(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 April 2004 (15.04.2004)

PCT

(10) International Publication Number
WO 2004/031643 A1

(51) International Patent Classification[7]: F17C 5/00

(21) International Application Number:
PCT/CA2003/001475

(22) International Filing Date: 6 October 2003 (06.10.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/265,096 4 October 2002 (04.10.2002) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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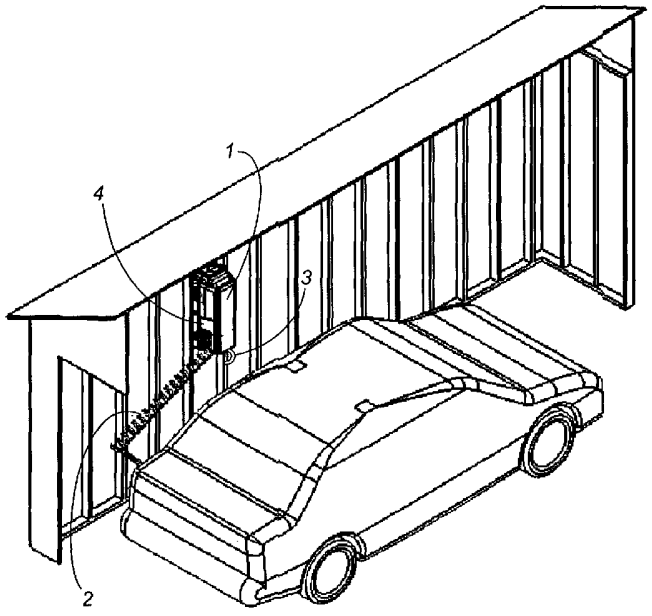
(54) Title: RESIDENTIAL COMPRESSOR FOR REFUELING MOTOR VEHICLES THAT OPERATE ON GASEOUS FUELS



(57) Abstract: A compressor for natural gas is made in a format suitable for mounting on a wall or upright support at a residential location. This permits refilling of the gas reservoir of a gaseous-fueled motor vehicle parked at the residence. The wall-mounted appliance has vibration isolation supports to minimize transmission of noise into the residence. It has a ventilation and air circulation system that allows it to test for the presence of flammable gas both leaking from the appliance and present in the adjacent ambient environment, e.g. a garage.

WO 2004/031643 A1

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE: RESIDENTIAL COMPRESSOR FOR REFUELING MOTOR VEHICLES THAT OPERATE ON GASEOUS FUELS

FIELD OF THE INVENTION

This invention relates to a home refueling appliance for the refueling motor vehicles that operate on gaseous fuels. In particular, it relates to a compressor that delivers high-pressure gas to the storage reservoir of gaseous fuel motor vehicles and monitoring and control elements that allow the appliance to operate in an unattended manner.

BACKGROUND TO THE INVENTION

Motor vehicles that operate on gaseous fuels, typically natural gas and hydrogen are refueled at stations that dispense gas at high pressure, typically 3000 pounds per square inch and higher. These refueling stations are generally of two types. The first type is either a public or private refueling station that is capable of refueling gaseous-fueled motor vehicles in about the same amount of time as is required to refuel a comparable gasoline-fueled motor vehicle.

The second type is a private refueling station that is more typically capable of refueling motor vehicles over a period of several hours, typically overnight.

To date, gaseous-fueled motor vehicles have not been an attractive option to private motor vehicle operators. Public natural gas refueling stations are too few and far between in most areas to meet private motor vehicle operators' expectations for refueling convenience. Private natural gas refueling stations have generally been too expensive to be attractive to private operators of one or two natural gas vehicles. Additionally, existing floor-mounted refueling compressors are bulky and inconvenient to install. Mainly for

these reasons, the market for natural gas vehicles has been largely restricted to motor vehicle fleet operators.

One of the greatest barriers to the commercial introduction of hydrogen-powered motor vehicles is the virtually complete absence of hydrogen refueling stations and related infrastructure such as hydrogen production and transportation facilities. It will be several years before even limited hydrogen refueling infrastructure is available.

A need exists for a home refueling appliance to compress gas for refueling motor vehicles that is simple to install, operates with reduced noise and vibration levels that are comparable to other residential appliances, and which can be operated safely by untrained users. Such a system should be suitable for use in residences or other locations that have a standard electrical service and have natural gas service, a source of hydrogen, such as either a water electrolyser or natural gas reformer, or a source of another type of gaseous fuel. Preferably, such a home refueling appliance should have the capacity to fill the fuel reservoir of a typical gaseous fuel light duty vehicle in five to eight hours. It is also desireable that such a unit be conveniently mounted at a position that will to protect it from damage. The present invention addresses all of these objectives.

During start-up and normal operation of a home refueling appliance vibration is generated by the reciprocating movement of the compressor pistons and by the rotating mass of the shaft that drives the pistons. The reciprocating and rotating masses are dynamically unbalanced, which results in a dominant low frequency vibration of about 10 to 15 hertz during start-up and low speed operation; and a dominant high frequency vibration of up to about 30 to 35 hertz occurring during normal operation. The primary modes of

vibration arise from reciprocating forces in a vertical plane and rotational reciprocating moments around an axis passing approximately through the center of mass of the motor/compressor assembly, as well as torsional forces caused by variations in gas pressure.

A need exists for minimizing the transmission of vibrations from the appliance to the structure that provides support.

Gas leaks can occur both from within a compressor unit and from outside a compressor unit, for example at the connection to the vehicle, or arising from the vehicle itself. It is important to detect gas leaks when they arise from either source. Gas leak sensors have been individually built into compressors, and mounted within structures to provide environmental leak detection. However, an opportunity exists with respect to the present invention to combine both functions. The present invention addresses that objective.

It is recognized that, if a gas supply line to a compressor becomes disconnected, air may be drawn into the compressor. As this air will mix with gas, it may form an explosive mixture. Thus it is an established practice to provide a gas sensing means for detecting the absence of gas pressure in the supply line that should be connected to a gas source.

Additionally, the inlet pressure from a domestic natural gas main is typically about 0.2 to 0.5 psi. This gas pressure may be needed to sustain pilot lights operating within a nearby residence. If the main gas supply system drops to a lower level, the added burden of the home refueling appliance may cause such pilot lights to go out. Consequently, to protect against the consumption of gas by an

appliance when this will expose neighbouring appliances to the risk of having their pilot lights extinguished.

The invention in its general form will first be described, and then its implementation in terms of specific embodiments will be detailed with reference to the drawings following hereafter. These embodiments are intended to demonstrate the principle of the invention, and the manner of its implementation. The invention in its broadest and more specific forms will then be further described, and defined, in each of the individual claims, which conclude this Specification.

SUMMARY OF THE INVENTION

The invention relates to a wall-mounted gas compressor, and more particularly an appliance for refueling gaseous fuel motor vehicles while they are parked at a residence or other location where a vertical wall or upright support is available, such as may be present in a garage or carport. According to one aspect, the invention applies in respect of an appliance having:

a) a housing containing a multi-stage gas compressor driven by an electric motor;

b) an electrical connection means to supply power to the motor;

c) a gas inlet on the appliance to connect the unit to a source of gas;

d) a gas outlet on the appliance for delivery of compressed gas to a gas storage reservoir, and

e) monitoring and control elements that allow the appliance to operate in an unattended manner.

The home refueling appliance variant of the invention is preferably designed to be mounted either on a wall, a post support member or other structure at about eye level. The unit is to be mounted preferably at least 36 inches above the ground, and more preferably, above the height of the hood of a standard passenger vehicle, e.g. above 48 inches from the ground. This is to ensure that the appliance is clear of any areas were it might be run into by a moving object, such as a motor vehicle. This avoids the cost of vehicle impact protection such as bollards and other barriers.

The appliance can be wall-mounted either between wall studs, or flush against a flat wall through mounting brackets that are fastened to the upright support. Alternatively, the appliance can be post mounted on, for example, a carport post or a freestanding post, either indoors or outdoors, again through mounting brackets as required. A spirally formatted discharge hose may be provided that retracts when not extended for use.

Preferably, the electric motor and compressor are combined in a single assembly that is mounted in a housing. This assembly is fitted to the housing through first vibration isolators that dampen vibrations. The housing itself is additionally mounted to its upright support means through second vibration isolators that further dampen vibration. Thus the home refueling appliance of the invention is preferably fitted with two stages of vibration absorption: vibration isolators that reduce the transmission of vibrations from the motor/compressor assembly into the housing and further, vibration isolators that reduce the transmission of vibrations through the mounting brackets of the housing into

the wall, post or other upright support to which the unit is attached.

This particularly allows the appliance to be mounted on walls as a support structure, making it more practical to mount the appliance on the wall of a garage adjacent to living quarters, since the amount of vibration and noise that is transmitted to the living quarters is reduced.

The outer housing, according to the invention, is mounted on a wall through a novel system of angled, rubber or rubber-like, e.g., flexible, polymeric, cushioning washers. Because the motor/compressor assembly is mounted on a wall surface or equivalent, with its back face to the wall, its weight tends to develop a twisting moment that would cause the unit to rotate away from the wall if it were released from its top end. If the unit were mounted on rubber cushioning washers that were oriented with their axes in a vertical alignment then, because of this torque effect, a shearing force would be applied to these washers. As these washers are intentionally very soft and of considerable thickness in order to absorb vibration, e.g., of a thickness that approaches their width, the presence of such a shearing force would be very undesirable.

Thus, according to the invention, the rubber cushioning washers are set at an inclined angle that eliminates or minimizes the shearing force on such washers. At the top of the unit, this means angling the upper portion of the axes of the washers away from the mounted unit, towards the direction of the wall or support structure, preferably by an angle of about 20° to 40°, such angle being based on the weight and geometry of the unit. At the bottom of the unit, the upper portions of the axes of the washers are angled away

from the wall and towards the unit by a similar angle or optionally differing angle. By mounting such vibration-reducing washers so as to minimize shear forces, they are able to more effectively provide vibrational isolation between the wall-mounted motor/compressor appliance and the wall surface against which it is mounted.

A further stage of vibration isolation is provided in the fittings through which the motor/compressor assembly is mounted in the housing. These fittings preferably comprise flexible polymeric, e.g. rubber, mounts that are located on either side of a horizontal plane passing approximately through and preferably slightly above the center of mass or rotation of the motor/compressor assembly. This arrangement allows the reciprocating movements within the assembly to tend to induce a rocking motion about an axis formed by a straight line extending between the mounts. A damping means may also be included between the motor/compressor assembly and the housing to absorb energy arising from such rocking vibrations. This damper may be located between the body of the motor/compressor assembly and any portion of the housing or may be located beneath the assembly. A preferred location is at the top or base of the motor/compress assembly where motion is greatest.

In a preferred variant this damper means includes a resilient, flexible, rubber-like member in the approximate shape of a finger extending from the motor/compressor casing downward into a socket or receiving means on the bottom, inside surface of the housing. The finger and receiving means act as a damping pot. The damper means may also be based on a rigid extension from the motor/compressor assembly extending into a flexible receiving means, e.g. a resilient rubber tube

mounted on the casing. As the appliance rocks about the axis extending between the mounts, this motion is resisted by the resilient, element to dampen the vibration caused by the rotational reciprocating moments of the compressor/motor assembly.

In this manner, using two vibration isolations positioned in series, a highly effective reduction in the transmission of vibrations from the appliance to its support structure is achieved.

The invention optionally but preferably includes a cooling and ventilation system for the appliance that serves as well to detect the leakage of gas both from within the unit and from within the environment around the unit. This system incorporates with the housing of the unit an air inlet, a fan and an air outlet to provide an air circulation zone around the motor/compressor assembly for cooling and ventilation. A flammable gas sensor is then mounted in the airflow path, preferably near the top of the appliance with circulating air entering from the bottom of the appliance. This sensor is positioned to sample air that has passed by the compressor, providing an indication if gas leakage should arise from within the unit.

By mounting the appliance at an elevated level on a wall or elevated support structure, the fan will tend to circulate air from the upper region of the adjacent environmental space, e.g. the top half of a room such as a garage. Since natural gas, hydrogen and many other flammable gases are typically lighter than air, any concentrations of such lighter than air flammable gases in the adjacent space will be found in the higher elevations of the space. Due to the circulation of air created by the ventilation system,

mixing will be induced and any flammable gas present in the room will tend to be drawn into the appliance.

The flammable gas sensor will then detect not only gas that has escaped from the compressor, but also gas that has escaped in the local environment, for example, from an adjacent, parked motor vehicle. Thus both machine gas and room gas may be sampled by a single flammable gas sensor.

An airflow sensor may also be placed in the path of the re-circulating air, preferably at the base of the housing. Such a sensor may be coupled to the control system for the appliance, ensuring that the appliance will be shut off if, for some reason, there is an interruption in the flow of ventilation and cooling air.

Optionally, the ventilation exhaust may be either re-circulated within the adjacent space or directed outdoors, as through a wall-penetrating duct connected to the air outlet of the appliance.

To prevent the introduction of air into the motor vehicle reservoir arising from the disconnection of the inlet hose of the unit from its gas source, the appliance will normally incorporate an input line pressure sensing means that detects the absence of pressure arising from the decoupling of the input connector from the gas line. This gas sensing means combined with processing circuitry, as is previously known, provides a signal for the appliance to be shut off when it senses the absence of source gas pressure. Consequently, if the inlet hose is disconnected, the appliance will not inadvertently introduce compressed air into the motor vehicle's fuel reservoir.

This pressure sensing system, according to the invention, also operates by sensing when the pressure of the

inlet gas falls below a settable, threshold pressure level that is above zero, for example, 0.2 psi. Under such conditions operation of the appliance is suspended.

Thus the system of the invention protects against the risk of having the compressor system of the invention interfere with neighbouring appliances.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a pictorial representation of a gaseous fuel motor vehicle parked in a garage having a home refueling appliance according to the invention mounted on its inner wall.

Figure 2 is an end view of Figure 1 showing air circulation around a vehicle parked in the garage.

Figure 3 is a face view of the appliance of Figure 1 exposing the front face of the inner housing that serves as a shroud or cowling covering and containing the compressor and motor assembly in combination with the back panel of the outer housing.

Figure 4 is a face view of the compressor and motor assembly with the inner cowling removed showing the two side mounts by which the assembly is connected to the housing and showing the ventilation fan and ventilation air flow path.

Figure 5 is a perspective view of the outer housing taken from a rear, wall-side position showing its wall-mounting frame.

Figure 6 is a perspective view of the frame of Figure 5 by itself.

Figure 7 is an exploded assembly perspective view of the rear panel of the outer housing and frame positioned for attachment to two horizontal brackets.

Figure 8 is the view of Figure 7 with the referenced components assembled.

Figure 9 is a partial, cross-sectional side view of the assembly of Figure 5 showing angled upper and lower resilient supports between the frame and the outer housing.

Figure 10A is a detailed side view of the upper support of Figure 9.

Figure 10B is a detailed side view of the lower support of Figure 9.

Figure 11 is a schematic depiction of the principal components of the appliance, including the unitary motor/compressor assembly, blow down volume, control circuits and other support elements including various sensors.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figure 1 the home refueling appliance 1 is shown mounted on a garage wall with the high-pressure discharge hose 2 connected to a car, the inlet hose 3 connected to a source of gas, and the electrical cord 4 plugged into a standard household receptacle.

In Figure 2 the circulation of air 60 caused by the ventilation fan in the appliance 1 within the garage is depicted. Because the appliance 1 is mounted at an elevated position on the garage wall 61, this circulation includes air from the upper region 62 of the garage.

Figure 3 is a face view of the appliance in its outer housing 7 mounted between wall studs 5 with the front access cover 6 open to expose the inner ventilation housing which serves as a shroud or cowling 22. The high-pressure discharge hose 2 is in its fully retracted position. Air inlet vents 13 are located at the bottom of the front access

cover 6, beneath the motor/compressor assembly 32. An air outlet 36 is mounted at the top of the unit. Gas source 3 and gas delivery 2 lines are also connected to the unit.

Referring to Figures 3 and 4, a front cowling 22 that serves as part of a shroud is attached to the back panel of the outer housing 7 by screws 23. The back panel of the outer housing 7 and the cowling 22 form a ventilation enclosure for the compressor 29, the compressor motor 30 and the blow-down volume 31, all of which are within a common case and constitute the motor/compressor assembly 32. The ventilation fan 32A and ancillary components are also shown in Figure 4. The ventilation fan 32A draws cooling air in through the inlet vents 13, past the air flow sensor 34, and circulates the air over the motor/compressor assembly 32, as well as other components within the enclosure formed by the back panel of the outer housing 7 and the cowling 22.

Air on leaving this ventilation enclosure passes by the flammable gas sensor 35, shown in Figure 4 and out through the air outlet 36. All sensors are connected to a central computer-circuit based main logic controller 11, as shown by the connections in Figure 7. If the air flow sensor 34 indicates that the cooling air flow is below a pre-set minimum limit e.g., if there is an interruption in the flow of ventilation and cooling air; or if the flammable gas sensor 35 detects the presence of a flammable gas in the cooling air, the central logic controller 11 ensures that the appliance 1 will not start up if it is already shut down; or will shut down if it is running.

By mounting the appliance at an elevated level on a wall or elevated support structure, the fan 32A will tend to circulate air from the upper region of the adjacent

environmental space, which may contain lighter than air flammable gases in the adjacent space. Due to the circulation of air created by the ventilation system, such flammable gas will tend to be drawn into the appliance. The flammable gas sensor 35 will then detect not only gas that has escaped from the compressor 29, but also gas that has escaped in the local environment.

The motor/compressor assembly 32 in casing 12 is secured to the back panel of the outer housing 7 by two vibration-limiting polymeric side mounts 37, shown in Figure 4. The casing 12 is further connected to a polymeric damper 39, shown in Figures 4. The side mounts 37 are located slightly above the approximate center of rotation or mass of the motor/compressor assembly 32, along a horizontal line that passes preferably along a horizontal plane that passes approximately just above such center. This arrangement allows the reciprocating movements within the assembly to tend to induce a rocking motion about an axis formed by a straight line extending between the mounts. The two polymeric side mounts 37 and the polymeric damper 39 suppress the transmission of vibration from the motor/compressor assembly 32 to the outer housing 7.

In a preferred variant the damper means 39 is in the form of a finger-like protrusion that extends into socket 39 mounted on the housing 7 that acts as a damping pot. As the appliance rocks about the axis extending between the side mounts 37, this motion is resisted by the resilient, socket-like fitting 39 to dampen the vibration caused by the rotational reciprocating moments of the compressor/motor assembly 32.

The outer housing 7 as shown in Figure 5 itself is

provided with mounting hardware which includes a frame 49 with two notched mounting bars 50 for mounting onto a lower mounting bracket 16, and an upper mounting bracket 19 as in Figures 7, 8. These brackets 16, 17 are fastened to the support structure. The outer housing 7, is mounted to the frame 51 through a novel system of angled, rubber or rubber-like, cushioning washers 53.

The rubber cushioning washers 53 as shown in Figures 9, 10A, 10B are set at an inclined angle that eliminates or minimizes the shearing force on such washers. At the top of the unit, this means angling the top portion of the axes 54 of the washers 53 away from the mounted unit, towards the direction of the wall, by an angle of about 30°, such angle being based on the weight and geometry of the unit. At the bottom of the unit, the top portion of the axes 55 of the washers 53 are angled away from the wall and towards the unit by an angle of about 45°. The angles of these respective cushioning washer 53 may differ in accordance with the location of the center of mass which they support. By mounting such vibration-reducing washers 53 at an angle, a more effective vibrational isolation is provided between the wall-mounted motor/compressor appliance and the surface against which it is mounted.

The notches 56 in the bars 50 of Figure 6 engage with tapered indentations 57 along the faces of brackets 16, 19. This permits the mounting of the appliance at its elevated location by the simple procedure of lifting the unit to align the notches 56 with the indentations 57 and advancing these elements into engagement. Angled sides on the indentations 57 reduce the accuracy demanded for carrying-out this "docking" procedure.

A latch or tether 58 may also be included as fastening security means to fix the engagement of the unit to the brackets 16, 19 These components provide security in the event of seismic disruptions i.e. earthquakes.

To prevent the introduction of air into the motor vehicle reservoir arising from the disconnection of the inlet hose 3 of the unit from its gas source, the appliance will normally incorporate an input line pressure sensing means 40 that detects the absence of pressure arising from the decoupling of the input connector from the source gas line 3. This gas sensing means 40 combined with processing circuitry, as is previously known, provides a signal for the appliance to be shut off when it senses the absence of source gas pressure. Consequently, if the inlet hose 3 is disconnected, the appliance will not inadvertently introduce compressed air into the motor vehicle's fuel reservoir.

This pressure sensing system, according to the invention, also operates by sensing when the pressure of the inlet gas falls below a settable, threshold pressure level that is above zero, for example, 0.2 psi. Under such conditions operation of the appliance is suspended. Thus the system of the invention protects against the risk of having the compressor system of the invention interfere with neighbouring appliances.

Referring to Figure 11, an inlet gas pressure sensor 40 for sensing the pressure of gas arriving from inlet line 3 is connected electrically to the main logic controller 11. If the inlet gas pressure sensor 40 sends a signal to controller 11 that a source gas pressure condition below a pre-set limit is being sensed, the controller 11 ensures that the appliance 1 will not start up if it is already shut down; or will shut

it down if it is running. The threshold pressure for such a shut-down is settable in order to allow the appliance to accommodate the requirements of different locations, e.g. in accordance with local line gas pressures or local regulations.

Referring to Figure 11, the motor controller circuitry 22 is located within the casing 12, in the blow-down volume 31. The wall of the casing 12 acts as heat sink for the heat produced by the motor controller circuitry 41 and as a shield for incoming and outgoing electromagnetic emissions.

As shown in Figure 11, the main logic controller 11 is connected to receive signals from air flow sensor 34, flammable gas sensor 35, source gas pressure sensor 40 as well as from the manual inputs on the control and display panel 15 and other sources such as the high pressure outlet gas sensor 43. The main logic controller 11 is able to activate the motor 30 and govern its speed through motor controller 22 providing low speed on start-up, high speed during initial compression and reduced speed during final compression.

On start-up, low motor speeds are adopted to reduce otherwise high start-up current drains on the electrical supply system. This enables the unit to operate off of a standard household voltage, e.g. 110-120 volt, moderately fused electrical supply system. After start-up, initial compression can be effected with a high motor speed. Once higher pressures have been established in the motor vehicle fuel reservoir by the final output stage of the compressor system, according to the invention motor speed is reduced in order to moderate ring wear and limit power consumption. This procedure is especially suited to oil-less compressors as the wear rate of the sealing rings within the compressor cylinders of such units increases when the compressor system is operated

at high speed against a high-back pressure.

According to the invention the speed of the electric motor is also controlled to avoid natural resonant frequencies arising from its mechanical components that would otherwise increase the noise and vibration generated by the unit.

CONCLUSION

The foregoing has constituted a description of specific embodiments showing how the invention may be applied and put into use. These embodiments are only exemplary. The invention in its broadest, and more specific aspects, is further described and defined in the claims which now follow.

These claims, and the language used therein, are to be understood in terms of the variants of the invention which have been described. They are not to be restricted to such variants, but are to be read as covering the full scope of the invention as is implicit within the invention and the disclosure that has been provided herein.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An appliance for refueling gaseous fuel motor vehicles while they are parked at a residence or other location where an upright support is available, comprising:

a) a housing containing a motor/compressor assembly in the form of a multi-stage gas compressor and an electric motor that drives the multistage compressor, said compressor and motor being contained in a common, sealed casing;

b) an electrical connection means to supply power to the motor

c) a gas inlet on the appliance to connect the unit to a source of gas;

d) a gas outlet for delivery of compressed gas to a fuel storage reservoir, and

e) monitoring and control elements that allow the appliance to operate in an unattended manner.

wherein said appliance is provided with means to allow the appliance to be mounted on said upright support at a height that is above 36 inches from the ground.

2. An appliance as in claim 1 comprising vibration isolation means positioned to reduce the transmission of vibrations arising from the motor assembly into the upright support.

3. An appliance as in claim 2 wherein the vibration isolation means comprises first and second vibration isolation means located in series between the motor assembly and the upright support.

4. An appliance as in claim 1 wherein the vibration isolation means comprises first vibration isolation means to reduce the transmission of vibrations arising from the motor assembly into the housing, said first isolation means comprising flexible polymeric mounts positioned on either side of a horizontal plane passing approximately through the center of mass of the motor/compressor assembly, along an axis formed by a straight line extending between the mounts and through said horizontal plane, to secure the motor/compressor assembly to the housing.

5. An appliance as in claim 4 comprising a damper means extending between the motor/compressor assembly and the housing to absorb vibrational energy arising from motion of the motor/compressor assembly about said axis.

6. An appliance as in any one of claims 2, 4 or 5 wherein the vibration isolation means comprises second vibration isolation means to reduce the transmission of vibrations from the appliance housing to said upright support, said second vibration isolation comprising a plurality of flexible polymeric washers that are placed between the housing and upright support.

7. An appliance as in claim 6 wherein each of said flexible, polymeric washers are set at an inclined angle that eliminates or minimizes the shearing force on such washers.

8. An appliance as in claim 7 wherein each of said flexible, polymeric washers has a width, a length, a central

axis and a mounting hole formed along its central axis, said length being approximately equal to said width.

9. An appliance as in claim 7 wherein housing 7 itself is provided with mounting hardware which includes a frame with two notched mounting bars for mounting onto mounting brackets positioned on the support structure, each of said flexible, polymeric washers being located between said frame and said brackets.

10. An appliance as in claim 9 wherein said brackets comprise tapered indentations to receive said notches, whereby the mounting of the appliance on said brackets may be effected by lifting the appliance with its frame to align the notches with the indentations 57 and advancing these elements into engagement.

11. An appliance as in claim 109 comprising a latch or tether extending between the frame or housing and at least one of said brackets to provide security in the event of a seismic disruption.

12. An appliance for refueling gaseous fuel motor vehicles while they are parked at a residence or other location where an upright support is available, comprising:

a) a housing containing a motor/compressor assembly in the form of a multi-stage gas compressor and an electric motor that drives the multistage compressor, said compressor and motor being contained in a common, sealed casing;

b) an electrical connection means to supply power to the motor

c) a gas inlet on the appliance to connect the unit to a source of gas;

d) a gas outlet for delivery of compressed gas to a fuel storage reservoir, and

e) means to allow the appliance to be mounted on said upright support

and further comprising as a ventilation system :

f) an air inlet, a fan and an air outlet in the housing to provide an air circulation zone around the motor/compressor assembly; and

g) a flammable gas sensor is positioned proximate to the air outlet to detect flammable gas passing through the ventilation system,

whereby, when the appliance is mounted on said support means with said support means elevated above the ground by at least 48 inches, the fan will draw air from the adjacent environmental space and the flammable gas sensor will detect flammable gas that has either escaped from the motor/compressor assembly or is present in the adjacent environmental space.

13. An appliance as in claim 12 comprising a cowling mounted over the motor/compressor assembly to confine the air circulation zone around said motor/compressor assembly.

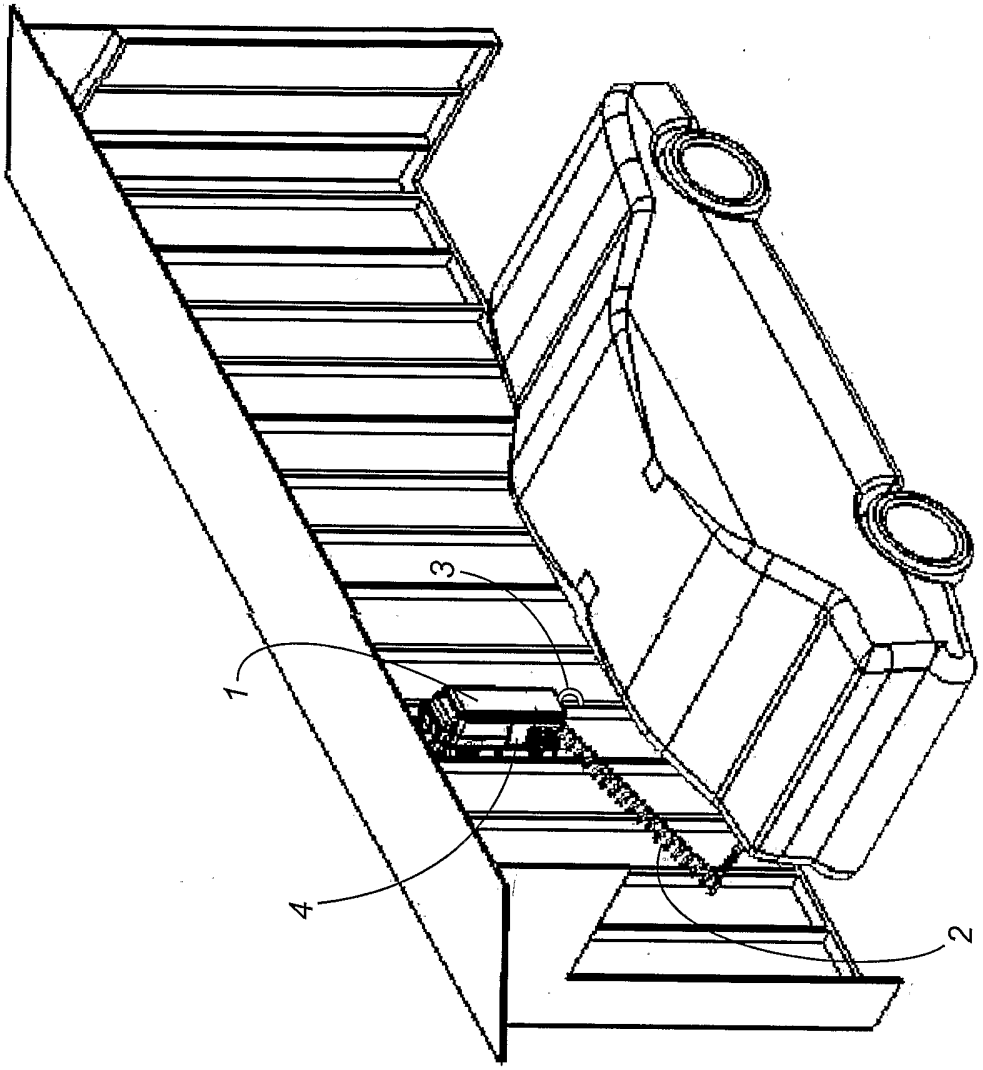


FIG. 1

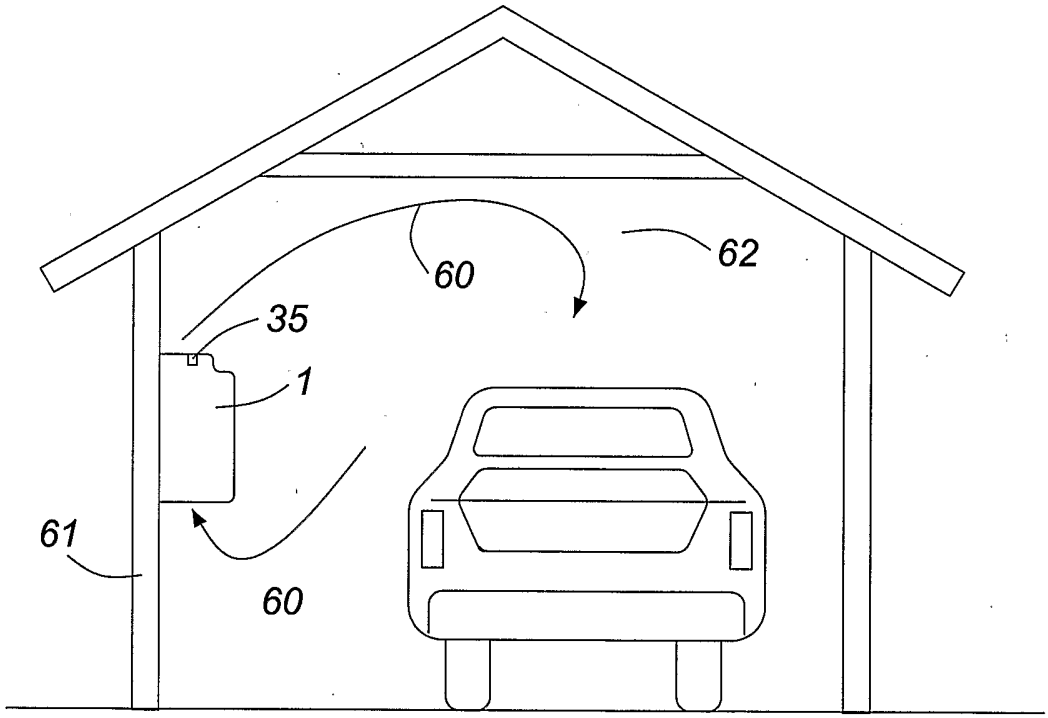


FIG. 2

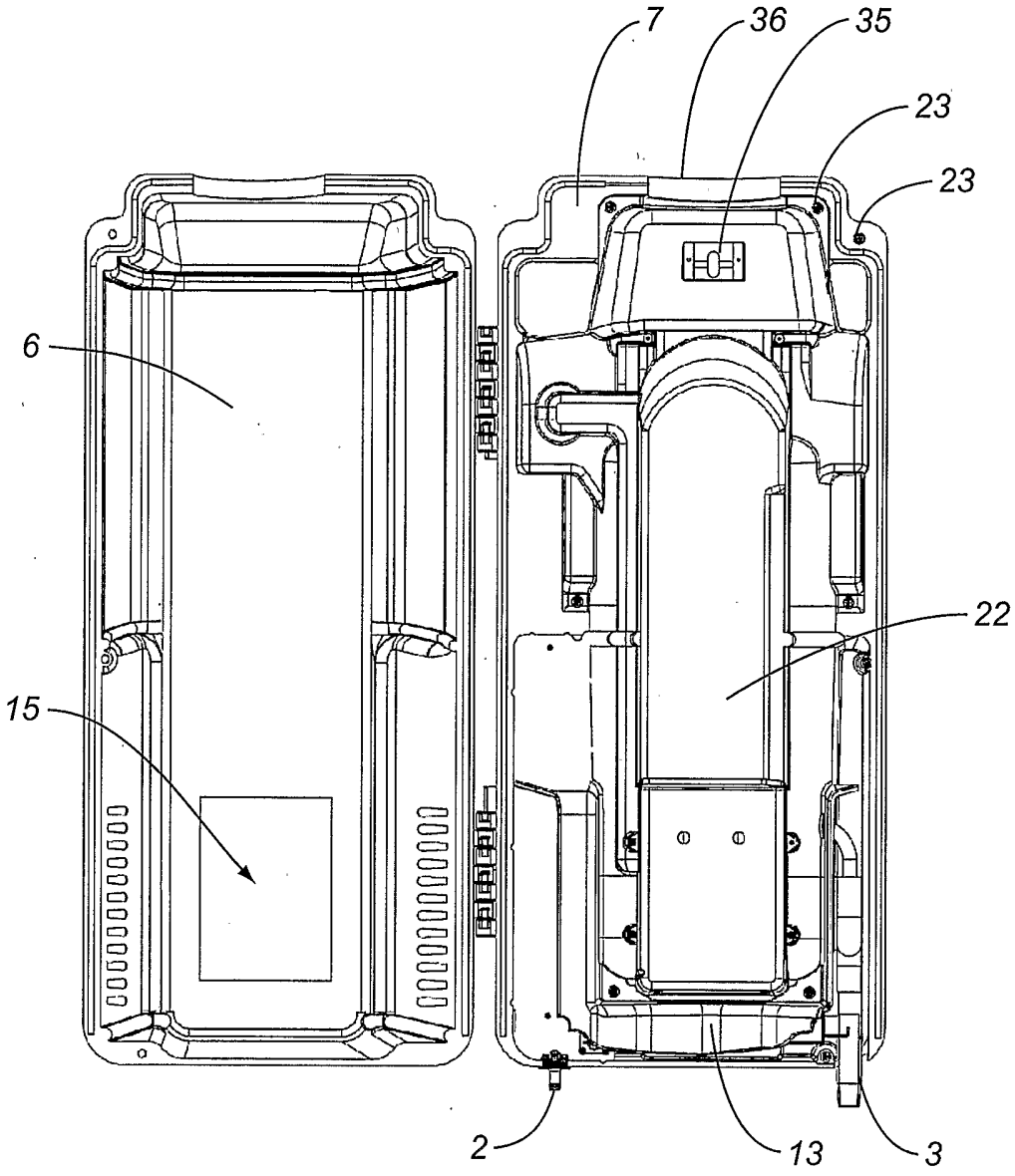


FIG. 3

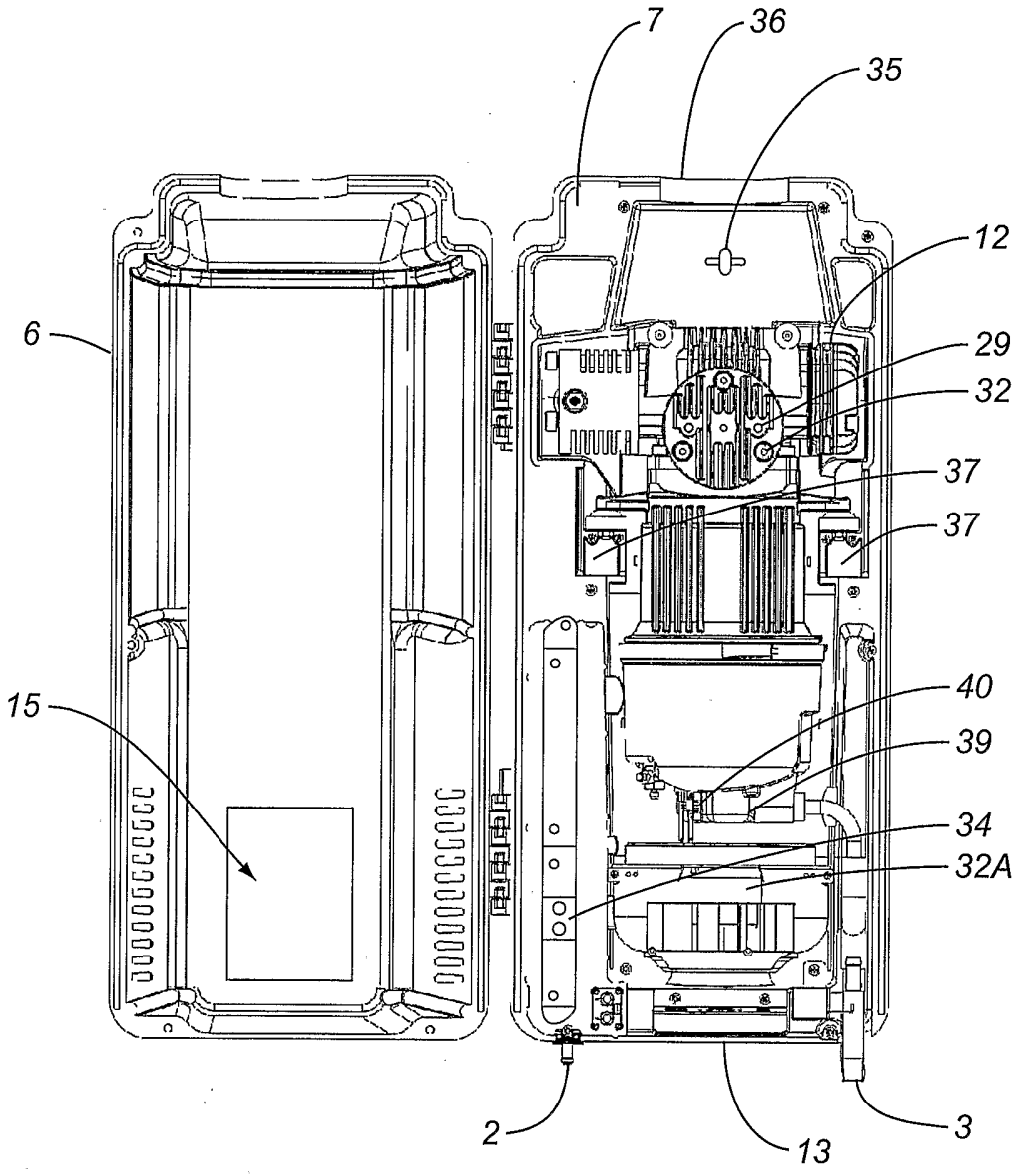


FIG. 4

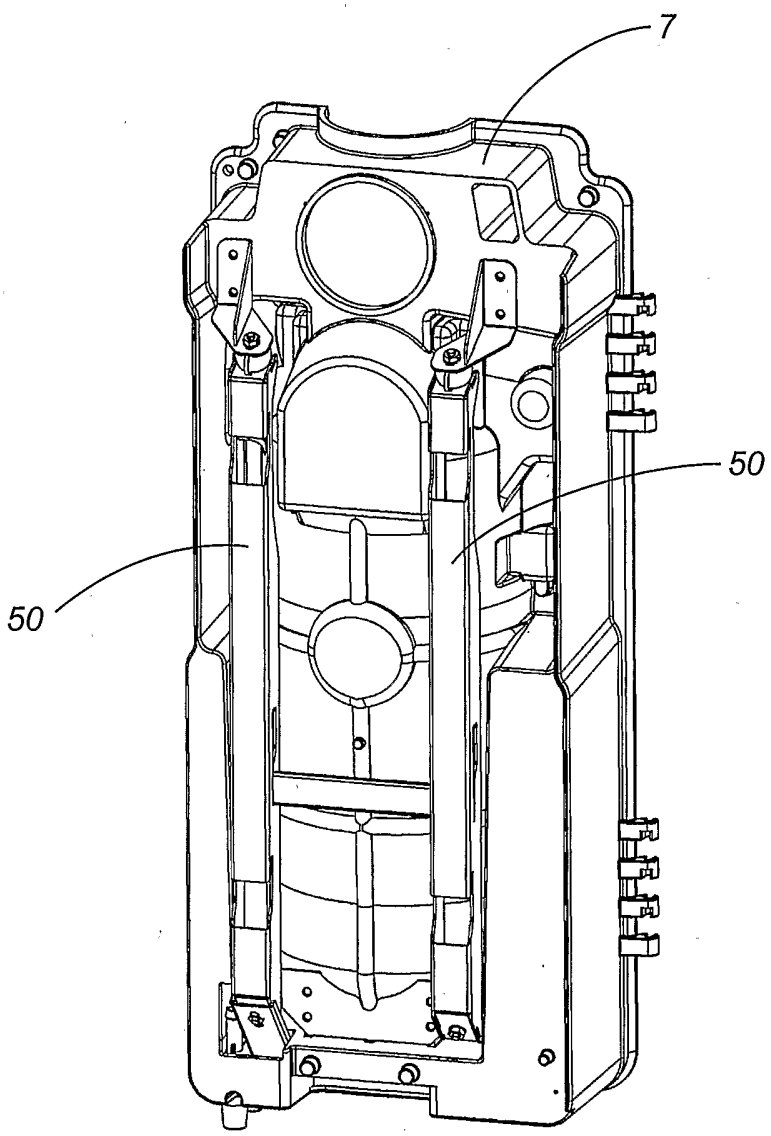


FIG. 5

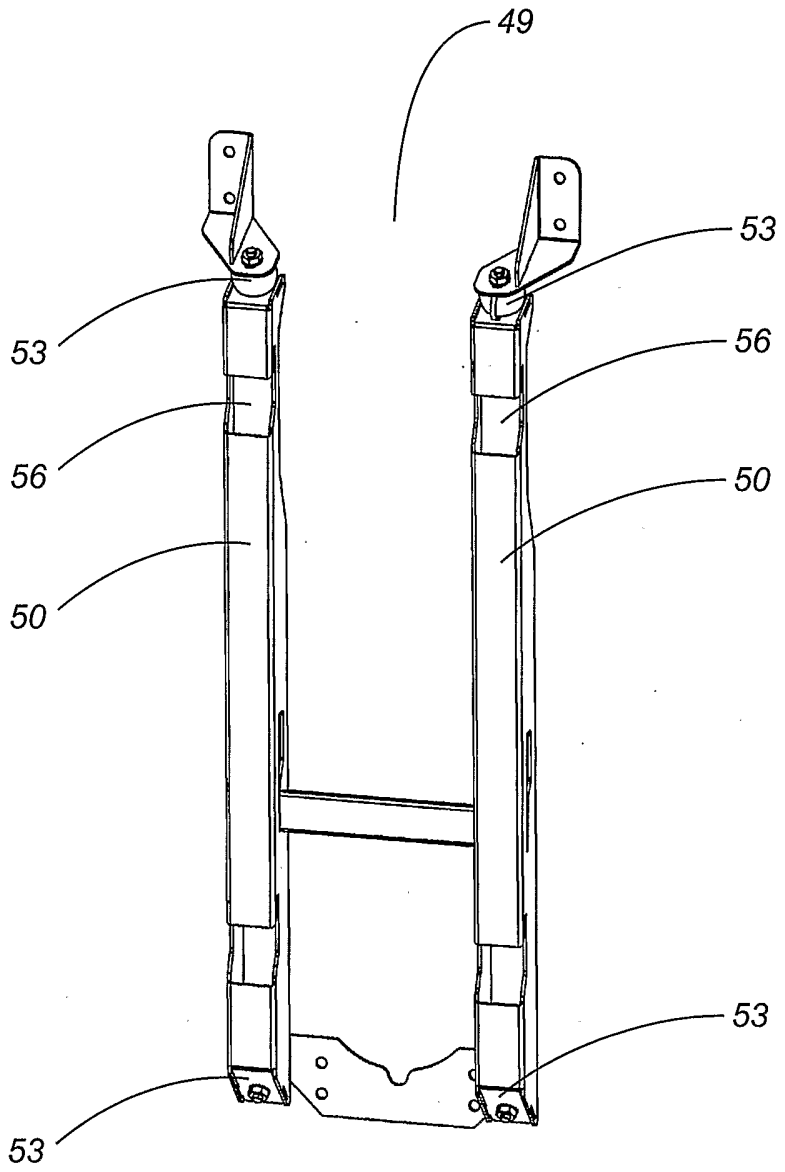


FIG. 6

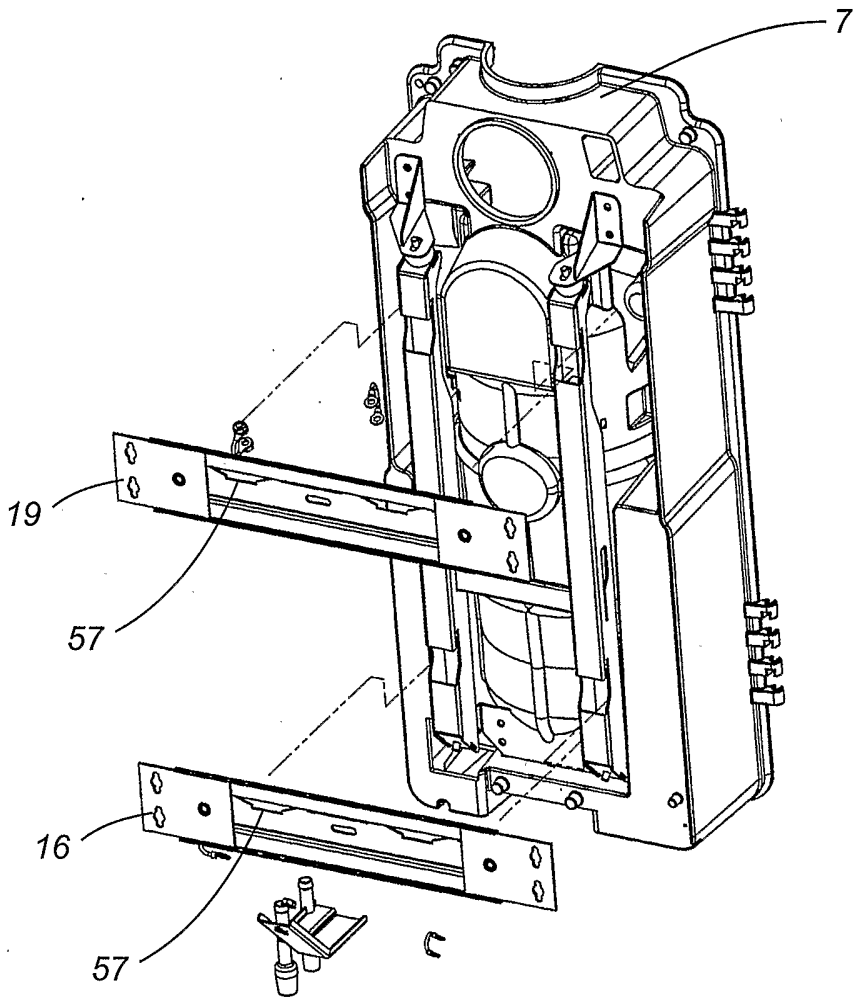


FIG. 7

FIG. 9

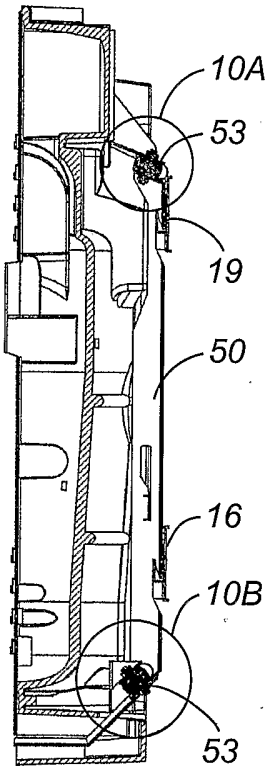


FIG. 10A

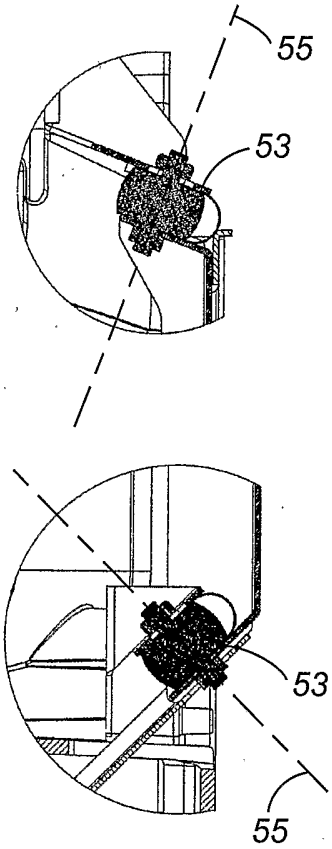


FIG. 8

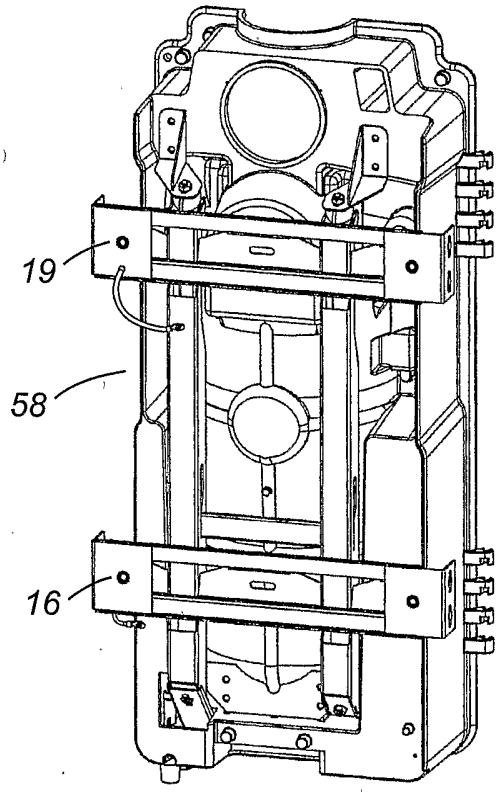


FIG. 10B

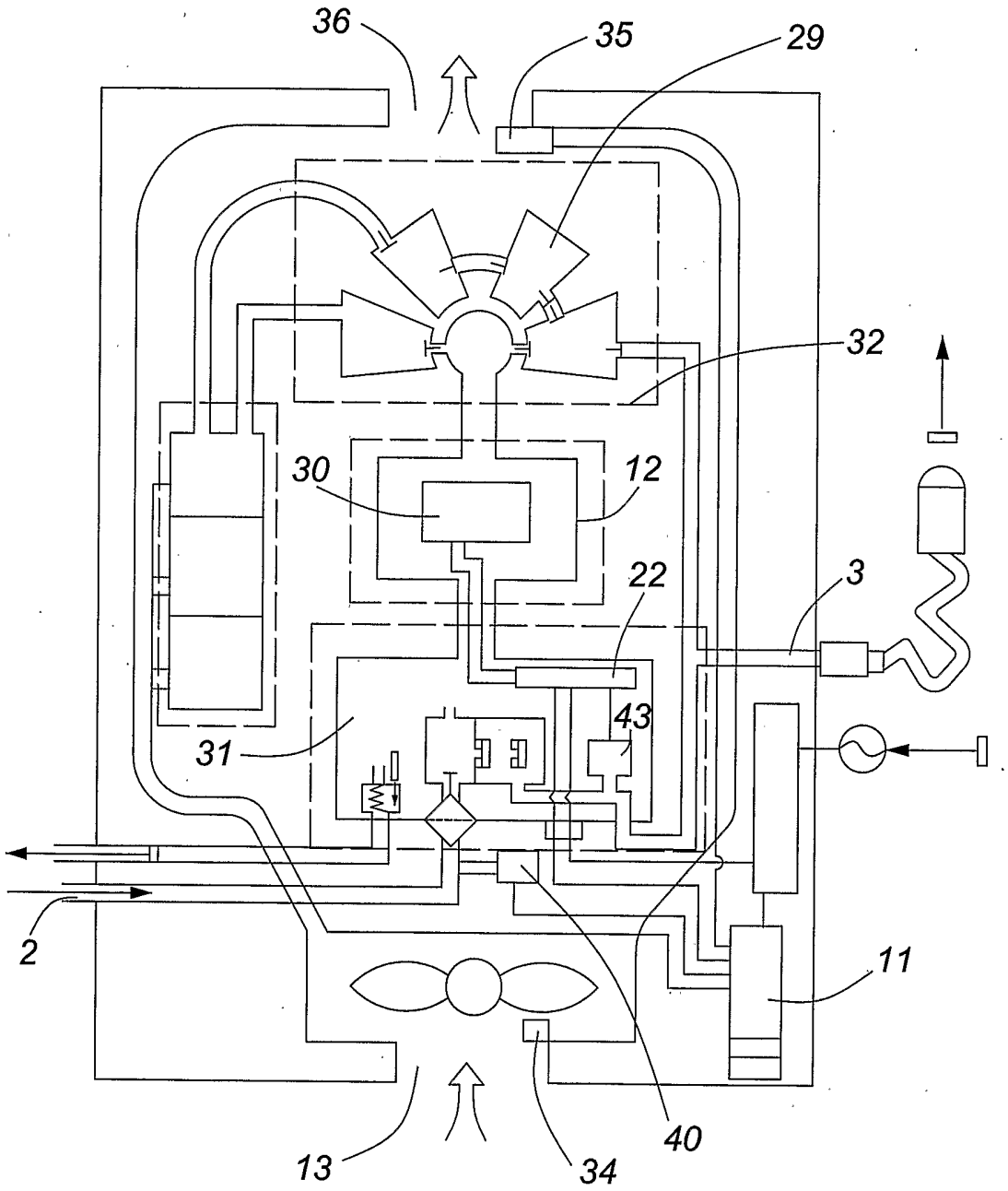


FIG. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 03/01475

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F17C5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F17C B60S B67D F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CH 676 951 A (SULZER AG) 28 March 1991 (1991-03-28) abstract column 1, line 1-9,17,27-29,43-45,52-54,65 column 2, line 10,39 ---	1-6,12, 13
Y	DE 198 59 423 C (HERMANN HEINZ BURGER GAS UND W) 20 April 2000 (2000-04-20) column 1, line 9-11,60-68 column 2, line 5,6,13,26,27,36,37 --- -/--	1-6,12, 13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 January 2004	17/02/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ott, T

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 03/01475

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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