

May 18, 1948.

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2,441,568

RADIANT ENERGY OPERATED POSITIONING CONTROL

Filed March 11, 1944

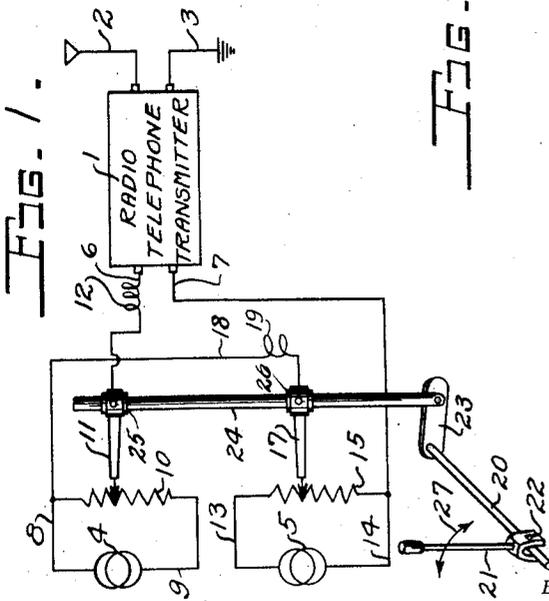
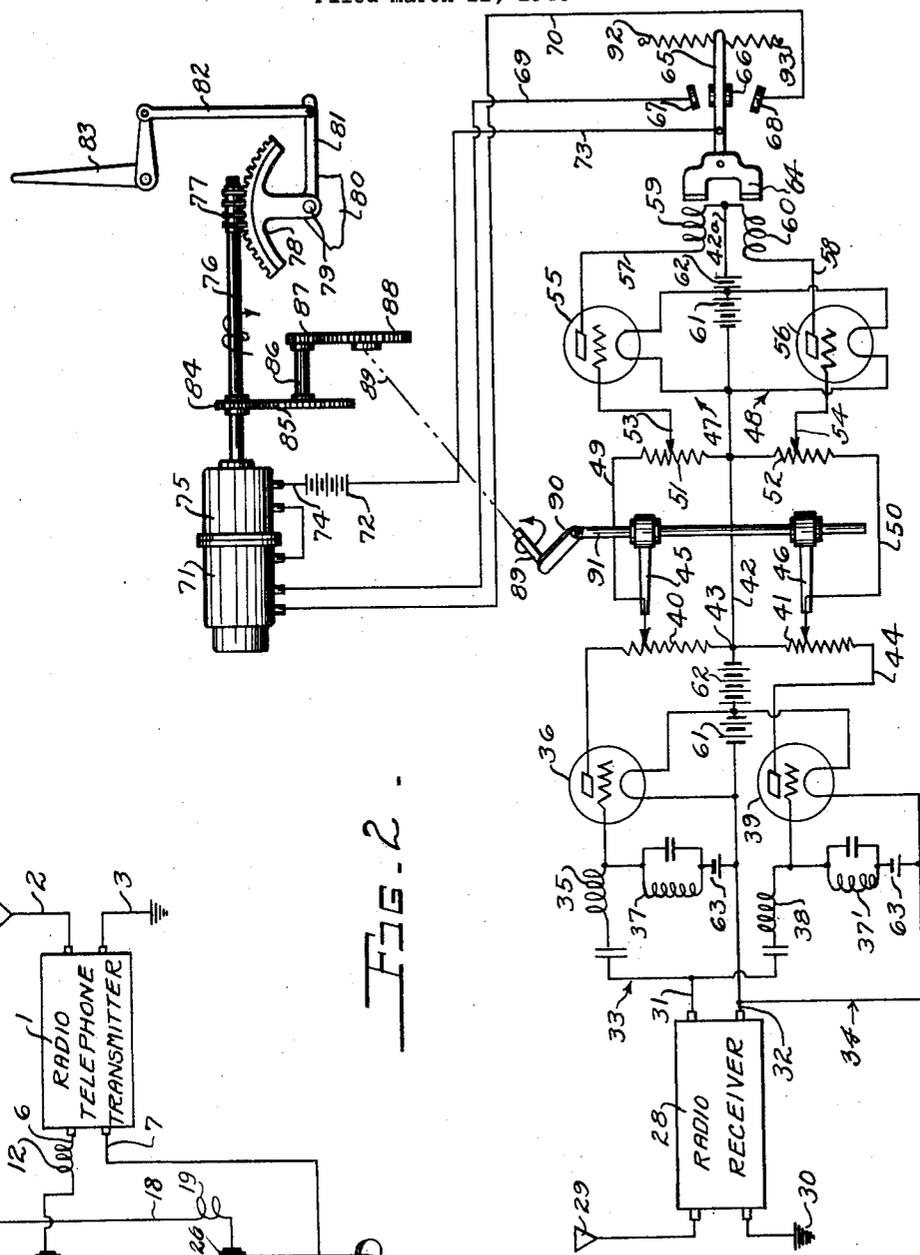


FIG. 1.



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# UNITED STATES PATENT OFFICE

2,441,568

## RADIANT ENERGY OPERATED POSITIONING CONTROL

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Application March 11, 1944, Serial No. 526,104

6 Claims. (Cl. 250-2)

(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 improvements in radiant energy operated control devices, and more particularly to radio controlled apparatus having a variably shiftable controlling element for causing an element to be controlled, located at a remote location, to be correspondingly accurately shifted an equal or proportional amount with respect to the movement of the controlling element.

Radiant energy control devices have been proposed in the prior art for controlling the position, or actuation, of control elements to be shifted, such as the rudders, or other control surfaces of an airplane, dirigible craft, or other vehicle. Some of these devices employ impulse transmitting apparatus and receivers for receiving the impulses and controlling the setting of the elements to be controlled in accord with the number of impulses received. Other of these devices employ transmitting means for transmitting a prolonged radio signal, the length or duration of the signal determining the position of the element to be controlled. The apparatus employed in each of these known systems is usually large, heavy, complicated, expensive to manufacture, employing special types of transmitters and receivers having relays, signal operated switches, limit switches etc., and the exact position of the controlled elements cannot usually be accurately determined unless the operators have the controlled elements in plain view, or the positions of the controlled elements are transmitted back to the operators at the radio controlling or transmitting stations.

The present invention differs from the aforementioned prior constructions in that it utilizes an extremely simple transmitting and receiving apparatus, employing substantially conventional radio transmitting means and includes means for impressing a plurality of different fixed audio frequencies on a carrier wave at variable amplitudes so as to vary the intensity of one of the transmitted frequencies with respect to the intensity of the other transmitted frequency, and utilize this variation in the intensity or amplitude of these different frequency radio waves to selectively position an element to be controlled at a remote radio receiving station located in a plane, vehicle or other structure.

An object of the invention is the provision of a radio remote control system having transmitting and receiving stations including means for se-

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lectively transmitting and receiving at least two radiant energy waves of differing frequencies, varying the amplitude of at least one of the frequencies at the transmitting station and utilizing this variation in the amplitude of the radio frequency signals received at the receiving station to selectively adjust an element to be controlled.

Another object of the invention is the provision of a radio remote control system having a radio transmitter adapted to send out two radio signals of different fixed frequencies including means for selectively varying the amplitude of one of said signal frequencies with respect to the other frequency, and a remotely located radio receiving station having a receiver selectively tuned to receive the dual frequency signals from the transmitting station in which selective circuits are tuned to receive each frequency, and means to be selectively controlled, common to both selective circuits, is provided operable by relative variations in the frequency amplitudes of the signals transmitted to selectively adjust the position of said selectively controlled means in accord with the degree of the relative variation between the amplitude of the signals received.

A further object of the invention is the provision of a radiant energy operated remote control system having a transmitter adapted to radiate a plurality of signals of different relatively predetermined frequencies, including controlling means for selectively varying the amplitudes of the transmitted signals in an opposite sense, and a remotely located radio receiver for receiving said transmitted signals having a plurality of selective circuits, each tuned to selectively receive a different one of said transmitted signals and reject the other signals, and the provision of adjustable signal amplifying means in said selective circuits for balancing the amplitude of said transmitted signals, including a differential relay device common to said selective circuits, operable by variations in the relative amplitudes of the transmitted signals to selectively adjust a controlled device, and an operating connection between the controlled device and the signal amplitude balancing means to balance the unbalanced amplitude of the received signals upon relative selective movement of the controlled device incident to the unbalanced amplitudes of said transmitted signal frequencies.

A still further object of the invention is the provision of a radio remote control system having a transmitter adapted to radiate at least two predetermined different signal frequencies, including controlling means for selectively increas-

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ing the amplitude of one signal frequency and correspondingly decreasing the signal amplitude of the other signal and a remote radio receiver having at least two selective circuits each tuned to receive one of said radiated signal frequencies in which means are provided common to both of said selective circuits comprising an element to be controlled selectively responsive to the variations of amplitude in the radiated signal frequencies, and signal amplitude balancing means in the selective circuits operated by said element to be controlled for balancing said radio frequency signal amplitude output upon relative predetermined movement of the element to be controlled due to a predetermined variation in the signal intensities between the two received signal frequencies.

A further object is the utilization of a single radio frequency channel to operate a number of independent control devices.

A still further object is the provision of apparatus which is simple in construction, compact, light in weight and economical to manufacture, utilizing as much as possible conventional elements in the construction and assembly of the apparatus in which the reception of signal waves of two different selected radio frequencies and amplitudes are employed to selectively predetermine the position of an adjustable servomotor operated element to be controlled, located at a radio receiving station.

Other objects and advantages of the invention will appear in the following description taken in connection with the accompanying drawings in which like reference characters refer to like parts in the several figures.

Figure 1 is a schematic wiring diagram of a control station employed in my invention for sending out a plurality of radio signals of different predetermined frequencies, and control means for selectively varying the amplitude of one signal frequency with respect to the amplitude of the other signal frequency.

Figure 2 is a schematic wiring diagram illustrating a remote receiving station having radio receiving means tuned to receive the signals from the sending station and having an element to be controlled which is selectively adjustably responsive to variations in the signal strength of the signals received from the sending or controlling station shown in Figure 1.

Referring to Figure 1 of the drawing, the numeral 1 indicates a conventional radio telephone transmitter having the usual suitable antenna and ground connections 2 and 3 and carrier wave transmitting means, the radio transmitter being connected to a plurality of audio frequency signal generators 4 and 5 by the conductors 6 and 7. The signal generators 4 and 5 produce signals of different predetermined frequencies, preferably in the audio range.

Adjusting means are provided intermediate the generators 4 and 5 and the conductors 6 and 7 for relatively varying the amplitude or intensity of one of the signal frequencies with respect to the intensity of the other signal frequency. The generator 4 is provided with output conductors 8 and 9 bridged by a variable resistor element 10, having adjusting means such as a sliding contact element 11 engageable with the said resistor 10, the contact element 11 being preferably connected by a pigtail 12 to the conductor 6 of the transmitter 1. The generator 5 has similar output conductors 13 and 14, bridged by a variable resistance element or resistor 15, having an ad-

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justable contact member 17, as seen in Figure 1 of the drawings. The adjustable contact member 17 is suitably connected by a conductor 18 and pigtail 19 to the output conductor 8 of the generator 4, while the other transmitter lead 7 is connected directly to the conductor 14 leading from the generator 5.

Relative movement of either of the contact elements 11 or 17 with respect to the resistors 10 or 15 will not effect the respective frequencies of the signals delivered to the transmitter 1, but the respective amplitudes or voltage intensities of the signals impressed on the radio transmitter carrier wave will be materially affected. Movement of the contact element 11 along the resistor 10 in one direction intensifies the amplitude of the frequency output of one of the signal generators while movement of the other element 17 with respect to the resistor 15 in the same direction effects a corresponding reduction in the amplitude of the voltage output of the other frequency signal generator.

Simultaneous movement of the two resistor contact elements 11 and 17 in the opposite direction from that noted above produces a converse variation in the relative intensity of the signal frequency output of the two frequency generators 4 and 5, these variations in output frequencies being delivered to the transmitter 1, causing the signal strength of the signals at one frequency to be reduced, while the signal strength of the signals at the other frequency are correspondingly increased.

I provide an adjustable controlling element at the control station in the form of a control stick 21 simulating a control stick in an airplane and pivoted at 22 to a rock shaft 20. The end of the rock shaft 20 has fixed thereto a crank arm 23, to the free end of which is pivoted a longitudinally shiftable actuating rod 24 having the two contact elements 11 and 17 fixed thereto and secured against relative movement with respect to each other. It is however preferable to insulate the contacts 11 and 17 from each other and from the rod 24, this being accomplished in any well-known manner such as by insulating bushings 25 and 26, fixed on the rod 24 and secured to the resistor contact elements 11 and 17.

Movement of the stick 21 forward or back, as indicated by the arrow 27, rotates the shaft 20, actuating the crank 23, which in turn shifts the rod 24 longitudinally, moving the two resistor contact elements 11 and 17 with respect to the resistors 10 and 15, effecting a relative decrease or increase in the signal output amplitude at one frequency with a corresponding relative increase or decrease in the relative signal strength of the other frequency signal depending upon which direction the stick 21 is moved.

Additional pairs of radio signal frequency generators similar to generators 4 and 5 may also be provided having frequencies differing from each other and from the just described radio signal frequency outputs, and signal intensity control means like that just described may be provided for each additional pair of signal frequency generators connected for operation by the control stick 21 when the same is moved back and forth in planes at different angular relations to the plane of movement of the stick, as indicated by the arrow 27 in Figure 1. These additional different radio signal frequencies may also be introduced into the radio transmitter 1 by the conductors 6 and 7 for selectively causing actuation

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of another element to be controlled by the said latter movement of the control member 21.

At some remote point or location, as indicated in Figure 2, such as in an airplane or other vehicle, the dual radio frequency signals are received by a radio receiver 23 over suitable antenna and ground connections 29 and 30. The output of this radio receiver is delivered over the conductors 31 and 32 to two selective circuits or networks generally indicated at 33 and 34, each consisting of parallel and series resonant circuits tuned to selectively receive the frequency signals of one of the signal generators 4 or 5.

My radio control system is based on the use of selective circuits or tuned receiving networks, each consisting of a combination of series and parallel resonant circuits in which the values of inductance and capacitance are such as to give resonance for both circuits at the same frequency in audio or near audio range. For any frequency other than the resonant frequency, the low impedance of each parallel circuit forms practically a short circuit across the input of the tube, and the signal does not appear in the plate circuit. The actual short circuiting of the non-resonant frequency is prevented by the series circuit which has a high impedance at all frequencies other than the resonant frequency.

If a voltage of the resonant frequency is impressed across the input of the selective circuit, the impedance of the parallel circuit is high and that of the series circuit is low, and the signal then appears in the plate circuit of the tube. High "Q" circuit components are employed which maintain the selectivity of these circuits fairly sharp so the combination of such selective circuits will effectively sort out a combination of input frequencies so that each frequency will appear only in its proper plate circuit.

If a voltage of the resonant frequency is impressed across the input of the selective circuit, the impedance of the parallel circuit is high and that of the series circuit is low, and the signal then appears in the plate circuit of the tube. High "Q" circuit components are employed which maintain the selectivity of these circuits fairly sharp so the combination of such selective circuits will effectively sort out a combination of input frequencies so that each frequency will appear only in its proper plate circuit.

Referring again to Figure 2, the signal amplifier is operated class A to give as little harmonic distortion as possible and to preserve a linear relationship between the input and output voltages. The parallel circuit for the selective circuit or network 33 is indicated at 37 while the series circuit is indicated at 35. The output from the receiver 23 at the resonant frequency is imposed on the plate circuit of the radio tube 36 in the usual manner.

The parallel circuit of the other selective circuit or network 34 is indicated at 37', while the series circuit is indicated at 35', and signals resonant to this circuit 34 are imposed on the plate circuit of the radio tube 39 in the usual manner. Load resistors 40 and 41 are connected to the common conductor 42 at 43. The other end of the resistor 40 is connected to the plate circuit of the tube 36 while the resistor 41 has its other end connected to the plate circuit of the tube 39, as indicated at 44. The resistors are of the variable type, each having a movable part for variably controlling the resistance such as the sliding contact members 45 and 46, respectively, arranged to contact the resistor elements 40 and 41.

The output voltages of the tubes 36 and 39 in the respective selective circuits or networks 33 and 34 are each a function of the signal strength of the resonant signals selectively received by one or the other of the respective circuits 33 and 34, and the signal strength or voltage intensity of the signals is introduced in the respective amplifying circuits 47 and 43 over the aforesaid common conductor member 42 and the conductor leads 49 and 50 bridged by the variable load resistors 51 and 52 having cooperating adjustable

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contacts 53 and 54, respectively, connected to the grids of the amplifying or triode radio tubes 55 and 56. The plate circuit or voltage output from the tubes 55 and 56 may be further amplified if desired in any conventional manner, these plate voltage output circuits from the amplifying tubes being connected as indicated at 57 and 58 to one terminal of each of the magnet devices 59 and 60 and to the other or common terminal for both of the magnet devices 59 and 60 through the common conductor 42a. The magnet devices 59 and 60 constitute a part of a differential relay control device. A, B and C batteries for the respective tubes 36, 39, 55 and 56 are provided in the usual manner as indicated at 61, 62 and 63 in the drawings.

Assuming that the frequency generators 4 and 5, as illustrated in Figure 1, are in operation, and the dual frequency signals are introduced into the radio-telephone transmitter 1, these signals will be transmitted or radiated in the usual way by the antenna and ground connections 2 and 3. If the control stick 21 is in neutral position the variable resistors 10, 11, and 15, 17 will be adjusted so that the intensity or amplitude of the transmitted signal strengths will be equal. Shifting the control stick 21 one way in the direction of the arrow 27, however, simultaneously moves the two variable resistor controlling elements 11 and 17 in the same direction, intensifying the signal strength of one of the signal frequencies and reducing the intensity of the other signal frequency.

The dual frequency signals received at the receiving station, such as disclosed in Fig. 2, from the transmitting station, are picked up by the antenna and ground connections 29 and 30, and pass through the radio receiver 23, after which they will be at or near audio range. According to the resonant frequencies of the transmitted signals, they will pass through one or the other of the selective circuits 33 and 34 and their relative intensities will be amplified. Assuming that the variable resistors 31, 53 and 52, 54 have been set to balance the voltage output of the two circuits when the resonant signal frequencies received are equal in intensity, the magnetic devices 59 and 60 will be equally energized and the armature 64 will be centralized. Upon an increase in the signal strength of one of the incoming resonant frequencies the voltage delivered to one of the magnetic devices 59 or 60 will be increased, depending upon which selective circuit is affected, and the voltage delivered to the other magnetic device will be correspondingly reduced since the other signal frequency output at the control station is correspondingly reduced. The signals received by one of the selective circuits is reduced in intensity as the signal received by the other selective circuit is correspondingly increased, producing an unbalanced relation between the respective magnet devices 59 and 60. The two magnet devices 59 and 60 are preferably in the form of solenoid coils forming a part of the differential relay, having a rocking armature 64 provided with a contact arm 65 carrying a central contact 66 movable by the armature arm 64 to engage either one of a pair of spaced electrical contacts 67 and 68, connected respectively to a pair of conductors 69 and 70, connecting the ends of two field coils of a conventional split field reversible electric motor 71. A battery 72 supplies current by means of the conductor 73 to the central contact arm 65 and contact 66 of the armature 64, the

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battery being connected by a conductor 74 connected in series with a conventional electromagnetic clutch device 75 of any well-known type which, upon the passage of current there-through, energizes the motor 71 to selectively rotate the same in either direction, and will automatically connect the armature of the motor 71 to a shaft 76 and rotate the same in the same direction as the rotation of the motor, and upon de-energizing, the motor will cause an uncoupling of the shaft 76. This arrangement provides means for uncoupling of the shaft 76 from the motor 71 immediately on the breaking of the operating circuit and stopping of the shaft so as to prevent overrunning of the motor and the elimination of any hunting movement of the shaft due to the overrunning action. The shaft 76 has fixed thereon a worm drive member 77 meshing with a worm gear segment 78, pivoted at 79 to a stationary part of the frame 80, the segment having an operating lever arm 81 fixed thereon and connected by a link member 82 to an element to be controlled, such as a rudder or other control surface 83 of an airplane, vehicle or other movable structure. Rotation of the shaft 76 in either direction will correspondingly shift the control element 83 in either direction.

In order to provide a follow up mechanism to again equalize or balance the voltage output or amplitude of the two selective circuits after the controlled elements 83 has been shifted to a selected position corresponding to the relative difference in the intensities of the transmitted signal frequencies a gear 84 is provided fixed on the shaft 76 meshing with a large gear 85 on a shaft 86. The shaft 86 carries a small gear 87 fixed thereon, forming part of a reduction gear train. The gear 87 meshes with a large gear 88, secured on the shaft 89 at one end, this shaft having a crank arm 90 fixed thereto to the end of which is pivoted an actuating rod 91, having the contact control members 45 and 46 of the adjustable load resistor elements 40 and 41 fixed thereon. The arms 45 and 46 are insulated from the shaft 91 and from each other.

As the motor 71 is put into operation, when the armature 64 is shifted by the magnetic devices 59 and 60, due to a variation in the signal strength of the two incoming radio frequencies with a corresponding variation between the output voltages of the two selective circuits 33-34, the controlled member 83 is shifted at a different angular position, and the arm 90 on the shaft 89 is, through the reduction gear train 84-88, shifted to simultaneously vary the position of the adjustable load resistor members 45 and 46. Depending upon the relative intensity of the incoming signal frequencies, the output voltages of the selective circuits 33 and 34 are again brought into balance as the motor 71 moves the controlled element 83 to some predetermined position at which said controlled element will remain fixed until the relative signal strength between the incoming signals is again changed.

If the control stick 21 is moved to again equalize the intensity of the transmitted signal frequencies from the generators 4 and 5, these signals, although being now of equal amplitude, when received by the receiving station 28 and the selective circuits 33 and 34, the former shifting of the variable resistor control elements 45 and 46 now creates an unbalanced voltage output at the differential relay magnet devices 59 and 60, and the armature 64 is shifted to move

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the contact 66 into engagement with one or the other of the contacts 67 or 68, depending upon the relative difference in the intensity of the voltage output between the plate circuits of the tubes 55 and 56. Depending upon which tube output is greater, the motor 71 is put into operation until the follow up means simultaneously shifts the variable resistors 45 and 46 to positions where the voltage output to the magnet devices or coils 59 and 60 of the differential relay is again balanced with the controlled member 83 in its central position corresponding to the position of the controlling member 21 at the control station.

Means are provided for initially balancing the output voltage intensity of the resonant circuits 33 and 34 or networks so that any slight voltage variation due to tube variations or other causes may be compensated for. With the incoming signal frequencies at equal amplitudes the variable resistors 51, 53 and 52, 54 are initially adjusted so as to position the armature 64 in its mid position, as shown in Fig. 2 of the drawings. Once the resistors just mentioned have been adjusted to effect this balance in the output voltage between the selective circuits 33-34 the resistors 51, 53 and 52, 54 are not further adjusted or disturbed.

It is preferable to provide light equalizing springs 92 and 93 to hold the contact arm 65 and contact 66 of the armature 64 in a mid position out of contact at all times with the contacts 67 and 68 while the control apparatus is not in operation, such as when the incoming signals are interrupted for any reason, and to assist in moving the armature 64 to mid position when the output voltages from the tubes 55 and 56 are equalized.

While the construction and arrangement of the device as herein described and illustrated is that of a generally preferred form, obviously modifications and changes may be made within the scope of what is claimed without departing from the spirit of the invention.

I claim:

1. In a remote control system, a transmitter adapted to radiate at least two distinct predetermined radio signal frequencies, control means for selectively varying the relative intensities of said radiated signal frequencies, a radio receiver for receiving said radiated radio signal frequencies comprising at least two signal frequency receiving networks each tuned to selectively receive one of said radiated signal frequencies and having a voltage output, a differential relay device common to said networks and operable by a variation in the output voltage between the said networks due to a variation in the signal strength between the radio signal frequencies received by each of said radio networks, a member to be controlled selectively operable by said differential relay device, follow up means including voltage controlling means common to both networks interposed between the networks and said differential relay device and connected for simultaneous operation with said element to be controlled to selectively restore a balance between the voltage outputs of said networks upon a predetermined movement of said member to be controlled relatively corresponding to the amount of said signal intensity variation in the radiated frequency signals received by said networks.

2. In a radiant energy operated remote control system, a transmitter for radiating at least two distinct radiant energy signal frequencies, adjustable control means for selectively varying the

relative intensity between said radiated signal frequencies, a radiant energy receiver having at least two selective radiant energy receiving networks each tuned to selectively receive a different one of said signal frequencies and having a voltage output proportional to the signal intensity received by said network, adjustable voltage balancing means common to both networks for balancing the voltage output between the networks, differential relay means selectively operable by the voltage output of said networks due to a variation in the voltage output between the networks, a reversible motor device selectively operable by said differential relay device, a shiftable element to be controlled movable by said motor device, follow up means operatively connected between said motor device and said adjustable voltage balancing means for adjusting said voltage balancing means in proportion to the out-of-balance relation of the signal frequency amplifications received by said networks to balance the voltage output of said networks upon predetermined movements of said element to be controlled incident to the operation of said relay device due to predetermined variations between the relative amplitudes of the radiant energy signal frequencies received by said networks.

3. In a remote control system, a radiant energy transmitter for transmitting at least two radio signal frequencies, control means for varying the amplitude of one of said transmitted frequencies with respect to said other transmitted frequency, a radio receiver having parallel selective circuits each tuned to receive one only of said transmitted signal frequencies, and to reject the other transmitted frequency and having a voltage output circuit for delivering a voltage proportional to the amplitude of the received radio signal frequency, adjustable voltage balancing means common to said parallel circuits for balancing the amplitude of the output voltages of said selective circuits, a differential relay device selectively operable by variations in the said voltage outputs of said selective circuits, reversible servomotor means operable in one direction by said relay device upon a relative increase in voltage output of one of said selective circuits with respect to the voltage output of the other selective circuit, said servomotor means being operable in the reverse direction by said relay device upon a relative decrease in the voltage outputs between the just mentioned selective circuits, means for rendering said relay device inoperative with respect to said motor device when the selective circuit voltage outputs are equalized, and shiftable means simultaneously operable by said motor device including an element to be controlled and voltage regulating means common to both selective circuits for variably shifting said element to be controlled in ratio to the difference in amplitudes between the voltage outputs and adjusting said voltage regulating means to balance said selective circuit voltage outputs when said element to be controlled is so shifted.

4. In a remote control system, a transmitter for transmitting a plurality of different radio frequency signals, interconnected means for simultaneously varying the relative amplitude of the transmitted frequency signals and a shiftable control member operatively connected to said frequency signal amplitude varying means selectively movable to vary the relative amplitude between the transmitted frequency signals in a predetermined ratio to the relative movement of said control member, a remote signal frequency

receiving station having dual signal frequency receiving networks each tuned to selectively receive one of said transmitted frequencies and having a voltage output proportional to the amplitude of the received signal frequency, adjustable voltage balancing means common to said dual frequency networks for restoring a balanced relation in the voltage output of the dual frequency networks, a shiftable member to be selectively controlled in a predetermined ratio to the relative difference in the transmitted signal frequency amplitudes operable by variations in the voltage output between the dual signal frequency receiving networks including follow up means operably connected between said shiftable member to be controlled and said adjustable voltage balancing means for causing said voltage balancing means to balance said output voltages upon predetermined movement of said shiftable member to be controlled incident to the said initial voltage variation between said voltage output of the networks due to the variation between the transmitted signal frequency amplifications.

5. In a remote control system, a radio transmitter, an associated control member variably shiftable to similarly shift a member to be controlled located at a remote radio receiving station, means for transmitting a plurality of different radio frequency signals, means for selectively varying the degree of intensity of said transmitted frequency signals, operable by variable shifting movement of said variably shiftable control member, a radio receiver at said remote receiving station for selectively receiving said radio frequency signals including a plurality of frequency signal receiving networks each tuned to receive one of said transmitted signal frequencies and having a voltage output proportional to the amplitude of the received signal frequency, adjustable voltage output balancing means common to said networks, to balance the voltage output from said networks, reversible servomotor means selectively operable by variations in said voltage output between the networks and having an operating connection with the member to be controlled and an operating connection with said output voltage balancing means for restoring a balance in the voltage output of the networks upon predetermined shifting movement of said member to be controlled incident to a predetermined amplitude variation in the transmitted frequency signals, and separate means in each network for independently regulating the voltage output thereof in proportion to the transmitted signal frequency received by said network.

6. In a remote control system, a transmitter for transmitting radio frequency signals having a plurality of different audio frequency modulations, interconnected means for simultaneously varying the relative amplitude of the transmitted audio frequency modulations and a shiftable control member operatively connected to said audio frequency modulation amplitude varying means selectively movable to vary the relative amplitude between the transmitted audio frequency modulations in a predetermined ratio to the relative movement of said control member, a remote signal frequency receiving station having dual signal frequency receiving networks each tuned to selectively receive one of said transmitted audio frequency modulations and having a voltage output proportional to the amplitude of the received modulation, adjustable voltage balancing means common to said dual frequency networks for re-

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storing a balanced relation in the voltage output of the dual frequency networks, a shiftable member to be selectively controlled in a predetermined ratio to the relative difference in the transmitted audio frequency modulation amplitudes operable by variations in the voltage output between the dual signal frequency receiving networks including follow up means operably connected between said shiftable member to be controlled and said adjustable voltage balancing means for causing said voltage balancing means to balance said output voltages upon predetermined movement of said shiftable member to be controlled incident to the said initial voltage variation between said voltage output of the net-

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works due to the variation between the transmitted audio frequency modulation amplifications.

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