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

(11) EP 0 318 074 B2

(12) **NEW EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the opposition decision:
20.03.1996 Bulletin 1996/12

(45) Mention of the grant of the patent:
03.04.1991 Bulletin 1991/14

(51) Int Cl.[6]: **E01H 1/10**

(21) Application number: **88202385.6**

(22) Date of filing: **26.10.1988**

(54) **Device for cleaning runways**

Vorrichtung zum Reinigen von Startbahnen

Dispositif de nettoyage de pistes d'envol

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

(30) Priority: **27.11.1987 NL 8702856**

(43) Date of publication of application:
31.05.1989 Bulletin 1989/22

(73) Proprietor: **A. HAK INTERNATIONAL B.V.**
NL-4196 HG Tricht (NL)

(72) Inventor: **Hermans, Henry Marie**
NL-3233 GB Brielle (NL)

(74) Representative: **Baarslag, Aldert D. et al**
Nederlandsch Octrooibureau
Scheveningseweg 82
P.O. Box 29720
NL-2502 LS 's-Gravenhage (NL)

(56) References cited:

EP-A- 0 121 511	**DE-A- 3 538 539**
DE-B- 2 617 635	**DE-B- 2 736 587**
DE-C- 3 034 058	**FR-A- 2 515 536**
US-A- 3 848 804	**US-A- 3 959 010**

- **"Das Atümat-System für die Kanalreinigung", brochure of the firm WOMA Apparatebau Wolfgang Maasberg + Co. GmbH, 4100 Duisburg 14(DE), published 05.78**

EP 0 318 074 B2

Description

The invention relates to a device for cleaning a flat surface with powerful water jets, in particular for removing rubber from runways, comprising one or more nozzles which are connected by means of a pipe to a source of pressurized water, a circulation system which is movable with the nozzles, said system being at least provided with a water tank, a pump unit connected thereto for raising the water to high pressure, a hood with suction line fitted around the nozzles, filter means for removing solids from the water extracted from the hood said filter means including filter means for coarse particles and filter means for small particles, a return pipe to the tank and a cyclone.

Such a device is known from DE-A-3538539.

It is known that tyre marks on airport runways can form an impenetrable layer which prevents water from draining away when there is heavy rain. There is then a risk of aircraft aquaplaning on landing or take-off. Various methods of removing the rubber layer are known. Using chemicals to dissolve the rubber and water jets to flush the runway clean has the disadvantages that the tyres of aircraft travelling on the runway run the risk of being attacked and the environment is adversely affected. Besides, this method is timeconsuming. The runway in question has to be shut down for two days.

Another known method is to remove the rubber deposit using powerful water jets which are directed at the runway from nozzles at a distance of about 60 cm. The pressure used is, for example, about 400 bars and water consumption is 70 to 100 litres of water per minute. The water polluted with rubber particles goes into the environment, so that this method also is harmful to the environment. Other disadvantages are that water consumption is high and control is so imperfect that there is a great risk of the asphalt surface being damaged.

The device disclosed in DE-A-3538539 comprises flotation means for removing small particles. These flotation means include a collecting tank for pre-cleaned liquid, two flotation tanks, a bag-type filter for receiving stripped-off skim and a tank for taking up rest water. The five tanks are space consuming and heavy. Further very small particles cannot be removed efficiently. The vehicle on which the device is mounted is very heavy and big and a lot of liquid must be present.

The aim of the invention is to provide a cleaning device according to the preamble which is relatively light and small, which works with a small water volume, which has a small water consumption, which prevents filter clogging by coarse rubber lumps and which enables the user to clean the filter for removing very small particles by flushing.

Preferably a very high water pressure is used which means a pressure of the order of 1,800 to 2,400 bars. Less than 25 litres per minute is sprayed onto the runway. The re-circulation means that the rubber passes into filters and quite a considerable quantity of the water sprayed onto the runway is returned to the tank. The water consumption is therefore only about one quarter of the water consumption with the water jet method without re-circulation. Since most of the water is removed from the runway, the latter is always available for emergency landings. The tank can be made relatively small and can be carried on a vehicle with the nozzles.

The brochure "Das Atümat-System für die Kanalreinigung" of the firm Woma Apparatebau Wolfgang Maasberg & Co, GmbH, 4100 Duisberg 14 in Germany discloses a device for cleaning a sewer with powerful water jets, comprising a number of nozzles connected by a high pressure hose to a source of pressurized water, a suction hose, a circulating system provided with a water tank, a pump unit for raising the water to high pressure, and filter means for removing solids from the water including a first filter step being a pushing plate for pushing the solids together, a second filter step being a screening chamber, a third filter step being a suction filter, a fourth filter step being a cyclone filter and a fifth filter step being a fine filter.

This known device is not suitable for removing rubber from runways since the big rubber pieces would lead to clogging of the filter system.

Among others it is essential for the present invention that in the first filter step air is removed by a cyclone and the coarse lumps are filtered out at the bottom of the cyclone. Further it is of importance that the bag-type filters for removing parts bigger than 3 μm are located downstream of the cyclone and the activated carbon filter is located downstream of the bag-type filters.

The bag-type filters have to be replaced periodically, and in order to do this without interrupting the working of the device, two or more bag-type filters are disposed in parallel and valves are present in the pipes to the bag-type filters.

In order to achieve the very high water pressure (about 2,200 bars) which is necessary for the process, the high-pressure pump is designed as an intensifier provided with a hydraulically driven plunger system which converts relatively low pressure and high delivery into very high pressure and low delivery into very

A high suction output as regards the water in the nozzle hood is achieved if the suction hose opens out tangentially into the hood fitted around the nozzles.

Normally, a number of nozzles will be disposed on a rotary vertical shaft.

The high-pressure pump (intensifier) must be protected from solids being washed out of the tank. A duplex filter is therefore provided in the connection between the water tank and high-pressure pump.

The invention will now be explained in greater detail with reference to the figures, in which an embodiment is shown.

Fig. 1 shows a schematic view of the device according to the invention.

Figs. 2, 3 and 4 show a side view, a top view and a cross section respectively of the hood in which the jet

nozzles are disposed.

The device shown is intended for cleaning flat surfaces. Its particular object is to remove rubber deposits caused by aircraft tyres on airport runways. Use is made of powerful water jets which are directed towards the ground at a distance of about 15 cm from the ground. The two nozzles are indicated by 1 in Fig. 4. They are each disposed on the end of a pipe 2 which is connectecd to a central hollow shaft 3, which can be rotated by means of a drive mechanism 4. The nozzles are located in a round hood 5 into which a suction line 6 opens tangentially.

The hood 5 with nozzles is disposed on a vehicle 7. Fig. 1 shows schematically the whole device with the pressure generator, filters and recirculation systems. This device is placed on a vehicle which can also carry the hood 5 with nozzles.

This is not necessary, in other words the filter and recirculation system can be placed on a separate vehicle which follows the vehicle 7 on which the hood 5 is mounted.

The suction line 6 of the hood 5 is connected to a suction hose 8 which leads to a cyclone 9. Provision is made on the cyclone for a cabinet 10 which is connected by of a basket 11 to the inside of the cyclone, and to which a number of venturi fittings 12 are connected.

Compressed air produced by a compressor 13 can be conveyed through line 14 to the cabinet 10 opposite the venturi fittings 12, vacuum being created in the top part of the cyclone. The purpose of this vacuum is to carry the soiled water through the hose 8 to the cyclone and in conjunction with the functioning of the cyclone to separate off the soiled water.

On the bottom of the cyclone is a filter 15 for separating off relatively coarse fragments from the deaerated soiled water. A diaphragm pump 16 is connected by means of a line 17 to the discharge side and by means of a line 18 to the inlet side of the filter 15.

A ball valve 19, 20 is provided in each of the lines 17, 18.

The diaphragm pump 16 is connected to bag-type filters 22 and 23 by means of line 21 and two branches 21a and 21b. A valve 24a, 24b is fitted in each of the branches.

The soiled water coming from the cyclone is pumped by the pump 16 to one of the bag-type filters 22, 23, in which particles larger than 3 μm are recovered.

A line 25 connects the discharge side of the bag-type filters to a diaphragm pump 26, which is connected by means of line 27 to a sand activated carbon filter 28. The discharge side of said filter is connected by means of a line 29 to a water tank 30.

The fine particles are removed in the filter 28 from the water from which the coarse material has been removed, and the cleansed water flows back into the tank 30. From this tank water flows through pipe 31 to a hydraulically driven variable displacement pump 32 (intensifier) for the generation of ultra-high pressure (for example, 2,200 bars), while a duplex filter 33 is placed in the line 31. By means of a plunger system in this pump, oil displacement at relatively low pressure and relatively high delivery is converted into water displacement at relatively high pressure and relatively low delivery. Such an intensifier is known and is marketed, inter alia, under the named JETPAC. The intensifier pump is connected by means of line 34 to the nozzle hood 5.

By means of the re-circulation system in which a substantial part of the water sprayed onto the runway or other surface is recirculated to the tank 30, daily water consumption can be limited to 4 to 5 m^3. With known flushing systems it is 20 to 25 m^3. A very considerable part of the rubber removed goes into the filters 15, 22 or 23 and 28, so that there is little or no adverse effect on the environment.

It is extremely important that flushing can be controlled through the ultra-high pressure and the height setting of the hood 5 above the surface in such a way that there is little or no damage to the asphalt. The quantity of water sprayed on the asphalt is about 24.5 litres per minute. Since the water sprayed onto the runway is removed, the runway is always available for emergency landings.

The recycling ensures that the tank 30 can be relatively small, and is thus transportable on a vehicle.

The sand activated carbon filter has to be flushed clean from time to time. For this purpose, provision is made between the tank 30 and a branch point of the line 25 for a line 35, in which a valve 36 is placed. The flushing system also needs a valve 37 in the line 25, a valve 38 in the line 27, a line 39 connecting the lines 27 and 29 to valve 40, and a line 41 connecting lines 27 and 21 to valve 42, and a valve 43 in the line 29. Through closing of the valves 37, 38, 43 and opening of the valves 36, 40 and 42, the filter 28 can be flushed back, water being conveyed to a bag-type filter 22 or 23.

In normal operation one of the bag-type filters is always in use. Through operation of the valves 24a, 24b, it is possible to switch over from one bag-type filter to the other, and the used filter can be replaced without the work having to be interrupted.

Various modifications are possible within the scope of the invention as specified in the appended claims. The system described is very kind to the environment, uses little water, and does little or no damage to the surface. The runway is always available for emergency landings. The whole system is mobile.

Claims

1. Device for cleaning a flat surface with powerful water jets, in particular for removing rubber from runways, comprising one or more nozzles (1) which are connected by means of a pipe (2) to a source of pressurized water, a circulation system which is movable with the nozzles, said system being at least provided with a water tank (30), a pump unit (32) connected

thereto for raising the water to high pressure, a hood (5) with suction line (6, 8) fitted around the nozzles, filter means (15) for removing solids from the water extracted from the hood (5) said filter means including filter means for coarse particles and filter means (22, 23, 28) for small particles, a return pipe to the tank (30) and a cyclone (9) meant for the extraction of air from the water extracted from the hood, characterized in that the cyclone (9) is located directly downstream of the hood that the filter means (15) for removing coars lumps is directly connected to the bottom of the cyclone (9), that the filter means for removing small particles consists of at least one bag-type filter (22, 23) suitable for removing particles larger than 3 µm and located downstream of the cyclone (9), and an activated carbon filter (28) suitable for removing particles smaller than 3 µm and located downstream of the bag-type filter (22, 23), and that a liquid connection (35 resp. 41) is provided both between the tank (30) and the liquid discharge side of the activated carbon filter (28) and between the liquid infeed side of said filter (28) and the bag-type filter (22, 23) and switchable valves (36, 37, 38, 40, 42, 43) are present in the system to take tank water to the side of the activated carbon filter (28) which is normally the discharge side, for periodic flushing of the activated carbon filter, and for taking flushing water from the normal infeed side of the activated carbon filter to the bag-type filter (22, 23).

2. Device according to claim 1, characterized in that two or more bag-type filters (22, 23) are disposed in parallel and valves (24a, 24b) are present in the pipes (21a, 21b) to the bag-type filters.

3. Device according to claim 1 or 2, characterized in that a diaphragm pump (16 resp. 26) is provided in the liquid line (21a, 21b) between the cyclone (9) and the bag-type filter (22, 23) and in the liquid line (25, 27) between the bag-type filter (22, 23) and the activated carbon filter (28).

4. Device according to one of the preceding claims, characterized in that the high pressure pump (32) is an intensifier provided with a hydraulically driven plunger system which converts relatively low pressure and high delivery into relatively high pressure and low delivery.

5. Device according to one of the preceding claims, characterized in that the suction line (6, 8) opens out tangentially into the hood fitted round the nozzles (1).

6. Device according to one of the preceding claims, characterized in that a number of nozzles (1) are provided on a rotary vertical hollow shaft (3).

7. Device according to one of the preceding claims, characterized in that a duplex filter (33) is fitted in the connection between the water tank (30) and the high pressure pump (32).

Patentansprüche

1. Vorrichtung zum Reinigen einer flachen Oberfläche mit kräftigen Wasserstrahlen, insbesondere zum Beseitigen von Gummi von Startbahnen, mit einer oder mehreren Düsen (1), die über eine Leitung (2) mit einer Quelle für unter Druck stehendes Wasser verbunden sind, und mit einem Zirkulationssystem, das mit den Düsen beweglich ist, wobei dieses System wenigstens mit einem Wassertank (30), mit einer damit verbundenen Pumpeneinheit (32), um das Wasser auf den hohen Druck zu bringen, mit einer um den Düsen angebrachten Haube (5) mit einer Saugleitung (6, 8), mit einer Filtereinrichtung (15) zum Entfernen von Feststoffen aus dem Wasser, das aus der Haube (5) abgeleitet wird, wobei die Filtereinrichtung eine Filtereinrichtung für grobe Teilchen und eine Filtereinrichtung (22, 23, 28) für kleine Teilchen beinhaltet, mit einer Rückleitung zum Tank (30) und mit einem Zyklonabscheider (9) für das Entfernen von Luft aus dem aus der Haube abgeleiteten Wasser versehen ist, dadurch **gekennzeichnet**, daß der Zyklonabscheider (9) in Strömungsrichtung unmittelbar nach der Haube angeordnet ist, daß die Filtereinrichtung (15) zum Entfernen von groben Teilchen direkt mit dem Boden des Zyklonabscheiders (9) verbunden ist, daß die Filtereinrichtung zum Entfernen der kleinen Teilchen aus wenigstens einem Beutelfilter (22, 23), der für das Entfernen von Teilchen mit einer Größe von mehr als 3 µm geeignet ist und der in Strömungsrichtung nach dem Zyklonabscheider (9) angeordnet ist, und einem Aktivkohlefilter (28) besteht, der für das Entfernen von Teilchen mit einer Größe von weniger als 3 µm geeignet ist und der in Strömungsrichtung nach dem Beutelfilter (22, 23) angeordnet ist, daß eine Flüssigkeitsverbindung (35 bzw. 41) sowohl zwischen dem Tank (30) und der Flüssigkeitsabgabeseite des Aktivkohlefilters (28) als auch zwischen der Flüssigkeitszuführseite des Filters (28) und dem Beutelfilter (22, 23) vorgesehen ist, und daß umschaltbare Ventile (36, 37, 38, 40, 42, 43) im System vorhanden sind, um Tankwasser zu der Seite des Aktivkohlefilters (28) zu führen, die normalerweise die Abgabeseite ist, um den Aktivkohlefilter periodisch zu spülen und um Spülwasser von der Seite des Aktivkohlefilters, die normalerweise die Zuführseite ist, zum Beutelfilter (22, 23) zu führen.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß parallel zwei oder mehr Beutelfilter

(22, 23) vorgesehen sind, und daß in den Leitungen (21a, 21b) zu den Beutelfiltern Ventile (24a, 24b) angeordnet sind.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß in der Flüssigkeitsleitung (21a, 21b) zwischen dem Zyklonabscheider (9) und dem Beutelfilter (22, 23) und in der Flüssigkeitsleitung (25, 27) zwischen dem Beutelfilter (22, 23) und dem Aktivkohlefilter (28) eine Membranpumpe (16 bzw. 26) vorgesehen ist.

4. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die Hochdruckpumpe (32) eine Verstärkerpumpe ist, die mit einem hydraulisch angetriebenen Kolbensystem versehen ist, das einen relativ niedrigen Druck und eine hohe Zuführrate in einen relativ hohen Druck und eine geringe Zuführrate umwandelt.

5. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß sich die Saugleitung (6, 8) tangential in die um den Düsen (1) angebrachte Haube öffnet.

6. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß an einer sich drehenden, vertikalen Hohlwelle (3) eine Anzahl von Düsen (1) angebracht ist.

7. Vorrichtung nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß in die Verbindung zwischen dem Wassertank (30) und der Hochdruckpumpe (32) ein Duplexfilter eingesetzt ist.

Revendications

1. Dispositif pour nettoyer une surface plate au moyen de jets d'eau puissants, en particulier pour enlever le caoutchouc des pistes d'envol, comprenant une ou plusieurs tuyères (1) qui sont reliées au moyen d'un tuyau (2) à une source d'eau sous pression, un système de circulation qui peut être déplacé avec les tuyères, ledit système étant au moins muni d'un réservoir d'eau (30), d'une unité de pompage (32) reliée à celui-ci pour amener l'eau à une pression élevée, d'une cloche (5) comprenant une ligne d'aspiration (6, 8) disposée autour des tuyères, de moyens de filtrage (15) pour retirer les solides de l'eau extraite de la cloche (5), ledit moyen de filtrage comprenant un moyen de filtrage destiné aux particules grossières et un moyen de filtrage (22, 23, 28) destiné aux petites particules, d'une conduite de retour au réservoir (30) et d'un cyclone (9) destiné à l'extraction de l'air de l'eau extraite de la cloche, caractérisé par le fait que le cyclone (9) est situé directement en aval de la cloche, que le moyen de filtrage (15) destiné à retirer les fragments grossiers est directement relié au bas du cyclone (9), que le moyen de filtrage destiné à retirer les petites particules consiste en au moins un filtre du type à manche (22, 23) apte au retrait de particules supérieures à 3 µm et situé en aval du cyclone (9), et un filtre à charbon actif (28) apte au retrait de particules inférieures à 3 µm et situé en aval du filtre du type à manche (22, 23), et qu'une conduite de liquide (35 et 41, respectivement) est prévue à la fois entre le réservoir (30) et le côté de l'évacuation du filtre à charbon actif (28) et entre le côté de l'entrée du liquide dudit filtre (28) et le filtre du type à manche (22, 23) et que des valves commutables (36, 37, 38, 40, 42, 43) sont présentes dans le système pour amener de l'eau du réservoir au côté du filtre à charbon actif (28) qui est normalement le côté de l'évacuation, afin de rincer périodiquement le filtre à charbon actif, et d'amener l'eau de rinçage depuis le côté du filtre à charbon actif qui est normalement celui de l'entrée jusqu'au filtre du type à manche (22, 23).

2. Dispositif selon la revendication 1, caractérisé par le fait que deux ou plus de filtres du type à manche (22, 23) sont disposés en parallèle et des valves (24a, 24b) sont présentes dans les conduites (21a, 21b) amenant aux filtres du type à manche.

3. Dispositif selon la revendication 1 ou 2, caractérisé par le fait qu'une pompe à diaphragme (16 et 26, respectivement) est prévue sur le conduit de liquide (21a, 21b) entre le cyclone (9) et un filtre du type à manche (22, 23), et sur le conduit de liquide (25, 27) entre le filtre du type à manche (22, 23) et le filtre à charbon actif (28).

4. Dispositif selon l'une des revendications précédentes, caractérisé par le fait que la pompe à haute pression (32) est intensificateur muni d'un système de piston à entraînement hydraulique qui convertit une pression relativement faible et un débit élevé en une pression relativement élevée et en un débit faible.

5. Dispositif selon l'une des revendications précédentes, caractérisé par le fait que la ligne d'aspiration (6, 8) s'ouvre tangentiellement dans la cloche qui est disposée autour des tuyères (1).

6. Dispositif selon l'une des revendications précédentes, caractérisé par le fait qu'il est prévu une pluralité de tuyères (1) montées sur un arbre creux (3) tournant et vertical.

7. Dispositif selon l'une des revendications précédentes, caractérisé par le fait qu'un filtre double (33) est monté sur la liaison entre le réservoir d'eau (30) et la pompe à haute pression (32).

fig-1

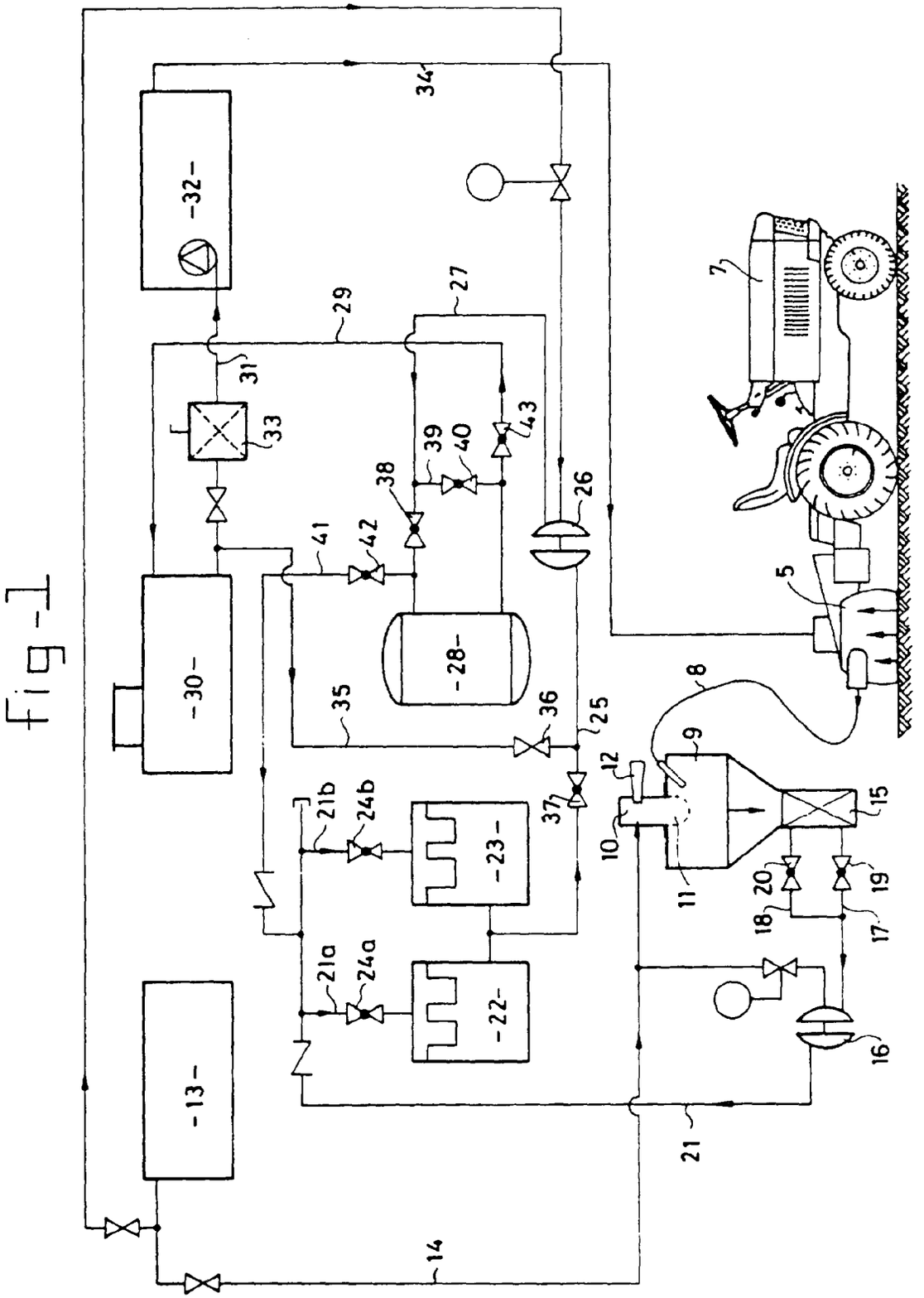
-32-
34
29
27
31
33
39
40
43
38
26
41
42
-30-
-28-
35
36
25
37
21b
24b
-23-
21a
24a
-22-
-13-
14
12
9
8
10
11
15
20
19
18
17
16
21
7
5

Fig-2

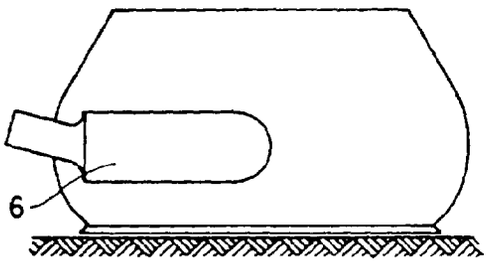

Fig-3

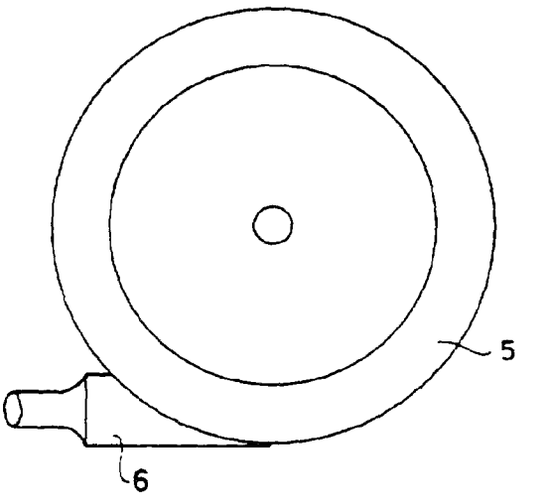

Fig-4