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Weinman et al.

[11] B **3,924,605**

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[54] **EMISSION CONTROL METHOD AND APPARATUS FOR SMOKESTACKS OR OTHER WASTE GAS DISCHARGE STACKS**

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[52] **U.S. Cl.** .... **126/307 A;** 55/213; 98/68; 110/162; 137/487.5; 431/20

[51] **Int. Cl.²** **F23J 11/12**

[58] **Field of Search** .... 98/68, 72, 74, 73, 77, 98/79, 82, 85, 119; 110/162; 126/307 A; 137/486, 487.5; 431/20; 55/212, 213, DIG. 34, DIG. 41

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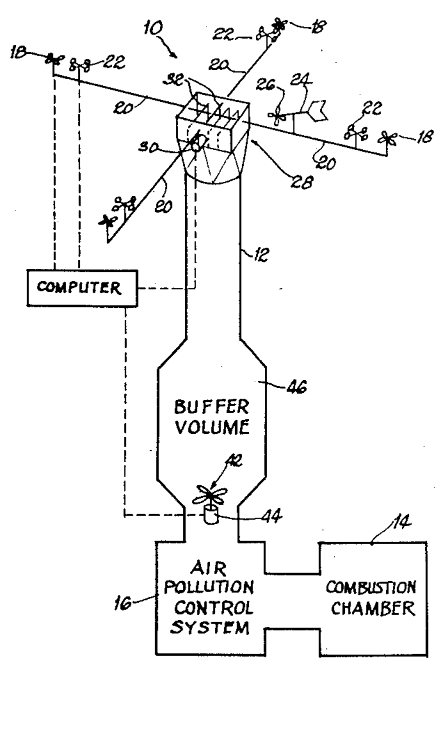
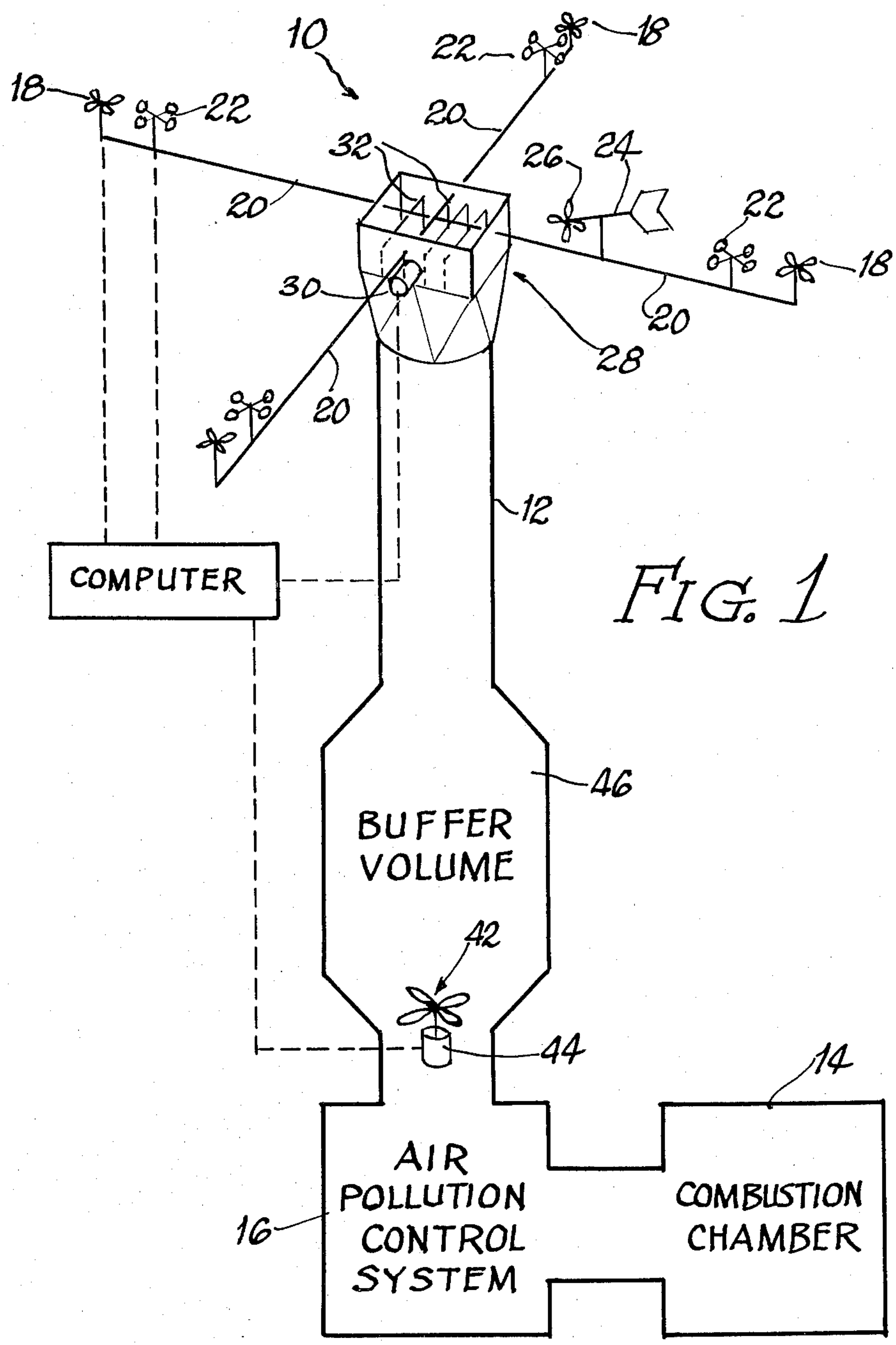
[57] **ABSTRACT**

The present invention prevents the emission of smoke, vapors or other waste gaseous products from a smokestack, chimney, flue or the like when downdraft winds would be likely to carry the smoke or the like downwardly to the ground level in the area near the stack. One or more vertical wind sensors are provided on or near the top of the stack. Such sensors may include various propellers, anemometers, and wind vanes with vertical as well as horizontal swinging movement. A valve mechanism is employed to close the top of the stack when such vertical wind sensors detect a downward wind direction or a downward component of wind speed exceeding a predetermined magnitude. The signals from the wind sensors are fed to a computer or other control device, which controls the power operating means for the valve mechanism. Preferably, horizontal wind sensors are also provided and are connected to the computer, which is then arranged so that the valve mechanism will be closed when the ratio of the vertical wind velocity to the horizontal wind velocity exceeds a predetermined magnitude. The computer also preferably controls the speed of an induced draft fan in the lower portion of the stack or in the associated duct work, so that the speed of the fan will be increased when the valve mechanism is operated to close the top of the stack. The fan thereby compresses the exhaust gases in the stack to maintain normal combustion in the associated furnace. An enlarged buffer volume is preferably provided in the stack or the associated duct work to minimize the pressure rise when the valve mechanism is closed. The computer may include a timer to open the valve mechanism after it has been closed for the maximum permissible time interval.

19 Claims, 4 Drawing Figures




10
18
22
20
32
26
24
30
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COMPUTER
46
BUFFER VOLUME
42
44
14
16
AIR POLLUTION CONTROL SYSTEM
COMBUSTION CHAMBER

FIG. 1

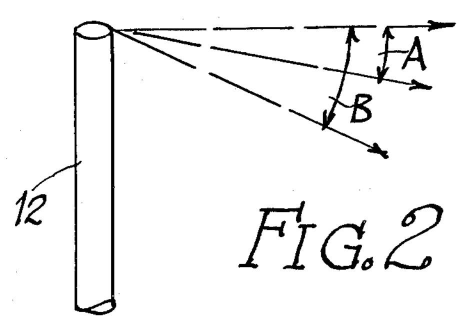
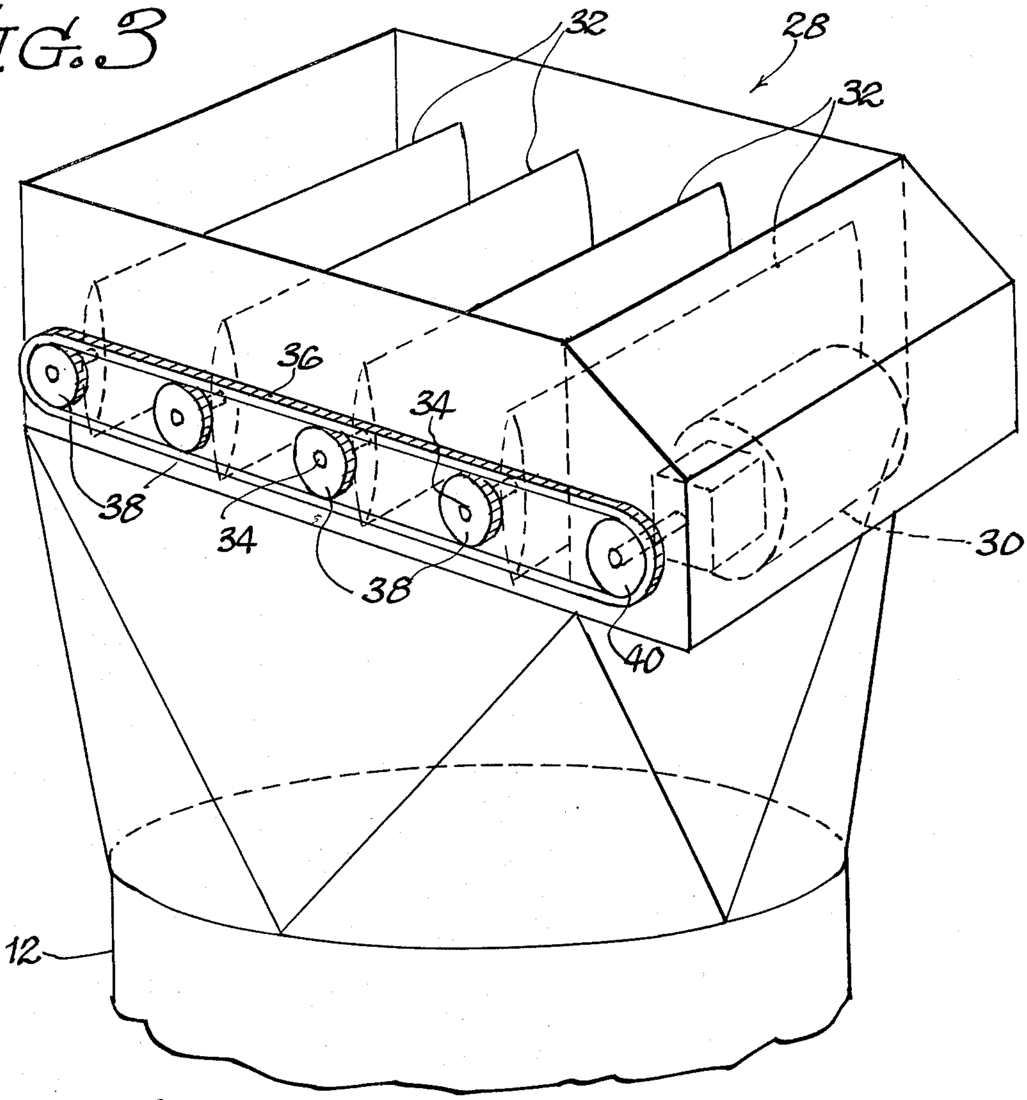

A
B
12

FIG. 2

FIG. 3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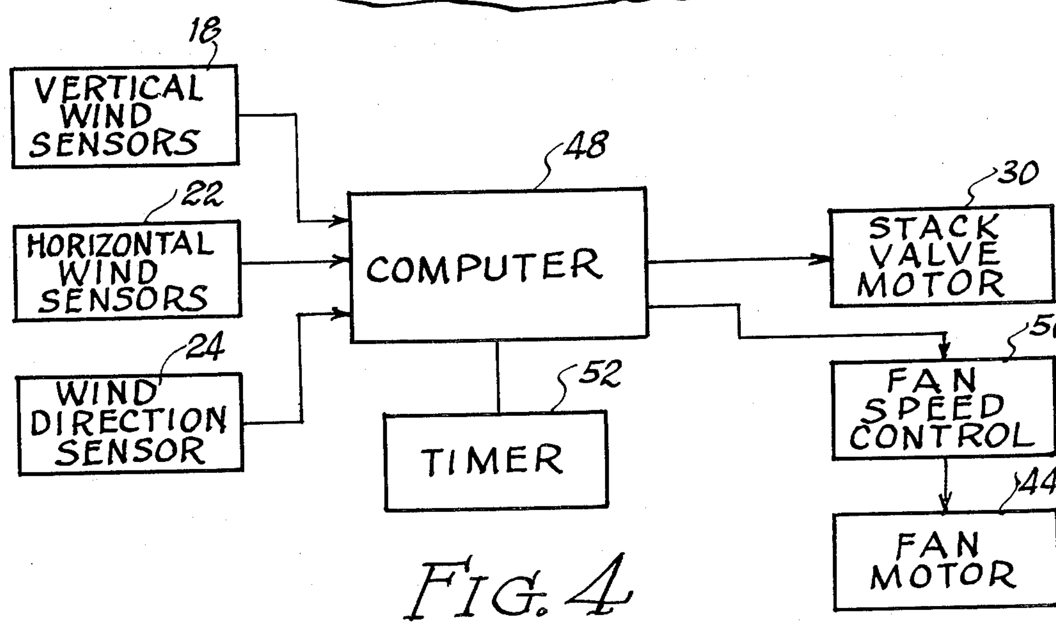
18
VERTICAL WIND SENSORS
22
HORIZONTAL WIND SENSORS
24
WIND DIRECTION SENSOR
48
COMPUTER
52
TIMER
30
STACK VALVE MOTOR
50
FAN SPEED CONTROL
44
FAN MOTOR

FIG. 4

EMISSION CONTROL METHOD AND APPARATUS FOR SMOKESTACKS OR OTHER WASTE GAS DISCHARGE STACKS

This invention relates to the control of smoke or other emissions from smokestacks or the like.

One object of the present invention is to control the emission of smoke, vapor or other combustion products from a smokestack or the like so that such combustion products will not descend to the ground level in the vicinity of the smokestack, but rather will be widely dispersed into the atmosphere.

While air pollution control equipment will virtually eliminate or at least greatly reduce the emission of visible smoke from a smokestack, the emissions from the smokestack will still contain noxious vapors and products of combustion which should be widely dispersed into the atmosphere and should not be allowed to be carried downwardly to the ground level in the vicinity of the smokestack. If the products of combustion are widely dispersed, they will not descend to the ground level to any perceptible degree and will not have any deleterious effect.

A further object of the present invention is to prevent the emission of combustion products from a smokestack when downdrafts or downward gusts of wind are present at the top of the stack.

It has been found that such downward components of wind velocity are largely responsible for carrying combustion products downwardly to the ground level in the vicinity of a smokestack. Such downward wind components are usually in the form of gusts which persist for only short time intervals. If the combustion products are not emitted from the smokestack during such downward gusts, the combustion products can be widely dispersed into the atmosphere between such gusts so that there will be little chance that the combustion products will reach the ground level in the vicinity of the smokestack.

To achieve these and other objects, the present invention preferably utilizes a new and improved method in which downward wind components are detected and preferably measured, at or near the top of the smokestack. When a downward wind gust of significant strength is detected, the smokestack is closed, preferably at the top thereof. In this way, the combustion products are retained in the smokestack. When the downward wind component no longer exists, the smokestack is again opened so that the combustion products will be widely dispersed into the atmosphere. The smokestack may be closed if the downward wind component at the top of the stack exceeds a predetermined magnitude. It is generally desirable to limit the closure of the stack to a predetermined maximum time interval.

Preferably, the horizontal wind components are also measured at or near the top of the stack. Such horizontal wind components tend to disperse the products of combustion. Thus, the downward wind component may be compared with the horizontal wind component in determining whether to close the stack. If the ratio of the downward wind component to the horizontal wind component exceeds a predetermined magnitude, the stack may be closed. Such ratio is an approximate measure of the downward angle at which the combustion products will be carried from the smokestack. If this angle is sufficiently small, the combustion products will

be widely dispersed before they can reach the ground level.

It is also preferred to measure the direction of the horizontal wind component, at or near the top of the stack. In many cases, there are certain wind directions which are more critical than other directions because such critical wind directions create situations in which the products of combustion may be carried to a nearby residential area, or some other area, where the products of combustion may be particularly objectionable. For such critical wind directions, the smokestack may be closed for downward wind components having a lower magnitude than otherwise would be the case.

When the top of the smokestack is closed, it is also preferred to increase the speed of any induced draft fan which may be used in connection with the smokestack. Such fan will then tend to maintain the normal flow of air through the combustion chamber or furnace which is served by the smokestack. The fan compresses the products of combustion into the smokestack.

It is preferred to provide an enlarged buffer volume in the smokestack or the associated duct work. By thus increasing the storage volume in the smokestack, it is possible to minimize the pressure rise due to the closure of the stack.

The system of the present invention may comprise a valve mechanism for closing the stack, preferably at the top thereof. One or more vertical wind sensors are preferably mounted on or near the top of the stack. One or more horizontal wind sensors are also preferably provided. In some cases, the system may also utilize one or more sensors for determining the direction of the horizontal wind component. The signals from these sensors may be supplied to a control device or computer, which is arranged to determine when the stack should be closed. The control device then energizes a motor which is preferably employed to operate the valve mechanism.

In one particular arrangement, the computer may be programmed to close the stack when the ratio of the downward wind component to the horizontal wind component exceeds a predetermined magnitude. When this situation no longer prevails, the computer reverses the valve motor so as to open the stack. In most cases, the stack will be closed for only several seconds because downward wind gusts are normally of short duration. However, it is possible to close the stack for several minutes without seriously affecting the combustion in the associated furnace, particularly if the stack utilizes a powerful induced draft fan and a large buffer volume.

Further objects, advantages and features of the present invention will appear from the following description, taken with the accompanying drawings, in which:

FIG. 1 is a diagrammatic perspective view showing a smokestack equipped with a control system to be described as an illustrative embodiment of the present invention.

FIG. 2 is a diagrammatic view illustrating the downward angles at which the products of combustion may be carried from the top of the stack due to downward wind components.

FIG. 3 is a somewhat diagrammatic perspective view showing illustrative details of the valve mechanism for closing the top of the stack.

FIG. 4 is a block diagram representing the illustrative control system for the stack.

As just indicated, FIG. 1 illustrates an embodiment of the present invention in the form of a control system **10** applied to a smokestack **12**. A furnace or combustion chamber **14** is connected to the stack **12**. It will be seen that an air pollution control system **16** is connected between the furnace **14** and the stack **12**. The furnace **14** and the air pollution control system **16** may be of any known or suitable construction. It will be understood that the smokestack **12** serves the purpose of dispersing the products of combustion into the atmosphere at a considerable elevation above the ground level.

The air pollution control system **16** removes almost all of the particulate matter from the products of combustion discharged by the furnace **14**. Thus, the small amount of particulate matter which goes up the stack **12** is normally insufficient to produce visible smoke. However, the stack **12** still discharges vapors and gaseous products of combustion, along with a minimal amount of particulate matter.

The stack **12** should be of sufficient height to disperse the products of combustion into the atmosphere so that they will not be noticeable or deleterious under most weather conditions. However, under certain weather conditions, downdrafts or downward wind components will occur and may be of sufficient strength to carry the products of combustion to the ground level in the vicinity of the smokestack **12**, or at least sufficiently close to the stack to be noticeable. To deal with such downdrafts, the control system **10** utilizes one or more vertical wind sensors **18**, which may be of any known or suitable type. As illustrated, the vertical wind sensors comprise propellers which are rotatable about vertical axes. However, the vertical wind sensors may be of any known or suitable types, such as hot wire or sonic anemometers.

In the illustrated arrangement, four such vertical wind sensors **18** are mounted on or near the top of the stack **12**. As shown, the vertical wind sensors **18** are mounted on horizontal supporting arms **20** which are secured to the stack **12** at or near the top thereof. The illustrated arms **20** radiate from the stack at equal angular intervals. Preferably, the supporting arms **20** are of a substantial length so that the vertical wind sensors **18** will be spaced outwardly a substantial distance from the top of the smokestack **12**. For example, the arms **20** may be approximately 50 feet in length.

It is also preferred to provide one or more horizontal wind sensors **22**, at or near the top of the stack **12**. The four illustrated horizontal wind sensors **22** are mounted on the supporting arms **20**. As illustrated, the horizontal wind sensors **22** take the form of cup anemometers rotatable about vertical axes. Horizontal wind sensors of any other known or suitable type may be employed.

It is preferred to provide one or more directional sensors **24**, at or near the top of the stack **12**, to determine the direction of the horizontal wind. One such directional sensor or indicator **24** is shown and is mounted on one of the supporting arms **20**. The directional indicator **24** may take the form of a wind vane rotatable about a vertical axis. It is possible to combine one or more of the horizontal or vertical wind sensors with the directional indicator **24**. Thus, the illustrated wind vane **24** is fitted with a propeller **26** rotatable about a horizontal axis. The propeller **26** may be employed as a horizontal wind sensor.

When a downward wind component of a sufficient magnitude is detected by one or more of the vertical wind sensors **18**, the smokestack **12** is closed so as to bring about a momentary interruption in the emission of the flue gases and other combustion products. Preferably, the stack **12** is closed at the top so that the entire volume of the stack **12** will be available to accumulate the combustion products. Thus, the illustrated stack **12** is provided with a valve mechanism **28** for closing the top of the stack. A motor **30** is preferably provided to operate the valve mechanism **28**, which may be of any known or suitable type. As shown, the valve mechanism **28** comprises a plurality of parallel vanes or flaps **32** which are swingable abut horizontal axes, between open and closed positions.

Further details of the valve mechanism **28** are shown in FIG. **3**. It will be seen that the vanes **32** are mounted on horizontal shafts **34**. A suitable drive is provided between the operating motor **30** and the shafts. As shown, such drive comprises a chain **36** which engages sprockets **38** on the vane shafts **34**. The chain **36** also engages a sprocket **40** on the shaft of the motor **30**, which may incorporate a speed reduction drive so as to operate the chain **36** at a suitable low speed. Each vane could be individually activated by its own motor. This is more expensive, but it might permit a faster response. The motor **36** may be employed for both opening and closing the vanes **32**.

The stack **12** is preferably provided with an induced draft fan **42** to draw the combustion products out of the combustion chamber **14** and to force such combustion products into the lower end of the smokestack **12**. Furnace installations are often provided with such induced draft fans. The illustrated fan **42** has an operating motor **44**.

When the stack **12** is closed by operating the valve mechanism **28**, it is preferred to increase the output of the fan **42**, preferably by increasing the speed of the fan motor **44**. In this way, the fan **42** tends to maintain the proper flow of air through the combustion chamber or furnace **14**, despite the closure of the stack **12**. The fan **42** compresses the flue gases and other products of combustion into the stack **12**.

When the stack **12** is closed, the pressure tends to build up in the stack **12** due to the continued operation of the fan **42**. The increase in the speed of the fan tends to increase the pressure rise in the stack **12**. To minimize the pressure rise or build up in the stack **12**, it is preferred to provide an enlarged buffer volume **46** in the lower portion of the stack **12**, or in the duct work connected to the lower end of the stack. If desired, the buffer volume **46** may be employed to house air pollution control equipment.

As shown in FIG. **4**, the vertical wind sensors **18** are preferably connected to a computer or control device **48**, which controls the operation of the valve motor **30**. The output of each vertical wind sensor **18** is preferably in the form of an electrical signal which varies in magnitude in accordance with the velocity of the vertical wind component. Such signal may also change polarity in accordance with the direction of the vertical wind component.

Normally, the computer **48** is programmed so that it causes the valve motor **30** to close the valve mechanism **28** when the vertical wind sensors **18** detect downward wind components of sufficient velocity to impose a substantial threat that the products of combustion will be carried downwardly to the ground level in the vicinity of the smokestack. The computer **48** controls the operation of the valve motor **30** in both directions, for opening as well as closing the valve **28**. When the downward wind component ceases or diminishes below the threatening level, the computer **48** causes the valve motor **30** to open the valve mechanism **28.** In this way, the accumulated products of combustion will be widely dispersed into the atmosphere in the absence of downward wind components of a substantial magnitude.

The horizontal wind sensors **22** and the wind direction sensor **24** are also preferably connected to the computer control device **48.** The outputs of all of the sensors **18, 22** and **24** are preferably in the form of electrical signals which represent the wind velocity components and the wind direction. The computer **48** may readily be arranged to respond to such electrical signals.

There is usually a horizontal wind component at the top of the stack whenever there is a downward wind component. The horizontal wind component is favorable in that it carries the combustion products away from the smokestack so that they will be dispersed more rapidly into the atmosphere. On the other hand, the downward wind component is unfavorable in that it tends to carry the products of combustion to the ground level before they are sufficiently dispersed into the atmosphere.

Thus, the computer **48** is preferably programmed or arranged to compare the downward wind component with the horizontal wind component. If the ratio of the downward wind component to the horizontal wind component is of a sufficient magnitude, the computer **48** causes the valve motor **30** to close the valve mechanism **28** so that the combustion products will be retained momentarily in the stack **12.**

When the wind has both downward and horizontal components, the wind is directed downwardly at an angle to the horizontal, such as the angle A, as shown in FIG. **2.** If such angle is small, the products of combustion will be widely dispersed before they can reach the ground level. Thus, there is no need to close the smokestack **12.** However, if the downward angle of the wind exceeds a larger angle B, as shown in FIG. **2,** the combustion products may be carried to the ground level so as to be noticeable in the vicinity of the smokestack **12.** Thus, the computer **48** may be programmed so as to close the stack **12** when the downward angle of the wind exceeds the angle B. The ratio of the downward wind component to the horizontal wind component is a measure of the downward angle of the wind. For small angles, the downward angle, expressed in radians, is approximately equal to such ratio.

In addition to controlling the valve motor **30,** the computer **48** is also preferably arranged to control the speed of the motor **44** which operates the induced draft fan **42.** The motor **44** may be provided with a speed control device **50** which is connected to the computer **48.** When the computer **48** operates the valve motor **30** to close the valve **28,** the computer also preferably sends a control signal to the speed control device **50** so as to increase the speed of the fan motor **44.** When the computer **48** causes the valve motor **30** to open the valve **28,** the speed control device **50** is caused to reduce the speed of the fan motor **44** to its normal value.

In almost all instances, downward wind components are of short duration, amounting to less than 1 minute, for example. The stack can be closed for such short intervals without causing any serious problem in the operation of the combustion chamber **14.** If the buffer volume **46** is made of adequate size, and if the induced draft fan **42** and its driving motor **44** are adequately large, the smokestack can be closed for several minutes without interfering seriously with the operation of the combustion chamber **14.**

If desired, however, the computer **48** may be provided with a timer **52** which will limit the maximum time interval during which the stack **12** will be closed. Such time interval should be chosen to coincide with the maximum permissible time during which the stack can be closed without creating a safety hazard or causing some other deleterious effect. If some particular downward wind component persists beyond the maximum time interval determined by the setting of the timer **52,** the computer **48** will open the valve **28** so as to permit the combustion products to escape from the stack **12.** Most frequently, the downward wind components will persist for less than 30 seconds and the stack will be closed for corresponding short time intervals so that the timer **52** will not come into play. Other safety devices may be connected to the computer **48,** if desired. A photocell and lamp which measure the transparency of the plume inside the stack may be used to control combustion parameters, i.e. soot would indicate that insufficient air is available for combustion. Spectral transmission might also be incorporated to measure NO_x which would suggest that less air should be blown into the flame. Some of these sensors are already in use, but the computer would enable them to activate appropriate controls on the furnace.

The pressure rise ΔP in the stack **12,** due to the closure of the valve **28,** may be presented by the following equation:

$$\Delta P = A\ P\ S\ t/V$$

In this equation, A is the throat area at the fan **42;** P is the ambient pressure, which is approximately one atmosphere; S is the velocity or speed of the gases at the fan throat for optimal combustion; t is the time interval during which the stack valve **28** is closed; and V is the volume within the stack **12** and the buffer chamber **46.**

It will be evident that the pressure rise ΔP may be minimized by increasing the buffer volume V. If the buffer volume V is large, and if the fan is sufficiently powerful to develop a substantial pressure increment in the stack, the closure of the stack may be maintained for a substantial time interval without causing any substantial decrease in the velocity or speed of the combustion products out of the furnace. Such velocity corresponds to the velocity of the air into the furnace so that satisfactory combustion can be maintained despite the closure of the stack.

The method and apparatus of the present invention constitute a useful and highly advantageous adjunct to air pollution control systems as applied to furnace installations utilizing smokestacks or chimneys. The present invention minimizes the possibility that the residual products of combustion, after being purified by the air pollution control system, will be carried downwardly to the ground level by downward wind gusts. Thus, the present invention largely prevents the residual combustion products from being noticeable at the ground level. In particular, the area in the immediate vicinity of the smokestack is protected from any perceptible impact due to the residual products of combustion.

By utilizing the present invention, it may often be possible to utilize a smokestack of less height than would otherwise be possible, while still preventing the combustion products from reaching the ground level to any noticeable extent in the vicinity of the smokestack.

Thus, the high cost of constructing tall smokestacks can be reduced to an extent more than sufficient to offset the cost of implementing the present invention. At the same time, the other advantages of shorter smokestacks can be realized, such as less hazard to aviation.

It will be understood that any known or suitable types of wind sensors may be employed to detect the vertical and horizontal components of wind speed and direction. Thus, for example, the vertical and horizontal wind sensors may be combined in the form of universal wind vanes, similar to the wind vane **24** but having provision for both vertical and horizontal swinging movement. Such a universal wind vane is swingable about a vertical axis so that the wind vane will line up with the horizontal wind direction, and also about a horizontal axis so that the wind vane will line up with the vertical wind direction. The universal wind vane may include a propeller to indicate the wind speed.

The valve to close the stack may also be of any known or suitable construction. Thus, for example, the valve may be of the type utilizing one or more horizontal vanes rotatable about a vertical axis to open and close corresponding openings. Various gate or damper valves may also be employed.

We claim:

1. A method of controlling the waste emissions from a waste gas discharge stack,

comprising the steps of measuring downwardly directed wind components in the neighborhood of the top of the stack,

and closing the stack to prevent the discharge of waste emissions therefrom when a downward wind component exceeding a predetermined magnitude is measured,

the stack being opened in the absence of a downward wind component, exceeding said predetermined magnitude,

the stack being kept open in the absence of a downward wind component exceeding said predetermined magnitude regardless of the presence or absence of horizontal wind components in the neighborhood of the top of the stack.

2. A method according to claim **1**, in which the stack is closed at the top thereof to retain the waste emissions therein.

3. A method according to claim **1**, in which any horizontal wind component is also measured,

said stack being closed when the ratio of the downward vertical wind component to the horizontal wind component exceeds a predetermined magnitude.

4. A method according to claim **1**,

the horizontal wind direction also being measured in the vicinity of the stack,

the predetermined magnitude of the downward vertical wind component at which the stack is closed being varied in accordance with the wind direction so that the stack will be closed for a lower wind component as to any horizontal wind direction which is particularly critical.

5. A method of controlling the waste emissions from a waste gas discharge stack

comprising the steps of detecting downwardly directed wind components in the neighborhood of the top of the stack,

and closing the stack to prevent the discharge of waste emissions therefrom when a downward wind component is detected,

the stack being opened when there is no longer a downward wind component,

the stack utilizing an induced draft fan,

the speed of such fan being increased whenever the stack is closed whereby the fan maintains the draft despite the closure of the stack.

6. Apparatus for controlling waste emissions from a waste gas discharge stack

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting a downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when a downward vertical wind component is detected by said sensor means,

said control means comprising means for causing said valve means to open the stack in the absence of such downward vertical wind component regardless of the presence or absence of a horizontal wind component in the vicinity of the stack.

7. Apparatus according to claim **6**,

in which said sensor means includes means for measuring the downward wind velocity,

said control means including means for closing said valve means when said sensor means indicates the presence of a downward wind component exceeding a predetermined magnitude.

8. Apparatus according to claim **6**,

in which the stack includes an enlarged buffer volume to reduce the pressure buildup in the stack when it is closed by said valve means.

9. Apparatus according to claim **6**,

in which said valve means is disposed at the top of the stack to retain the waste emissions therein when said valve means is closed.

10. Apparatus according to claim **6**,

in which said sensor means includes a universal wind vane swingable both vertically and horizontally.

11. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting any downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when any substantial downward vertical wind component is detected by said sensor means,

said sensor means including means for measuring the downward wind component,

said apparatus also including means for measuring any horizontal wind component in the vicinity of the stack,

said control means including means for closing the stack when the ratio of the downward wind component to the horizontal wind component exceeds a predetermined magnitude.

12. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting any downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when any substantial downward vertical wind component is detected by said sensor means,

said sensor means including means for measuring the downward wind component,

said apparatus also including means for measuring the direction of any horizontal wind component in the vicinity of the stack,

said control means including means for closing the stack when the downward wind component exceeds a magnitude which is a function of the wind direction,

the stack being closed at a lower magnitude of the downward wind component for any wind direction which is particularly critical.

13. Apparatus for controlling waste emissions from a waste gas discharge stack

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting a downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when a downward vertical wind component is detected by said sensor means,

the stack utilizing an induced draft fan,

said control means including means for increasing the output of said fan when the stack is closed by said valve means whereby the fan maintains the draft despite the closure of the stack.

14. Apparatus for controlling waste emissions from a waste gas discharge stack

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting a downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when a downward vertical wind component is detected by said sensor means,

the stack utilizing an induced draft fan,

said control means including means for increasing the speed of the fan when the stack is closed by said valve means whereby said fan maintains the draft despite the closure of the stack.

15. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting a downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when a downward vertical wind component is detected by said sensor means,

the stack utilizing an induced draft fan,

said control means including means for increasing the speed of the fan when the stack is closed by said valve means whereby the fan maintains the draft despite the closure of the stack,

said stack including a buffer volume to minimize the buildup of pressure due to the closing of the stack and the speeding up of the fan.

16. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting any downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when any substantial downward vertical wind component is detected by said sensor means,

said control means including timer means for opening said valve means to vent the stack after said valve means has been closed for a predetermined time considered to be the maximum permissible interval of closure.

17. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting a downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when a downward vertical wind component is detected by said sensor means,

said valve means including a plurality of movable damper vanes for closing the stack,

and motor means for moving said vanes between open and closed positions.

18. Apparatus for controlling waste emissions from a waste gas discharge stack,

comprising valve means for selectively closing the stack to prevent the discharge of waste emissions therefrom,

vertical wind sensor means for detecting any downward vertical wind component in the vicinity of the stack,

and control means for operating said valve means to close the stack when any substantial downward vertical wind component is detected by said sensor means,

said vertical wind sensor means including means for measuring the vertical wind component,

said apparatus also including horizontal wind sensor means for measuring any horizontal wind component in the vicinity of the stack,

said control means including means for closing said valve means when the vertical wind component exceeds a predetermined magnitude in relation to the horizontal wind component,

the stack utilizing an induced draft fan,

said control means including means for increasing the speed of said fan when said valve means is closed whereby the fan maintains the draft despite closure of said valve means.

19. Apparatus according to claim **18**,

in which the stack includes an enlarged buffer volume for minimizing the buildup of pressure in the stack when the valve means is closed.

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