(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 104 345**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **83107107.1**

(22) Date of filing: **20.07.83**

(51) Int. Cl.³: **A 47 L 11/34**
A 47 L 11/30

(30) Priority: **06.08.82 DK 3541/82**

(43) Date of publication of application:
04.04.84 Bulletin 84/14

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

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(54) In-situ carpet cleaning method and apparatus.

(57) When cleaning a carpet (118) using a cleaning head with nozzles (102) for directing a cleaning liquid against the carpet and a suction mouthpiece (113) for removing cleaning liquid and dirt dislodged from the carpet, the liquid is directed against the carpet (118) with a delivery pressure of at least 20 bar, preferably 20-60 bar, under a relatively acute angle (α) of maximum approximately 30° with the plane of the carpet, and the vacuum in the suction mouthpiece (113) is held at a value as measured behind the mouthpiece of at least 60 per cent of atmospheric pressure, preferably between 60 and 80 percent, the lips (113a,113b) of the mouthpiece engaging the carpet in or close to the area, where the liquid jets from the nozzles (102) hit the carpet.

The method makes it possible to remove dirt and cleaning liquid substantially more effectively than has been possible with known equipment using lower pressure and lower vacuum, and where the mouthpiece does not engage the carpet close to the area, in which the cleaning liquid hits the carpet.

In a preferred embodiment of the method, a detergent is sprayed onto the carpet and left to loosen the dirt for, say, 15 minutes, after which the above process is carried out using pure rinsing liquid, for example hot demineralised water.

It is suggested that Figure 1 be published.

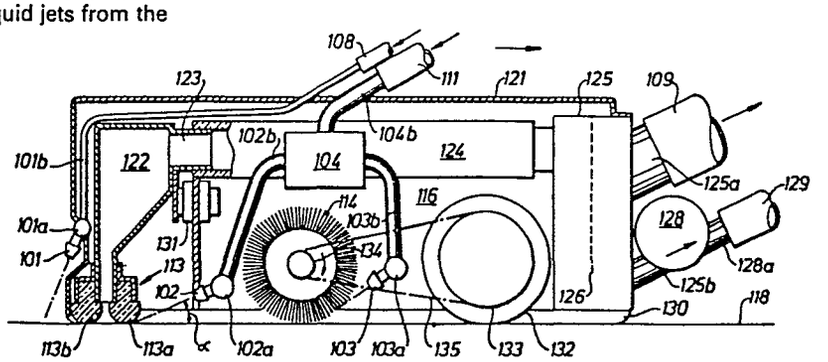


Fig.1

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IN-SITU CARPET CLEANING METHOD AND APPARATUS

TECHNICAL FIELD

The present invention relates to a method of cleaning carpets placed on a support, such as a floor, said method being of the kind comprising the following steps a-c:

a) a liquid is directed against the carpet through a number of nozzles,

b) the carpet is subjected to suction in order to remove at least part of the liquid thus directed together with dirt from the carpet, and

c) the carpet is dried or allowed to dry.

BACKGROUND ART

In previously known methods of this kind the liquid, which may consist of water with soap or other detergent in solution, is sprayed onto the carpet or into its pile under a relatively low pressure. In the next processing step the carpet is subjected to suction, e.g. by means of a suction mouthpiece, in order to remove the sprayed-on liquid and dirt from the carpet. These known methods have not proved very effective in removing the clean liquid and the dirt from the carpet. The cause of this state of affair is presumably partly that the washing liquid is delivered under a relatively low pressure, partly that the suction is applied with a relatively low vacuum, normally only about 3%, at the highest about 18% of atmospheric pressure. Further, the quantity of washing liquid is limited to the greatest extent possible, as otherwise there are risks of damage due to moisture, both in the base of the carpet itself and in

the cement or glue securing the carpet to the floor,and - by evaporation and condensation - on furniture and especially wallpaper. Experience has shown that after treating a carpet in accordance with one of the known methods, deeply-embedded dirt will remain in the deeper parts of the carpet - such as at the roots of the pile - and particles with sharp edges, such as grains of sand, may cut the pile, when somebody treads on the carpet. It has further been found that up to 30 to 40% of the moisture remains in the carpet after treatment, and this remaining moisture will - together with the dirt and the dissolved solid constituents of the detergent - turn into an extremely slow-drying mass. During this period of drying, the room in question cannot be used for its normal functions, as a high degree of ventilation is required. The long time during which the moisture remains in the carpet also entails a risk of mould formation. Even after the complete drying-out of the remaining mass it constitutes a risk of allergic reactions in persons occupying the room in question.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide a method of the kind referred to above, which does not suffer from the drawbacks and inconveniences described above.

According to the present invention, this object is attained by using a method that is characterised in

d) that the liquid is directed against the carpet under a pressure as measured upstream of the nozzles of at least 20 bar, preferably between 20 and 60 bar, under a relatively acute angle (α) with the plane of the carpet of approximately 30°, and

e) that the suction is applied with a vacuum of at least 60%, preferably between 60 and 80%, of atmospheric pres-

sure by means of a suction mouthpiece with lips that are held close to or in engagement with the carpet in or in the immediate vicinity of that area, in which liquid issuing from the nozzles impinges upon the carpet or the deep-lying parts of its pile.

By proceeding in this manner, the cleaning liquid will be projected onto or injected into the carpet at a relatively high pressure resulting in a high velocity and correspondingly great kinetic energy, and this enables the liquid to form turbulences lifting the dirt from the base of the carpet. The use of a relatively acute angle prevents the cleaning liquid from penetrating deep into or through the base of the carpet, where it could dissolve the glue holding the carpet to the floor. By applying the suction in the manner indicated under a relatively high vacuum and with correspondingly high suction air velocity and kinetic energy, the turbulent mixture of liquid and dirt will be sucked away from the carpet before it has time to come to rest on the base of the carpet. At the same time, the very high vacuum used ensures that a far greater proportion of liquid is removed from the carpet than has previously been possible. Trials have shown that the drying time, previously of the order of about two days (i.e. 48 hours), can be brought down to between 4 and 6 hours. This means that e.g. an office, in which the carpet is cleaned after normal working hours, will be ready for use already on the morning of the following day.

A preferred embodiment of the method according to the invention is characterised in

a) that a surface-active agent, such as a solution of soap or a sulphonated fatty alcohol, is applied to the carpet before the liquid mentioned is applied to the carpet,

b) that the surface-active agent is allowed to act on the

dirt present in the carpet, e.g. during a period of up to 15 minutes, and

c) that as the liquid mentioned is used a rinsing liquid substantially devoid of solids in solution, e.g. pure water or ion-exchanged water, said rinsing liquid being supplied in a quantity per unit weight of the carpet sufficient to remove the major proportion of said surface-active agent together with dirt from the carpet, e.g. approximately 7 litres of pure water per kilogramme of textile fibre in the upwardly facing parts of the carpet.

In this embodiment, the cleaning process is divided into two main steps, viz.

I. a first, "chemical" step, comprising steps a) and b) above, and in which the detergent is applied and is given time to act on the dirt, and

II. a second, "mechanical" step, consisting of step c) above, in which both the dirt and the detergent - which may contain solids in solution - are thoroughly rinsed out from the carpet.

The present invention also relates to an apparatus for carrying out the method according to the invention. Such an apparatus would be of the kind adapted to the cleaning of carpets placed on a support, such as a floor, said apparatus being of the kind comprising

a) a number of nozzles for directing a liquid against the carpet, and

b) at least one suction mouthpiece adapted to be held in contact with or close to the carpet and connected to a vacuum source in order to remove at least part of the liquid thus directed together with dirt from the carpet by suction,

and in accordance with the present invention, this apparatus is characterised by/in

c) liquid supplying means adapted to supply the liquid mentioned to the nozzles under a pressure of at least 20 bar, preferably between 20 and 60 bar,

d) that the nozzles are adapted to direct the liquid against the carpet under a relatively acute angle (α) of not more than approximately 30^{o},

e) vacuum means to apply a vacuum to the suction mouthpiece of at least 60%, preferably between 60 and 80%, of atmospheric pressure, and

f) that the suction mouthpiece is adapted to be held in such a position during the use of the apparatus, that its lips are held close to or in engagement with the carpet in or in the immediate vicinity of that area, in which liquid issuing from the nozzles impinges upon the carpet or the deep-lying parts if its pile.

It is preferred that the lips of the suction mouthpiece comprise downwardly facing convex engagement portions with a radius of curvature of the order of 5 mm. A larger radius of curvature results in the effective supporting area being too large and the vacuum insufficient for effective removal of the liquid from the carpet, whereas a smaller radius of curvature results in the lips "digging into" the carpet, partly causing a locking of the cleaning head against the requisite movement, partly preventing the passage of air and liquid.

It is also preferred that the lips of the suction mouthpiece are spaced from each other with a gap of the order of 3mm, preferably not exceeding 3.75 mm. A larger gap is not always able to prevent the suction mouthpiece from "losing water", as the velocity of the air may be too low, whereas a narrower gap does not allow the requisite amounts of air and liquid to pass.

In practice it is further preferred that at least those

parts of the lips of the suction mouthpiece likely to come into contact with the carpet being cleaned are made of a material having a low coefficient of friction with carpet textile fibre, preferably of the order of 0.08 or less, said material e.g. consisting of low-pressure polyethylene with a high degree of polymerization. A low coefficient of friction prevents the mouthpiece from pulling the carpet along the floor, and materials of the kind indicated are suitable, both for providing the low coefficient of friction and for enabling the lips to be manufactured at a reasonable cost.

At the present stage of technological development, such items of machinery as vacuum pumps, high-pressure liquid pumps etc. required to provide the necessary vacuum and high pressure respectively for the method and apparatus according to the invention are too heavy and voluminous to be placed on or in an apparatus designed to be moved along a carpet lying on a floor by one person in an efficient manner, taking into consideration problems arising in corners and below fixed furniture etc. The present invention also comprises a solution of this problem in an embodiment, which is characterised in that the apparatus consists of two sub-units, viz.:

a) a mobile, manually operable, cleaning head comprising those parts designed to come into contact with or to be situated close to the carpet to be cleaned, such as the rinsing nozzles and the suction mouthpiece as well as associated equipment, such as a liquid separator for separating used rinsing liquid from the mixture of air and liquid sucked in through the suction mouthpiece, and

b) a power and processing unit comprising those parts of the apparatus, which are not required to come into contact with or to be placed close to the carpet to be cleaned, such as equipment for supplying, treating and, when required, heating the rinsing liquid and deliver-

ing it under high pressure to the cleaning head, equipment for applying a vacuum to the suction mouthpiece in the cleaning head and filtering the air drawn from the suction head, and equipment for filtering the used rinsing liquid separated-out in said liquid separator before discharging same, as well as

c) flexible connection means connecting the parts of the apparatus situated in the cleaning head with those parts situated in the power and processing unit, with which they cooperate.

In this manner, only the parts required to be close to the carpet being cleaned are subject to being moved by the operator, who will have no difficulty in manoevering these parts in the form of the manually operable cleaning head. Further, the power and processing unit, which may be in the form of a lorry or a road trailer to be parked outside the building concerned, can be made large enough to easily accommodate all the remaining parts of the apparatus, and also to give room for present and future additions of ancillary and auxiliary equipment, and even the necessary personnel facilities.

In a further preferred embodiment of the apparatus according to the invention, the cleaning head is closed on all sides except below, the closed space enclosing at least the rinsing nozzles and the region between the rinsing nozzles and the suction mouthpiece, preferably also a set of moistening nozzles and a rotary brush situated between the moistening nozzles and the rinsing nozzles. If hot liquid is used as rinsing liquid, this feature prevents undue cooling of the liquid by contact with passing air and evaporation and - if a liquid giving off noxious fumes is used - prevents or at least limits contamination of the atmosphere in the space concerned.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained in more detail with reference to the accompanying, partly schematic, drawings, in which

Figure 1 is a side view, partly in section, of an example of a cleaning head according to the invention, and

Figure 2 is a "transparent" side view of an example of a power and processing unit according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The cleaning head as shown in Figure 1 comprises a frame or chassis 116 made of comparatively rigid material, such as sheet steel, which carries the various components of the cleaning head. The chassis 116 rests on a symbolically shown carpet 118 placed on a floor and normally bonded or nailed to said floor, partly through a drum motor 132, partly through a suction mouthpiece 113. The drum motor 132 is of a type, in which the shaft (not shown) is stationary and in this example fixed to the chassis 116 by means not shown, the housing or drum rotating relative to the shaft in a manner to enable the motor to propel the chassis 116 in the direction indicated or, when reversed, in the opposite direction. The drum motor 132 may be a variable-speed, reversible motor, preferably with continuous speed variation.

The suction mouthpiece 113 comprises a pair of lips 113a and 113b, which may be of similar or different configuration, as seen in cross section, i.e. as seen in Figure 1. In the example shown, each lip 113a and 113b comprises a lower rounded portion with a radius of curvature of the order of 5 mm, and the gap between the lips is in the or-

der of 3 mm. It should be noted in this connection that the lips 113a and 113b are shown in Figure 1 on a different scale than the rest of the cleaning head, which in practice could have a length of the order of 65 cm and a width normal to the plane of Figure 1 of the order of 50 cm. The lips 113a and 113b are made of a material with a low coefficient of friction - preferably of the order of 0.08 or less - such as low-pressure polyethylene with a high degree of polymerization.

The suction mouthpiece 113 is connected to a suction chamber 122, which - like the mouthpiece 113 - extends along substantially the full width of the cleaning head, measured in a direction normal to the plane of Figure 1. The suction chamber 122 is closed on all sides apart from its connection with the suction mouthpiece 113 and a number of pipe stubs 123 leading to an equal number of flexible suction tubes 124. The pipe stubs 123 and the flexible tubes 124, of which there may be four - or any other convenient number - are placed parallel to each other in a row normal to the plane of Figure 1, although other configurations are possible. The important condition to be met by the flexible tubes 124 that connect the suction chamber 122 with a water separator 125 is that their flow resistance should be so low as not to represent a substantial hindrance to the flow of air mixed with water from the suction chamber 122 to the separator 125. Equally, the suction chamber 122 itself should not present a substantial hindrance to the flow of air and water from the suction mouthpiece 113 to the flexible tubes 124.

The water separator 125 contains one or more baffles illustrated symbolically by a baffle 126 shown in dotted line. The separator 125 comprises an air exit tube 125a and a water exit tube 125b. The air exit tube 125a is con-

nected to a flexible suction tube 109 leading to a power unit to be described below. The water exit tube 125b is connected to the input side of a water pump 128, such as a rotary displacement pump with a rubber-winged rotor of the type marketed under the trade name JABSCO, the output side of which is connected to a tube 128a, which in turn is connected to a flexible water removal tube 129 leading to said power unit to be described below.

Both the drum motor 132 and the motor (not shown) driving the water pump 128 may be adapted to run on high-frequency alternating current power, i.e. of a frequency in excess of 100 Hz, as this makes it possible to reduce their weight/power ratio and thus to reduce the weight of the cleaning head while maintaining a sufficient motor power for the functions concerned, i.e. the movement of the cleaning head along the carpet 118 and the removal of the water separated-out in the water separator 125. The high-frequency electric power may be supplied from said power unit through a cable not shown in Figure 1.

A rotary brush 114 is also rotatably mounted in the chassis 116 with its axis at right angles to the direction of movement of the cleaning head and parallel to the floor, and is adapted to be driven by the drum motor 132 by means of a sprocket 133 on the motor and a sprocket 134 on the brush, interconnected by a drive chain 135. The chain drive 133-135 may be dimensioned to drive the brush 114 at a peripheral speed of the order of six times that of the drum motor 132. A belt drive or gears may, of course, be used instead of the chain drive shown, or the brush 114 may have its own drive means.

The suction chamber 122 is fixed to the chassis 116 ny means of a pivot bearing 131, allowing the suction chamber 122, and with it the suction mouthpiece 113, to turn

slightly about a horizontal axis parallel to the direction of movement of the cleaning head. This enables the suction mouthpiece 133 to adapt itself to the minor irregularities in the floor bearing the carpet 118, the suction tubes 124 being flexible for this purpose.

Mounted in the chassis 116 by means not shown are three set of nozzles, all three sets extending across the working area of the cleaning head, i.e. transversely to the plane of Figure 1. These nozzles are, reckoned from right to left in Figure 1, i.e. in the order of processing, a set of moistening nozzles 103 adapted to direct water to the area immediately in front of and below the rotary brush 114, a set of rinsing nozzles 102 adapted to direct high-velocity jets of water to the area immediately in front of and/or below the suction mouthpiece 113, and a set of after-treatment nozzles 101 adapted to direct after-treatment liquid, such as an anti-static solution, to the carpet 118 after the passage of the suction mouthpiece 113. The nozzles in each row are, of course, placed in a sufficient number per unit length to ensure that the particular area of the carpet receives a sufficient amount of the liquid concerned in closely spaced jets.

Water under high pressure and possibly at a suitably elevated temperature is supplied from the power unit to be described below through a flexible water supply tube 111 connected to a supply tube 104b on a valve unit 104. The valve unit 104 is adapted to regulate the flow of water from the supply tube 104b to both the moistening nozzles 103 and the rinsing nozzles 102, flowing through supply tubes 103b and 102b and distributing manifolds 103a and 102a respectively to the nozzles. The valve unit 104, the details of which need not be described further, as they are obvious to a skilled person, may be adapted to control the flow to the

nozzles 103 and 102 in response to the direction of rotation of the drum motor 132, so that water only issues from these nozzles when the drum motor rotates in a direction to drive the cleaning head forward,i.e. in the direction shown, and also in response to a "dead man's button" (not shown) on the cleaning head's operating handle (not shown). The requisite control arrangements could be constructed in accordance with well-known principles, and further explanation should be unnecessary in the present context.

The after-treatment nozzles 101 are adapted to receive liquid through a manifold 101a being supplied through a supply tube 101b and a flexible supply tube 108 connected to the power unit described below. The supply tube 101b could pass through a section of the valve unit 104 isolated from the tubes 103b and 102b, or through its own valve (not shown) to make it possible also to control the flow of after-treatment liquid in a similar manner to the liquid issuing through the nozzles 103 and 102.

The space containing the parts described above with the exception of the after-treatment nozzles 101, the front of the water separator 125 and the pump 128 is substantially closed by a cover 121, which is secured to the chassis 116 by suitable fastening means not shown, such as screws, and encloses all these parts above, behind (i.e. to the left in Figure 1) and on both sides parallel to the plane of Figure 1. This space is, however, substantially open below, facing the carpet 118, and is sealed more or less fluid-tight to the carpet by means of a flexible skirt 130 of rubber or the like, which may or may not extend all the way round the lower edge of the cleaning head.

In the same manner as previously known cleaning heads, the cleaning head according to the present invention is

equipped with several control elements that are not shown in Figure 1, such as a handle and control buttons - including the "dead man's button" mentioned above - and switches for controlling the various functions, such as the supply of liquid to the nozzles and the movement of the drum motor 132, as well as associated wiring.

Figure 2 shows - purely diagrammatically - a power unit for use with the cleaning head described above with reference to Figure 1. The unit is more than a mere power unit, as it both supplies water, which may or may not be heated, under pressure and anti-static liquid to the cleaning head and withdraws air under vacuum and used rinsing water from the unit. Further, the power unit is adapted to treat water supplied to the cleaning head, such as by a "softening" or ion-exchanging process, and to filter air and used rinsing water coming from the cleaning head before discharging same to atmosphere and sewers respectively. Finally, the power unit shown in Figure 2 may contain a high-frequency electric generator for supplying power to the electric motors for the cleaning head's drum motor and pump motor,as well as equipment to serve other related purposes.

To fulfil the above-mentioned functions, the power unit shown in Figure 2 contains a number of pieces of equipment now to be described.

Thus, the rinsing water is taken from a supply, such as the municipal water mains, through a pipe 136, leading to a water treatment unit 137. The water treatment unit 137 comprises equipment to carry out the treatment required on the water found in the mains supply area concerned. As most municipal waterworks supply water with a certain amount of calcium compounds making the water

"hard", this equipment will normally comprise a "water softener" or ion exchanger for removing the calcium compounds. Other treatment sub-units may be added as and when need arises. From the water treatment unit 137 the water passes to a heating unit 138, in which the water is heated when required to the requisite temperature. The heating unit may be supplied with heat in any convenient manner, such as from a burner and/or the cooling water of an internal combustion engine in an associated vehicle or in the power unit itself, and the temperature of the water leaving the heating unit may be thermostatically controlled using known technology. From the heating unit 138 the water passes to the intake side of a high-pressure pump 139, shown symbolically as a single-stage centrifugal pump, but a multiple-stage centrifugal pump or other types of pumps may be used, depending on the speed of rotation of the drive motor available. The water leaving the pump 139 under high pressure, such as between 20 and 60 bar, flows through the flexible water supply tube 111 into the cleaning head as shown in Figure 1. A vacuum pump 140 capable of delivering a vacuum of at least 40%, i.e. an absolute pressure corresponding to 60% of atmospheric pressure, draws air from the flexible suction tube 109, the other end of which is connected to the cleaning head as shown in Figure 1. As this air may contain various impurities, such as dust and/or droplets of dirty rinsing water, the outlet side of the vacuum pump 140 is connected to the inlet side of a filter 141 of any suitable type, the outlet side of which discharges to atmosphere. If the air coming from the cleaning head is hot, its heat may be extracted by means of a heat exchanger (not shown) and used for preheating the water supplied to the water heater 138 or some other useful purpose.

The dirty rinsing water separated from the suction air in the water separator 125 shown in Figure 1 and transported

through the flexible water removal tube 129 by means of the water pump 128 is conducted through a filter 142 (optional) and to the sewers. Any heat contained in this water coming from the water separator 125 may, of course, also be extracted by means of a heat exchanger (not shown) and used as indicated above.

The power unit shown in Figure 2 also contains a high-frequency electric generator 143, shown symbolically as being driven by an internal combustion engine 144, although other means for driving the generator 143 could be used, such as an electric motor connected to the mains, or the auxiliary drive shaft of an associated traction vehicle. The term "high frequency" is to be understood as comprising frequencies of the order of 100 Hz and above, or at least sufficiently high to allow a reduction in the weight of the iron parts of the electric motors concerned, i.e. the drum motor 132 and the motor for the water pump 128 shown in Figure 1. The wiring concerned is not shown in the Figures.

Shown in Figure 2 is also an anti-static liquid tank 145, supplying anti-static liquid to the cleaning head as shown in Figure 1 by means of a liquid pump 146 and the flexible supply tube 108.

The power unit shown in Figure 2 may contain additional equipment not shown, such as for heating, cooling, ventilating (including forced ventilation for accelerated drying of the carpet after cleaning) and/or lighting the room or rooms in which the carpet or carpets to be cleaned is/are situated. If other liquids than water, such as chlorinated hydrocarbons, are used for rinsing the carpet or carpets, this equipment may also comprise means for supplying breathing air to the person or persons operating

the cleaning head so as to prevent poisoning by noxious fumes. In this connection, it should be noted that the term "water" as used in describing the various parts of the equipment shown in the Figures and explaining their function should be understood as comprising any liquid suitable for use in cleaning carpets in the manner described herein.

When carrying out the method according to the invention, the carpet to be cleaned is first made wet or moist with a suitable detergent or surfactant, such as a solution of soap or a sulphonated fatty alcohol. The detergent is given a suitable period of time to act upon the particles of dirt embedded in or adhering to the carpet, such as between 5 and 15 minutes, although both longer and shorter periods are possible, depending on circumstances. The period should, however, be sufficiently long to allow the detergent or surfactant to reduce the surface tension between the liquid and the particles of dirt.

The next step in the process consists of running the cleaning head shown in Figure 1, suitably connected through flexible tubes, conduits and cables to the power unit shown in Figure 2, across the carpet. During this step, which may be characterised as a "multiple step", the following sub-processes take place as the cleaning head is moved by the drum motor 132 as from left to right in Figure 1:

1) water is sprayed on the carpet from the moistening nozzles 103 immediately in front of the rotary brush 114 so as to re-moisten any areas, that may have dried out since the detergent or surfactant was applied,
2) the rotary brush 114 effects a mechanical loosening of carpet pile, that may adhere to each other, and/or of particles of dirt adhering to the carpet pile and/or base material,

3) water under high pressure, such as at least 20 bar, preferably between 20 and 60 bar, as measured in the supply tubes 102b, is ejected from the rinsing nozzles 102 in jets making an angle α of preferably not more than about 30° and impinging on the carpet or between its pile so as to loosen the dirt particles already moistened by the detergent or surfactant previously applied and lift these particles from the base of the carpet in a turbulent mass of rinsing water, said jets impinging on the carpet immediately below and/or in front of the suction mouthpiece 113 or the front lip 113a thereof,

4) the turbulent mass of rinsing water with its content of suspended particles of dirt dislodged from the carpet base and/or pile is sucked up through the suction mouthpiece 113 together with air from the atmosphere passing between the carpet 118 and the lip 113b into the suction chamber 122, where the pressure should not be higher than corresponding to a vacuum of 40%, i.e. an absolute pressure of 60% of atmospheric pressure, although lower pressures, i.e. down to 20% of atmospheric pressure, or even lower still, could be used,

5) the carpet 118 is supplied with a small quantity of anti-static liquid through the after-treatment nozzles 101.

After a suitable period of drying-out the comparatively small residue of water now remaining in the carpet, the carpet is now ready for use. As indicated above with reference to the power unit shown in Figure 2, this drying-out may be accelerated by forced ventilation, if necessary accompanied by additional heating, of the space concerned.

After having sucked up through the suction mouthpiece 113 into the suction chamber 122, the rinsing water with its

content of particles of dirt - and also a small proportion of detergent or surfactant in solution - is carried by the air likewise sucked in through the mouthpiece 113 through the flexible suction tubes 124 and into the water separator 125, where the water is separated out and removed from the cleaning head through the water pump 128 and the water removal tube 129, while the air leaves the cleaning head through the flexible suction tube 109.

It is important that the jets of rinsing water ejected by the rinsing nozzles 102 impinge on or in the carpet 118 in or as closely as possible to the area below the suction mouthpiece 113, so that the turbulent mass of rinsing water and dirt particles may be removed from the carpet 118 before this mass has had time to come to rest and the particles to settle to the base of the carpet.

The angle α of maximum approximately 30° has been chosen to avoid the risk of the rinsing water penetrating too far into or even through the base of the carpet and dissolving the glue or cement, with which the carpet is secured to the floor.

The quantity of water ejected through the rinsing nozzles 102 - as determined by the supply pressure and the flow cross-section and number of nozzles per unit length across the direction of movement of the cleaning head - should be sufficient to ensure that the cleaning head need only be used once on each are of the carpet. Use of "soft" water - either in the natural state or "softened" by means of the water treatment unit 137 shown in Figure 2 to a degree of about 5°dH - improves the rinsing action and reduces the amount of solid matter left in the carpet after the cleaning process, and also reduces the risk of the rinsing nozzles 102 being blocked by residues of calcium compounds,

especially when using hot rinsing water.

The temperature of the rinsing water should be adjusted according to the material in the carpet to be cleaned, but should be held as high as possible, partly in order to kill bacteria, fungi, parasites and eggs thereof as effectively as possible, partly to accelerate the drying-out process after the cleaning. It should be noted that if the detergent or surfactant applied before the rinsing process contains noxious agents designed to kill such organisms, these agents will be removed in quantity by the subsequent rinsing, and the risk of their contaminating the working space above the carpet is thus considerably reduced, if not altogether eliminated.

The closed space provided above the carpet 118 by the cover 121 and the water separator 125 prevents undue cooling of the rinsing water jets issuing from the rinsing nozzles 102, and also of the jets of moistening water issuing from the moistening nozzles 103. If hot water is used for moistening and rinsing, this results in the portion of the carpet 118 in this area being held at a high temperature for a period of time, so that the possibility of killing parasite's eggs, which are known to be very heat-resistant, is increased.

The suction mouthpiece is thought to function in the following manner, the front lip 113a and the rear lip 113b having two distinct functions:

a) the front lip 113a and the base of the carpet together constitute a narrow gap or an area of restricted flow, which allows the rinsing water to pass in a continuous body and to such an extent that its path of movement through the pile is of a suitable length to ensure the requisite rinsing effect, and that its velocity is sufficient to ensure that dirt and particles, such as grains

of sand, are carried in suspension with the water and out through the pile,

b) the rear lip 113b and the base of the carpet in a similar manner constitute a narrow gap or an area of restricted flow, but in this case it is air that is being sucked in, said air necessarily having such a kinetic energy that the rinsing water remaining in the pile is carried with the air into the suction chamber 122.

It has been shown in practice that in this way it is possible to remove water from the carpet to such an extent that the feel of the carpet is only "slightly moist", i.e. with a moisture content of a few decilitres per square metre, in contradistinction to a carpet felt as "moist, almost wet" with a moisture content of from several decilitres to 2 litres of water per square metre of carpet.

It is obvious that that part of the weight of the cleaning head shown in Figure 1 carried by the suction mouthpiece 113 will influence the height of the narrow gaps mentioned above between the lips 113a and 113b and the base of the carpet, and for this reason the cleaning head may be provided with means (not shown) for holding one or more weights secured to the cleaning head in the region above the suction mouthpiece 113. A corresponding reduction in the force urging the suction mouthpiece 113 into engagement with the carpet could be provided by placing counterweights on a cantilever extending to the opposite side of the drum motor 132, i.e. to the right as seen in figure 1. Alternatively, a weight capable of sliding adjustment between these two positions could be used. In this connection, it should be noted that the sub-atmospheric pressure in the suction mouthpiece 113 produces an additional force urging the mouthpiece 113 downwards. For this reason, the spacing between the tangency areas of the two lips 113a and 113b

with the carpet should not be too great, as the force produced by the suction may effectively lock the mouthpiece 113 against movement. Another reason for not having too large a spacing between the lips 113a and 113b - in this aspect the gap defining the minimum flow cross-sectional area between them - is to avoid the suction mouthpiece "losing water" due to too low air velocity in the gap.

It is within the scope of the invention to use a common power unit of the type indicated in Figure 2 with more than one cleaning head as shown in Figure 1. This would necessitate adapting the connections and controls accordingly, especially with a view to avoiding interaction between the various cleaning heads. The flexible tubes and cables connecting each cleaning head to the power unit could conveniently be arranged in a common conduit that could also contain intercommunication telephone lines to enable the operator of each cleaning head to communicate with the person controlling the power unit, so that the latter may be warned in case of leaks or other faults in the mobile parts of the equipment, i.e. the cleaning head and associated tubes and cables.

In addition to the invention as claimed in the following claims, a method of cleaning carpets, substantially as described herein with reference to the accompanying drawings, an apparatus for cleaning carpets, substantially as described herein with reference to the accompanying drawings, a cleaning head for cleaning carpets, substantially described herein with reference to Figure 1 of the accompanying drawings and a power and processing unit adapted to cooperate with one or more cleaning heads for cleaning carpets, substantially as described herein with reference to Figure 2 of the accompanying drawings, as well as any novel feature or combination of features described herein, are also the subject of this application.

C L A I M S

1. A method of cleaning carpets (118) placed on a support, such as a floor, said method being of the kind comprising the following steps a - c:

a) a liquid is directed against the carpet (118) through a number of nozzles (102),

b) the carpet is subjected to suction in order to remove at least part of the liquid thus directed together with dirt from the carpet, and

c) the carpet is dried or allowed to dry,

c h a r a c t e r i z e d in

d) that the liquid is directed against the carpet (118) under a pressure as measured upstream of the nozzles (102) of at least 20 bar, preferably between 20 and 60 bar, under a relatively acute angle (α) with the plane of the carpet (118) of approximately 30°, and

e) that the suction is applied with a vacuum of at least 60%, preferably between 60 and 80%, of atmospheric pressure by means of a suction mouthpiece (113) with lips (113a,113b) that are held close to or in engagement with the carpet (118) in or in the immediate vicinity of that area, in which the liquid issuing from the nozzles (102) impinges upon the carpet (118) or the deep-lying parts of its pile.

2. A method as claimed in claim 1, c h a r a c t e r i s e d in

a) that a surface-active agent, such as a solution of soap or a sulphonated fatty alcohol, is applied to the carpet before the liquid mentioned (in claim 1, item a) is applied to the carpet,

b) that the surface-active agent is allowed to act on the dirt present in the carpet (118), e.g. during a period of up to 15 minutes, and

c) that as the liquid mentioned (in claim 1,item a)) is used a rinsing liquid substantially devoid of solids in solution, e.g. pure water or ion-exchanged water, said rinsing liquid being supplied in a quantity per unit weight of the carpet sufficient to remove the major proportion of said surface-active agent together with dirt from the carpet, e.g. approximately 7 litres of pure water per kilogramme of textile fibre in the upwardly facing parts of the carpet.

3. A method as claimed in claim 1 or claim 2, c h a r a c t e r i s e d in that the carpet (118) is subjected to mechanical treatment, such as brushing with a rotating brush (114), prior to the liquid mentioned (in claim 1, item a)) being directed against the carpet.

4. An apparatus for use in carrying out the method as claimed in claims 1 to 3 and adapted to the cleaning of carpets (118) placed on a support, such as a floor, said apparatus being of the kind comprising

a) a number of nozzles (102) for directing a liquid against the carpet (118) and

b) at least one suction mouthpiece (113) adapted to be held in contact with or close to the carpet (118) and connected to a vacuum source (140) in order to remove at least part of the liquid thus directed together with dirt from the carpet by suction,

c h a r a c t e r i s e d by/in

c) liquid supplying means (139 etc) adapted to supply the liquid mentioned (in item a)) to the nozzles (102) under a pressure of at least 20 bar, preferably between 20 and 60 bar,

d) that the nozzles (102) are adapted to direct the liquid against the carpet (118) under a relatively acute angle (α) of not more than approximately 30°,

e) vacuum means (140 etc.) to apply a vacuum to the suction mouthpiece (113) of at least 60%, preferably between 60 and 80%, of atmospheric pressure, and

f) that the suction mouthpiece (113) is adapted to be held in such a position during the use of the apparatus that its lips (113a, 113b) are held close to or in engagement with the carpet (118) in or in the immediate vicinity of that area, in which liquid issuing from the nozzles (102) impinges upon the carpet (118) or the deep-lying parts of its pile.

5. An apparatus as claimed in claim 4, c h a r a c t e r i s e d in that the lips (113a, 113b) of the suction mouthpiece (113) comprise downwards facing convex engagement portions with a radius of curvature of the order of 5 mm.

6. An apparatus as claimed in claims 4 or 5, c h a r a c t e r i s e d in that the lips (113a, 113b) of the suction mouthpiece (113) are spaced from each other with a gap of the order of 3 mm, preferably not exceeding 3.75 mm.

7. An apparatus as claimed in any one of the claims 4 to 6, c h a r a c t e r i s e d in that at least those parts of the lips (113a, 113b) of the suction mouthpiece (113) likely to come into contact with the carpet (118) being cleaned are made of a material having a low coefficient of friction with carpet textile fibre, preferably of the order of 0.08 or less, said material e.g. consisting of low-pressure polyethylene with a high degree of polymerization.

8. An apparatus as claimed in any one of the claims 4 to 7, c h a r a c t e r i s e d in that it consists of two sub-units, viz.:

a) a mobile manually operable cleaning head (Figure 1) comprising those parts designed to come into contact with or to be situated close to the carpet (118) to be cleaned, such as the rinsing nozzles (102) and the suction mouthpiece as well as associated equipment, such as a liquid separator (125) for separating used rinsing liquid from the mixture of air and liquid sucked in through the suction mouthpiece (113), and

b) a power and processing unit (Figure 2) comprising those parts of the apparatus, which are not required to come into contact with or to be placed close to the carpet to be cleaned, such as equipment (136-139) for supplying, treating and, when required, heating the rinsing liquid and delivering it under high pressure to the cleaning head, equipment (140,141) for applying a vacuum to the suction mouthpiece (113) in the cleaning head and filtering the air drawn from the suction head, and equipment (142) for filtering the used rinsing liquid separated-out in said liquid separator (125) before discharging same, as well as

c) flexible connection means (111,109,129 etc.) connecting the parts of the apparatus situated in the cleaning head with those parts situated in the power and processing unit, with which they cooperate.

9. An apparatus as claimed in clam 8, c h a r a c t e r i s e d in that the liquid exit (125b) of the liquid separator (125) is connected to the intake side of a pump (128), the delivery side of which is connected to the flexible connection means (129) for conveying used rinsing liquid to the power and processing unit.

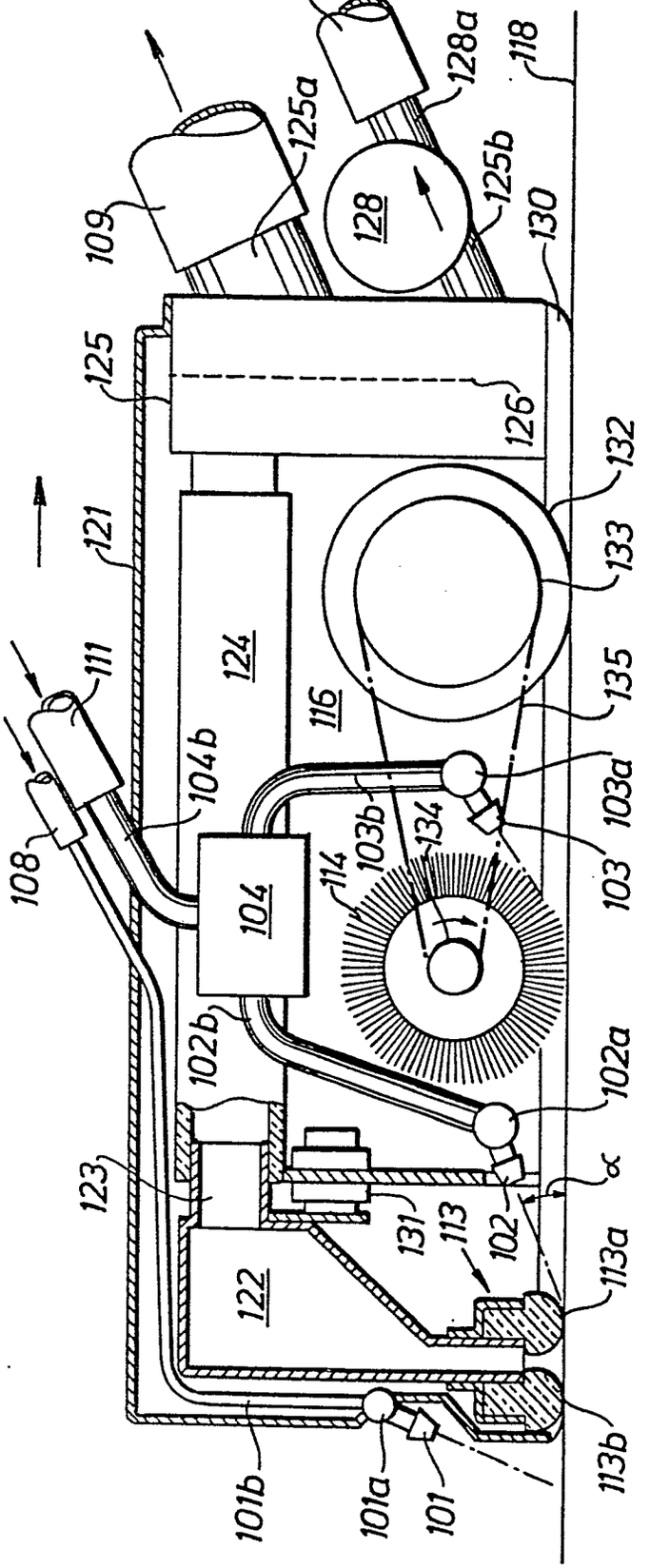
10. An apparatus as claimed in any one of claims 4 to 9, and comprising electrically powered propelling (132) and/or pumping (128) and/or other equipment, c h a r a c t e r -

i s e d in that the electric motors used for driving the equipment in question are adapted to run on alternating current power with a frequency of the order of 100 Hz or higher.

11. An apparatus as claimed in claims 8 and 10, c h a r a c t e r i s e d in that the power and processing unit (Figure 2) comprises a high-frequency electric generator (143) for supplying power to said electrically powered equipment.

12. An apparatus as claimed in any one of the claims 4 to 11, c h a r a c t e r i s e d in that the cleaning head (Figure 1) is closed on all sides except below, the closed space enclosing at least the rinsing nozzles (102) and the region between the rinsing nozzles (102) and the suction mouthpiece (113), preferably also a set of moistening nozzles (101) and a rotary brush (114) situated between the moistening nozzles (101) and the rinsing nozzles (102).

Fig.1


129
128a
118
125a
125b
109
128
130
125
126
132
121
133
111
124
116
135
104b
103a
108
103b
134
114
104
103
102b
102a
123
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113
102
122
113a
101b
101a
101
113b

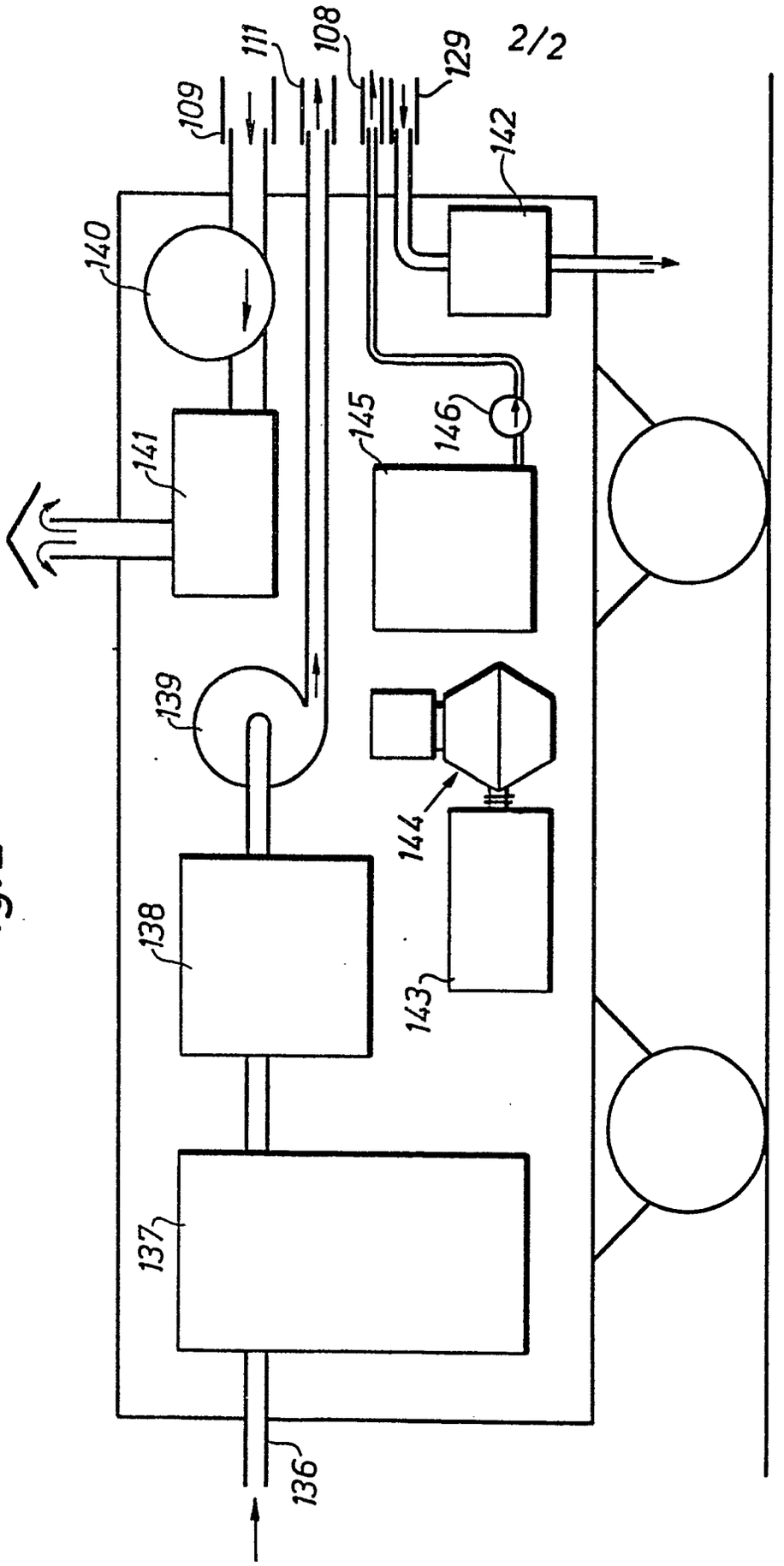


Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 10 7107

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	WO-A-8 100 805 (WETROK, INC.) * Frontpage; pages 3,4; figures 3-7 *	1,4	A 47 L 11/34 A 47 L 11/30
Y	US-A-4 191 590 (SUNDHEIM, J.J.) * Column 2, lines 22-52; column 4, lines 46-54; figures 2,6 *	1,4,9	
A	US-A-3 958 298 (CANNAN, B.M.) * Column 6, lines 7-17; figure 2 *	5-7,9	
A	DE-A-2 904 058 (SIEMENS AG) * Pages 2-4 *	2,3	
A	EP-A-0 032 654 (NOVUM) * Frontpage; figures 1,2 *	1,4,12	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	FR-A-2 400 348 (GENERAL SIGNAL CORP.)		A 47 L
A	US-A-4 308 636 (DAVIS, J.W.)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23-11-1983	MUNZER E.

CATEGORY OF CITED DOCUMENTS

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