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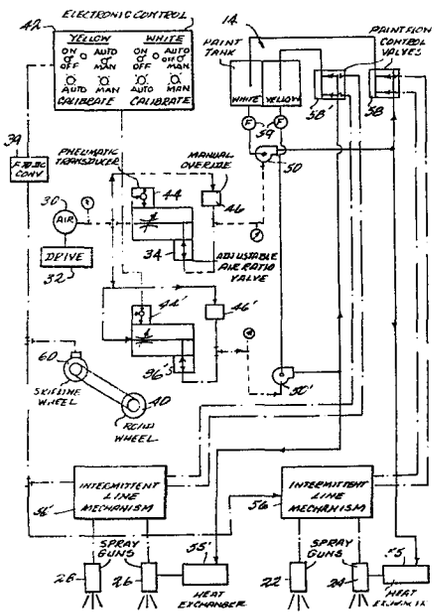
(71) Applicant: **REDLAND PRISMO CORPORATION,**
300 Lanidex Plaza, Parsippany New Jersey 08045 (US)

(72) Inventor: **Mark, Gary L., 390 Harding Avenue,**
Williamsport Pennsylvania 17701 (US)
Inventor: **Wands, Kenneth, 306 Gearhart Street,**
Riverside Pennsylvania, 17868 (US)

(74) Representative: **Laight, Martin Harvey et al, W H Beck,**
Greener & Company 7 Stone Buildings Lincoln's Inn,
London WC2A 3SZ (GB)

(54) Apparatus for and method of controlling rate of deposition of material from a moving vehicle.

(57) Apparatus for and method of spraying a substance such as paint onto a road surface or the like to form a coating of uniform thickness in which the speed of the vehicle (10) mounting the system is detected and a speed signal produced which controls air flow through a variable flow air valve (34) to a diaphragm air pump (50) which supplies paint or other substance to a spray gun (22, 24). The speed is detected by a road wheel (40) which feeds a train of pulses to a frequency to D.C. converter (39). The converter (39) produces an electrical signal which controls a transducer (44) for controlling the variable air valve (34).



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Apparatus for and method of controlling rate of deposition of material from a moving vehicle.

The invention relates to apparatus for automatically controlling the rate at which a substance such as paint is deposited from a moving vehicle onto an adjacent surface such as roadway in order to form a coating of uniform thickness.

It is necessary during the application of quick drying road marking materials, such as paint, that the material be applied at a thickness which is within fairly rigid upper and lower limits. If the line is too thick, the material will not dry in the prescribed time. If the line is too light, then the material will not hold its beads or will not be as durable as may be required. A factor which results in uneven paint thickness is intentional or unintentional variation in vehicle speed. In order to maintain the proper constant line thickness, the paint flow should be increased and decreased in direct proportion to increases and decreases in vehicle speed.

On conventional vehicle mounted line painting machines paint flow must be manually controlled by an operator, usually by manually backing off the air pressure regulator. There is no means for automatically changing the volume requirement to correspond to the vehicle road speed.

A number of disadvantages result from the manual method of volume control. The operator must be constantly monitoring the vehicle speed and the level of paint flow, removing his attention from the other aspects of vehicle control. Human error is likely to result in line thicknesses which are uneven or incorrect thicknesses.

A method of metering the thickness of the paint in accordance with the vehicle speed which has been tried is to use gear pumps powered by the vehicle power take-off. The power take-off increases and decreases with the road speed of the vehicle in a specific gear, so that as the pumps go faster or slower they meter the thickness of the paint, at least to an approximation, to correspond to the vehicle speed. However, this method has a serious disadvantage in that the mechanical drives on the gear pumps interfere with the operation of the vehicle.

Another method, as described in U.S. patent 4,247,045 issued January 27, 1981, is to control the flow of hydraulic fluid to hydraulic pumps which apply the paint or other substance to the spray guns. While this prior art system effectively and satisfactorily controls the thickness of the paint, several problems exist.

Since it contains silicon, paint is a material which is difficult to pump and which quickly wears parts which it contacts in a pump. Using a positive displacement pump such as a hydraulic pump, often requires that the pump be replaced within a few months at a substantial cost. Further, since an air-driven system is normally provided on a vehicle of this type for atomizing, the use of a separate hydraulic system is a substantial additional expense.

According to the present invention an air pump is used to supply the substance to be sprayed. More particularly, a variable flow air valve controls flow of air to a diaphragm pump in accordance with a signal indicating the speed of the vehicle so that a uniform coating is sprayed onto the highway or other surface.

The use of an air pump and particularly use of a diaphragm air pump substantially reduces the expense of maintenance since the parts which must be replaced are very inexpensive. Moreover, the pump surfaces which contact the paint can be coated with polytetrafluoroethylene (Teflon $_R$) and are therefore much more resistent to corrosion. Moreover, air pumps of this type can handle greatly varying flow rates and therefore the same pump can be used for filling the paint tank requiring high flow rates, for example, 25 gallons per minute and at the same time for spraying at low levels, for example, 4 gallons per minute. Since spraying and filling do not occur at the same time, the entire capacity of the compressor can be used during the filling operation and yet the compressor volume is sufficient to provide both the pumping and atomizing of the paint during striping.

Another advantage of the present invention is the elimination of the necessity of recirculation of the fluid which drives the pump. Like any air system, the air can simply be exhausted after operating the pump or other elements of the system.

Preferably, two separate and parallel spray lines are provided so that two colors or types of paint may be sprayed simultaneously. Typically yellow paint and white paint are sprayed to create two different colored highway lines. In this embodiment, air from the compressor is directed to separate adjustable air ratio valves each of which is controlled by a signal indicating vehicle speed.

The vehicle speed is preferably detected utilizing the pulse train which is conventionally produced and used to intermittently interrupt the spray to produce the broken line which is conventionally desired for highway striping. In this

arrangement a wheel can be lowered into contact with the road surface so as to rotate with the vehicle during striping. An electrical pulse train is thus produced, the frequency of which indicates the vehicle speed. According to one aspect of the present invention, this pulse train is converted to a DC signal by a conventional frequency to DC converter and applied to a control circuit. The control circuit in turn applies a signal to an electric pneumatic transducer which controls the air valve. The same pulses are used then conventionally to operate the intermittent line mechanism and periodically interrupt spraying to produce the broken highway stripes.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:-

FIGURE 1 shows a perspective view of a striping truck mounting a control system embodying the present invention; and

FIGURE 2 shows a schematic diagram of the control system embodying the present invention.

Referring now to FIGURE 1, road line painting truck 10 includes a chassis indicated as 12 which mounts a tank 14 for storing a fluid to be sprayed such as paint. An air compressor 16, a control indicated as 18 and a pair of spray gun carriages generally indicated as 20 (only one of which can be seen in FIGURE 1) are mounted on chassis 12. Paint is pumped by a pump (not shown in FIGURE 1), in the present invention a diaphragm air pump, from tank 14 to the spray gun carriages 20 where it is sprayed by

the respective guns. Two guns 24 and 26 can be seen in FIGURE 1 but it will be understood that any suitable number can be utilized.

The system for automatically controlling the rate of spray of a substance such as paint from a moving vehicle such as shown in FIGURE 1 is schematically illustrated in FIGURE 2. In accordance with the preferred embodiment of the invention, an air compressor 30, driven by a power source 32 on the truck deck provides air to two adjustable air ratio valves 34 and 36' each having an automatically adjustable orifice. Adjustable air ratio valves 34 and 36' are each independently adjustable at their adjustable orifices and are connected to a separate carriage for spraying a substance such as paint from the vehicle in a controlled manner as will be described. One spraying carriage may be for one type of paint and the other for spraying another type of paint, e.g., white paint and yellow paint. Since these carriages are substantially identical, only one will be described.

Adjustable valve 34 is automatically adjusted according to the speed of the vehicle by a DC voltage generated by a frequency to DC converter 39 which is responsive to the speed of road wheel 40. The converter 39 controls the adjustable orifice of adjustable air ratio valve 34 through a conventional control unit 42 which contains a circuit for calibrating the signal from convertor 39 and switches which permit the system to be operated in either a manual or automatic mode. Dials on unit 42 permit the paint thickness to be adjusted to the appropriate level for each of the paints being utilized. The output of control unit 42 drives the electric to pneumatic transducer 44. A model T-512D transducer

from Fairchild Industrial Products Division is satisfactory. A manual override device 46 permits manual operation of the valve 34 when the automatic control means is malfunctioning. The output air pressure at valve 34 drives a paint pump 50, which causes the subtance to be sprayed, i.e., the white paint, to be forced from paint tank 14 through spray guns 26 and 28 and guns 22 and 24 (not shown in FIGURE 1). A paint filter 59 is suitably disposed between paint tank 14 and paint pump 50. A heat exchanger 55 is suitably disposed between pump 50 and spray guns 22 and 24 for recovering waste heat in the exhaust as described in the patent to Mitchel et al 4,190,205.

Glass beads are commonly mixed with road paint to improve visibility after application, and the system of this invention may be used for spraying such glass beads in addition to paint. The spray guns may comprise double and single color continuous bleed type paint guns or automatic pressure injection glass guns. Typically quick drying road marking materials are applied at 15 mils thickness.

Line painting vehicles of the kind described typically include an intermittent line mechanism 56 which can be set to turn spray guns 26 and 28 or spray guns 22 and 24 on and off at a rate proportional to the vehicle speed in order to obtain dashed lines of a preset length. In accordance with this aspect of the invention, the vehicle speed is communicated to the intermittent line mechanism 56 by skipline wheel 60 which in turn develops skipline pulses at a rate proportional to the speed of road wheel 40. The intermittent line mechanism 56 is also connected to a dual orifice bypass valve 58 which bypasses paint around spray guns 22 and 24 when one or both of spray

guns 24 and 26 are closed and returns the bypassing paint to paint tank 14. In this way, a continous flow of paint is driven by paint pump 50 at a continuous pressure relative to road speed, regardless of whether none, one or two spray guns are open as the various road line patterns require.

As indicated above, a similar system for spraying yellow paint, whose components are designated by primed (') numerals is connected to adjustable air ratio valve 36'.

Although only one exemplary embodiment of this invention has been described in detail above, those skilled in the art will readily appreciate that many embodiments are possible in the exemplary embodiment without materially departing from the novelty teachings and advantages of this invention. In an alternate embodiment, the intermittent line mechanism may suitably comprise a single unit including an electronic solid state counter capable of providing intermittent line pattern control to all four spray guns and both dual orifice bypass vavles 58 and 58 primed. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the following claims.

CLAIMS

1. Apparatus for controlling the rate at which a substance is deposited from a moving vehicle (10) onto an adjacent surface to form a coating, comprising means (22,24) for spraying said substance onto said surface at a variable rate related to the speed of the vehicle (10),

characterised by means (40) for detecting the speed of said vehicle (10) and producing a speed signal which varies as a function thereof,

an air pump (50) for supplying said substance to said spraying means (22,24) at a rate dependent upon the rate of air supplied thereto, and

a variable flow air valve means (34,44,39) connected to said detecting means (40) and to said air pump (50) for controlling flow of air to said air pump (50) in accordance with said speed signal so as to deposit a coating of uniform thickness independent of speed.

2. Apparatus according to claim 1 in which said air pump is a diaphragm air pump (50).

3. Apparatus according to claim 1 or 2 wherein said detecting means includes a wheel (40) adaptable to contact said surface and rotate as said vehicle is driven, and means for producing a pulse train, the frequency of which indicates the speed of rotation of said wheel; and wherein said valve means includes an

adjustable air valve (34), an electric pneumatic transducer (44) for controlling said air valve, and means (39) for receiving said pulse train and producing an electrical signal for controlling said transducer (44).

4. Apparatus according to claim 3 wherein said signal receiving and producing means comprises a frequency to DC converter (39).

5. Apparatus according to any preceding claim including manual control valve means (46) connected to said pump (50) for supplying air thereto independent of said variable flow air valve means (34, 44, 39).

6. Apparatus according to any preceding claim further including means (28,26) for spraying a second substance onto said surface, a second diaphragm pump (50') for supplying said substance to said second spraying means (28,26) at a rate dependent upon the rate of air supplied thereto and second variable flow air valve means (36',44',39) connected to said second diaphragm pump (50') for controlling flow of air to said second diaphragm pump (50') in accordance with said speed signal so as to deposit a coating of uniform thickness independent of speed.

7. Apparatus according to any preceding claim further including means (56,56') for intermittently preventing said spray means (22,24,28,26) from spraying in accordance with said speed signal.

8. Apparatus according to any preceding claim in which said spraying means includes at least one spraying gun (22,24,26,28) mounted on said vehicle for spraying paint on an adjacent road surface to form highway stripes.

9. Apparatus according to any preceding claim including a paint tank (14) connected to said air pump.

10. A method of controlling the rate at which a substance is deposited from a moving vehicle (10) onto an adjacent surface to form a coating, comprising the step of spraying said substance onto said surface at a variable rate related to the speed of the vehicle (10),

characterised by the steps of detecting the speed of said vehicle (10) and producing a speed signal which varies as a function thereof, spraying said substance onto said surface with a spray means (22,24), supplying said substance to said spray means (22,24) by an air pump (50) at a rate dependent upon the rate of air supplied thereto, and controlling flow of air to said air pump in accordance with said speed signal so as to deposit a uniform thickness independent of speed.

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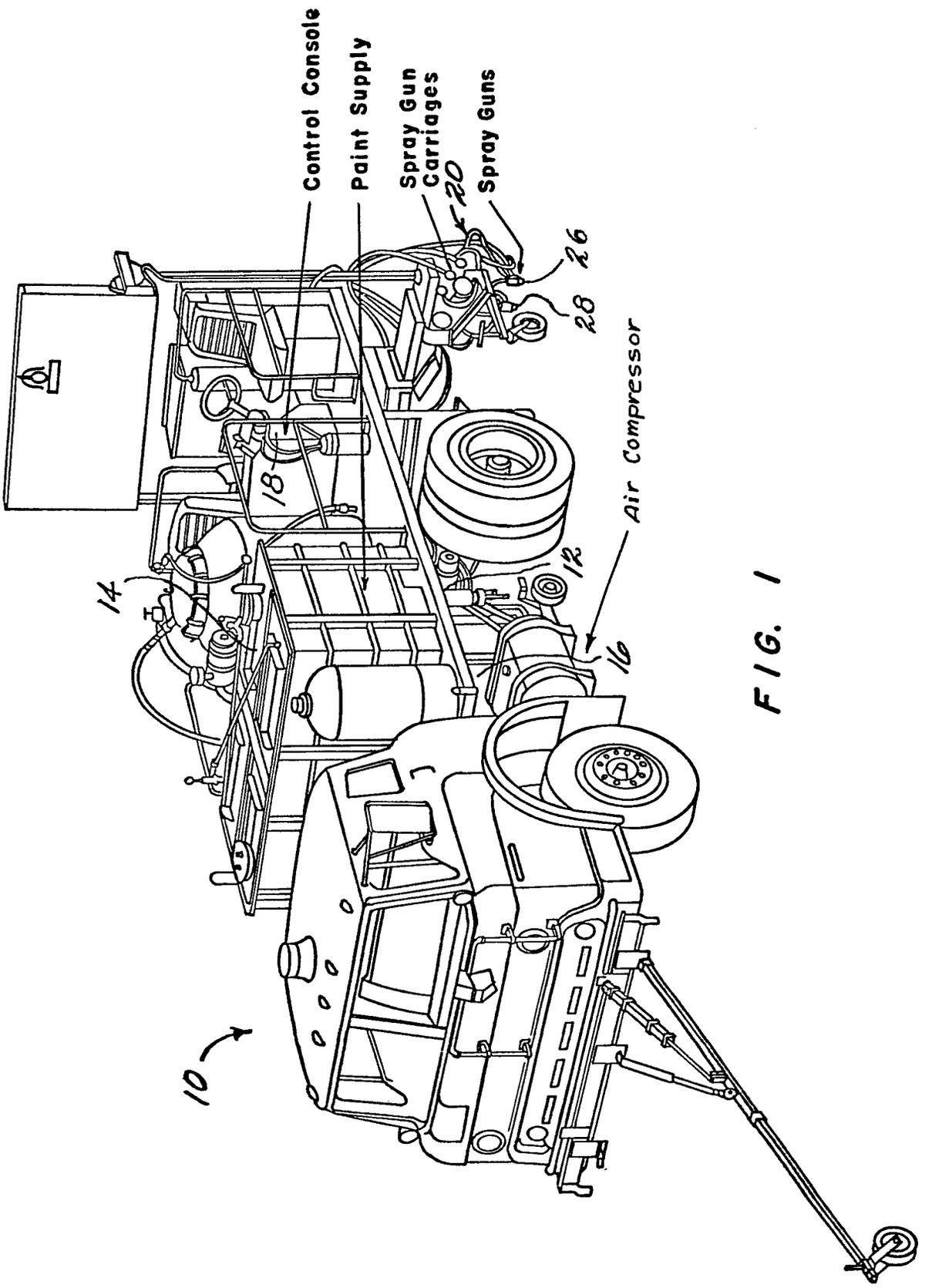

FIG. 1

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FIG. 2