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(54) Benævnelse: **Marksprøjte.**

(56) Fremdragne publikationer:
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EP-A1- 2 510 785
EP-A2- 1 958 506
EP-A2- 2 213 164

Agricultural sprayer

Description

The invention relates to an agricultural sprayer according to the preamble of Patent Claim 1.

In a liquid-conveying system of this kind known from EP 1 958 506 A, only a stock tank quick-filling function is performed by the non-self-priming rotary pump, while the cleaning function, the inflow function, the stirring function, the spraying function and the venting function is performed by the self-priming pump, for example a diaphragm pump. The self-priming pump performs the venting function for the non-self-priming rotary pump in a parallel line loop of a filling line attached to the clear water suction connector from the suction side of the rotary pump. The efficiency of the liquid-conveying system leaves something to be desired, as the main functions are performed by the diaphragm pump, while the rotary pump, which is high-performance in principle, is only used for the quick-fill function. In order to ensure a conveying capacity that is sufficient for the plurality of basic functions and to guarantee the stability of the diaphragm pump, said pump needs to be of a substantial size and is expensive and heavy. Since it works in the part of the network that conveys stock, at least during the spray function, it must be resistant to additives introduced into the stock.

Although diaphragm pumps have the functional advantage of self-priming and a high conveying pressure, large volume flows require a large installation space and weight. Rotary pumps for comparable volume flows are substantially smaller in size and lighter. Moreover, a rotary pump can be operated without damage, even when the pressure side is closed. The functional disadvantage of rotary pumps is that they are not self-priming, but have to be vented first.

The problem addressed by the invention is that of creating a liquid-conveying system, particularly for an agricultural sprayer, which can be operated with great efficiency and a high degree of functional reliability.
The problem posed is solved by the features of Patent Claim 1.

The liquid-conveying system can be operated more efficiently, because the robust, high-performance rotary pump performs all the main functions, while the self-priming pump is only used for venting the rotary pump and for the cleaning

function. It can be relatively small in size and is deliberately kept out of contact with the stock and the additives contained therein and may be a functionally reliable and yet cost-effective clear-water pump. The part of the network conveying clear water is only connected to the part conveying stock at least during the spraying function, when the rotary pump has to be vented or also the part of the network otherwise conveying stock has to be cleaned, i.e. if no stock is circulating in this part of the network or else the rotary pump is not in operation. As soon as the rotary pump is in operation and performing the main functions, the self-priming pump can even be switched off. However, it is entirely possible, particularly during the filling function, so to speak, to support the filling of the stock tank with clear water through the additional operation of the self-priming pump beyond the cleaning function or an additional valve for filling purposes.

Although it is known from DD 202 752 A and EP 1 157 601 A for a rotary pump and a ring pump or self-priming rotary pump to be operated in parallel, in order to create negative pressure at the suction end of the non-self-priming rotary pump, until the non-self-priming rotary pump runs wet. However, this liquid-conveying system is designed for a slurry tank from which slurry is extracted under the effects of gravity. Similarly, a slurry pumping system is known from DE 20 2004 015 338 U1, Fig. 3, in which a non-self-priming rotary pump is vented by a vacuum pump housed in a tank. The rotary pump is only used for filling the slurry tank. The extraction of slurry takes place by gravity. Also of interest are: EP 2 510 785 A1, EP 2 213 164 A2 and EP 1 4444 893 A1.

In an advantageous embodiment of the conveying system according to the invention, the part of the network conveying clear water is isolated from the otherwise stock-conveying part of the network via a 2/2-way valve. The 2/2-way valve may be configured as a ball valve and is switched by the controller or possibly by hand between a shut-off position and a through-flow position.

It is also possible, in addition, for a 3/2-way valve to be provided between the rotary pump, the 2/2-way valve and the inflow lock. This 3/2-way valve may be configured as a ball valve. In particular, it is a 3/2-way pressure-regulating valve, possibly even a proportional pressure-regulating valve. The 3/2-way valve not only controls the spraying function, the filling function, the stirring function and the activation of the inflow lock, but also the venting function for the non-self-priming rotary pump.

It may also be expedient for a 3/3-way valve to be arranged between the clear-water suction connector and the suction side of the rotary pump and a filling connector of the stock tank. This 3/3-way valve is also used for the filling function, the venting function, the spraying function and the stirring function.

In addition, it is advantageous for a further 3/3-way valve having a short-circuit loop to be disposed between the 3/3-way valve and the filling connector of the stock tank, to which a filling section disposed in the stock-conveying part of the network is connected. This 3/3-way valve controls the filling process, in addition preferably a flushing process of the rotary pump to expel air pockets following venting and a possibly necessary stock tank-emptying function via the short-circuit loop.

This stock tank emptying function is carried out by the rotary pump, which draws stock via the retrieval connector of the stock tank and conveys it via the 3/3-way valve with the short-circuit loop and also the 3/3-way valve to the clear-water suction connector which, for this function, is attached where appropriate to a collection container or empties out into a pit or onto the ground.

So that the cleaning function can not necessarily only be carried out when clear water is available at the clear-water suction connector, or possibly even the venting function, it is advantageous for the part of the network conducting clear water to be attached to a clear-water container which is connected to the self-priming pump and can be filled in advance from the clear-water suction connector, in order to provide a clear-water buffer.

Furthermore, it is advantageous for a clear-water 3/3-way valve to be attached to the pressure side of the self-priming pump via a bypass line, from which a cleaning line leads to at least one cleaning connector or a cleaning nozzle in the stock tank and a filling line leads to a filling/retrieval connector in the clear-water tank. This 3/3-way valve thereby controls the functions of filling the clear-water container and the cleaning function in the stock tank.

In addition, it is advantageous for a 3/2-way valve having a short-circuit loop to be disposed between the clear-water container and the self-priming pump. This also controls the filling of the clear-water tank and the venting function, during which clear water is pumped via the short-circuit loop from the clear-water suction connector of the self-priming pump via the rotary pump and is possibly

pumped into the stock tank.

A suction line or a suction hose, preferably secured by a non-return valve, is advantageously provided between the 3/3-way valve in the case of the clear-water suction connector and the clear-water suction connector, which branches off to the 3/2-way valve having the short-circuit loop. This suction line may be sufficiently long (suction hose) to draw clear water from a pit or well, even over relatively great heights.

In order to be able to help control the flushing function to expel air pockets when venting the rotary pump and also the spraying function, the stirring function and also the activation of the inflow lock, a 2/2-way retrieval valve is disposed between a retrieval connector in the stock tank and the suction side of the rotary pump, which is also switched to through-flow during the venting function.

In an advantageous embodiment, the self-priming pump is a piston diaphragm pump for clear water.

The non-self-priming rotary pump is advantageously conceived for a conveying performance of up to 1,000 l/min, while the piston diaphragm pump, being of compact design and lightweight, can be conceived for a conveying performance of only approx. 100 - 250 l/min.

Where the venting function is performed by the self-priming pump, clear water is advantageously pumped via the pressure side of the rotary pump into the stock tank, in order largely to expel air pockets from the rotary pump and the lines.

Finally, it may be advantageous during the filling function using the operated rotary pump to use the cleaning function carried out by the self-priming pump with clear water as the additional filling function of the stock tank, in order to guarantee an optimally large filling conveying output and therefore the quickest possible filling of the stock tank.

Embodiments of the subject matter of the invention are explained with the help of the drawings. In the figures:

Fig. 1 shows a block diagram of a liquid-conveying system, for example in an agricultural spray, in a pressureless state,

Fig. 2 shows the liquid-conveying system in Fig. 1 during a venting function,

Fig. 3 shows the liquid-conveying system in Fig. 1 during a cleaning function and a flushing function and

Fig. 4 shows the liquid-conveying system during a filling function.

Fig. 1 shows a liquid-conveying system S, for example in an agricultural sprayer F, which contains a set of spraying system rods 6, a nozzle system D with valve arrangements 1. The liquid-conveying system S has a line and/or hose network N, in which a stock tank 2, optionally a clear-water container 3, a clear-water system 4, an inflow lock 5 for additives, the spraying system 6 and also a clear-water suction connection 29 (possibly in a tank 30) are integrated. The container 30 may be a pit or a well or a clear-water supply and is not part of the conveying system. In this context, clear water does not necessarily mean drinking water, but industrial water.

The stock tank 2 contains at least one cleaning connector 7, for example in the form of a plurality of cleaning nozzles for cleaning the inside walls of the stock tank 2, for example, an inflow connector 8 for the introduction of additives, a retrieval connector 9 for removing the stock, a filling connector 10 for filling clear water and at least one stirring connector 11, for example nozzles for agitating the stock in the stock tank 2. The clear water container 3 contains a filling/retrieval connector 12.

In addition, a plurality of through-flow meters 13 and pressure sensors 14 is contained in the network N, which are attached via signal lines to a preferably computerized controller CU, to which filling level meters 15 in the clear water container 3 and in the stock tank 2 are connected.

A line 16 for clear water leads from the filling/retrieval connector 12 of the clear-water container 3 via a 3/2-way valve 17 having a short-circuit loop 17a and a filter 18 to the suction side of a self-priming pump 19, advantageously a piston diaphragm pump, and further to a 2/2-way valve 22, which can be operated either manually or via the controller CU and is possibly configured as a ball valve. The self-priming pump 19 is circumvented by a line loop 20, in which a pressure-limiting valve 21 pressure-precontrolled from the pressure side of the self-priming

pump 19 is contained (for example, a pressure difference of roughly 10 bar).

Leading to the 2/2-way valve 22 from the retrieval connector 9 of the stock tank 2 is a retrieval line 23 which branches off to a 3/2-way valve 27, advantageously a pressure-regulating valve or a proportional valve, in a line branch 23a and a line branch 27a. Contained in the retrieval line 23 are, downstream of the retrieval connector 9, a 2/2-way valve 24, a filter 25, and also upstream of the 3/2-way valve 27, a non-self-priming rotary pump 26. The line branch 23a leads via a filter 25' to a 2/2-way valve 50, to which the spraying system 6 is connected via a line 26. The 2/2-way valve 50 is advantageously a pressure-regulating valve or even a proportional pressure-regulating valve.

From the inflow lock 5, a line 28 leads to the inflow connector 8 in the stock tank 2. From the clear-water suction connector 29 a suction line or a suction hose 31, preferably with a non-return valve 32 blocking the clear water suction connector 29, leads to the 3/2-way valve 17 with the short-circuit loop 17a. A branch line 16a branches off from the line 16 on the pressure side of the self-priming pump 19 and leads via a 3/3-way valve 33, on the one hand, to a line 35 back to the line 16 and, on the other hand, via a cleaning line 34 to the at least one cleaning connector 7 of the stock tank 2.

From the retrieval line 23, a line 36 branches off between the 2/2-way valve 24 and the filter 25 to the clear-water suction connector 29, in which a 3/3-way valve 37 is contained, from which a line 38 leads via a 3/3-way valve 39 with a short-circuit loop 39a to the filling connector 10 in the stock tank 2. A line 40 is additionally connected to the 3/3-way valve 39 with the short-circuit loop 39a, which line branches off from the branch line 23a. In addition, a line 41 branches off from the branch line 23a to the stirring connector 11 in the stock tank 2, in which a 2/2-way valve 42, preferably a pressure-regulating valve or proportional valve, is contained. From the filter 25', a line 43 leads to the line 41 downstream of the 2/2-way valve 42. In the line 43, a further 2/2-way valve 44 is contained.

From the retrieval line 16, a line 45 branches into the inflow lock 5. In addition, a possible means 46 of external cleaning may be attached to the branch line 16a.

Using the self-priming pump 19, a cleaning function with clear water can be carried out via the cleaning connector 7 in the stock tank 2 or in the entire network and also a venting function of the non-self-priming rotary pump 26. In addition,

using the self-priming pump 19 a clear-water filling function of the clear-water container 3 from the clear water suction connector 29 can be carried out. The essential basic functions of the liquid-conveying system S, i.e. a spraying function, a filling function, a stirring function and an inflow function and also, if necessary, an emptying function of the stock tank 2 can be carried out using the rotary pump 26, insofar as said pump is vented.

The rotary pump 26 may be designed for a conveying output of up to roughly 1000 l/min, while the non-self-priming pump 19, i.e. the piston diaphragm pump, can be designed for a conveying output of only roughly 100 - 250 l/min and is therefore space-saving and functionally reliable, particularly since it is contained in a part 16, 16a, 34, 35, 31 of the network N conveying only clear water and is separated by the 2/2-way valve 22 from the stock-conveying part of the network N, at least during the spraying function.

Fig. 2 illustrates the setting of the liquid-conveying system when the venting function is being carried out by the self-priming pump 19. The 3/3-way valve 37 is in its shut-off setting, as is the 3/3-cold water way valve 33. The 2/2-way valves 24 and 22 are in their through-flow settings. The 3/2-way valve 17 is in a switch setting, in which the short-circuit loop 17a connects the suction line/the suction hose 31 to the suction side of the self-priming pump 19. In order to vent the non-self-priming rotary pump 26, the self-priming pump 19 pumps clear water via the pressure side of the rotary pump 26 and through the filter 25 and the retrieval line 23 and the 2/2-way valve 24, possibly via the retrieval connector 9 in the stock tank 2, in order to expel air pockets in the rotary pump 26 and the line system as far as possible.

Alternatively, in the event that the clear water container 3 should be sufficiently filled, the venting function can be supplied form the clear water container 3. In this case, the 3/2-way valve 17 is switched with the short-circuit loop 17a into the position shown in Fig. 1.

Fig. 3 illustrates two functions possibly performed in parallel, namely the cleaning function and a flushing function of the rotary pump 26. These two functions need not necessarily be performed simultaneously. For the cleaning function, the 2/2-way valve 22 is switched into its shut-off position, so that the self-priming pump 19 feeds the at least one cleaning connector 7 in the stock tank 2 when the 3/2-way valve 17 is in the switch setting as in Fig. 2 via the branch line 16a. For this

purpose, the 3/3-way valve 33 is switched into its through-flow setting, in which the branch line 16a is connected to the cleaning line 34.

During the flushing function (indicated by a dotted line) of the rotary pump 26, the rotary pump 26 which has already been vented pumps liquid (clear water or stock) via the retrieval line 23 through the 2/2-way valve 24 switched to through-flow and the branch line 23a and also the line 40 and the 3/3-way valve 39 with the short-circuit loop 39a and the line 38 into the filling connector 10 of the stock tank. The 3/3-way valve 39 in this case is set in a switch position, in which the line 40 is connected to the line 38. The liquid circulates in the circuit until the rotary pump 26 has reached its maximum conveying performance or a desired conveying performance or conveying pressure, which is reported to the controller CU via the pressure sensor 14 and the flow meter 13.

To initiate a subsequent filling function, the 3/3-way valve 37 according to Fig. 4 is switched into its through-flow setting, in which the clear-water suction connector 29 is connected with the line 36 to the retrieval line 23, so that the rotary pump 26 draws clear water out of the clear-water suction connector 29 and fills the stock tank 2.

Simultaneously with the filling function or after a sufficient filling level has been reached in the stock tank 2, the desired additive can be added via the inflow lock 5 and the line 28 into the stock tank 2, in that the 3/2-way valve 27 is switched partially or fully into its through-flow setting to the line 27a, wherein the pump/flushing function, as shown in Fig. 3, is furthermore operated or by switching the 2/2-way valve 42, the stirring function is activated via the line 41 and the at least one stirring connector 11 in the stock tank.

When the filling function is carried out using the rotary pump 26, the cleaning function may be further operated using the self-priming pump, where appropriate, in order to supply additional clear water via the cleaning connector 7 into the stock tank 2 (additional filling function).

Once the stock tank 2 is adequately filled and the desired concentration of stock has been reached, the liquid-conveying system S is ready for the spraying function. In order to perform the spraying function (not shown), the 2/2-way valve 24 is switched to through-flow, while the 3/3-way valve 39 and also the 3/3-way valve 37 is switched into its shut-off settings, and when the 2/2-way valve 22 is

in the shut-off position, the 2/2-pressure regulating valve 50 is set to through-flow. In order to perform a stirring function of the stock in the stock tank 2 simultaneously, the 2/2-pressure regulating valve 42 can be switched to through-flow and/or internal cleaning of the filter 25' is possible by changing the 2/2-way valve 44 to through-flow.

By means of a processing of the signals from the pressure sensor 14 and the flow meter 13 in Fig. 4, the controller CU can regulate the speed of the rotary pump 26, where appropriate, which is driven conventionally, e.g. by a hydraulic motor (not shown), and also the self-priming pump 19.

In Figs. 2 to 4 the 3/2-way valve 27 is depicted in simplified schematic form in its shut-off setting to the inflow lock 5. Fig. 4 also shows in addition for the rotary pump 26 a line loop 20' with a pressure-precontrolled pressure-limiting valve 21' to guarantee a given pressure drop via the rotary pump 26.

PATENTKRAV

1. Væsketransportsystem (S), navnlig for en marksprøjte (F), med en selvansugende pumpe (19) og en ikke-selvansugende centrifugalpumpe (26), der på sugesiden i givet fald kan forbindes med en klartvandsansugningskonnektor (29), og som i et forsyningsnetværk og/eller slangenetværk (N), der indeholder ventiler, som kan aktiveres ved hjælp af en styring (CU), og som omfatter i det mindste én lagertank (2), klartvandsansugningskonnektor (29), sprøjtedyser (D) til udbringning af ajlen og i det mindste én ajletilsætnings-indskylningssluse (5), er integreret på en sådan måde, at styringen (CU) kan realisere en påfyldningsfunktion, en gylletank- og/eller netværksrensningsfunktion, en gylletankindstrømningsfunktion, en gylleomrøringsfunktion, en sprøjtefunktion og en ventileringsfunktion for den ikke-selvansugende centrifugalpumpe (26), **kendetegnet ved**, at det væsketransporterende system (S) er konfigureret til udelukkende at realisere rensningsfunktionen og ventileringsfunktionen ved hjælp af den selvansugende pumpe (19) samt til eksekvering af påfyldnings-, indstrømnings-, omrørings- og sprøjtefunktionerne ved hjælp af den ikke-selvansugende, men ventilerede centrifugalpumpe (26), og ved, at den selvansugende pumpe (19) er placeret i en del (16, 31, 34, 35) af netværket (N), som leder klartvand, og som er adskilt fra en del (23, 23a, 26) af netværket (N), der leder gylle, i det mindste under eksekvering af sprøjtefunktionen.

2. Væsketransportsystem ifølge krav 1, **kendetegnet ved**, at den del af netværket (N), som leder klartvand, kan adskilles fra den del, som leder gylle, ved hjælp af en omskifterventil, fortrinsvis en 2/2-vejsventil (22).

3. Væsketransportsystem ifølge krav 1, **kendetegnet ved**, at en yderligere omskifterventil, fortrinsvis en 3/3-vejsventil (37) eller en 2/2-vejsventil, er tilvejebragt mellem klartvands-sugekonnektoren (29) og centrifugalpumpens (26) sugeside og en påfyldningskonnektor (10) for gylletanken (2).

4. Væsketransportsystem ifølge krav 1, **kendetegnet ved**, at den del (16, 16a, 34, 35) af netværket (N), som leder klartvand, er forbundet til en klartvandsbeholder (3), der

ved hjælp af den selvansugende pumpe (19) er i stand til at blive fyldt fra klartvands-sugekonnektoren (29).

5. Væsketransportsystem ifølge krav 1,
k e n d e t e g n e t v e d , at der med henblik på realisering af rensningsfunktionen på tryksiden af den selvansugende pumpe (19) via en bypassledning (16a) er tilsluttet en klartvands-omskifterventil, fortrinsvis en 3/3-vejsventil, hvorfra der føres en rensningsledning (34) til i det mindste en rensningskonnektor (7) på gylletanken (2) og en fyldeledning (35) til en fyldeudtagskonnektor (12) i klartvandstanken (3).

6. Væsketransportsystem ifølge krav 1,
k e n d e t e g n e t v e d , at en 3/2-vejsventil (17) med en kortslutningssløjfe (17a) er anbragt mellem klartvandsbeholderen (3) og den selvansugende pumpe (19).

7. Væsketransportsystem ifølge i det mindste eet af de foregående krav,
k e n d e t e g n e t v e d , at der mellem omskifterventilen, fortrinsvis 3/3-vejsventilen (37) og klartvands-sugekonnektoren (29) sker afgrening af en sugeledning/en sugeslange (31), som fortrinsvis er sikret af en kontraventil (32), til 3/2-vejsventilen (17) med kortslutningssløjfen (17a).

8. Væsketransportsystem ifølge i det mindste eet af de foregående krav,
k e n d e t e g n e t v e d , at der mellem udtagskonnektoren (9) i gylletanken (2) og centrifugalpumpens (26) sugeside er anbragt en 2/2-vejs-udtagningsventil.

9. Væsketransportsystem ifølge krav 1,
k e n d e t e g n e t v e d , at den selvansugende pumpe (19) er en klartvands-stempelmembranpumpe.

10. Væsketransportsystem ifølge i det mindste eet af de foregående krav,
k e n d e t e g n e t v e d , at den ikke-selvansugende centrifugalpumpe (26) er dimensioneret til en transportydelse på indtil cirka 1000 l/min. Og den selvansugende pumpe (19) til en transportydelse på cirka 100 – 250 l/min.

11. Væsketransportsystem ifølge i det mindste eet af de foregående krav,

k e n d e t e g n e t v e d , at ventileringsfunktionen kan realiseres ved hjælp af den selvansugende pumpe (19) for den ikke-selvansugende centrifugalpumpe (26) ved hjælp af sidstnævntes trykside til ind i gylletanken.

12. Væsketransportsystem ifølge krav 1,
k e n d e t e g n e t v e d , at rensningsfunktionen, som kan udføres ved hjælp af den selvansugende pumpe (19), i givet fald kan anvendes som en ekstra fyldefunktion for gylletanken (2) fra den del af netværket (N), som leder klartvand.

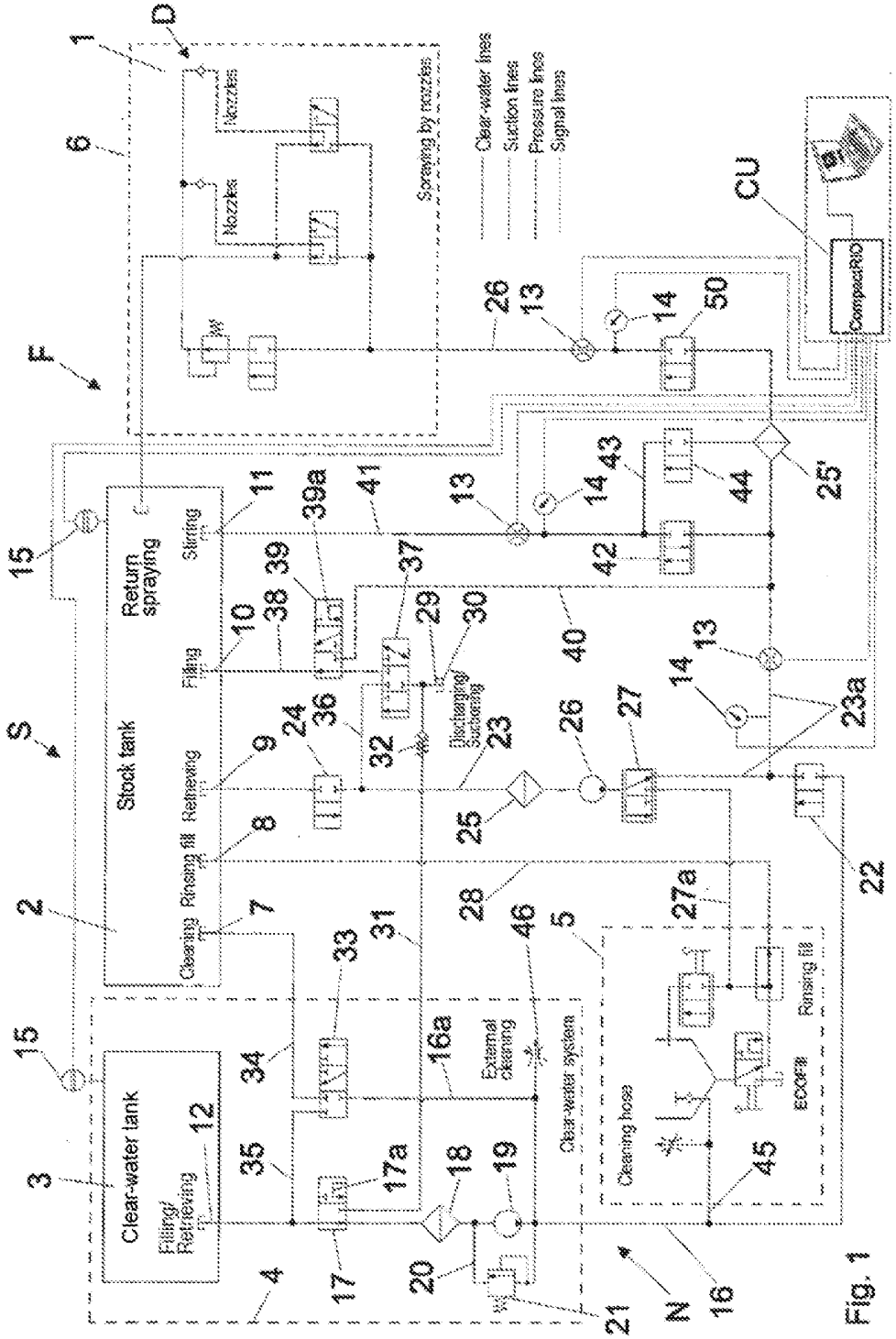
Clear-water lines
Suction lines
Pressure lines
Signal lines
Screwing by nozzles
Nozzles
Nozzles
Compact-RIO
CU
Return spraying
Stirring
Filling
Retrieving
Rinsing fill
Cleaning
Stock tank
Discharging Suctioning
Clear-water tank
Filling/ Retrieving
External cleaning
Clear-water system
Cleaning hose
ECOFIX
Rinsing fill
D
F
S
N

Fig. 1

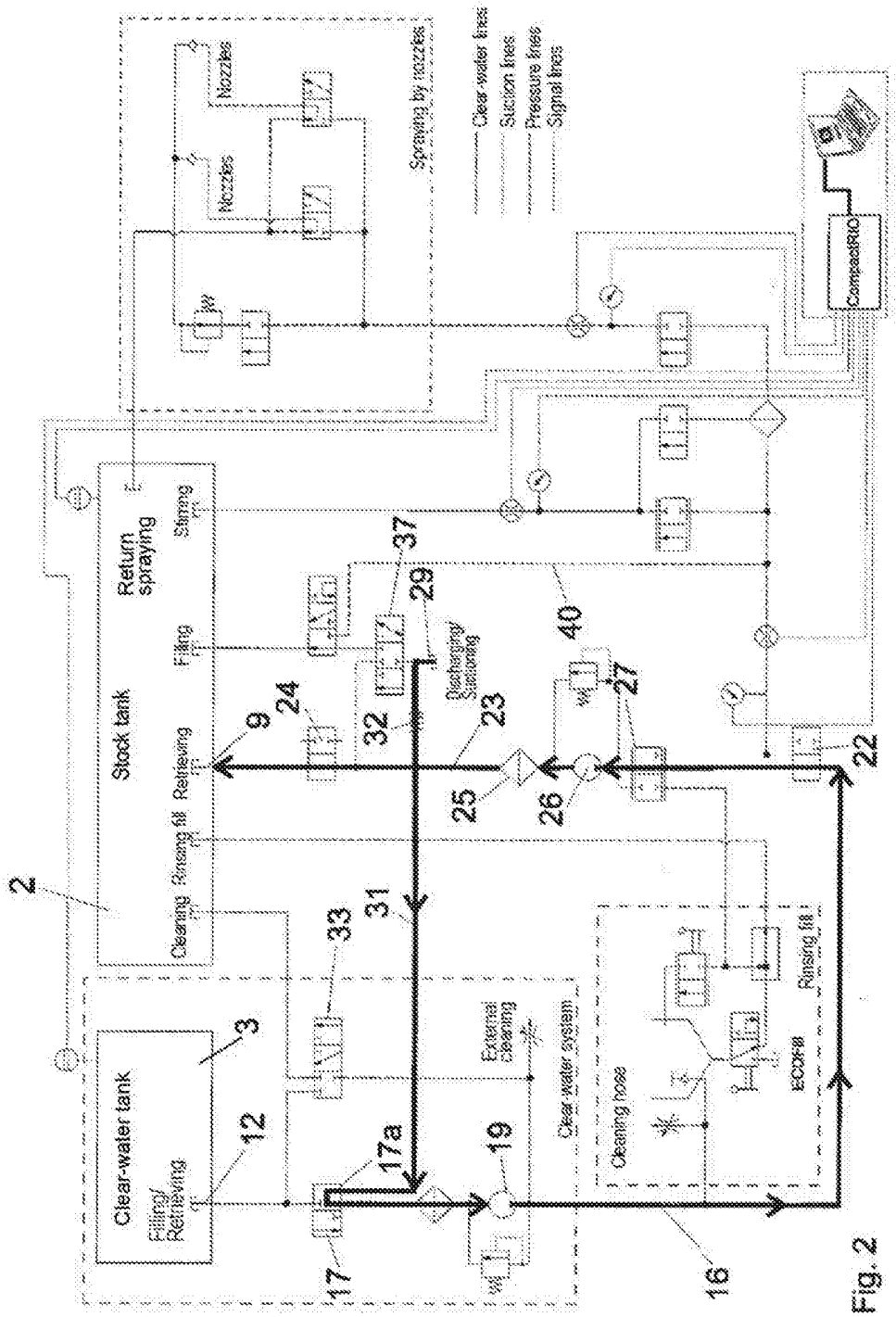
Clear water lines
Suction lines
Pressure lines
Signal lines
Spraying by nozzles
Nozzles
Nozzles
CompactRIO
Return spraying
Stirring
Filling
Stock tank
Retrieving
Rinsing fill
Cleaning
Discharging/ Siphoning
Clear-water tank
Filling/ Retrieving
External cleaning
Clear water system
Cleaning hose
Rinsing fill
2
3
9
12
16
17
17a
19
22
23
24
25
26
27
29
31
32
33
37
40

Fig. 2

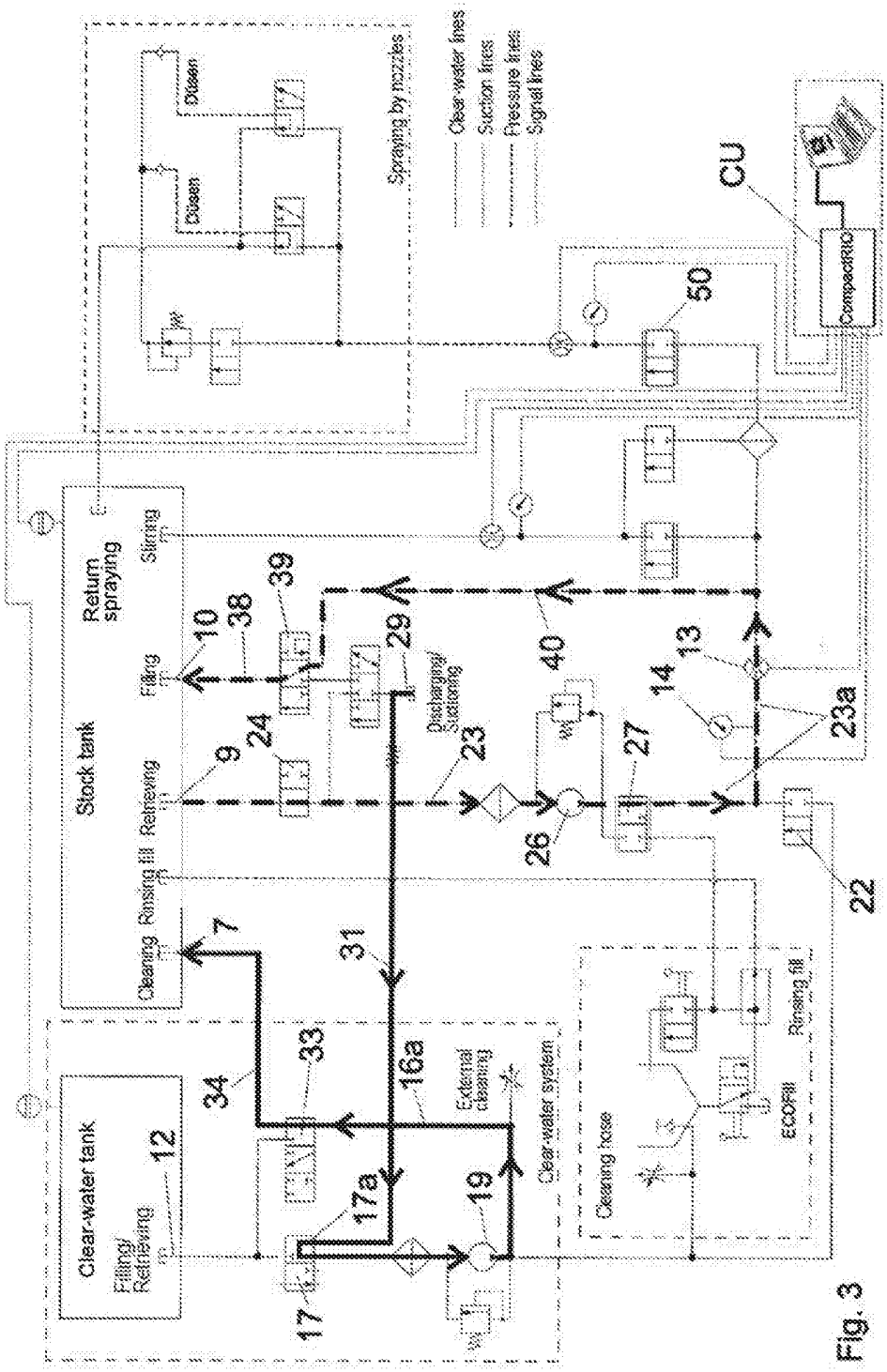
Clear-water lines
Suction lines
Pressure lines
Signal lines
Spraying by nozzles
Düsen
Düsen
CU
Compactrio
50
Return spraying
Slinging
Stock tank
Filling
Retrieving
Rinsing fill
Cleaning
10
38
39
29
40
9
24
23
13
14
23a
27
26
22
7
31
33
34
16a
17a
19
17
External cleaning
Clear-water system
Clear-water tank
Filling/ Retrieving
12
Cleaning hose
ECOFill
Rinsing fill

Fig. 3

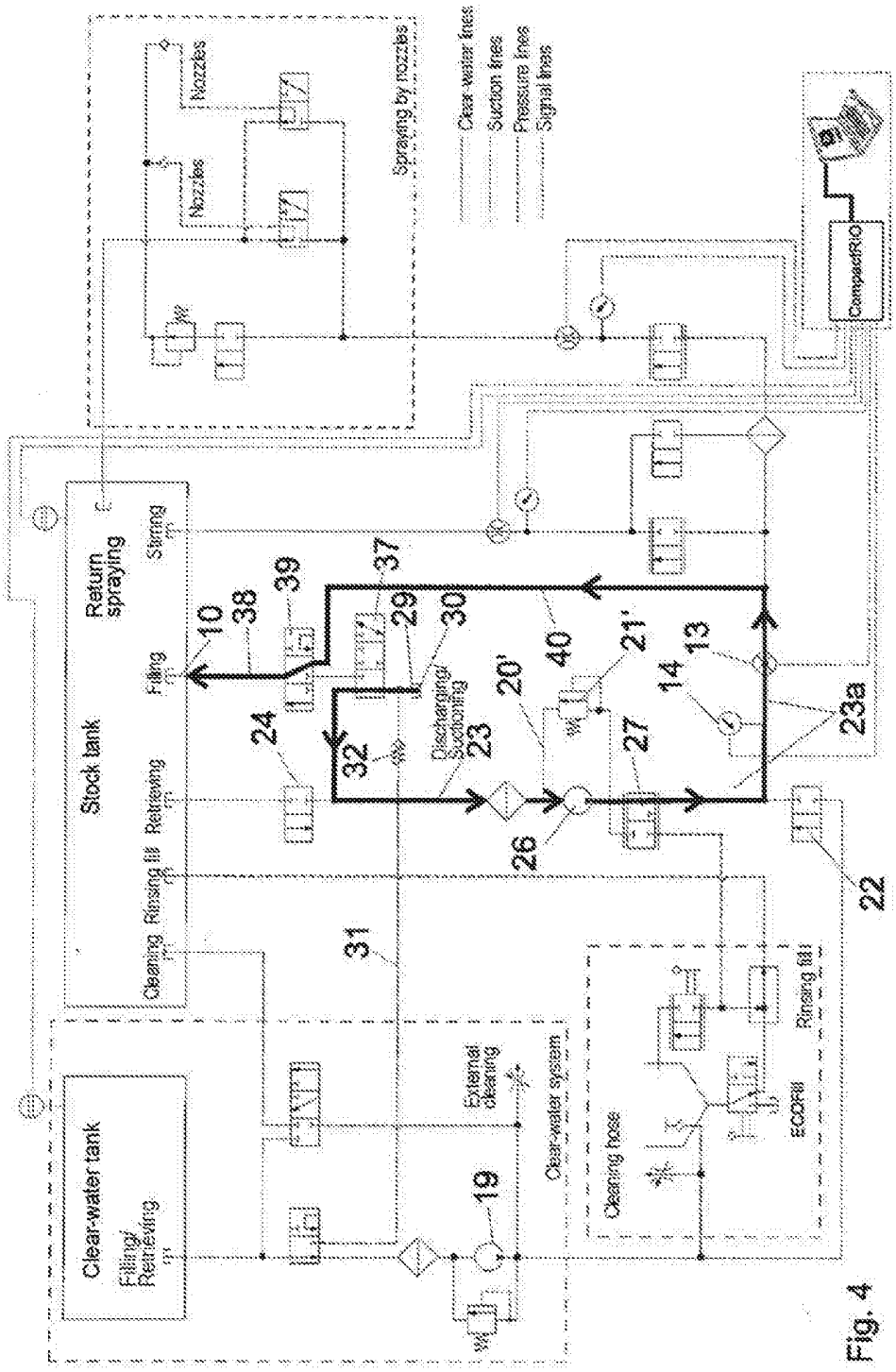
Clear-water lines
Suction lines
Pressure lines
Signal lines
Spraying by nozzles
Nozzles
Nozzles
CompactRIO
Return spraying
Stirring
Filling
Stock tank
Rinsing fill
Removing
Cleaning
Rinsing fill
Discharging/ Suctioning
Clear-water tank
Filling/ Removing
External cleaning
Clear-water system
Cleaning hose
ECO Fill
Rinsing fill
10
38
39
37
29
30
40
21'
20'
13
14
23a
24
32
23
27
26
22
31
19

Fig. 4