

March 28, 1944.

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2,345,472

REMOTE CONTROL SYSTEM

Filed Oct. 20, 1939

4 Sheets-Sheet 1

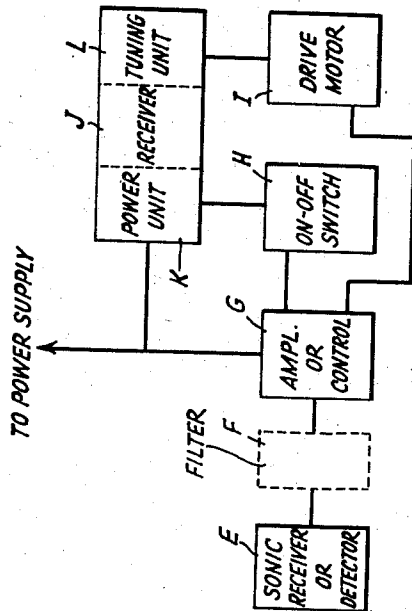


Fig. 1

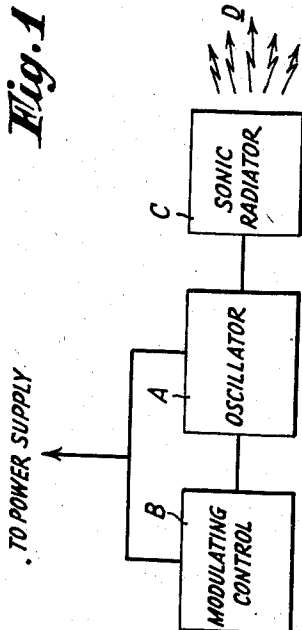


Fig. 2

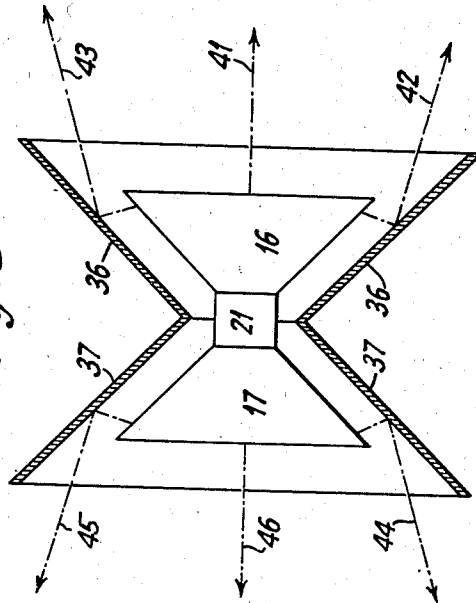
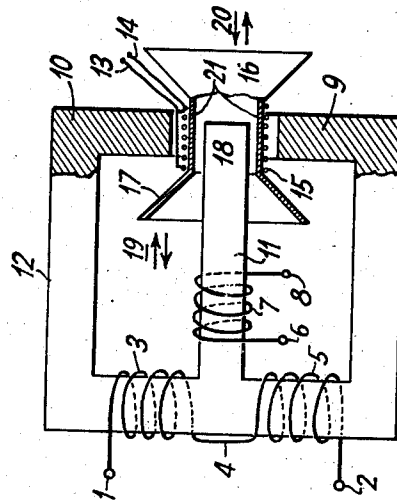


Fig. 3



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Fig. 4

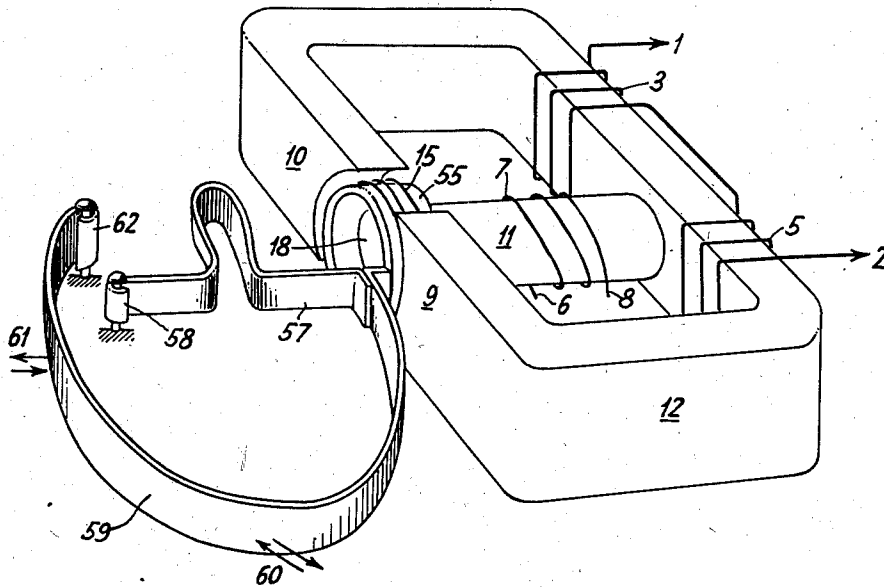
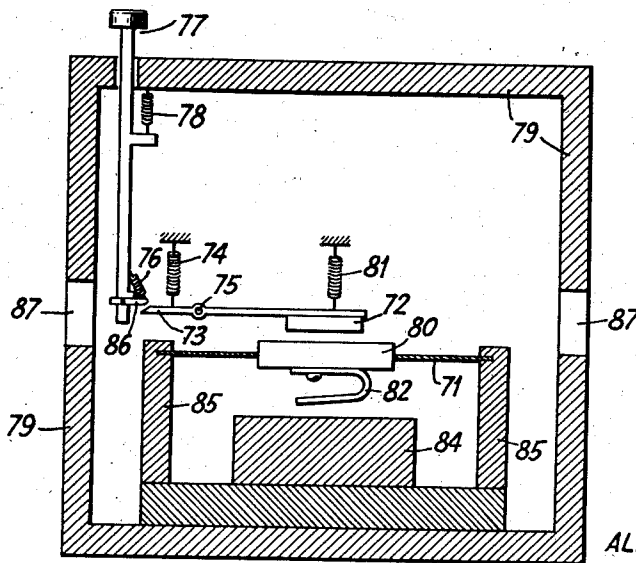


Fig. 5



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Fig. 6A

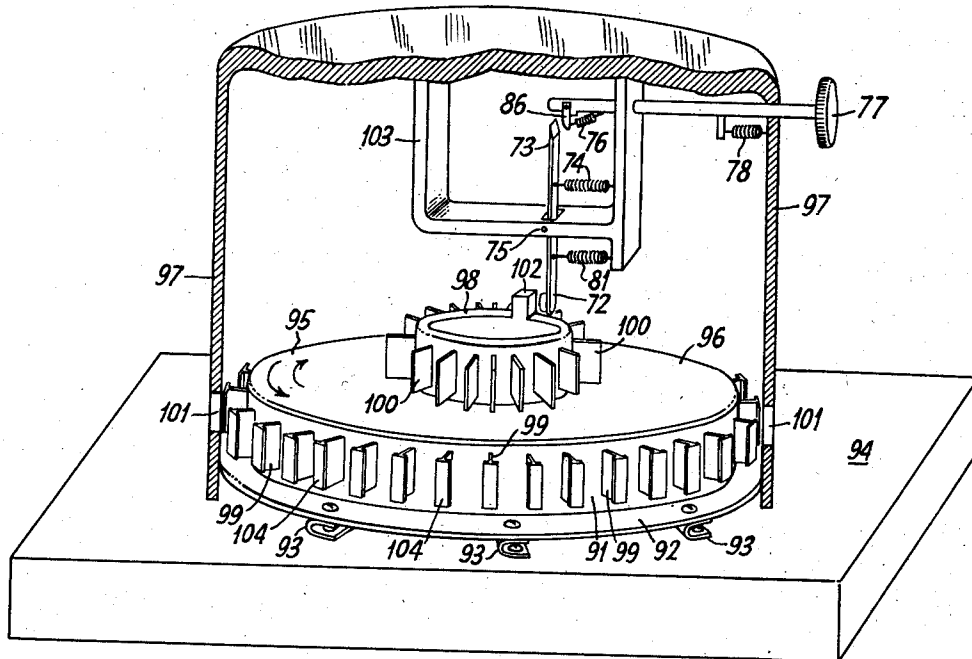
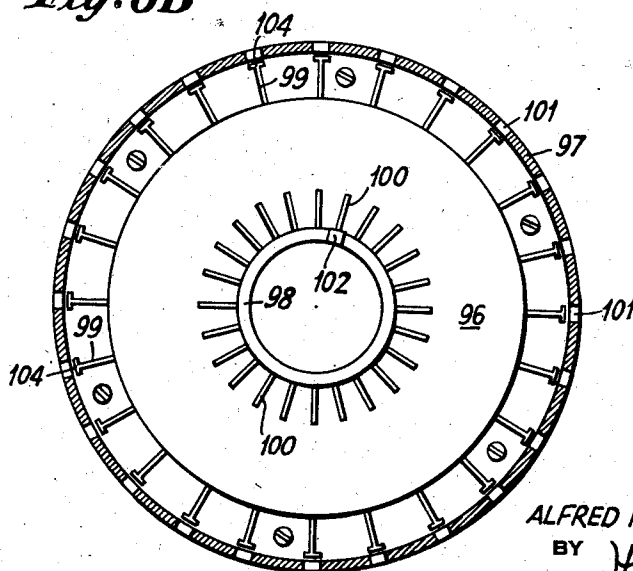


Fig. 6B



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Fig. 7

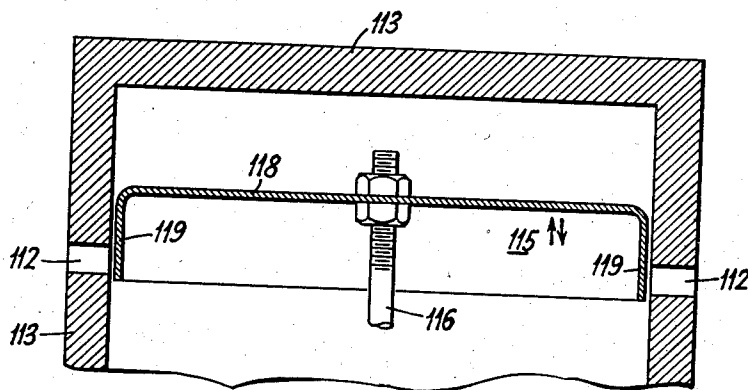
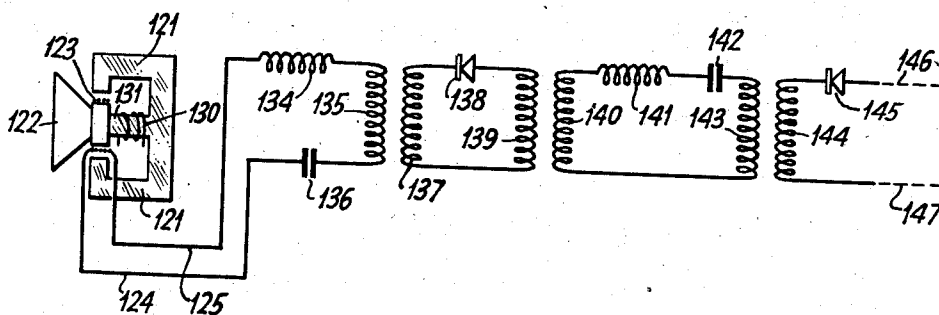


Fig. 8



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REMOTE CONTROL SYSTEM

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7 Claims. (Cl. 250-2)

The present invention relates broadly to remote control systems which they may be used, for example, to control the operating controls of a radio receiver from a remote point. It is a feature of the present invention to effectuate remote control by suitably modulated waves in air. In one particular embodiment of the invention modulated supersonic waves are used to remotely control a radio receiver.

Among the objects of the invention may be mentioned the following:

1. To enable the remote control of a radio receiver (or transmitter or other similar controllable device) within a given room without special or direct electric wiring between the control device and the controlled receiver.
2. To permit such control with a multiplicity of selective procedures as, for example, turning the receiver "on" and "off," tuning the receiver in one or both directions, and the like.
3. To obtain the above control regardless of the nature of the power circuits feeding the receiver.
4. To obtain such control even in the case of battery-operated receivers having no connection to electric circuits.
5. To obtain such control alternatively with or without connection of the control device to any outside electric power supply or circuit.
6. To secure such control regardless of the relative positions of the control device and the receiver in the room.
7. To secure such control without acoustic interference with persons in the room or reproduced music or speech.

While other objects of the invention will be apparent from a reading of the following detailed specification, it is apparent from the preceding that the aims of the present invention are unusually broad.

In one method of carrying out the present invention use is made of sound impulses, waves or trains radiated from the control device and received by the receiver which is at all times activated to the extent necessary to respond to such sound impulses. In the present specification the term "impulses" is intended to include waves, trains or other formed groups or sequences of groups of sound whether audible or inaudible.

The invention may be best understood by referring to the accompanying drawings and the description of the arrangements disclosed therein.

In said drawings,

Fig. 1 illustrates in schematic form, a diagram

which will be referred to in describing the general aspects of the invention;

Fig. 2 illustrates one form of an electrically operated modulated supersonic oscillator;

Fig. 3 illustrates in schematic form an arrangement for diffusing the waves emitted by a device such as disclosed in Fig. 2;

Fig. 4 illustrates an oscillator using a similar drive to that illustrated in Fig. 2 but employing a wide angle radiator;

Fig. 5 is a representation of a device for producing control waves by mechanical excitation;

Fig. 6A illustrates another form of a mechanically excited oscillator;

Fig. 6B is a sectional view of the oscillator shown in Fig. 6A;

Fig. 7 is a diagrammatic showing of a device using a siren method of modulation; and,

Fig. 8 is a diagrammatic illustration of an arrangement which may be used to receive the control waves.

In the system illustrated in Fig. 1, A is an oscillator which may be supplied with power either from an A. C. or D. C. power supply available from a power outlet in the room in which it is located or if desired power may be supplied from a self-contained battery or if desired the power may be supplied by mechanical means derived from the operator either as impulsive or sustained effort. The mechanical power may also be supplied by a suitable power storage device such as a spring or the like.

The frequency of the oscillator may be either infrasonic (e. g. below about 20 cycles per second) or ultra-sonic (that is, above about 15,000 cycles per second). Ultra-sonic frequencies are preferred. The oscillator may be of the tube type, of the crystal type, of the magnetostrictive type or of the mechanical vibrator type.

In order to enable appropriate control signals to be sent there is provided the modulating control B which controls the oscillator A. Physically, the control may be by knobs, buttons, and the like. The mode of control may be either by amplitude modulation or frequency modulation or a combination of these. The control may involve a setting for "on-off" of the receiver and a reversible-motor tuning control or else a continuous-rotation tuning motor control, or the equivalent of these, together with such added controls as may seem desirable (example, in the case of television receivers and the like). Fine tuning control may also be provided if desirable.

The modulated output of A and B energizes the sonic radiator C. This may be any type of

sound radiator or loudspeaker appropriate for the frequency range to be radiated. It may be made either non-directional in its radiation or it may be arranged to be directional, with the direction of radiation controllable (for example toward the receiving set).

In the drawing, D indicates the radiated sonic waves between the control device and the receiver. Infra-sonic or ultra-sonic waves are used because these do not interfere with the persons in the room and further because these frequencies fall outside of the range of frequencies acoustically radiated by the receiver and can therefore be selectively received at the receiver during the time that the receiver is in operation, thus enabling changes in its operation to be performed without interference from the sound which is radiated by the receiver itself.

In the right hand portion of Fig. 1 is shown in a general manner a suitable arrangement at the receiving set for effectuating the control. The control signals are received by a sonic receiver or detector E which may be any type of sound receiving or detecting device suitable for the frequency range in question and of adequate sensitivity. Thus it may be a telephone transmitter of the electro-dynamic, electro-static, microphonic, or piezo-electric or similar type. It may be the loudspeaker of the receiving set provided such loudspeaker is sufficiently responsive to the control frequencies. It may be the high-frequency unit ("tweeter") of the receiving loudspeaker provided this is sensitive to the frequencies used. Or it may be the low frequency unit of the receiver loudspeaker. It may be made directional or non-directional. It may be connected to a power supply for energizing or amplifying the response, or it may be not so connected.

It may be sharply resonant or broadly resonant to the incoming control frequencies. If it is made sharply resonant, it will probably be more sensitive but will build up in response more slowly. It can be changed from sharp to broad resonance or vice versa by the incoming signals thus altering its sensitivity.

The output of the sonic detector E passes through a filter F the function of which is to permit only control frequencies to reach the controlling mechanism of the receiver. The filter will be of the low-pass type for infra-sonic control signals or of the high-pass type for ultra-sonic control signals. The filter may be either electrical or mechanical.

The filter output passes into the amplifier or control G which may be supplied with power locally as indicated in the drawings. The amplifier in question may operate by amplitude variation control or it may be primarily responsive to a frequency or frequencies through resonant response.

The output of the amplifier G acts upon and energizes the remaining portions of the receiver control. Thus the output of the amplifier may be used to control the on-off switch H with an intervening relay if required. It may also control with a relay as required the tuning motor I.

The receiver J contains the power unit K which is controlled by the on-off switch H. The power supply of devices E and G, if required, is always on. Accordingly any tubes in E and G, if used, are of such types as to require minimum power to energize them and to give a maximum change in the controlled energy for minimum received excitation.

The receiver J may be provided with auto-

matic frequency control or not, but should preferably have this feature. The drive motor I will have a starter relay as required and as mentioned above. It may be made reversible or non-reversible in its control.

The drive motor I controls the tuning device L in the receiver. This tuning device may be a group of variable capacities, a group of variable inductances, a combination of these, and wave-range switching means as required. The tuning may therefore be either one involving electro-mechanical devices (for example, a variable condenser bank) or the tuning may be of the straight "electronic" type whereby inductances or capacities or a combination of these are "reflected" through a tube into a tuned circuit or modified in amount by a tube or tubes suitably connected to such inductances and capacities. Or combination electro-mechanical and electronic tuning may be used.

For generating supersonic oscillations which are modulated at either sub-audible or super-audible frequencies various arrangements may be used. Such oscillators may be either electrically or mechanically excited or a combination of these. While electrically operated remote control stations require a source of electric power they have the advantage that there is no demand for power upon the person handling the remote control. One such form of supersonic modulated oscillator is illustrated in Fig. 2. It will be understood however that the electromagnetic form of oscillator having a small conical radiator of air waves illustrated in Fig. 2 is purely illustrative since piezo-crystals, vibrating rods, tuned air columns or other primary or secondary sources of air waves may be alternatively employed.

The form shown in Fig. 2 is essentially an electrically modulated supersonic air wave radiator. The two cones 16 and 17 are joined by a thin cylindrical member 21 on which is wound the motor coil 15, the terminals of which are 13 and 14. The coil 15 surrounds the end portion 18 of the core 11 which may be either a permanent magnet of maximum strength or which may be wound with the coil 17 fed by direct current applied across terminals 6 and 8 and therefore magnetic. If an electric current of supersonic frequency, e. g., 20 kilocycles, is fed into the coil 15 through flexible conductors from the terminals 13, 14, the two cones 16 and 17 will be caused to vibrate simultaneously in the directions indicated by the arrows 19, 20. It is not believed necessary here to show any means for flexibly supporting the cones in question since such means are well known in the loudspeaker art. It will be noticed that the field from the core 11 is for example vertically up through the upper half of coil 15 and vertically downward through the lower half of coil 15, assuming north polarity of the core within the coil and south polarity of the adjacent ends of the yokes 9, 10. The cones 16 and 17 will then be a supersonic air wave radiator.

Coils 3 and 5 may be wound as shown on the yoke and a sub-audible current, e. g., of 30 cycles and of suitable amplitude may be passed through coils 3 and 5 from terminals 1 and 2. The magnetic flux through coil 15 resulting from the current in coils 3 and 5 will not be radially outward through coil 15 but will be half radially inward and half radially outward. Accordingly, there will be no motor effect on the cones 16 and 17 due to the current in coils 3 and 5. In any case even if an audible frequency were used through

coils 3 and 5 in place of the 30 cycle sub-audible frequency current there would be little air wave radiation from these small cones at so low a frequency and, of course, no audible sound. The current in coils 3 and 5 does however change the magnetic condition of the yoke 9, 10 and the core 11. Thus, it brings these magnetic elements nearer to saturation when the flux is in the same direction as that produced by the D. C. current in coil 7 and it reduces the flux far below saturation in the other half of the cycle of current through coils 3 and 5. As a result the twenty kilocycle field of coil 15 interacts with a second field of frequency of 30 cycles and accordingly the amplitude of the oscillations of cones 16 and 17 at 20 kilocycles is modulated by the 30 cycle current in coils 3 and 5.

In the operation of a device such as that shown in Fig. 2, it will be appreciated that to selectively control the operation of a plurality of devices which are located at a remote point, it is only necessary to employ different modulating frequencies in a selective manner, that is, assigning a certain action to be performed at the remote point to each modulating frequency or combination of modulating frequencies and modulating the transmitted energy by the particular modulating frequency or frequencies corresponding to the action desired to be performed at the remote point. At the remote point the transmitted control energy is received and demodulated. The products of demodulation are then suitably segregated and used for control purposes such as to operate relays and the like.

It may be mentioned parenthetically that a system of supersonic and inaudible telephony by air waves may be based on this principle by feeding the telephone currents into terminals 1 and 2. However, in this case the supersonic oscillations must be made intense and the straight line portion of the magnetization curve of the yoke and core must be used to avoid non-linear modulation and consequent rectification and audible speech radiation.

It is appreciated that normally supersonic air wave radiation has a highly directional nature. Figs. 3 and 4 of the drawings illustrate methods of modifying this highly directional nature. One method of modifying the highly directional radiation from cones 16 and 17 of Fig. 2 is to place between and around each of these cones conical spherical or otherwise curved surfaces as shown in Fig. 3. The cones 16 and 17 of Fig. 3 correspond to the cones 16 and 17 of Fig. 2 and the connecting element 21 of Fig. 3 corresponds to the connecting element 21 of Fig. 2. It is to be understood, though not illustrated, that in Fig. 3 the element 21 carries a motor coil such as coil 15 of Fig. 2. Reflectors 36 and 37 which are shown as frustra of cones with their smaller openings in juxtaposition, are placed surrounding the cones 16 and 17 respectively. The arrows 41 and 46 have been drawn in Fig. 3 to represent the direct air wave radiation resulting from the motion of the cones. Supersonic waves reflected from the frustra 36 and 37 and diverging outward are shown by the arrows 42, 43, 44 and 45. It is recognized that interference phenomena between radiation from one or two cones and reflective radiation may occur but the finite magnitude of the oscillators and reflector as well as the receiving element for the transmitted air waves will in general give a finite acoustic input to the receiver through a wide angle of directions.

In the form of multi-directional or wide angle

supersonic radiator illustrated in Fig. 4, the radiator is shown as a cylindrical surface 50 which is fastened at one end 52 and which is attached to the motor element 55 arranged to oscillate at supersonic frequency. A spring restoring element 57 is shown as fastened at 58. If the radiator 50 is made of appropriately small dimensions and suitable mass and elasticity it will oscillate in the directions shown by the arrows 60 and 61 and will radiate considerable amounts of supersonic energy in a wide angle of directions. The coils 3 and 5, 7 and 15 of Fig. 3 correspond to the coils in Fig. 2 bearing the same numbers and the yokes 9 and 10 and the core 11 of Fig. 4 correspond to the same elements of Fig. 2.

As previously pointed out it is sometimes desirable to avoid the use of electric power at the remote point. Under these circumstances it becomes necessary to have available a powerful source of supersonic air waves produced by mechanical excitation. These mechanically generated supersonic waves may also be modulated at a sub-audible, audible or super-audible frequency. One form of such oscillator is shown schematically in Fig. 5 wherein 80 is a vibrator of any suitable type which is capable of producing supersonic vibrations when violently struck by means of a hammer 72 which is capable of striking element 80 when swung about its pivot point 75. The hammer 72 is operated by means of a key or lever 77 against the force of a spring 78 which is attached between a lug on the key and casing 79. Element 80 is mounted on a comparatively thin metal sheet 71 which is held at its edges by the cylindrical support 85. A spring 82 and a stop 84 are provided to prevent excessive amplitude of vibration of sheet 71. From the preceding it is seen that the supersonic oscillator 80 is carried on an audio oscillator 71 and accordingly the supersonic waves passing outward through the holes or slots 87 in box or enclosure 79 which may be composed of wood, will be to some extent modulated by the vibration frequency of 71. As previously inferred the vibration frequency of 71 may be sub-audible, audible or super-audible. The arrangement shown in Fig. 5 constitutes an association of a supersonic oscillator, a lower frequency oscillator, and a common impulse excitation means for both.

In the operation of the device shown in Fig. 5, depression of key 77 causes counter-clockwise rotation of hammer 72 about its pivot point 75 against the force of spring 74. This movement continues until the continued downward movement of key 77 causes arm 86 to slip off of shoulder 73 thereby releasing all of the mechanical energy stored up by spring 74 which causes the hammer 72 to strike vibrator 80 violently. Spring 81 tends to bring back the hammer to its normal released position. When key 77 is released it returns to its normal released position through the action of spring 78. Arm 86 is pivoted on the key 77 and is held resiliently against a suitable stop by the action of a spring 76. This is for the purpose of permitting arm 86 to ride over shoulder 73 on the return movement of key 77.

Another form of possible mechanical oscillator for both supersonic and lower frequency oscillation with modulation of the supersonic frequency is shown schematically in Figs. 6A and 6B. Referring to Fig. 6A it will be seen that there is provided a pair of torsional oscillators 91 and 92. These oscillators are hollow or solid

cylinders. The oscillator 91 is preferably rigidly fastened at its bottom surface to a suitable mounting ring 92 which in turn is resiliently mounted by means of spring clips 93, 93 to a base plate 94. The arrangement is such that oscillator 91 can be twisted by impact so as to cause it to oscillate in the directions indicated by the arrows 95 at sub-audible, audible or super-audible frequency. Fastened to the upper portion of oscillator 91 is a suitable sheet of elastic material 96 which serves as a support for oscillator 98 which is also simultaneously excited by impact or which may be excited by repeated later impacts during the time of oscillation of 91. The torsional oscillations of 98 are in the direction indicated by the arrows 95. Oscillator 91 is provided with small vanes 99 while the oscillator 98 is provided with small vanes 100. These small vanes become air wave radiators. The whole structure is enclosed within a suitable housing 97 which is provided with a plurality of slots or openings 101 in registration with the vanes 99. The oscillator 98 is provided with an impact block 102 against which hammer 12 operates. Hammer 12 is operated by depression of key 17 similarly in every way to the arrangement described in connection with Fig. 5.

As indicated in Fig. 6B it is possible to cause the supersonic radiation from oscillator 98 to travel outward through openings 101 in the casing 97 which may be blocked or opened by the flat portions 104 of vanes 99 thus modulating such supersonic frequencies by the frequency of oscillator 91.

Still another method of modulating the supersonic vibrations is schematically indicated in Fig. 7. This arrangement applies either to electrically excited or mechanically excited supersonic waves. In Fig. 7 the enclosure 113 is provided with a series of holes or slots 112. A diaphragm 118 carries the cylindrical element 119 which may be part of it on its outer portion in approximate registry with the openings 112. If in such an arrangement the diaphragm 118 is caused to vibrate through the attachment elements 116 by any suitable means not here shown and in the directions indicated by the arrows 115, the exit of supersonic waves through openings 112 will be facilitated or retarded in substantial synchronism with the oscillations of 118. Essentially this arrangement is a siren method of modulating supersonic waves. It may be added that the generated supersonic waves in the arrangement shown in Fig. 7 may be produced in any well known manner, as, for instance, by means of a pneumatically-operated device. It is obvious from the above that the arrangement shown in Fig. 7 combines a pneumatically-operated supersonic oscillator and a siren or mobile gate valve type modulator at sub-audible, audible or super-audible frequencies.

Suitable receiving means for waves transmitted by any of the foregoing arrangements may take the same form as the radiators of said arrangements. If a supersonic oscillator alone is used as a receiver an arrangement such as that indicated in Fig. 8 may be utilized. In said figure the receiving oscillator 122 carries the coil 123 in a constant magnetic field excited by coil 130 through yoke 121 and core 131. Current of modulated supersonic frequency will flow through conductors 124, 125 into the tuned circuit 134, 135 and 136. This tuned circuit is coupled to a rectifying circuit 137, 138, 139 wherein rectified supersonic modulated impulses are produced. These

impulses are then fed into a tuned circuit 140, 141, 142, 143 which may in turn be tuned to the modulating frequency, e. g., 30 cycles (which modulating frequency may be audible, sub-audible or super-audible). This last named tuned circuit is in turn coupled to rectifying circuits 144, 145, the rectified output of which passes from leads 146, 147 into the controlling relays or similar elements.

If a receiving element of the type shown in Fig. 5 is provided, that is, if the receiving element is responsive to both supersonic and low frequency air waves, the modifications of the circuit of Fig. 8 are believed to be obvious therefrom. In this case the doubly resonant receiving system will produce an output which can be withdrawn preferably in the form of currents of modulated supersonic frequencies or in the form of two currents one of which is supersonic in frequency and the other of which is of a lower frequency. The selection of such currents, their amplification and their rectification, together with their utilization in appropriate relay systems need not be further described herein.

It is thought to be obvious from the above discussion that it is the intent of the receivers described herein to respond to modulated supersonic air waves and effectively to utilize resonant response to the supersonic frequency and also to the lower frequency of modulation in order to minimize false indications and to give a maximum number of possible indicating signals from a given group of frequencies in the remote control station.

I claim:

1. The steps in a method of remote control which comprise generating aerodynamic wave energy of a low supersonic frequency, modulating said energy of supersonic frequency with energy of a sub-audible frequency, radiating the thus modulated energy of supersonic frequency as airborne-free wave energy, receiving the said airborne free wave energy, demodulating the received energy, selecting from the demodulated energy the modulating frequency component of the received energy, and utilizing the resultant energy output for remote control purposes.

2. In a system for the remote control of an element of a radio receiver or the like, means for generating wave energy of a low supersonic frequency, means for generating wave energy of a sub-audible frequency, means for modulating the wave energy of low supersonic frequency by the wave energy of sub-audible frequency, means for radiating the resultant modulated supersonic frequency energy as aero-dynamic free wave energy, means located adjacent said radio receiver for receiving and demodulating the radiated free wave energy, means for selecting from the demodulated energy the modulating frequency component of the received energy, and means utilizing the latter to control said element of the radio receiver or the like.

3. In an aero-dynamic remote control system, means for generating electrical energy of a supersonic frequency, means for generating electrical energy of a lower frequency, means for modulating the electrical energy of supersonic frequency by the electrical energy of lower frequency and means for radiating the resultant modulated supersonic frequency energy as air-borne free wave energy, said last named means comprising a magnetic circuit provided with a gap, a surface radiator of supersonic energy, a coil system mounted in said gap and rigidly attached to said radiator, means adapted to connect said coil

system across the supersonic frequency generating means, and means for exciting said magnetic circuit by the generated modulating frequency energy.

4. In an aero-dynamic remote control system, means for generating electrical energy of a supersonic frequency, means for generating electrical energy of a lower frequency, means for modulating the electrical energy of supersonic frequency by the electrical energy of lower frequency and means for radiating the resultant modulated supersonic frequency energy as air-borne free wave energy, said last named means comprising a magnetic circuit provided with a gap, a surface radiator of supersonic energy, a coil system mounted in said gap and rigidly attached to said radiator, means adapted to connect said coil system to the source of supersonic frequency energy, means for exciting said magnetic circuit by the electrical energy of the modulating frequency, direct current energizing means electrically associated with said magnetic circuit whereby the latter is affected as to flux and permeability only by a constant excitation through direct current.

5. In an aerodynamic remote control system, a source of electrical energy of a supersonic frequency, a source of electrical energy of a lower frequency, a unitary device for modulating the supersonic frequency energy by the lower frequency energy and radiating the resultant modulated supersonic frequency energy as air-borne free wave energy, said device comprising a magnetic circuit provided with a gap, a surface radiator and a coil system mounted in said gap and rigidly attached to said radiator, means for connecting the coil system to said source of super-

sonic frequency energy, and means for exciting said magnetic circuit by energy derived from said source of modulating frequency.

6. In a system for the remote control of an element of a radio receiver or the like, means for generating electrical energy of a low supersonic frequency, means for generating electrical energy of a sub-audible frequency, means for modulating the electrical energy of low supersonic frequency by the electrical energy of sub-audible frequency, means for radiating the resultant modulated supersonic frequency energy as aerodynamic free wave energy, means located adjacent said radio receiver for receiving and demodulating the radiated free wave energy, means for selecting from the demodulated energy the modulating frequency component of the received energy, and means utilizing the latter to control said element of the radio receiver or the like.

7. In a system for the remote control of an element of a radio receiver or the like, means for generating aerodynamic energy of a low supersonic frequency, means for modulating said energy of low supersonic frequency with energy of a sub-audible control frequency, means for radiating the resultant modulated supersonic frequency energy as air-borne free wave energy, means located adjacent said radio receiver for receiving and demodulating the radiated free wave energy, means for selecting from the demodulated energy the modulating frequency component of the received energy, and means utilizing the latter to control said element of the radio receiver or the like.

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