United States Patent

[11] 3,614,727

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[54] CHANGEABLE HIGHWAY SIGN AND MOTORIST AID SYSTEM

8 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** ..... **340/22,** 40/132 H
[51] **Int. Cl.** **G08g 1/09**
[50] **Field of Search** ..... 340/22, 90; 40/132 H, 133 B, 125 I; 165/51; 179/35

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Assistant Examiner—Jan S. Black
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ABSTRACT: A changeable sign is disclosed which is adapted for use as a changeable highway sign located along a highway and which is capable of visually displaying to a motorist travelling in a vehicle along the highway any one of several predetermined driving messages. Additionally, a changeable highway sign system which incorporates a changeable highway sign is disclosed wherein the system includes a remotely located central station for selectively controlling changeable highway signs to continually inform the motorists of current speed limits, driving conditions and the like associated with the particular portion of the highway over which the motorists is traversing. The changeable highway sign and system, as disclosed herein, are adapted to include a motorist voice communication system to permit a motorist to communicate with a dispatcher at a central station.

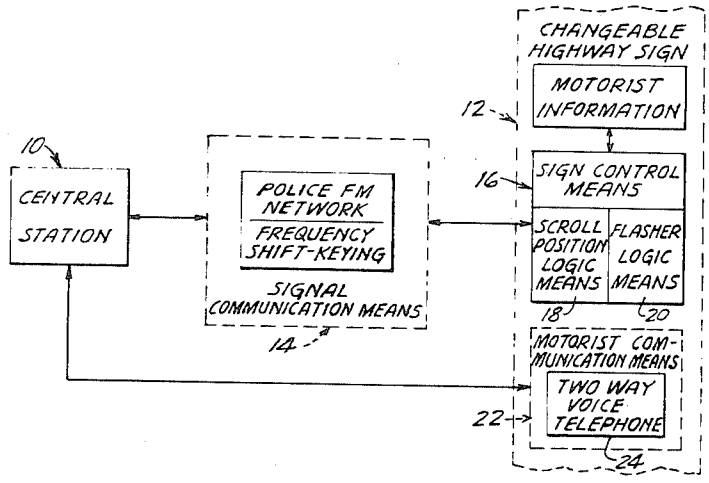

FIG. 1

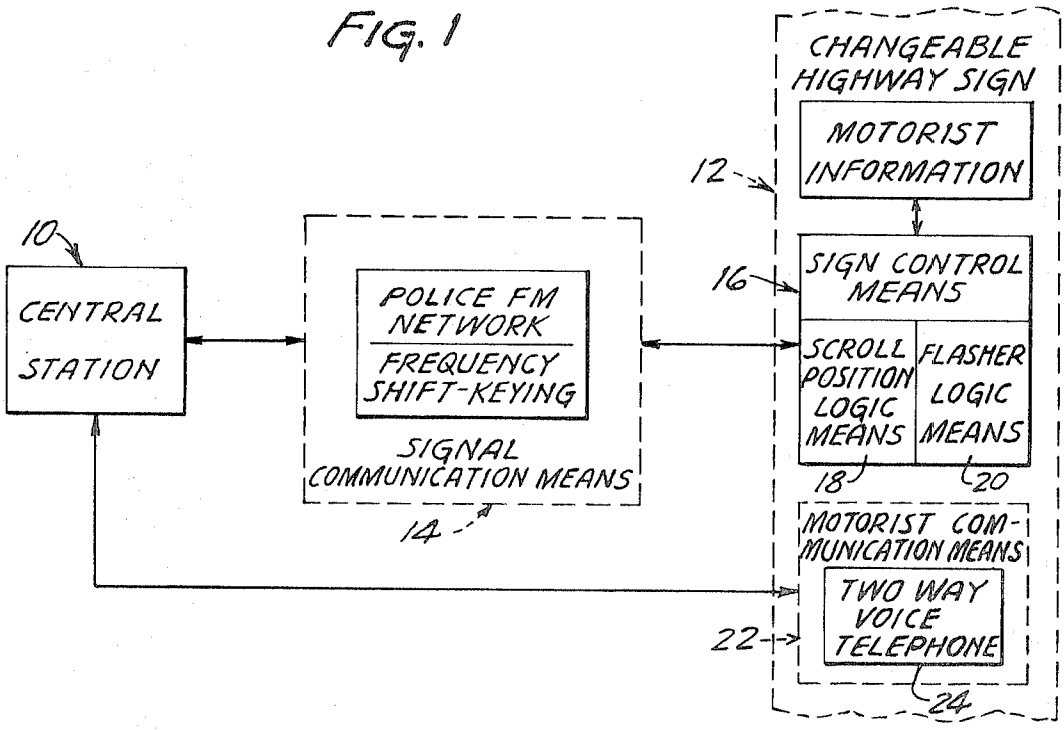

FIG. 2

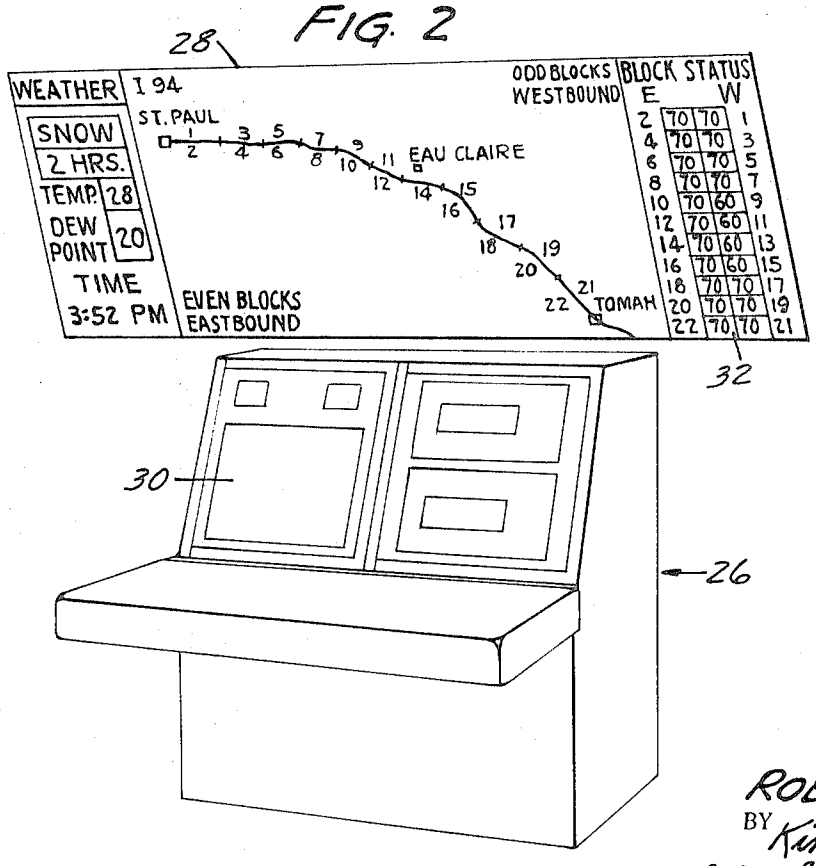

FIG. 6B

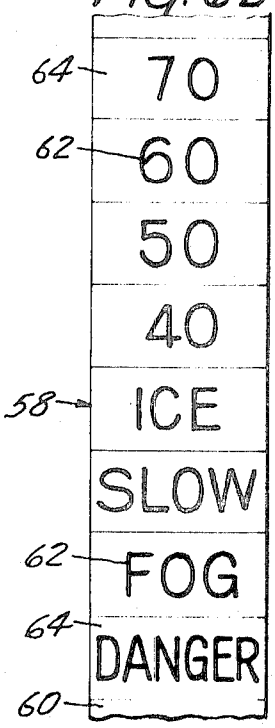

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FIG. 3

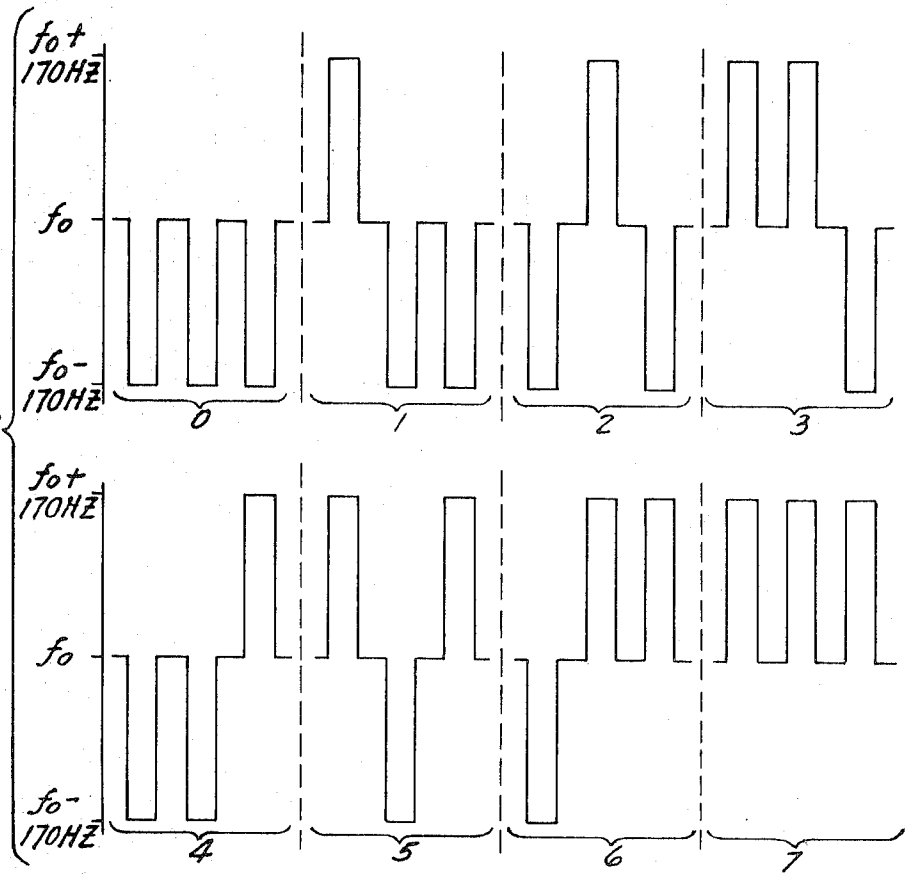

FIG. 4

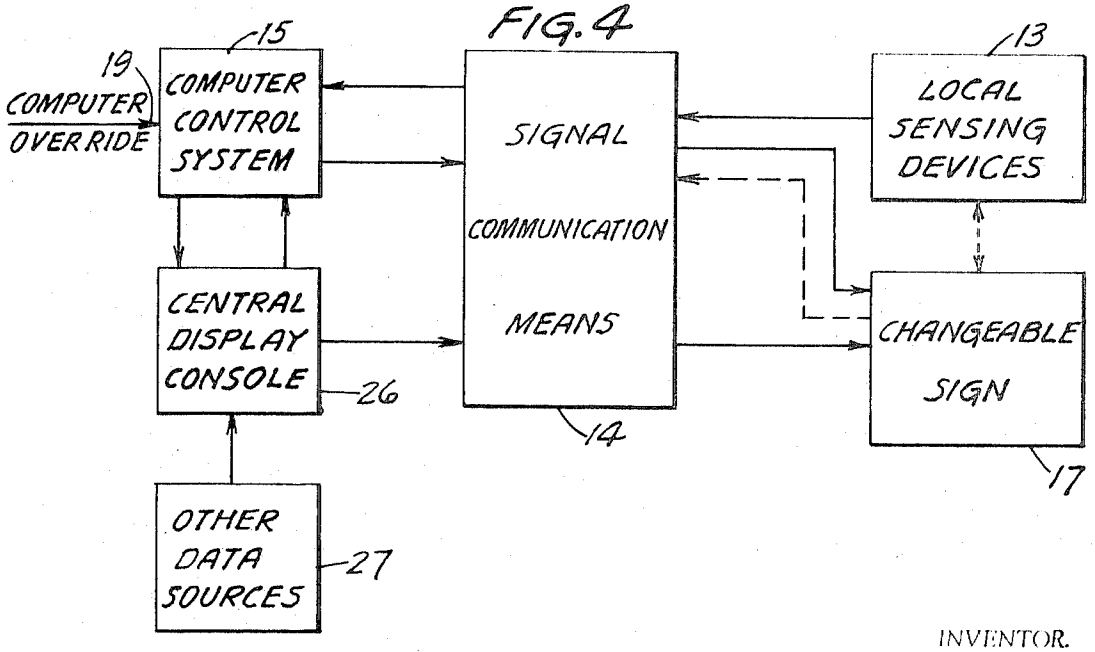

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FIG. 5

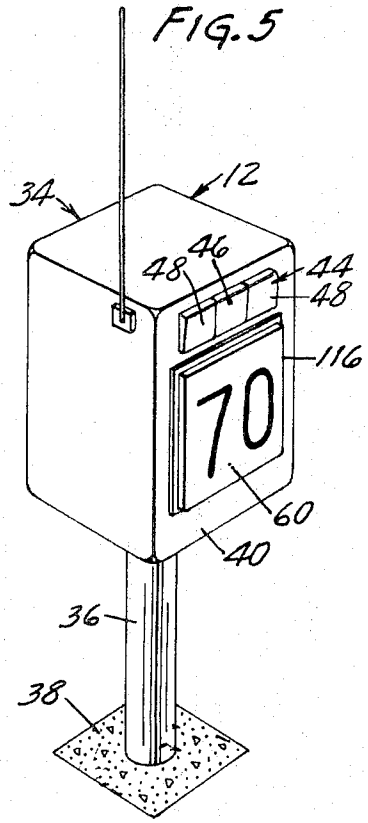


FIG. 6A

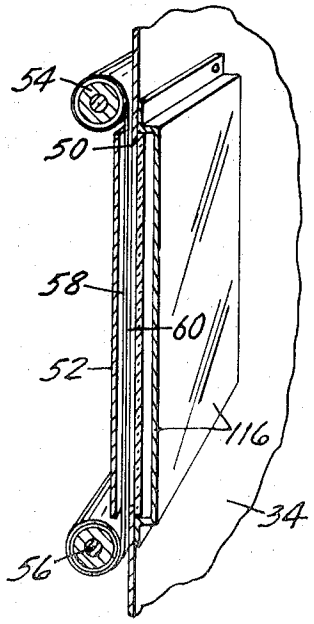


FIG. 7

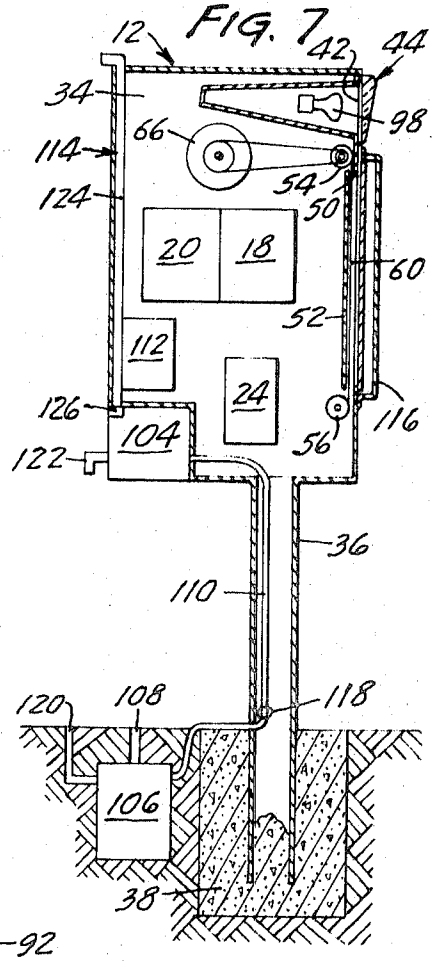


FIG. 8

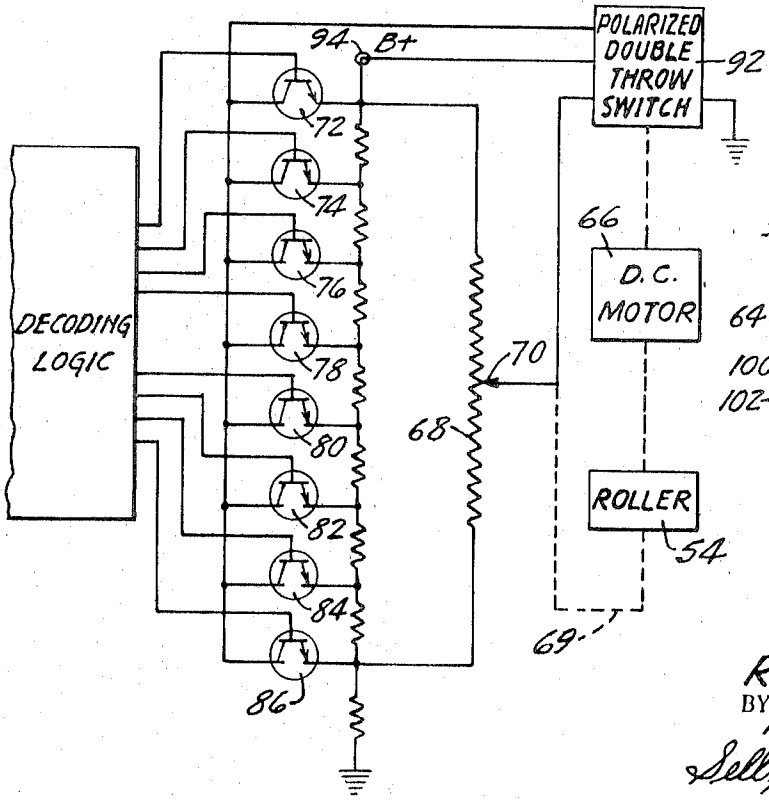
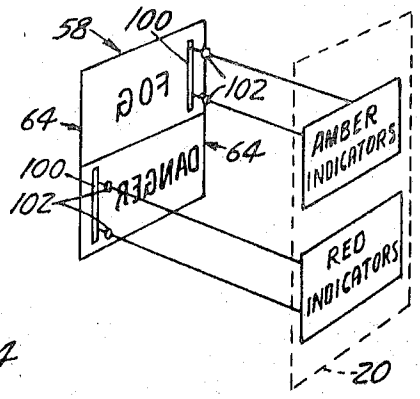


FIG. 9



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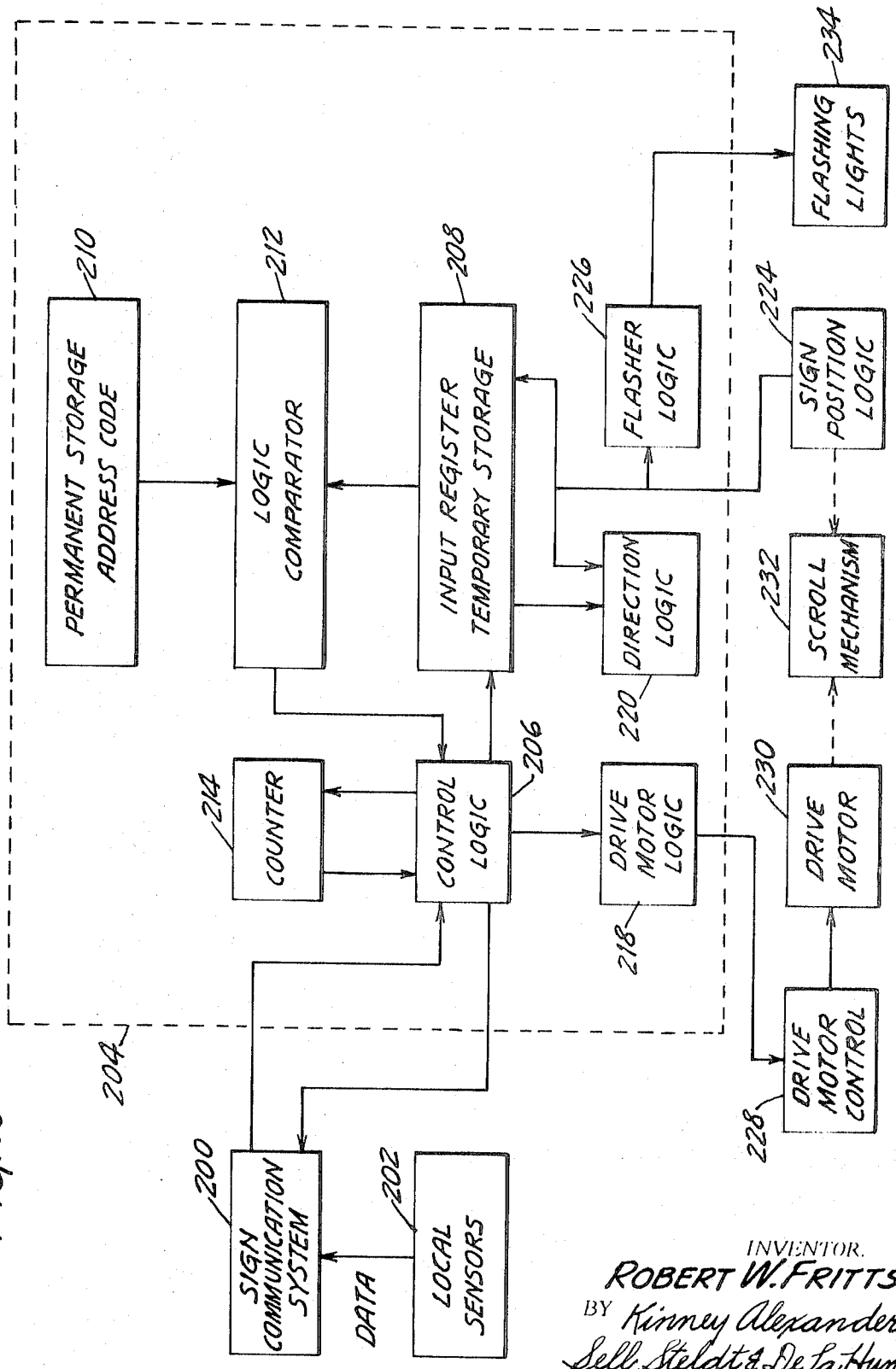

FIG. 10

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CHANGEABLE HIGHWAY SIGN AND MOTORIST AID SYSTEM

Known changeable highway signs are controlled from a central station via radio control devices or via direct communication channels such as telephone cables. Certain of these signals include lighting for illuminating sign indicia when visibility along the highway in the vicinity of the sing is below a predetermined lumen level. Other known changeable highway signs contain a plurality of predetermined driving conditions which are selectively illuminated to inform a motorist of current driving conditions. Typically, the highway signs require a large amount of front lighting to make them visible during nighttime driving times. S

Such prior art changeable highway signs have several disadvantages. Typical disadvantages include high-installation cost, high-power requirements requiring external electrical power distribution systems, sensing devices for controlling sign illumination and the like.

The present invention overcomes difficulties of the prior art devices by a novel and unique changeable sign which is capable of displaying to a motorist travelling along the highway any one of several predetermined messages during both day and night driving conditions.

The changeable highway sign disclosed herein is capable of remote control and can use either analog or digital control at the sign for controlling sign operation. In addition, digital control signals having an address code portion and a command code portion can address a selected sign and command which predetermined driving message is to be displayed to a motorist.

If desired, a changeable highway sign is capable of including a retroreflective member which is located behind a strip of transparent material having the predetermined driving messages imaged thereon. When driving conditions are such that a motorist must use the vehicle's headlights for visibility, the headlights are concurrently used as the means for illuminating the highway sign by the retroreflective member. Thus, front lighting of such a sign is not required and the total power requirements of such changeable highway signs are substantially reduced.

In another embodiment, the changeable highway sign may be front or back lighted because of existing traffic standards and the availability of electrical power. Thus, a retroreflective member may not be required. However, such a changeable highway signal can be remotely controlled from a central station by using the teachings of the present invention.

It is known to utilize flashing lights in combination with a highway sign to attract a motorist's attention. By using the teachings of the present invention, flashing light-sign combinations utilizing lights and backgrounds of the same single color are possible. If desired, the flashing lights can be arranged in spacial patterns for indicating various caution and emergency conditions.

In one embodiment, the changeable highway sign disclosed herein uses a flashing light arrangement wherein the color of the flashing lights, arranged in a certain spacial pattern, indicates degrees of dangerousness of a predetermined driving condition being displayed. In addition, flashing light patterns can be established to cooperate with displayed messages to control certain traffic movements such as MERGE and CHANGE LANES.

In the preferred embodiment, an amber flashing light is used to indicate to a motorist that caution should be used for the particular driving condition being displayed, such as for example FIG. Also, in the preferred embodiment, two flashing red lights, flashing either sequentially or simultaneously, are used to indicate an emergency predetermined highway condition being displayed, such as for example DANGER.

Other known changeable sign units have high-power requirements and, of necessity, have been connected to commercial power distribution lines. In such arrangements, the sign unit becomes subject to power outages which usually occur in severe weather when the sign operation is most needed. In locations where the sign units are remotely located from existing power distribution lines, the expense of extending individual feeder lines for each sign unit becomes prohibitive.

In some installations, a solar power source is used as an independent source of electrical power to overcome the above disadvantages. However, solar power sources have certain inherent disadvantages in that they cannot be used in areas where sunlight is prevented from illuminating the solar cell. This typically includes areas having high-smog levels, areas which are continually shaded and the like.

In one embodiment of the changeable highway sign of the present invention, the power requirements are minimized such that a self-contained power source such as, for example, a thermoelectric generator can be used as a source of electrical power. A thermoelectric generator is capable of operating on relatively inexpensive and generally available fuel, such as liquid propane, and produces substantially more electrical power than solar power sources of comparable cost. If desired, such a changeable highway sign can be energized from existing power lines with the self-contained power source as a standby power source.

A propane-fired thermoelectric generator power source has certain other additional advantages besides economy and relatively high electrical power output compared to solar cells. The thermal energy produced by the generator in producing the electrical power can be transferred throughout the sign unit to warm the various components to improve cold weather performance.

It is known to install motorist aid systems along heavily congested highways. Typically, such units are energized by means of self-contained solar power sources. In addition to the above disadvantages of using solar cells, the low power output of solar sources limits operation of such a motorist aid system to simple precoded communications of short duration. In such systems, the motorist is unable to engage in voice communication with the central station for the purpose of supplying and receiving information concerning the nature of the emergency condition. Generally, by using precoded message, the power requirements of the motorist aid system are minimal and a motorist, when involved in an emergency condition, is limited to pushing a button to summon aid. SUch a motorist communication system is unable to provide two-way voice communication between a motorist on the highway and a dispatcher at a remote central station when a real emergency condition exists.

One embodiment of a changeable highway sign of the present invention utilizes a radio-telephone system such that two-way voice communication can be effected between a motorist and the central station. This arrangement provides a dispatcher with the opportunity to determine the most effective action to be taken in the particular emergency situation, together with the capability of informing the motorist of the action to be taken. In addition, a motorist voice communication system provides a dispatcher located at the remote central station with the capability to obtain additional information from a motorist with respect to traffic control, such as, for example, number of blocked lanes, seriousness of traffic problem and the like.

One advantage of the present invention is that a changeable sign can be remotely controlled to display any one of several predetermined messages.

Another advantage of the present invention is that a changeable sign has a minimal power requirement such that the sign may be powered by a self-contained power source for operation in areas remote from power distribution lines or as a standby for signs operated from power distribution lines.

A further advantage of the present invention is that a changeable highway sign may include a retroreflective backing member located behind the displayed predetermined driving message or condition such that the same is brightly illuminated at night by a motor vehicle's headlights striking the retroreflective backing.

Another advantage of the present invention is that a changeable highway sign may incorporate at least two dif-

ferent arrangements of flashing lights to attract a motorist's attention and to indicate the degree of dangerousness of a predetermined driving condition along the highway.

Still another advantage of the changeable highway sign of the present invention is that the sign may include a motorist voice communication system to permit voice communication between a motorist requiring aid and a dispatcher at a remotely located central station.

Yet another advantage of the present invention is that this novel and unique changeable highway sign uses conventional and known traffic signal symbols and known colored backgrounds such that a motorist can easily respond to and follow commands and instructions displayed by the sign without requiring special education and familiarization with operation of such signs.

A further advantage of the present invention is that a changeable highway sign can be incorporated as part of a computer controlled highway system wherein traffic movement can be quickly and easily controlled in emergency situations, such as an accident, for emergency vehicles and the like.

These and other advantages of the present invention will become apparent from the following detailed description taken together with the following drawing wherein:

FIG. 1 is a block diagram of a changeable highway sign system;

FIG. 2 is a pictorial illustration of a control console located in a central station for controlling a system having a plurality of changeable highway signs located along a highway;

FIG. 3 is a graph illustrating waveforms representing binary coded signals which can be assembled by frequency shift-keying techniques controlling a changeable highway sign;

FIG. 4 is a block diagram illustrating a computerized system for controlling a changeable highway sign system;

FIG. 5 is a perspective drawing of a changeable highway sign;

FIGS. 6A and 6B are diagrammatic representations of sign indicia means including a strip of transparent material in the form of a scroll for displaying a predetermined driving condition in an opening defined by the sign housing;

FIG. 7 is a diagrammatic representation of an actuating means for transporting the scroll past the opening in said changeable sign;

FIG. 8 is a schematic diagram partially in block form illustrating circuitry for one embodiment of an analog sign control means for controlling position of said scroll;

FIG. 9 is a diagrammatic representation illustrating one type of flasher logic means for controlling flashing lights used on the changeable highway sign; and

FIG. 10 is a block diagram illustrating a digital control system for controlling operation of a changeable sign.

Briefly, a changeable sign for visually displaying a selected one of several predetermined messages is disclosed. The sign includes a housing defining an opening through which any one of the predetermined messages can be visually displayed. A strip of imaged transparent material is used which has a plurality of sections each of which contains a predetermined message. The sign also includes a sign indicia means located within the housing and operatively coupled to the strip of transparent material for positioning in the opening a selected section of the strip of transparent material. An actuating means is operatively coupled to the sign indicia means for driving the sign indicia means to transport the strip of imaged material in a direction to position a selected one of the predetermined messages in the opening. A sign position logic means is operatively coupled to the sign indicia means for determining which of the predetermined messages is positioned in the opening. A sign control means is operatively connected to the actuating mans and the sign position logic means and is responsive to a command signal designating a selected predetermined message to be displayed by the sign for programming the actuating means to drive the sign indicia means in a direction determined in response to the sign position logic means to transport the web of imaged material until the selected predetermined message designated by the command signal is positioned in the opening.

FIG. 1 is a block diagram of the operation of a changeable highway sign system. The system includes a central station **10** remotely located from a changeable highway sign **12**. The sign **12** is capable of displaying a variety of information to motorists in the form of speed limits and actual driving conditions as well as in the form of flashing lights.

The central station **10** is capable of monitoring and changing the information displayed by the sign **12**. These changes are based on information gathered from sources including the United States Weather Bureau (USWB), patrol cars, local sensing devices and from communications with motorists via motorist voice communication systems located along the roadway. The central station **10** utilizes a signal communications **14** to send command signals to a sign control means **16** within the sign **12**.

The sign control means **16** includes a scroll position logic means **18** to control which of a selected one of several predetermined messages, such as speed limits, driving commands and traffic condition information, is to be visually displayed by the sign **12** in response to control signals from the central station **10**. The sign control means **16** further includes a flasher logic means **20** which activates flashing lights whenever a cautious or dangerous driving message is displayed.

The sign **12** includes a motorist communication means **22** which may be used by a motorist in an emergency. The motorist is able to communicate with the central station **10** via signal communication means **14** to summon help or to alert a dispatcher as to a traffic control problem, such as a blocked lane and the like. In the preferred embodiment, the motorist communication means **22** consists of a two-way voice radiotelephone **24**.

FIG. 2 illustrates pictorially one embodiment of a central display console **26** located at the central station **10**. A sign location display **28** indicates the location of a for the of signs **12** along a given highway. A control panel **30** includes means for individually controlling each sign **12**. The signs located along a highway can be grouped into convenient sign groupings of, say, four to five signs per group. The predetermined message visually displayed by each sign group is displayed as a sign status display **32** on the control panel **30** at the central station **10**. In certain preprogrammed situations, it is possible that certain of the signs **12** in a predetermined sign grouping may display a message other than that generally designated on the control panel **30** for the sign grouping. A separate indication can be displayed to indicate this condition.

In the preferred embodiment, the signal communication means **14** utilizes the police or maintenance FM radio network wherein signal communication is accomplished by means of frequency shift-keying techniques. Typically, the police or maintenance FM radio networks use an FM modulated 300 to 3,000 Hertz (Hz.) bandwidth channel for voice transmission. Generally, it is known that the 2,635 to 3,000 Hz. portion of the channel is not essential for maintaining male voice intelligibility. This 365 Hz. range may therefore be used to carry FM modulated digital control signals which may be superimposed on voice transmission FM modulated signals. Suitable filtering of the compressed voice band will eliminate shift-keying noise therefrom. Such communication techniques are known and may be readily assembled by one skilled in the art.

Frequency shift-keying control is achieved by generating positive and negative pulses about the middle frequency between 2,635 and 3,000 Hz. FIG. 3 illustrates how these pulses may be used to represent binary numbers. The scheme illustrates a 3-bit binary work capable of representing a binary number from 0 to 7, but the number of bits per word may be varied according to the specific application. The position of positive pulses relative to negative pulses determines the binary number represented. A person skilled in the art using known techniques can design and fabricate encoding and decoding logic necessary for implementing frequency shift-keying.

In one embodiment, an encoded 6-bit 2-work control signal is sent to the changeable highway signs. The control signal comprises an address signal and a command signal each of which comprises a 3-bit 1-word signal. The address signal selects which sign is to be controlled while the command signal selects which of the sign indicia is to be displayed. It is contemplated that the number of signs capable of responding to a given command signal may be selected in accordance with the specific system.

It is contemplated that other communication systems could be used for controlling operation of a changeable sign. Typically, other known systems which could be used to accomplish the same purpose include telephone pairs, preassigned FM radio links and the like devoted wholly to control of changeable signs.

FIG. 4 illustrates an alternative embodiment for controlling the changeable highway signs 12. Sets of local sensing devices 13, shown in block form, may be associated within all or some of the changeable highway signs within each group to gather information concerning driving conditions and the like. The sensing devices 13 gather measurements concerning humidity, visibility, temperature and traffic density in a format suitable for transmission to a computer control system 15 for analysis and control functions.

In the embodiment of FIG. 4, the measurement are transmitted via signal communication means 14 to the computer control system 15 located at the central station. The computer control system 15 analyzes the measurements and generates an appropriate control signal in response thereto. This control signal is transmitted via signal communication means 14 to either a single sign 12 or a group of signs, depending on the particular system, associated with the set of sensing devices 13 corresponding to the control signal. A new set of driving conditions are displayed by the signs 12 in response to the control signal to inform the motorist travelling within the area of the latest driving conditions. The embodiment of FIG. 4 also includes direct communication between a sign group 17 and the computer control system 15. This provides the computer control system 15 with information concerning the current status the the signs 12 within the sign group 17. This information provides input data to the computer control system 15 to provide a basis for controlling traffic when a traffic problem is encountered.

The computer control system 15 is able to display at the console 26 the status of the various signs 12 in the system. The computer control system 15, however, is also capable of receiving information introduced to it by the console 26. This information introduced to it by the console 26. This information may be obtained from data sources 27, such as police patrols and the USWB. Furthermore, the computer control system 15 may be bypassed by a computer override means 19 associated with the scroll position logic means of the signs 12. The computer override 19 allows the sign group 17 to be changed by a command directly from the central station 10.

FIG. 5 depicts a single-changeable highway sign 12 positioned along a highway. The sign 12 includes a housing 34 positioned above the surface of the ground by a support means 36. The support means 36 is solidly embedded in the ground by a footing 38.

A surface 40 of the housing 34 has an opening 42 (FIG. 7) facing the flow of motor vehicle traffic along the highway. In the preferred embodiment, the opening 42 is covered by a lens arrangement 44. The lens arrangement 44 includes a center lens 46 of amber positioned over the center area of the opening 42 and adjacent lenses 48 of red covering the remainder of the opening 42. In the preferred embodiment, the lens may comprise a fresnel lens constructed in accordance with the teachings of Appledorn, application Ser. No. 571,639, having a common assignee. By using such a fresnel lens, a relatively small wattage lamp can be used. The combination of the fresnel lens and lamp provides a high intensity, directional, low power lighting system for informing motorists of the degree of dangerousness of road conditions.

Surface 40 also includes an aperture 50 (in FIG. 7) covered by a weathertight window 116. A reflective member 52 is rigidly mounted within the housing 34 adjacent to the spaced from the aperture 50. Rollers 54 and 56 are rotatably mounted within the housing 34 above and below the aperture 50. In the preferred embodiment, a scroll 58 composed of a transparent material 60 containing sign indicia is positioned between the rollers 54 and 56. One end of the scroll 58 is wrapped around one of the rollers 54 and 56 and the other parallel end of the scroll 58 is wrapped around the other roller. The scroll 58 passes between the reflective member 52 and the aperture 50. When ordinary daylight or light from a motor vehicle headlight strikes the sign, the light passes through the transparent material 60, is reflected by the reflective member 52 and is directed back to the motorist in the vehicle. The reflected light backlights the sign indicia on scroll 58 thereby making the indicia appearing between rollers 54 and 56 in aperture 50 visible to a motorist.

One known reflective surface which is capable of providing diffuse reflection by daylight and bright retroreflection at night utilizes a cube corner construction with a bright reflecting background as described in a copending application of Schultz, Ser. No. 593,948, having a common assignee, now U.S. Pat. No. 3,417,959.

FIGS. 6A and 6B are diagrammatic views of the scroll 58 showing the possible sign indicia 62 appearing on transparent material 60 which may be selected for a particular terrain. The indicia 62 to be displayed to motorists are placed on separate areas of the scroll 58, each area being designated as one frame of motorist information 64. When properly positioned relative to the aperture 50, the frame 64 is located adjacent the reflective member 52. The reflective member 52 is illuminated at night by vehicle headlights as described.

As shown in FIG. 5, both speed limits, caution and dangerous condition warnings may be displayed by the sign. In one embodiment, speed limit information is displayed by black numerals on a white field, the white field comprising the fixed reflective member 52. It is desirable to increase the driver's awareness of a dangerous condition, such as FIG. or ICE, by using different colored backgrounds. In the preferred embodiment, ICE and FOG conditions are displayed as black letters on a yellow background. DANGER utilizes clear white lettering over a red background. The yellow and red backgrounds are attached to the transparent material 60 of the appropriate frames 64. It is contemplated that other combinations of highway information or indicia and reflective backgrounds may be utilized. Also, an alternative embodiment may eliminate reflective member 52 by having all reflective backgrounds attached to the scroll 58. Yellow and red lights are utilized in conjunction with the messages having a similar colored background as they are visually displayed by the changeable sign to call to the motorist's attention that a caution or dangerous condition warning is being displayed and the seriousness of the displayed condition.

FIG. 7 diagrammatically illustrates the changeable highway sign 12. Housing 34 includes the scroll position logic means 18 which is operatively connected to a scroll driving means, which in the illustrated embodiment is a reversible DC motor 66. The reversible motor 66 is operatively connected to roller 54 and is capable of driving roller 54 in either a forward or reverse direction. Upon receiving an appropriate command signal from the central station 10, the scroll position logic means 18 activates the reversible motor 66 to drive the roller 54 in a selected direction. The scroll 58 and frames of information 64 are transported across the aperture 50 until the desired frame 64 is properly positioned relative to the aperture 50. The scroll position logic means 18 senses this point and automatically terminates scroll motion.

In the preferred embodiment, the scroll 58 contains 8 frames of driving information or sign indicia 62. Utilizing the frequency shift-keying method and a 3-bit binary work described hereinbefore, eight different command signals are available to properly position each frame 64 of driving infor-

mation relative to the aperture **50** once a given sign **12** has been selected by its appropriate address signal.

A two-way radio telephone **24** is located within the housing **34**. The sign **12** further includes a self-contained power source means. In the preferred embodiment, the power source means comprises a thermoelectric generator **104** located within the housing **34**. The generator **104** is operatively connected to a storage battery **112** located within the housing **34**. The generator **104** continuously charges the battery **112** which supplies power to the electrical components within the housing **34**. In this manner, the generator provides sufficient energy on a continuous basis to meet the average power needs of the total system.

The generator **104** may utilize a propane fuel in vapor form. The fuel is stored as a liquid in a tank **106** located underground beneath the sign. The tank **106** is equipped with a pressure regulator **120** which controls the pressure of the vapor fed to the generator **104** via fuel line **110**. The fuel tank **106** is equipped with a fuel filling port **108** which is located just beneath the ground to prevent injury in case of an accident. The fuel line **110** may be equipped with a self-sealing valve **118** known in the trade as an excess flow valve. In the event of a vehicle collision with the sign, the fuel line is sealed off instantly to avoid the danger of an explosion.

A suggested thermoelectric generator unit is Minnesota Mining and Manufacturing Company's Model 515. This unit, producing approximately 15 watts at 12 volts, will operate for 6 months on 150 gallons of liquid propane gas costing approximately $22. The liquid propane gas is stored in tank **106**. Refueling on an annual or semiannual basis may be accomplished with a 5-minute stop by a bulk pumping truck.

In the preferred embodiment, the heat produced by the generator **104** is used to warm the components within the housing **34** during cold weather. The heat is transferred to the components via a heat-exchanging system **114**. The system **114** includes a duct **124** for channeling the hot exhaust gases produced by the generator **104** through the housing **34** to the exterior. THis heating process is important to maintain charging efficiency of the battery **112** at low temperatures and to maintain free movement of the lubricant used on the roller bearings. The heat further helps to sublime away any snow, ice or raindrops which may collect on the weathertight window **116** and the housing **34**.

The heat-exchanging system **114** further includes a bypass duct **122**. THe duct **122** automatically conducts the exhaust gases directly to the exterior rather than through the housing **34** when the external temperature rises to a certain level. The duct **122** is controlled by a temperature sensitive switch **126**. This bypass prevents overheating of the sign components during warm weather.

FIG. **8** is a schematic diagram partially in block form illustrating analog circuitry and apparatus by which a command signal is able to change the sign indicia **62** displayed by the sign **12**. Roller **54** is driven by the reversible motor **66** and is mechanically connected by linkage **69** to a sliding contact **70** positioned on a fixed potentiometer **68**. The sliding contact **70** gives an electrical signal indicating the present location of the frames of information **64** relative to the aperture **50**.

Upon receiving a control signal, the command portion of the signal is decoded by the decoding logic to generate a positioning signal. The positioning signal is applied to the bases of the appropriate combination of NPN transistors **72–86** switching them into conduction.

When a transistor **72–86** switches, a voltage appears is relay switch **92**. This relay is a double-pole type and is polarized so as to apply a voltage B+ (**94**) to the DC motor **66** in a polarity direction corresponding to the polarity of the voltage across relay switch **92**. The application of the B+ voltage **94** causes the motor **66** to advance the scroll **58** to a new position by driving the roller **54** until a zero voltage or a "null" spot is produced across relay switch **92** due to the changed position of the sliding contact **70** on the potentiometer **68**. the system is calibrated so that this "null" spot corresponds to the proper positioning of the desired frame of information **64** within the aperture **50**. The direction in which the reversible motor **66** is driven depends upon the polarity of the voltage appearing across relay switch **92**.

Referring again to FIG. **7**, the changeable highway sign **12** includes a system of flashing lights to indicate various driving conditions. Individual light sources are located behind each lens located over the opening **42**. Flasher logic means **20** are located within the housing **34** and are operatively connected to lighting means **98**. Upon the selection of a specific frame of information **64** by a command signal from the central station **10**, the flasher logic means **20** selects and activates the appropriate light sources **98** corresponding to the frame of information **64** selected.

FIG. **9** illustrates one technique and means for actuating the flashing lights. Certain frames of information **64**, such as those indicating FOG and ICE, may utilize the activation of the flashing lights to heighten the motorist's awareness of these conditions. Each of such frames includes a ribbon **100** of a conductive material located along one edge of the scroll **58**. Two switches **102** are located along the same edge of the frame **64**. The switches **102** are connected to the flasher logic means **20**. When a specific frame **64**, such as the one displaying the FOG indicia, is positioned within the aperture **50**, both switches **102** are in contact with the conductive ribbon **100** to complete a circuit and activate the amber indicators. A conductive ribbon **100** could be located on the opposite edge of a different frame **64** and could be used in conjunction with another pair of switches **102** to activate a different arrangement of flashing indicators.

FIG. **9** also illustrates the frame **64** displaying the DANGER indicia activating the red indicators. In the preferred embodiment, flashing amber is used to indicate an intermediate state of emergency. Flashing red is used to indicate the situation of extreme danger.

FIG. **10** is a block diagram of the control logic for remotely located changeable sign. Communication between a remote central station and the changeable sign is accomplished by means of a sign communication system, generally designated as **200**. The transmitter portion of the communication system is located remotely at a control station with a receiver located in each of the changeable signs to be controlled.

Also, if desired, each sign can contain its own separate transmitter such that the sign is able to communicate directly with the remote central station upon command. AS mentioned hereinbefore, each changeable sign can be equipped with separate detectors for sensing a local condition and transmitting data thereof via the sign communication system **200** For example, local sensors generally represented by block **202** which include such detectors and sensors as traffic density detectors, weather condition sensors excessive speed detector-alarms, automatic vehicle identification detectors and the like, are operatively connected to the sign communication system **200** for communication with the remote central station. The sensors **202** would include the necessary logic and circuitry for detecting transmitted interrogation codes and for transmitting the requested data from the local sensors. It is contemplated that the sign communication system **200** could communicate with a remote central station with any known communication means, such as teletype, telephone cables, FM radio signals and the like.

Generally, the sign communication system **200** is used to transmit received information to the sign control system illustrated by dashed box **204**. In one embodiment, a sign control signal is encoded in a binary format and has a station address code or address signal portion and a command position code or command signal portion. In this embodiment, a 20-bit code is used comprising an address signal formed of a first and second character each of which comprise 8 bits each and a 4-bit command signal. Each 8-bit character includes a 3-bit parity and a 5-bit coded address. In FIG. **10**, one embodiment of a sign control system **204** includes control logic **206** which is operatively connected to the sign communication system **200**

to receive demodulated sign control signals therefrom. The sign control signals are coded and modulated by the radio frequency signal by transmission from a remote central station to the signs located in the area which is controlled by the central station. Each sign simultaneously receives and demodulates the transmitted modulated coded sign control signal and applies the demodulated control signal to the control logic 206. The control logic 206 removes the parity bits from the control signals and passes the same to an input register 208 which is utilized for temporary storage of the received signal. Typically, the input register 208 can be formed of a plurality of flip-flops.

In addition, each sign has a permanent storage memory 210 into which a preassigned address signal has been stored. The address signal for the particular sign is applied as one input to a logic comparator 212 while the other input to the logic comparator 212 is the address code portion of the control signal from input register 208. The logic comparator 212, which functions as a logic translator, determines if the address code portion of the control signal matches the permanent address code stored in the permanent storage memory 210. The result of this logic comparison is applied by the logic comparator 212 to the control logic 206 to determine if the particular sign should execute the command portion of the control signal. If the logic comparator 212 determines that the address code is for the particular sign, the control logic 206 then activates a counter 214 and a drive motor logic 218 to execute the command code portion of the sign information signal. The command code portion of the sign control signal stored in the input register 208 is applied to a direction logic 220 so that the appropriate sign direction can be determined in order to activate the drive motor logic 218. The position of the scroll before execution of the command code is determined by a sign position logic 224. A digital code representing the sign position is generated by the sign position logic 224 and applied to the direction logic 220, the input register 208 and a flasher logic 226. The direction logic 220 then determines he direction in which the drive motor logic 218 is to program a drive motor control 228 for actuating a control motor 230 for driving the scroll mechanism 232 to transport the strip of transparent material 60 in FIG. 6B. By use of a sign position logic 224, the drive motor control 228 can actuate the control motor 230 in either the forward or reverse direction such that the scroll mechanism 232 is properly driven to position the desired sign indicia in the opening of the sign housing.

As illustrated in FIG. 6B, the more dangerous conditions are shown to occur toward the bottom of the strip of transparent material 60. In this manner, as road conditions worsen, it takes less time to advance from a less dangerous driving condition to a more dangerous driving condition. For example, if normal driving conditions exist, the maximum speed limit, such as 70 m.p.h. illustrated by area 64 on the transparent strip 60 in FIG. 6B, can be displayed advising a motorist of the maximum speed limit. As the driving conditions become less favorable, a slower speed can be shown, such as a 60, 50 or 40 m.p.h. indication. If a SLOW, FOG or DANGER condition is shown, it takes less time to advance the strip of transparent material from, say, 40 m.p.h. to DANGER than it would take to advance the sign from 70 m.p.h. to DANGER.

As discussed hereinbefore, when a caution or dangerous condition is displayed by the sign, the flasher logic 226 is responsive to the sign position logic 224 to actuate the flashing lights, generally designated as 234 in FIG. 10. In this manner, the sign control system is responsive to the sign communication system 200 to control the sign apparatus which includes the drive motor control 228, the control motor 230, the scroll mechanism 232 which in turn controls the sign position logic 224, and the flashing lights 234.

It is contemplated that the sign control logic could be constructed of solid-state components using known resistor-transistor logic (RTL) integrated circuits which are well known in the art. Since RTL is well known in the art, a detailed description of the circuits forming the sign control system 204 is not deemed necessary.

I claim:

1. A changeable sign for displaying a selected one of several predetermined messages comprising

a housing defining an enclosure and having means defining a window through which any one of several predetermined messages displayed in alignment with the window can be observed;

sign indicia means within said housing for providing the messages and for rapidly changing the visible message on demand and including

a first roller positioned within said enclosure near said window,

a second roller positioned within said enclosure near said window and spaced from said first roller to support a message area in alignment with and adjacent said window, and

a web of light transmissive material having a plurality of predetermined message areas each with a message imaged thereon in a programmed sequence, said web being supported by said first and second rollers and movable upon rotation thereof to align a said predetermined message with said window;

actuating means operatively coupled to said sign indicia means for driving said sign indicia means to transport said web of imaged material in a direction to position different selected messages in alignment with said window;

a stationary retroreflective member positioned in parallel-spaced aligned relation with said window to permit said web of light transmissive material to pass therebetween, said retroreflective member forming a retroreflective background for each message bearing area of said web to display said predetermined message, said member having retroreflective areas interspersed with diffuse reflective areas;

sign position logic means operatively coupled to said sign indicia means for determining which of said predetermined messages is positioned in alignment with said window; and

a sign control means operatively connected to said actuating means and said sign position logic means and responsive to a command signal designating a selected predetermined message to be displayed by said sign for programming said actuating means to drive said sign indicia means in a direction determined in response to said sign position logic means to transport said web until a selected predetermined message designated by said command signal is positioned in alignment with said window.

2. The changeable sign of claim 1 wherein said sign position logic means is coupled to said sign indicia means for producing a position signal designating which of said predetermined messages is positioned within said window;

direction logic means operatively connected to said sign position logic means and said actuating means for comparing said command signal with said position signal to determine in which direction said web must be transported to display the predetermined message designated by said command signal in said opening and for controlling said actuating means to drive said sign indicia means to transport said web in a determined direction until said sign position logic means produces a position signal indicating said selected one of said predetermined messages indicated by said command signal is positioned in said window.

3. The changeable sign of claim 1 further comprising

a communication means operatively coupled to said sign control means adapted to receive a control signal having an address signal and a command signal transmitted from a remote station and apply said received control signal to said sign control means; and

wherein said sign control means includes decoding means for separating said address signal from said command signal.

4. The changeable sign of claim 1 wherein said sign control means includes

control logic means operatively connected to said decoding logic means for responding to said command signal to program said actuating means; and

translating logic means including means for storing a preassigned address code operatively coupled to said decoding logic means for receiving said address signal and comparing said received address signal to said preassigned address signal, said translating logic means upon determining said received address signal equals said preassigned address signal being operative to enable said control logic means to actuate said actuating means in the direction determined by said direction logic means and as programmed by said command signal.

5. A changeable sign for displaying a selected one of several predetermined messages and adapted to be mounted along a highway and capable of visually informing a motorist by current driving messages upon said sign receiving and responding to command signals from a remote control station, said sign comprising

a housing defining an enclosure having means defining a window through which a message positioned in alignment therewith may be observed,

sign indicia means within said housing for visually displaying information in the form of sign indicia and including a light transmissive web having a plurality of message bearing sections which may be displayed by alignment with said window;

a stationary retroreflective member positioned in spaced-parallel alignment with said window to permit said web of transparent material to pass therebetween, said retroreflective member forming a retroreflective background for each message bearing section of said transparent material to display said predetermined message, said member having retroreflective areas interspersed with diffuse reflective areas;

actuating means operatively coupled to said sign indicia means for positioning a selected one of said message bearing sections in a position to be visually displayed;

a sign control means operatively coupled to said actuating means and responsive to a said command signal for programming said actuating means to position a selected one of said sections bearing sign indicia for visually displaying the sign indicia;

a thermoelectric generator operated by the use of a vaporized propane fuel;

a fuel tank located adjacent said sign and beneath the ground for storing liquid propane which may be vaporized for use by said generator, said fuel tank including connecting means to said generator for transporting said vaporized propane fuel between said fuel tank and said generator, said fuel tank further including a fuel-filling port readily accessible for filling of said tank; and

means connecting said generator to said sign control means for powering said sign control means and said actuating means and for supplying heat generated by consumption of said fuel to said sign.

6. The changeable highway sign of claim 5 further including

a storage battery located within said housing and connected to said thermoelectric generator in an arrangement whereby said storage battery may be charged by said generator, said storage battery being connected to said sign control means and said actuating means to supply power thereto.

7. The changeable highway sign of claim 5 wherein said means for supplying heat to said sign includes

heat-exchanging means connected to said sign to cooperate with said thermoelectric generator to transfer heat produced by the exhaust gases of said generator to other components located within said sign to improve the performance of said components in cold temperatures.

8. The changeable highway sign of claim 7 wherein said heat-exchanging means includes

a first duct capable of being selectively connected to said generator when the ambient temperature drops below a predetermined value to vent said exhaust gases through the interior of said sign to the exterior thereby warming the components within said sign;

a second duct capable of being selectively connected to said generator when the ambient temperature rises above said predetermined value to vent said exhaust gases from said generator directly to the exterior of said sign; and

a temperature sensitive switching means capable of selectively connecting said first duct with and disconnecting said second duct from said generator when the ambient temperature drops below said predetermined value and vice versa when said temperature rises above said predetermined value.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,614,727 Dated October 19,1971

Inventor(s) Robert W. Fritts

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 7, "sing" should be -- sign --.

Col. 1, line 13, "S" at the end of the line should be deleted.

Col. 1, line 66, "FIG" should be -- FOG --.

Col. 2, line 42, "SCuh" should be -- Such --.

Col. 6, line 3, "the" (second occurrence) should be -- and --.

Col. 6, line 40, "FIG" should be -- FOG --.

Col. 7, line 66, "is" should be -- across --.

Col. 7, line 74 "the" (second occurrence) should be -- The --.

Col. 8, line 46, "AS" should be -- As --.

Col. 8, line 49, after "200" the words -- to a remote central station -- should be added.

Col 8, line 52, after "sensors" a -- , -- should be added.

Signed and sealed this 27th day of February 1973.

(SEAL)
Attest;

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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