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(54) **Title**: PARTICLE COLLECTION APPARATUS

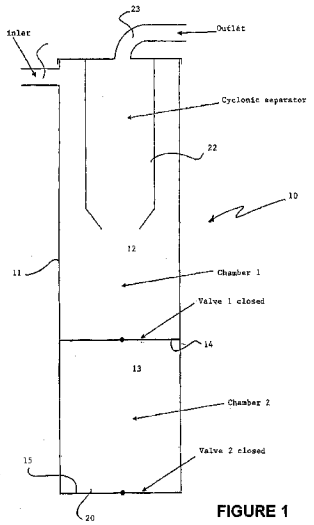

FIGURE 1

(57) **Abstract**: An apparatus for collecting particles from a mixture of particles and air and then discharging of the collected particles, the apparatus comprising: a first chamber in which the particles are separated from the-mixture and a second chamber in which the separated particles are collected, the first and second chambers being in communication with each other, the second chamber having an outlet for discharging the collected particles therethrough; a first gate between the first chamber and the second chamber, the first gate having an open condition in which the separated particles are allowed to flow from the first chamber to the second chamber and a closed condition in which the separated particles are substantially prevented from flowing from the first chamber to the second chamber; and a second gate in the outlet of the second chamber having an open condition in which the collected particles are allowed to be discharged from the second chamber and a closed condition in which the collected particles are substantially prevented from leaving the second chamber, the second gate operable to be able to adopt its open condition when the first gate is in its closed condition.

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PARTICLE COLLECTION APPARATUS

Technical Field

The present disclosure relates to an apparatus for collecting particles from a mixture of particles and air. The apparatus is configured to enable safe disposal of the collected particles. The apparatus finds particular application in grinding tools for grinding and polishing hard surfaces such as wood and concrete.

Background

Grinding tools are used to smooth and polish hard surfaces such as wood and concrete floors. The grinding creates dust and other particles which present a significant health hazard should the particles contact a person's eyes or be breathed in or ingested. Even though and operator wears protective equipment such as goggles and face masks, it remains important to minimise the spread of dust and other particles created during grinding. In addition, the particles are waste, which need to be cleaned up and removed. The less that they are spread during grinding, the less cleaning that needs to be done after the grinding operation has been completed.

Accordingly, most grinding tools incorporate a vacuum which sucks up the particles as the grinding tool is used and an apparatus which filters out or otherwise separates the particles from the stream of air containing particles that is created by the vacuum. The separated particles are typically then collected in a bag. However, a problem with many of these types of particle collectors is that once the bag becomes full and requires replacing, the vacuum and therefore the grinding tool itself has to be stopped. This downtime means that it takes longer to complete the task of grinding, particularly of large surface areas.

Summary of the Invention

According to an aspect of the present invention, there is provided an apparatus for collecting particles from a mixture of particles and air and then discharging of the collected particles, the apparatus comprising:

a first chamber in which the particles are separated from the mixture and a second chamber in which the separated particles are collected, the first and second chambers being in communication with each other, the second chamber having an outlet for discharging the collected particles therethrough;

a first gate between the first chamber and the second chamber, the first gate having an open condition in which the separated particles are allowed to flow from the first chamber to the second chamber and a closed condition in which the separated particles are substantially prevented from flowing from the first chamber to the second chamber; and

a second gate in the outlet of the second chamber having an open condition in which the collected particles are allowed to be discharged from the second chamber and a closed condition in which the collected particles are substantially prevented from leaving the second chamber, the second gate operable to be able to adopt its open condition when the first gate is in its closed condition.

The first gate may be operable to only adopt its open condition when the second gate is in its closed condition.

The second gate may be operable to only adopt its open condition when the first gate is in its closed condition.

The first gate may isolate the first chamber from the second chamber when the first gate is in its closed condition.

The first and second chambers may be connected by a conduit. In this embodiment, the first gate may be located in the conduit.

The first and second chambers may comprise portions of a unitary internal space.

The first gate may divide the internal space to define the first and second chambers.

The apparatus may comprise a unitary housing that forms the first and second chambers.

The first gate may be located in a mid-section of the housing.

The second gate may be located in an end section of the housing.

The first chamber may comprise at least one mixture inlet for the mixture of particles and air to be fed into the first chamber.

The at least one mixture inlet may be located at an opposed end of the apparatus to the outlet of the second chamber.

The first chamber may comprise at least one air outlet for separated air to flow out of the first chamber.

The first chamber may comprise at least one air inlet for air in addition to the mixture of air and particles to be fed into the first chamber to control air flow in the first chamber.

The first gate may comprise at least one movable member.

Each movable member may be configured to rotate to move the first gate between its open and closed conditions.

Each movable member may be configured to slide to move the first gate between its open and closed conditions.

The first gate may be a valve, such as a butterfly valve for example.

The second gate may comprises at least one movable member.

Each movable may be member is configured to rotate to move the second gate between its open and closed conditions.

Each movable member may be configured to slide to move the second gate between its open and closed conditions.

The second gate may be a valve., such as a butterfly valve for example.

The apparatus may comprise a separator for separating particles from the mixture.

The separator may be located in the first chamber.

In one embodiment, the separator is configured to separate the particles from the mixture by density separation. In another embodiment, the separator is configured to separate the particles from the mixture by cyclonic separation. The separator may also be any other suitable type of separator such as a filter for example.

The apparatus may comprise a further chamber and wherein the second gate when in its open condition enables the particles in the second chamber to flow to the further chamber.

The apparatus may comprise an attachment portion at the outlet of the second chamber for a particle collection container to be attached to receive the particles discharged from the second chamber.

The apparatus may comprise a particle collection container connected to the second chamber for receiving particles discharged from the second chamber.

The apparatus may comprise a controller for controlling the opening and closing of the first and second gates.

According to another aspect of the present disclosure, there is provided a grinding tool for grinding a surface, the tool incorporating an apparatus as disclosed herein.

According to a further aspect of the present disclosure, there is provided a method of collecting particles from a mixture of particles and air and then discharging of the collected particles, the method comprising using the apparatus as disclosed herein.

According to a further aspect of the present disclosure, there is provided a method of collecting particles from a mixture of particles and air and then discharging of the collected particles, the method comprising:

feeding the mixture of particles and air into a first chamber;

separating particles from the mixture in the first chamber;

allowing the separated particles to flow from the first chamber to a second chamber by causing a first gate between the first and second chambers to adopt an open condition;

collecting the separated particles in the second chamber; and

causing the first gate to adopt a closed condition to substantially prevent the flow of separated particles from the first chamber to the second chamber; prior to

discharging the collected particles from the second chamber through an outlet of the second chamber by causing a second gate in the outlet to adopt an open condition.

Whilst carrying out the step of allowing the separated particles to flow from the first chamber to a second chamber, the second gate may remain in a closed condition in which the collected particles are substantially prevented from leaving the second chamber.

The steps of feeding and separating the particles from the mixture may continue whilst carrying out the step of discharging the collected particles from the second chamber.

Brief Description of the Drawings

Embodiments of the present disclosure will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1-3 are schematic views of an apparatus for collecting particles from a mixture of particles and air and then discharging of the collected particles, in which first and second valves of the apparatus are shown in open and closed conditions; and

Figures 4-6 are schematic views of the apparatus of Figures 1-3 showing the collection and flow of collected particles through the apparatus.

Detailed Description of Embodiments

Referring to the Figures, an apparatus 10 for collecting particles from a mixture of particles and air and then discharging of the collected particles is shown. The apparatus 10 comprises a unitary housing 11 that defines an internal space that is divided into first and second chambers 12, 13 by a first gate in the form of a butterfly valve 14. Although, in other embodiments, the first and second chambers may comprise separate units connected by and in communication via a conduit. The apparatus 10 also comprises a second gate also in the form of a butterfly valve 15 that is located in an outlet 20 of the second chamber.

The first chamber 12 has a mixture inlet 21 through which the mixture of particles and air are fed into the chamber. The mixture inlet 21 is located at an opposed end of the apparatus 10 to the outlet 20 of the second chamber 12. It is to be understood, of course, that the first chamber could have more than one such inlet. The mixture of particles and air are typically drawn into the first chamber 12 through the mixture inlet 21 by a vacuum pump (not shown) that is operating to 'suck up' the particles.

Inside the first chamber 12 is a separator in the form of a cyclonic separator 22 for separating the particles from the mixture. However, other types of separators may be incorporated into the apparatus including a density separator or a filter for example. The cyclonic separator 22 is configured so that the separated particles fall to the bottom of the first chamber 12 and air, separated from the mixture, flows out of the chamber 12 (and thus out of the apparatus 10) through an air outlet 23, typically provided at the top of the first chamber. The air outlet 23 may incorporate a filter to prevent any particles from unintentionally escaping the apparatus 10 through the air

outlet. Although not shown in the Figures, because a cyclonic separator is employed, the first chamber may also incorporate one or more air inlets for feeding air in addition to the air particle mixture into the chamber, preferably through nozzles, to control the air flow within the first chamber.

The first butterfly valve 14 is located in a mid-section of the housing 11, in the space or conduit between the first and second chambers 12, 13. In its open condition as shown in Figure 2 for example, the first butterfly valve 14 allows the separated particles to flow from the first chamber 12 to the second chamber 13. In its closed condition as shown in Figure 3 for example, the first butterfly valve 14 prevents this flow and closes the second chamber 13 from the first chamber 12. In a preferred embodiment, the first butterfly valve 14 in its closed condition is tightly sealed to isolate the second chamber 13 from the first chamber 12 so that neither particles nor any air can flow between the chambers. The first butterfly valve 14 comprises a plate like member that rotates about a central axis to move between its open and closed conditions.

It is to be understood, however, that in other embodiments, other suitable forms of valves or gates could be used for the first gate instead of a butterfly valve. These gates could include one or more than one movable members that rotate and/or slide between open and closed conditions.

The second butterfly valve 15 is located in an end section of the housing 11; at an opposed to end to the location of the air-particle mixture inlet 21. In the embodiment shown in the Figures, the second butterfly valve 15 is substantially identical to the first butterfly valve 14 and comprises a plate like member that rotates about a central axis to move between open and closed conditions. However, as with the first butterfly valve, the second butterfly valve could instead be any other suitable type of valve or gate and furthermore need not be identical to the first butterfly valve. In its open condition, as shown for example in Figure 3, the second butterfly valve 15 allows the particles that have collected in the second chamber 13 to be discharged from the chamber (and thus from the apparatus 10) through the outlet 20 in the second chamber. In its closed condition, as shown for example in Figure 2, the

second butterfly valve 15 occludes the second chamber outlet 20 to prevent particles from leaving the second chamber. In a preferred embodiment, the second butterfly valve 15 in its closed condition is tightly sealed.

Referring specifically to Figures 4-6, operation of the apparatus 10 will now be described. The apparatus 10 has been specifically designed to be incorporated into a grinding tool so as to be used in the collection and safe disposal of the dust and other particulates generated when the tool is used to grind a concrete or wood floor surface. However, it is envisaged that the apparatus 10 could be incorporated into other tools such as cutters that also generate dust and other particles when used.

During grinding a vacuum pump is used to 'suck up' the particles produced. The vacuum pump sends a stream of air mixed with these particles to the apparatus 10, the mixture entering the first chamber 12 through the mixture inlet 21. The separator separates the particles from the mixture, the separated particles dropping under gravity towards the bottom of the first chamber 12. Initially, the first butterfly valve 14 is configured in its open condition and the second butterfly valve 15 is configured in its closed condition. This means that the separated particles are able to flow from the first chamber 12 to the second chamber 13, collecting in the second chamber, as shown in Figure 4. This flow of separated particles to the second chamber occurs under gravity because the second chamber 13 is positioned below the first chamber 12. Although the vertical arrangement of the chambers advantageously enables the particles to flow under gravity, it is to be understood that in other embodiments, the chambers may be in a horizontal configuration with respect to each other.

Once the second chamber 13 has filled or is approaching a filled level of particles. The first butterfly valve 14 is operated to adopt its closed condition before the second butterfly valve 15 is then operated to adopt its open condition. The second butterfly valve 15 is operated so that it cannot adopt its open condition whilst the first butterfly valve 14 is in its open condition (at least whilst the grinding tool in which the apparatus is incorporated is in use). This is because if the second valve 15 opened whilst the first valve 14 was open, then the air flowing through the first chamber 12 would potentially blow particles out of the second chamber 13 and possibly into the

atmosphere which would result in a health hazard for the operator of the grinding tool. Movement of the valves 14, 15 is controlled by a controller which may be triggered manually or through the use of sensors monitoring the level of particles in the second chamber. When the first valve 14 is closed and the second valve 15 is open, the collected particles in the second chamber 13 are safely discharged from the chamber through its outlet 20 and into a collection bag or container attached to an attachment portion of the apparatus 10. At same time, particles continue to be separated from the air-particle mixture in the first chamber 12 of the apparatus 10, the separated particles accumulating at the bottom of the first chamber 12 on top of the first valve 14. This is shown in Figure 5. Thus, advantageously, the apparatus 10 and thus also the grinding tool in which it is incorporated can be continuously operated and does not need to be stopped when the collected particles are being discharged from the apparatus 10.

Once all the particles have been discharged from the second chamber 13, the second valve 15 is operated to adopt its closed configuration. Then the first valve 14 can be operated to adopt its open configuration, so that any separated particles that have accumulated in the first chamber 12 whilst the second chamber 13 was being discharged can now flow into and be collected in the second chamber. This is shown in Figure 6. The first valve 14 is also operated so that it cannot adopt its open condition whilst the second valve 15 is in its open condition (at least whilst the grinding tool in which the apparatus is incorporated is in use) for the same reasons that second valve cannot be opened whilst the first valve is open. With the second valve 15 closed again, if the collection bag or container is full following the discharge of particles from the second chamber, the bag or container can be safely disconnected from the apparatus 10 for disposal and a new bag or container attached, which can occur without stopping the separation and collection process within the apparatus 10 and thus without the operator having to stop using the grinding tool.

Accordingly, a significant advantage of the apparatus 10 is that the cycle of collecting the separated particles in the second chamber 13 and then discharging the particles can occur without any interruption to the use of the grinding tool.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

CLAIMS

1. An apparatus for collecting particles from a mixture of particles and air and then discharging of the collected particles, the apparatus comprising:

a first chamber in which the particles are separated from the mixture and a second chamber in which the separated particles are collected, the first and second chambers being in communication with each other, the second chamber having an outlet for discharging the collected particles therethrough;

a first gate between the first chamber and the second chamber, the first gate having an open condition in which the separated particles are allowed to flow from the first chamber to the second chamber and a closed condition in which the separated particles are substantially prevented from flowing from the first chamber to the second chamber; and

a second gate in the outlet of the second chamber having an open condition in which the collected particles are allowed to be discharged from the second chamber and a closed condition in which the collected particles are substantially prevented from leaving the second chamber, the second gate operable to be able to adopt its open condition when the first gate is in its closed condition.

2. An apparatus according to claim 1, wherein the first gate is operable to only adopt its open condition when the second gate is in its closed condition and the second gate is operable to only adopt its open condition when the first gate is in its closed condition.

3. An apparatus according to claims 1 or 2, wherein the first gate isolates the first chamber from the second chamber when the first gate is in its closed condition.

4. An apparatus according to any one of the preceding claims, wherein the first and second chambers are connected by a conduit and the first gate is located in the conduit.

5. An apparatus according to any one of the preceding claims, wherein the first and second chambers comprise portions of a unitary internal space.

6. An apparatus according to any one of the preceding claims, wherein the first gate divides the internal space to define the first and second chambers.

7. An apparatus according to any one of the preceding claims, wherein the apparatus comprises a unitary housing that forms the first and second chambers.

8. An apparatus according to claim 7, wherein the first gate is located in a mid-section of the housing.

9. An apparatus according to claim 7 or 8, wherein the second gate is located in an end section of the housing.

10. An apparatus according to any one of the preceding claims, wherein the first chamber comprises at least one mixture inlet for the mixture of particles and air to be fed into the first chamber.

11. An apparatus according to claim 10, wherein the at least one mixture inlet is located at an opposed end of the apparatus to the outlet of the second chamber.

12. An apparatus according to any one of the preceding claims, wherein the first chamber comprises at least one air outlet for separated air to flow out of the first chamber.

13. An apparatus according to any one of the preceding claims, wherein the first chamber comprises at least one air inlet for air in addition to the mixture of air and particles to be fed into the first chamber to control air flow in the first chamber.

14. An apparatus according to any one of the preceding claims, wherein the first gate comprises at least one movable member.

15. An apparatus according to claim 14, wherein each movable member is configured to rotate to move the first gate between its open and closed conditions.

16. An apparatus according to claim 14, wherein each movable member is configured to slide to move the first gate between its open and closed conditions.

17. An apparatus according to any one of the preceding claims, wherein the first gate is a valve.

18. An apparatus according to claim 17, wherein the valve is a butterfly valve.

19. An apparatus according to any one of the preceding claims, wherein the second gate comprises at least one movable member.

20. An apparatus according to claim 19, wherein each movable member is configured to rotate to move the second gate between its open and closed conditions.

21. An apparatus according to claim 19, wherein each movable member is configured to slide to move the second gate between its open and closed conditions.

22. An apparatus according to any one of the preceding claims, wherein the second gate is a valve.

23. An apparatus according to claim 22, wherein the valve is a butterfly valve.

24. An apparatus according to any one of the preceding claims, wherein the apparatus comprises a separator for separating particles from the mixture.

25. An apparatus according to claim 24, wherein the separator is located in the first chamber.

26. An apparatus according to claims 24 or 25, wherein the separator is configured to separate the particles from the mixture by density separation.

27. An apparatus according to any one of claims 24-26, wherein the separator is configured to separate the particles from the mixture by cyclonic separation.

28. An apparatus according to any one of the preceding claims, wherein the apparatus comprises a further chamber and wherein the second gate when in its open condition enables the particles in the second chamber to flow to the further chamber.

29. An apparatus according to any one of the preceding claims, wherein the apparatus comprises an attachment portion at the outlet of the second chamber for a particle collection container to be attached to receive the particles discharged from the second chamber.

30. An apparatus according to any one of the preceding claims, wherein the apparatus comprises a particle collection container connected to second chamber for receiving particles discharged from the second chamber.

31. An apparatus according to any one of the preceding claims, wherein the apparatus comprises a controller for controlling the opening and closing of the first and second gates.

32. A grinding tool for grinding a surface, the tool incorporating an apparatus as claimed in any one of the preceding claims.

33. A method of collecting particles from a mixture of particles and air and then discharging of the collected particles, the method comprising using the apparatus according to any one of claims 1-31.

34. A method of collecting particles from a mixture of particles and air and then discharging of the collected particles, the method comprising:

feeding the mixture of particles and air into a first chamber;

separating particles from the mixture in the first chamber;

allowing the separated particles to flow from the first chamber to a second chamber by causing a first gate between the first and second chambers to adopt an open condition;

collecting the separated particles in the second chamber; and

causing the first gate to adopt a closed condition to substantially prevent the flow of separated particles from the first chamber to the second chamber; prior to

discharging the collected particles from the second chamber through an outlet of the second chamber by causing a second gate in the outlet to adopt an open condition.

35. A method according to claim 34, wherein whilst carrying out the step of allowing the separated particles to flow from the first chamber to a second chamber, the second gate remains in a closed condition in which the collected particles are substantially prevented from leaving the second chamber.

36. A method according to claim 34 or 35, wherein the steps of feeding and separating the particles from the mixture continue whilst carrying out the step of discharging the collected particles from the second chamber.

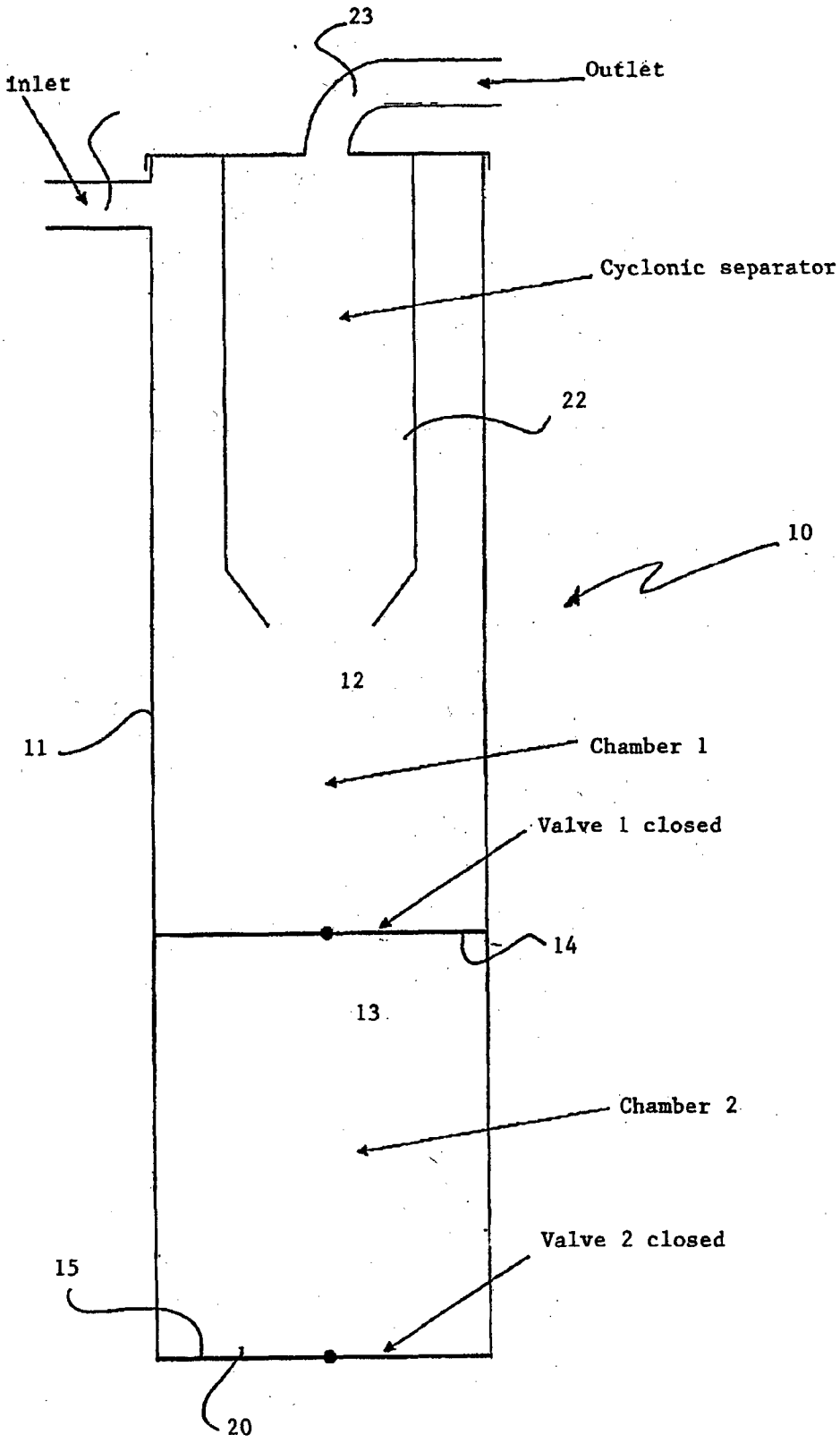
23
Outlet
Inlet
Cyclonic separator
22
10
12
11
Chamber 1
Valve 1 closed
14
13
Chamber 2
Valve 2 closed
15
20

FIGURE 1

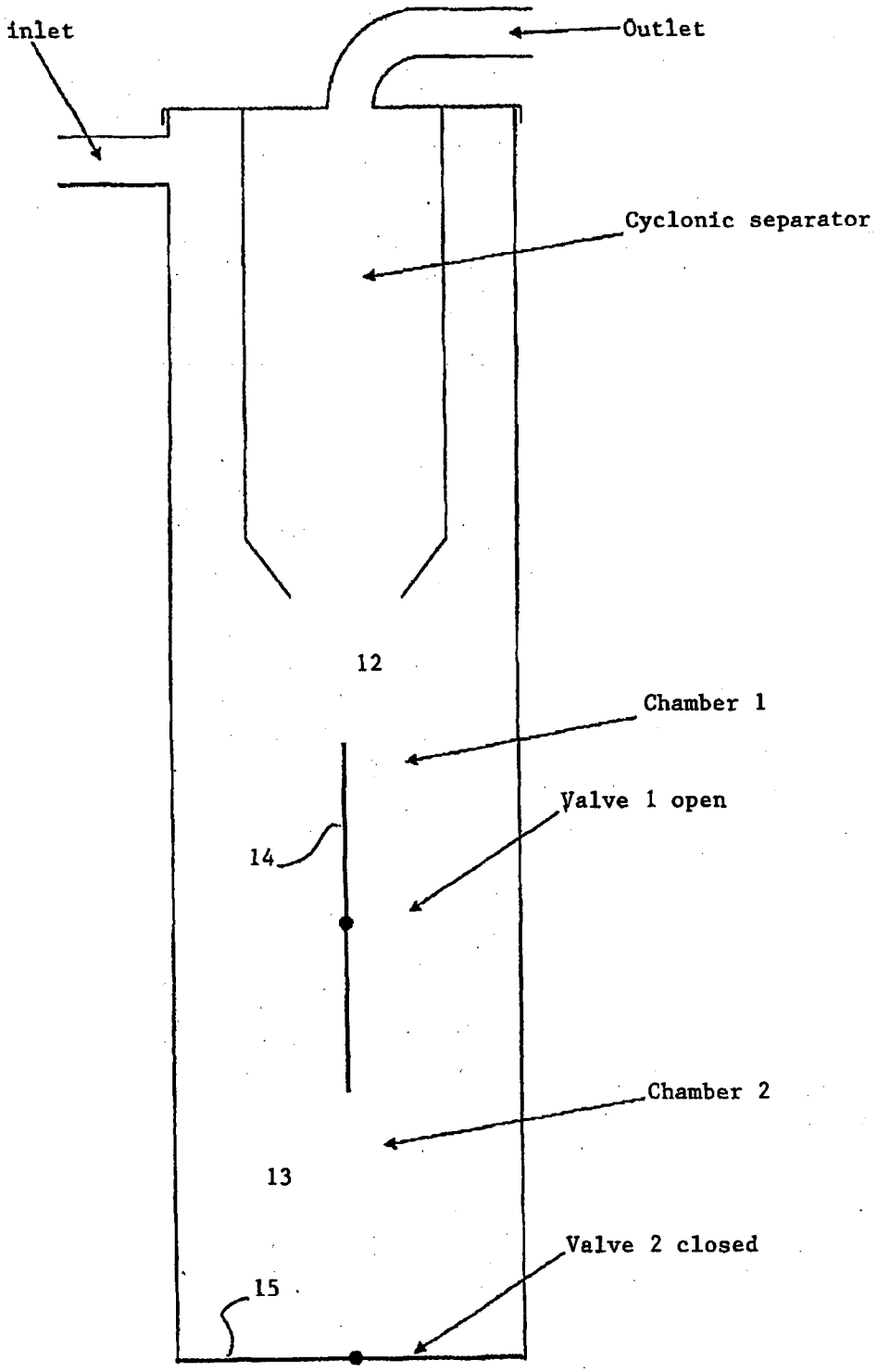
inlet
Outlet
Cyclonic separator
12
Chamber 1
Valve 1 open
14
Chamber 2
13
Valve 2 closed
15

FIGURE 2

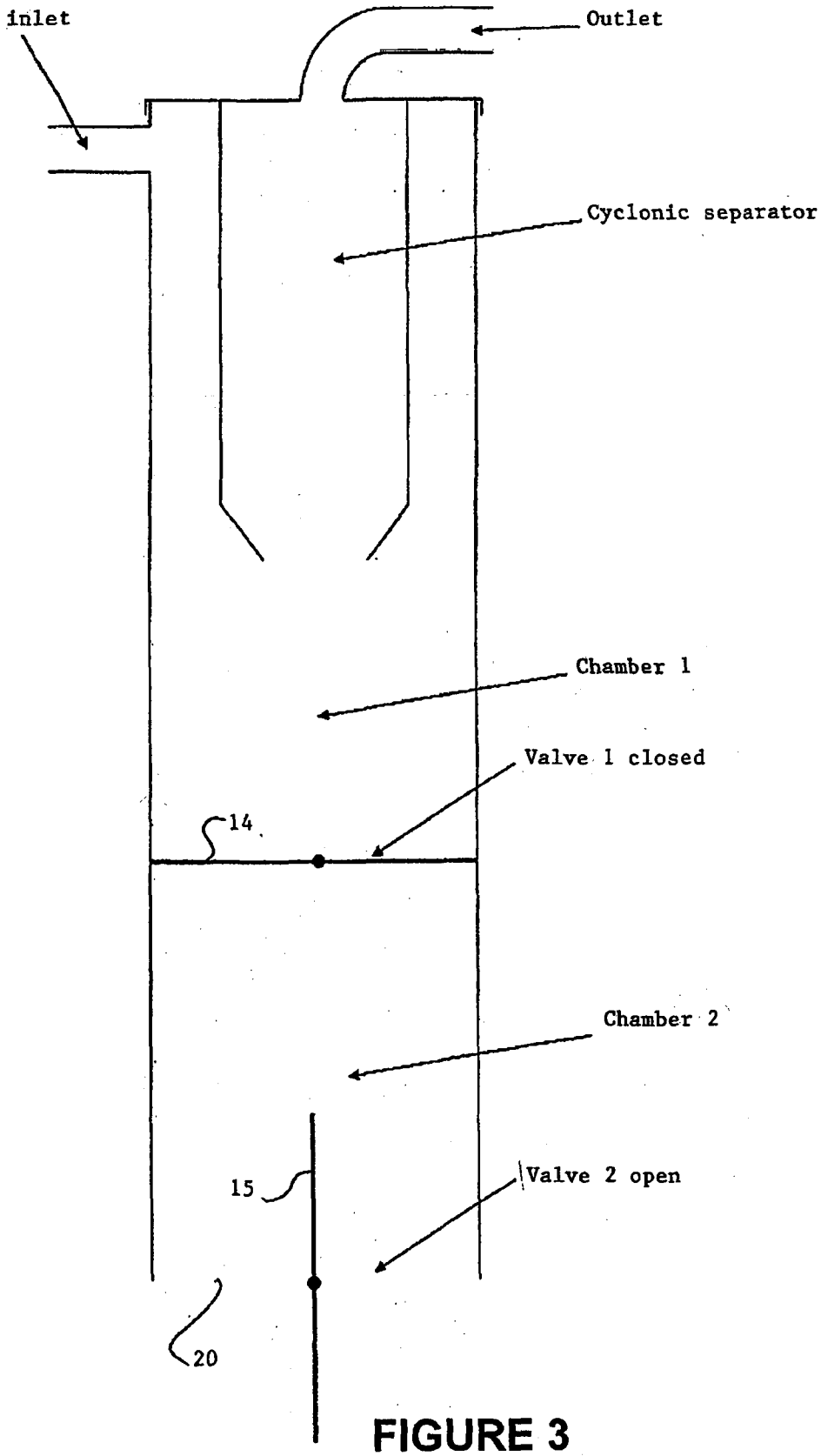
inlet
Outlet
Cyclonic separator
Chamber 1
Valve 1 closed
14
Chamber 2
15
Valve 2 open
20

FIGURE 3

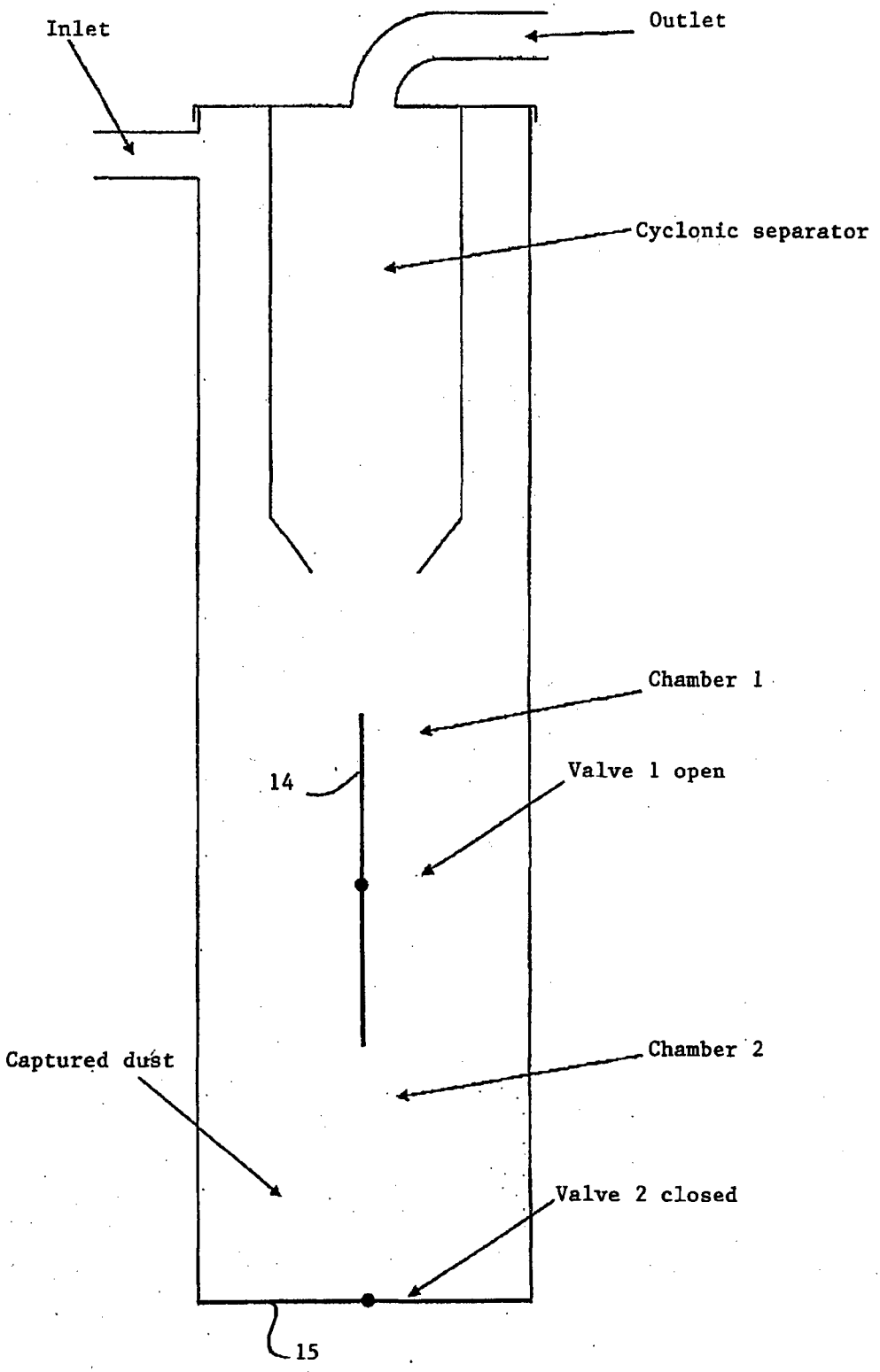
Inlet
Outlet
Cyclonic separator
Chamber 1
14
Valve 1 open
Captured dust
Chamber 2
Valve 2 closed
15

FIGURE 4

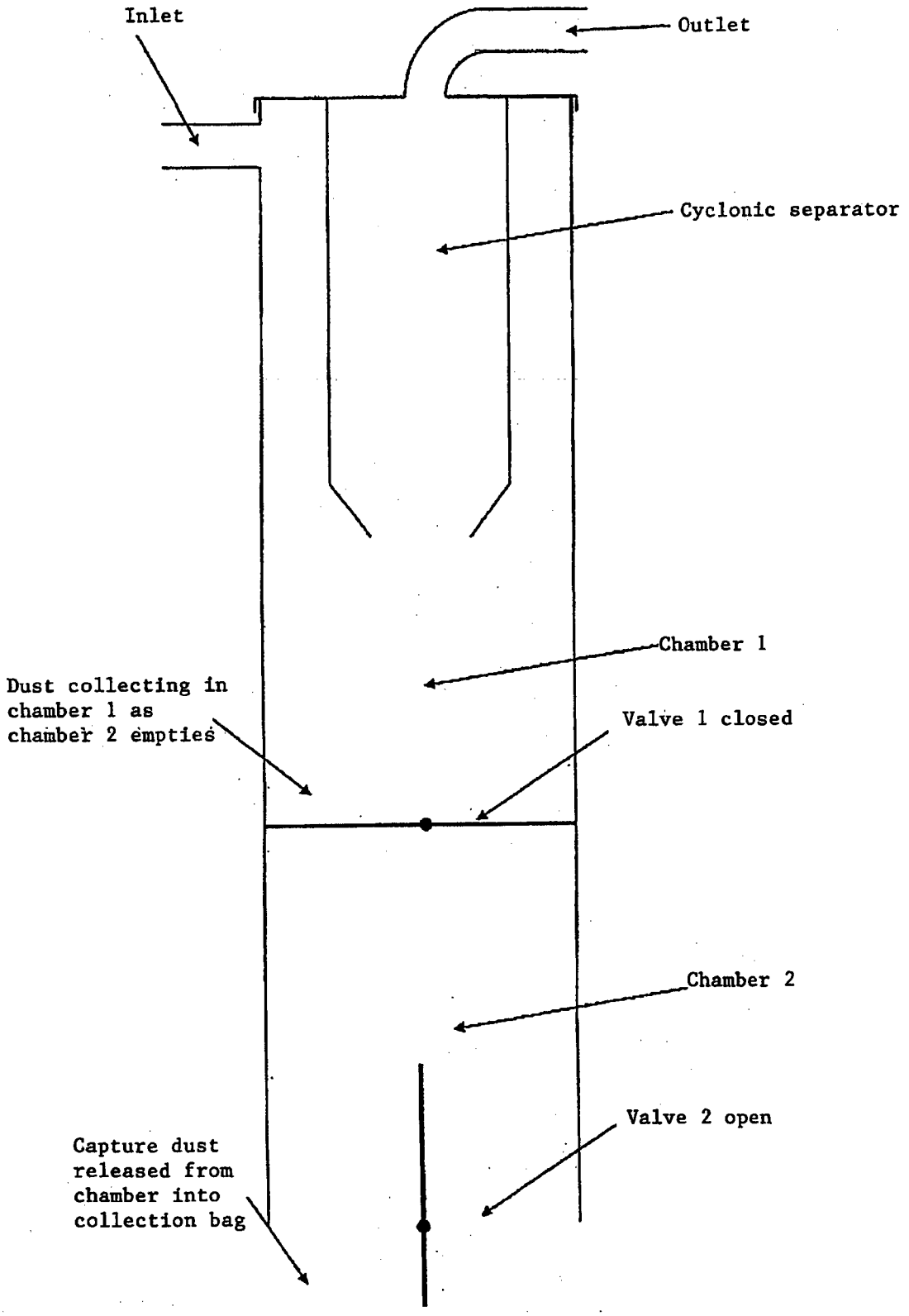
Inlet
Outlet
Cyclonic separator
Chamber 1
Dust collecting in chamber 1 as chamber 2 empties
Valve 1 closed
Chamber 2
Valve 2 open
Capture dust released from chamber into collection bag

FIGURE 5

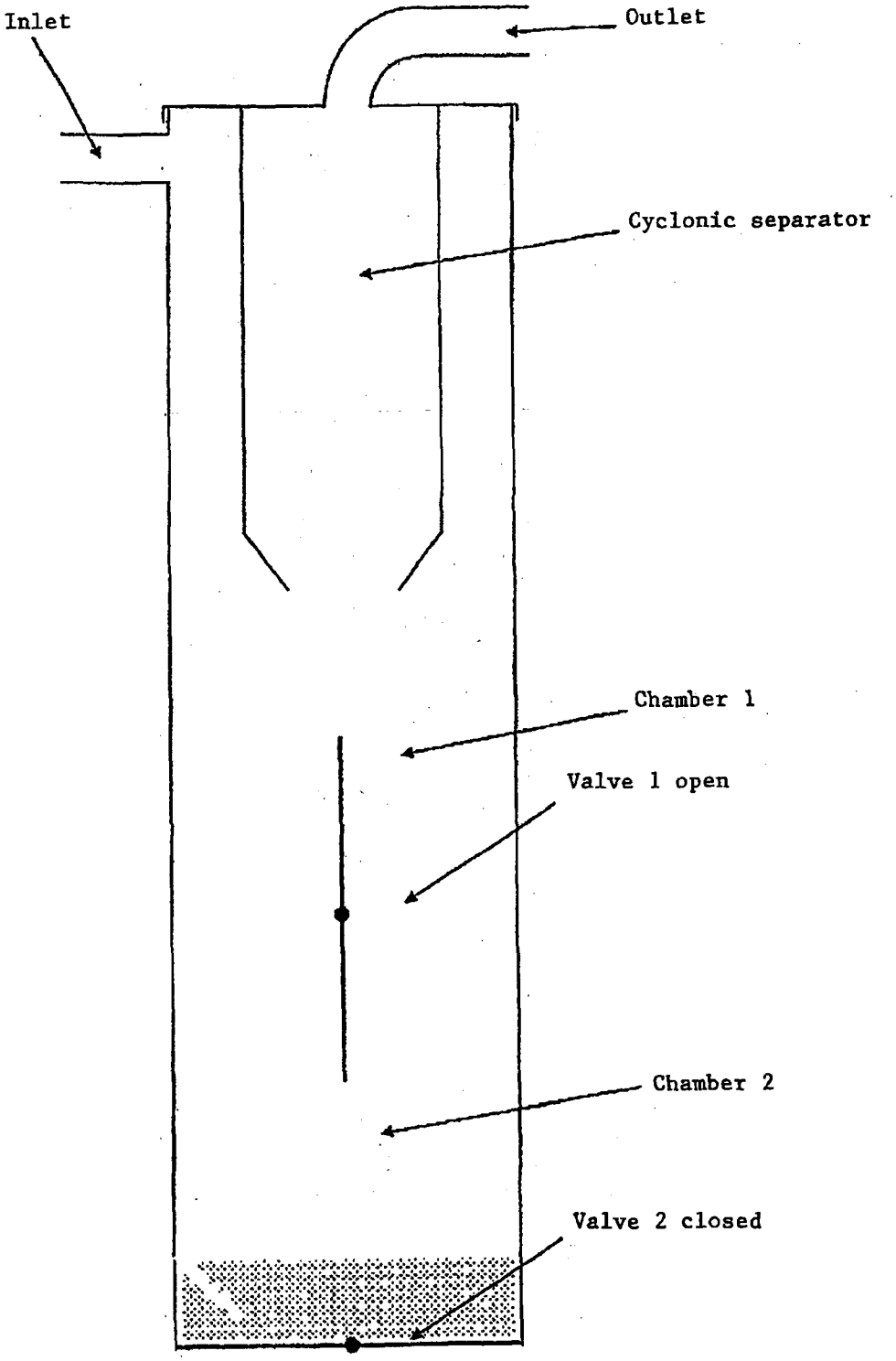
Inlet
Outlet
Cyclonic separator
Chamber 1
Valve 1 open
Chamber 2
Valve 2 closed

FIGURE 6