April 25, 1967 P. A. DICKE 3,316,469

PLURAL MOTOR REMOTE CONTROL SYSTEM

Filed Sept. 3, 1963 3 Sheets-Sheet 1

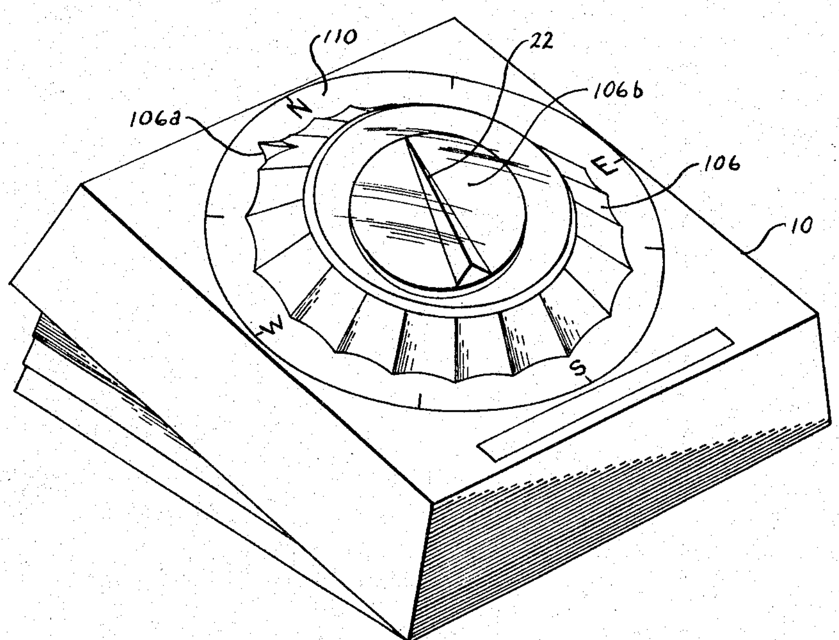

FIG. 1

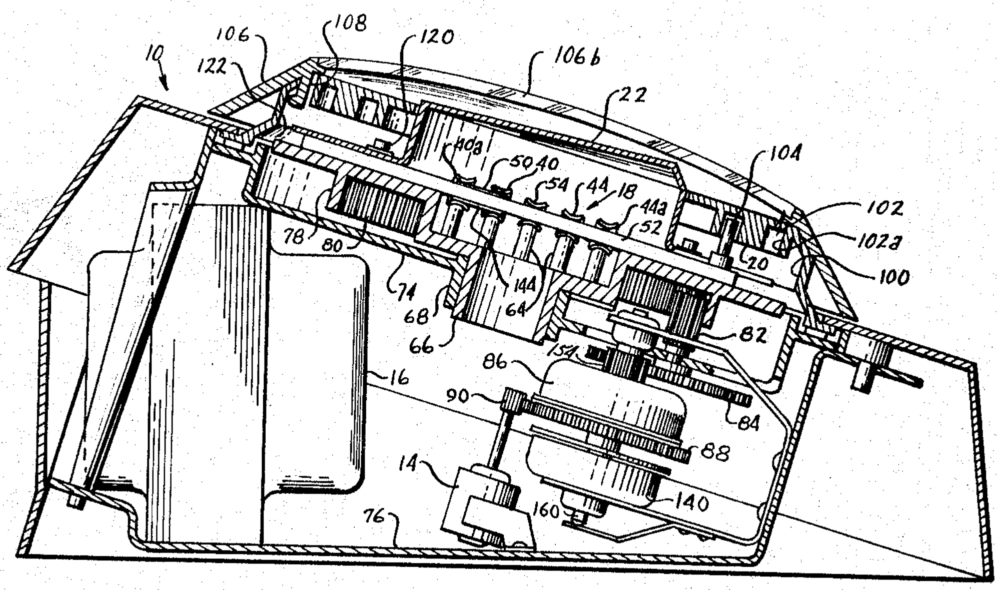

FIG. 2

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PLURAL MOTOR REMOTE CONTROL SYSTEM

Filed Sept. 3, 1963 3 Sheets-Sheet 2

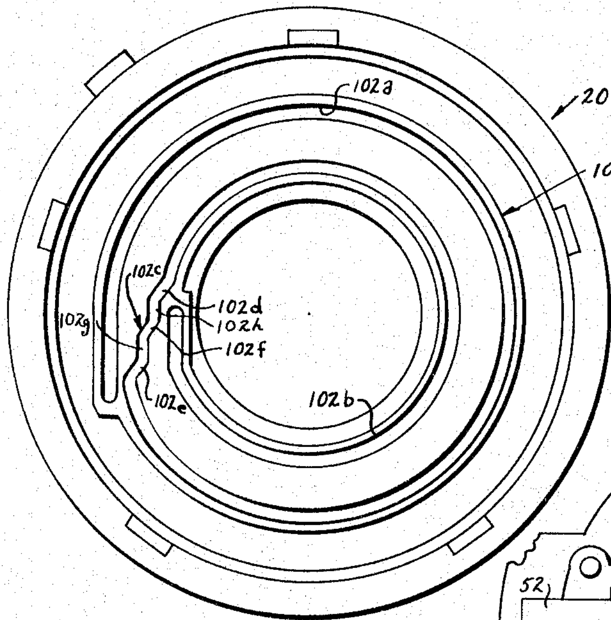

FIG. 3

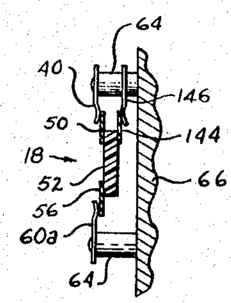

FIG. 5

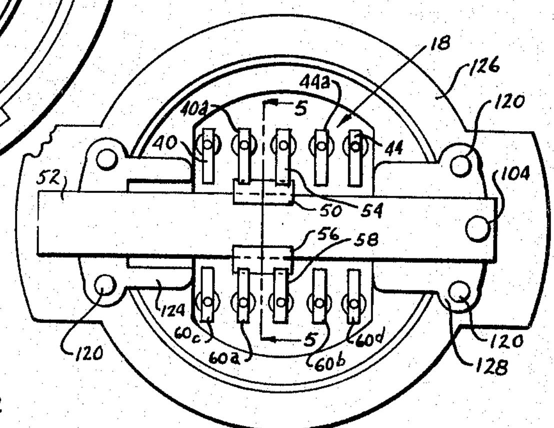

FIG. 4

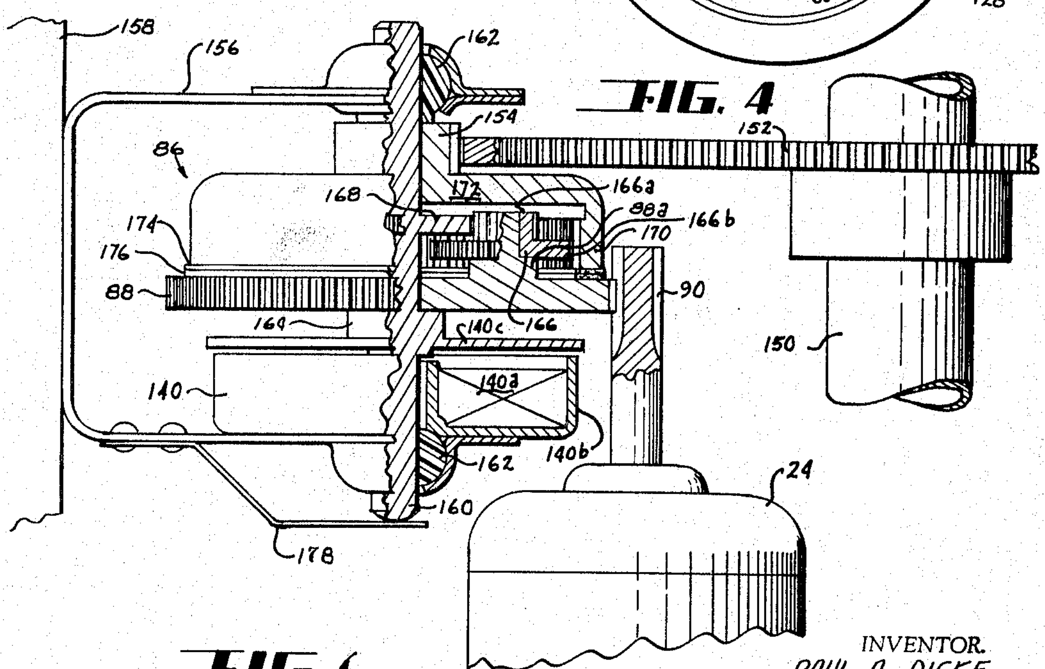

FIG. 6

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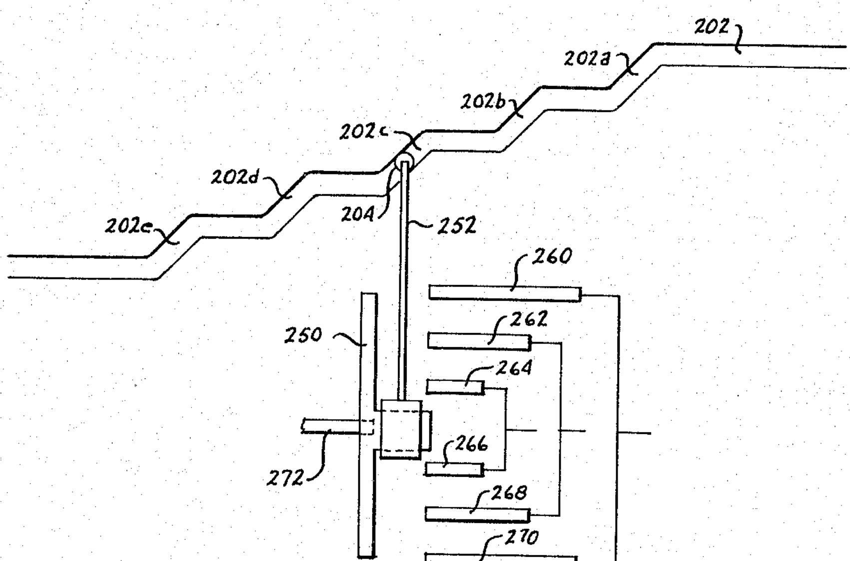

FIG. 8

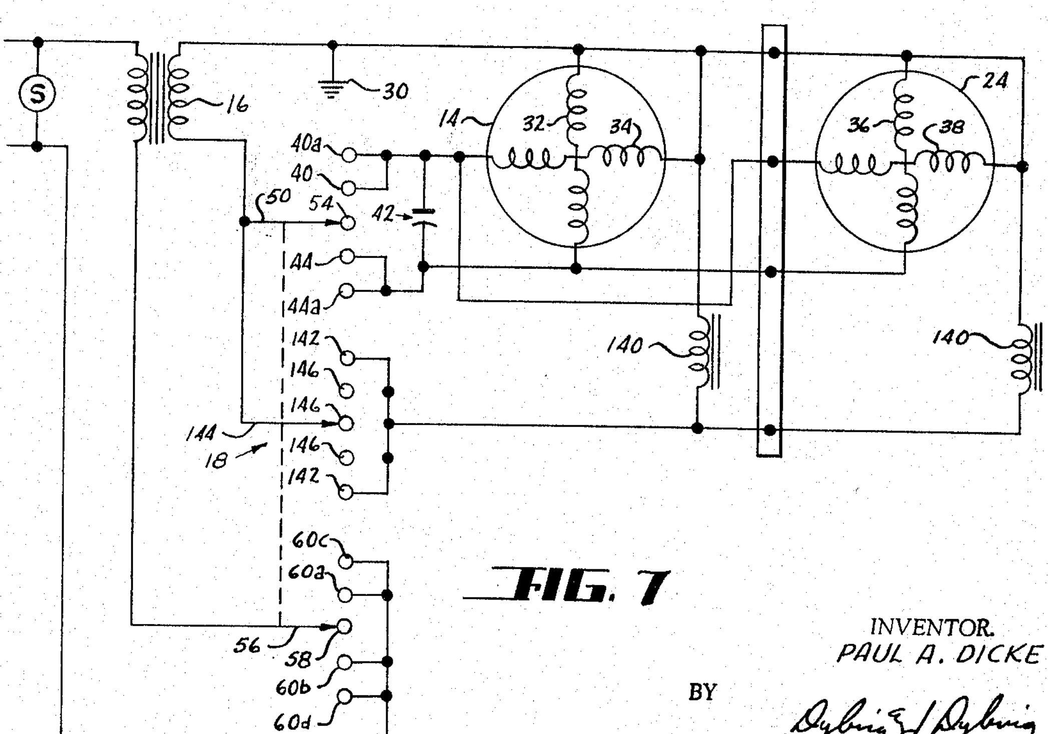

FIG. 7

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PLURAL MOTOR REMOTE CONTROL SYSTEM

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Filed Sept. 3, 1963, Ser. No. 305,936
8 Claims. (Cl. 318—41)

This invention relates to a remote control system and more particularly to a remote control system for use with an antenna rotator, although not necessarily so limted.

At present, the usual antenna rotators drive radio or television antennas at a speed approximating one revolution per minute. Although it would be desirable to position antennas in an optimum direction at a faster speed, one revolution per minute has been considered the fastest acceptable rate. Due to the weight and length of antennas, acceleration to a faster rotational speed could create too great a torque on the antenna mast when initiating the rotational drive. Also, the momentum of an antenna rotating at a faster speed, when suddenly stopped, may cause the antenna to overrun and thus, it may not be in precisely the position desired or indicated at the control point. Moreover, the user of the antenna rotator control may not know, in advance, the precise antenna position for optimum reception. Therefore, the user must often "feather in" to the precise antenna direction desired. For example, if the antenna is used in connection with a household television receiver, the user would observe the television picture and set the antenna to that position which results in the clearest picture. If the antenna rotates at too great a speed, such "feathering in" would be difficult due to the tendency to overrun.

An object of this invention is the provision of a method and apparatus for increasing the acceptable speed of rotatable antenna drives.

In accordance with this invention, an antenna is driven at one rate during the initial and final stages of rotation and at another, faster rate during the remaining portion of its rotation. For example, the antenna may be driven at one revolution per minute during the first and last few degrees of travel and at two revolutions per minute throughout the remainder of travel. With a more elaborate system, the antenna may be rotated at even greater speeds by gradually increasing the rotational speed at the beginning of travel and gradually decreasing the speed at the end of travel. Accordingly, a further object of this inventnon is to provide apparatus for increasing and decreasing the rotational speed of an antenna during its travel.

In my copending application for United States Letters Patent entitled, "Plural Motor Remote Control System," Ser. No. 39,840, filed in the United States Patent Office on June 30, 1960, now Patent No. 3,102,218, a plural motor remote control system which may be used as an automatic antenna rotator is described. This system utilizes similar proximal motors and servo or distal motors, each having two sets of field windings cooperating for driving the motors in a selected direction. The distal motor is selected so as to have a speed slightly greater, although not much greater, than the speed of the proximal motor, so that when the distal motor drives a load, such as an antenna, the load slows the distal motor so as to have substantially the same rate of speed as the proximal motor. Thus, the two motors are substantially in synchronism. A switch mechanism is described in said aforementioned patent application having three positions, one is a neutral position, one is for clockwise movement of the proximal motor, and another for counterclockwise movement thereof. The switch also includes an

actuator having a linear travel for actuating the switch mechanism from one position to another. The actuator in turn is controlled by a cam mechanism and a cam follower, the cam mechanism having two concentric cam surfaces, one of which has a larger diameter than the other, one for clockwise movement and one for counterclockwise movement. The two concentric cam surfaces are connected by a diagonal surface, the midpoint of which places the switch actuator in the neutral or "off" position. The cam member may be manually moved to actuate the switch mechanism, causing the distal motor to rotate either in a clockwise or in a counterclockwise direction. The proximal motor is actuated at the same time to drive the cam follower back to the diagonal, neutral or "off" position. Thus, as the distal motor drives the load, the proximal motor drives a cam actuated switch mechanism to its "off" position. The instant invention is described herein with relation to such an automatic rotator control. It is to be understood, however, that the instant invention may also be used in connection with a manual or semi-automatic antenna rotator.

A further object of this invention is to provide a simple switching device in association with the control for a proximal motor for actuating a distal motor.

Another object of this invention is to provide a simple switching device for varying the speeds of rotation of units driven by a proximal motor and a distal motor.

Still another object of this invention is to provide a simple solenoid controlled variable gear mechanism.

Other objects and advantages reside in the construction of parts, the combination thereof, the method of manufacture and the mode of operation, as will become more apparent from the following description.

In the drawings:

FIGURE 1 is a perspective view of a control unit made in accordance with this invention.

FIGURE 2 is a cross-sectional view of the control unit of FIGURE 1.

FIGURE 3 is a plan view of a cam used in control unit of FIGURE 1.

FIGURE 4 is a plan view of a switch used in the control mechanism.

FIGURE 5 is a cross-sectional view of a portion of the switch, as viewed in the direction of arrows 5—5 of FIGURE 4.

FIGURE 6 is an enlarged view of a portion of a drive mechanism made in accordance with this invention.

FIGURE 7 is a schematic wiring diagram of the control system made in accordance with this invention.

FIGURE 8 is a schematic illustration of a modified control system made in accordance with this invention.

Referring to the drawings in greater detail and in particular to FIGURES 1 and 2, the reference character **10** indicates broadly the housing for a control unit made in accordance with this invention. The control unit includes a control or proximal motor **14**, a transformer **16**, a switch mechanism **18**, an adjustable cam **20** and a pointer **22**.

Referring to FIGURES 6 and 7, an antenna drive, servo or distal motor **24** is connected in parallel with the proximal motor **14**. As will be described below, the distal motor **24** is mounted in close proximity to an antenna mast **150** and is driven substantially in synchronism with the motor **14**. Although the motors are not synchronous, the motors have been selected with such speed characteristics that the two motors have substantially identical speeds under normal load conditions. In order to prevent the antenna leads from being twisted, it is necessary to confine the rotary motion of the distal motor **24** in each direction to one revolution of the antenna driven thereby plus a few degrees as, for example, to an angle of 365° in each direction. Since the mechanism for limiting the rotation of the motors in either direction forms no part of the instant invention and such mechanism is described in my aforesaid copending application, Ser. No. 39,840, now Patent No. 3,102,218, to which reference is made, it is not described in detail herein.

With reference to FIGURE 7, the secondary winding of the transformer **16** has one terminal grounded at **30**, the grounded terminal being series connected to one terminal of each of the windings **32** and **34** of the motor **14** and to one terminal of each of the windings **36** and **38** of the distal motor **24**. The switch mechanism **18** may have a contact **40** adapted to be series connected through a movable contact **50** to the secondary winding of the transformer **16** to supply electrical energy directly to the windings **34** and **38**. A phase-shifting impedance, such as a condenser **42**, connects the ungrounded terminals of the windings **32** and **36** to the contact **40**. By this arrangement, as is well known to those skilled in the art, a leading current is supplied to the windings **32** and **36**, which current leads the current supplied to the windings **34** and **38**. This will cause the motors **14** and **24** to rotate in one direction. By shifting the contact **50** from the contact **40** to a contact **44**, the current from the secondary winding of the transformer **16** is then supplied to the ungrounded terminals of the windings **32** and **36**, the leading current being then supplied to the ungrounded terminals of the windings **34** and **38**, thus reversing the direction of the motors **14** and **24**.

Referring to FIGURE 4, in connection with FIGURE 7, the switch mechanism **18** for accomplishing the reversal of direction of rotation of the motors **14** and **24** is as follows. The movable contact **50** is mounted upon an actuating bar **52** that is slidably mounted such that the contact **50** may be selectively engaged with a centrally located open contact **54** and either of the contacts **40** and **44**. Mounted upon the opposite side of the actuating bar **52** from the contact **50** is another movable contact **56** adapted to engage an open transformer contact **58** when the contact **50** is engaged only with the contact **54**. Note that the contacts **50** and **54** are shorter than the separation between the contacts **40** and **44**, so that the only open contacts **54** and **58** may be engaged by the contacts **50** and **56**, respectively. When the actuating bar **52** is moved such that the contact **50** engages the contact **40**, the contact **56** will then be in engagement with a transformer contact **60***a*, which completes a circuit through the primary winding of the transformers **16** and the source S. Similarly, when the actuating bar **52** is positioned to place the contact **50** in engagement with the contact **44**, the contact **56** will be engaged with a transformer contact **60***b*. The contacts **60***a* and **60***b* are connected together such that the primary winding of the transformer **16** is connected to the source S regardless of which of the contacts **60***a* or **60***b* is engaged by the contact **56**. As apparent from an inspection of FIGURES 4 and 7, the movable contact **50** is also adapted to engage a contact **40***a* and a contact **44***a* which are, respectively, electrically the same as the contacts **40** and **44**. At the same time, the movable contact **56** is adapted to engage fixed contacts **60***c* and **60***d* at the extreme ends of movement of the actuating bar **52**, which contacts are electrically identical to the contacts **60***a* and **60***b*. The latter contacts **40***a*, **44***a*, **60***c* and **60***d* are required for actuation of a speed change mechanism which will be described in detail below.

The fixed switch contacts **40**, **40***a*, **44**, **44***a*, **54**, **58** and **60***a* through **60***d* are mounted on spaced support members **64**, there being five such support members **64** on each side of the actuating bar **52**. For clarity, the spacing between the support **64** is somewhat magnified in FIGURE 2. Support for the members **64** is provided by a switch support plate **66** rotatably mounted in a bushing **68**, which in turn is mounted in a frame member **74** fixedly mounted upon a bracket **76** supported in the bottom of the housing **10**. The switch support plate **66** is provided with a downwardly extending annular geared flange **78** having internal gear teeth **80** meshing with a pinion **82** mounted for rotation upon the frame member **74**. The pinion **82** is driven by a drive gear **84**, which in turn is rotated by a variable speed gear mechanism, generally designated **86**, to be described below. The input gear **88** of the gear mechanism **86** derives its rotation from a pinion **90** driven by the motor **14**. As will appear below, when the motor **14** rotates in one direction, the entire switch mechanism mounted upon the plate **66** rotates in a clockwise direction and when the motor **14** rotates in the opposite direction, the switch mechanism rotates in a counterclockwise direction.

The mechanism for driving the actuating bar **52**, and accordingly controlling the switch mechanism **18**, is illustrated in FIGURES 2, 3 and 4 and includes the cam member **20**, which has a cam groove **102** therein, within which is received a cam follower pin **104** mounted on one end of the actuating bar **52**. The cam member **20** has a peripheral portion **100** mounted for rotation on the frame member **74**. A cover plate **106** for the housing **10** has a plurality of depending hooks **108** projecting through cooperating apertures in the peripheral portion **100** of the cam **20** such that one may manually rotate the cover member **106** in turn to rotate the cam **20**. Notations may be made on a scale **110** on the control housing **10**, the notions cooperating with an indicant **106***a*, whereby the user of the device may set the indicant **106***a* to a selected position on the scale **110** which corresponds to a desired direction of antenna position.

Referring to FIGURE 3, the cam groove **102** consists of an outer circular portion **102***a* and an inner circular portion **102***b* connected by a generally diagonal or median connecting portion designated **102***c*. The cam grooves **102** and **102***b* provide two concentric, radially offset cam surfaces and the diagonal or median portion **102***c* provides a plurality of radially decreasing cam surface steps, designated **102***d*, **102***e* and **102***f*. The cam follower pin **104**, and thus the bar **52**, are moved linearly only when the pin **104** is slidingly engaged with one of the radially decreasing steps **102***d*, **102***e* or **102***f*. If the cam follower pin **104** is in the grooved portion **102***a*, the contact **50** is engaged with contacts **44** and **44***a* and the motor **14** drives the cam follower **104** in a clockwise direction, as viewed in FIGURE 3. Since the cam portion **102***a* is circular, the actuating bar **52** is not moved relative to the fixed contacts **44** and **44***a* during the travel of the pin **104** in the groove **102***a*. As the pin **104** engages the portion **102***d*, the bar **52** is moved relative to the fixed contacts until the cam follower **104** reaches substantially the midpoint of the center step **102***f* of the connecting groove **102***c*, at which time only the open contacts **54** and **58** are engaged by the contacts **50** and **56**, respectively. Thereupon, both the motor **14** and the motor **24** are disconnected from the source S and the rotation of the motors **14** and **24** will be arrested. If the cam follower **104** is located in the inner groove **102***b*, as viewed in FIGURE 3, the cam follower **104** will similarly be rotated in a counterclockwise direction until it reaches the midpoint of the step **102***f*, whereupon the switch **18** will again be open-circuited.

The pointer **22** is mounted by pins **120** upon spaced flange members **122**, **124**, **126** and **128**, which have opposed surfaces providing a guideway for the actuating bar **52**. The midportion, designated **106***b*, of the cover plate **106** is transparent so that the pointer **22** may be viewed from above the housing **10**. As the motor **14** drives the cam follower support plate **66**, in turn causing the switch **18** to be actuated, the pointer **22** rotates into a position aligned with the indicant **106***a*. The relationship between the pointer **22** and the indicant **106***a* is such that they will be aligned when the cam follower **104** arrives at the neutral or "off" position **102***f* and the rotation of the motors **14** and **24** is thus arrested. Of course, due to the substantial synchronism of the motors **14** and **24**, the position of the pointer **22** indicates the antenna position at all times.

The operation of the mechanism thus far described will be apparent to those skilled in the art. The antenna drive or distal motor **24**, which is drivingly connected to the antenna mast **150** in any suitable fashion, causes the antenna to rotate if the cam member **20** is rotated to any selected position out of alignment with the pointer **22**. This occurs because the cam follower pin **104** is thereby located in one of the circular cam grooves **102***a* or **102***b*, causing both the motors **14** and **24** to rotate. The distal motor **24** rotates the antenna while, at the same time, the proximal motor **14** rotates the cam follower pin **104** toward the cam step **102***f* such that both motors are arrested when the antenna reaches the optimum position for the selected radio or television station. The structure and operation of the motor control system thus far described is similar to that described in my aforementioned copending application Ser. No. 39,840.

It will be appreciated that, by the provision of the several steps in the cam groove **102**, it is possible to actuate several switches or other mechanisms for changing the rotational speed of the antenna mast **150** and of the cam follower pin **104**. In accordance with this invention, it is desired that the speed of rotation of the antenna be increased by increments up to a maximum speed and as it comes to the end of its travel, the speed of rotation of the antenna is decreased by increments. This is accomplished in the embodiment disclosed herein by utilizing the steps **102***d* and **102***e* in the cam groove **102**, the portions **102***d* and **102***e* being on each side of the median step **102***f* and separated therefrom by radially offset steps **102***g* and **102***h*, respectively. As the cam **20** is rotated relative to the cam follower pin **104**, so as to offset the cam follower position from the neutral, median position **102***f*, either the contact **40** or the contact **44** is engaged by the contact **50**, whereupon the antenna is rotated at substantially one revolution per minute. The initial rotational speed remains constant while the pin **104** moves along the steps **102***g* and **102***h*. As the cam follower pin **104** moves along the radially varying steps **102***d* or **102***e* toward either the groove **102***a* or **102***b*, the bar **52** is moved relative to the fixed contacts to actuate mechanism for changing the rotational speed of the antenna. The mechanism for changing the speed of rotation of the antenna could take a variety of forms. For example, variable speed motors could be used. The presently preferred embodiment disclosed herein is to provide switch controlled means for varying the gear mechanism **86** between the motor **24** and the antenna mast **150**. This gear mechanism **86** is identical for both the antenna drive, shown in FIGURE 6, and for the cam follower drive, shown in FIGURE 2.

Schematically illustrated in FIGURE 6 is the rotatable antenna mast **150**, upon which is affixed an antenna drive gear **152** driven by the output gear **154** of the antenna gear drive mechanism **86** mounted upon a bracket **156** that in turn is supported upon a suitable fixed support **158**. The gear mechanism **86** includes a center shaft **160**, which is mounted for rotary and lineal movement within a pair of spaced bearing members **162** supported by the bracket **156**. A comparison of FIGURES 2 and 6 will reveal that the pinion **90** may either be cut into the surface of the output shaft of the motor associated therewith, as indicated in FIGURE 6, or may be splined therein, as indicated in FIGURE 2. The input gear **88**, which is coaxial with the center shaft **160**, derives its support from an enlarged portion **164** of the shaft **160**. Mounted upon the input gear **88** on an axis offset from the shaft **160** is a vertically upright spindle support **88***a* for a two-part planet gear **166** having a smaller geared portion **166***a* meshed with the teeth of a sun gear **168** fixedly connected to and coaxial with the center shaft **160**. The larger geared portion, designated **166***b*, of the planet gear **166** is meshed with the teeth of a ring gear **170**, which is mounted upon the same plate, designated **172**, to which the output gear **154** is mounted. Both gears **154** and **170** are also coaxial with the center shaft **160**. A first annular friction clutch plate **174** is affixed to the base of the ring gear **170** and a second annular friction clutch plate **176** is affixed to the top of the input gear **88**. The center shaft **160**, and accordingly the portion **164** and the input gear **88** are biased vertically upwardly, as viewed in FIGURE 6, by a spring member **178** affixed to the lower leg of the bracket **156**. So long as the center shaft **160** is so biased upwardly, creating engagement of the clutch plates **174** and **176**, which is the position illustrated in FIGURE 6, there is a direct reduction drive between the pinion **90** and the output gear **154**, since the gears **88**, **166**, **168** and **154** rotate as a unit. The gear reduction is so designed that the member **150** is rotated at substantially one revolution per minute.

Supported upon the lower leg of the bracket **156** and coaxial with the shaft **160** is an annular solenoid **140** including a solenoid coil **140***a* nested within a hollow cup-shaped housing or support member **140***b*, having a vertically oriented, annular outer periphery. The armature of the solenoid **140** comprises a clutch disc **140***c* integral with or affixed to the center shaft **160**. Upon energization of the solenoid coil **140***a*, the disc **140***c* is drawn into engagement with the top surface of the member **140***b*. The top surface of the portion **140***b* and the lower surface of the clutch disc **140***c* constitute friction clutch surfaces such that, when engaged, the disc **140***c* cannot rotate. Accordingly, the center shaft **160** and the sun gear **168** carried thereby will be restrained from rotation. At the same time, the portion **164** lowers with the clutch disc **140***c*, whereupon the clutch plate **176** becomes disengaged from the clutch plate **174** so that the gear **88** may rotate relative to the gear **170**. As apparent, when the pinion **90** is then rotated, the planet gear **166** will revolve about the sun gear **168** creating a faster drive for the ring gear **170** and, therefore, the output gear **154**. Thus, when the solenoid **140** is energized, the speed of rotation of the output gear **154** and, accordingly, the load driven thereby, is increased. It should be noted that the gear mechanism **86** is so designed that the output speed is independent of the direction of rotation, also it may be observed in FIGURE 5 that parts of gear mechanism which are fixedly connected together, such as the sun gear **168** and the shaft **160**, may be integral.

Since identical gear assemblies **86** and speed change mechanisms, or solenoids **140**, therefor are used in connection with both the proximal motor **14** and the distal motor **24**, the circuitry for insuring that the speed change of the antenna mast **150** is reflected in the cotnrol housing **10** is comparatively simple. Referring to FIGURE 7, both solenoids **140** have one terminal connected to the ground **30** and another terminal connected to switch contacts **142** mounted on a pair of support members **64** at opposite ends of the array of members **64**. The contacts **142** are adapted to be engaged by a sliding contact **144** (see FIGURE 5) carried by the actuating bar **52** and spaced from the movable contact **50**. The movable contact **144** also engages a plurality of open contacts **146** intermediate the two contacts **142**. As apparent, when the cam **20** is rotated such that the cam follower pin **104** is located within the cam portions **102***g* or **102***h*, the contact **144** will not have contacted either of the contacts **142**. The solenoids **140** thus are not energized. However, as the cam **20** is rotated such that the cam follower is relatively moved with respect to the cam groove **102** such that it passes along either of the grooved portions **102***d* or **102***e*, the bar **52** is moved linearly whereupon the contact **144** engages one of the contacts **142**, causing both solenoids **140** to be energized.

FIGURE 8 schematically illustrates a more elaborate speed change system. A cam groove **202** is illustrated having diagonal portions **202***a*, **202***b*, **202***c*, **202***d* and **202***e* therein. A cam follower **204** is shown located in the cam groove **202** with an actuating bar **252** attached thereto adapted to drive a contact member **250** relative to a plurality of spaced contact elements **260**, **262**, **264**, **266**, **268** and **270**. The line connection to the contact member **250** is indicated by contact member **272**. It will be appreciated that, as the cam groove **202** moves relative to the cam follower **204**, the contact member **250** will selectively engage the various contacts **260**, **262**, **264**, **266**, **268** and **270**. The various contact members **260** through **270** may be used to control either mechanical, electrical, or electrical-mechanical means for changing the speed of rotation of the proximal and distal motors **14** and **24** or the loads driven thereby. Therefore, it may be seen that by providing the more elaborate cam groove **202**, a variety of rotational speeds may be made available. Of course, it is to be understood that FIGURE 8 is only schematic and that the cam groove **202** will actually be arcuate, each of the diagonal portions **202***a* through **202***e* being radially offset, as in the case of the cam groove **102** shown in FIGURE 2. Similarly, the various elements **250** through **272** may correspond to the elements of the switch **18** shown in FIGURE 4.

In review, in the embodiment described in FIGURES 1 through 7, the motors **14** and **24** are rotated at substantially one revolution per minute when the pin **104** is located in either cam step **102***g* or **102***h*, because the contact **50** is accordingly engaged with either the contact **40** or the contact **44**. As the cam follower **104** is moved relative to the cam groove **102** along either groove portion **102***d* or **102***e*, the solenoids **140** are energized, since the movable contact **144** engages one of the fixed contacts **142**. Upon energization of the solenoids **140**, the rotational speed of the output gears **154** is increased. This speed increase may be of the order of 2 to 2.5 times the initial rotary speed of the gears **154**. Accordingly, the antenna will be driven at two or two and one-half revolutions per minute. The initial relative movement of the cam follower **104** relative to the cam groove **102** is caused by rotation of the cam member **20** upon manual rotation of the cover member **106**. Thereafter, the proximal or control motor **14** drives the cam follower **104** back to the midpoint of the step **102***f*. As the cam follower **104** is so driven, if located in either groove portion **102***a* or **102***b*, the antenna **150** will be driven at the increased speed.

When the cam follower reaches the step **102***d* or **102***e*, as the case may be, the antenna speed is reduced to substantially one revolution per minute. The rotation of the motors **14** and **24** is then arrested when the cam follower reaches the step **102***f*. Thus, the antenna speed is automatically increased up to a faster rate than presently deemed acceptable. At the same time, there is no great surge of torque upon the antenna mast because the initial speed approximates one revolution per minute. Similarly, it is possible to accurately "feather in" to an optimum antenna direction, since the antenna speed slows to one revolution per minute before coming to a stop. The steps **102***g* and **102***h* may represent approximately 10° of antenna rotation so that minor antenna direction adjustments may easily be made with the antenna rotating at only one revolution per minute within 10° on each side of the antenna position. The system schematically illustrated in FIGURE 8 provides a further extension of the principle disclosed in FIGURES 1 through 7.

Although the presently preferred embodiment of the device has been described, it will be understood that within the purview of this invention various changes may be made in the form, details, proportions and arrangement of parts, the combination thereof and mode of operation, which generally stated consist in a device capable of carrying out the objects set forth, as disclosed and defined in the appended claims.

Having thus described my invention, I claim:

1. The combination including:

an energy source, a reversible antenna drive motor;

means connecting said motor to an antenna for rotation thereof, said means connecting said motor to an antenna including a variable speed gear mechanism and speed change means connected to said variable speed gear mechanism, said speed change means including mechanism varying the ratio between the input and output of said gear mechanism by operation of said speed change means;

switch means connecting said energy source to said drive motor for selectively actuating said motor in a forward or a reverse direction to thereby rotate said antenna in a forward or reverse direction, said switch means including a switch setting means connected to said switch, said switch setting means including a manually rotatable cam having an arcuate cam surface and a cam follower connected to said slidable switch actuator and operatively engaged by said cam surface for setting the switch position, portions of said cam surface having a changing radius for shifting said switch from one position to another, said switch means being connected to said speed change means so that said speed change means is actuated at predetermined relative positions of said cam and said cam follower;

a control motor, said control motor being adapted to be connected to said energy course through said switch means, said control motor being connected to drive said cam follower with respect to said cam surface from a manually selected position wherein said switch means connects said energy source to said control motor toward a surface portion of said cam in which said follower causes said switch to disconnect said drive motor from said source.

2. The structure of claim **1** wherein said control motor is connected to said source by said switch means whereby said control motor is disconnected from said source when said drive motor is disconnected from said source, wherein said control motor is connected to said cam follower by means including a variable gear mechanism substantially identical to said aforementioned variable gear mechanism, and wherein additional speed change means controlled by said switch means varies the speed of said cam follower when the speed of said antenna is changed.

3. The combination including:

an energy source, a proximal motor, a distal motor for driving a load;

switch means connected between said energy source and said proximal motor and said energy source and said distal motor, said switch means including a movable actuator capable of being positioned in a plurality of different positions and carrying a plurality of switch contacts connectable in its different positions, said switch means further comprising a cam follower connected to said actuator, said switch means further including a cam member having two concentric surfaces, one of which has a larger radius than the other, and a diagonal cam surface connecting between said concentric cam surfaces, said cam follower being in contact with one of said cam surfaces, said diagonal cam surface having a plurality of steps of decreasing radius, said proximal motor being connected to control the position of said cam with respect to said cam follower whereby said switch means is moved to a plurality of different positions upon relative movement of said cam member and said cam follower.

4. The structure of claim **3** wherein cam follower drive means connects said proximal motor to said cam follower, and said cam follower, when engaged with one of said steps of said cam member, actuates said switch to an "off" position thereby disconnecting said motors from said energy source, said cam follower drive means causing said cam follower to move along said cam surfaces toward said one of said steps until said follower is engaged with said one of said steps.

5. The structure of claim **4** wherein said distal motor is connected to a load by a variable speed gear mechanism and said cam follower drive means includes a substantially identical variable speed gear mechanism, the output speeds of said gear mechanisms being controlled by a pair of solenoids, one for each gear mechanism, connected to said source by said switch means, said switch means being constructed to cause said solenoids to be energized at the same time.

6. The structure of claim 4 wherein said cam follower drive means includes a variable speed gear mechanism, said gear mechanism comprising, a center shaft, support means mounting said shaft for rotation about and lineal movement along a fixed axis, a sun gear fixedly connected to said shaft for rotation about said axis, an input gear driven by said proximal motor and supported on said shaft for rotation about said axis, a ring gear mounted for rotation on said shaft about said axis, an output gear connected to said cam follower and connected to said ring gear and coaxial therewith, a planet gear mounted on said input gear for rotation about an axis offset from said fixed axis, said planet gear including a first geared portion meshed with said sun gear and a second geared portion meshed with said ring gear, first clutch means locking said input gear to said ring gear whereby said input gear and said output gear rotate together, means actuating said first clutch means, speed change means releasing said first clutch means whereby said ring gear may rotate relative to said input gear, and second clutch means actuated by said speed change means restraining rotation of said shaft and thereby said sun gear when said first clutch means is

released whereby said planet gear revolves about said sun gear as said input gear rotates.

7. The structure of claim 6 wherein said first clutch means comprises cooperating clutch plates on said input gear and said ring gear, said means actuating said first clutch means comprising bias means biasing said center shaft such that said clutch plates are engaged, and said speed change means includes a solenoid cooperating with said shaft to overcome said bias means, the operation of said solenoid being controlled by said switch means.

8. The structure of claim 7 wherein said solenoid includes a housing, a coil disposed within said housing, an armature plate affixed to said center shaft, said plate being drawn toward said housing upon energization of said coil, and said second clutch means comprises cooperating clutch surfaces on said armature plate and said housing.

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