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FREQUENCY RESPONSIVE ANTICOINCIDENT REMOTE CONTROL SYSTEM

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Fig. 1

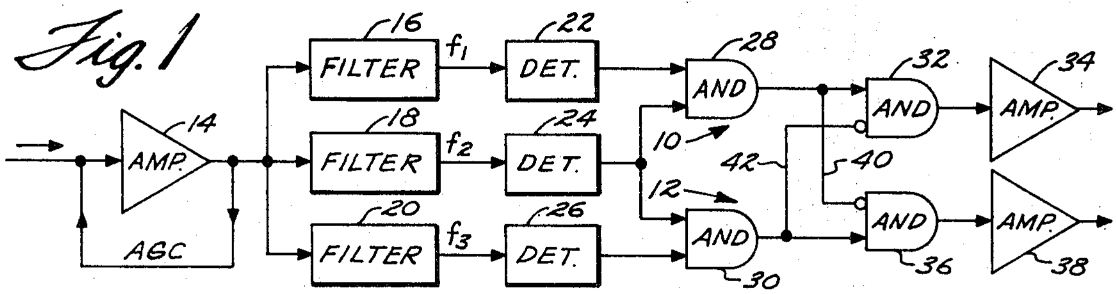
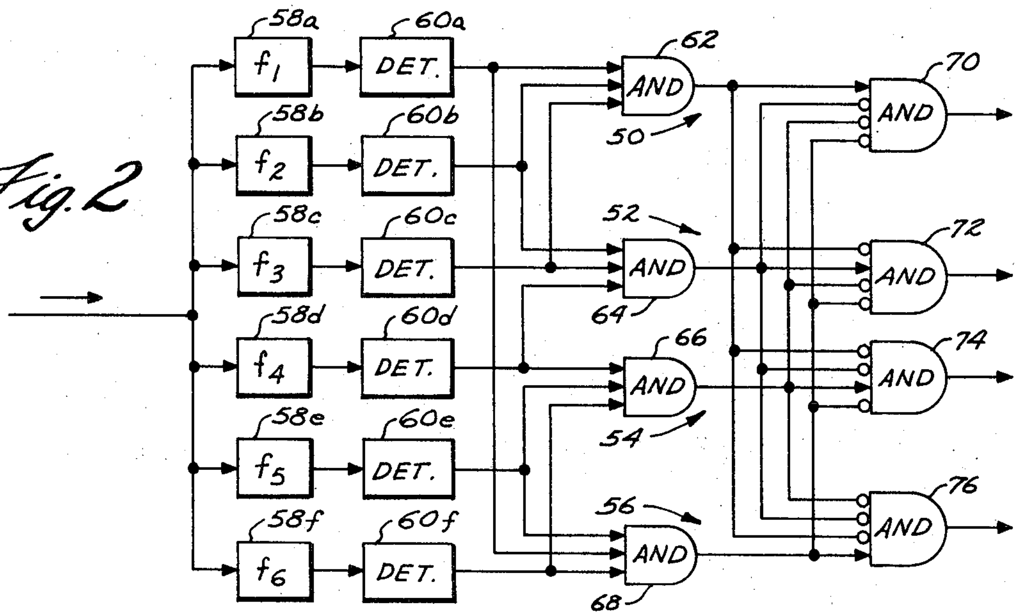


Fig. 2



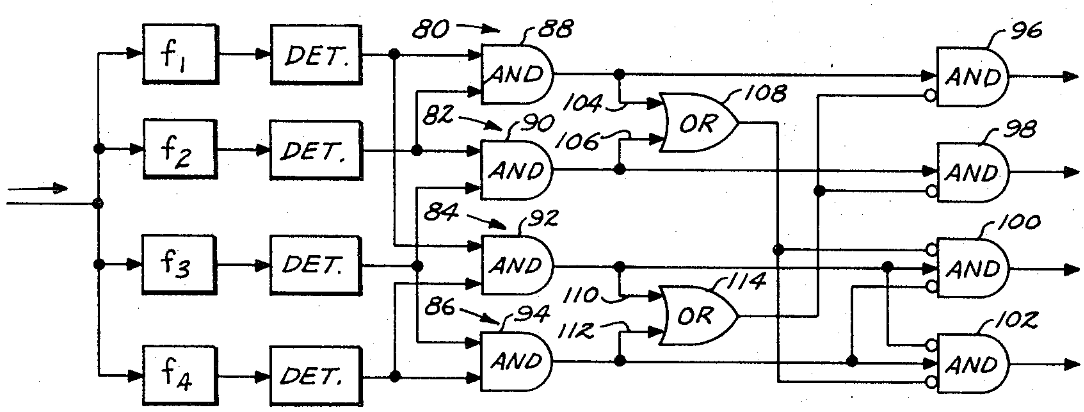


Fig. 3

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FREQUENCY RESPONSIVE ANTICOINCIDENT REMOTE CONTROL SYSTEM

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ABSTRACT OF THE DISCLOSURE

A specific example of the remote control system is one which has two control channels, each channel being responsive to a particular input frequency pair to effect an output control signal from that channel. An interlock arrangement is provided between the channels. If both channels attempt to generate an output control signal simultaneously, the interlock of each channel prevents the other channel from becoming actuated, and no output control signal can be derived from the system until this condition terminates.

BACKGROUND OF THE INVENTION

The present invention relates to a system for controlling remote apparatus by the receipt and detection of multi-frequency signals.

It is a common practice to use multi-frequency signals, such as frequency pairs, to control the remote operation of various equipment, as desired. In such situations the control system at the remote station is made selectively responsive to the frequency pairs to produce the desired remote function. For satisfactory operation this remote system must provide a high degree of discrimination against spurious signals such as noise or abnormal transmission.

While the use of multi-frequency signals in itself lends some security, it has sometimes been the practice to provide additional circuitry to guard against false operation due to spurious signals. In its simplest form, where there is a single control channel responsive to the receipt and detection of two frequencies, a third frequency detector is used which blocks the control channel in response to spurious signals containing all three frequencies. This design is shown in U.S. Pat. No. 2,513,342. In a multi-channel system, there has been proposed a detection system which requires a timed and sequential arrival of two frequencies to provide an output from any one channel. This approach is taught by U.S. Pat. No. 3,057,964.

There are other techniques available but none so far have been directed to providing an effective interlock against the energization of a plurality of channels in a multi-channel control system. More particularly, in a multi-channel control system, when a plurality of frequency pairs cause control signals to attempt to emanate from more than the desired number of channels, none of the prior art techniques presents an effective way to prevent such control signals from emanating from any channel in the system.

SUMMARY OF THE INVENTION

The present invention provides an improved remote control system which is responsive to the receipt and detection of multi-frequency signals. The system contains a plurality of channels, each of which is capable of providing an output control signal in response to a particular multi-frequency signal. An interlock is provided between the channels so that all channels are prevented from providing output control signals when more than

a predetermined number of channels are actuated in response to multi-frequency signals.

A significant advantage of the present invention is the marked improvement in security in a remote control system. In the event that spurious signals are received and processed and attempt to activate more than one channel, the interlock functions to prevent any channel from operating. The present invention also guards against transmission errors originating at the control station. If more than one signal is transmitted and is subsequently received and processed, the interlock will again prevent any channel from operating. The equipment being controlled remains unaffected. This technique avoids improper operation caused by what might be a false signal. Similarly, if a true input signal arrives simultaneously with a false signal, the interlock will again block all channels. Once again the equipment being controlled will await the receipt and processing of a true signal unaccompanied by such a false signal.

In some multi-channel remote control systems, there is a need for simultaneous outputs from certain channels as where compatible control functions need to be effected. However, control signals from other channels would at this time be undesirable. The advantages afforded by this invention apply equally as well to this type of remote control arrangement. The interlock is designed to permit simultaneous outputs from those channels where such outputs are desired; however, if any other channel attempts to provide an output in response to incoming signals, then all channels are blocked by the action of the interlock.

Accordingly, an object of the present invention is to provide an improved multi-channel remote control system which is responsive to multi-frequency signals.

Another object of the present invention is to provide such a system having improved interlocking means between the channels of said system.

A further object of the invention is to provide such a system having an improved interlocking means between the channels of said system for effectively preventing outputs from all said channels when more than a predetermined number of channels attempt to respond to the incoming multi-frequency signals.

Still another object of the present invention is to provide such a system having improved interlocking means between the channels of said system for effectively preventing outputs from all channels when simultaneous input signals are present but which thereafter permits a true input signal to activate the responsive control channel.

Other objects and advantages of the present invention will become apparent from a reading of the following specification in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an embodiment of the invention in block diagram form showing a two-channel system including interlocking means; and

FIGS. 2 and 3 are additional embodiments of the present invention, also in block diagram form, showing additional control system arrangements including their interlocking means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 there is shown a remote control system for receiving multi-frequency input control signals and having two output control channels indicated generally by the arrows **10** and **12**. The input signals to the remote control system, which can be applied by any preferred means such as a wire or radio link, are received at amplifier **14**. AGC feedback can be provided at amplifier **14** to put its output at a substantially constant level. Connected to the output of the amplifier **14** are three filters **16**, **18** and **20**, each of which is designed to selectively pass one frequency in the incoming signal. The output of these three filters are connected respectively to detectors **22**, **24** and **26**. The output of each of these detectors is a DC level. If desired, voltage doublers or amplifiers (not shown) can be connected to the output of the detectors to increase the DC level.

Each of the channels **10** and **12** has at its input a coincidence or AND gate **28** and **30**, respectively. In channel **10**, the two inputs to AND gate **28** are connected from the outputs of detectors **22** and **24**. The output of AND gate **28** is connected to one input of another AND gate **32**, and the output of this latter AND gate is connected to amplifier **34**. The output control signal for channel **10** is taken from the output of amplifier **34**.

In channel **12**, the inputs to AND gate **30** are taken from the output of detectors **24** and **26**. The output of AND gate **30** is applied to one input of AND gate **36**, and the output of this latter AND gate is applied to amplifier **38**. The output control signal from control channel **12** is taken at the output of amplifier **38**.

An interlock is provided between channels **10** and **12**. This is accomplished by connecting the output of AND gate **28** in channel **10** via line **40** to the inhibit input of AND gate **36** in channel **12**. Likewise, the output of AND gate **30** in channel **12** is applied as an inhibit input via line **42** to AND gate **32** in channel **10**.

In the operation of FIG. 1, control channel **10** is designed to provide an output control signal from amplifier **34** when the control system receives and processes an input control signal containing frequencies *f1* and *f2*. Similarly, control channel **12** is designed to be responsive to the receipt of input signals containing frequencies *f2* and *f3* in order to provide an output control signal from amplifier **38**. Assuming that a control function is desired to be effected by channel **10**, an input control signal is generated remotely by means not shown and applied to the system of FIG. 1. This signal contains the frequencies *f1* and *f2*. These signals are amplified at **10** and applied to all three filter circuits **16**, **18**, and **20**. However, only the filter circuits **16** and **18** respond, respectively, to the frequencies *f1* and *f2*; and accordingly, these frequencies are applied to detectors **22** and **24**. The outputs from these two detectors are applied to AND gate **28** to open this gate, and the output of this gate is now applied to the input of AND gate **32**. Because the output of AND gate **30** in channel **12** is unchanged, AND gate **32** is enabled and a signal will pass to amplifier **34** and from this amplifier to effect the desired control function.

Thus, in response to the application of a control signal containing frequencies *f1* and *f2*, only channel **10** will respond to provide the desired output control signal. Note that with AND gate **28** open, an inhibit input is applied via line **40** to AND gate **36**. This inhibits the operation of AND gate **36**, and thereby channel **12**, in the event that AND gate **30** should open while control channel **10** is actuated.

Assume now that a spurious signal containing the frequency *f3* appears at the input to the remote control system. This signal is amplified in amplifier **14** and frequency *f3* passes through filter *f3* to detector **26**. The output of detector **26** is applied to AND gate **30**. Because the output of detector **24** is now at a DC level, AND gate **30** is enabled and applies an output to AND gate **36**. However, with an inhibit signal present at the inhibit input of this AND gate, the output from AND gate **30** is prevented from passing through AND gate **36**. Thus, no output control signal is derived from channel **12**. Furthermore, with AND gate **30** now open an inhibit signal is applied via line **42** to the inhibit input of AND gate **32**. Gate **32** will close and no further signals can pass at this time. The output control signal at amplifier **34** will terminate. Thus, the interlock feature is effective to block outputs from both of the channels **10** and **12**.

Assuming next that neither channel **10** or **12** is actuated, and that input signals containing all three frequencies *f1*, *f2*, and *f3* are simultaneously applied to amplifier **14**. This type of signal can be the result of noise, faulty operation of the transmission equipment, or caused by other reasons. In any event, the filter circuits each pass their frequency causing each of the three detectors to generate a DC output level. The result is that both of the AND gates **28** and **30** are opened, and apply a signal to AND gates **32** and **36**, respectively. However, the output of AND gate **28** in channel **10** inhibits AND gate **36** in channel **12** while AND gate **30** in that channel simultaneously inhibits AND gate **32** in channel **10**. The result is that this interlock successfully blocks any output from the remote control system.

The blocking of all channels by the interlock when more than one channel attempts to actuate, prevents the system from responding to what might be a false signal. Once the false signal terminates, the system is then again in condition to respond to a true signal, when it is applied. If desired, a delay circuit can be imposed in each channel after the AND gates **32** and **36** to provide a slight delay to prevent actuation of any channel by short-term signals.

The system of FIG. 1 has found particular utility with pre-pay, coin-operated telephones. In such telephones the coins are deposited at the beginning of the call but are not collected at that time. Once the call is completed, the operator back at the central office sends a signal on the telephone line to collect the coins. Assuming this signal contains the frequencies *f1* and *f2*, channel **10** responds to this multi-frequency signal to provide an output control signal to collect the coins. Alternatively, if the call is not completed, the operator can transmit a control signal containing the frequencies *f2* and *f3*. In this case, channel **12** responds to this multi-frequency signal and provides an output control signal which will actuate the coin-return mechanism. The interlocking arrangement effectively guards against the inadvertent or improper collection or return of the coins.

In FIG. 2 there is shown a four-channel control system. In this figure the input and output amplifiers have not been shown but can, of course, be included if the signal-level conditions so dictate. In this embodiment six frequencies are used to control the four channels **50**, **52**, **54**, and **56**. Each channel is here made responsive to input control signals formed of three frequencies. The interlocking arrangement has been expanded to accommodate the increased number of channels.

Input signals are applied to the six filters **58*a*** through **58*f***, and the output of each filter is applied to detectors **60*a*** through **60*f***, respectively. Each control channel is again headed by an AND gate **62**, **64**, **66**, **68**. In channel **50** the output of AND gate **62** is applied to the input of a second AND gate **70**. In channel **52** the output of AND gate **64** is applied to the input of a second gate **72**. In channel **54**, the output of AND gate **66** is applied to gate **74**; and in channel **56**, the output of AND gate **68** is applied to gate **76**. The output control signals come from these second gates and are used to perform the desired control functions.

Each of the AND gates at the beginning of each channel has three inputs and thus makes each channel responsive to the reception of three-frequencies in the incoming control signal. If the incoming control signals contain frequencies *f1*, *f2*, and *f3*, AND gate **62** opens and channel **50** responds. Similarly, channel **52** responds to the reception of frequencies *f2*, *f3*, and *f4*; channel **54** responds to the reception of frequencies *f4*, *f5*, and *f6*; and channel **56** responds to the reception of frequencies *f1*, *f5*, and *f6* in the incoming signals.

If the incoming signals due to noise, interference, faulty transmission, or any other reason, contain frequencies to which more than one channel is responsive, the interlock feature described with regard to FIG. 1 above again comes into play to block outputs from all channels. To this end, the output of each of the AND gates **62**, **64**, **66** and **68** is applied as in inhibit input to each of the second gates **70**, **72**, **74**, and **76**, other than the second gate in its own channel. Thus, if channel **56** is actuated due to the reception of frequencies $f1$, $f5$, and $f6$, the inhibit input out of AND gate **68** prevents any output signals from being generated in the other three channels **50**, **52**, and **54**. If at this time frequency $f4$ appears, at the input, AND gate **66** now opens and an inhibit input is applied by this AND gate to the gates **70**, **72**, and **76**. Channel **56** thus also becomes inhibited, and no output signal is thereafter derived from any channel in the system so long as both AND gates remain open.

In FIG. 3, four frequencies are used to actuate four output control channels. In this embodiment the input and output amplifiers have again for brevity been omitted from the drawing. The four channels **80**, **82**, **84**, and **86** are headed by AND gates **88**, **90**, **92**, and **94**, respectively. Channel **80** is responsive to the receipt of frequencies $f1$ and $f2$ in the incoming remote control signals. Channel **82** is responsive to the receipt of frequencies $f2$ and $f3$ in such signals. Channel **84** is responsive to the receipt of frequencies $f1$ and $f4$; and channel **86** is responsive to the receipt of frequencies $f3$ and $f4$.

The multi-channel control system of FIG. 3 is designed to permit simultaneous outputs from channels **80** and **82** without actuating the interlocking arrangement. To this end there is again provided the second set of AND gates **96**, **98**, **100**, and **102**, each of which is connected to the output of the AND gate in its associated channel. The output of AND gates **88** and **90** are also connected via lines **104** and **106** to OR gate **108**, and the output of this OR gate is connected as an inhibit input to each of the gates **100** and **102** in channels **84** and **86**, respectively. The output of AND gates **92** and **94** are connected via lines **110** and **112** to OR gate **114**, with the output of this OR gate being connected as an inhibit input to the gates **96** and **98** in channels **80** and **82**, respectively. The output of AND gate **92** is also connected as an additional inhibit input to the gate **102** of channel **86**, and the output of AND gate **94** is connected as an additional inhibit input to the gate **100** in channel **84**.

When either AND gate **88** or **90** is enabled, channels **84** and **86** only will be inhibited from passing a control signal because there is no interlock between channel **80** and **82**. For example, if channel **80** is actuated due to the receipt of the frequency pair to which AND gate **88** is responsive, an inhibit input is applied from AND gate **88** by line **104** and OR gate **108** to the inhibit inputs of gates **100** and **102** in channels **84** and **86**, respectively. However, no inhibit input is applied to channel **82**. Thus, if a second control signal is applied to the input of this system containing frequencies $f2$ and $f3$, AND gate **90** opens, and an output control signal is provided by channel **82** simultaneously with that of channel **80**.

It should be noted that whenever one or both of channels **80** and **82** are actuated, and either of channels **84** or **86** attempts to actuate because of the presence at the input of the frequencies to which either of these channels is responsive; the interlock arrangement, as shown, becomes effective to block all further outputs from all channels in the system. This interlock is provided by either lines **110** or **112**, depending on whether gate **92** or **94** is open, through the OR gate **114** to the inhibit inputs of gates **96** and **98**. Gates **100** and **102** are also inhibited at this time because of the inhibiting signal being applied to those AND gates by the OR gate **108**.

In the situation where either control channel **84** or **86** is actuated in response to receipt of its frequency pair, then the interlock functions as in FIGS. 1 and 2. Inhibit inputs are applied to the other three channels to prevent their actuation and control signals emanate from only one channel. For example, if AND gate **92** is open by virtue of frequencies $f1$ and $f4$ being present in the incoming control signals, channel **84** is actuated; and an inhibit signal is applied to channel **86** at gate **102**, and to the two channels **80** and **82** through OR gate **114** to the inhibit inputs of gates **96** and **98**. An output control signal is obtianed only from channel **84**. If any of the other three AND gates becomes enabled by virtue of its two critical frequencies appearing in the input signal, channel **84** will also be restrained from passing any further output control signals due to the inhibiting of gate **100**. In such case, no output control signals are derived from the system.

It is to be understood that the above-described arrangements are illustrative of the applications of the principles of the invention. The output control signals can obviously be used for any of a variety of control functions. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A remote control system responsive to the input of multi-frequency signals comprising a plurality of control channels, means at the input of each control channel which is actuated in response to the simultaneous receipt by said system of a predetermined input multi-frequency signal for providing an output control signal, means for inhibiting the generation of output control signals from all channels upon receipt by said system of input signals containing frequencies which would actuate greater than a predetermined number of control channels, gating means in each control channel, said inhibiting means including interconnections between each control channel input means and selected gating means in the other channels, which upon receipt of normal multi-frequency input signals by said remote control system become effective to inhibit the actuation of said gating means except in predetermined control channels, and upon receipt of abnormal input signals by said remote control system which would actuate greater than the predetermined number of control channels become effective to inhibit the actuation of said gating means in all of said control channels.

2. A remote control system as claimed in claim **1** wherein there are n control channels and the input signals contain m selective frequencies, and each of said control channels is responsive to a pair of said m frequencies.

3. A remote control system as claimed in claim **2** further comprising m means for selecting signals of one of said m frequencies and means for detecting the output of each said selecting means to provide a DC level input to said control channels.

4. A remote control system as claimed in claim **3** wherein each said control channel input means is formed as a coincidence gate, the input to each coincidence gate being connected to the output of two of said detecting means, each coincidence gate being enabled upon receipt of DC output signals from said detecting means, thereby to actuate the associated control channel to provide an output control signal.

5. A remote control system as claimed in claim **4** wherein said m selecting means are m filters, each filter being selective of signals of one of the m frequencies in the input signals applied to said system.

6. A remote control system as claimed in claim **4** wherein $n=2$ and $m=3$, and said inhibiting means in each channel connects the output of its associated coincidence gate as an inhibit input to the gating means in the other channel.

7. A remote control system as claimed in claim **4** wherein the ratio of m to n equals 3/2.

8. A remote control system responsive to the input of multi-frequency signals comprising at least three control channels, each of said control channels responsive to the simultaneous receipt of at least two predetermined frequencies, means for inhibiting the generation of output control signals from all of said channels upon receipt by said system of input signals containing frequencies which would actuate greater than one channel, a gate in each control channel, said inhibiting means including interconnections between each channel and the gate in selected ones of said other channels, said inhibiting means being effective to inhibit enabling of each said gate except the gate in one control channel during receipt of normal multi-frequency input signals, and being effective to inhibit the actuation of all said gates in all control channels upon receipt of multi-frequency input signals which would actuate greater than one control channel.

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