# United States Patent

[11] **3,569,969**

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[54] **MAGNETIC INDUCTION, AUDIOFREQUENCY SELECTIVE, REMOTE CONTROL SYSTEM**
**3 Claims, 6 Drawing Figs.**

[52] **U.S. Cl.** ........................................................ **343/225,** 46/210, 46/244
[51] **Int. Cl.** ........................................................ **A63h 33/26,** H04b 7/00
[50] **Field of Search** ........................................... 317/123, 147; 340/171; 318/16; 325/169; 343/202, 225; 179/82; 178/43; 325/37; 340/148

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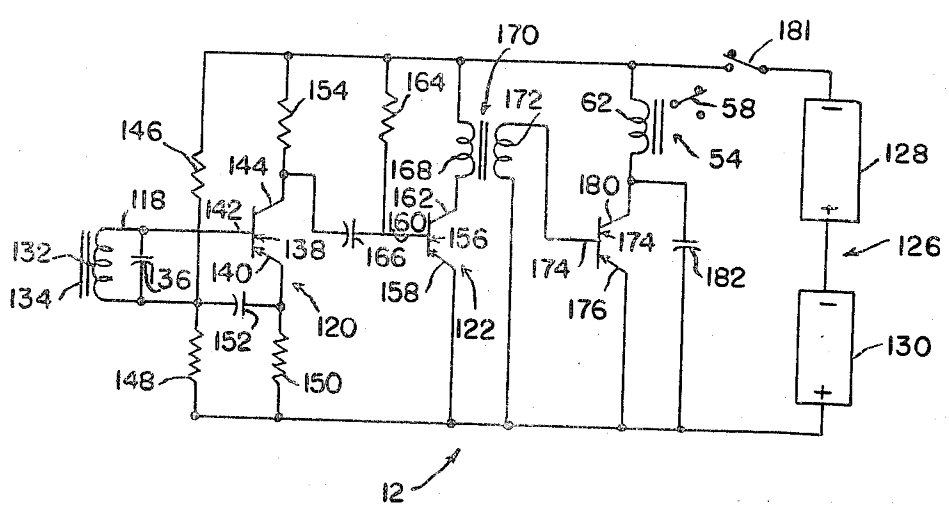
**ABSTRACT:** A remote control system for models and the like including a transmitter having a magnetic induction loop in which electromagnetic waves are generated and transmitted including desired intelligence. The magnetic induction loop preferably encompasses an area in which remote control is desired whereby on operation of the transmitter an electromagnetic flux of controlled intensity is provided within the area. The remote control system further includes a receiver for receiving the electromagnetic waves from the transmitter magnetically inductively coupled to the transmitter and means for controlling a model in accordance with the output of the receiver.



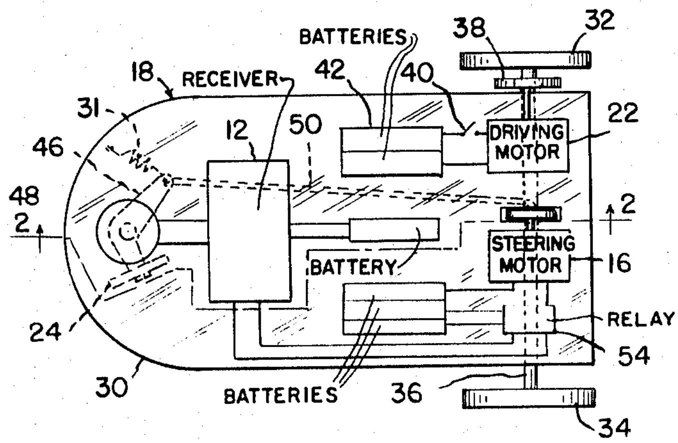



FIG.1.

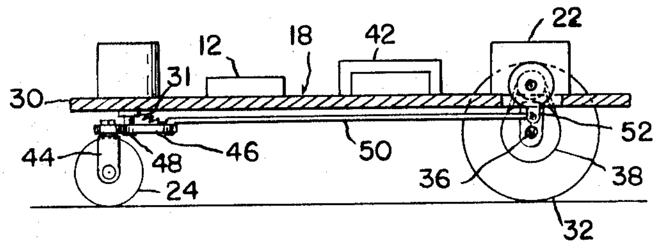



FIG.2.

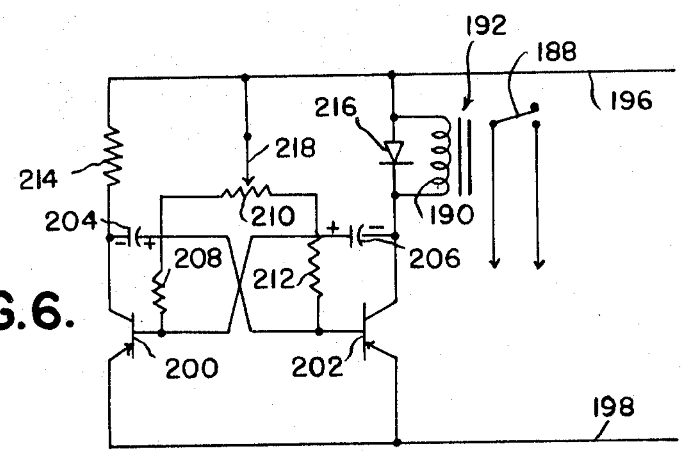



FIG.6.

FIG.3.

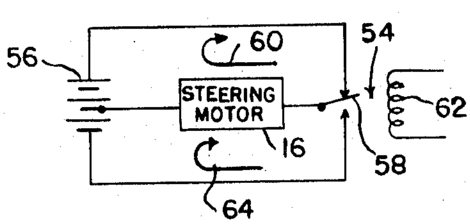



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FIG.4.

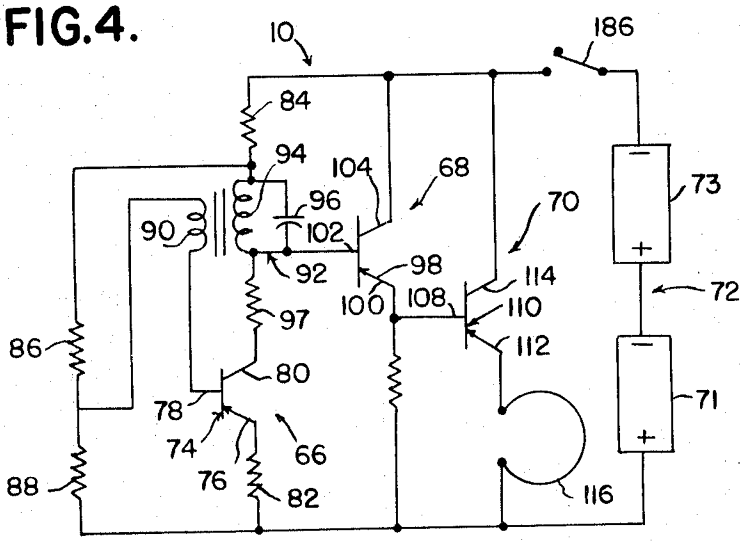
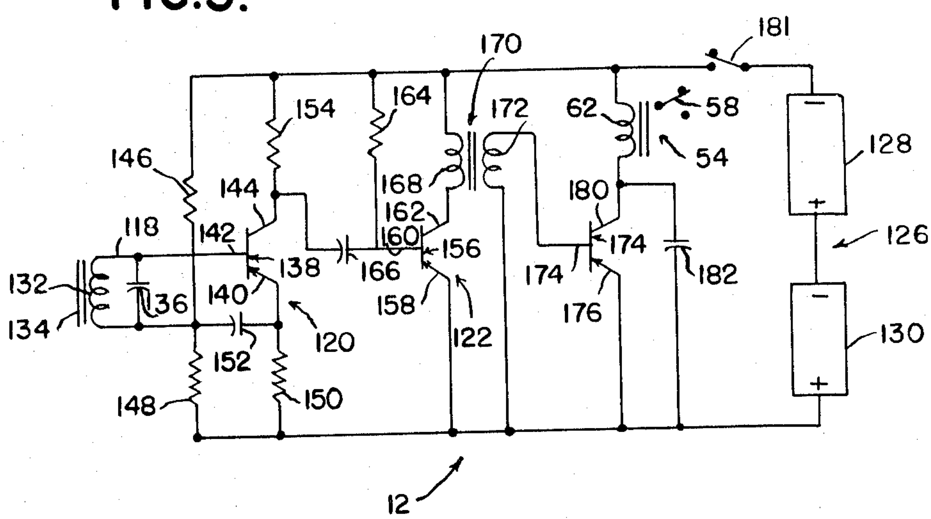



FIG.5.

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# MAGNETIC INDUCTION, AUDIOFREQUENCY SELECTIVE, REMOTE CONTROL SYSTEM

The invention relates to electromagnetically coupled transmitters and receivers and refers more specifically to an audiofrequency selective, magnetic induction coupled short range communication or remote control system or the like.

In the past remote control systems for private use have been seriously limited by the crowded nature of the frequency spectrum and the control of frequencies above audiofrequencies by the Federal Communications Commission.

The usual transmitters and receivers for remote control or communication systems have extremely low power output for power input at low frequencies. The poor efficiency in terms of power output over power input of low frequency transmitting and receiving systems operating at audiofrequencies and below is due largely to the length of waves transmitted at these frequencies and the poor sensitivity to long waves of the relatively short antennae usually available for transmission and reception thereof.

It is therefore an object to provide a primarily electromagnetically coupled short range communication or remote control system.

Another object is to provide a primarily electromagnetically coupled system as set forth above which is frequency selective.

Another object is to provide a remote control system for a model automobile or the like, including a magnetic induction, audio frequency selective remote control transmitter having an oscillator, a pair of emitter follower amplifiers and a source of electrical energy with one of the amplifiers including an elongated magnetic induction loop transmitting element connected in the circuit thereof as a load thereon.

Another object is to provide structure as set forth above wherein means are provided to pulse the one amplifier to provide discrete signal-on and signal-off times of transmission from said magnetic induction loop.

Another object is to provide transmitter structure as set forth above wherein the means for pulsing the one amplifier comprises a free running multivibrator and means for varying the pulse width thereof.

Another object is to provide a magnetic induction, audiofrequency selective remote control transmitter including an oscillator, a pair of emitter follower amplifiers and a source of electrical energy operably associated in a transmitting circuit with one of the amplifiers including an elongated magnetic induction loop transmitting element connected in the circuit thereof as a load thereon.

Another object is to provide a remote control system for a model automobile or the like, including a magnetic induction, audiofrequency selective, remote control receiver having a magnetic induction signal pickup circuit tuned to a selected audio frequency, two audiofrequency amplifiers, a rectifier and audiofrequency amplifier and a power supply connected in a receiving circuit with the rectifier and audiofrequency amplifier including a relay coil in circuit therewith as the load thereon.

Another object is to provide a magnetic induction, audiofrequency selective receiver including a magnetic induction signal pickup circuit tuned to a selected audiofrequency which circuit includes a coil having a permeable core operably associated therewith.

Another object is to provide a receiver as set forth above including a pair of audio amplifiers and a rectifier-amplifier connected across a source of voltage and connected to the magnetic induction pickup circuit.

Another object is to provide a remote control receiver as set forth above and further including a relay coil as a load on the rectifier-amplifier.

Another object is to provide a remote control system for a model automobile wherein a first motor is used to provide the driving force for the automobile, a second motor is used to provide steering for the automobile and a receiver is secured to the automobile for alternately energizing the steering motor in opposite directions in accordance with reception or nonreception of a transmitted control signal.

Another object is to provide an audiofrequency selective, magnetic induction, remote control system which is simple in construction, economical to manufacture and efficient in use.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a diagrammatic representation of a model automobile chassis having a receiver constructed in accordance with the invention positioned thereon.

FIG. 2 is a longitudinal section view of the model automobile chassis illustrated in FIG. 1 taken substantially on the line 2–2 in FIG. 1.

FIG. 3 is a schematic diagram of the steering motor energizing circuit of the model automobile chassis illustrated in FIGS. 1 and 2.

FIG. 4 is a schematic diagram of a magnetic induction audiofrequency selective remote control system transmitter constructed in accordance with the invention.

FIG. 5 is a schematic diagram of an audiofrequency selective magnetic induction remote control receiver constructed in accordance with the invention.

FIG. 6 is a schematic diagram of an electronic pulsing circuit for use in the transmitter illustrated in FIG. 4.

With particular reference to the FIGS. of the drawings, one embodiment of the invention will now be disclosed in detail.

In accordance with the invention the transmitter **10** produces an electromagnetic signal at a selected frequency. The electromagnetic signal produced by the transmitter **10** is received by the receiver **12**. Receiver **12** in turn operates relay **54** to energize steering motor **16** of model automobile **18** in one direction. Steering motor **16** is normally energized in the opposite direction when no signal is received by the receiver **12** from the transmitter **10**.

Thus in operation the model automobile **18** is caused to move in the direction of arrow **20** on energizing drive motor **22** and may be steered through drive motor **16** coupled to steering wheel **24** in accordance with whether or not the steering motor **16** is energized.

Transmitter **10** may be pulsed by the electronic pulsing circuit **26** if desired. With the pulsing circuit **26** in use the direction of steering of automobile **18** may be changed by varying the position of the wiper arm **218** in pulsing circuit **26** if desired, as will be explained in more detail subsequently.

More specifically the model automobile **18** which it is desired to remotely control, as best shown in FIGS. 1 and 2, comprises a frame **30** to which the driving wheels **32** and **34** are secured by means of axle **36** which is rotatably mounted on frame **30**. Axle **36** is turned through a pulley and flexible belt arrangement **38** from drive motor **22**. Drive motor **22** is energized on closing of switch **40** to connect the batteries **42** to the drive motor **22**.

Steering of the automobile **18** is accomplished through the steering wheel **24** secured for rotation to a bracket **44** connected to bellcrank **46**. Bellcrank **46** is pivotally secured by pivot pin **48** to chassis **30** and is urged in one direction by spring **31**. Bellcrank **46** is also pivotally connected to the reciprocally mounted rod **50**. Rod **50** is in turn connected to the arm **52** which is secured to steering motor **16** for rotation between limits therewith.

In operation rod **50** moves longitudinally in one direction in opposition to spring **31** on energization of the steering motor **16** in one direction. The rod is moved in the opposite direction by spring **31** in conjunction with steering motor **16** energized in the opposite direction. Reciprocation of the rod **50** in opposite directions about an axis perpendicular to the chassis **30** due to pivotal movement of bellcrank **46** on pivot pin **48**. It will be understood that steering motor **16** could be energized in only one direction with movement of rod **50** in the opposite direction only by spring **31**.

Steering motor **16** is energized in one direction when the relay **54** is energized. Steering motor **16** is energized in the opposite direction when relay 54 is not energized. Such operation will be evident from FIG. 3 wherein the connection of the relay 54 to the batteries 56 is illustrated in detail. Thus when the coil 62 of relay 54 is nonenergized and the armature 58 thereof is in the normal position illustrated, current flows through the motor 16 in the direction of arrow 60. On energizing of the coil 62 the motor is energized in the direction of arrow 64, as illustrated in FIG. 3. Coil 62 of relay 54 is energized in accordance with whether or not a signal id received by receiver 12 from transmitter 10, as will be evident subsequently.

Transmitter 10, as best shown in FIG. 4, includes the oscillator 66, two emitter follower power amplifiers 68 and 70 and the power supply 72. Power supply 72 comprises two 1.5 volt batteries 71 and 73 connected in series.

Oscillator 66 includes the transistor 74 having emitter, base and collector elements 76, 78 and 80, respectively, emitter resistor 82, a voltage divider network from power supply 72 including resistors 84, 86 and 88, feedback coil 90 and tuned circuit 92 including coil 94 and capacitor 96 in parallel with each other and in series with resistor 84 and resistor 97. The emitter resistor 82 limits the amplitude of the sine wave signal from oscillator 66 and provides a high degree of temperature stability for the oscillator. The voltage divider network including resistors 84, 86 and 88 has a relatively low impedance, as for example a total of less than one hundred ohms, so that no bypass capacitor across 88 is necessary.

In accordance with the invention the tuned circuit 92 is adjustable in frequency by means of the tuning capacitor 96 and in the present example the circuit 92 is tuned to a predetermined frequency, such as for example 1.5 kilocycles or 9 kilocycles.

The emitter follower power amplifier 68 includes the transistor 98 having emitter 100, base 102 and collector 104 connected as shown in FIG. 4 to the load resistor 106, the tuned circuit 92 and the power supply 72 respectively. Amplifier 68 receives the sine wave signal from tuned circuit 92, amplifies the power thereof and feeds an output sine wave signal across load resistor 106 to the base 108 of transistor 110 of power amplifier 70.

Transistor 110 includes the emitter 112 and collector 114 in addition to the base 108. As shown in FIG. 4 the load on the power amplifier 70 is an induction loop 116 formed of one hundred sixty feet of number 24 copper wire. In operation of the transmitter 10 the signal received by transistor 110 is amplified in power through the amplifier 70 and is radiated from the induction loop 116. The radiation from the loop 116 is primarily at the audio frequencies transmitted.

In operation of the model automobile 18 illustrated in FIGS. 1 and 2 the induction loop 116 may be laid out in a fifty foot diameter circle or around the periphery of a room and will provide sufficient power anywhere within the induction loop to operate steering motor 16 on the model automobile 18 through reception of the transmitted electromagnetic signal from the transmitter 10 by the receiver 12. Care should be taken not to include reentrant portions in the induction loop which would distort the field strength within the loop. Further, due to the use of the magnetic induction field rather than the electric induction field in both the transmitter 10 and receiver 12 the transmitter is efficient and the receiver is selective whereby a plurality of models may be operated within the same area or room. Such selective operation is not possible at audiofrequencies with apparatus as simple, economical and efficient as that herein disclosed if the transmitted radiation field is used for model control due to the length of a tuned antenna required with radiation fields at such frequencies. The electromagnetic power transmitted from induction loop 116 and picked up by resonant circuit 118 is not similarly dependent on antenna length.

The receiver 12, as shown best in FIG. 5, includes the tuned magnetic induction pickup circuit 118, audio amplifiers 120 and 122, amplifier-rectifier 124 and power supply 126 consisting of two one and one-half volt direct current batteries 128 and 130 in series.

The magnetic induction audiofrequency pickup circuit 118 includes a coil 132 having a permeable ferrite core 134 operably associated therewith and the tuning capacitor 136. Thus, the pickup circuit 118 is particularly responsive to the electromagnetic rather than the electrostatic field radiated from the induction loop 116 of the transmitter 10. Further, inasmuch as the pickup circuit 118 is tuned to resonate at the predetermined frequency of transmitter 10 much greater power reception by receiver 12 from transmitter 10 is possible than would be possible if the pickup circuit were not tuned.

Audio amplifier 120 includes transistor 138 having emitter, base and collector elements 140, 142 and 144 respectively, a biasing network including resistors 146 and 148 connected in a voltage divider circuit across the power supply 126, the resistor 150 in the emitter circuit of the transistor 138, bypass capacitor 152 and load resistor 154. Amplifier 138 serves to amplify the power of the electromagnetic audiofrequency signal received by the pickup circuit 118 and is connected with the pickup circuit across the emitter base thereof, as shown in FIG. 5.

Amplifier 122 includes the transistor 156 having the emitter, base and collector elements 158, 160 and 162 respectively, the coupling resistor and capacitor 164 and 166 respectively, and the primary winding 168 of the coupling transformer 170. The amplified signal received from amplifier 138 through the resistance-capacitance coupling circuit by amplifier 156 is again amplified in the amplifier 156 and is coupled to the rectifier-amplifier 124 by means of the secondary winding 172 of the coupling transformer 170.

The rectifier-amplifier circuit 124 includes the transistor 174 having the emitter, base and collector elements 176, 178 and 180 respectively, filter capacitor 182 and relay load coil 62 connected, as shown in FIG. 5. Rectifier-amplifier 124 serves to again amplify the signal received from amplifier circuit 122, rectifies the amplified signal and operates relay 54, as previously indicated, on a signal being received by the tuned circuit 118 from transmitter 10.

Thus, in overall operation of the model automobile 18 with the transmitter 10, receiver 12, drive motor 22, and steering motor 16, the transmitter is placed in the area in which it is desired to operate the model automobile with the induction loop extending around the area, such as around the periphery of a room. The model automobile is placed within the induction loop 116 and the switch 140 to the drive motor 22 and receiver power on-off switch 181 are closed. At this time the automobile 18 will run in a circle with the steering motor at one limit of its operation. The direction of turning of the automobile 18 will be determined by the direction in which the drive motor is connected with the relay 54 no energized. Suitable limit switches (not shown) can be used to limit the operation of the motor 16 if considered desirable. However, with the small motors and low power contemplated the limit of mechanical movement of bellcrank 46 determines the steering limits.

The transmitter 10 is then energized through closing the switch 186 at which time the transmitter 10 will transmit an electromagnetic signal at a frequency of for example 1.5 kilocycles or 9 kilocycles. The transmitted signal will be picked up by the magnetic induction pickup circuit 118 of the receiver 12 and the relay 54 will be energized to reverse the direction of energizing the reversible steering motor 16 to cause the automobile to change the direction of movement thereof. By timing the opening and closing of the transmitter switch 186 complete steering of the automobile 18 may be accomplished.

If opening and closing of the transmitter switch 186 is considered objectionable an electronic pulsing circuit 26, such as that illustrated in FIG. 6, may be included in the transmitter 10. The electronic pulsing circuit 26, as illustrated in FIG. 6, may be connected in the transmitter circuit 10 by providing a relay armature 188 in the conductor between the emitter 112 of transistor 110 and the induction loop 116 so as to alternately make or break the connection between the emitter 112 and induction loop 116 depending on whether or not the coil 190 of relay 192 is energized.

The electronic pulsing circuit comprises a free running multivibrator **194** connected across the power supply **72** through conductors **196** and **198**. Multivibrator **194** is conventional and includes the transistors **200** and **202**, capacitors **204** and **206** and resistors **208**, **210** and **212** connected, as shown in FIG. 6. Load resistor **214** is provided in conjunction with transistor **200** while the load for transistor **202** includes the rectifier **216** and relay coil **190** in parallel. The resistor **210** includes the variable position wiper arm **218** as shown.

Thus in operation with the electronic pulsing circuit **26** the transmitter **10** is turned on with switch **186** and switch **186** is left closed. Thus, with the wiper arm **218** centered on resistor **210** the output signal from transmitter **10** will be equally divided between on and off times since the multivibrator **194** is designed to operate in this manner with the wiper arm **218** centered. In other words, the relay **192** will be energized one-half of the time during operation of the multivibrator **194** so that the induction loop **116** will be connected to the emitter **112** one-half of the time.

To vary the direction of steering of the automobile **18** with the electronic pulsing circuit the wiper arm **218** is moved in one direction or the other from center to vary the conducting time of the transistor **202** in the multivibrator circuit **194** and thus the closed time of the relay **192**.

While one embodiment of the audiofrequency selective, magnetic induction coupled, remote control system of the invention has been considered in detail, other embodiments and modifications thereof are contemplated. Thus control of many other items, both model and full size, may be effected through use of the extremely simple, economical and efficient receiver and transmitter which are magnetically coupled as disclosed herein. Further, it will be readily understood that a plurality of other controls could be effected in the automobile or other models through the use of the magnetically coupled frequency selective transmitters operating at audiofrequencies below 20 kilocycles. Also, it will be understood that the transmitter and receiver disclosed may be used for other than remote control systems. Thus short distance communication systems, such as are used by skin divers, may advantageously include the principles of the invention. Further, while the transmitter and receiver disclosed have particular advantage operating at audiofrequency, the invention is not so limited. It is intended to include all such modifications and embodiments as are defined by the appended claims within the scope of the invention.

I claim:

1. A remote control system for models comprising an audiofrequency induction loop generated magnetic induction wave transmitting transmitter including a transmitter power supply, an audiofrequency oscillator including an oscillator transistor having emitter, base and collector elements, an emitter resistor connected between one side of the power supply and the oscillator transistor emitter, a transmitter voltage divider network connected between the opposite sides of the transmitter power supply, a feedback coil connected between the base of the oscillator transistor and a point on the transmitter voltage divider network and a resistance and tuned circuit operably associated with the tuned circuit connected in series between the collector of the oscillator transistor and a second point on the transmitter voltage divider network, a first transmitter amplifier including an amplifier transistor having emitter, base and collector electrodes, means connecting the collector electrode of the amplifier transistor to the one side of the transmitter power supply, means connecting the base of the amplifier transistor to the tuned circuit and a resistor connected between the one side of the transmitter power supply and the emitter of the amplifier transistor whereby the amplifier transistor is connected in emitter follower configuration, and a second amplifier transistor having emitter, base and collector electrodes, means for connecting the collector electrode of the second amplifier transistor to the other side of the power supply, means for connecting the base of the second amplifier transistor to the emitter of the first amplifier transistor and a magnetic induction loop antenna encompassing the area in which the model is to be controlled connected in series between the emitter of the second amplifier transistor and the one side of the transmitter power supply, an audiofrequency induction wave receiving receiver primarily magnetic induction coupled to said transmitter mounted in the model including a frequency selective magnetic pickup circuit tuned to the same audiofrequency as the transmitter transmits and comprising a coil having a permeable core and a capacitor connected in parallel, a reciever power supply, a series receiver amplifier for receiving the signal from the pickup circuit and amplifying it including emitter, base and collector electrodes, a collector resistor connected in series between one side of the reciever power supply and the collector electrode of the receiver amplifier transistor, an emitter resistor connected between the emitter of the receiver amplifier transistor and the other side of the receiver power supply, a voltage divider connected between the opposite sides of the power supply, means connecting the base of the receiver amplifier transistor to one side of the pickup circuit, a capacitor connecting the emitter of the receiver amplifier to a point on the receiver voltage divider and means connecting the other side of the pickup circuit to the same point on the receiver voltage divider, a second amplifier including a transistor having emitter, base and collector electrodes, a transformer primarily winding connected in series between the collector electrode of the second amplifier and the one side of the power supply, a resistor connected to the one side of the rectifier power supply and the second amplifier base, a capacitor connected between the collector of the receiver amplifier and the second amplifier base, and means connecting the emitter of the second amplifier to the other side of the power supply and a reciever power amplifier rectifier including a transistor having emitter, base and collector electrodes, means connecting the base electrode of the amplifier rectifier through the secondary winding of the transformer to the other side of the receiver power supply, means connecting the emitter of the receiver power amplifier to the other side of the receiver power supply, a capacitor connected between the collector of the receiver power amplifier and the other side of the receiver power supply, a relay coil connected between the receiver power supply and the amplifier rectifier collector and means connected to the receiver for controlling the model in response to the magnetic induction wave transmitted by the transmitter to the receiver including a reversible motor, a power source for energizing said motor and means for energizing the steering motor in accordance with the energy through the relay coil of the receiver amplifier rectifier circuit.

2. Structure as set forth in claim 1 and further including means for energizing and deenergizing the magnetic induction loop antenna for pulsing the output of the transmitter comprising a free-running multivibrator connected across the transmitter power supply and including a relay having the coil as the load on one side thereof and a switching armature responsive to the coil in series with the emitter collector circuit of the receiver power amplifier.

3. Structure as set forth in claim 2 wherein the means connected to the receiver for controlling the model further includes an arm connected to the steering motor for rotation thereby, a steering wheel, a vertical pivot mounting the steering wheel on the model, means for moving the steering wheel about the vertical pivot in accordance with rotation of the arm by the steering motor and resilient means for urging the steering wheel to a central position about the pivot mounting therefor.