Nov. 11, 1969 B. O. HOWARD 3,477,358

INSPIRATOR VENTILATOR

Filed Dec. 21, 1967

FIG. 1.

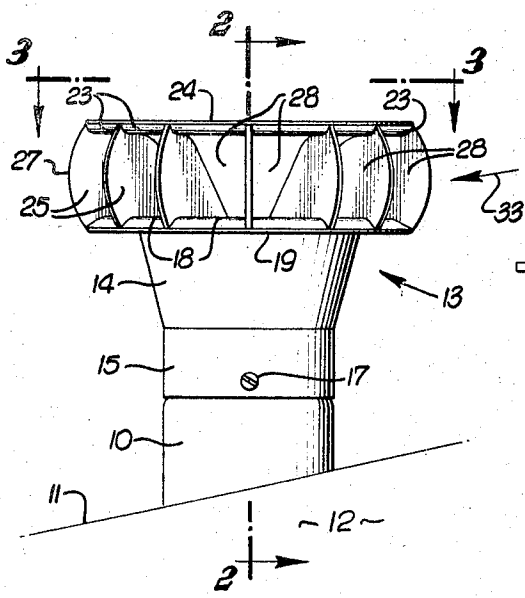


FIG. 4.

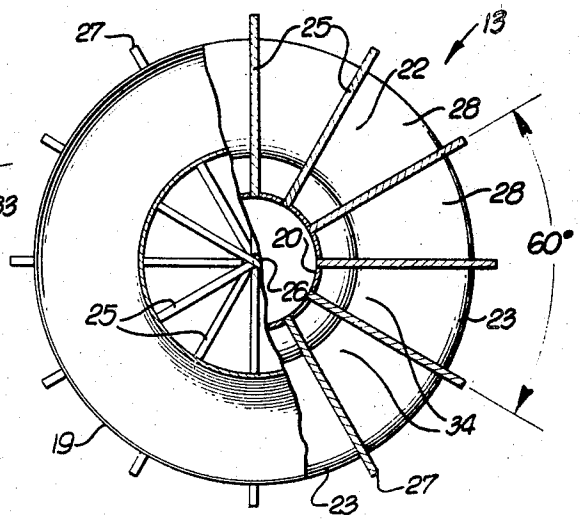


FIG. 3.

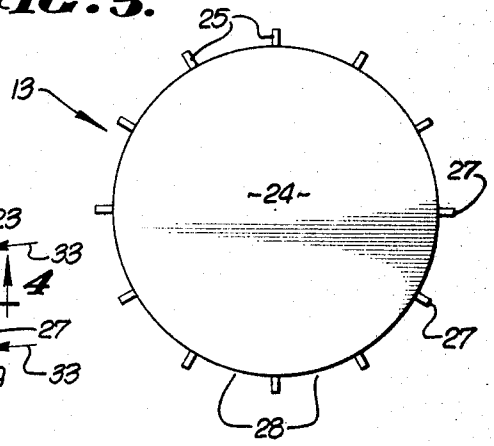
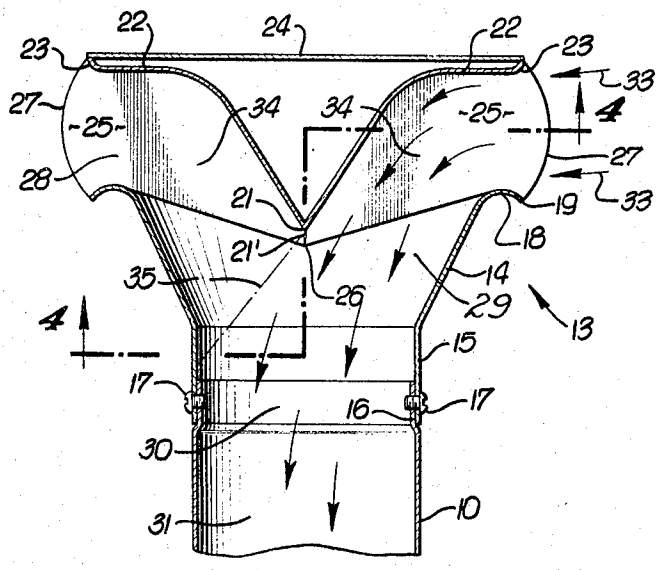


FIG. 2.



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INSPIRATOR VENTILATOR

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ABSTRACT OF THE DISCLOSURE

The invention involves a stationary type ventilator of such character that when air impinges upon it, the air will be directed inwardly and downwardly into an appropriate chamber to be ventilated, in a path of flow such that there will be no appreciable flow outwardly. The invention makes use of a ventilator apparatus on the top of a vent pipe which is substantially symmetrical throughout the entire circumference, there being provided an inlet area at the outermost circumference subdivided by baffles into a multiplicity of separate channels, the interior of the stationary portion being specially formed to deflect air from the windward side downwardly into a passage, the shape and capacity of which is one encouraging the continued downward flow of air in such manner that the down-flowing air serves as a fluidic valve to cut off flow outwardly on the downwind side of the device. Inasmuch as the device is symmetrical, this effect will prevail irrespective of from which direction air impinges upon the device.

Although in the past there have been many varieties of ventilators the main purpose of which has been to draw air outwardly from a chamber to be vented in response to the action of air in motion passing over the exterior surface, there have been relatively few inspirator or injector type ventilators. In all probability the most typical of the inspirator type ventilators consist of cowlings or vents on shipboard where large funnels are rotated, on occasions into the wind, to catch the wind and direct it downwardly into chambers below deck which are to be ventilated. These funnel type injectors have not been popular for stationary objects because they are capable of functioning with an airflow in one direction only and whenever there is a change in the direction of airflow such devices will no longer act as inspirator or injector ventilators. On those rare occasions where injector or inspirator ventilators have been made adjustable in order to accommodate different directions of airflow, the adjustment is one frequently requiring constant attention, and even if somewhat automatic in nature, has the defects of requiring an assortment of moving parts. Such inspirator ventilators as have been claimed to be omnidirectional either are not in fact omnidirectional or operate so poorly as to be of negligible value. None make use of a fluidic valve in the throat structure.

It is therefore among the objects of the invention to provide a new and improved inspirator ventilator of unitary construction which is stationary and, more particularly, which is omnidirectional in its operation.

Another object of the invention is to provide an inspirator type ventilator, all of the parts of which are fixed in position, and which when responsive to air flowing in any one particular direction serves always to act as an inspirator ventilator and to bar the air from flowing outwardly on the opposite or downwind side.

Still another object of the invention is to provide a new and improved stationary type omnidirectional inspirator ventilator, wherein there are no moving parts, wherein the device will function with equal success irrespective of from which compass direction air impinges upon it, and which is of simple construction and positive in its action when in operation.

With these and other objects in view, the invention consists in the construction, arrangement and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims and illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a side elevational view of the device mounted upon an appropriate surface.

FIGURE 2 is a longitudinal sectional view on the line 2—2 in FIGURE 1.

FIGURE 3 is a plan view on the line 3—3 of FIGURE 1.

FIGURE 4 is a cross-sectional view on the line 4—4 of FIGURE 2.

In an embodiment of the invention chosen for the purpose of illustration there is shown a flue pipe **10** mounted above a surface **11** beneath which is a chamber **12** of some appropriate kind into which air is to be inspirated. Above, and mounted upon the flue pipe **10**, is a housing indicated generally by the reference character **13** and consisting of a lower frusto-conical section **14** joining at its lower end a cylindrical section **15** which is attached to a reduced portion **16** of the flue pipe **10** by means of screws **17**.

At the upper end of the frusto-conical section **14**, namely the wide portion as readily viewed in FIGURE 2, there is an annular rounded entrance portion **18**, at the outer circumferential edge of which is an annular flared leading edge **19**.

Located above the frusto-conical portion **14** is an inverted conical portion **20**, an apex **21** of which points downwardly at the axial centerline of the housing **13** and the flue pipe **10**. Around the perimeter of the large or upper end of the inverted conical portion is an annular flat section **22** terminating at its circumference in an annular flared leading edge **23**. The flared leading edges **19** and **23** are in substantial vertical alignment with each other and spaced from each other as shown. A circular plate **24** may be applied to the upper sides of the flared leading edge **23**, covering the conical shape within the inverted conical portion **20**.

Spaced circumferentially around the interior of the housing **13** is a series of dividers or dividing baffles **25**. The dividers are in engagement at their upper edges with the exterior of the inverted conical portion **20**, the flange section **22** and the flared leading edge **23**. The lower edges of the dividers **25** are in engagement near their outer ends with the annular rounded entrance portion **18** and flared leading edge **19** of the frusto-conical section **14**. The dividers in the embodiment shown serve also structurally as a means of connecting the inverted conical portion with the frusto-conical section and spacing them at the desired distance apart. The dividers **25** at their inner ends may be joined at the location **26**. It will also be significant that the dividers are provided with protrud-

ing rounded edges **27** which extend outwardly beyond the circumferences of the leading edges **19** and **23**.

In the device described the structure and proportions are made such that there is provided a series of inflow openings **28** of equal proportion and area which together may be described as providing an inflow port. The inflow openings communicate with an inflow passage **29** which is connected to what may be appropriately described as an injector flow port **30**, immediately adjacent the interior passage **31** of the flue pipe **10**.

In operation the device is customarily stationarily mounted upon such location as the surface **11**, and the flue pipe **10** is connected to an appropriate chamber **12** located some distance below, depending upon a variety of structural circumstances. If it be assumed for the purpose of illustration that wind is blowing from right to left, and in a slightly downward direction as suggested by the arrow **33**, there will be an abundance of air impressed upon the series of inflow openings **28** throughout a horizontal segment of 60° more or less, i.e. 30° either side of center, wherein the air may be said to maintain a high pressure impact. For the remaining 150° on each side aggregating 300°, including the ports **28** next to the 60° segment, air flowing at an accelerated rate, as it does because of the rounded contour of the device, will tend to cause a reduction in pressure which in turn will tend to draw out such air as has entered through the windward 60° segment, unless it is prevented from doing so by fluidic valve action.

In putting this invention to practice, what has been referred to as a fluidic valve is made use of to divert the air entering the device through the windward inflow openings **28**, regardless of the direction the wind is blowing, directly into the ventilating flue pipe **10** and to provide appropriate resistance to its escape through the rearward or downwind openings **28**. To accomplish this effect the entering air is ducted into the device through passages of such size and in such a manner as to change its direction to that of the ventilating flue pipe with a minimum loss of kinetic energy and velocity pressure. Exhaustive wind tunnel tests of this device confirm these losses to be less than 50% of the velocity pressure with zero ventilating flow and less than 50% of flow with zero back pressure when the volume of ventilating flow is equated to the area of the windward 60° segment of the inflow openings and the velocity of the wind.

If the flow of air on the exterior windward side is slightly downward as shown by the arrow **33**, air will be caught by the lower flared leading edge **19** and redirected into the inflow port. The flared leading edges assist in this redirection when the flow of air on the exterior may be from an angle slightly above or slightly below as well as substantially horizontal, the flared leading edges thereby functionally gathering the air from slightly above or below a horizontal direction. They also serve specifically to prevent "spoiler action" which may take place concurrently with air flowing over what may be considered sharp edges or lips on the exterior of the housing. For roof surfaces pitched at greater angles it may be preferable to mount the device so that its axis is perpendicular to the surface over which air normally flows in a direction parallel to it.

The effective cross-sectional areas of ducts **34** which are immediately downstream of the inflow openings **28** are such that they increase the velocity of the air stream while maintaining its kinetic energy of flow, thereby directing the air stream to inner portions of these ducts **34** defined by the frusto-conical section **14**, namely the inflow passage **29**. This condition prevails as the air stream passes through the injector port **30** and into the interior **31** of the flue pipe **10**, this being with the minimum of loss of static pressure past a "fluidic valve" **35**. The fluidic valve **35** has been depicted by a broken line extending in an oblique direction from a location adjacent the apex **21'** of the junction of the baffles **25** of the conical portion **20** downwardly past the small end of the frusto-conical section **14**.

Air entering the ducts **34** which face the windward high pressure 60° segment proceeds downwardly at high velocity into the inflow passage **29** and will upon entering the inflow passage **29** produce a marked pressure drop at the termination of other ducts **34** immediately adjacent. This will encourage additional inflow through these adjacent ducts, the total force and mass of which will generate an air stream whose cross-sectional area is substantially equal to the cross-sectional area of the interior passage **31** in the flue pipe **10**. That way the air stream is injected into the flue pipe with a minimum of loss into the downwind ducts. This is another approach to a description of what has previously been referred to as a "fluidic valve."

Although the air has been described as flowing from right to left in a slightly downward direction, it will be apparent that, inasmuch as the device is symmetrical throughout its entire circumference, the same effect will be achieved irrespective of from which compass direction air may be approaching.

Further still, under circumstances where the dividers **25** extend outwardly as defined by the rounded edges **27**, they serve to reduce air velocity around the effective periphery of the device, thereby to appreciably reduce the pressure drop tendencies in the vicinity of the lateral and downwind openings.

As shown and described, therefore, by the creation of the fluidic valve effect, the action of the device is such as to always produce an inspirator or injector effect and to eliminate any aspirating effect which might take place were it not for the size, capacity and contour of the ducts **34**.

While the invention has herein been shown and described in what is conceived to be practical and effective embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having described the invention, what is claimed as new in support of Letters Patent is:

1. A stationary type omnidirectional injector ventilator device for injecting air into a flue passage comprising a hollow body having an injector port section adapted to be mounted on said flue passage, vertically spaced upper and lower obliquely disposed annular walls in fixed position defining a clear annular inflow passage, respective edge sections of said walls being spaced from each other and defining an inflow port in communication with said inflow passage, said upper annular wall having a substantially conical shape with the apex portion thereof extending downwardly into said passage, said lower annular wall having a substantially frusto-conical shape, and a series of circumferentially spaced longitudinally extending divider baffles having respective upper and lower edges connected respectively to said upper and lower annular walls and extending from said inflow port to a junction adjacent the apex of said upper annular wall, said divider and adjoining portions of the upper and lower walls on one horizontal side of the device adapted to face wind defining an air flow path traversing the clear annular inflow passage in a direction transverse to a similarly defined air flow path on the opposite side of the device which is then facing away from the wind, whereby air flows into said inflow port at substantially full effectiveness throughout an arcuate distance on the windward side of about 60° and travels through said inflow passage to and through said injector flow port and substantially avoids a change in direction and expiration of air outwardly on the leeward side of said device.

2. An injector ventilator device according to claim **1** wherein the cross-sectional area of said inflow passage is one of size progressively diminishing to a point substantially midway between said inflow port and said injector port.

3. An injector ventilator device according to claim 1 wherein said respective edge sections of said walls have an outward flare away from the central portion of said inflow port.

4. An injector ventilator device according to claim 1 wherein the cross-sectional area of said injector port is not greater than about the area of the portion of said inflow port comprehended within a horizontal angle of about 60°.

5. An injector ventilator device according to claim 1 wherein said divider baffles have leading edges protruding radially outwardly beyond the edge sections of said annular walls.

6. An injector ventilator device according to claim 2 wherein air at an increased velocity through said inflow passage provides a fluidic valve barrier substantially impeding outflow of air through ports on the downwind side.

7. An injector ventilator device according to claim 2 wherein the areas respectively of said inflow port and said injector port are substantially equal.

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U.S. Cl. X.R.

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