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3,229,660

APPARATUS TO CONTROL STEERING, SPEED AND COATING APPLICATION OF
PAVEMENT MARKER

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2 Sheets-Sheet 1

Fig. 1.

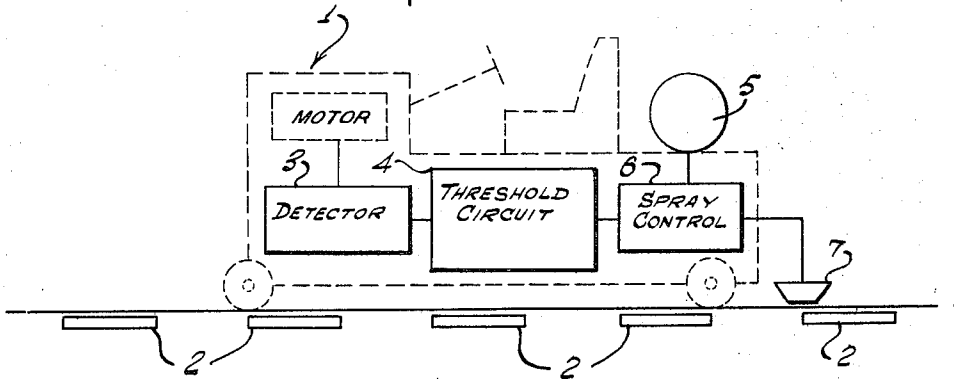
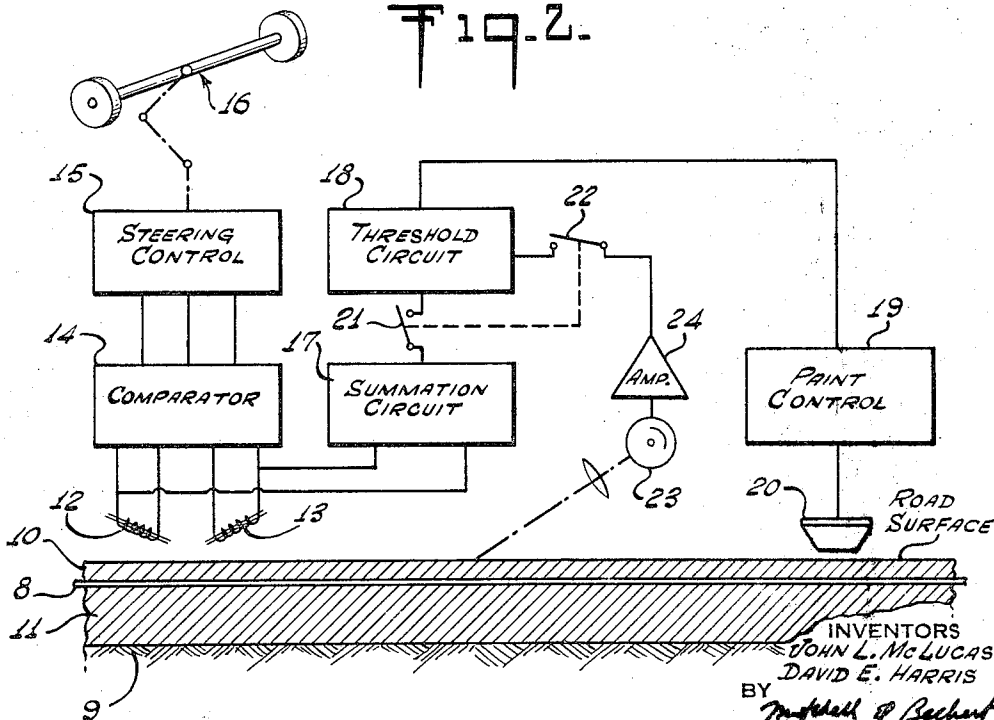


Fig. 2.



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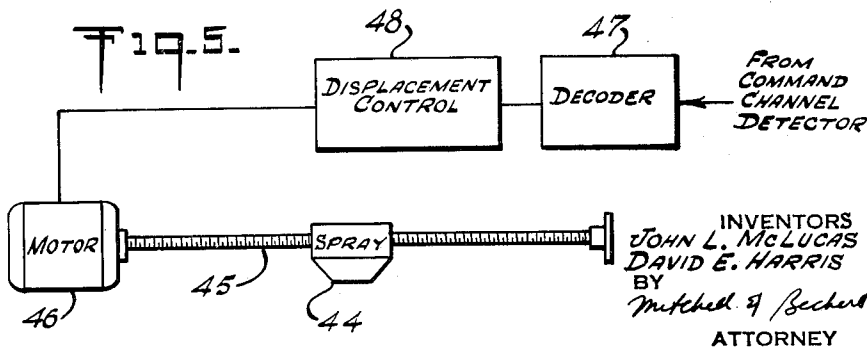
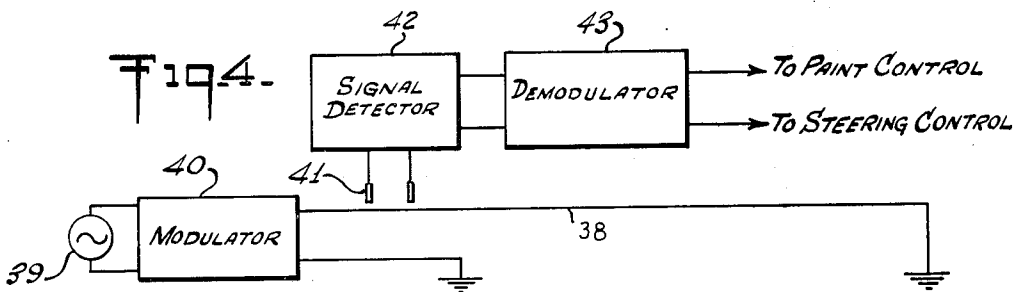
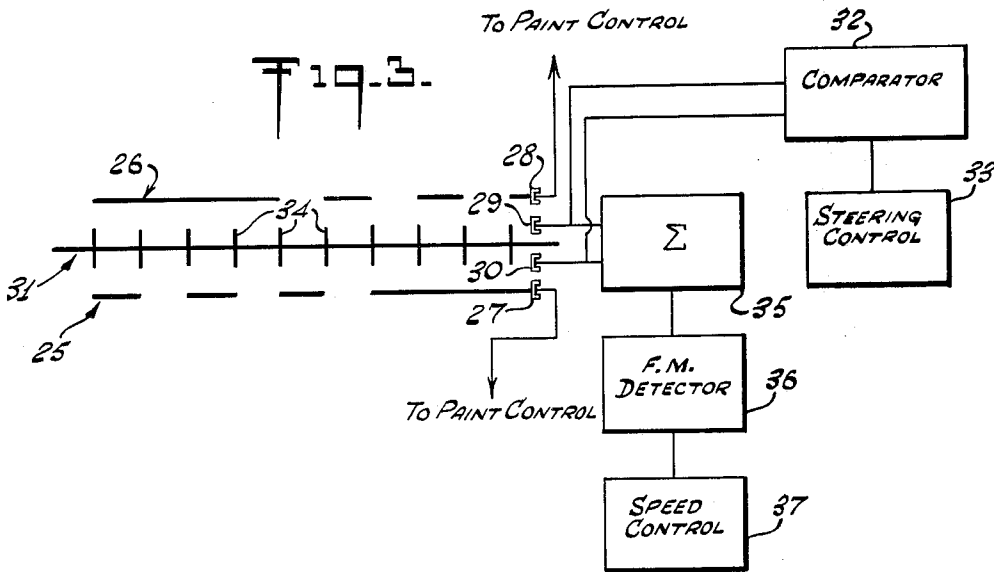
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3,229,660 APPARATUS TO CONTROL STEERING, SPEED AND COATING APPLICATION OF PAVE- MENT MARKER

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3 Claims. (Cl. 118—8)

This invention relates to apparatus for applying markings to highway pavements and the like and more particularly to apparatus for automatically controlling a paint applying vehicle to mark a pavement in accordance with a predetermined pattern.

At present it is common practice to mark highways, roads and other paved surfaces to indicate lanes of traffic and other road conditions such as curves or hills. Generally, the marking of the pavement is accomplished by employing a power driven vehicle containing a tank of paint and a spray nozzle. The driver of the vehicle steers the desired course along the road and marks the pavement by operating the spray equipment in accordance with a predetermined pattern, as the vehicle proceeds along its course. Unfortunately, the accuracy of the markings produced by such equipment is dependent upon the skill of the operator. Often when a road is being repainted, the discrepancy between the location of the new paint and the old markings causes confusion to drivers and makes the inaccuracy of the marking vehicle operator quite obvious.

Accordingly, it is an object of this invention to provide apparatus for automatically painting a predetermined pattern on a pavement.

Another object of this invention is to provide a power driven vehicle including paint applying means controlled by information from signal elements associated with the pavement, to paint a predetermined pattern.

A feature of this invention is the use of a vehicle including valve controlled paint applying means which is operated from information obtained from signal elements on or in the pavement.

Another feature of this invention is the use of a continuous element having a predetermined signal pattern disposed in the pavement to guide automatically a vehicle along the element during the application of markings to the pavement in accordance with the signal pattern on the continuous element.

The above-mentioned and other objects and features of this invention will become more apparent by reference to the following description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a schematic diagram of one embodiment of pavement marking apparatus in accordance with the principles of this invention;

FIG. 2 is a schematic diagram of one embodiment of this invention having provision for the automatic guidance of the pavement marking apparatus during the marking;

FIG. 3 is a schematic diagram of an alternate embodiment of this invention having means for automatically controlling the speed of the apparatus while marking the pavement;

FIG. 4 is a schematic diagram of still another embodiment of this invention in which the pavement marking pattern signals are impressed on a continuous element embedded in the pavement; and

FIG. 5 is a schematic diagram of an embodiment of this invention wherein the paint applying means is capable of being displaced laterally from the axis of the pavement in accordance with displacement control signals.

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Referring now to FIG. 1 of the drawing, one embodiment of pavement marking apparatus in accordance with the principles of this invention, is illustrated comprising a power driven vehicle 1 and information bearing signal elements 2 incorporated in the pavement. Mounted in the vehicle 1 is a detector 3 which detects the presence of the information bearing signal elements 2 and has its output coupled to a threshold detector circuit 4. The threshold detector circuit 4 prevents false or spurious signals due to extraneous causes from actuating the paint spraying equipment. The paint spraying equipment mounted on the vehicle 1 comprises a tank of paint 5 whose output is controlled by a spray control 6 which is contained in the pipe line between paint tank 5 and the spray nozzle 7. The spray control 6 generally comprises a valve. As the vehicle 1 proceeds along the highway or pavement and the detector 3 passes over a signal element 2, a signal exceeding the threshold level determined by circuit 4, is coupled to the spray control 6 causing paint from tank 5 to be applied to the pavement surface by nozzle 7.

The information bearing signal elements may comprise strips of metal embedded in the pavement and the detector 3 would then comprise a metal sensing unit. When strips of metal are used as the signal elements they should be embedded close to the surface of the pavement in order to permit the detector 3 and threshold circuit 4 to differentiate between the information bearing signal elements and the metal reinforcing rods, if any, which are embedded deeper in the pavement.

Alternately, the information bearing signal elements may be white paint previously affixed to the road surface. In such an embodiment, the portion of the pavement to which the paint was previously affixed would have different optical characteristics than the remainder of the pavement, and the detector 3 could be a photoelectric device such as a photocell, capable of distinguishing the different optical property. It is also possible to utilize radio-active material embedded in the pavement in accordance with the predetermined pattern to be painted. In such an event the radio activity is detected and utilized to control the valve 6 associated with the paint applying apparatus.

In the embodiment of the pavement marking apparatus illustrated in FIG. 1 it is necessary for the operator to steer the vehicle 1 so that the detector 3 is continuously in position to detect the presence of the information bearing signal elements.

Referring now to FIG. 2 of the drawing, there is shown an embodiment of the pavement marking apparatus wherein a continuous signal element provides guidance control for the paint applying vehicle. A continuous element or wire 8, which may be composed of a material having a high magnetic retentivity, is embedded in the pavement 9 near the surface 10 and spaced from the portion 11 of the pavement in which the reinforcing rods may be located. When a continuous element or wire 8 is utilized having a high magnetic retentivity it may bear recorded magnetic signals in accordance with the marking pattern which is to be applied to the surface of the pavement. A pair of detectors 12 and 13 straddle the continuous element 8. The output of the detectors 12 and 13 are coupled to phase sensitive differentiating detector means, or amplitude comparator 14 depending on the nature of the recorded signals, and the output thereof is fed to steering control 15 to which the steering mechanism 16 of the vehicle is joined. When the output of the detectors 12 and 13 are equal, the output of the comparator 14 is coupled to the steering control 15 causing the vehicle to proceed along the same course. Any deviation from its course causes an unbalance in the signals from detectors 12 and 13 which is detected in the comparator 14. The output of the comparator 14 then

couples a guidance signal to the steering control 15, causing the steering mechanism 16 to correct the course deviation and maintain the detectors 12 and 13 in a straddling position over the continuous signal element 8.

When the continuous element 8 is composed of a magnetic retentive material on which is recorded the marking pattern signals, the detectors 12 and 13 may comprise magnetic field sensitive devices such as pick-up heads, and in order to control the application of the paint in the desired pattern, the outputs of the detectors 12 and 13 are coupled to a summation circuit 17 where the outputs of the pair of detectors are added together. As the detectors 12 and 13 pass over a portion of the continuous element on which a magnetic signal was previously recorded or impressed, the sum of their outputs coupled from summation circuit 17 exceeds a level determined by the threshold circuit 18 and a signal is coupled to the paint control 19 causing paint to be sprayed from the nozzle 20 onto the road or pavement surface 10.

In the absence of recorded signals on the element 8 or if it is desired to utilize the wire 8 embedded in the pavement only for steering or guidance purposes, previous markings on the pavement or other signal elements can be utilized to control the application of the paint from the nozzle. In such an event switch 21 is opened and switch 22 is closed. Then, as the vehicle proceeds along the pavement under control of the guidance signals derived from the continuous element 8, a second detector, such as a photoelectric cell 23 detects the previous markings or other pattern control signal elements and couples a signal through amplifier 24 to the threshold circuit 18 whose output activates the paint control 19 to cause paint to be sprayed from nozzle 20.

Referring to FIG. 3, an embodiment of this invention for simultaneously painting a plurality of parallel markings on a pavement, is shown comprising a plurality of signal channels 25 and 26 each containing information bearing signal elements. A detector 27 and 28 is associated with each of the channels 25 and 26. In a manner as hereinbefore explained, the output of each detector 27 and 28 controls spray paint applying means. As the vehicle proceeds along the pavement, each detector 27 and 28, responsive to the information contained in its associated signal channel 25 and 26 respectively, causes the paint applying means to spray markings on the pavement in accordance with the predetermined pattern contained in the signal bearing information in each channel. If desired, the embodiment shown in FIG. 3 may also include a pair of detectors 29 and 30 associated with a continuous strip guidance channel 31. The output of the detectors 29 and 30 are coupled to a comparator 32 whose output is fed to the steering control circuits 33 in order to guide the vehicle as hereinbefore described. In addition, the guidance channel 31 may include speed control information bearing signals such as at 34. As the detectors 29 and 30 pass over the speed control signals 34 their output is added in summation circuit 35 and coupled to circuit 36 where a signal is generated proportional to the speed of the vehicle. It is apparent that if the signals 34 are equally spaced in channel 31 and the vehicle is proceeding at a constant speed, then a signal at a given frequency is generated, and if the vehicle increases its speed, the generated signal will be at a greater frequency. Thus, by measuring the frequency of the signal generated in circuit 36 and maintaining the frequency constant, the speed of the vehicle proceeding along channel 31 will remain constant. This signal generated in circuit 36 is coupled to the speed control mechanism 37 of the vehicle to adjust its speed to a predetermined figure and to hold it constant. Thus, as shown in FIG. 3 a pavement marking apparatus in accordance with the principles of this invention may have its marking equipment, speed and guidance all responsive to signal elements incorporated in the pavement to be marked.

Referring to FIG. 4, an alternate embodiment of this invention is shown, comprising a continuous wire or

signal element 38 incorporated in the pavement to be marked, and a source of carrier frequency energy 39 having its output modulated by circuit 40 with signals indicative of the predetermined markings to be applied to the pavement. Detectors 41 couple their outputs to signal detector circuit 42 whose output is fed to a demodulator 43 which generates a signal to control the paint applying means carried by the marking vehicle. Of course, it will be readily understood by those skilled in this art that a plurality of modulations may be impressed on the carrier frequency energy and coupled to element 38 in order to control a plurality of paint controls after the various signals are demodulated.

It is desirable that the marking vehicle proceed along the element 38 at a constant speed and toward this end it is possible also to modulate the carrier frequency energy with a speed control signal.

Referring now to FIG. 5, paint applying means for marking pavement at varying distances laterally of the axis of the pavement is shown comprising a paint spray nozzle 44 mounted on a lead screw 45. Lead screw 45 is actuated by motor 46 to laterally displace the nozzle 44. A command signal information bearing element may be incorporated in the pavement to be marked and a detector provided on the marking vehicle to detect the command channel signals. The output of the command channel detector is decoded in circuit 47 and the output coupled to displacement control circuit 48. The output of the displacement control circuit 48 actuates the motor 46 causing the lead screw 45 to rotate and displace the nozzle 44 the desired distance in accordance with the decoded signals from the command channel.

It is to be realized that magnetic signals may be erased and new information encoded into the signal bearing element when desired.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the objects thereof and in the accompanying claims.

What is claimed is:

1. Apparatus for marking a pavement comprising in combination, a vehicle, signal means in the form of a long strip of signal bearing material incorporated with said pavement, said signal means being positioned so as to define a predetermined path to be followed by said vehicle, signal pickup means mounted on said vehicle and responsive to the position of said signal means and to signals impressed thereon, said signal pickup means comprising a pair of signal pickup heads positioned to straddle said strip when said vehicle is traveling along said predetermined path, automatic steering means mounted on said vehicle and coupled to said signal pickup heads to automatically steer said vehicle along said predetermined path in response to signals received from said signal means, said automatic steering means being operable to steer said vehicle so as to equalize the output of said pair of pickup heads, valve controlled paint applying means mounted on said vehicle, said signal means having a predetermined valve control signal pattern impressed thereon to define a predetermined sequence of operation of said valve, automatic valve control means mounted on said vehicle and coupled to said signal pickup heads to automatically control said valve in response to said predetermined valve control signal pattern, a comparator circuit coupled between said pickup heads and said automatic steering means, a threshold circuit coupled between one of said pickup heads and said automatic valve control means, and said threshold circuit being operable to actuate said valve control means only in response to signals above a predetermined threshold level so that said latter means remains unactuated despite the presence of spurious signals produced in said pickup heads thereby automatically producing a predetermined pattern of painted marks on said pavement.

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2. The combination defined in claim 1 wherein said signal means has a predetermined speed control signal pattern impressed thereon to define a predetermined speed of said vehicle along said predetermined path, and also including automatic speed control means mounted on said vehicle and coupled to said signal pickup means to automatically control the speed of said vehicle in accordance with said predetermined speed control signal pattern.

3. The combination defined in claim 1 and also including a periodic speed control signal pattern impressed on said strip of signal bearing material, an F.M. detector coupled to one of said pickup heads to receive said periodic speed control signals, automatic speed control means coupled to said F.M. detector and responsive to the output signal thereof, said F.M. detector being operable to produce a null output signal at a predetermined speed of said vehicle, and a summation circuit coupled between said pair of pickup heads and said threshold and F.M. detector circuits, said summation circuit being operable to add together the signals received by said pair of pickup heads and to apply the sum thereof to said threshold circuit and said F.M. detector circuit, whereby the

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speed of said vehicle is automatically controlled in accordance with said speed control signal pattern.

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