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(54) Benævnelse: **FREMGANGSMÅDE OG ANLÆG TIL FREMSTILLING AF CEMENT**

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Description

The invention relates to a plant and a method for producing cement, in particular white cement.

Bulk goods which become damaged or lose quality as a result of oxidation are processed in an inert, in particular non-oxidizing atmosphere. In the production of bright cements, in particular white cement, usually raw cement meal is burnt in a rotary furnace to form cement clinker and then comminuted in a comminuting device. A method for producing white cement is disclosed, for example, in CH355073 A. JP H06 8195 B2 also discloses a plant for producing white cement, wherein the cooling takes place by spraying the cement clinker with water. EP 0 629 448 A2 discloses a classification of the material into two grain sizes for the purpose of optimizing a grinding plant.

In known plants for producing white cement, the clinker in the hot state is comminuted directly following the rotary furnace and then cooled in an inert atmosphere. Comminuting the coarse fraction before cooling the clinker offers the advantage that complete cooling of the clinker is possible. Since the number of large particles in the product is low, usually a higher grade of whiteness is achieved than in the case of the same plant configuration having a crusher downstream of the inert cooling. The comminuting device is subjected here to very high temperatures of up to approximately 1350°C, thereby resulting in complex and cost-intensive production of the comminuting device, high wear of the crushing tools and thus often an exchange of the crushing tools over the course of a year, and stocking at least of the crushing rolls or of a complete exchange unit. This leads to a lower availability of the entire plant.

Comminuting the clinker material following direct cooling of the clinker material after it exits the rotary furnace leads usually to oxidation of the metal constituents to form for example iron oxide, thereby leading to a darker hue of the cement clinker. It is thus necessary to carry out relatively complex and cost-intensive cooling and comminution of the material in an inert atmosphere with exclusion of oxygen, in order to obtain the white colour of the cement.

Against this background, it is the object of the present invention to specify a method and a plant for producing cement, in particular white cement, which plant is more cost-effective and involves lower energy expenditure.

Said object is achieved according to the invention by a method having the features of independent method claim 1, as well as by a device having the features of independent device claim 9. Advantageous refinements will emerge from the dependent claims.

A method for producing cement, in particular white cement, comprises according to a first aspect at least the following steps of:

- thermally treating material in a furnace and
- cooling the material in an inert atmosphere in a cooling device, wherein

the material, following the inert cooling, is classified into at least two grain sizes, coarse material and in particular dispersible fine material, in a classifying device, and wherein the fine material is cooled separately from the coarse material following the classification.

White cement is understood in particular to be cement which has a low content of iron oxide of approximately $FE_2O_3 < 0.4\%$ in relation to the raw mixture without loss of ignition. In particular, white cement has low fractions of manganese oxide, chromium oxide and magnesium oxide of approximately $Mn_2O_3 < 0.02\%$, $Cr_2O_3 < 0.01\%$ and $MgO < 3\%$ in relation to the raw mixture without loss of ignition.

The furnace is preferably a rotary furnace in which raw cement meal is burnt to form cement clinker. In particular, the material exiting the furnace is fed directly to the cooling device for the purpose of cooling in an inert atmosphere. The material is in particular additionally heated and deacidified, preferably by a calcinator, in a preheater upstream of the furnace, wherein the exhaust gases of the furnace are fed for example to the calcinator and then to the preheater, with the result that the material passing through the preheater is heated in a counterflow arrangement.

The cooling device is, for example, a cooling drum to which is fed a coolant, such as for example water, for cooling the material. The cooling of the material in the cooling device takes place in an inert atmosphere. This is understood to be an oxygen-poor environment, for example a water vapour atmosphere, wherein oxidation of the metal fraction, in particular iron, manganese, chromium and/or magnesium, of the material is avoided. The cooling device is in particular designed such that the material is dried in the cooling device and/or removed preferably with low residual moisture.

The cooling device is in particular designed such that it cools the material having a grain size of greater than 250 μm to 1000 μm to a temperature of approximately 100°C to 700°C, in particular 180°C to 500°C. In particular, the cooling device is designed such that it cools the material having a grain size of less than 250 μm to 1000 μm, preferably 0 μm to 500 μm, to a temperature at which oxidation, in particular of the iron, manganese, chromium and/or magnesium fraction of the material, during further cooling is ruled out or very low. A loss of whiteness of the finished material is ruled out or greatly reduced as a result. The cooling device can preferably be operated and is designed such that it cools the surface of the material having a grain size of greater than 250 μm to 1000 μm to a temperature of approximately 100°C to 700°C, in particular 150°C to 500°C, preferably 160°C to 180°C, wherein the core temperature of the material lies above the stated temperature.

A classification of the material in the classifying device enables targeted further processing of the coarse material of the material, which requires comminution, and separate processing of the fine material, said fine material for example merely requiring further cooling. In particular, exclusively the fine-material fraction of the material is fed for further cooling by a gas flow, wherein the coarse-material fraction is fed in particular to a comminuting device and/or for further inert cooling. This enables smaller dimensioning of the inert cooling device, in which both the coarse material and the fine material are cooled together following the furnace. In particular, the fine material is cooled in the cooling device to a temperature of approximately 100°C to 700°C, in particular 150°C to 500°C, preferably 160°C to 180°C, wherein the fine material is cooled to the abovementioned temperature as far as the core.

In particular, the fine material of the material has a lower temperature than the coarse material upon leaving the cooling device. At a temperature of the coarse material of greater than 600°C, it is still possible for the degree of whiteness of the entire product to be influenced. A separate cooling of the coarse material and the fine material thus additionally offers the advantage that no further quantity of water is fed to the fine material, which can lead to a high degree of moisture and difficulties when packing the material.

According to a further embodiment, the classifying device comprises a screen, in particular a static and/or dynamic screen, wherein the material is exposed to a gas flow such that the in particular dispersible fine material is separated from the in particular non-dispersible coarse material. By way of example, the classifying device has a substantially vertical pipeline, in which the material is exposed to a gas flow in a counterflow arrangement, wherein the heavier coarse material leaves the pipeline counter to the gas flow and the fine material leaves the pipeline with the gas flow. By way of example, the classifying device comprises a dynamic or a static screen or a combination thereof. The fine material has, for example, a grain size of less than 250 µm to 1000 µm, preferably 0 µm to 500 µm, and the coarse material has a grain size of greater than 250 µm to 1000 µm. A screening device makes it possible to separate fine material having a small grain size, which fine material in particular is dispersible, from the coarse material. The setting of the flow velocity of the gas flow makes it possible to set the cut-off point of the classifying device such that, for example, at a lower power of the inert cooling device, fine material of a smaller grain size is classified from the coarse material.

According to a further embodiment, the classification encompasses cooling of the fine material by means of cooling air. The gas flow of the classifying device has preferably a lower temperature than the material to be classified, such that the gas flow in the classifying device brings about cooling of the material.

According to a further embodiment, cooling of the fine material following the classification takes place in a centrifugal separator, in particular a cyclone cooler, and/or a screening device. Furthermore, in the centrifugal separator, the gas flow is separated from the fine material. In the cooling operation downstream of the classifying device, the fine material is exclusively cooled and/or dried, which takes place spatially separately from an optional cooling of the coarse material.

The cooling of the fine material takes place following the classification in at least two cooling stages, wherein each cooling stage comprises a centrifugal separator and/or a screening device. With preference, a plurality of cooling stages which each comprise a centrifugal separator and/or a screening device are connected downstream of the classifying device.

According to a further embodiment, the material is comminuted before classification. With preference, the material is comminuted in an inert comminuting device with exclusion of oxygen, such that the white colour of the cement remains. Inert comminution of the coarse material following the classification is likewise conceivable. In particular, following the classifying device, the coarse material is fed to a further inert cooling device and then for example to an inert comminuting device. It is also conceivable to comminute the coarse material following the classification in an inert comminuting device and then to cool said coarse material to a temperature of 100°C to 700°C, in particular 150°C to 500°C, preferably 160°C to 180°C, such that further oxidation of the coarse material does not take place or takes place only to a very small extent.

According to a further embodiment, the exhaust air from the at least one centrifugal separator and/or the exhaust air from the cooling device are/is fed to a heat exchanger and heated in the heat exchanger. In particular, the heated gas flow is then fed to the furnace as furnace feed air. Using the exhaust air from the at least one centrifugal separator and/or the exhaust air from the cooling device as furnace feed air offers the advantage that said furnace feed air is heated already by the heat transfer from the material to be cooled, and the temperature difference in relation to the feed air required in the furnace is smaller than when ambient air is used as furnace feed air.

According to a further embodiment, before the thermal treatment in the furnace, the material is heated in a preheater and the exhaust gas from the preheater is fed to the heat exchanger to heat the exhaust air from the centrifugal separator and/or the exhaust air from the cooling device. Using the preheater exhaust gas to heat the exhaust air from the at least one centrifugal separator and/or the exhaust air from the cooling device makes it possible to provide furnace feed air in an energy-efficient manner.

The invention further comprises a plant for producing cement, in particular white cement, having a furnace for the thermal treatment of a material, and an inert cooling device, connected downstream of the furnace in the direction of flow of the material, for cooling the material in an inert atmosphere, wherein downstream of the cooling device there is connected a classifying device for classifying the material into at least two grain sizes, coarse material and fine material, and wherein downstream of the classifying device there is connected at least one cooling stage for cooling the fine material separately from the coarse material.

The advantages and explanations described with reference to the method for producing cement, in particular white cement, apply to the plant for producing cement, in particular white cement, in a corresponding manner in device terms.

According to one embodiment, at least one cooling stage for cooling the fine material is connected downstream of the classifying device. The cooling stage is in particular a centrifugal separator and/or a screening device. With preference, a plurality of cooling stages, each of which comprises a centrifugal separator and/or a screening device, is connected downstream of the classifying device.

According to a further embodiment, a for example inert comminuting device is connected upstream of the classifying device. In particular, downstream of the classifying device there is connected a comminuting device, preferably an inert comminuting device, for comminuting the coarse material, which comminuting device is operated for example with an inert or reducing gas, such as nitrogen, CO_2 or a flue gas without oxygen.

According to a further embodiment, the plant has a preheater, connected upstream of the furnace, for preheating the material before it enters the furnace. With preference, the plant comprises at least one heat exchanger, wherein the exhaust air from the preheater is conducted into the heat exchanger and/or calcinator or furnace for the purpose of heating combustion air, such as e.g. the exhaust air from the centrifugal separator and/or the exhaust air from the cooling device. The exhaust air from the centrifugal separator and/or the exhaust air from the cooling device is preferably connected to the heat exchanger and the calcinator and/or furnace via a recovery line.

Description of the drawings

The invention is explained in more detail below on the basis of several exemplary embodiments with reference to the appended figures.

Figure 1	shows a schematic representation of an installation for producing cement according to a first exemplary embodiment.
Figures 2 to 5	show a schematic representation of a plant for producing cement according to a further exemplary embodiment.

Figure 1 shows a plant 10 for producing cement, having a preheater 12 which has a plurality of cyclones. By way of example, Figure 1 illustrates four cyclone stages which the raw material passes through. In the preheater 12, the material is in particular preheated and deacidified. Adjoining the preheater 12 in the direction of flow of the material is a furnace 14, in particular a rotary furnace 14, in which the material is burnt to form cement clinker. The exhaust gases from the furnace 14 flow through the preheater 12 in counterflow with respect to the direction of material flow, with the result that the material is heated. At the furnace exit, the material, in particular the burnt cement clinker, has a temperature of approximately 1150 – 1450°C, preferably 1400°C. The furnace exhaust gas leaving the preheater 12 is fed to a heat exchanger 32 in which furnace feed air 40 drawn in from the environment is heated.

Adjoining the furnace 14 in the direction of flow of the material is an inert cooling device 16 for cooling the material exiting the furnace 14. The cooling device 16 is, for example, a cooling drum in which the material is cooled by means of water injection. The cooling device 16 cools the material in an inert atmosphere, wherein no oxygen or only a very small fraction of oxygen is present in the cooling device 16. The material is cooled in the cooling device 16 by way of the contact of the material with the water. In the inert cooling device 16, the material is cooled to a temperature of approximately 400°C to 700°C, in particular 500°C to 600°C. When the material exits the cooling device 16, it has a temperature at which oxidation, in particular of the iron fraction of the material, is ruled out or is very low during further cooling. A loss of whiteness of the material, in particular the fine material, is ruled out or greatly reduced as a result.

Arranged following the inert cooling device 16 is an air excluding member, such as a cellular wheel sluice 20 which is connected to a classifying device 24, in which the cooled material is classified into at least two grain sizes, specifically a proportion of fine material and a proportion of coarse material. The classifying device 24 is for example a gravity classifier, wherein the material is exposed to a gas flow such that the in particular dispersible fine material is separated from the in particular non-dispersible coarse material. By way of example, the material is exposed to a gas flow in a vertical pipeline in a counterflow arrangement, wherein the heavier coarse material leaves the pipeline counter to the gas flow and the fine material leaves the pipeline with the gas flow. It is likewise conceivable to configure the classifying device 22 as a dynamic or static screen. The fine material has for example a grain size of 0-1000 µm, preferably 0 µm to 500 µm, and the coarse material has a grain size of more than 250 μm, preferably more than 500 μm.

In particular, after the cooling in the inert cooling device 16, the fine material has a temperature of approximately 400°C to 700°C, in particular 500°C to 600°C, it being possible for the core temperature of the larger grains of the coarse material to lie above approximately 700°C such that further inert treatment, with exclusion of oxygen, of the coarse material may be necessary.

Arranged between the classifying device 22 and the cooling device 16 is a closing member, such as a cellular wheel sluice 20 which enables an exclusion of air between the cooling device 16 and the classifying device 24 as well as a uniform introduction of material from the cooling device 16 into the classifying device 24.

The coarse material classified in the classifying device 24 is conducted to a conveying device 18, which is for example a conveyor belt or a chute. The fine material classified by the classifying device 24 is conducted with the gas flow of the classifying device 24 to a first centrifugal separator 26. The gas flow of the classifying device 24 preferably has a temperature which is lower than that of the fine material exiting the cooling device 16, such that cooling of the fine material by means of the gas flow takes place in the classifying device and during the transport of the fine material in the gas flow to the first centrifugal separator 26. In the centrifugal separator, in particular cyclone separator, the gas flow is separated from the fine material. The fine material is conducted from the first centrifugal separator 26, preferably via a cellular wheel sluice for homogenizing the material flow, to a further classifying device 22. The further classifying device 22 is a screen, wherein the material is exposed to a gas flow such that the in particular dispersible fine material is separated from the in particular non-dispersible coarse material. In the further classifying device 22, the flow velocity of the gas flow is for example set, in particular increased, such that the grain size of the coarse material falling onto the conveying device 18 counter to the gas flow is smaller than the grain size of the coarse material of the upstream classifying device 24. It is likewise conceivable that the fine material is substantially cooled in the further classifying device 22, wherein virtually all of the fine material leaving the first centrifugal separator 26 is transported to the second centrifugal separator 28 by means of the gas flow of the further classifying device 22. In the second centrifugal separator 28, the gas flow is separated from the fine material, wherein the second centrifugal separator 28 is for example a cyclone separator.

The fine material leaving the second centrifugal separator 28, in particular via a cellular wheel sluice, falls onto the conveying device 18 as a result of gravity and is processed for example together with the coarse material. Following the second centrifugal separator 28, the fine material has a temperature of approximately 100°C to 200°C, in particular 150°C - 180°C.

Furthermore, it is conceivable to conduct the fine material leaving the second gravity separator 28 to a further conveying device which is not illustrated, such that the coarse material is subsequently processed separately from the fine material. After leaving the second centrifugal separator 28, the fine material is in particular a finished material, wherein the coarse material requires further processing, such as for example comminution and cooling. By way of example, the coarse material is comminuted with exclusion of oxygen in an optionally inert comminuting device which is not illustrated and then cooled in a further inert cooling device to a temperature of approximately 400°C to 700°C, in particular 500°C to 600°C, at which no further oxidation of the material takes place.

The gas flow leaving the first and the second centrifugal separators 26, 28 is fed to a filter 30 together with the cooler exhaust air and subjected to a dust removal treatment in said filter. The dust separated off in the filter is fed to the conveying device 18 and conveyed together with the coarse material and the fine material.

Cooling of the fine material which is separate from the cooling of the coarse material offers the advantage of saving energy, which has to be applied to cool the material, in comparison with the common cooling of the coarse material and the fine material. It is also possible to use a smaller cooling device 16 for the inert cooling of the material, since inert cooling of the fine material takes place merely to a temperature of approximately 400°C to 700°C, in particular 500°C to 600°C, wherein the fine material is subsequently cooled by a gas flow, in particular an air flow.

Figure 2 shows a plant 10 for producing cement, which corresponds substantially to the plant described with reference to Figure 1. By contrast to the plant 10 of Figure 1, the plant of Figure 2 has a calcinator 42 and a line 44 which branches off from the furnace air feed 40 and feeds air heated in the heat exchanger 32 to the calcinator 42. The calcinator 42 has the purpose of achieving a high degree of preliminary deacidification of the raw meal and relieving the furnace of load by virtue of combustible material being burnt also in the calcinator. For this purpose, the feeding of separate combustion air is necessary.

Figure 3 shows a plant 10 for producing cement, which corresponds substantially to the plant described with reference to Figures 1 and 2. By contrast to the plant 10 of Figures 1 and 2, the plant of Figure 3 does not have a furnace air feed 40 which feeds air heated by means of the heat exchanger 32 to the furnace 14. The air heated by means of the heat exchanger 32 is fed merely via the line 44 to the calcinator 42. In addition, the plant 10 of Figure 3 differs from Figures 1 and 2 in that the gas flow leaving the centrifugal separator 26 is fed to the furnace 14, wherein the gas flow leaving the second centrifugal separator 28 is fed to the filter 30.

Figure 4 shows a plant 10 for producing cement, which corresponds substantially to the plant described with reference to Figure 1. By contrast to the plant 10 of Figure 1, the plant of Figure 4 has a recovery line 38, in which the exhaust air separated off at the first and the second centrifugal separators 26, 28 is fed to a heat exchanger 32. In the heat exchanger 32, the gas flow conducted in the recovery line 38 is heated by the furnace exhaust gas leaving the preheater 12 and then fed as preheated furnace feed air 40 to the furnace 14.

The feeding of the cooler exhaust air and the exhaust air from the first and the second centrifugal separators 26, 28 to the filter 30 is regulated respectively via a valve 34 and 36, such that, depending on the air requirement of the furnace system, a dust removal treatment takes place in the filter 30. The dust separated off in the filter 30 is conducted to the conveying device 18 and further processed with the coarse material and the fine material. It is likewise conceivable to feed the separated-off dust to the fine material which is conveyed separately from the coarse material.

Following the second centrifugal separator 28, in Figure 4, for the purpose of further cooling, the fine material is transported by means of a gas line 48 to the filter 30 and separated from the gas flow in said filter.

By way of example, Figures 1 to 5 illustrate two centrifugal separators 26, 28 for cooling and separating off the fine material, wherein it is likewise conceivable for merely one centrifugal separator or a plurality, for example three, four or five centrifugal separators, to be arranged in series or parallel with respect to one another.

Figure 5 shows a plant 10 for producing cement, which corresponds substantially to the plant described with reference to Figure 4. By contrast to the plant 10 of Figure 4, the plant of Figure 5 does not have a furnace air feed 40 which feeds air heated by means of the heat exchanger 32 to the furnace. The air heated by means of the heat exchanger 32 is fed merely to the calcinator 42. A further difference with respect to the plant 10 of Figure 4 consists in the fact that the recovery line 38 has a branching point 46 which feeds gas conducted in the recovery line 38 to the furnace 14.

List of reference signs

10	Plant for producing cement
12	Preheater
14	Furnace

16 Inert cooling device
18 Conveying device
20 Cellular wheel sluice
22 Classifying device
24 Classifying device
26 Centrifugal separator
28 Centrifugal separator
30 Filter
32 Heat exchanger
34 Valve
36 Valve
38 Recovery line
40 Furnace feed air
42 Calcinator
44 Line
46 Branching point
48 Gas line

Patentkrav

1. Fremgangsmåde til fremstilling af cement, med i det mindste følgende trin:

- termisk behandling af materiale i en ovn (14) og

- køling af materialet i inert atmosfære i en køleanordning (16)

kendetegnet ved, at

materialet efter den inerte køling sorteres i en sorteringsanordning (22, 24) i mindst to partikelstørrelser, grove partikler og fine partikler, og hvor de fine partikler efter sorteringen køles separat fra de grove partikler.

2. Fremgangsmåde ifølge krav 1, hvor kølingen af de fine partikler efter sorteringen sker i en cyklonseparator (26, 28), og/eller en sianordning.

3. Fremgangsmåde ifølge et af de foregående krav, hvor sorteringen omfatter køling af de fine partikler ved hjælp af køleluft.

4. Fremgangsmåde ifølge et af de foregående krav, hvor kølingen af de fine partikler efter sorteringen sker i mindst to køletrin, hvor hvert køletrin omfatter en cyklonseparator (26, 28) og/eller en sianordning.

5. Fremgangsmåde ifølge et af de foregående krav, hvor materialet findeles før sorteringen.

6. Fremgangsmåde ifølge et af de foregående krav eller et af kravene 2 eller 4, hvor afgangsluften fra den mindst ene cyklonseparator (26, 28) og/eller afgangsluften fra køleanordningen (16) tilføres en varmeveksler (32) og opvarmes i varmeveksleren (32).

7. Fremgangsmåde ifølge krav 6, hvor materialet før den termiske behandling i ovnen (14) opvarmes i en forvarmer (12), og udstødningsgassen fra forvarmeren (12) tilføres varmeveksleren (32) til opvarmning af afgangsluften fra cyklonseparatoren (26, 28) og/eller afgangsluften fra køleanordningen (16).

8. Anlæg til fremstilling af cement, med en ovn (14) til termisk behandling af et materiale og en inert køleanordning (16) til køling af materialet i inert atmosfære, som er efterkoblet ovnen (14) i materialets strømningsretning, **kendetegnet ved, at**
en sorteringsanordning (22, 24) er efterkoblet køleanordningen (16) til sortering af materialet i mindst to partikelstørrelser, grove partikler og fine partikler, og hvor mindst et køletrin til køling af de fine partikler separat fra de grove partikler er efterkoblet sorteringsanordningen (22, 24).

9. Anlæg ifølge krav 8, hvor køletrinnet omfatter mindst en cyklonseparator (26, 28) og/eller en sianordning (22, 24).

10. Anlæg ifølge et af kravene 8 eller 10, hvor en finmalingsanordning er forkoblet sorteringsanordningen (22, 24).

11. Anlæg ifølge et af kravene 8 til 11, hvor sorteringsanordningen (22, 24) omfatter en sianordning, en statisk og/eller dynamisk sigte.

12. Anlæg ifølge et af kravene 8 til 12, hvor der er tilvejebragt en forvarmer (12), som er forkoblet ovnen (14), til forvarmning af materialet, før det kommer i ovnen (14), og der er anbragt en varmeveksler (32), som er forbundet med afgangsluften fra forvarmeren til opvarmning af afgangsluften fra cyklonseparatoren (26, 28) og/eller afgangsluften fra køleanordningen (16).

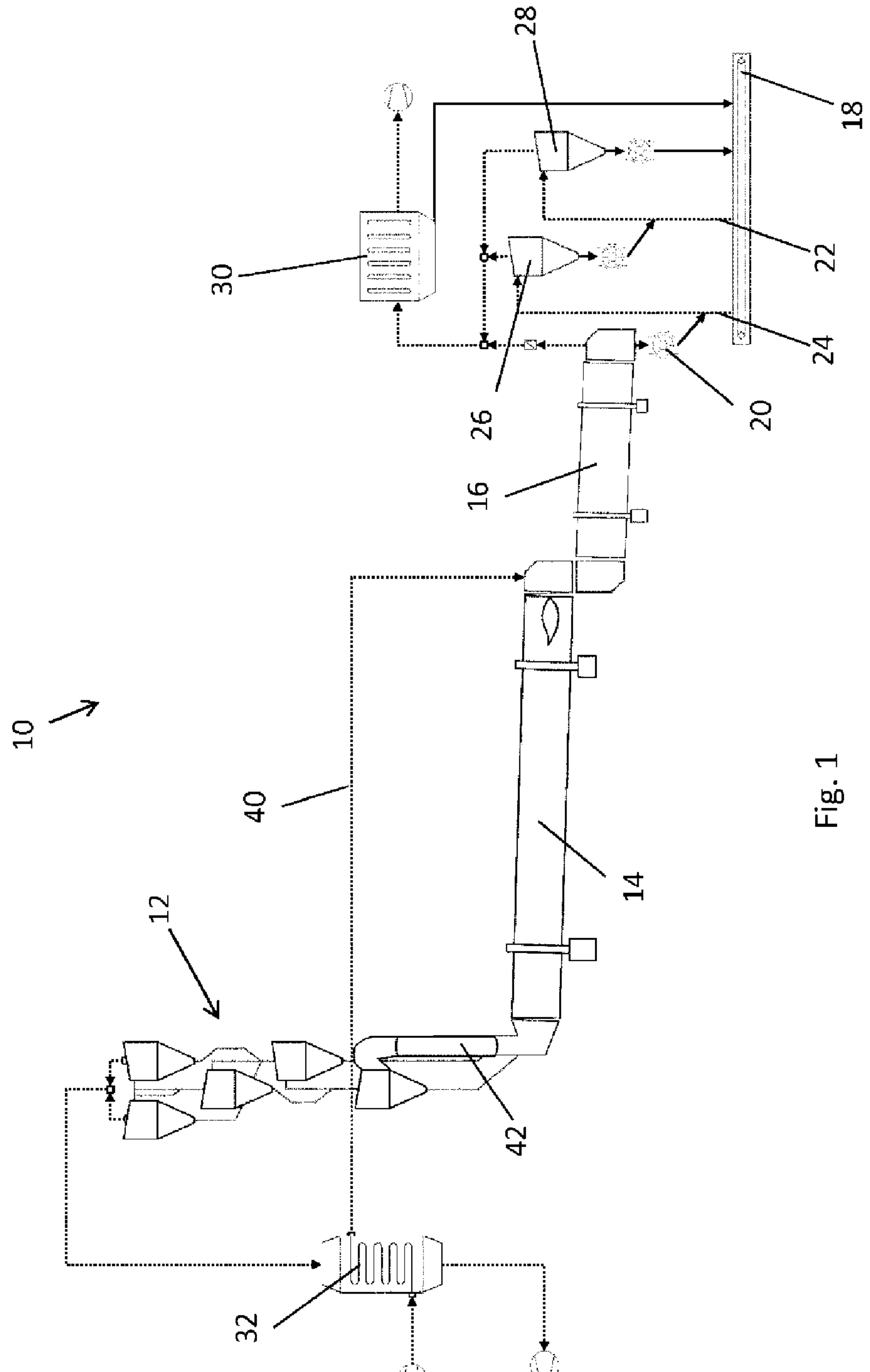

Fig. 1

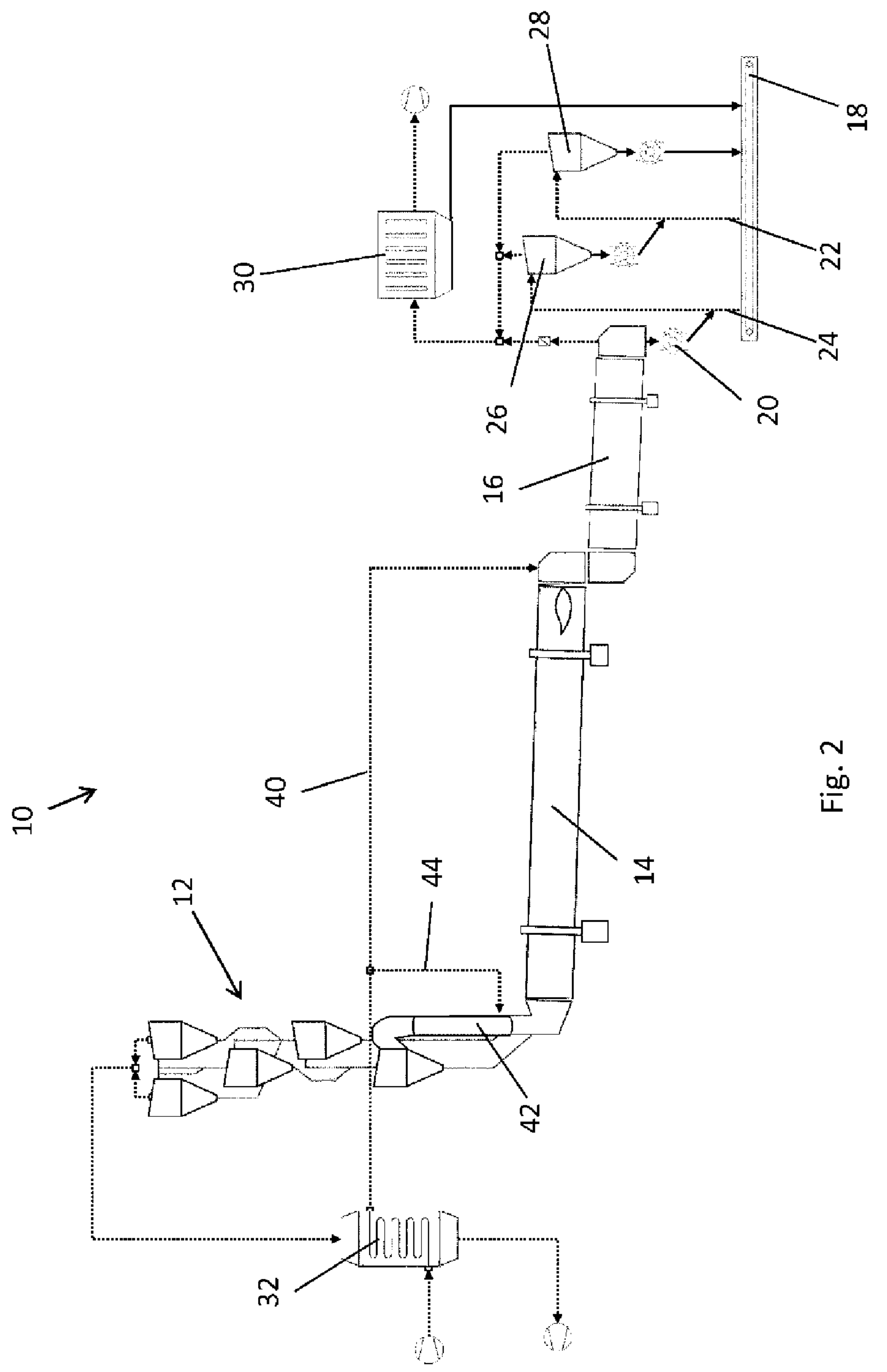

Fig. 2

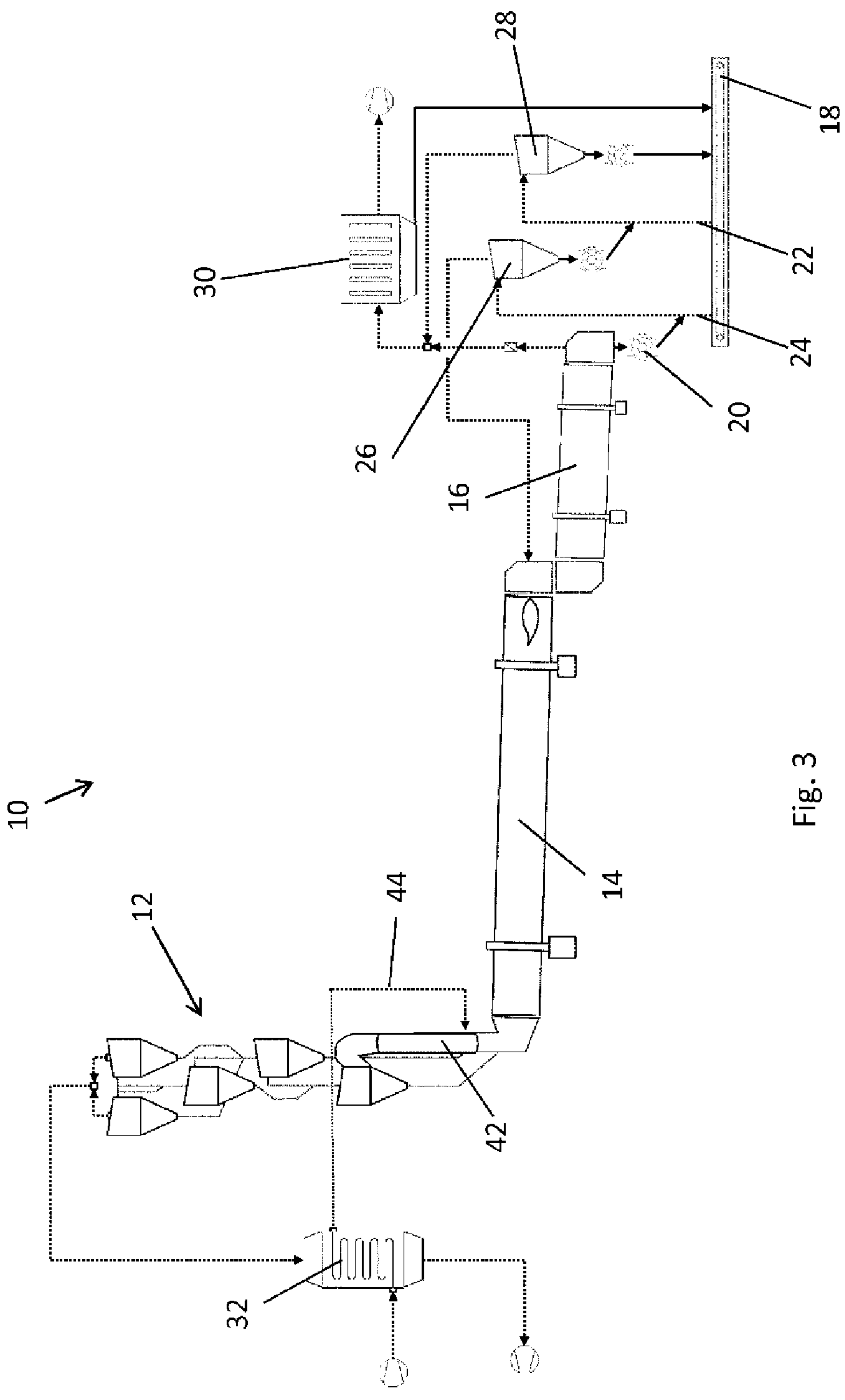

Fig. 3

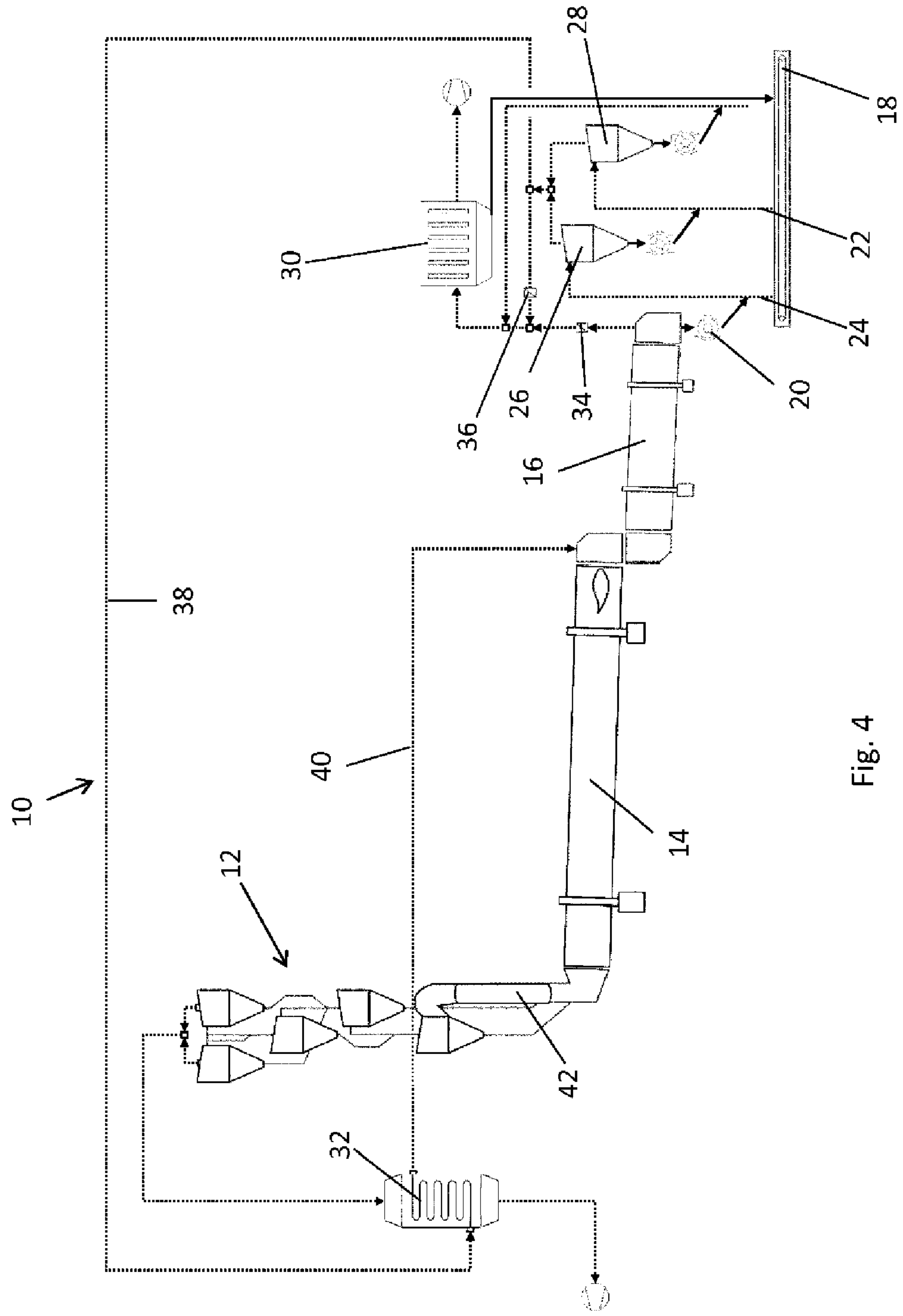

Fig. 4

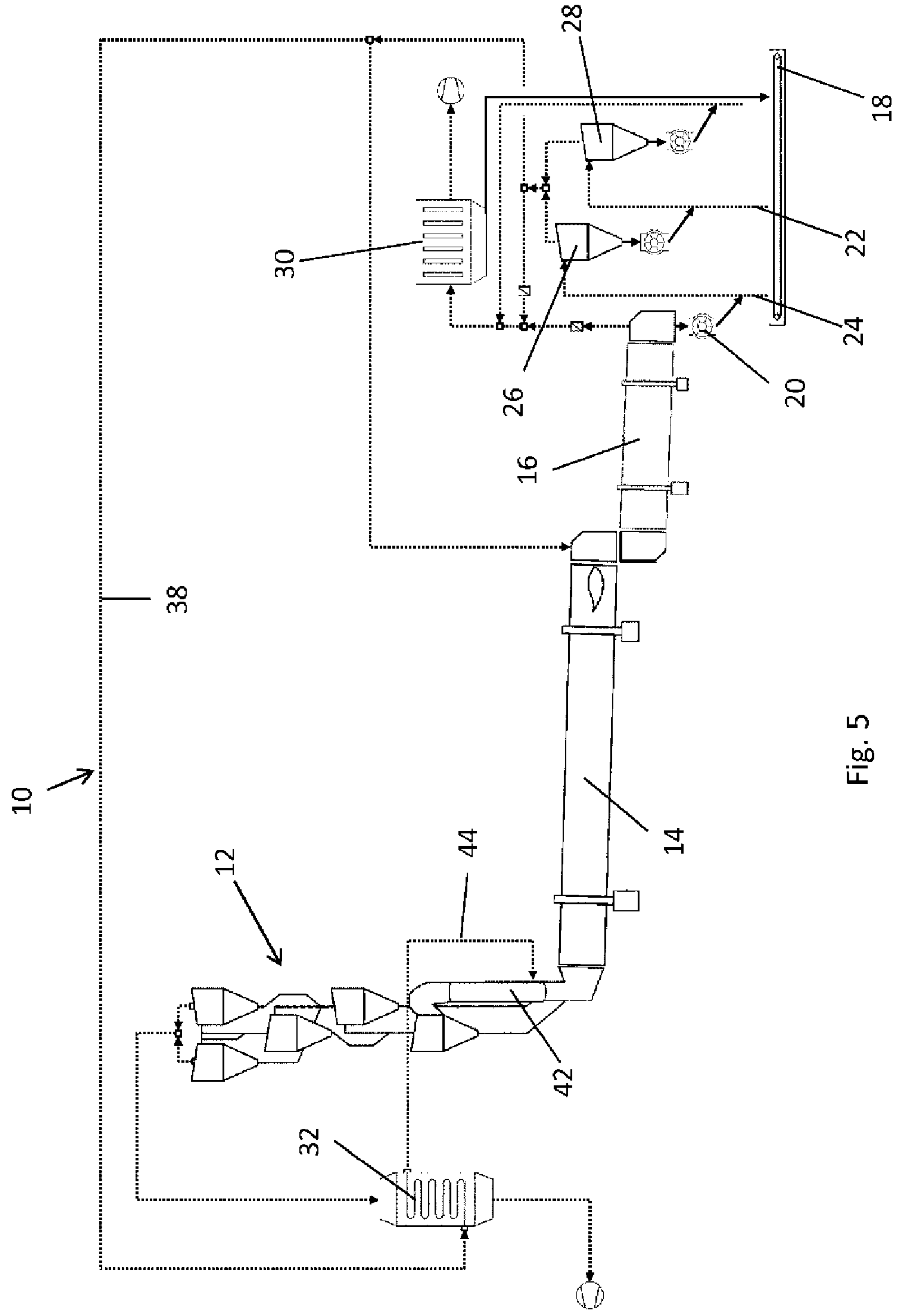

Fig. 5