Aug. 28, 1956 G. G. BRADLEY ET AL 2,761,060

AUTO ALARM SYSTEMS

Filed Aug. 1, 1952 4 Sheets-Sheet 1

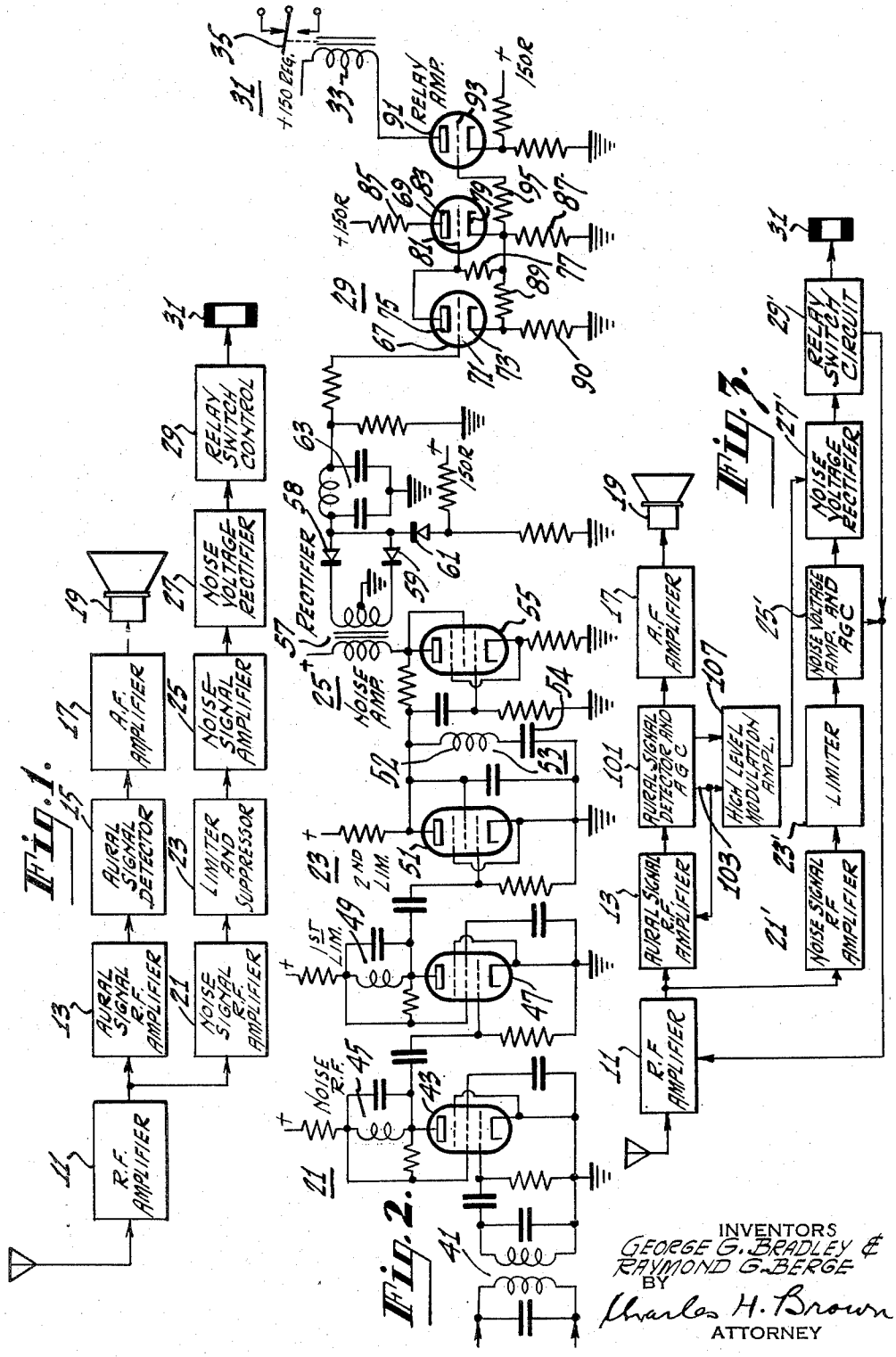


Fig. 1.

Fig. 2.

Fig. 3.

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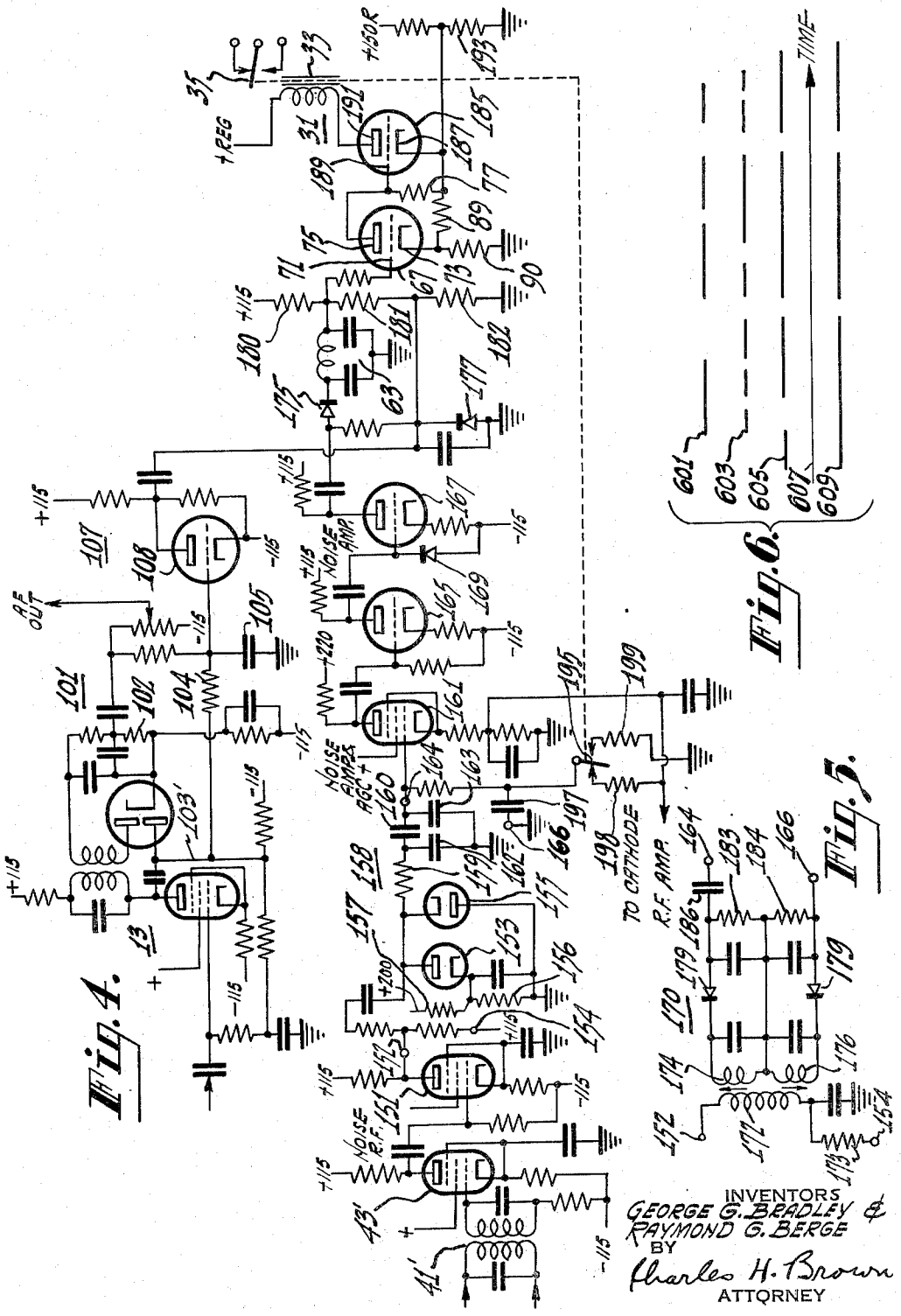


Fig. 4.

Fig. 5.

Fig. 6.

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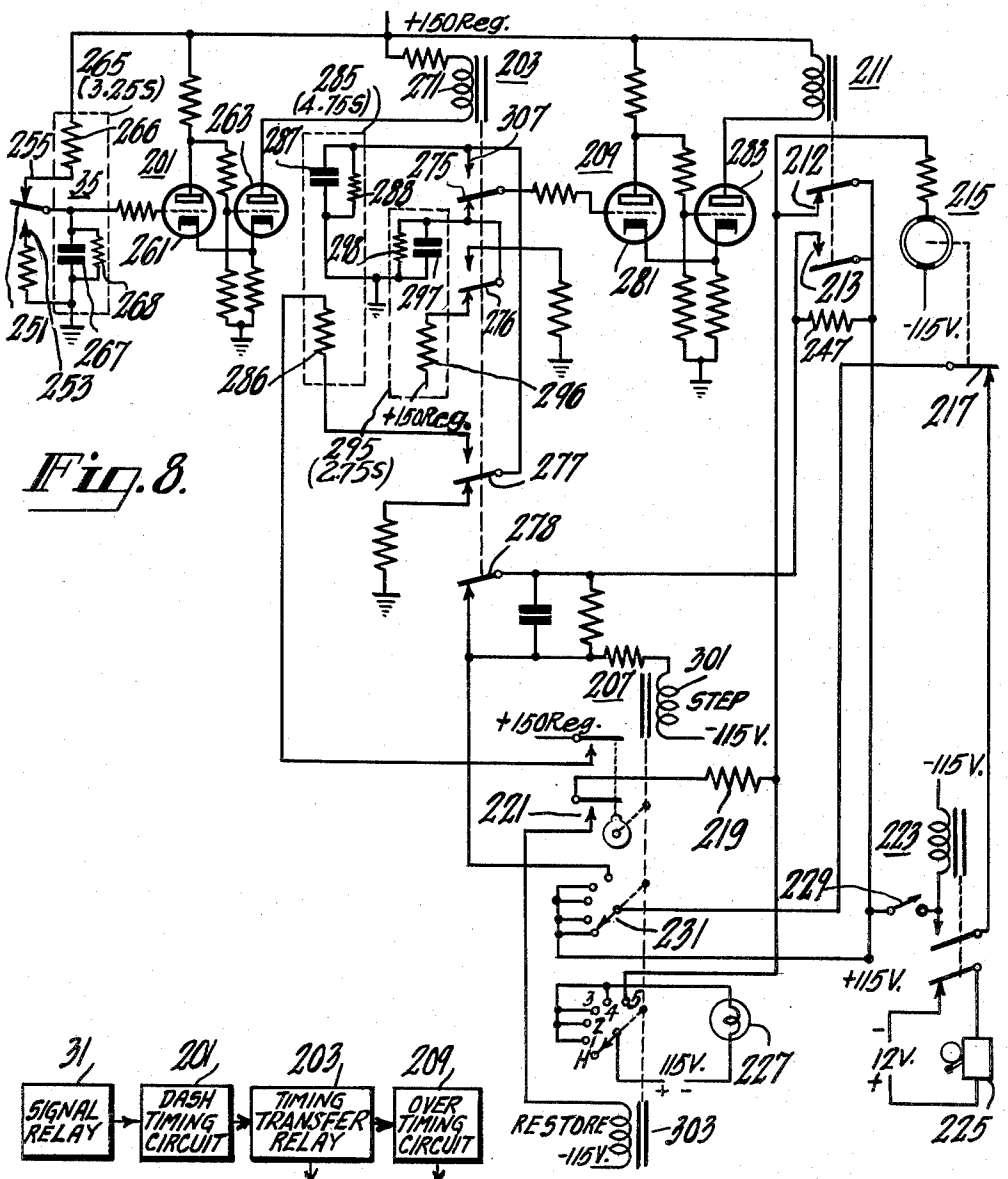


Fig. 8.

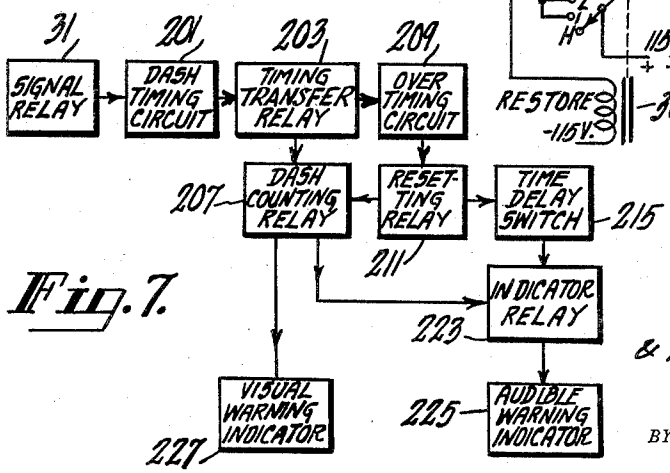


Fig. 7.

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Fig. 10.

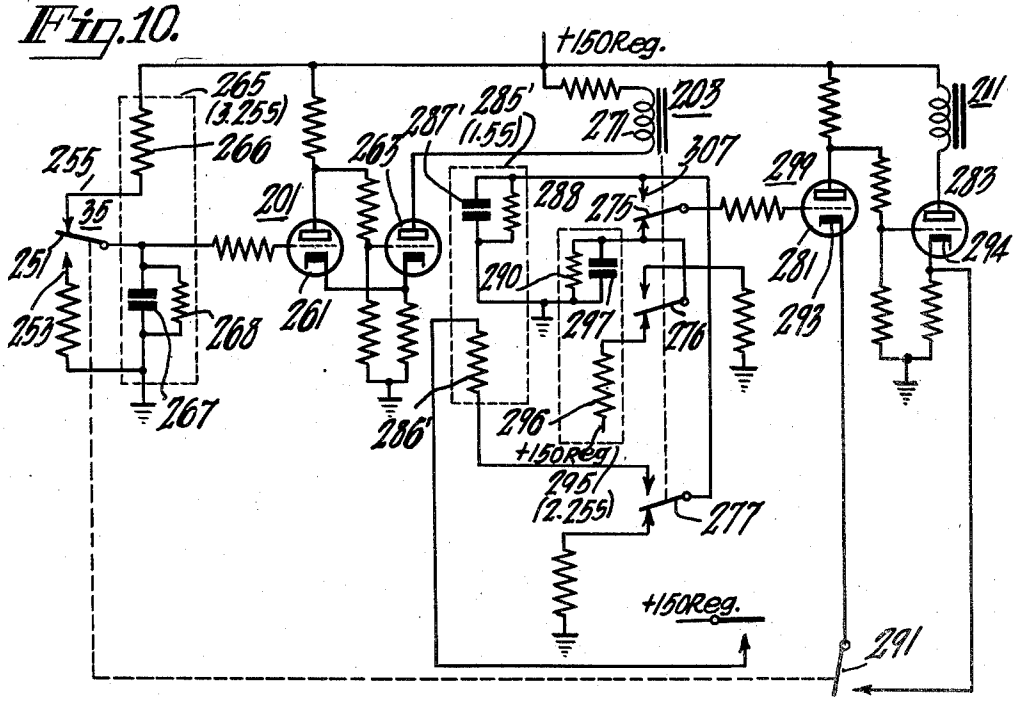
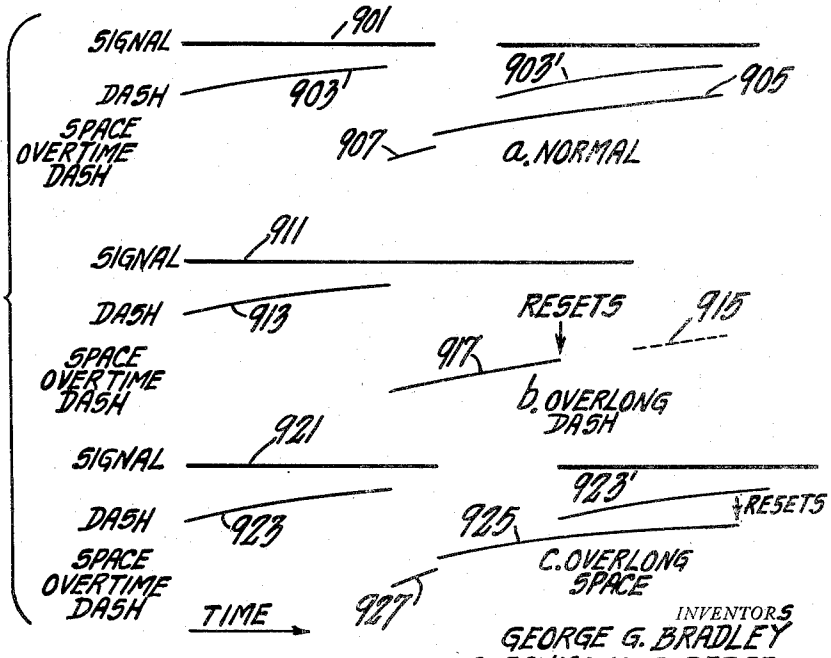


Fig. 9.



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United States Patent Office

2,761,060

Patented Aug. 28, 1956

2,761,060

AUTO ALARM SYSTEMS

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Application August 1, 1952, Serial No. 302,036

10 Claims. (Cl. 250—20)

The invention relates to radio receivers and signal responsive devices therefor. It particularly pertains to radio receivers and signal selector circuits for auto alarm systems.

An important application of auto alarm systems is in the transmission and reception of the international distress signals of ships at sea although other applications for the basic components of the apparatus will be readily suggested to those skilled in the art.

The fundamental purpose of the auto alarm is to stand a watch on the 500 kc./s. internationally assigned distress frequency at all times when the radio operator is not on duty. The international auto alarm signal consists of a series of dashes four seconds in length, separated by spaces having a duration of one second. Twelve such dashes and spaces transmitted in one minute, precede the international distress signal, SOS, after which the desired text may be transmitted. Auto alarms designed to meet the requirements of the Federal Communications Commission are arranged to actuate warning bells when four correct dashes and spaces have been received.

The transmission of alarm signals from the vessel in distress—or sometimes by shore stations for distressed vessels—is accomplished by hand using a radioroom clock having a sweep second hand and suitable marking on the dial to facilitate transmission of the correct dashes and spaces, or by means of an automatic alarm signal keying device.

In marine radio communication systems both past and present, it is common practice to transmit these signals by a hand key timed with the aid of a watch, and the alarm apparatus is designed to produce a response to manually keyed signals despite considerable variations within certain limits in the length of the dots and dashes.

Automatic alarm systems such as heretofore used have employed selective signal selector circuits operable to sound the alarm after reception of several long dashes. However, it was difficult, if not impossible, to adjust the parameters of these prior art receiver circuits so that the alarm signal would not be sounded in response to static and interference. Furthermore, it was difficult to adjust prior art selector circuits so that there would be no response to extraneous signals brought in on the same carrier wave as that of the established distress signal frequency assignment.

There is another serious limitation in the heretofore used auto alarm systems, in that interfering radio signals or static tend to effect an increase in the length of the dashes sent out from a vessel in distress or to completely "fill in" the space which should be provided between the dashes. Since the auto alarm signal is transmitted by on-and-off keying, the carrier and the modulation are both removed during the space interval between dashes.

Under these conditions the use of a conventional automatic gain control circuit is not practical. Even with so-called long-time-constant automatic gain control circuits, the action would be "bootstrapped" in that the signal dashes would reduce the overall gain during the very time when the gain should be maintained constant.

This, in turn, required that the sensitivity of the auto alarm receiver be adjusted manually, rendering it susceptible to blocking by strong interference or static which may occur after the manual adjustment has been made.

If the sensitivity control is turned up to the extreme limit, or nearly so, it may be found that the average noise level and static will cause the selector relay to hold over for long periods of time, or to chatter or vibrate steadily. This adjustment, of course, is not a favorable one, for not only will the warning light be illuminated frequently, whenever static or noise persists for 3.5 seconds or more, but also an authentic distress signal will be more apt to have the dashes prolonged and the spaces filled in, with such an adjustment. On the other hand, if the sensitivity control is adjusted too low, only very strong signals will operate the auto alarm, and a distress call from a distant ship might be missed.

Furthermore, accidental static or other interference may occasionally cause the counting means in the selector circuit to advance to the fourth position, which will cause the warning bells to ring continuously.

An object of the invention is to provide an improved more completely fail-safe automatic distress signal auto alarm.

It is another object of the invention to provide an improved selector circuit arrangement for use in an auto alarm system.

It is a further object of the invention to provide a selector circuit arrangement for an auto alarm system having fewer component parts and providing accurate action with less critical adjustment than the prior art selectors.

It is still another object of the invention to provide a receiver for an auto alarm system which is unaffected by varying levels of static.

It is still another object of the invention to provide a receiver circuit which in operation will not be subject to the deleterious effect of blocking by static.

Still another object of the invention is to provide an A. G. C. circuit arrangement suitable for use in an auto alarm type receiver.

It is still a further object of the invention to provide an alarm which will operate over a wide range of received signal and atmospheric noise without the use of a manually operated gain control, thereby to eliminate continual readjustment of gain control settings depending upon the level of atmospheric noise.

These and other objects of the invention are attained by means of a high gain fixed-tuned receiver circuit arranged to amplify the inherent noise of random nature generated in the R. F. stages to sufficient magnitude to saturate a limiter tube. The output of the limiter tube, consisting of noise voltage, is amplified, rectified, filtered and applied to a switching tube which, in turn, controls a signal relay which is held in one condition of operation, preferably the energized condition, in the absence of signal. With an incoming signal which has sufficient amplitude to overcome the inherent circuit noise, the D. C. output of the rectifier which follows the noise amplifier is reduced to zero, or nearly so, thereby allowing the signal relay to move to the other condition of

operation, preferably the deenergized condition. The auto alarm selector or time mechanism is controlled by the signal relay. Since the limiter is saturated by internal noise, additional noise picked up by the antenna will have little or no effect on the signal relay. Moreover, since the signal relay operates on the absence of noise, a strong received signal which causes R. F. circuit blocking will not affect the operation, hence, no gain control is necessary.

In a refinement of the receiver according to the invention, a voltage obtained from a channel of the receiver circuit translating audio frequency modulated carrier waves is applied to a high level modulation amplifier tube circuit and a subsequent rectifier circuit from which the rectified component is obtained and applied to the switching tube in polarity opposite to that presented in the noise channel of the receiver by a highly modulated signal with carrier present. Such a heavily modulated signal with carrier present when passing through the noise signal circuits will ordinarily tend to act in the same manner as the noise voltage would. However, it will be partially opposed by the aforementioned voltage to such an extent that undesirable effects will be prevented.

According to the invention an automatic gain control is incorporated into a modification of the receiver in such manner that the signal relay operates to interpose either of two networks having different time constants in the automatic gain control circuit. In the absence of carrier signals the time constant effective in the automatic gain control circuit is of given value longer than that used in conventional A. G. C. circuits. When carrier wave signals are present the signal relay is actuated to change the time constant of the automatic gain control circuit to a much higher value tending to carry the automatic gain control bias voltage along with the "bootstrapped" bias to prevent reducing the overall gain of the receiver during the reception of carrier wave signals.

In a modification of the receiver of the invention a frequency discriminator type of circuit may be employed to produce voltage changes in response to the transitions between received carrier wave signals and received noise voltages. This type of circuitry produces sharper distinction between modulation in the presence of carrier and the absence of carrier conditions.

The alarm selector according to the invention comprises a first monostable reciproconductive circuit controlling a dash timing relay which in turn actuates a dash counting relay, and a second monostable reciproconductive circuit having suitable time constants for dash and space signal over-timing which in turn controls a resetting relay. An indicator relay is coupled to the dash counting relay to energize an audible warning indicator when the proper number of dashes have been received. Discrepancies in the timing of the dashes and spaces occasioned in the conventional relay operated selector circuits are obviated by the relay controlling reciproconductive circuits according to the invention.

The invention will be described in connection with specific embodiments thereof, given by way of example only with reference to the accompanying drawing forming a part of the specification and in which:

Fig. 1 is a functional diagram of an auto alarm receiver according to the invention;

Fig. 2 is a schematic diagram of the noise signal channel of the receiver shown in functional form in Fig. 1;

Fig. 3 is a functional diagram of another alarm receiver embodying features according to the invention;

Fig. 4 is a schematic diagram of portions of the receiver shown in Fig. 3;

Fig. 5 is a schematic diagram of an alternate noise/carrier signal discriminator according to the invention;

Fig. 6 is a graphical representation useful in explaining the operation of an automatic gain control circuit according to the invention;

Fig. 7 is a functional diagram of a selector circuit according to the invention;

Fig. 8 is a schematic diagram of an embodiment of the selector circuit shown in Fig. 7;

Fig. 9 is a graphical representation useful in explaining the operation of the selector shown in Fig. 8; and

Fig. 10 is a schematic diagram of a modification of the selector shown in Fig. 8.

THE BASIC RECEIVER

Referring to Fig. 1, there is shown in block form a radio receiver according to the invention for receiving distress signals on an antenna which is connected by way of a common R. F. amplifier **11** to an aural signal R. F. amplifier stage **13** followed by an aural signal discriminator or detector stage **15**. The detected aural signals are applied to an audio frequency amplifier stage **17** which is used to drive a loud speaker **19** or any other desired utilization device. These stages may, for example, be evacuated electron discharge device circuits. Amplifiers **11** and **13**, detector **15**, audio amplifier **17**, and speaker **19** may be entirely conventional as they form no part of the invention in and of themselves. Moreover, these circuits may form part of an existing receiver available for signals other than the distress or auto alarm signals and the circuit arrangement according to the invention may be connected into the circuit for operation in conjunction therewith. An example of such an arrangement is given in U. S. Patent 2,431,167, issued November 18, 1947, to I. F. Byrnes which describes a different form of alarm receiver and selector.

What is hereinafter termed a noise signal R. F. amplifier **21** is connected to the output of the common R. F. signal amplifier **11** for driving a noise limiter and carrier suppressor stage **23**. Actually amplifier **21** and the limiter stage **23** are designed for translating modulated carrier signals as well as noise frequency voltages as will be seen in the detailed discussion of the circuitry according to the invention. These stages may, for example, be evacuated electron discharge device circuits. However, for convenience these stages are referred to as "noise signal" stages or as the "noise channel." Any carrier component, whether modulated or simply keyed, appearing in the limiter and suppressor stage **23** is detected and eliminated from the further stages leaving only noise voltage in the absence of carrier or zero signal voltage to be applied to a noise signal amplifier stage **25**. The amplified noise signal is converted to a D.-C. voltage by means of a noise voltage rectifier stage **27** and applied to a relay switch control circuit **29** for actuating a signal relay **31**. Circuits controlled by the signalling relay **31** will be further described in connection with the signal selector circuit.

Referring to Fig. 2, there is shown a schematic diagram of practical embodiments of stages **21**—**29** according to the invention. The output of the common R. F. amplifier **11** is applied to a radio frequency transformer **41** tuned to the distress carrier frequency of 500 kc./s. in the input of the noise signal R. F. amplifier **21** including noise R. F. pentode **43** having a parallel resonant circuit **45** in the anode lead thereof also tuned to 500 kc./s. Two cascade limiter pentodes **47** and **51** form the limiting portion of stage **23**. The anode circuit of the pentode **47** has a parallel resonant circuit **49** tuned to 500 kc./s. These stages as thus far described are constructed in the manner conventional for the I. F. and limiter stages of conventional F. M. superheterodyne receivers. The detector or carrier suppressor portion of stage **23** is formed by the series circuit **53** comprising an inductor **52** and a capacitor **54** connected across the second limiter pentode **51** and tuned to series resonance at the carrier frequency. This series tuned circuit presents a low impedance to the carrier frequency preventing any energy at that frequency from being applied to the grid of the following noise amplifier pentode **55**. Stages **21** and **23**

are so adjusted that the limiter tubes 51 and 47 are saturated to deliver a substantially constant output in the absence of any applied carrier frequency signal. In the absence of carrier this noise voltage from the second limiter is applied to the grid of a noise amplifier pentode 55. When a carrier signal is received, however, the operation of the limiter tubes is such that the noise rides the carrier frequency component and is limited out by the action of pentodes 47 and 51. The action takes place on both halves of the wave due to the cascade connection of the limiter pentodes 47 and 51. The carrier frequency component is then shorted to ground through the series tuned resonant circuit 53. Thus when the carrier component is being received no input signal voltage is applied on the control grid of pentode 55. In the absence of carrier voltage, noise frequency potential is applied to the control grid and is amplified in the usual manner. By means of a transformer 57 connected in the anode lead of the noise amplifier pentode 55 a pair of diode elements 58 and 59 are connected to provide full wave rectification of the noise voltage. A filter network 63 is used to smooth out the D.-C. potential for application to the succeeding relay switch control circuit.

The relay switch control circuit 29 comprises a triode tripper tube 67 and a triode control tube 69 coupled in series and having regenerative feedback connections to provide a sharper control of current flowing in the output circuit. The output voltage obtained from the series tube circuit is applied to a relay amplifier tube 91 in the anode circuit of which is connected the winding 33 of the signal relay 31. The armature 35 of the signal relay 31 is used to operate the selector circuit later to be described. Instead of an electro-mechanical signal relay 31 as shown, it is understood that additional tube circuitry may be used to effect the same result. For example, the single-pole double-throw armature 35 may be replaced by a known form of electronic switching circuit.

In the operation of the relay switch control circuit 29, when R. F. carrier signal is being received no noise voltage is rectified by noise rectifiers 58, 59 and substantially zero potential is applied to the control grid 71 of the tripper tube 67. The cathode 73 of the tube 67 is biased positively rendering the grid 71 relatively negative so that the current at anode 75 is zero. There is no drop across the series resistor 77 between the tubes 67 and 69 since there is no current flowing at the anode 75. Therefore, the cathode 79 and grid 81 of the control tube 69 are at the same potential. Regulated operating potential is applied to the anode 83 through an anode resistor 85 and since the grid 81 has no bias with respect to the cathode 79, current flows producing a drop through cathode resistor 87. This cathode drop is also produced across the cathode coupling resistor 89 and the cathode resistor 90 further biasing the tripper tube 67 to cutoff. The positive voltage produced at the cathode 79 is applied to the control grid 93 of the relay amplifier tube 91 through a limiting resistor 95 causing the signal relay 31 in the anode-cathode circuit of tube 91 to "pull up."

In the absence of the carrier, the rectified noise from the rectifiers 58, 59 produces a positive D.-C. voltage which is applied to the grid 71 of the tripper tube 67 sufficient to overcome the cutoff bias on the cathode 73. This causes anode current to flow in the tube 67 which produces a voltage drop across the coupling resistor 77 causing the potential at the grid 81 of the control tube 69 to drop. The lowered potential on the grid 81 allows less current to flow through the cathode resistors 87, 89 and 90, further reducing the bias on the cathode 73 and allowing more current to flow to the anode 75.

The drop across the coupling resistor 77 soon becomes so great that the anode current at the anode 83 approaches cutoff, producing little potential drop across the cathode resistor 87. The reduced potential across the resistor 87 is applied to the relay amplifier tube 91 through a limiting resistor 95 causing this tube to approach cutoff. As the anode-to-cathode current drops through the minimum required to energize the signal relay 31, the relay armature falls back.

A clipper diode 61 is used to stabilize the action of the switch control circuit 29 to prevent chattering of the signal relay 31 in the presence of low frequency noise components which may not be adequately filtered by the noise filter network 63.

THE ADVANCED RECEIVER

Referring to Fig. 3 there is shown in block form an alternate receiver according to the invention. The common R. F. stage 11, the aural signal R. F. amplifier 13, the audio frequency amplifier 17, and speaker 19 like those of the arrangement shown in Fig. 1 may be entirely conventional and likewise may form part of an existing receiver available for signals other than the distress signals if desired. An aural signal detector and automatic gain control circuit 101, which also may be of conventional form, is used to perform the same functions as the detector 15 and to apply A. G. C. voltage over a lead 103 to the preceding R. F. amplifier 13, and is also used to perform another function to be described hereinafter.

As in the above described embodiment a noise signal R. F. amplifier 21′ is connected to the output of the common R. F. signal amplifier 11 for driving a noise limiter, detector and carrier suppressor stage 23′. Any carrier component whether modulated or simply keyed appearing in the limiter and suppressor stage 23′ is detected and eliminated from the further stages leaving only noise voltage in the absence of carrier or zero signal voltage to be applied to a noise voltage amplifier and A. G. C. voltage developing stage 25′. The amplified noise signal is converted to a D.-C. voltage by means of a noise voltage rectifier stage 27′ and applied to a relay stage control circuit 29′ for actuating the signal relay 31 controlling the signal selector circuit. Again, for convenience these stages are referred to as "noise signal" stages or the "noise channel." A high level modulation amplifier 107, having automatic control of gain, is connected to the aural signal detector 101 to apply a potential to the noise voltage rectifier 27′ in polarity and amplitude opposite to that presented by the noise channel by a high modulated signal with carrier present.

Referring to Fig. 4 there is shown a schematic diagram of practical embodiments of the noise channel stages 21′—29′ according to the invention. The output of the common R. F. amplifier 11 is applied to a radio frequency transformer 41′ tuned to the carrier frequency of 500 kc./s. in the input of the noise signal R. F. amplifier including noise R. F. pentode 43′, actually one of several connected in cascade. A limiter pentode 151 connected in cascade with a double diode limiter circuit comprising diodes 153, 155 form the limiting stage. Two resistors 156 and 157 are arranged to bias the diodes 153, 155 to render the same ineffective below a predetermined threshold. Detection or demodulation is performed by the limiter pentode 151 acting as a grid leak biased detector. Carrier frequency components are removed from the rectified voltage by the filter network 158 comprising a series resistor 159 and capacitor 160 and shunt capacitors 162 and 163. The resulting noise voltage is applied to the grid of a noise amplifier pentode 161. When a carrier signal is received, however, the noise rides the carrier frequency component and is limited out by the action of pentode 151 and the limiter diodes 153, 155. Thus when the carrier component is being received, zero, or in the case of a weak signal at least a minimum, input voltage is applied to the control grid of the noise amplifier pentode 161. In the absence of carrier voltage, noise frequency potential is applied to the control grid in the usual manner. A pair of cascade connected noise amplifier triodes 165, 167 further amplify the noise voltage. A diode 169 connected in the grid circuit of the tube 167 serves to prevent ex-

cessive grid voltage swings in the positive direction. A diode element 175 is connected to provide half wave rectification of the noise voltage. A filter network 63 is used to smooth out the D.-C. potential for application to the succeeding relay switch control circuit as in the previous embodiment.

The relay switch control circuit comprises a triode tripper tube 67 and a triode control tube 185 in a series tube amplifier circuit similar to that of Fig. 2. The output current of the series tube circuit is applied directly to the winding 33 of the signal relay 31. As before, the armature 35 of signalling relay 31 is used to operate the selector circuit later to be described.

In the operation of the relay switch control circuit when an R. F. carrier signal is absent the noise voltage is rectified by the noise rectifier 175 and the resulting negative voltage derived is substantially balanced by a positive potential obtained from the bleeder comprising resistors 180, 181 and 182 rendering the grid 71 at substantially zero potential with respect to ground. The cathode 73 of the tube 67 is biased positively rendering the grid 71 relatively negative so that the current at the anode 75 is at cutoff. There is no drop across the resistor 77 coupling the tubes 67 and 185 since there is no current flowing at the anode 75. Therefore, the cathode 187 and grid 189 of the control tube 185 are at the same potential. Regulated operating potential is applied to the anode 191 through the signal relay winding 33 and since the grid 189 has no bias with respect to the cathode 187 current flows producing a drop through cathode resistor 193. This cathode drop is also produced across the cathode coupling resistor 89 and the cathode resistor 90 further biasing the tube 67 to cutoff. The current flow through the tube 185 energizes the winding 33 of the signal relay 31 and causes the armature to "pull up."

In the presence of the carrier, little or no rectified noise voltage is produced and a positive D.-C. voltage is found on the grid 71 of the tripper tube 67 due to action of the bleeder comprising resistors 180, 181 and 182 connected across the power supply. This causes anode current to flow which produces a voltage drop across the coupling resistor 77 causing the potential at the grid 189 of the control tube 185 to drop. The lowered potential on the grid 189 allows less current to flow through the cathode resistors 193, 89 and 90, further reducing the bias on the cathode 73 and allowing more current to flow to the anode 75. The drop across the coupling resistor 77 becomes so great that the anode current at the anode 191 approaches cutoff, and at a low value of current through the winding 33, the signal relay 31 is deenergized causing the armature to "fall back."

A voltage component is obtained from the output resistor 102 of the detector circuit 101 of the aural channel, and amplified by a triode amplifier tube 108 to which A. G. C. voltage, obtained from a common A. G. C. lead 103' is applied by way of filter resistor 104 and capacitor 105. The amplified voltage is rectified by means of diode 177 and applied to grid 71 of the tripper tube 67 through resistor 181 in polarity opposite to that which the same signal voltage component produces across resistor 181 as a result of rectification in the noise signal rectifier 175. This circuit offsets at least to a great extent the deleterious effects of any high percentage modulated signal received or otherwise appearing in the noise channel.

An alternate detector arrangement, shown in Fig. 5, may be used to replace that portion of the circuit of Fig. 4 between the terminals 152, 154 and 164, 166. The detector as shown is a double-tuned frequency discriminator type detector comprising an R. F. transformer having a primary winding 172 coupled to terminals 152 and 154 by way of a resistor 173, and also having two secondary windings 174 and 176 connected in series. The secondary windings are tuned to resonance at predetermined frequencies equi-distant from the carrier frequency. When a carrier wave is received only a small amount of noise voltage component at most will pass the limiter tube 151 and substantially zero potential will exist across the load resistors 183 and 184 for application to the noise amplifier tube 161. A sharper distinction between noise alone and noise in the presence of carrier is obtained with this detector. A Foster-Seeley type discriminator can be substituted for the double-tuned type discriminator with equal results. It is also contemplated that a Seeley ratio detector may be connected to the output circuit of the last noise amplifier 43' and to the input terminals 164, 166 of the noise amplifier tube 161 replacing the entire stage 23' with equal results. Some additional filtering might be required due to additional noise side bands but the elimination of the limiter stage will compensate for the cost of the additional components.

The automatic gain control voltage is obtained from the cathode circuit of the noise amplifier tube 161. Cathode follower action is effected and the A. G. C. voltage amplitude variations are in phase with the output of the detector stage. The action of the A. G. C. system comprising a capacitor 197 and a fixed resistor is varied by selecting the resistor 198 connecting the input circuit to the A. G. C. voltage lead or the resistor 199 connecting the input circuit to ground to discharge the capacitor 197. This selection also alters both the value of fixed bias voltage applied to the tube 161 and the time constant of the filter in the A. G. C. lead to all stages to which the A. G. C. voltage is applied. The ratio of resistors 198 to 199 is about 10:1 for the duration of the automatic distress signals, other ratios will, of course, be suggested for other services. The selection is made as shown by an auxiliary contact 195 on the armature 35 of the signal relay 31, although an electronic switch, actuated in response to current flow in the switch control tubes 67 or 185, could be used as well. This A. G. C. circuit responds only to the presence of received signals and not to the strength of the received signal. This is explained with reference to Fig. 6 showing a group of curves representing the operation of the A. G. C. system. Curves 601, 603 and 605 represent on-off continuous wave or modulated signals of carrier frequency or some frequency within the pass band of the receiver. The location of the curves above the time axis 607 bears no relationship to the amplitude or signal strength but only indicates whether the carrier is present at a given instant of time. The curve 609 indicates the position of the signal relay 31 with respect to time. In the absence of received signal, the resistor 199 is connected in the A. G. C. circuit, but if any signal at all is receved the A. G. C. voltage is applied by way of the resistor 198.

THE BASIC SELECTOR

An auto alarm selector to operate efficiently with the international alarm signal, and to reject all interfering signals, must perform three main functions. It should reject signals having a duration less than approximately 3.25 seconds. It should reject signals having a duration greater than 6.00 seconds. It should also be designed to recognize spaces between signals provided these spaces do not exceed 1.5 seconds. For other services different time periods may apply but the necessary changes in the circuits to be described hereinafter should be obvious to one skilled in the art.

Referring to Fig. 7 there is shown a functional diagram of a selector according to the invention. The signal relay 31, previously described, is pulled up in the absence of signal and falls back when a signal is received (in the Fig. 4 circuit) to actuate a dash timing circuit 201. The dash timing circuit in turn actuates a timing transfer relay 203 having connections to a dash counting relay 207 and to an over-timing circuit 209. These circuits are so arranged that if a dash of over 3.25 seconds is received,

the timing transfer and the dash counting relays are operated tentatively establishing a dash count of one. The over-timing circuit is also actuated at this time and has timing circuits arranged to actuate a resetting relay **211** if the dash persists for a time over 6.0 seconds or if the space following the dash exceeds 1.5 seconds. In either case, the resetting relay **211** restores the dash counting relay to the initial position, but if the dash and following space is correct the count stands.

An indicator relay **223** is connected to the dash counting relay to operate an audible warning indicator **225** when the proper number of dashes are counted. A visual warning indicator **227** is preferably connected to the dash counting relay **207** to indicate when acceptable signals are being received. Indicator **227** is arranged to show on the reception of a single dash element of proper length. A time delay switch **215** is connected to the resetting relay **211** and to the indicator relay **223** to open the circuit to the latter if the resetting relay **211** fails for any reason to reject a time period greater than a predetermined period. The audible warning indicator **225** will then indicate as though a warning signal has been received. On checking the receiver, it can be determined whether the warning indicator **225** is functioning in accordance with correct operation of the dash counting relay **207** or failure of the circuit, thus a fail-safe feature is incorporated in the selector of the invention.

Referring to Fig. 8 there is shown a schematic diagram of one arrangement fulfilling the requirements for a selector according to the invention as described above in connection with Fig. 7. When the circuit arrangement is energized by the application of operating potential in the absence of a received signal, the signal relay **31**, the timing transfer relay **203**, the resetting relay **211** and the indicator relay **223** are pulled up; the latter being pulled up only after a reset switch **229** is operated. If the dash counting relay **207** is not in the home position H it will be stepped thereto immediately.

As described above, correct incoming carrier signals will lower the current flowing through the relay winding **33** (shown in Figs. 2 and 4 only) causing the tongue **251** of armature **35** held on the front contact **253** by the application of rectified noise voltage to fall onto the back contact **255**. This removes ground potential from and applies a positive voltage to the grid of a tripper tube, **261**, through a suitable resistance-capacity network **265** comprising a resistor **266** and a capacitor **267**. The capacitor **267** is shunted by a resistor **268** to minimize the effect of leakage resistance of the capacitor, which resistor is, of course, taken into account in determining the time constant of the network. The dash timing network **265** causes a time delay in rendering the grid of the tripper tube **261** positive so that no anode current will flow in the tripper tube **261** circuit until approximately 3.25 seconds have elapsed. The resistor **266** may be adjusted in value so as to cause a time delay of anywhere from 1.5 to 3.5 seconds. At the end of this time, the anode current of the tripper tube **261** triggers the control tube **263**, tubes **261** and **263** forming a monostable reciproconductive circuit, to de-energize the coil **271** of a timing transfer relay **203** and close tongues **275—278** on the associated back contacts. A sensitive relay is used for **203**, one that will hold in with a low value of current. Tubes **261** and **263**, which form a reciproconductive circuit, have a common cathode resistor. The value of this resistor is made such as to produce degeneration, stabilizing the quiescent value of anode current, thereby minimizing vacuum tube variations. Since the anode current in tube **261** is of the order of only 0.6 milliampere, the anode current is never more than the emission capabilities of the cathode, so that there is little or no change in timing over wide ranges in heater voltage. Over a wide range of anode supply voltage the voltage on the cathodes of tubes **261** and **263** always remains approximately 36% of the supply voltage. Since the bias at which the triode **261** begins conduction is approximately proportional to the anode potential and since the charging voltage to the capacitor **267** through resistor **266** is proportional to the anode supply voltage, the timing circuit described will always trigger at about the same length of time after the tongue **251** falls onto the back contact **255**. Summarizing the foregoing, the timing is substantially independent of normal variations in vacuum tube characteristics, of variation in anode supply voltage over a wide range (30–150 volts, for example) and of variation in heater supply voltage over a wide range (3–9 volts, for example).

As employed herein the term "reciproconductive circuit" is construed to include all two tube regenerative devices in which conduction alternates in one or the other tube in response to applied triggering potential. The term "multivibrator" is sometimes applied to this circuit and the term "flip-flop" circuit is sometimes applied to the monostable reciproconductive circuit which is one in which but one trigger is required to switch from the stable state to the unstable state and return. The reciproconductive circuits used in the selector of the invention preferably have a very short unstable condition or substantially instantaneous return to the stable state when the trigger is removed. The step tongue **278** on the associated back contacts then energizes the "notch" or step coil **301** of a stepping relay **207**, which advances this latter relay one position from the initial or home position H to position 1. The tongue **275** and associated contacts on the timing transfer relay **203** is arranged for selective connection of two resistance capacity networks **285** and **295** in the grid circuit of a second tripper tube **281** of the overtiming circuit. The space timing network **285** is constituted by a resistor **286** and a capacitor **287** shunted by a leakage minimizing resistor **288**. The dash over-timing network **295** is constituted by a resistor **296** and a capacitor **297** shunted by a leakage minimizing resistor **298**. When the timing transfer relay **203** is released, that is, when a dash has been received for at least 3.25 seconds (the dash continuing), the dash over-timing network **295** is connected to the grid of tube **281**. If the incoming signal lasts for more than 6.00 seconds, current will flow in the anode circuit of the second tripper tube **281** causing the output tube **283** to be cut off and de-energize a resetting relay **211**. Since the relay **203** is not released until 3.25 seconds have elapsed after the dash was first received the total time for release of the resetting relay **211** is the sum of the times for networks **265** and **295** or $3.25+2.75=6.00$. The lowering of anode current of the tube **283**, in turn, will cause contacts **212** to close on the resetting relay **211**, which will energize the "restore" coil **303**, on the stepping relay **207**. When the signal ceases under these conditions, the dash-counting stepping relay **207** is returned to the initial or home position H.

From the foregoing it may be seen that signals having a duration between 3.25 and 6.0 seconds will cause the stepping relay **207** to advance one position. It is also necessary to provide means for checking that the spaces between dashes are not excessive. This is also accomplished by means of the over-timing reciproconductive circuit comprising the tripper tube **281**, the control tube **283** and the resetting relay **211**. The contacts **212** on the resetting relay **211** energize the "restore" coil **303** of the stepping relay **207**. Spaces are checked as follows. At the end of any dash lasting between 3.25 and 6.00 seconds, the coil of the timing transfer relay **203** is re-energized and the tongue **275** engages front contacts **307** to apply voltage to the grid of the tube **281** through the space over-timing, resistance-capacity network **285**. After a time interval of approximately 4.75 seconds has elapsed, anode current begins to build up in the tripper tube **281**. However, if the subsequent dash after the first one is triggered before the time interval of 4.75 seconds, the timing transfer relay **203** opens again, re-energizing the

tripper tube **281** through the other resistance-capacity network **295**. If the second or subsequent dashes are not completed in time, the resetting relay **211** falls off, thereby energizing the "restore" coil **303** on the stepping relay **207**. In other words, the actual timing of the spaces is performed by measuring the time for the space between dashes plus the minimum time during which the succeeding dash must be present.

A time delay switch **215** is also connected to the resetting relay **211** to be energized if the back contacts **212** are closed so that if for some reason a fault occurs in the system which holds for a long period, or an enormously long dash is received, the time delay switch contacts **217** will open after a given delay time and the indicator relay **223** will be released. The indicator **225** will sound the alarm as though the proper signal had been received, but brief attention to the visual signal **227** will indicate faulty operation rather than receipt of a distress signal. Without the time delay switch **215** it would be possible for the stepping relay **207** to be advanced one step and there remain until the fault was discovered.

The stepping relay **207** is advanced one position after 3.25 seconds of each received dash have elapsed. If the dash persists for 2.75 seconds longer the resetting relay **211** is released causing the dash counting relay **207** to be restored to the home position H. The application of +115 volts through the contacts **212**, a current limiting resistor **219**, and the homing circuit disabling contacts **221**, which are closed at all positions except the home position, to the restore coil **303** causes the relay **207** to be stepped back to the home position. If the dash is between 3.25 and 6.00 seconds long the counting relay **207** remains on the sector corresponding to the dash counted. After 3.25 seconds of the fourth dash, the dash counting relay will be advanced to the fourth position. Thereafter, the indicator relay **223** is held closed during the remainder of the dash by means of the circuit from the +115 volt supply lead through contacts **213** of resetting relay **211**, through contacts **278** of the timing transfer relay **203**, through the dash counting relay arm **231**, through contacts **217** of the time delay switch **215** and thence through the holding contacts of the indicator relay **223**. As soon as the relay **203** is pulled up at the completion of the dash and, provided the relay **211** is still pulled up, contact **278** of timing transfer relay is pulled up, thus removing the voltage supplied to the indicator relay **223** and causing the audible warning indicator **225** to sound. If the fourth dash is too long the relay **211** will fall back before the above mentioned releasing of the indicator relay **223** and will restore the dash counting relay **207** to the home position H. At the end of 3.25 seconds of the fifth dash the arm of relay **207** which in positions 1–4 energizes indicator **227**, energizes the restore coil **303** through the current limiting resistor **219** and the contacts **221**.

The operation of the selector circuit shown in Fig. 8 is graphically represented in Fig. 9. The curve **901** represents two normal four second dashes with a one second space in between. Charging of the dash timing network **265** is represented by curves **903** and **903'**, which network causes the tripper tube **261** to trip after 3.25 seconds of the dash have elapsed as shown. The space overtiming network **285** begins charging at the completion of the dash as shown by curve **905** and is discharged at the completion of the next charging of the network **265** as shown by curve **903'**. The dash overtime network **295** begins charging as soon as the tripper tube **261** trips and is discharged at the end of the dash as shown by curve **907**. Curve **911** represents an overlong dash of seven seconds duration. The dash timing network **265** charges for 3.25 seconds as shown by curve **913** when the tripper tube **261** trips, initiating the dash overtime network charging as represented by curve **917**. The resetting relay **211** resets the dash counting relay **207** at the end of the overtime charging as shown by the arrow. The space overtiming network is not effective in this case as shown by the broken line **915**. An overlong space of two seconds is found between the four second dashes indicated by curve **921**. Curves **923** and **923'** indicate the normal operation of dash timing network **265** and associated components. The space overtiming network is permitted to charge fully for 4.75 seconds as shown by curve **925**, at the end of which resetting occurs as indicated by the arrow. The dash overtime network **295** is charged only for a short length of time as indicated by the curve **927**.

It is possible to time the actual spaces between the dashes instead of timing a space and a dash interval together. Fig. 10 shows the portion of the circuit arrangement shown in Fig. 8 for so timing the spaces. This circuit is exactly the same as the former except that the signal relay **31** has an extra set of contacts **291** which serve to connect the cathode **293** of the tripper triode **281** to the cathode **294** of the output tube **283** in the absence of signal and the time constant of the space timing network **285'** is chosen to be 1.5 seconds instead of 4.75 seconds. The signal relay must be used to eliminate the 3.25 second delay between the signal relay **31** and the timing transfer relay **203**. The use of the latter arrangement is predicated on the availability of fast operating multiple relays for the signal relay. Present F. C. C. standards call for 10 millisecond operating time. The accuracy of the timing operation is considerably greater, however, since the given percentage tolerance at 1.5 seconds is much easier to meet than at 4.75 seconds. The choice of circuit used will depend on the components available.

Automatic alarm systems comprising receivers having circuitry as shown in Figs. 2 and 4 and a selector as shown in Fig. 8 were constructed and tested. Two power supplies were used in these tests. One was a conventional 115 volts ship supply connected as indicated on the drawing at +115 and −115. It is a feature of the design of this system that either of these leads may be at ground potential or both may be free with respect to ground, depending entirely on the particular shipboard installation. The other power supply was a conventional rectifier operating on 60/cs. alternating current directly or from a D. C.-to-A. C. inverted connected to the above mentioned D. C. supply. This rectifier delivered 150 volts, regulated between + reg. and ground and 220 volts unregulated between + and ground.

The following values for component parts particularly described in the specification are given by way of example only:

Tubes

Ref. No.:	Type
43	6AK5
43'	6BJ6
47	6AK5
51	6AK5
55	6AK5
67, 69	12AU7
91	6AK6
151	6BH6
153, 155	6AL5
161	6BJ6
165, 167	12AU7
185	12AU7
108	12AU7
261, 263	12AU7
281, 283	12AU7

Crystal diodes

Ref. No.:	Type
58	1N35
59	1N35
61	1N34
169	1N34
175	1N34
177	1N34
179	1N34A

Resistors

Ref. No.:	Type
77	39 kilohms.
85	6.8 kilohms.
87	47 kilohms.
89	10 kilohms.
90	1100 ohms.
95	470 kilohms.
102	330 kilohms.
104	750 kilohms.
156	2200 ohms.
157	56 kilohms.
159	47 kilohms.
173	15 kilohms.
180	320 kilohms adjustable.
181	8200 ohms.
182	2200 ohms.
183	1 megohm.
184	1 megohm.
193	47 kilohms.
198	10 megohms.
199	1 megohm.
266	2.2 megohms adjustable.
268	10 megohms.
286	3.2 megohms adjustable.
288	10 megohms.
296	1.95 megohms adjustable.
298	10 megohms.

Capacitors

Ref. No.:	Type
105	270 $\mu\mu$f.
160	150 $\mu\mu$f.
162	220 $\mu\mu$f.
163	270 $\mu\mu$f.
186	.0001 μf.
197	2.0 μf.
267	2.0 μf.
287	2.0 μf.
297	2.0 μf.

It should be obvious to one skilled in the art that different values may be used in circuits for different services without departing from the underlying principles of the invention.

The invention claimed is:

1. A receiver including a noise voltage generating carrier wave amplifying circuit, means to apply received carrier waves to said circuit, an amplitude limiting circuit connected to said amplifying circuit, frequency-responsive means connected to said limiting circuit to suppress any carrier frequency component to leave noise frequency components of a different frequency range in the absence of received carrier waves, a noise rectifier circuit coupled to said frequency-responsive carrier frequency suppressing means to derive a direct potential on application of noise frequency components, a current switching circuit coupled to said rectifier circuit, and a relay having a winding coupled to said current switching circuit, said current switching circuit causing one value of current to flow through the winding of said relay insufficient to energize said relay in the absence of said derived direct potential and another value of current sufficient to energize said relay in the presence of said derived direct potential, said limiting circuit being arranged to limit out said noise voltage in the presence of received carrier waves, thereby to de-energize said relay when carrier waves are received or on the failure of any of said circuits to translate said noise voltage to said current switching circuit.

2. A receiver including a modulated carrier wave amplifying circuit, means to apply received waves to said amplifying circuit, an aural signal channel coupled to said amplifying circuit and comprising a detector for detecting any aural signal modulated carrier wave received; a noise signal channel coupled to said amplifying circuit

and comprising an amplitude limiting circuit, a filter circuit coupled to said limiting circuit to suppress any carrier wave component, a noise voltage rectifier circuit coupled to said filter circuit to derive a direct control voltage on the application of noise voltage, a filter network to smooth said derived control voltage, a relay switching circuit coupled to said filter network to pass current of different values in response to said derived direct control voltage, and a relay switching element coupled to said switching circuit to be actuated in opposite manners by said different values of current, said limiting circuit being arranged to limit out said noise voltage in the presence of received carrier waves, thereby to de-energize the relay controlled by said switching element when carrier waves are received or on the failure of any circuit in said noise signal channel to translate said noise voltage to said switching circuit; and connections between said aural signal detector and said noise voltage rectifier to apply potentials from said detector to said rectifier with a polarity opposite to that which is presented to said rectifier from said noise channel.

3. An auto alarm selector, including a signal relay energized in one condition of received signals, a dash timing circuit under the control of said signal relay and comprising a dash timing tube circuit having an input circuit and an output circuit, and a dash timing resistance-capacitance delay network connected to said dash timing tube circuit under control of said signal relay; a timing transfer relay having a plurality of contacts and a winding connected to the output circuit of said dash timing tube circuit, an overtiming circuit comprising an overtiming tube circuit having an input connected to contacts of said timing transfer relay and an output circuit, a dash overtiming resistance-capacitance delay network connected to said overtiming tube circuit under control of said timing transfer relay, and a space overtiming resistance-capacitance delay network connected to said overtiming tube circuit under control of said timing transfer relay; a resetting relay having a set of contacts and a winding connected to the output circuit of said overtiming tube circuit, a dash counting relay having a stepping winding connected to contacts of said timing transfer relay, and a restoring winding connected to contacts of said resetting relay, an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with contacts of said dash counting relay to hold the indicator relay in one condition of operation for a predetermined number of dashes and then to reverse said condition of operation, and means to energize said alarm selector to energize said timing transfer relay, said resetting relay and said indicator relay in a given condition of received signals, said resistance-capacitance networks having time constants at which only signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said dash counting relay.

4. An auto alarm selector, including a signal relay energized in the absence of received mark signals and having a tongue and associated front and back contacts, a dash timing circuit comprising a mark timing reciproconductive circuit having an input circuit and an output circut, and a mark timing resistance-capacitance delay network connected between the back contacts of said signal relay and the input of said reciproconductive circuit; a timing transfer relay having a plurality of arms and associated front and back contacts and a winding connected to the output circuit of said reciproconductive circuit, an overtiming circuit comprising an overtiming reciproconductive circuit having an input connected to one arm of said timing transfer relay and an output circuit, a mark overtiming resistance-capacitance delay network connected to the back contacts of one of said timing transfer relay arms, and a space overtiming resistance-capacitance delay net-

work connected to the front contacts of said one arm; a resetting relay having an arm and associated front and back contacts and a winding connected to the output circuit of said overtiming reciproconductive circuit, a mark counting relay having a stepping winding connected to another arm of said timing transfer relay, and a restoring winding connected to the back contact of said resetting relay, said mark counting relay having a set of stepping contacts, an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with the contacts of said mark counting relay to hold the indicator relay energized for a predetermined number of received mark signals and then to release the indicator relay, and means to energize said alarm selector to energize said timing transfer relay, said resetting relay and said indicator relay in the absence of received mark signals, said resistance-capacitance networks having time constants at which only mark signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said mark signal counting relay.

5. An auto alarm selector, including a signal relay energized in the absence of received signals and having a tongue and associated front and back contacts, a dash timing circuit comprising a dash timing monostable reciproconductive circuit having an input circuit and an output circuit, and a dash timing resistance capacitance delay network connected between the back contact of said signal relay and the input of said monostable reciproconductive circuit; a timing transfer relay having a plurality of arms and associated front and back contacts and a winding connected to the output circuit of said reciproconductive circuit, an overtiming circuit comprising an overtiming monostable reciproconductive circuit having an input connected to one arm of said timing transfer relay and an output circuit, a dash overtiming resistance-capacitance delay network connected to the back contacts of one of said timing transfer relay arms, and a space overtiming resistance-capacitance delay network connected to the front contacts of said one arm; a resetting relay having an arm and associated front and back contacts and a winding connected to the output circuit of said overtiming reciproconductive circuit, a dash counting relay having a stepping winding connected to another arm of said timing transfer relay, and a restoring winding connected to the back contact of said resetting relay, said dash counting relay having a set of stepping contacts, an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with the stepping contacts of said dash counting relay to de-energize the indicator relay only after a predetermined number of dashes have been counted, and means to energize said alarm selector to energize said timing transfer relay, said resetting relay and said indicator relay in the absence of received signals, said resistance-capacitance networks having time constants at which only signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said dash counting relay, the space overtiming network having a time constant determined by the minimum duration of the dash timing network plus the maximum space allowable between dashes.

6. An auto alarm selector, including a signal relay energized in the absence of received signals and having two tongues and associated front and back contacts, a dash timing circuit comprising a dash timing monostable reciproconductive circuit having an input circuit and an output circuit, and a dash timing resistance-capacitance delay network connected to the input of said monostable reciproconductive circuit between one of the back contacts of said signal relay and the associated tongue; a timing transfer relay having a plurality of arms and associated front and back contacts and a winding connected to the output circuit of said reciproconductive circuit, an overtiming circuit comprising an overtiming monostable reciproconductive circuit having an input connected to one arm of said timing transfer relay and the other arm of said signal relay to disable the overtiming circuit in the absence of signal and an output circuit, a dash overtiming resistance-capacitance delay network connected to the back contacts of one of said timing transfer relay arms, and a space overtiming resistance-capacitance delay network connected to the front contacts of said one arm; a resetting relay having an arm and associated front and back contacts and a winding connected to the output circuit of said overtiming reciproconductive circuit, a dash counting relay having a stepping winding connected to another arm of said timing transfer relay, and a restoring winding connected to the back contact of said resetting relay, said dash counting relay having a set of stepping contacts, an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with the stepping contacts of said dash counting relay to de-energize the indicator relay only after a predetermined number of dashes have been counted, and means to energize said alarm selector to energize said timing transfer relay, said resetting relay and said indicator relay in the absence of received signals, said resistance-capacitance networks having time constants at which only signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said dash counting relay.

7. An auto alarm system including an alarm indicator device operable in response to electric current passing therethrough, an indicator energizing circuit comprising a switching element and a source of electric current connected in series with said indicator device, an alarm signal receiver, means to apply operating potential to said receiver, said receiver having an output circuit at which a given output current is provided due to noise in the absence of received carrier wave alarm signals and a substantially reduced output current is provided upon receipt of carrier wave signals, a current responsive circuit arrangement coupled between said receiver output circuit and said switching element to hold said switching element open in the presence of said given output current, a signal selector circuit arrangement interposed between said current responsive circuit arrangement and said switching element and arranged to hold said switching element open on reception of all but a predetermined carrier wave alarm signal and to cause said alarm indicator device to function only upon receipt of said predetermined alarm signals or failure of a circuit component.

8. A fail-safe auto alarm signal receiving system comprising an auto alarm receiver including a noise voltage generating wave translating circuit, means to apply received carrier waves to said circuit, a discriminating circuit connected to said translating circuit to detect and suppress any carrier frequency component upon receipt of carrier waves and to leave noise frequency components in the absence of received carrier waves, a noise rectifier circuit coupled to said discriminating circuit to derive a direct potential in response to the application of noise frequency components, a current switching circuit coupled to said rectifier circuit, a signal relay coupled to said current switching circuit, said current switching circuit causing one value of current to flow through the winding of said relay insufficient to energize said relay in the absence of said derived direct potential and another value of current sufficient to energize said relay in the presence of said derived direct potential, an auto alarm selector in-

cluding contacts of said signal relay, a carrier wave signal timing circuit comprising a signal timing tube circuit having an input and an output, and a signal timing delay network connected to the input of said timing tube circuit under control of said signal relay; a timing transfer relay having a plurality of contacts and a winding connected to the output of said timing tube circuit, an overtiming circuit comprising an overtiming tube circuit having an input connected to contacts of said timing transfer relay and an output, a signal overtiming delay network connected to contacts of said timing transfer relay, and a space overtiming delay network connected to said contacts of said timing transfer relay; a resetting relay having contacts and a winding connected to the output of said overtiming tube circuit, a carrier signal counting relay having a stepping winding connected to said timing transfer relay and a restoring winding connected to said resetting relay, and an auto alarm indicator circuit comprising an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with the contacts of said signal counting relay to maintain current flow through the indicator relay for a predetermined number of received carrier wave signals and then to deenergize the same, said timing delay networks having time constants at which only signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said signal counting relay, to de-energize said indicator relay when said predetermined number of carrier wave signals is received or on the failure of any of said circuits to translate said noise voltage to said indicator current holding circuit, and means to energize said circuits to energize said relays in the absence of received carrier waves.

9. An auto alarm selector, including a signal relay energized in one condition of received signals, a dash timing circuit under the control of said signal relay, a dash timing delay network connected to said dash timing circuit under control of said signal relay, a timing transfer relay having a plurality of contacts and a winding connected to the output of said dash timing circuit, an overtiming circuit connected to contacts of said timing transfer relay, a dash overtiming delay network connected to said overtiming circuit under control of said timing transfer relay, a space overtiming delay network connected to said overtiming circuit under control of said timing transfer relay, a resetting relay having a set of contacts and a winding connected to the output of said overtiming circuit, a dash counting relay having a stepping winding connected to contacts of said timing transfer relay and a restoring winding connected to contacts of said resetting relay, an indicator device actuated by flow of current therethrough, an indicator relay having a winding, holding contacts and indicator contacts connected in circuit with said indicator device, the holding contacts of said indicator relay being in circuit with contacts of said dash counting relay to maintain the indicator relay in one condition of operation for a predetermined number of dashes and then to invert said condition of operation, means to energize said alarm selector to energize said timing transfer relay, said resetting relay and said indicator relay in a given condition of received signals, said delay networks having time constants at which only signals having a length lying between predetermined limits and spaced apart not greater than a predetermined time period are counted by said dash counting relay.

10. A receiver including a noise voltage generating carrier wave amplifying circuit, means to apply received carrier waves to said circuit, an amplitude limiting circuit connected to said amplifying circuit, frequency responsive means connected to said limiting circuit to suppress any carrier frequency component to leave noise frequency components of a different frequency range in the absence of received carrier waves, a noise rectifier circuit coupled to said frequency responsive carrier frequency suppressing means to derive a direct potential on application of noise frequency components, a current switching circuit coupled to said rectifier circuit, and a relay having a winding coupled to said current switching circuit, said current switching circuit causing one value of current to flow through the winding of said relay to cause said relay to assume one condition of operation in the absence of said derived direct potential and another value of current to cause said relay to assume its other condition of operation in the presence of said derived direct potential, said limiting circuit being arranged to limit out said noise voltage in the presence of received carrier waves, thereby to cause said relay to assume said one condition of operation when carrier waves are received or on the failure of any of said circuits to translate said noise voltage to said current switching circuit.

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