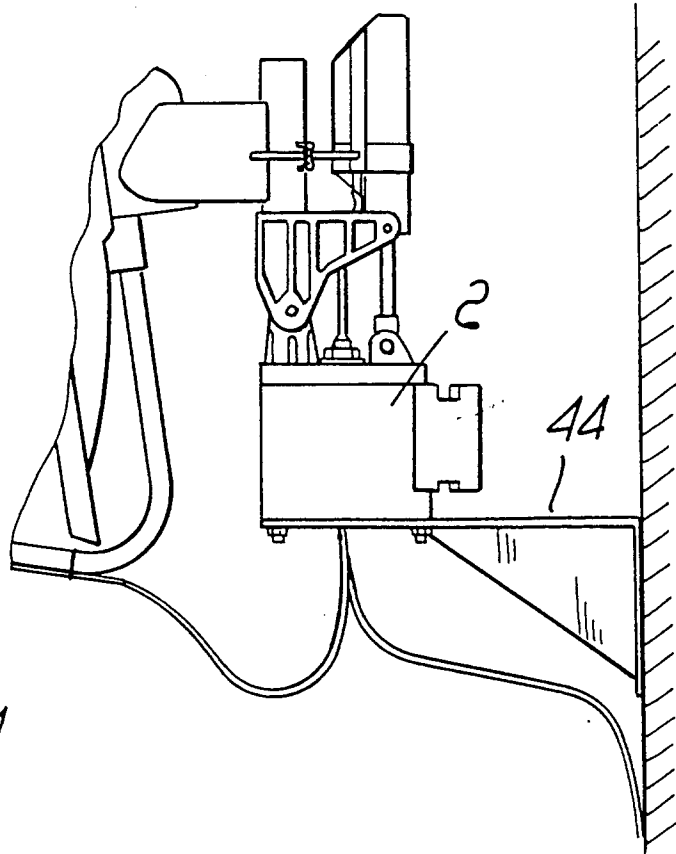


Fig. 4

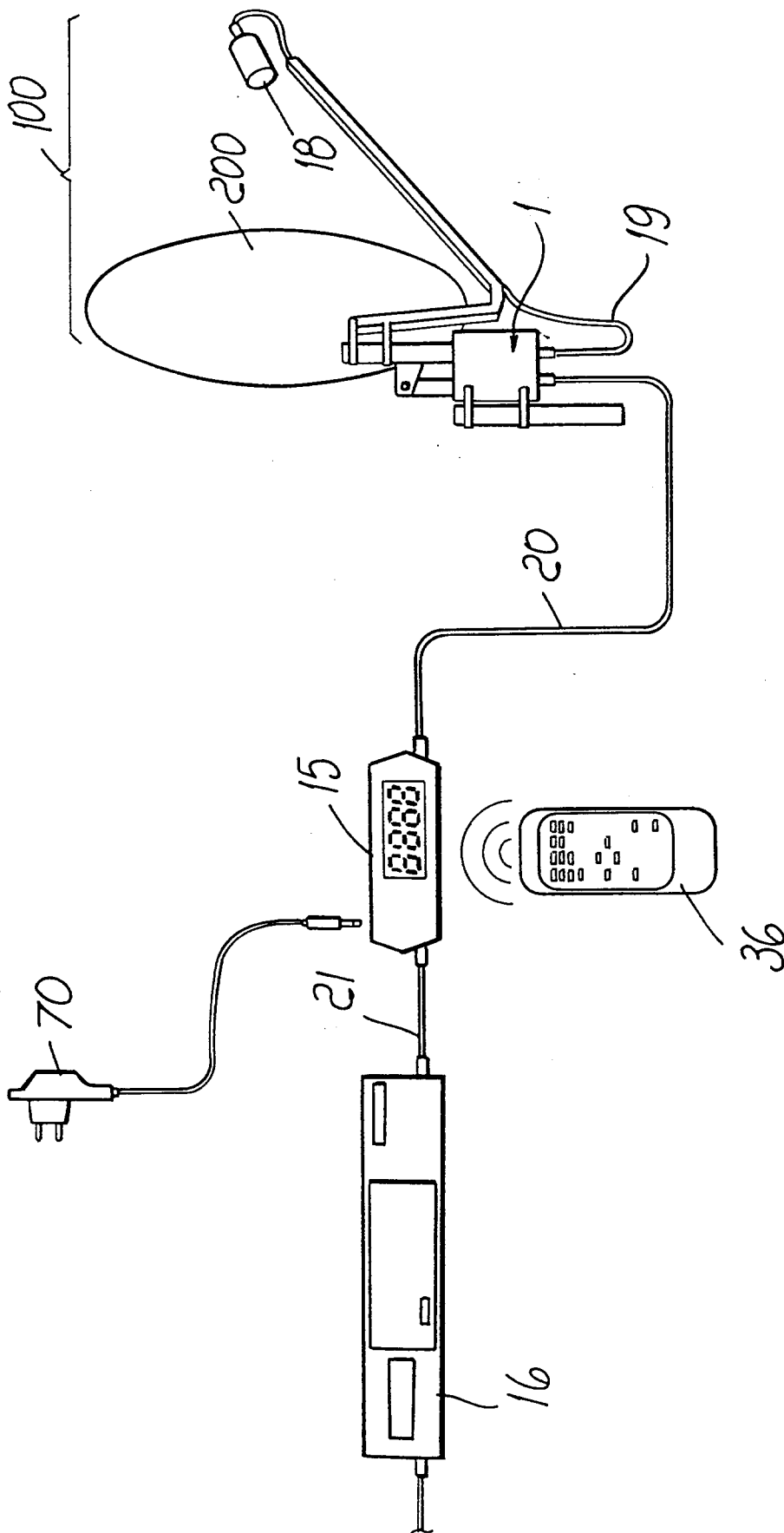


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 96 10 9933

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	DE-A-38 23 109 (AISIN SEIKI) * column 5, line 1 - column 6, line 64; figures 2,3A,3B *	1	H01Q1/12
Y	US-A-4 691 207 (A. A. TIMINERI) * column 2, line 34 - column 3, line 48; figures 1-3 *	1	
Y	FR-A-2 603 426 (C. J. BAUD) * page 3, line 27 - page 4, line 2; figure 1 *	27	
Y	EP-A-0 058 289 (BRIONVEGA) * claim 1; figure 1 *	27	
A	US-A-5 077 560 (E. T. HORTON ET AL) * column 3, line 49 - column 5, line 6; figure 1 *		
A	EP-A-0 246 635 (NEC CORP.) * abstract; figures 1-5 *		TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 104 (E-397) [2161] , 19 April 1986 & JP-A-60 242706 (SONY), 2 December 1985, * abstract *		H01Q
A	FR-A-2 627 635 (LMT RADIOPROFESSIONNELLE) * abstract; figure 2 *		
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 31 October 1996	Examiner Breusing, J
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
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