Aug. 4, 1970 W. S. REYNOLDS 3,522,536

REMOTE CONTROL SYSTEM WITH PLURAL MODULATION

Filed Nov. 24, 1967

3 Sheets-Sheet 1

Fig. 1

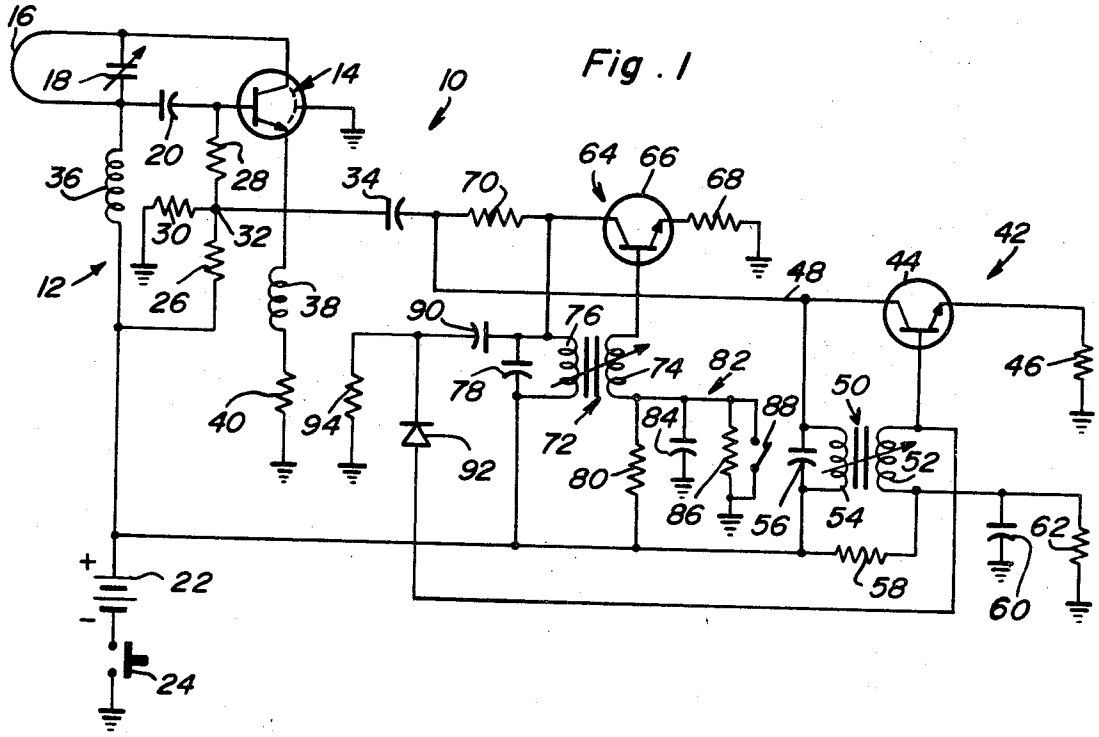
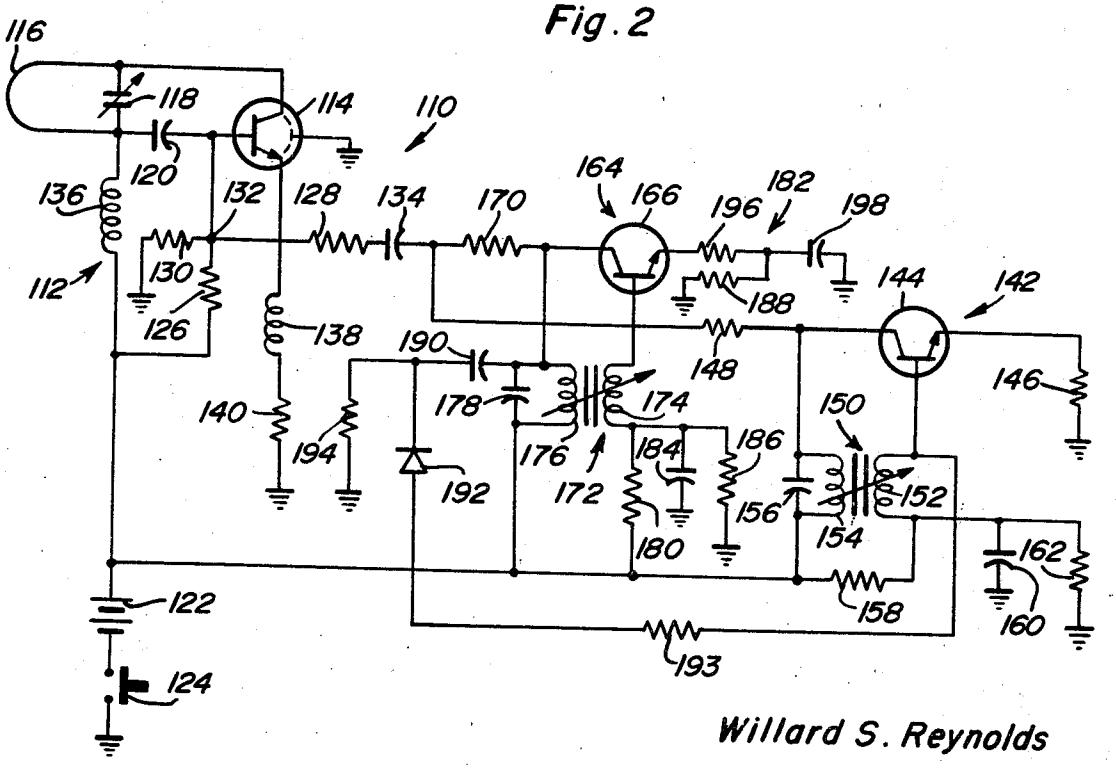


Fig. 2



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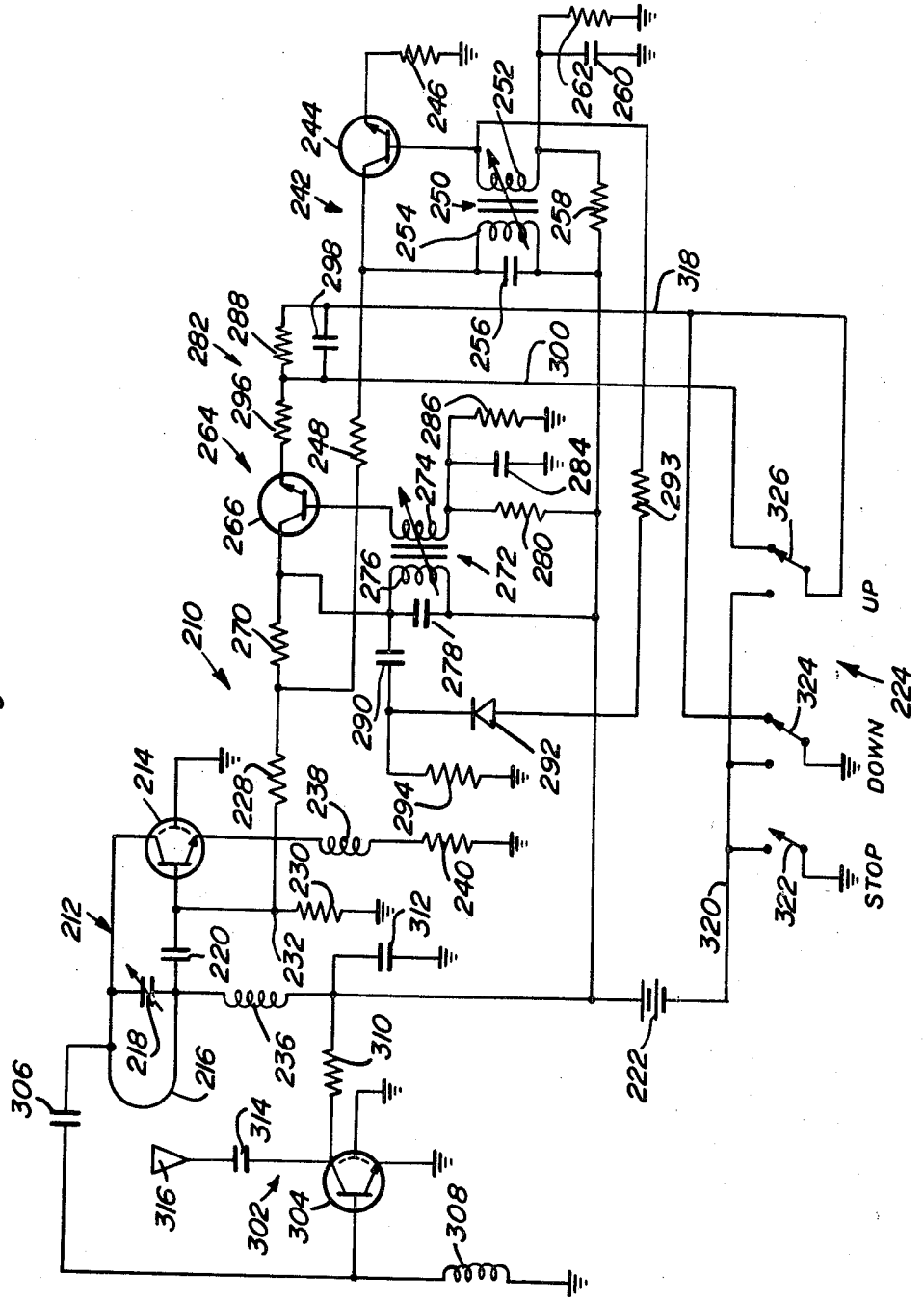
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Fig. 3



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REMOTE CONTROL SYSTEM WITH PLURAL MODULATION

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Fig. 6

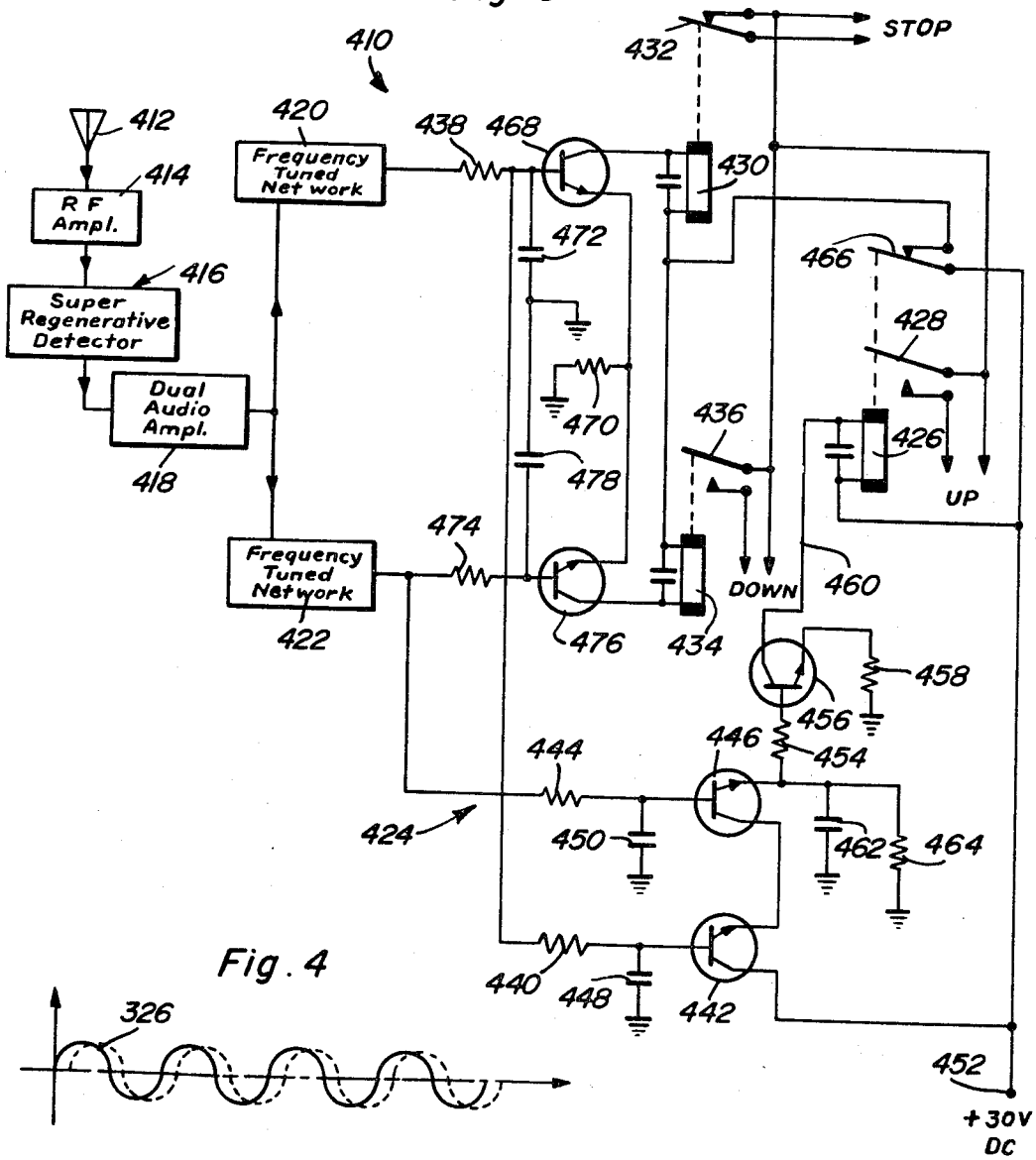
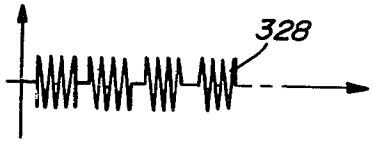


Fig. 4

Fig. 5



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REMOTE CONTROL SYSTEM WITH PLURAL MODULATION

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U.S. Cl. 325—37 18 Claims

ABSTRACT OF THE DISCLOSURE

A remote control system in which an RF oscillator transmits a carrier frequency output sequentially modulated by two different audio frequency tones derived from two audio oscillators energized simultaneously with the RF oscillator. An oscillating output from one of the audio oscillators applies a reverse bias to the transistor associated with the other audio oscillator to prevent simultaneous operation. One of the audio oscillators has a time controlled operational period in order to obtain sequential modulation at the two different audio frequencies.

This invention relates to a remote radio control system for controlling power-operated devices such as commercial doors.

One of the important considerations in providing a remote radio control system is to prevent unauthorized or unintentional operation of the control mechanism. To provide such safeguards however, usually involves expensive modification of both the transmitter and receiver components associated with the remote control system.

A further consideration in controlling power-operated mechanism from some remote location by radio signals is to accommodate several different operational controls. In connection with commercial doors, for example, it is necessary to reverse and stop operation of power-operated motors for correspondingly moving or stopping movement of the door. Accordingly, both the transmitter and receiver components of the remote control system must have such multifunction capabilities.

It is therefore an important object of the present invention to provide a remote control system in which the transmitter component avoids expensive complexities but is nevertheless capable of performing multifunctions and produce a coded output keyed to the receiver component. Similarly, the receiver component must have the multifunction capability and respond exclusively to the coded output of the transmitter component.

In accordance with the present invention, the transmitter component features a solid state, radio frequency oscillator immediately triggered into operation upon closing of a switch to supply DC operating voltage for establishing a suitable base bias for the transistor associated with the radio frequency oscillator. Bias voltage is also simultaneously applied from the voltage source to the transistors associated with a pair of audio oscillators connected in parallel to the radio frequency oscillator for modulating the carrier frequency output thereof. A timing circuit is associated with one of the audio oscillators for

either delaying operation thereof or limiting its operation to a relatively short period. Thus, during the non-operating period of the audio oscillator controlled by the timing circuit, the other audio oscillator is operative to modulate the output of the radio frequency oscillator at one audio frequency. When the time controlled oscillator begins to operate, at another audio frequency, a reverse bias is applied to the other audio oscillator in order to prevent simultaneous operation of both oscillators. Accordingly, the output of the radio frequency oscillator is sequentially modulated at two different audio frequencies. The carrier frequency of the radio frequency oscillator, the timed operational period of one of the audio oscillators and the respective audio frequencies of the audio oscillators therefore provide a large number of code factor combinations that may be utilized to insure privacy of the radio control system.

In one form of the invention, switch means are provided to change the operational mode of the transmitter. Three operational modes are thus possible consisting of sequential modulation of the carrier frequency output at the two audio frequencies, exclusive modulation of the carrier frequency output by one of the audio frequencies and exclusive modulation of the carrier frequency output by the other of the audio frequencies. The transmitter component is therefore arranged to recognize not only the code factors or the values of the carrier and audio frequencies associated with the transmitter component but also is capable of distinguishing between the three different operational modes in order to perform diverse functions such as effecting upward movement, downward movement or stopping movement of a commercial door.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is an electrical circuit diagram illustrating one form of transmitter in accordance with the present invention.

FIG. 2 is an electrical circuit diagram illustrating another form of transmitter.

FIG. 3 is an electrical circuit diagram illustrating a third form of transmitter.

FIGS. 4 and 5 are graphical illustrations showing the signal wave forms associated with the two audio frequency modulating signals.

FIG. 6 is an electrical circuit diagram illustrating the receiver component associated with the transmitter illustrated in FIG. 3.

Referring now to the drawings in detail, FIG. 1 illustrates one form of transmitter component generally referred to by reference numeral **10**. Signal energy is radiated from the transmitter component by means of a radio frequency oscillator **12** having a transistor **14** of the NPN type. The collector of transistor **14** is connected to an oscillating output circuit having an inductive loop **16** connected in parallel with a tuning capacitor **18** by means of which the output circuit is adjusted to oscillate at a selected carrier frequency within the radio

frequency range. The output circuit is connected by means of the feedback capacitor **20** to the base of transistor **14** in order to introduce into the base of sufficient voltage of proper phase so that the AC component of the collector current will persist for sustained oscillation of the output circuit at the carrier frequency. Toward this end, proper base bias is derived from a DC source of voltage such as battery **22** upon closing of the switch **24** grounding the negative terminal of the battery. The positive terminal of the battery is connected through resistors **26** and **28** to the base of transistor **14** while a leakage resistor **30** is connected between ground and the input juncture **32** between the resistors **26** and **28** in order to maintain the proper base bias. As will be hereafter explained, modulating signal voltage may also be applied to the base of transistor **14** through the signal coupling capacitor **34** connected to the input juncture **32**. Also in order to establish proper bias for the output circuit, the inductive loop **16** is connected to the DC voltage source **22** through a choke coil **36** which prevents AC current from being conducted through the voltage source and the base of the transistor. Emitter bias for the transistor **14** is established by means of the emitter resistor **40** connected between ground and the emitter through the choke coil **38** preventing any AC components from being conducted through ground to the voltage source.

One of the modulating signals applied to the radio frequency oscillator through coupling capacitor **34**, is derived from the audio oscillator **42** which includes an NPN type of transistor **44**. An emitter resistor **46** is connected between ground and the emitter of transistor **44** while the output collector of the transistor is connected by the output line **48** to the signal coupling capacitor **34** for supplying a modulating signal at a predetermined audio frequency. The base and collector of the transistor **44** are inductively coupled by the coupling transformer **50** having a primary winding **52** and a secondary winding **54** respectively connected to the base and collector of the transistor **44**. The transformer **50** is tuned for sustained oscillation of collector current at the predetermined audio frequency. Collector bias is established by connection of the secondary winding **54** in parallel with capacitor **56** to the positive output terminal of the DC voltage source **22**. Base bias on the other hand is established through the primary winding **52** connected in series with the bias resistor **58** to the output voltage terminal of battery **22**. In order to prevent any AC components from being conducted through the battery **22**, the primary winding **52** is connected to the grounded by-pass capacitor **60** and grounded bleed resistor **62**. It will be apparent therefore, that upon closing of the switch **24**, operation of the audio oscillator **42** will begin immediately simultaneously with the radio frequency oscillator **12**.

The transmitter **10** includes a second audio oscillator **64** which is similar in circuit arrangement to the audio oscillator **42**. Thus, the audio oscillator **64** includes a transistor **66** of the NPN type having an emitter connected to the grounded emitter resistor **68** and an output collector connected to the coupling capacitor **34** through the resistor **70**. The base and collector of transistor **66** are coupled by the tuned transformer **72** having a primary winding **74** and a secondary winding **76**. The secondary winding **76** is connected in parallel with the capacitor **78** to the output voltage terminal of battery **22** while the base of transistor **66** is supplied with base bias from the voltage source through the bias resistor **80** in series with the primary winding **74** of the transformer. The primary winding **74** is furthermore connected to a timing circuit **82** which includes the grounded storage capacitor **84** having a relatively large capacitance value and a bleed resistor **86** connected in parallel with the capacitor to the primary winding. A tuning switch **88** is connected in shunt relation to the capictor **84** and resistor **86** in order to disable oscillator **64**. The capacitance of capacitor **84** and the resistance value of bleed resistor **86** therefore determine the charging period of the timing circuit during which operation of the audo oscillator **64** is delayed upon closing of the switch **24**. Thus, upon closing of the switch **24**, insufficient forward bias will be applied to the base of transistor **66** until such time as the capacitor **84** is charged to a value corresponding to the forward bias potential of the transistor **66** causing it to conduct. When conducting, the audio oscillator **64** will produce an oscillating output at the collector of transistor **66** of an audio frequency different from the audio frequency associated with the audio oscillator **42**.

When the audio oscillator **64** is operating, a negative voltage component is fed through the coupling capacitor **90** and diode rectifier **92** to the base of transistor **44** associated with the audio oscillator **42**. The capacitor **90** is also connected to the bleed resistor **94** in order to control discharge thereof. The negative voltage conducted through diode **92** applies a reverse bias to the base of transistor **44** producing cut-off. Thus, as soon as audio oscillator **64** begins to operate, audio oscillator **42** stops operating.

It will be apparent from the foregoing description, that upon closing of the switch **24** radio frequency oscillator **12** and audio frequency oscillator **42** will begin to simultaneously operate producing a carrier frequency output modulated at one audio frequency by the audio oscillator **42**. After a predetermined period determined by the capacitance of capacitor **84** and the resistance of resistor **86**, audio oscillator **64** begins to operate cutting off operation of the audio oscillator **42**. Thus, the carrier frequency output of the radio frequency oscillator **12** is sequentially modulated at two different audio frequencies, modulation at the initial audio frequency persisting for a relatively short period of time after which it is followed by modulation at the audio frequency of the oscillator **64** for as long as the switch **24** is held closed. The audio modulating frequency output of oscillator **64** may of course be adjusted through the transformer **72**. In order to adjust the audio frequency output of oscillator **42**, tuning switch **88** is closed in order to disable the audio oscillator **64** by grounding the base of transistor **66**. Thus, oscillator **42** will continue to operate without interruption so that its output frequency may be adjusted by tuning the transformer **72**.

FIG. 2 illustrates a transmitter **110** which is similar in circuit arrangement to the transmitter **10** previously described and is also somewhat similar in operation. The transmitter **110** thus includes a radio frequency oscillator **112** having a transistor **114** of the NPN type, an inductive loop **116** connected to the collector of the transistor, a tuning capacitor **118** connected in parallel with the inductive output loop **116**, a feedback capacitor **120** connecting the output circuit to the base of transistor **114**, a DC battery source of voltage **122** supplying DC voltage to the base of transistor **114** upon closing of the switch **124** through the resistor **126**. Base bias for transistor **114** is maintained by the leakage resistor **130** connected to the base through the input juncture **132** to which the modulating signals are applied through resistor **128** and coupling capacitor **134**. The radio frequency oscillator **112** also includes the choke coils **136** isolating the battery **122** from the AC components of the current conducted through the output circuit and the choke coil **138** between the emitter of transistor **114** and the emitter resistor **140**.

The transmitter **110** also includes an audio oscillator **142** having a transistor **144** of the NPN type, an emitter resistor **146**, a coupling resistor **148** connecting the collector of the transistor **144** to the coupling capacitor **134**, a coupling transformer **150** having a primary **152** and a secondary **154**, the secondary being connected in parallel with the capacitor **156** between the collector and the positive output terminal of the battery **122**, the output terminal of the battery being connected through the bias resistor **158** to the base in series with the primary **152**. Also, by-pass capacitor **160** and bleed resistor **162** are connected to the primary **152**. Thus, oscillator **142** is

similar in arrangement and operation to the oscillator 42 associated with transmitter 110. However, unlike the operation of the transmitter 10, oscillator 142 of transmitter 110 is not initially operative simultaneously with the radio frequency oscillator 112 upon closing of the switch 124 as will be hereafter explained.

The other audio oscillator 164 associated with transmitter 110 includes the transistor 166 having an output collector connected by the resistor 170 to the signal coupling capacitor 134 for modulating the carrier frequency output of the radio frequency oscillator 112. The base and collector of transistor 166 are coupled by the transformer 172 having a primary 174 connected to the base and a secondary 176 connected to the collector. The secondary is connected in parallel with capacitor 178 to the positive output voltage terminal of battery 122, the output terminal also being connected by the bias resistor 180 to the base through primary 174 to which the by-pass capacitor 184 and bleed resistor 186 are connected. When the oscillator 164 is operating, reverse bias is applied to the base of transistor 144 to prevent operation of oscillator 142 and toward this end, the collector of transistor 166 is coupled by capacitor 190 and diode 192 to the base of transistor 144, a bleed resistor 194 being connected to the capacitor 190. Further, a timing circuit 182 is associated with oscillator 164 in the form of a grounded storage capacitor 198 connected through resistor 196 to the emitter of transistor 166. A bleed resistor 188 is also connected to the juncture between capacitor 198 and resistor 196. As soon as transistor 166 begins to conduct, the capacitor 198 is charged at a rate determined by its capacitance and the resistance of bleed resistor 188 so that when a predetermined charge is attained, a cut-off bias will be established at the emitter of transistor 166 to stop operation of the oscillator 164.

It will be apparent from the foregoing description of the transmitter 110 that upon closing of switch 124, radio frequency oscillator 112 and audio oscillator 164 begin to operate immediately in order to produce a carrier frequency output modulated by the output of the oscillator 164 at one predetermined audio frequency. At this time, operation of oscillator 142 is prevented by the reverse bias applied to the base of its transistor 144 through the diode 192. After a predetermined period established by the timing circuit 182, operation of oscillator 164 stops and the reverse bias applied to transistor 144 is removed. Oscillator 142 thus begins to operate in order to modulate the carrier frequency output of oscillator 112 at another audio frequency. The oscillator 164 remains inoperative until the capacitor 198 is discharged through the bleed resistor 188 in order to begin another operational cycle. Thus, the carrier frequency output of radio frequency oscillator 112 is alternately modulated at two different frequencies in a cyclic fashion.

FIG. 3 illustrates a transmitter 210 which has the same operational capability as the transmitter 110 but in addition thereto may produce a carrier frequency output exclusively modulated at either one of the two audio frequencies between which modulation alternates when the transmitter 210 operates in the same manner as hereinbefore described in connection with transmitter 110. Transmitter 210 includes a radio frequency oscillator 212 similar to the oscillator 112 both in arrangement and operation. The oscillator 212 is therefore provided with a transistor 214 of the NPN type having a collector connected to the inductive loop 218 through which oscillating current is conducted at a carrier frequency adjusted by the tuning capacitor 218. A feedback capacitor 220 connects the output loop 216 to the base of transistor 214 to which the leakage resistor 230 is connected at the input juncture 232 for maintaining proper base bias. A DC source of voltage in the form of battery 222 is connected to the output circuit through the choke coil 236 while choke coil 238 connects the emitter of transistor 214 to the emitter resistor 240. Modulating signals are applied to the input juncture 232 through resistor 228. Further, in the case of transmitter 210, the oscillating output current in the inductive loop 216 is fed through the coupling capacitor 306 to the base of transistor 304 in a radio frequency amplifier circuit 302. The choke coil 308 is connected to the base of transistor 304 to isolate the power supply from AC components. The emitter of transistor 304 is grounded while the collector is connected to the output terminal of the battery 222 through load resistor 310, the outpu terminal also being connected to a filter capacitor 312. Thus, the oscillating signal fed through signal coupling capacitor 306 from the inductive loop 216 is amplified at the collector of transistor 304 and the signal is fed through capacitor 314 to the transmitter antenna 316.

The audio oscillators 242 and 264 are similar in arrangement and operation to the oscillators 142 and 164 associated with the transmitter 110. Thus, the oscillator 242 includes a transistor 244 of the NPN type having an emitter connected to the emitter resistor 246, an output collector connected by resistor 248 to the coupling resistor 228 in parallel with the output from the oscillator 264. Coupling transformer 250 includes a primary 252 connected between the base of transistor 244 and the bias resistor 258 while the secondary 254 is connected in parallel with capacitor 256 between the collector and the output terminal of battery 222. By-pass capacitor 260 and bleed resistor 262 are also connected to the primary 252. Similarly, oscillator 264 includes the NPN type transistor 266 having an output collector connected by the resistor 270 to the coupling resistor 228 and a coupling transformer 272 having a primary 274 connected between the base of transistor 266 and the bias resistor 280 while secondary 276 is connected between the collector and the output terminal of battery 222 in parallel with capacitor 278. A by-pass capacitor 284 and bleed resistor 286 are connected to the primary 274 while the output collector is connected by the coupling capacitor 290, diode rectifier 292 and resistor 293 to the base of transistor 244 for applying reverse bias thereto when the oscillator 264 is operating. A bleed resistor 294 is also connected to the capacitor 290 similar to the arrangements hereinbefore described in connection with transmitters 10 and 110. The oscillator 264 is also provided with a timing circuit 282 capable of periodically timing the operational periods of the oscillator 264 for alternate modulation of the carrier frequency output at the two different audio frequencies corresponding to the oscillators 264 and 242 as hereinbefore described in connection with the transmitter 110.

The alternate, sequential modulation of the carrier frequency output of transmitter 210 occurs when the switch element 326 of the mode selecting switch assembly 224 is displaced from the non-operating position illustrated to the other operating position. In its non-operating position, the switch 326 shunts the storage capacitor 298 and bleed resistor 288 associated with the timing circuit 282. On the other hand, when the switch 326 is in its operating position, the capacitor 298 and bleed resistor 288 are connected to ground through the switch 324 in its illustrated position and are connected in series with the resistor 296 to the emitter of transistor 266. Thus, oscillator 264 will begin to operate immediately simultaneously with the radio frequency oscillator 212 since the switch 326 in its operating position will also ground the negative terminal of battery 222 through the switch 324. When capacitor 298 is charged to a cut-off potential value determined by its capacitance and the resistance of bleed resistor 288, operation of the oscillator 264 stops. Reverse bias applied to the base of transistor 244 through diode 292 is then also removed so that oscillator 242 may begin to operate until capacitor 298 is discharged sufficiently to begin another operational cycle.

Assuming the switches 324 and 326 are in the positions illustrated in FIG. 3, movement of the switch 322 of

the mode selector switch assembly 224, to its closed position grounds the negative terminal of battery 222. With the capacitor 298 and bleed resistor 288 shunted by switch 326, the emitter of transistor 266 is connected through resistor 296 and switch 324 to ground so that oscillator 264 immediately begins to operate simultaneously with the radio frequency oscillator 212 upon closing of the switch 322. The oscillator 264 remains operating since the timing circuit 282 is disabled by the switch 326. Accordingly, the carrier frequency output of the transmitter is exclusively modulated by the oscillator 264. On the other hand, when switch 324 is displaced from its non-operating position illustrated in FIG. 3 to its other operating position, ground is removed from the emitter of transistor 266 at the same time that ground is applied to the negative terminal of battery 222 through ground line 320. Thus, operation of oscillator 264 is prevented so that the carrier frequency output of oscillator 212 will be exclusively modulated by the oscillator 242. It will be apparent from the foregoing, that the switches of the mode selector switch assembly 224 will produce three modes of operation and that each operational mode may correspond to a different function labelled "up," "stop" and "down" in FIG. 3.

As shown in FIGS. 4 and 5, the modulating component of the signal transmitted by transformer 210 and derived from the audio oscillator 264 is depicted by wave form 326 while the audio signal component derived from oscillator 242 is depicted by wave form 328. These audio components of the signal as well as the carrier frequency of the transmitter 210 are recognized by the receiver component 410 illustrated in FIG. 6. As shown, the radiated signal is picked up by the antenna 412 and amplified in the radio frequency amplifier component 414 from which the signal is fed to a superregenerative type of detector component 416 tuned to the carrier frequency of the transmitter 210. The audio frequency components are fed from the detector component 416 to the dual audio amplifier component 418 from which these audio frequency signal components are fed to the frequency tuned networks 420 and 422. The network 420 for example will pass signal components in one narrow audio frequency band such as the signal component 326 while the other network 422 will pass signal components within a narrow audio frequency band including the frequency of the wave form 328. In this fashion, the receiver component 410 will respond only to the combination of carrier frequency and two audio modulating frequencies associated with the transmitter 210.

The frequency tuned networks 420 and 422 establish two audio frequency signal channels connected to a utilization circuit 424 through which the diverse functions are performed. Accordingly, there are three control devices associated with the utilization circuit performing these diverse functions consisting of the relay coil 426 performing an "up" function by closing of the relay switch 428 upon energization thereof, a relay coil 430 performing a "stop" function upon opening of the relay switch 432 when the relay coil is energized, and a relay coil 434 energized to close the relay switch 436 in order to perform a "down" function. The relay coil 426 is energized in response to alternate modulation of the carrier frequency signal by the two audio modulating signals whereas the relay coils 430 and 434 are respectively energized by exclusive modulation of the carrier frequency output by one of the audio modulating frequency signals. The audio frequency signals are operative in this fashion on the utilization circuit 424 through the signal channels established by the frequency tuned networks 420 and 422.

The network 420 is connected through resistors 438 and 440 to the base of transistor 442 while the frequency tuned network 422 is connected by the resistor 444 to the base of transistor 446. Grounded capacitors 448 and 450 are respectively connected to the bases of transistors 442 and 446 so as to delay switching of these transistors to the conductive states when signals are applied to the bases from the signal channels established by the frequency tuned networks 420 and 422. The transistors 422 and 446 are connected in series to each other and toward this end, the emitter of transistor 442 is connected to the collector of transistor 446. The collector of transistor 442 is connected to a suitable positive voltage source 452 while the emitter of transistor 446 is connected through coupling resistor 454 to the input base of transistor 456 having an emitter resistor 458 and an output collector connected by line 460 to one terminal of the relay coil 426, the other terminal of the relay coil being connected to the positive voltage source 452. Because of the rapidity with which the carrier frequency signal is alternately modulated at the two different audio frequencies, in one mode of operation of the transmitter 210, and in view of the capacitance of capacitor 448 relative to capacitor 450, transistor 442 will remain conductive after the signal applied to its base from the network 420 has ceased at the same time that the transistor 446 is switched on by a signal applied to its base from the network 422. Thus, while transistors 442 and 446 are simultaneously conductive, a current path is established from the voltage source 452 to the input of transistor 456 causing it to switch on. Since the base of transistor 456 is connected to the capacitor 462 and bleed resistor 464, it remains conductive for a sufficient length of time to energize relay coil 426 and close the relay switch 428 in order to perform the "up" function. At the same time that the relay switch 428 is closed, the normally closed relay switch 466 is opened so as to disconnect the voltage source 452 from the relay coils 430 and 434 thereby preventing energization of these relay coils.

On the other hand, receipt of a carrier frequency signal modulated exclusively by one of the audio modulating signals, will produce a signal in only one of the channels associated with the networks 420 and 422. For example, the existence of only a signal from the network 420 will apply forward bias to transistor 468 having an output collector connected to the relay coil 430 and an emitter connected to the emitter resistor 470. Storage capacitor 472 connected to the base of transistor 468 delays switching on of the transistor 468 for a period sufficient to permit prior energization of relay coil 426 if there is any alternate modulation of the carrier frequency signal. Similarly, an exclusive audio modulating signal will be fed from the network 422 through resistor 474 to the base of transistor 476 causing it to switch on after a delay determined by capacitor 478 in order to energize the relay coil 434. Thus, the utilization circuit 424 will respond to the different operational modes of the transmitter 210 in order to perform the diverse functions by exclusive energization of either relay coil 426, relay coil 430 or relay coil 34.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact constructon and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In a transmitter having a radio frequency oscillator, means for modulating the output of the radio frequency oscillator comprising a pair of audio oscillators connected in parallel to said radio frequency oscillator having different output frequencies, a source of voltage, each of said audio oscillators including a current conducting device having a control electrode and an output electrode operatively coupled to the radio frequency oscillator, switch means for simultaneously connecting

the source of voltage to the control electrodes of the current conducting devices to energize the audio oscillators, cut-off means coupling the output electrode of one of the audio oscillators to the control electrode of the other of the audio oscillators for preventing operation of said other of the audio oscillators when said one of the audio oscillators is operating and timing means connected to one of the current conducting devices for temporarily preventing operation of the audio oscillator associated therewith.

2. The combination of claim 1 wherein said cut-off means comprises a coupling capacitor connected to the output electrode of the current conducting device associated with said one of the audio oscillators and a diode connecting the coupling capacitor to the control electrode of the current conducting device associated with the other of the audio osillators.

3. The combination of claim 2 wherein each of said audio oscillators further includes inductive coupling means interconnecting the control and output electrodes, said source of voltage being connected by the switch means to the control electrode through the inductive coupling means.

4. The combination of claim 3 wherein each of said current conducting devices comprises a transistor having a base constituting said control electrode, a collector constituting said output electrode and an emitter.

5. The combination of claim 4 wherein said timing means includes a storage capacitor connected to the emitter of one of the transistors.

6. The combination of claim 5 including additional switch means for selectively rendering either one or the other of the audio oscillators operative to the exclusion of the other of the audio oscillators.

7. The combination of claim 1 wherein each of said audio oscillators further includes inductive coupling means interconnecting the control and output electrodes, said source of voltage being connected by the switch means to the control electrode through the inductive coupling means.

8. The combination of claim 7 wherein said timing means comprises a capacitive delay circuit connected to the control electrode of the current conducting device associated with said one of the audio oscillators for delaying conduction therethrough in response to closing of the switch means.

9. The combination of claim 8 wherein said cut-off means comprises a coupling capacitor connected to the output electrode of the current conducting device associated with said one of the audio oscillators and a diode connecting the coupling capacitor to the control electrode of the current conducting device associated with the other of the audio oscillators.

10. A transmitter comprising a radio frequency oscillator having an output element and an input element, a pair of audio frequency oscillators connected to the input element for modulation of the carrier frequency output of the radio frequency oscillator at two audio frequencies, a source of voltage, cut-off means interconnecting said audio frequency oscillators for preventing simultaneous operation of both audio frequency oscillators, timing means rendered operative for cyclically limiting operation of one of the audio frequency oscillators to predetermined intervals, and switch means connecting said source of voltage to all of the oscillators for simultaneous operation of the radio frequency oscillator and one or the other of the audio frequency oscillators.

11. The combination of claim 10 wherein said switch means includes a first switch device for energizing both of the audio frequency oscillators, a second switch device connected to said timing means for disabling said one of the audio frequency oscillators, and a third switch device connected to the second switch device for rendering the timing means operative, whereby said carrier frequency output is modulated only at one of the two audio frequencies or sequentially modulated at said two audio frequencies.

12. In combination with the transmitter defined in claim 11, a receiver having detector means tuned to said carrier frequency, a pair of audio frequency responsive networks for establishing two signal frequency channels, and utilization circuit means connected to said channels having three control devices respectively actuated by signals transmitted through one of said channels at one of the two audio frequencies and sequentially through both of said channels at the two audio frequencies.

13. The combination of claim 12 wherein said utilization circuit means includes a pair of series-connected switching devices connected to one of the control devices, means independently connecting said signal channels to the switching devices for sequentially controlling the switching devices, delay means responsive to a signal at one audio frequency in one of the channels followed by a signal in the other channel at the other audio frequency for establishing a current path through both of the switching devices to energize said one of the control devices, means responsive to energization of said one of the control devices for preventing energization of the other of the control devices, and means connecting said signal channels to the other of the control devices for energization thereof in delayed response to signals in one of the channels at one of the two audio frequencies.

14. In combination with a transmitter radiating signals at a carrier frequency modulated at two different audio frequencies, a receiver comprising detector means tuned to said carrier frequency, a pair of audio frequency responsive networks for establishing two signal frequency channels, and utilization circuit means connected to said channels having three control devices respectively actuated by signals transmitted through one of said channels at one of the two audio frequencies and sequentially through both of said channels at the two audio frequencies.

15. The combination of claim 14 wherein said utilization circuit means includes a pair of series-connected switching devices connected to one of the control devices, means independently connecting said signal channels to the switching devices for sequentially controlling the switching devices, delay means responsive to a signal at one audio frequency in one of the channels followed by a signal in the other channel at the other audio frequency for establishing a current path through both of the switching devices to energize said one of the control devices, means responsive to energization of said one of the control devices for preventing energization of the other of the control devices, and means connecting said signal channels to the other of the control devices for energization thereof in delayed response to signals in one of the channels at one of the two audio frequencies.

16. In a transmitter, an RF oscillator including a transistor having a base and a collector, an oscillating output circuit connected to said collector, a feedback capacitor coupling said output circuit to the base, a source of DC voltage connected to the base, a leakage resistor connected to the base for establishing base bias sustaining oscillations in the output circuit at a carrier frequency, a pair of audio oscillators connected to the base for modulating the carrier frequency oscillations, each of said audio oscillators including a transistor having base, collector and emitter elements, an inductive circuit coupling the base and collector elements having primary and secondary windings respectively connected to the base and collector elements, and bias means connecting the source of voltage to the base element through the primary winding for sustaining oscillations in the inductive circuit at audio frequencies, unidirectional coupling means connecting the collector element of one of the audio oscillators to the base element of the other of the audio oscillators for applying a reverse bias thereto, and timing means

connected to said one of the audio oscillators for controlling operation thereof.

17. The combination of claim **16** wherein said timing means comprises a storage capacitor connected to the primary winding for delaying establishment of a forward bias on the base element.

18. The combination of claim **16** wherein said timing means comprises a storage capacitor connected to the emitter element for cyclically limiting conduction through the transistor to predetermined operational periods of the audio oscillator.

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