

TITLE OF THE INVENTION

Low Pressure Low Power device to clean carpeted interiors of airplanes.

5 FIELD OF THE INVENTION

This invention relates to a low pressure low power light weight cleaning device to clean carpeted interiors of air planes.

10 DISCUSSION OF PRIOR ART

The use of carpets as floor coverings has greatly increased in recent years such that it is being used on air planes.

- 15 Normal carpet cleaners would not operate well in cleaning of interior of air planes (while on the tarmac) due to different power supply and need for quick turnaround of aircraft. Carpet cleaners using detergent produces foam must ensure the carpet is quickly dried or else the carpet tends to promote bacteria and fungi growth. Such carpet cleaners using foam for cleaning are also bulky and heavy. In order to be more
- 20 efficient, carpet cleaners using foam tend to be powerful in suction power. The use of detergent necessitates the addition of a detergent container which again contributes to the weight of the vacuum cleaner. In order for powerful suction to be generated, the vacuum machines and parts tend to be thick to withstand the high pressure. Thus the use of detergent and high pressure contribute to the weight of
- 25 the vacuum cleaner. In order to be powerful, the motor has to be big and again, contribute to the weight of the vacuum cleaner. The use of detergents necessitate quick removal of the detergent else the carpet would be damp and moist, conditions which promote bacteria growth. Consequently, for efficient and effective vacuum cleaning of carpets in the interior of airplanes, normal industrial vacuum cleaners
- 30 while capable of being used, are too bulky and heavy to be carried up to the air plane by workers. Modern air planes are also high and therefore the cleaner has to carry the vacuum cleaner up a flight of stairs into the airplane cabin. The weight of typical industrial vacuum cleaners is about 40 kilos. The electrical consumption of industrial vacuum carpet cleaners are 230 volt/50 hz or 115 volt/60 hz. However,
- 35 aircraft power consumption is at 115 volt/400 hz. Therefore, industrial vacuum cleaners are not practical for use on air planes, for a number of good reasons.

The need for efficient and effective cleaning of carpets in the interior of air plane itself has resulted in demands for specialized solutions.

There is a need for an improved carpet cleaning system which can be easily carried
5 up the stairs to the interior of the air plane.

SUMMARY OF INVENTION

An object of the invention is a foam type carpet cleaner to clean carpeted interiors of
10 air planes, comprising

a low power motor to drive a carpet cleaning brush;
a low pressure air pump for producing an air flow;
air duct means to supply the air flow to a spray foaming mechanism,
15 a dosing device to supply a flow of foam chemical to the spray foaming
mechanism, and
an air flow/foam chemical balancing means

so that the air flow/foam chemical balancing means control the inflow and mixture of
20 air and foam chemical into the spray foaming mechanism to produce bubbles of
foam chemical in the spray foaming mechanism, said bubbles of foam chemical
being sprayed from the foaming mechanism onto the carpeted interior to form a
layer of bubbles of foam chemical on the carpeted interior, trapping the dirt in the
carpet, so that the dirt and bubbles of foam chemical are then sucked up from
25 the carpet.

Preferably, the spray foaming mechanism has a perforated disc and one or more
layers of wire mesh, an inlet for flow of low pressure air into the spray foaming
mechanism and another inlet for flow of foam chemical, for the formation of
30 bubbles of foam chemical on the layers of wire mesh.

Preferably, the dosing device has a low power solenoid pump, dosing circuit and
a micro-controller which controls accurately the inflow of foam chemical into the
spraying mechanism as and when needed.
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BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, its advantages, and the objects
attained by its use, reference should now be made to the accompanying drawings.

The accompanying drawings illustrate one or more embodiments of the invention and together with the description herein, serve to explain the workings and principles of the invention.

5 Fig. 1 is a schematic of a vacuum carpet cleaner of the prior art.

Fig. 2 is another schematic of another vacuum carpet cleaner of the prior art.

Fig. 3 is a schematic of the low pressure low power light weight cleaning device to
10 clean carpeted interiors of air planes described in the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a schematic of a vacuum carpet cleaner of the prior art. Fig. 2 is another
15 schematic of another vacuum carpet cleaner of the prior art.

The workings of the vacuum cleaner using foam chemical is well know so its basic workings will be described herein. The basic structure of such a vacuum cleaner using foam chemical consists of:-

- an air pump/air compressor (10);
- an air inlet (12) with control means to regulate air flow;
- a tank containing foam chemical (36);
- a foam dosing pump (20) with control means to regulate inflow of foam chemical (16);
- a foaming mechanism (14); and
- a foam outlet (22) with brush unit

The vacuum cleaner generates a stream of moist droplets containing foam chemical (16) is similar to a water stream. The moist foam chemical (16) droplets spread over the carpet and encompass the loosened debris or dust, which has been loosened up by a brush unit inside the foam outlet (22). The debris or dust now floats on the layer of foam chemical (16) formed on the carpet. Immediately the layer of foam chemical (16) and dirt and debris are sucked up by the suction power of the vacuum hose. The layer of foam chemical (16) must not be too thick so that the suction of the foam is not complete, leaving some foam chemical (16) on the carpet. A major consideration is that foam chemical (16) left on carpet of air planes cause the carpet to shrink, thereby causing damage to the carpeted floor of the air plane. A second consideration is that the carpet remains moist, thereby promoting

bacteria and fungi growth in the carpet of the air plane. Over time, the carpet in the interior of the air plane would smell due to growth of bacteria and fungi which is compounded by the absence of sunlight which would not only dry a carpet but also kill bacteria and fungi.

The prior art vacuum cleaner represented in Fig 1 uses a high pressure air compressor (10). To keep power and weight of air compressor (10) within reasonable bounds, volume of air delivered is lowered. This requires the air to be accumulated in
5 an air reservoir (26) prior to foam generation. As a result, there is a waiting time of 5 to 10 minutes for foam to be generated. The high pressure necessitate thicker walls for the air reservoir (26), air hoses and a heavier compressor, thereby increasing the weight of the cleaning device.

10 The high pressure air also require high pressure from the solenoid pump (20). Again, this calls form high power of the solenoid pump (20), again contributing to its weight. The solenoid pump (20) delivers a fixed volume per pumping cycle. Since metering of the foam chemical (16) is carried out using a restrictor type of metering valve (24), the bulk of foam chemical (16) is pumped and then back via a by pass
15 valve (28) as unused foam chemical (16).

The foam chemical/air mix is controlled by balancing the air pressure via pressure regulator (30) and chemical pressure from the metering valve (24). The balancing is difficult to maintain for long periods of time . Attaining an optimum mix is difficult and
20 unstable due to:-

(a) variation in air/foam chemical pressure;

(b) scaling of line and orifice of metering valve (24)
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The foaming mechanism (14) is just a spiral brush. This is inefficient in generating bubbles (foam) because:-

(a) bulk of air and foam chemical (16) escape through the spiralling gap of
30 the brush

(b) the foam chemical are blown into a mist instead of forming bubbles.

The prior art vacuum cleaner represented by Fig 2 uses an air/foam chemical (16)
35 mix by balancing the differential pressure from a diverting valve (32) leading to the

inlet to the foam chemical tank (36) and a check and restrictor valve (34) leading to the inlet of the foaming mechanism (14). Again, maintaining a stable air/foam chemical mix is difficult. The foaming mechanism (14) of Fig 2 uses a divergence section to produce an even and uniform flow of air. However, due to the angle of divergence formed at the inlet to the foaming mechanism (14), eddy currents are encountered. The eddy currents blow the chemical film formed on the wire mesh (18) used to produce bubbles of foam chemical (16), turning the foam chemical (16) into a mist.

The reason the vacuum works so well is because of its suction power. There are a number of factors that produce the suction power which is relied on to suck the dirt and foam in order to clean the carpet. The first of these is fan power which can normally be adjusted to change the level of suction strength the vacuum gives off. In order for suction to be strong, the motor and fan have to be running at a high speed.

- 10 The final factor in suction power is the intake port size. The larger the intake port, the larger the fan inside the vacuum can be, meaning more suction will be provided by a larger intake port.

The length, thickness and diameter of the air hose therefore contributes to the weight of the air hose.

- 15 The suction motor is one of the important part of vacuum cleaner. It is this motor which takes electrical power from the power source & converts it to give suction with air flow. Once again, the bigger the motor, the more powerful the suction. In order to have powerful suction for effective cleaning, the vacuum cleaner must have a big motor and this again contribute to the weight of the vacuum cleaner.

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- With all the above considerations in mind, it would be natural to manufacture a vacuum cleaner to clean carpets in the interior of air planes with big suction power. However, any vacuum cleaner with big suction power would have a big and powerful motor and thick walled hoses. With the foam chemical tank (36), any vacuum cleaner for use to clean the carpeted interior of an air plane would be heavy. The weight of current vacuum cleaners used to clean carpeted interiors of air planes are from 40 to 60 kg. Since a big motor is required, the power output is from 1,200 to 1,500 watts.

While a big motor and big suction power is needed to suck the foam up again, a spreading of a fine and thin foam layer is necessary. Therefore while a big motor and big suction power is needed, a controlled spread of a thin layer of foam chemical (16) must be achieved. Therefore the power of the air flow at the
5 foaming mechanism (14) must be stepped down so that a fine layer of foam is formed in the foaming mechanism (14), thus enabling a layer of chemical foam to be sprayed out onto the carpet.

A consequence of a big motor and big suction power is that the foam output in
10 the form of foam layer to be spread over the carpet must be constantly monitored. The layer of foam chemical (16) to be spread over the carpet must be a fine and thin layer or else there would be too much foam chemical (16) on the carpet. Having too much foam chemical (16) on the carpet would lead to moist foam left behind thus promoting bacteria and fungi growth. This would also lead to shrinkage
15 of the carpet in the air plane interior.

The prior art vacuum cleaners used to clean carpeted interiors of air planes have their air/chemical foam mix controlled by manually adjustment of air flow/air pressure and foam chemical (16). Such manual adjustment have to be carried out at
20 very regular intervals in order to maintain the production of a fine layer of foam chemical (16). Current prior art vacuum cleaners therefore suffer from a lack of automatic control over the production of a fine layer of foam chemical (16) formed over the carpet. As a result of the high pressure used, excess foam chemical (16) would be drawn. Such excess foam chemical (16) has to be brought back to the
25 foam chemical tank (36) using a by-pass valve (28). While this saves foam chemical (16), much power and energy is spent on control of this factor, which is a consequence of a big and powerful motor for suction power.

Finally, when using vacuum cleaners inside the interior of air planes, the power
30 systems of air planes are different from normal electrical systems in offices and households. As a result, the power systems must be modified to be used on air planes.

The inventors have been using machines of the prior art to clean carpeted interior
35 of air planes. However, the machines of the prior art are too heavy even for men of average size to carry up the flight of steps into the interior of an air plane. Although big suction power and consequently high pressure is required to suck up the foam and dirt from the carpet, low pressure is necessary to produce a layer of moist foam chemical (16) on the carpet for the purpose of cleaning. As a result,

the inventors experimented with vacuum cleaners using low power and low pressure and were able to arrive at the solution offered through this invention.

Fig. 3 is a schematic of the low pressure low power light weight cleaning device to
5 clean carpeted interiors of air planes described in the invention. Air is brought into
the cleaning device through an low pressure low power air pump (100). The air is
passed through an one-way valve (190) to the spray foaming mechanism (140). The
foam chemical (160) is drawn into the cleaning device using a solenoid pump (200).
The foam chemical (160) is then fed through the one-way valve (190) into the spray
10 foaming mechanism (140). The air flow/foam chemical (160) mix and other parameters
of the foam chemical (160) is controlled by a dosing circuit (250), which is controlled
by a micro-controller.

A close up of the spray foaming mechanism (140) is shown in Fig 3. Air is pumped
15 into the spray foaming mechanism (140) while foam chemical (160) is fed from a
side of the spray foaming mechanism (140). The air meets the foam chemical (160)
at right angles, bringing the foam chemical (160) through a perforated disc (290).
The air flow carrying the foam chemical (160) through the perforated disc (290)
forces the foam chemical (160) to evenly flow through the perforated disc (290).
20 These foam chemical /air mixture then passes through a few layers of thin wire mesh
(180) situated further inside the spray foaming mechanism (140). A thin film of
foam chemical (160) is thus formed on the empty spaces formed between the wires
in the wire mesh (180). As the low air pressure continues to pass through the
spray foaming mechanism (140), it gently pushes the film of foam chemical (160)
25 on the empty spaces in the layers of wire mesh (180), forming foam bubbles. These
foam bubbles are blown by the gentle air flow flowing through the wire mesh
(180). Eventually the foam bubbles formed would be carried out through the
outlet of the spray foaming mechanism (140). The foam bubbles when sprayed out
of the spray foaming mechanism (140) would form a layer of foam chemical (160)
30 on the carpeted interior.

The solenoid pump (200) of the inventive device also delivers a fixed volume of foam
chemical (160). However, the air/foam chemical mix is controlled by using dosing
frequency.

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The following advantages are obtained:-

- (a) All foam chemical (160) that is pumped is used. There is no need to re-circulate the foam chemical (160) into a tank.

5 (b) The control of air/foam chemical (160) mix is not based on balancing pressure (as in the prior art) but based on dosing frequency, which is independent of variation in pressure, scaling. Stable air/foam chemical can be attained.

(c) Both air/foam chemical are pumped only when need. Efficient use of power is achieved. Foam bubbles are generated when required.

10 (d) Simplier to control, use and maintain.

(e) Less components used and not only lighter in weight but also less prone to breakdown.

15 With a brush attachment (which is known in the art), the foam chemical (160) not only loosens the dirt in the carpet but enables the dirt to float up with the foam. The foam and dirt are then quickly sucked up.

20 With the use of this low pressure low power cleaning device, the thin layer of foam chemical (160) sprayed onto the carpet interior would be quickly sucked up again. Thus there is no concern over the carpeted interior of the air plane being moist with foam chemical (160) left behind on the carpeted interior of the air plane, which promotes bacteria and fungi growth.

25 Since the carpet is dried almost at once, there is no concern over the moistness causing shrinkage of the carpet in the air plane interior.

30 Since the air pump (100) uses low power in the range of 30 to 40 W, there is no need to have a big motor and fan. A small motor would be used, thus reducing the weight of the cleaning device to 15 to 25 kg. Such a cleaning device can easily be carried up a flight of stairs to the interior of an airplane.

35 With a low power dosing pump (270), the dosing of foam chemical (160) can be easily controlled, thus obviating the need for continuous adjustment of dosing of foam chemical (160). With the addition of dosing circuit (250) and a micro-controller, the forming of fine layer of foam chemical (160) is achieved. Furthermore, with a low pressure low power motor and air pump (100) controlled by dosing frequency circuit (250) and microcontroller, the formation of a layer of foam chemical (160) can be continuously maintained.

Comparison of the technical features of Fig 1 or Fig 2 with Fig 3 shows the following:-

5 Air compressor (10) 350 W, Pump 70 W and Vacuum Motor 1000 W (Fig 1)

Air Compressor (10) 1200 W (Fig 2).

By contrast, the motor of the subject invention uses an air pump (100) of 35 W. A

10 solenoid pump (200) of the invention uses 16 W.

The foaming mechanism used in the prior art and used in the subject invention is also different in structure and approach.

15 Control of foaming in the prior art is manual using mechanical meters while control of foaming in the subject invention is electronically controlled through use of a micro-controller.

Metering of foam chemical (160) for the subject invention is controlled by varying
20 the frequency of dosing using a dosing circuit (250) and a micro-controller. This produces accurate and stable control of foam generation. There is little wastage of energy since the dosing pump (270) is used only as required.

More importantly, through the use of low pressure (instead of high pressure
25 machines of prior art), a smaller motor of 35 W is used. A smaller and less powerful motor is therefore lighter. Since the pressure is not high, the walls of hoses are thinner, resulting in weight savings. As a result the subject invention weighs approximately 20 kg as compared to prior art machines which weigh 40 to 50 kg.

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The inventors found that the low pressure allows the formation of consistent layer of foam chemical (160) bubbles over the carpet, thereby enabling the carpet to be coated with a consistently thin layer of chemical foam for cleaning purpose. The use of a perforated disc (290) and wire mesh (180) ensures even air flow necessary
35 for the formation of a thin layer of chemical foam on the empty spaces between the wires in the wire mesh (180). Once a layer of foam is formed on the empty spaces in the wire mesh (180), the air inflow (120) going through foam chemical (160) formed on the empty spaces in the wire mesh (180), will form bubbles of foam chemical (160). The bubbles of foam chemical (160) are then blown out of the

spray foaming mechanism (140) into the exterior, and forms a layer of foam chemical (160) on the carpet.

5 Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to the precise embodiment as described herein, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the claims.

10 ADVANTAGEOUS EFFECTS OF THE INVENTION

The invention allows the continuous production of bubbles of foam chemical (160) which are then sprayed onto the carpeted interior of the air plane. Since the bubbles of foam chemical (160) is formed using low power and low pressure,
15 smaller motor and air hoses with thinner walls can be used. All this contribute to a lighter cleaning device, which is easier to haul up an air plane.

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CLAIMS:

1. A chemical foam type carpet cleaner to clean carpeted interiors of air planes, comprising

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a low power motor to drive a carpet cleaning brush;
a low pressure air pump (100) for producing an air flow;
air duct means to supply the air flow into a spray foaming mechanism (140),
a dosing device (250) to supply a flow of foam chemical (160) into the spray
10 foaming mechanism (140); and
an air flow/foam chemical balancing means

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wherein the air flow/foam chemical balancing means controls the inflow and mixture of air and foam chemical into the spray foaming mechanism (140) to produce
15 bubbles of foam chemical (160) in the spray foaming mechanism (140), said bubbles of foam chemical (160) being sprayed from the spray foaming mechanism (140) onto the carpeted interior to form a layer of bubbles of foam chemical (160), said bubbles of foam chemical (160) formed on the carpeted interior lifting the dirt from the carpet, so that the dirt and the bubbles of foam chemical (160) are then sucked
20 up from the carpet.

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2. A spray foaming mechanism (140) as claimed in Claim 1 having a perforated disc (290) and one or more layers of wire mesh (180), an air inlet (120) for flow of low pressure air into the spray foaming mechanism (140) and another inlet for
25 inflow of foam chemical (160), for the formation of bubbles of foam chemical (160) on the layers of wire mesh (180).

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3. A dosing device (250) as claimed in Claim 1 comprising of a low power solenoid pump (200), dosing circuit (250) and a micro-controller which controls
30 accurately the inflow of foam chemical (160) into the spray foaming mechanism (140) as and when needed.

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