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

(11) EP 1 577 559 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.09.2005 Bulletin 2005/38

(51) Int Cl.[7]: **F04C 29/10**, F04B 49/06

(21) Application number: **04425172.6**

(22) Date of filing: **15.03.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(71) Applicant: **VARIAN S.p.A.**
10040 Leini' (Torino) (IT)

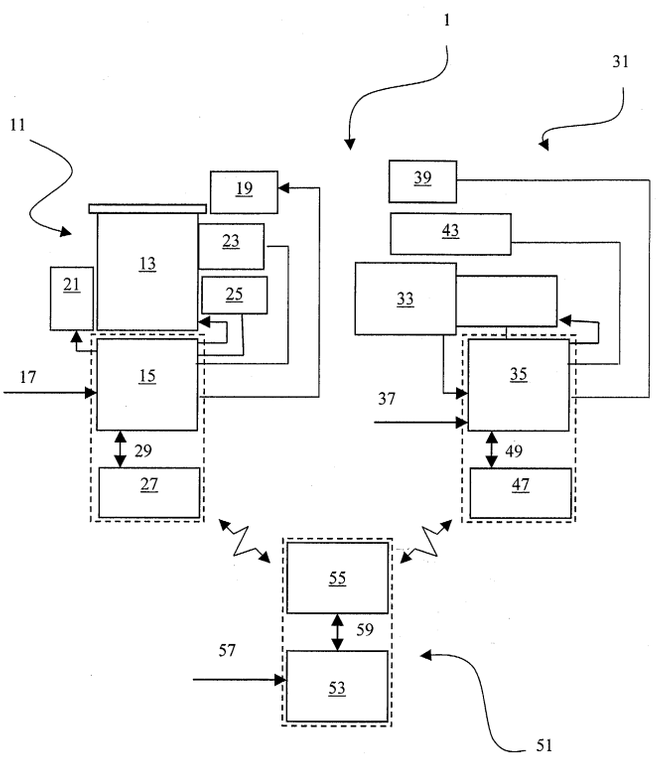
(72) Inventors:
- **Maccarrone, Cristian**
  10149 Torino (IT)
- **Titolo, Massimiliano**
  10145 Torino (IT)

(74) Representative: **Robba, Pierpaolo et al**
Interpatent,
Via Caboto 35
10129 Torino (IT)

Remarks:
Amended claims in accordance with Rule 86 (2) EPC.

(54) Vacuum pumping system

(57) The present invention concerns a vacuum pumping system (1) comprising at least one vacuum pumping device (11; 31), including a vacuum pump (13; 33) and a local electronic control unit (15; 35) for monitoring and controlling the operating parameters of said pump, and a control station (51), remotely located relative to said at least one pumping device (11; 31) and equipped with a corresponding remote control unit (53); wherein said remote control unit (53) and said local control unit (15; 35) are equipped with wireless communication modules (27, 55; 47, 55) for communicating data and commands for controlling the operation of said at least one vacuum pumping device.



EP 1 577 559 A1

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] 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.

[0013] 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.

[0014] Clearly, the higher the number of vacuum pumps in the pumping system, the more severe said drawbacks.

[0015] 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.

[0016] The above and other objects are achieved by the vacuum pumping system as claimed in the appended claims.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] In the embodiment shown, said vacuum pumping system 1 includes a high-vacuum pumping device 11 and a backing or fore pumping device 31.

[0022] 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.

[0023] 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.

[0024] 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

[0025] Said local electronic control units 15, 35 are preferably powered through the mains voltage, by means of corresponding power supply cables 17, 37.

[0026] 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.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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:

- at least one vacuum pumping device (11; 31), 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 at least one vacuum pumping device (11; 31) and equipped with a corresponding remote control unit (53);
  said remote control unit (53) and said local electronic control unit (15; 35) being equipped with corresponding communication modules (27, 55; 47, 55) for data and commands for controlling the operation of said at least one vacuum pumping device; the system being **characterised in that** said communication modules (27, 55; 47, 55) are wireless communication modules.

2. The vacuum pumping system (1) as claimed in claim 1, wherein said pumping device (11) comprises a turbomolecular pump (13).

3. The vacuum pumping system (1) as claimed in claim 1 or 2,
wherein said pumping device (11) comprises a backing pump (33).

4. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises a plurality of pumping devices, including 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).

5. The vacuum pumping system (1) as claimed in claim 4, wherein said two pumping devices (11, 31) comprise a turbomolecular pump (13) and an oil mechanical pump (33), respectively.

6. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises a plurality of pumping devices, including 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).

7. The vacuum pumping system (1) as claimed in claim 1 or 4 or 6,
wherein said pumping device(s) further comprise(s) 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.

8. The vacuum pumping system (1) as claimed in claim 1 or 4 or 6,
wherein said remote control unit (53) is associated with an electronic processor, by means of which the operating parameters of said vacuum pump(s) (13, 33) can be monitored and controlled through said local control unit(s) (15, 35).

9. The vacuum pumping system (1) as claimed in claims 7 and 8,
wherein the operating parameters of one or more of said secondary apparatuses can be monitored and controlled by means of said electronic processor.

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

11. The vacuum pumping system (1) as claimed in any of claim 1 to 9, wherein said wireless communication modules (27, 47, 55) are radiofrequency communication modules.

12. The vacuum pumping system (1) as claimed in any preceding claim, wherein said control station (51) consists in a portable device.

13. A vacuum pumping device (11; 31) including a vacuum pump (13; 33) and a local electronic control unit (15; 35) for monitoring and controlling the operating parameters of said pump, **characterised in that** said local control unit (15; 35) is equipped with a wireless communication module (27; 47) for communication of data and commands for controlling the operation of said pumping device.

14. The vacuum pumping device (11) as claimed in claim 13, wherein said vacuum pump is a turbomolecular pump (13).

15. The vacuum pumping device (31) as claimed in claim 13, wherein said vacuum pump is a backing pump (13).

16. The vacuum pumping device (11; 31) as claimed in any of claims 13 to 15, wherein said wireless communication module (27; 47) is an infrared communication module.

17. The vacuum pumping device (11; 31) as claimed in any of claims 13 to 15, wherein said wireless communication modules (27; 47) is a radiofrequency communication module.

Amended claims in accordance with Rule 86(2) EPC.

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

- at least one vacuum pumping device (11; 31), 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 at least one vacuum pumping device (11; 31) and equipped with a corresponding remote control unit (53);

said remote control unit (53) and said local electronic control unit (15; 35) being equipped with corresponding communication modules (27, 55; 47, 55) for data and commands for controlling the operation of said at least one vacuum pumping device;
the system being **characterised in that** said communication modules (27, 55; 47, 55) are wireless communication modules.

2. The vacuum pumping system (1) as claimed in claim 1, wherein said pumping device (11,31) operates at pressures lower than 10^{-4} mbars.

3. The vacuum pumping system (1) as claimed in claim 1 or 2, wherein said pumping device (11) comprises a turbomolecular pump (13).

4. The vacuum pumping system (1) as claimed in claim 1 or 2 or 3, wherein said pumping device (11) comprises a backing pump (33).

5. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises a plurality of pumping devices, including 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).

6. The vacuum pumping system (1) as claimed in claim 5, wherein said two pumping devices (11, 31) comprise a turbomolecular pump (13) and an oil mechanical pump (33), respectively.

7. The vacuum pumping system (1) as claimed in claim 1, wherein said system comprises a plurality of pumping devices, including 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).

8. The vacuum pumping system (1) as claimed in claim 1 or 5 or 7, wherein said pumping device(s) further comprise(s) 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.

9. The vacuum pumping system (1) as claimed in claim 1 or 5 or 7, wherein said remote control unit (53) is associated with an electronic processor, by means of which the operating parameters of said vacuum pump(s) (13, 33) can be monitored and controlled through said local control unit(s) (15, 35).

10. The vacuum pumping system (1) as claimed in claims 8 and 9, wherein the operating parameters of one or more of said secondary apparatuses can be monitored and controlled by means of said electronic processor.

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

12. The vacuum pumping system (1) as claimed in any of claim 1 to 10, wherein said wireless communication modules (27, 47, 55) are radiofrequency communication modules.

13. The vacuum pumping system (1) as claimed in any preceding claim, wherein said control station (51) consists in a portable device.

14. A vacuum pumping device (11; 31) including a vacuum pump (13; 33) and a local electronic control

unit (15; 35) for monitoring and controlling the operating parameters of said pump, **characterised in that** said local control unit (15; 35) is equipped with a wireless communication module (27; 47) for communication of data and commands for controlling the operation of said pumping device.

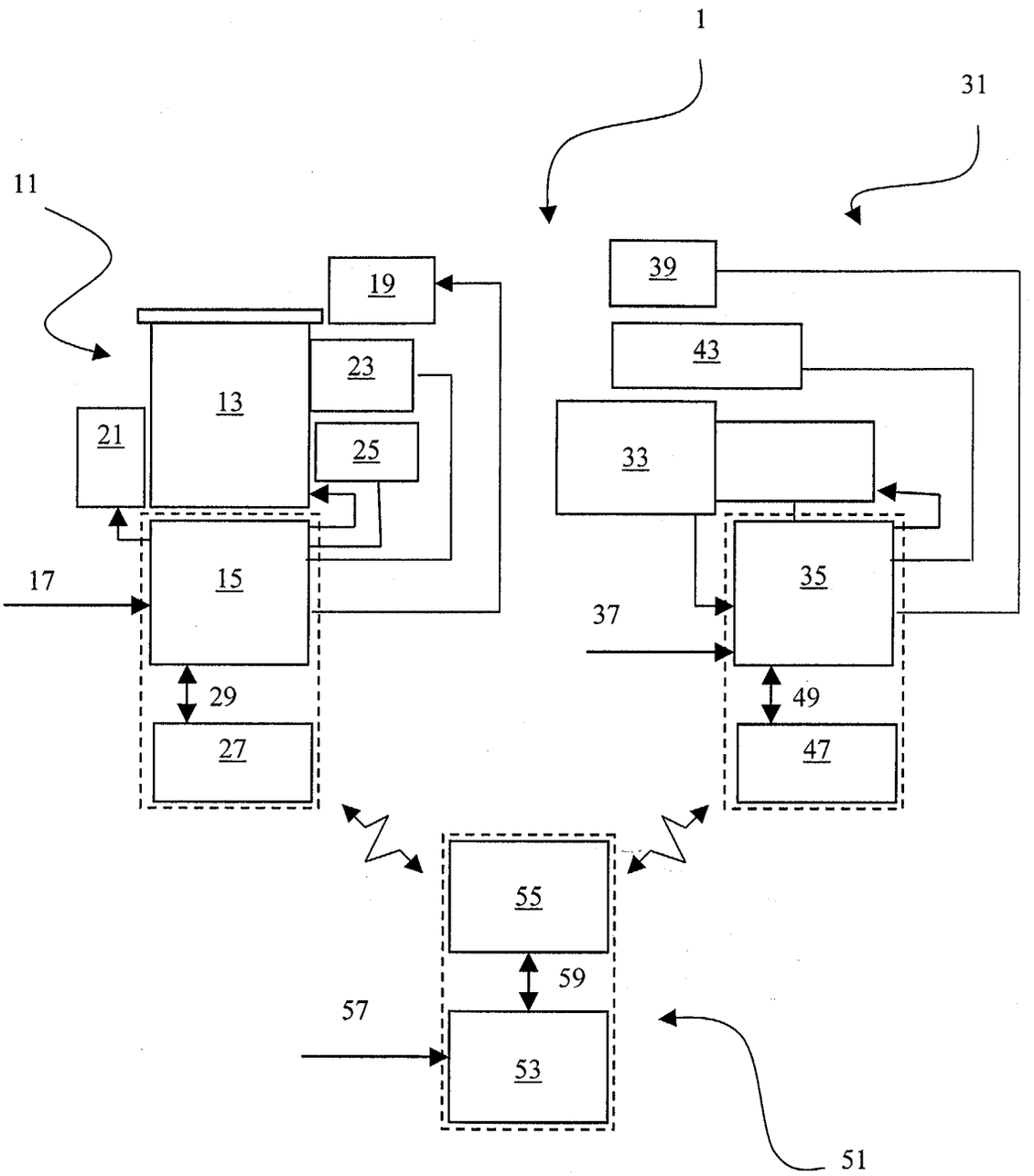
15. The vacuum pumping device (1) as claimed in claim 14, wherein said pumping device (11,31) operates at pressures lower than 10^{-4} mbars.

16. The vacuum pumping device (11) as claimed in claim 14 or 15, wherein said vacuum pump is a turbomolecular pump (13).

17. The vacuum pumping device (31) as claimed in claim 14 or 15, wherein said vacuum pump is a backing pump (13).

18. The vacuum pumping device (11; 31) as claimed in any of claims 14 to 17, wherein said wireless communication module (27; 47) is an infrared communication module.

19. The vacuum pumping device (11; 31) as claimed in any of claims 14 to 17, wherein said wireless communication modules (27; 47) is a radiofrequency communication module.


1
31
11
19
39
43
23
13
21
25
33
17
15
35
37
29
49
27
47
55
59
57
53
51

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5172

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
D,Y	US 5 971 711 A (NOBUHARU NOJI) 26 October 1999 (1999-10-26) * column 8, line 66 - column 10, line 15; figures 7-9 *	1-9, 11-15,17	F04C29/10 F04B49/06
Y	US 5 696 495 A (PIETZSCH) 9 December 1997 (1997-12-09) * column 3, line 26 - column 4, line 11; figures 1-3 * * column 4, line 60 - column 5, line 32; figure 5 *	1-9, 11-15,17	
A	US 5 713 724 A (CENTERS) 3 February 1998 (1998-02-03) * column 5, line 11 - column 10, line 41; figures 1-3 * * column 18, line 10 - column 19, line 16; figure 8 *	1-17	
A	EP 1 138 949 A (COPELAND CORP) 4 October 2001 (2001-10-04) * column 13, line 24 - line 44; figure 11 *	1-17	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F04C F04B
A	EP 1 197 661 A (COPELAND CORP) 17 April 2002 (2002-04-17) * column 11, line 32 - column 13, line 11; figure 16 *	1-17	
A	WO 98/30912 A (SCIENTIFIC-ATLANTA INC.) 16 July 1998 (1998-07-16) * page 1, last paragraph * * page 2, line 1 - page 6, line 11; figure 1 * * page 7, line 9 - line 11 *	1,13	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 July 2004	Kapoulas, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 42 5172

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

06-07-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5971711 A	26-10-1999	DE 69706472 D1	11-10-2001
		DE 69706472 T2	16-05-2002
		EP 0809164 A1	26-11-1997
		JP 10054369 A	24-02-1998
US 5696495 A	09-12-1997	DE 59008975 D1	01-06-1995
		WO 9104938 A1	18-04-1991
		EP 0447511 A1	25-09-1991
		JP 2599504 B2	09-04-1997
US 5713724 A	03-02-1998	CA 2163572 A1	24-05-1996
		GB 2295468 A	29-05-1996
		WO 9917178 A1	08-04-1999
		US 2002182082 A1	05-12-2002
		US 6529590 B1	04-03-2003
		US 6244824 B1	12-06-2001
		US 6450771 B1	17-09-2002
		US 6077051 A	20-06-2000
EP 1138949 A	04-10-2001	US 6302654 B1	16-10-2001
		AU 2320301 A	30-08-2001
		BR 0100912 A	30-10-2001
		CN 1311397 A	05-09-2001
		EP 1138949 A2	04-10-2001
		TW 546442 B	11-08-2003
		US 2002018724 A1	14-02-2002
EP 1197661 A	17-04-2002	US 6412293 B1	02-07-2002
		AU 7824401 A	18-04-2002
		BR 0104494 A	28-05-2002
		CN 1348064 A	08-05-2002
		EP 1197661 A1	17-04-2002
		EP 1413760 A2	28-04-2004
		JP 2002161878 A	07-06-2002
		TW 530126 B	01-05-2003
WO 9830912 A	16-07-1998	AU 5793998 A	03-08-1998
		TW 378299 B	01-01-2000
		WO 9830912 A2	16-07-1998
		US 6167389 A	26-12-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82