(12) UK Patent Application (19) GB (11) 2 205 766 (13) A

(43) Application published 21 Dec 1988

(21) Application No 8813634

(22) Date of filing 9 Jun 1988

(30) Priority data
(31) 20902 (32) 15 Jun 1987 (33) IT

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(51) INT CL'
B01D 47/12 53/34

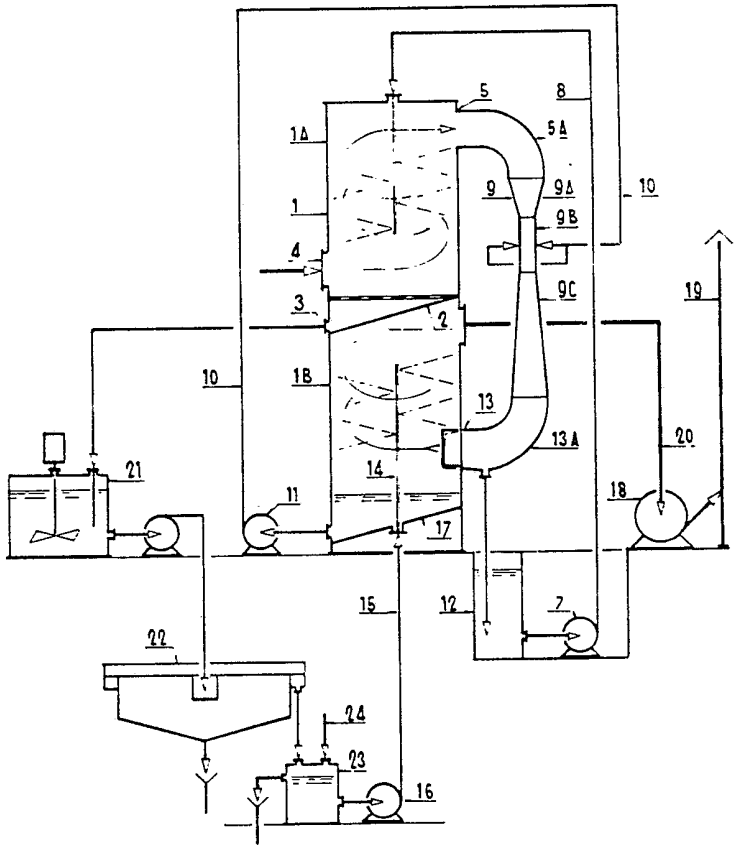
(52) Domestic classification (Edition J):
B1R 203 205 301 4163 AC

(56) Documents cited
IT 1045466 IT 0961166

(58) Field of search
B1R
F4B
Selected US specifications from IPC sub-classes
B01D F23J

(54) Process and equipment for cleaning industrial fumes

(57) In a process and equipment for cleaning industrial fumes of the type wherein the fumes are submitted to a first washing stage in a cyclonic-scrubber 1A operating as a saturator, wherein the fumes, flowing along a spiral path, are sprayed by a washing liquid, and to a second stage, wherein the fumes, leaving the saturator, flow through a Venturi-scrubber 9, the cleaning efficiency is considerably improved, both with regard to dusts collection and chiefly to the capture of polluting gases (such as SOx, NOx, Cl_2, F , and so forth), by providing, downstream of the Venturi-scrubber, a further washing stage in a second cyclonic-scrubber 1B. Washing liquid in the equipment is recirculated, and tanks 12, 21, 23 may be supplied with an alkaline reagent e.g. lime.



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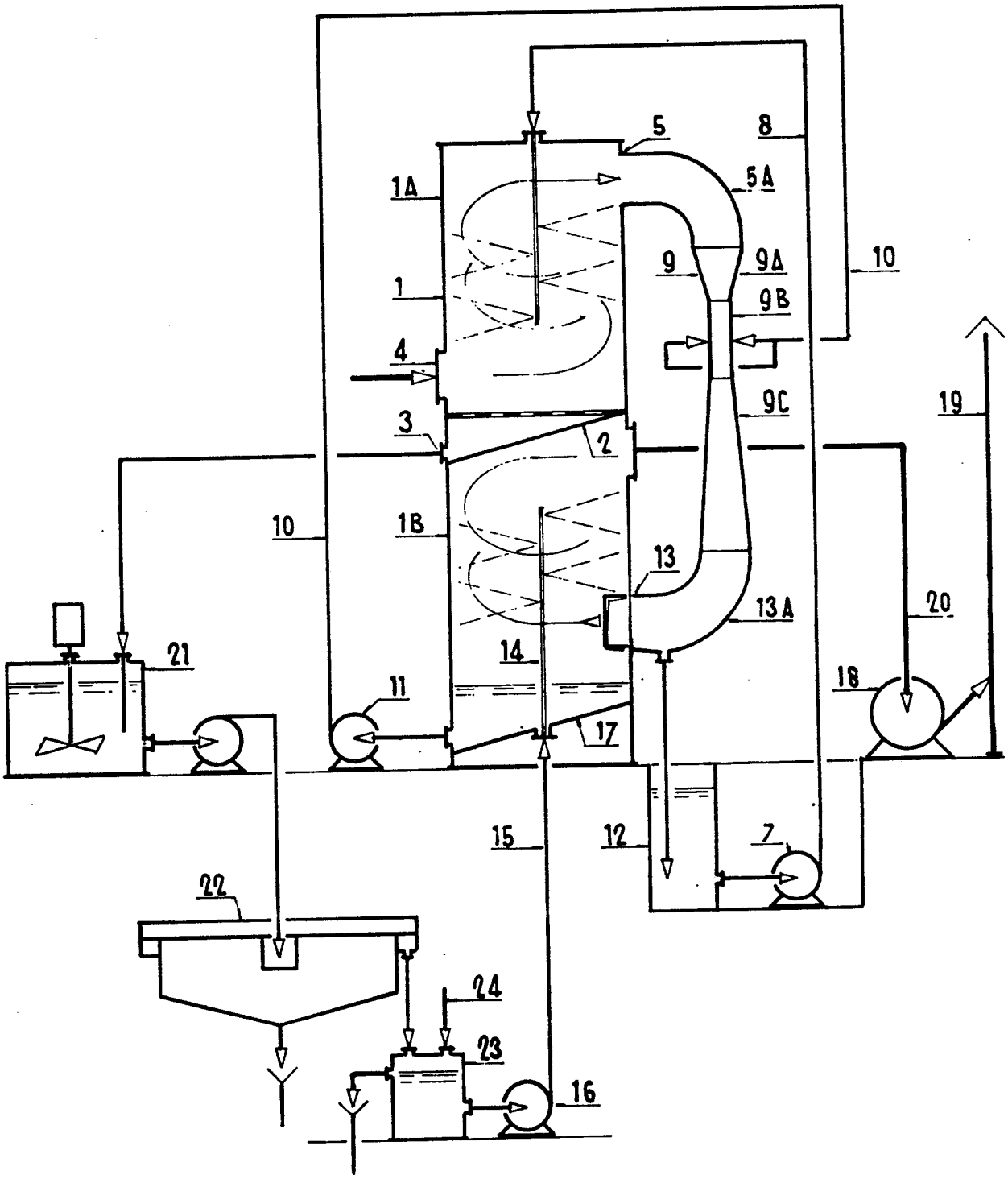
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"PROCESS AND EQUIPMENT FOR CLEANING INDUSTRIAL FUMES"

This invention concerns industrial fumes cleaning and more specifically the capture of polluting dusts and gases (such as SOx, NOx, Cl_2, F^-, and so forth).

Among known processes and equipments for the same purpose, those disclosed by Italian Patent N. 961,166 and 1.045.466 to the same Applicant's name, can be mentioned.

In such patents process and equipment for cleaning fumes at least partially combustible and carrying dusts (essentially metal oxydes) and chiefly the fumes developed by steelmaking are described.

The said processes consist of a post-combustion stage of combustible gases and a dust collection stage by washing (with water or other liquids) in two steps: first step of pre-washing in a saturator and second step of end washing in a Venturi scrubber.

In the frame of the processes and equipments subject matter of the above mentioned Patents, a washing tower is described, divided in two separate parts by a baffle, having the following features:

- a tangential fitting for the inlet of the fumes to be cleaned in the upper portion of the washing tower, which operates as a saturator;
- a header with nozzles spraying water in cross-current to the fumes rising according to spiral flow pattern, as in a cyclone washer;
- a Venturi scrubber outside the tower and connected to this latter by two elbow ducts: the upper one between the saturator outlet and the convergent portion of the Venturi pipe, the lower between the divergent portion of the Venturi pipe and the tangential inlet into the lower part of the washing tower;

- a tangential inlet for the cleaned fumes in the lower portion of the tower in order to collect the finest droplets.

Inasmuch as the industrial fumes, especially the flue gases from combustion of coal and/or fuel oil, e.g. in the production of steam and/or electrical power, contain dusts, prevailingly metal oxides, and acid gases, the industrial and social importance of any improvement of the cleaning degree become evident.

According to this invention, if to the process and equipment as disclosed in the above said Italian Patents a third washing stage is added, i.e. downstream the Venturi scrubber a cyclone-type washing stage, further improvements of the cleaning degree are achieved with minimum additional operating costs and no increase of washing water consumption.

The typical features and advantages of this invention are cleared up by the following detailed description, referring to the accompanying drawing, which shows diagrammatically an exemplary embodiment of the equipment according to the invention.

Having now reference to the drawing, a washing tower 1 is shown, partitioned by a sloping baffle 2 in an upper washing section 1A and a lower washing section 1B.

The baffle 2 is sloping in such a way as to convey water falling on it to a drain 3. The reference numeral 4 indicates the inlet of the fumes to be cleaned and the reference numeral 5 indicates the outlet from the section 1A for the fumes processed inside the same section.

The washing of the fumes is made by a spraying pipe 6 which delivers radial jets of water, fed through the pipe 8 by the pump 7.

From the outlet 5 the fumes go through an elbow 5A into the Venturi scrubber 9 consisting of an upstream, or convergent,

section 9B, a narrow section 9A to which wash water is fed through the pipe 10 by the pump 11 and a downstream, or divergent, section 9C.

From the elbow 13A of the Venturi scrubber the water separated due to centrifugal effect is collected and discharged into a tank 12 from which it is drawn by the pump 7.

The fumes or gases from the outlet 13 of the Venturi scrubber 9 enter the lower section 1B of the washing tower 1 where a washing process, almost in the same way as in the upper section 1A, is carried out by the spraying pipe 14 fed with pressure water through the pipe 15 by the pump 16.

The water collected on the sloping bottom 17 of the section 1B feeds the pump 11 and the cleaned fumes intaken by the fan 18 through the duct 20 are exhausted to the atmosphere through the stack 19.

The wash water discharged from the first cyclone washing device (section 1A) goes to a tank 21, wherein it is preferably neutralized with an alkaline reagent, e.g. lime, and is sent to a settling and washing tank 22 whose water feeds the pump 16 through the reservoir 23, whilst the sludges are removed and disposed of in the usual way.

Finally through the tube 24 it is possible to restore the washing water.

From the above stated description two important features of this invention appear clearly:

a) an improvement of the cleaning degree of the fumes, which approach 99-99,5% referred to the dusts and 92-98% referred to the polluting gases and vapours, whilst by the prior art a cleaning degree of 98-99% for the dusts and 60-92% for the gases and vapours was achieved;

b) a substantial saving of water, as the wash water is recycled from the one to the other washing stage, clear water being used in the final high-level cleaning stage.
In this connection, it should be observed, however, that, if necessary, water recycled to the various stages can undergo particular cleaning treatments.

Concerning the operation and process conditions, reference can also be had to the aforementioned Italian Patents, since the third stage of the cyclone-washing takes place in a way similar to that of the first washing stage.

In order that the features and advantages of the invention may be better understood, two practical embodiments of the relevant procedure will be illustrated hereinafter.

EXAMPLE 1

The apparatus and the procedure of the invention are used to purify the fumes coming from a coal-fired power station: a typical concentration of dusts (ash) in the fumes is in the order of magnitude of 20,000 milligrams (mg) per normal cubic meter (Nm^3).

By adopting the installation and the procedure outlined hereinbefore, the final dust concentration in the flues drastically drops to as little as 40 mg/Nm^3.

By comparison, with the prior art installations and procedures, including those referred to above, the dust-stripped flues still contained as many as 100 mg/Nm^3 of dusts. This means that the purifying efficiency of the procedure and installation according to the present invention is more than twice that of the prior art approaches: stated another way, the degree of dust removal is as high as 99,8% with the instant process and installation, as compared with 99,5% obtainable with the prior art methods and installations.

As regards the removal of sulphur dioxide, the prior art arrived at removing, from an initial SO_2 content in the flues of 4,000 mg/Nm^3, only an amount corresponding to a final SO_2 concentration of 800-1,000 mg/Nm^3, corresponding to 80%-70% removal, respectively, whereas the process and the installation according to the present invention permit to obtain final concentrations of sulphur dioxide as low as 400 mg/Nm^3, corresponding to a 90% removal.

Also in this case, therefore, the removal efficiency of the process and installation according to the present invention is at least twice that obtainable with the prior art teachings.

EXAMPLE 2

The fumes exiting a purification installation for Fe-Si alloys usually contain 15,000 mg/Nm^3 of dusts: these can be reduced, with the process and installation according to the invention, to as few as 30 mg/Nm^3, that which corresponds to a degree of stripping as high as 99,8%, as compared with 99% removal of the prior art, that is, 150 mg/Nm^3: it is observed, incidentally, that the dust removal difficulty is the more serious, the smaller the dust particle size is.

As regards gaseousSiF_4, from an initial content of 500 mg/Nm^3, the invention permits to arrive at as few as 5 mg/Nm^3, that which is tantamount to say that the removal efficiency is at least 99,0%, as compared with the 95% removal of the prior art, that is 25 mg/Nm^3 of residual SiF_4.

Modifications and changes can be introduced in the process and the installation according to this invention without departing from the scope thereof: if so desired or necessary, for example, it is well possible to supplement alkaline reagents not only to the tank 21, but also to the reservoir 23 and to the tank 12.

Claims

1. Process for industrial fumes and gases cleaning, of the type wherein the fumes are submitted to a first washing in a cyclonic-scrubber operating as a saturator and to a second washing in a Venturi scrubber, characterized in that the fumes are submitted to a further washing in a second cyclonic-scrubber.

2. Process according to claim 1, characterized in that the exhaust water from the first cyclone washing are purified and sent to a settling tank from which the third cyclone washing stage is fed.

3. Process according to claim 2, characterized in that the exhaust water from the Venturi scrubber feeds the first cyclone washing stage and the exhaust water from the third cyclone washing stage feed the Venturi scrubber.

4. Equipment for industrial fumes and gases cleaning of the type including a first cyclonic-scrubber followed downstream by a Venturi scrubber, characterized in that it includes a further cyclonic scrubber downstream said Venturi scrubber.

5. Equipment for industrial fumes and gases cleaning according to claim 4, characterized in that said first and second cyclonic scrubbers constitute two separate sections, axially superposed to each other, of a single cyclonic washing tower, each section being provided with a sloped bottom for wash water collection and drain, said equipment including furthermore a spray tube for each section, axially installed to deliver radial water jets, and fumes or gases inlet fitting so arranged as to cause a helical upward motion of the fumes or gases along the respective section.

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