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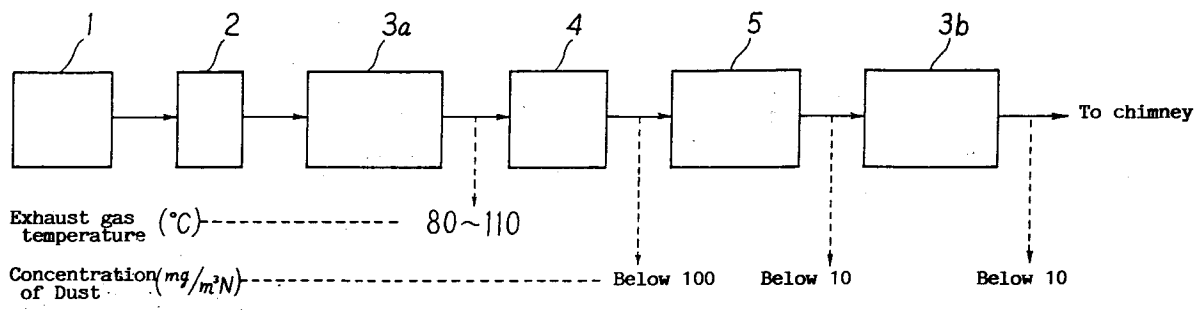
(54) **Method and system for handling exhaust gas in a boiler.**

(57) In a coal-fired boiler (1), a heat recovery unit (2,3a) is located upstream of a dry electrostatic precipitator (4) so as to reduce the temperature of exhaust gas at the inlet of the dry electrostatic precipitator (4) and thus, prevent reverse ionization in the electrostatic precipitator (4). The heat recovery unit (2,3a) located upstream of the dry electrostatic precipitator will in no way be corroded even if the concentration of dust is reduced in the dry electro-

static precipitator (4). The desulfurization unit (5) does not require a cooling/dust removing section and eliminates the need for a wet electrostatic precipitator. The dry electrostatic precipitator (4) includes a gas passage divided into a plurality of parallel passages and dampers (15,16) operable to close the passages. This arrangement prevents dust from being dispersed as a result of hammering without charge.

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Fig. 1



BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a handling method and system for removing dust and Sox from exhaust gas in a coal-fired boiler.

2. Description of the Related Art

Figs. 4 and 5 are block diagrams of conventional systems for removing dust and SOx from exhaust gas in a coal-fired boiler.

With reference first to Fig. 4, a system includes a coal-fired boiler 1. The temperature of exhaust gas from the boiler 1 is reduced to 120 to 160° in an air preheater 2. Dust is removed from the exhaust gas in a dry electrostatic precipitator 4 until its concentration is reduced to about 100 mg/m³N or slightly higher. Heat recovery is effected in a regeneration-type gas-gas heater 7. Thereafter, the temperature of the exhaust gas is reduced to its saturation temperature in a cooling/dust removing section 6a of a wet desulfurization unit 6, and dust is further removed from the exhaust gas. The concentration of SOx is also reduced in a SOx absorbing section 6b. Finally, the exhaust gas is reheated in the gas-gas heater 7 and then, directed to a chimney.

This prior system suffers from the following problems:

(1) As shown in Fig. 6, the temperature of exhaust gas in the dry electrostatic precipitator is high, and the specific resistance of dust arising from burning of some coals is above 10¹¹ Ω-cm. When the specific resistance of the dust exceeds 10¹¹ Ω-cm, reverse ionization occurs in the electrostatic precipitator. This substantially deteriorates the performance of the electrostatic precipitator. To this end, a large electrostatic precipitator is needed to collect dust at a required rate.

(2) If the concentration of dust at the outlet of the electrostatic precipitator is reduced to 100 mg/m³N or lower, then SO₃ is atomized while the exhaust gas is being cooled by the gas-gas heater. SO₃ thus atomized is then deposited in the gas-gas heater. This results in corrosion of the same. It is thus necessary to raise the concentration of dust above 100 mg/m³N so as to neutralize SO₃. As a result, the concentration of dust is approximately 20 mg/m³N at the outlet of the desulfurization unit 6. Gas leakage (approximately 10%) takes place in the gas-gas heater 7. As such, the concentration of dust is reduced only to as low as 30 mg/m³N at the inlet of the chimney.

(3) The desulfurization unit uses lime (limestone)

- gypsum method. When gypsum as collected is used, dust mixed therewith deteriorates the quality of the gypsum. In order to maintain the purity of gypsum at a predetermined level, the desulfurization unit must be of so-called twin-tower type including a cooling/dust removing section 6a and an absorbing section 6b. This results in an increase in the consumption of space and the production cost.

With reference next to Fig. 5, there is shown a system adapted to reduce the concentration of dust to for example, 10 mg/m³N. This system includes a leak-free type gas-gas heater wherein heat exchange is effected through a heating medium. The system is different from the system of Fig. 4 in that a heat recovery section 3a is separated from a reheater section 3b, and a wet electrostatic precipitator 8 is located downstream of the purifier 6. However, this system suffers from the problems (1) and (3). A more critical problem of this system is that the wet electrostatic precipitator 8 consumes larger space and results in an increase in the production cost of the system.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a system for handling exhaust gas which is able to solve the foregoing problems encountered in the prior art and meet the following needs:

(1) A dry electrostatic precipitator can maintains its high performance regardless of types of coals to be used and can be made compact.

(2) Those units located downstream of the dry electrostatic precipitator should not be adversely affected if the concentration of dust is approximately below 100 mg/m³N at the outlet of the dry electrostatic precipitator.

(3) The concentration of dust at the inlet of the desulfurization unit can be reduced to the extent that the quality of the gypsum is maintained at a predetermined level if dust is mixed with the gypsum as collected in a single-tower type desulfurization unit wherein the gas cooling/dust removing section and the absorbing section are integrated together.

(4) The concentration of dust can be reduced below 10 mg/m³N at the inlet of a chimney without the need for a wet electrostatic precipitator.

In order to achieve the foregoing objects, the present invention provides a method for handling exhaust gas in a boiler which comprises the steps of cooling exhaust gas from a coal-fired boiler to a temperature of between 80 and 110° by an air preheater and a heat recovery unit, reducing the concentration of dust to as high as 100 mg/m³N by

a dry electrostatic precipitator, and introducing the exhaust gas to a desulfurization unit so as to reduce SOx.

According to the present invention, there is also provided a system for handling exhaust gas in a boiler which comprises a gas flue of a coal-fired boiler in which an air heater, a heat recovery unit, a dry electrostatic precipitator, and a desulfurization unit are provided in that order, the dry electrostatic precipitator including a gas passage divided into a plurality of parallel passages, and dampers provided in said parallel passages respectively and operable to inhibit exhaust gas flow therethrough.

In the present invention, the heat recovery unit is located upstream of the dry electrostatic precipitator so as to reduce the temperature of exhaust gas to 80 to 110° at the inlet of the electrostatic precipitator. This results in a corresponding decrease in the specific resistance of dust and thus, prevents reverse ionization in the electrostatic precipitator and improves the performance of the dry electrostatic precipitator. With this arrangement, the heat recovery unit is not suffer from corrosion due to SO₃ if the concentration of dust is reduced to 100 mg/m³N in the electrostatic precipitator, because the heat recovery unit is not located downstream of the dry electrostatic precipitator. Since the dry electrostatic precipitator is able to substantially reduce the concentration of dust, the desulfurization unit does not require a cooling/dust removing section and can be of the single-tower type. Also, a wet electrostatic precipitator is unnecessary.

Also, in the present invention, by successively closing the plurality of parallel passages in the dry electrostatic precipitator and hammering without charge, dispersion of dust can be substantially reduced, thereby improving the performance of the electrostatic precipitator.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention may be had by reference to the following description of a preferred embodiment when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram of a system made according to one embodiment of the present invention;

Fig. 2 is a vertical schematic view of a dry electrostatic precipitator included in the system shown in Fig. 1;

Fig. 3 is a graph showing the flow rate of exhaust gas vs. gas ratio;

Figs. 4 and 5 are block diagrams of conventional systems for handling exhaust gas in a coal-fired boiler;

Fig. 6 is a graph showing the temperature of exhaust gas vs. specific resistance of dust;

Fig. 7 is a graph showing the results of test, that is, the relationship between the temperature of exhaust gas and the rate of dust collection in the dry electrostatic precipitator;

Fig. 8 is a graph showing time after hammering has been effected without charge vs. the concentration of dust at the outlet of the dry electrostatic precipitator;

Fig. 9 is a graph showing the flow speed of exhaust gas within the electrostatic precipitator vs. the concentration of dust at the outlet of the dry electrostatic precipitator; and

Fig. 10 is a graph showing the dust collection characteristics of the desulfurization in the present system and the prior art system, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a block diagram of a system according to one embodiment of the present invention. Fig. 2 is a vertical sectional view schematically showing a dry electrostatic precipitator. Fig. 3 is a graph showing the flow rate of exhaust gas under control of the electrostatic precipitator shown in Fig. 2.

With reference now to Fig. 1, there is shown a system which includes a coal-fired boiler 1. Exhaust gas from the boiler 1 includes SOx and dust. The temperature of the exhaust gas is reduced to 120 to 160° in an air preheater 2. A gas-gas heater 3a is of the leak-free type and uses a heating medium. The gas-gas heater 3a includes a heat recovery section 3a in which the temperature of the exhaust gas is further reduced to 80 to 110°. The concentration of dust is reduced to 100 mg/m³N in a dry electrostatic precipitator 4. Further removal of dust from the exhaust gas is effected in a desulfurization unit 5. The desulfurization unit 5 is of the single-tower type and employs lime - gypsum method and said unit 5 reduces the concentration of SOx to a predetermined level. The exhaust gas as cooled to a saturation temperature is then reheated in a reheater section 3b of the gas-gas heater of the leak-free type and is directed to a chimney.

A denitrification unit or a gas fan (suction fan or pressure fan) which may be located between the boiler 1 and the air heater 2 and a heating medium line of the gas-gas heater are not shown in Fig. 1.

In the illustrated embodiment, the heat recovery section 3a of the gas-gas heater is located upstream of the dry electrostatic precipitator 4 so as to reduce the temperature of the exhaust gas to 80 to 110° as compared to 120 to 160° in the

conventional systems. In this way, the specific resistance of dust, regardless of types of coals, is reduced to 10^{11} Ω -cm where no reverse ionization occurs. This provides an improved charging condition of the dry electrostatic precipitator and ensures high performance of same. The dry electrostatic precipitator can thus be made compact.

Also, in the illustrated embodiment, the concentration of dust at the inlet of the heat recovery section 3a of the gas-gas heater is the same as that at the outlet of the air preheater 2 (usually 10 - 20 g/m³N) and sufficient to fully prevent corrosion of the former due to the presence of SO₃. The gas-gas heater is of the leaf-free type, and therefore, no leakage of dust takes place at the inlet of the chimney.

Moreover, the concentration of dust at the outlet of the dry electrostatic precipitator 4 is sufficiently reduced below 100 mg/m³N. Accordingly, the purity of the gypsum as collected can be maintained at a predetermined level when a single-tower type desulfurization unit is used. The concentration of dust at the outlet of the desulfurization unit is reduced below a predetermined level by the dry electrostatic precipitator. This eliminates the need for a wet electrostatic precipitator.

Reference will next be made to the results of a test carried out by the inventors, with a pilot plant to which the present system is applied, as well as to an improvement in the system.

The specific resistance of dust arising from burning of several kinds of coals is measured. Fig. 6 shows the results of measurement of three typical kinds of coals. The specific resistance of dust is 10^{11} Ω -cm or higher in the prior art systems. In the present invention, the temperature of the exhaust gas is reduced to 90 to 100° to ensure that the specific resistance of the dust is below 10^{11} Ω -cm. As a result, the dry electrostatic precipitator no longer suffers from reverse ionization. This ensures constant charging.

Fig. 7 is a graph showing the temperature of exhaust gas vs. the rate of dust collectable by the dry electrostatic precipitator. Dust is effectively attracted to collector elements in the electrostatic precipitator as shown by the line A in Fig. 7 since charging conditions have been improved as stated earlier. The exhaust gas is saturated at a temperature of 110° or lower. However, the dust are again dispersed due to hammering, etc. This results in a rapid increase in the dust discharged from the electrostatic precipitator. In fact, the rate of dust collection is reduced as shown by the line B in Fig. 7. Dust dispersed from the collector elements is shown by a shaded area C in Fig. 7.

Various attempts have been made to prevent dust from being dispersed from the collector elements. As a result, it has been found that disper-

sion of dust can be substantially reduced, and the dust can be highly effectively collected by including dampers in the electrostatic precipitator, and hammering without charge. In Fig. 2, 11 is a body of the dry electrostatic precipitator. 12 is an inlet duct. 13 is an outlet duct. 14 are partitions by which a gas passage within the electrostatic precipitator body 11 is divided into a plurality of parallel passages (eight passages in Fig. 2). 15 and 16 are inlet and outlet dampers provided for the respective passages.

Fig. 8 shows the concentration of dust at the outlet of the electrostatic precipitator vs. time after hammering has been effected without charge. It has been found that the amount of dust dispersed is kept low for a period of two to three hours after hammering has been effected. With the arrangement shown in Fig. 2, hammering is carried out for about fifteen minutes without charge while the eight gas passages are subsequently closed by the respective dampers. In this way, the hammering can be repeated every two hours so as to prevent an increase in the dispersion of dust.

Fig. 9 shows the flow speed of exhaust gas vs. the concentration of dust or the amount of dust dispersed as a result of hammering. From Fig. 9, it is clear that dust is rapidly and substantially dispersed when the flow speed of the exhaust gas is below 0.5 m/s. This means that the electrostatic precipitator is less effective when the boiler is operated under low load. To this end, the number of the passages closed by the dampers in the electrostatic precipitator is changed in response to the flow of the exhaust gas so as to control the flow speed of the exhaust gas flowing therethrough.

Fig. 10 shows dust collection characteristics of the desulfurization unit. It has been found that the desulfurization unit of this embodiment provides a substantial improvement in dust collection over the prior art desulfurization unit. In the illustrated embodiment, the ratio of dust dispersed as a result of hammering is relatively high in the outlet duct of the dry electrostatic precipitator, and this dust is largely agglomerated. This results in a further advantage of the system which effectively and efficiently removes dust without the need for a wet electrostatic precipitator.

In the present invention, the wet desulfurization unit can use method other than the lime-gypsum method. In order to further reduce the concentration of dust, a wet electrostatic precipitator of a small capacity may be provided downstream of the desulfurization unit.

The present invention provides a method and system for handling exhaust gas in a coal-fired boiler which consumes less space and is economical to manufacture. Advantages of the present invention are as follows:

(1) A compact dry electrostatic precipitator can be used regardless of coals having a wide variety of characteristics.

(2) The quality of gypsum as collected can be maintained with a compact single-tower type desulfurization unit. 5

(3) Dust can be greatly removed without the need for a wet electrostatic precipitator.

Claims 10

1. A method for handling exhaust gas in a boiler comprising the steps of:
 - cooling exhaust gas from a coal-fired boiler to a temperature of between 80 and 110° 15
 - by an air preheater and a heat recovery unit;
 - reducing the concentration of dust to 100 mg/m³N or lower by a dry electrostatic precipitator; and
 - introducing the exhaust gas to a desulfurization unit so as to reduce SO_x. 20
2. A system for handling exhaust gas in a boiler comprising:
 - a gas flue of a coal-fired boiler including in 25
 - which an air heater, a heat recovery unit, a dry electrostatic precipitator, and a desulfurization unit are provided in that order,
 - said dry electrostatic precipitator including a gas passage divided into a plurality of parallel passages, and dampers provided in said 30
 - parallel passages respectively and operable to inhibit exhaust gas flow therethrough.

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Fig. 1

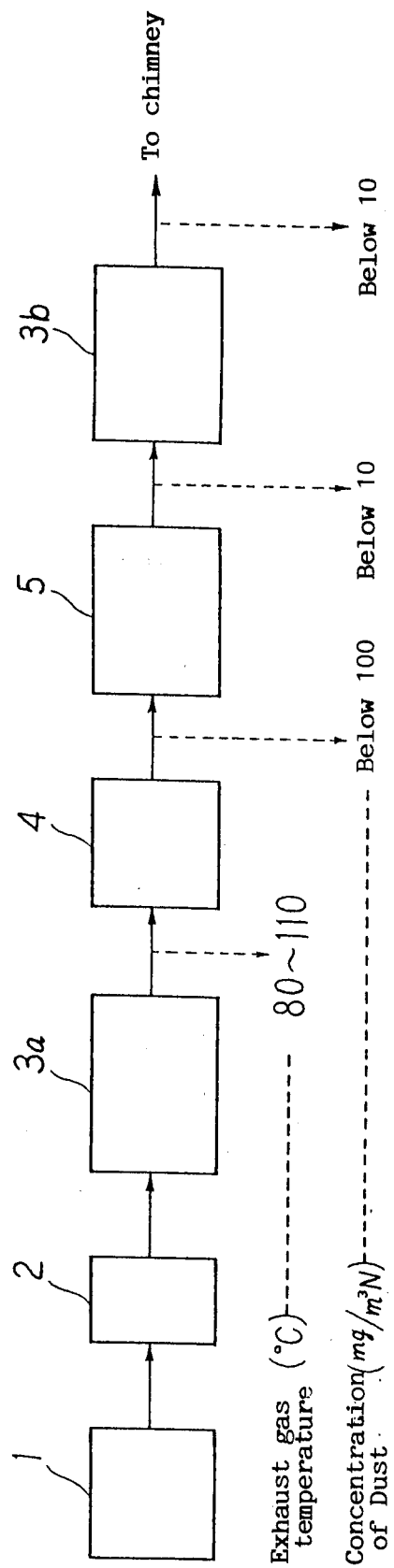


Fig. 2

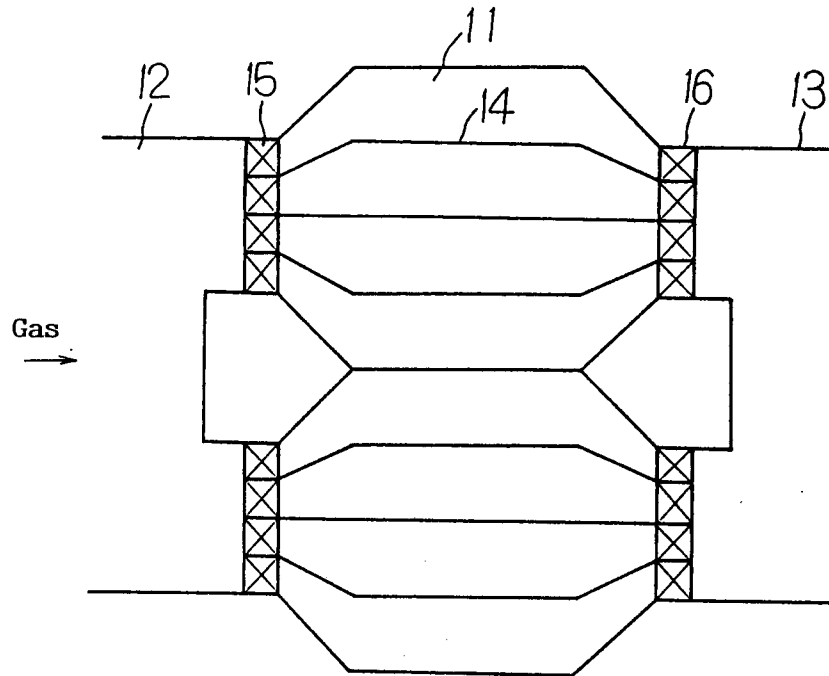


Fig. 3

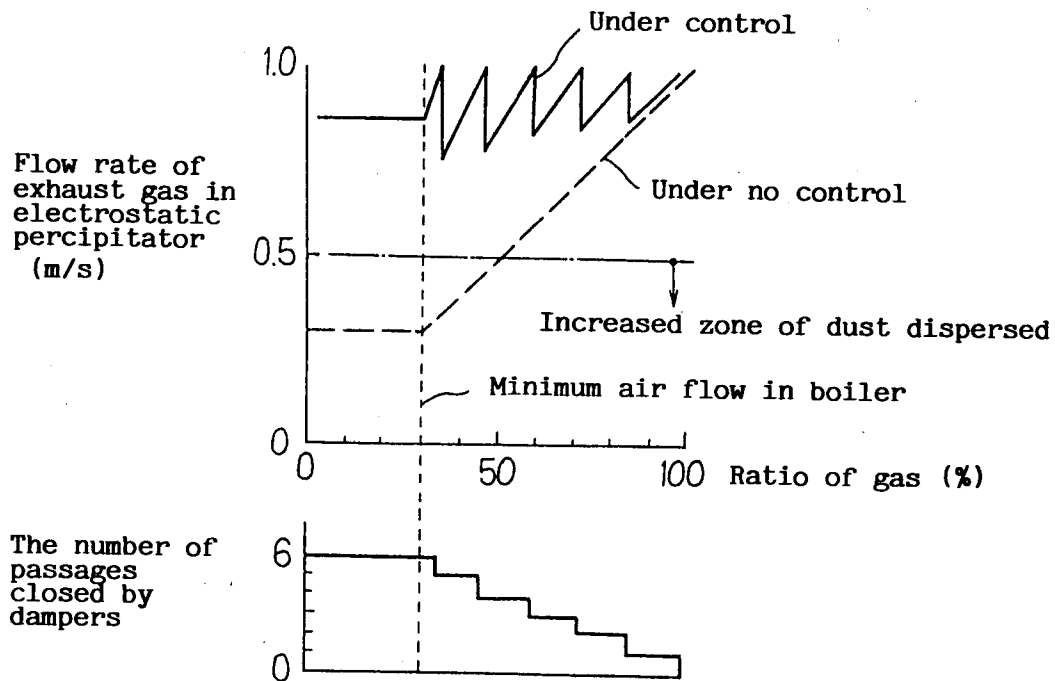


Fig. 4

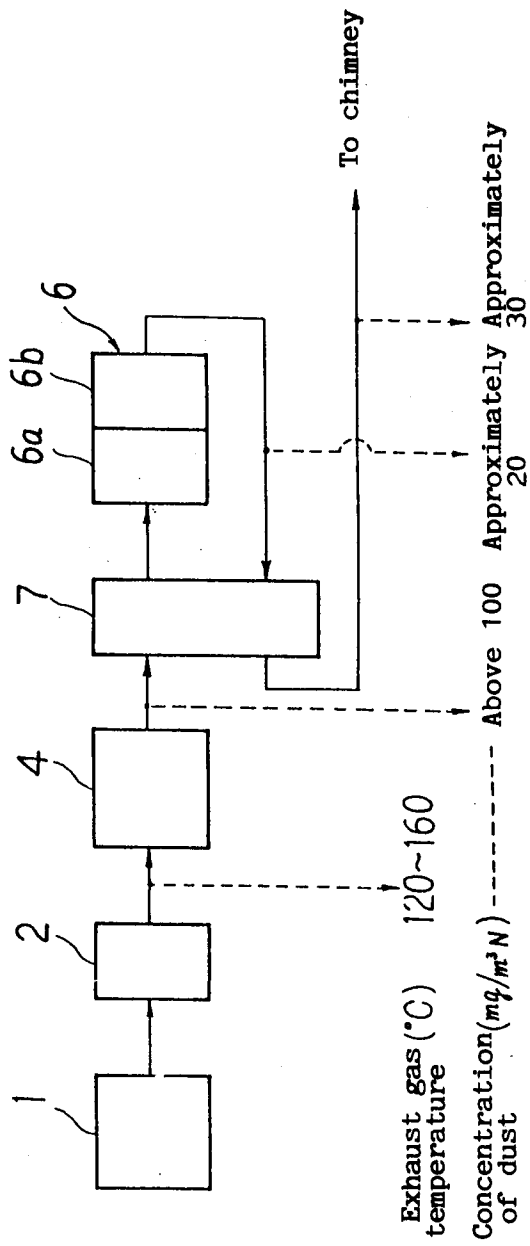


Fig. 5

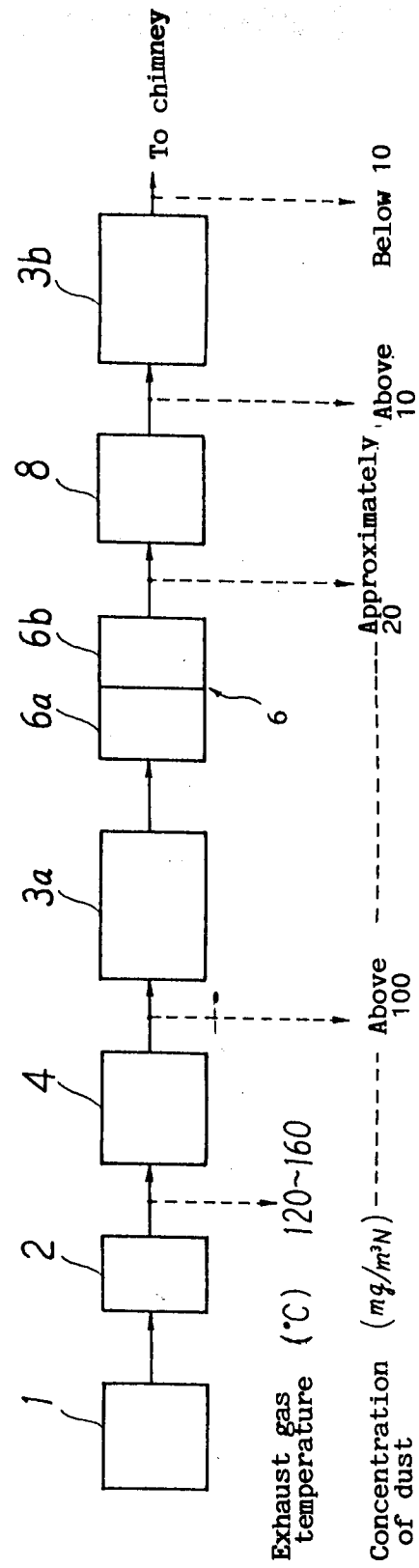


Fig. 6

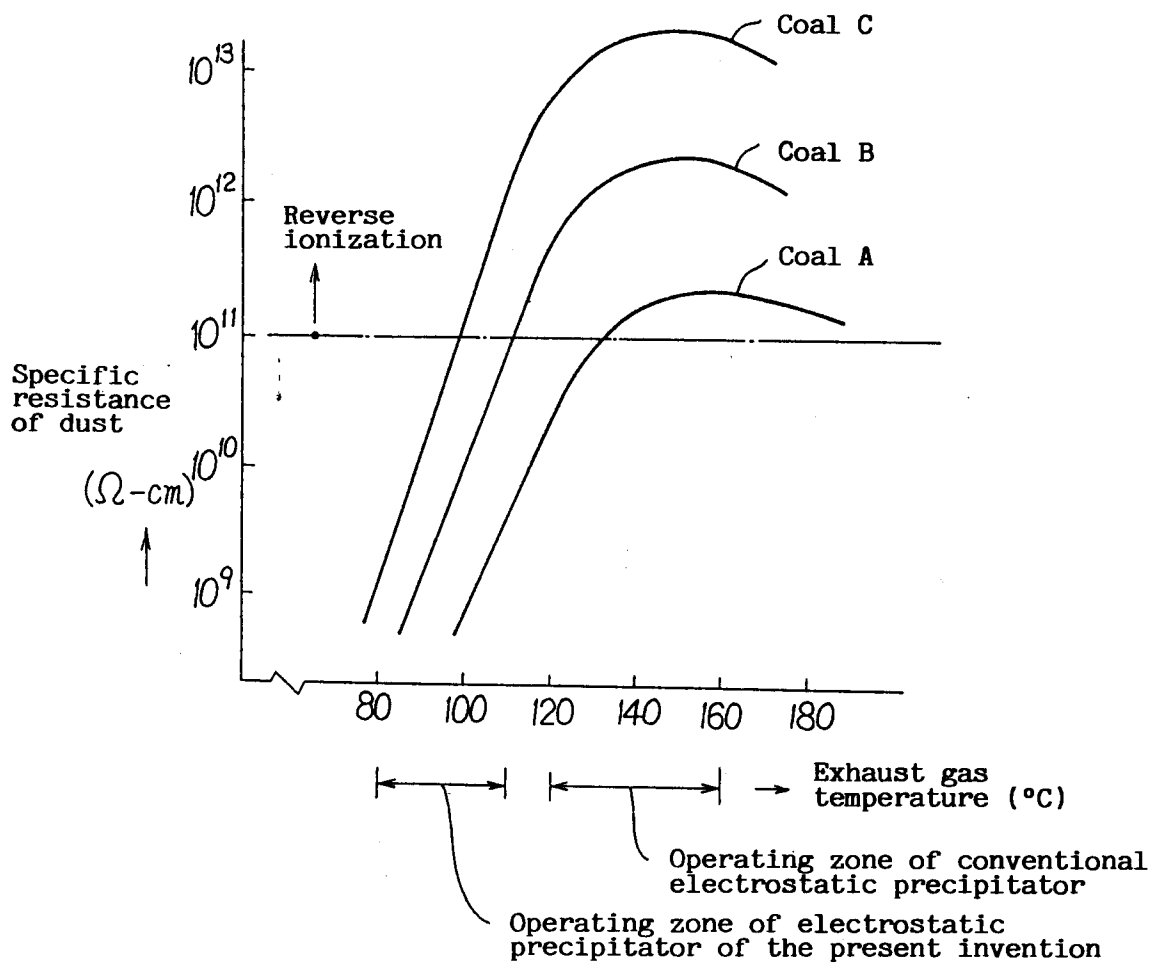


Fig. 7

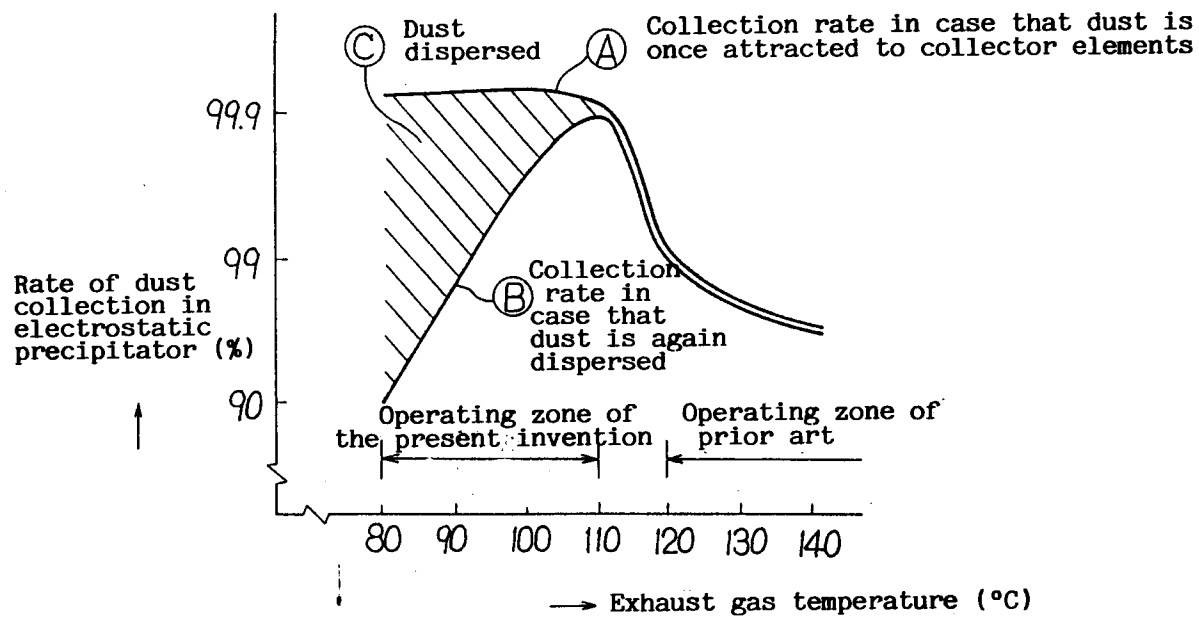


Fig. 8

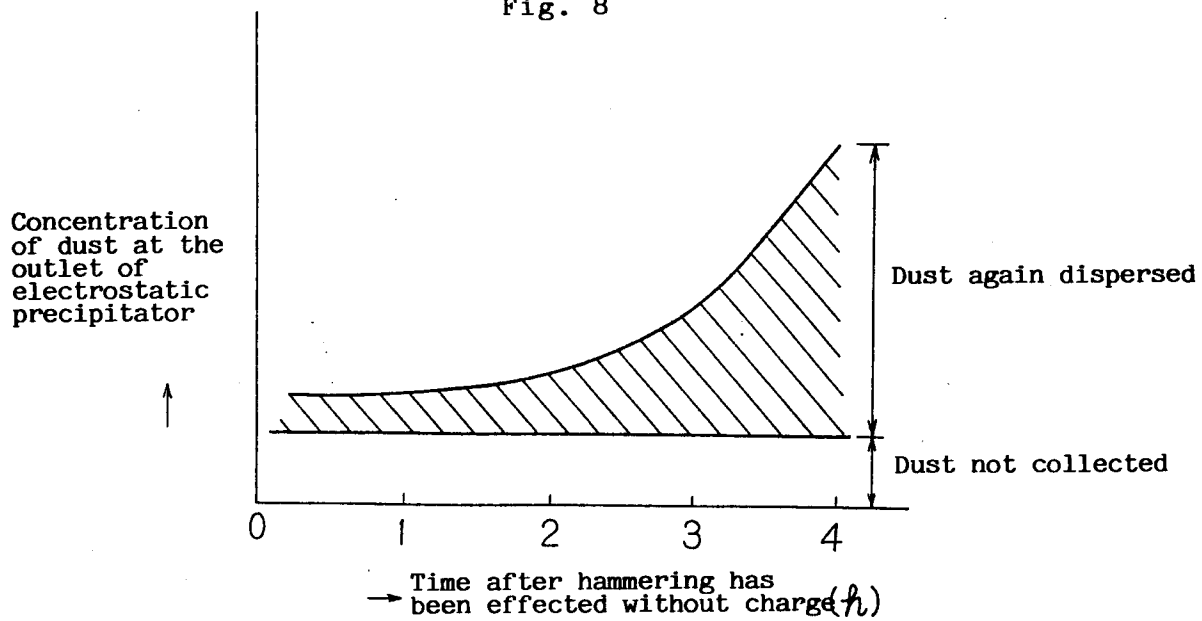


Fig. 9

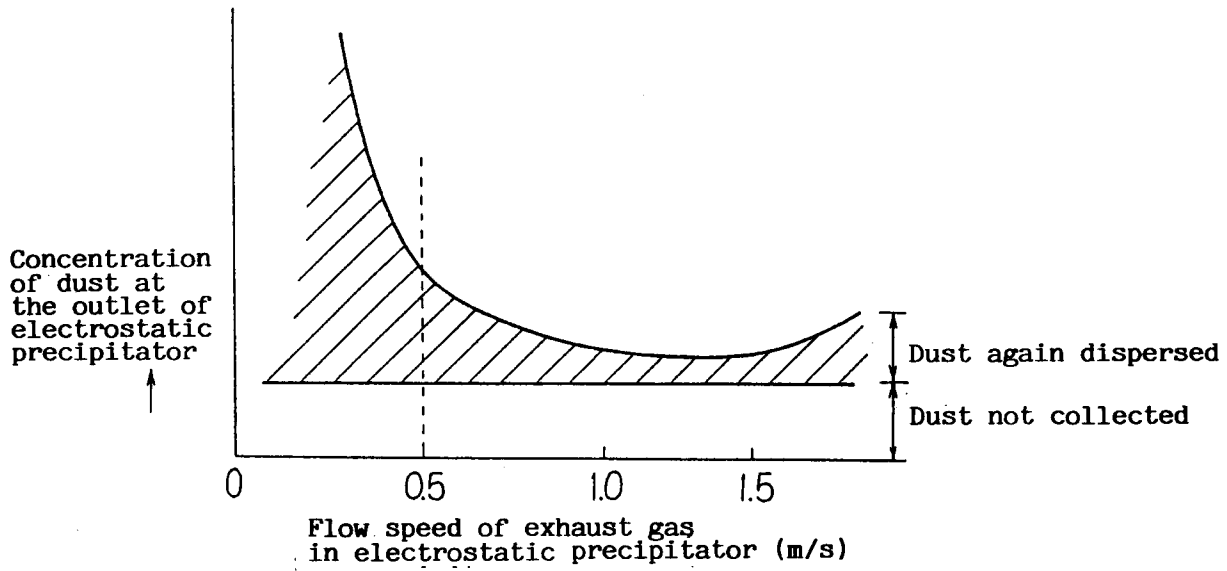
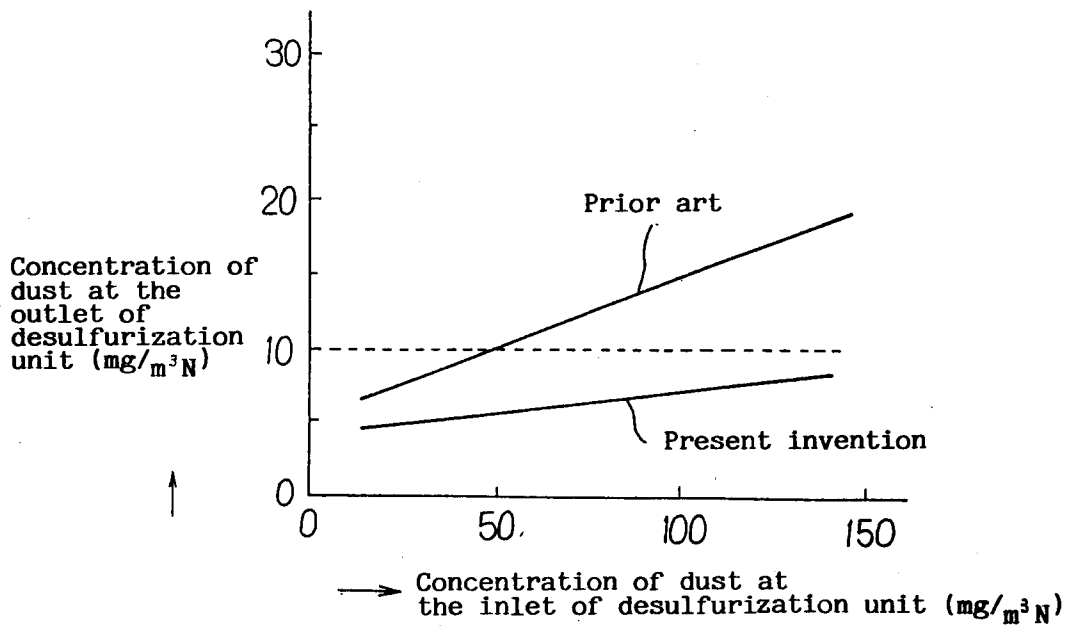


Fig. 10





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 1801

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	FR-A-2 550 610 (LINDE AG) * page 7, line 31 - page 8, line 33; figure 1 * ---	1,2	F23J15/00 B03C3/01 B03C3/74
Y	AU-B-500 466 (METALLGESELLSCHAFT AG) * page 6, line 22 - page 7, line 6 * * page 15 - page 18 * ---	1	
Y	DE-A-2 724 372 (KLÖCKNER-HUMBOLDT-DEUTZ AG) * page 9, line 19 - page 10, line 17; figure * ---	1	
A	US-A-4 559 211 (FELDMAN ET AL) * column 6, line 3 - line 17 * * column 6, line 33 - column 8, line 13; figure 1 * ---	1	
A	FR-A-2 572 952 (KAISER) * page 7, line 34 - page 8, line 27; claims 1,12,14; figures 1,2 * ---	1	
A	FR-A-2 310 794 (METALLGESELLSCHAFT AG) * page 3, line 24 - line 29 * ---	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
Y	US-A-3 988 127 (SCHUMANN) * abstract; figure 1 * ---	2	F23J B03C
A	DE-A-3 604 946 (JAVAD) * page 8, last paragraph - page 9, paragraph 2; figure 4 * ---	1,2	
A	DE-A-3 608 690 (RENNEBECK) * figure * -----	1,2	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 SEPTEMBER 1991	Examiner SHALLOE D.M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	