Feb. 2, 1965 R. WEINSTEIN 3,168,737

RADIO CONTROLLED LOCK

Filed Nov. 7, 1962

FIG. 1

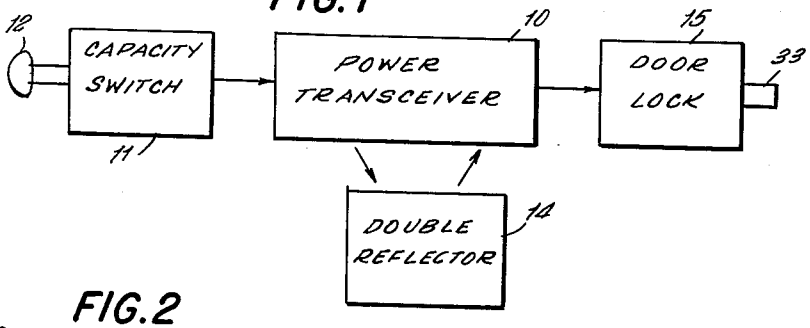


FIG. 2

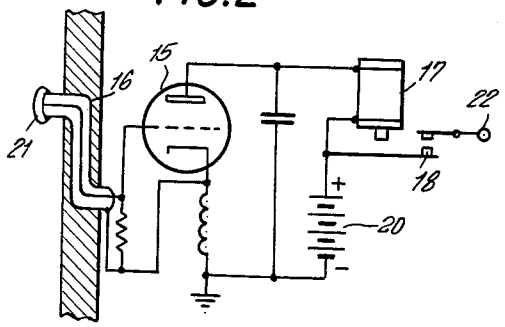


FIG. 3

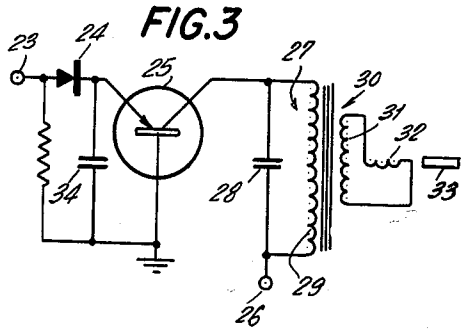


FIG. 4

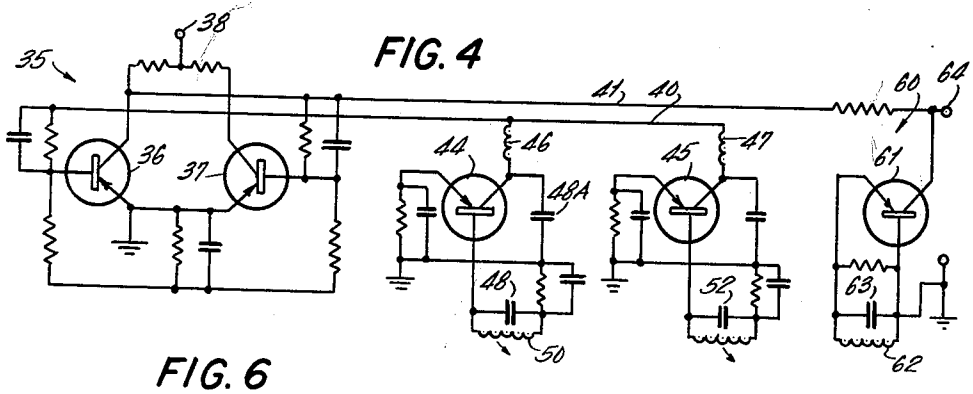


FIG. 6

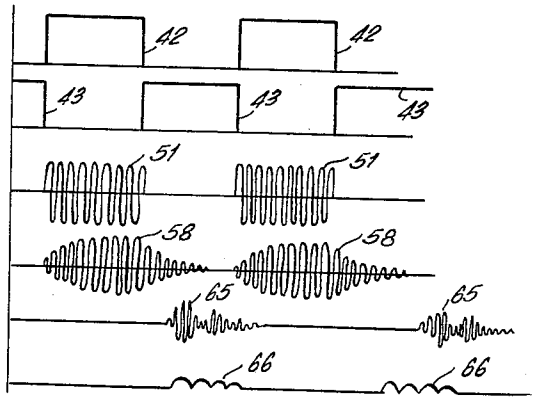
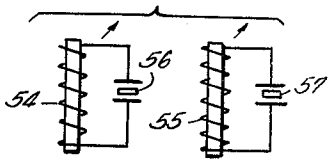


FIG. 5



INVENTOR.
RICHARD WEINSTEIN
BY Albert F. Kosman
ATTORNEY

United States Patent Office 3,168,737 Patented Feb. 2, 1965

3,168,737

RADIO CONTROLLED LOCK

Richard Weinstein, Huntington, N.Y., assignor, by mesne assignments, to Commercial Factors, Ltd., Montreal, Quebec, Canada

Filed Nov. 7, 1962, Ser. No. 235,982
8 Claims. (Cl. 343—225)

This invention relates to an electronic means for operating a mechanical transducer at a distance. It has specific application for the operation of a lock whereby access may be obtained without the use of a key or without the manipulation of a combination lock.

Prior art locks have either been operated by keys or by locks which required the use of a combination to set a series of tumblers so that a lock bolt can be withdrawn. The first type of lock not only requires the possession of the key but the operator must insert it into a key hole before the lock can be opened. The combination lock requires the knowledge of the combination and the manipulation of a dial or other arrangement of controls which may take considerable time. The present invention requires the use of a small electronic circuit which can be kept in the pocket, a briefcase, or a lady's handbag. It is not necessary to remove this circuit from the pocket in order to open the door. The operator with the circuit walks up to the door, puts his hand on the knob, and the door is opened immediately, thereby saving considerable time and omitting the necessity for removing the circuit from the pocket.

One of the objects of this invention is to provide an improved electronic lock which avoids one or more of the disadvantages and limitations of prior art arrangements.

Another object of the invention is to provide a lock which is secure against unauthorized entry but can be opened without the use of a key or the manipulation of a combination lock.

Another object of the invention is to increase the speed of response of a signal-operated control means.

Another object of the invention is to operate a signal-control mechanism without the use of a portable power unit.

Another object of the invention is to reduce the size of the control circuit so that it may be carried in the pocket of a coat or in a lady's handbag.

The invention comprises a power transceiver which may be activated by a capacity-sensitive oscillator circuit connected to the door knob. The transceiver broadcasts radio waves at two frequencies and receives radio waves at a combination modulated frequency. The arrangement is such that the transmitter and receiver circuits are activated in sequence so that the waves sent out by the combination of oscillator circuits cannot be received directly by a third circuit. The portable circuit carried by the operator is a high Q reflector which receives the radio power from two oscillator circuits and reflects this power at the same frequencies after the oscillators have stopped their power broadcasts. The reflected waves operate the receiver circuit and open the door lock. One feature of the invention includes a free running multivibrator which transfers operating power from the oscillators to the receiver in a sequential manner.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accompanying drawings.

FIG. 1 is a schematic diagram of the complete system showing the various circuit components in block form.

FIG. 2 is a capacity switch circuit connected between a door knob and a relay.

FIG. 3 is a schematic diagram showing one form of door lock which may be used with the system.

FIG. 4 is a schematic diagram of connections showing the transceiver which includes two oscillator circuits and a receiver circuit, each activated by a multivibrator.

FIG. 5 is a diagram of connections showing the reflector circuits carried by the operator.

FIG. 6 is a series of graphs showing some of the currents and voltages present in the operating system.

Referring now to FIG. 1, the system includes a power transceiver **10** which may be controlled for its operation by a capacity switch **11** controlled by a door knob **12**. The capacity switch circuit is not necessary but it is convenient for the operation of the system since it saves power and insures that the door will not be opened until the operator is in a position to operate the door. The receiver portion of the power transceiver operates a door lock **15** only when a portable reflector circuit **14** is brought within an operating distance of the transceiver circuit **10**.

The capacity switch circuit is shown in detail in FIG. 2 and includes a vacuum tube **15** with its cathode and control electrode connected to a resonant concentric line **16**. The anode-cathode circuit of triode **15** includes a relay having a winding **17** and a pair of contacts **18**, and a source of potential **20**. Because of the resonant circuit **16**, there is sufficient feed-back to produce oscillation at a high frequency. Under the conditions of oscillation, the current through the anode circuit is reduced and contacts **18** remain in their open condition. Now, if a large conductor such as the human body is connected to the outer end of the concentric line (door knob **21**) the resonant feed-back is altered and the circuit will stop oscillating, thereby increasing the current through the relay winding and closing contacts **18** to apply the potential of source **20** to the output terminal **22**. This circuit may be replaced by many other types of circuits such as, a push button, a lever, or any other type of circuit arrangement which can be employed to close a pair of contacts in the permanent installation and thereby activate other parts of the circuit.

The door lock circuit is shown in FIG. 3 and includes an input terminal **23**, a rectifying means **24**, and some form of an amplifier element **25** which may be either a transistor or a vacuum tube. The output circuit of the transistor **25** includes a power supply terminal **26** and a resonant circuit **27**. The resonant circuit may be connected in a number of ways, the one shown in FIG. 3 includes a capacitor **28** and an inductive winding **29** which may be the primary winding of a transformer **30** having a secondary winding **31** which is connected directly to a solenoid **32** which operates the door bolt **33**. When modulated radio waves are received by this circuit the rectifier element **24** rectifies them and the capacitor **34** removes the radio frequency components. Transistor amplifier **25** amplifies the resultant current pulses and applies them to the resonant circuit **27**. If the modulation frequency corresponds to the resonant frequency of circuit **27**, power is transmitted through transformer **30** to operate the solenoid **32** and withdraw the bolt to open the door. Terminal **26** is connected to terminal **22** for receiving power from source **20**.

The transceiver circuit is shown in FIG. 4 and includes a free running multivibrator circuit **35** having transistors **36** and **37** arranged with the usual circuit components and receiving direct current power from terminal **38** which is connected to terminal **22** of the capacity switch circuit. The multivibrator circuit is well known in the art and has been described in prior publications. When this circuit oscillates, the potentials on the transistor collectors are sequentially raised and lowered at the frequency of the multivibrator operating frequency. It should be noted that while the potential is always high

on one of the supply conductors 40 or 41, it is never high on both of them at the same time. This switching of operating potentials is illustrated in FIG. 6 where the square-topped waves 42 are applied to conductor 40 and square topped waves 43 are applied to conductor 41.

Conductor 40 is connected to the collector electrodes of both transistors 44 and 45, each arranged for oscillation at a high radio frequency. Radio frequency chokes 46 and 47 are connected in series with these supply conductors to block the generated radio frequencies from mixing with the multivibrator circuit pulses. A resonant circuit, including a capacitor 48 and an inductor 50, is connected between the base and emitter of transistor 44, thereby providing a feed-back circuit (with capacitor 48A) which produces oscillation at a first radio frequency. The waves generated by this circuit and broadcast into space are shown in FIG. 6 as waves 51. The second oscillating circuit, containing transistor 45, is similar to the first circuit except that its resonant circuit, including capacitor 52 and inductor 53, is tuned to a second radio frequency. The result is two radio frequency waves broadcast for the duration of each of the waves 42. The wave forms from the second oscillator are not shown in FIG. 6 since they are substantial duplicates of forms 51.

The reflector circuit 14 is shown in detail in FIG. 5. It includes two loop antennas 54 and 55, each wound on a ferrite core and each coupled to a piezoelectric crystal 56 and 57. Other forms of antennas can be used such as folded dipoles. One of the antennas and its crystal is tuned to the first radio frequency and the other antenna is tuned to the second frequency. Each of the antennas absorbs power from the broadcast waves, but because of the high Q of the crystal, the oscillating current (and the mechanical vibrations of the crystal) build up slowly after the start of the train of waves and, for the same reason, decay slowly after the end of the wave train. This action is illustrated by wave trains 58 in FIG. 6. Each antenna produces a similar set of wave trains, only one of which is shown in the graph.

Because of the high Q of the crystals 56 and 57, the antennas "ring" or continue to oscillate after the end of wave trains 51. During this time the oscillators are cut off but a receiver circuit 60 is activated by one of the square topped waves 43 applied over conductor 41. The receiver circuit includes a transistor 61 and a tuned loop antenna having an inductor 62 and a capacitor 63, this circuit arranged for receiving both of the waves from antennas 54 and 55. The collector of transistor 61 is connected to terminal 64 which is connected to input terminal 23 of the door lock circuit. Since the frequencies of the waves from the two antennas differ, the sum of the received currents produces a variable power train, the frequency of the power variations being equal to the difference between the first and second broadcast frequencies. This series of wave trains is shown at 65 in FIG. 6.

The door lock amplifier circuit (FIG. 3) is a part of the receiver circuit and includes a rectifier 24 and a filtering capacitor 34. These elements rectify the wave trains 65 and eliminate the radio frequency components, thereby producing a series of pulses 66 (see FIG. 6) having a frequency equal to the differences in frequency of the two broadcast waves. This series of pulses is applied to the resonant circuit 28, 29, in the collector circuit of transistor 25 (FIG. 3) which is adjusted for resonance at the pulse frequency and the solenoid 32 is activated to withdraw bolt 33.

From the above description it will be evident that the door lock can be opened only by the application of two radio waves, each having a frequency which can be received by resonant circuit 62, 63, and having a difference frequency which causes resonance in circuit 28, 29. Such a lock cannot be opened by an adjustable portable signal generator. Access is possible only when the reflector 14 is available or when two frequencies are known.

Having thus fully described the invention, what is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A radio control system for operating a distant electromechanical transducer comprising a power transceiver circuit including; a first transmitter circuit for generating and broadcasting alternating current power at a first frequency and a second transmitter circuit for generating and broadcasting alternating current power at a second frequency; a portable double reflector in close proximity to said transmitter circuits for receiving said power during a broadcast time interval and for re-radiating a portion of the power after the end of the time interval; a radio receiver in said transceiver for receiving said re-radiated power after the end of the time interval; said radio receiver including a first broadly tuned circuit for receiving both the first and second of said frequencies from the double reflector, an amplifying means, a rectifier connected to the broadly tuned circuit for rectifying the received waves, a second tuned circuit connected to the rectifier responsive to current pulses having a frequency equal to the difference between said first and second frequencies, and a coupling means connected to the rectifier for applying said current pulses to said transducer; a source of operating power; switching means for alternately switching said source of operating power to said transmitter circuits during the broadcast time intervals and for switching said power source to the radio receiver at the end of each of said time intervals and means for initiating operation of said switching means at essentially the same time as said double reflector is brought in close proximity to said transmitter circuit.

2. A radio control system as claimed in claim 1 wherein said transceiver circuit is connected to said power source by means of a pair of relay contacts.

3. A radio control system as claimed in claim 1 wherein said transceiver circuit is connected to said power source by means of a capacity switch circuit which includes a resonant line, an amplifier component, and a relay, said resonant line, amplifier component, and relay being connected in series.

4. A radio control system as claimed in claim 1 wherein both of said transmitter circuits include a resonant circuit for determining the operating frequency, said resonant circuits each including an inductor and a capacitor.

5. A radio control system as claimed in claim 1 wherein said portable double reflector includes two passive antennas, each tuned to receive the waves broadcast from one of said transmitter circuits.

6. A radio control system as claimed in claim 5 wherein said antennas each include a piezoelectric coupling component.

7. A radio control system as claimed in claim 1 wherein said switching means includes a free-running multivibrator circuit.

8. A radio control system as claimed in claim 7 wherein said multivibrator circuit includes two transistors with the collector electrode of each connected respectively to a conductor which supplies operating power to the receiving circuit and to the transmitter circuits.

References Cited by the Examiner

UNITED STATES PATENTS

2,812,427 11/57 Magondeaux ------ 343—225 XR

NEIL C. READ, *Primary Examiner.*