



⑮ Federal Republic of
Germany



GERMAN PATENT
OFFICE

⑫ **Utility model**
⑩ **DE 296 22 089 U 1**

⑤① Int. Cl.⁶:
B 64 F 1/36
F 24 F 1/04

⑳ File no.: 296 22 089.2
㉔ Application date: 12/ 19/ 1996
㉕ Date of registration: 04/ 09/ 1998
㉗ Publication in the Patent
Bulletin (Patentblatt): 05/ 20/ 1998

DE 296 22 089 U 1

⑦③ Owner:
Lechmotoren GmbH, 86972 Altenstadt, DE

⑦④ Representative:
Ernicke und Kollegen, 86153 Augsburg

⑤⑥ Search results according to § 7 para. 2 of the Utility Model
Act (*Gebrauchsmustergesetz*, **GbmG**):

DE	33 14 763 C2
GB	20 05 819 A
US	29 29 223

⑤④ Air conditioning unit

DE 296 22 089 U 1

AB1

DE-G 296 22 089.2

Note: Lechmotoren GmbH

File: 898-10 er/sw

03/05/1998

5

DESCRIPTION

Air conditioning unit

10 The invention relates to an air conditioning unit for air conditioning, in particular heating, of aircrafts on the ground, having the features in the generic part of the main claim.

15 Such an air conditioning unit is known from practical experience. It consists of an electric heating unit with an air circulation device that blows warm air into the aircraft cabin to bring the aircraft to a comfortable temperature and heat it up before and
20 during the arrival of passengers. The familiar air conditioning unit works with a normal 50 Hz current, which is available at various points at the aircraft parking spaces. The disadvantage of the well-known air conditioning unit is that it takes a relatively
25 long time to heat the aircraft, and this is associated with considerable costs.

GB 2 005 819 A shows a different air conditioning unit in the form of a mobile cooling device for
30 general purposes. The unit has an electrical power supply with a voltage of 230 V or 400 V in conjunction with a mains frequency of 50 Hz.

Another air conditioning unit is known from DE 33 14
35 763 C2. It works with a combustion engine that drives compressors for the cooling device and hydrostatic pumps. The heating energy is obtained from the waste heat of the engine.

Finally, US patent A-2,929,223 shows a mobile air conditioning unit with a cooling device for generating cold air. This unit also works with a combustion engine or an electric motor that is powered by an unspecified power. The area of application of the unit is not specified in more detail.

In practice, there are also electric air conditioning units that have a built-in diesel-powered generator. Other variants have an oil or gas burner. They have the same problems and disadvantages as the aforementioned state of the art, with the additional problem of exhaust and environmental pollution.

It is therefore the purpose of the present invention to demonstrate a better air conditioning unit.

The invention solves this problem with the features in the main claim.

The electrically operated air conditioning unit according to the invention is designed for a power supply of 400 Hz. This has the advantage that a power supply can be used which is required for many types of aircraft anyway.

(continued on page 2 of the original description)

35

and is available at airfields. The 400 Hz power supply enables the air circulation device, in particular the fan used for this purpose, to achieve higher speeds and outputs without mechanical transmission and without any other additional constructional effort. There are also advantages for the air-conditioning pack. Overall, the air conditioning unit has a higher air conditioning output and can bring a larger volume of air into the aircraft, even at a higher dynamic pressure. This means that it takes much less time to air-condition the aircraft. This has an economic advantage because the air conditioning units can be moved more quickly due to the shorter air conditioning time and thus fewer air conditioning units are needed at an airfield. They can also be deployed at shorter notice. The machine components used are partly cheaper to buy and maintain, are more environmentally friendly and are smaller than the familiar units. This makes them more cost-effective and economical.

It is particularly advantageous that the air conditioning unit can be switched in conjunction with an external 400 Hz power supply unit and the aircraft. These power supply units are actually designed and required for aircraft for ground power supply. They are available in sufficient numbers either as a fixed connection in the ground, at a passenger boarding bridge or similar locations, or as a mobile power generator. This means that the aircraft's existing power supply can be used. Additional power supply units for the air conditioning of the aircraft are not required. In particular, no separate 50 Hz power connection is required.

The electrical circuits of the air conditioning unit and the aircraft can be connected in series or in parallel. The advantage of connecting the air conditioning unit in series is that the electrical
5 output of the power supply unit can be limited and still be fully utilized. The 400 Hz power supply unit is usually designed for a power output of 90 kVA and a limit current at the aircraft plug of approx. 260 A, apart from short current peaks. The aircraft
10 does not need the full output, or only needs it intermittently. The air-conditioning system can utilize the residual output not required for the aircraft, due to the interposition of the air conditioning unit. This has the advantage that the
15 power supply unit is utilized more evenly and is not overloaded despite the additional energy demand.

The advantage of a parallel connection is that the full air-conditioning output can always be used if
20 the power supply unit has the appropriate output reserve. The air conditioning unit can also be connected and disconnected independently and without affecting the aircraft.

25 For optimization, it is advantageous to equip the air conditioning unit with a suitable control system that adjusts the air conditioning output, i.e., the heating or cooling output and the air circulation output, to the ambient conditions and to the
30 available residual output or to the existing power demand of the aircraft. This can be achieved relatively easily by measuring the power demand at the aircraft and controlling the output of the air-conditioning pack and, if necessary, the air
35 circulation accordingly.

Aircraft cabins come in different sizes. Furthermore, the electrical residual output available for the air

conditioning unit can change depending on the aircraft's output demands. To adapt to these variable operating conditions, it is advantageous to provide a controllable air-conditioning pack, e.g., a multi-
5 stage heater or similar. It is also advantageous to make the fan switchable and to provide several output levels.

The air conditioning unit can have one or more air-
10 conditioning packs, which can also be configured differently. This may involve heating and/or cooling devices. The air-conditioning packs can also be combined units that work with thermodynamic cycles and provide both cooling output and heating output,
15 which are tapped or applied accordingly. This means that the air conditioning unit can be used in both warm and cold zones. For perfect air conditioning, it is also advantageous to use dehumidifiers, humidifiers, filters, and other appropriate devices
20 to condition the recirculated air and cabin air.

To control the climate conditions, it is advisable to provide one or more sensors and/or switches connected to the control system on the air conditioning unit
25 and/or near the aircraft to measure the climate values that occur. These can be, for example, temperature and/or humidity. Thresholds can also be set or specified by hand.

30 The sensor and/or switch is preferably located at the air outlet of the air-conditioning pack and/or at the end of the supply air hose leading to the aircraft and connected to the control system of the air conditioning unit via a cable. To adapt to different
35 hose and cable lengths and also to protect the cable, it is advisable to lay it in a spiral and to place it in the supporting spirals of the elastic supply air hose. Preferably, the sensor and/or switch measures

the temperature of the heating or cooling air coming from the air conditioning unit at the aircraft in order to maintain predefined conditions. These may be, for example, limit temperatures for reasons of
5 accident and damage protection, for reasons of human tolerance or the like.

The air conditioning unit is preferably mobile and mounted on a trailer or a self-propelled vehicle.
10 However, it can also be stationary, e.g., on passenger boarding bridges.

Further advantageous designs of the invention are given in the dependent claims.

15

20

25

30

The invention is shown in the drawings for example and schematically. In detail, show:

5

Figure 1: the air conditioning unit for an electrical series connection in side view,

Figure 2: a plan view of the air conditioning unit
10 corresponding to arrow II in Figure 1 and

Figure 3: electrical wiring of the air conditioning unit.

15

Figures 1 and 2 show an air conditioning unit (1) for air conditioning the passenger cabin and possibly the cockpit of an aircraft (23). The aircraft (23) is shown symbolically. The air conditioning unit (1) is
20 designed for a 400 Hz power supply. It receives the electrical energy from a suitable 400-Hz power supply unit (7) that is arranged, for example, as a stationary electrical connection in the ground of the apron or another location at the airport. The power
25 supply unit (7) can also be a self-propelled or trailer-mounted generator that runs on diesel or another primary energy source.

The power supply unit (7) and air conditioning unit
30 (1) can be separate units. Alternatively, they can also be combined to form a combined unit (not shown).

The electrically operated air conditioning unit (1) is connected to the power supply unit (7) and/or the
35 aircraft (23). In practice, aircraft (23) currently only have one or more 400 Hz power inputs, but no 400 Hz power output. The air conditioning unit (1) is therefore preferably connected electrically in series

between the power supply unit (7) and the aircraft (23) in the embodiment of Figures 1 and 2.

Alternatively, there may also be a parallel
5 connection. Fig. 3 shows both variants. If a 400 Hz power output is available on aircraft, the air conditioning unit (1) can also be connected electrically in series behind the aircraft (23).

10 In the embodiment shown, the air conditioning unit (1) has at least one input-side electrical connection (5) with a socket or the like, which can be connected to the external supplier (7) by cable (22) or the like. In addition, there is at least one electrical
15 connection (6) on the output side with a socket or the like, which leads to at least one aircraft (23) via a cable (22). The aircraft (23) thus receives its electrical energy via the upstream air conditioning unit (1). The air conditioning unit (1) can be
20 operated even when the aircraft (23) is not connected to electricity.

The usual 400 Hz power supply units (7) for supplying aircraft with ground power supply have an electrical
25 output of 90 kVA or more. This output is not, or only partially, demanded of the aircraft (23), depending on its size and the time of day. In addition, apart from brief current spikes, a limit current of approx. 260 A must not be exceeded at the power plug to the
30 aircraft (23).

The air conditioning unit (1) has at least one air-conditioning pack (4) and an air circulation device (12), which are largely housed together in a housing
35 or frame (2) and are described in more detail below. The housing (2) can be fixed to the floor, to a passenger boarding bridge or similar. However, it can also be arranged on a vehicle (3), e.g., a trailer,

in a movable manner.

The air-conditioning pack (4) has a variable and controllable output. The air conditioning unit (1) has a suitable control system (8), which is preferably designed as a programmable logic control system and allows the air conditioning output to be adapted to different ambient conditions. These can be climatic or technical environmental conditions, e.g., temperature, humidity, aircraft size, etc. In addition, the series connection makes it possible to adapt to the aircraft's (23) power demands. The air conditioning unit (1) only draws as much output from the power supply unit (7) as is not needed by the aircraft (23). The control system (8) is preferably designed to use as much of the remaining energy as possible to operate the air conditioning unit (1).

The control system (8) can be computer-assisted and can have one or more microprocessors in conjunction with several data and program memories, several I/O interfaces and other conventional computer or control system components. The control system (8) has a measuring device (9) for measuring the aircraft's (23) power or output demands. The measuring device (9) can be integrated into the control system (8) or arranged externally. The control system (8) also has a suitable regulating device (10) that adjusts the output of the air-conditioning pack (4) to the available residual energy and controls it in a suitable manner.

The control system (8) is also connected to one or more displays (11) arranged on the outside of the housing (2). The aircraft's power demands, the current output of the air conditioning unit, etc. can be signaled here. In addition, various control elements (not shown) are located on the housing (2)

for setting and controlling the air conditioning unit (1) and for other tasks.

5 The air conditioning unit (1) has one or more air-conditioning packs (4). In the exemplary embodiment shown, the air-conditioning pack (4) consists of an electric heating system, in particular a resistance heating system with several plate-shaped or rod-shaped heating elements. The heating pack (4), for
10 example, has a maximum total output of approx. 70 kW, which is divided between four heating levels. The heating levels can be activated individually by the control system (8). The number of heating levels activated is determined by the instantaneous power
15 consumption of the connected aircraft (23) and the maximum permissible current through the aircraft plug.

20 All control and regulating functions are realized by the control system (8). If the maximum permissible total output is exceeded, the number of heating levels that are activated is immediately reduced so that no overload occurs at the power supply unit (7), but the maximum possible heating output can still be
25 generated. In addition, the operator can limit the maximum possible number of heating levels using a selector switch. To prevent damage caused by overheating, the temperature of the heating unit in the housing (2) or air circulation device (12) is
30 also measured, monitored and controlled in a suitable manner. If the internal temperature rises above a threshold value of, for example, 80°C, the heating levels are reduced one after the other until the temperature falls below the threshold. Likewise, the
35 heating levels are automatically switched back on one after the other until the temperature is reached. Four signal lamps (11), which are assigned to the individual heating levels, show the operator the

number of levels activated.

In a modification of the shown exemplary embodiment, the air-conditioning pack (4) can also be designed as
5 a cooling device (not shown) or can have a cooling pack in addition to the heating pack. The above packs can be present individually or in multiples. The air-conditioning pack (4) can also work with a thermodynamic cycle with compressor and condenser and
10 can therefore provide heating and/or cooling output as required. In the heating pack shown (4), the heating levels are directly supplied with the 400 Hz current, which is immediately converted into heating energy. In the alternative embodiments, the
15 individual machine components are operated with the 400 Hz current.

The air circulation device (12) consists of at least one air supply (13), which is designed, for example,
20 as a fresh air supply and draws in outside air from the housing (2) in a suitable manner. Alternatively or additionally, there may be an air supply (14) that is designed as a recirculated air supply and is connected to the outlet side of the aircraft cabin
25 (23) via an exhaust air hose or the like.

The air circulation device (12) also has one or more air outlets (15) on the housing (2) with connected supply air hoses (16) or similar, which lead to the
30 aircraft (23) on the input side and are connected there via adapters. Conditioned fresh air is blown into the aircraft cabin via the air supply (13). The recirculated air supply (14) allows the air flow to be circulated through the aircraft (23) and the air
35 conditioning unit (1) in a cycle.

One or more filters, dehumidifiers, humidifiers (20), or other suitable packs for influencing the air may

be present at the fresh air supply (13) and/or the recirculated air supply (14).

5 The air circulation device (12) also has one or more fans (17) or similar devices that draw in fresh air or recirculated air, send it through a discharge duct (19) through the air-conditioning pack (4), and blow it into the aircraft (23) through the air outlet (15) and the supply air hose (16). The fan (17) is
10 preferably designed as a radial fan that draws in fresh air or recirculated air axially out of the housing (2) and discharges it radially at the periphery through the discharge duct (19).

15 The fan (17) is preferably driven directly by an electric motor (18), in particular a three-phase motor, which is connected to the control system (8).

20 Preferably, the fan (17) or the motor (18) can be controlled or regulated in speed, e.g., pole-changing, and has several output levels. The motor (18) operates, for example, at a voltage of 200 V / 400 Hz and has a speed of approx. 5000 rpm at full load. The speed can be reduced to 2500 rpm, for
25 example. The fan output can thus be adapted to the existing air conditioning output, in particular to the heating output and the residual electrical energy of the power supply unit (7) available for the air conditioning unit (1).

30 The fan (17) is designed as a high-pressure fan. The motor output is approx. 11 kW. In connection with the 400 Hz power supply, the high-pressure fan (17) can preferably generate a counterpressure of at least
35 8000 Pa and an air flow rate of at least 2500 m³/h.

The air conditioning unit (1) may have one or more sensors and/or switches (21) that measure the climate values of the air blown into the aircraft (23). This
40 applies in particular to a measurement of temperature

and/or humidity. The sensor and/or switch (21) is preferably located at the air outlet of the air-conditioning pack (4) and/or at the front end of the supply air hose (16) that is connected to the aircraft (23). The sensor(s) and/or switch(es) (21) are connected to the control system (8) via a cable (22). If the air temperature at the aircraft (23) inlet rises above 60°C, for example, the heating output is gradually reduced in the manner described above.

Furthermore, to prevent damage due to overheating, for example, the air conditioning unit (1) is switched off when a temperature threshold of 90°C is reached and/or when an air flow monitor is triggered. In such a case, it can be assumed that, for example, the supply air hose (16) has been kinked or that the fan (17) is no longer working properly. For such safety circuits, additional sensors and/or switches can also be arranged in the housing (2), on the air-conditioning pack (4) or in a suitable location. The switching or threshold values are signaled by at least one thermal switch and/or airflow monitor.

To protect the cable (22) of the sensor and/or switch (21) and to adapt it to variable hose lengths, the cable (22) is routed in a spiral through the supply air hose (16) to the housing (2) and from there to the control system (8). It can be arranged in or on the metal supporting spiral of the supply air hose (16) within the supply air hose (16). It automatically adjusts to the length of the hose.

In a variant that is not shown, the sensor or switch (21) can also be designed to be portable and freely movable and connected to the control system (8) by means of wireless data transmission. One or more sensors or switches (21) can be placed in the aircraft (23) during air-conditioning and measure or

switch by remote control system on site. The sensors or switches (21) are equipped with a battery-operated transmitter that sends the measurement or switching signals wirelessly to a corresponding receiver on the control system (8) by radio, infrared, or similar. The signals can be coded for parallel operation and to distinguish between several sensors or switches (21).

The individual sensor or switch (21) may have an anti-loss protection that prevents it from being forgotten in the aircraft (23) after the air conditioning has been switched off. The anti-loss protection can, for example, consist of an electric start control for the drive system of a self-propelled air conditioning unit (1). The traction drive can only be started when the sensor or switch (21) is inserted into a prepared receptacle on the air conditioning unit (1) and closes the starter circuit that is interrupted there. Alternatively, the anti-loss protection can also consist of an alarm device with a probe holder that forces the user to insert the probe or switch (21) into the holder before the air conditioning unit (1) is switched off. Otherwise, an alarm is triggered. In addition, any other protective measures against losing or forgetting the probe or switch (21) are possible.

To operate the air conditioning unit (1) without the plug (6) connected to the aircraft (23) or without the 28-V interlock voltage from the aircraft (23), it is also possible to generate the interlock voltage required for the self-locking of the power supply unit (7) from a control transformer (not shown) integrated in the air conditioning unit (1). An additional contactor interrupts the power supply to the aircraft plug (6) of the air conditioning unit

(1) in the event of an accident.

In the electrical parallel connection of the air conditioning unit (1) and the aircraft (23) shown in Figure 3, the power supply unit (7) has two 400-Hz power outputs or there are two power supply units (7). A 400 Hz cable (22) runs from the power supply unit (7) to the aircraft (23) and to the air conditioning unit (1). If the power supply unit (7) has sufficient output reserves, it is possible to provide the full air-conditioning output at all times, even if the aircraft (23) has a greater electrical output demand. In this case, there is no need to measure and distribute the electrical output. The air conditioning unit (1) can also be disconnected before or during the 400 Hz supply to the aircraft (23), which is sometimes useful for short handling times. When connecting in parallel, the power connection to the aircraft (23) does not have to be disconnected. The output-side electrical connection (6) can be omitted for the parallel connection version of the air conditioning unit (1).

Further modifications of the described exemplary embodiments are possible in various ways. Other air circulation devices may be used instead of the radial fan (17). The air-conditioning packs (4) can be modified, for example, in the manner already described. Variants are also possible with regard to the number and design of the air connections (13, 14, 15) and the other components described above.

LIST OF REFERENCE SYMBOLS

	1	Air conditioning unit, heating unit
5	2	Housing, frame
	3	Vehicle, trailer
	4	Air-conditioning pack, heating pack
	5	Electrical connection, external power
		supply
10	6	Electrical connection, aircraft
	7	Power supply unit
	8	Control system
	9	Measuring device
	10	Regulating device
15	11	Display
	12	Air circulation device
	13	Air supply, fresh air supply
	14	Air supply, recirculated air supply
	15	Air outlet
20	16	Hose
	17	Fan, radial fan
	18	Motor
	19	Discharge duct
	20	Filter, dehumidifier
25	21	Probes and/or switches
	22	Cable
	23	Airplane

30

35

CLAIMS

- 1.) Air conditioning unit for air-
5 conditioning, in particular heating, of
aircrafts on the ground, comprising an
electrically operated air conditioning unit, in
particular a heating unit, an air circulation
10 device, at least one air supply and an air
outlet connectable to the aircraft,
characterized in that the air conditioning unit
(1) is designed for a 400 Hz power supply.
- 2.) Air conditioning unit according to
15 claim 1, characterized in that the air
conditioning unit (1) is electrically
connectable in series or parallel between an
external power supply unit (7) and the aircraft
(23).
- 20 3.) Air conditioning unit according to
claim 1 or 2, characterized in that the air
conditioning unit (1) has an input-side
electrical connection (5) for connection to the
25 external power supply unit (7) and an output-
side electrical connection (6) for connection to
the aircraft (23).
- 4.) Air conditioning unit according to
30 claim 1, 2, or 3, characterized in that the air-
conditioning pack (1) has at least one
controllable air-conditioning unit (4).
- 5.) Air conditioning unit according to
35 claim 4, characterized in that the air-
conditioning pack (4) is designed as an
adjustable heating and/or cooling device.

6.) Air conditioning unit according to one of claims 1 through 5, characterized in that the air conditioning unit (1) has a control system (8) for adapting its air conditioning output to the power demand of the aircraft (23).

7.) Air conditioning unit as claimed in claim 6, characterized in that the control system (8) has a measuring device (9) for the power demand of the aircraft (23) and a regulating device (10) for adjusting the power supply of the air-conditioning pack (4).

8.) Air conditioning unit according to claim 5, 6, or 7, characterized in that the control system (8) is designed as a programmable logic control system.

9.) Air conditioning unit according to claim 1 or one of the following, characterized in that the air conditioning unit (1) has a radial fan (17).

10.) Air conditioning unit as claimed in claim 9, characterized in that the fan (17) has several output levels.

11.) Air conditioning unit according to claim 1 or one of the following, characterized in that the air conditioning unit (1) has at least one filter (20) and/or at least one humidifier or dehumidifier.

12.) Air conditioning unit according to claim 1 or one of the following, characterized in that the air conditioning unit (1) has a

fresh air supply (13) and/or a recirculated air supply (14).

5 13.) Air conditioning unit according to claim 1 or one of the following, characterized in that the air conditioning unit (1) has at least one sensor and/or switch (21) connected to the control system (8) for measuring climate values, in particular temperature and/or
10 humidity.

14.) Air conditioning unit as claimed in claim 13, characterized in that the sensor and/or switch (21) is arranged at the air outlet
15 (15) of the air-conditioning pack (4) and/or at the aircraft end of a supply air hose (16) connectable to the air outlet (15).

15.) Air conditioning unit as claimed in claim 14, characterized in that the sensor and/or switch (21) is connected to the control system (8) via a cable (22) laid in the supporting spiral of the supply air hose (16).

25 16.) Air conditioning unit according to claim 13, characterized in that the probe and/or switch (21) is designed to be portable and freely movable and can be connected to the control system (8) by wireless data
30 transmission.

17.) Air conditioning unit as claimed in claim 16, characterized in that the probe and/or switch (21) has an anti-loss protection.

35 18.) Air conditioning unit according to claim 1 or one of the following, characterized in that the air conditioning unit (1) is

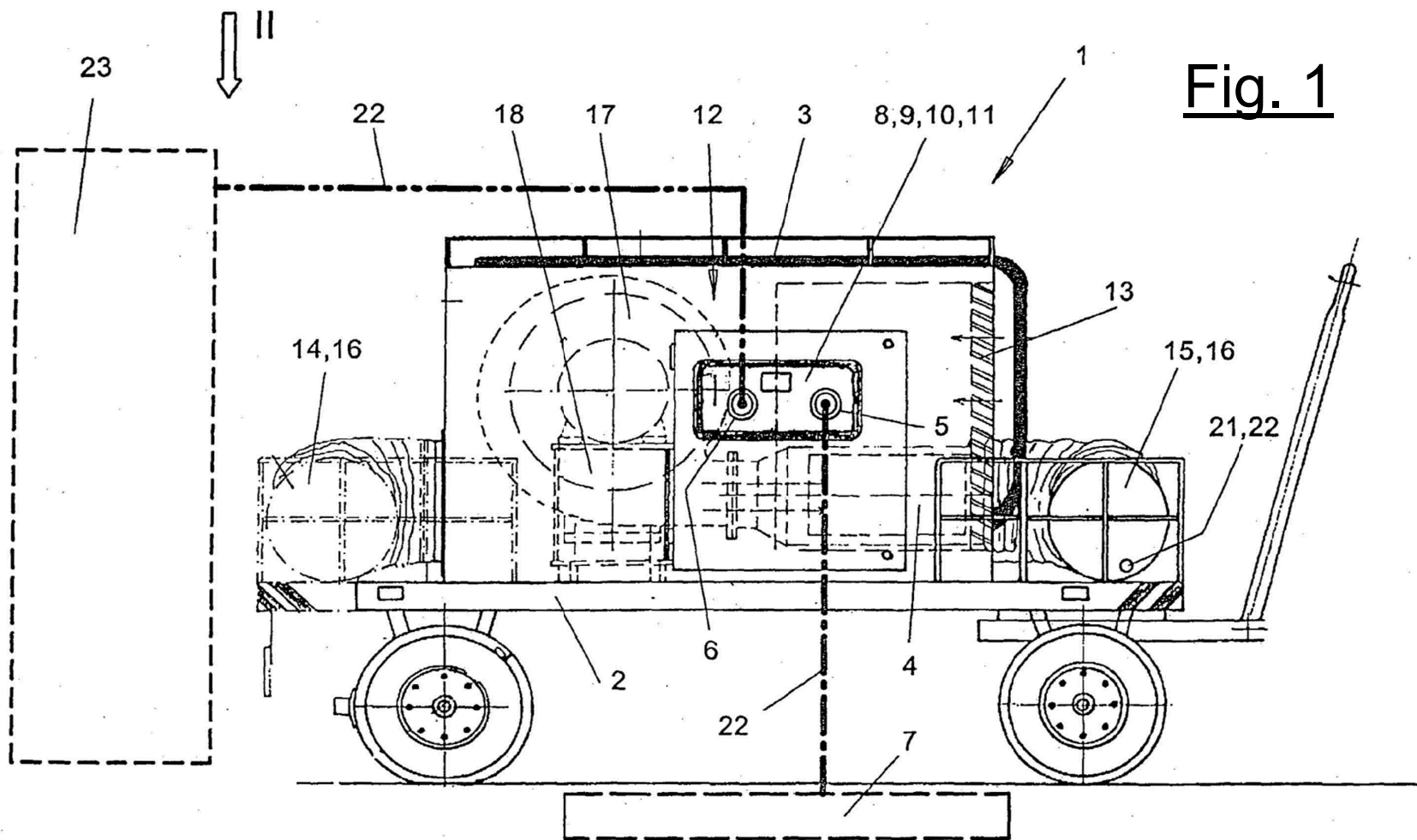
19.12.96

- 19 -

arranged in a stationary manner or on a vehicle
(3), in particular a trailer.

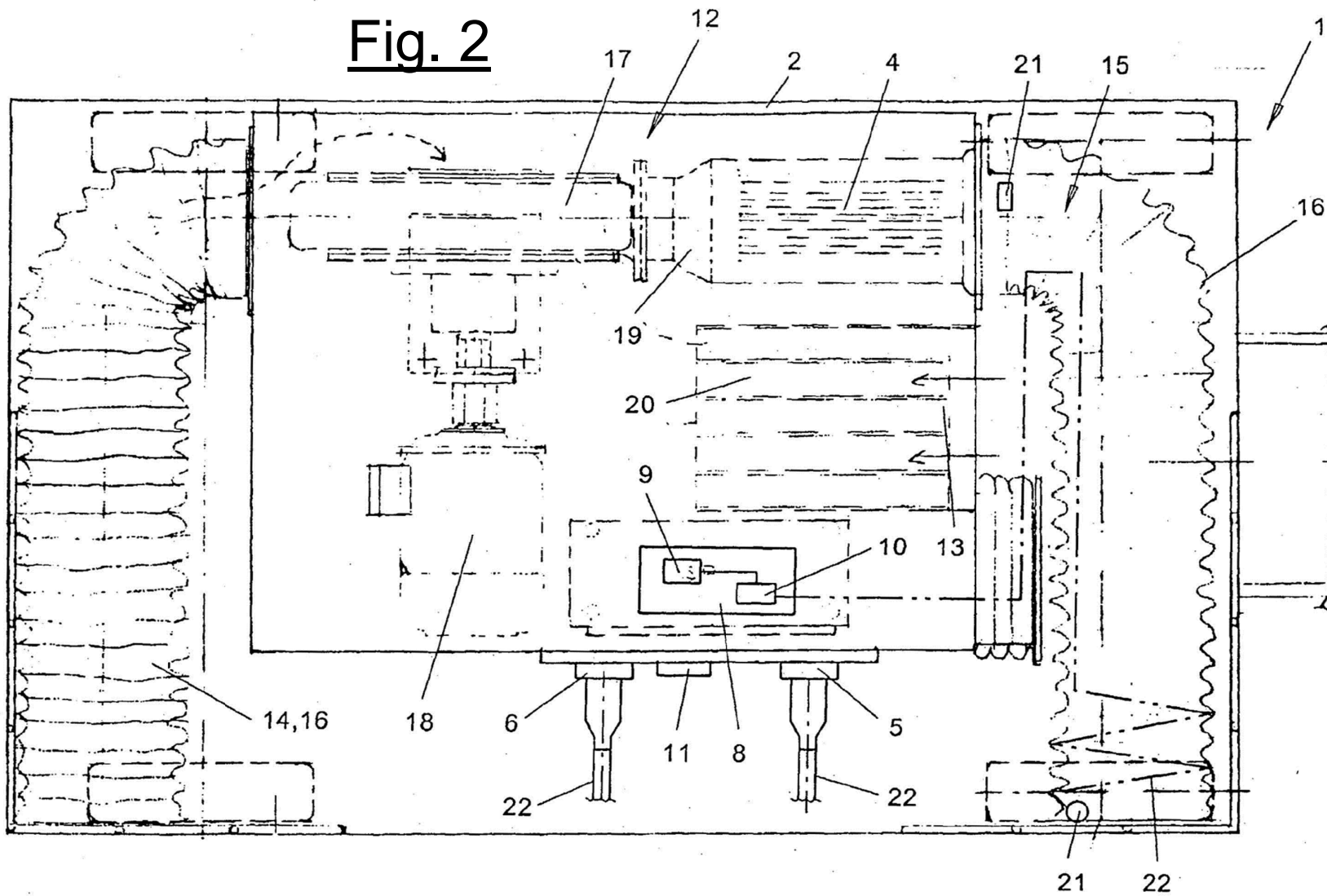
19.12.96
- 20 -

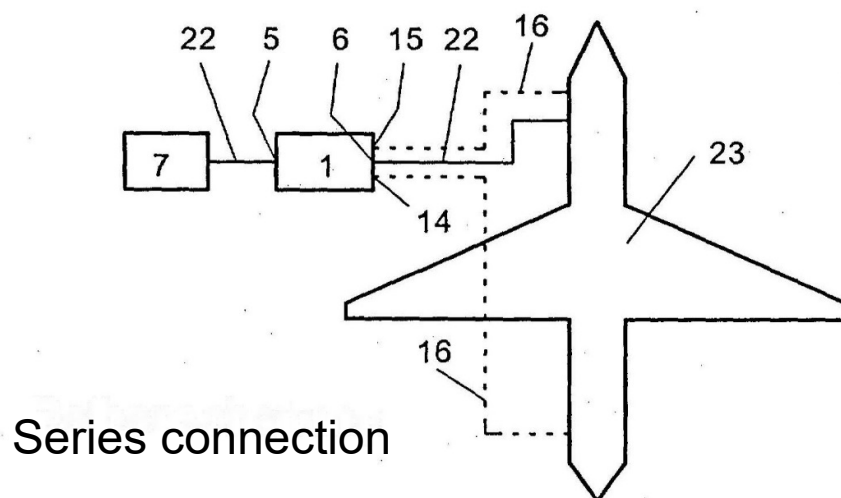
Fig. 1



19.12.96
- 21 -

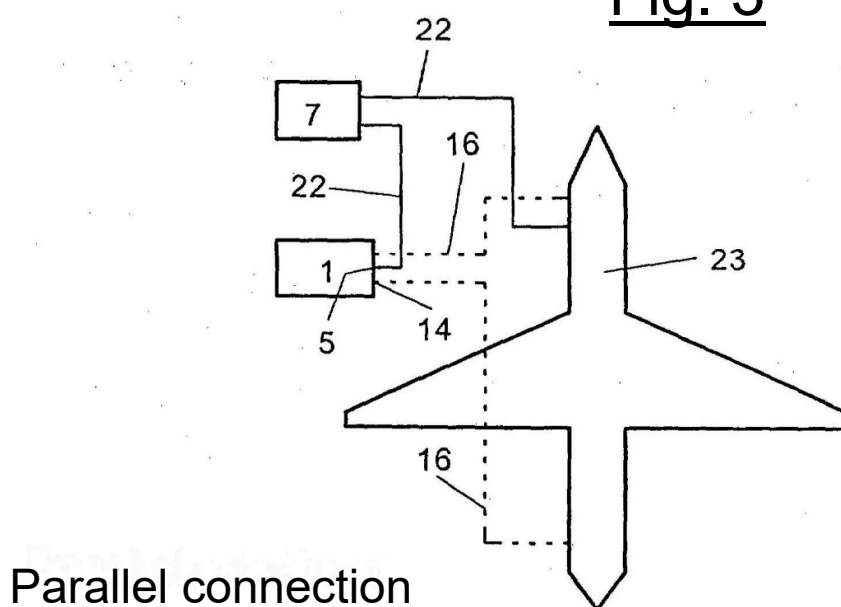
Fig. 2





Series connection

Fig. 3



Parallel connection