

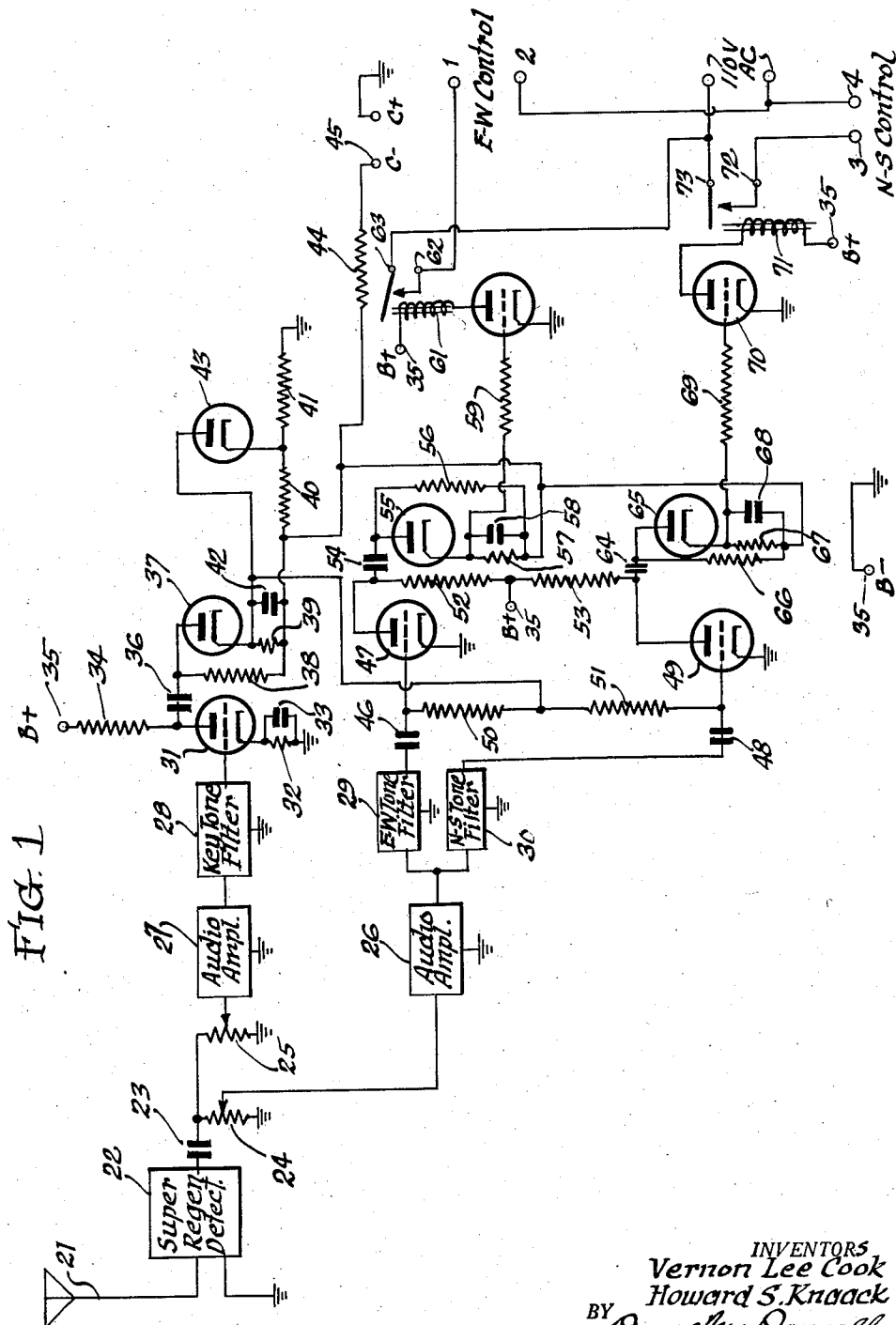
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V. L. COOK ET AL
SIGNALLING SYSTEM

2,881,409

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3 Sheets-Sheet 1



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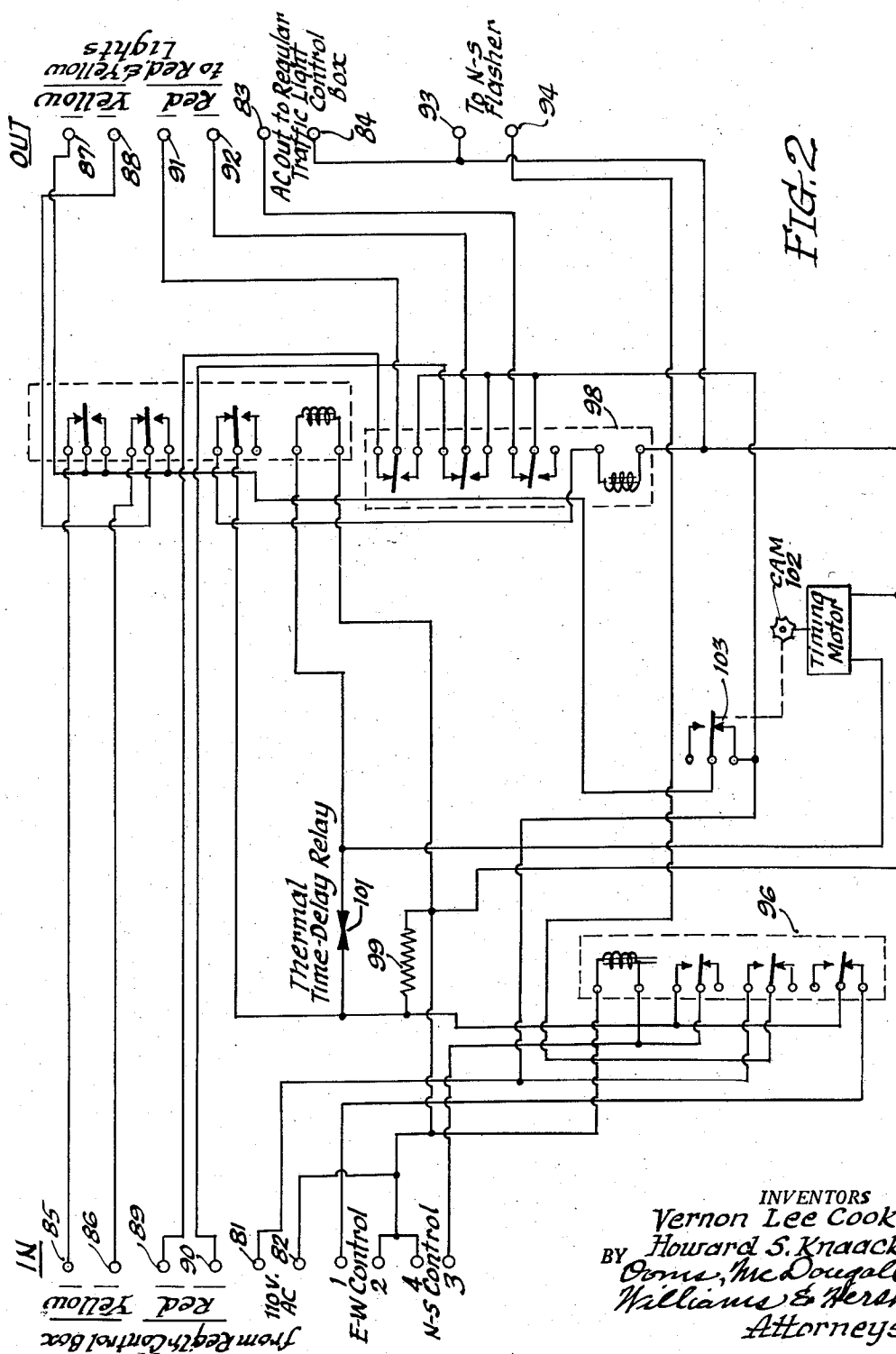
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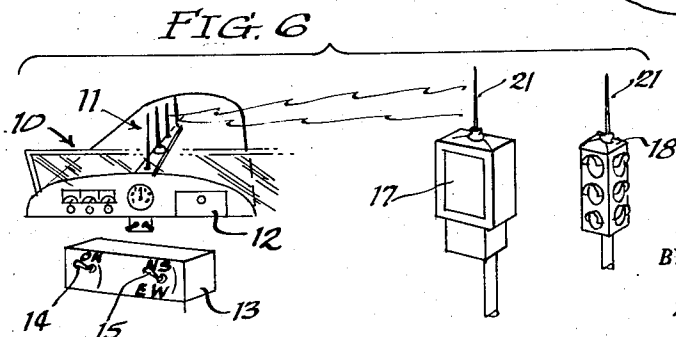
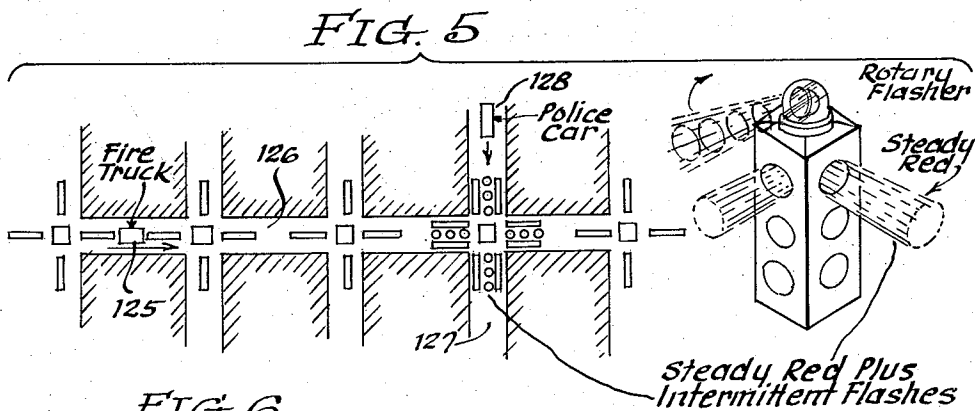
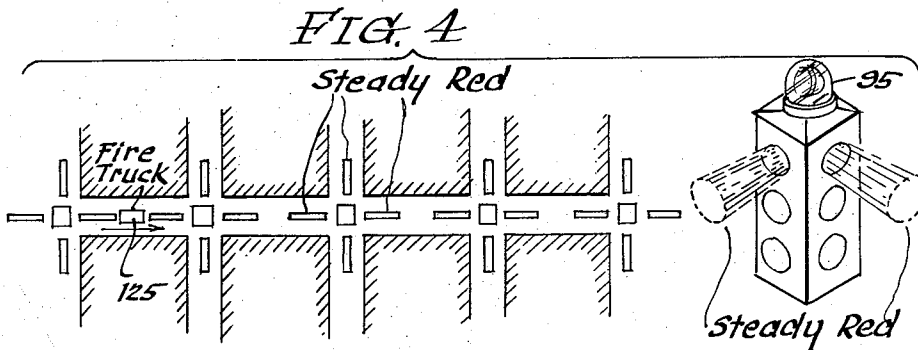
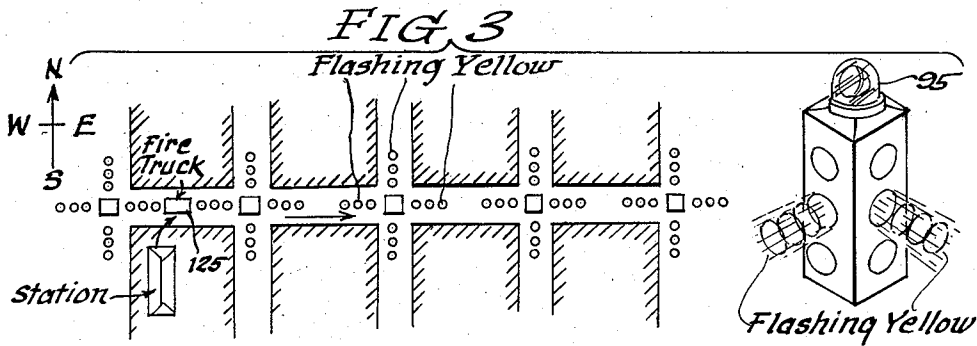
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3 Sheets-Sheet 3



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2,881,409

SIGNALLING SYSTEM

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13 Claims. (Cl. 340—33)

This invention relates to signalling systems, and is particularly directed to a radio-controlled emergency warning system applicable in situations involving mobile units such as railway trains, emergency highway vehicles, and aircraft.

Broadly speaking our invention provides means whereby warning signals or other apparatus may be actuated responsively to movement of mobile units, with means provided particularly for selective actuation of the warning signals or other apparatus responsively to the direction of movement or character of particular mobile units.

In the detailed description of the invention set forth in the appended drawing and the following paragraphs of this specification, the invention will be described as applied to a system of highway traffic control wherein traffic signals are selectively actuated responsively to movement of radio-equipped emergency vehicles such as police squad cars, ambulances, fire-fighting equipment, and so on. From the illustrative description of the invention as applied to such an application, however, persons skilled in the art will readily see how the invention may be used in connection with other applications such as railway signalling and aircraft traffic control. It is to be understood, therefore, that the invention is broadly applicable to many applications and that the detailed description contained herein is merely exemplary.

In the particular application to be described in detail herein, our invention is employed for the purpose of controlling traffic lights when emergency vehicles are on the streets in their vicinity, overriding the conventional timed control of such lights and causing them to halt normal traffic movement so as to provide clear passage for the emergency vehicles. In the application to be described, our invention also encompasses novel means for preventing collisions or interference between emergency vehicles when more than one such vehicle is operating in a given area simultaneously.

A major object of the present invention is to provide means whereby warning signals or other apparatus can be selectively actuated by radio signals emanating from a particular mobile unit, the character of the actuation depending on the direction of movement, type, or other distinguishing characteristic of the mobile unit.

Specifically, as applied to a highway traffic control system, it is an object of the invention to provide means whereby the normal operation of traffic lights may be overridden responsively to radio signals from an emergency vehicle and such lights caused to halt all normal traffic while the emergency vehicle is passing through the area.

Another object of the present invention, as applied specifically to a highway traffic control system, is to provide means whereby the traffic lights in a given area, while stopping all normal traffic while an emergency vehicle is passing through, may be caused also to give forth a distinctive signal indicative of the direction of travel of the emergency vehicle, whereby the driver of another

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emergency vehicle traveling in an intersecting direction may be given warning of the existence and direction of movement of the first vehicle.

Still another object of the present invention is to provide, in a signalling system operable responsively to radio signals emanating from mobile units, novel means controllable for limiting in desired manner the effective range within which such signals can actuate warning devices or other apparatus.

A still further object of the present invention is to provide, in a signalling system operable responsively to radio signals transmitted from mobile units, means preventing chance actuation of warning signals or other apparatus responsively to radio signals other than the desired control signals.

Other objects and advantages of our invention will appear from the following detailed description of a specific embodiment thereof.

In the appended drawing, Figure 1 is a schematic and block diagram showing a portion of the receiving apparatus employed in connection with a typical traffic signal in accordance with our invention, and Fig. 2 is a schematic and block diagram showing the remainder of such receiving apparatus. Figs. 1 and 2 may be studied in conjunction with one another. Fig. 3 is a diagrammatic view of an area comprising several street intersections equipped with traffic lights, showing the manner in which, according to our invention, the traffic lights are controlled by radio signals from an emergency vehicle during the few seconds immediately after the transmitting equipment is turned on or the vehicle comes within radio range, as the case may be. Fig. 4 is a similar view showing the manner in which the traffic lights are controlled following the initial few seconds of radio reception. Fig. 5 is a diagrammatic view of several street intersections, generally similar to Figs. 3 and 4, showing the operation of our invention in the situation wherein two emergency vehicles are simultaneously moving in the area, on intersecting courses. Fig. 6 is a diagrammatic showing of the transmitting equipment normally mounted on emergency vehicles in accordance with our invention and showing also alternative methods of mounting the receiving apparatus.

In the application of our invention to a system of highway traffic control, we provide each traffic light, or group of traffic lights at a single intersection, with a receiving unit comprising a radio receiver and control mechanism to be described in detail hereinafter. Each emergency vehicle which is to operate within the affected area is provided with a radio transmitter and a directional antenna. The various receiving units are continuously operative, while the transmitting units are operative only when turned on by persons in the vehicles. This permits the operators of emergency vehicles either to control the traffic lights or not, at will, just as in the past the operators of such vehicles could at will turn on or off sirens, rotating lights, and other types of warning signals. A typical transmitting installation, and two different forms of receiving installation are diagrammatically shown in Fig. 6, wherein an emergency vehicle 10 is provided with a directive radio antenna 11, a radio transmitter 12, and a control box 13. As will be observed from Fig. 6, control box 13 is provided with an off-on switch 14 and a second switch 15 having two positions, one of which is marked "N-S" and the other of which is marked "E-W," standing respectively for north-south and east-west. The change in transmitted signal which results from a shift of switch 15 from one position to the other is effective, in a manner to be described hereinafter, to change the character of the warning signals produced by the traffic lights. Thus an emergency vehicle traveling

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north or south can cause the traffic lights along its path of movement to produce distinctive signals which will not only cause a ordinary traffic to stop but will warn drivers of other emergency vehicles moving east or west.

Since the electronic circuitry of transmitter 12 may be conventional, we have not herein shown it in detail and will describe it only in general terms. It should comprise an R-F. section effective to generate a carrier signal of the desired UHF frequency, typically about 450 megacycles per second. The transmitter should also be provided with a suitable modulator operative to modulate the carrier wave with a plurality of low-frequency signals, normally tones in the audio range. The particular frequencies of these tones are not critical, although they should be separated in frequency sufficiently to facilitate filtering one from another. In the embodiment shown herein, three modulating tones are provided.

One modulating tone, hereinafter called the "key tone," is impressed on the R-F. carrier at all times when transmitter 12 is radiating. The other two tones will hereinafter be referred to respectively as the "N-S tone" and the "E-W tone." The transmitter 12 is so arranged that when the switch 15 is in the N-S position the N-S tone and the key tone simultaneously modulate the carrier signal, the E-W tone being absent. When switch 15 is in the E-W position, the key tone and the E-W tone are impressed on the carrier wave, the N-S tone being absent.

The antenna 11 should be designed for the carrier frequency in use and should preferably be designed so as to radiate a major lobe of energy in the forward direction and a weaker minor lobe to the rear. The antenna 11 shown in Fig. 6 is a ground-plane array comprising a driven element, a reflector, and two director elements.

Each traffic light or group of traffic lights to be controlled by our invention is provided with a receiving apparatus responsive to radio signals in the frequency range transmitted by the various transmitters 12. In cases where a group of traffic lights on the various corners of an intersection are operated from a common control box, the receiving equipment will normally be incorporated within the control box 17, as shown in Fig. 6, or, at intersections wherein a single traffic light controls traffic at an intersection, the receiving equipment may be installed within the housing of the traffic light itself, as designated in Fig. 6 with the reference numeral 18.

The electronic circuitry of a typical receiving installation is shown in Fig. 1 in block and schematic form, while the associated control equipment used therewith is diagrammatically illustrated in Fig. 2. In studying Figs. 1 and 2, it should be assumed that the numbered terminals on Fig. 1 are connected to the correspondingly numbered terminals on Fig. 2.

In a typical receiving installation as shown in Fig. 1, a receiving antenna 21 is connected to a suitable receiver, which in the illustrated embodiment is a super-regenerative detector 22. It will be understood that more complicated receiving circuits may be used if desired, but we have found them to be unnecessary in practice.

It will of course be understood that the detector 22 is designed and tuned to respond to signals of the frequency transmitted by the various transmitters 12—in a typical case, waves in the neighborhood of 450 megacycles per second.

The signal at the output of the super-regenerative detector 22 will of course consist of the modulation components of the transmitted signal being received at the moment—that is, a mixture of the key tone with either the N-S tone or the E-W tone. (In some cases, of course, the output signal may include all three tones, since signals may be coming in simultaneously from one emergency vehicle traveling north or south and another emergency vehicle traveling east or west.)

The output signal from detector 22 is fed through a coupling capacitor 23 to a pair of potentiometers respectively marked 24 and 25. The fixed resistance elements

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of potentiometers 24 and 25 are connected in parallel across the output of detector 22. The adjustable arm of potentiometer 24 is connected to the input of an audio amplifier 26, while the adjustable arm of potentiometer 25 is connected to the input of a separate audio amplifier 27.

The output of audio amplifier 27 is fed to a band-pass filter 28 designed to pass the key tone and to reject other frequencies, so that the signal at the output of filter 28 consists only of the key tone, provided the received signal carries a key-tone modulation component. If no such component is present in the signal being received, then there is no signal present at the output of filter 28.

The output of audio amplifier 26 is fed simultaneously to a pair of band-pass filters 29 and 30. Filter 29 is a band-pass filter designed to pass the E-W tone and to reject all other frequencies, while filter 30 is a band-pass filter designed to pass the N-S tone, rejecting other frequencies.

The output of key-tone filter 28 is applied to the grid of triode 31, the cathode of which is connected to ground through a parallel circuit comprising resistor 32 and bypass capacitor 33. The plate of tube 31 is connected to a positive voltage source 35 through plate load resistor 34, the negative of such voltage source being grounded. The plate of tube 31 is also connected through coupling capacitor 36 to the plate of diode 37. Resistors 38 and 39 are connected in series between the plate and cathode of diode 37. The junction between resistors 38 and 39 is connected to ground through a series circuit comprising resistors 40 and 41. Resistor 39 is shunted by capacitor 42. The plate of diode 43 is connected to the cathode of diode 37, while the cathode of diode 43 is connected to the junction of resistors 40 and 41. The junction point between resistors 38 and 39 is connected through resistor 44 to the negative terminal of a bias-voltage source 45, the positive terminal of such voltage source being grounded.

The output of filter 29 is fed through coupling capacitor 46 to the grid of a triode 47, the cathode of which is grounded. Similarly, the output of filter 30 is fed through coupling capacitor 48 to the grid of triode 49, the cathode of which is grounded. Resistors 50 and 51 are connected in series between the grid of tube 47 and the grid of tube 49, the junction point of such resistors being connected to the cathode of diode 37. Plate load resistors 52 and 53 are connected in series between the plate of tube 47 and the plate of tube 49, the junction point of such resistors being connected to the positive terminal of voltage supply 35.

The plate of tube 47 is also connected through coupling capacitor 54 to the plate of diode 55. Resistors 56 and 57 are connected in series between the plate of diode 55 and its cathode, resistor 57 being shunted by capacitor 58. The junction between resistors 56 and 57 is connected to the junction between resistors 38 and 39.

The cathode of diode 55 is connected through resistor 59 to the grid of triode 60, the cathode of which is grounded. The plate of tube 60 is connected to the positive terminal of voltage source 35 through the coil 61 of a relay having a pair of normally open contacts 62 and 63, which close when coil 61 is energized. Terminal 62 is connected to output terminal 1, while output terminal 2 is connected to one side of a conventional A.-C. power line, normally 110 volts at 60 cycles per second. The terminals 1 and 2 are marked with the legend "E-W" control," and are connected to the correspondingly numbered terminals on Fig. 2.

The plate of tube 49 is connected through coupling capacitor 64 to the plate of diode 65. Resistors 66 and 67 are connected in series between the plate and cathode of diode 65, resistor 67 being shunted by capacitor 68. The junction of resistors 66 and 67 is connected to the junction of resistors 38 and 39. The cathode of diode 65

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is connected through resistor 69 to the grid of triode 70, the cathode of which is grounded. The plate of tube 70 is connected to the positive terminal of voltage source 35 through the coil 71 of a relay having a pair of normally open contacts 72 and 73. Contact 72 is connected to output terminal 3, while contact 73 is connected to the same side of the 110-volt power line as contact 63. Output terminal 4 is connected to the same side of the 110-volt power line as output terminal 2. Terminals 3 and 4 are marked with the legend "N-S control" and are connected to the correspondingly numbered terminals on Fig. 2.

As shown in Fig. 2, the control mechanism which forms a part of our invention is connected in circuit between the traffic lights themselves and the regular control box which governs their normal operation. In addition, the regular source of 110-volt alternating current normally supplied to the regular control box is connected instead of terminals 81 and 82 of our apparatus and A.-C. for normal operations is supplied to the regular control box from the terminals 83 and 84 of our control apparatus. By this means, we are able to "take over" the control of the lights from the regular box whenever a radio signal from one of the transmitters 12 is received.

As persons familiar with traffic-light operation will understand, control of the lights of a given color normally involves two time phases—that is, when the red lights directed north and south are energized, the red lights directed east and west will be off, and vice versa. Similarly, the amber or yellow lights have a two-phase operation, since normally the amber lights will be energized only for a brief interval near the end of the "green" period along a given line of direction, the amber lights along the other line of direction being off during such period.

The input terminals on Fig. 2 designated 85 and 86 receive the "hot" leads normally running from the regular control box to the north-south and east-west yellow lights respectively, it being understood that the other terminals of such lights are connected to a common return circuit. The respective sets of yellow lights are connected to the output terminals 87 and 88 on Fig. 2.

Similarly, the "hot" leads normally controlling the two sets of red lights are connected to input terminals 89 and 90 on Fig. 2 and the red lights themselves are respectively connected to the output terminals 91 and 92, there being as usual a common return circuit for both sets of lights.

The signals developed at the output terminals 1 and 2 of Fig. 1 are applied to the correspondingly numbered input terminals on Fig. 2, and similarly the output signal developed at terminals 3 and 4 of Fig. 1 is applied to the correspondingly numbered terminals 3 and 4 of Fig. 2. Output terminals 93 and 94 of the Fig. 2 structure are in the illustrated embodiment connected to a rotary flasher 95 of the type commonly found on the roofs of police cars, operative when energized to send out a rotating beam of red light, either continuously or in intermittent flashes. (See Figs. 3-5.)

As will be hereinafter explained in connection with the operation of the invention, the flasher 95 is actuated responsively to radio signals emanated from an emergency vehicle traveling north or south, in order that the presence of such a vehicle may be made known to drivers of other emergency vehicles moving on intersecting paths. It should be understood, of course, that the use of rotary flasher 95 for this purpose is merely illustrative and any other type of suitably distinctive signal may be substituted therefor.

The control mechanism illustrated in Fig. 2 comprises relays 96, 97, and 98, each of which is provided with an energizing coil and a plurality of contacts. In addition, the apparatus includes a time-delay relay comprising a heating element 99 and a pair of normally closed

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contacts 101. In the embodiment shown, the time-delay relay should be designed to open contacts 101 a short time—perhaps three to five seconds—after current is applied to heating element 99.

The control equipment also comprises a flasher mechanism consisting of a motor-driven cam 102 and a pair of cam-operated contacts 103.

The various components in the control mechanism are wired together in the manner illustrated schematically in Fig. 2. It will be unnecessary in this specification to describe in detail this wiring, since it is fully disclosed in the drawing, but the operation of the mechanism will be dealt with in considerable detail in subsequent paragraphs hereof.

The values of components employed in the illustrative receiving and control apparatus shown in Figs. 1 and 2 may be varied considerably in accordance with the taste of the particular designer. The following table of component values has been found to be highly satisfactory in practice and is given herein as typical. It should be understood, however, that the following table of values is merely illustrative:

Component No.:	Value
24, 25	500,000 ohms.
31, 47, 49	12AX7.
60, 70	12AU7.
37, 43, 55	6AL5.
32	3,300 ohms.
33	20 mf.
34, 52, 53	180,000 ohms.
50, 51	500,000 ohms.
36	.01 mf.
38, 56, 66	220,000 ohms.
39	1 megohm.
40	100,000 ohms.
41	10,000 ohms.
42	1 mf.
44	10,000 ohms.
46, 48	0.1 mf.
54, 64	0.1 mf.
57, 67	6.8 megohms.
58, 68	1 mf.
59, 69	2.2 megohms.

The relays 61 and 71 are conventional high-sensitivity relays designed to operate on the normal plate current of the particular tubes chosen as tubes 60 and 70. Similarly, the relays 96, 97, and 98 shown on Fig. 2 are conventional relays having contacts as indicated and coils designed to operate on 110-volt A.-C.

Operation

Describing the operation of our invention, we shall first deal with the manner in which the Fig. 1 equipment develops an appropriate control voltage responsively to radio signals received from a transmitter 12.

Normally, when no signal from an emergency vehicle is being received, both relay 61 and relay 71 are de-energized, so that no output voltage appears across either terminals 1 and 2 or terminals 3 and 4. This condition is brought about by the fact that both tubes 60 and 70 are normally biased negatively beyond cut-off by the voltage from the bias supply 45.

Now suppose, for purposes of illustration, that an emergency vehicle is travelling on a street in a westerly direction and is accordingly transmitting signals from its transmitter 12 with the switch 15 in the E-W position. In such case, the radiated signal will consist of the UHF carrier wave modulated by the key tone and the E-W tone. On being received at the receiving antenna 21, the signal is detected by detector 22 and the modulation components are fed to amplifiers 26 and 27.

The key-tone filter 28 filters off the signal component of the key-tone frequency and applies that signal to the grid of tube 31. The amplified output of tube 31 is rec-

tified by diode 37, producing a D.-C. voltage across resistor 39 of polarity which bucks the voltage from bias supply 45 and hence raises the potential on the grids of tubes 47 and 49 to a level above cut-off.

At the same time, the filter 29 picks off the E-W tone component from the received signal and applies it to the grid of tube 47. Since tube 47 is now in a conducting condition, it amplifies the applied signal, and the amplified output at the plate of tube 47 is rectified by diode 55, producing a D.-C. voltage across resistor 57 having a polarity bucking the voltage of bias supply 45 and hence raising the potential of the grid of tube 60 above cut-off. As a result tube 60 commences to conduct, relay 61 is energized, contacts 62 and 63 are closed, and an A.-C. potential of 110 volts, 60 cycles, appears across terminals 1 and 2.

No corresponding action takes place with respect to the output terminals 3 and 4, for the reason that no N-S tone is present in the received signal and hence no signal voltage is applied to the grid of tube 49.

If the received signal be derived from a transmitter 12 which is radiating an N-S signal, the modulation components will consist of the key tone plus the N-S tone. In such event, the operation just described will take place, except that the relay 71 will be actuated and the control voltage will appear at terminals 3 and 4 rather than at terminals 1 and 2.

Should signals be received simultaneously from emergency vehicles traveling at right angles, so that both E-W tone and N-S tone are present in the output signal from detector 22, it is possible for both relays 61 and 71 to be actuated with the result that control voltage may appear at both sets of output terminals.

Now referring to Fig. 2 we shall describe the operation of the control circuit responsively to the appearance of control voltage at terminals 1 and 2 or 3 and 4.

Normally, when no radio signal from an emergency vehicle is being received, the traffic light will operate in conventional fashion, since under such conditions terminals 85 and 86 are respectively connected to terminals 87 and 88, terminals 89 and 90 are respectively connected to terminals 91 and 92, and terminals 81 and 82 are respectively connected to terminals 83 and 84. (All the relay contacts on Fig. 2 are shown in the position which they occupy when the relay coils are deenergized.)

Now suppose a radio signal is received from an emergency vehicle transmitting an E-W signal, with the result that 110 volts A.-C. appears across terminals 1 and 2, the E-W controls terminals. Thereupon the circuit by which 110-volt A.-C. power is supplied to the regular control box is interrupted, cutting off normal control of the traffic lights, and the yellow or amber lights in both directions are caused to commence intermittent flashing. This condition lasts until after heating element 99 has sufficiently heated the thermal relay 101 to cause contacts 101 to open. When that occurs, the yellow flashes cease, and the traffic light gives off steady red signals in all directions so long as control voltage continues to appear between terminals 1 and 2, that is, so long as the radio signal continues to be received by receiver 22.

The flashing-yellow condition which occurs for a few seconds just after the radio signals are received is illustrated diagrammatically in Fig. 3. In that figure, an emergency vehicle 125 is shown just after entering the street. Since it is traveling eastward, its transmitter 12 is radiating an E-W signal, by means which will be described in a later paragraph, the various receivers associated with the traffic lights are so adjusted that the signals from a transmitter 12 will be operative for four or five blocks ahead of the emergency vehicle and for about one block behind it. As a result all the traffic lights shown in Fig. 3 will be thrown over into emergency operation and will begin showing flashing yellow in all directions.

After a few seconds, all the traffic lights within range

of the signal from the emergency vehicle 125 will shift to steady red in all directions, as shown in Fig. 4.

As vehicle 125 progresses eastward along the street, the lights behind it will gradually return to normal operation as the vehicle 125 passes out of radio range, and the traffic lights ahead of vehicle 125 will, one by one, commence the emergency-operation cycle as vehicle 125 comes within radio range.

Now suppose an emergency vehicle traveling north or south commences transmitting with the switch 15 of its transmitter 12 placed in N-S position. Under those conditions, a 110-volt A.-C. potential will appear at terminals 3 and 4, the N-S control terminals.

Appearance of voltage at terminals 3 and 4 initiates a cycle similar to that caused by voltage at the E-W control terminals 1 and 2 except that, in addition to producing flashing yellow signals in all directions followed by steady red signals in all directions, the rotary flasher 95 is placed into operation. Thus an emergency vehicle traveling north and south will produce, on the traffic lights within its radio range, an emergency warning signal which is distinctively different from that produced by an emergency vehicle traveling east or west. This situation is illustrated in Fig. 5. In that figure, the emergency vehicle 125 previously mentioned is traveling eastward, causing the traffic lights along street 126 to be thrown into emergency condition as previously described. On street 127, however, a second emergency vehicle 128 is traveling southward and, of course, transmitting N-S radio signals. As a result, the radio receiver controlling the traffic lights at the intersection of streets 126 and 127 is receiving an N-S signal as well as an E-W signal, with the result that its flasher 95 is transmitting red flashes in all directions in addition to showing steady red in all directions on the regular red traffic lights. Hence the driver of vehicle 125 is made aware, as he approaches street 127, that another emergency vehicle is operating on that street, and he will accordingly approach street 127 with caution to avoid a collision with vehicle 128.

When the emergency vehicles pass out of radio range and signals are hence no longer being received by receiver 22, the operation of the traffic light being controlled by receiver 22 will promptly return to normal.

An important feature of our invention consists in its freedom from chance actuation by random radio signals other than those transmitted by authorized emergency vehicles. This immunity is achieved by our apparatus which requires that both the key tone and a control tone be present as modulation components of the received signal before the normal operation of a traffic light can be affected.

Another important feature of our invention consists in the arrangement by which the radio range can be accurately adjusted without cutting down significantly the sensitivity of the receiving apparatus to the control tones, N-S or E-W as the case may be. This operation is achieved by the separate gain-control potentiometers 24 and 25 which permit independent adjustment of the sensitivity of the receiving apparatus to the key tone on the one hand and the control tones on the other hand.

Still another important feature of our invention involves the operation of the cathode capacitors 42, 58 and 68, in conjunction with the resistors 39, 57, 59 and 67, 69 with which they are respectively associated. As may be noted by reference to Fig. 1, capacitor 42, shunted by resistor 39, forms a charge-storage circuit of relatively long time constant. Capacitor 42, in the presence of a key-tone signal, may be charged rapidly through the relatively low impedance of diode 37, but its discharge can take place only through the high-impedance path provided by resistor 39. Thus capacitor 42, once charged to a given potential, will hold a substantial charge for a considerable interval.

Similarly, the cathode capacitor 58 in circuit with diode 55 and cathode capacitor 68 in circuit with diode 65 can

charge rapidly through the respective diodes but can discharge only through high-resistance discharge paths.

The result achieved by these circuits is that once the signal channels have become unblocked by the presence of a received radio signal, they will not reblock or cut out except after signals have been absent for several seconds.

This leads to a very important practical result—it makes operation of our signalling system independent of short-term variations in signal strength—so-called “dead spots”—which are likely to be encountered during reception of UHF radio signals from a moving source such as a vehicle. Without this feature, the signalling system would be subject to erratic operation whenever signals from the controlling vehicle are momentarily at a low level.

Generally speaking, it will be desirable to have the zone of emergency control extend four or five blocks ahead of an emergency vehicle and about one block behind it. The ratio of the effective range forward to effective range rearward will be determined by the characteristics of the transmitting antenna 11; a ratio of four to one or five to one can easily be obtained with a relatively simple directional array.

To limit the effective range to the desired value, say five blocks, the potentiometer 25 is adjusted in each of the receiving installations until the key-tone signal applied to diode 37 from a vehicle five blocks away is just sufficient to “unlock” the grids of tubes 47 and 49. At the same time, potentiometer 24 can be adjusted to yield a substantially higher gain, so as to insure that an ample signal will be present for triggering relay 61 or 71, as the case may be, out to the limit range.

This feature by which the receiver sensitivity to the key tone can be adjusted independently of the receiver sensitivity to the control tones is highly important in assuring stable and dependable operation. Without that feature, as the distance from the transmitting station is increased, the key-tone and control-tone signals drop down to marginal levels simultaneously with resulting susceptibility to fading and other disturbing factors. With independent sensitivity control of the key tone and the control tones, as provided in our invention, strong, noise-free control-tone signals can be employed all the way out to limit range.

While we have in this specification described in detail an embodiment of our invention as applied to the field of traffic-light control by emergency vehicles, it will be understood that the embodiment of our invention thus described is merely illustrative of one application of our invention. Numerous other fields of application for our invention exist. Moreover, the specific apparatus herein disclosed is merely illustrative, and persons skilled in the art will be able to introduce many changes and variations in the apparatus disclosed without departing from the spirit and basic principles of our invention.

We claim:

1. In a remotely controlled signalling system, the combination which comprises a mobile vehicle, radio signal transmitting means carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and a control component, means associated with said transmitting means manually operable to activate and inactivate said transmitting means, a warning signal located off said vehicle, radio receiving means associated with said warning signal and adapted to receive the radio signals from said transmitting means, said receiving means being provided with at least two separate receiving channels, one of said channels being adapted to receive selectively the key component of said radio signal and the other of said channels being adapted selectively to receive the control component of said radio signal, gate means for rendering inoperative said control-component receiving channel, means coupling said key-component receiving channel to said gate means operative to ungate said control-com-

ponent receiving channel responsively to receipt of said key component by said first-mentioned receiving channel, and control means coupling the output of said control-component receiving channel to said warning signal operative to actuate said warning signal responsively to receipt of said control component at the output of said control-component receiving channel.

2. In a remotely controlled signalling system, the combination which comprises a mobile vehicle, radio signal transmitting means carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and one control component, means associated with said transmitting means selectively adjustable to either of two states for controlling the character of said radio signal, said radio signal comprising a key component and a first control component when said means is in one state and comprising said key component and a second control component when said means is in said other state, warning-signal means located off said vehicle, said warning-signal means being adapted to produce either a first warning signal or a second warning signal sensually distinct from said first warning signal, radio receiving means associated with said warning-signal means adapted to receive radio signals from said transmitting means, said receiving means being provided with three separate receiving channels, one of said channels being adapted to receive selectively the key component of said radio signal, another of said channels being adapted to receive selectively said first control component, and the other of said channels being adapted to receive selectively said second control component, gate means for rendering inoperative both of said control-component receiving channels, means coupling said key-component receiving channel to said gate means operative to ungate said control-component receiving channels responsively to receipt of said key component by said first-mentioned receiving channel, first control means coupling the output of said first control-component receiving channel to said warning-signal means operative responsively to receipt of said first control component at the output of said last-mentioned channel to cause said warning-signal means to produce said first type of warning signal, and second control means coupling the output of said other control-component receiving channel to said warning-signal means operative responsively to receipt of said second control component at the output of said other channel to cause said warning-signal means to produce said distinctive other type of warning signal.

3. In a remotely controlled signalling system, the combination which comprises a mobile vehicle, radio signal transmitting means carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and a control component, means associated with said transmitting means manually operable to activate and inactivate said transmitting means, a warning signal located off said vehicle, radio receiving means associated with said warning signal and adapted to receive the radio signals from said transmitting means, and control means coupling said receiving means to said warning signal operative to actuate said warning signal responsively to receipt of said radio signal by said receiving means, said control means comprising means selectively responsive to said key component and said control component and being operative to actuate said warning signal only when both of said components are present in the radio signal received by said receiving means.

4. In a remotely controlled signalling system, the combination which comprises a mobile vehicle, radio signal transmitting means carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and one control component, means associated with said transmitting means selectively adjustable to either of two states for controlling the character of said radio signal, said radio signal

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comprising a key component and a first control component when said means is in one state and comprising said key component and a second control component when said means is in said other state, warning-signal means located off said vehicle, said warning-signal means being adapted to produce either a first warning signal or a second warning signal sensually distinct from said first warning signal, radio receiving means associated with said warning-signal means adapted to receive radio signals from said transmitting means, and control means coupling said receiving means to said warning-signal means operative to actuate said warning-signal means responsively to receipt of radio signals, said control means being adapted to cause said warning-signal means to produce said first warning signal when said received radio signal comprises said key component and said first control component and to cause said warning-signal means to produce said second warning signal when said received radio signal comprises said key component and said second control component.

5. Apparatus according to claim 4 wherein said last-mentioned control means comprises also a gating circuit operative to inactivate said control means except upon receipt of a radio signal comprising said key component.

6. Apparatus according to claim 1 wherein said separate receiving channels have independently adjustable sensitivity-control means.

7. Apparatus according to claim 2 wherein said key-component receiving channel is provided with sensitivity-control means operable independently of said control-component receiving channels.

8. In a system for controlling street traffic to provide clear right of way for emergency vehicles, the combination which comprises a mobile emergency vehicle, a transmitter carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and a control component, means associated with said transmitting means operable manually at will to cause said transmitting means to transmit a signal including said key component and either a first control component or a second control component, a traffic light positioned at a street intersection, said traffic light normally displaying green and red signals in accordance with a predetermined time pattern for controlling movement of traffic at such intersection, said traffic light comprising also an additional signal apart from said red and green lights, radio receiving means associated with said traffic light adapted to receive radio signals from said transmitting means, and control means coupling said receiving means to said traffic light operative responsively to radio signals received by said receiving means to suspend the normal operation of said traffic light and to cause said traffic light to display special warning signals in lieu of said normal operation, said control means being adapted to cause said traffic light to display red signals in all directions of traffic movement at said intersection when said receiving means is receiving a signal comprising said key component and said first control component and causing said traffic light to display red signals in all directions of traffic movement at said intersection and to actuate also said additional signal when said receiving means is receiving a radio signal comprising said key component and said second control component.

9. In a system for controlling street traffic to provide clear right of way for emergency vehicles, the combination which comprises a mobile emergency vehicle, a transmitter carried by said vehicle operative to transmit a radio signal, means associated with said transmitting means manually operable at will for causing said transmitting means to transmit either a first-type radio signal or a second-type radio signal, a traffic light positioned at a street intersection, said traffic light normally displaying green and red signals in accordance with a predetermined time pattern for controlling movement of traffic at such intersection, said traffic light comprising also

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an additional signal apart from said red and green lights, radio receiving means associated with said traffic light adapted to receive radio signals from said transmitting means, said receiving means being responsive to both first-type signals and second-type signals, and control means coupling said radio receiving means to said traffic light operative responsively to radio signals from said transmitting means received by said receiving means to suspend normal operation of said traffic light and to cause said traffic light to display special signals so long as said radio signals continue to be received by said receiving means, said control means being operative responsively to receipt of first-type signals by said receiving means to cause said traffic light to display red lights in all directions of traffic movement at said intersection and being operative responsively to receipt of second-type signals by said receiving means to display red lights along all directions of traffic movement at such intersection and also to actuate said additional signal.

10. For use in a radio-controlled traffic-control system for facilitating free movement of emergency vehicles, the combination which comprises a traffic light situated at a street intersection and having red and green lights normally operated in accordance with a predetermined time pattern for controlling movement of traffic at said intersection, said traffic light having also another warning signal in addition to said red and green lights, radio receiving means associated with said traffic light and situated at said intersection, said radio receiving means comprising a first signal channel and a second signal channel, each of said signal channels being adapted for selective reception of a distinct radio signal of predetermined character, and control means coupling said receiving means to said traffic light operative responsively to signals derived from said receiving channels to suspend the normal operation of said traffic light and to cause said traffic light to display special signals throughout the period wherein said channel-derived signals are being applied to said control means, said traffic light being caused to display red lights along all directions of traffic movement at said intersection responsively to signals derived from said first signal channel and being caused to display red lights along all directions of traffic movement at said intersection plus said additional warning signal responsively to signals derived from said second signal channel.

11. For use in a radio-controlled traffic-control system for facilitating free movement of emergency vehicles, the combination which comprises a traffic light situated at a street intersection and having red and green lights normally operated in accordance with a predetermined time pattern for controlling movement of traffic at said intersection, said traffic light having also another warning signal in addition to said red and green lights, radio receiving means associated with said traffic light and situated at said intersection, said radio receiving means comprising a key channel and two control channels, each of said channels being adapted for selective reception of a distinct radio signal of predetermined character, gating means normally operative to inactivate said first and second control channels, means coupling said key channel to said gate means operative to ungate said control channels responsively to receipt of a radio signal at the output of said key channel, and control means coupling said control channels to said traffic light operable responsively to receipt of radio signals at the outputs of said control channels to suspend the normal operation of said traffic light and to cause the same to display special signals so long as said radio signals continue to be received at the output of either of said control channels, said traffic light being caused to display red lights along all directions of traffic movement at said intersection responsively to receipt of radio signals at the output of said first control channel and being caused to display red lights along all directions of traffic movement at said intersection plus said additional warning signal respon-

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sively to receipt of radio signals at the output of said second control channel.

12. In a remotely controlled signalling system, the combination which comprises a mobile vehicle, radio signal transmitting means carried by said vehicle operative to transmit a radio signal comprising distinct components including at least a key component and a control component, means associated with said transmitting means manually operable to activate and inactivate said transmitting means, a warning signal located off said vehicle, radio receiving means associated with said warning signal and adapted to receive the radio signals from said transmitting means, said receiving means being provided with at least two separate receiving channels, one of said channels being adapted to receive selectively the key component of said radio signal and the other of said channels being adapted selectively to receive the control component of said radio signal, gate means for rendering inoperative said control-component receiving

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channel, means coupling said key-component receiving channel to said gate means operative to ungate said control-component receiving channel responsively to receipt of said key component by said first-mentioned receiving channel, said coupling means comprising time-delay means operative to hold said control-component receiving channel ungated for a short interval of time after said key component ceases to be received, and control means coupling the output of said control-component receiving channel to said warning signal operative to actuate said warning signal responsively to receipt of said control component at the output of said control-component receiving channel.

13. Apparatus according to claim 11 wherein said gate means is provided with time-delay means operative to delay for a short time interval the gating action thereof after suspension of said radio signal.

No references cited.