United States Patent [19]

Buckley

[11] **3,860,859**

[45] **Jan. 14, 1975**

[54] **ROTATOR SYSTEM INCLUDING A REMOTE DRIVE MOTOR AND A LOCAL INDICATOR-CONTROL MOTOR**

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[73] Assignee: **RCA Corporation,** New York, N.Y.

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[21] Appl. No.: **274,638**

[52] **U.S. Cl.** **318/265,** 318/41, 318/673

[51] **Int. Cl.** **G05d 3/00**

[58] **Field of Search** 318/41, 265–267, 318/466, 467, 672, 673, 675, 676

[56] **References Cited**

UNITED STATES PATENTS

2,496,485	2/1950	McNaney	318/673
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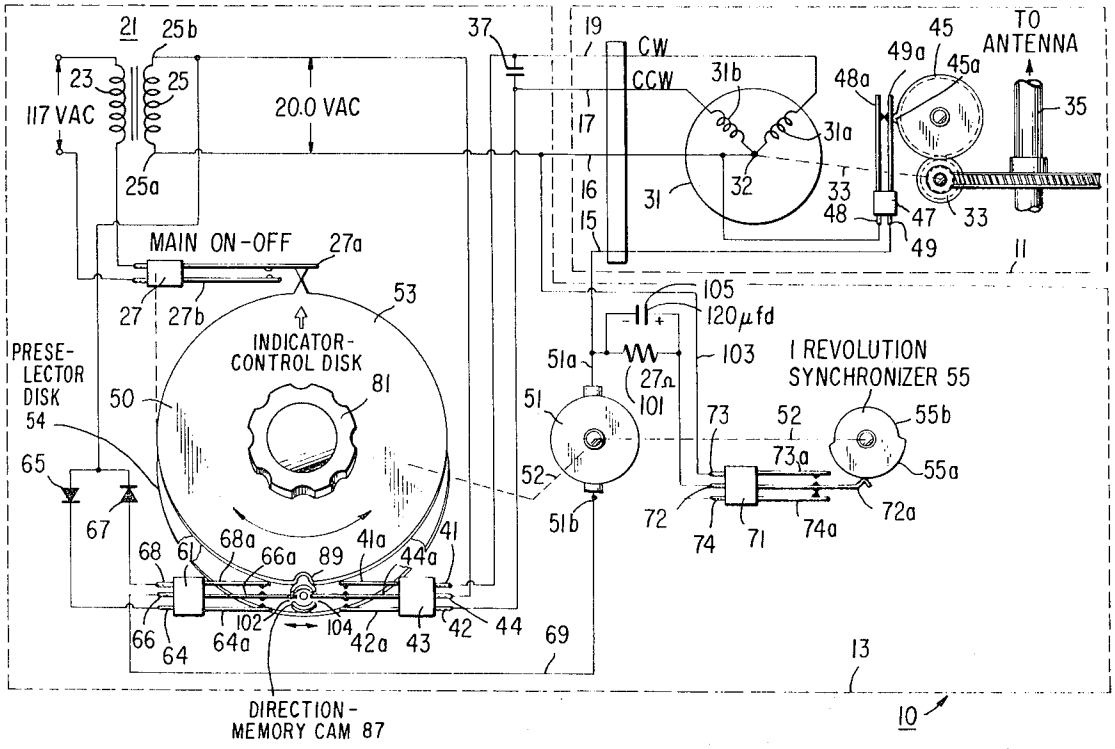
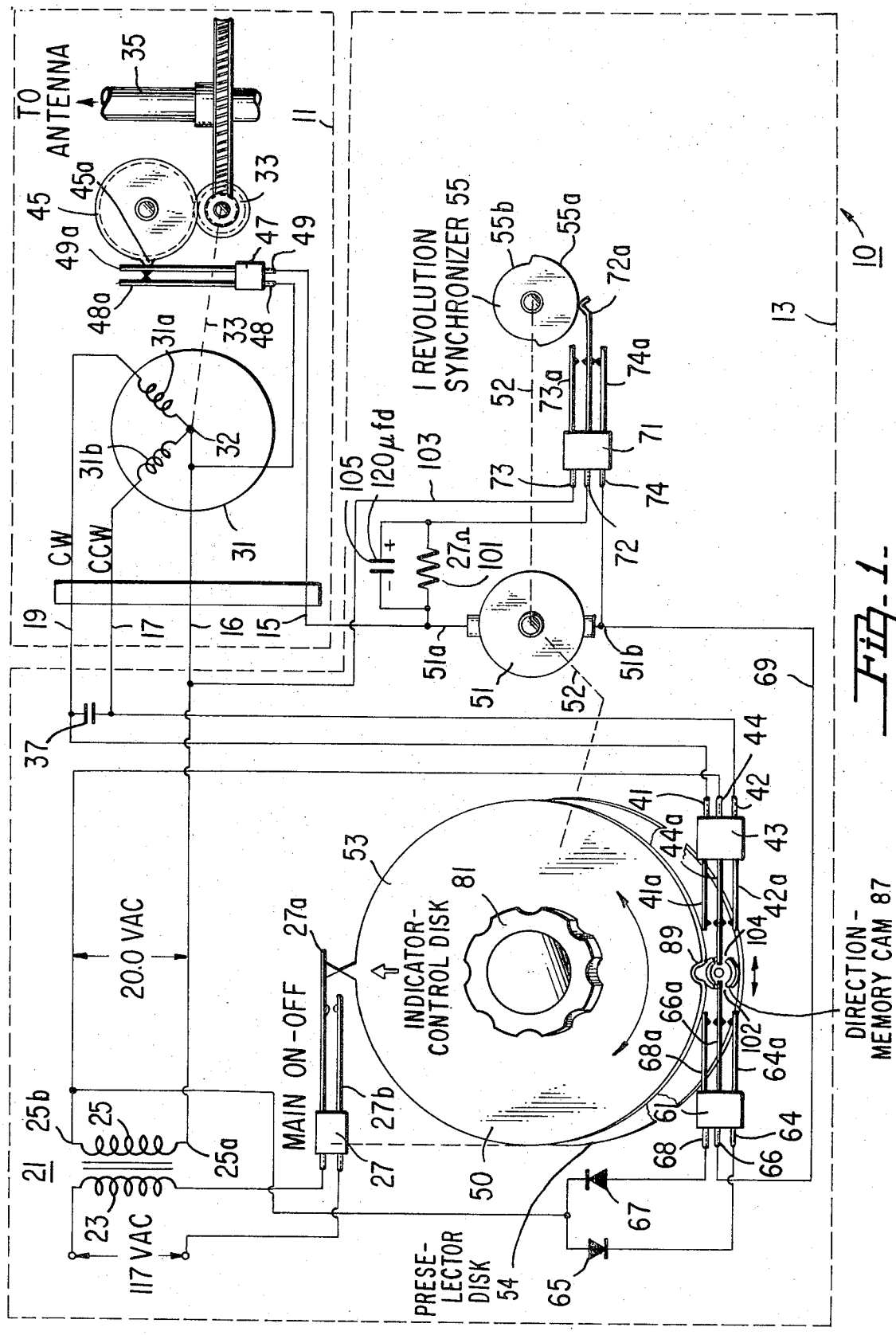
Primary Examiner—Robert K. Schaefer
Assistant Examiner—W. E. Duncanson, Jr.
Attorney, Agent, or Firm—Edward J. Norton; Robert L. Troike

[57] **ABSTRACT**

A remotely controlled shaft rotator is described wherein a local indicator-control device is driven by a regulated local reversible motor. The local motor is initially responsive to a pulse derived at the remote drive unit for driving the indicator-control device a given amount as controlled by a cam operated switch.

9 Claims, 4 Drawing Figures




TO ANTENNA
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I REVOLUTION SYNCHRONIZER 55
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105
120μfd
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27a
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51a
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41a
42a
89
104
66a
68a
102
64a
61
64
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66
67
65
50
54
27a
27b
27
MAIN ON-OFF
INDICATOR-CONTROL DISK
DIRECTION-MEMORY CAM 87
PRESE-LECTOR DISK
20.0 VAC
117 VAC
21
25b
25
25a
23

FIG. 1.

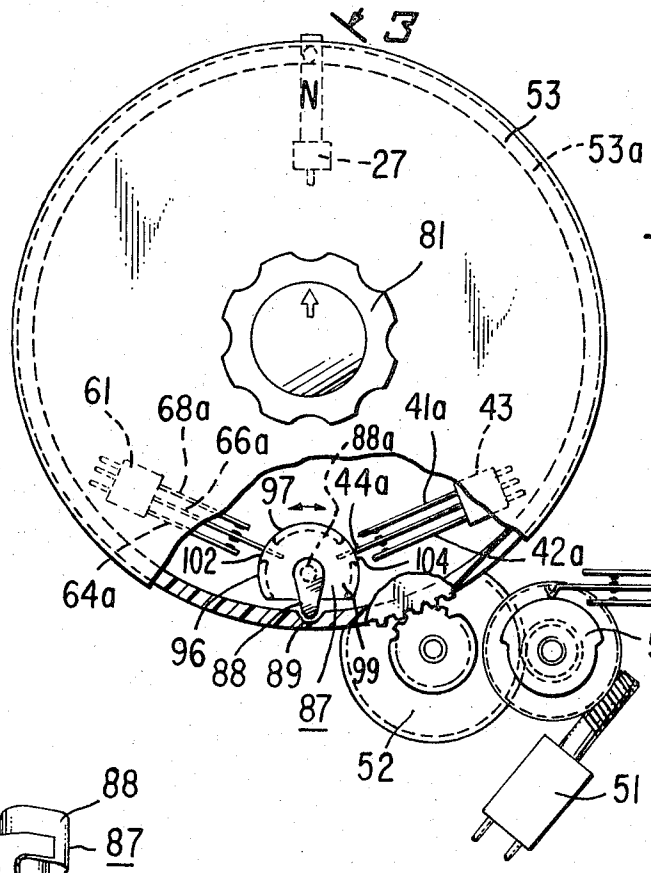

Fig. 2

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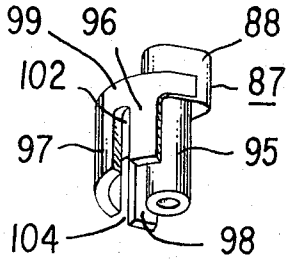

Fig. 4

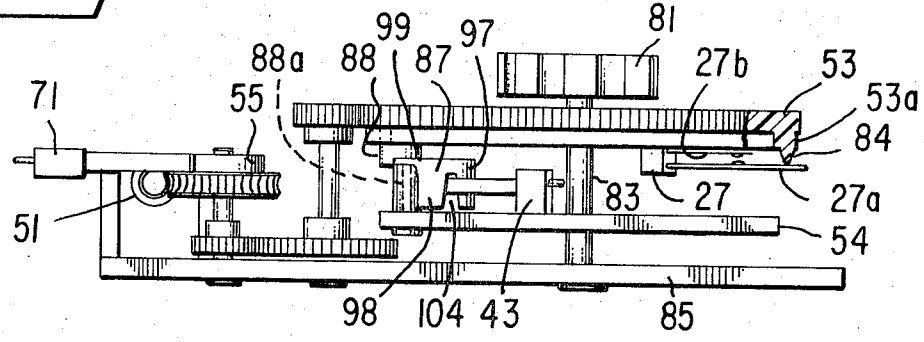

Fig. 3

ROTATOR SYSTEM INCLUDING A REMOTE DRIVE MOTOR AND A LOCAL INDICATOR-CONTROL MOTOR

This invention relates to a rotator system and particularly to the use of a controlled, reversible electric motor in a rotator system to drive an indicator-control device that both indicates position of a remote rotating shaft and automatically deactivates the system when at a preselected position.

In antenna rotators, for example, it is desirable to remotely preselect and to indicate the direction that an antenna is pointing. One way of achieving this is by means of a synchro system, i.e., a system of a generator and a motor where the rotor of a motor aligns itself with the fields of a stator winding. Such a synchro system is costly and therefore is generally considered as being undesirable as a rotator for home television antenna systems, FM receiving antennas, etc.

Another technique for indicating antenna direction is by the pulsed energization of a solenoid which causes either the stepping of a ratchet wheel (see U.S. Pat. No. 3,501,969) or allows the movement of a spring driven escapement wheel one notch or tooth per movement of the solenoid. These ratcheting and escapement systems are noisy and sometimes require a pair of solenoids unless a specific structure is used to provide bidirectional movement. Further it is desirable to preselect the desired antenna direction and to use the same system for both indicating the pointing direction of the antenna and for automatically stopping the antenna at a preselected direction.

Briefly, according to the present invention a system is provided for rotating a remote shaft relative to a support and for providing an indication of the position of the shaft. A first reversible drive unit includes a first reversible motor and a first drive train by which the first motor when energized drives the first drive train and a shaft. A local movable indicator is coupled to a second drive unit including a second reversible motor and a second drive train. The second reversible motor in response to energizing potential drives the second drive train and the indicator. A first switching means is coupled between a suitable source of potential and the first motor to operate the first motor to provide shaft rotation and movement of the first drive train. A second switching means is coupled between a suitable source of potential and the second motor and is further responsive to each given movement of the first drive train to cause activation of the second motor. A motor control means is responsive to the movement of the second drive train to control the energization potentials and the rotation of the second motor and the movement of the indicator coupled thereto.

DETAILED DESCRIPTION

A more detailed description follows in conjunction with the accompanying drawing wherein:

FIG. 1 is a schematic diagram of a rotator system according to the present invention;

FIG. 2 is a top plan view of the control unit of the antenna rotator system without connecting wires and transformer;

FIG. 3 is an elevation view of the local control unit of FIG. 2 as viewed in the direction of line 3—3; and

FIG. 4 is a perspective view of the direction-memory cam according to an embodiment of the present invention.

Referring to FIG. 1, a rotator system 10 includes a shaft rotator, remote drive unit 11, a local control unit 13 and four wires 15, 16, 17 and 19 interconnecting the control unit 13 and the remote drive unit 11. The control unit 13 may be located on top of a television set, and the drive unit 11 may be located at a remote position such as at an antenna mast supported from and extending above the roof top of a dwelling.

At the input to the control unit 13 is a transformer 21 which in response to 117 volts AC at the primary 23 provides 20 volts AC at the secondary 25. A main, on-off switch 27 is coupled in series with the primary 23 of transformer 21. When the contacts 27*a* and 27*b* of switch 27 are closed, the 117 volts AC is applied across the primary 23 and coupled to the secondary 25 of transformer 21. If the contacts 27*a* and 27*b* are open, the transformer 21 and consequently the overall system 10 is de-energized.

The opening and closing of contacts 27*a* and 27*b* is provided by misalignment and alignment, respectively, of a preselector disk 54 (shown in more detail in FIGS. 2 and 3) and an indicator disk 53. For purposes of illustration, disks 53 and 54 are shown in simplified form in FIG. 1 and are tilted slightly so disk 54 can be seen. A more detailed description of this structure is discussed below in connection with FIGS. 2 and 3. Briefly, however, when a knob 81 is rotated clockwise or counterclockwise, the disk 54 that is mechanically coupled thereto is rotated clockwise or counterclockwise. Switch 27 which may be coupled to disk 54 turns with disk 54. The indicator-control disk 53 is spaced parallel to and above preselector disk 54 on a shaft 83 (see FIG. 3). Disk 53 is mounted so as to freely rotate on the shaft. Disk 53 has an extension 84 thereon adapted so that when the disks 53 and 54 are aligned, an extension 84 pushes contact 27*a* away from contact 27*b*, de-energizing the system. When extension 84 is misaligned with switch 27, as when knob 81 rotates the disk 54 clockwise or counterclockwise, the contacts 27*a* and 27*b* being free of the extension 84 are closed and the system is energized.

The remote drive unit 11 includes an AC motor 31. The drive unit motor 31 includes a pair of windings 31*a* and 31*b*. Coupled to the drive unit motor 31 is a gear train 33 (partially shown) and a rotatable shaft 35. An antenna mast (not shown) may be fixed to the rotatable shaft 35. The shaft 35 and the mast is driven via the gear train 33 by drive unit motor 31. One end 25*a* of secondary winding 25 is coupled by wire 16 to one end 32 of AC motor windings 31*a* and 31*b*. The opposite end of the motor winding 31*a* is coupled over wire 19 to a terminal 41 of motor direction switch 43. The opposite end of motor winding 31*b* is coupled by wire 17 to a second terminal 42 of motor direction switch 43. A phase shifting capacitor 37 is coupled between wires 17 and 19 for providing phase shift therebetween and providing activation of the motor 31. The other end 25*b* of secondary winding 25 is coupled to the center terminal 44 of motor direction switch 43.

Motor direction switch 43 is a flexible leaf contact switch with a flexible contact member 44*a* connected to terminal 44 and adapted, when flexed, to make contact with either contact member 42*a* connected to terminal 42 or with contact member 41*a* connected to

terminal 41. When member 44*a* makes contact with member 41*a*, the drive unit motor 31 rotates clockwise for example, with the current going through wire 19 and winding 31*a* via contacts 44*a* and 41*a*. When contact member 44*a* is closed with contact member 42*a*, the drive unit motor 31 rotates in the opposite or counterclockwise direction with currents coupled via contact members 44*a* and 42*a* along wire 17 to winding 31*b*.

The motor direction switch 43 is, for example, fixed to disk 54. Also fixed to the disk 54 is a direction-memory cam 87. The cam 87 is rotatably mounted to the disk 54 and has an extension that fits into a groove 89 in disk 53 when disks 53 and 54 are aligned. As shown in FIGS. 2 and 3, the cam 87 has gaps 102 and 104 therein. Flexible leaf contact 44*a* extends into gap 104. When knob 81 rotates clockwise, the direction-memory cam 87 rotates counterclockwise and causes direction-memory cam 87 to push contact 44*a* into connection with contact 41*a*. When knob 81 rotates counterclockwise, the direction-memory cam 87 rotates clockwise and causes contact 44*a* to connect with contact 42*a*. A more detailed discussion of this cam 87 and the disks 53 and 54 is provided in connection with FIGS. 2 thru 4.

A local indication of the rotated position of the remotely located rotating shaft and hence the pointing direction of the antenna is provided by a pulsing circuit at the drive unit 11, a DC control unit motor 51, a synchronizer cam 55, the indicator-control disk 53, a pair of rectifier diodes 65 and 67 and a pair of control switches 61 and 71. At the drive unit 11 is located an intermittent switch 47. The intermittent switch 47 has one terminal 48 connected to wire 16 and the other terminal 49 connected to one end 51*a* of the DC control unit motor 51. The switch 47 has a pair of contacts 48*a* and 49*a* which are normally open. Associated with the gear train 33 of motor 31 is a cam 45 which has a high point 45*a* which when driven by the drive unit motor 31 through the gear train 33 intermittently provides contact between contacts 49*a* and 48*a* of switch 47. The result is a pulse output and an energizing source of potential from switch 47 that is coupled by wire 15 to DC control unit motor 51.

The direction in which the DC control unit motor 51 turns is determined by the position of switch 61. The switch 61 is fixed, for example, to disk 54 with a center contact member 66*a* positioned in gap 102 of the direction-memory cam 87. A first terminal 68 of switch 61 is coupled to the anode of diode 67. The cathode of diode 67 is coupled to end 25*b* of secondary 25. Terminal 64 of switch 61 is coupled to the cathode of diode 65. The anode end of diode 65 is coupled to the end 25*b* of secondary 25. Diodes 65 and 67 each provide half wave rectification of the AC signal at the secondary 25.

Since diodes 65 and 67 are oppositely connected, current direction and DC control unit motor rotation direction is controlled by which of terminals 64 or 68 completes the circuit through the DC control unit motor 51. The center leaf contact member 66a can make contact with either member 68*a* or 64*a*. Contact member 68a is connected with terminal 68, and contact member 64*a* is connected with terminal 64. The flexible contact member 66*a* is connected to terminal 66, and terminal 66 is coupled by wire 69 to terminal 51*b* of DC control unit motor 51. When knob 81 is rotated clockwise, cam 87 is rotated counterclockwise, causing center flexible leaf contact member 66*a* to make contact with member 64*a*. The 20 volt AC is then half wave rectified by diode 65, and the DC current is coupled through contacts 64*a* and 66*a* and wire 69 to control unit motor 51, resulting in the control unit motor 51 rotating in a first direction. When knob 81 is rotated counterclockwise, cam 87 is rotated clockwise causing flexible contact 66*a* to make contact with member 68*a*. In this position the 20 volts AC is half wave rectified with current flowing through diode 67, contact members 66*a* and 68*a*, wire 69 and through control unit motor 51 to drive motor 51 in the other direction.

The DC control unit motor 51 is coupled by a gear train 52 to indicator-control disk 53 and to a synchronizing cam 55. The synchronizing cam 55 has a raised or camming region 55*a* and a low or "off" region 55*b*. A synchronizing switch 71 having a center flexible leaf contact member 72*a*, a contact member 73*a* and a contact member 74*a* is provided for controlling the DC control unit motor 51. Terminal 72 of switch 71 is connected to center flexible member 72*a*. Terminal 74 of switch 71 is connected through switch 71 to contact member 74*a*, and terminal 73 is connected through switch 71 to contact member 73*a*. Terminal 74 is connected to wire 69 and end terminal 51*b* of DC control unit motor 51. Terminal 73 is connected by wire 103 to wire 16. Terminal 72 is coupled through 27 ohm resistor 101 and bypass charge capacitor 105 (120 microfarad) to terminal 51*a* of motor 51. The synchronizing cam 55 is positioned relative to the flexible leaf contact member 72*a* so that when the raised region 55*a* is in contact with the member 72*a*, this member 72*a* makes contact with member 74*a*. When cam 55 is in position to present the low or "off the cam" portion 55*b*, contact member 72*a* which is spring loaded or otherwise biased, makes contact with contact member 73*a*.

In the operation of the above described indicating portion of the remote control system 10, drive unit cam 45 makes one revolution for every 6° of rotation of the drive unit shaft 35. Similarly, synchronizing cam 55 is geared to make one revolution for every 6° turn by the indicator-control disk 53. The same ratio of turns that exists between drive unit cam 45 and the antenna shaft 35 (60 to 1) exists between the revolution synchronizer cam 55 and indicator-control disk 53. When the drive unit motor 31 rotates the cam 45 to close the contacts 48*a* and 49*a* at high point 45*a*, a pulse is coupled to control unit motor 51 which initially energizes control unit motor 51. Control unit motor 51 turns in response to the direction indicated by switch 61 so that synchronizing cam 55 is rotated from presenting its high or raised portion 55*a* to switch 71 to its low (or "off the cam") position 55*b*. When contact member 72*a* of switch 71 is "off" the cam or presenting its low position 55*b*, switch member 72*a* makes contact with member 73*a* keeping the DC control unit motor 51 energized through the resistor-capacitor combination 101 and 105, contact member 72*a*, contact member 73*a* and wire 103 to a connection at wire 16. When the synchronizer cam 55 is driven by the control unit motor 51 and gear train 52 to present the raised portion 55*a*, member 72*a* breaks contact with member 73*a* and makes contact with member 74*a* to de-energize the control unit motor 51. Motor resistor 101 and charging capacitor 105 operate to prevent the DC control unit motor

from overdriving the high or raised portion **55***a* of the synchronizing cam **55.** Capacitor **105** charges against the direction of current through DC control unit motor **51** and resistor **101** acts as an additional load resistor in series with the DC control unit motor **51.**

The speed of the DC control unit motor **51** is such that the synchronizer cam **55** turns faster than drive unit cam **45.** Control cam **55** is driven faster by DC motor **51** than is the cam **45** by the motor **31** so that cam member **55** turns one complete revolution and indicator-control disk **53** progresses 6° before the cam member **45** is able to make a second connection of members **48***a* and **49***a* at switch **47** and before shaft **35** and the antenna has rotated 6°. DC control unit motor **51** and cam member **55** then wait for another pulse from the drive unit **11.** The resynchronization at 6° intervals by energizing the DC control unit motor **51,** rotating the cam **55** one revolution and shutting off the motor continues for each pulse applied from the drive unit **11** until the selected position is reached, wherein the drive unit **11** is de-energized and the main on-off switch **27** is in the "off" or open position. This resynchronization at 6° intervals of the two motors ensures that the antenna or remote rotator is kept in alignment with the control unit despite variations in the drive motor speed due to variable loading on the antenna drive motor **31.**

Referring to FIGS. **2, 3** and **4,** there is shown a top view and an elevation view respectively of the control unit **13** which includes the indicator-control disk **53** positioned in a given alignment above the disk **54.** The control knob **81** is coupled to a shaft **83** which extends through indicator-control disk **53** and is fixed to selector disk **54.** Indicator-control disk **53** is mounted to shaft **83** so that it freely rotates about the shaft. Selector disk **54** is fixedly mounted and rotates with the shaft. The shaft **83** is fixed but rotatably mounted to a baseboard **85.** Extending between selector disk **54** and indicator-control disk **53** is the leaf spring type, normally closed contact switch **27.** A small member **84** extends from a point near the periphery of control disk **53** and only makes contact with normally closed on-off switch **27** when disks **53** and **54** are in aligned position therewith to break the contact between the members **27***a* and **27***b*, deactivating the system **10.**

The motor direction switches **61** and **43** are mounted to selector disk **54.** The rotatable direction-memory cam **87** is rotatably mounted to the selector disk **54** by a pin **88**a having a head below disk **54** and extending through disk **54** and base portion **95.** Referring to FIG. **4,** the direction-memory cam **87** includes a base portion **95** adapted to receive pin **88**a and three parallel extending members **96, 97** and **98** spaced from each other and from the base portion **95** by spacer portion **99.** A tooth shaped member **88** extends vertically and laterally from the base member **95.** A gap **104** exists between members **98** and **97,** and a gap **102** exists between members **97** and **96.** The rotatable direction-memory cam **87** extends in the region between indicator-control disk **53** and disk **54** with the tooth-shaped extending member **88** positioned just below control disk **53.** A ring member **53**a positioned below indicator-control disk **53** may be formed as an extension of disk **53** so as to extend about the periphery of this disk. The ring member **53***a* has a groove **89** therein extending from the inboard surface. The tooth-shaped member **88** of direction-memory cam **87** is adapted to fit into groove **89** when the control disk **53** and selector disk **54** are aligned and the main on-off switch **27** is de-energized.

The direction-memory cam **87** and the switches are arranged so that flexible leaf member **44***a* extends through gap **104** and flexible leaf member **66***a* extends through gap **102.** See FIGS. **2** and **4.** When the control disk **53** and the disk **54** are aligned, the tooth-shaped member **88** is lodged into slot **89** and the flexible contact members **66***a* and **44***a* make no contact with either of their adjacent contact members. When the control knob **81** and disk **54** is rotated, for example, in a clockwise direction, the tooth-shaped member **88** is driven laterally and thereby rotates out of slot **89** and causes the direction-memory cam **87** to rotate, in the example, in a counterclockwise direction. When direction-memory cam **87** rotates in a counterclockwise direction, the member **98** of direction-memory cam **87** pushes contact member **44***a* and member **97** of direction-memory cam **87** pushes contact member **66**a so that contact member **44**a makes contact with member **41***a* and contact member **66***a* makes contact with member **64***a*. The drive unit **11** is then made to rotate in the selected direction with the DC control motor **51** made to drive the control disk **53** in the proper direction in response to impulses from the drive unit **11** to realign disk **53** with disk **54.**

When the DC motor **51** drives disk **53** back to the aligned position with disk **54,** the tooth-shaped member **88** is again in slot **89** of disk **53** centering the contact members **66***a* and **44***a*. When the control knob **81** is rotated in the opposite direction, counterclockwise, direction-memory cam **87** is rotated in a clockwise direction, with the member **44***a* making contact with member **42***a* and member **66***a* making contact with associated contact member **68**a. The operation will be as described above.

What is claimed is:

1. A system for rotating a remote shaft and for providing a local indication of the rotated position comprising:

a first driving means including a first reversible motor and a first drive train, said first reversible motor being responsive to energization potential applied thereto for driving said remote shaft and said first drive train,

a local movable indicator,

a second driving means including a second reversible motor and a second drive train coupled to each other and said indicator and responsive to an energization potential applied thereto for driving said indicator,

first switching means coupled between a suitable source of potential and said first motor for causing rotation of said shaft and movement of said first drive train,

second switching means including a first cam and a first cam-operated switch driven by said first cam coupled between a suitable source of potential and said second motor and coupled to said first drive train responsive to a given movement of said first drive train to cause activation and rotation of said second motor and movement of said indicator,

motor control means including a second cam and a second cam-operated switch driven by said second cam coupled to said second drive train for controlling the rotation of said second motor to provide a

predetermined movement of said indicator each time said first drive train moves said given amount.

2. The combination as claimed in claim **1**, wherein said second cam-operated switch is a single pole double throw switch with the movable arms thereof being driven by said second cam.

3. The combination as claimed in claim **1**, wherein said second motor rotates at sufficiently higher speed than said first motor so that said second reversible motor has provided said predetermined movement of said indicator before the first motor has moved said first drive train another of said given amount.

4. A system for rotating a remote shaft and for providing a local indication of the rotated position thereof comprising:

a first driving means including a first reversible motor and a first gear train, said first reversible motor being responsive to energization potential applied thereto for driving said remote shaft and gear train,

first switching means coupled between a suitable source of potential for said first motor and said first motor for causing rotation of said shaft and movement of said first gear train,

a local movable indicator,

a second driving means including a second reversible motor and a second gear train coupled to each other and said indicator and responsive to an energizing potential applied thereto for driving said indicator,

interrupting switch means coupled between a suitable source of potential for said second motor and said second motor and coupled to said first gear train for in response to a given movement of said first gear train causing momentary activation and rotation of said second motor and movement of said indicator,

a cam coupled to said second gear train,

motor control switch means driven by said cam and coupled between said suitable source of potential for said second motor and said second motor and responsive to momentary activation of said cam for operating said second motor to provide a predetermined movement of said second gear train.

5. The combination as claimed in claim **4**, wherein said interrupting switch means includes a cam and a cam operated switch with said cam being driven by said first gear train and said switch being coupled between said suitable source of potential for said second motor and said second motor.

6. A system for automatically rotating a remote shaft to which an antenna may be coupled to a preselected position comprising in combination:

a first driving means including a first motor having reversing means, said first driving means coupled to said remote shaft for causing rotation thereof,

a second driving means including a second motor having reversing means,

means by which said first and second driving means can be energized,

means coupled to said first driving means and said energization means for providing an energizing signal potential for said second motor each time said remote shaft turns a given amount,

a movable preselector member,

an indicator-control member driven by said second driving means and movably mounted relative to said preselector member,

a first switching means coupled between said energization means and said first driving means in a manner to cause when in a first switch position said first driving means to rotate said shaft in a first direction or in a second switch position said first driving means to rotate said shaft in a second opposite direction,

a second switch means coupled between said energization means and said second driving means in a manner to cause when in a first switch position said second driving means to drive said indicator-control member in a first direction or in a second switch position said second driving means to drive said indicator-control member in a second reverse direction,

said first and second switch means being coupled to said movable preselector member and said indicator-control member so that misalignment of said members in one sense causes rotation of said first and second reversible motors in one direction and misalignment of said members in a second sense causes rotation of said first and second reversible motors in a second sense.

7. The combination as claimed in claim **6**, including a third switch means coupled to said members and said energization means for de-energizing said first and second motors only upon alignment of said disks.

8. A system for automatically rotating a remote shaft to which an antenna may be coupled to a preselected position comprising in combination:

a first driving means including a first motor having reversing means, said driving means coupled to said remote shaft for causing rotation thereof,

a second driving means including a second motor having reversing means,

means by which said first and second driving means can be energized,

means coupled to said first driving means and to said energization means for providing an energization potential for said second motor each time said remote shaft rotates a given amount in a selected direction,

a movable preselector disk and an indicator-control disk, said indicator-control disk having a groove therein at a point near the periphery of said disk,

a first single pole double throw switch having a flexible contact member coupled to said energization means and centered between two relatively fixed contact members with a first of said fixed contact members coupled to said first motor in a manner to cause said first motor to rotate in a first direction and with the second of the fixed contact members coupled to said first motor in a manner to cause said first motor to rotate in a reverse direction,

a second single pole double throw switch having a flexible contact member coupled to said energization means and centered between two relatively fixed contact members with the first of said fixed contact members of said second switch coupled to said second motor in a manner to cause when said second switch is in a first position said second motor to rotate in a first direction and with the second of the fixed contact members of the second switch coupled to said second motor in a manner to cause when said second switch is in a second position said second motor to rotate in a reverse direction,

a direction-memory cam having a pair of apertures therein adapted to receive said flexible contact members,

said direction-memory cam being rotatably mounted to said preselector disk with said direction-memory cam extending between said preselector disk and said indicator-control disk with an extended portion of said cam fitting into said groove located in said indicator-control disk when said preselector disk and said indicator-control disk are in their aligned position,

said first switch being arranged with the center flexible contact member thereof extending into one aperture of said direction-memory cam to cause, when said preselector disk moves with respect to said indicator-control disk in a first non-aligned direction, said flexible contact member thereof to contact said first fixed contact member of said first switch causing said first motor to rotate in said first direction and to cause, when said preselector disk moves with respect to said indicator-control disk in a second non-aligned direction said flexible contact member to contact said second fixed contact member thereof causing said first motor to rotate in said reverse direction,

said second switch being arranged with the center flexible contact member extending into the second aperture of said direction-memory cam to cause, when said preselector disk moves with respect to said indicator disk in said first non-aligned direction, the flexible contact member of the second switch to contact with said first fixed contact member thereof causing said second motor to rotate said indicator disk in said first direction unless said disks are aligned and to cause, when said preselector disk moves with respect to said indicator disk in said second non-aligned direction, said flexible contact member of the second switch to contact said second fixed contact member thereof causing said second motor to rotate said indicator disk in said reverse direction unless said disks are aligned.

9. The combination as claimed in claim **8**, wherein said second motor is a DC motor and said reversing means for said second motor includes a pair of diodes wherein said first fixed contact member of said second switch is coupled to a first diode poled in one sense and said second fixed contact member of said second switch is coupled to the second diode poled in an opposite sense.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,860,859

DATED : January 14, 1975

INVENTOR(S) : Bruce Harry Buckley

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the page containing the abstract, after "Filed: July 24, 1972", insert -- Foreign Priority Application - British Provisional Application No. 47310/71, October 11, 1971 --

Signed and Sealed this

fourteenth Day of *October 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,860,859

DATED : January 14, 1975

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

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Signed and Sealed this

fourteenth Day of *October 1975*

[SEAL]

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