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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 August 2012 (16.08.2012)

(10) International Publication Number
WO 2012/107352 A1

(51) International Patent Classification: *F01N 3/20* (2006.01)

(21) International Application Number: PCT/EP2012/051809

(22) International Filing Date: 2 February 2012 (02.02.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data: 10 2011 010 644.8 9 February 2011 (09.02.2011) DE

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU,

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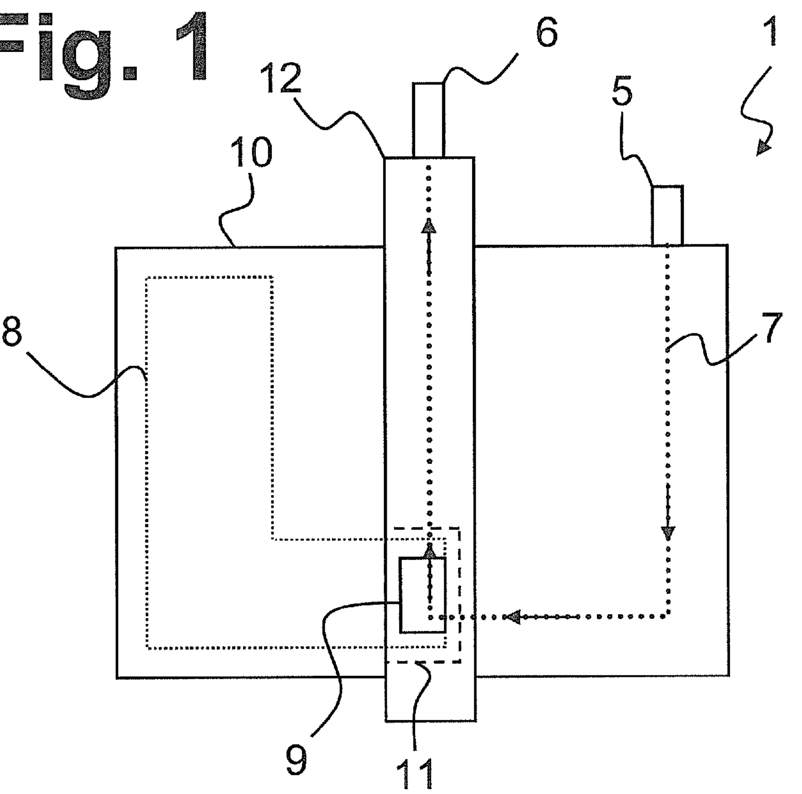
**(54) Title**: CONVEYING UNIT FOR A REDUCING AGENT

Fig. 1




**(57) Abstract**: The present invention relates to conveying unit (1) for conveying reducing agent from a tank (2) to an exhaust gas treatment device (3) for treating the exhaust gases from an internal combustion engine (4). The conveying unit (1) comprises a pump (8), wherein the pump (8) comprises a drive unit (10) and a pump chamber unit (11). The pump chamber unit (11), at least in part, limits a pump chamber (9), and the drive unit (10) and the pump chamber unit (11) are detachable from one another.

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TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17**:

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

**Published**:

— *with international search report (Art. 21(3))*

# Conveying unit for a reducing agent

The invention relates to a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine.

Exhaust gas treatment processes in which a reducing agent is fed to the exhaust gas to reduce pollutants in the exhaust gas have been used increasingly in recent years, in particular in the automotive industry. One such exhaust gas cleaning process is the process of selective catalytic reduction (SCR process). With this process, nitrogen oxide compounds in the exhaust gas, in particular, are reduced using a reducing agent. Ammonia is often used as a reducing agent. In particular in motor vehicles, ammonia is supplied not directly but in the form of a reducing agent precursor or in the form of a reducing precursor solution. Urea-water solution is an example of such a reducing agent precursor solution. Urea-water solution can be converted to ammonia in the exhaust gas. A 32.5 % urea-water solution is available under the trade name AdBlue®. The term "reducing agent" will be used hereinafter for the reducing agent itself and also for the reducing agent precursor solution.

A device for preparing urea-water solution faces the problem that urea-water solution freezes at temperatures of -11 °C. The term "freezes" herein is taken to mean the phase transition from solid to liquid. Temperatures of this type generally occur during the operation of internal combustion engines, in particular in the automotive industry, for example during prolonged idle periods in winter. A conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device must therefore be designed in such a way that it is not damaged by the freezing of reducing agent. In addition, it is necessary for the conveying unit to quickly be operative again if there is frozen reducing agent in the conveying unit. At the same time, the conveying unit should have maximum metering precision. It can thus be ensured that precisely the amount of reducing agent required for exhaust gas cleaning is fed to the exhaust gas treatment device in each case. Minimum reducing agent consumption can thus be achieved.

Starting from the foregoing, it is an object of the present invention to solve or at least mitigate the above-mentioned technical problems. In particular, a particularly cost-effective, freeze-proof, precisely metering conveying unit for reducing agents is to be disclosed.

These objects are achieved with a conveying unit having the features of claim 1. Further advantageous configurations are recited in the respective dependent claims. The features recited individually in the claims may be combined with one another in any technologically feasible manner and may be supplemented by explanatory facts from the description, further variants of the invention being illustrated.

The invention relates to a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine, comprising a pump, wherein the pump comprises a drive unit and a pump chamber unit, wherein the pump chamber unit, at least in part, limits a pump chamber and the drive unit and the pump chamber unit are detachably connected to one another.

The pump chamber is a compartment in the pump in which the driving power of the drive unit is converted into a movement of the reducing agent. This transfer of energy may be brought about, for example, by changing the volume or the shape of the pump chamber or by a mechanical transfer means. A mechanical transfer means may be, for example, an impeller. However, transfer by means of a change in the volume of the pump chamber is preferred here. This transfer mechanism is produced, for example, in piston pumps and diaphragm pumps.

In the past reducing agents were conventionally conveyed in conveying units using respective ready-made pumps, which were available as ready-made components from a pump manufacturer and used as a type of “black boy”. Pumps of this type have the advantage that they are cost-effective and reliable. They typically have a feed line and a return line which can each be connected to corresponding fittings on the conveying unit. Pumps of this type can therefore only be replaced as a whole. The present invention departs from this approach by proposing that the pump chamber of a pump be arranged at least in part in a pump chamber unit. According to the present invention, a drive unit which may be fixed to the pump chamber unit exists separately from this pump chamber unit. The drive unit and the pump chamber unit may be replaced separately from one another. This subdivision makes the construction of the overall pump more complex than the construction of the above-described formerly conventional pumps. On the other hand, the drive arranged in the drive unit and the pump chamber arranged in the pump chamber unit can each be adapted separately to the respective requirements of reducing agent conveyance. The configuration according to the invention also enables separate replacement of the drive unit and the pump chamber unit if the drive unit or the pump chamber unit is damaged. The expression “the pump chamber unit, at least in part, limits a pump chamber” is taken to mean, in particular, that the pump chamber unit forms at least a part of the pump chamber wall. The pump chamber may additionally be limited by a diaphragm which then also forms a part of the pump chamber wall.

In a particularly advantageous development, the conveying unit according to the invention comprises a flange to which the drive unit is fastened and the pump chamber unit is formed at least in part by the flange.

The term “flange” in this context is taken to mean, in particular, a common carrier structure on which all components of the conveying unit are mounted. The expression “components” is taken to mean, for example, the above-described pump drive unit, various valves, various sensors and/or compensating members for compensating the increase in volume of the reducing agent when it freezes. A filter for filtering the reducing agent may also be a component of the conveying unit. The flange may be constructed, for example, as a metallic structure. The preferred material for the flange is aluminium because aluminium has high thermal conductivity on the one hand and is very light on the other hand. The flange is preferably configured in the form of a plate, the individual described components being mounted on one or both sides of the flange. The material of the flange is preferably a good conductor of heat so that heat introduced into the conveying unit by a heating system is well distributed in the individual components of the conveying unit.

The pump chamber unit is preferably a constituent of the flange. The pump chamber may be constructed, for example, as a cavity, recess or indentation in the flange. The drive unit is preferably mounted on the flange in such a way that the drive of the conveying unit acts on the pump chamber unit. The pump is preferably a reciprocating pump, for example a piston pump, a diaphragm pump or a piston/diaphragm pump. The drive unit preferably has a rotary drive which performs a rotational movement which is then converted by a transfer element into a reciprocating or linear movement of a movable pump element. This movement has a regularly alternating direction of movement and an upper return point and a lower return point. The transfer element may be constructed, for example, in the form of an eccentric member and a connecting rod or in the form of a camshaft or a cam disc. Alternatively, however, it is also possible that the drive unit includes a linear drive which directly performs a linear movement. This may be, for example, an electric linear drive. If the drive unit comprises a linear drive, it is not necessary to provide a transfer element for converting the movement of the drive into a linear movement of the movable pump element. The linear movement of the movable pump element is used uniformly to increase or decrease the volume of the pump chamber.

In a particularly advantageous development of the conveying unit according to the invention, the pump chamber unit and the drive unit are separated by a pump diaphragm. A movable drive unit pump element can then act directly on the pump diaphragm which then uniformly increases and decreases the volume of the pump chamber unit so that the pump conveys reducing agent. However, the pump diaphragm can also itself be considered as a constituent of the movable pump element.

In this connection, it is also particularly advantageous if the pump chamber unit is constructed in the form of a half shell and the pump chamber is limited by the pump chamber unit and by the pump membrane. The pump chamber may be constructed, for example, as a recess in a flange of the conveying unit. This recess can be covered by the pump diaphragm. The drive unit can then be positioned on the flange so that it covers the pump diaphragm and a movable pump element of the drive unit can move the pump diaphragm.

In a further advantageous development of the conveying unit according to the invention, the pump chamber unit comprises a principal compartment and a spur duct branching from the principal compartment, and at least one inlet valve and at least one outlet valve adjoin the spur duct.

This approach can also be adopted independently of the remaining features of the invention described here. In particular, a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine is proposed, comprising a pump, wherein the pump chamber comprises a principal compartment and a spur duct branching from the principal compartment, and at least one inlet valve and at least one outlet valve adjoin the spur duct. A conveying unit of this type may optionally be combined with any other features described here, without the need to embody the features recited in claim 1.

Reducing agent can pass from an intake side of the pump through the inlet valve into the pump chamber. Reducing agent can pass from the pump chamber through the outlet valve to an outlet side of the pump. The inlet valve and the outlet valve together determine the conveying direction of the pump.

The term “spur duct” also covers, in particular, a spur duct system consisting of a plurality of individual ducts branching from a principal compartment of the pump chamber. Within the meaning of the present invention, a spur duct is in particular present, when during admission of the reducing agent into the pump chamber or into the principal compartment of the pump chamber through the inlet valve and the spur duct or the spur duct system and during discharge of the reducing agent from the pump chamber or from the principal compartment of the pump chamber through the spur duct or the spur duct system and the outlet valve, the reducing agent at least in part travels the same path through the spur duct. The direction of flow of the reducing agent in the spur duct or in the spur duct system therefore has to be reversed, at least in some regions, during the changeover from intake through the inlet valve to discharge through the outlet valve. A spur duct system which is understood as a spur duct within the meaning of the present invention is characterised, in particular, in that there is a connection, through which reducing agent can pass, between the individual ducts of the spur duct system, the connection being arranged closer to the inlet valve and the outlet valve than the principal compartment of the pump chamber is. In regard to the arrangement of the spur duct it is preferred that the spur duct is aligned substantially in a horizontal manner, i.e. the spur duct is arranged above the pump chamber. Thereby, air bubbles might be removed easily, if air bubbles were formed within the pump chamber.

A particularly small pump chamber dead volume can be achieved as a result of the described configuration of the pump chamber with a principal compartment and a spur duct. The dead volume is the smallest volume which emerges as a result of the deflection of the pump diaphragm. The movable pump element is typically located at a lower return point when the dead volume is located in the pump chamber. In the case of a diaphragm pump or a piston pump, the dead volume exists in the pump chamber when the diaphragm or the piston are located at their lower return point.

In a particularly advantageous development of the conveying unit according to the invention, the spur duct from the principal compartment to the inlet valve and to the outlet valve has a length of between 1 mm (millimetre) and 20 mm.

In a further advantageous development of the conveying unit according to the invention, the spur duct has a cross-sectional area of between 0.1 $mm^2$ [square millimetre] and 4 $mm^2$ per litre of the maximum capacity of the pump per hour, in particular between 0,1 $mm^2$ and 2 $mm^2$.

The resistance to flow of the reducing agent as it enters the pump chamber and is discharged from the pump chamber basically depends on the length of the spur duct from the principal compartment to the inlet valve and to the outlet valve and on the cross-sectional area of the spur duct. Therefore, it is particularly advantageous if the length and the cross-sectional area are dimensioned according to the capacity of the conveying pump. At the same time, a greater length of the spur duct allows particularly flexible positioning of the inlet valve and the outlet valve of the pump. This in turn simplifies design, assembly and maintenance of the conveying unit according to the invention.

According to a further advantageous development of the conveying unit according to the invention, the pump chamber has a chamber volume which can be reduced during a pumping procedure to a dead volume, wherein the dead volume is less than 20 %, preferably less than 10 % and particularly preferably less than 5 % of the chamber volume. A large difference of this type between the dead volume and the chamber volume may be achieved, in particular, by the configuration according to the invention of the pump chamber with a principal compartment and a branching spur duct.

In a further advantageous development of the conveying unit according to the invention, the pump has a rotary drive, a movable pump element and a transfer element for converting a rotational movement of the rotary drive into a linear movement of the movable pump element, wherein at least one smoothing means is provided for smoothing the movement of the movable pump element.

This approach can also be adopted independently of the remaining features of the conveying unit according to the invention. In particular, a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine is provided, comprising a pump, wherein the pump comprises a rotary drive, a movable pump element and a transfer element for converting a rotational movement of the rotary drive into a linear movement of the movable pump element, wherein at least one smoothing means is provided for smoothing the movement of the movable pump element. A conveying unit of this type may optionally be combined with any other features described here, without the need to embody the features recited in claim 1.

Typical transfer elements for converting a rotational movement into a linear movement produce a linear movement having at least a sinusoidal component. If a connecting rod converts a uniform rotational movement into a linear movement, the linear movement has a respective upper and lower return point. The linear movement has the highest speed exactly in the centre between the two return points in each case. The speed decreases and increases sinusoidally toward the respective return points, and the direction of movement changes at the return points.

A movement of this type which is at least in part sinusoidal has a drawback for a metering pump. The speed of movement of the movable pump element determines the delivery rate of the conveying pump. Owing to the sinusoidal movement, therefore, the delivery rate is not uniform but varies. That is undesirable, in particular for a metering pump which is to have a uniform output. To overcome this problem, it is proposed to provide at least one smoothing means which smoothes and, in particular, linearises the movement of the movable element. In a first variant, smoothing means can be produced mechanically in the movable pump element. For example, a special eccentric member in the form of a cam disc can be used, which is so shaped that the movement of the movable pump element is linear at least in some regions. It is also possible to provide a specific connecting rod or a specific connecting rod system which linearises the conversion of the rotational movement into a linear movement. A connecting rod system can consist of a plurality of interconnected connecting rods.

In a second variant, a smoothing means can be produced in the form of a rotary drive controller. It is possible, for example, that the rotary drive drives the transfer element at variable speed and the irregular transfer of the movement by the transfer element is thus compensated at least in part. Complete linearization of the movement of the movable pump element is not possible, in particular in the region of the return points of the movable pump element. The direction of movement of the movable pump element is reversed at the return points. For this purpose, the movable pump element has to be initially decelerated and then accelerated. A deviation from an exactly linearised movement is required to decelerate and to accelerate the movable pump element respectively. Here, sensing means for monitoring the motion of the pump element can be provided, i.e. a magnetic sensor, an optical sensor or a pressure sensor, which detects pressure fluctuations (indirectly) in the conveyed reducing agent due to an insufficient linearised movement.

In a further advantageous development, the conveying unit according to the invention comprises a control device which is configured to operate the pump for a test run with minimal driving power in order to determine whether frozen reducing agent in the conveying unit is impeding operation of the pump.

This approach can also be adopted independently of the further features of the conveying unit according to the invention. In particular, a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine is provided, comprising a pump, wherein the conveying unit comprises a control device which is configured to operate the pump for a test run with minimal driving power in order to determine whether frozen reducing agent in the conveying unit is impeding operation of the pump. A conveying unit of this type may optionally be combined with any other features described here, without the need to embody the features recited in claim 1.

The invention also relates to a process for operating a conveying unit for conveying reducing agent from a tank to an exhaust gas treatment device for treating the exhaust gases from an internal combustion engine, comprising a pump, wherein the process comprises the following steps:

a) activation of a pump drive with minimal driving power,

b) checking whether the movable pump element is moving,

c) deactivating the drive if the movable pump element is not moving,

d) increasing the driving power if a movement of the movable pump element has been established in step b).

It is also possible to establish indirectly whether the movable pump element is moving, by checking whether the rotary drive is moving. This is possible, in particular, if the rotary drive and the movable pump element are coupled to one another via the transfer element. Damage to the pump can be prevented by initially checking at a low driving power whether free movement of the movable pump element is possible. The pump can easily be damaged if it develops its full driving power while the movement of the movable pump element or the drive is impeded by frozen reducing agent, for example in the pump chamber.

The invention and the technical field will be described in greater detail hereinafter with reference to the figures. The figures show particularly preferred embodiments, although the invention is not limited thereto. In particular it is pointed out that the figures and, in particular, the dimensions shown are merely schematic. In the figures,

Fig. 1 shows a variant of a conveying unit according to the invention,

Fig. 2 shows a first variant of a pump of a conveying unit according to the invention,

Fig. 3 shows a second variant of a pump of a conveying unit according to the invention.

Fig. 4 shows a view of a pump chamber unit for a pump of a conveying unit according to the invention,

Fig. 5 shows a section of the pump chamber unit according to Fig. 4,

Fig. 6 shows a valve for a pump for a conveying unit according to the invention,

Fig. 7 shows a section of the valve according to Fig. 6,

Fig. 8 shows a motor vehicle comprising a conveying unit according to the invention,

Fig. 9 shows a graph of the speeds of the rotary drive and of the movable pump element,

Fig. 10 shows a pump for a conveying unit according to the invention,

Fig. 11 shows a section through a flange of a conveying unit according to the invention,

Fig. 12 shows a detail of the illustration in Fig. 11,

Fig. 13shows a first exploded view of Fig. 11,

Fig. 14shows a second exploded view of Fig. 11,

Fig. 15 shows a further section through a flange of a conveying unit according to the invention,

Fig. 16 shows a detail from Fig. 15,

Fig. 17 shows a further detail from Fig. 15,

Fig. 18 shows a first exploded view of Fig. 15, and

Fig. 19 shows a second exploded view of Fig. 15.

Fig. 1 shows a conveying unit 1 according to the invention comprising a flange 12. The various components of the conveying unit 1 are mounted on this flange 12. According to Fig. 1, for example, a drive unit 10 for a pump 8 is fixed on the flange 12. In addition to the drive unit 10, the pump 8 comprises a pump chamber unit 11. The pump chamber unit 11 is a constituent of the flange 12. The pump chamber 9 is located in the pump chamber unit 11. A conveyance path 7 through the conveying unit 1 extends from an inlet fitting 5 through the pump chamber 9 in the pump chamber unit 11 to an outlet fitting 6.

Fig. 2 is a detailed view of a first variant of the pump 8 showing the drive unit 10 and the pump chamber unit 11. The drive unit 10 comprises a motor 28 which drives an eccentric member 30 via a gear 29. The motor 28, the gear 29 and the eccentric member 30 together form the rotary drive 20. The movement of the eccentric member 30 is transferred via a transfer element 22 to the movable pump element 21. In the transfer element 22 there can optionally be provided a smoothing means 23 by means of which the conversion of the rotational movement of the rotary drive 20 into the linear movement of the movable pump element 21 can be smoothed. The pump chamber 9 can initially be seen in the pump chamber unit 11. The pump chamber 9 consists of a principal compartment 14 and a spur duct 15. An arrow in the spur duct 15 indicates how the reducing agent flows into the pump chamber 9 during intake and flows out of the pump chamber 9 during discharge, alternately in different respective directions in the spur duct 15. The inlet valve 16 and the outlet valve 17 adjoin the spur duct 15. The inlet valve 16 and the outlet valve 17 are preferably identical in construction. A path 7 for the conveyance of reducing agent through the pump 8 extends from the inlet valve 16 through the spur duct 15 into the principal compartment 14 of the pump chamber 9 and back through the spur duct 15 and the outlet valve 17. The inlet valve 16 and the outlet valve 17 are inserted into a corresponding passage in the pump chamber unit 11.

In the second variant of the pump 8 shown in Fig. 3, the illustration focuses on different aspects from Fig. 2. In this case, the pump chamber 9 is merely shown schematically. A smoothing means 23 for smoothing the transfer of the rotational movement of the rotary drive 20 into the linear movement of the movable pump element 21, arranged on the transfer element 22, is not illustrated either. Instead, a pressure sensor 31 is illustrated which adjoins the conveyance path 7 through the pump 8. The pressure in the conveyance path downstream of the pump 8 can be established by this pressure sensor 31. The pressure measured by the pressure sensor 31 can be evaluated in a controller 32 so that the rotary drive 20 of the pump 8 is controlled in such a way that the rotational movement of the rotary drive 20 takes place in such a way that the linear movement of the movable pump element 21 is linear at least in some regions or in part. Fig. 3 also shows that the drive unit 10 comprises a housing 33 which is open on one side and sealed on the pump chamber unit 11 by a seal 34. The pump chamber unit 11 can be a constituent of a flange of the conveying unit 1 according to the invention. The housing 33 which is open on one side can thus cover further components such as the pressure sensor 31, the controller 33 or also a temperature sensor (not shown here) in addition to the rotary drive 20 of the pump 8. These components need not be direct constituents of the pump 8. The pump 8 and further components of the conveying unit 1 according to the invention can thus be integrated with one another.

Fig. 4 is a view of a pump chamber unit 11 for a pump 8 of a conveying unit 1 according to the invention, showing the principal compartment 14 of the pump chamber 9. The spur duct 15 branches from the principal compartment 14. The inlet valve 16 and the outlet valve 17 adjoining the spur duct 15 are shown in broken lines below the principal compartment 14.

The principal compartment 14 and the spur duct 15 forming the pump chamber 9 are shown in the section in Fig. 5. The manner in which the inlet valve 16 and the outlet valve 17 adjoin the spur duct 15 is also shown. A pump diaphragm 13 which limits the pump chamber 9 is additionally shown. The chamber volume 37 which exists when a movable pump element 21 is at the upper return point is shown in broken lines. The chamber volume 37 corresponds to the maximum volume occurring in the pump chamber 9 during conveyance. The dead volume 36 which corresponds to the minimum volume of the pump chamber 9 during conveyance is also indicated. This dead volume 36 exists in the pump chamber 9 when the movable pump element 21 is located at its lower return point. Fig. 5 also shows a length 35 of the spur duct 15 from the principal compartment 14 of the pump chamber 9 to the inlet valve 16 and to the outlet valve 17. The cross-section 38 of the spur duct 15 is further indicated in broken lines.

Fig. 6 shows an inlet valve 16 which may be used in a particularly advantageous manner in the conveying unit 1 according to the invention.

A valve corresponding to the illustrated inlet valve 16 can also be used as an outlet valve 17. The inlet valve 16 comprises a base body 18 which is rotationally symmetrical. The valve ducts and mechanism are indicated in broken lines in the base body 18. The base body 18 has a circumferential connecting duct 19 which communicates with the internal ducts in the inlet valve 16. An inlet valve 16 of this type may be positioned as desired in a passage in a pump chamber unit 11 of a conveying unit 1 according to the invention and, by means of the circumferential duct, can produce a connection to a channel which opens laterally into the passage.

To clarify the illustration in Fig. 6, Fig. 7 shows a further section through the inlet valve 16 in Fig. 6.

Fig. 8 shows a motor vehicle 27 comprising an internal combustion engine 4 and an exhaust gas treatment device 3 for cleaning the exhaust gases from the internal combustion engine 4. The motor vehicle 27 comprises a tank 2 for storing reducing agent. Reducing agent can be conveyed from the tank 2 through an intake pipe 24 to a conveying unit 1. The conveying unit 1 then conveys the reducing agent through an outlet pipe 25 to an injector 26 which feeds the reducing agent to the exhaust gas treatment device 3.

Fig. 9 shows a graph of the speeds of a rotary drive 20 and a movable pump element 21. The speed of movement of the rotary drive 20 is illustrated by a dotted line whereas the speed of the movable pump element is illustrated by a continuous line. The two bold lines belong together as do the two faint lines. The movement of the rotary drive 20 is transferred to the movable pump element 21 in this case by means of a respective transfer element 22 which does not have a smoothing means 23. The speeds are plotted on the speed axis 46 with respect to the time axis 47 in each case. According to the bold dotted line, the rotary drive 20 is operated at a constant speed. This produces the sinusoidal speed of movement of the movable pump element 21 corresponding to the bold continuous line. According to the faint dotted line, the rotary drive 20 is operated at a regularly varying speed. The rotary drive 20 is driven faster in some regions in order to linearise the movement of the movable pump element 21 at least in some regions, as can be inferred from the faint continuous line showing the speed of the movable pump element 21 produced when the rotary drive is driven in accordance with the faint dotted curve. However, complete linearization is not possible, in particular in the region of the reversals of the direction of movement of the movable pump element 21 at the upper return point and at the lower return point. For this it would in fact be necessary for the rotary drive 20 to be operated at extremely high speeds.

Fig. 10 shows an example of a smoothing means 23 on the transfer element 22, illustrating a pump 8 for a conveying unit 1 according to the invention with a rotary drive 20. The movement of the rotary drive 20 is transferred to the movable pump element 21 via the transfer element 22. The transfer element 22 is constructed as a camshaft or as a cam disc. The smoothing means 23 is produced by configuring the pitch of the camshaft or of the cam disc in such a way that the movement of the movable pump element 21 is uniform, at least in some regions, during uniform movement of the rotary drive 20. The movable pump element 21 is moved to and fro between the upper return point 48 and the lower return point 45. The pump chamber 9, of which the volume is increased and decreased by the movement of the movable pump element 21, is merely schematically indicated.

Fig. 11 shows a flange 12 for a conveying unit 1 with a few accessories. For example, the outlet fitting 6 can be seen.

Fig. 12 shows a detail from Fig. 11 which is designated by XII in this figure. A duct 40 can be seen, through which the conveyance path of the conveying unit 1 extends. A pressure sensor 31 is arranged on the duct 40.

Fig. 13 is an exploded view of the flange 12 according to Fig. 11. It can be seen how the biased ice pressure compensation means 39 is mounted on the flange 12 via the first diaphragm 41. The outlet fitting 6 is also shown in Fig. 13 for orientation purposes. In Fig. 13 it can also be seen that a duct 40 in the flange 8 may also be located on the surface of the flange 8, the duct then being closable by an accessory 42 which is sealed against the flange 12 by an O-ring seal 43.

In Fig. 14 it is possible to see how a temperature sensor 44 and a pressure sensor 31 are attached to the flange 12. An O-ring seal 43 is additionally provided on the flange 8, surrounds the temperature sensor 44 and the pressure sensor 31, and can be used to form a splash-proof seal between the flange 12 and a cover (not shown here). This cover may be formed by a pump head (not shown). A pump chamber 9 can also be seen in Fig. 14. The pump chamber 9 is a constituent of the flange 12. A pump diaphragm 13 can be placed over the pump chamber 9. This pump diaphragm 13 can be moved by a drive unit 10 (also not shown here) in order to convey reducing agent. The drive unit 10 is preferably disposed in the pump head (not shown).

Fig. 15 is a further sectional view through a conveying unit 1 according to the invention with a flange 12. Details from Fig. 15 are shown in Figs 16 and 17 respectively.

Fig. 16 shows the inlet valve 16 and the outlet valve 17 of the pump 8 of the conveying unit 1 which are inserted into the flange 12 through a passage. The inlet valve 16 and the outlet valve 17 are biased in the passage by a resilient element constructed as a spring. The inlet valve 16 and the outlet valve 17 are thus movable when the pressure in the conveying unit 1 exceeds a threshold pressure. A biased ice pressure compensation element 39 is thus formed. The inlet valve 16 and the outlet valve 17 communicate with the pump chamber 9 via a spur duct 15.

Fig. 17 illustrates the outlet fitting 6, which is also fixed by a spring-loaded element constructed as a spring in a passage in the flange 12. The outlet fitting 6 is thus also movable when the pressure in the conveying unit 1 exceeds a threshold pressure. A biased ice pressure compensation element 39 is thus also formed on the outlet fitting 6.

Figs 18 and 19 are respective exploded views, showing how the inlet valve 16 and the outlet valve 17 or the outlet fitting 6 are inserted into the flange 8. The pump chamber 9 formed on the flange 12 can also be seen.

List of reference numerals

| | |
|---|---|
| 1 | conveying unit |
| 2 | tank |
| 3 | exhaust gas treatment device |
| 4 | internal combustion engine |
| 5 | intake fitting |
| 6 | outlet fitting |
| 7 | conveyance path |
| 8 | pump |
| 9 | pump chamber |
| 10 | drive unit |
| 11 | pump chamber unit |
| 12 | flange |
| 13 | pump diaphragm |
| 14 | principal compartment |
| 15 | spur duct |
| 16 | inlet valve |
| 17 | outlet valve |
| 18 | base body |
| 19 | connecting duct |
| 20 | rotary drive |
| 21 | movable pump element |
| 22 | transfer element |
| 23 | smoothing means |
| 24 | intake pipe |
| 25 | outlet pipe |
| 26 | injector |
| 27 | motor vehicle |
| 28 | motor |
| 29 | gear |
| 30 | eccentric member |
| 31 | pressure sensor |
| 32 | controller |
| 33 | housing |
| 34 | seal |

| | |
|---|---|
| 35 | length |
| 36 | dead volume |
| 37 | chamber volume |
| 38 | cross-section |
| 39 | biased compensating element |
| 40 | duct |
| 41 | first diaphragm |
| 42 | accessory |
| 43 | O-ring seal |
| 44 | temperature sensor |
| 45 | lower return point |
| 46 | speed axis |
| 47 | time axis |
| 48 | upper return point |

Claims

1. Conveying unit (1) for conveying reducing agent from a tank (2) to an exhaust gas treatment device (3) for treating the exhaust gases from an internal combustion engine (4), comprising a pump (8), wherein the pump (8) comprises a drive unit (10) and a pump chamber unit (11), wherein the pump chamber unit (11), at least in part, limits a pump chamber (9) and the drive unit (10) and the pump chamber unit (11) are detachably connected to one another.

2. Conveying unit (1) according to claim 1, wherein the conveying unit (1) comprises a flange to which the drive unit (10) is fastened and the pump chamber unit (11) is formed, at least in part, by the flange (12).

3. Conveying unit (1) according to either claim 1 or claim 2, wherein the pump chamber unit (11) and the drive unit (10) are separated by a pump diaphragm (13).

4. Conveying unit (1) according to any one of the preceding claims, wherein the pump chamber unit (11) is constructed in the form of a half shell and the pump chamber (9) is limited by the pump chamber unit (11) and the pump diaphragm (13).

5. Conveying unit (1) according to any one of the preceding claims, wherein the pump chamber (9) comprises a principal compartment (14) and a spur duct (15) branching from the principal compartment (14), and at least one inlet valve (16) and at least one outlet valve (17) adjoin the spur duct (15).

6. Conveying unit (1) according to claim 5, wherein the spur duct (15) has a length (35) of between 1 mm and 20 mm from the principal compartment (14) to the inlet valve (16) and to the outlet valve (17).

7. Conveying unit (1) according to either claim 5 or claim 6, wherein the spur duct (15) has a cross-sectional area (38) of between 0.1 $mm^2$ [square millimetre] and 2 $mm^2$ per litre of the maximum capacity of the pump (8) per hour.

8. Conveying unit (1) according to any one of the preceding claims, wherein the pump chamber (9) has a chamber volume (37) which can be reduced during a pump-

ing procedure to a dead volume (36), wherein the dead volume (36) is less than 20 % of the chamber volume (37).

9. Conveying unit (1) according to any one of the preceding claims, wherein the pump (8) has a rotary drive (20), a movable pump element (21) and a transfer element (22) for converting a rotational movement of the rotary drive (20) into a linear movement of the movable pump element (21), wherein at least one smoothing means (23) is provided for smoothing the movement of the movable pump element (21).

10. Conveying unit (1) according to any one of the preceding claims, wherein the conveying unit (1) comprises a control device (28) which is configured to operate the pump (8) for a test run with minimal driving power in order to determine whether frozen reducing agent present in the conveying unit (1) is impeding operation of the pump (8).

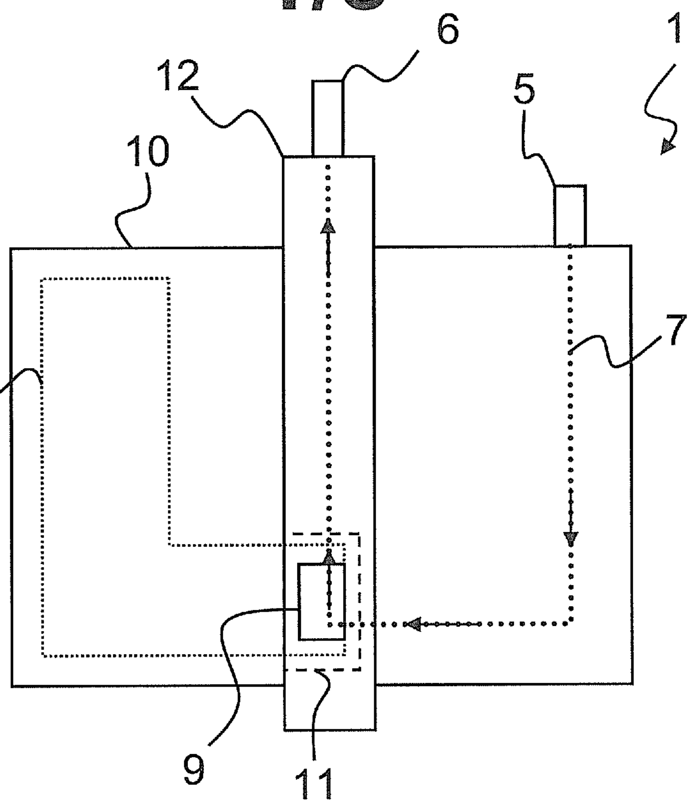



Fig. 1

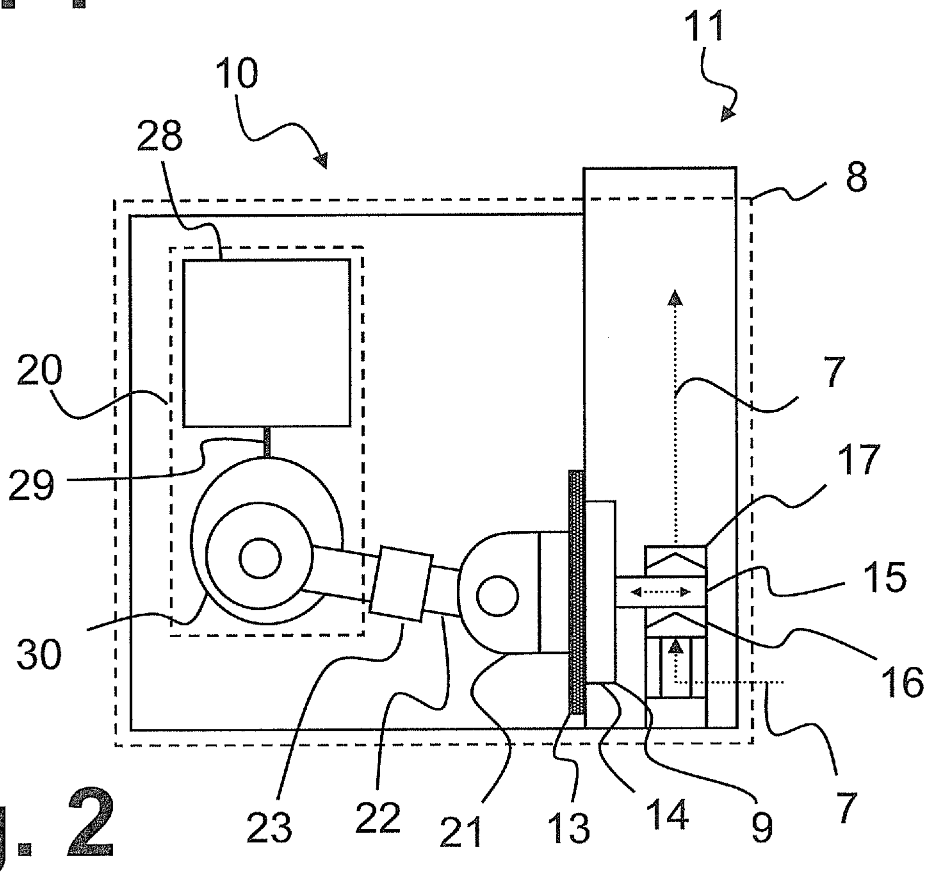



Fig. 2

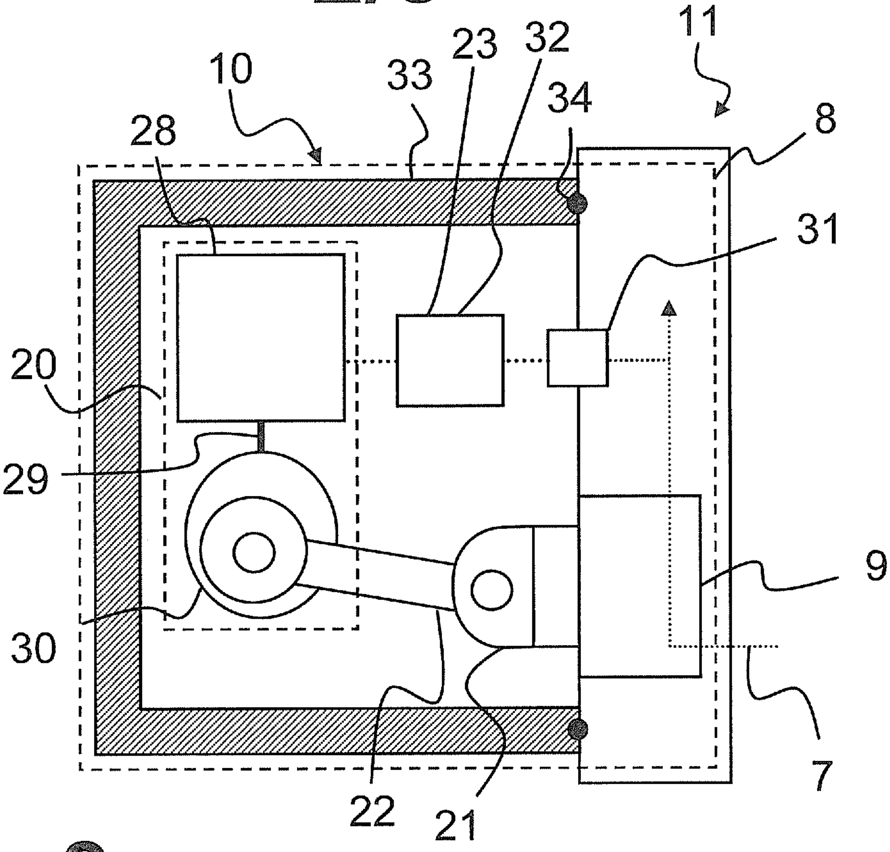



Fig. 3

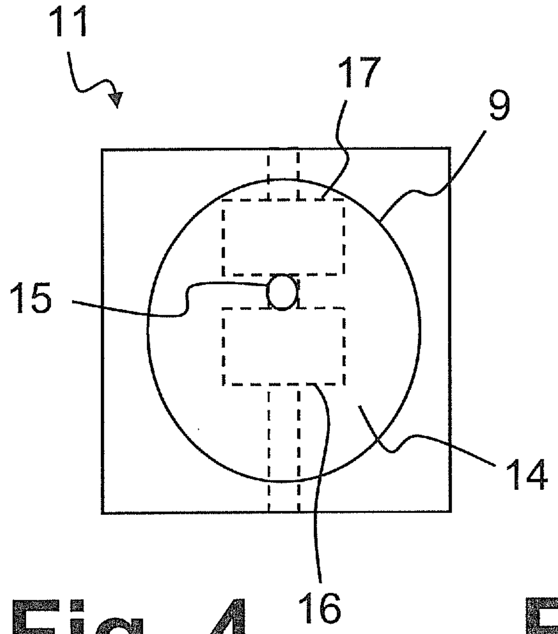



Fig. 4

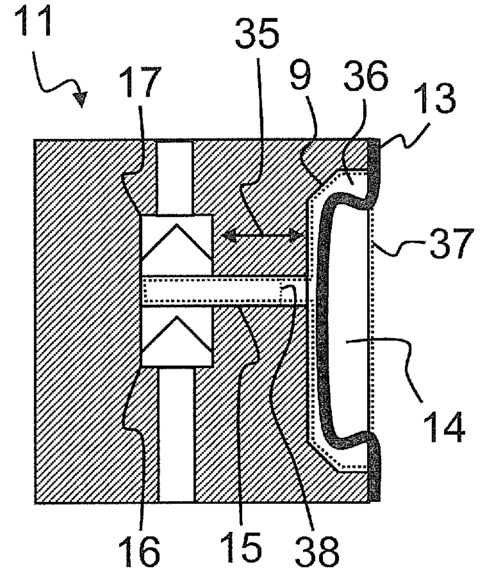



Fig. 5

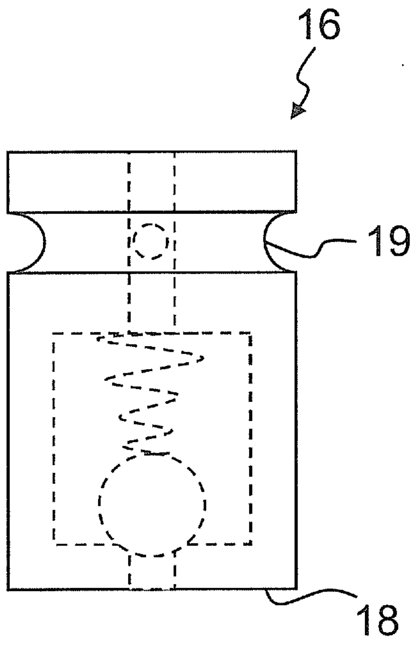



Fig. 6

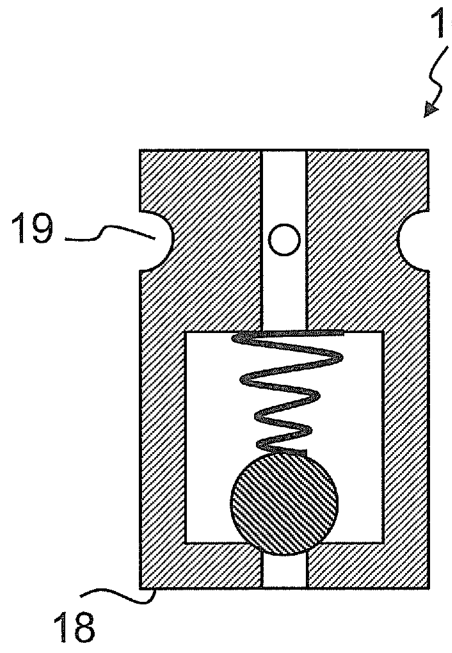



Fig. 7

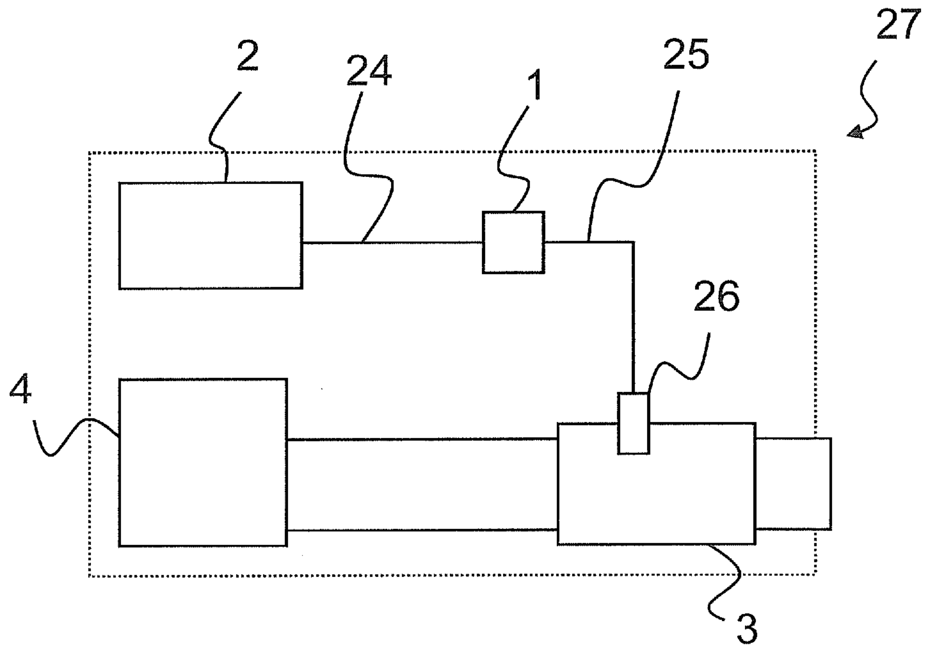



Fig. 8

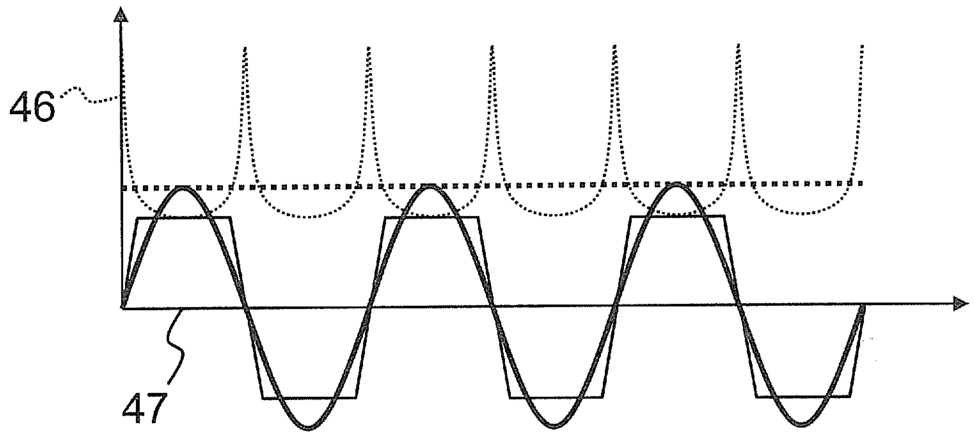



Fig. 9

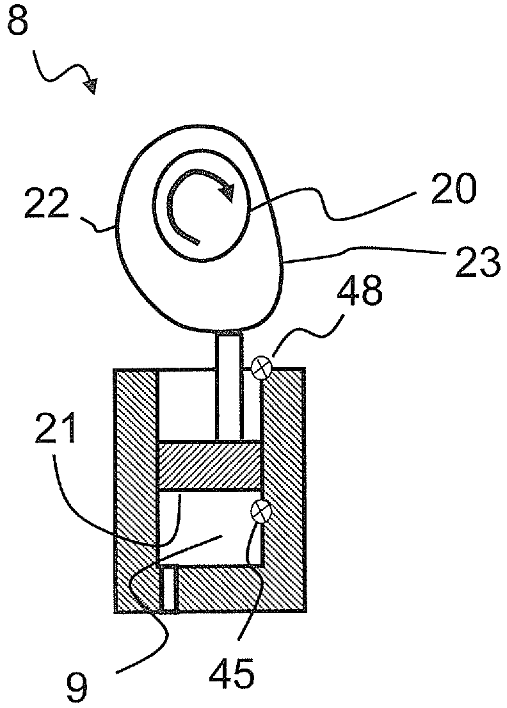



Fig. 10

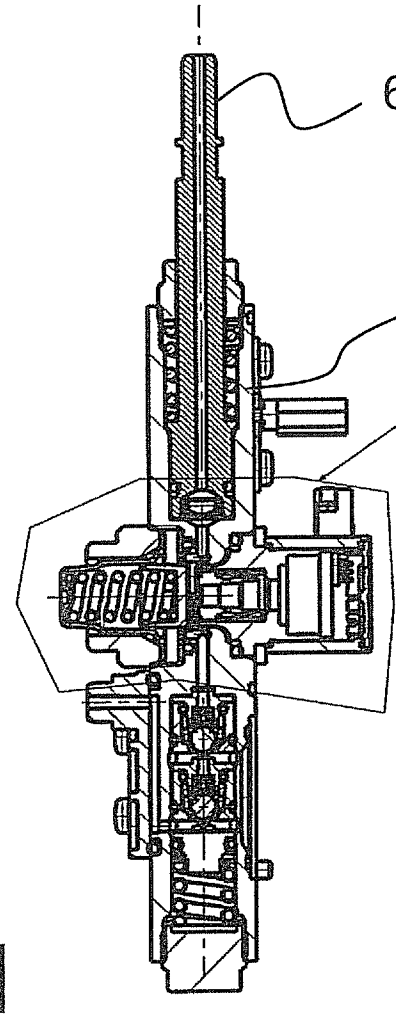
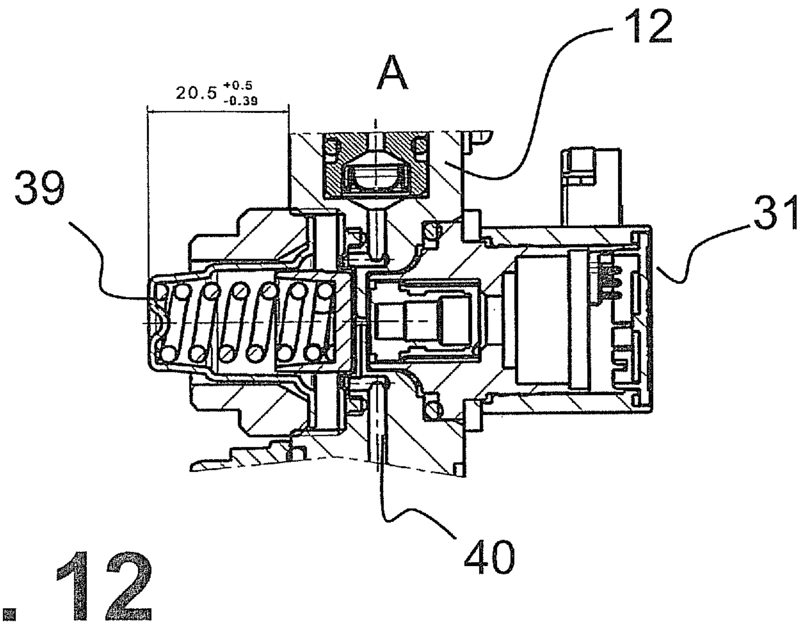



Fig. 11

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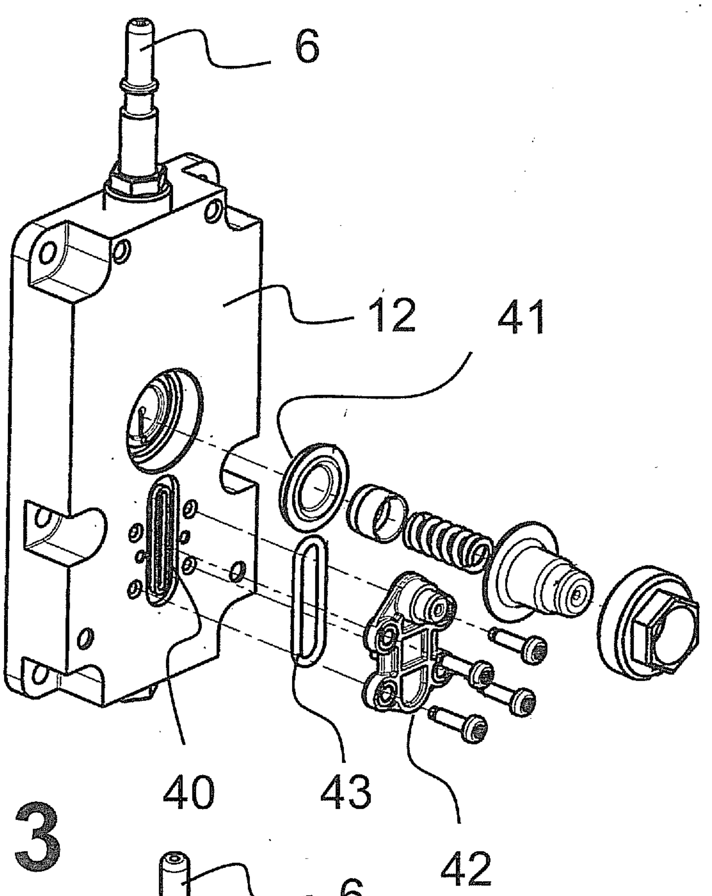


Fig. 13

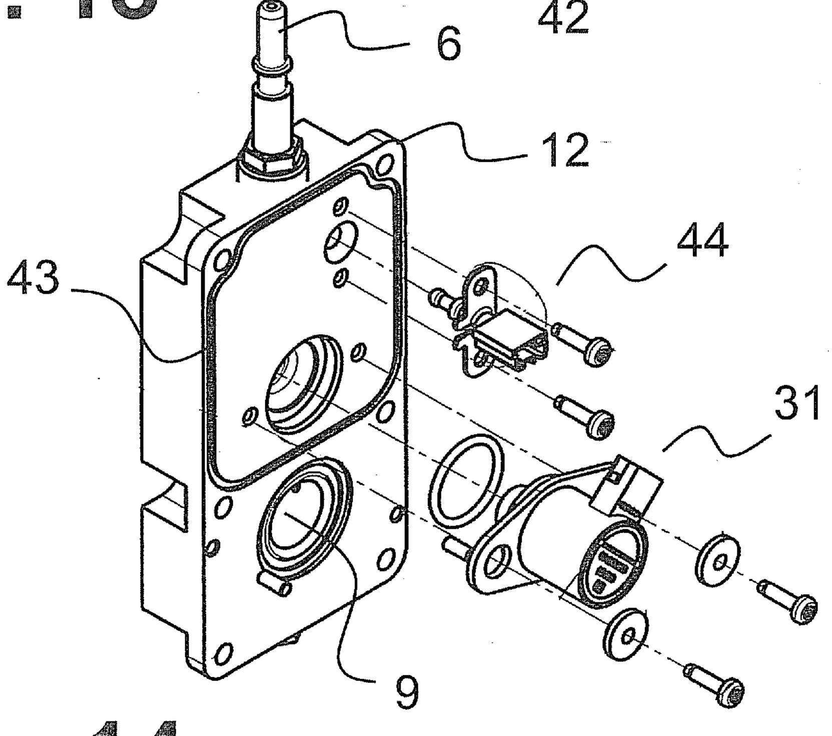


Fig. 14

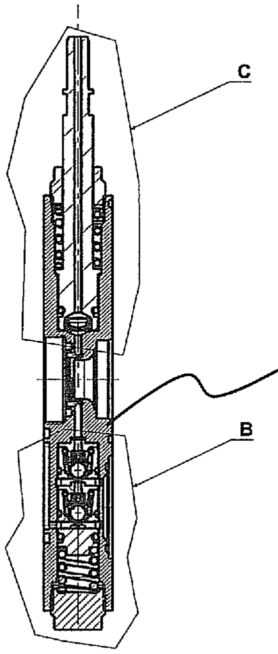


Fig. 15

B

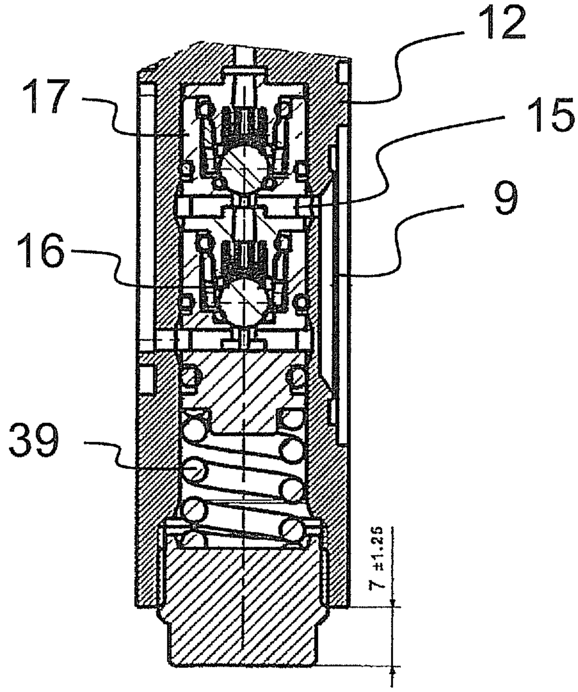


Fig. 16

C

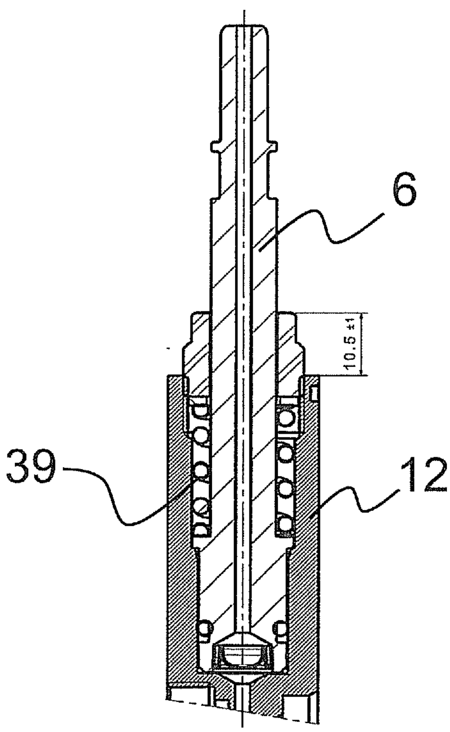


Fig. 17

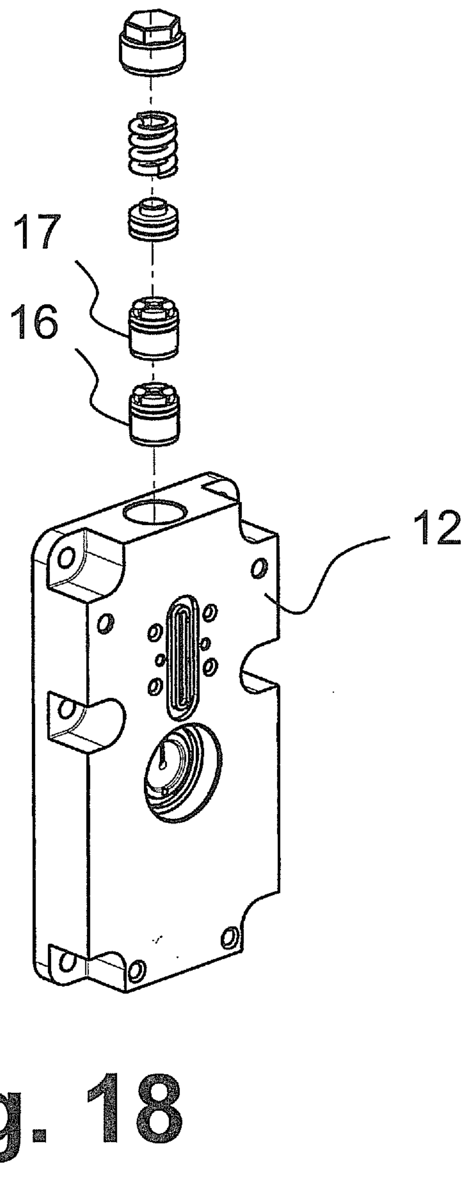


Fig. 18

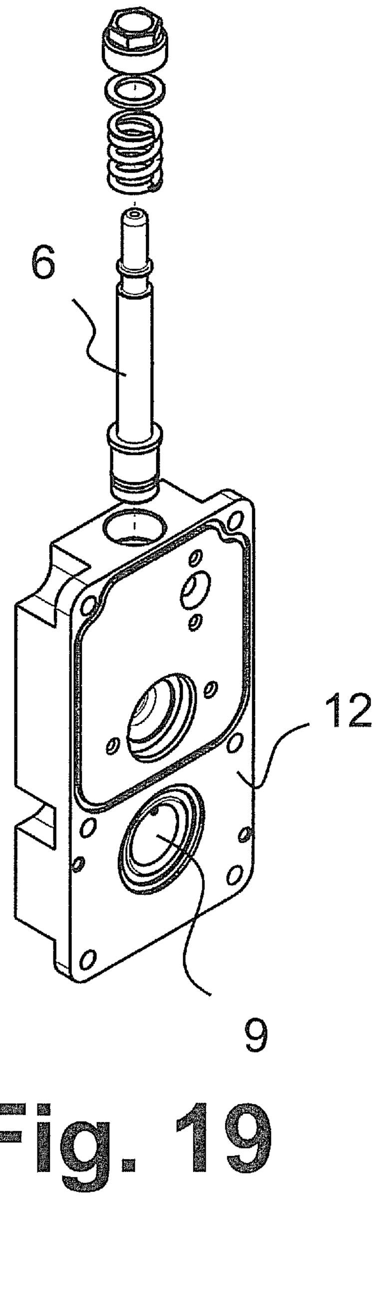


Fig. 19

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/051809

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01N3/20
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F01N

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 23 April 2012 | 21/05/2012 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Morales Gonzalez, M |

1

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Information on patent family members

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