

[54] GAS PURIFYING APPARATUS

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55/227; 261/92, 118, 88, 84, 90, 89, 115,
261/116, 177; 239/220, 224, 219, 221, 222

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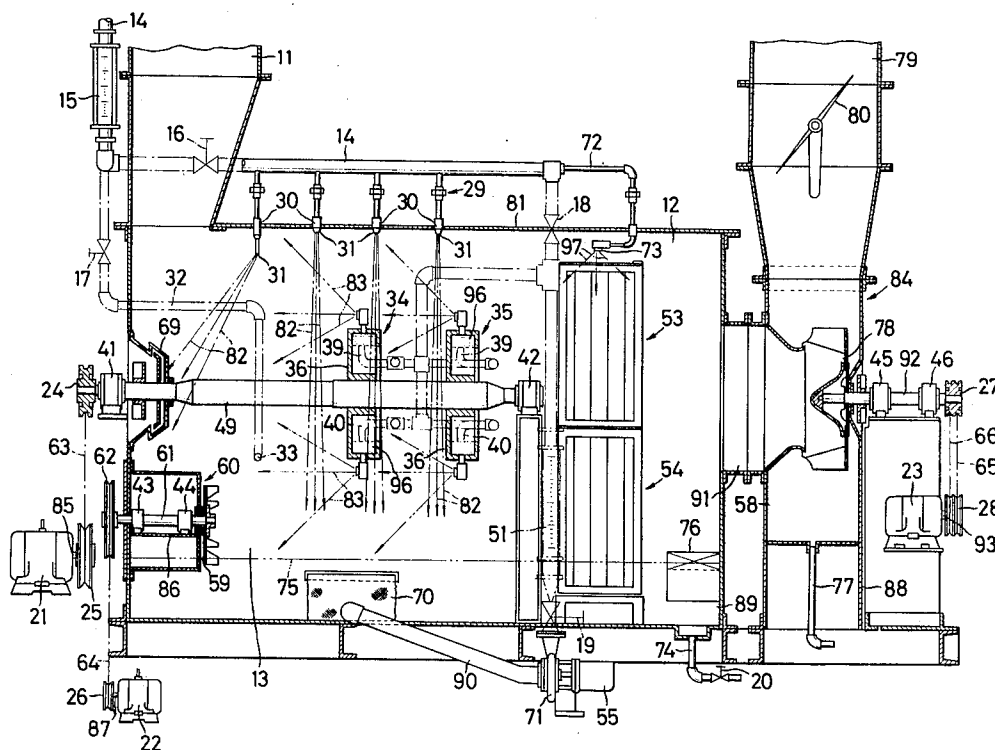
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ABSTRACT

A gas purifying apparatus comprises a casing, a gas feeding opening for feeding said gas to said casing, a gas discharging opening for discharging said gas from said casing, and at least one liquid atomizing apparatus positioned in said casing. The liquid atomizing apparatus includes a rotary liquid-storing means mounted rotatably and having a circular liquid-storing groove on its periphery, nozzle means arranged adjacent to the periphery of said rotary liquid-storing means and communicating with said liquid-storing groove, liquid-feeding means feeding said liquid-storing groove with liquid, and a driving means rotating said rotary liquid-storing means. In this liquid-atomizing apparatus, the smaller the nozzle, the smaller the particle size of the atomized liquid.

9 Claims, 6 Drawing Figures



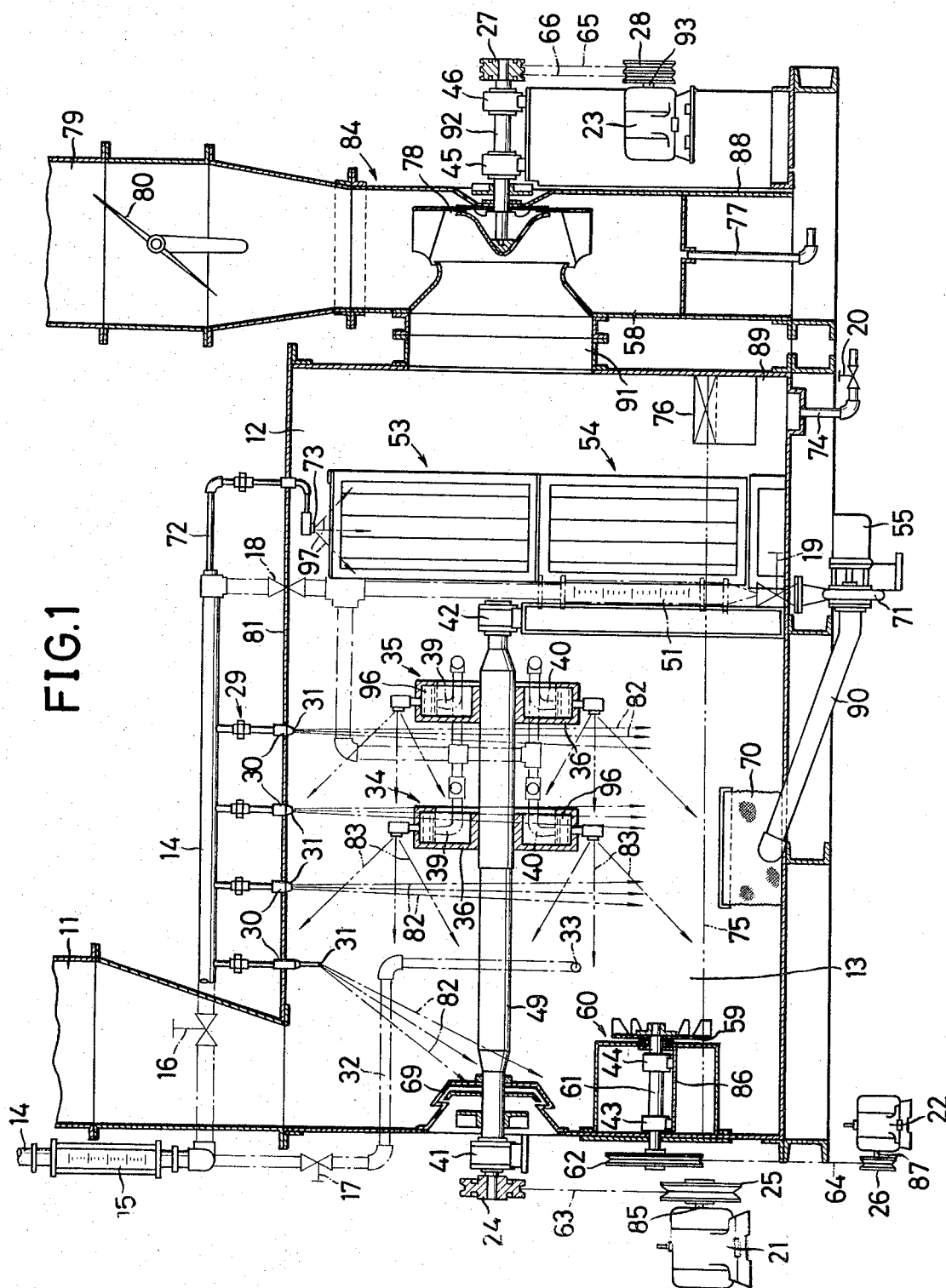


FIG.2

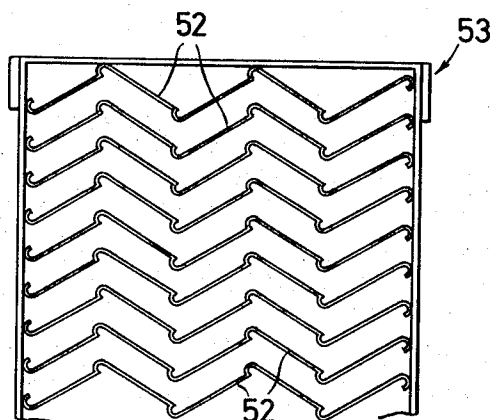


FIG.4

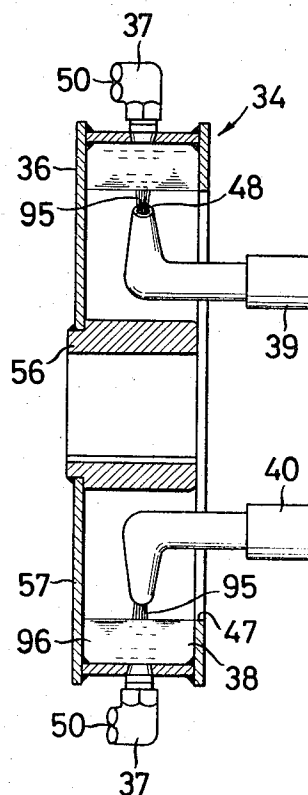


FIG.3

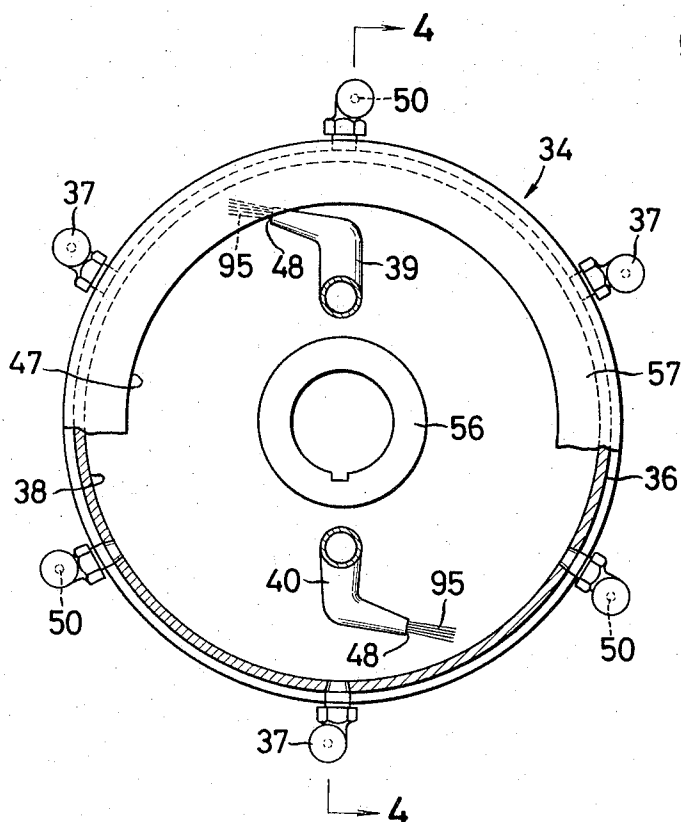


FIG. 6

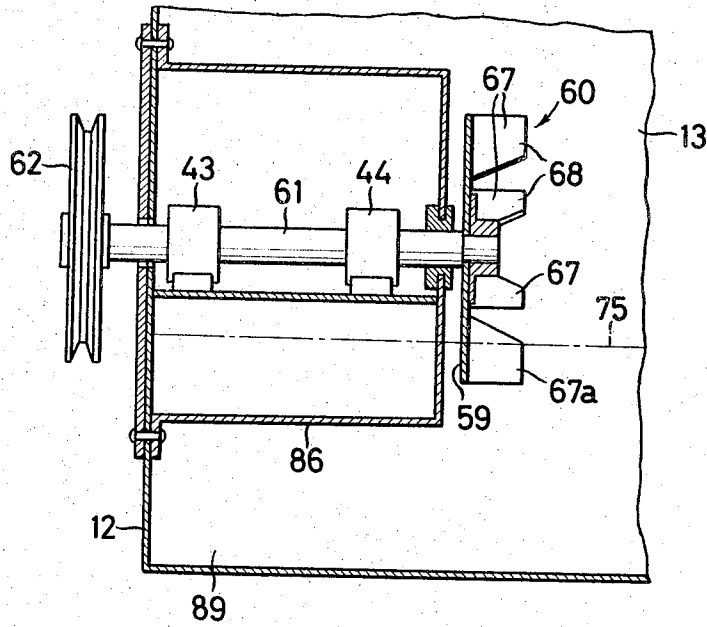
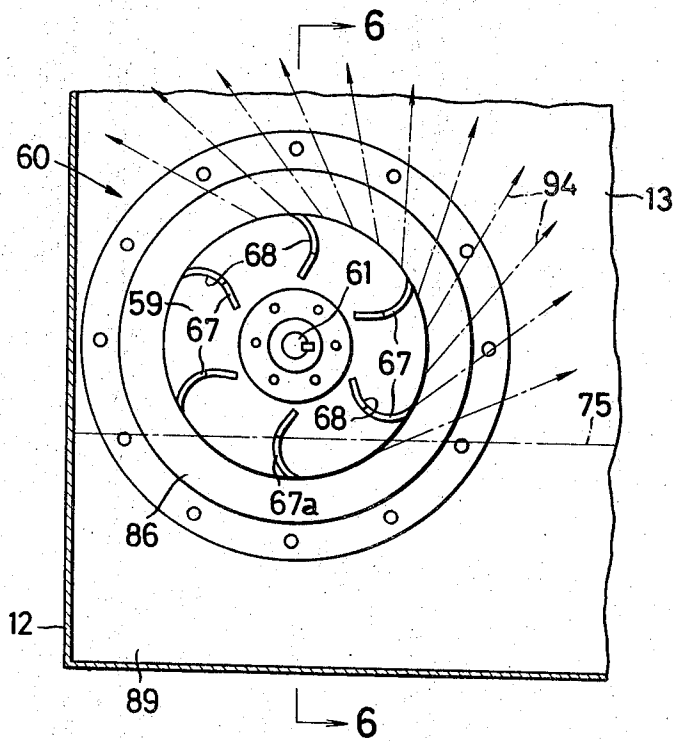


FIG. 5



GAS PURIFYING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a gas purifying apparatus such as a desulfurization and/or dust-removal apparatus.

2. Description of the Prior Art

Industrial pollution is a problem of concern to all. Various kinds of devices for removal of pollution have been developed. However, it is very difficult to remove air pollution caused by exhaust gas occurring combustion of heavy oil or other fuel. Various kinds of exhaust gas purifying devices which are available have large and complex structures, and are very costly, and their dust removal efficiency and desulfurization efficiency are comparatively low. The cause is that a liquid atomizer in an exhaust gas purifying apparatus does not effectively atomize a cleaning liquid.

Consequently, a liquid-atomizing apparatus with a simple structure, capable of effectively atomizing a cleaning liquid is greatly needed.

SUMMARY OF THE INVENTION

Accordingly, one object of this invention is to provide a gas purifying apparatus in which the particle size of the atomized cleaning liquid is small.

Another object of this invention is to provide a gas purifying apparatus in which the liquid is atomized as it is turned.

A further object of this invention is to provide a liquid atomizing apparatus having a simple structure.

According to this invention a gas purifying apparatus comprises a casing, a gas feeding opening for feeding said gas to said casing, a gas discharging opening for discharging said gas from said casing, and at least one liquid atomizing apparatus positioned in said casing, said liquid atomizing apparatus comprises a rotary liquid-storing means mounted rotatably and having a circular liquid-storing groove on its periphery, nozzle means arranged adjacent to the periphery of said rotary liquid storing means and communicating with said liquid-storing groove, liquid feeding means feeding said liquid-storing groove with liquid, and a driving means rotating said rotary liquid-storing means.

The above and other objects, features and advantages of this invention will become apparent from the following detailed description of the illustrated embodiment of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic vertical sectional view of one embodiment of an apparatus to purify gas exhausted from a boiler for air-heating using heavy oil as fuel, which is equipped with a liquid atomizing apparatus in accordance with this invention;

FIG. 2 is a partial schematic plan view of the steam separator shown in FIG. 1;

FIG. 3 is a front view of the liquid-atomizing apparatus, shown in FIG. 1, partially broken away;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a front view of the liquid-scattering device shown in FIG. 1; and

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The whole exhaust gas purifying apparatus is shown in FIG. 1. An exhaust gas from a boiler is fed into a gas purifying chamber 13 in a casing 12 through a gas feeding pipe 11.

Plural, for instance, for sprinkling pipes 30 extending horizontally are disposed on an upper surface 81 of the casing 12. Many sprinkling nozzles 31 are arranged in each sprinkling pipe 30 at regular intervals. The pipe 30 communicates with a main water pipe 14 whereby it forms a sprinkling device 29 together with the nozzles 31.

A rotating shaft 49 is horizontally disposed in the center portion of the gas purifying chamber 13, which is mounted rotatably in bearings 41 and 42. Each rotating reservoir or rotating drum 36 of a pair of liquid atomizing apparatuses 34 and 35 is fixed to the shaft 49. The drum 36 comprises a cylindrical portion 56, a flat drum portion 57 fixed on the cylindrical portion 56 and many, for instance, six nozzles 37 disposed on the periphery of the drum portion 57 at nearly regular intervals.

A circular-groove reservoir 38 is formed on the periphery of the drum portion 57, within which an opening 47 for water supply is formed on one side of the drum portion 57. An outer diameter of the opening 47 corresponds with an inner diameter of the groove reservoir 38 which is preferably one-half to fourteen-fifteenths, or more preferably three-fourths to seven-eighths of an outer diameter of the groove reservoir 38. Too large an outer diameter of the opening 47 results in too little water stored in the groove reservoir 38 in comparison with the rotating drum 36 and so causes a danger of intermittent ejection of atomized liquid, while too small an outer diameter of the opening 47 prevents high speed rotation of the rotating drum 36 because of too much stored water.

A nozzle-opening 50 with a diameter of, for instance, about 6mm in the nozzle 37 is facing a direction opposite the flow of the exhaust gas in the axial direction of the rotating drum 36.

A pair of water supplying pipes 39 and 40 opposed to each other are inserted into the opening 47, the head portions of which are inclined to the periphery of the rotating drum 36 as shown in FIG. 3, whereby cleaning liquid, for instance, water or caustic soda aqueous solution 95 is ejected in the rotational direction of the rotating drum 36 or in the counterclockwise direction in FIG. 3 from water supplying openings 48 of the pipes 39 and 40. One end of the rotating shaft 49 extends out of the casing 12 through a leak-proof element 69, on which a pulley 24 is fixed. A belt 63 is wound around the pulley 24 and a pulley 25 fixed on a shaft 85 of a motor 21.

A liquid-scattering device 60 is arranged under a front portion of the gas purifying chamber 13. The liquid-scattering device 60 is provided with an auxiliary casing 86 in which a rotating shaft 61 is mounted rotatably in bearings 43 and 44. A pulley 62 is fixed at one end of the shaft 61, and a rotary vane-disk 59 is fixed at another end of the shaft 61. A belt 64 is wound around the pulley 62 and a pulley 26 fixed at a shaft 87 of a motor 22. Many, for instance, six vanes 67 for liquid-scooping are almost radially formed on the rotary vane-disk 59 and have a semi-cylindrically curved

groove 68 for liquid-storing as a rotary plow-blade of a cultivator.

The whole lower portion of the gas purifying chamber 13 forms a tank 89 for liquid-storing in the rear portion of which an opening 76 for overflowing is disposed, and so the tank 89 always stores liquid to a level of a water-line 75 which is positioned midway on or a little above the lowest vane 67a of the rotary vane-disk 59. In other words, about half the lowest vane 67a is submerged. Under the water-line 75 of the tank 89, a strainer 70 is positioned in the liquid, which communicates with a pump 71 driven by a motor 55 through a liquid-conducting pipe 90.

In the rear portion of the gas purifying chamber 13, a pair of steam separators 53 and 54 are arranged lengthwise, in which many meandering plates 52 are lengthwise disposed at near regular intervals. A cleaning nozzle 73 disposed at the top of a cleaning-liquid supplying pipe 72 communicating with the main liquid pipe 14 is arranged above the steam separator 53. When the cleaning of the meandering plates 52 is required, a cleaning liquid 97 is ejected from the nozzle 73.

An opening for water-replenishing 33 facing to the gas purifying chamber 13 is arranged at the top of a water replenishing pipe 32 communicating with the main liquid pipe 14. An amount of water replenished to the tank 89 is adjusted by a cock 17 disposed at the pipe 32.

Flow meters 15 and 51 are disposed on the main liquid pipe 14, the former meter 15 indicates an amount of water supplied from external and the latter meter 51 an amount of liquid supplied by the pump 71. Moreover, cocks 16, 18 and 19 are disposed on the main liquid pipe 14. The cocks 16 and 18 control the amount of water or liquid supplied to the liquid supplying opening 48 and the cleaning nozzles 73, and the cock 19 adjusts an amount of liquid supplied to the liquid supplying opening 48 by the pump 71.

A discharging pipe 74 communicating with the tank 89 is disposed under the opening for overflowing 76. A discharging cock 20 is disposed on the pipe 74.

A blowing chamber 58 formed by cylindrical casing 88. A blowing means 84 is positioned in a rear portion of the gas purifying chamber 13. The chamber 58 communicates with the gas purifying chamber 13 through a communicating pipe 91 with a larger diameter. In the blowing chamber 58, an impeller 78 is fixed on one end of a rotary shaft 92 which is mounted rotatably in bearings 45 and 46. A discharging pipe 79 for cleaned gas provided with a damper 80 for adjusting of flow is disposed above the impeller 78, and a drain pipe 77 for the blower is disposed under the impeller.

A pulley 27 is fixed on another end of the rotary shaft 92. Belts 65 and 66 are wound around the pulley 27 and a pulley 28 fixed on a shaft 93 of a motor 23.

In operation, an exhaust gas from the boiler which generates a steam for air heating by the combustion of the heavy oil, is led into the gas-feeding pipe 11 of the exhaust gas purifying apparatus through which the dust particles of the exhaust gas is fed into the gas purifying chamber 13. In the gas purifying chamber 13, the exhaust gas are removed and the exhaust gas is desulfurized by three kinds of exhaust gas purifying means, that is to say, the sprinkling device 29, the liquid atomizing apparatuses 34 and 35 and the liquid scattering device 60.

The operation is now described in detail.

In the liquid scattering device 60 disposed under the pipe 11, the motor 22 drives the rotary shaft 61 through the pulley 27, the belt 64 and the pulley 62. The rotary vane-disk 59 rotates at a rate such as 500 to 1,000 r.p.m. and many vanes 67 move anticlockwise in a circle as shown in FIG. 5. About half of the vane 67a in the lowest position is submerged under the water line 75. The vane 67a scoops a little water with the rising by its groove 68.

A little water in the groove 68 is scattered radially in the form of atomized liquid 94 by centrifugal force as shown in FIG. 5, and so the atomized water 94 is extremely fine. Moreover, since the vane 67 moves in a circle, the atomized water is turned and scattered across the whole front end portion of the gas purifying chamber 13. Consequently, the dust particles of the exhaust gas is effectively removed and the exhaust gas is effectively desulfurized by the scattered water or caustic soder aqueous solution.

In the sprinkling device 29, a sprinkling liquid 82 of 1 to 2 atm. indicated by a guage is ejected from the nozzle 31 through the sprinkling pipe 30, is scattered across the whole front portion, and removes the dust particles of the exhaust gas and desulfurizes the exhaust gas. Because the particle of the sprinkling liquid has a comparatively large diameter, it can effectively catch a larger dust particle.

In the liquid atomizing apparatuses 34 and 35, the rotating shaft 49 is rotated by the motor 21 through the pulley 25, the belt 63 and the pulley 24 to rotate the rotating drum 36 at the rate of 1,200 - 1,800 r.p.m. The liquid, which is ejected from the liquid supplying opening 48 of the liquid supplying pipes 39 and 40, is stored as a stored water 96 in the groove-reservoir 38 in a circular form by centrifugal force. The liquid supplied from the liquid supplying opening 48 in excess of a capacity of the groove 38 flows out from the opening 47 to the tank 89. An ejecting direction of the liquid 95 ejected from the liquid supplying opening 48 is nearly equal to the rotational direction of the drum 36 as clearly shown in FIG. 3. And so, as the ejected liquid 95 has a component of force in the rotational direction of the drum 36, the rotation of the drum 36 is not entirely or scarcely prevented by the liquid supplied from the liquid supplying opening 48, but on the contrary the rotation of the drum 36 may be promoted by it.

As the drum 36 rotates at a high rate of 1,200 - 1,800 r.p.m. with the stored liquid 96 in the groove 38 as shown in FIG. 4, extremely great centrifugal force occurs in the stored liquid 96, whereby the stored liquid 96 is radially ejected forward from the opening 50 of the nozzle 37. As the opening 50 moves in a circle at a high rate, the ejected and atomized liquid 83 is radially scattered from the opening 50 as it is turned. Since the scattered and atomized liquid 83 is ejected in the axial direction of the drum 36 and the nozzle opening 50 moves in a circle at a high rate, the atomized water 83 is scattered as it is turned, extending the whole center portion of the gas purifying chamber 13 in the form of an extremely fine particle, whereby it can very effectively remove the dust particles and desulfurize the exhaust gas.

The exhaust gas is dehydrated as it flows through the group of the meandering plates 52 of the steam separators 53 and 54. And the purified exhaust gas or the clean gas is led from the gas purifying chamber 13 into

the blowing chamber 58 of the blower-means 84 through the communicating pipe 91. The gas is drawn into the blowing-chamber 58 by suction of the impeller 78 to which the rotation of the motor 23 is transmitted through the pulley 28, the belts 65 and 66, the pulley 27 and the rotary shaft 92.

The cleaned gas led into the blowing chamber 58 is conducted into the discharging pipe 79 for the cleaned gas by the impeller 78 through which it is discharged outward from a chimney. The discharging can be manually or automatically adjusted by the damper 80 for adjusting of flow.

The water scattered by the sprinkling device 29, the liquid atomizing apparatuses 34 and 35 and the liquid scattering device 60 falls down into the liquid storing tank 89 and moreover some water is replenished from the liquid-replenishing opening 33 into the tank 89 as occasion demands, so that the water or the liquid in the tank 89 tends gradually to increase in volume. However, the water line 75 is always positioned at a constant level in the tank 89 because the liquid purified by the strainer 70 and conducted by the conducting pipe 90 is fed back upwards through the cock 19 by the pump 71, and the liquid over the water line 75 is discharged outwards from the overflowing opening 76.

In the above embodiment, when water is employed as the cleaning liquid, a desulfurizing efficiency amounts to about 50 to 60 percent, and when caustic soda aqueous solution of PH 12 is employed as cleaning liquid, the desulfurizing efficiency amounts to about 95 percent or more.

Although the preferred embodiment of this invention has been described in detail with reference to the accompanying drawings, it is to be understood that the invention is not limited to the details shown and described, and that various changes and modifications can be made.

What is claimed is:

1. A gas purifying apparatus comprising a casing, a gas feeding opening for feeding said gas to said casing, a gas discharging opening for discharging said gas from said casing, and at least one liquid atomizing apparatus positioned in said casing, said liquid atomizing apparatus including a liquid storing means, means rotatably mounting said storing means for rotation about an axis parallel to the gas flow, a liquid storing groove defined by said storing means, nozzle means positioned on the periphery of said storing means and communicating with said groove, outlets of said nozzle means facing in a direction substantially parallel to the axis of rotation of said storing means and opposite to the direction of gas flow, feeding means for feeding liquid to said groove, and drive means for rotating said storing means, said feeding means injecting said liquid such that it has a component of force in the rotational direction of the rotating storing means whereby the injection

of said liquid contributes to the rotation of said storing means, whereby the atomized liquid ejected spirally by centrifugal force from said nozzle means of said liquid atomizing apparatus is adapted to remove dust and desulfurize the gas passing through said casing.

2. A gas purifying apparatus according to claim 1, wherein said storing means comprises a rotating drum with an opening defined centrally of the drum communicating with said groove, and defining the height of the groove, said feeding means comprising a liquid supplying pipe extending to said opening and operating to supply liquid sufficient to overfill the groove, whereby said feeding means feeds extremely easily said groove with liquid and excess water in said groove flows outwardly through said opening to maintain a constant level of liquid in said groove.

3. A gas purifying apparatus according to claim 1 including a liquid sprinkling nozzle positioned to sprinkle gas entering said casing whereby the liquid sprinkled by said sprinkling nozzle removes mainly dust of larger particle size from the gas to be purified.

4. A gas purifying apparatus according to claim 1, wherein at least one liquid scattering device is arranged in said casing, and said liquid scattering device comprises rotary vane means provided with vanes for liquid-scooping having a groove for liquid-storing, driving means rotating said rotary vanes, and a tank for liquid-storing, whereby at least one part of said vanes for liquid-scooping dips into and out of a liquid line of said tank for liquid-storing on the rotating of said rotary vanes.

5. A gas purifying apparatus according to claim 4, wherein means for controlling said liquid line is disposed in said casing always to maintain said liquid line at the predetermined level, whereby the liquid scattering of the vanes for liquid scooping in said scattering device is always maintained in the desired condition.

6. A gas purifying apparatus according to claim 5 wherein said means for controlling said liquid line comprises an opening defined by said casing whereby excess liquid overflows said casing and means for supplying liquid to said casing to maintain said liquid at said level.

7. A gas purifying apparatus according to claim 1 wherein at least one steam separator is positioned for contact with said gas after contact of the gas with said liquid atomizing apparatus.

8. A gas purifying apparatus according to claim 7 wherein said steam separator includes a plurality of meandering plates disposed substantially vertically and in spaced apart relationship.

9. A gas purifying apparatus according to claim 8 including at least one blower-means to forcibly ventilate said casing.

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