

May 30, 1950

E. N. HOWELL ET AL
SUPERSONIC DOOR CONTROL

2,509,345

Filed June 19, 1947

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Fig. 2.

B

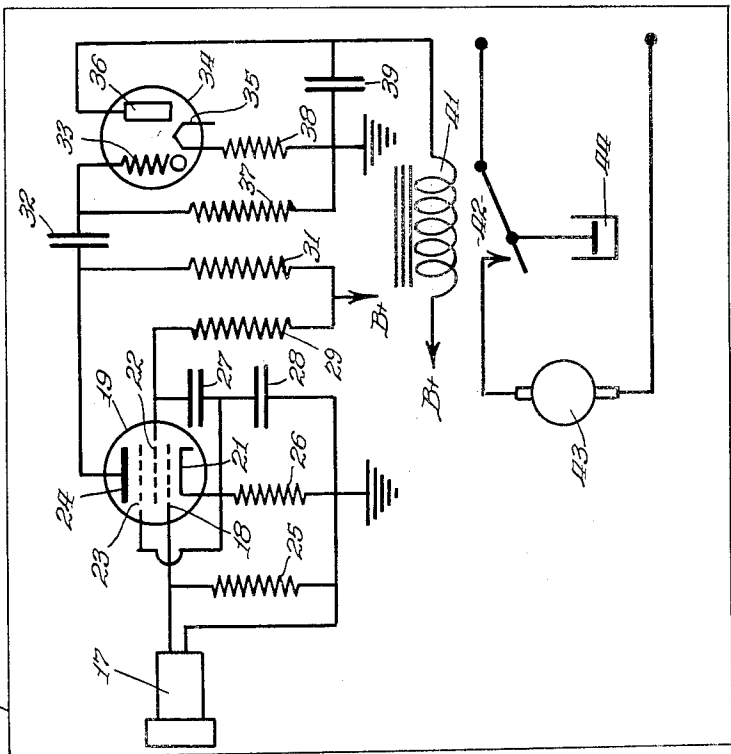
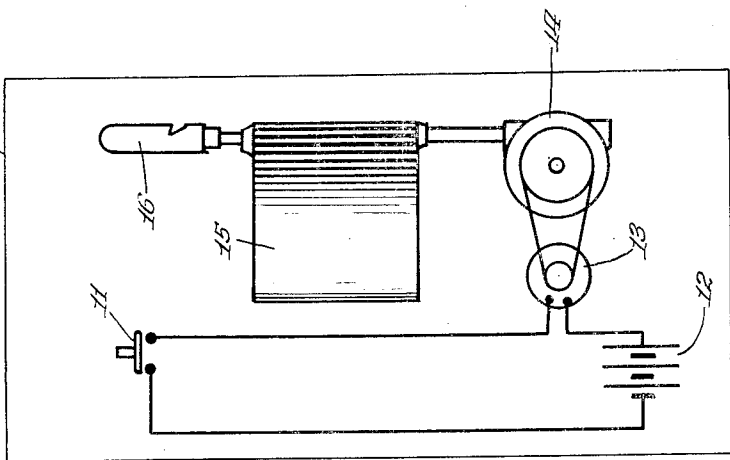


Fig. 1.

A



INVENTORS
E. N. Howell and
F. W. D'Arcy
BY

L. F. Hammond

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Fig. 4.

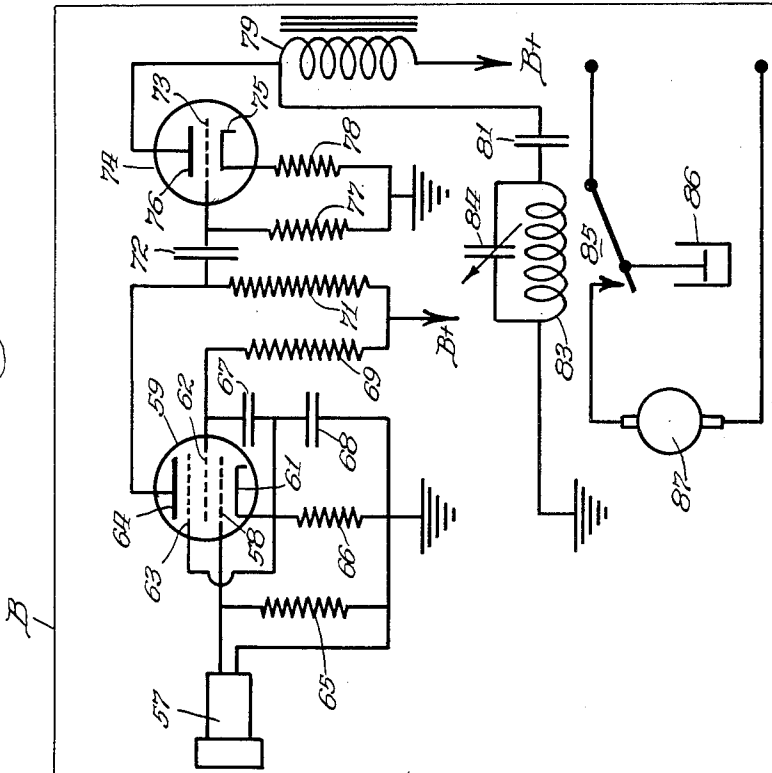
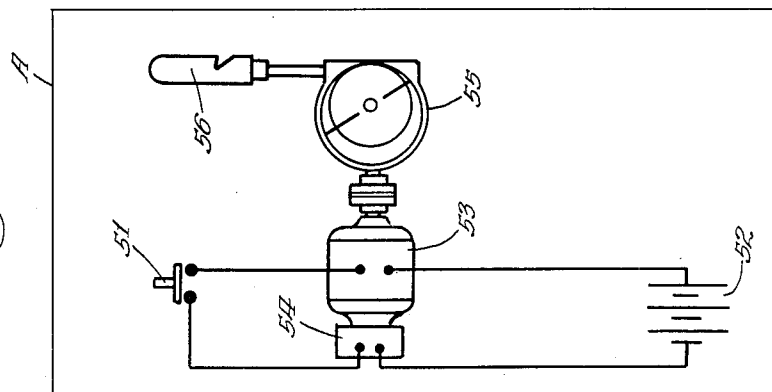


Fig. 3.



INVENTORS.
E. N. Howell and
E. W. D'Arcy
BY
L. F. Hammond
Att'y

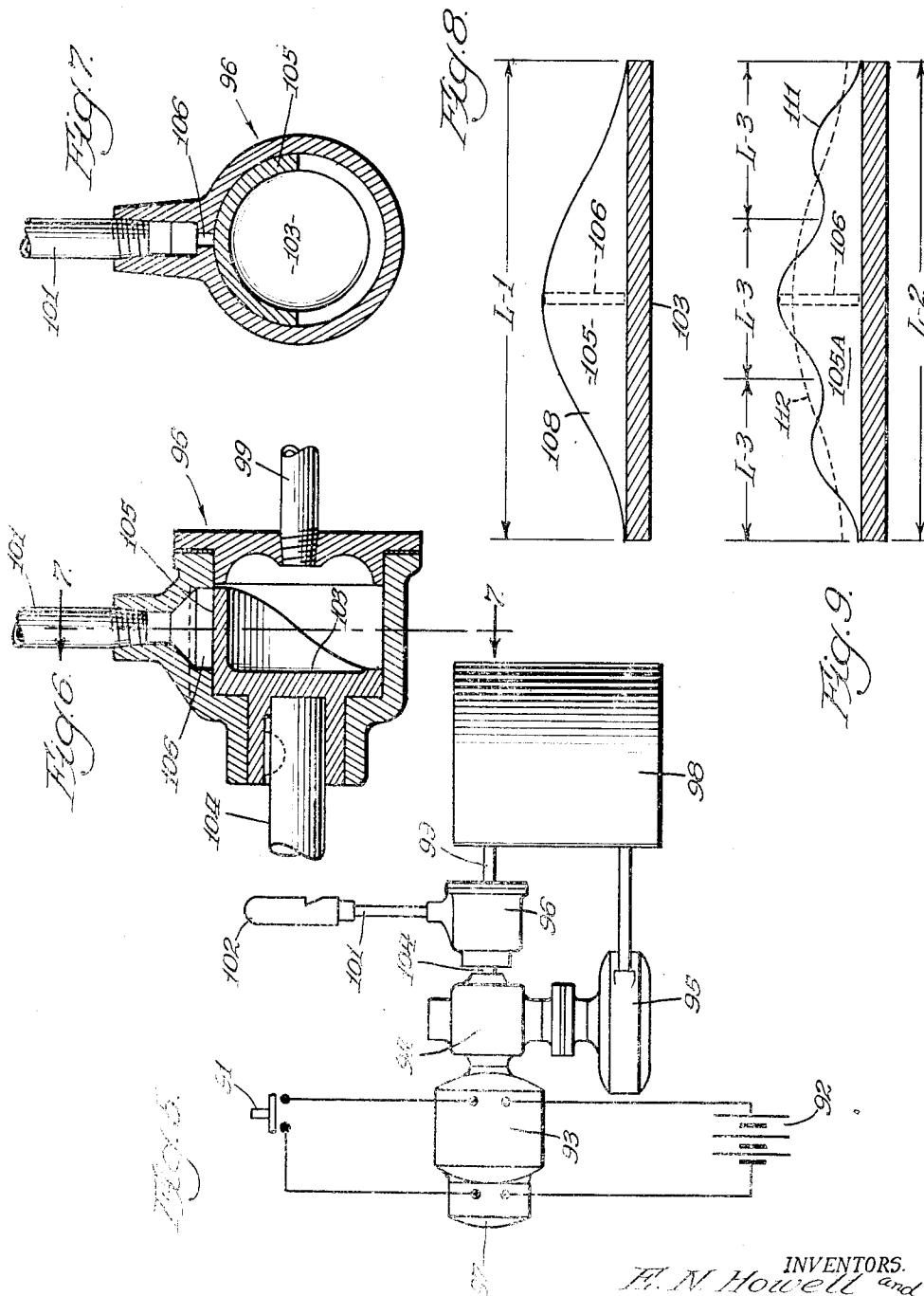
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INVENTORS.
E. N. Howell and
E. W. D'Arcy

BY
L. F. Hammond
Att'y.

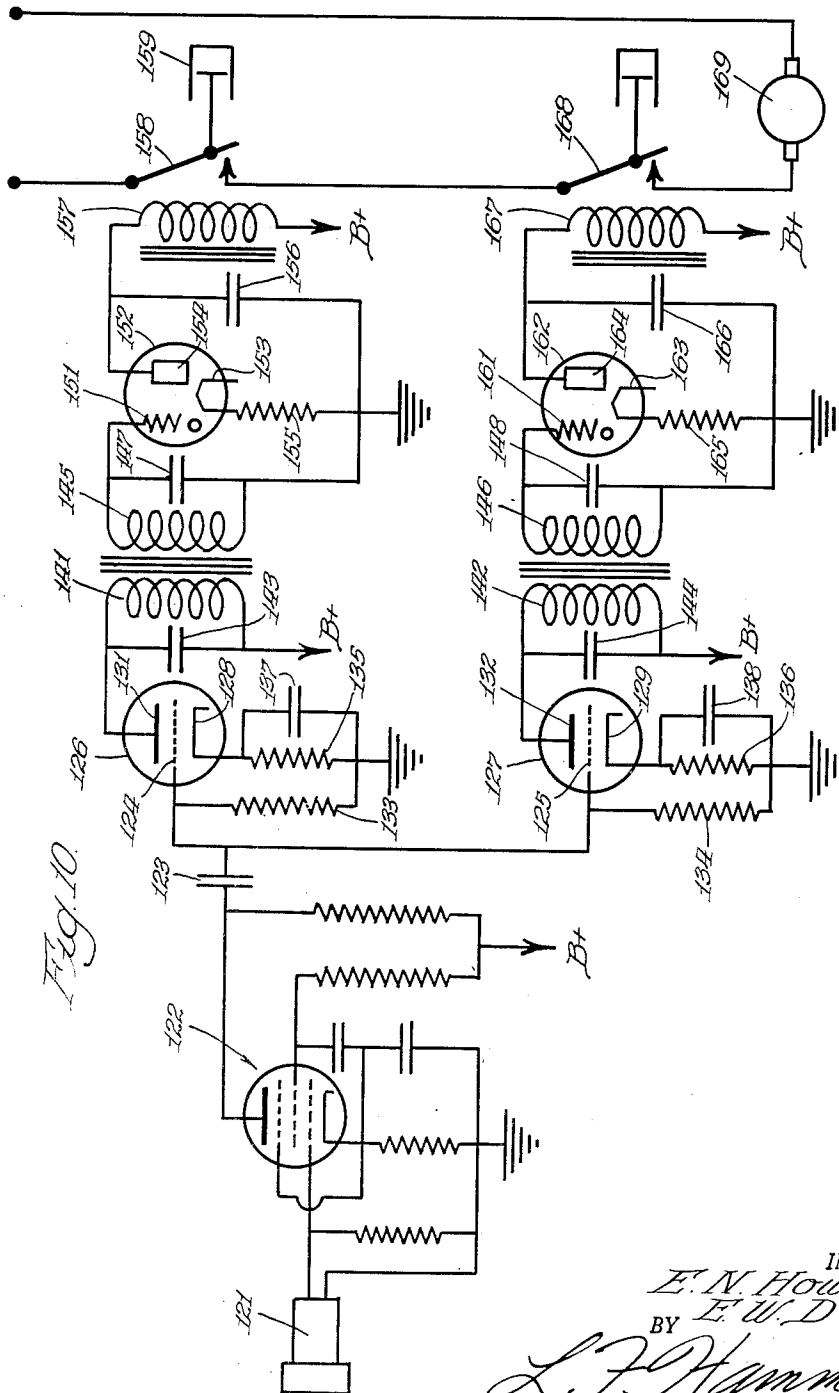
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INVENTORS.
E. N. Howell and
E. W. D'Arcy

BY L. F. Hammond
Att'y

UNITED STATES PATENT OFFICE

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SUPERSONIC DOOR CONTROL

Edward N. Howell, Lombard, and Ellis Wellington
D'Arcy, Chicago, Ill.

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4 Claims. (Cl. 318—16)

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The present invention relates to remote control devices and particularly to a remote control utilizing a supersonic wave as the means for causing the control devices to function. In its broadest aspect the invention is generally applicable to any type of remote control, but since it is particularly suited for opening and closing garage doors, it will be described in connection with a typical garage door installation.

It is the primary object of the invention to provide remote control devices whereby a motor vehicle operator approaching his garage may cause the garage doors to open without leaving the seat of the automobile and without the need of any physical connection between the vehicle and the door mechanism. In this connection it is also desirable that the mechanism be designed and constructed to function without the use of any beams of light, photo-electric cells, or audible sounds; so that there are no features of the mechanism that will mar the appearance of the vehicle or of the garage building.

A further object of the invention resides in the provision of a remote door control that is non-directional in operation but limited to a relatively short range.

A further object of the invention resides in the provision of a remote control adapted to actuate the door of a building, wherein the control devices comprise a generator for a supersonic wave mounted on a vehicle and means associated with the garage to open the door responsive to such a wave. Since the supersonic wave has a frequency below the range of the radio spectrum it will cause no interference with electronic apparatus, yet the frequency is above the range of sounds audible to the human ear, so that there will be no perceptible sound incident to the operation of the control.

A still further object of the invention resides in the provision of a vehicle carrying means for generating a supersonic wave, and means responsive to the supersonic wave to actuate the door of a building; together with means on the vehicle for modulating the supersonic wave by a relatively low audio frequency, and means associated with the response circuit to limit the response of the mechanism to a wave so modulated.

A still further object of the invention resides in the provision of a supersonic door control of the type indicated above wherein the response circuit includes a pair of tuned circuits adapted to respond to two different modulating frequencies, both below the frequency of the supersonic carrier wave, and thus adapted to be simul-

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taneously actuated by a supersonic carrier wave modulated by a complex audio wave.

The foregoing objects are accomplished by the provision of a supersonic signal generator carried by an automobile and a response circuit associated with the building door and including a resonant crystal microphone having a natural frequency corresponding to the frequency of the signal generator, together with an amplifier for the output from the microphone and a relay actuated by the output of the amplifier to control a door operating motor.

The invention also contemplates further refinements of the basic arrangement including the provision of means for modulating the supersonic carrier wave either by a simple wave of lower frequency or a plurality of lower frequency waves superimposed on each other to produce a complex modulation in the carrier. In this embodiment of the invention the response circuit includes resonant circuits associated with the motor relays so that the motor relays cannot be closed merely by the carrier wave alone, but must be actuated by a signal modulated in exact accordance with the tuning of the response circuit. This arrangement is of advantage over the basic arrangement in that it is selective in operation so that the signal device of one automobile is unlikely to cause accidental operation of a door to which it is not intentionally tuned. Also, this arrangement forestalls any possibility of actuation of the door mechanism by high frequency sounds accidentally produced by other sources and thus limits the responsiveness of the door actuating mechanism to the particular wave generator for which it is designed.

It is to be recognized that the principles of this invention are not to be limited to the specific forms of apparatus illustrated in the drawings hereof or described in this specification, since the details of construction may be varied within wide limits without departing from these teachings. The drawings disclose typical structural arrangements for attaining the desired results, however, and are so characteristic of the principle involved as to be well adapted to the description of the fundamental operations contemplated by this disclosure.

In the drawings,

Figure 1 is a diagrammatic illustration of a supersonic signal generator, comprising the portion of the control mechanism normally carried on the automobile.

Figure 2 is a diagrammatic illustration of a signal response circuit, comprising the portion

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of the control mechanism normally associated with the building and adapted to effect power operation of the door.

Figure 3 is a diagrammatic view of a modified form of signal generator designed to produce a modulated carrier wave.

Figure 4 is a diagrammatic view of a modified form of response circuit adapted to respond to a modulated carrier.

Figure 5 is a diagrammatic view of another modified form of signal generator.

Figure 6 is a detail central sectional view of the modulating valve shown in Figure 5.

Figure 7 is a detail sectional view taken substantially on the plane of the line 7-7 of Figure 6.

Figure 8 is a developed view of the rotor of the modulating valve showing a simple wave formation.

Figure 9 is a developed view similar to Figure 8 showing a complex wave formation on the valve rotor, and

Figure 10 is a diagrammatic view of a signal response circuit adapted to respond only to a supersonic carrier modulated by a complex low frequency wave.

The form of the invention illustrated in Figures 1 and 2 is representative of the basic inventive thought and illustrates a relatively simple structural arrangement adapted to accomplish the primary objects of the invention. The signal generator is actuated by an electrical push button 11 adapted to close the circuit from the automobile battery 12 through a motor 13 coupled to a pump or air compressor 14 in communication with a tank or storage chamber 15. A supersonic air horn 16 is also connected with the tank so that when the push button is depressed to close the circuit through the motor, the pump will force air through the horn and produce a supersonic carrier wave in the atmosphere. It is understood that the natural frequency of the air horn 16 will be in the range of sound, but that it will be above the maximum frequency normally audible to the human ear, so that its signal cannot be detected even by persons in the immediate vicinity. The tank or chamber 15 is of sufficient volume to equalize any pulsations of the air output from the compressor, so that the horn will emit a steady and continuous high frequency wave as long as the push button is depressed. These parts of the control, which comprise the signal generator, are preferably carried on the automobile or other vehicle, indicated by the box A in the illustrations.

The portions of the device associated with the building are illustrated in Figure 2 and enclosed within the box B. These parts comprise the response circuit adapted to energize a door operating motor in response to the high frequency signal.

The response circuit includes a resonant crystal microphone 17 of the same natural frequency as the air horn 16 with which it is to be used. The circuit from the microphone 17 extends to the control grid 18 of a voltage amplifier tube 19, the circuit of which may also include a cathode 21, screen grid 22, suppressor grid 23 and a plate or anode 24. The tube has an external circuit including a grid leak 25, cathode resistor 26, condensers 27 and 28, screen grid resistor 29 and plate resistor 31, so that it acts as a voltage amplifier to increase the intensity of signals coming from the microphone and feed the signals through the coupling condenser 32 to impress

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them on the grid 33 of a thyratron tube 34. This tube also includes a filament 35 and plate 36 and has an external circuit which may include a grid resistor 37 and a cathode resistor 38, and a condenser 39 bridged between the plate circuit and ground to take off the alternating current component of the plate circuit. The plate is connected to the B+ power supply through the windings 41 of the relay 42, so that the direct current flowing when the thyratron fires will close the relay 42 and energize the motor 43 to operate the building door. It is contemplated that it may be desirable to utilize a relay having a delayed action device so that it will respond only to a signal of continued duration, and such device is diagrammatically represented by the dashpot 44.

The operation of this form of the invention is relatively simple. It will be seen that the mere closing of the push button 11 will start the motor 13 and pump 14 and cause the high frequency horn 16 to generate a sound wave which, while not audible to the human ear, will be picked up by the resonant crystal microphone 17 of the response circuit. The signal from the microphone is sent through the amplifier tube 19 so that its intensity is sufficient to fire the thyratron 34 and energize the windings 41 of the relay. This closes the contacts of the relay to complete the circuit between a source of power and the motor 43 and actuate the door.

The form of the invention shown in Figures 3 and 4 is generally similar to that just described but is designed to utilize a high frequency carrier wave modulated by a relatively low frequency. To this end the push button 51 is connected between the battery 52 and the driving motor 53, but the circuit also passes through the contacts of a motor governor 54 so that the circuit will be broken if the motor speed increases above its predetermined speed. The driving motor 53 is coupled to an air pump or compressor 55. The pump may be of a piston type or of the vane type indicated, but should be of a construction characterized by pulsations in its output flow of air. These pulsations will naturally be in accordance with the speed of rotation of the pump, so that when the air is sent directly from the pump 55 to the high frequency air horn 56 without an intermediate tank, the signal emitted by the horn 56 will have a basic supersonic frequency but will be modulated by a frequency corresponding to the rate of the pulsations of air reaching it from the pump. That is, it will be a carrier wave of supersonic frequency on which a lower frequency audio wave has been impressed.

The response circuit adapted to receive this modulated wave is illustrated in Figure 4. A resonant crystal microphone 57 is provided to pick up the signal and impress it on the control grid 58 of the amplifier tube 59. The tube 59 may be the same as the tube 19, and includes a cathode 61, a screen grid 62, suppressor grid 63 and a plate 64. The external circuit of the tube includes a grid leak 65 and cathode resistor 66, as well as the condensers 67 and 68, screen grid resistor 69 and plate resistor 71. The output from the amplifier tube 59 is fed through a coupling condenser to the grid 73 of a second amplifier tube 74. Tube 74 includes a cathode 75 and plate 76 and its external circuit may include a resistor 77 between the grid and ground and a cathode resistor 78 to effect bias of the tube. The circuit of the direct current component from the plate of the tube extends through a choke

coil 79 to the B+ supply. The alternating current component of the output circuit is fed through the condenser 81 and into a resonant relay circuit including the relay windings 83 and a variable condenser 84 so that the capacity of the condenser may be varied to tune the tank circuit to the exact frequency of the pulsations of the pump 55. Then the relay contacts 85 will close only in response to a signal in which the frequency of the carrier is modulated exactly in accordance with the speed of the motor 53. When a wave with the proper modulating frequency is received, however, the relay contacts 85 close against the action of the dashpot 86 to energize the door motor 87.

Another modified form of signal generator is illustrated in Figure 5. In this form of the invention the push button 91 closes the circuit from the battery 92 through the motor 93 which is coupled through a gear box 94 to a compressor 95 and also to a rotary air valve 96. The circuit also extends through the governor 97 to fix the speed of the motor. The air output from the compressor 95 flows to a tank 98 and thence through an input line 99 to the valve 96. The output line 101 extends from the air valve 96 to the high frequency air horn 102. The air valve 96 includes a generally cylindrical housing enclosing a valve rotor having a flat bottom portion 103 mounted on the end of the rotary shaft 104, which extends from the gear box 94. The valve rotor includes a side wall 105 extending upwardly in close contact with the inner walls of the housing and adapted to close the outlet port 106 of the valve as the shaft 104 rotates. The outlet port 106 preferably extends across the full length of the cylindrical cavity of the valve housing, while the side wall of the valve rotor is formed according to a predetermined curve so that the flow of air through the outlet port and to the horn 102 will be regulated in accordance with the position of the valve rotor. A developed view of a typical form of modulating curve for the valve rotor is illustrated in Figure 8. This figure shows the wall cut in a sine curve 108, so that the flow of air through the outlet port will be gradually opened during the first half revolution as the valve rotates from the position shown, and closed during the next half revolution. The air flow to the horn 102 will thus be intermittently restricted, so that the supersonic wave emitted from the horn 102 will be modulated by a wave having a wave length indicated by L-1 (Figure 8) and a wave form corresponding to the general configuration of the curve 108.

It is contemplated that the output of the horn 102 may be modulated in accordance with a wave of any desired frequency lower than the frequency of the carrier, and it is further contemplated that, if desired, the output may be modulated according to a complex wave having two more basic frequencies. The manner in which this is done is illustrated in Figure 9, where it is seen that the upper edge of the valve wall 105A is cut in a complex wave form 111. The complex curvature of the wave 111 consists of two separate components, the lower frequency component having a wave length L-2 and being indicated by the dotted line 112. The higher frequency component is shown as a wave length L-3 of three times the frequency of the wave 112. These two component waves result in a wave corresponding to the curve 111.

The response circuit illustrated in Figure 10

is specifically designed to be used in connection with a carrier modulated by a complex wave. In this circuit the resonant microphone 121 is used to pick up the carrier frequency and the signal is amplified by a circuit generally indicated at 122, which may be identical with the amplifiers previously described. The signal is then sent through a coupling condenser 123 to the control grids 124 and 125 of a pair of amplifier tubes 126 and 127. These tubes include cathodes 128 and 129 and plates 131 and 132 and the external circuits may include grid resistors 133 and 134, cathode resistors 135 and 136, and condensers 137 and 138 in conventional arrangement. The circuits from the plates of the tubes extend through a pair of tuned transformers 143 and 144. The secondary windings 145 and 146 are also bridged by condensers 147 and 148 to tune the secondary circuits also, so that the transformers are responsive only to the frequency for which they are designed, and discriminate against the frequencies of each other.

It is contemplated that the frequency of one of these circuits may be substantially higher or lower than the other and they may be harmonic if desired. The signal from the secondary winding 145 is impressed on the grid 151 of the thyratron 152. This tube includes a cathode 153 and a plate 154, and has an external circuit including a cathode resistor 155 and a condenser 156 which is grounded to take off the alternating current component of the output. The direct current output of the tube passes through the winding 157 of a relay 158 and thence to the B+ supply.

The signal from the secondary winding 146 of the other transformer is fed into an identical thyratron circuit in which the elements 161 to 166 correspond to the parts 151 to 156 just described. The direct current component of the output of the tube 162 flows through the windings 167 of the relay 168. The relay windings 157 and 167 are thus energized by the tubes 152 and 162 respectively, and since the coupling transformers of those tubes respond only to definite frequencies the relays will operate only when the supersonic carrier is properly modified. The relay contacts 157 and 167 are in series with each other so that it is necessary that both frequencies be present in order that the relay contacts close simultaneously and energize the driving motor 169.

From the foregoing it will be apparent that the present invention provides a remote control device well adapted to many and varied uses, but particularly suited for the control of garage doors. By means of it, a motor vehicle operator approaching his garage may open the garage doors without leaving the seat of the automobile. It is unnecessary to establish any physical connection between the vehicle and the door mechanism.

There is no audible sound, no light rays or other visible indication of the presence of the mechanism. The appearance of the building and the automobile are both unchanged.

The mechanism is not subject to accidental actuation, and is non-directional in operation and limited to a relatively short range, so that it will effectively control the door when the vehicle is in the immediate vicinity, but when the car is not in the vicinity of the garage, there is no danger of accidentally opening the door by inadvertently touching the push button.

The forms of the invention illustrated in the

drawings and described in the specification have been selected as typical embodiments of the inventive concept and are believed to be well illustrative of the means by which these teachings can best be utilized, but it is recognized that various other modifications are possible without sacrifice of all of the advantages of the invention, and it is accordingly pointed out that the scope of the inventive thought extends to any variations of structure coming within the terms of the appended claims.

Having thus described the invention, what we claim as new and desire to protect by United States Letters Patent is:

1. In a supersonic device adapted to effect opening of garage doors in response to the actuation of a manual control instrumentality on a vehicle, the combination of means carried by the vehicle for generating a supersonic carrier wave above the frequency audible to the human ear, and means for modulating said carrier wave with a complex wave comprising at least two different fundamental frequencies, both lower than the frequency of the supersonic carrier; a resonant microphone adjacent the garage and responsive to supersonic frequencies only and a thermionic amplifier fed by the microphone; at least two tuned circuits to receive the output from the amplifier, said tuned circuits being selectively responsive to the different fundamental frequencies used to modulate the carrier wave; a relay in each of said tuned circuits and a motor controlled by the relays and adapted to open the door of the garage.

2. In a supersonic device adapted to effect opening of garage doors in response to the actuation of a manual control instrumentality on a vehicle, the combination of means carried by the vehicle for generating a supersonic carrier wave above the frequency audible to the human ear, and means for modulating said carrier wave with an audio frequency wave of frequency lower than the frequency of the supersonic carrier, a resonant microphone adjacent the garage and responsive to supersonic frequencies only and a thermionic amplifier fed by the microphone; at least one tuned circuit to receive the output from

the amplifier, said tuned circuit being responsive to the audio frequency only; a relay in said tuned circuit, and a motor controlled by the relay and adapted to open the door of the garage.

3. In a supersonic device adapted to effect opening of garage doors in response to the actuation of a manual control instrumentality on a vehicle, the combination of means carried by the vehicle for generating a supersonic wave above the frequency audible to the human ear; a resonant microphone responsive only to the frequency of said wave, a thermionic amplifier fed by the microphone, a relay in the output circuit of the amplifier, and a motor controlled by the relay and adapted to open the door of the garage.

4. In a supersonic device adapted to effect opening of garage doors in response to the actuation of a manual control instrumentality on a vehicle, the combination of means carried by the vehicle to generate a supersonic wave and to propagate the wave into the atmosphere; means to modulate the supersonic wave by a wave of lower frequency, means associated with the door of the building to energize a thermionic amplifier in response to a supersonic wave in the atmosphere, a low-pass filter circuit fed by the output of said amplifier, the filter being responsive to the frequency of the aforementioned means for modulating the supersonic waves and a relay in the filter circuit adapted to control the garage door.

EDWARD N. HOWELL.

ELLIS WELLINGTON D'ARCY.

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