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(54) **EMERGENCY VEHICLE WARNING SYSTEM AND METHOD**

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Filed: **Jun. 6, 1995**

(51) **Int. Cl.**[7] **G08G 1/00**

(52) **U.S. Cl.** **340/902**; 340/903; 340/904; 340/825.36

(58) **Field of Search** 340/901, 902, 340/903, 904, 905, 825.36; 342/450, 455, 457

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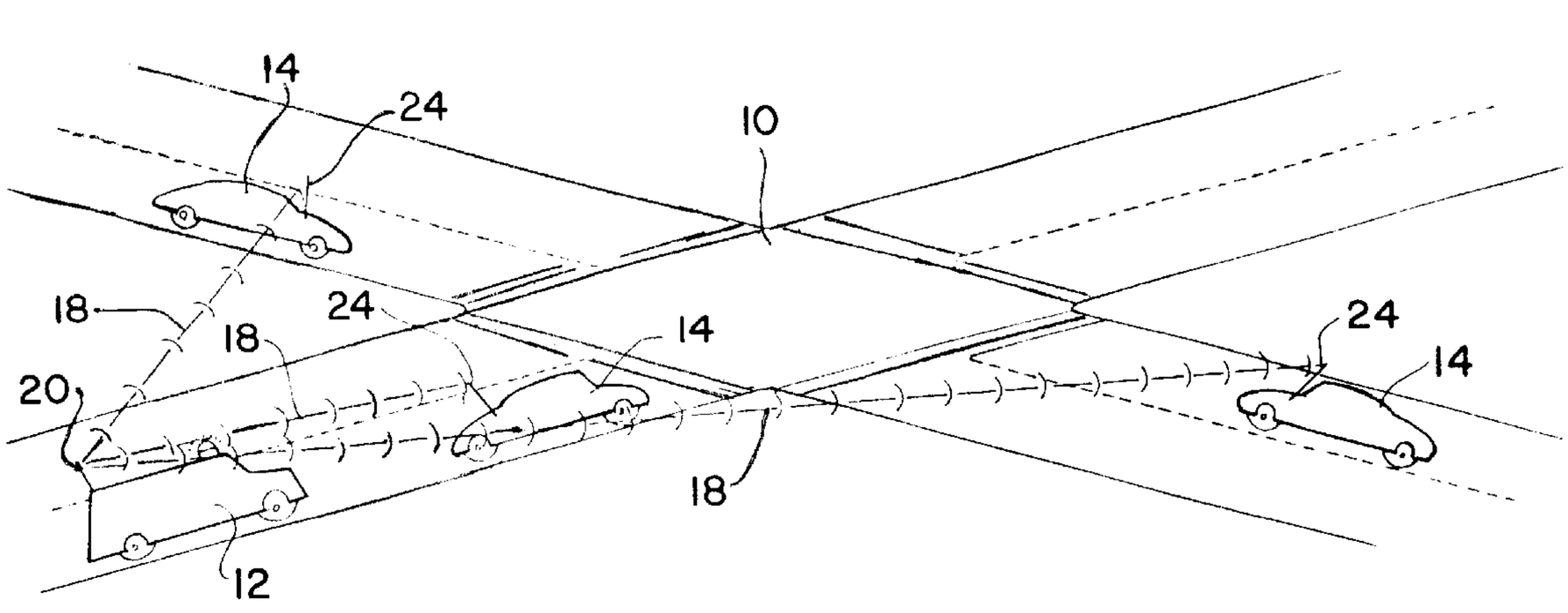
(57) **ABSTRACT**

A system and method for altering a driver of a motor vehicle of the approach of an emergency vehicle in an emergency state, comprising a transmitter in the emergency vehicle which produces and transmits a radio frequency signal having a unique audio encoded data signature modulated thereon when the emergency vehicle is in an emergency status, a receiver in motor vehicle which receives the radio frequency signal, demodulates and decodes the radio frequency signal and produces a voltage output when the data signature is present; and an alarm producing device which produces an alarm in response to the voltage output warning the driver of the motor vehicle of the approach of the emergency vehicle.

7 Claims, 2 Drawing Sheets



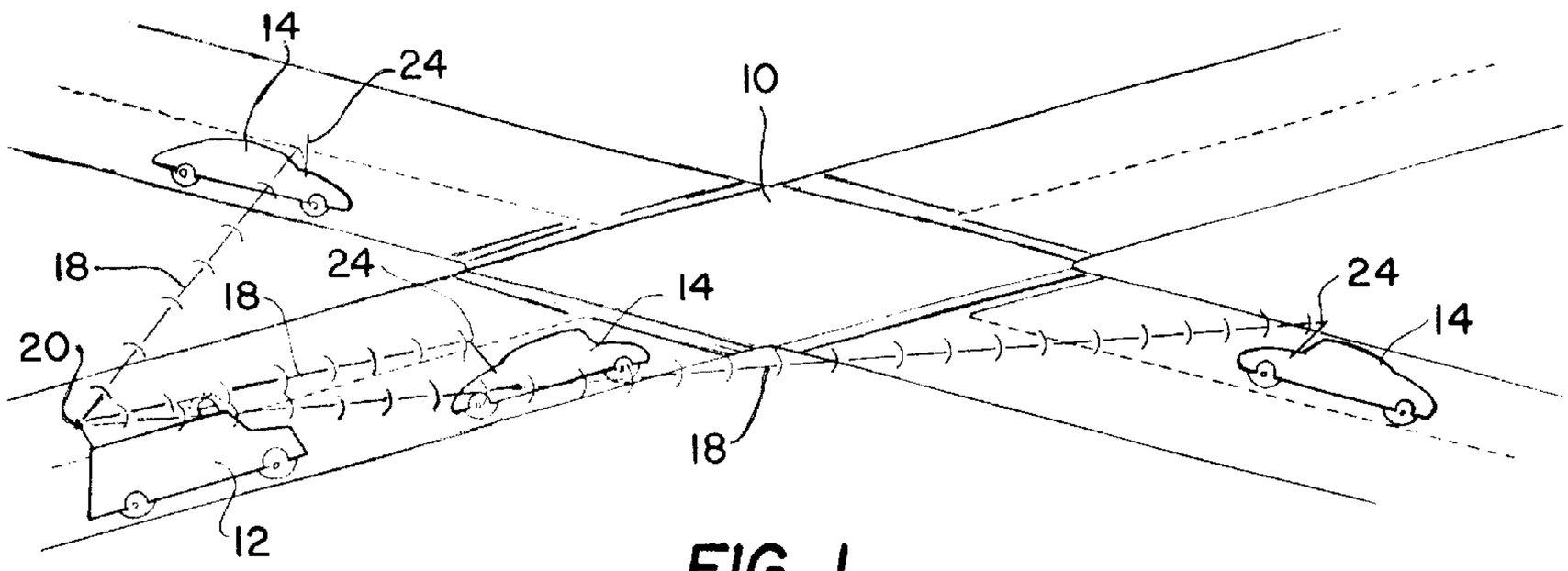

14
24
10
18
24
18
14
20
24
14
18
12

FIG. 1

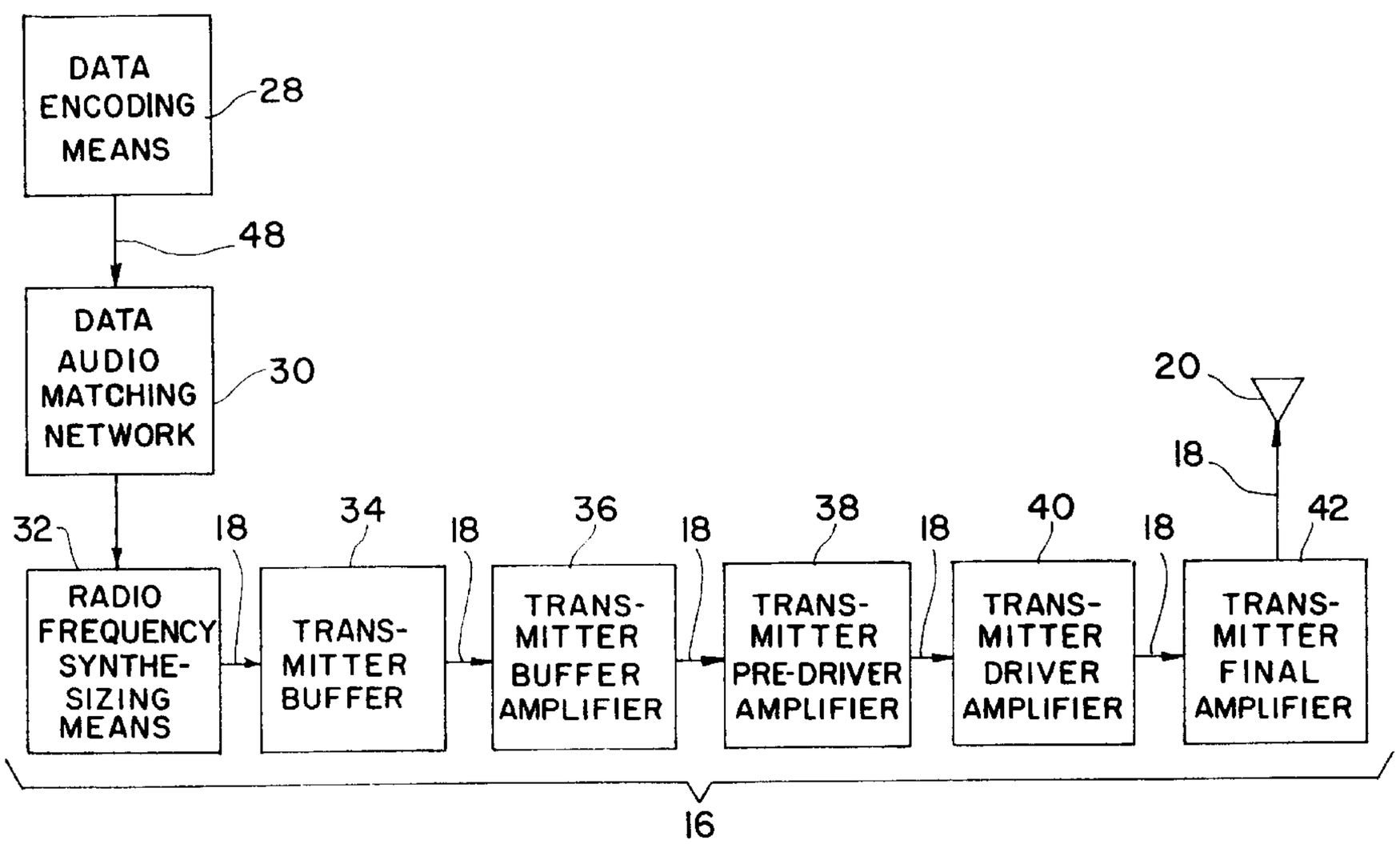

DATA ENCODING MEANS
28
48
DATA AUDIO MATCHING NETWORK
30
20
18
32
18
34
18
36
18
38
18
40
18
42
RADIO FREQUENCY SYNTHE-SIZING MEANS
TRANS-MITTER BUFFER
TRANS-MITTER BUFFER AMPLIFIER
TRANS-MITTER PRE-DRIVER AMPLIFIER
TRANS-MITTER DRIVER AMPLIFIER
TRANS-MITTER FINAL AMPLIFIER
16

FIG. 2

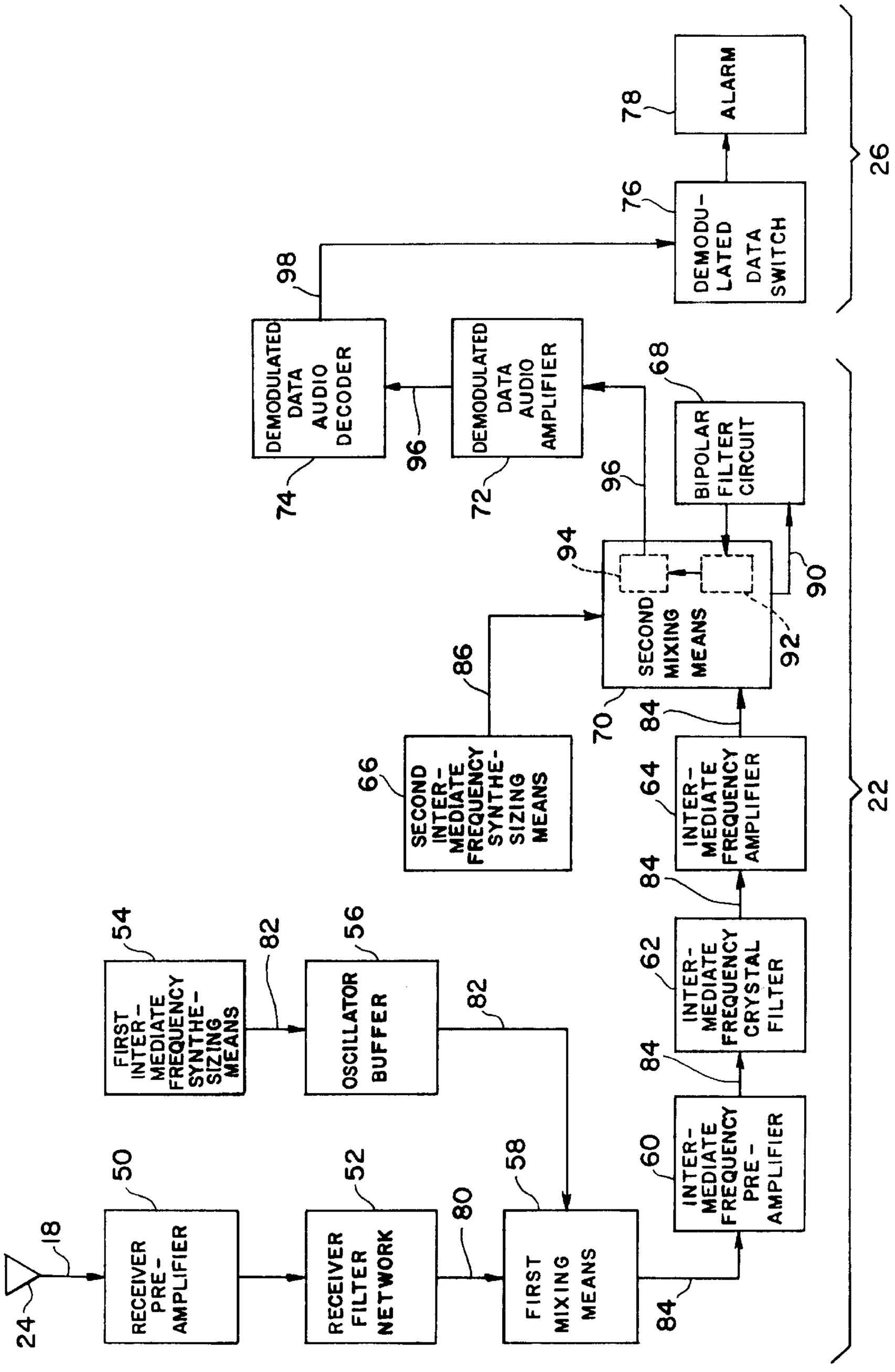

ALARM
78
DEMODU-LATED DATA SWITCH
76
26
98
DEMODULATED DATA AUDIO DECODER
74
96
DEMODULATED DATA AUDIO AMPLIFIER
72
68
BIPOLAR FILTER CIRCUIT
96
94
SECOND MIXING MEANS
92
90
86
70
84
SECOND INTER-MEDIATE FREQUENCY SYNTHE-SIZING MEANS
66
INTER-MEDIATE FREQUENCY AMPLIFIER
64
22
84
54
82
56
FIRST INTER-MEDIATE FREQUENCY SYNTHE-SIZING MEANS
OSCILLATOR BUFFER
82
INTER-MEDIATE FREQUENCY CRYSTAL FILTER
62
84
50
52
58
60
18
RECEIVER PRE-AMPLIFIER
RECEIVER FILTER NETWORK
80
FIRST MIXING MEANS
INTER-MEDIATE FREQUENCY PRE-AMPLIFIER
24
84

FIG. 3

EMERGENCY VEHICLE WARNING SYSTEM AND METHOD

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The present invention relates generally to an emergency vehicle warning system and method and, more particularly, to an emergency vehicle warning system and method utilizing a radio frequency communication link.

Emergency vehicles, such as police patrol cars, ambulances and fire engines, when in an emergency state, travel at a high rate of speed and usually, do so through crowded streets and roadways. The law requires that other motor vehicles immediately give the right-of-way to the emergency vehicle. The driver of the motor vehicle, then, must be aware of the approach of the emergency vehicle within a suitable time to safely allow this right-of-way. In order to alert drivers of motor vehicles the approach of an emergency vehicle in an emergency status, the emergency vehicle relies on sight and sound; eg. flashing lights, sirens and horns.

These methods for alerting drivers to the approach of an emergency vehicle are becoming less effective. Advancements in automobile sound proofing and dampening have diminished the amount of external sound intruding into the passenger compartment of an automobile. Combining those advancements with the increased use of cellular car phones and more powerful car stereo systems employing tape decks and CD's, as well as radios, results in a driver being less aware of a siren or horn of an emergency vehicle. Although automobile design advancements have not impaired the driver's vision, the driver must be looking in the emergency vehicle's general direction to be able to see its flashing lights to become aware that it is an emergency state. This would not necessarily occur in the case of a emergency vehicle located behind, and traveling in the same direction of, a motor vehicle. This is also the case of an emergency vehicle approaching an intersection where the cross traffic approaching that intersection can neither hear not see the emergency vehicle. Without an effective way of communicating the approach of an emergency vehicle in an emergency state there is a heightened risk of collisions and therefore, the safety of the emergency vehicle and its occupants along with other motor vehicles and their occupants is jeopardized.

Previous efforts involving emergency vehicles focused on traffic signal preemption or vehicle location. U.S. Pat. No. 4,914,434 issued to Rodney K. Morgan and Bradley K. Cross on Apr. 3, 1990 teaches a system for transmitting a series of UHF spaced apart messages. The emergency vehicle transmits the signal to preempt the normal operation of traffic signals. This patent was an improvement over prior patents teaching traffic signal preemption devices utilizing radio and optical transmitters. U.S. Pat. No. 3,984,807 issued to Adrian B. Haemmig on Oct. 5, 1976 teaches a system for locating emergency vehicles utilizing a plurality of wayside stations each having a radio transmitter with a unique geographical coding. As the emergency vehicle passes such a station a signal is transmitted to a home base or headquarters advising of the whereabouts of the emergency vehicle.

Patents teaching vehicle collision avoidance systems or devices are based on ultrasonic transmitters (U.S. Pat. No. 5,339,075 issued to Terrill Abst on Aug. 16, 1994 and U.S. Pat. No. 5,235,316 issued to Gregory K. Qualizza on Aug. 10, 1993), permanent magnets embedded in a highway (U.S. Pat. No. 5,369,591 issued to Charles Broxmeyer on Nov. 29, 1994) and road surface friction detectors (U.S. Pat. No. 5,286,099 issued to Yasuhiko Fujita, Toshiaki Arai and Makoto Sato on Feb. 15, 1994. U.S. Pat. No. 5,281,947 issued to Clarence W. Durley and Jerry A. Robinson on Jan. 25, 1994 teaches a vehicle safety sensor and warning system employing Microwave Doppler Radar Shift Technology to detect personnel within a predetermined proximity.

These patents, while generally teaching a system for locating a vehicle or avoiding a collision between vehicles and accidents involving people, do not address or resolve the problem of adequately advising a driver of a motor vehicle of the approach of an emergency vehicle when it is an emergency state to allow the driver to give it the right-of-way and, thereby, assuring its safe and expedient passage while, at the same time, assuring the safety of other motor vehicles in or crossing the emergency vehicle's path.

Accordingly, a need exists for a system to advise the driver of a motor vehicle of the approach of an emergency vehicle in an emergency state in addition to the traditional methods of sight and sound.

SUMMARY OF THE INVENTION

The present invention provides a system to satisfy the aforementioned need.

Accordingly, the present invention is directed to a system for alerting a driver of a motor vehicle of the approach of an emergency vehicle in an emergency status, comprising an emergency vehicle with transmitting means therein which produces and transmits a radio frequency signal with a certain range and has a unique audio encoded data signature modulated thereon when the emergency vehicle is in an emergency status. The system also comprises a motor vehicle within the range of the radio frequency signal having receiving means which receives the radio frequency signal, demodulates and decodes it and produces a voltage output when the unique audio encoded data signature is present. The system also comprises alarm producing means which produces an alarm in response to the voltage output warning the driver of said motor vehicle of the approach of said emergency vehicle.

In another aspect, the invention is directed to a method for alerting a driver of a motor vehicle of the approach of an emergency vehicle in an emergency status, comprising the steps of: providing an emergency vehicle equipped with transmitting means therein, transmitting from the emergency vehicle a radio frequency signal with a certain range and having a unique audio encoded data signature modulated thereon when the emergency vehicle is in an emergency status, providing a motor vehicle within the range of the radio frequency signal and having receiving means and alarm producing means therein, receiving the radio frequency signal by the receiving means in the motor vehicle, demodulating the radio frequency signal, decoding the radio frequency signal, producing a voltage output when the unique audio encoded data signature is detected, and producing an alarm in response to the voltage output warning the driver of the motor vehicle of the approach of said emergency vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features of the present invention will become apparent to those skilled in the art to which the present invention relates from reading the following specification with reference to the accompanying drawings in which:

FIG. **1** is a perspective view of a roadway grid with an emergency vehicle and other motor vehicles thereon illustrating the use of the system of the invention.

FIG. **2** is a block diagram of the transmitting means located in the emergency vehicle.

FIG. **3** is a block diagram of the receiving means and alarm producing means located in a motor vehicle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and, more particularly, FIG. **1**, there is shown a roadway grid **10** with an emergency vehicle **12** and other motor vehicles **14** located thereon. The emergency vehicle **12** is equipped with transmitting means **16** (not shown in FIG. **1**) which produces and transmits a radio frequency signal **18** having a unique audio encoded data signature modulated thereon when the emergency vehicle **12** is an emergency status. The transmitting means **16** broadcasts the radio frequency signal **18** using a directional radiator **20**. The motor vehicles **14** each have a receiving means **22** (not shown in FIG. **1**). When the motor vehicle **14** is within the range of the radio frequency signal **18**, the receiving means **22** in that particular motor vehicle **14** receives the radio frequency signal **18** from the emergency vehicle **12** using an omni-directional antenna **24**, demodulates and decodes the radio frequency signal **18** and causes alarm producing means **26** (not shown in FIG. **1**) to produce an alarm to warn the driver of the motor vehicle **14** of the approach of an emergency vehicle **12** in an emergency status. The driver of the motor vehicle **14**, upon being warned of the approach of an emergency vehicle **12**, then has sufficient time to move the motor vehicle **14** to give the emergency vehicle **12** the right-of-way. The radio frequency signal **18** can be any suitable frequency but, advantageously, is at least about 780 MHz. The radio frequency signal range is at most about 3500 feet.

Referring now to FIG. **2** there is shown a block diagram of the transmitting means **16** of the present invention. The data encoding means **28** produces a specifically coded data audio output **48** when power is applied to it. The encoding performed by the data encoding means **28** creates a unique signature that causes the receiving means **22** (not shown in FIG. **2**) to react only to a transmitted signal with that signature. The data audio matching network **30** insures impedance and audio level matching between the data encoding means **28** and the radio frequency synthesizing means **32**. The radio frequency synthesizing means **32** generates the radio frequency signal **18** and applies the specifically coded data audio output **48** to it such that a unique audio encoded data signature is modulated thereon. Advantageously, the radio frequency synthesizing means **32** is a phase-locked-loop type having a voltage controlled oscillator, but can be crystal/oscillator/multiplier type. The transmitter buffer **34** assures proper impedance matching between the radio frequency synthesizing means **32** and the transmitter buffer amplifier **36**. Amplification means comprising a transmitter buffer amplifier **36**, transmitter predriver amplifier **38**, transmitter driver amplifier **40** and transmitter final amplifier **42** each, in turn, increase the gain of the radio frequency signal **18** and provide impedance matching. The transmitter final amplifier **42** increases the gain of the radio frequency signal **18** to a sufficient level to overcome any radio frequency losses that may occur in the matching network means **44** and still be able to be broadcasted by the directional radiator **20**. The matching network means **44** provides impedance matching between the transmitter final amplifier **42** and the directional radiator **20**. The low pass filter circuit **46** provides adequate attenuation of any spurious frequency outputs and minimizes transmitter harmonics to acceptable government standards before the radio frequency signal **18** is applied to the directional radiator **20**.

Referring now to FIG. **3**, there is shown a block diagram of the receiving means **22** and alarm producing means **26** of the present invention. The omni-directional antenna **24** receives the radio frequency signal **18** transmitted by the transmitting means **16**. A receiver preamplifier means **50** has a bandpass filter circuit that removes any spurious signals from the radio frequency signal **18**, a pre-selector filter circuit tuned to the frequency of said radio frequency signal **18** and an amplifier circuit to amplify the radio frequency signal **18**. An image filter network **52** is an image rejection circuit which is used to eliminate any similar image frequencies that may be generated. The output of the image filter network **52** is a conditioned radio frequency signal **80**.

First intermediate frequency synthesizing means **54** generates a first mixing signal **82**. An oscillator buffer **56** amplifies the first mixing signal **82** and provides impedance matching with a first mixing means **58**. The first mixing means **58** mixes the conditioned radio frequency signal **80** with the first mixing signal **82** resulting in a first intermediate frequency signal **84**. Intermediate frequency preamplifier **60** increases the gain of the first intermediate frequency signal **84** and provides a high impedance output. The intermediate frequency crystal filter **62** filters the first intermediate frequency signal **84** to eliminate all but one of the four frequencies produced at the output of the first mixing means **58**. A intermediate frequency amplifier **64** increases the gain of the first intermediate frequency signal **84** to a usable level of approximately +5 dbm to overcome any losses that may have occurred in the intermediate frequency crystal filter **62**. The intermediate frequency amplifier **64** also provides impedance matching.

Second intermediate frequency synthesizing means **66** has a crystal controlled oscillator which generates a second mixing signal **86**. The second intermediate frequency synthesizing means **66** operates similarly to the first intermediate frequency synthesizing means **54** but at a lower frequency. Second mixing means **70** mixes the second mixing signal **86** with first intermediate frequency signal **84** and results in a second intermediate frequency signal **90**, advantageously, at a frequency of 455 KHz. A bipolar filter circuit **68** filters the second intermediate frequency signal **90**. The second mixing means **70** operates similarly to the first mixing means **58** but at a considerably lower frequency based on the frequency of the second intermediate frequency synthesizing means **66**. The bipolar filter circuit **68** contains a crystal filter which filters the second intermediate frequency signal **90** to eliminate all but one of the four frequencies produced at the output of the second mixing means **70** but is broad enough to pass a modulated radio frequency of 455 KHz. This allows for the modulation changes and possible slight frequency drifts that are encountered. The second mixing means **70** has a limiter circuit **92** that provides gain uniformity and amplification and a discriminator circuit **94** that removes the modulated data information from the second intermediate frequency signal **90** and converts it into demodulated data audio output **96**. The demodulated data audio output **96** is an exact audio replica (with the exception of audio level) of the coded data audio output **48** of the transmitting means **16**.

A demodulated data audio amplifier **72** amplifies the demodulated data audio output **96** and includes an imped-

ance matching circuit which provides a proper match between the second mixing means **70** and a demodulated data audio decoder **74**. The demodulated data audio decoder **74** decodes the demodulated audio output **96** and, if it detects the unique signature originally encoded by the data encoding means **28** of the transmitting means **16**, produces a voltage output **98**.

Alarm producing means **26** has a demodulated data switch **76** which responds to the voltage output **98** and activates alarm **78** alerting the driver of the motor vehicle **14** of the approach of an emergency vehicle **12** in an emergency state. The alarm **78** can be incorporated into the motor vehicle's radio which would turn down, or turn off, the radio when the voltage output **98** is produced.

Now that the invention has been described, variations and modifications will become apparent to those skilled in the art. It is intended that such variations and modifications be encompassed within the scope of the appended claims.

What is claimed is:

1. A *radio frequency transmission* system **[**for alerting a driver of a motor vehicle of the approach of an emergency vehicle is an emergency status,**]** comprising:

[a) an emergency vehicle;**]**

[b)**]** *a*) transmitting means **[**within said emergency vehicle, said transmitting means**]** having data encoding means which produces a specifically coded data audio output, radio frequency synthesizing means whereby a radio frequency signal having a certain frequency is generated and whereby said specifically coded data audio output is applied to said radio frequency signal such that said unique audio encoded data signature is modulated thereon **[**when said emergency vehicle is in an emergency state,**]** amplifying means whereby the gain of said radio frequency signal is increased and impedance matching provided, a low pass filter circuit whereby any spurious frequency outputs are attenuated and transmitter harmonics minimized to acceptable government standards, and a directional radiator such that said transmitting means broadcasts said radio frequency signal within a certain range;

[c) a motor vehicle within said certain range of said radio frequency signal;**]**

[d)**]** *b*) receiving means **[**in said motor vehicle**]** having an omni-directional antenna which receives said radio frequency signal from said transmitting means, a receiver preamplifier means which removes any spurious signals from said radio frequency signal and amplifies it, an image filter network which eliminates any similar image frequencies and resulting in a conditioned radio frequency signal, first intermediate frequency synthesizing means which generates a first mixing signal, a first mixing means whereby said conditioned radio frequency signal is mixed with said first mixing signal such that a first intermediate frequency signal results, an intermediate frequency crystal filter whereby said first intermediate frequency signal is filtered to eliminate all but one of the four frequencies resulting from said first mixing means, second intermediate frequency synthesizing means having a crystal controlled oscillator whereby a second mixing signal is generated, second mixing means whereby said first intermediate frequency signal is mixed with said second mixing signal resulting in a second intermediate frequency signal, a bipolar filter circuit having a crystal filter whereby said second intermediate frequency signal is filtered such that modulates changes and slight frequency drifts are allowed, a limiter circuit whereby gain uniformity and amplification of said second intermediate frequency signal is provided, a discriminator circuit whereby said secondary intermediate frequency signal is demodulated and converted into a demodulated data audio output, and a demodulated data audio decoder whereby said demodulated data audio output is decoded such that if said unique audio encoded data signature is detected a voltage output is produced**[**.**]** *and*

[e)**]** *c*) alarm producing means having a demodulated data switch such that when said voltage output is produced by said demodulated data audio decoder, said demodulated data switch responds to said voltage output and actuates said alarm **[**warning the driver of said motor vehicle of the approach of said emergency vehicle.**]**

2. The system of claim **1** wherein said radio frequency signal has a frequency of at least about 780 MHz.

3. The system of claim **1** wherein said radio frequency signal has arrange of at most about 3500 feet.

4. The system of claim **1** further comprising a radio **[**in said motor vehicle**]** whereby said alarm is incorporated into said radio such that said radio is turned down or off when said voltage output is produced.

5. The system of claim **1** wherein said frequency synthesizing means is a phase locked loop circuit with a voltage controlled oscillator.

6. The system of claim **1** wherein said frequency synthesizing means is a crystal oscillator multiplier type.

7. The system of claim **1** wherein said second intermediate frequency signal has a frequency of about 455 KHz.

* * * * *