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(54) Vacuum pumping system

Vakuumpumpenanlage

Dispositif de pompage à vide

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Description

[0001] The present invention relates to a vacuum pumping system.

[0002] More particularly, the present invention concerns a vacuum pumping system of the kind comprising one or more vacuum pumping devices and a corresponding electronic control unit for controlling and monitoring the operation of said devices.

[0003] Vacuum pumping systems are known for instance from US 5,733,104.

[0004] In case of high vacuum, i.e. in case of pressures in the range 10^{-4} to 10^{-8} mbars, said pumping systems generally comprise a turbomolecular vacuum pump associated with a backing pump or fore pump, for instance of mechanical type, allowing the turbomolecular pump to evacuate gas at atmospheric pressure.

[0005] An example of turbomolecular pump is disclosed in US 5,238,362 in the name of the present Applicant.

[0006] Both the turbomolecular pump and the fore pump need a local electronic control unit for controlling and monitoring the operation of the pump and of the accessory devices, if any, mounted on board or associated with the pumping device, such as for instance valves, pressure detectors, cooling systems etc.

[0007] Electronic control units for vacuum pumps are known for instance from EP 597,365.

[0008] In order the vacuum pump operation can be controlled from a remote electronic control unit, said remote unit and the local electronic control unit of said pump are generally equipped with serial interfaces and they can be connected together by cables, permanently or only occasionally, when necessary.

[0009] EP 1,041,471 discloses a device for the remote control of a vacuum pump, in particular a turbomolecular pump equipped with magnetic suspensions, comprising a local control unit mounted on board the pump and a remote control unit, said units being arranged to communicate with each other thanks to a connection by means of an RS232 serial cable.

[0010] In case of more complex pumping systems, comprising a plurality of pumps of different types, either mutually connected through a vacuum line or independent of one another, the remote control unit comprises a multiple interface capable of simultaneously communicating with the interfaces of all local control units in order to monitor and control the corresponding vacuum pumps.

[0011] A pumping system of the above type is disclosed for instance in US 5,971,711, disclosing a system consisting of multiple pumps of different kinds (turbomolecular, mechanical, cryogenic...pumps), each having its own local control unit, connected through an RS232 serial cable with a corresponding communication gate of a single remote control unit.

[0012] US 5,696,495 discloses a system for controlling and regulating a construction installation having a plurality of components, said components being coupled through cables to a single control unit, which in turn communicates with a remote routing station through a communication network.

[0013] Connections by means of serial cables between the remote control unit and the local control units are a considerable drawback, since they give rise to a number of problems in the installation phase of the vacuum pumping system, as far as both the positioning of the individual vacuum pumps and the distances between said vacuum pumps are concerned.

[0014] Moreover, during operation, serial cables can be accidentally disconnected or damaged, with a consequent interruption of the communication between the remote control unit and the corresponding local control unit.

[0015] Clearly, the higher the number of vacuum pumps in the pumping system, the more severe said drawbacks.

[0016] It is the main object of the present invention to provide a vacuum pumping system, equipped with a remote central control unit, in which said drawbacks are overcome.

[0017] The above and other objects are achieved by the vacuum pumping system as claimed in the appended claims.

[0018] Thanks to the use of wireless communication interfaces for communication between the remote control unit and the local control units of the vacuum pumps, the constraints on the pumping system installation, related to the use of serial cables, are eliminated. The vacuum pumps forming said system can thus be located in the most suitable positions and at greater mutual distances, without any limitation related to the use of wired connections.

[0019] According to the invention, being the remote control unit free from any physical connection with the local control units, a mobile and portable remote unit could be provided, instead of a fixed station as in the prior art.

[0020] The pumping system according to the invention can be advantageously built starting from conventional control units, since it will be sufficient to connect said control units (both the local units and the remote one) with corresponding wireless interface modules.

[0021] A preferred embodiment of the vacuum pumping system according to the invention, given by way of non-limiting example, will be described in more detail hereinafter with reference to the accompanying drawing, which shows a block diagram representing the operation of the vacuum pumping system according to the invention.

[0022] In the embodiment shown, said vacuum pumping system 1 includes a high-vacuum pumping device 11 and a backing or fore pumping device 31.

[0023] Said pumping devices 11 and 31 are mutually connected through a vacuum line (not shown), so that the gas flow sucked from a chamber under high vacuum conditions by said high-vacuum pumping device 11 can be evacuated at atmospheric pressure through said

backing pumping device 31.

[0024] Pumping device 11 is preferably equipped with a high vacuum pump 13, for instance a turbomolecular pump, and further comprises a local electronic control unit 15 for monitoring and controlling the operation parameters of said high vacuum pump 13, by driving the electric motor of said pump and other electromechanical devices that will be described hereinafter.

[0025] Similarly, pumping device 31 is equipped with a fore pump 33, preferably a mechanical pump, for instance an oil pump, and includes a local electronic control unit 35

[0026] Said local electronic control units 15, 35 are preferably powered through the mains voltage, by means of corresponding power supply cables 17, 37.

[0027] Pumping device 11 is further equipped with a set of secondary apparatuses, which also can be controlled by said local control unit 15. If high vacuum pump 13 is a turbomolecular pump, said apparatuses may comprise a pressure detector 19 for monitoring the residual pressure inside said pump, a cooling fan 21, a vent valve 23 controlling the admission of a gas for slowing down the pump during the stopping phase, a purge valve 25, controlling the admission of a dilution gas before discharging the pumped gas to the outside environment, when said pumped gas is a corrosive or harmful gas.

[0028] Similarly, local control unit 35 can control the secondary apparatuses pumping device 31 is equipped with. If fore pump 33 is an oil mechanical pump, said apparatuses may comprise a pressure detector 39 for monitoring the residual pressure inside said pump, an oil detector 41 for monitoring the level and the temperature of the oil bath, a foreline valve 43 located in the vacuum line connecting high-vacuum pumping device 11 with backing pumping device 31.

[0029] Pumping system 1 further includes a single remote control station 51 including a remote control unit 53, usually equipped with or connected to an electronic processor, for central management and control of pumping system 1.

[0030] To this end, both said remote control unit 53 and said local control units 15, 35 of pumping devices 11, 31 must be equipped with interfaces for two-way communication of data and commands for controlling the pumping system operation.

[0031] According to the invention, each local control unit 15, 35 is equipped with a wireless communication module 27, 47 allowing said local control units 15, 35 to dialogue with a corresponding communication module 55, also of wireless type, connected with remote control unit 53.

[0032] As known, the most widely used technologies in wireless technology field are those in which transmission employs radiofrequencies (RF) or infrared radiation. Since such technologies and the devices exploiting them are well known, they will not be described further herein.

[0033] Wireless communication module 55 of remote control unit 53 is chosen so that it can dialogue with wireless communication modules 27, 47 of each local control unit 15, 35.

[0034] Module 55 can be for instance a multi-channel communication module, communicating on each channel with the communication module of a different local control unit. That solution allows, among othet things, avoiding potentially disturbing crosstalk between the communication signals of contiguous pumping devices or of different pumping systems, equipped each with its control station and located close to one another.

[0035] As an alternative, the use of an encoding system can be envisaged, so that the signals directed to and/or coming from the individual local control units can be discriminated.

[0036] Thus, the local control units of a plurality of pumps, even of different types, can be managed by means of a single remote control station 51, both when said pumps are connected together by a vacuum line, as in the example disclosed, and when they are mutually independent and are used for degassing different environments.

[0037] Advantageously, according to the invention, all wired connections between control station 51 and pumping devices 11, 31 controlled by the station can be eliminated, so that the only wired connections in pumping system 1 consist in power supply cables 17, 37, 57 of said pumping system and said control station, for connection to the mains.

[0038] Advantageously as well, control station 51, if it is not connected to the mains but is powered otherwise, for instance by means of batteries, can be built as a portable device instead of being a fixed station.

[0039] Note also that pumping system 1 according to the invention does not require use of special control units, but it can be built by connecting conventional control units 15, 35, 53 with corresponding wireless communication modules 27, 47, 55, for instance through serial connections 29, 49, 59.

[0040] The above description clearly shows that the invention attains the desired objects. Actually, thanks to the use of wireless communication modules, it is possible to control a plurality of vacuum pumping devices, arranged in any manner and located at great distance from one another, from a remote control station. For that reason, use of the pumping system according to the invention is particularly advantageous in case of complex applications, using a pumping system comprising multiple vacuum pumps of different types, connected together by a vacuum line, as in the example disclosed, or independently operating.

[0041] It is moreover clear that the above description has been given only by way of non-limiting example and that changes and modifications are possible without departing from the scope of the invention.

Claims

1. A vacuum pumping system (1), comprising:

- a plurality of vacuum pumping devices (11; 31), each of said vacuum pumping devices comprising a vacuum pump (13; 33) and a local electronic control unit (15; 35) for monitoring and controlling the operating parameters of said pump;
- a control station (51) remotely located relative to said plurality of vacuum pumping devices (11; 31) and equipped with a corresponding remote control unit (53);

said remote control unit (53) and said local electronic control units (15; 35) being equipped with corresponding communication modules (27, 55; 47, 55) for data and commands for controlling the operation of said plurality of vacuum pumping devices;
the system being **characterised in that** said communication modules (27, 55; 47, 55) are wireless communication modules such that the communication module (55) of the remote control unit (53) communicates directly with the communication modules (27, 47) of each local unit (15, 35).

2. The vacuum pumping system (1) as claimed in claim 1, wherein said plurality of pumping devices comprises at least two pumping devices.

3. The vacuum pumping system (1) as claimed in claim 1 or 2, wherein said communication module (55) of said remote control unit (53) is a multi-channel communication module for communicating on each channel with the communication module (27; 47) of the local control unit (15;35) of each of said plurality of pumping devices, thus avoiding crosstalk between the communication signals addressed to different pumping devices.

4. The vacuum pumping system (1) as claimed in claim 1, wherein said pumping devices (11,31) operate at pressures lower than 10^{-4} millibars.

5. The vacuum pumping system (1) as claimed in claim 1, wherein at least one of said pumping devices (11) comprises a turbomolecular pump (13).

6. The vacuum pumping system (1) as claimed in claim 1 or 4, wherein at least one of said pumping devices (11) comprises a backing pump (33).

7. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises at least two vacuum pumping devices (11, 31), connected by a vacuum line and comprising each a vacuum pump (13, 33) and a local electronic control unit (15, 35) for monitoring and controlling the operating parameters of the respective pump, both said local control units (15, 35) being equipped with a wireless communication module (27, 47) for the dialogue with said wireless communication module (55) of said remote control unit (53).

8. The vacuum pumping system (1) as claimed in claim 7, wherein said two pumping devices (11, 31) comprise a turbomolecular pump (13) and an oil mechanical pump (33), respectively.

9. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises at least two independently operating vacuum pumping devices comprising each a vacuum pump and a local electronic control unit for monitoring and controlling the operating parameters of the respective pump, both said local control units being equipped with a wireless communication module for the dialogue with said wireless communication module (55) of said remote control unit (53).

10. The vacuum pumping system (1) as claimed in claim 1 or 7 or 9, wherein said pumping devices further comprise a plurality of secondary apparatuses, such as for instance a pressure detector (19, 39) for monitoring the residual pressure inside said device, a fan (21) for cooling said device, a vent valve (23), a purge valve (25), an oil detector (41) for monitoring the level and the temperature of an oil bath, a valve (43) for controlling the opening/closing of a vacuum line for connection with another pumping device, if any.

11. The vacuum pumping system (1) as claimed in claim 1 or 7 or 9, wherein said remote control unit (53) is associated with an electronic processor, by means of which the operating parameters of said vacuum pumps (13, 33) can be monitored and controlled through said local control units (15, 35).

12. The vacuum pumping system (1) as claimed in claims 10 and 11, wherein the operating parameters of one or more of said secondary apparatuses can be monitored and controlled by means of said electronic processor.

13. The vacuum pumping system (1) as claimed in any preceding claim, wherein said wireless communication modules (27, 47, 55) are infrared communication modules.

14. The vacuum pumping system (1) as claimed in any of claim 1 to 12, wherein said wireless communication modules (27, 47, 55) are radiofrequency communication modules.

15. The vacuum pumping system (1) as claimed in any

preceding claim, wherein said control station (51) consists in a portable device.

Patentansprüche

1. Vakuumpumpsystem (1) mit:

- einer Vielzahl von Vakuumpumpvorrichtungen (11; 31), wobei jede der Vakuumpumpvorrichtungen eine Vakuumpumpe (13; 33) und eine lokale elektronische Steuereinheit (15; 35) zum Überwachen und Steuern der Betriebsparameter der Pumpe aufweist;
- einer Steuerstation (51), die relativ zur Vielzahl von Vakuumpumpvorrichtungen (11; 31) entfernt angeordnet ist und mit einer entsprechenden Fernsteuereinheit (53) ausgestattet ist;

wobei die Fernsteuereinheit (53) und die lokalen elektronischen Steuereinheiten (15; 35) mit entsprechenden Datenübertragungsmodulen (27, 55; 47, 55) für Daten und Befehle zum Steuern des Betriebs der Vielzahl von Vakuumpumpvorrichtungen ausgestattet sind;
wobei das System **dadurch gekennzeichnet ist, dass** die Datenübertragungsmodule (27, 55; 47, 55) drahtlose Datenübertragungsmodule sind, so dass das Datenübertragungsmodul (55) der Fernsteuereinheit (53) direkt mit den Datenübertragungsmodulen (27, 47) jeder lokalen Einheit (15, 35) kommuniziert.

2. Vakuumpumpsystem (1) nach Anspruch 1, wobei die Vielzahl von Pumpvorrichtungen mindestens zwei Pumpvorrichtungen aufweist.

3. Vakuumpumpsystem (1) nach Anspruch 1 oder 2, wobei das Datenübertragungsmodul (55) der Fernsteuereinheit (53) ein Mehrkanal-Datenübertragungsmodul zum Kommunizieren mit dem Datenübertragungsmodul (27; 47) der lokalen Steuereinheit (15; 35) jeder der Vielzahl von Pumpvorrichtungen auf jedem Kanal ist, wobei somit Nebensprechen zwischen den Datenübertragungssignalen vermieden wird, die an verschiedene Pumpvorrichtungen adressiert sind.

4. Vakuumpumpsystem (1) nach Anspruch 1, wobei die Pumpvorrichtungen (11, 31) bei Drücken arbeiten, die niedriger sind als 10^{-4} Millibar.

5. Vakuumpumpsystem (1) nach Anspruch 1, wobei mindestens eine der Pumpvorrichtungen (11) eine Turbomolekularpumpe (13) aufweist.

6. Vakuumpumpsystem (1) nach Anspruch 1 oder 4, wobei mindestens eine der Pumpvorrichtungen (11) eine Vorpumpe (33) aufweist.

7. Vakuumpumpsystem (1) nach Anspruch 1, wobei das System mindestens zwei Vakuumpumpvorrichtungen (11, 31) aufweist, die durch eine Vakuumleitung verbunden sind und jeweils eine Vakuumpumpe (13, 33) und eine lokale elektronische Steuereinheit (15, 35) zum Überwachen und Steuern der Betriebsparameter der jeweiligen Pumpe aufweisen, wobei beide lokalen Steuereinheiten (15, 35) mit einem drahtlosen Datenübertragungsmodul (27, 47) für den Dialog mit dem drahtlosen Datenübertragungsmodul (55) der Fernsteuereinheit (53) ausgestattet sind.

8. Vakuumpumpsystem (1) nach Anspruch 7, wobei die zwei Pumpvorrichtungen (11, 31) eine Turbomolekularpumpe (13) bzw. eine mechanische Ölpumpe (33) aufweisen.

9. Vakuumpumpsystem (1) nach Anspruch 1, wobei das System mindestens zwei unabhängig arbeitende Vakuumpumpvorrichtungen aufweist, die jeweils eine Vakuumpumpe und eine lokale elektronische Steuereinheit zum Überwachen und Steuern der Betriebsparameter der jeweiligen Pumpe aufweisen, wobei beide lokalen Steuereinheiten mit einem drahtlosen Datenübertragungsmodul für den Dialog mit dem drahtlosen Datenübertragungsmodul (55) der Fernsteuereinheit (53) ausgestattet sind.

10. Vakuumpumpsystem (1) nach Anspruch 1 oder 7 oder 9, wobei die Pumpvorrichtungen ferner eine Vielzahl von sekundären Vorrichtungen aufweisen, wie beispielsweise einen Druckdetektor (19, 39) zum Überwachen des Restdrucks innerhalb der Vorrichtung, ein Gebläse (21) zum Kühlen der Vorrichtung, ein Lüftungsventil (23), ein Spülventil (25), einen Öldetektor (41) zum Überwachen des Pegels und der Temperatur eines Ölbades, ein Ventil (43) zum Steuern des Öffnens/Schließens einer Vakuumleitung zur Verbindung mit einer weiteren Pumpvorrichtung, falls vorhanden.

11. Vakuumpumpsystem (1) nach Anspruch 1 oder 7 oder 9, wobei die Fernsteuereinheit (53) einem elektronischen Prozessor zugeordnet ist, durch den die Betriebsparameter der Vakuumpumpen (13, 33) über die lokalen Steuereinheiten (15, 35) überwacht und gesteuert werden können.

12. Vakuumpumpsystem (1) nach den Ansprüchen 10 und 11, wobei die Betriebsparameter von einer oder mehreren der sekundären Vorrichtungen mittels des elektronischen Prozessors überwacht und gesteuert werden können.

13. Vakuumpumpsystem (1) nach einem vorangehen-

den Anspruch, wobei die drahtlosen Datenübertragungsmodule (27, 47, 55) Infrarot-Datenübertragungsmodule sind.

14. Vakuumpumpsystem (1) nach einem der Ansprüche 1 bis 12, wobei die drahtlosen Datenübertragungsmodule (27, 47, 55) Hochfrequenz-Datenübertragungsmodule sind.

15. Vakuumpumpsystem (1) nach einem vorangehenden Anspruch, wobei die Steuerstation (51) aus einer tragbaren Vorrichtung besteht.

Revendications

1. Système de pompage à vide (1), comprenant :

- une pluralité de dispositifs de pompage à vide (11 ; 31), chacun desdits dispositifs de pompage à vide comprenant une pompe à vide (13 ; 33) et une unité de commande électronique locale (15 ; 35) destinée à contrôler et commander les paramètres de fonctionnement de ladite pompe ;
- une station de commande (51) située à distance par rapport à ladite pluralité de dispositifs de pompage à vide (11 ; 31) et équipée d'une unité de télécommande (53) correspondante ;

ladite unité de télécommande (53) et lesdites unités de commande électroniques locales (15 ; 35) étant équipées de modules de communication correspondants (27, 55 ; 47, 55) pour données et commandes destinées à commander le fonctionnement de ladite pluralité de dispositifs de pompage à vide ;

le système étant **caractérisé en ce que** lesdits modules de communication (27, 55 ; 47, 55) sont des modules de communication sans fil, de sorte que le module de communication (55) de l'unité de télécommande (53) communique directement avec les modules de communication (27, 47) de chaque unité locale (15, 35).

2. Système de pompage à vide (1) selon la revendication 1, dans lequel ladite pluralité de dispositifs de pompage comprend au moins deux dispositifs de pompage.

3. Système de pompage à vide (1) selon la revendication 1 ou 2, dans lequel ledit module de communication (55) de ladite unité de télécommande (53) est un module de communication multi-canaux destiné à communiquer sur chaque canal avec le module de communication (27 ; 47) de l'unité de commande locale (15 ; 35) de chacun de ladite pluralité de dispositifs de pompage, évitant ainsi une diaphonie entre les signaux de communication adressés à différents dispositifs de pompage.

4. Système de pompage à vide (1) selon la revendication 1, dans lequel lesdits dispositifs de pompage (11 ; 31) fonctionnent à des pressions inférieures à 10^{-4} millibars.

5. Système de pompage à vide (1) selon la revendication 1, dans lequel au moins l'un desdits dispositifs de pompage (11) comprend une pompe turbomoléculaire (13).

6. Système de pompage à vide (1) selon la revendication 1 ou 4, dans lequel au moins l'un desdits dispositifs de pompage (11) comprend une pompe primaire (33).

7. Système de pompage à vide (1) selon la revendication 1, dans lequel ledit système comprend au moins deux dispositifs de pompage à vide (11, 31), reliés par une ligne de vide et comprenant chacun une pompe à vide (13, 33) et une unité de commande électronique locale (15, 35) destinée à contrôler et commander les paramètres de fonctionnement de la pompe respective, les deux dites unités de commande locales (15, 35) étant équipées d'un module de communication sans fil (27, 47) pour le dialogue avec ledit module de communication sans fil (55) de ladite unité de télécommande (53).

8. Système de pompage à vide (1) selon la revendication 7, dans lequel lesdits deux dispositifs de pompage (11, 31) comprennent une pompe turbomoléculaire (13) et une pompe à huile mécanique (33), respectivement.

9. Système de pompage à vide (1) selon la revendication 1, dans lequel ledit système comprend au moins deux dispositifs de pompage à vide fonctionnant indépendamment comprenant chacun une pompe à vide et une unité de commande électronique locale destinée à contrôler et commander les paramètres de fonctionnement de la pompe respective, les deux dites unités de commande locales étant équipées d'un module de communication sans fil pour le dialogue avec ledit module de communication sans fil (55) de ladite unité de télécommande (53).

10. Système de pompage à vide (1) selon la revendication 1 ou 7 ou 9, dans lequel lesdits dispositifs de pompage comprennent en outre une pluralité de dispositifs secondaires, tels que par exemple un détecteur de pression (19, 39) destiné à contrôler la pression résiduelle à l'intérieur dudit dispositif, un ventilateur (21) destiné à refroidir ledit dispositif, une soupape de mise à l'air libre (23), une soupape de purge (25), un détecteur d'huile (41) destiné à contrôler le niveau et la température d'un bain d'huile, une sou-

pape (43) destinée à commander l'ouverture/fermeture d'une ligne de vide pour connexion à un autre dispositif de pompage, le cas échéant.

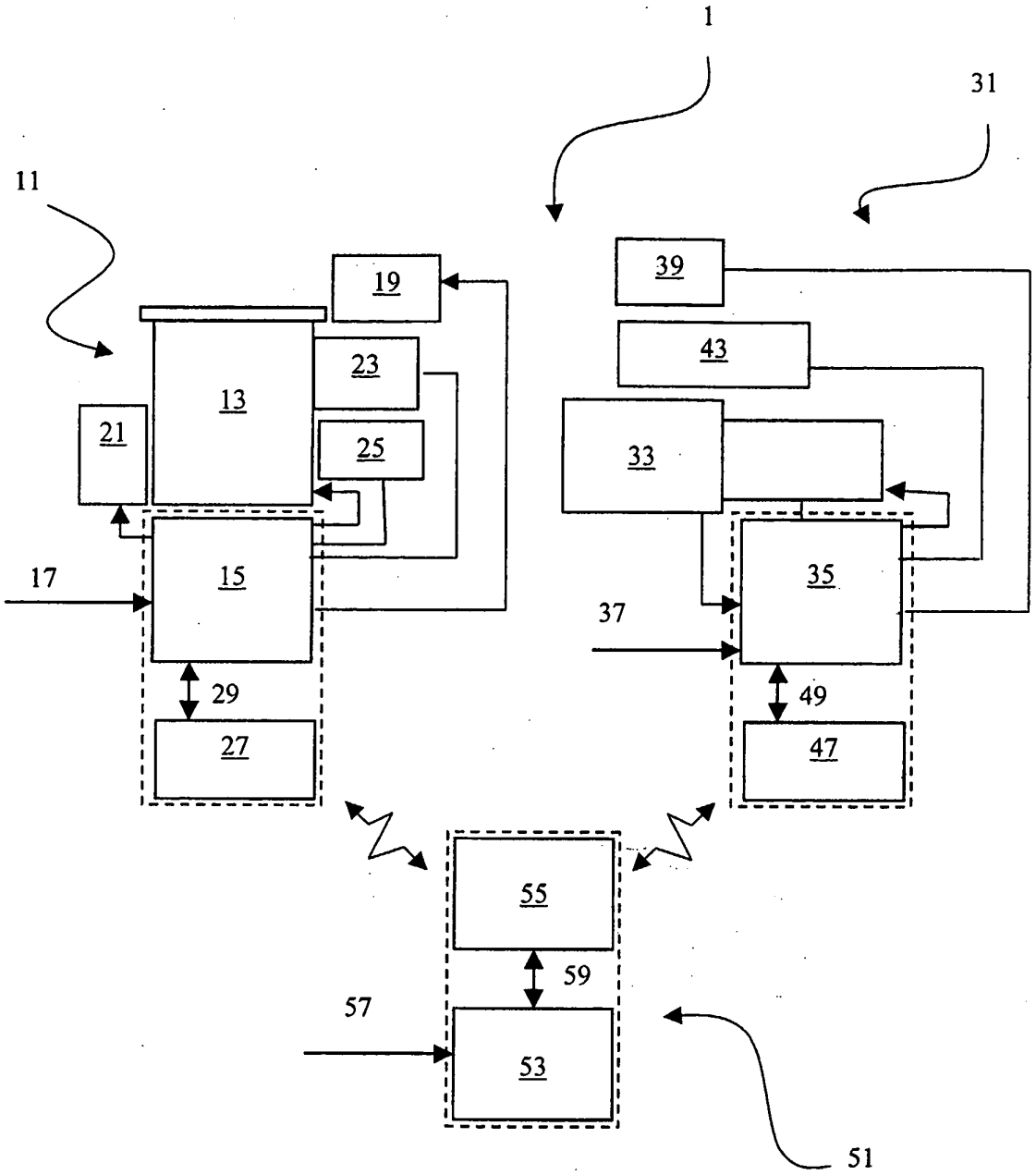
11. Système de pompage à vide (1) selon la revendication 1 ou 7 ou 9, dans lequel ladite unité de télécommande (53) est associée à un processeur électronique, au moyen duquel les paramètres de fonctionnement desdites pompes à vide (13, 33) peuvent être contrôlés et commandés par le biais desdites unités de commande locales (15, 35).

12. Système de pompage à vide (1) selon les revendications 10 et 11, dans lequel les paramètres de fonctionnement d'un ou plusieurs desdits dispositifs secondaires peuvent être contrôlés et commandés au moyen dudit processeur électronique.

13. Système de pompage à vide (1) selon l'une quelconque des revendications précédentes, dans lequel lesdits modules de communication sans fil (27, 47, 55) sont des modules de communication infrarouge.

14. Système de pompage à vide (1) selon l'une quelconque des revendications 1 à 12, dans lequel lesdits modules de communication sans fil (27, 47, 55) sont des modules de communication par radiofréquence.

15. Système de pompage à vide (1) selon l'une quelconque des revendications précédentes, dans lequel ladite station de commande (51) consiste en un dispositif portable.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