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(54) **Applying marking materials to surfaces.**

(57) A method and apparatus for marking road surfaces, runways etc. Marking material, normally a heat fusable solid in particulate form, is passed from a hopper (10) into a duct (18) where it is mixed with hot pressurised gas from a burner (20), the heat from the gas causing the marking material to partially melt. The marking material is then directed along a flight tube (22) from which it is expelled onto the surface (24) being marked. When the material cools the particles fuse together leaving a durable marking on the road surface. The apparatus is mounted on a vehicle in such a way that markings may be applied on either side of the vehicle.

Control of the flow of marking material is by variable aperture venturi valves (40), as is control of flow of pigment and, when necessary, of purging material.

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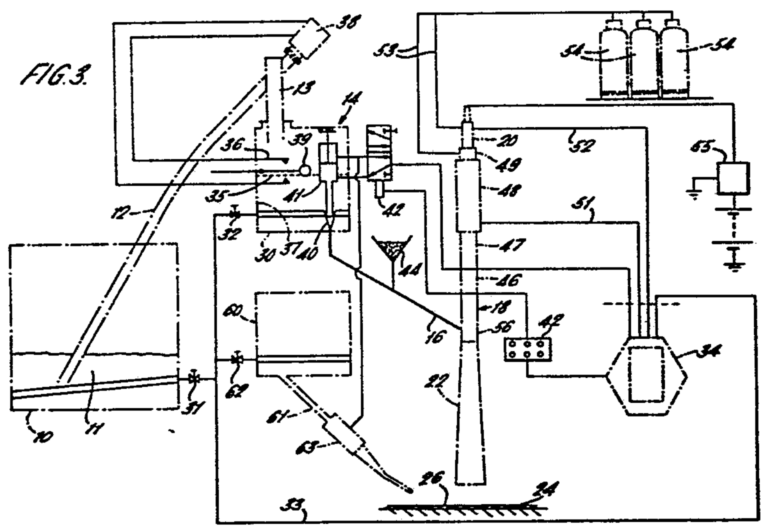
FIG.3.



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APPLYING MARKING MATERIALS TO SURFACES

This invention is concerned with improvements in or relating to marking surfaces and is particularly concerned with an improved method of applying marking materials and an apparatus for use therein.

Various methods of applying marking materials to surfaces such as highways and airport runways are known. These include methods in which a supply of the marking material is preheated to melt a constituent of the material and is then applied to a surface to be marked by passing through insulated pipes to an applicator. This method suffers the drawback that it involves a high capital outlay on the apparatus for heating the marking material in bulk and maintaining it at an appropriate temperature until it is applied. This is usually done by employing two vehicles one carrying the bulk supply of material and the other the applicator apparatus, although one large vehicle may suffice.

Other methods are known, for example as described in British Patents 1087031 and 1234601 in which the surface to be marked is preheated and the marking material is then melted by contact with the surface. Some preheating of the material may take place but the melting of the material takes place by contact with the surface. This method again involves the use of complicated apparatus and is also limited in the materials which may be employed. The heat softenable constituent of the marking material must be chosen with a sufficiently low melting point to ensure that it is satisfactorily melted by contact with the preheated surface.

Devices for spraying particulate materials to form coatings on substrates are also known and include "flame" spray devices or apparatuses which are normally used to apply coatings of refactory material and the like.

In such "flame" spray devices for example as shown in British Patent 1109481 it is usual for the particulate material to be subjected to the direct effect of a flame. This has the disadvantage that, where materials with low melt temperatures are subjected to the direct effect of the flame, great care has to be taken to ensure the accuracy of the residence time of such materials in the flame if charring of the materials is to be avoided.

On the other hand, in arrangements where high melt temperature materials are subjected to the heating effects of combustion gases there often has to be some additional heat supply in

order to achieve the desired results. For example, in United Kingdom Patent Specification Nos. 1087031 and 1234601 pre-heating of the highway surface to between 150°F and 500°F is advocated.

In one aspect, the present invention provides a method of marking a surface with a marking material comprising, or providing at elevated temperatures, a material which is fusible, comprising the steps of burning a gaseous fuel in air under pressure to provide a supply of heated pressurised gas, directing this supply of gas onto the surface to be marked, injecting a supply of marking material in unfused form into the hot gas stream and thereby causing the material to impinge on the surface, and maintaining the temperature of the hot gas stream and the distance of the point of injection of the marking material from the surface throughout the marking process such that at least some of the material is fused before the marking material impinges on the surface.

The material is preferably in particulate form and may be fluidised before injection into the hot gas stream. Preferably the marking material is injected into the hot gas stream in a reducing atmosphere. The method is particularly suitable for applying markings to highways and runways and the like.

The invention also provides an apparatus for applying marking material comprising, or providing at elevated temperatures, a material which is fusible, onto a surface, the apparatus comprising means to burn a gaseous fuel in air under pressure to provide a supply of heated pressurised gas, an elongate duct means to direct this hot gas onto the surface to be marked and means to inject a supply of marking material in unfused form into the hot gas stream, thereby to cause the marking material to impinge on the surface, the arrangement being such that the temperature of the gas stream and the distance of the point of injection of the marking material from the surface are maintained so that at least some of the material is fused before the marking material impinges on the surface. The means to direct the hot gas onto the surface maybe in the form of a duct which may be rectangular in cross-section at its outlet and, conveniently the duct may be provided with baffle meanswhereby, when the apparatus is in use, oscillation of the material is prevented thereby obviating accretion of the material to inner walls of the duct. Conveniently the material is injected by feed means which may comprise at least one inlet port arranged so that material is injected into the hot gaseous jet upstream of the duct.

Preferably the material is injected into the hot gaseous jet upstream of the duct as aforesaid coincident with the direction of the jet or at an acute angle to said direction.

Conveniently the acute angle may be up 70° but is preferably 35°.

In one preferred apparatus provided by the invention there are two inlet ports arranged as aforesaid for injecting material into the hot gaseous jet.

The feed means may also include a fluidised bed arrangement for feeding material to the inlet ports.

Conveniently the feed means may be controlled by means which may be manually operated or may be operated automatically in response to actuation of sensing means.

There is preferably a burner to provide the supply of heated pressurised gas.

Conveniently the burner is a flash back burner utilising liquified propane gas as a fuel and in a preferred apparatus provided by the invention the burner may be connected to the duct through a swirl chamber for damping unwanted oscillations in the exhaust gases from the burner.

Preferably the surface is a highway, airport runway or the like. The apparatus may also be used to form markings on a transfer surface, the preformed markings subsequently being applied to a road or the like.

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

Figure 1 is a side view of a vehicle fitted with the apparatus for applying marking material of the present invention:

Figure 2 is a plan view of the vehicle and apparatus shown in Figure 1;

Figure 3 is a diagrammatic representation of the spraying apparatus;

Figure 4 is a diagrammatic representation of an alternative apparatus incorporating a gravity feed arrangement for feeding particulate material;

Figure 5 and 6 each show front and side views of alternative configurations of a flight tube for use in the apparatus of Figures 1 to 4 ,

Figure 7 shows two views, side and plan, of a gas deflector for attachment to a flight tube of the apparatus;

Figure 8 shows a burner and swirl chamber in section; and

Figure 9 shows a further configuration of flight-tube with a variable geometry.

Apparatus used hitherto, for the application of markings, to highways or airport runways, etc., has not always resulted in a well defined durable marking at an acceptable speed of application or an acceptable cost per unit area covered by the marking.

The apparatus shown in the drawings enables a layer of a marking material to be sprayed onto a high-way, airport runway or the like, with great economy

in material usage, at low power consumption and with minimum interruption of traffic flow.

Referring first to Figure 3, the apparatus comprises a bulk storage hopper 10 from which particulate marking material 11 may be fed via a screw elevator 12 to a fluidised bed feed device 14 and then via a line 16 to a mixing tube 18 where the material 11 is injected into a hot gaseous jet, created by a burner 20, before passing along a duct or flight tube 22 to be sprayed onto a highway 24, as shown at 26, to form a marking on the highway 24. The material is injected into a reduced atmosphere. The bulk storage hopper 10 is fed with compressed air from compressor 34 via a line 33 and control valve 31, so that the marking material 11 forms a fluidised bed. The hopper 10 can usefully have a capacity of between one and six tonnes depending upon the size of vehicle on which the novel apparatus is to be used.

The screw elevator 12 ideally has a feed rate of between one and fifteen litres per minute and feeds the particulate marking material via a duct 13 to the feed device 14. The feed device 14 has a capacity for 200 kilos of the particulate material fed thereto and comprises a container 30 fed with compressed air to form a fluidised bed. The compressed air is fed from compressor 34 via a line 33 and control valve 32 into the base of the container 30.

Material in the container 30 is ideally maintained at a

level indicated by the dotted line 35. A level switch 36, provided on a side wall 37 of the container 30, is connected to a motor 38 whereby rotation of the screw elevator 12 is effected in response to movement of a float member 39 forming part of the valve 36. The feed device 14 also comprises a venturi valve 40 connected to the line 16 inside the container 30 which valve 40 is controlled by an actuator 41 whereby the rate of feed of particulate material through the valve 40 may be adjusted or shut-off as required. The actuator 41 is in turn controlled pneumatically, via a solenoid controlled valve 42, from an appropriate control console 72 which may be mounted at any convenient location.

The disposition of the venturi valve 40 and the line 16 within the container 30 is consistent with obtaining a flow of the particulate material which is of an acceptable range of particle sizes,i.e. the particulate material will only show small diversities in size over a given period. This is achieved by positioning the valve 40 and line 16 at an optimum level within the container. This occurs because the effect of the fluidised bed 14 is to stratify the particulate material in the container 30 according to the size of granule. Large granules will be more prevalent towards the top of the container and small granules towards the bottom. Thus, at an optimum level the ideal size range of granule can be expected.

On the outlet side of the line 16 between the container and the mixing tube 18 there is shown a pigment feed hopper 44

see Figure 3. In an alternative arrangement there may be two or more hoppers 44 and switching of appropriate venturi valves located within the hoppers 44 enables the desired pigment to be fed into the flow of particulate material in the line 16. There may be spaced along line 16 a number of annular passages for cooling the air.

The mixing tube 18, see Figure 3, is provided by a tubular chamber, 46 of circular cross section connected at an upper end portion 47, thereof to a combustion chamber 48. The combustion chamber 48 is in turn connected to the outlet end 49 of the burner 20, see Figure 8.

The burner 20 may be a commercially available flash back burner using liquid propane gas and air mixture as fuel. The air is supplied via a line 52 from the compressor 34 and the gas is supplied via lines 53 from liquid petroleum gas storage tanks 54, see Figure 3. A spark generator 55 is provided to initially ignite this fuel mixture.

The arrangement is such that a mixture of air and propane is combusted in the flash back burner 20 and the gases produced as a jet are prevented from oscillating unduly by passing the gaseous jet through the swirl chamber 48 as shown in Figure 8. This combustion chamber consists of two coaxial cylindrical tubes 57 and 59. The inner tube 57 has two rings of ports 58, which allow the air, fed via line 51 into the passage between tubes 57 and 59, to pass into tube 57 to react with any unreacted fuel. These ports 58 are set at an angle, as shown, so as to introduce the air into tube 57 with a component of velocity in the direction of the general velocity of the gases already in the tube.

At the lower end portion 56 thereof the mixing tube 18 is connected to the flight tube 22 by a suitable adaptor, not shown.

The length of the flight tube 22 is chosen so that the particulate material, which is admixed with the hot gaseous jet in the mixing chamber 18, will remain in the flight tube for a sufficient time for enabling sufficient heat transfer from the gaseous jet to a heat softenable portion of the particulate material to substantially liquify said portion.

In the arrangement shown diagrammatically in Figure 3 the ratio of the length of the tube 22 to its maximum cross-sectional dimension (width) is approximately 6.5:1. However, in other arrangements the tube 22 may have a length to width ratio of between 2:1 and 30:1. The actual dimensions of the flight tube 22 will be chosen to suit the application, the particulate material, the feed rate of particulate material and the capacity of the burner 20. Thus, in Figure 5 and 6 there are shown two further flight tubes 22a and 22b having length: width ratios of 9:1 and 4.75:1 respectively.

The flight tube 22 is also shaped to give a lamella flow of particulate material therefrom. Thus; as can clearly be seen from Figure 5 the tube 22a is rectangular in cross-section and of constant dimensions along its length while the tube 22b of Figure 6 is of variable cross-section along its length, being approximately square at its upper end and tapered in one dimension and flared in the other from that

end to its lower end. The rectangular shape of the outlet end of the flight tube helps to ensure that markings applied by the apparatus do not have blurred edges.

In the arrangement shown in Figure 3 the flight tube 22 is of constant dimension along its length and no great difficulty is encountered in obtaining a true lamella flow of material from a nozzle end 25 thereof. However, with some lengths of tube conditions may arise in which the gaseous jet and admixed particulate material oscillate within the tube leading to accretion of the particulate material to the side walls of the flight tube 22.

In order to prevent the occurrence of unwanted oscillations and the consequent accretion of the particulate material to the side walls of the flight tube 22, baffle plates may be provided down the centre of the flight tube 22 to split the tube in two length-wise. Indeed several baffles may be provided splitting the flight tube along its length into several parts. Tests on such arrangements have shown that the resultant markings are not impaired in any way while accretion of material to side walls of the flight tubes 22 is prevented.

It is also envisaged that use may be made of alternative methods of preventing unwanted oscillation of the material in the flight tube. Such alternative methods may include the use of annular inlet ducts for introducing hot gas to the tube 22

to augment the flow of the gaseous jet therethrough. Accretion is also prevented by lining the flight tube with a perforated lining plate, which also has the advantage of reducing the noise of the operation.

In the arrangement shown in Figure 3 only one line 16 is shown connecting with the mixing chamber 18; however two or more such lines may be connected to the chamber 18, see Figure 4. In addition it is envisaged that, while the lines 16 are arranged at an acute angle of 35° to a longitudinal axis of the mixing chamber 18, in the embodiments illustrated, any convenient angle of entry may be used. In addition the entry ports need not be diametrically opposite one another, as shown in Figure 4, but may be staggered along the length of the mixing chamber 18.

The apparatus may also include purging means for purging the apparatus of particulate material at the end of work shift. This purging means may comprise a container for cleaning grit, sand, or the like material. This material may be fed into the feed device 14 via a venturi valve similar to valve 40.

Thus, air from the compressor will cause cleansing material to be fed to the mixing chambers 18 as aforesaid, via the valve 40 and line 16 to purge the mixing chamber 18 and flight tube 22 of any residual particulate material.

The purging means may also comprise a fluidised bed for agitating the sand in the container.

It is often desired to spray a material such as small glass beads onto the road 24 to form a top reflective layer of the marking 26. These beads are held in a hopper 60, and may be agitated to form a fluidised bed. To feed these beads to the road they are passed down a tube 61 and through a pneumatically controlled venturi valve 63 onto the road 24.

The apparatus described above may be adapted for mounting on a vehicle 80, see Figure 1 and 2, which vehicle is of much simpler design than known road marking vehicles.

In the arrangement shown in Figures 1 and 2, there is a laterally moving carriage 81. This carriage includes a feed means 14, and a hopper 60 to hold glass beads and the like. There are also two sets of flight-tube 22, mixing chamber 18, feed line 16, combustion chamber 48 and burner 20 one set at each end of unit 81 and thus one set on either side of the vehicle 80. In addition there are two tubes 61 running from hopper 60, one tube disposed behind each flight-tube 22.

As an alternative, there may only be one set of flight-tube, mixing chamber, feed line, combustion chamber and burner, all of which may be mounted as a boom to swing to either side of the vehicle. This boom may be covered by a thermally insulating jacket to protect operative personnel from burns.

Although the apparatus described hitherto is provided with a fluidised bed feed means it may be useful in some applications to utilize a gravity feed arrangement as shown in Figure 4. The particulate material can thus be fed to the line 16 via a line 84 and a venturi valve 85 of known configuration.

In a further modified apparatus (see Figure 7) a gas deflector 86 may be attached to the lower end portion 25 of the flight tube 22. This arrangement is utilised to assist the adhesion and setting of the sprayed on marking 26.

The apparatus described above has several major advantages in determining suitable marking materials which it may utilise.

In the conventional thermoplastic road marking materials, the binder resins must melt to a state of high fluidity to enable the overall composition to be sprayed or flowed (screeded or extruded) onto the road surface. This limits the types of resin, or polymer, which can be used,

and also effectively limits the final performance of the road marking material. High fluidity results from relatively low molecular weight which in turn leads to low mechanical strength and toughness.

The materials capable of being used by the above apparatus do not have this limitation, in that it is apparently sufficient that individual binder particules should melt in order to adhere to the surrounding particles of filler, pigment, beads, etc. Thus binder polymers can be chosen of much higher molecular weight which give enhanced mechnical properties over existing thermoplastic compositions.

The individual components of the materials used do not need to be thoroughly compounded before application. Thus, a simple blend of polymer powder, pigment, aggregate and glass beads providing it is mixed uniformly before use, apparently gives an homogeneous coating to substrates.

The apparatus is suitable not only for the use of thermoplastic materials, but also for thermo-setting materials. A typical thermo-setting type would be an epoxy powder coating material which comprises an intimate blend of an epoxy compound and a reactant, which do not effectively

react to give a polymer until a threshold temperature above 100° is reached. If used in the above apparatus, such particles would melt to fuse into a coherent whole and a chemical reaction would occur to improve the mechanical properties still further.

A composition, particularly suitable for use in the apparatus described above to provide markings on highways or airport runways, etc., is one such as described in our Patent Specification No.1344255 entitled "Improvements Relating to road marking."

Although such a material is described as particulate, material in other forms may also be used in the apparatus e.g. particulate materials in a liquid suspension are envisaged.

The vehicle 80, may incorporate any convenient sighting or sensing device for alignment of the flight tube 22 of the spraying apparatus over the portion of the highway 24 to be marked.

The vehicle 80 is driven along the highway 24 and a marking 26 applied thereto. The thickness of the marking may be in the range 0.3 - 4.0 mmand is preferably in the range 0.5 - 1.5 mm.

The operation of the apparatus may be automatic in response of sensing of areas to be marked or the apparatus may be

controlled manually from the console 42 by the vehicle driver. In either case the on-off cycle may be achieved by opening and closing the venturi valve 40 of the feed device 14 to interrupt the feed of the particulate material. In short line markings interruption of the burner operation is not necessary; however, in long line markings where long gaps are formed between the markings it is economical to shut off the burner 20.

The end of line definition is remarkably clear and no ghosting in the gaps between markings is evident.

The high impact velocity of the marking material on the road surface improves its adhesion.

In addition almost perfect resolution and material distribution is achieved with the spraying apparatus.

In use, the burner 20 creates a hot gaseous jet in a reducing atmosphere capable of raising the temperature of the particulate material without charring to above its melt temperature which, according to the heat softenable portion of the particulate material used, will be 100 to 400^{o} C. The heat generated by the burner 20 must therefore be in the order of 1 M BTUs per hour in order to provide sufficient latent heat in the hot gaseous jet to enable it to affect the particulate materials as aforesaid.

Other advantages of using the apparatus described above to carry out the method of spraying particulate material

are:

(i) low cost compared with presently available line spraying equipment;

(ii) operation as a continuous process by one man using a single vehicle;

(iii) short warm up periods for operation conditions to be reached;

(iv) low pigment level requirement;

(v) instantaneous colour change where hoppers 44 and venturi valves are utilised;

(vi) lower fuel consumption compared with known arrangements;

(vii) less environmental pollution;

(viii) less hazard to operatives from easily shielded applicator assembly;

(ix) no hot materials to handle or maintain in liquified condition;

(x) temperature sensitive materials may be used because of short duration at high temperature.

In the arrangement described a flashback burner is used to create the gaseous jet. In alternative arrangements a gas turbine or free piston gas generator may be used.

Further modifications may also be made to the apparatus with the scope of the invention. For example, a variable geometry flight tube as shown in Figure 9 might be employed rather than the fixed flight tubes described above in order to adjust the width of markings and form symbols such as arrows. Furthermore, the ingredients of the marking material need not all be injected into the flight tube at the same point and the aggregate, for example, could be injected upstream of the burner.

Claims:-

1. A method of marking a surface with a marking material comprising, or providing at elevated temperatures, a material which is fusible, characterised by the steps of burning a gaseous fuel in air under pressure to provide a supply of heated pressurised gas, directing this supply of gas onto the surface to be marked via an elongate duct means, injecting a supply of marking material in infused form into the hot gas stream and thereby causing the material to impinge on the surface, and maintaining the temperature of the gas stream and the distance of the point of injection of the marking material from the surface throughout the marking process so that at least some of the material is fused before the marking material impinges on the surface.

2. A method as claimed in claim 1, characterised in that the supply of marking material is in particulate form.

3. A method as claimed in claim 2, characterised in that the marking material is entrained in an air stream and supplied in fluidised form.

4. An apparatus for applying marking material comprising, or providing at elevated temperatures, a material which is fusible onto a surface, characterised by comprising

a means (48) to burn a gaseous fuel in air under pressure to provide a supply of heated pressurised gas, an elongate duct means (22) to direct this hot gas onto the surface to be marked (24) and means to inject a supply of marking material in unfused form into the hot gas stream, thereby to cause the marking material to impinge on the surface, the arrangement being such that the temperature of the gas stream and the distance of the point of injection of the marking material from the surface are maintained so that at least some of the material is fused before the marking material impinges on the surface.

5. An apparatus as claimed in claim 4, characterised in that the elongate duct means comprises at least one duct (22), the outlet end of which is of generally rectangular cross-section.

6. An apparatus as claimed in claim 5, characterised in that at least one duct includes a baffle extending longitudinally of the duct.

7. An apparatus as claimed in any one of claims 4 to 6 characterised in that the injection means for the marking material comprises a container (30) for the material, at least one supply line (16) connecting the container to the duct or ducts (18) and means (34) for supplying compressed gas to the container to entrain the material and carry it through the supply line or lines.

8. An apparatus as claimed in claim 7, characterised in that the container (30) is a fluidised bed and includes at least one Venturi valve (40) for controlling the flow of material from the container.

9. An apparatus as claimed in claim 8, characterised in that it further comprises a hopper (10) for the marking material, a conveyor (12) for transferring material from the hopper to the container and a float valve (36) for determining the level of material in the container and controlling the conveyor in response thereto.

10. An apparatus as claimed in any one of claims 7 to 9 characterised in that it further comprises means for supplying purging material under pressure to the supply line to clear the supply line and duct.

11. An apparatus as claimed in any one of claims 4 to 10, characterised in that the gaseous fuel is ignited in a flashback burner (20) and burns as it is passed through a combustion chamber (48), producing a resultant stream of hot gas.

12. An apparatus as claimed in any of claims 4 to 11 characterised in that the gaseous fuel is liquified petroleum gas.

13. A method as claimed in any of claims 1 to 3

characterised in that the gaseous fuel is liquified petroleum gas.

14. A road marking vehicle characterised by comprising a self-propelled chassis and apparatus as claimed in any one of claims 4 to 12.

15. A road marking vehicle as claimed in claim 14 characterised by having two ducts (22) and associated with each duct a burner (20) and a supply line (16), both supply lines feeding from a common container (30), characterised in that the supply lines, burners and ducts are rigidly mounted on the container such that one duct faces the road surface (24) on each side of the container.

16. A road marking vehicle as claimed in claim 15, characterised in that the container is transversibly mounted on the vehicle.

FIG. 1.

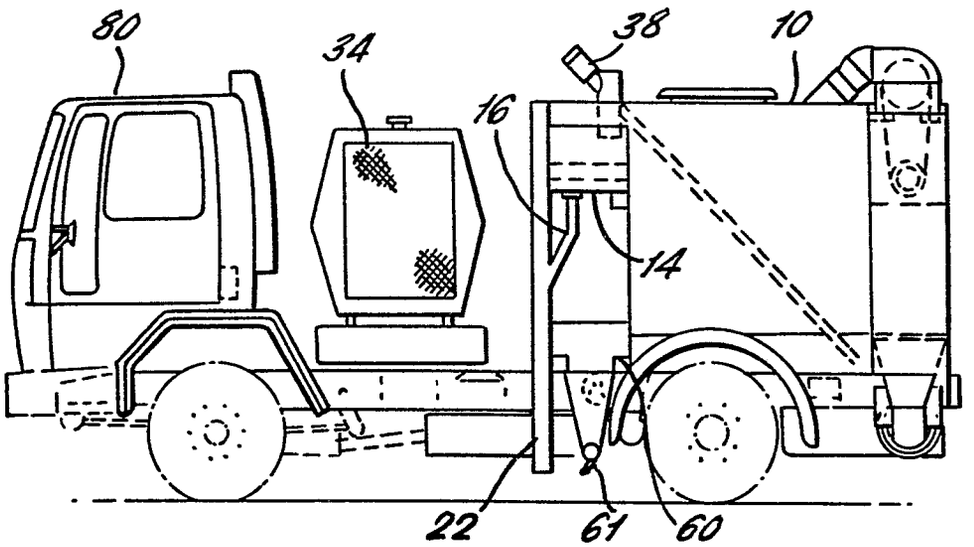
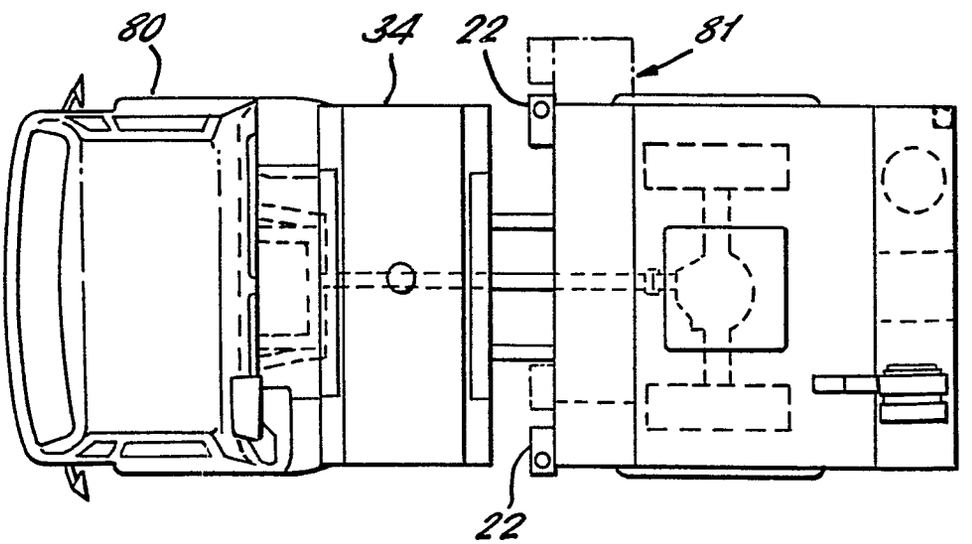


FIG. 2.



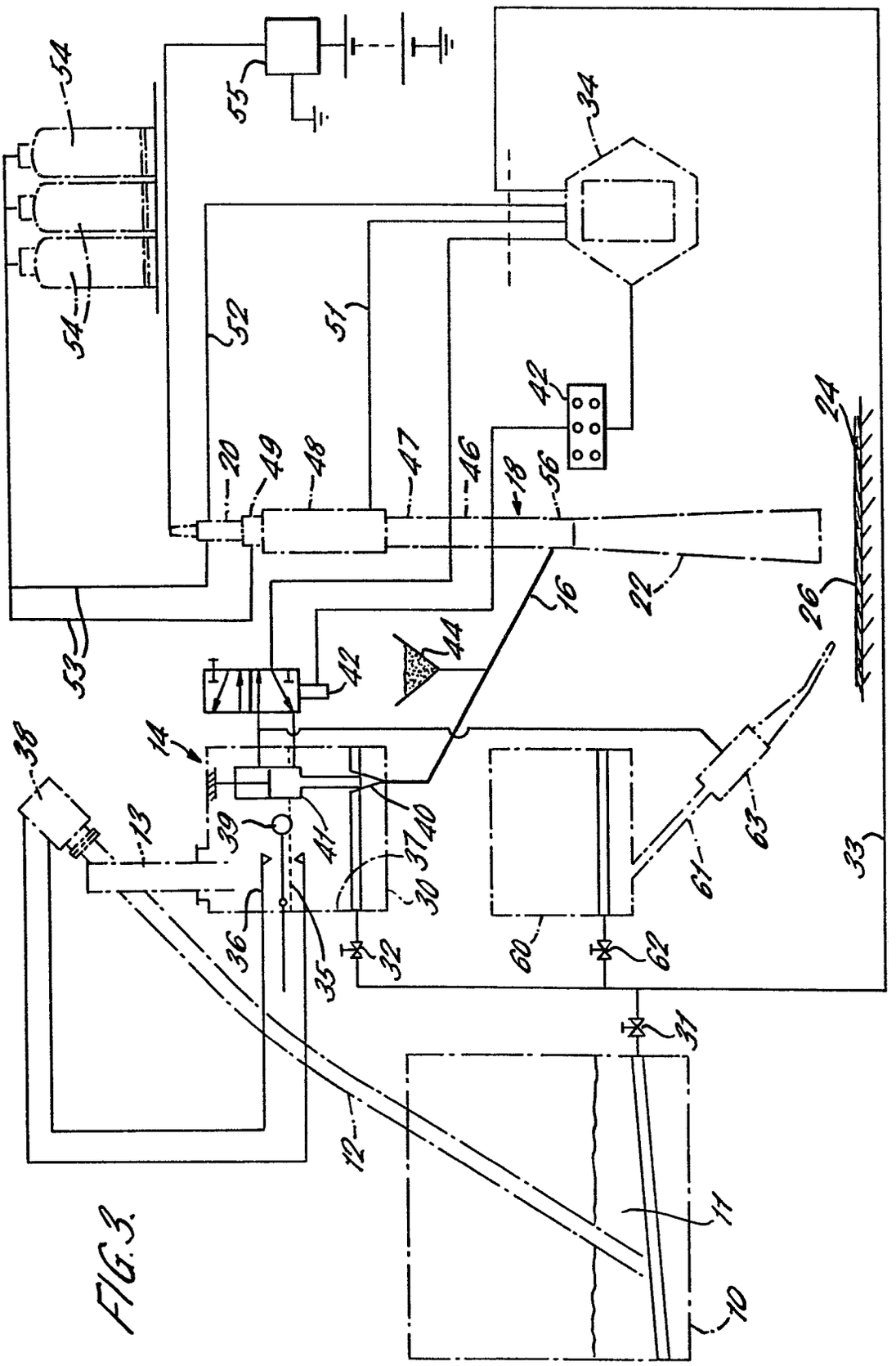

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FIG. 3.

FIG. 4.

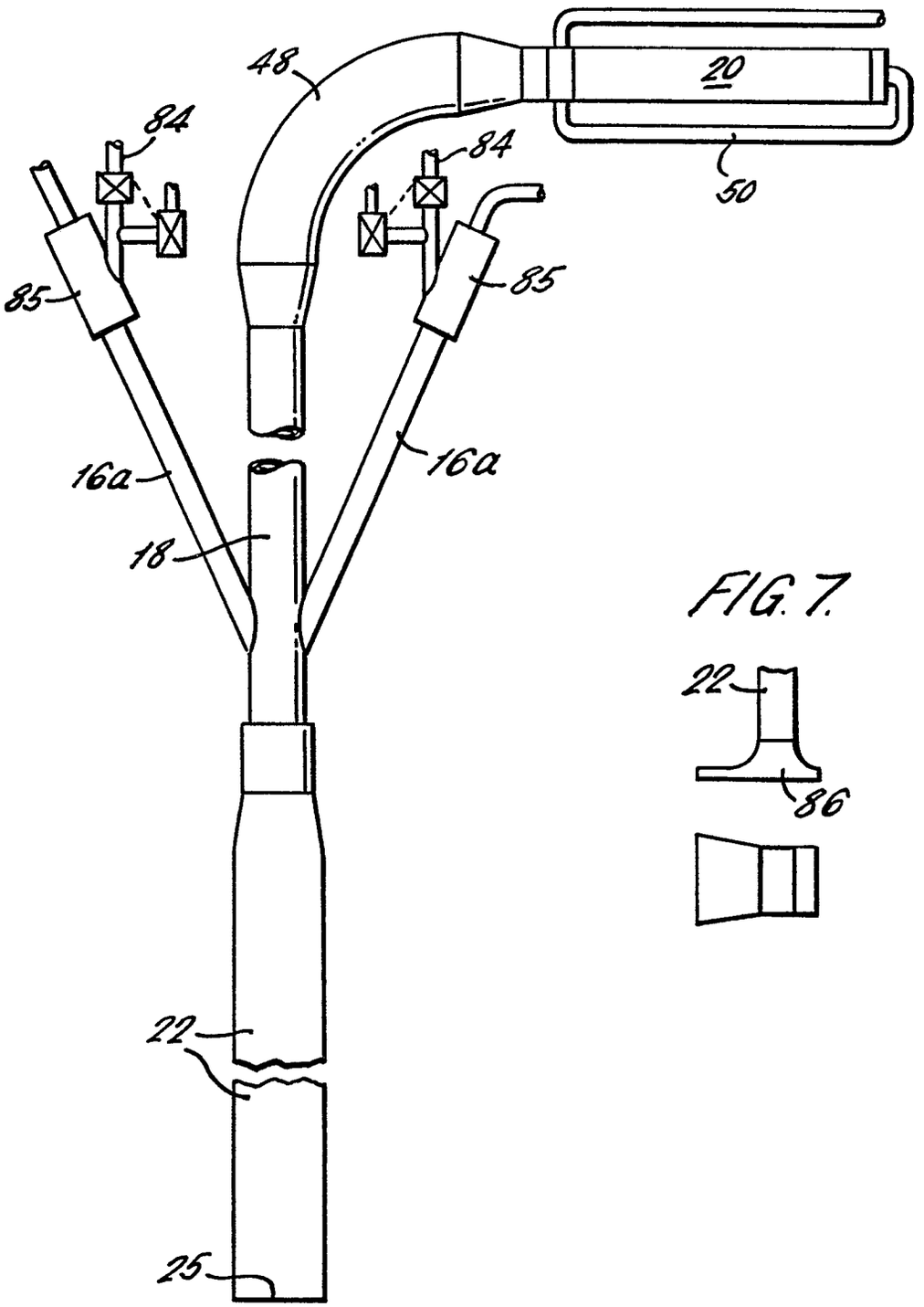


FIG. 7.

FIG. 5.

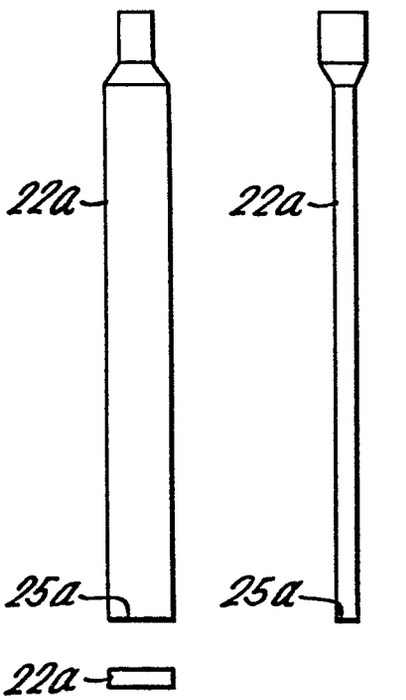


FIG. 9.

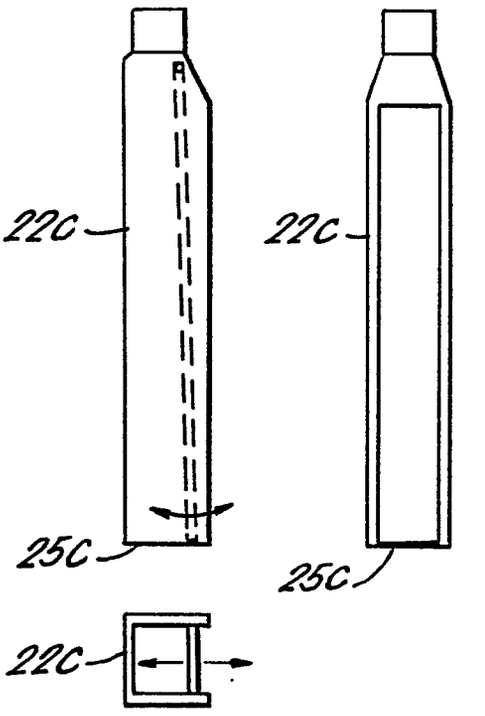


FIG. 6.

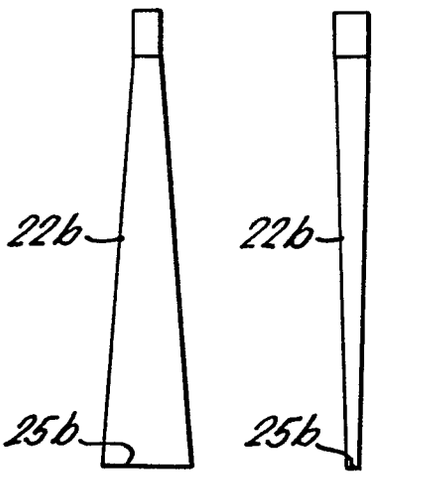
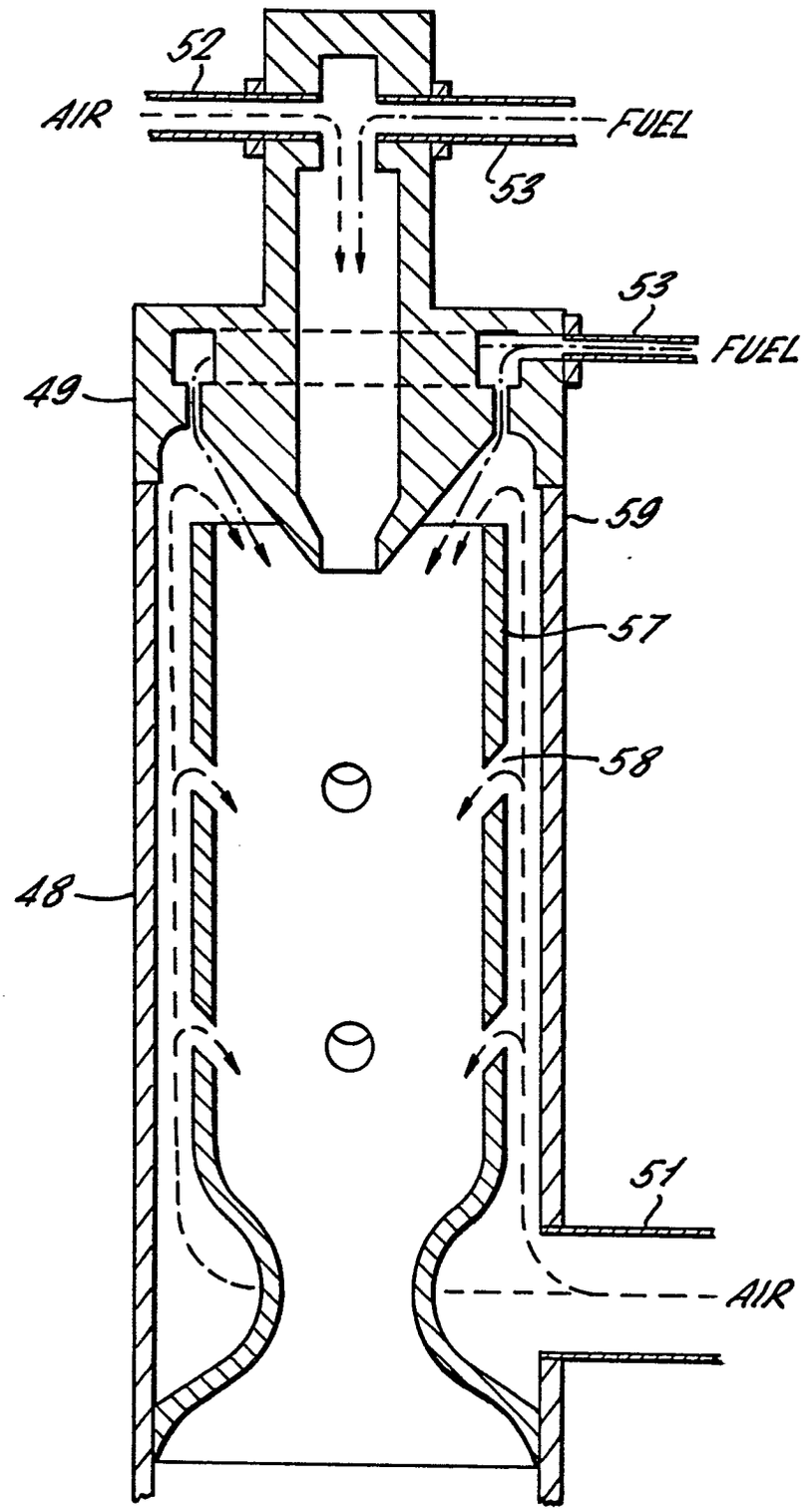


FIG. 8.



European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 82 30 0274.6

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	US - A - 3 393 615 (D.D. MICHELN) * complete document *	1-4, 7,8, 12-14
X	FR - A - 2 155 837 (LE BRUNO) * pages 2, 3; fig. *	1-4, 12,13
A	DE - B - 1 094 782 (R. EHRISMANN) * column 5, line 61 to column 6, line 2 *	10
A	DE - C - 891 852 (R. FISCHHOEDER) * fig. 1 to 3 *	15
A	BE - A - 807 374 (LA SOUDURE ELECTRIQUE AUTOGENE PROCEDES ARCOS)	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

E 01 C 23/16

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

E 01 C 23/00
E 01 F 9/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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A: technological background
O: non-written disclosure
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E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	01-03-1982	PAETZEL

EPO Form 1503.1 06.78