

(19) **DANMARK**



Patent- og
Varemærkestyrelsen

(10) **DK/EP 3472500 T3**

(12) Oversættelse af
europæisk patentskrift

-
- (51) Int.Cl.: **F 16 K 11/087 (2006.01)** **F 16 K 24/02 (2006.01)** **F 16 K 27/06 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2020-08-17**
- (80) Dato for Den Europæiske Patentmyndigheds
bekendtgørelse om meddelelse af patentet: **2020-05-20**
- (86) Europæisk ansøgning nr.: **16747619.1**
- (86) Europæisk indleveringsdag: **2016-06-20**
- (87) Den europæiske ansøgnings publiceringsdag: **2019-04-24**
- (86) International ansøgning nr.: **IB2016053655**
- (87) Internationalt publikationsnr.: **WO2017221048**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV
MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **Sanitær omledningsventil, tørresystem indbefattende et forbedret ventilaggregat omfattende en
sådan ventil, og fremgangsmåde til rengøring af systemet**
- (56) Fremdragne publikationer:
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DESCRIPTION

Field of invention

[0001] The present invention relates to a drying system comprising at least one powder recovery unit, at least one conveying line for powdery material such as fines from the powder recovery unit, at least one purge line connected to a purge arrangement, and a valve assembly comprising at least one sanitary diverter valve. The invention furthermore relates to a method for cleaning a system.

Background of the invention

[0002] In such drying systems, including spray drying systems, there are means for transporting powdery material from powder recovery units such as cyclones and bag filters downstream of the drying chamber to upstream units such as to relevant positions of the drying chamber itself or to a finishing treatment unit such as a vibrating fluidizer or integrated/static fluid bed for handling the material discharged from the drying chamber. Typically, such conveying lines are configured to transport powdery material in the form of fines, that is, powdery material of satisfying composition but of a size and/or configuration that needs further processing in order to fulfil quality requirements, i.e. a so-called fines return system, during normal operation, and the same conveying lines are often used for transporting powdery material to the drying chamber and for transporting powdery material to a finishing treatment unit by having one or more multiple diverter valves in line with the conveying lines. Such diverter valves will direct the flow from the powder recovery units to one of a number of destinations. The conveying lines leading from the diverter valve to non-active destinations are thus empty. These non-active conveying lines are known as idling lines. Due to the high temperatures, which are commonly present in spray drying systems, the idling lines have a lower temperature than the active lines, and as such any moisture in the air, will condensate in the idling lines. Thus, when switching the diverter valve to activate a formerly idling line, the powdery material will enter a moist section, which is to be avoided for the hygroscopic and sticky characteristic reasons mentioned above as well as hygienic and bacterial reasons. A common solution to this problem is to add a purge gas valve after each exit of the diverter valve, as close to the valve as possible, in order to run purge gas through the idling lines in order to remove the condensation. This solution, while alleviating the problem somewhat has some limitations as the purge gas valve can never be placed close enough to the diverter valve, in order to remove all moisture. As such, some moisture will be present.

[0003] Cleaning requirements for the drying and powder handling equipment, i.e. the so-called dry areas, can be met by either dry or wet methods, or a combination of both. Dry methods involve manual sweeping of surfaces in contact with the product, or air sweeping by allowing a high velocity air stream to pass over the surfaces in question. Wet methods involve either

manual hosing of surfaces or more effectively by use of automated cleaning-in-place systems (CIP systems).

[0004] The very nature of e.g. dairy and food products means that the possibility of product deposits formation on the surface of the process equipment is always real. The products' fat, sugar and protein content, gives hygroscopic and sticky characteristics at the temperature and humidity conditions present during processing. For drying plants in general, it is often relevant and profitable to equip the plants with automatic CIP in order to reduce the downtime of the plant. The risk of deposit formation increases with the running time of the plant. Industrial CIP systems can clean individual items or complete process plants, involving integrating cleaning nozzles into the plant components together with their associated pipe work, and instrumentation.

[0005] Examples of prior art drying systems and methods for cleaning are shown and described in US patent No. 3,047,020, DE 41 03 976 A1, and Applicant's published DK patent application 2015 70712.

[0006] The complex nature of the cleaning regimen is particularly pronounced in spray drying systems comprising a fines return system. In such systems, it is of course vital that the conveying line for the stream of powder is thoroughly dried by air or other gas after wet CIP to ensure that the stream of powder in the conveying line is not compromised by any remains of moisture.

[0007] Although such CIP systems provide a thorough cleaning, it is also a challenge that the CIP liquid needs to be drained and the parts involved need to be dried very thoroughly in order to avoid the risk of contamination and subsequent sticking of product. It is not uncommon that cleaning regimens do not involve all parts of such a spray drying system to be cleaned by CIP. This applies in particular to the dry sections of the system, including typically the fines return system.

Summary of the invention

[0008] With this background, it is therefore an object of the present invention to provide a drying system by which the overall operational conditions of such a system are improved.

[0009] It is a further object to increase the efficiency of the cleaning process and improve the hygiene conditions in such a system even further.

[0010] In a first aspect of the invention, these and further objects are obtained by a drying system as defined in claim 1.

[0011] The provision of such a drying system comprising at least one sanitary diverter valve makes it possible to handle not only powder during normal operation but also liquid and

air/gas. In turn, this makes it possible to clean the conveying lines of the system and the valve assembly including the diverter valve itself very thoroughly. The drying system according to the invention provides for excellent hygienic properties as the system is easy and efficient to clean and subsequently dry thoroughly. Furthermore, as the sanitary diverter valve is able to be operated as a two-way valve, less valves are needed compared to traditional systems.

[0012] The drying system may be any system in which powder is handled and comprise any operational units, and as such also powder handling systems are incorporated. However, the principles underlying the invention are particularly useful in a drying system comprising a spray dryer with a drying chamber and a process gas supply device.

[0013] In a presently preferred embodiment, the drying system furthermore comprises a cleaning-in-place, CIP, arrangement connected to said at least one purge line. This allows for particularly thorough cleaning of the system.

[0014] In an alternative application, a by-pass arrangement is provided, comprising at least one further two-way sanitary diverter valve connected to a secondary conveying line optionally connectable to a secondary destination. This configuration provides for optimum flexibility in operation of the drying system.

[0015] In a second aspect of the invention, a method for cleaning a system of the type described above is provided.

Brief description of the drawings

[0016] The invention will be described in more detail below by means of non-limiting examples of presently preferred embodiments and with reference to the schematic drawings, in which:

Fig. 1 shows a schematic view of a prior art spray drying system;

Fig. 2 shows a functional flowchart indicating the flows in operation mode and purge mode, respectively, of a prior art spray drying system;

Fig. 3 shows a schematic view of an embodiment of the drying system according to the invention;

Fig. 4 shows a schematic flowchart of an embodiment of the drying system according to the invention;

Fig. 5 shows a schematic plan view of a diverter valve of a valve assembly in an embodiment of the drying system according to the invention;

Fig. 6 shows a side view of the valve assembly of Fig. 5;

Fig. 7 shows a plan view of the valve assembly of Figs 5 and 6;

Fig. 8 is a side view of a valve assembly in an embodiment of the invention, in a closed position of a second valve;

Fig. 9 is a side view of the valve assembly of Fig. 8, in an open position;

Fig. 10 is a view corresponding to Fig. 5 of a valve assembly in an embodiment of the spray drying system according to the invention, in a first position and indicating flows through the diverter valve;

Fig. 11 is a view corresponding to Fig. 5 of a valve assembly in an embodiment of the drying system according to the invention, in a second position and indicating flows through the diverter valve; and

Fig. 12 is a schematic plan view of a detail of the valve assembly of Fig. 5, on a larger scale.

Detailed description of embodiments of the invention

[0017] Fig. 1 shows a schematic view of the main components of a spray drying system 1'. In a manner known per se, the spray drying system 1' comprises a spray dryer with a drying chamber 2' and a process gas supply device, typically including an air disperser 3'. It is noted that the term "gas" will be used alongside with the term "air" and is to be interpreted as encompassing any gas that is suitable as process gas in such a spray drying system. The drying chamber 2' also incorporates atomizing means, such as nozzles and/or an atomizer wheel.

[0018] At the lower end of the drying chamber 2', an outlet 5' for dried material is provided. In the shown spray drying system 1', an after-treatment unit in the form of a vibrating fluidizer 6' or integrated static fluid bed is provided. At one end, the vibrating fluidizer 6' receives dried material from the outlet 5' of the drying chamber 2' for further treatment of the material, which is then to be collected at an outlet at the other end of the vibrating fluidizer. Further downstream equipment may be present as well, but is not relevant to the present invention.

[0019] Furthermore, the spray drying system 1' comprises at least one powder recovery unit 4', to which spent process gas with particles entrained in the process gas is conducted via an exhaust line (not indicated). The powder recovery units 4' may take the form of cyclones or bag filters, or any combination thereof.

[0020] A conveying line 11' is provided for transporting the powdery material recovered in the powder recovery unit 4' to upstream equipment such as the drying chamber 2' itself, at an arbitrary position such as at the air disperser 3 and/or to the chamber bottom cone, or to the vibrating fluidizer 6' or integrated static fluid bed, likewise to an arbitrary position in these units. Typically, the recovered material is in the form of fines, which are powdery material of

satisfying composition but of a size and/or configuration that needs further processing in order to fulfil quality requirements. The position of introduction of the fines return into the upstream units typically depends on the size and/or configuration of the material and of the prevailing operating conditions in the drying chamber 2' and the vibrating fluidizer 6'. A valve assembly 7' is present in the system as well in order to ensure proper sorting and distribution of the returning fines to upstream units and to ensure that the spray drying system may be purged, i.e. blown through by a gas or air. To this end, purge valves 8' are connected to respective diverter valves 9' to allow a purge gas to be supplied via a purge line 10'.

[0021] In the following, an embodiment of the drying system according to the present invention will be described. Elements having the same, analogous, or corresponding function as in the prior art spray drying system will be denoted by the same reference numerals as in the description of the prior art spray drying system, with the exception that the mark ' of the description of the prior art spray drying system has been removed. In the following, the drying system will be described in the form of a spray drying system. It is to be understood, however, that the principles of the invention are applicable to any kind of drying system comprising one or more powder recovery units, a conveying line for the transport of powder, and a purge line. Examples of such drying systems include spray drying systems comprising operational units other than the ones shown and described, fluid bed systems, flash drying systems etc.

[0022] Referring now to Fig. 3, the spray drying system 1 of the present embodiment comprises a spray dryer with drying chamber 2 and process gas supply device in the form of an air disperser 3. At least one powder recovery unit is present, here two cyclones 4. A conveying line 11 for powdery material from the cyclones 4 leads to a set of valve assemblies 7, here three sets of valve assemblies 7.

[0023] From the valve assemblies 7 fines are conveyed through further conveying lines (not indicated) to various locations in upstream units including the drying chamber 2 or to the vibrating fluidizer 6 or integrated static fluid bed.

[0024] The valve assemblies 7 are also connected to a purge line 10, which in the embodiment shown also functions as a conduit for CIP liquid and dry out air to be described in further detail below.

[0025] Arrangements for providing conveying air and purge air are also present in the spray drying system although not indicated in detail in the drawings.

[0026] Fig. 4 shows a schematic flowchart of details of the spray drying system including the valve assemblies 7 in another embodiment.

[0027] Referring now in particular to Figs 5 to 7 and 10 to 12, the valve assembly 7 comprises a sanitary two-way diverter valve 70 according to the invention. The diverter valve 70 is provided with a substantially cylindrical valve housing 71 having a number of openings including a first opening 72, a second opening 73 and a third opening 74.

[0028] In the installed condition, the first opening 72 may be connected to the conveying line 11, and the second and third openings 73, 74 to further conveying lines leading from the valve assembly 7 as described in the above.

[0029] A rotatable diversion member 75 is located in the housing 71 and is connected thereto by means of shaft stub 75a journaled in a top wall of the housing 71. The diversion member 75 is provided with a flow channel 76 having a first end 76a and a second end 76b. An open space 77 is defined between the valve housing 71 and the rotatable diversion member 75. It is noted that the open space 77 of the valve housing 71 should have a volume of the same magnitude as the volume of the rotatable diversion member 75 in order to ascertain good flow conditions in the valve housing 71. For instance, it is conceivable to have a ratio between the volume of the open space 77 and the volume of the rotatable diversion member 75 in the range of 1:4 to 1:1, although any ratio suitable to the person skilled in the art is conceivable.

[0030] The rotatable diversion member 75 is configured to be rotated between a first position, shown in Figs 5 to 7 and 10, in which the first end 76a of the flow channel 76 is located opposite the first opening 72 of the valve housing 71 and the second end 76b of the flow channel 76 is located opposite the third opening 74 of the valve housing 71, and a second position, shown in Fig. 11, in which the first end 76a of the flow channel 76 is located opposite the second opening 73 of the valve housing 71 and the second end 76b of the flow channel 76 is located opposite the first opening 72 of the valve housing 71. In this manner, fluid communication is selectively provided between the first opening 72 and the third opening 74 and between the first opening 72 and the second opening 73 of the valve housing 71. In turn, this means that fluid communication is provided between the open space 77 and the second opening 73 of the valve housing 71 in the first position and between the open space 77 and the third opening 74 of the valve housing 71 in the second position.

[0031] In the specific embodiment, the flow channel 76 of the rotatable diversion member 75 comprises two channel sections 761 and 762 extending at a relative angle α to each other (cf. in particular Fig. 7).

[0032] The angle α may in principle be chosen freely as long as it is possible to position the rotatable diversion member 75 with the channel sections 761, 762 of the flow channel 76 opposite the openings 71, 72, 73. Preferably, the angle α is in the range 5° to 85° , preferably 10° to 45° , more preferably 20° to 30° , most preferred about 22.5° corresponding to an included angle β of 157.5° of the angled channel sections 761, 762 of the flow channel (76). The two sections need not necessarily be formed as two straight channel sections 761, 762, but rounded shapes are conceivable as well.

[0033] Corresponding to the specific embodiment, the second opening 73 and the third opening 74 of the valve housing 71 are positioned such that a central angle between the second opening 73 and the third opening 74 is two times the relative angle α of the channel sections of the flow channel 76 of the rotatable diversion member 75. That is, the central angle

is 45° in the embodiment shown.

[0034] The materials of the components of the sanitary two-way diverter valve 70 are chosen according to the specific requirements in the field of application of the drying system according to the invention. Typically, the valve housing 71 and the diversion member 75 are made from sanitary grade stainless steel.

[0035] In principle, the first and second positions of the diverter valve 70 of the valve assembly may in addition to being used for conveying fines in the conveying line 11 to distribute the fines to other operational units, also be used for purging the conveying lines and the valve assembly 7 itself. However, it is preferred that the spray drying system 1 comprises a cleaning-in-place, CIP, arrangement connected to said at least one purge line 10.

[0036] Thus, in addition to the arrangements for providing conveying air and purge air, arrangements for supplying CIP liquid and dry out air are also present in the spray drying system in the embodiment shown, although not indicated in detail in the drawings.

[0037] Turning now to Figs 8 and 9, the valve assembly 7 comprises a second valve 90 connected to the two-way diverter valve 70 via a fourth opening 78 included in the number of openings of the valve housing 71. The fourth opening 78 is in fluid connection with the open space 77 of the two-way diverter valve 70.

[0038] The second valve 90 is configured to be brought from a closed position shown in Fig. 8 to an open position shown in Fig. 9 in which it is in fluid connection with the conveying line 11 and the purge line 10 via the diverter valve 70.

[0039] In the embodiment shown in Figs 8 and 9, the second valve is a plug valve 90 having a plug end 91 adapted to close off the fourth opening 78 of the valve housing 71.

[0040] The flows through the valve assembly 7 of the preferred embodiment are thus shown in Figs 9, 10 and 11.

[0041] When it has been determined to carry out a CIP procedure, the CIP liquid is supplied to the valve assembly 7 and following cleaning, the CIP liquid may also be drained through the same lines and flow paths. Once the CIP liquid has been drained, dry out air is blown through the valve assembly 7, thereby drying and possibly also heating the entire valve assembly 7.

[0042] Referring now to Fig. 12, a seal 80 is provided between the valve housing 71 and one or more of the respective first, second and third openings 72, 73, 74 of the number of openings of the valve housing 71. In the embodiment shown, a seal 80 is provided at all the openings 71, 72, 73, the second opening 73 being shown.

[0043] Alternatively or additionally, a gap (not shown) may be provided between the valve housing 71 and one or more of the respective first, second and third openings 72, 73, 74 of the

number of openings of the valve housing 71. By pressurising the valve housing 71 to a slight overpressure, it is prevented that powder penetrates from the conveying lines whereby contamination is prevented.

[0044] An alternative use of the valve assembly 207 is shown in Fig. 3, in which a by-pass arrangement is provided, comprising at least one further two-way diverter valve 270 connected to a secondary conveying line optionally connectable to a secondary destination.

[0045] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

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- US3047020A [0005]
- DE4103976A1 [0005]
- DK201570712 [0005]

P A T E N T K R A V

1. Tørresystem (1) omfattende mindst én pulvergenvindingsenhed (4), mindst en transportlinje (11) til pulverformigt materiale så som fine partikler fra pulvergenvindings-
5 enheden (4), mindst en udrensningslinje (10) forbundet til en udrensningsanordning, og et ventilaggregat (7) omfattende mindst én sanitær omledningsventil (70), hvor den sanitære omledningsventil omfatter:

et ventilhus (71) med et antal åbninger (72, 73, 74) indrettede til at skulle forbindes med respektive linjer i systemet, hvor ventilhuset (71) er i det væsentlige cylindrisk og
10 indbefatter en første åbning (72), en anden åbning (73) og en tredje åbning (74); omledningsventilen (70) omfatter ydermere et roterbart omledningselement (75) forsynet med en strømningskanal (76) med en første ende (76a) og en anden ende (76b), hvor et åbnet rum (77) er defineret mellem ventilhuset (71) og det roterbare omledningselement (75); det roterbare omledningselement (75) er indrettet til at roteres mellem en første stilling, i
15 hvilken den første ende (76a) af strømningskanalen (76) er placeret modsat den første åbning (72) i ventilhuset (71), og den anden ende (76b) af strømningskanalen (76) er placeret modsat den tredje åbning (74) i ventilhuset (71), og en anden stilling, i hvilken den første ende (76a) af strømningskanalen (76) er placeret modsat den anden åbning (73) i ventilhuset (71), og den anden ende (76b) af strømningskanalen (76) er placeret modsat
20 den første åbning (72) i ventilhuset (71), således at der selektivt tilvejebringes fluidforbindelse mellem den første åbning (72) og den tredje åbning (74) og mellem den første åbning (72) og den anden åbning (73) i ventilhuset (71); og fluidforbindelse tilvejebringes mellem det åbne rum (77) og den anden åbning (73) i ventilhuset (71) i den første stilling og mellem det åbne rum (77) og den tredje åbning (74) i ventilhuset (71) i den anden
25 stilling;

hvor ventilaggregatet (7) omfatter en anden ventil (90) forbundet til den sanitære tovejsomledningsventil (70) via en fjerde åbning (78) indbefattet i antallet af åbninger i ventilhuset (71), hvilken fjerde åbning (78) er i fluidforbindelse med det åbne rum (77) i tovejsomledningsventilen (70), hvor den anden ventil (90) er indrettet til at blive bragt i
30 fluidforbindelse med den mindst ene transportlinje (11) og med den mindst ene udrensningslinje (10), og hvor desuden den anden ventil er en kegleventil (90) med en kegleende (91) tilpasset til at aflukke den fjerde åbning (78) i ventilhuset (71);

og hvor den sanitære omledningsventil (70) er forbundet til den mindst ene transportlinje (11) og den mindst ene udrensningslinje (10), således at den sanitære omledningsventil (70) er indrettet til at drives som en sanitær tovejsomledningsventil selektivt
35 med hensyn til væske, luft/gas og/eller pulver.

2. Tørresystem (1) ifølge krav 1, hvor tørresystemet omfatter en forstøvningstørrer med et tørrekammer (2) og en procesgastilførselsanordning (3).

3. Tørresystem ifølge et hvilket som helst af kravene 1 og 2, hvor tørresystemet (1)
40 omfatter en indretning til rengøring på stedet (CIP), forbundet til den mindst ene udrensningslinje (10).

4. Tørresystem ifølge et hvilket som helst af kravene 1 til 3, hvor der er tilvejebragt en omledningsindretning, omfattende mindst én yderligere sanitær tovejsomledningsventil (270) forbundet til en sekundær transportlinje (211), der eventuelt kan forbindes til et sekundært endemål.

5 5. Fremgangsmåde til rengøring af et system indbefattende en eller flere transportlinjer og mindst én udrensningslinje i en udrensningsanordning, og et ventilaggregat (7) indbefattende mindst én sanitær omledningsventil (70), hvor den sanitære omledningsventil (70) i ventilaggregatet (7) er forbundet til den mindst ene transportlinje (11) i normal drift, hvilken fremgangsmåde omfatter følgende trin:

10 at bestemme at en CIP-arbejdsgang skal igangsættes,
at tilføre CIP-væske gennem den mindst ene udrensningslinje (10) til ventilaggregatet (7),
efter at CIP-arbejdsgangen i systemet er tilendebragt at dræne CIP-væsken fra systemet,

15 at blæse tørreluft/-gas gennem ventilaggregatet for at tørre systemet,
hvor den mindst ene sanitære omledningsventil omfatter:

et ventilhus (71) med et antal åbninger (72, 73, 74) indrettede til at skulle forbindes med respektive linjer i systemet, hvor ventilhuset (71) er i det væsentlige cylindrisk og indbefatter en første åbning (72), en anden åbning (73) og en tredje åbning (74); omledningsventilen (70) omfatter ydermere et roterbart omledningselement (75) forsynet med en strømningskanal (76) med en første ende (76a) og en anden ende (76b), hvor et åbne rum (77) er defineret mellem ventilhuset (71) og det roterbare omledningselement (75);
20 det roterbare omledningselement (75) er indrettet til at roteres mellem en første stilling, i hvilken den første ende (76a) af strømningskanalen (76) er placeret modsat den første
25 åbning (72) i ventilhuset (71), og den anden ende (76b) af strømningskanalen (76) er placeret modsat den tredje åbning (74) i ventilhuset (71), og en anden stilling, i hvilken den første ende (76a) af strømningskanalen (76) er placeret modsat den anden åbning (73) i ventilhuset (71), og den anden ende (76b) af strømningskanalen (76) er placeret modsat den første åbning (72) i ventilhuset (71), således at der selektivt tilvejebringes fluidforbindelse mellem den første åbning (72) og den tredje åbning (74) og mellem den første åbning (72) og den anden åbning (73) i ventilhuset (71); og fluidforbindelse tilvejebringes mellem det åbne rum (77) og den anden åbning (73) i ventilhuset (71) i den første stilling og mellem det åbne rum (77) og den tredje åbning (74) i ventilhuset (71) i den anden stilling;

35 hvor ventilaggregatet (7) omfatter en anden ventil (90) forbundet til den sanitære tovejsomledningsventil (70) via en fjerde åbning (78) indbefattet i antallet af åbninger i ventilhuset (71), hvilken fjerde åbning (78) er i fluidforbindelse med det åbne rum (77) i tovejsomledningsventilen (70), hvor den anden ventil (90) er indrettet til at blive bragt i fluidforbindelse med den mindst ene transportlinje (11) og med den mindst ene udrens-

ningslinje (10), og hvor desuden den anden ventil er en kegleventil (90) med en kegleende (91) tilpasset til at aflukke den fjerde åbning (78) i ventilhuset (71).

6. Fremgangsmåde ifølge krav 5, hvor den sanitære omledningsventil i ventilaggre-
gatet bringes fra den første stilling til den anden stilling, eller omvendt, efter trinnet at
5 tilføre CIP-væske.

DRAWINGS

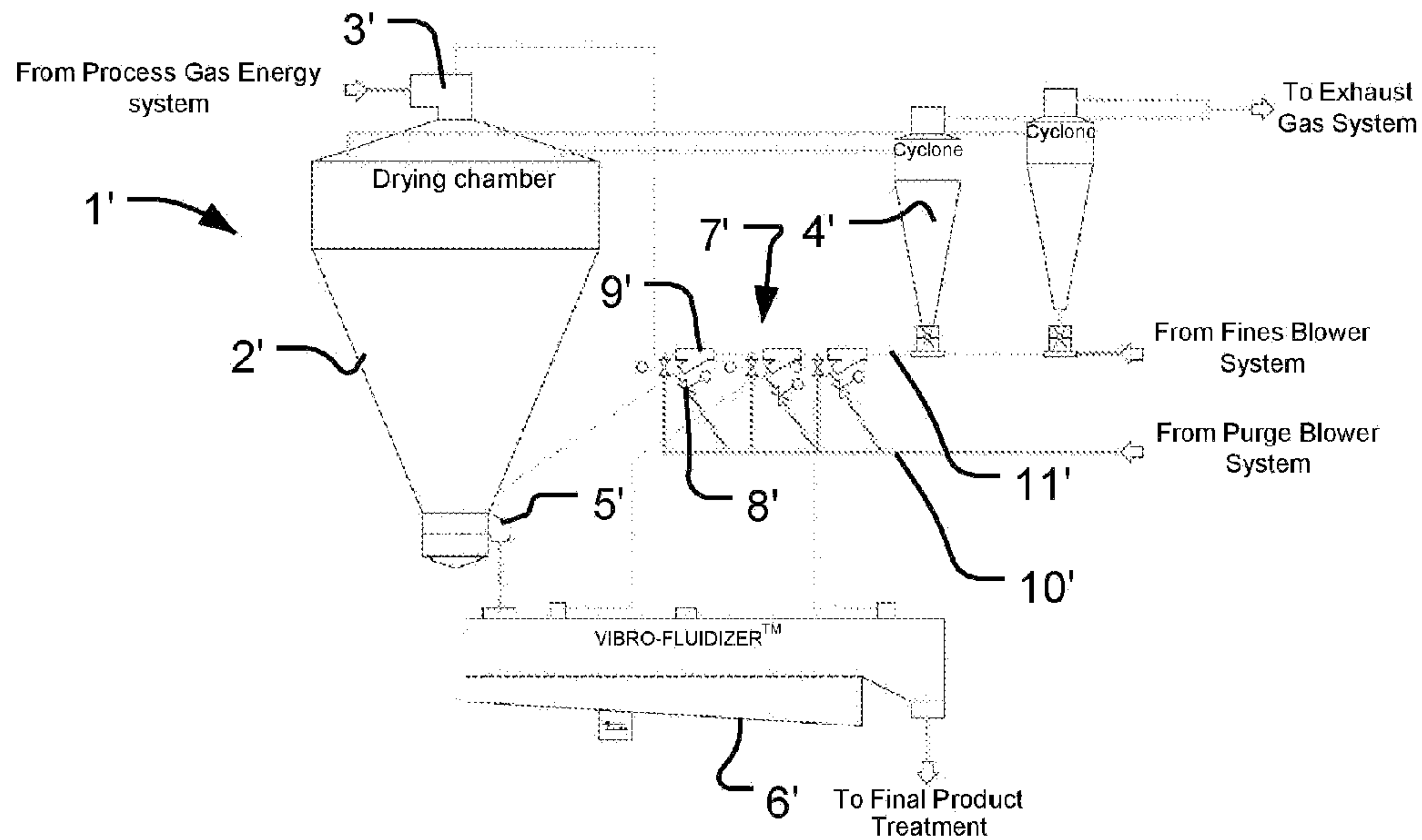


Fig. 1 (PRIOR ART)

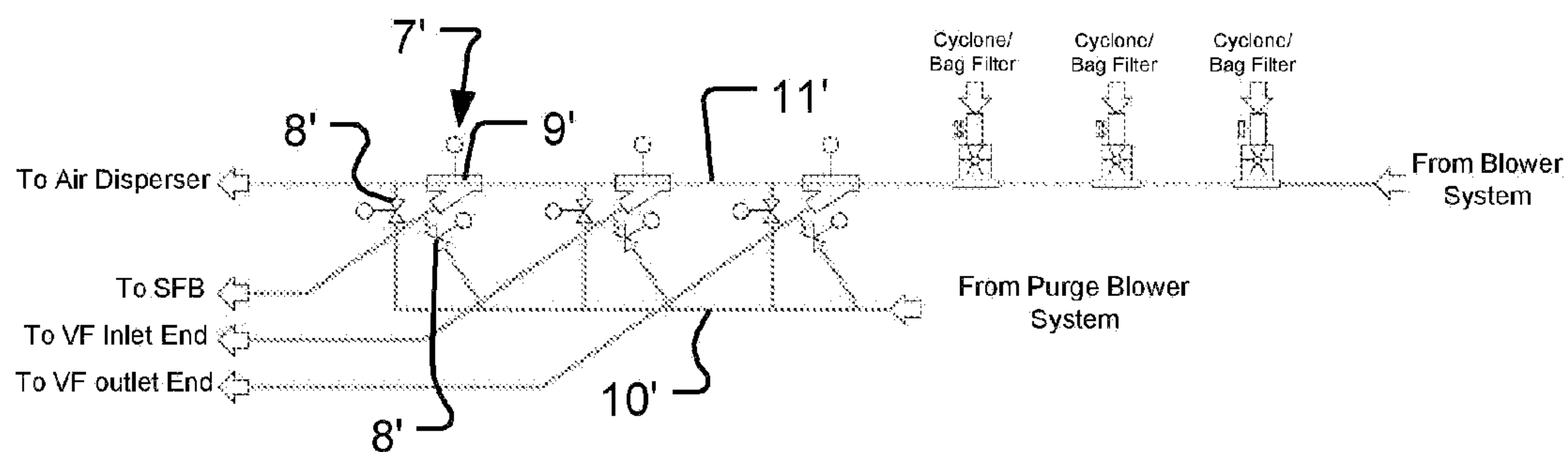


Fig. 2 (PRIOR ART)

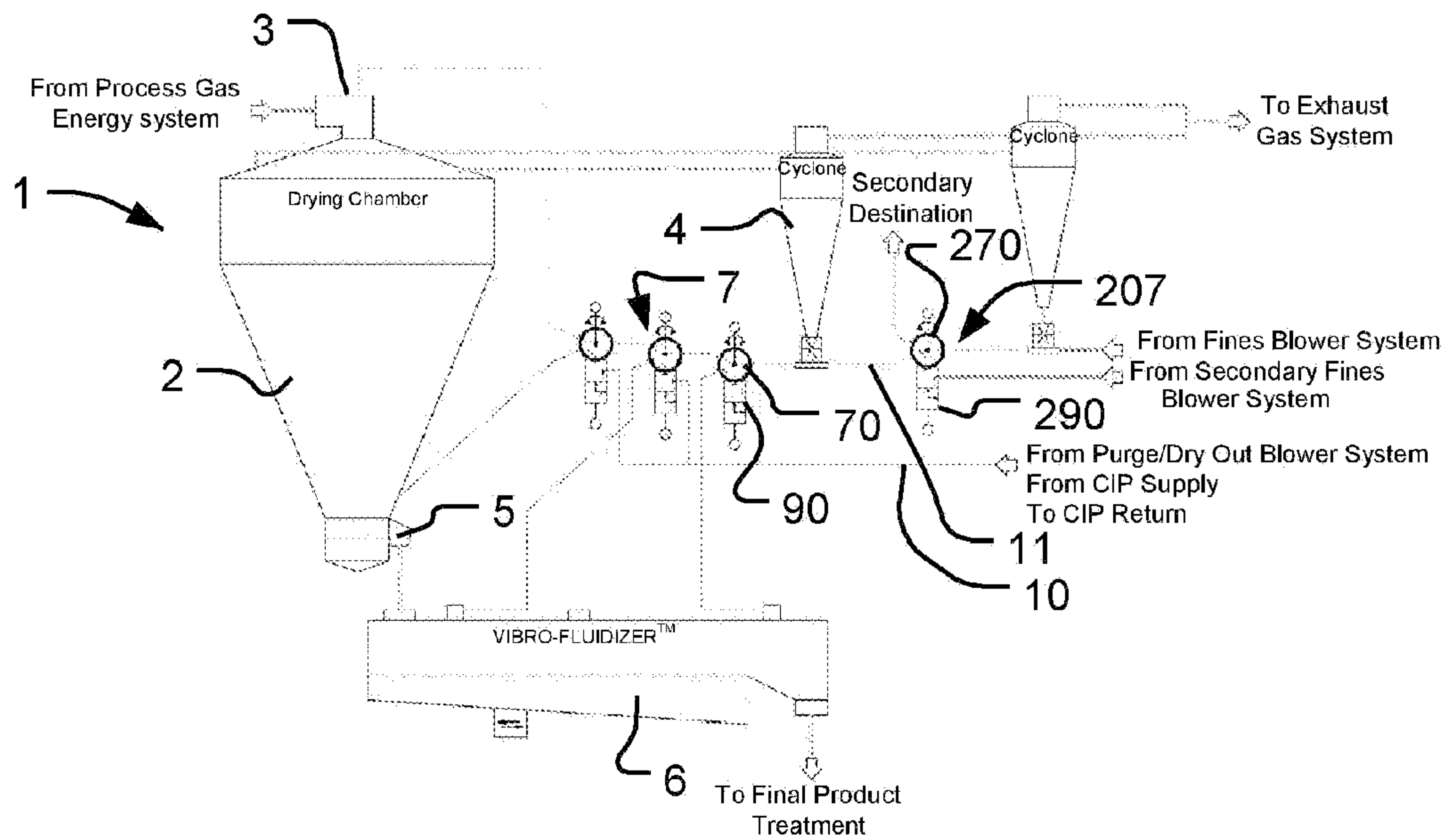


Fig. 3

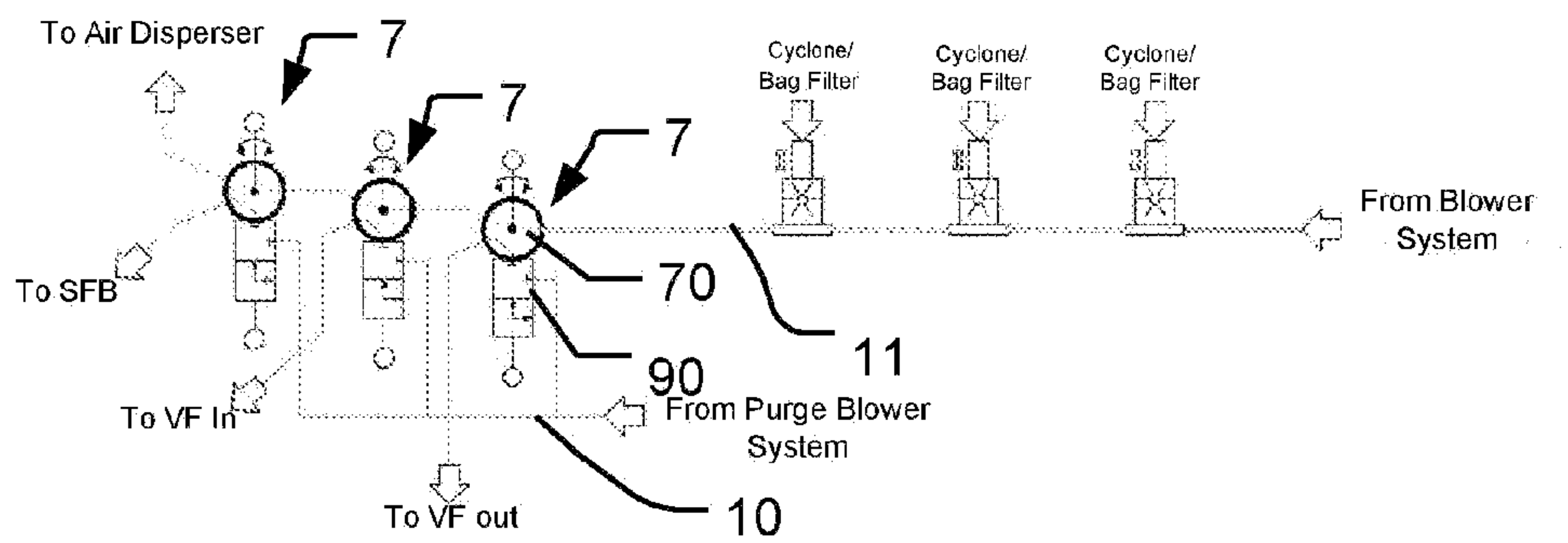
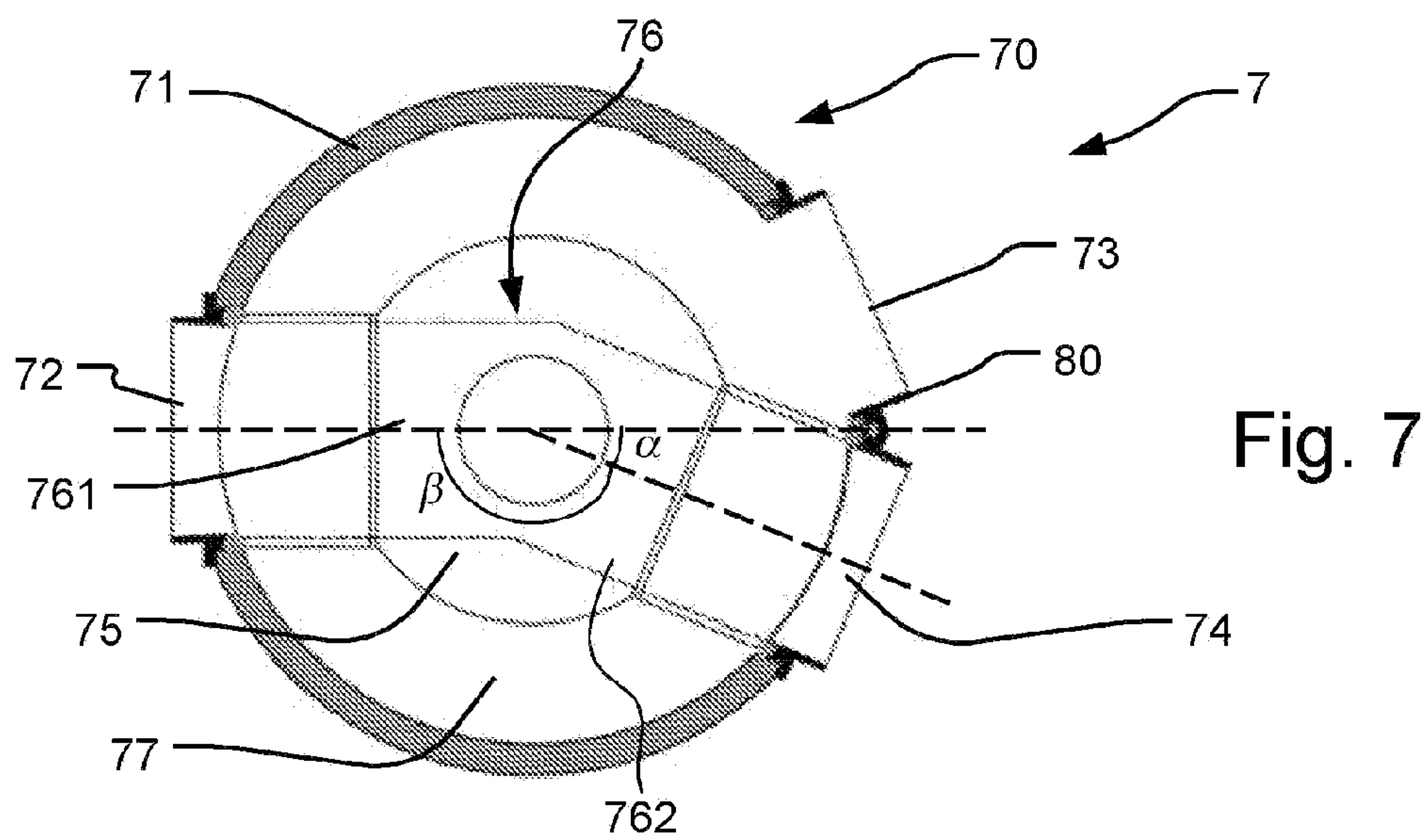
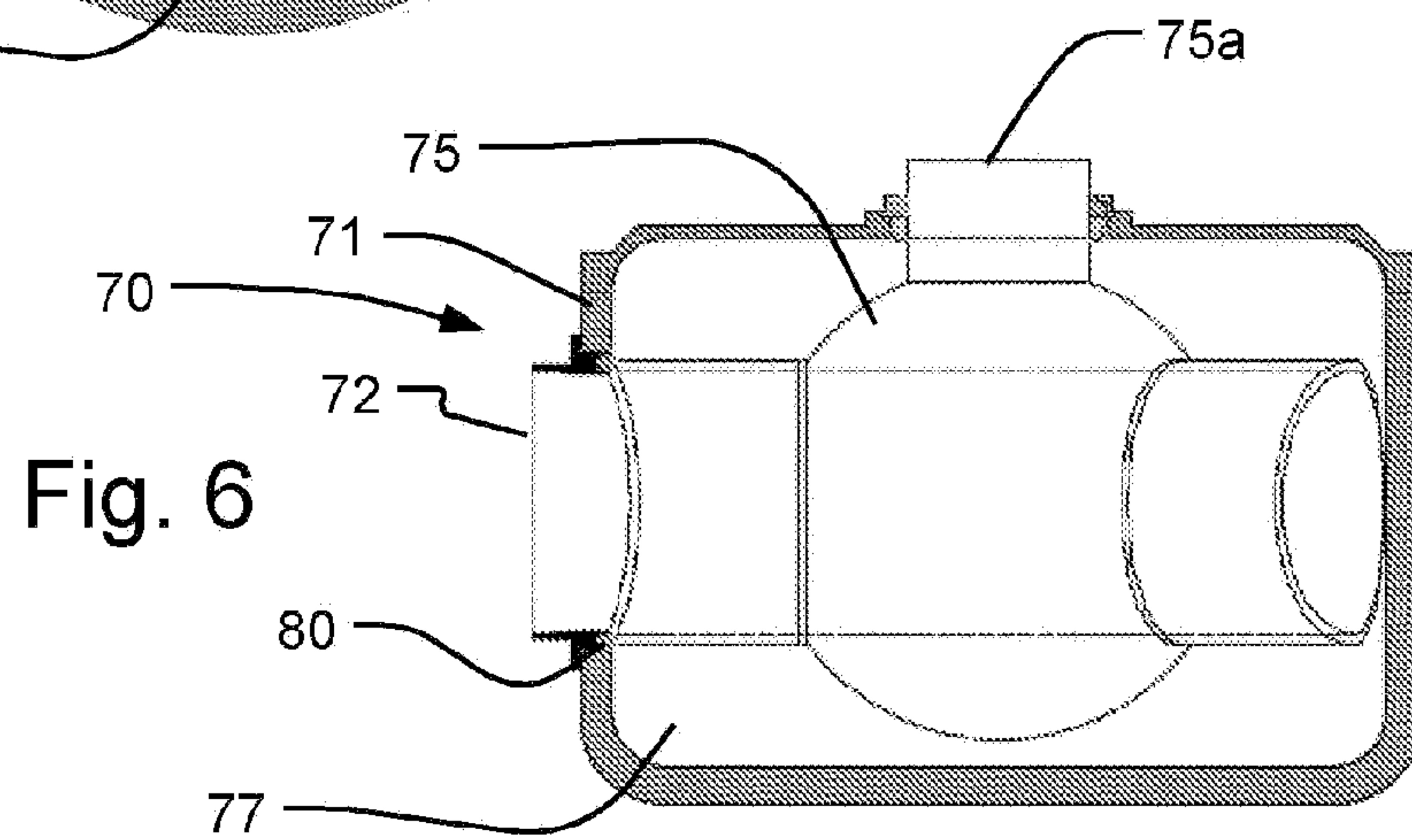
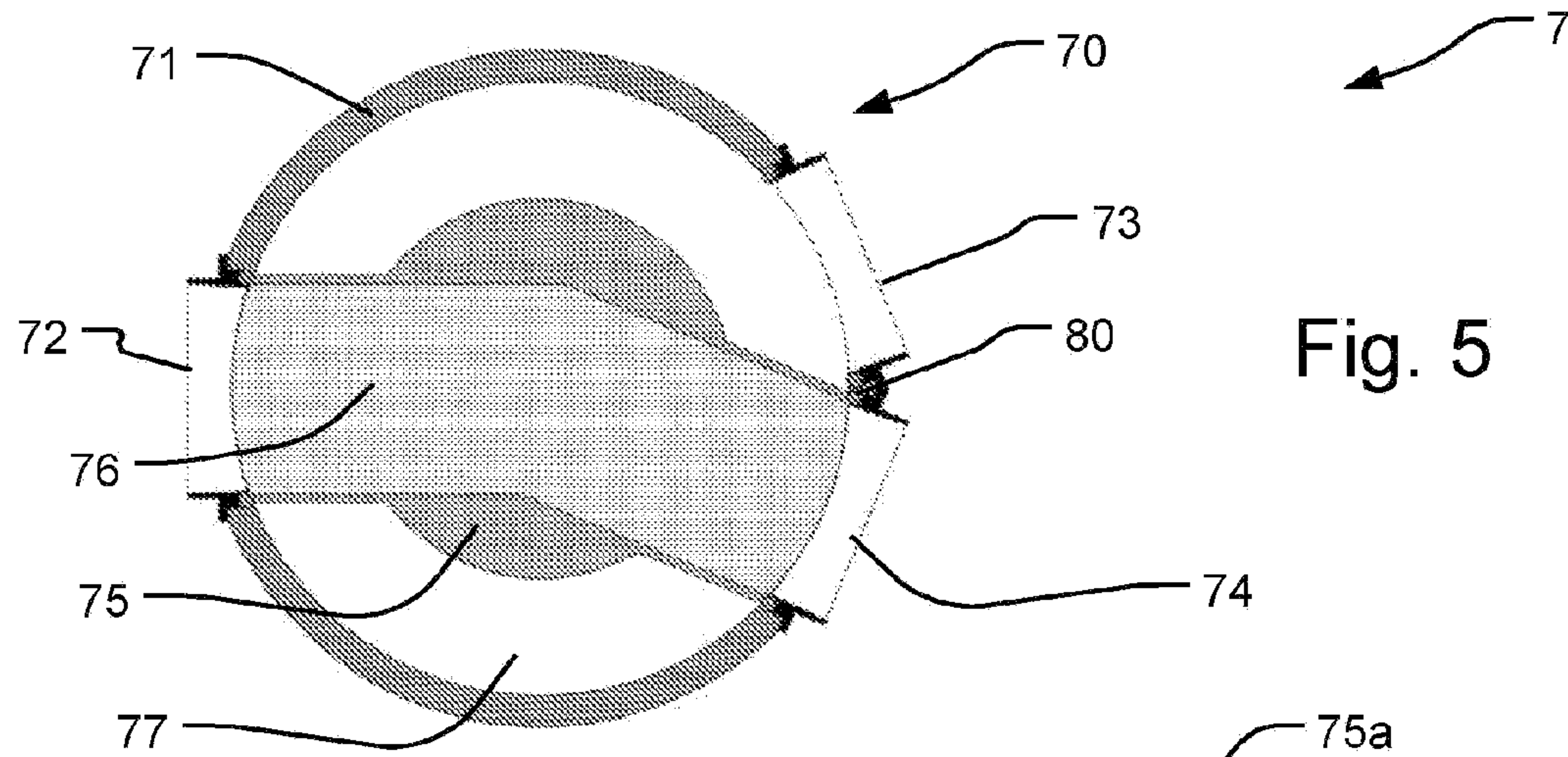


Fig. 4



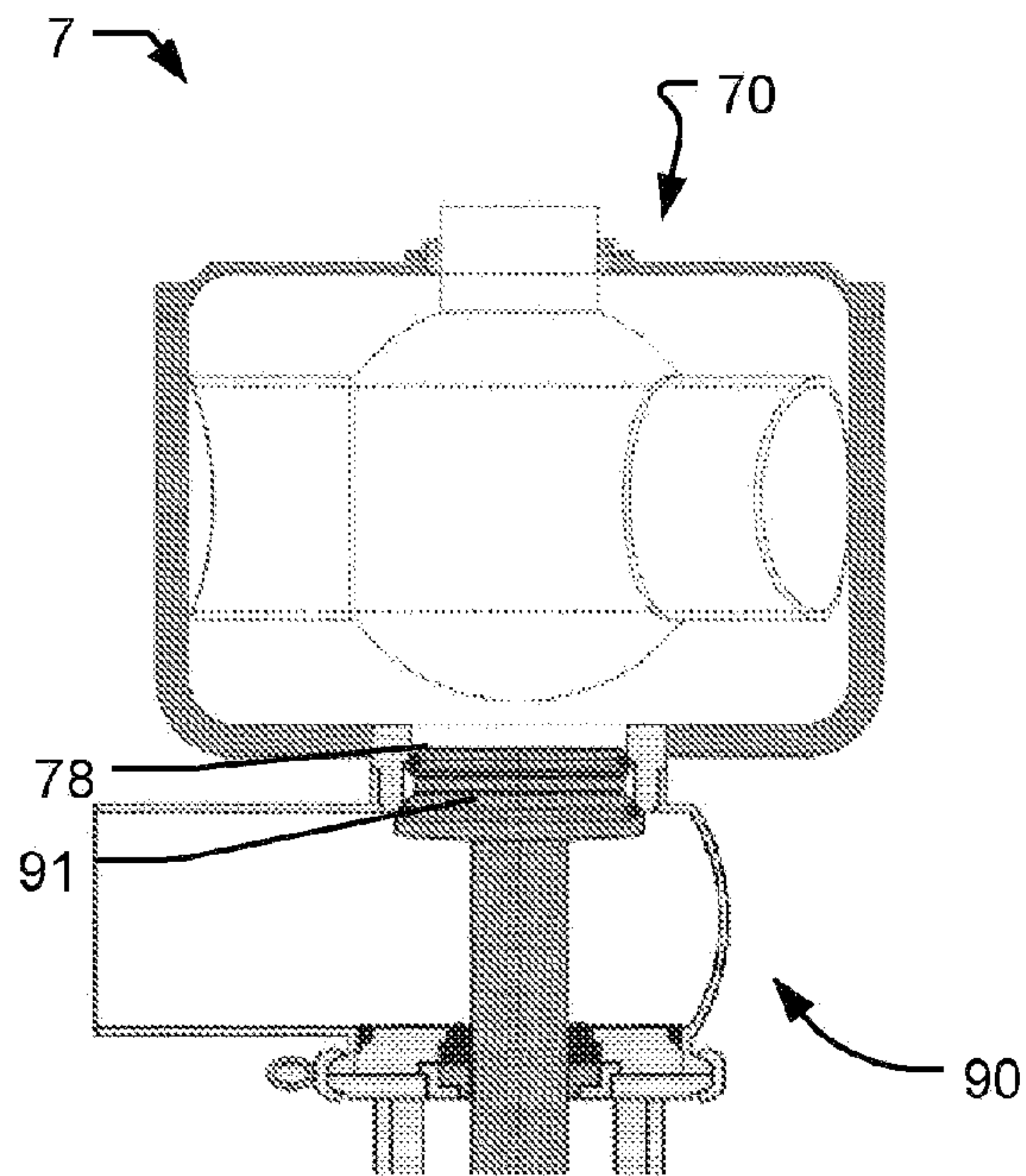


Fig. 8

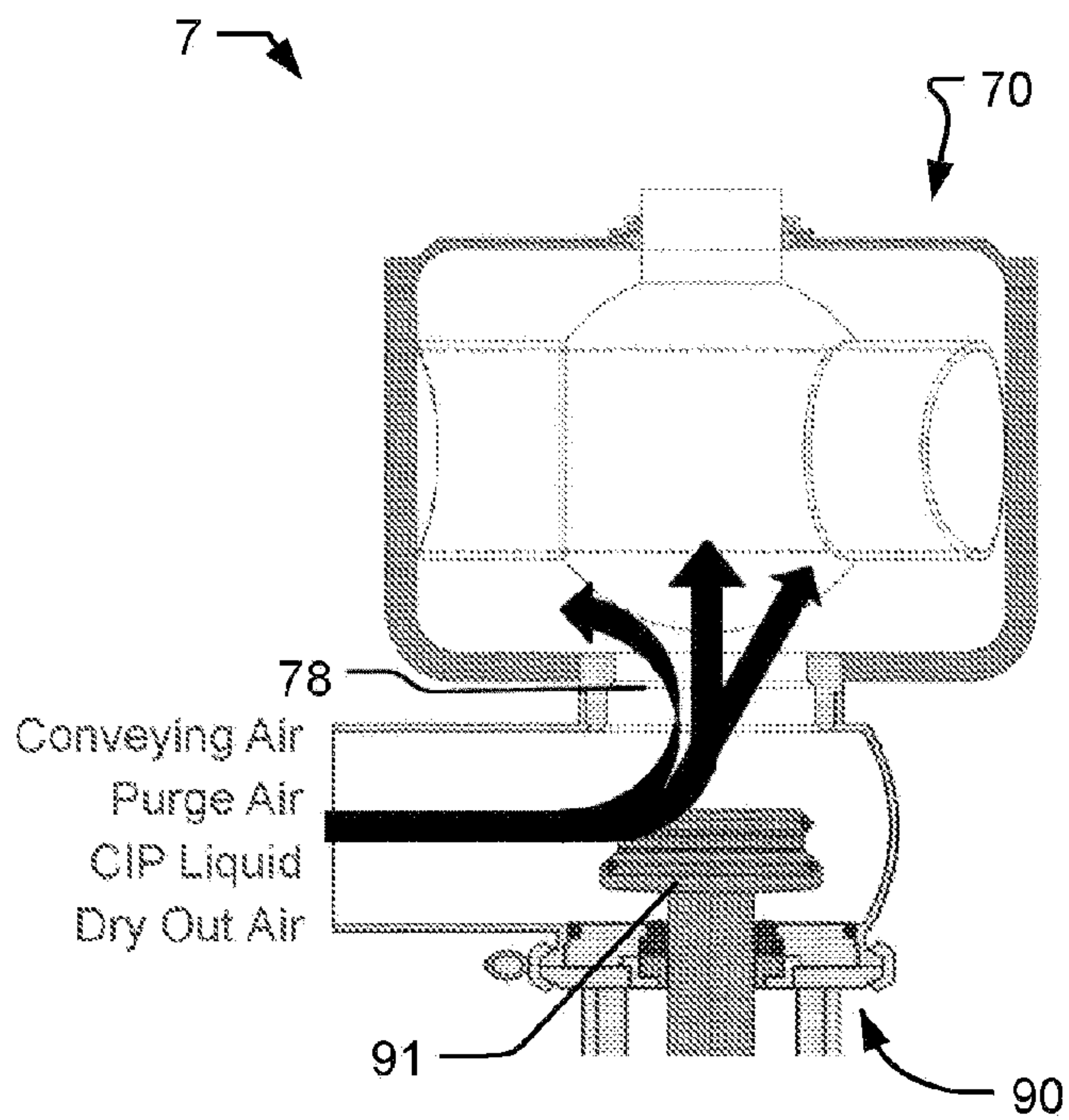


Fig. 9

