Nov. 2, 1971 H. KLEIN 3,616,619

# TORNADO-FLOW SEPARATOR WITH RAW-GAS PRECLEANSER

Original Filed July 9, 1968

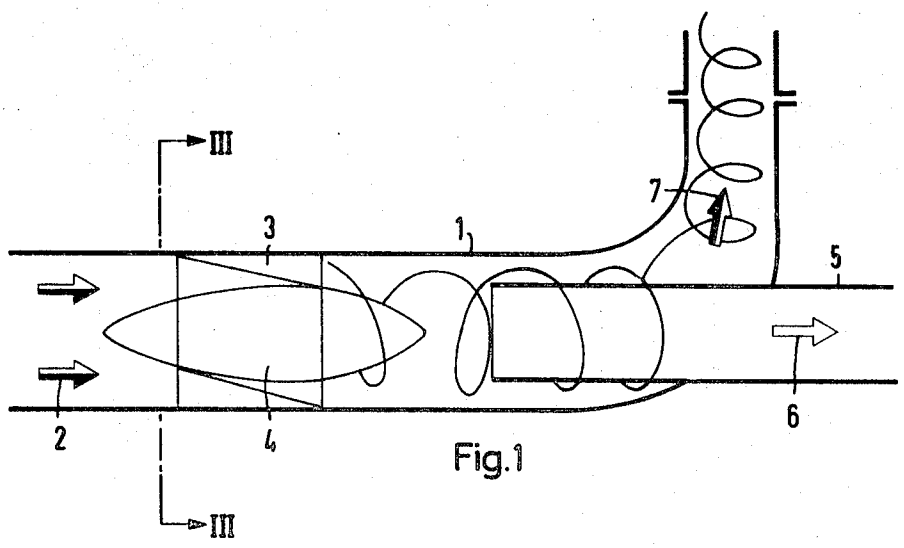


Fig.1

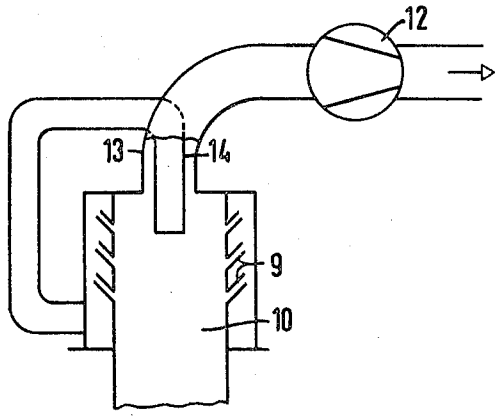


Fig. 4

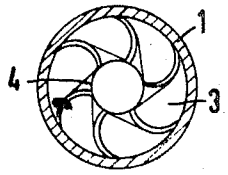


Fig. 3

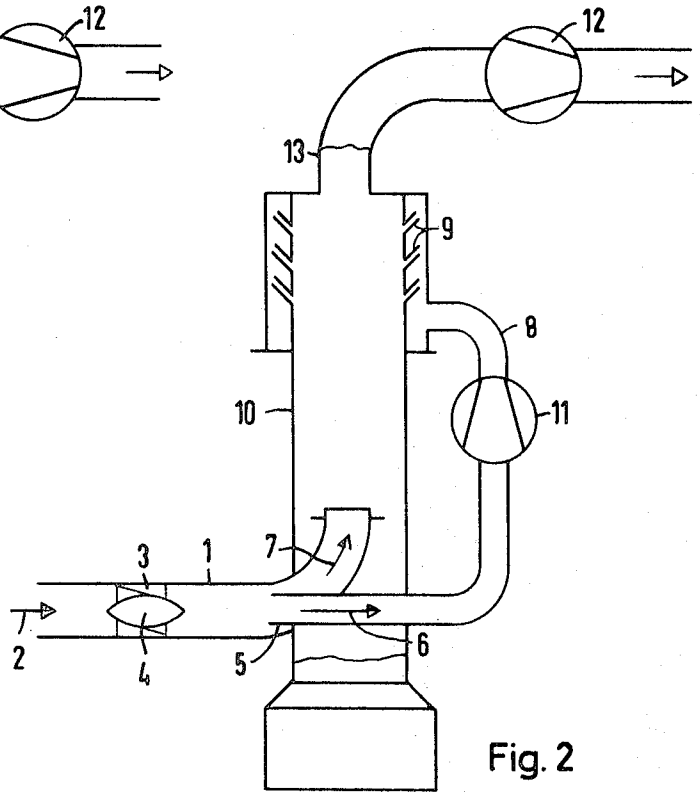


Fig. 2

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3,616,619

# TORNADO-FLOW SEPARATOR WITH RAW-GAS PRECLEANSER

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Continuation of application Ser. No. 743,514, July 9, 1968. This application Nov. 19, 1969, Ser. No. 871,693
Claims priority, application Germany, Sept. 27, 1967, S 112,044
Int. Cl. B01d 45/12
U.S. Cl. 55—338 2 Claims

## ABSTRACT OF THE DISCLOSURE

A dust-from-gas separator of the tornado-flow type has its row-gas inlet equipped with a device for partially precleaning the entering gas flow. The device comprises a flow-guide structure shaped as a body of rotation and coaxially mounted in the gas inlet duct so as to leave an annular interstice in which a coaxial group of guide vanes provides a helically twisting path for the gas flow. An axial tube of smaller diameter than the gas inlet duct has its inlet opening situated behind the vanes and receives the precleaned partial current of gas which flows near the axis of the duct, whereas the more heavily dust-laden outer portion of the gas flow enters into the tornado-flow separator vessel proper.

This application is a continuation of Ser. No. 743,514 filed July 9, 1968, now abandoned.

My invention relates to dust-from-gas separators generally of the tornado-flow type and, in a more particular aspect, concerns a device in the raw-gas inlet duct of such a separator for the purpose of precleaning the gas flow so as to branch off a relatively clean portion of the flow while passing a dust-enriched portion of the flow into the separator vessel proper.

Tornado-flow separators comprise a cylindrical or tubular separator vessel with a coaxial gas inlet duct located axially opposite the clean-gas outlet of the separator. The vessel is provided with nozzle means for supplying an amount of gas in a direction generally tangential but inclined toward the axis of the vessel. The nozzle means may be constituted by nozzle tubes located at the cylindrical jacket of the separator vessel. The gas thus injected in a tangentially and inclined direction, produces in the vessel a rotational flow composed of an outer helical potential flow and an inner, likewise helical rotational flow, the rotation of these two component flows being in the same sense but the respective axial directions of flow being opposed to each other. The particles entering with the raw gas, when reaching a vortex source above the opening of the inlet duct, are flung outwardly in the direction toward the jacket of the separator space and are then seized by the downwardly directed potential flow in the vicinity of the jacket wall but without impinging upon the wall. The particles thus entrained by the potential flow collect in a ring-shaped space around the axial inlet duct from which they are drained out of the vessel.

As regards the performance and theory involved in such tornado-flow devices, as well as with respect to various design details, reference may be had for example to U.S. Pats. No. 3,199,268 and No. 3,199,272 which both issued Aug. 10, 1965.

The dimensioning of tornado-flow devices for separating solid or liquid particles from gases mainly depends upon the throughput quantity of raw gas to be cleaned in each case arising in actual industrial practice. For relatively slight dust charges of the raw gas and relatively



large throughput quantities, the separator must be given correspondingly large dimensions in order to take care of the entire raw-gas quantity. It has been proposed to reduce the structural height of such plants by branching off a portion of the raw gas prior to its entering into the tornado-flow chamber proper, and using the branched-off portion as an auxiliary gas for feeding the nozzles that inject the gas quantity in a tangential and inclined direction into the separator vessel. This, however, may impair the efficiency of the tornado-flow separator because of the relatively large dust content of the tangentially injected gas quantity.

It is an object of my invention to provide a device for the partial cleaning of the raw-gas current so that, on the one hand, a precleaned partial current can be employed as tangential-injection gas for the above-mentioned purposes and, on the other hand, the remaining raw-gas is more strongly enriched with particles.

To this end, and in accordance with my invention, I provide in the inlet duct for the raw-gas a coaxial guide-vane group with a centrally located deflector or guide structure of generally rotationally symmetrical shape, this guide structure having a smaller diameter than the gas inlet duct. I further provide behind the guide vanes, seen in the gas-flow direction, a coaxial tube having a smaller diameter than the inlet duct and having its opening located to receive the precleaned partial current of gas flowing near the axis of the gas inlet duct.

These and other features of my invention will be more fully understood from the following description of an embodiment of a tornado-flow separator device according to the invention illustrated by way of example on the accompanying drawing in which:

FIG. 1 is a schematical and sectional view of a gas precleaning device with which the separator is provided in accordance with the invention;

FIG. 2 illustrates the same device as a component of the entire separator plant, the separator being shown schematically in section;

FIG. 3 is a cross section along the line III—III in FIG. 1; and

FIG. 4 is a partial sectional view showing a modified portion of a separator otherwise corresponding to FIGS. 1, 2 and 3.

According to FIG. 1, the particle-laden raw gas **2** enters from the left into the inlet duct **1**. Mounted in the duct **2** there is a coaxial ring-shaped arrangement of peripherally distributed guide vanes **3** with an axial flow-deflector or guide body **4** located in the center of the vane arrangement. The vanes have a helical shape. The guide body **4**, having an axially elongated shape and constituting a rotationally symmetrical body of revolution, imparts to the entering gas flow a twisting motion and flings the entrained particle from the axial region of the raw-gas current outwardly into those regions where the centrifugal forces have correspondingly higher magnitudes. As a result, the particles entrained in the raw gas collect predominantly in the region near the peripheral wall surface of the inlet duct **1**. Shortly behind the guide vanes **3** and the flow guiding body **4** there is located the opening of a coaxial tap tube **5** whose diameter is smaller than the inner diameter of the inlet duct **1** so as to leave a sufficient annular interstice for the dust-enriched gas flow to pass by the tube **5**. The relatively dust-free portion of the gas is sucked through the tube **5** out of the axial region of the inlet duct **1**. Consequently, the smaller quantity of gas remaining in the inlet duct **1** and passing beyond the tube **5** carries a correspondingly increased volumetric burden of dust.

For example, when the tap tube **5** withdraws approximately one-half of the raw-dust quantity supplied to the

inlet duct **1**, the volumetric charge of the remaining raw-gas current entering into the tornado-flow separator proper is approximately doubled. Hence, the separator need be designed for only one-half the throughput quantity. The other portion is already precleaned and may be withdrawn as cleaned gas.

It has been found advantageous to employ the precleaned tap gas as secondary gas for the operation of the tornado-flow separator. This is exemplified by the separator plant shown in FIG. 2. In this case, the tornado flow in the separator vessel **10** proper is excited by inclined-tangential injection nozzles **9** located in the jacket of the vessel. The tap tube **5** is shown extended by means of a pipe **8** and opens into a ring channel through which the nozzles **9** are fed. A blower **11** may be mounted in the gas line **8** if the main suction blower **12** located behind the separator should turn out to be insufficient.

If desired, the tap tube **5** may also be arranged in coaxial relation to the clean-gas outlet **13** of the tornado-flow device and may partially protrude into the tornado flow chamber proper. This makes it possible, especially in cases where the clean gas is being subjected to after-purification, to directly withdraw the portion of gas which flows in the axial region through the separator; and this gas may then be also employed, if desired, for directly supplying the injection nozzles with gas, so that only the gas portion flowing in the outer region need be subjected to after-cleaning operation.

The device of the latter type is exemplified by the modification to the separating plant partially shown in FIG. 4. The tap duct **14** in this embodiment protrudes downwardly into the tornado-flow chamber in coaxial relation to the clean-gas outlet duct **13** and withdraws the almost dust-free gases which flow in the axial region of the tornado-flow separator. The tapped-off gas flow is directly supplied to the injection nozzles **9**. If desired, a blower may be inserted into the tap duct **14**. The duct **14** may be used without or with the duct **5**. If the tap duct **14** alone is used, the vanes **3** and the guide body **4** need not necessarily be provided because the tornado flow in vessel **10** suffices to produce the desired effect.

To those skilled in the art it will be obvious, upon a study of this disclosure, that my invention permits of various modifications and may be given embodiments other than particularly illustrated and described herein, without departing from the essential features of my invention and within the scope of the claims annexed hereto.

What is claimed is:

**1.** With a dust-from-gas separator having a tornado-flow separator vessel defining a main flow path with raw-gas inlet means at one end thereof and clean-gas outlet means at the other end thereof, the combination of a device for precleaning part of the raw gas of particles entrained therein comprising an inlet duct forming part of said raw-gas inlet means, a flow-guide structure shaped as a body of rotation and coaxially mounted in said inlet duct to form therewith an annular interspace, and a coaxial group of guide vanes peripherally distributed about said structure for providing a helical twist to raw gas flowing in the main flow path so that particles entrained in the raw gas are flung radially outwardly from the axis of the flow path and so that the gas continuing to flow in the main flow path is clean, and an axial clean gas tap tube having a smaller diameter than said inlet duct and having its inlet opening situated in said inlet duct behind said group of vanes relative to the gas-flow direction and substantially at the axis of the main flow path so as to tap off a precleaned quantity of gas flowing near the axis of the inlet duct, said vessel being substantially cylindrical, and having nozzle means extending tangentially to the peripheral surface of the said vessel and in direction inclined to the axis of said vessel for injection of gas to excite a tornado flow in said vessel, said axial tube for precleaned gas extending out of said raw-gas dust and being connected to said nozzle means to supply injection gas thereto.

**2.** In a separator according to claim **1**, said clean-gas outlet means comprising an outlet duct extending from the top of said vessel, and said clean gas tap tube having a smaller diameter than said outlet duct and extending from the outside in coaxial relation to said outlet duct into said chamber so as to downwardly protrude beyond the end of said outlet duct.


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