May 28, 1957 R. D. MOHLER ET AL 2,794,156

CONTROL SYSTEM

Filed May 9, 1955 2 Sheets-Sheet 1

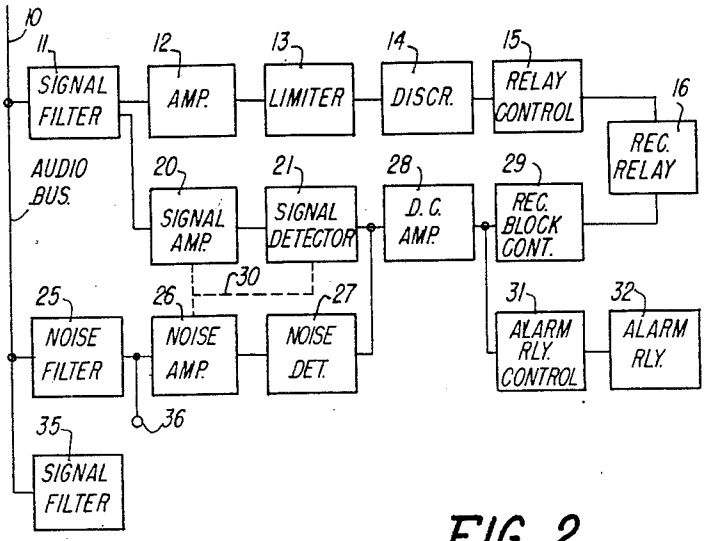


FIG. 1

FIG. 2

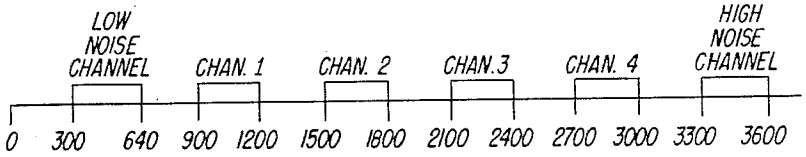
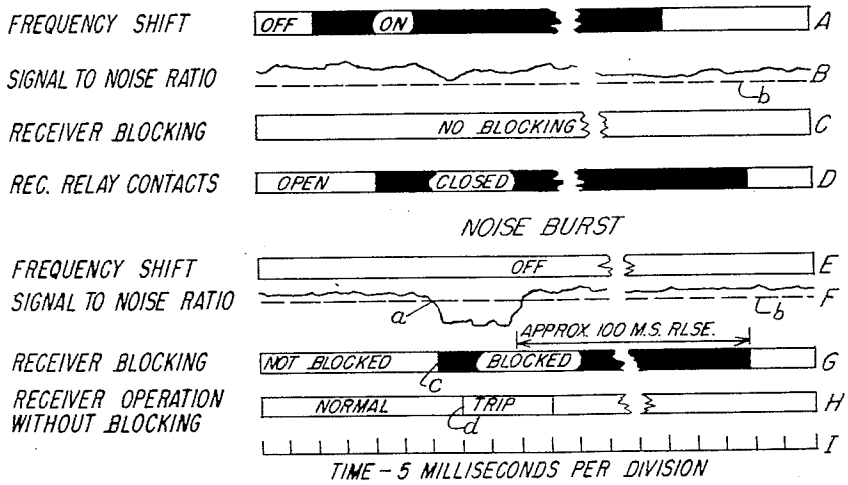


FIG. 3



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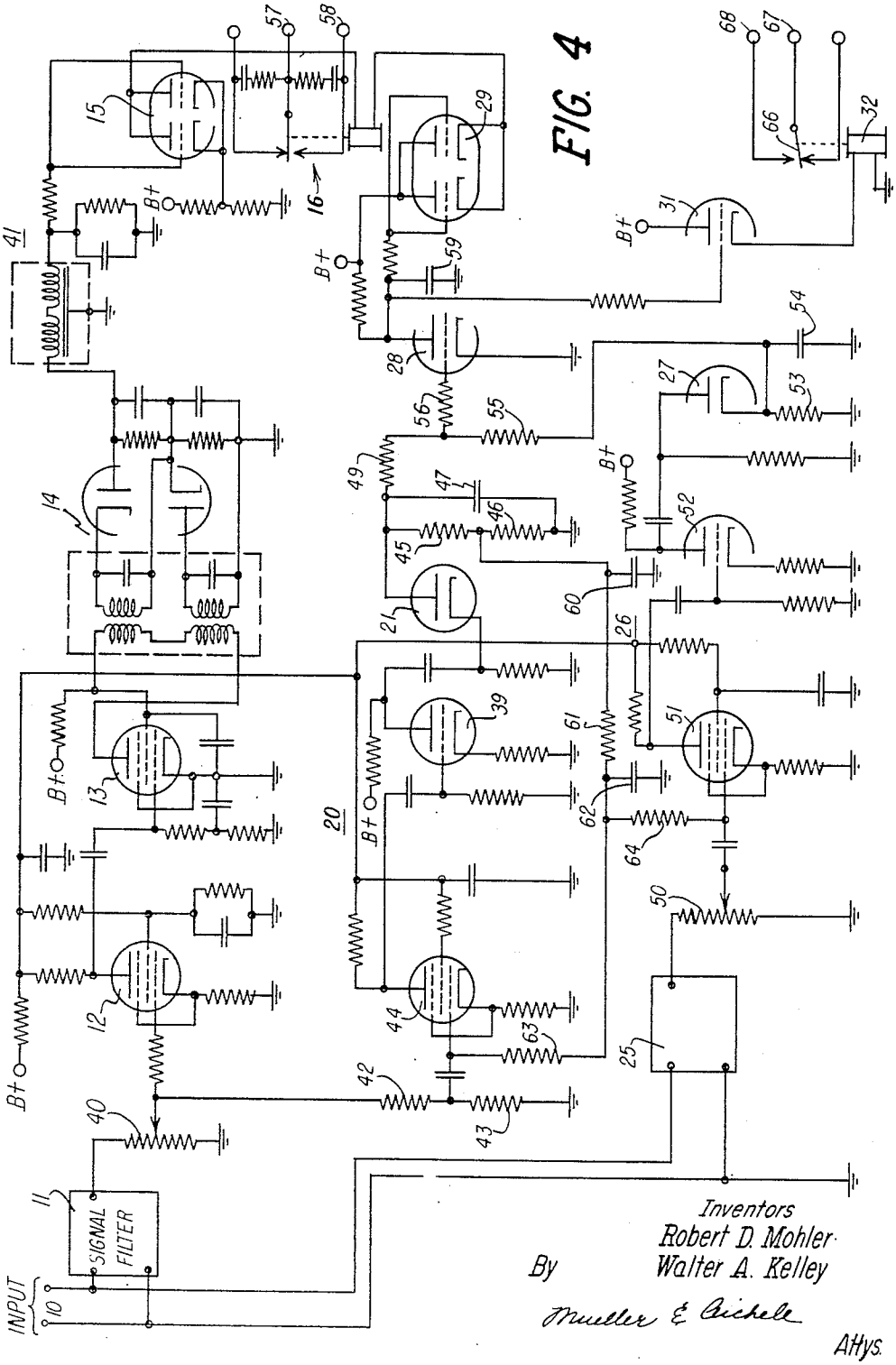
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CONTROL SYSTEM

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2 Sheets-Sheet 2

FIG. 4



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2,794,156

CONTROL SYSTEM

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Application May 9, 1955, Serial No. 507,116

11 Claims. (Cl. 317—149)

This invention relates generally to remote control systems, and more particularly to systems wherein control signals are transmitted by frequency shift of voice frequency carriers and received and utilized for high speed control, with the control operation being blocked when the signals are not substantially greater than noise.

In many applications, it is desired to transfer a control from one point to another, and to reduce the cost of such systems a plurality of controls may be applied over a single channel. When it is desired to provide fast operation, the channels must have substantial band width and, accordingly, the number will be reduced. Although in some applications it is merely necessary to produce an indication of the condition of equipment and speed is not particularly important, in other applications it is desired to directly control equipment and to be sure that the proper control takes place accurately and rapidly.

As an example of such remote control systems, in power line operation a breaker at a particular point may open because of conditions existing along the line. It may be desired to open other breakers when the first breaker opens to protect the line, and this can be accomplished by the control system. However, it is particularly important that such other breakers are not improperly opened when no dangerous conditions occur on the line by faulty operation of the control system. Accordingly, it is important both that the system is fast and reliable to provide the desired control, and also that it does not through faulty operation provide controls which are not desired.

It is therefore an object of the invention to provide an improved fast acting control system operated by voice frequency carrier signals.

A further object of the invention is to provide a system for directly controlling equipment including a receiver which is blocked when the control signals are not sufficiently strong to be reliable.

Another object of the invention is to provide an improved receiver for fast acting control systems operating from voice frequency multiplex signals wherein controlling action is prevented when the relative strength of the received signals with respect to the noise is not sufficient to provide reliable operation.

A feature of the invention is the provision of a fast acting control system operating from voice frequency multiplex signals with filter means for selecting the signal and noise, and differential combining means for producing a voltage for blocking the control action when the signal is not sufficiently greater than noise to provide reliable control action, with the blocking circuit operating faster than the control system to prevent undesired control.

Another feature of the invention is the provision of a blocking circuit which samples control signals and noise received from a multiplex channel and includes a feedback circuit controlled by the strength of the signal for simultaneously holding the signal and noise within predetermined levels so that control action responds to the instantaneous relative strengths of signal and noise and is effective over a wide range of signal strengths.

A further feature of the invention is the provision of a blocking circuit for a relay control system wherein the relay actuating circuit includes an electron discharge valve which is instantaneously rendered non-conducting when the blocking signal is produced so that the relay circuit is broken before the relay can be operated, to thereby prevent relay operation by undesired signals.

Further objects, features and the attending advantages of the invention will be apparent from a consideration of the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a block diagram of a control system receiver in accordance with the invention;

Fig. 2 is a chart showing the channel distribution in the voice frequency multiplex system;

Fig. 3 is a chart illustrating operation of the system; and

Fig. 4 is a circuit diagram of the receiver in accordance with the invention.

In practicing the invention there is provided a receiver for the control system for controlling equipment in response to voice frequency carrier signals. In order to provide high speed operation, frequency shift operation with channel widths of 300 cycles is used so that four voice frequency carriers and two noise channels are provided on a communication channel extending from 300 to 3600 cycles. Such a channel may be provided by a wire line or by one channel of a microwave communication system. As the signals may be used to directly control equipment, it is desired to block the control if the signal on the channel is not sufficiently greater than the noise on the channel to provide reliable operation. The signals of the various channels are selected by highly selective filters and are applied to translating channels which control relays in accordance with the signals received. Each translating channel includes a discriminator which responds to the frequency shift signals to provide a control voltage which may operate a relay. A blocking circuit prevents the control operation when the signal received is not sufficiently greater than noise, and includes a signal channel coupled to the signal selecting filter, and a noise channel including a filter for selecting a frequency band on which no signals are transmitted. The signal and noise channels each include an amplifier and a detector for producing a voltage in accordance with the signals therein. The voltages from the signal and noise channels are combined differentially to provide a direct current voltage utilized to block the relay operation. A feedback circuit is provided to hold the outputs of the signal and noise channels within desired operating range and applies a portion of the output of the detector of the control channel to the amplifiers of the signal and noise channels to simultaneously control the gain of these two amplifiers. The blocking operation is provided by an electron discharge valve in series with the control relay which operates instantaneously in response to the blocking voltage to open the relay circuit before the relay can operate by substandard signals. An alarm circuit may be provided for producing an alarm when the blocking voltage is present.

Referring now to the drawings, in Fig. 1 there is illustrated in block diagram form the receiving system in accordance with the invention. Line **10** represents a voice channel over which a plurality of different signals are applied by use of voice frequency carriers. Fig. 2 illustrates the voice frequency carrier channel distribution which may be used wherein relatively wide band channels are provided. Four channels are provided extending from 900 to 1200 cycles, 1500 to 1800 cycles, 2100 to

2400 cycles and 2700 to 3000 cycles, respectively. Above and below the four signal channels are two noise channels, one between 300 and 640 cycles and the other between 3300 and 3600 cycles. These noise channels are used in a manner to be described. The lower noise channel is widened somewhat to provide more representative noise pickup.

Referring again to Fig. 1 the desired carrier is derived from the line **10** by signal filter **11**. Signals received by the filter are applied to amplifier **12** and then to limiter **13**. As previously stated, the signals may be frequency shift signals, that is, a carrier of a particular frequency may be normally transmitted and then the frequency of the carrier shifted when a control operation is desired. The frequency shift signal is converted to a direct current control signal by discriminator **14**. A control signal from discriminator **14** is applied to a relay control circuit **15** which controls the receiving relay **16**.

In many applications the receiving relay may be directly connected to an item to be controlled such as a circuit breaker. Accordingly, when the voice frequency carrier selected by the filter **11** is shifted in frequency, the discriminator **14** will produce a control voltage which is applied to the relay control circuit **15** to operate the relay **16**. It is particularly important in many applications that the relay control not be actuated by noise which may appear on the communication channel **10**, as undesired operation of the relay **16** may cause improper operation of the equipment controlled thereby to produce serious damage.

To prevent improper operation of the relay **16**, a blocking control circuit is provided including a signal channel and a noise channel. The signal channel includes a signal amplifier **20** which amplifies the signal selected by filter **11**. The amplified signal is applied to detector **21** which produces a voltage in accordance with the strength of the signal received. The noise channel includes a noise filter **25** connected to the line **10** and adjusted to select a frequency at which no signal is applied. The noise filter may be tuned to the low noise channel or the high noise channel as shown in Fig. 2. Noise selected by the filter **25** is applied to noise amplifier **26** and from the amplifier to detector **27**. The outputs of the detectors **21** and **27** are differentially combined and applied to amplifier **28**. This combined voltage is applied through the amplifier **28** to the receiver blocking control **29** to disable the relay **16**. As shown by the dotted connection **30**, a portion of the output of the detector **21** is fed back to the amplifiers **20** and **26** to control the gain thereof so that the detector outputs fall within a desired range. This results in accurate comparison of the signal with noise for a wide range of signal levels.

Connected to the output of the direct current amplifier **28** is an alarm control **31** which operates an alarm relay **32**. The alarm relay **32** indicates when the blocking control is in operation to show that the noise is of a sufficient level to interfere with proper operation of the control. This indicates to the operator that the control is not operating and indicates faulty operation of the entire control system.

As previously stated, a plurality of channels, for example 4, may be applied to the line **10**. As shown in Fig. 1, additional signal filters **35** may be provided which select different channels than that selected by the filter **11**. The same noise output from filter **25** may be used in the blocking control for a plurality of signal channels. Accordingly, a terminal **36** is provided from the output of noise filter **25** which may be used for blocking the operation of receivers utilizing signals from other channels derived by the signal filter **35**.

Reference is now made to Fig. 3 which illustrates the operation of the system which has been described. Chart A shows the operation of the transmitter of a particular channel. At the beginning of the time, marked "off," the normal frequency is transmitted. During the shaded part, marked "on," the frequency is shifted to produce a control. Chart B shows the signal to noise ratio of the voice frequency carrier, with the dotted line *b* showing the signal to noise ratio at which blocking action takes place. As the signal to noise ratio of chart B never falls to line *b*, no blocking action results as shown by chart C. Chart D shows the operation of the receiver relay showing that the relay is unoperated at the beginning and is later closed after the frequency has been shifted. It will be noted that there is a delay of the order of 10 milliseconds from the frequency shift to the operation of the relay control, which is the delay produced in the receiver by the discriminator and the carrier filter as will be set forth in more detail.

Considering now the action from high noise, chart E of Fig. 3 again shows the operation of the transmitter and the frequency is not shifted for the entire duration of the chart. Chart F again shows the signal to noise ratio at the receiver, and it will be noted that at the point *a* the signal to noise ratio falls below the dotted line *b*. Chart G shows the receiver blocking and shows that at point *c*, shortly after point *a*, the receiver is blocked. As will be explained, the receiver is blocked for the duration of the time that the signal to noise ratio falls below the dotted line and for an additional period of approximately 100 milliseconds. Chart H shows the operation of the receiver and indicates that the receiver would have operated at the point *d* had there been no blocking protection at point *c*. It is noted that point *d* occurs after point *c* so that the receiver is blocked before the tripping action can take place. This is accomplished by design of the blocking circuit so that the time delay therethrough is less than the delay through the signal channel.

Referring now to Fig. 4, the more detailed operation of the receiver system will be apparent from this circuit diagram. The signal selected by the filter **11** is applied to potentiometer **40** which controls the level of the signal channel. This signal is amplified by the amplifier **12** and limited in the stage **13**. The frequency shift is translated to a direct current control signal by discriminator **14**. The voice frequency carrier is removed by filter **41** which applies the control voltage to the parallel connected triodes of the stage **15** to render the same conducting. The anodes of the triodes are connected to the relay **16**.

The signal of potentiometer **40** is also applied to a voltage divider including resistors **42** and **43** from which a portion of the signal is applied to the amplifier **20** of the control channel. The amplifier includes the pentode stage **44** and a triode stage **39** which feeds the detector **21**. The output of the detector **21** is applied to a load circuit including resistors **45** and **46** connected in series and shunted by condenser **47**. A negative voltage is developed by diode **21** across resistors **45** and **46** which is a measure of the strength of the signal in the channel being used. That is, the voltage across resistors **45** and **46** is negative at the plate of diode **21** with respect to ground.

The noise signal selected by the filter **25** is applied to potentiometer **50**, with a portion of the signal from potentiometer being applied to amplifier **26**. This amplifier is identical to amplifier **20** and includes a first pentode stage **51** and triode stage **52**. The output of the amplifier is applied to detector **27** which produces a positive voltage across load resistor **53** which is shunted by a condenser **54**. That is, the voltage across resistor **53** is positive at the cathode of diode **27** with respect to ground. This voltage is a measure of the strength of the noise selected by filter **25** which will be generally the same as the noise in the channel selected by filter **11**.

As previously stated the diode **21** is connected so that the voltage across resistors **45** and **46** is negative with respect to ground and the diode **27** is connected so that the voltage appearing across resistor **53** is positive with respect to ground. These voltages are combined through isolating resistors **49** and **55** and applied through resistor **56** to the direct current amplifier **28**. If the combined voltage is more negative than a predetermined value, for

example, 2 volts, the direct current amplifier **28** is driven to cutoff. Therefore the voltage at the plate is a high positive voltage which is supplied to the grids of the triodes of the blocking stage **29** so that these triodes conduct. The relay control triodes **15** are normally very slightly conducting but not sufficiently conducting to operate the relay **16**. However, when the frequency is shifted the positive discriminator output causes the control tubes **15** to conduct. When the tubes **15** and **29** are both conducting, the relay **16** will operate to close the circuit between terminals **57** and **58** which may be connected to provide control of any desired equipment.

If the received signal level is reduced with respect to the noise, the negative voltage from the detector **21** will not exceed the positive voltage from the detector **27** by the required amount to cut off tube **28**. Tube **28** will then conduct to hold the plate voltage low and cut off the triodes of the blocking stage **29**. This will prevent operation of the relay **16** even though a positive potential is applied to the grids of the relay control tube **15**. The input to the noise amplifier **26** controlled by potentiometer **50** may be adjusted so that the voltage from the noise channel has a predetermined relation to the voltage derived by the signal channel to give the desired protection. For example, it may be desired to let the system operate only when the signal level is 20 decibels above the noise level. Adjustment of potentiometer **50** may be set to provide this relationship.

In order to make the system give the same protection for signals of different strengths, a feedback circuit is provided for controlling the amplifier stages **44** and **51**. This feedback circuit is connected from the intermediate point between resistors **45** and **46** to derive a portion of the negative voltage produced by the detector **21**. The feedback voltage is filtered by condenser **60**, resistor **61** and condenser **62** and applied through resistor **63** to the grid of tube **44** and through resistor **64** to the grid of tube **51**. The same feedback bias is applied to both tubes so that as the gain of tube **44** is reduced to reduce the level of the signal, the gain of tube **51** is simultaneously reduced to reduce the gain of the noise. By using the same feedback voltage for both amplifiers, the gains are simultaneously controlled whereas the use of a separate feedback voltage for each amplifier from its respective output might result in the gain of one amplifier being reduced before the gain of the other so that the differential output does not represent the relative instantaneous levels. The feedback holds the detected voltages at the rectifiers **21** and **27** within a predetermined range even though the signals received may vary through a much wider range. This makes the relative differential control operate for substantially the same difference in signal and noise levels through a wide range. This is to be desired since the reliability of the receiving system depends upon the relative levels rather than the absolute levels.

As previously mentioned, the operation of the relay **16** is delayed with respect to the frequency shift of the voice frequency carrier applied through the filter **11**. This delay results in part from the tuned circuits of the discriminator **14** and in part because of the carrier filter **41**. As it is desired to have very fast acting control, the delay is held to a minimum. Accordingly, the blocking control must operate very fast to be faster than the control through the signal channel in order to prevent false operation by noise pulses. To accomplish this the amplifiers and detector of the signal and noise channels must have a minimum time delay so that the blocking action takes effect faster than the control action through the signal channel. The use of an electron tube **29** to provide blocking instead of a relay further speeds up the blocking action since the tube will open the circuit of the control relay **16** instantaneously before this relay can operate.

It is necessary to hold the system blocked for a predetermined time after each blocking action since noise pulses in the control channel are delayed and may cause operation of the control tube **15** after the noise has passed through the blocking circuit. This holding action is accomplished by the use of condenser **59** connected to the plate of tube **28**. The tube **28** is normally blocked so that the plate voltage is high and the condenser **59** is charged to this voltage. However, when the noise increases with respect to the signal to the point that the tube **28** is rendered conducting, the condenser **59** will discharge rapidly. That is, the condenser is discharged during the blocking of the system. However, when the differential voltage which produces the blocking action ceases, the voltage across condenser **59** will remain low until the condenser can charge from the B plus potential. This delays the conductivity of the tubes **29** for a predetermined time.

As previously stated an alarm relay is provided for indicating when the system is blocked because the noise level is so high with respect to the signal level that control by the signal will not be reliable. The tube **31** of the alarm relay has its grid connected to the plate of tube **28**, and since the plate of the tube **28** is normally at a high potential, the tube **31** will normally conduct to actuate the relay **32**. However, when the potential of the plate of triode **28** drops because of increased noise, the tube **31** will cease to conduct and the relay **32** will drop out. This causes the contact **66** thereof to move to a different position to close the circuit through terminals **67** and **68** to energize an alarm circuit.

It is therefore seen that the receiving system disclosed provides reliable fast acting control. The system may be used to directly control equipment since it is blocked when the signal falls to a level at which the control may be unreliable so that equipment is not improperly operated thereby. The overall system is relatively simple with a single relay providing the control action and the disabling thereof.

We claim:

1. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, said translating means including a predetermined time delay, relay means connected to said translating means and operated by control signals derived thereby for providing controlling action, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the wave applied to said first rectifier means, second selecting means for selecting a frequency band including only noise, second amplifier means having the same gain as said first amplifier means connected to said second selecting means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for controlling the gains thereof to hold the output of said first rectifier means within predetermined limits, said feedback circuit controlling the gains of said first and second amplifier means so that said gains remain the same, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, and means connected to said relay means and responsive to said first and second voltages for rendering said relay means inoperative when said first voltage fails to exceed said second voltage by a fixed amount, the delay in said first and second amplifier means and said first and second rectifier means

being less than the delay through said translating means so that said relay means is rendered inoperative before control signals are applied thereto.

2. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, and relay means connected to said translating means and operated by the signals derived thereby for providing controlling action, first amplifier means connected to said first selecting means, first detecting means connected to said first amplifier means for producing a first voltage varying with the strength of the wave applied to said first detecting means, second selecting means for selecting a frequency band including noise, second amplifier means connected to said second selecting means, second detecting means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first detecting means to said first and second amplifier means for controlling the gains thereof to hold the outputs of said first and second detecting means within predetermined limits, and means connected to said relay means and responsive to said first and second voltages for rendering said relay means inoperative when said first voltage fails to exceed said second voltage by a fixed amount.

3. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, apparatus for providing controlling action at a receiver only when the strength of the carrier wave at the receiver exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, relay means adapted to be operated by the receiver for providing controlling action, first selecting means for selecting the frequency band including the carrier wave, first amplifier means connected to said first selecting means for amplifying the carrier wave, first detecting means connected to said first amplifier means for producing a first voltage varying with the strength of the amplified wave from said first amplifier means, second selecting means for selecting a frequency band containing noise, second amplifier means connected to said second selecting means, second detecting means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first detecting means to said first and second amplifier means for controlling the gains thereof to hold the output of said first detecting means within predetermined limits and to simultaneously control the gain of said second amplifier means, and means connected to said relay means and responsive to said first and second voltages for rendering said relay means inoperative when said first voltage fails to exceed said second voltage by a fixed amount.

4. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, relay means connected to said translating means and operated by the signals derived thereby for providing controlling action, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the wave from said first amplifier means, second selecting means for selecting a frequency band including only noise, second amplifier means connected to said second selecting means, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for controlling the gains thereof to hold the outputs of said first and second rectifier means within predetermined limits, control means responsive to said first and second voltages actuated when said first voltage fails to exceed said second voltage by a fixed amount, said control means when actuated rendering said relay means inoperative, and alarm means connected to said control means for indicating activation of said control means.

5. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, first control means connected to said translating means and actuated by the signals derived thereby, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the wave from said first amplifier means, second selecting means for selecting a frequency band including noise, second amplifier means connected to said second selecting means, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for controlling the gains thereof to hold the outputs of said first and second rectifier means within predetermined limits, second control means responsive to said first and second voltages and actuated when said first voltage fails to exceed said second voltage by a fixed amount, and relay means connected to said first and second control means, said relay means being operated in response to actuation of said first control means in the event said second control means is not actuated, with actuation of said second control means rendering said relay means inoperative.

6. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, relay means connected to said translating means and including a blocking portion, said relay means being operated by the signals derived from said translating means for providing controlling action when said blocking portion

is disabled, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the wave from said first amplifier means, second selecting means for selecting a frequency band including only noise, second amplifier means connected to said second selecting means, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for controlling the gains thereof to hold the outputs of said first and second rectifier means within predetermined limits, and means connected to said blocking portion of said relay means and responsive to said first and second voltages for actuating said blocking portion and thereby preventing operation of said relay means when said first voltage fails to exceed said second voltage by a fixed amount.

7. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, receiving apparatus for providing controlling action only when the strength of the carrier wave at the receiving apparatus exceeds the accompanying noise by the predetermined amount, said receiving apparatus including in combination, first selecting means for selecting the frequency band including the carrier wave, translating means connected to said selecting means for deriving the control signals from the carrier wave, a control circuit including relay means connected in series with an electron device to said translating means, said relay means being operated by the signals derived from said translating means for providing controlling action when said electron device is conductive, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the wave from said first amplifier means, second selecting means for selecting a frequency band including only noise, second amplifier means connected to said second selecting means, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for controlling the gains thereof to hold the outputs of said first and second rectifier means within predetermined limits, and means connected to said electron device of said control circuit and responsive to said first and second voltages for rendering said electron device non-conducting when said first voltage fails to exceed said second voltage by a fixed amount to thereby prevent operation of said relay means.

8. In a control system operated by control signals transmitted by frequency shift of a voice frequency carrier wave in a multiplex system, and in which the control is reliable only when the carrier wave exceeds the noise on the multiplex system by a predetermined amount, receiving apparatus for providing controlling action including in combination, first selecting means connected to the multiplex system for selecting waves in a channel carrying the control signals, frequency shift translating means connected to said selecting means for deriving the control signals from said selected waves, controlling relay means connected to said translating means and operated by the signals derived thereby, first amplifier means connected to said first selecting means first rectifier means connected to said first amplifier means for producing a first voltage varying with the strength of the waves applied thereto, second selecting means connected to the multiplex system for deriving noise from a channel thereof to which no signals are applied, second amplifier means connected to said second selecting means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for simultaneously controlling the gain thereof to hold the output of said first rectifier means within predetermined limits, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, and means coupled to said relay means and responsive to said first and second voltages for rendering said relay means inoperative when said first voltage fails to exceed said second voltage by a fixed amount.

9. In a control system operated by control signals transmitted by frequency shift of a voice frequency carrier wave in a multiplex system and in which the control is reliable only when the carrier wave exceeds the noise on the multiplex system by a predetermined amount, receiving apparatus for providing controlling action only when the carrier wave exceeds the noise on the multiplex system by a predetermined amount, said receiving apparatus including in combination, first selecting means connected to the multiplex system for selecting waves in a channel carrying the control signals, frequency shift translating means connected to said selecting means for deriving the control signals from said selected waves, a control circuit including relay means connected in series with an electron device to said translating means, said electron device normally being conductive to cause operation of said relay means by signals derived by said translating means, first amplifier means connected to said first selecting means, first rectifier means connected to said first amplfier means for producing a first voltage varying with the strength of the waves applied thereto, second selecting means connected to the multiplex system for deriving noise from a channel thereof to which no signals are applied, second amplifier means connected to said second selecting means, second rectifier means connected to said second amplifier means for producing a second voltage varying with the strength of the noise from said second amplifier means, a feedback circuit connected from said first rectifier means to said first and second amplifier means for simultaneously controlling the gain thereof to hold the output of said first and second rectifying means within predetermined liimts, and means coupled to said electron device and responsive to said first and second voltages for rendering said electron device non-conducting when said first voltage fails to exceed said second voltage by a fixed amount to thereby prevent operation of said relay means.

10. In a control system for operation by wide band control signals transmitted by a carrier wave, and in which the control is reliable only when the carrier wave exceeds the accompanying noise signals by a predetermined amount, apparatus for providing controlling action at a receiver only when the strength of the received carrier wave exceeds the accompanying noise by the predetermined amount, said apparatus including in combination, control means adapted to be operated by the receiver, first selecting means for selecting the frequency band including the carrier wave, first translating means connected to said first selecting means for controlling the level of the carrier wave, first detecting means connected to said first translating means for producing a first voltage varying with the strength of the wave from said first translating means, second selecting means for selecting a frequency band containing noise, second translating means connected to said second selecting means, second detecting means connected to said second translating means for producing a second voltage varying with the strength of the noise from said second translating means, a feedback circuit connected from said first detecting means to said first and second translating means for controlling the levels therein to hold the output of said first detecting means within predetermined limits and to simultaneously control the gain of said second translating means, and means connected to said control means and

responsive to said first and second voltages for rendering said control means inoperative when said first voltage fails to exceed said second voltage by a fixed amount.

11. In a control system operated by control signals transmitted by frequency shift of a voice frequency carrier wave in a multiplex system, and in which the control is reliable only when the carrier wave exceeds the noise on the multiplex system by a predetermined amount, receiving apparatus for providing controlling action including in combination, first selecting means connected to the multiplex system for selecting waves in a channel carrying the control signals, frequency shift translating means connected to said selecting means for deriving the control signals from said selected waves, control means connected to said translating means and operated by the signals derived thereby, first circuit means connected to said first selecting means and including first rectifier means for producing a first voltage varying with the strength of the selected waves, second selecting means connected to the multiplex system for deriving noise from a channel thereof to which no signals are applied, second circuit means connected to said second selecting means and including second rectifier means for producing a second voltage varying with the strength of the noise, a feedback circuit connected from said first rectifier means to said first and second circuit means for simultaneously controlling the levels therein to hold the output of said first rectifier means within predetermined limits, and means coupled to said control means and responsive to said first and second voltages for rendering said control means inoperative when said first voltage fails to exceed said second voltage by a fixed amount.

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