

July 23, 1968

D. D. MICHELN
APPARATUS AND METHOD FOR APPLYING FUSIBLE ORGANIC
PARTICULATE IN A COALESCED FILM
CONDITION TO A SURFACE

3,393,615

Filed July 18, 1966

2 Sheets-Sheet 1

FIG. 1

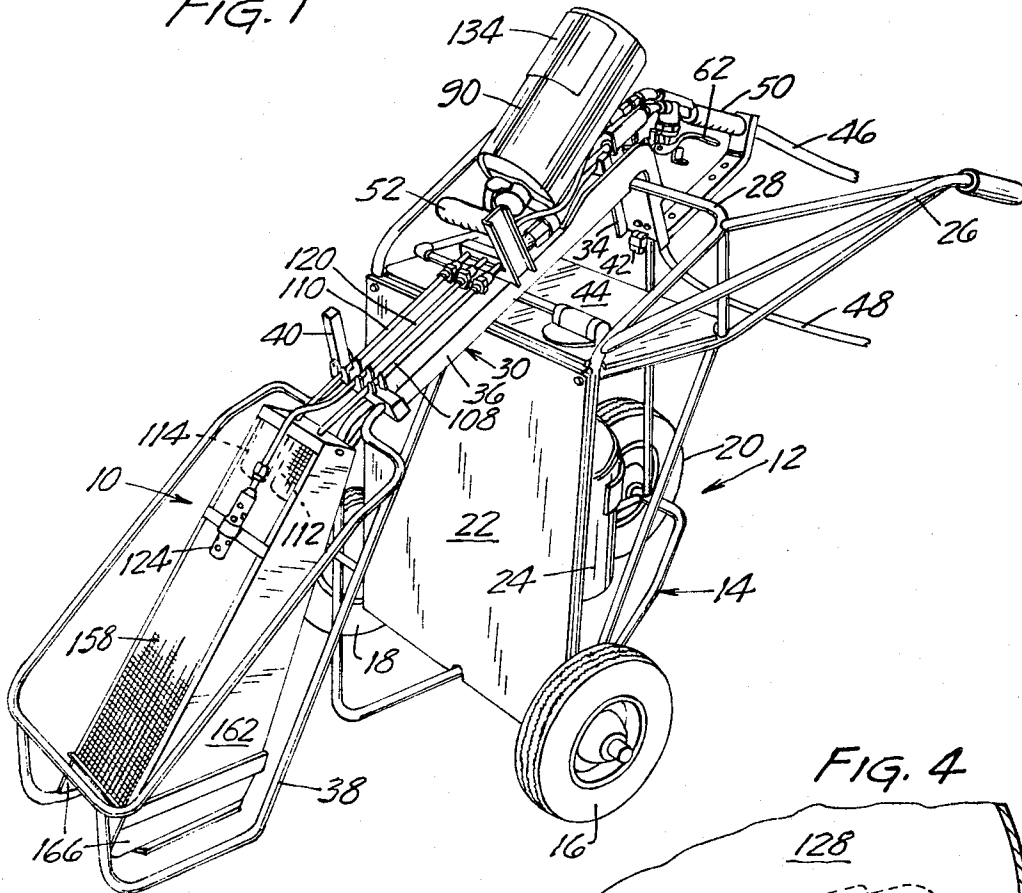


FIG. 4

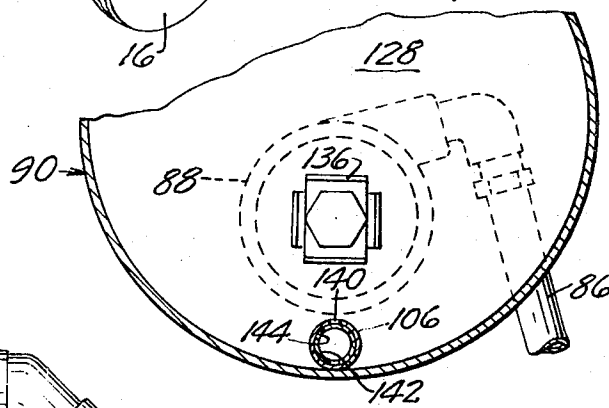
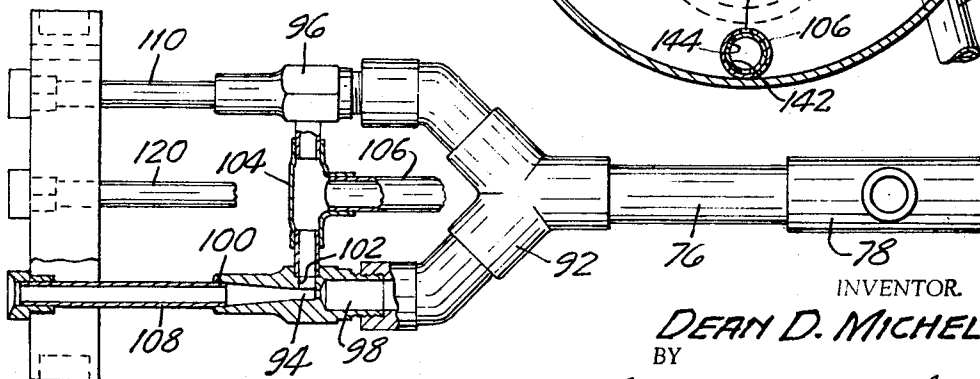


FIG. 5



INVENTOR
DERN D. MICHELN
BY
Carpenter, Kinney & Boulter
ATTORNEYS

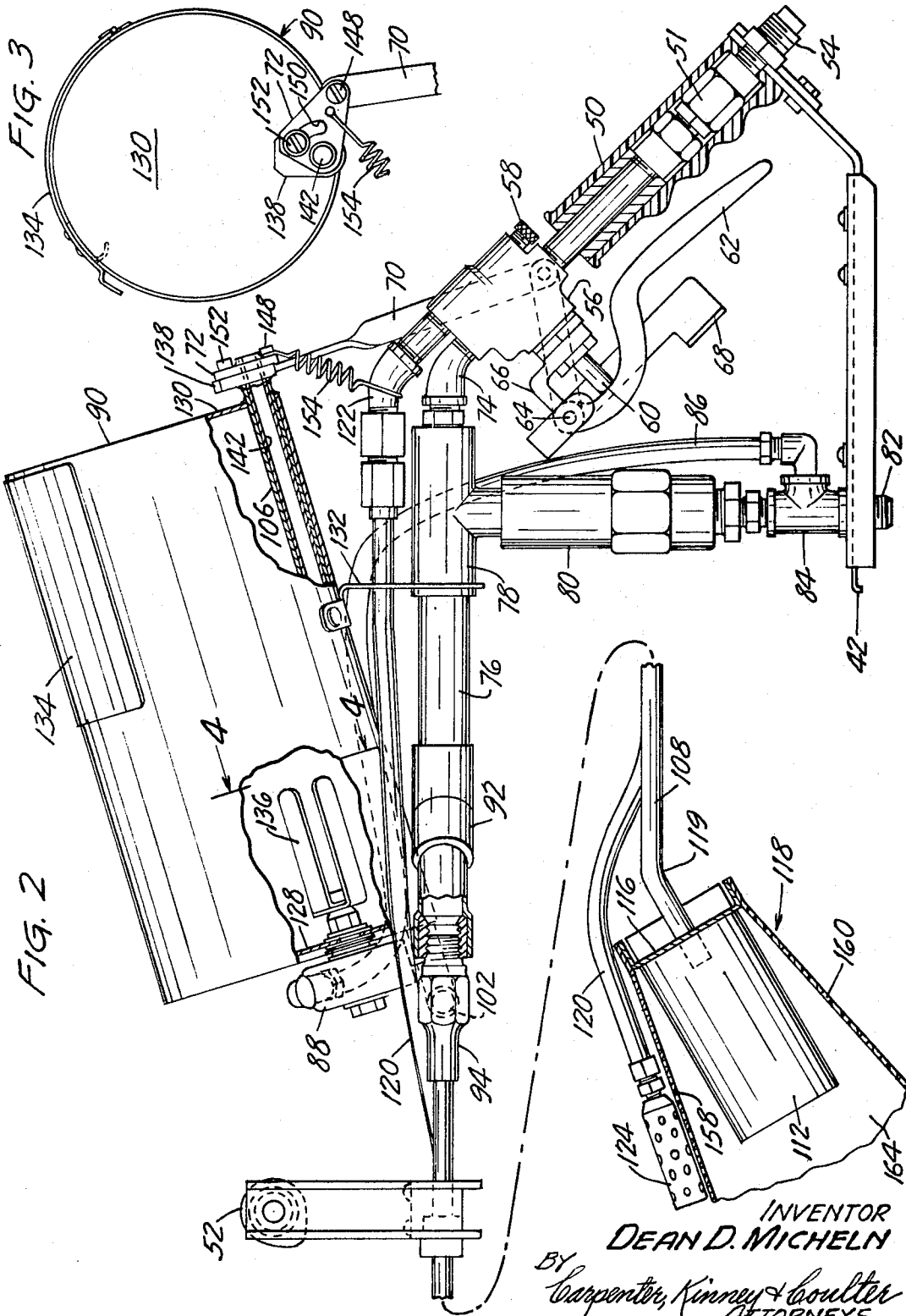
July 23, 1968

D. D. MICHELN
 APPARATUS AND METHOD FOR APPLYING FUSIBLE ORGANIC
 PARTICULATE IN A COALESCED FILM
 CONDITION TO A SURFACE

3,393,615

Filed July 18, 1966

2 Sheets-Sheet 2



INVENTOR
 DEAN D. MICHELN

BY
 Carpenter, Kinney & Coulter
 ATTORNEYS

1

3,393,615

APPARATUS AND METHOD FOR APPLYING FUSIBLE ORGANIC PARTICULATE IN A COALESCED FILM CONDITION TO A SURFACE

Dean D. Micheln, North St. Paul, Minn., assignor to Minnesota Mining and Manufacturing Company, St. Paul, Minn., a corporation of Delaware
Filed July 18, 1966, Ser. No. 566,068
12 Claims. (Cl. 94—39)

This invention relates to a coating apparatus and method, and in one aspect to a device for and a method of applying coatings or markings to roadways.

There has become an increasing demand for suitable means for providing lane markings to pavement surfaces without significantly delaying or rerouting traffic. It is further desirable that the equipment not require any costly solvent and/or time consuming clean-up operation after each use. The use of a fusible organic particulate material has therefore met with considerable success. The prior known machines for applying an organic particulate material to a pavement surface have been awkward and cumbersome. Such machines had numerous or large burners with a very high heat capacity to preheat the surface and melt the dispensed particulate, and to post-heat the stripe. The units operated to dispense the material from 4 to 6 inches above the surface and high heat capacity was required to provide a uniform coalesced film condition.

In some prior known devices the organic material is preheated and is in substantially a liquid state before being dispensed. These devices have the stated disadvantages of size, costly clean up, numerous burners, etc.

A device constructed according to the present invention has all the advantages present with the prior known particulate material applicators and also affords a size reduction to a hand held unit.

In the device of the present invention the particulate is mixed with the combustible mixture before it is discharged. Thus each particle of organic material is surrounded by the combustible gas when dispensed so they are not protected by an envelope of air from the flame. Thus the particles are quickly melted in the flame and as it strikes the heated surface to be marked it quickly freezes to a coalesced uniform film. This film of material affords essentially an immediate marking stripe which is ready to function as a safety marking and bear road traffic within seconds after its application. This negates the necessity of barricading and rerouting traffic while applying lane markings.

Thus the advantage of the present invention is that it provides a simple, economical, lightweight apparatus for applying a polymeric coalesced film of uniform color to a surface. The present invention affords equipment for applying such organic particulate to road surfaces which is light enough to be held in the operators hand for special applications such as applying legends through stencils, marking vertical surfaces, or which may be placed on a small transport for straight line application.

A device constructed in accordance with the present invention is safe and efficient.

The method of the present invention permits the coating of a surface with a resinous film using material, having a relatively low melting temperature, supplied as a finely ground particulate.

The method of this invention comprises the steps of mixing pressurized fuel and an oxidizing medium and passing it through an aspirator, supplying finely ground polyamide-based resin particulate material to the aspirator to be drawn into the exiting stream of fuel and oxidizing medium, directing a discharge tube connected to

2

the aspirator at the surface to be coated, and igniting the fuel adjacent the exit of the tube to produce a flame affording the heating of the surface to be coated and the melting of the particulate.

These features and others will become more apparent after reading the following detailed description which refers to the accompanying drawing wherein:

FIGURE 1 is a perspective view of a novel applicator mounted on a wheeled support in accordance with the present invention;

FIGURE 2 is a fragmentary detail side view of the applicator subassembly of the present invention;

FIGURE 3 is a fragmentary plan view, partially in section, illustrating the mixing chamber and powder aspirators;

FIGURE 4 is a fragmentary end view of a portion of the applicator taken along the lines 4—4 of FIGURE 2; and

FIGURE 5 is a sectional view taken along the lines 5—5 of FIGURE 2.

Referring now to the drawing the device of the present invention includes a novel applicator 10 for applying a fusible organic particulate material in the form of a coalesced film of said material to a surface. The applicator may be hand held during use or placed on a wheeled transporting cart 12. The cart 12 comprises a tubular frame 14 having three wheels 16, 18 and 20 arranged in a right triangular pattern. Two wheels are preferably axially aligned and the third wheel may be forward or rearward of the other wheels so the cart can be maneuvered by pressing downward on a handle or by lifting the handle, respectively. The frame 14 includes a vertical panel 22 between the aligned wheels 16 and 18 providing a partial shield on the cart. Behind the panel 22 and mounted on the frame 14 is a supply tank 24 for the fuel. Extending rearwardly from the upper portion of the panel 22 is a handle and frame assembly 26 affording a handle for the operator to grasp to push and manipulate the cart. Pivoted on the frame 14 to a transversely extending upper cross-member 28 is an applicator cradle 30. This cradle 30 comprises a rigid generally L-shaped channel member having the short leg 34 thereof extending downwardly behind the cross-member 28 and long leg 36 extending downwardly and forwardly from the cross-member 28. On the lower end of the long leg 36 depends a tubular fender-like frame section 38 adapted to surround the depending forward edge of the applicator 10 when it is mounted in transport position on the cart 12. A releasable clamp member 40 is formed at the lower end of the leg 36 to clamp the applicator 10 to the cradle 30. A second clamp 42 is provided on the lower end of the leg 34 attaching the trigger guard and frame of the applicator 10 to the cradle 30.

Supported on a deck 44 below the cross-member 28 are suitable pressure gauges and valves for the fuel line and the line for the oxidizing medium which preferably and economically is compressed air. These valves and gauges however are conventional and not shown. The fuel line leads from the fuel tank 24 to a valve and gauge on the deck 44 and through a hose 46 which may be of any desired length, e.g., about 25 feet in length, which at its other end leads to the pistol grip portion of the applicator 10. The compressed air source is generally a separate compressor mounted on a truck or trailer and connected to suitable valves and gauges on the cart 12 and to a long hose 48 leading to the applicator 10. This construction requires one supply line to the cart from another device, but this single line may be easily pulled along with the cart 12. Where a source of compressed air is mounted on the cart, the cost, size and weight are increased. The cart 12 affords a transport for the applicator and it may differ in design.

The applicator 10 comprises means defining a hollow, elongated mixing chamber having opposed ends, means coupling one end of the chamber to the source of pressurized gaseous oxidizing medium and to the source of pressurized vaporous fuel including suitable valves. The fuel and oxidizing medium enter at positions normal to each other to enhance the mixing of the two. A hopper is provided for storing a supply of fusible organic particulate. Valve means on the hopper controls the flow of particulate into an air stream created by and leading to an aspirator means joined to the other end of the mixing chamber. A discharge conduit means connects the aspirator means to burner means where combustion of the fuel and oxidizing medium mixture occurs to melt the particulate and heat the surface to get the coalesced film condition on the surface. The applicator is also provided with a pilot burner for igniting the main burner means and a directed air stream for preventing carbonaceous residue from settling and sticking on the applied film.

The applicator 10 is provided with spaced hand grips 50 and 52. The hand grip 50 is positioned to afford easy access to trigger mechanisms for controlling the flow of particulate and fuel through the applicator. The hand grip 52 affords a fulcrum and is located near the center of gravity of the applicator.

The hand grip 50 covers a section of conduit and a commercial conventional one-way check valve 51 leading from a coupling 54, for connection to the fuel line 46, to a commercial plunger actuated control valve 56 having a bypass or bleeder line controlled by an adjustable needle valve 58. The plunger 60 of valve 56 is actuated, from a position normally closing the valve, by a trigger mechanism 62 pivoted about a pin 64 supported by a bracket 66. A bell-crank trigger mechanism 68 is pivoted on pin 64 to operate a link 70 connected to a crank arm 72 for operating the valve means controlling the flow of the powder or particulate material, which will be described in greater detail hereinafter.

A coupling or street L 74 connected to the main line through the valve 56 leads to one end a hollow tube 76 defining a mixture chamber. This coupling 74 leads to a T coupling 78 connected to the tubing 76, as illustrated in FIGURE 2. The depending leg of the T 78 is connected to one end of a commercial conventional one-way check valve 80 positioned in the compressed air line allowing the compressed air to flow toward the T 78 from a coupling 82 to which the compressed air line 48 is attached. The T 78 provides for the fuel and air to enter one end of the mixing chamber at right angles to each other and in the same general vertical plane to enhance the mixing of the two. Intermediate the valve 80 and a coupling 82 is a further T coupling 84 allowing some of the compressed air to be directed through a branch line 86 leading to a vibrator 88 mounted on a hopper 90. An operator control valve for the compressed air is not provided on the applicator 10 thus the air is allowed to pass through the applicator between stripe applications. This bleeding of the air keeps the vibrator operating and restricts heat build up in the applicator during prolonged operation. Air may also be directed from line 86 to the lower rear portion of a flame shield 118 for the desooter (not shown) which directs air toward the applied stripe beneath the shield and prevents carbonaceous residue from the burners settling on the applied film. In the illustrated embodiment the opposite end of the mixing chamber 76 is connected to a Y coupling 92 affording two symmetrical branch lines from the mixing chamber through which the gas and air may flow. Each leg of this Y 92 is connected to the inlet of an aspirator 94 and 96.

The aspirators 94 and 96 are disposed in a parallel arrangement. Each aspirator has an inlet port at one end defined by a first bore 98 leading to a venturi tube and a bore 100 on the opposite or outlet side of each aspirator. An aspiration port or orifice 102 is formed in the side

wall of the venturi tube of the aspirators 94 and 96 on the vacuum side and the orifices are positioned in opposed aligned relation. To these orifices 102 is connected a T coupling 104, the leg of which is connected to a particulate supply sleeve 106 leading from the powder hopper 90. Connected to and extending from the outlet side of the aspirators are discharge pipes 108 and 110 which extend parallelly therefrom. Each of the pipes are formed of hollow tubular stock, e.g., a stock having an inside diameter of 0.335 inch and an outside diameter of 0.437 inch. The discharge ends of the pipes are positioned within hollow cylindrical flame holders 112 and 114 respectively, which are about 2½ to 3½ inches long and have an inside diameter of 2 inches. These flame holders maintain the flame plasma away from the discharge end of pipes 108 and 110 to avoid the discharge end of the pipes becoming heated and to avoid the particulate melting and building up on the discharge end of the pipes. One end of each flame holder is closed by a disk or is secured to a plate 116 forming the top of the flame shield generally designated by the numeral 118. The ends of the pipes 108 and 110 extend into the cylindrical member by approximately ½ inch, as illustrated in FIGURE 2. This position restricts undesirable pressures in the closed end of the flame holder which cause the fine particulate to build up in the cylinder. Formed in the pipes and about 1.8 inches from the discharge end thereof, preferably 1⅓ inches, is a bend 119. Each bend places the axis of the lower end of the pipe at an angle of between about 120 and 150° relative to the axis of the end connected to the aspirator. At the bend the cross-section is changed in that the inside diameter of the pipe, in a plane defined by the axis of both ends of the pipe, is reduced by about 0.08 inch. The bend is formed by bending the pipe about a 1 inch roller. The terminal or discharge end of the pipes 108 and 110 are also formed with a 45° chamfer to improve the nozzle design at this discharge end.

A third tube 120 extends from a street L 122, which is joined to the bypass line of the valve 56, around hopper 90 and down between and generally parallel to tubes 108 and 110. An atmospheric burner 124 connected to the end of this fuel line 120 affords a pilot light for the burners defined by the flame holders 112 and 114.

In operation with air as the oxidizing medium and liquefied petroleum gas, propane-butane, as the fuel the air pressure for the line leading to the coupling 82 may be approximately 40 p.s.i. and the pressure in the fuel line leading to the coupling 54 may be approximately 20 p.s.i. This air and gas flow through the system affords suction at the orifice 102 of each aspirator 94 and 96 of about 12 to 18 inches Hg which is sufficient to draw the particulate into the aspirators at about 2 pounds per minute with a powder as in the example later described. The gas consumption by the pair of burners in this combination will amount to about 20 pounds of fuel per hour, and will produce a calculated heat output of about 450,000 B.t.u. per hour. The flow rate at the pressures exemplified would be about 7 cubic feet per minute per burner or about 15 cubic feet per minute for the applicator. When the particulate is not being fed to the aspirators, air is allowed to flow or be drawn into the aspirators through the orifices. Thus in effect, when the powder is allowed to flow into the aspirators the relatively delicate balance between the air and gas mixture is not disturbed. Further, the emergence flow rate of the air/gas mixture is maintained greater than the flame propagation rate of such mixture preventing any flashback or combustion within the applicator.

This applicator has the advantage of providing a stream of combustible gas and particulate with the gas surrounding each particle of the organic material as it is discharged from the discharge tubes. Means in the form of the bend in the pipes, which is properly placed and is of a desired angular extent increases the area covered by the discharged particles in each discharge tube 108 and 110.

This is important when it is necessary to provide a stripe six inches in width. It was discovered that without the bend in tubes 108 and 110, the area covered by the discharge with the flame holder at about 20 inches away was circular and only two inches in diameter, excluding any unnatural out flow or deflection of the particulate. The bend in the tube, on the other hand, affords a discharge having an elliptical shape and a length along the major axis of about three and one-half to four inches, at 20 inches from the flame holder. This phenomenon is not totally understood but it is believed that the bend causes the particles to have an erratic and possibly collision path from the location of the bend to the point of discharge such that the pattern of the discharge mixture is elliptical in cross-section affording greater coverage and greater uniformity to the applied film.

The particulate material is stored in the cylindrical hopper 90 with opposed end walls 128 and 130. The hopper 90 has an access door 134 located in its upper side. The vibrator 88, is attached to the end wall 128 and has blades 136 extending into the hopper. The vibration of the blades affords even flow for the particulate material. Secured to and extending axially of the hopper, along the lower inner peripheral surface and through the end walls 128 and 130, is the hollow cylindrical sleeve which defines the particulate supply sleeve 106 which has one end received in the T coupling 104. The other end has a flange 138 secured thereto. The sleeve 106 is illustrated as having three axially extending circumferentially spaced slots 140 (FIGURE 4) formed therein. Fitted snugly but slidably within the sleeve 106 is a hollow cylindrical valving tube 142 which is open at both ends. The tube 142 allows air surrounding the hopper to be drawn into the orifice of each of the aspirators. The tube 142 is also formed with axial slots 144 defining valving means which, upon rotation of the tube to align the slots 144 with the slots 140, allows the particulate material to flow into tube 142 and to pass with the air down into the sleeve 106 and the aspirators 94 and 96. The tube 142 extends into sleeve 106 to about the end wall 128. The end of the tube adjacent the flange 138 has the crank arm 72 secured thereto. This crank arm 72 is connected at its outer end to link 70 by a fastener 148 and has an arcuate guide slot 150 receiving a pin 152 secured to the flange 138. A spring 154 urges the crank arm 70 and tube 142 in a clockwise "closed position" as shown in FIGURES 4 and 5. The tube 142 is moved to "open position" by trigger mechanism 68.

The flame shield 118 is disposed about the flame holders to allow operation of the applicator in the wind and to give better edge definition to the stripe applied. Also the shield, when the applicator is held in the hand, maintains the burners at an optimum height without guessing by the operator. The shield 118 has a top plate 116, foraminous front and back plates 158 and 160 respectively, and side walls 162 and 164. At the bottom of the side walls 162 and 164 are depending malleable shields 166 affording edge guides that may be positioned as desired.

An illustrative formula for the organic portion of the particulate will now be discussed.

	Parts by weight
Plasticized polyamide, melting at 183° F.-201° F.	
by capillary tube method	43.75
Polyamide melting at 252° F.-260° F.	
by capillary tube method	43.75
Ketone resin	12.5
Chlorinated naphthalene	5.0

Blending of the foregoing ingredients together was readily accomplished by merely melting and stirring the same at approximately 250° F. for about ½ hour.

The completed blend exhibited a viscosity at 300° F. of 460 cps. At approximately 250° F. the blend viscosity was about 1,500 cps., and 210° F. it was about 10,000 cps. On cooling to about 75° F., it essentially lost tack

immediately. Reheating of the blend to 150° F. failed to cause development of tackiness. Tackiness was, however, imparted to the blend by heating it to 155° F.

The plasticized polyamide in the above formula is an intimate blend of about 5% to 15% of a mixture of ortho and para-N-ethyl-toluenesulfonamide, which acts as a low molecular weight plasticizer, and the condensation product of about 295 parts by weight of dimerized fatty acid of linseed oil and about 18 parts of monomeric fatty acid with about 32 parts of ethylene diamine reacted at elevated temperatures of about 200°C.-300° C. until approximately the theoretical amount of water generated on condensation is obtained. The resulting condensation polyamide product has a molecular weight of about 3,000, an amine value of about 4, a relatively sharp melting point according to the capillary tube method from 220° F. to 226° F., and a viscosity at 300° F. of about 1,300 cps., and at 250° F. of about 8,000 cps.

The straight polyamide in the formula has a melting point of about 250° F. according to the ball and ring method and from 252° F. to 260° F. according to the capillary tube method. Its viscosity at 300° F. is about 350 cps. and at 250° F. about 22,000 cps. It likewise is a condensation reaction product of polymerized fatty acid with polyamines, and has many of the characteristics of a polyamide formed by reaction of a dimerized drying oil acid with an alkylene diamine such as ethylene diamine, suitably with a low molecular weight aliphatic dicarboxylic acid such as sebacic or maleic acid on terminals of the condensation polymer. Its molecular weight is about 2,100 and amine value is 4.

The ketone resin is a condensation product of formaldehyde with cyclohexanone having a molecular weight of approximately 500 and a melting point of about 164° F. according to the ball and ring method and 133° F.-153° F. according to the capillary tube method.

The chlorinated naphthalene is a mixture of tri and tetrachloronaphthalenes. It is a white crystalline wax-like solid with about 50% chlorine content. Its molecular weight is approximately 255, and its melting point is approximately 200° F. according to the ball and ring method.

The material is suitably ground under cold conditions to a particle size of not greater than about 850 microns and preferably 80% by weight is between 100 microns and 600 microns and no significantly measurable portion less than 50 microns.

The handles 50 and 52 permit the applicator 10 to be removed from the cart 12. When removed it is easily moved from place to place and operated to heat and coat a surface by manipulation of the respective trigger mechanisms 62 and 68. Portability affords rapid pavement marking in conjunction with stencils for applying legends or other indicia. Also markings may be applied to vertical surfaces such as curbs.

Having thus described the preferred embodiment of the present invention it will be appreciated that certain changes and alterations may be made therein without departing from the spirit and scope of this invention.

What is claimed is:

1. An applicator for applying fusible organic particulate material to a surface to form a coalesced film of said material on said surface, said applicator comprising:

means defining a gas mixing chamber,
conduit means connected to one end of said mixing chamber and adapted for connection to a source of gaseous fuel and gaseous oxidizing medium,
aspirator means having an inlet side, outlet side and an aspiration orifice connected at said inlet side to the other end of said chamber,
a hopper for particulate material,
passage means communicating with the ambient air and with said hopper by valve means for the introduction of particulate material and air to said aspirator means,

pipe discharge means connected at one end to the outlet side of said aspirator means, and flame holding means positioned at the other end of said discharge means for forming the flame plasma in spaced relation to said other end.

2. An applicator as described in claim 1 wherein said aspirator means includes a pair of aspirators connected in a symmetrical parallel arrangement with discharge means connected to each aspirator.

3. An apparatus for applying fusible organic particulate in the form of a coalesced film to a surface, said apparatus comprising:

means defining a gas mixing chamber,
conduit means leading to one end of said mixing chamber for introducing gaseous fuel and gaseous oxidizing medium to said chamber,
at least one aspirator having an inlet side, outlet side and an aspiration orifice in said outlet side, said aspirator being connected at said inlet side to the other end of said chamber,
a hopper for particulate material,
passage means including valve means connecting said hopper to said orifice for the introduction of particulate and air to said aspirator,
discharge pipe means having opposite ends, one end of said pipe means being connected to the outlet side of said at least one aspirator,
means formed in said pipe means intermediate its ends for shaping the discharged mixture including particulate material into an elliptical pattern affording greater uniformity to the applied film, and
flame holding means positioned at the other end of said pipe means for forming the flame plasma in spaced relation to said other end.

4. An apparatus for applying fusible organic particulate material to a surface to form a coalesced film of said material on said surface, said apparatus comprising:
means defining a cylindrical mixing chamber,
conduit means including valve means adapted for introducing gaseous fuel and gaseous oxidizing medium from suitable sources thereof into one end of said mixing chamber,
aspirator means having an inlet side, outlet side and an aspiration orifice, said inlet side being connected to the other end of said chamber,
a hopper for particulate material,
passage means including valve means connecting said hopper to said orifice for the introduction of particulate material and air to said aspirator means,
cylindrical flame holder means,
discharge means connected to said outlet side of said aspirator means, said discharge means including a hollow cylindrical pipe having opposite ends, one end connected to said outlet side of said aspirator means and the other end disposed in said cylindrical flame holder means, and a bend formed in said pipe adjacent said other end to dispose the axis of said other end of the pipe at an angle of between about 120 and 150° to the axis of the pipe at said one end, whereby the cross-section of the discharged mixture including particulate will be generally elliptical.

5. An apparatus as claimed in claim 4 wherein said bend is formed in said pipe about 1.8 inches from said other end.

6. An apparatus as claimed in claim 5 wherein the cross-section of said pipe is changed at said bend.

7. An apparatus as claimed in claim 4 wherein said passage means includes:

a tube communicating directly with the atmosphere at one end and communicating with said aspiration orifice at the other, and

said valve means affords the flow of particulate material from said hopper into said tube intermediate its ends.

8. An apparatus as claimed in claim 1 wherein said conduit means includes:

a first line for said fuel, and

a second line for said oxidizing medium,

said first line having a control valve therein for regulating the flow of fuel into said mixing chamber,

said second line being substantially normal to said first line at the point of juncture therewith at one end of said mixing chamber.

9. An apparatus as claimed in claim 7 wherein said conduit means includes:

a first line for said fuel, and

a second line for said oxidizing medium,

said first line having a control valve therein for regulating the flow of fuel into said mixing chamber,

said second line being substantially normal to said first line at the point of juncture therewith at one end of said mixing chamber.

10. The method of applying a film-forming material to a surface to be coated comprising the steps of:

mixing in a chamber a stream of pressurized gaseous fuel and a stream of gaseous oxidizing medium which will exit through an aspirator,
supplying a finely ground polyamide based resin particulate material to the aspirator to be drawn into the exiting stream of fuel and oxidizing medium,
directing a discharge tube connected to the aspirator at the surface to be coated, and

igniting the fuel adjacent the exit of the tube to produce a flame affording the heating of the surface to be coated and the melting of the particulate material such that, upon striking a said surface, the particulate material will coalesce to a film condition.

11. The method of claim 10 wherein the heating and melting are simultaneous and the exit of the tube is spaced sufficiently above the surface to melt the particulate material before it strikes the surface.

12. The method of claim 10 including the step of deflecting the stream of material, fuel and oxidizing medium before igniting the fuel.

References Cited

UNITED STATES PATENTS

2,108,998	2/1938	Schori	239—85
2,875,675	3/1959	Searight	94—39
3,279,336	10/1966	Eaton	94—39 XR
3,280,710	10/1966	Glade	94—39
3,352,283	11/1967	Maus	118—301

FOREIGN PATENTS

830,456 3/1960 Great Britain.

65 JACOB L. NACKENOFF, *Primary Examiner*.