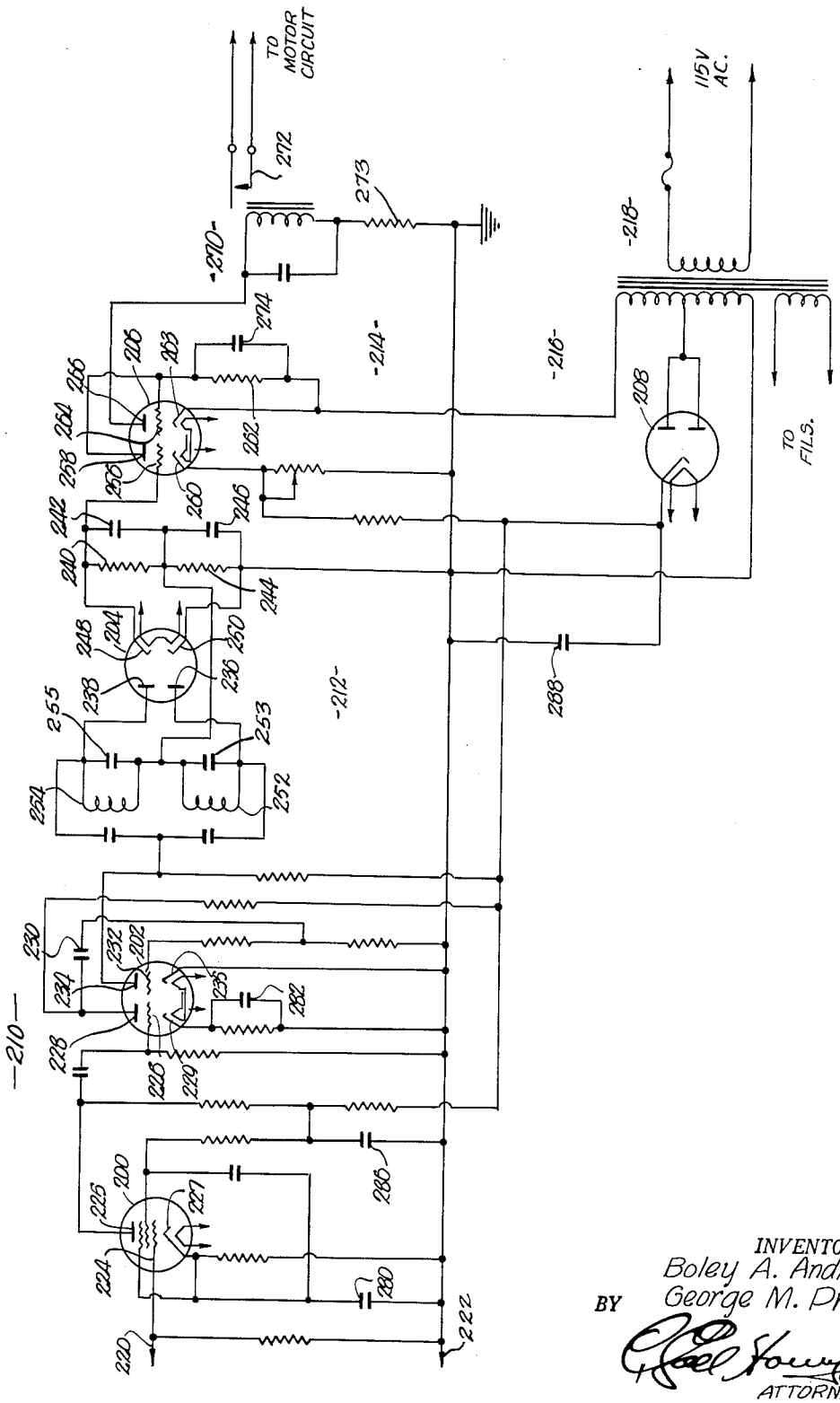
March 20, 1956 B. A. ANDREWS ET AL 2,739,273

ELECTRONIC CONTROL UNIT FOR DOOR CONTROLLING MECHANISM

Original Filed March 24, 1947



United States Patent Office 2,739,273 Patented Mar. 20, 1956

2,739,273

ELECTRONIC CONTROL UNIT FOR DOOR CONTROLLING MECHANISM

Boley A. Andrews, Kansas City, Kans., and George M. Pro, Kansas City, Mo., assignors to The Vendo Company, Kansas City, Mo., a corporation of Missouri

Original application March 24, 1947, Serial No. 736,684, now Patent No. 2,574,684, dated November 13, 1951. Divided and this application August 13, 1951, Serial No. 241,549

3 Claims. (Cl. 317—142)

This invention relates to a system for remotely controlling the operation of movable structure and more particularly to a control unit for garage doors or the like, the primary object being to provide a system having an electronic relay control unit for receiving supersonic or ultrasonic sound waves to control a motor circuit and therefore, a motor for actuating the door.

The most important object of this invention is to provide in a door controlling system, a relay control unit for receiving supersonic sound waves to control the operation of door operating mechanism, and having a plurality of electrical circuits including a cascade amplifier and current limiter circuit for introducing a constant voltage into a discriminator tube circuit forming a part of the unit, a time delay voltage relay circuit adapted to close a circuit through an electrically operated prime mover for the door operating mechanism and a rectifier circuit to produce a direct current potential at the plates of each of a number of vacuum tubes forming a part of certain of the other aforesaid circuits of such unit.

An important object of this invention is to provide in a door controlling system an electronic relay control unit having a discriminator tube circuit as a part thereof serving to select a desired and predetermined signal frequency from a supersonic sound transmitter, rectify such frequency and apply a negative direct current to a voltage relay circuit to the end that the unit is protected against operation by unwanted or foreign supersonic signals.

Another important object of this invention is to provide in door operating mechanism, an electronic relay control unit operable only upon receipt of a negative voltage of predetermined amplitude and wherein the time delay network delays operation of control mechanism for the door a predetermined length of time to the end that only signals of predetermined steady duration at a selected frequency received by the unit, will cause operation of the system.

Another object of this invention is to provide in a door controlling system, an electronic relay control unit provided with a discriminator circuit, which circuit includes a pair of pretuned circuits, responsive to a predetermined band of frequencies, one of such pre-tuned circuits constituting an "acceptance" circuit tuned to a predetermined desired frequency and the other pre-tuned circuit constituting a "rejection" circuit tuned to an undesired frequency for presenting a selective induction capacity network to the end that the entire unit is operable only in response to the supersonic signals generated at a given frequency for a certain length of time.

Many additional objects of this invention will be made clear or become apparent during the course of the following specification, reference being had to the accompanying drawing, wherein the single figure is a schematic wiring diagram showing the "Electronic Control Unit For Door Controlling Mechanism" made pursuant to the present invention.

This is a division of our co-pending application, Serial No. 736,684, filed March 24, 1947, entitled "Door Controlling Mechanism and Limit Switch," now Patent No. 2,574,684, dated November 13, 1951, and wherein

is disclosed one type of garage door actuating mechanism with which the electronic control unit hereof is adapted to be used.

Our co-pending application Serial No. 241,548, now Patent No. 2,695,001, filed on even date herewith and entitled "Sound Generator and Transmitter For Door Controlling Mechanism," also a division of said application Serial No. 736,684 (Patent 2,574,684), relates to structure for producing sound waves of a supersonic nature by utilization of the vacuum system of an automobile.

As above indicated, our Patent No. 2,574,684 discloses a garage door actuating assembly that is adapted for operation through use of a reversible electric motor, and while the present invention is adaptable for use in connection therewith, other door controls may be substituted.

Reference is had to a co-pending application Serial No. 61,473, filed November 22, 1948, entitled "Motor Actuated Door Operator," now abandoned; and a co-pending application Serial No. 241,550 filed on even date herewith, entitled "Door Operating Mechanism Having Motor Actuator," now Patent No. 2,715,662, both in the name of Boley A. Andrews.

Patent No. 2,558,032, dated June 26, 1951, and a co-pending application filed on even date herewith, entitled "Electric Motor Circuit For Door Controlling Mechanism," Serial No. 241,551, now abandoned, both in the name of Boley A. Andrews, disclose electric circuits for interconnecting the electronic conversion unit hereof and the motor, all of the aforesaid applications, said patents and present application having a common assignee.

The electronic relay control unit hereof utilizes five vacuum tubes **200**, **202**, **204**, **206** and **208** respectively, arranged in four distinct circuits broadly designated by the numerals **210**, **212**, **214** and **216**.

The circuit **210** consists of a cascade amplifier followered by a triode serving as a current limiter.

The circuit **212** receives the amplifier and limited signal from the circuit **210** and constitutes a "discriminator" tube circuit. The purpose of this discriminator circuit **212** is two-fold, first, to select the desired signal frequency, rectify such frequency, and apply a negative D. C. voltage to the circuit **214**. Secondly, the circuit **212** serves to protect the control unit against operation by unwanted supersonic signals, as hereinafter more fully set forth.

The circuit **214** is a time-delay voltage relay circuit operable to close a circuit through the prime mover for the door mechanism. This circuit **214** contains the tube **206**, which is a two-stage, triode relay control tube, and a time delay network, all operable only when a negative voltage of predetermined amplitude is applied to one of the grids of tube **206**.

The circuit **216** constitutes primarily a half-wave rectifier circuit. A transformer **218** supplies A. C. current for the rectifier tube **208**, which in turn produces a D. C. potential at the plates of the tubes **200** and **202**. Transformer **218** also supplies a relatively large A. C. potential to cathode **268** of tube **206**, a lesser A. C. potential to the corresponding grid **264** of tube **206** and to plate **258** of tube **206**, and a source of A. C. filament voltage to the filaments of all of the tubes.

The circuit **210** includes first, the tube **200** which comprises a pentode having the usual grouping of a number of electrodes serving as a high gain amplifier. All sound waves received by a microphone or the like (not shown) are converted thereby into electrical currents which pass to circuit **210** through lead lines **220** and **222**. Since these sound waves will vary both in frequency and amplitude of vibration, it is necessary to limit the amplitude of the electrical waves to a predetermined level. After the electrical impulse output of the microphone is magnified

by the pentode 200, such current is applied to the tube 202 within the amplifier-limiter circuit 210.

The output of the microphone is applied to the grid 224 of pentode 200, which varies the plate current flowing between plate 225 and cathode 227 of tube 200 to produce an A. C. voltage on grid 226 of tube 202. This tube 202 is a duo-triode and the voltage imposed on grid 226 serves to vary the plate current of the triode circuit flowing between plate 228 and cathode 229 of this tube 202. This produces an amplified A. C. voltage at the plate 228 of tube 202 which is applied through a condenser 230 to grid 232 of tube 202. The plate current flowing between plate 234 and cathode 235 of this second triode section of tube 202 is then varied to produce an A. C. current at the plate 234 of tube 202.

The voltage produced at the plate 234 of tube 202 is substantially limited and of constant amplitude because of the fact that the second triode section of tube 202 is operated at saturation level. The limiter action takes place preferably with an input voltage of 7 m. v. or over and introduces into the discriminator circuit 212, a constant voltage, regardless of signal intensity variations.

Such variations are dependent upon many conditions such as position of the sound generator with respect to the microphone, wind velocity and its direction, and a multitude of other factors tending to either increase or decrease the supersonic intensity.

The amplified and limited signal is then fed from the amplifier-limiter circuit 210 to the discriminator or "accept-reject" circuit 212. Circuit 212 includes two tuned circuits which are responsive to a predetermined band of frequencies. One of these circuits is tuned to a desired frequency and constitutes an "acceptance" frequency. The other tuned circuit, consisting of a "rejection" circuit, is tuned to an undesired frequency.

The constant or limited voltage from plate 234 of duo-triode 202 is applied to the plates 236 and 238 of tube 204, which tube 204 constitutes a duo-diode. The cathodes of this tube 204 are interconnected by a resistor-condensor network in a voltage opposing circuit. This network consists of resistor 240 and condensor 242 as well as resistor 244 and condensor 246 for cathodes 248 and 250 respectively of tube 204.

In parallel with each of the plates 236 and 238 of tube 204 is a frequency selective induction capacity network. This network comprises a pair of coils 252 and 254 tuned to different frequencies by their respective parallel coupled condensers 253 and 255.

The coil 252 is tuned to the "acceptance" frequency to produce a negative voltage in the output of the resistor-condensor network. The desired signal frequency is thus selected and rectified, and a negative D. C. voltage is applied to the relay circuit 214.

The coil 254 is tuned to a higher frequency than the desired signal and any signal received by this "rejection" frequency will be rectified and delivered as a positive voltage to the relay circuit 214. In other words, coil 254 is tuned to a rejection frequency to produce a positive D. C. voltage in the output of the resistor-condensor network.

It is therefore, clear that since the resistor-condensor network is connected in a voltage opposition circuit, the appearance of both rejection and acceptance frequencies at the coils 254 and 252 respectively, will produce opposing voltages. These voltages will cancel out each other and leave a zero output at the grid 256 of tube 206 within the relay circuit 214. The voltages appearing at the resistor-condensor circuit are substantially D. C. because of the rectifying action produced by the diodes of tube 204.

When a negative voltage is applied to grid 256 of the duo-triode 206, the plate current flowing between plate 258 and cathode 260 of tube 206 will decrease. A decreased voltage will therefore, appear across a resistor 262 within relay circuit 214. This resistor 262 will in turn supply a decreased grid bias voltage to the grid 264 of tube 206. This decreased grid bias voltage will cause an increase in the plate current flowing between plate 266 and cathode 268 of tube 206.

This increase in plate voltage will cause an increased current flow in a relay 270 forming a part of the relay circuit 214, which in turn will cause armature alterations in relay 270 to actuate a switch 272. The circuit through relay 270 may be traced from the secondary of transformer 218, to the cathode 268 of tube 206, through conducting tube 206 to the plate 266 of tube 206, to the coil of relay 270, through the coil of relay 270 to ground through a resistor 273, and from ground to the other end of the secondary of transformer 218. Closing of the switch 272 by such operation of the relay 270 will close a circuit through an electric motor or the like coupled to the circuit hereof.

When a positive voltage appears at grid 256 of tube 206, the plate current between plate 258 and cathode 260 of tube 206 will increase. This causes an increased voltage across resistor 262 to apply an increased grid bias voltage to the grid 264 of tube 206. A decrease in plate current will then be caused to flow between plate 266 and cathode 268 of tube 206.

This decrease in plate current will cause decreased voltage in relay 270 to the end that switch 272 will not be closed.

It is notable that the steady state of conditions within the triodes of tube 206 are such that when zero voltage is applied to grid 256 of tube 206, no appreciable current flow is present in the relay 270, thereby leaving switch 272 normally open. Such zero voltage is always present when both the wanted and an unwanted voltage is received by the pentode 200.

The resistor 262 and a condensor 274, both within the relay circuit 214, are of such time constants as to present a time delay for operation of the relay 270. These elements are set to operate only if the sound received is of a predetermined duration. This is inserted in the unit to insure against operation of relay 270 by sounds which may be of the proper frequency but of short duration or a series of short sound pulses. For example, experiments and tests have indicated that supersonics can be produced by such sources as jingling of keys and coins, rustling of tissue or cellophane paper, tapping together of pieces of metal, and the like. Analysis of these sounds by heterodyne supersonic detectors indicated the presence of a large number of supersonic frequencies which were not of great strength at any one frequency, but gave small responses at a number of frequencies in the range of approximately 13,000 to as high as 40,000 C. P. S.

The time delay network is therefore, set to close the contacts of relay 270 after about three seconds of steady signal reception. Virtually all such transient and short duration sounds, as well as sudden line voltage surges, will fail to cause closing of switch 272 with such time interval.

It is also preferable that relay 270 have a low armature release point, generally 50% of the attract value. This is necessary because during operation of a motor coupled herewith, a substantially large drop in line voltage occurs, particularly when the motor is running on its starter winding. Such reduction in line voltage would drop out the relay 270 if it were set too close to its attract value.

It is notable that the outputs of the two tuned circuits (coils 252 and 254) are both rectified and integrated in the discriminator circuit 212 which produces a direct current voltage. The polarity of these outputs as above specified, is positive for undesired frequencies and negative for desired frequencies. If both acceptance and rejection frequencies are present, the resultant output voltage is zero, thus making the unit as a whole inoperative.

The need for this type of discriminator circuit is, therefore, obvious. The control unit is designed to respond

to supersonic waves created by the air whistle (not shown) which will produce a clean sound wave, free from any extraneous frequencies. Safety against theft or other ulterior motives would not otherwise be possible. A multitude of frequencies within the supersonic range selected, may be produced simultaneously by use of an air jet which allows air to escape at a great velocity. This escapement of air from a small jet would produce spurious sound waves, rich in frequencies, any number of which would operate the control pre-tuned to a desired frequency range. Use of the circuit above described therefore, becomes imperative. Only one frequency will produce a negative voltage in the integrating circuit forming a part of this control unit.

Arrangement of the component parts of the unit in a suitable cabinet will include a pair of condensors **280** and **282** and a pair of condensors **286** and **288** in rectifier circuit **216**.

A supersonic sound wave generated by a whistle or the like is transmitted to a microphone, which in turn converts the waves into electric current.

These sound waves must be continued for at least 3 seconds in order to cause operation of the time delay network in the relay circuit **214** of receiving unit **113**. Since the "acceptance" circuit in discriminator circuit **212** is tuned to the frequency of signals generated by the whistle, a negative D. C. current will be passed to circuit **214**.

Operation of relay **270** will close switch **272** and thus a motor circuit, whereby operation of an electric motor opens or closes a garage door, as the case may be. The motor continues to operate until it reaches either the open or closed position; until stalling of the door operates a switch to open the motor circuit; or until the motor circuit is opened by manual actuating one of a number of auxiliary switches. Furthermore, operation of the whistle during the time the door is being opened or closed will open the motor circuit and discontinue operation of the motor, because of actuation of switch **272** by relay **270**.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. In electrical apparatus, a delayed action, relay control comprising a pair of input terminals; a relay having a coil provided with a pair of energizing terminals; conductive means coupling one input terminal to ground; a resistance coupling one energizing terminal of the coil to ground; a pair of triode vacuum tubes each having a cathode, a grid and a plate; conductive means coupling the grid of one tube with the other of said input terminals; conductive means coupling the plate of said one tube with the grid of the other tube; conductive means coupling the plate of said other tube with the other of said energizing terminals of the coil; a resistance coupling the cathode of said one tube to ground; a source of positive, direct current potential with respect to ground coupled with the cathode of said one tube; a source of alternating current potential coupled between the cathode of said other tube and ground; and a parallel, resistance-capacitance delay circuit having a predetermined time constant coupled between the cathode and the grid of said other tube, whereby said coil is energized to operate said relay only when a negative, direct current potential with respect to ground has been applied to said other input terminal for a predetermined period of time.

2. Electrical switching apparatus responsive to applied signals of a first, preselected frequency only, and so responsive only when signals of a second, preselected frequency different from the first are not simultaneously applied, said apparatus comprising a low frequency, vacuum tube, signal amplifier circuit adapted for coupling with a source of signals having an electrical output which may include signals of either, neither or both of said preselected frequencies, said amplifier circuit being of the resistance coupled type to render its band pass characteristics of sufficient breadth for amplifying any signals of either of said frequencies received from said source to a predetermined, minimum level of amplitude; a vacuum tube signal limiter circuit coupled with the amplifier circuit and receiving any signals of said frequencies present in the electrical output of the amplifier circuit, said limiter circuit including a vacuum tube conducting at its saturation level whenever signals of said frequencies and of said minimum level of amplitude are being received from the amplifier circuit for limiting the amplitude of signals of said frequencies in the electrical output of the limiter circuit to predetermined, substantially equal, maximum amplitudes; a vacuum tube, signal discriminator circuit coupled with the limiter circuit and receiving any signals of said frequencies present in the electrical output of the limiter circuit, said discriminator circuit including a pair of frequency selective circuits for separating signals of said pair of frequencies received from the limiter circuit, a vacuum tube rectifier coupled with each selective circuit respectively for converting signals of the corresponding frequency into a direct current potential, and a voltage integrating, impedance network coupled with said rectifiers and arranged for presenting a direct current, electrical output of one polarity and predetermined minimum magnitude when signals of only said first frequency are received from the limiter circuit, of the opposite polarity and predetermined minimum magnitude when signals of only said second frequency are so received, and of substantially zero magnitude when signals of neither or both of said frequencies are so received; a relay control circuit coupled with the discriminator circuit and receiving any electrical output from said network of the latter, said control circuit including a vacuum tube and a bias circuit biasing said last-mentioned tube against conduction except when an output of said one polarity and said predetermined magnitude is received from the discriminator circuit for producing an electrical output from the control circuit only when an output of said one polarity and said magnitude is so received; and a relay having a coil and a switch responsive to energization of the coil, said coil being coupled with the control circuit and receiving any electrical output from the latter for energization of the coil and operation of the switch in response thereto.

3. In the apparatus as set forth in claim 2, wherein said bias circuit includes a parallel, resistance-capacitance, delay circuit having a predetermined time constant for holding said tube of the control circuit biased against conduction until an output of said one polarity and said predetermined magnitude has been received from the discriminator circuit for a predetermined, minimum period of time.

References Cited in the file of this patent

UNITED STATES PATENTS

1,318,342	Hammond	Oct. 7, 1919
1,733,045	Baker	Oct. 22, 1929
2,194,559	Koch	Mar. 26, 1940
2,207,540	Hansell	July 9, 1940
2,380,947	Crosby	Aug. 7, 1945
2,397,539	Dent	Apr. 2, 1946
2,399,695	Satterlee	May 7, 1946
2,429,771	Roberts	Oct. 28, 1947
2,455,646	Beard	Dec. 7, 1948
2,535,157	Markusen	Dec. 26, 1950
2,537,163	Shenk et al.	Jan. 9, 1951
2,558,100	Rambo	June 26, 1951
2,559,959	Hipps	July 10, 1951
2,561,088	Anderson	July 17, 1951
2,569,000	Hadfield	Sept. 25, 1951
2,573,554	Dwyer	Oct. 30, 1951
2,611,861	Heath	Sept. 23, 1952
2,682,019	Molnar	June 22, 1954
2,682,963	Hathaway	Oct. 26, 1954

OTHER REFERENCES

"Radio & Television News," May 1951, pages 57 and 98.