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ANTENNA FOR AIRCRAFT

2,522,222

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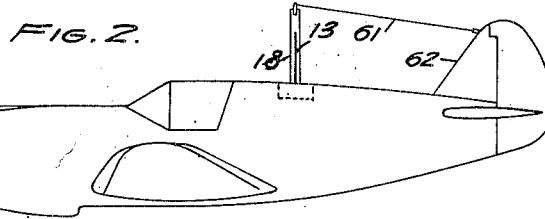


FIG. 3.

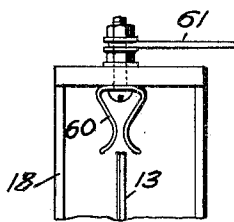
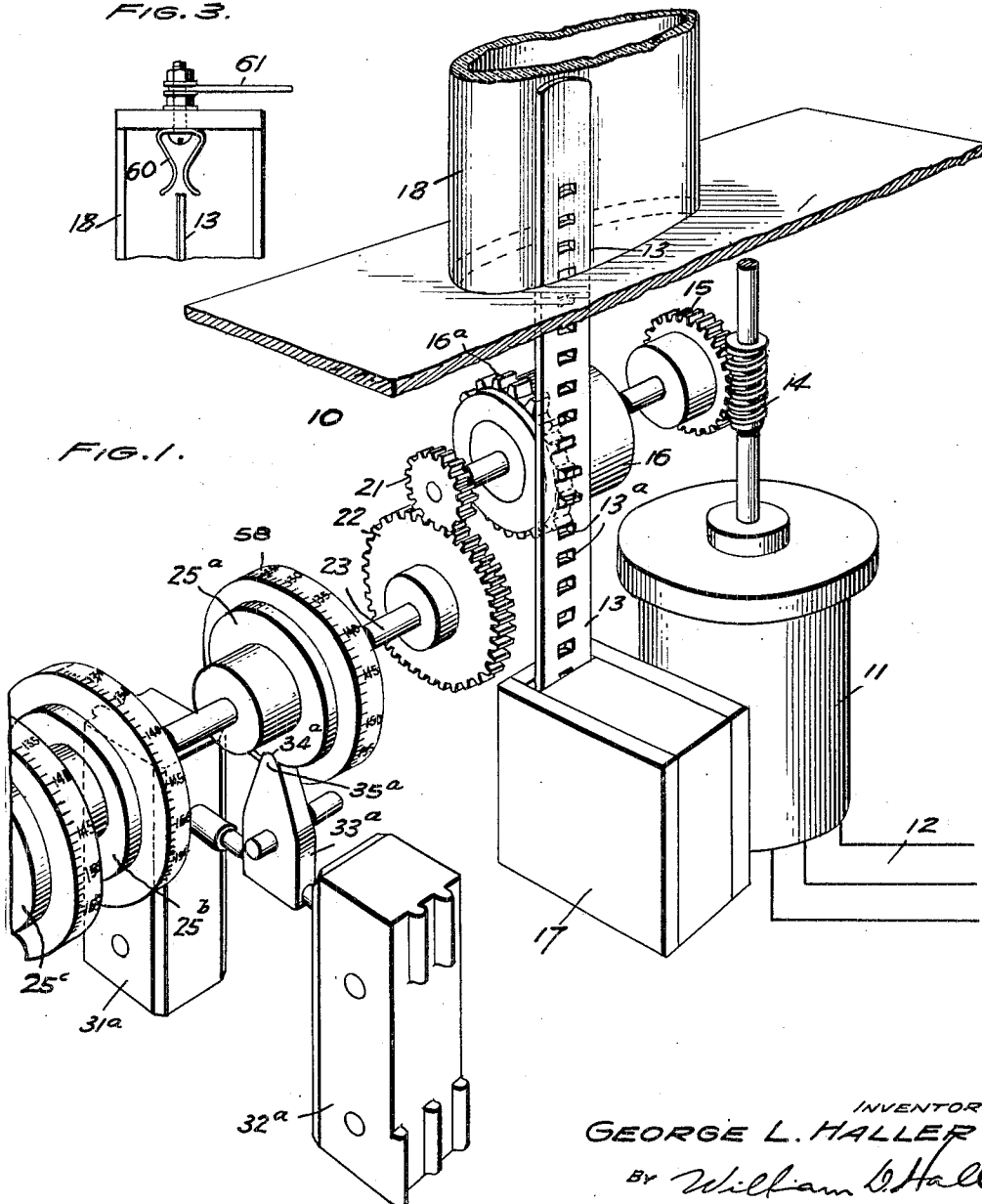


FIG. 1.



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FIG. 4.

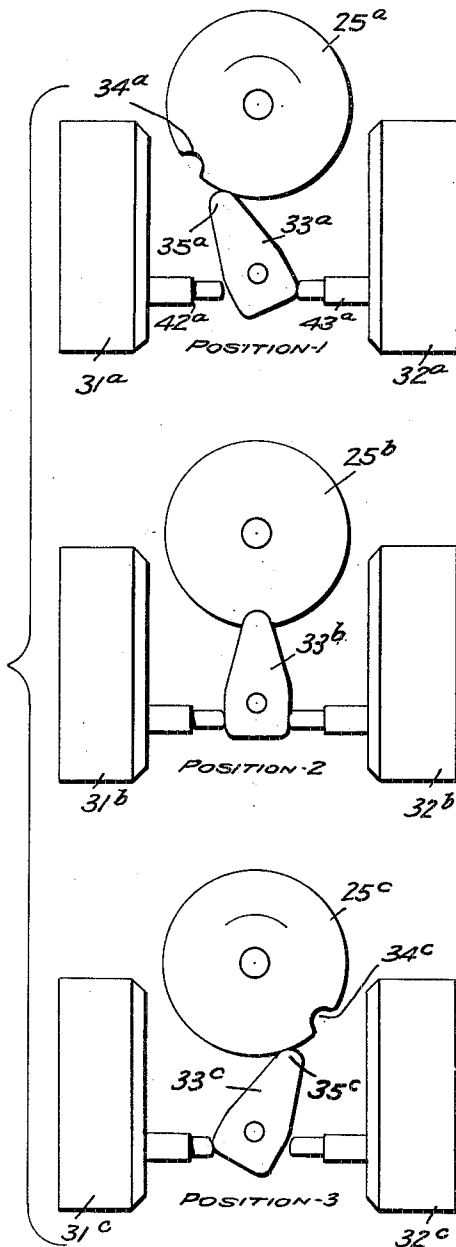
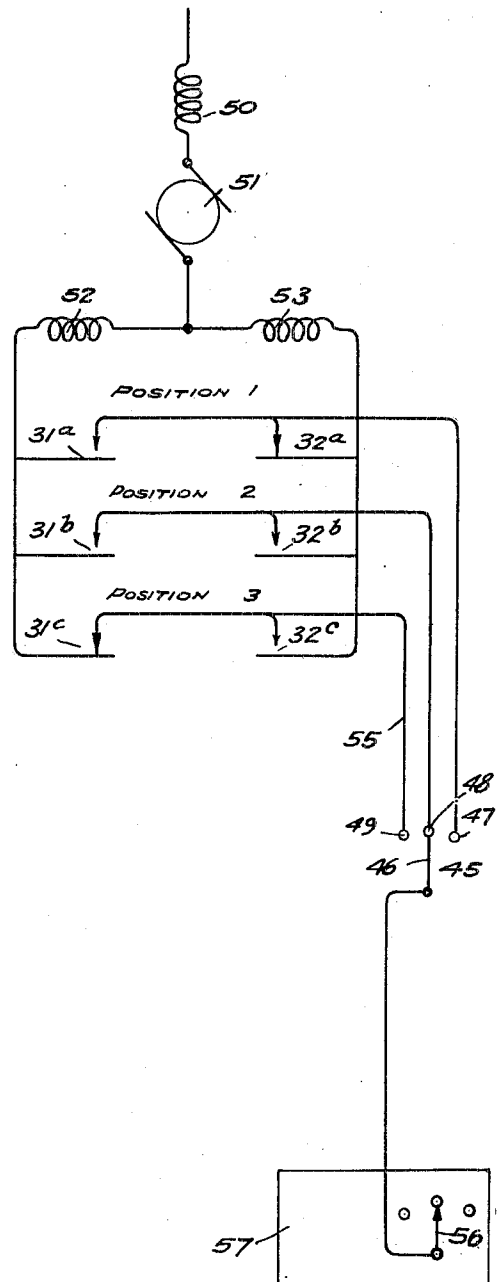


FIG. 5.



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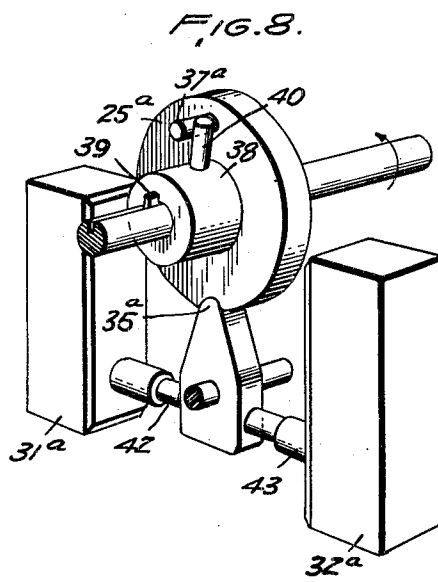
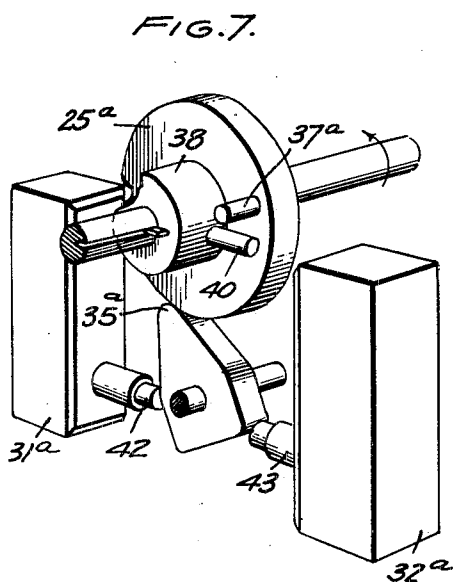
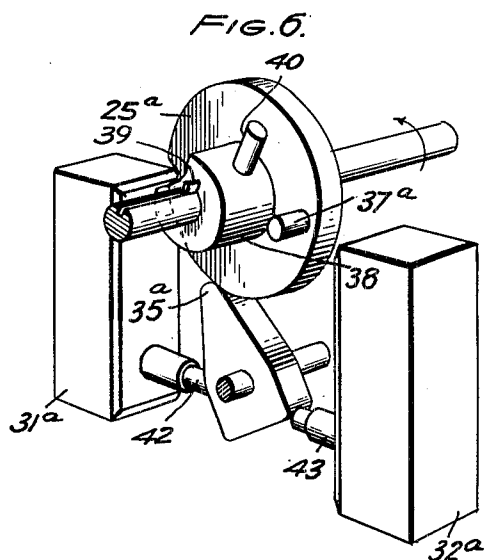
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ANTENNA FOR AIRCRAFT

George L. Haller, Dayton, Ohio

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7 Claims. (Cl. 250—33)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to antenna system for aircraft.

One object of this invention is to make an antenna adjustable in height for tuning with means for automatically moving the antenna to predetermined selected positions after manually selecting the desired position.

Another object of this system is to make the active antenna element in such a form and cross section that the extended portion will be self-supporting and the unextended portion can be rolled into a small space.

Another object of this invention is to provide a series of sprocket holes in the active antenna element which are engaged by an accurately controlled sprocket. This allows accurate adjustment of antenna length.

Another object of this invention is to provide a pre-selection mechanism whereby a given number of frequencies can be set up, and the antenna adjusted to corresponding pre-selected lengths, by a tap switch which may be ganged with the frequency selecting switch on the radio equipment using the antenna.

Another object of this invention is to provide a positive automatic positioner for the antenna length, to be used when the pre-selected lengths are being selected.

Another object of this invention is to provide pre-selector dials calibrated directly in frequency by means of which the pre-selector mechanism can be adjusted or changed quickly and easily.

Another object of this invention is to provide a connecting clip at the top of the insulated housing which will be engaged by the movable antenna element when this antenna element is in its fully ejected position. This clip can be connected to an external wire for using the whole antenna system at some lower frequency.

The construction and the arrangement of the various parts of the system, including the antenna and its control equipment, are illustrated in the accompanying drawings, in which:

Figure 1 is a schematic perspective view showing the function and disposition of the various parts of the equipment for controlling the antenna;

Figure 2 is a schematic side view of an airplane, showing the relative disposition of the antenna;

Figure 3 is a front elevational view of the antenna and the upper end of the mast housing for

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the antenna with the front of the mast housing broken away to show the antenna;

Figure 4 is a schematic end view of the several cam and switch assemblies, showing their relative positions at one selected instant;

Figure 5 is a diagrammatic circuit of the operating motor for the antenna system, and illustrates the arrangement of the control switches in the assemblies in Figure 4;

Figures 6, 7, and 8 are perspective views of one of the cam and switch assemblies showing the provision of travel limiting stops for controlling the associated cams.

As shown in Figure 1, a control system 10 for an antenna that is particularly to be employed in aircraft, is illustrated as including a reversible motor 11, whose operating energy is derived from a suitable source or circuit 12, to operate a train of gear mechanism, to adjustably position an antenna mast 13 at any one of a number of pre-selected positions that will provide an antenna of suitable length to receive radiant energy of a pre-selected frequency. The gear train for controlling the antenna 13 is shown as comprising a worm 14 on the motor shaft, and worm gear 15 meshed with the worm 14, and a sprocket wheel 16 provided with sprocket teeth 16-a that fit into spaced sprocket openings 13-a centrally along the length of the antenna mast 13.

The antenna mast 13 is preferably made of a spring strip material, and is concavely shaped across its width in such manner as to be self-supporting in its extended portion. The antenna mast material is similar to the well-known spring measuring tapes which are concave in form across their width, and which may be easily coiled and retracted into a suitable housing. In this case, the antenna mast 13 is similarly provided with a receiving enclosing housing 17 for the retracted or unextended portion of the antenna strip material.

One of the particular difficulties that was encountered in the past, in providing an adjustable antenna for aircraft, was the fact that the extremely high wind pressure on the antenna imposed a heavy load upon the operating motor for the antenna mast, and therefore required a motor of relatively large power capacity and correspondingly large weight.

In the present arrangement, I have eliminated the effect of the wind stresses on the antenna by extending the antenna mast upward into a protective enclosing housing 18 of dielectric material. The housing is, of course, of sufficient strength to withstand the wind pressures encountered during

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flight, and it is provided with suitable flow-line contours to diminish its resistance. Consequently, the operating motor for the antenna mast need have but small power capacity, and can be correspondingly small in size and of relatively light weight.

In order to position the antenna 13 to provide an extended portion of proper length and to receive the wave length or frequency that is to be detected, the electric circuit of the motor is controlled by suitably effective limit switches that are disposed to be operated to control the motor circuit when the extended portion of the antenna has attained a pre-determined selected position.

The control equipment for the limit switches is also shown in Figure 1, wherein a pinion 21, on the shaft with the worm gear 15 and the sprocket 16, is meshed with a gear 22 on a control shaft 23 on which are disposed several control cams 25—a, 25—b, and 25—c, corresponding in number to the number of positions to which the antenna is to be adjustably positioned. The three cams are mounted for frictional rotary movement on the shaft 23, but are held against axial movement.

Each of the three control cams controls an associated pair of switches. Cam 25—a controls the operation of two associated switches 31—a and 32—a by means of a pivoted operating arm 33—a. The cam 25—a consists of a circular disk having a notch or slot 34—a extending radially inward from the periphery of the disk, providing a small recess or pocket into which the tip 35—a of the operating arm 33—a can extend when the cam disk 25—a reaches proper position to permit the tip 35—a to enter the slot 34—a.

The cam disk 25—b and the cam disk 25—c are correspondingly shaped and each disk includes in its control assembly a similar pair of switches and a similar operating arm, that are identified by the corresponding numerals as those controlled by cam 25—a but with the subscripts b and c, respectively, as indicated particularly in Figure 4.

The cams 25—a, 25—b and 25—c control the operation of the associated limit switches according to the positions at which the cams have been set on the driven control shaft 23.

For the operation of the present system, three positions of the antenna are desired. Three cams are therefore used, and they are initially angularly spaced on the control shaft 23 so each cam will operate the associated limit switches to stop the motor when the shaft 23 reaches a position corresponding to a predetermined position of the antenna.

The control shaft 23 is driven by the motor through gears of proper ratio to turn the shaft through one rotation for the full movement of the antenna between its two limit positions. When the control shaft 23 reaches the proper position for each antenna setting, the corresponding cam should effect or permit switch operation to open the motor circuit.

Since the antenna is out of sight, in the enclosing strut housing, its position cannot be seen when the cams are initially angularly adjusted on the shaft for proper positioning to operate the switches. The associated receiver is utilized to determine when the antenna is sufficiently and properly extended for each desired frequency setting.

During such initial adjustment to determine proper positioning of the cams, each cam may be held by hand while the motor-drive control shaft

23 is turning so the cam will not control its switches while proper tuning adjustment is being sought. When the receiver indicates proper positioning of the antenna, the motor is then stopped and the cam turned on the shaft to proper switch-controlling position.

If the tuned condition is not immediately observed, and the motor de-energized, during such initial adjusting operation, the motor would try to turn the control shaft 23 too far, and the sprocket wheel 16—a would injure the antenna mast 13 at the sprocket holes.

In order to prevent such possibility of excess travel of the motor shaft, each cam 25—a, 25—b and 25—c is provided with a crank-pin 37—a, 37—b and 37—c, respectively, so the shaft 23 may take control of the cam through a crank-pin and move the cam out of the restraining hand of the operator in time to prevent such injury.

When the cams are in their proper positions on the shaft, they will be generally in the relative positions shown in Fig. 4. On each cam, the crank-pin 37 is preferably placed diametrically opposite the notch or groove 34—c, for uniformity, as shown in Figs. 6 to 8. The end limits of the permitted rotary movement of the shaft 23 are established in a selected line, for example, a vertical line above the shaft 23.

In order to establish control of the cams by the shaft 23, during adjustment as mentioned above, a spacer 38 is secured to the control shaft adjacent each cam by a suitable fixing means, such as a key 39. A control crank-pin 40 is positioned on the spacer 38 so it may engage the extending crank-pin 37—a that is secured to the associated cam 25—a. Each crank-pin 40 is positioned to be in the vertical line above the shaft 23 when the shaft is at one terminal position, as in Fig. 8. Thus, if the cam were being held as shown in Fig. 6, during adjustment, while the motor was turning the shaft 23, the crank-pin 40 would be turned to the position shown in Fig. 7, where it would pick up the cam crank-pin 37—a and push that crank-pin to move the cam 25—a with the shaft 23.

The motor would then be reversed and the antenna moved back through its path to try again to pick up the proper tuning adjustment. When proper adjusted position of each cam is established, the cam may be fixed to the shaft, if desired, instead of relying solely upon its friction fit.

To aid in setting the cams on the shaft and to indicate the frequency setting which each cam is to control, a dial calibrated to frequency is secured to each cam. The dial for each cam is preferably disposed so the corresponding frequency setting will be aligned diametrically opposite the notch or slot 34—a. The dial reading thus indicates when the cam is in neutral position between the two associated limit switches.

The limit switches 31—a and 32—a, associated with cam 25—a, and the other limit switches that are associated with the other cams, are normally biased toward their open positions, and are moved to their respective closed positions only so long as the associated pressure operating pins 42 and 43 are respectively pressed inwardly into the housing for the associated switch. When the pressure is removed from either of these pins 42 and 43, the biasing force or restoring force of the switch restores the switch to normal open position.

The limit switches may be of any suitable type

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that will provide the functional operation required, as described, but are here shown merely by way of illustration as being of a type at present available on the market, that are operable from their normal open position to their desired operated or closed position, upon the pressing movement of the operating pin 42, through a relatively short distance, of the order of one-thousandth of an inch. A correspondingly small pressure force is sufficient to operate these switches, and the load upon the operating motor 11 is thus correspondingly held to a minimum.

In Figure 5, the circuit diagram illustrates the manner in which the equipment is controlled to move the extended portion of the antenna to desired position, by the use of a selector switch 45 that embodies a contact arm 46, and three contact buttons 47, 48, and 49, respectively. The control motor 11 includes a common field winding 50, the armature 51, and two directional windings 52 and 53, for controlling the direction of rotation of the motor in opposite directions.

Each control button of the selector switch 45 controls the energization and operation of the control motor 11 to move the antenna 13 to a respectively corresponding extended position. One pair of limit switches is connected with each of the contact buttons 47, 48, or 49 of the selector switch 45. Each pair of switches is controlled by the motor 11, through the cam that is associated with that pair of limit switches, to insure an accurate extension or retraction of the antenna mast to the proper length, corresponding to each position selected at the selector switch 45.

The limit switches are illustrated in the diagram in Figure 5, in the positions corresponding to the physical positions shown in Figure 4, when the cams are in the positions shown in Figure 4.

The switches and the cams are shown in Figure 4, at the time the antenna mast has reached and is at its second position. The cam 25—b has reached its neutral position, at which the operating arm 33—b is also in neutral position, and the associated switches 31—b and 32—b are both open at that position, as shown in the diagram in Figure 5. In Figure 4, the operating stems of the two switches are in their respective extended positions, under the influence of the biasing forces that move the respective associated switches to open position.

The energizing circuit for the motor 11 is therefore open at these two switches 31—b and 32—b, and the motor will therefore have come to a stop, with the antenna moved exactly to the desired length, corresponding to the second position.

When it is desired to move the antenna to either of the other two positions, that is, to the first position or to the third position, the movable contact arm of the selector switch 45 should be shifted to engage the contact button 47 or the contact button 49, according to the position to which it is desired to move the antenna.

Assuming that the antenna is to be moved to the third position, the contact arm 46 will be moved to engage contact button 49, from which the circuit conductor 55 proceeds to the two limit switches 31—c and 32—c, connected as shown in Figure 5. At that moment, switch 31—c is closed, and switch 32—c is open. The mechanical disposition and relationship of the cam 25—c, to the two associated switches 31—c and 32—c, is shown in Figure 4.

The energizing circuit through contact button 49, conductor 55, and limit switch 31—c energizes directional winding 52 of the motor, and rotates

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the motor in such direction as to move all the cams in the clock-wise direction.

The motor circuit, after being thus established, through switch 31—c, will be maintained so long as the limit switch 31—c is closed. Limit switch 31—c will remain closed until cam 25—c is rotated into neutral position, where its peripheral slot 34—c will move into alignment with the tip 35—c of the operating arm 33—c. When such alignment occurs, the cam 25—c and the arm 33—c will assume the position illustrated in Figure 4 as position 2. At that time the limit switch 31—c will open, and will open the motor circuit. The motor will thereupon stop, and the antenna 13 will stop and remain in the stopped position, corresponding to the third position for the antenna, so long as the selector switch contact arm 46 remains on contact button 49.

While the antenna is in that third position, with the contact arm 46 on button 49, the two associated limit switches 31—c and 32—c will be open. The other two cams 25—a and 25—b, however, will both be in positions where their respective notches or slots 34—a and 34—b are to the clock-wise side beyond their respective neutral positions. Under these conditions, the switches 32—a and 32—b for first and for second positions, will both be closed. Consequently, when it is desired to retract the antenna back to the second position or to the first position, the selector switch contact arm will be moved over to engage button 48 or button 47. The circuit to the counter-clock-wise winding 53 of the motor will have been already set up at the switches 32—a and 32—b, and will be completed by the movement of the contact arm of the selector switch 45 to either button 48 or 47. When either such operation is made at the selector switch, and the motor is consequently energized through the counter-clock-wise winding 53, all of the cams will be rotated in a counter-clock-wise direction until the cam 25—a or the cam 25—b reaches its respective neutral position, depending upon which position was selected for the readjustment of the antenna.

Thus, by means of the cams 25—a, 25—b, and 25—c, and the co-operating pivoted arms 33—a, 33—b, and 33—c, the limit switches may be accurately and sensitively controlled to move the antenna to the exact position that is desired, without any hunting or over-travel.

In the functional operation of the cams as illustrated schematically in Figure 4, it will be clear that each cam is respectively controlled according to its position on the shaft. The crank-pin on each cam is not employed after the proper position of the cam is established.

In order to simplify the adjustment of each cam to predetermine its neutral position, according to the frequency to which the antenna is to be adjusted, a frequency dial 58 is fixed to each cam.

For simplicity of operation and other obvious advantages, the selector switch 45 may be arranged for gang or mutual operation with the frequency selecting switch 56 on the radio equipment 57 that uses the antenna.

In Figures 2 and 3, the arrangement is shown whereby the antenna mast 13 when extended to its extreme position in the housing 18, is caused to engage and enter the jaws of a contacting clip 60 that constitutes a terminal for a horizontal antenna wire 61 for reception of longer wave lengths than the antenna 13 is intended for. The antenna 61 is shown supported between the

housing 18 for the antenna mast 13, and a structural part of the support 62 for the rudder, at the rear of the plane.

By means of the arrangement shown, the antenna mast 13 may be selectively and automatically extended or retracted to any one of several pre-determined tuning positions, while protected from wind pressure. The operating load on the motor is thus reduced to a minimum, and the size and weight of the motor and of the associated control equipment may be correspondingly reduced to a minimum.

Although I have referred to the antenna as used for receiving operations, it may equally well be used for transmitting.

My invention is not limited to the specific details of the construction as is shown in the specific arrangement and location, since various modifications may be made thereon without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. An adjustable antenna system for an aircraft comprising an extensible self-supporting metal antenna element; means for extending or retracting the antenna element; a metallic contact terminal adapted to be engaged by the antenna element to establish a good electrical circuit contact; an external antenna conductor supported on the aircraft and electrically connected to the contact terminal; and means for selectively controlling the extending means.

2. An adjustable antenna system for an aircraft, comprising an extensible and retractable metallic element disposed for vertical positioning as an antenna; means including a reversible motor for positioning the metallic antenna element; a dielectric housing to receive and protect the antenna element against wind pressure; a terminal contact to receive and electrically engage the upper end of the antenna element; and a limit switch for controlling the de-energization of the motor when the antenna element engages the terminal contact.

3. An adjustable antenna system for an aircraft, comprising an extensible and retractable antenna mast normally hidden from the view of the operator; a reversible motor to supply the motive power to extend and to retract the mast; a source of energy for the motor; means for controlling the connection of the motor to the source, said means including a pair of limit switches, normally biased to open position; and a cam mounted on a motor-controlled shaft and disposed between the pair of switches to operate the appropriate switch to open the motor circuit and to stop the motor, the cam being frictionally rotatable on the motor-controlled shaft when held against rotation by the hand of an operator, to permit adjustable positioning of the cam on the shaft; and means on the cam adapted to be controlled by a co-operating means on the shaft at the end limits of movement desired for the antenna mast, to remove control of the cam from the operator, to prevent the continued applications of force to the antenna mast, at the terminal positions, that would tend to move the antenna mast beyond the terminal positions and thereby stress the mast.

4. An adjustable antenna system for an aircraft comprising an extensible self-supporting metal antenna element; means for extending or retracting the antenna element; a tubular element secured to the aircraft body to serve as an enclosing housing for the antenna element; a

motor for operating the antenna-extending means; means including a plurality of control assemblies, each having a cam and two limit switches, for controlling the motor circuit to stop the motor when the antenna reaches a pre-determined selected position, the several cams being simultaneously driven by the motor to operate and control their associated switches at different positions of the antenna; and a selector switch to select the cam and switch assembly that is to control the movement of the antenna to a selected desired position.

5. An adjustable antenna system comprising an extensible self-supporting metal antenna element; means for extending or retracting the antenna element; a motor for operating the antenna-extending means; and means including a plurality of control assemblies for controlling the motor circuit to stop the motor when the antenna reaches a predetermined selected position; said motor controlling means including a shaft driven by the motor; a pair of limit switches in fixed position; an operating arm pivotally mounted between said pair of limit switches; a cam adjustable on the shaft to control the limit switches, the cam having a circular periphery except for a narrow groove to receive the end of said pivoted arm when the cam groove is aligned between the cam axis and the axis of the pivoted arm; said arm shifting to neutral position when such alignment occurs and permitting the limit switches to move to open positions.

6. An adjustable system for an aircraft, comprising an extensible and retractable antenna mast; a reversible motor for supplying the motive power to extend and to retract the mast; a source of energy for the motor; and means for controlling the connection of the motor to the source, said means including a pair of limit switches normally biased to open position, and cam means disposed between the pair of switches and controlled by the motor to operate the appropriate switch to open the motor circuit and stop the motor, said cam means including a shaft driven by the motor, an arm fixed on the shaft, a cam rotatably loose on the shaft and provided with an operating crank-pin to be engaged by the fixed arm on the shaft, and a pressure element controlled by the cam to act directly upon the switches.

7. An adjustable antenna system comprising an extensible self-supporting metal antenna element; means for extending or retracting the antenna element; a motor for operating the antenna-extending means; and means including at least one control assembly for controlling the motor circuit to stop the motor when the antenna reaches a selected position; each said control assembly comprising a shaft driven by the motor; a cam associated with said shaft to rotate therewith; a pair of limit switches; an operating arm pivotally mounted between said pair of switches adjacent said cam; said cam having a circular periphery except for a narrow groove; said operating arm adapted to bear against said cam periphery, and to be received in said groove when said groove is aligned between the cam axis and the axis of said pivoted operating arm, said operating arm engaging at least one of said switches when bearing against said circular portion of the cam periphery, and disengaged from said switches when received in said peripheral cam groove.

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