April 16, 1968 S. P. KINNEY 3,378,240

FURNACE GAS CLEANING AND COOLING APPARATUS

Filed Aug. 1, 1966 3 Sheets-Sheet 1

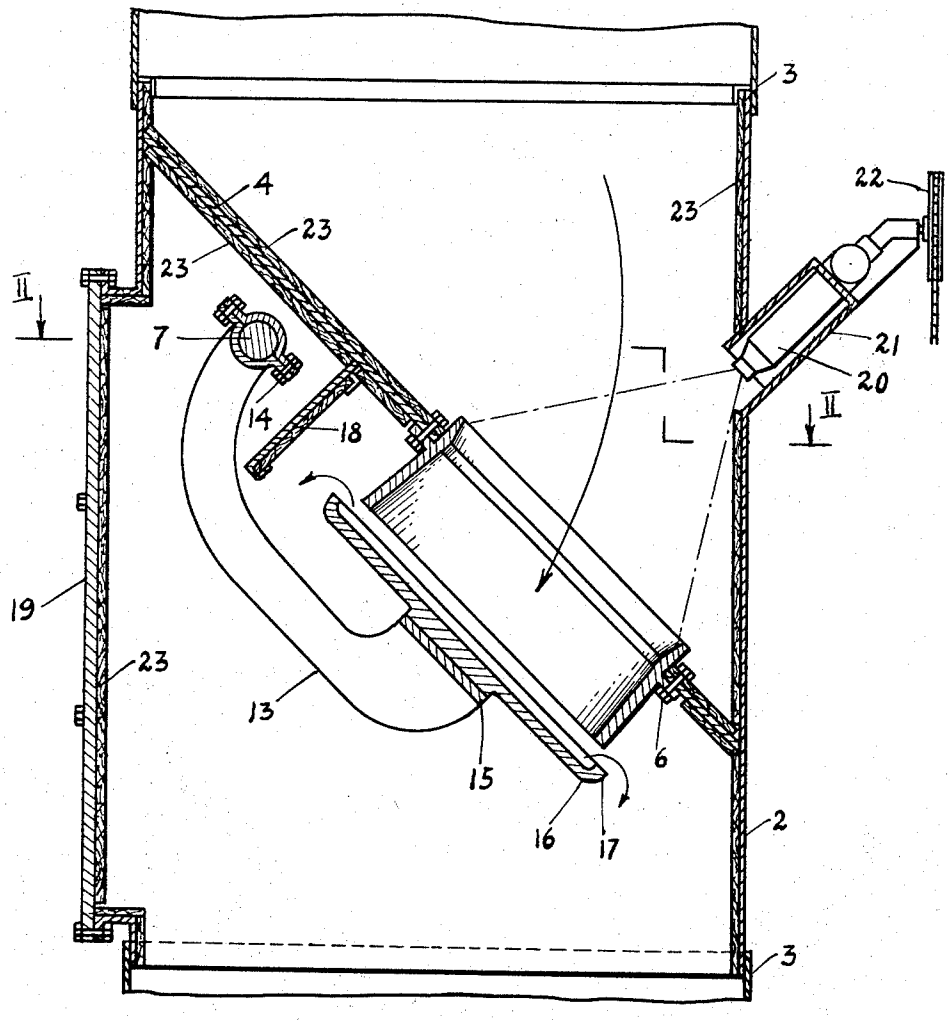


Fig. 1.

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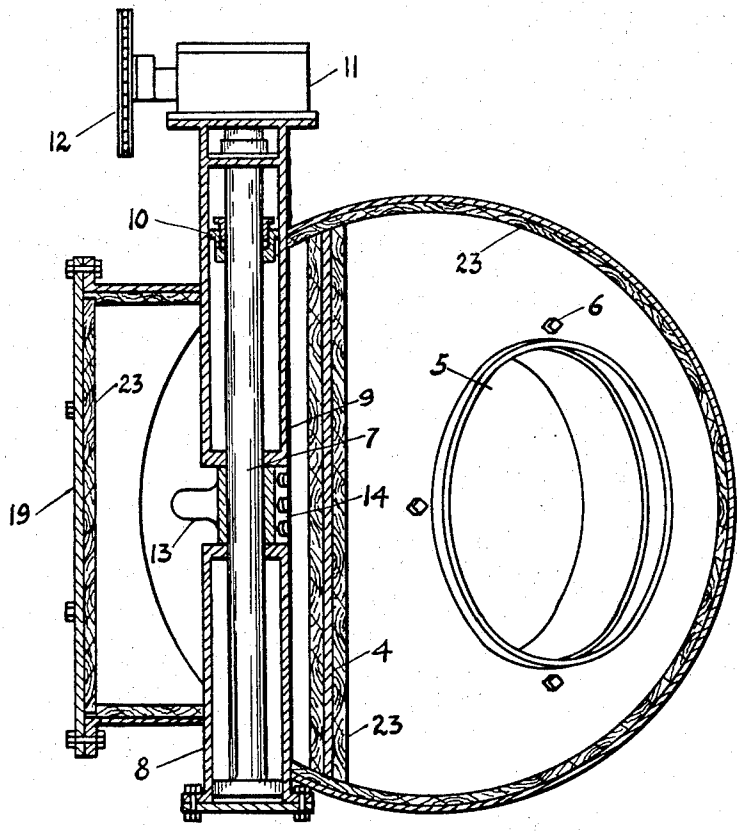


Fig. 2.

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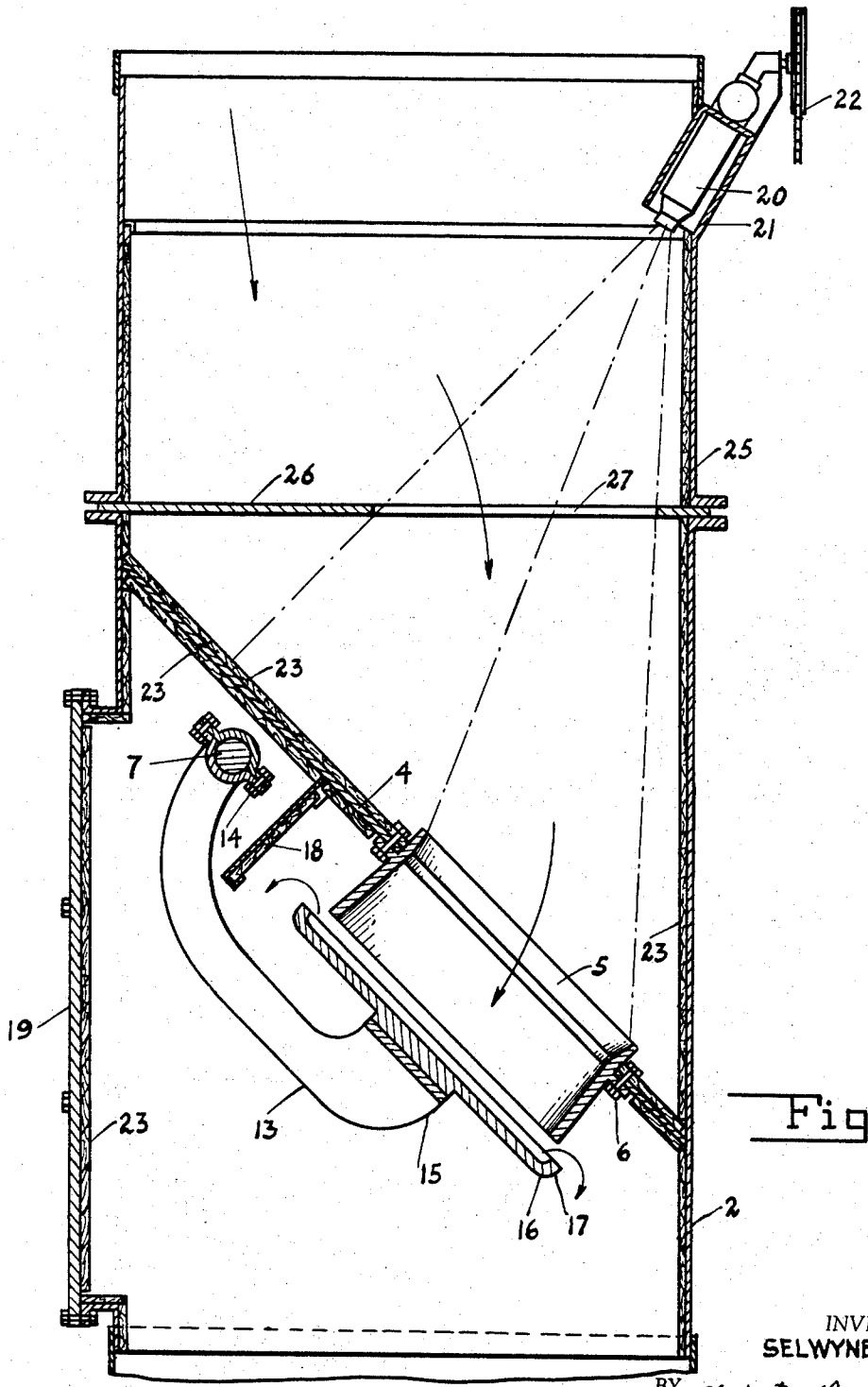


Fig. 3.

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FURNACE GAS CLEANING AND COOLING APPARATUS

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7 Claims. (Cl. 261—115)

This invention is for a hot gas cleaning and cooling apparatus of the general type disclosed in my Patent No. 3,113,168, granted Dec. 3, 1963.

The present invention, like that of Patent No. 3,113,168, is especially designed for use in cleaning and cooling blast furnace gas and will be so described in this specification.

In the aforesaid patent there is disclosed a duct through which blast furnace gases, after passing from the furnace through a dust collector that removes heavy dust, is carried to a gas washing tower up which the gases pass in counter current to downflowing streams of water. In this duct there is a venturi through which the gases flow with a nozzle upstream of the venturi directing a water spray into the venturi. There is an adjustable cap at the discharge side of the venturi for regulating the pressure drop across the venturi according to variations in the rate of gas production by the furnace. The importance of this is explained in said patent because blast furnaces may be operated at different rates, and a venturi type washer that will effectively clean the gas at the maximum rate of gas combustion will be less efficient at lower rates, whereas by having a cap adjustable toward and away from the discharge end of the venturi, the pressure drop across the venturi may be adjusted to the rate of gas production and the back pressure that may be imposed on the furnace.

In order to provide a venturi of adequate diameter and to provide for the removal of the cap from out of the gas stream when it is not required, it was necessary to substantially enlarge the diameter of the duct at the level of the venturi. Since these ducts are usually of the order of eight feet or more in diameter, this was a costly installation. Moreover, the water spray nozzle that is positioned upstream from the venturi to spray water into the venturi necessarily projected radially into the duct a distance of several feet, and to be protected from the abrasion of dust particles required heavy armor from special abrasion-resistant steel so that the nozzle alone for such an installation was heavy and costly, a usual cost being in the area of $3,000.00.

According to the present invention, the venturi is positioned in a plane diagonal to the axis of the duct, eliminating the need for increasing the diameter of the duct or gas main in which it is located. This construction enables also the adjustable cap to be moved clear of the discharge of gas through the venturi and permits the nozzle to be set against the exterior of the duct with its axis inclined to discharge into the oppositely-inclined venturi instead of being centrally positioned inside the duct with its axis on the vertical axis of the unit, thus eliminating any need for armor covering over the nozzle and making it more accessible, as well as very much less costly.

In addition, a preferred embodiment of the invention utilizes an orifice plate between the venturi and the nozzle which affords some protection to the venturi and which may be economically replaced and provides for water from one nozzle being effectively used both in the orifice plate and the venturi. The orifice is of such size that at the maximum rate of gas flow, the pressure drop across the orifice does not exceed, and is desirably less than that across the venturi, and as the rate of gas flow reduces, the pressure drop across the orifice decreases, but by manipulation of the adjustable cap element at the discharge side of the venturi, the pressure drop through the venturi is increased and the total pressure drop through the cleaner combining both elements can be regulated to provide all the back pressure the furnace will accept, and thus use the water spray most effectively.

The invention therefore has for its objects to provide a venturi type of gas washer of unique construction which avoids increasing the diameter of the duct to accommodate the venturi, and an improved arrangement for the cap which throttles the gas flow through the venturi with a substantially more economical nozzle construction. A further object is to provide a new combination in a gas washer of an orifice plate followed by a venturi with a single spray nozzle serving both elements.

These and other objects and advantages are secured by this invention as will be fully understood by those skilled in the art from the following description in conjunction with the accompanying drawings wherein:

FIG. 1 is a vertical section through a gas washer embodying the invention in its simplest form, and designed especially for use when the gas pressure is inadequate to justify the combined venturi and orifice plate;

FIG. 2 is a transverse horizontal section in substantially the plane of line II—II of FIG. 1; and

FIG. 3 is a view similar to FIG. 1 of the preferred embodiment using a combined venturi and orifice plate and especially adapted for use where higher gas pressures may exist.

In the drawings, like reference numerals refer to corresponding parts throughout this specification.

In the drawing, **2** designates a cylindrical shell preferably of about the same diameter as the duct sections **3** into which it is to be connected, the diameter being just under the diameter of the duct sections so as to telescope into these sections. Inclined across the interior of the duct here is a supporting metal plate **4** that fits into the duct with its edges welded into the interior of the shell. Set eccentrically into the plate **4** is a venturi **5** having a peripheral flange **6** bearing against the under side of the plate **4** and bolted or otherwise secured thereto. The top edge of the venturi preferably extends above the plane of the plate **4** while most of the body of the venturi is below this plane. The venturi is desirably so positioned that the tops of the opening through it are entirely to one side of the vertical axis of the shell.

There is a transverse shaft **7** supported in the shell on the opposite side of the vertical axis of the shell from the venturi, close under the supporting plate **4** with its axis at a level above the top of the venturi. One end of the shaft is supported in a sealed mounting or bearing structure **8**, and the other end extends through a sleeve **9** with an internal gland **10** to the exterior of the shell. At the outer end of the sleeve **9** there is supported a gear box **11** of a well-known construction containing a worm wheel (not shown) on the shaft **7** with a worm gear (not shown) meshing therewith, this gear having an operating means, such as a sprocket wheel and chain **12** by which the shaft may be rotated from ground level or from a catwalk near the base of the cleaner, such a walk being indicated in broken lines.

There is an arm **13** clamped at **14** to the center of the shaft which curves downwardly and radially inward with an upturned terminal **15** that, in the position shown in the drawings, is centered on the center line of the venturi. Attached to this terminal is a cap **16** of slightly larger diameter than the venturi, and which has an upturned peripheral flange **17**.

By rotating the shaft **7** in a clockwise direction the cap **16** may be swung from a position directly confronting the end of the venturi to a position where it is generally vertical and remote from the venturi. There is a transverse depending baffle **18** on the under side of the sup-

porting plate 4 between the venturi and the shaft 7, and which extends below the bottom level of the nearest edge portion of the cap 16 when the cap is in the position shown in the drawings, that is, in a plane normal to the axis of the venturi throat. This protects the shaft from the impingement of gas, dust or dirt-laden water that will spray upwardly and outwardly when the cap is in this position. Since the venturi is offset in the support toward the side on which the nozzle is located, the nozzle is steeply inclined toward the vertical, and the spray follows closely the direction of gas flow instead of being projected across the stream.

The side of the shell 2 opposite the venturi has an access opening therethrough with a removable closure plate 19 that normally seals the opening. By removal of this cover plate, access may be had to the venturi to inspect it and replace it when necessary. The shell itself constitutes a section of the gas main.

The water spray nozzle 20 is positioned on the side of the shell 2 opposite the side on which the shaft 7 is located and at a level above the level of the shaft. It is located in FIG. 1 on the projected axis of the venturi throat to discharge a divergent spray of water that is substantially extensive with the area of the open upper end of the venturi. The nozzle, which is of the self-cleaning type such as disclosed in Patent No. 2,992,777, granted July 18, 1961, is housed in a gas-tight enclosure 21 with an operating means 22 at the end of the enclosure.

The gas cleaner is lined throughout with cypress wood 23, such linings being commonly used in the art.

With this arrangement the nozzle is effectively located on the upstream side of the venturi and directs its spray into the venturi, but the nozzle itself is entirely protected from the abrasive action of the dust-laden high-velocity gas flow. The venturi cap carried at one end of an arm 13 secured to an operating shaft 7 can be easily adjusted while the shaft that carries the arm is well protected from gas and water which has been used to clean the gas. With the venturi carried by an inclined supporting plate, the cap need travel 45° or less from the point of maximum approach to the venturi to a nearly vertical position instead of nearly 90°, as would be the case if the venturi were supported in a horizontal position, and the venturi, cap and supporting arm are all readily accessible by removal of the cover plate 19.

The eccentric positioning of the venturi with respect to the vertical axis of the shell of course contributes to the positioning of the nozzle at the side wall of the shell and to providing adequate clearance for the shaft 7 and the arm and venturi cap arrangement.

In FIG. 3 the venturi, shaft 7, arm 13 and cap 16 are arranged as shown in FIG. 1 and corresponding reference numerals have been used. However, in this construction the shell 2 has an additional section 25 at its upper end and a horizontal orifice plate 26 is interposed between the sections 2 and 25. The plate has an orifice 27 therein eccentric to the vertical axis of the cleaner and located above the venturi 5.

The spray nozzle 20 is located on the side of the shell, on the extension section 25, and is angled so that the area of its spray will cover the orifice 27 with a large portion thereof passing through the orifice directly into the throat of the venturi, as indicated by the lines on the drawing indicating the spray pattern.

With this arrangement, the size of the orifice 27 is selected to produce a pressure drop no greater than the venturi at maximum gas flow, and as the gas flow decreases, the cap is moved closer to the discharge end of the venturi to increase the pressure drop through the venturi. In the drawings, the parts are proportioned to a gas main 3 of approximately eight feet O.D. and a gas flow in both FIGS. 1 and 3 of 100,000 c.f.m. The orifice size is selected to provide a nominal pressure drop of about 20 inches of water, and there is a pressure loss equal to about 10 inches of water through the venturi with the cap moved to a full open position most remote from the venturi. The operation of the cleaner is based on a constant discharge of water at the rate of six gallons per thousand cubic feet of gas.

The arrangement shown in FIG. 3 provides a two-stage washing of the gas, first through an orifice, and then in a venturi, with a single water spray upstream of both of them, and is to be preferred where higher gas volumes are encountered.

The invention provides a substantial cost advantage both from the disposition of the venturi eccentrically located in an inclined supporting plate, with the spray nozzle on the side of the shell but upstream of the venturi, and in FIG. 3 there is the added advantage of providing two stages of cleaning with a single water spray nozzle. Other advantages and benefits will be apparent to those skilled in the art. It will be further understood that various changes and modifications may be made in the construction within the contemplation of my invention and under the scope of the following claims.

I claim:

1. Gas cleaning apparatus comprising a gas main having a section in the form of a cylindrical shell through which flows the gas to be cleaned, a venturi support in said section diagonal to the longitudinal axis thereof, a venturi mounted in said support with the axis of its throat normal to the plane of the support, the support so blocking the flow of gas around the venturi as to direct its flow through the venturi, and a water nozzle within a gas-tight enclosure on the exterior of the section upstream of the venturi angled to direct a spray of water through an opening in the section into the full area of the venturi.

2. Gas cleaning apparatus as defined in claim 1 in which the venturi is eccentrically positioned with respect to the axis of the section, being positioned off-center toward the side on which the spray nozzle is located.

3. Gas cleaning apparatus as defined in claim 1 in which there is an orifice plate with an orifice therethrough extending across the tubular section in a plane transverse to the longitudinal axis of the section, the orifice being positioned over the venturi, the nozzle being arranged to direct its spray over the area of the orifice and through the orifice to the venturi.

4. Gas cleaning apparatus as defined in claim 1 in which there is an orifice plate with an orifice therethrough extending across the tubular section in a plane transverse to the longitudinal axis of the section, the orifice being positioned over the venturi, the nozzle being arranged to direct its spray over the area of the orifice and through the orifice to the venturi, the venturi and the orifice both being eccentric with respect to the longitudinal axis of the sections, being positioned off-center toward the side of the section on which the nozzle is located.

5. Gas cleaning apparatus as defined in claim 1 in which the venturi is eccentrically located on the support with its center being closest to the side of the section on which the spray nozzle is mounted, a cap element under the support, an arm on which the cap element is mounted, a rock shaft to which the arm is secured, said rock shaft extending transversely to the section and being located between the venturi and the side of the shell opposite the side on which the nozzle is mounted, said shaft and arm supporting the cap for arcuate movement toward and away from the lower end of the venturi.

6. A gas cleaner as defined in claim 5 wherein the rock shaft is at a level above the level of the lower end of the venturi.

7. A gas cleaner as defined in claim 5 wherein the rock shaft is at a level above the level of the lower end of the venturi the arm extending downwardly from the shaft, then radially toward the venturi and having an upwardly-turned terminal portion to which the cap is secured, and a baffle on the support extending downwardly therefrom toward the arm between the venturi and the shaft for

shielding the shaft from the flow of gas and water through the venturi.

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