KRAFTWERK UNION AKTIENGESSELLSCHAFT

hereby apply for the grant of a Patent for an invention entitled

"IMPROVEMENTS IN OR RELATING TO HELICAL FLOW CENTRIFUGAL SEPARATORS"

which is described in the accompanying complete specification.
This application is a Convention Application and is based on the application numbered P 28 20 233.7

for a patent or similar protection made in Germany

on 9th May, 1978

My address for service is:

Care: SPRUSON & FERGUSON
PATENT ATTORNEYS
ESSO HOUSE, 127 KENT STREET
SYDNEY, NEW SOUTH WALES.
AUSTRALIA.

Dated this TWENTY-THIRD day of APRIL, 1979

KRAFTWERK UNION AKTIENGESSELLSCHAFT

By: [Signature]
Registered Patent Attorney

To: The Commissioners of Patents
APPLICATION FOR A PATENT OR PATENT OF ADDITION

In support of the Convention Application made for a patent for an invention entitled 4680779

"IMPROVEMENTS IN OR RELATING TO HELICAL FLOW CENTRIFUGAL SEPARATORS"

Full name and address of Declarant.
Burghard von Alvensleben
C/- Kraftwerk Union Aktiengesellschaft
Wiesenstrasse 35, 4330 Mulheim (Ruhr), Germany

do solemnly and sincerely declare as follows:

1. I am the applicant for the patent of addition.
   (or, in the case of an application by a body corporate)
   1. I am authorised by KRAFTWERK UNION AKTIENGESELLSCHAFT the applicant for the patent of addition to make this declaration on its behalf.

2. The basic application as defined by Section 141 of the Act was made in Germany on the 9th day of May 1978 by Kraftwerk Union Aktiengesellschaft

3. I am the actual inventor of the invention referred to in the basic application.
   (or where a person other than the inventor is the applicant)
   3. HEINRICH KLEIN of Wehnelstrasse 12, 8520 Erlangen, Germany,
   RUDOLF PIEPER of Essenbacher Strasse 6, 8520 Erlangen, Germany and
   EDUARD WEBER of Peyerstrasse 18, 8500 Nuernberg, Germany

are

is the actual inventor of the invention and the facts upon which the applicant is/are entitled to make the application are as follows:

The said applicant is the assignee of the actual inventors.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Mulheim this 30th day of January 1979

Signature of Declarant
Burghard von Alvensleben

Full name and address of Inventor(s)

HEINRICH KLEIN of Wehnelstrasse 12, 8520 Erlangen, Germany,
RUDOLF PIEPER of Essenbacher Strasse 6, 8520 Erlangen, Germany and
EDUARD WEBER of Peyerstrasse 18, 8500 Nuernberg, Germany
Claim 1. A tornado-flow vortex generator assembly for separating particulates from gases comprising a cylindrical vortex chamber, an inlet tube for raw gas coaxially disposed in the vortex chamber and terminating in a nozzle for providing an advance rotation in a flow of the raw gas therethrough, a hopper connected to the vortex chamber, a hopper diaphragm surrounding the inlet tube and positioned in the vicinity of the vortex-chamber casing, with an annular particulate-discharge slot communicating with a space within the hopper wherein a given pressure exists, a clean-gas outlet disposed in the vortex chamber spaced from and opposite the raw gas inlet tube, an auxiliary-gas outlet surrounding the clean-gas outlet, and an auxiliary-gas inlet disposed at the vortex-chamber casing for blowing auxiliary gas into the vortex chamber at an inclination and tangentially to the casing thereof and connected by a blower to the auxiliary-gas outlet wherein a pressure source having a pressure lower than the given pressure existing in the hopper space is connected via a line and a control valve to said hopper space.
Complete Specification for the invention entitled:

"IMPROVEMENTS IN OR RELATING TO HELICAL FLOW CENTRIFUGAL SEPARATORS"

The following statement is a full description of this invention, including the best method of performing it known to us:

Address of Applicant: Wiesenstrasse 35, 4330 Mülheim (Ruhr), Germany

Actual Inventors: HEINRICH KLEIN, RUDOLF PIEPER and EDUARD WEBER

Abstract

The invention provides improvements in or relating to helical flow centrifugal separators. One such separator comprises a cylindrical separating chamber 1 into which runs a coaxial inlet tube 3 for crude gas terminating in spin-producing nozzle 2. A bunker diaphragm 4 surrounds the inlet tube 3 and defines a particle delivery ring slit 5 (leading to a bunker 6) close to the peripheral surface of the chamber 1. There is a clean gas outlet 9 and an auxiliary gas outlet surrounding the clean gas outlet 9. An auxiliary gas inlet 11 is situated on the peripheral surface of the chamber 1, for auxiliary gas which is to be obliquely tangentially blown in. The auxiliary gas inlet 11 is connected to the auxiliary gas outlet by way of a blower. A bunker chamber 6 is adjustably connected by way of a duct 7 to a region of the separator at which the pressure is lower than the pressure in the bunker chamber.
Improvements in or relating to
Helical Flow Centrifugal Separators

The invention relates to helical flow centrifugal separators, also known as tornado-flow vortex generators or cyclones, for separating particles from crude gas and comprising bunker chambers for receiving separated particles.

Such devices have proved suitable for separating solid or liquid particles from gas.

According to the present invention there is provided a helical flow centrifugal separator for separating particles from crude gas, comprising a bunker chamber for receiving separated particles and means for reducing pressure in the bunker chamber.

In this way the quantity of particles received in the bunker chamber can be increased. This is particularly the case if a relative negative pressure is set up in the bunker chamber.

According to one aspect of the present invention a tornado-flow vortex generator assembly for separating particulates from gases comprising a cylindrical vortex chamber, an inlet tube for raw gas coaxially disposed in the vortex chamber and terminating in a nozzle for providing an advance rotation in a flow of the raw gas therethrough, a hopper connected to the vortex chamber, a hopper diaphragm surrounding the inlet tube and positioned in the vicinity of the vortex-chamber casing, with an annular particulate-discharge slot communicating with a space within the hopper wherein a given pressure exists, a clean-gas outlet disposed in the vortex chamber spaced from and opposite the raw gas inlet tube, an auxiliary-gas outlet surrounding the clean-gas,
outlet, and an auxiliary-gas inlet disposed at the vortex-chamber casing for blowing auxiliary gas into the vortex chamber at an inclination and tangentially to the casing thereof and connected by a blower to the auxiliary-gas outlet wherein a pressure source having a pressure lower than the given pressure existing in the hopper space is connected via a line and a control valve to said hopper space.

In this manner, a relative underpressure of negative pressure can be attained in the hopper and the quantity of dust transported through the annular particulate-discharge slot can thereby be increased.

In accordance with another feature of the invention, the tornado-flow vortex generator is constructed with a line connecting the hopper space to the raw-gas inlet tube.

In accordance with a further feature of the invention and for the purpose of providing supplemental suction, an additional suction blower can be built into the line connecting the hopper space to the raw-gas inlet tube.

In accordance with an added feature of the invention, the pressure source is the suction side of the blower for the auxiliary gas.

In accordance with an additional feature of the invention, the line for producing the underpressure extends through an auxiliary dust remover, which affords an improved separation and which is the pressure source.

In accordance with yet another feature of the invention, and in order to set the desired conditions, suitable control valves are advantageously provided in the respective lines.

In accordance with yet further features of the
invention and in order to prevent dust particles from being sucked back out of the hopper, the line is advantageously provided with an enlarged cross-sectional area at an inlet location thereof to the hopper space and, for best results, terminates in a part of the hopper which is located laterally of the annular particulate-discharge slot.

A preferred embodiment of separator is designed for cleaning flue gases at high temperature and pressure for driving a gas turbine. This application of the invention arises from the fact that for increasing the efficiency of coal-fired power stations, increasing attention is now being paid to so-called fluidised bed firing. In this firing, flue gases occur at for example 800°C and under a pressure of 15
atmospheres, and these are to be further utilised in gas turbines. It will be appreciated that the flue gases must first of all be intensively cleaned.

For a better understanding of the invention and to show how it may be put into effect reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a cross-section through a cyclone or helical flow centrifugal separator;

Figures 2 and 3 illustrate modifications of the separator of Figure 1; and

Figure 4 illustrates in perspective part of the separator of Figure 1.

Figure 1 shows a helical flow centrifugal separator comprising a cylindrical centrifugal separator chamber 1, into which crude gas Q1 is introduced by way of a coaxial inlet tube 3. Clean gas Q2, i.e. gas which has been freed as far as possible from dust particles, leaves the separator axially at the top by way of a clean gas outlet 9. The separation of the dust from the gas takes place between the crude gas inlet and the clean gas outlet and is brought about by auxiliary gas Q3 which is blown into the chamber 1 by way of an auxiliary gas inlet 11 and a ring of guide vanes 12 close to the wall of the chamber 1. The auxiliary gas Q3 flows with tangential rotation spirally close to the wall of the chamber 1 as shown, and finally around the inside of the whole external wall downwards to a bunker diaphragm 4. The auxiliary gas Q3 is here sharply deflected and guided radially inwards to the crude gas inlet. The auxiliary gas here again changes its direction of flow and now travels from the bottom upwards with the flow of the crude gas - rotating in the same direction - in the centre of the separator towards the clean gas outlet 9, where some of the auxiliary gas leaves the dust extractor together with the clean gas. However, most of the auxiliary gas misses the outlet 9 as shown and is recirculated by a blower 8 after being collected in an
auxiliary gas outlet surrounding the clean gas outlet 9.

In principle, it is possible for the auxiliary gas alone to impart the required spin to the crude gas, but from the energy viewpoint it is more favourable if an initial spin is imparted to the crude gas at the crude gas inlet by means of fixed guide vanes 2 in the end of the inlet tube 3.

The dust particles present in the crude gas are transported in the direction of the wall of the separator chamber 1 due to the centrifugal force and the general axial helical flow along a more or less curved path. Finally, the dust particles enter the region of the auxiliary gas close to the wall and are guided axially downwards therewith. At the bunker diaphragm 4, the direction of the auxiliary gas is sharply turned through 90° while, owing to their greater inert mass, the dust particles fall through a particle delivery ring slit 5 into a bunker chamber 6 situated below it and settle therein. Owing to the narrowness of the slit 5, only a small percentage of the auxiliary gas passes into the bunker chamber 6 itself and the dust particles sink to the bottom in the large bunker chamber 6 as a result of the settling action.

It has been found that any dust remaining in the top of the separator is mainly situated close to the wall thereof, that is to say it has mainly been centrifuged out of the gas which flows through the outlet 9. Thus when the auxiliary gas is extracted at the top of the separator, the greater part of the dust still remaining is separated from the pure gas Q2 and is returned in the auxiliary gas Q3 to the dust extractor by means of the blower 8 and the ring of guide vanes 12.

In addition, for increasing the separating efficiency a relative negative pressure can be artificially produced in the bunker chamber 6 by connecting it by way of a duct 7 to the suction side 81 of the
blower 8. For controlling the pressure conditions, there is advantageously provided in the duct 7 a control valve 71 which is adjustable by means of a hand wheel 72.

As is apparent from the drawing, the exhausting is advantageously effected in a bunker portion 61 situated laterally of the actual bunker chamber 6, this being done over the largest possible area by way of a correspondingly wide duct portion 73. The bunker portion 61 situated laterally of the actual bunker chamber 6 can be separated from the latter by protective grids 62 or the like.

Figure 4 illustrates in perspective view a possible construction according to Figure 1, and shows how the duct 7 widens to form the duct portion 73 and surrounds the inlet tube 3.

In respect of the pressure, substantially the following values can be recommended in the case of the present construction. Assuming that the crude gas flows in at a relative pressure of 0 millimetres of water column, a negative pressure of about 120 millimetres of water column exists in relation thereto in the pure gas outlet 9 and hence on the suction side of the blower 8. On the high pressure side of the blower 8, i.e. at the ring of guide vanes 12, the relative positive pressure is about 320 millimetres of water column. In the separator chamber itself, there is obtained close to the peripheral surface a relatively high pressure which falls towards the centre. A relative positive pressure of about 40 to 60 millimetres of water column is then preferably set up in the bunker 6 through the duct 7.

In this way, the delivery of dust via the particle delivery ring slit 5 into the bunker chamber 6 is increased by a considerable percentage.

In the arrangement illustrated in Figure 1, there may additionally or alternatively be effected reduction of pressure by way of a control valve 4 and a chain-lined duct 75 leading into the inlet tube 3,
because here again a relative negative pressure exists in relation to the bunker chamber 6.

The arrangement illustrated in Figure 2 corresponds substantially to the arrangement according to Figure 1, except that an exhaust cowl 15 situated centrally in the bunker chamber 6 is directly connected to the inlet tube 3 by way of a pipe 13 and a control valve 14. If desired, the exhaust effect may be assisted by a suction fan 16. The pressure conditions obtaining here correspond substantially to those described with reference to Figure 1.

Figure 3 illustrates a further variant, in which a suction duct 27 opening into the lateral bunker portion 61 by means of a widened portion 28 is connected to an auxiliary dust extractor 20 by way of a control valve 26. The relatively small auxiliary dust extractor 20 corresponds in its construction and operation to the helical flow centrifugal separator described with reference to Figure 1. The gas purified in the auxiliary dust extractor 20 then passes by way of a suction fan 24 and the remainder of the duct 27 to the clean gas outlet 9. The dust particles separated off in the auxiliary dust extractor 20 are returned into the bunker chamber 6 by way of a duct 25.

The described and illustrated embodiments offer an increased separating efficiency, particularly in regard to the cleaning of flue gas under extreme conditions.
CLAIMS
The claims defining the invention are as follows:

1. A tornado-flow vortex generator assembly for separating particulates from gases comprising a cylindrical vortex chamber, an inlet tube for raw gas coaxially disposed in the vortex chamber and terminating in a nozzle for providing an advance rotation in a flow of the raw gas therethrough, a hopper connected to the vortex chamber, a hopper diaphragm surrounding the inlet tube and positioned in the vicinity of the vortex-chamber casing, with an annular particulate-discharge slot communicating with a space within the hopper wherein a given pressure exists, a clean-gas outlet disposed in the vortex chamber spaced from and opposite the raw gas inlet tube, an auxiliary-gas outlet surrounding the clean-gas outlet, and an auxiliary-gas inlet disposed at the vortex-chamber casing for blowing auxiliary gas into the vortex chamber at an inclination and tangentially to the casing thereof and connected by a blower to the auxiliary-gas outlet wherein a pressure source having a pressure lower than the given pressure existing in the hopper space is connected via a line and a control valve to said hopper space.

2. A tornado-flow vortex generator according to claim 1 wherein said pressure source is the raw-gas inlet tube.

3. A tornado-flow vortex generator according to claim 2 including a suction blower connected in said line connecting the hopper space to the raw-gas inlet tube.

4. A tornado-flow vortex generator according to claim 1 wherein said pressure source is the suction side of the blower.

5. A tornado-flow vortex generator according to
claim 1 including an auxiliary dust separator through which said line extends, said auxiliary dust separator being said pressure source.

6. A tornado-flow vortex generator according to claim 1 wherein said line has an enlarged cross-sectional area at an inlet location thereof to the hopper space.

7. A tornado-flow vortex generator according to claim 1 wherein said hopper includes a hopper part disposed laterally of the annular particulate-discharge slot and communicating with the space within the other part of the hopper, said line terminating in said hopper part.

8. A tornado-flow vortex generator according to claim 7 including protective partitioning means for separating the lateral hopper part from the other hopper part.

9. A tornado-flow vortex generator according to claim 8 wherein said protective partitioning means comprise a protective screen.

10. A tornado-flow vortex generator substantially as described with reference to Figs 1 and 4, or Fig. 2, or Fig. 3 of the drawings.

DATED this NINETEENTH day of NOVEMBER, 1982

KRAFTWERK UNION AKTIENGESELLSCHAFT

Patent Attorneys for the Applicant
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